Solar Energy Australia

Guardian Lithium-ion Battery System

Installation and Operation Manual

374-1601X2

Contents

INTRODUCTION

Solar Energy Australia's Guardian Series is a family of pre-wired battery systems for On grid, Off grid and hybrid applications. Designed and manufactured in Australia, with solar installers in mind, the Guardian Series smart lithium-ion battery system provides reliable backup power for residential, and commercial & industrial (C&I) applications.

The Guardian Series brings to the Australia marked tried and tested lithium ion battery technology from Polarium, a Swedish-based global leader in energy storage. These battery modules have stood the test of time in some of the most demanding Australian applications including remote telecommunications and critical infrastructure installations across Australia.

Document Description

This document details safety, transportation, installation, commissioning, operation, troubleshooting, maintenance, and disposal of the SEA Guardian series of lithium-ion pre-assembled battery systems: Guardian 26, Guardian 38, and Guardian 50.

Symbols

Throughout this document following symbols are used to identify hazards related to battery systems and their installation. Pay particular attention to sections identified in this way.

Caution

Warning

Danger

The following safety symbols are used in this document and are marked on equipment. Please obey these symbols.

	Refer to instruction manual / booklet		No open flame		Keep away from children
	General warning		Warning: Electricity hazard		Warning: Flammable material
	Warning: Battery fire hazard		Warning: Heavy object.		Please recycle

SAFETY

User Guide

Installers and owners are responsible for reading, understanding and familiarizing themselves with all sections of this manual. Installers must follow all safety and installation requirements specified in this document.

This document is an integral part of the Guardian battery system. Keep it in a convenient dry place for future reference.

Qualifications

All installation, commissioning and maintenance of the Guardian battery system and power system design and installation incorporating a Guardian battery system must only be performed by a suitably qualified and experienced installer as required by Australian federal, state and territory regulations. It is recommended that this work be performed by CEC-accredited battery storage and/or stand-alone (off-grid) installers and designers.

Intended Use

The Guardian battery system is for residential and commercial energy storage (on-grid) and stand-alone (off-grid) applications.

The Guardian battery system must only be used as stationary equipment.

The Guardian battery system is suitable for indoor applications only.

The Guardian battery system must be operated only with compatible power conversion equipment (PCE). Refer to PCE Compatibility. Use of PCE not listed must be approved in writing by Solar Energy Australia.

The Guardian battery system must not be used to power life-sustaining medical devices.

Basic Safety

Lithium-ion batteries can be dangerous if they are not handled correctly. The below precautions must always be followed.

- Do not expose the battery system to temperatures greater than 50°C or less than 0°C when charging, and greater than 60°C or less than -20°C when discharging or idling.
- Do not place the battery system near any heat sources, flammable material, open flames, or sources of ignition.

- Place the battery system in a secure location away from children and animals.

- Do not expose battery modules or the battery system to moisture or liquids.
- Do not install the battery system where it can become wet.
- The battery system must not be exposed to direct sunlight.
- Do not expose battery modules or the battery system to strong impacts.
- Do not crush or puncture battery modules.
- Battery modules are non-user serviceable and have no maintainable components. They must not be disassembled or opened for repair.

- Do not short circuit a battery module or the battery system terminals or connect with reverse polarity.

Handling

- Battery modules are heavy and there is a risk of injury if they are lifted incorrectly or dropped while being transported.
- The battery module is a 2-person lift.

- Correct and proper lifting techniques and/or equipment must be applied when moving and installing battery modules and the Guardian battery system. Follow workplace health and safety regulations.
- Do not install a battery module if it appears damaged in any way.
- Avoid touching metal components including but not limited to busbars, terminals, lugs or exposed electrical conductors.

Damaged Battery Module / First Aid Measures

Do not use a battery module if it has been damaged. Contact Solar Energy Australia.

Refer to Safety Data Sheet – Polarium Battery Cells and Modules[1]. A copy of this document is available for download from Solar Energy Australia's website.

First aid measures

The hazardous components of the cells within each battery module are contained within a sealed unit. The following measures are only applicable if exposure has occurred to components when a cell or battery module leaks, is exposed to high temperature or is mechanically, electrically, or physically abused / damaged. The hazardous contents are caustic alkaline electrolytes contained in these cells. Undamaged closed cells do not represent a danger to health.

- Ingestion: Rinse mouth thoroughly with water. Do not induce vomiting. Quickly transport to an emergency care facility.
- Eye contact: If eye contact with an open cell occurs, immediately flush the contaminated eye(s) with water. Quickly transport to an emergency care facility.
- Skin Contact: Immediately flush with water. If irritation or pain persists, seek medical attention.
- Inhalation: Remove the patient from exposure into fresh air. Seek medical attention.

Protection for first aiders

Do not enter corrosive vapor containment areas without a respirator or self-contained breathing apparatus. Wear adequate personal protective equipment as indicated in the Safety Data Sheet Chapter 8.[2]

First aid facilities

Eye wash bottle, fountain, safety showers or at least a source of running water are required in the area where the product is used.

Most important symptoms & effects, acute & delayed, caused by exposure

- Acute: The contents of battery modules are rated as corrosive. Ingestion of the electrolyte could lead to severe gastrointestinal tract irritation with nausea, vomiting and potentially burns. Inhalation of vapours may lead to severe irritation of the mouth and upper respiratory tract with a burning sensation, pain, burns and inflammation in the nose and throat; there may also be coughing or difficulty breathing. Eye contact may lead to severe eye irritation or in worst case scenario

[1] Henrik Lundgren. "Polarium Safety Data Sheet." §4.
[2] Henrik Lundgren. "Polarium Safety Data Sheet." §8.

irreversible damage and possible eye burns. Skin contact may lead to irritation and possible skin burns.

- Chronic: Skin contact may aggravate/exacerbate skin conditions, such as dermatitis. Chronic inhalation may lead to the same symptoms as listed for acute inhalation above.

Indication of any immediate medical attention and special treatment needed

- Advice to doctor: Treat symptomatically if the person comes into contact with the corrosive electrolyte liquid contents of a damaged battery cell or module.

Risk of Fire

Do not disassemble battery modules.

Do not intentionally short circuit a battery module.

Do not expose a battery module to fire or temperatures higher than 70°C (158°F) under any conditions. High temperature may cause the battery module to overheat.

Immediately shutdown a battery module (refer to Shutdown Procedure) if, during operation the battery module appears to heat up rapidly or in any way feels abnormally hot, 60°C (140°F) or greater, or appears abnormal in any way.

Fire Fighting Measures

Refer to Safety Data Sheet – Polarium Battery Cells and Modules.[3] A copy of this document is available for download from Solar Energy Australia's website.

Ventilate the room and vacate if smoke or gases are present.

Suitable extinguishing media

Cold water and dry powder in a large amount are suitable. A standard ABC dry chemical fire extinguisher, carbon dioxide extinguisher, or a foam extinguisher may be used.

The lithium-ion cells used in the Guardian battery system contain a flammable liquid electrolyte, A fire involving these batteries is a Class B fire.

Special hazards

A damaged cell may form hydrofluoric acid if its electrolyte comes into contact with water. In case of fire, the following flue gases may be produced: Hydrogen fluoride (HF), Carbon monoxide (CO) and Carbon dioxide (CO_2).

Protective equipment and precautions for firefighters

Firefighters should wear a protective suit and self-contained breathing apparatus.

[3] Henrik Lundgren. "Polarium Safety Data Sheet." §5.

Transport

Solar Energy Australia's / Polarium's lithium-ion battery modules are classified as Dangerous Goods (DG), UN3480, transport hazard Class 9. They are approved for transport in Australia per this classification.

Battery modules are packed individually in packaging dedicated for transportation (UN Certified package for Transport of Dangerous Goods). Battery modules must be shipped individually in this original packaging. Do not ship battery modules loose or pre-installed in the Guardian system enclosure. Keep battery modules in this packaging until installation.

This packaging is designed for transportation in weather-protected environments. Do not expose to rain, excessive heat, vibration or sudden impacts. Do not transport on open flat decks.

When transporting battery modules, handle them in accordance with specific markings on the packaging such as regarding packaging position and stacking.

Battery modules are shipped in a partially discharged state with terminal protection and the circuit breaker off.

The Guardian system enclosure is shipped without battery modules installed in its own palletised wooden enclosure.

Product Description

Overview

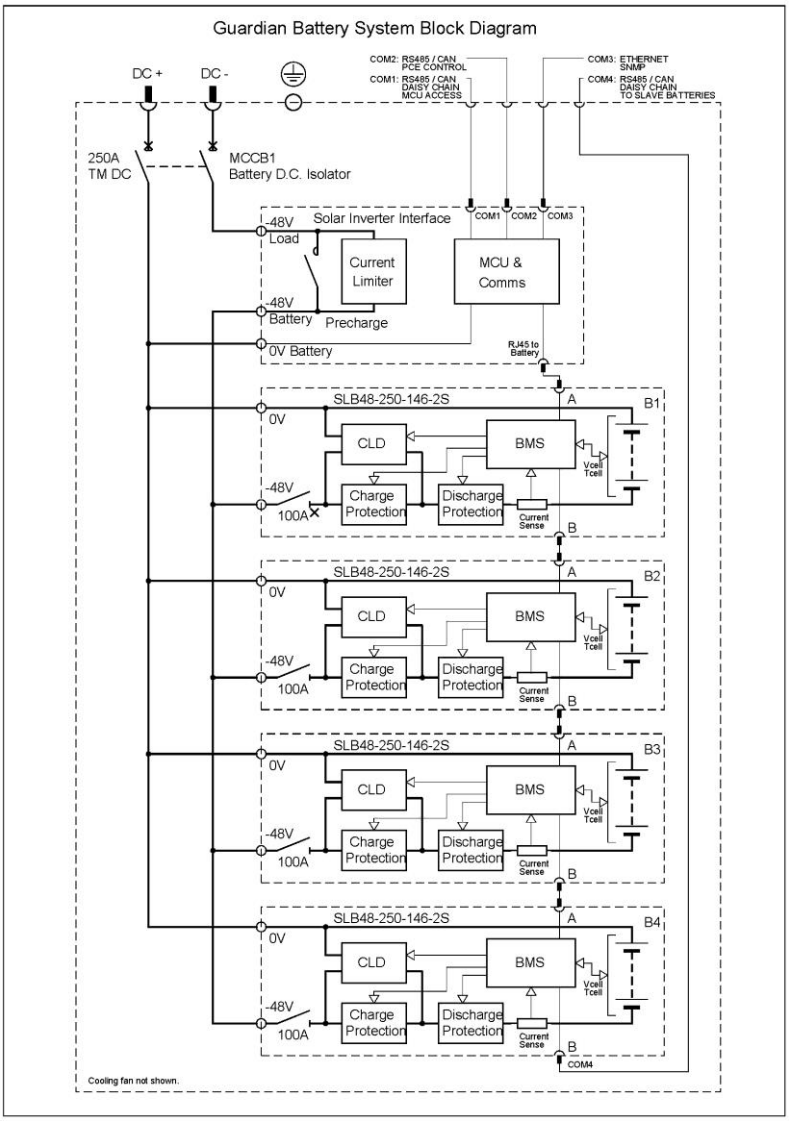
The Guardian Battery System is classified as a pre-assembled battery system (BS) equipment per the Best Practice Guide: Battery Storage Equipment – Electrical Safety Requirements (BPG).

The Guardian battery system is a family of stationary 50.8Vdc battery storage systems with capacities / Watt-hours of 500Ah / 25400Wh (GUARDIAN 26), 750Ah / 38100Wh (GUARDIAN 38), and 1000Ah / 50800Wh (GUARDIAN 50). The Guardian battery system employs 2, 3 or 4 Polarium SLB48-250-146-2S NMC battery modules, a Solar Inverter Interface providing precharge and communications, a double pole 250A DC MCCB / battery DC isolator, thermostatically-controlled cooling and pluggable DC connections via Amphenol SurLok Plus 10.3mm receptacles, all installed in a proprietary powdercoated steel enclosure.

Each battery module has a sophisticated Battery Management System (BMS) which manages charging and discharging, cell balancing, state of charge and protection as well as many other functions. Each module also includes Polarium's trademarked CLD device which reduces charging current if it exceeds the battery module's maximum 100A rating.

There is no limitation to how many Guardian Battery systems can be installed in parallel; however, up to 26 SLB-250-146-2S battery modules (six Guardian 50 systems) can be connected in parallel with automatic charge balancing and communications provided by a single RS485 Comms loop.[4]

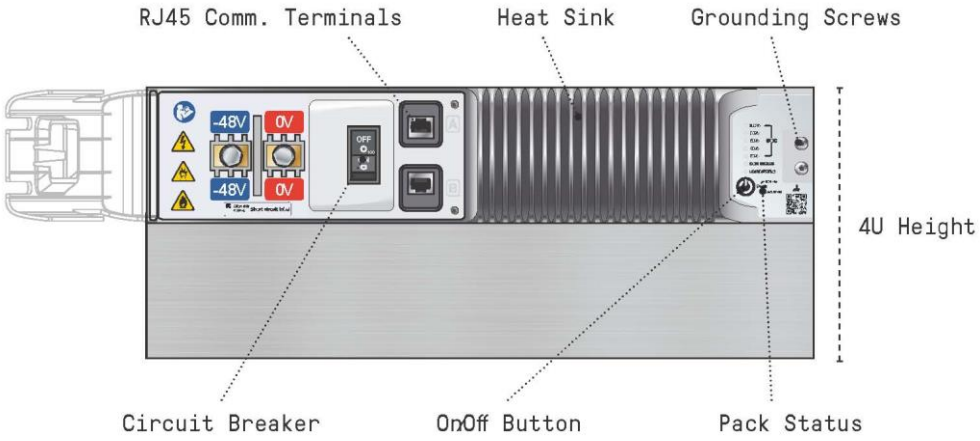
System Block Diagram



[4] Polarium Energy Solutions AB. "Installation and Operation Instructions - Generation 5 Lithium Battery", §1.3.

Polarium SLB48-250-146-2S Battery Module

Each Guardian battery system uses 2, 3 or 4 Polarium SLB48-250-146-2S battery modules. This is a 250Ah (0.2C, 25°C to 35V) 48V DC NMC (Nickel Manganese Cobalt Oxide) lithium-ion battery module which is designed for indoor backup power solutions. Each battery module includes its own Battery Management System (BMS), patented Current Limiting Device (CLD), 100A circuit breaker, and RJ45 RS485 / CAN communications.



BMS Function of Battery Module

Each battery module's Battery Management System (BMS) monitors the battery module's conditions in real-time. The following functions are provided by the BMS:

- Cell voltage monitoring
- Battery pack voltage monitoring
- Battery pack circuit current monitoring
- Battery pack temperature monitoring
- State-of-Charge (SoC) monitoring
- State-of-Health (SoH) monitoring
- Cell balancing management
- Battery module over-charge protection
- Battery module over-discharge protection
- Single cell over-charge protection
- Single cell over-discharge protection
- Over-current (charge and discharge) protection
- Short-circuit protection
- High temperature protection
- And more…

Current Limiting Device (CLD™)

Polarium's patented Current Limiting Device (CLD) provides key functionality to the battery module's safety, as well as optimizing the charging of the battery module. The CLD prevents dangerous overcharging of cells by close monitoring and limiting of charging voltage to cells irrespective of external voltage levels. CLD features include:

- Allows the battery module to be charged with any charge current*
- Allows the battery module to be used with any PCE*
- Optimized battery charging
- Limits charge current at high cell temperatures (above +50°C)
- Differences in SoC between parallel battery modules does not matter and no pre-balancing is required

* Note: If the charge current to a battery module is greater than 100A the battery module will activate the CLD which automatically reduces the charge current into the module to within the range 6 – 12A to protect it from overcharging and elevated temperature. The installer should verify that the PCE charging voltage and current are compatible with the battery system. The PCE charging current limit supplying the Guardian battery system should be set to the recommended charge current specified in Setup and Commissioning to allow for fast charging without activating the CLD.

Electronic Protection and Circuit Breaker

Each Polarium SLB48-250-146-2S battery module is fitted with electronic switches which connect or disconnect its cells from the Guardian battery system's busbars. These electronic switches are controlled by the BMS and are used to provide the battery module protection functions under normal conditions. Separate switches are provided for charging and discharging allowing one of these functions to be prevented while allowing the other to occur. Each SLB48-250-146-2S battery module is also fitted with a circuit breaker on its front panel, as an extra disconnect and protective feature. This circuit breaker disconnects the battery module's negative from the system's busbars under fault conditions outside of the battery module's specifications.

RJ45 RS485 / CAN Communications

Each Polarium SLB48-250-146-2S battery module has a galvanically isolated RS485 MODBUS RTU / CAN interface which facilitates communications between battery modules and between the battery modules and external PCE and monitoring equipment. Communications between battery modules in the Guardian battery system ensures automatic state of charge balancing between these battery modules.

Polarium Solar Inverter Interface

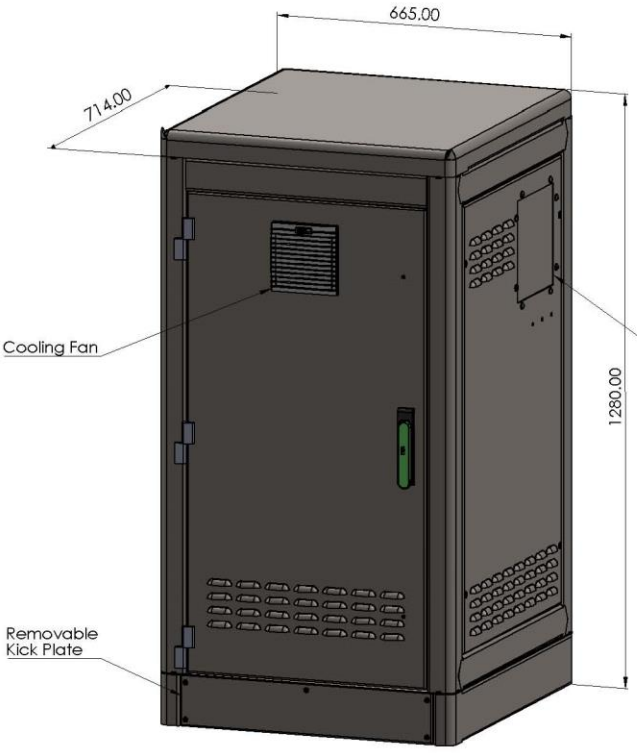
Most renewable-energy inverters and inverter chargers employ large electrolytic capacitors on their DC bus. On system commissioning or on cold restart of the energy system from the Guardian battery system, the very large inrush currents required to charge these capacitors can exceed the programmed protection curve on these battery modules causing them to shut down in short circuit protection mode. A Polarium Solar Inverter Interface (SII) is included in each Guardian system to limit the charging current into these capacitors on startup from the battery system. The SII includes a precharge circuit which limits the in-rush current drawn by large electrolytic capacitors on PCE charging them slowly. This current limiter is shunted by a contactor after ten seconds facilitating full power draw from the Guardian battery system.

The SII also contains a Polarium Connect-Bridge which facilitates RS485 MODBUS communications with a PC and Bluetooth communications with a mobile device. The Connect-Bridge also supports CAN and MODbus protocols for communications with PCE or a system controller, and SNMP protocol via Ethernet. Ports for these connections are available in the termination box of the Guardian. These ports are also used for communications between multiple Guardian battery systems on large installations.

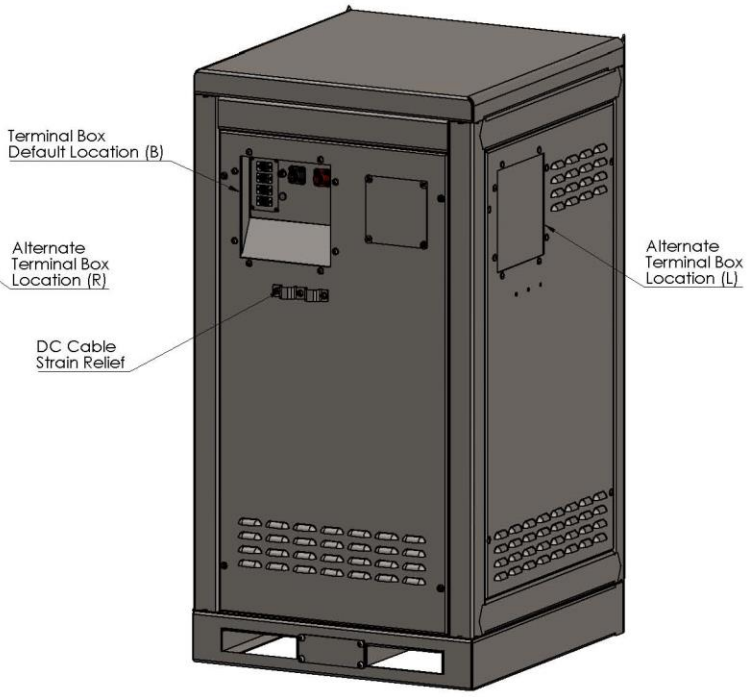
The Polarium Studio PC program provides detailed RS485 MODBUS monitoring of the Guardian battery system on a PC.

On Apple and Android mobile devices, the Guardian battery system can be monitored via Bluetooth using the Polarium Connect Mobile App.

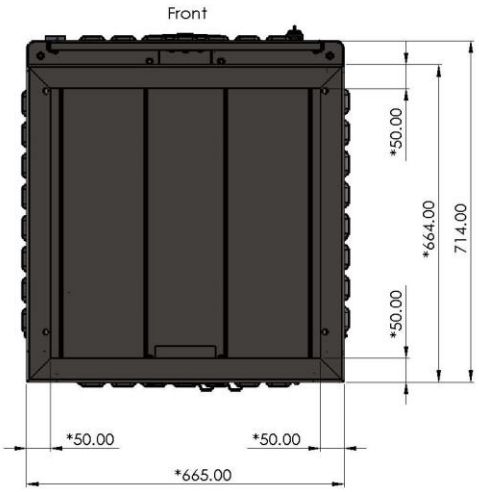
Mechanical Outline



Front and Right Side



Rear and Left Side



Bottom View

PHYSICAL ATTRIBUTE	GUARDIAN26	GUARDIAN38	GUARDIAN50
Weight [kg]			
Battery modules not installed	200		
Battery modules installed	332	393	454
Dimensions [wxdxh] [mm]			
Enclosure only	656 (w) x 714 (d) x 1280 (h)		
Overall	685 (w) x 763 (d) x 1280 (h)		

Battery D.C Isolator (MCCB1)

Solar Inverter Interface (SII)

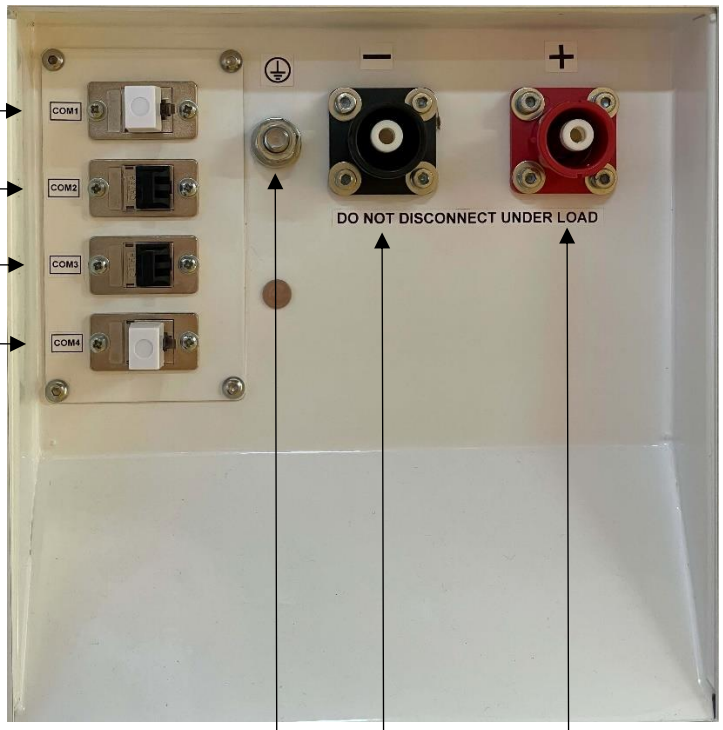
SLB48-250-146-2S
Battery Module (B1)

SLB48-250-146-2S
Battery Module (B2)

SLB48-250-146-2S
Battery Module (B3)

SLB48-250-146-2S
Battery Module (B4)

Terminal Box Connections



COM1: RJ45, RS485 / CAN, DAISY CHAIN, MCU

COM2: RJ45, RS485 / CAN, PCE CONTROL

COM3: RJ45, ETHERNET, SNMP

COM4: RJ45, RS485 / CAN, DAISY CHAIN, TO SLAVE BATTERY SYSTEMS

⏚ PROTECTIVE EARTH: M8, TORQUE TO 11Nm

DC-: AMPHENOL SURLOK PLUS 10.3mm RECEPTACLE, BLACK 90°
MATING CONNECTOR: RIGHT ANGLE 10.3mm PLUG, BLACK 90°
SUPPLIED ON 1.5m D/I R-E-110 INS / V90HT SHEATH 95mm^2 MATING CABLE

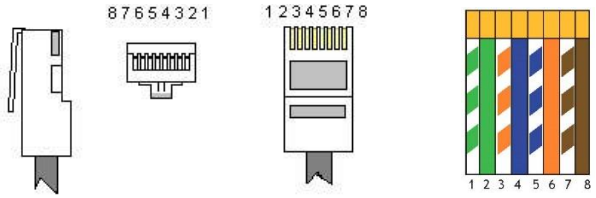
DC+: AMPHENOL SURLOK PLUS 10.3mm RECEPTACLE, RED 180°
MATING CONNECTOR: RIGHT ANGLE 10.3mm PLUG, RED 180°
SUPPLIED ON 1.5m D/I R-E-110 INS / V90HT SHEATH 95mm^2 MATING CABLE

RJ45 Communications ports pinouts

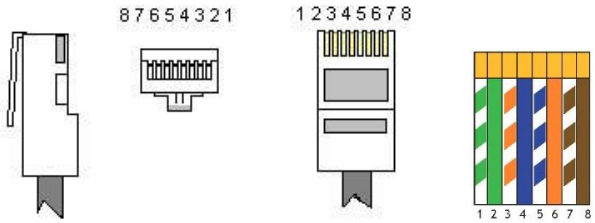
Note: All communications cabling is to be CAT5E F/UTP shielded and earthed or higher

COM1, COM2 and COM4: RS485/CAN pinouts

RJ45 Pin	Signal	T-568A Colour
1	Floating	White/Green
2	Floating	Green
3	Floating	White/Orange
4	RS485 Data+ (A)	Blue
5	RS485 Data- (B)	White/Blue
6	Ground	Orange
7	CAN-L	White/Brown
8	CAN-H	Brown



COM3: Ethernet, T-568A



Guardian Battery System Ordering Information

The following shows the order codes for Guardian system ordering. Please note that the location of the terminal box must be specified at time of order since this must be configured in the factory.

GUARDIAN	50	B
1	2	3

1 Series name
2 Capacity
- 26: 25.4kWh – 2 x Polarium SLB48-250-146-2S
- 38: 38.1kWh – 3 x Polarium SLB48-250-146-2S
- 50: 50.8kWh – 4 x Polarium SLB48-250-146-2S

3. Terminal Box Location* – Viewed facing front of battery system enclosure
- B: Back / Rear
- L: Left Side
- R: Right Side

* Must be specified at time of order – factory configured.

PCE Compatibility

Each Polarium SLB48-250-146-2S NMC Li-ion battery module has a sophisticated battery management system and protection features. These features allow these battery modules to protect themselves regardless of the power conversion equipment to which they are attached without requiring direct communication between the PCE controller and the battery module.

To ensure long life, and as a condition of the warranty provided on the Guardian battery system, PCE must be configured per SEA recommended operating conditions. This is detailed in Setup and Commissioning in the various PCE Configuration sections.

Load-Powering PCE

Load-powering PCE such as inverters and inverter / chargers require a minimum size Guardian battery system to operate. The following tables list the smallest battery system which SEA requires for use with each model of load-powering PCE. Further PCE models will be added in the future. If your PCE is not listed below, contact Solar Energy Australia. The listed smallest Guardian battery system is based upon operating the PCE at its published continuous power rating into a unity power factor load at the Guardian battery's nominal voltage. Operation under more onerous conditions may require a larger battery system.

Victron Energy Products

PCE Model	Smallest Guardian Model
MultiPlus 48/1200/13-16 (P_o = 1000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus 48/1600/20-16 (P_o = 1300W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus 48/2000/25-32 (P_o = 1600W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus 48/3000/35-16 (P_o = 2400W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus 48/3000/35-50 (P_o = 2400W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus 48/5000/70-100 (P_o = 4000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus-II 48/3000/35-32 (P_o = 2400W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus-II 48/3000/35-32 GX (P_o = 2400W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus-II 48/5000/70-50 (P_o = 4000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus-II 48/5000/70-50 GX (P_o = 4000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
MultiPlus-II 48/8000/110-100 (P_o = 6400W at 25°C)	Guardian38 (3 x SLB48-250-146-2S)
MultiPlus-II 48/10000/140-100 (P_o = 8000W at 25°C)	Guardian38 (3 x SLB48-250-146-2S)
MultiPlus-II 48/15000/200-100 (P_o = 12000W at 25°C)	Guardian38 + Guardian26 in parallel (5 x SLB48-250-146-2S)
Quattro 48/5000/70-100/100 (P_o = 4000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
Quattro-II 48/5000/70-50 (P_o = 4000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
Quattro 48/8000/220-100/100 (P_o = 6400W at 25°C)	Guardian38 (3 x SLB48-250-146-2S)
Quattro 48/10000/140-100/100 (P_o = 8000W at 25°C)	Guardian38 (3 x SLB48-250-146-2S)
Quattro 48/15000/200-100/100 (P_o = 12000W at 25°C)	Guardian38 + Guardian26 in parallel (5 x SLB48-250-146-2S)

Selectronic Products

PCE Model	Smallest Guardian Model
SP Pro Series 2i SPMC480-AU (P_o = 3500W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
SP Pro Series 2i SPMC481-AU (P_o = 5000W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
SP Pro Series 2i SPMC482-AU (P_o = 7500W at 25°C)	Guardian38 (3 x SLB48-250-146-2S)

SMA Products

PCE Model	Smallest Guardian Model
Sunny Island SI4.4M-13 (P_o = 3300W at 25°C)	Guardian26 (2 x SLB48-250-146-2S)
Sunny Island SI6.0H-13 (P_o = 4600W at 25°C)	Guardian50 (4 x SLB48-250-146-2S)
Sunny Island SI8.0H-13 (P_o = 6000W at 25°C)	Guardian50 (4 x SLB48-250-146-2S)

Other Battery Chargers – Solar / Micro-hydro / Wind

For battery chargers, generally there are no size limitations on Guardian battery systems. However, not all battery chargers are compatible with Guardian battery systems.

- No increase in smallest battery size is needed above that required by the energy system's load-powering PCE.
- Pulse width modulated (PWM) battery chargers are NOT compatible with the Guardian.
- Chargers must be configured per SEA recommended operating conditions.
- The maximum battery charging current supplied by the PCE must be limited to the maximum charging current as detailed in Setup and Commissioning in the various PCE Configuration sections.
- The total combined battery charging current supplied to the battery system simultaneously by all PCE (ie. Inverter charger(s) plus all other chargers such as solar, micro-hydro, or wind) must be limited to the maximum charging current as detailed in Setup and Commissioning. This may require use of an additional controller.

The following table lists battery chargers which are compatible with all sizes of Guardian battery systems. Further PCE models will be added in the future. If your PCE is not listed below, contact Solar Energy Australia.

Victron Energy Products

Compatible PCE Models
BlueSolar MPPT150/45 (45A, 2600W)
BlueSolar MPPT150/60 (60A, 3440W)
BlueSolar MPPT150/70 (70A, 4000W)
BlueSolar MPPT150/100-Tr.VE.Can (100A, 5800W)
BlueSolar MPPT250/70-Tr VE.Can (70A, 4000W)
BlueSolar MPPT250/100-Tr VE.Can (100A, 5800W)
SmartSolar MPPT150/70 VE.Can (70A, 4000W)
SmartSolar MPPT150/85 VE.Can (85A, 4900W)
SmartSolar MPPT150/100 VE.Can (100A, 5800W)
SmartSolar MPPT 250/70 (70A, 4000W)
SmartSolar MPPT 250/85 (85A, 4900W)
SmartSolar MPPT 250/100 (100A, 5800W)

The following table lists battery chargers which are NOT compatible with Guardian battery systems.

Victron Energy Products

NON-compatible PCE Models
BlueSolar PWM

Pre-installation

General

Although battery storage systems and their installation are not subject to specific Small-scale Renewable Energy Scheme eligibility requirements, installations shall meet all local, state, territory and federal requirements, including electrical safety. Guardian battery systems must only be installed by suitably qualified persons, with appropriate training, accreditation and/or licensing.

The Guardian series of pre-assembled battery systems complies with the Best Practice Guide: Battery Storage Equipment – Electrical Safety Requirements (BPG).

Battery energy storage systems (BESS) employing the Guardian battery system should be designed and installed in accordance with AS/NZS 5139:2019 and AS/NZS 3000:2018.

The Guardian battery system should be installed under section 5 of AS/NZS5139:2019 including risk assessment.

Assembly and installation of the Guardian battery system must follow the procedures in this manual and use the materials provided. No changes to the design and assembly of the Guardian battery system may be made by the BESS designer or installer unless approved in writing by Solar Energy Australia or warranty will be void. The electrical boundary of the Guardian battery system is the free ends of the DC output cables supplied by Solar Energy Australia excluding terminations attached to these cables by the installer for connection to the energy system, the protective earth stud in the termination box and the four RJ45 COM sockets in the termination box.

Location and Environment

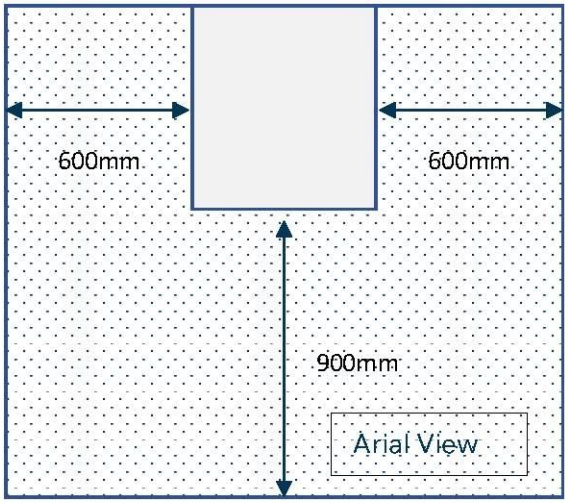
The location of a Guardian BS must meet the following conditions:

- The Guardian BS is suitable for indoor use only.
- The battery system must not be exposed to temperatures greater than 50°C or less than 0°C when charging, and greater than 60°C or less than -20°C when discharging or idling.
- The Guardian BS is to be installed on a floor. This floor should be level and free from obstacles. This floor must be rated to support the assembled weight of the Guardian BS: Guardian26: 332kg, Guardian38: 393kg, Guardian50: 454kg.
- The area must be clean and dust-free.
- The Guardian BS must not be installed in locations where battery modules or the battery system can be exposed to water, high humidity, moisture or liquids.
- The Guardian BS must not be installed in locations near any heat sources, flammable material, open flames, or sources of ignition.
- The battery system must not be installed in locations where battery modules or the battery system can be exposed to direct sunlight.
- The Guardian BS must be installed in a secure location away from children and animals.
- The Guardian BS must not be installed in locations where it can be exposed to salt-laden air.
- The location must be free from vermin or extra precautions should be taken to ensure insects or vermin cannot enter the battery system enclosure.
- The Guardian BS must be installed in a well ventilated location. Special ventilation is not required.

A Guardian BS installation must comply with the location and fire protection requirements defined in clauses 5.2.2, 5.2.4 and 5.2.5 of AS/NZS 5139:2019.

A Guardian BS installation must not be installed in restricted locations as defined in clause 5.2.2.2 or AS/NZS 5139:2019. The BS must not be installed in habitable rooms.

Equipment not associated with the Guardian BS and BESS must not be located in the following restricted areas around the BS.



If the Guardian BS is to be installed within 300mm of a wall or structure separating it from a habitable room, a non-combustible barrier must be placed between the BS and the wall or structure. This barrier must extend 600mm beyond the vertical sides of the BS, 900mm above the top of the BS and to the bottom of the Guardian BS.

To ensure proper cooling of the Guardian BS, a separation of 100mm is required between the left side, right side and top of the Guardian BS and any equipment associated with the BESS.

Power conversion equipment (PCE) which generates hot cooling air-flow must be located so that this hot air is directed away from the cooling air inlets and hot air outlets on the Guardian BS located on the left side, rear side, right side and front of its enclosure.

Unimpeded access of at least 1200mm must be provided in front of the Guardian BS including 600mm for the front door.

A separation of at least 100mm must be provided between the side of the Guardian BS where the terminal box is located and any wall, structure or equipment associated with the BESS to ensure sufficient access to the terminal box.

BESS Electrical and Installation Requirements

The design and installation of battery energy storage systems (BESS) employing the Guardian BS is the responsibility of the system designer / installer. Battery energy storage systems employing the Guardian BS must be designed and installed in compliance with AS/NZS 5139:2019, AS/NZS 3000 and any additional mandated regulations. In particular, BESS designs and installations must comply with Clause 5.3 of AS/NZS 5139:2019.

Overcurrent protection and isolation of the BS from the PCE

The Guardian BS includes a Noark Electrics Ex9MD2B TM DC250 2P moulded case 250A double-pole 500VDC circuit breaker (MCCB1) compliant with IEC/EN 60947.2 in its positive and negative DC output conductors. This device provides overcurrent protection and isolation between the battery system and the load / PCE. It provides compliance with clauses 5.3.1.2 and 5.3.1.3 of AS/NZS 5139:2019 and can be used as the Battery D.C. Isolator. This device is located on the front panel of the BS inside the front door. To guarantee access to this device, the front door of the Guardian BS must not be locked. An additional Battery D.C Isolator may be required, such as in systems where there is greater than 2m of separation between the Guardian BS and PCE, or in installations with multiple battery systems.

Additional overcurrent protection connected to the DC output of the Guardian BS must be rated to In=250ADC maximum and must be selected to ensure discrimination with MCCB1. Refer to MCCB1 Trip Curve.

Battery system wiring to PCE

D.C. Output connections to the Guardian BS are made via Amphenol Electric Surlok Plus 10.3mm receptacles located in the terminal box (Red = DC+, Black = DC-). These receptacles are keyed to prevent wrong polarity insertion. These connectors are rated to a maximum current of 350A when wired with 95mm^2 cable. 1.5m mating cables with right angle plugs (Amphenol Electric Surlok Plus 10.3mm) are provided with the system. These must be used for connection to the balance of the BESS. These cables employ 95mm^2 flexible cables with R-E-110 insulation, V90HT sheath to AS/NZS 5000.1 – 0.6/1kV voltage rating. Contact Solar Energy Australia if longer cables are required.

Any additional cabling connected to the DC output of the Guardian BS must be at least 95mm^2 with equivalent or superior rating to the supplied mating cables.

These connectors are not rated for load breaking. Turn off MCCB1 before plugging-in or disconnecting these connectors.

Earthing of the BS

The Guardian BS is suitable for use in floating or either positive or negative directly or resistively earthed systems. The design of the BESS earthing system must comply with clauses 5.3.1.6 and 5.3.1.7 of AS/NZS 5139:2019.

Connection of the protective earth bonding conductor to the battery system is made via an M8 stud terminal in the terminal box.

Access to DC busbars

Contact with the internal busbars on the Guardian battery system by users is prevented by the polycarbonate cover installed over these busbars. This cover must be installed on all installations.

Prospective short circuit current and arc flash

Protection against short circuits on the output of the Guardian battery system is provided initially by the electronic overcurrent protection circuitry in each battery module which is controlled by its battery management system. Each battery module has a prospective short circuit current of I_{SC} = 1300A with an overcurrent protection trip time of 85µs (= arcing time). The prospective short circuit current of each battery system is I_{SC} = 1300A x number of battery modules installed. This fast protection ensures that the arc flash energy for this system is low.

To prevent any risks or damage to the Guardian battery system Solar Energy Australia requires that all battery modules be shut down when working on internal DC wiring or busbars.

Example Arc Flash Boundary Calculation:

A four battery Guardian50 system has a prospective short circuit current of I_{SC} = 5200A with an arcing time t_{arc} of 85µs. Using the maximum system voltage of 58.8Vdc, a multiplying factor of 3 for an enclosed battery system, the arc flash incident energy for a short circuit across the DC output or across the internal busbars at a working distance of 45cm, calculated using equations F.1 and F.2 from AS/NZS 5139:2019 is 0.000192 cal/cm^2.[5] The arc flash boundary (incident energy = 5J/cm^2 (1.2cal/cm^2)) calculated using equation F.4 is 0.57cm.

Parallel Guardian BS

For installations employing more than one Guardian battery system connected in parallel, contact Solar Energy Australia.

[5] Australian Standard AS/NZS 5139:2019, Appendix F

Installation

Required Tools

The following tools are required to install a Guardian battery system.

Tool	Remarks / Use
Torque Wrench with 13mm socket (M8)	Torque Setting 15Nm Securing busbars
Torx Screwdriver – Size T30	Securing battery module protective earth leads.
Torx Screwdriver – Size T25	Moving battery module mounting brackets (if necessary).
Phillips Screwdriver – Size No. 2	Busbar cover supports and battery module lower mounting screws.
Pozidriv Screwdriver – Size No. 3	Battery module upper mounting cage screws.
Allen Key or Screwdriver – Size 4mm	Polycarbonate busbar cover. DC cable strain relief.
Sharp Knife / Box Cutter / Stanley Knife	
Combination wrenches and / or socket and ratchet – 17mm. (2 required)	Removal of 4 x transportation bolts.

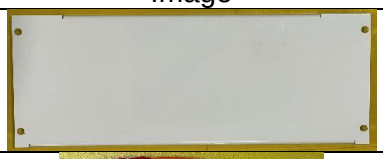
Optional Tools

Tool	Remarks / Use
Torque screwdriver with 10mm socket (M6)	Removal of door protective earth if removing door.
Allen Key or Screwdriver – Size 2.5mm	Removal and re-attachment of front kick plate if using forklift.

Included Equipment and Hardware

The following equipment and hardware are included with each Guardian battery system

Name	Image	Quantity	Remarks / Use
Guardian Enclosure		1	
Polarium SLB48-250-146-2S Battery Module*		2: G26 3: G38 4: G50	

Name	Image	Quantity	Remarks / Use
4RU Blanking Plate*		2: G26 1: G38 0: G50	Supplied installed in enclosure.
95mm^2 x 1.5m Positive Output DC Cable		1	Red – Terminated with Amphenol SLPPC85BSR1 Supplied loose
95mm^2 x 1.5m Negative Output DC Cable		1	Black – Terminated with Amphenol SLPPC85BSB0 Supplied loose
2-3 RU Busbar – 300A		2	Supplied loose. SII to battery module B1 DC power.
4-5 RU Busbar – 300A*		2: G26 4: G38 6: G50	Supplied loose Inter-battery module DC power.
RS485 Communication Cable*		2: G26 3: G38 4: G50	Packed with each SLB48-250-146-2S battery module. Inter-battery module communications
RS485 Communication Cable		1	Supplied loose. SII to battery module communications
RS485 / CANbus / MODBUS Terminator Plug*		2: G26 3: G38 4: G50	Packed with each SLB48-250-146-2S battery module. Only 1 required - COM4 Termination.
DC Cable Strain Relief		1	Supplied attached to enclosure below termination box.
M6 x 16mm button head screw with spring washer		3	Supplied attached to enclosure. Secures output cable strain relief.
Polycarbonate busbars cover		1	Supplied installed in enclosure
M6 x 16mm button head screw		4	Supplied installed in enclosure. Secures busbars cover to supports.
Busbar cover support		2	Supplied installed in enclosure. Supports busbars cover.
M5 x 20 Phillips pan head screws with captive washers		8	Supplied installed in enclosure. Secures busbar supports and battery modules to enclosure rack mounts.
M6 x 16 Pozidriv Cage Screw and Retaining Cup Washer		8	Supplied loose. Secures battery modules to enclosure rack mounts.

Name	Image	Quantity	Remarks / Use
M6 shake-proof internal star washer		4	Supplied loose. Battery module protective earth.
SEA Guardian – Installation and Operation Manual		1	This document.
DCA50152 MOD USB to RS485 Serial Cable		1	RS485 communications between a PC and Guardian battery system. Used with Polarium Studio application.
BESS Labels		1	Supplied loose.

Notes:
* G26 = Guardian 26, G38 = Guardian 38, G50 = Guardian50

Unpacking System Enclosure

Unpack the system enclosure and battery modules on site, not beforehand. The system enclosure and battery modules must be transported in their original packaging to prevent damage.

WARNING: The system enclosure is heavy (200kg without battery modules). Movement of this enclosure requires a suitably-rated trolley or forklift. Follow workplace health and safety regulations.

Inventory

After unpacking the enclosure check that all equipment and hardware listed above supplied either fitted into the enclosure or loose has been included.

Safety Checks Before Installation of System Enclosure

Before installing the system enclosure:

- Ensure that MCCB1 on the battery system is in the OFF position.

Preparation of System Enclosure

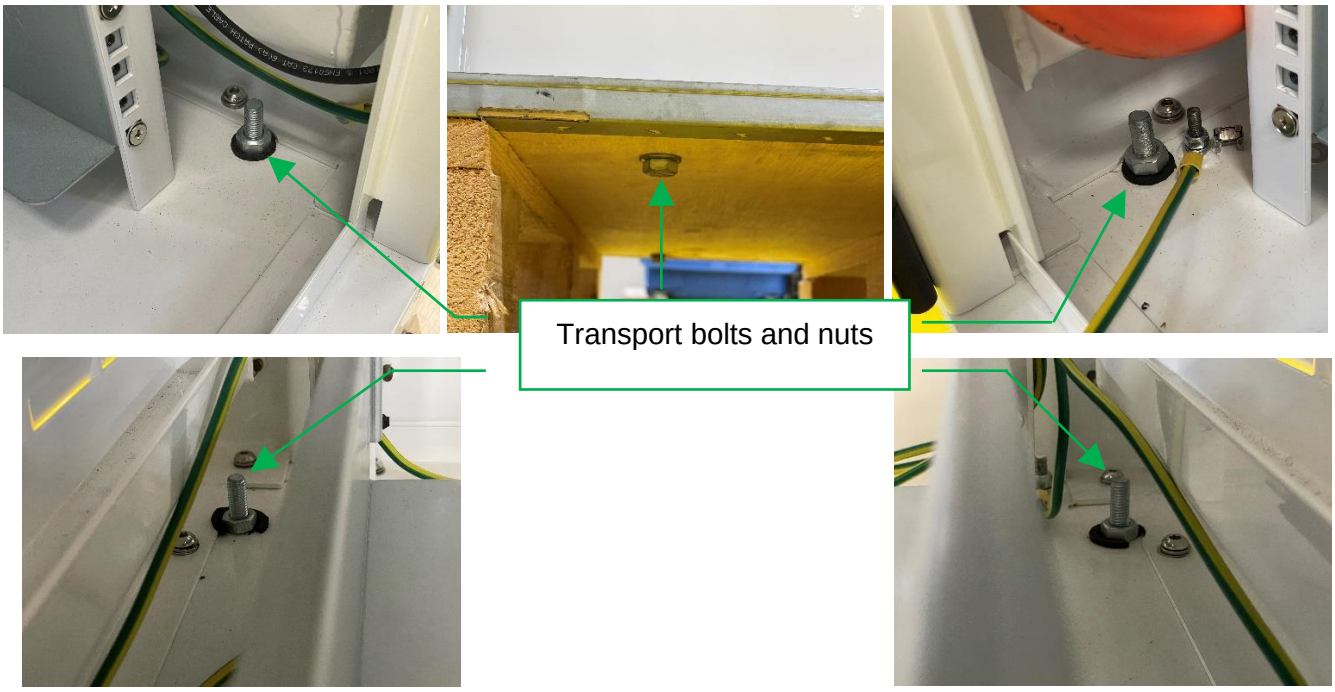
Before moving the system enclosure into position, remove the following items from the enclosure and store them to prevent them from being damaged:

- Open the enclosure door. To ease installation, the door may be removed. See Door Removal .
- Remove the polycarbonate busbars cover from its supports by removing the 4 x M6 x 16mm button head screws from the two busbar cover supports using a 4mm Allen key or Screwdriver. Retain these fasteners for reuse during re-assembly.

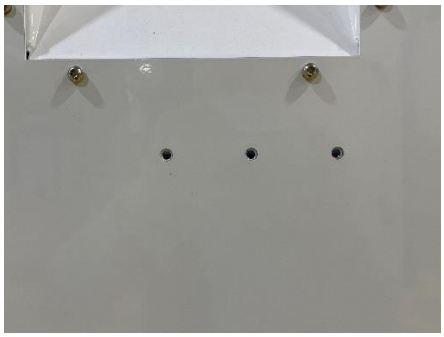
- Remove the two busbar cover supports from the rack angles by removing the 2 x M5 x 20mm Phillips pan head screws with captive washers using a No. 2 Phillips screwdriver. Retain these fasteners for reuse during re-assembly.



- Remove the two system output cables. These are supplied loose inside the enclosure. Retain these cables for installation later.
- Remove the four M10 transport bolts and nuts fastening the enclosure to the shipping pallet using 2 x 17mm combination wrenches and/or socket and ratchet. These are located at the front and rear on the left and right sides of the base as shown below. The nuts can be accessed through the front door, below the shelves for the bottom battery module. The bolt heads can be accessed through the sides of the shipping pallet.



- Remove the DC cable strain relief located below the termination box using a 4mm Allen key or screwdriver. Retain the strain relief and fasteners (3 x M6 x 16mm button head screws + M6 spring washers) for re-installation during system assembly.

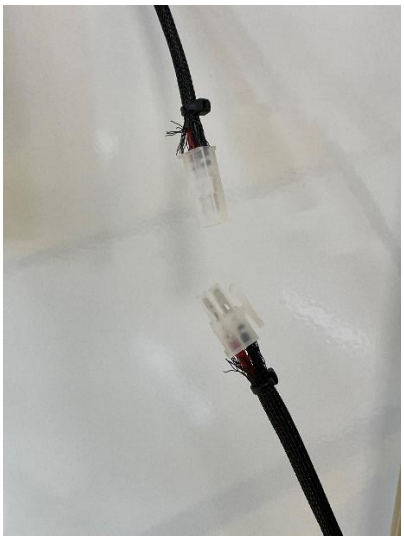

Door Removal

If the door cannot be opened fully (180°) when the enclosure is in its final location, the door can be removed as follows to facilitate installation of each battery module by at least two people:

- Disconnect the door protective earth cable from the door by removing the M6 Nylok nut and 2 x M6 shakeproof internal star washers on either side of the protective earth cable lug. This requires a flexible driver with a 10mm (M6) socket. Retain these fasteners for reuse during re-assembly.




- Disconnect the fan power cable.



- Lift the door off its hinges.

- Re-installation is the reverse of this procedure.

Locate System Enclosure

The system must be located and installed in compliance with AS/NZS 5139. Refer to “Location and Environment”.

- When fully assembled, a battery system can weigh up to 454kg. Ensure that the selected installation surface is able to support this weight.
- Ensure that the selected installation surface is level.
- **WARNING:** The system enclosure is heavy (200kg without battery modules installed). Movement of this enclosure requires a suitably-rated trolley or forklift. Follow workplace health and safety regulations.
- If a forklift is to be used, forklift tunnels are available behind the bottom kick plate. To remove this plate, remove the five M4 button-head screws holding this plate in place. Removal of these screws requires a 2.5mm Allen key or screwdriver.

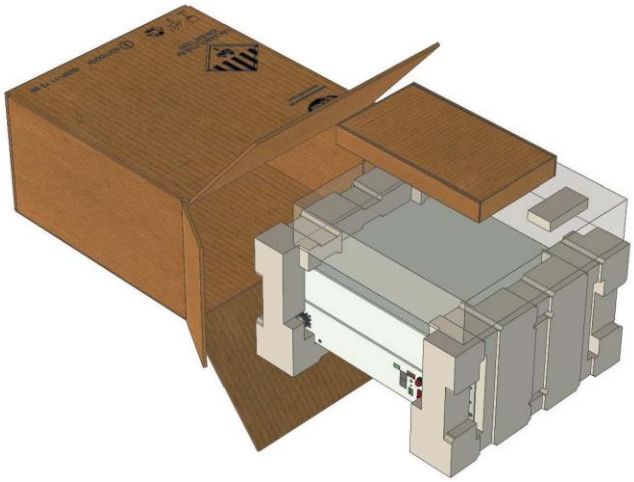

- After placement of the enclosure, if necessary level it using shims before installing the battery modules.

Unpacking Battery Modules

WARNING: Polarium SLB48-250-146-2S battery modules are heavy (66kg each). Movement requires at least two people. Follow workplace health and safety regulations.

Inspect the package and battery module for any damage. Record (photograph) any noticeable damage and do not install a battery module that is suspected to have been damaged during transport.

Lay the battery module box flat on the floor and slide the battery module from the box. Never attempt to lift the battery module vertically from the box. Retain the packaging material for use if warranty repair is required.



Inventory

After unpacking each battery module check that all equipment and hardware listed above supplied with each battery module has been included.

Battery Module Safety Checks Before Installation

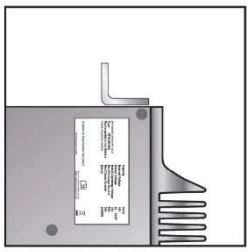
Before installing the battery module into the system enclosure:

- Ensure that the circuit breaker on the battery module front panel is in the OFF position.

Install Battery Modules in Shelves

Install battery modules by sliding them into the shelves in the system enclosure.

- For two battery module systems (Guardian 26), battery modules are located in the top two locations (B1 and B2).
- For three battery module systems (Guardian 39), battery modules are located in the top three locations (B1, B2 and B3).
- For four battery module systems (Guardian 52), battery modules are located in all four locations (B1, B2, B3 and B4).
- Before installing battery modules into the system, check that the mounting brackets on the sides each battery module have the flanges facing to the rear at the front of each side as shown below.

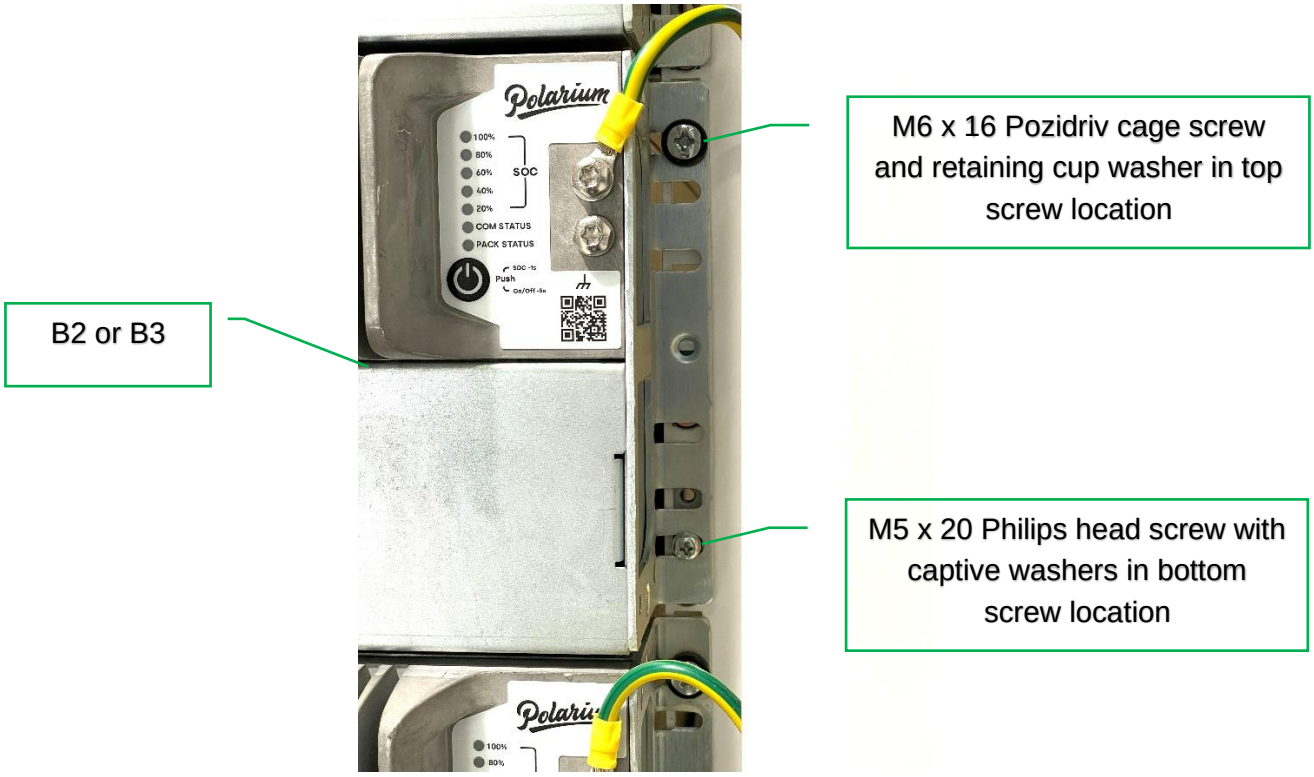


The mounting brackets can be relocated using the 2 x M5 x 6mm countersunk screws and a T25 Torx screwdriver.

- Starting from the bottom location (B2, B3 or B4 depending on system size), install the battery modules into the system enclosure.
- SLB48-250-146-2S battery modules are heavy (66kg each). If a battery lifter or forklift is available, position each battery module on this device with the rear of the battery module facing the front of the system enclosure. Adjust the height of the lifter so that the bottom of the battery module is at or slightly above the height of the shelves. Slide the battery module from the lifter/forklift onto the shelves until the mounting brackets are in contact with the rack mounts. The shelves are lubricated to ease this process
- If the battery modules are to be lifted into position manually, at least two people are required. Follow workplace health and safety regulations.

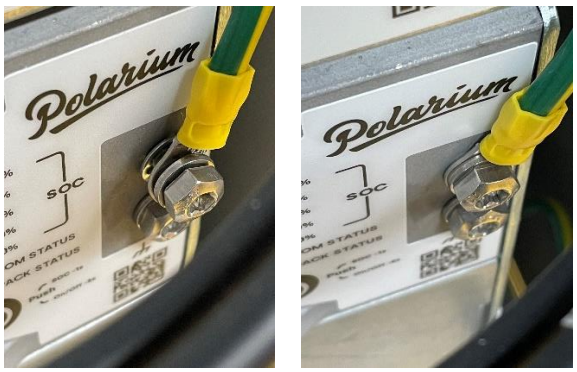
- Install 2 x M6 x 16 Pozidriv head cage screws and retaining cup washers in the top screw locations on all battery modules using a No 3 Pozidriv screwdriver. Torque = 2.0 Nm.

- Install 2 x M5 x 20 Phillips pan head screws with captive washers in the bottom screw locations on battery modules B2 and B3 (if installed). Use a No. 2 Phillips screwdriver. Torque = 2.0 Nm. Do not install these screws in battery module locations B1 and B4 at this time.



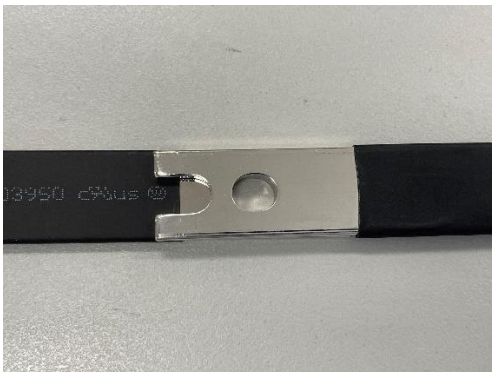
Connect Battery Modules Protective Earth Cables

- Locate the protective earth cable for each battery module. These are located on the enclosure at the top right of each battery module.
- Connect the protective earth cable for each battery module using the top earth screw and washer on each battery module. Add an M6 shake-proof internal star washer (supplied loose with system) between each earth lug and the front surface of the battery module. Use a T30 Torx screwdriver. Torque = 6 Nm.

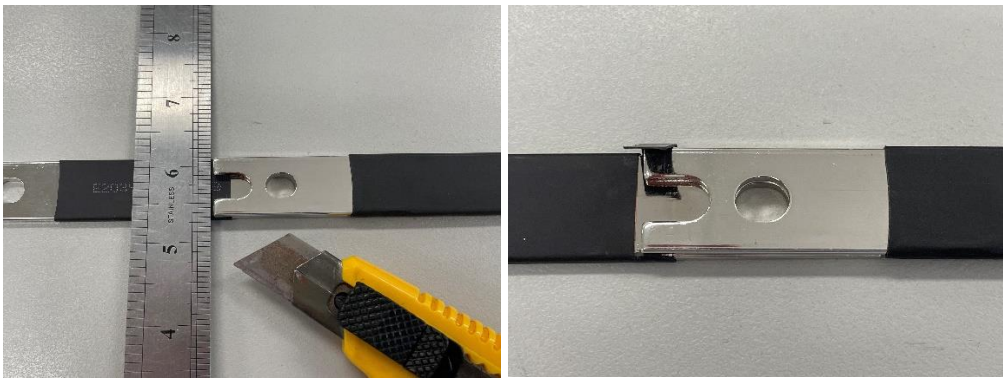


Install Busbars, Battery 0V Cable, and Fan -48V Tap

- Before installing any busbars, if necessary trim the heatshrink tubing on these busbars so that they it will not be compressed between the conducting surfaces of two busbars as shown below. Use a sharp knife, box cutter or Stanley knife.



UNACCEPTABLE - Heatshrink tubing between conducting surfaces of busbars

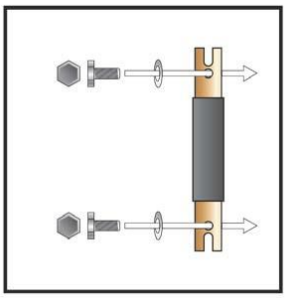


Trim heatshrink tubing with a sharp knife

GOOD - No heatshrink tubing between conducting surface of busbars

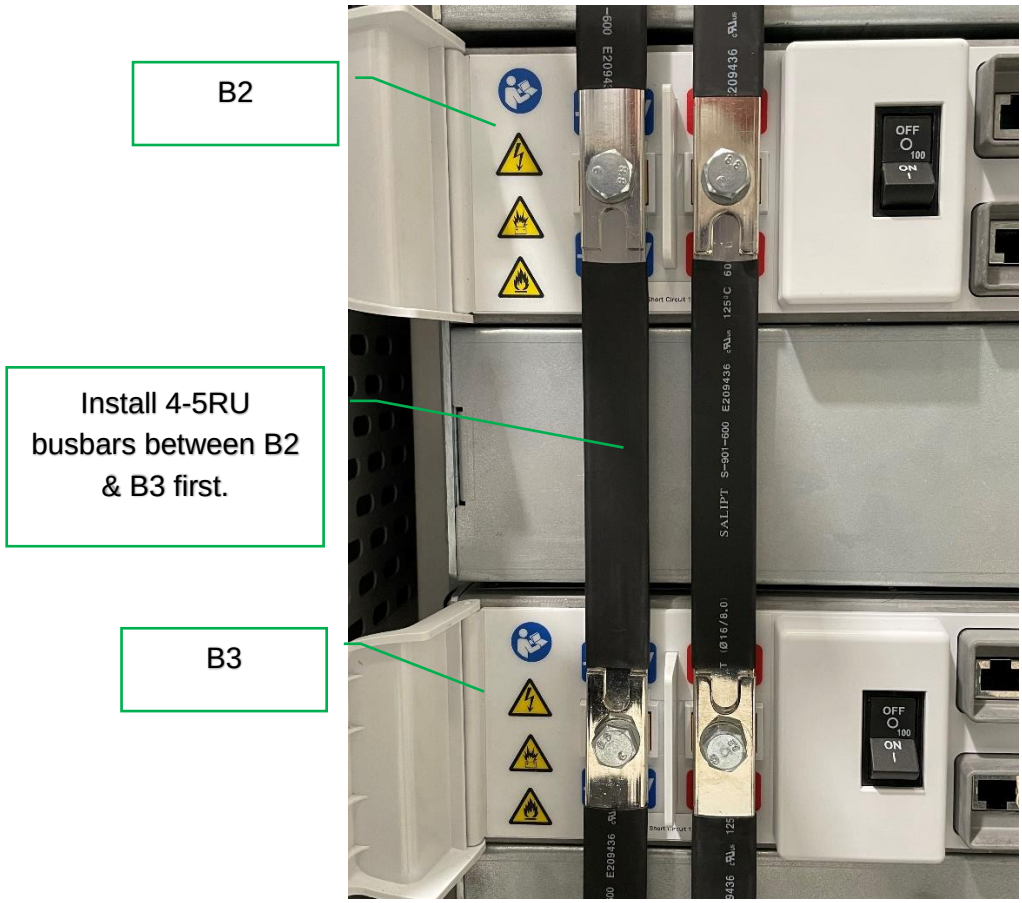
- Open the isolation cover on each battery module to expose the -48V, 0V and RJ45 communications terminals.

- Install all busbars, the 0V cable and the fan -48V tap finger-tight as follows.
- All busbar connections are made using the M8 bolts and wave washers supplied attached to the SII and battery modules.



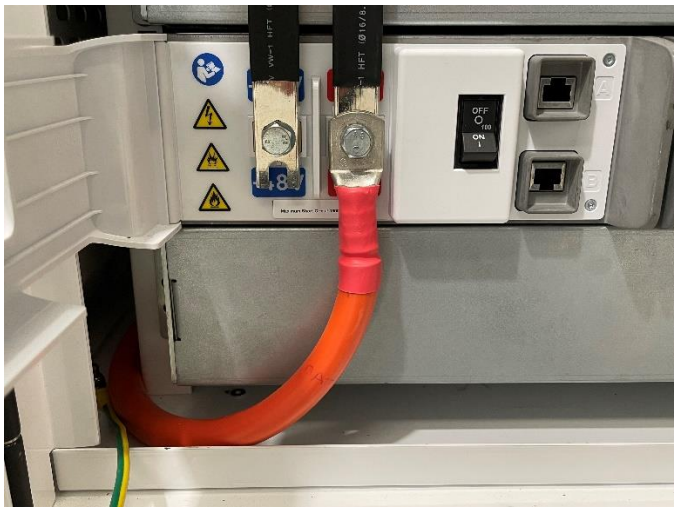
- The 2-3 RU Busbars are used to connect the SII to the top battery module (B1). The 4-5 RU Busbars are used to connect the battery modules to each other.
- Install the top of the 2 x 2-3RU Busbars into the SII -48V Battery and 0V Battery terminals first. Fit the fan -48V tap to the SII -48V Battery terminal between the wave washer and the busbar as shown below.

- Install the 4-5 RU Busbars to parallel the battery module -48V and 0V terminals, as shown below. If three or more battery modules are installed, the busbars connecting battery module 2 (B2) and battery module 3 (B3) should be closest to the battery module's terminals.



- The 2-3 RU Busbars connecting the SII to B1 should be closest to the battery module's terminals as shown below. The 4-5 RU Busbars connecting B1 to B2 should be between the wave washers and the 2-3 RU Busbars.

- Locate the system 0V cable. This will be in the gap to the left of the battery modules. Align the lug on this cable with the 0V terminal on the bottom installed battery module with the busbar against the battery module's terminal and the 0V cable lug between the wave washer and the busbar as shown below.

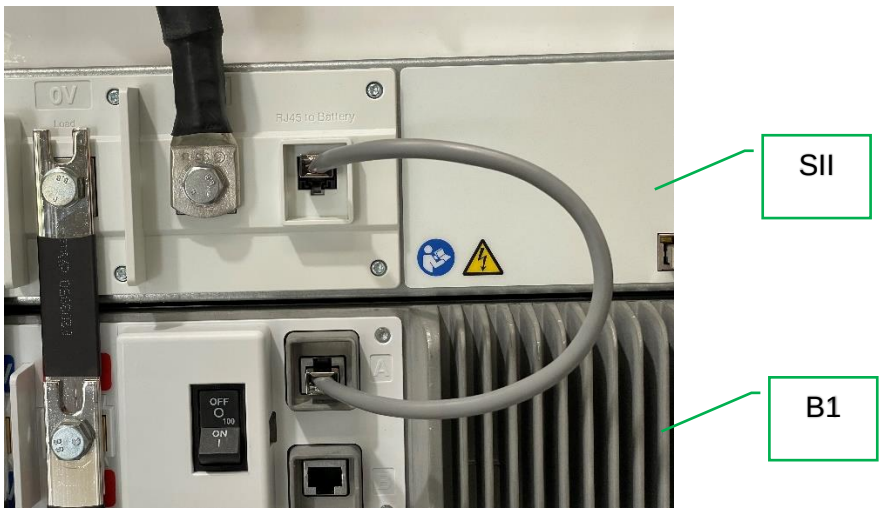


- After all busbars and cables are mounted, torque all M8 bolts to 15Nm[6] using a torque wrench with a 13mm socket. Ensure that no heatshrink tubing is pinched between any of the conducting surfaces.

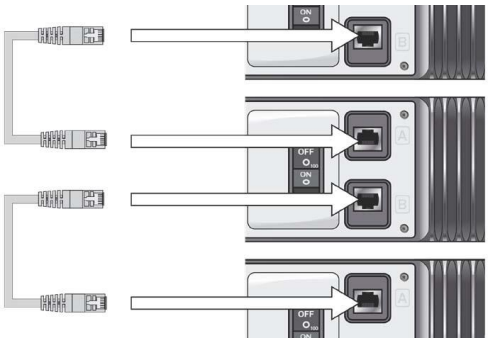
[6] Polarium Energy Solutions AB. "Installation & Operation Instructions – Generation 5 Lithium Battery", §5.8.

Install Battery Module RJ45 Communications Cables

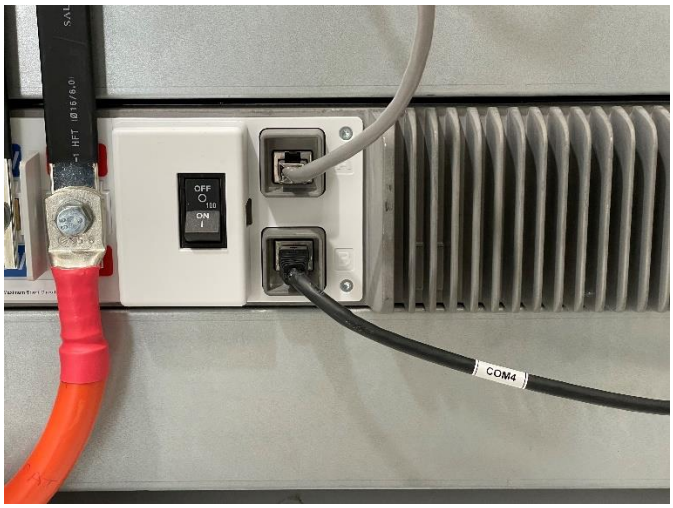
- Shielded and earthed RJ45 cables communications cables (CAT5E F/UTP) are supplied with the system and each battery module.
- Plug the first RJ45 cable into the SII “RJ45 to Battery” socket. Plug the other end of this cable into B1 “A” socket, as shown below.



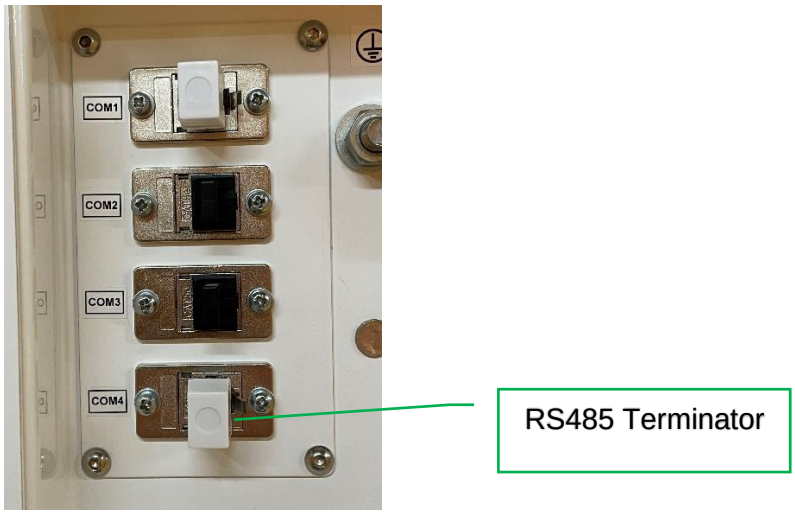
- Plug the second RJ45 cable into B1 “B” socket. Plug the other end of this cable into B2 “A” socket.
- Continue with the third cable between B2 “B” to B3 “A” and so-on until all battery modules are connected.



- Locate the cable labelled “COM4”. This should be in the gap to the right of the battery modules. Plug this cable into the last battery module’s “B” socket as shown below.

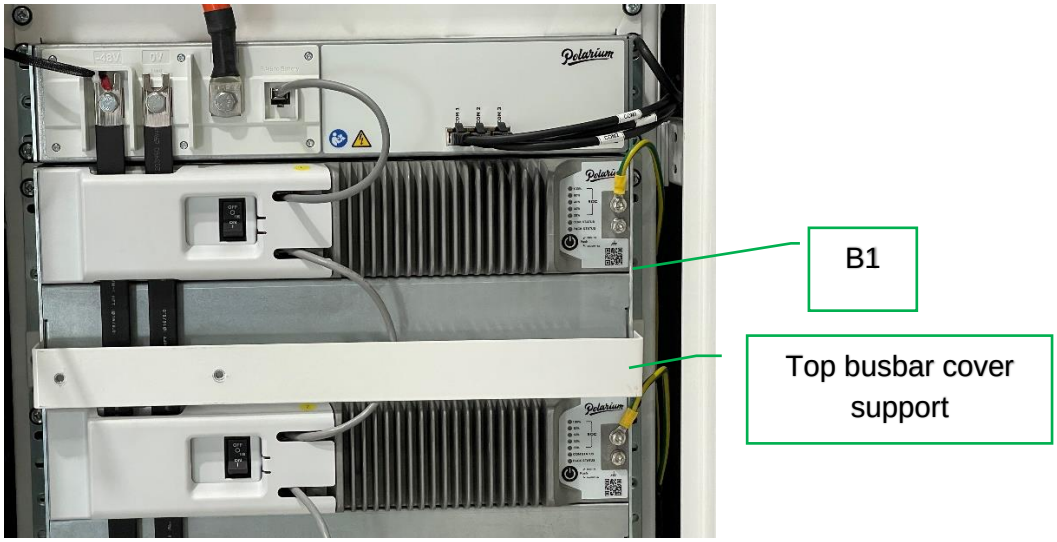


- Plug one of the supplied RS485 terminators into the socket labelled “COM4” on system termination box as shown below.

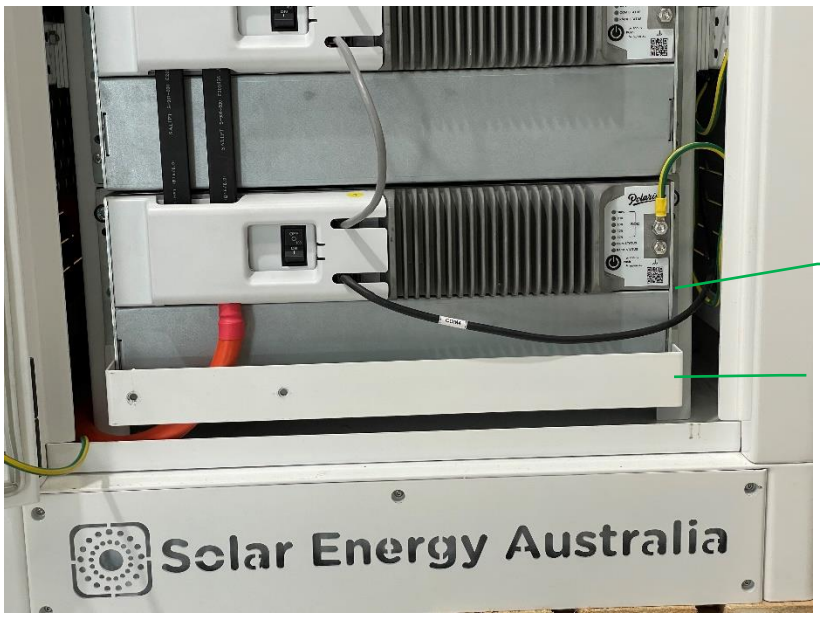


Installation of Polycarbonate busbars cover

- Close the isolation covers on all battery modules.
- Install the top busbar cover support in front of the top battery module (B1) using 2 x M5 x 20mm Philips pan head screws with captive washers (supplied loose) into the bottom mounting holes on B1 as shown below. Use a No. 2 Phillips screwdriver. Torque = 2.0 Nm.



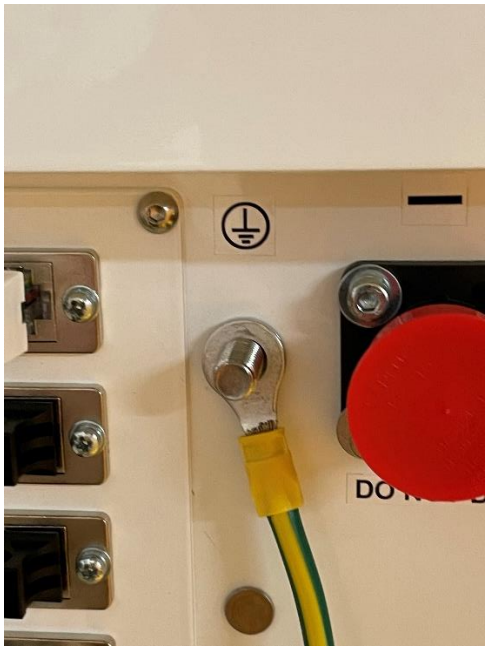
- Install the bottom busbar cover support in the bottom battery module location (B4). Fasten using 2 x M5 x 20mm Philips pan head screws with captive washers (supplied loose) either into the bottom mounting holes on B4 (if installed) or into the bottom holes on the shelf for B4 (if not installed) as shown below. Use a No. 2 Phillips screwdriver. Torque = 2.0 Nm.

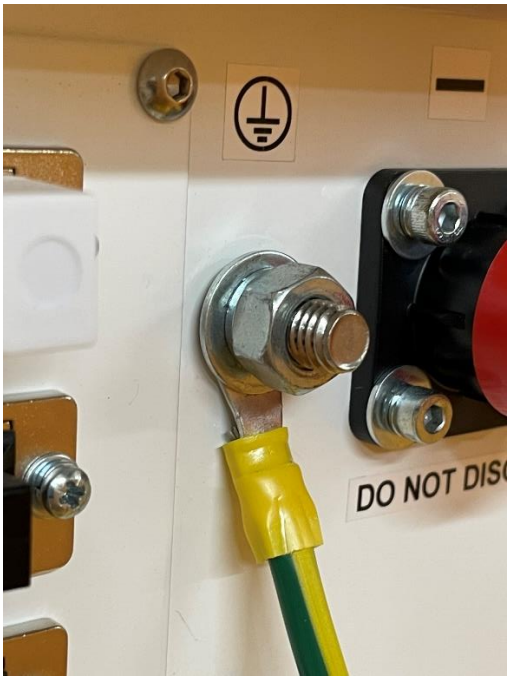


- Attach the polycarbonate busbars cover to the busbar cover supports using the retained 4 x M6 x 16mm button head screws. Use a 4mm Allen key or screwdriver. Torque = 2.0 Nm.
- Reinstall the door if it was removed. Refer to Door Removal.

Connect System Protective Earth

- The battery system enclosure must be earthed to the installation protective earthing system. The earthing cable must be sized appropriately per AS/NZS 5139 and AS/NZS 3000.
- Connect the battery system protective earth to the labelled M8 stud in the system termination box using the supplied star, flat and spring washers and M8 full nut as shown below. Torque to 11Nm using a torque wrench with a 13mm socket.

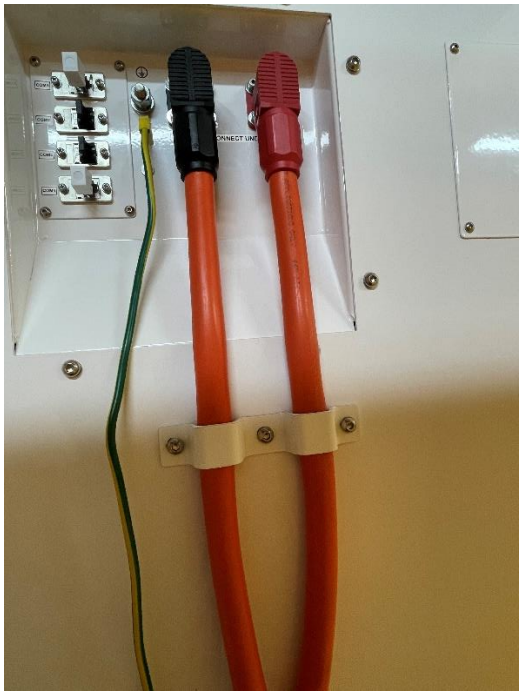


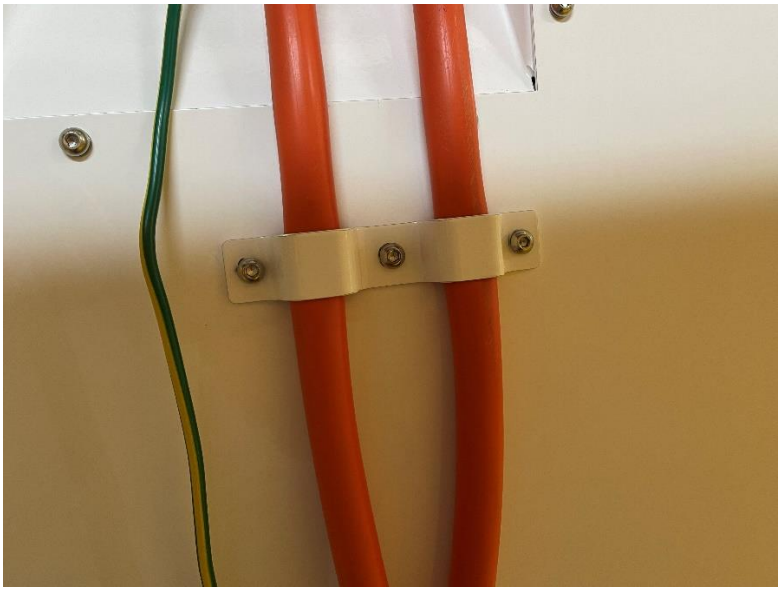


Connect System DC cables and Strain Relief

- The design of the installation to which the Guardian Battery System is to be connected is the responsibility of the installer.
- The installation must comply with the requirements of AS/NZS 5139 and AS/NZS 3000.
- Connection of the Guardian Battery System to the DC installation is made using the supplied 95mm^2 double insulated R-E-110 x 1.5m cables pre-terminated with Amphenol 10.3mm SurLok Plus 10.3mm Plugs (Red = +, Black = -). These connectors are keyed to prevent incorrect polarity connection. The other ends of these cables are unterminated. Termination is the responsibility of the system installer.
- Contact SEA if replacement connectors or cables are required.

- Ensure that the DC system to which Guardian Battery System is to be connected is de-energized before connecting the DC cables to this system.
- Ensure MCCB1 is in the off position before connecting the system DC cables.
- Connect supplied cables to the DC installation (Red = +, Black = -).
- Plug the Amphenol 10.3mm plugs into the sockets on the termination box (Red = +, Black = -).
- The 95mm^2 DC cables are to hang down vertically below termination box as shown below. The keying shrouds on the Amphenol sockets can be rotated to achieve this alignment.
- Install the retained DC cable strain relief to secure the 95mm^2 DC cables to the enclosure below the termination box using the retained fasteners (3 x M6 x 16mm button head screws + M6 spring and flat washers). Use a 4mm Allen key or screwdriver. Torque = 3.0Nm.





- **Warning:** The DC cable strain ***must*** be installed as shown above. The weight of the DC cables must be supported by this strain relief, not by the Amphenol connectors.

Connection of Guardian Communications to PCE

- No communication connection between Guardian and the installation PCE is required, provided that the Guardian Battery System is at least the minimum size specified for the PCE as identified in PCE Compatibility.
- The PCE must be configured to work correctly with Guardian Battery System. See Setup and Commissioning.

Setup and Commissioning

The following section details procedures to be followed on the initial commissioning of a system. For normal operation refer to Operation.

During commissioning, the Guardian battery system can be monitored using a mobile device via Bluetooth and/or using a PC via the included DCA50152 MOD USB to RS485 Serial Cable. Refer to Monitoring using a Mobile Device and Monitoring using Polarium™ Studio on a PC. Monitoring is available after completing initial startup.

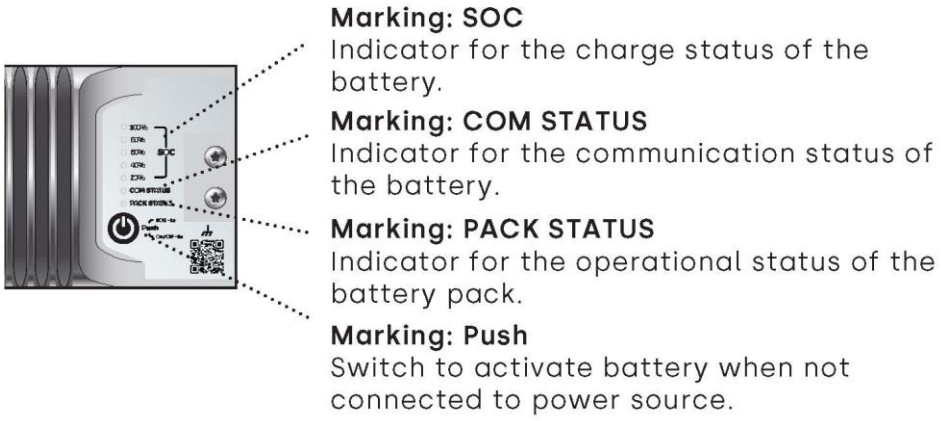
No configuration of the Guardian is needed for most installations. If configuration of the Guardian (SII Connect-Bridge) is required, it is performed on a mobile device via Bluetooth. Contact SEA for details. Configuration is only required in the following cases.

- The Guardian is to be connected to an Ethernet network. Note monitoring of SNMP data is the only communications available on the Ethernet interface.
- The Guardian is to be a managed battery and is connected to PCE via the CANBUS (COM2). At present the only PCE which can manage the Guardian battery system is SMA Sunny Island. Management by other inverters will be added in the future.

Initial Startup

Initial startup of the battery system and the installation which it powers is as follows. Please note that if this procedure is not followed, the battery modules may shut down due to overload.

- Ensure that all PCE is OFF.
- Ensure that the circuit breaker on the front of each battery module is OFF.
- Ensure that all battery modules are shut down: All LEDs on the battery front panels are OFF.
- Close MCCB1 (Battery DC Isolator) on the battery system.
- If the system has a separate DC isolator supplying the battery power to the PCE (ie. If PCE is located > 2m from the battery system), turn this isolator ON.
- Check that the ON/OFF control on the PCE is in the OFF position.
- Measure the DC voltage on the PCE battery input using a multimeter. Confirm that this voltage is less than 2.0VDC. If this voltage is greater than 2.0VDC wait until this voltage discharges to less than 2.0VDC before proceeding.
- Switch the circuit breakers on the front of each battery module to “ON”.
- Push and hold the power button (marked “PUSH”) on the top battery module (B1) for greater than 8 seconds.



- PACK STATUS LED on the top battery module should turn SOLID or BLINKING GREEN indicating normal operation.
- After a few seconds, the remaining battery modules should automatically turn on by themselves and their PACK STATUS LED’s should also turn SOLID or BLINKING GREEN indicating normal operation.

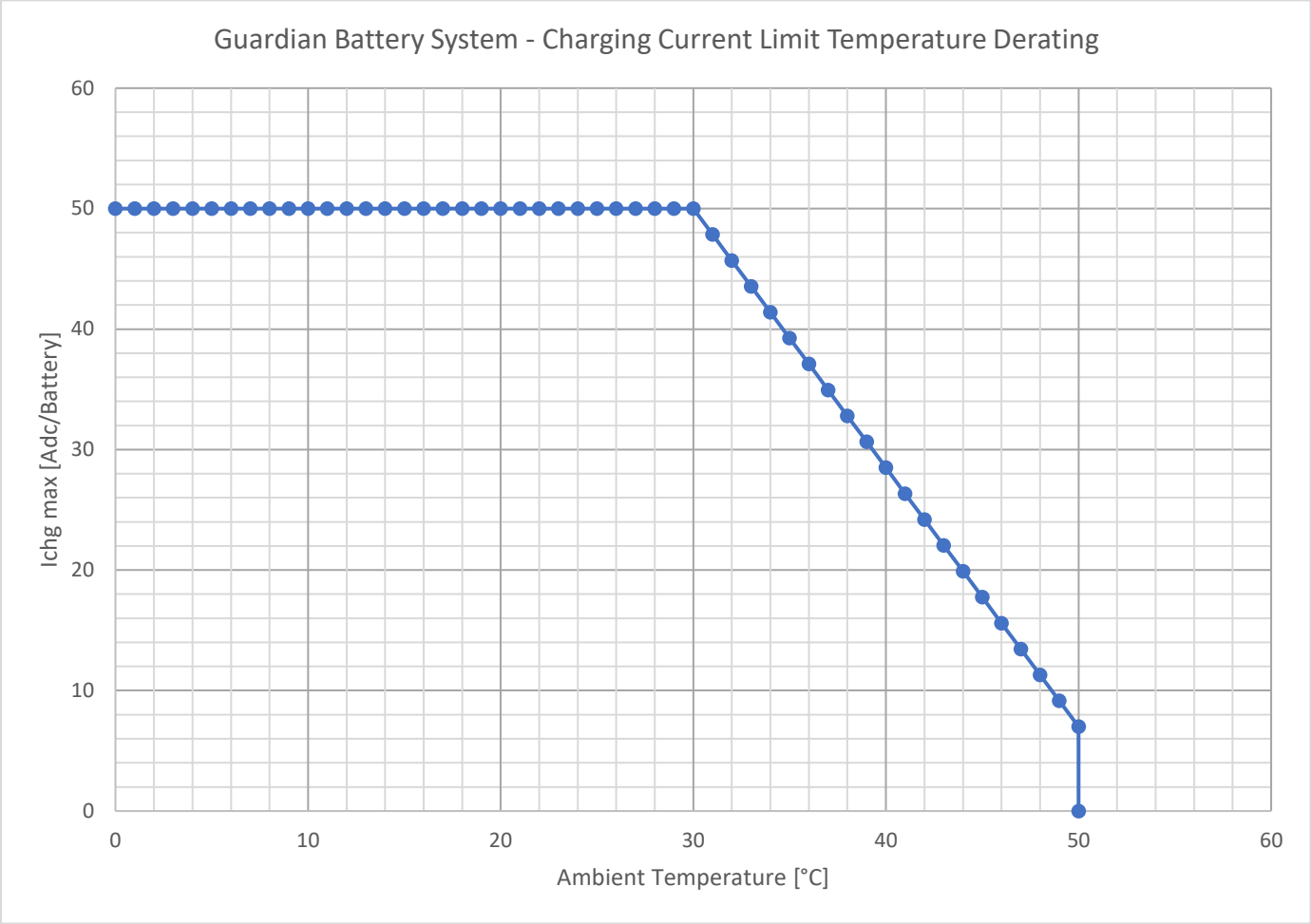
- After approximately 10 seconds, there should be an audible “click” from the SII, indicating that the startup sequence has completed. The electrolytic capacitors on the input to the PCE should be fully charged and the DC bus should be at operating voltage.
- Check that the PACK STATUS LED’s on all battery modules are SOLID or BLINKING GREEN.
- Check that all COM STATUS LED’s on all battery modules are OFF.
- If all PACK STATUS and COM STATUS LED’s are correct, proceed to PCE Configuration - Generic PCE Parameters below.
- If any of the PACK STATUS or COM STATUS LED’s are not correct, refer to the troubleshooting guide in “Troubleshooting”.
- If the PACK STATUS LED’s are steady RED on all battery modules, it is likely that the PCE battery input voltage was greater than 2.0VDC when the battery system was started by the “PUSH” button on the top battery. Shutdown the battery system following “Shutdown Procedure”, wait until the PCE battery input voltage is less than 2.0VDC and restart the system following the above procedure.

PCE Configuration - Generic PCE Parameters

Since the Guardian Battery System does not require direct communications with PCE and control of this PCE by the battery system, to ensure correct operation of the power installation and as a part of the Guardian Battery System’s warranty conditions, the operating parameters of the PCE must be configured to the following settings.

PCE Parameter	Setting	Remarks
Battery Charging		
Charging Mode	2-Step	Recommended charging mode. If not available, other modes can be used. See “PCE-Specific Configurations”.
Maximum Charging Voltage	57.4Vdc	Ensure charger switches to constant voltage charging as soon as maximum charging voltage is reached.
Charging Voltage Temperature Compensation	OFF	
Battery Charging Current Limit*	≤ 100A: G26 ≤ 150A: G38 ≤ 200A: G50	0°C ≤ T_a ≤ 30°C. Ta > 30°C: Derate per Temperature Derating Curve below.
Battery Discharging		
DC Input Low Shutdown	43.4Vdc	
Continuous Discharge Current*	≤ 160A: G26 ≤ 240A: G38 ≤ 250A: G50	0°C ≤ T_a ≤ 60°C

Notes:
* G26 = Guardian 26, G38 = Guardian 38, G50 = Guardian50



PCE-Specific Configurations

The following sections detail PCE-specific configuration which SEA requires for use with each model of PCE. Further PCE models will be added in the future. If your PCE is not included below, contact Solar Energy Australia for compatibility.

PCE Configuration – Victron Energy MultiPlus, MultiPlus-II, MultiPlus-II GX, Quattro or Quattro-II Inverter/Chargers

Refer to the appropriate manual from the following list (or alternate/revised manuals as advised by Victron Energy) for procedures to be followed in installing, connecting and configuring these inverter chargers. These can be downloaded from the Victron Energy website.

- Manual-MultiPlus-Compact-800-1200-1600-EN-NL-FR-DE-ES.pdf
- MultiPlus_2kVA-en.pdf
- Manual-MultiPlus-3k-230V-16A-50A-(firmware-xxxx4xx)-EN-NL-FR-DE-ES-SE.pdf
- Manual-MultiPlus-5k-100A-230V-(firmware-xxxx4xx)-EN-NL-FR-DE-ES-SE.pdf
- 32424-MultiPlus-II__Quattro-II_120V-230V-pdf-en.pdf
- 2983-MultiPlus-II_GX-pdf-en.pdf
- Manual-Quattro-5k-8k-10k-15K-100-100A-230V-(firmware-xxxx4xx)-EN-NL-FR-DE-ES-SE-IT

Setups shown below have been performed using VEConfigure 3 on a computer connected to a Quattro 48/10000/140-100/100 using a Victron Interface MK3-USB. Other equipment can be used provided that the same PCE configuration is achieved.

Victron Energy inverter/chargers employ an adaptive 4-stage charging characteristic which cannot be overridden.

- Ensure that no AC loads are connected to the PCE.
- Ensure that no AC power is present at the input of the PCE.
- Ensure that the “ON/OFF/CHARGER ONLY” switch on the front of the PCE is in the “OFF” position.
- Start up the battery system per Initial Startup above.
- Switch the “ON/OFF/CHARGER ONLY” switch to “ON”.
- Startup VEConfigure 3 and establish communications with the PCE.
- Enter the following settings.

General	Guardian 26	Guardian 38	Guardian 50
Enable battery monitor	Yes		
State of charge when Bulk finished	90%		
Battery capacity	500Ah	750Ah	1000Ah
Charge efficiency	0.96		

Charger	Guardian 26	Guardian 38	Guardian 50
Enable charger	Yes		
Weak AC input	No		
Stop after excessive bulk	No		
Lithium batteries	Yes		
Charge curve	FIXED		
Absorption voltage	57.40V		
Float voltage	56.00V		
Charge current (max.)*	100A	150A	200A
Absorption time	1.00 Hr		
Repeated absorption time	1.00 Hr		
Repeated absorption interval	7.00 Days		

* Limiting maximum combined total charge current including solar chargers via a GX or equivalent device is required for warranty

Inverter	Guardian 26	Guardian 38	Guardian 50
Inverter output voltage	230V or 240V as required by the installation.		
DC input low shutdown	43.40V		
DC input low restart	48.00V		
DC input low pre-alarm	48.00V		
Shut-down on SOC	No		
Power assist	As required by installation.		
Do not restart after short-circuit	As required by installation.		
Enable AES	As required by installation.		

- Click “Send settings” to programme the inverter/charger with these settings.
- On the “Charger” tab, create a new battery type with these settings and save it to the computer.
- The inverter/charger is now ready for use.

PCE Configuration - Selectronic SP Pro Series 2i Inverter/Chargers

Refer to the manual OI0003_42 004122 SP PRO Manual.pdf (or revised as advised by Selectronic Australia) for procedures to be followed in installing, connecting and configuring these inverter chargers. A copy of this manual is supplied with the inverter/charger. The latest revision can be downloaded from the Selectronic website.

Download and install the latest copy of SP LINK software from the Selectronic website. This is used to configure the SP PRO inverter/charger. Refer to the manual OI0005_30 SP LINK Manual.pdf (or revised as advised by Selectronic Australia) for use of the SP LINK software to configure the SP Pro.

The setup detailed below has been performed on a single SPMC482-AU in an off-grid installation using SP LINK version 15.0.8139. This is a simplified set of installation details for those parameters relevant to the Guardian battery system.

- Ensure that no AC loads are connected to the PCE.
- Ensure that no AC power is present at the input of the PCE.
- Connect the SP PRO to the computer using the USB cable supplied with the inverter/charger.
- Start up the battery system per Initial Startup above.
- Start up SP LINK on the computer.
- On the easy start guide select “Site Configuration Wizard”. If the easy start guide has not started automatically, go to menu File->Site Information->New (Easy Start Guide).
- On the “New Site Connection Details” screen, enter the site name, select “Single Inverter” and select “Select a detected USB Device for L1”. The SP PRO should appear in this drop-down box. Click “Next”
- On the “Select Battery Configuration” screen, select “Custom Battery Configuration”. Select “Lithium LiFePO4”, enter “Battery Capacity” in Ah and set “Max Charge Current” to 20% of battery capacity. Confirm that the maximum charge current in Amperes is as specified in the tables below. Click “Next”.
- On the “Source of Renewables” screen, enter the information relevant to the site. Note: If a DC Coupled Charge controller is to be used, ensure that a shunt to measure the output current from this device is installed in its negative output lead, as detailed under “DC Coupled Charge Controller Preparation” in the SP PRO manual, and the characteristics of this shunt are entered under “DC Coupled” on this screen. Click “Next”.
- On the “Select Unit Application” screen, select the appropriate application. In the installation detailed here, “Off Grid (no grid available) was selected. Click “Next”
- On the “Extra Options” screen, enter details of any of the listed devices if they are installed. Click “Next”.
- On the ”Generator” screen, enter the type of generator to be used in the system (No Generator, Auto Start Generator, or Manual Start Generator) and the “Generator Size” in kVA. Click “Next”.

- On the “Summary of settings” screen, verify the information. The details relevant to the Guardian battery system are listed in the table below. After confirming that the settings are correct, click “Finish”.

Easy Start Guide	Guardian 26	Guardian 38	Guardian 50
Battery Type	NMC (use Lithium LiFePO4)		
Battery Capacity	500Ah	750Ah	1000Ah
Max. Charge Current % of Battery Capacity & Amperes	20% / 100A	20% / 150A	20% / 200A

- On the “Next actions after finishing wizard”, note the actions to be performed. These as well as additional actions are detailed below. Click “OK”.
- Select the “Site Information” tab. Enter a “Site Name” and other site details in the top section as appropriate.
- On the “Site Information” tab, “Connection Settings” tab, confirm the method of connection, the SP PRO model and serial number and the Login Password. In this case, “Connection Type” = “USB”, “Model SPMC482 Serial ######”, “Login Password” = “Selectronic SP PRO”.
- On the “Configuration Settings” tab, confirm that the information in the “Quick Start” information is as entered above.
- On the “Configuration Settings” tab, “Inverter” tab, confirm / adjust the settings to the values in the following table.

Configuration Settings / Inverter	Guardian 26	Guardian 38	Guardian 50
Econo Power Save Mode			
Econo Mode	Disabled		
Econo Transition Level	10W		
Econo Pulse Period	0.5s		
Inverter Output			
Nominal AC Voltage	230V or 240V as required by the installation.		
Nominal AC Frequency	50Hz		
DC Shutdown			
Battery 0% Load	43.4V		
Battery 100% Load	43.4V		
Recovery Voltage	48.0V		
SoC Shutdown	Disabled		
Shutdown SoC	0%		

- On the “Configuration Settings” tab, “Battery” tab, confirm / adjust the settings to the values in the following table.

Configuration Settings / Battery	Guardian 26	Guardian 38	Guardian 50
Limits			
Max Charge Voltage	58.8V		
Hi Battery Alert	60.0V		
Hi Battery Alert Clear	59.0V		
AC Coupled Trip			
AC Coupled Trip	60.0V		
Over Target Charge Voltage Trip	2.0%		
Over Target Charge Current Trip	2.0%		
Trip Delay	2.0s		
BMS Charger Adjustment			
Float Voltage Adjust	0.0%		

Configuration Settings / Battery	Guardian 26	Guardian 38	Guardian 50
Current Target Scale	100%		
Battery			
Periodic Equalise	Disabled		
Equalise Period	28 Days		
Periodic Recharge	Disabled		
Recharge Period	28 Days		
Soft Battery	Disabled		
Mid Point			
Monitoring	Disabled		
Mid Point Range	5%		
Equalise Request	Disabled		
SoC Setting			
Peukert's Exponent	1.00		
Over Temp. Protection			
Limit Charge above	35°C		
Limit Rate	7%		

- On the "Configuration Settings" tab, "Charger" tab, confirm / adjust the settings to the values in the following table.

Configuration Settings / Charger	Guardian 26	Guardian 38	Guardian 50
Charge Settings			
Max. Charge Current	20% / 100A	20% / 150A	20% / 200A
Initial Return Voltage	54.2V		
Initial Return SoC	95%		
Initial Stage			
Voltage	57.4V		
Current	100% / 100A	100% / 150A	100% / 200A
Time	1 min		
Bulk Stage			
Voltage	57.4V		
Current	100% / 100A	100% / 150A	100% / 200A
Time	1 min		
Absorption Stage			
Voltage	57.4V		
Current	100% / 100A	100% / 150A	100% / 200A
Absorb-Float Transition			
Net Change	1.0%		
Change Time	30 min		
Max Time	60 min		
Float Stage			
Voltage	56.0V		
Current	100% / 100A	100% / 150A	100% / 200A
Long Term Voltage	56.0V		

Configuration Settings / Charger	Guardian 26	Guardian 38	Guardian 50
Equalise Stage			
Voltage	57.4V		
Current	100% / 100A	100% / 150A	100% /200A
Time	1.0 hours		
Battery Temperature Compensation	Not available / not adjustable / disabled		

- On “Configuration Settings” tab, other tabs, adjust settings as required by the remainder of the system. The changes on these other tabs are not related to the Guardian battery system.
- On menu File->Site Information-> Save, save the site information to the computer.
- On “Site Information” tab, “Connection Settings” tab, click “Connect”. The Status field at the top should change to “Connected to USB”.
- On the “Configuration Settings” tab, click “Configure SP PRO”. You will be prompted to enter the Settings Passcode. This is available in the SP LINK manual.
- You should receive a message that programming has succeeded.
- If the system uses a DC Coupled Charge Controller, zero the DC Solar Shunt as follows.
  - Turn off the DC coupled charge controller by turning off its circuit breaker.
  - On “Service Settings” tab, “Shunts”, click either “Zero Shunt 1” or “Zero Shunt 2” depending upon which shunt input the DC coupled charge controller is connected to.
- Adjust the SP PRO’s Battery SoC state of charge value as follows.
  - Monitor the Guardian battery system on a PC via the supplied DCA50152 MOD USB to RS485 Serial Cable using the Polarium™ Studio Application or via Bluetooth on a moblile device using the Polarium Connect Mobile App.
  - Note the “SOC usable capacity”. For this value to be valid, the battery modules in the Guardian battery system must be balanced. It may be necessary to delay adjusting the SP PRO’s Battery SoC state of charge value until after the initial charge has been performed on the Guardian battery system to balance the battery modules Refer to Initial Charge below.
  - In SP LINK, on “Service Settings” tab, “Reset SoC”, enter the SOC usable capacity in “New SoC” and click “Set SoC”. “Present SoC” should now read the correct SOC usable capacity.
- The Selectronic SP PRO inverter/charger is now ready for use.

PCE Configuration –Victron Energy SmartSolar MPPT and BlueSolar MPPT Solar Chargers

Refer to the appropriate manual from the following list (or alternate/revised manuals as advised by Victron Energy) for procedures to be followed in installing, connecting and configuring these solar chargers. These can be downloaded from the Victron Energy website.

- MPPT_solar_charger_manual-en.pdf
- 26939-MPPT_solar_charger_manual-pdf-en.pdf

The Victron Energy SmartSolar MPPT series employs an adaptive 4-stage charging characteristic which cannot be overridden.

Setups shown below have been performed using VictronConnect for iOS connected to a SmartSolar MPPT 250/100-Tr VE.Can via Bluetooth. Other methods of programming can be used provided that the same PCE configuration is achieved.

The SmartSolar MPPT can operate from 12, 24, 36 and 48V battery systems. On its initial startup, this solar charger configures which battery voltage it is connected to automatically, so it must be started up from the battery system as detailed here. Once it is configured, if the battery system is fully discharged and is OFF, this solar charger will start up from the PV array and then startup the battery system automatically.

- Ensure that the PV isolator and battery circuit breaker for the solar charger are turned off.

- Start up the Guardian battery system per Initial Startup above. If the battery energy system has already been commissioned, ensure it has been started up.
- Turn the battery circuit breaker for the solar charger ON. The solar charger will automatically detect that the battery system is a 48V system and will configure itself to default 48V settings.
- On your mobile device, open the VictronConnect app and connect to the solar charger using Bluetooth.
- Tap the settings icon in the upper right corner to go to the settings page. Tap “Battery” to open the battery settings page.
- Tap “Expert mode”.
- Confirm / enter the following settings.

General	Guardian 26	Guardian 38	Guardian 50
Battery voltage	48V		
Max charge current (max)*	100A	150A	200A
Charger enabled	Yes		
Battery preset	User defined		
Expert mode	On		

* Limiting maximum combined total charge current including inverter/chargers via a GX or equivalent device is required for warranty

Charge voltages	Guardian 26	Guardian 38	Guardian 50
Absorption voltage	57.4V		
Float voltage	56.0V		
Equalization voltage	57.4V		

Bulk	Guardian 26	Guardian 38	Guardian 50
Re-bulk voltage offset	0.40V		

Absorption	Guardian 26	Guardian 38	Guardian 50
Absorption duration	Fixed		
Absorption time	1h 0m		
Tail current	Disabled		

Equalization	Guardian 26	Guardian 38	Guardian 50
Equalization current percentage	0%		
Automatic equalization	Disabled		
Equalization stop mode	Fixed time		
Equalization duration	1h 0m		

Voltage compensation	Guardian 26	Guardian 38	Guardian 50
Temperature compensation	Disabled		

Battery limits	Guardian 26	Guardian 38	Guardian 50
Low temperature cut-off	0°C		

- The solar charger is now ready for use.

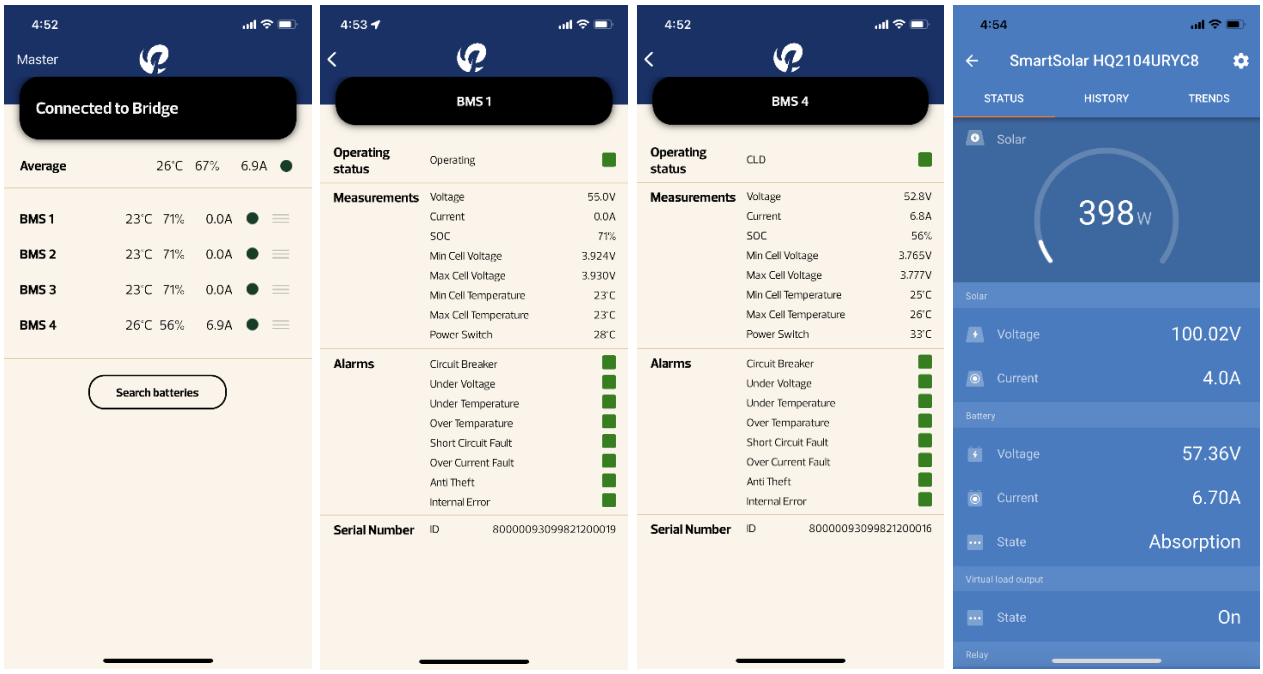
Initial Charge

Battery modules are shipped in a partial state of charge as is required for transportation. On commissioning for the first time, the Guardian battery system should be fully charged until the states of charge on all battery modules are greater than 80% and the voltages and states of charge of all cells and battery modules are balanced.

Since the battery modules in a Guardian system may have different initial states of charge, the CLD may activate on individual battery modules during this initial charge. The status of CLD’s can be monitored

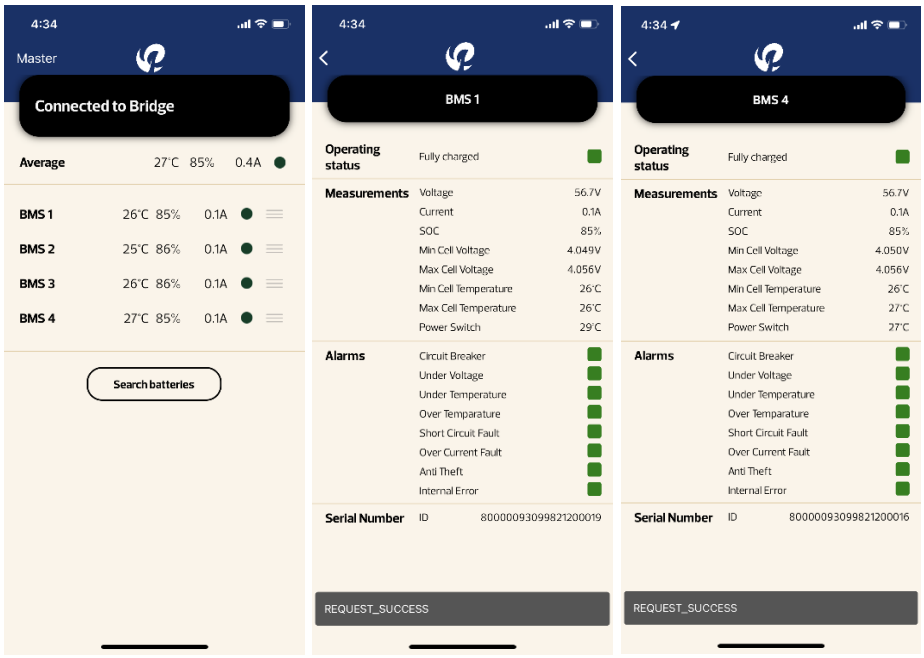
using a mobile device as shown below, or on a PC using Polarium Studio. During CLD operation on a battery module, the PACK STATUS LED's on the other battery modules in the Guardian system may blink green indicating that they have gone into Charge-Stop Balancing Mode. In the example below, the states of charge and voltages of B1, B2 and B3 are 77% and 55.0V, but B4 is only 56% and 52.8V. The CLD on BMS4 (B4) has activated limiting its charging current to 6.8A and BMS1 (B1), BMS2 (B2) and BMS3 (B3) have gone into Charge-Stop Balancing Mode reducing their charging currents to 0A. This is normal operation of the automatic battery balancing functions in the Guardian battery system. The output voltage from the PCE has risen to 57.36V (absorption) because it is able to provide more current than the 6.8A being drawn by the CLD in B4.

Battery Modules with Imbalanced SOC's – CLD and Charge-Stop Balancing Modes Active



After this initial charge, battery module states of charge and voltages should be well balanced as shown below.

Fully Charged and Balanced Battery Modules



The battery module states of charge and voltages should remain balanced due to the operation of the BMS in each battery module. Due to this tight balance, CLD's should never activate in normal operation.

Operation

Normal Startup from PCE after PCE DC Low Voltage Shutdown

In a typical installation, under normal operation with the battery system being discharge by the PCE, the PCE should shut itself down before the battery system shuts down due to low state of charge or low voltage. The battery system will remain operational after this PCE shutdown. When external power is available (eg. solar power or generator) the PCE should automatically restart.

Normal Startup from PCE after Battery System Shutdown

In a typical installation, battery system shutdown would only occur due to a low state of charge or low cell voltage. This situation could occur in the event the battery system was left operating in a low state of charge for an extended period of time. This situation could also occur due to a battery system overload.

Depending upon the behaviour of the PCE, no action should be required on the part of the user to restart the battery system. When external power is available to the PCE (eg. solar power or generator), the PCE should automatically restart and provide DC power to the installation. The battery modules will then sense the presence of this DC power, start up automatically and connect to the DC bus. The PCE should then start recharging the battery modules.

Since the battery system does not provide DC power to the PCE when the battery system is shut down, it is important that the PCE be able to start up without DC power as follows.

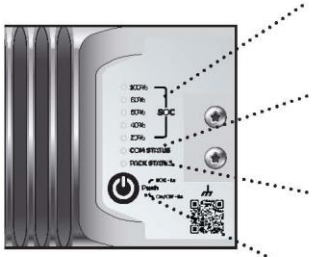
- For photovoltaic regulators, the regulator should be able to start up from PV array power alone without the presence of DC battery voltage.
- For inverter-chargers, the unit must be able to start up its inverter-charger circuitry from external AC power such as a generator. The inverter-charger must not require DC battery power to be present for this startup to work.

If the PCE cannot be restarted this way, the battery system will need to be restarted following the procedure in “Startup from Battery System – If required“ below.

Startup from Battery System – If required

In a system where the PCE and battery system have both shut down and in which the application of external power (eg. solar power or generator) to the PCE will not restart the system, the energy system will need to be started up from the battery system using the following procedure.

- Ensure that all PCE is OFF.
- Open the front door of the battery system to provide access to its controls.
- Ensure that the circuit breaker on the front of each battery module is OFF.
- Ensure that all battery modules are shut down: All LEDs on the battery module front panels are OFF. If the battery modules are not shut down, push and hold the power button (marked “PUSH”) for greater than 8 second on each battery module in turn starting with the top battery module (B1). This will turn all battery modules OFF.
- Close MCCB1 (Battery DC Isolator) on the battery system.
- If the system has a separate Battery DC Isolator supplying the battery power to the PCE (ie. If PCE is located > 2m from the battery system), turn this isolator ON.
- Check that the ON/OFF control on the PCE is in the OFF position.
- If a multimeter is available to measure the DC voltage on the PCE battery input, confirm that this voltage is less than 2.0VDC. If this voltage is greater than 2.0VDC wait until this voltage discharges to less than 2.0VDC before proceeding. If such a measurement cannot be made, wait several minutes for the DC voltage on the PCE battery input to discharge before proceeding.
- Switch the circuit breakers on the front of each battery module to “ON”.
- Push and hold the power button (marked “PUSH”) on the top battery module (B1) for greater than 8 seconds.



Marking: SOC
Indicator for the charge status of the battery.

Marking: COM STATUS
Indicator for the communication status of the battery.

Marking: PACK STATUS
Indicator for the operational status of the battery pack.

Marking: Push
Switch to activate battery when not connected to power source.

- PACK STATUS LED on the top battery module should turn SOLID or BLINKING GREEN indicating normal operation.
- After a few seconds, the remaining battery modules should automatically start up by themselves and their PACK STATUS LED's should also turn SOLID or BLINKING GREEN indicating normal operation.
- After approximately 10 seconds, there should be an audible "click" from the SII, indicating that the startup sequence has completed.
- Check that the PACK STATUS LED's on all battery modules are SOLID or BLINKING GREEN.
- Check that all COM STATUS LED's on all battery modules are OFF.
- If any of the PACK STATUS or COM STATUS LED's are not correct, refer to the troubleshooting guide in "Troubleshooting".
- If the PACK STATUS LED's are steady RED on all battery modules, it is likely that the PCE battery input voltage was greater than 2.0VDC when the battery system was started by the "PUSH" button on the top battery module. Shutdown the battery system following "Shutdown Procedure", wait until the PCE battery input voltage is less than 2.0VDC and restart the system following the above procedure.
- If all PACK STATUS and COM STATUS LED's are correct, turn the PCE ON following the PCE manufacturer's instructions. Typically this involves turning the ON/OFF control on the PCE to the ON position.

Shutdown Procedure

To shut down the battery system, perform the following procedure:

- Shut down and disconnect all PCE connected to the DC output of the battery system including inverters, chargers or inverter-chargers and solar regulators before performing this procedure. In systems where the inverter is greater than 2m from the battery system, turn the inverter's battery DC isolator to OFF.
- Open the front door of the battery system to provide access to its controls.
- Turn MCCB1, the battery system's DC isolator, to OFF.
- Individually turn the circuit breaker on the front panel of each battery module to OFF by pushing OFF. The PACK STATUS on each battery module should turn RED.
- Individually push and hold the power button (marked "PUSH") on each battery module for greater than 8 seconds until the PACK STATUS LED blinks, then release the power button. All LED's on each battery module should go out indicating that the battery module has shut down.

Battery Module Status LED's

The front panel of each battery module has seven LED's which display the status of the battery module. Information provided by the LED's is interpreted as follows:

- SOC LED's– Five LED's (20%, 40%, 60%, 80%, 100%): Battery state of charge. Battery modules are delivered with a state of charge less than 30% due to transport restrictions for lithium-ion batteries. Note that the actual state of charge is less than the maximum LED which is illuminated; for example, if the 40% LED is on, the actual SOC is in the range 20% to 40%.

- PACK STATUS LED:

Pack Status LED		
Steady Green		Normal Condition
Flashing Green		Charge-Stop Balancing Mode
Steady Red		Any Error Condition Preventing Discharge (DSG Alarm)
White		Report Faulty - Take Out of Service
Unlit		Shut Down or Waking Up

- COM STATUS LED:

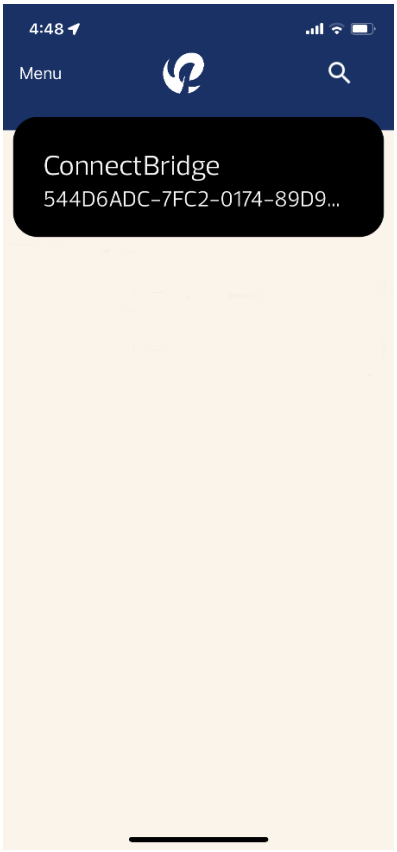
Communication Status LED		
Unlit		Normal Condition
Flashing Blue		Battery Installed Alone or Communication Failure

Monitoring using a Mobile Device

The Guardian battery system can be monitored from a mobile device via Bluetooth. Download the Polarium Connect Mobile App from the Apple App store or Google Play.

Connecting to Guardian Battery System

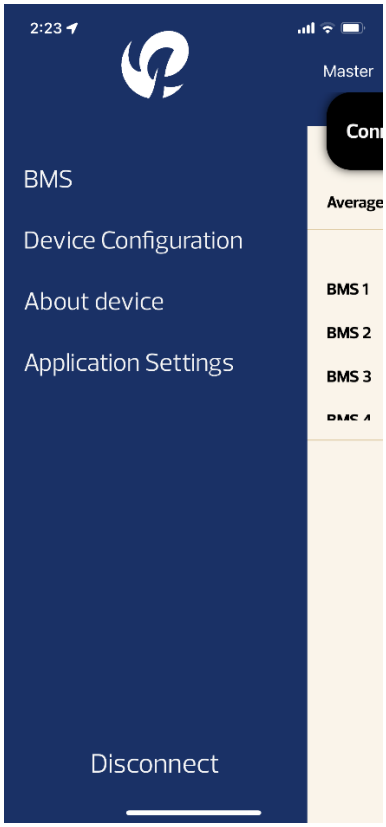
Open the Polarium Connect app on your mobile device and tap the search Icon. Select “ConnectBridge”. The app will open the camera on your mobile device. Scan the QR code on the top of the SII as shown below.

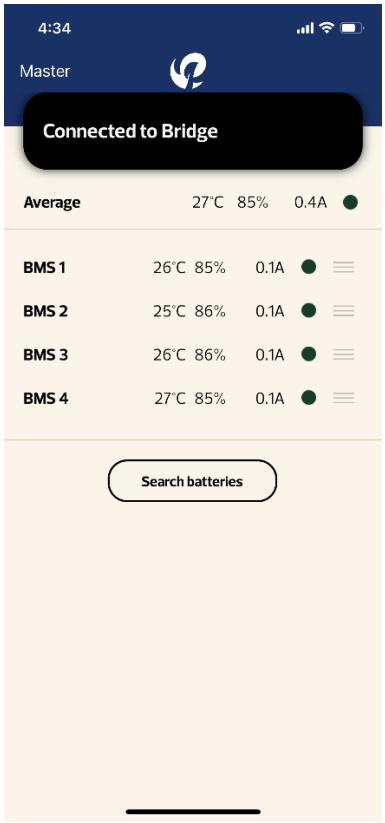


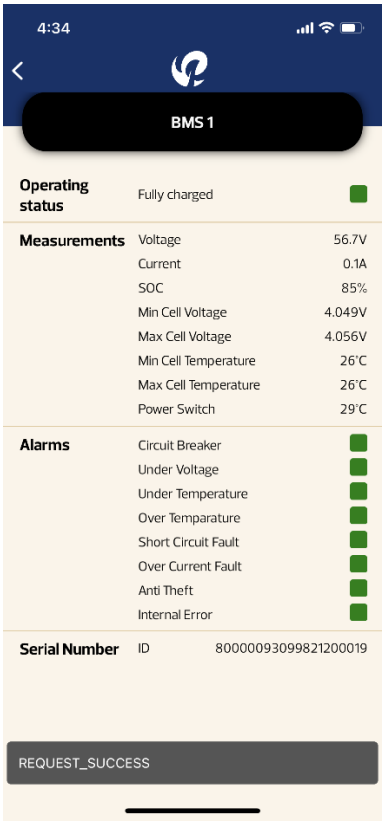
The app will connect to the ConnectBridge in the SII.

Guardian Battery System Battery Module BMS Data

When Polarium Connect first connects to the ConnectBridge in the SII, the “Connected to Bridge” screen should appear showing the summary of the BMS data from each battery as shown below. If the “Master” screen appears, tap “BMS” to go to the “Connected to Bridge” screen. If a summary of the BMS data from individual battery modules does not appear, tap “Search batteries”. Tapping on each individual BMS will show detailed data for that battery module.







Monitoring using Polarium™ Studio on a PC

The Guardian battery system can be monitored from a PC using the Polarium™ Studio PC Application. This program can be used by installers to monitor the operation of the battery system during commissioning and maintenance. A DCA50152 MOD USB to RS485 Serial Cable is included with each system to connect a PC USB port to the Guardian system's RJ45, RS485 MODBUS communications.

Software Installation

- Download the latest copy of Polarium Studio from https://polarium.com/studio/ .
- Extract the downloaded folder "setup_studio_#.#.#"
- Start the appropriate installer for the operating system being used.
  - Windows: "setup_studio_#.#.#.exe"
  - MAC: "._setup_studio_#.#.#.exe" in _MACOSX folder.
- Should a Windows security window pop up, press "Yes"
- Select a directory in which to install the software, then press "Next".
- Press Start.

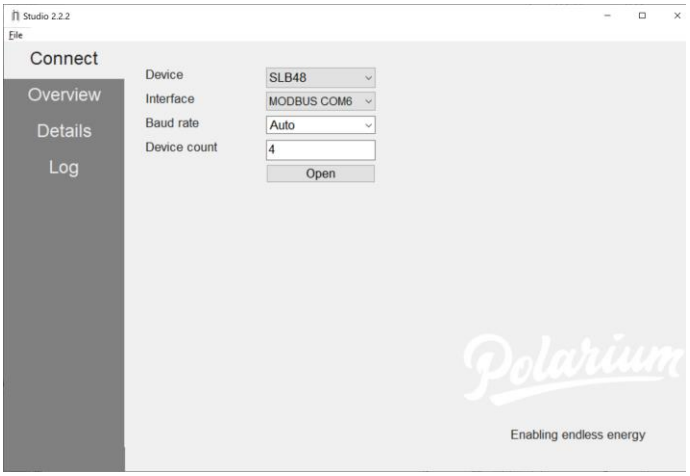
During installation, a folder will be created labelled "\Studio\#.#.#\" at the location designated. Remember this location as it is where the application is started from. The installer may create a desktop shortcut to this folder for quick access.

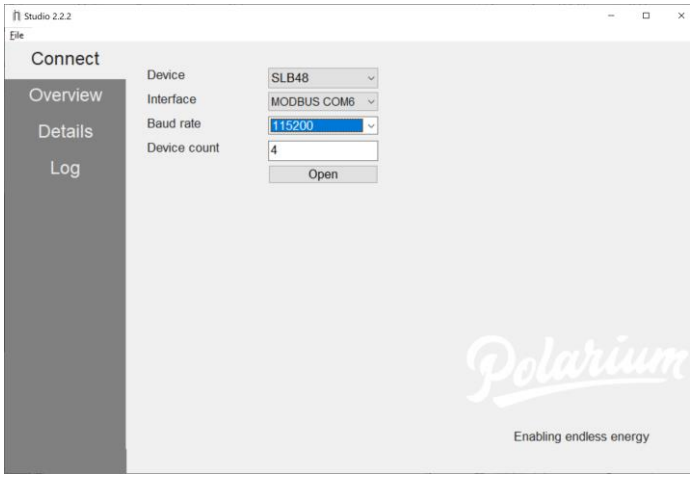
Installation of USB to RS485 Serial Cable

- Remove the RS458 terminator from COM1 in the terminal box of the Guardian battery system and plug the RJ45 end of the serial cable into COM1. Retain the terminator for reconnection in COM1 if the serial cable is to be disconnected in the future. This terminator is mandatory for proper operation of Guardian battery system's RS458 MODBUS communications.
- Plug the USB end of the serial cable into a free USB port on the PC.
- Wait for the PC to install the drivers for the serial cable. Note the COM port number.

Startup Polarium Studio and Connect to Guardian Battery System

- From the installation folder start Polarium Studio by executing the file "Studio.exe". The Connect screen will appear. Set "Device" = "SLB48", "Interface" = "MODBUS COM#" and "Baud rate" = 115200. Set "Device count" equal to the number of SLB48-250-146-2B modules installed in your Guardian battery system. The below example is for a Guardian50 system with four battery modules.

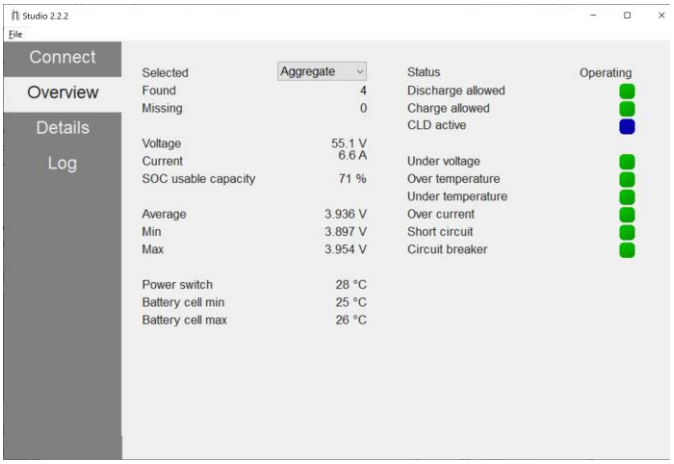




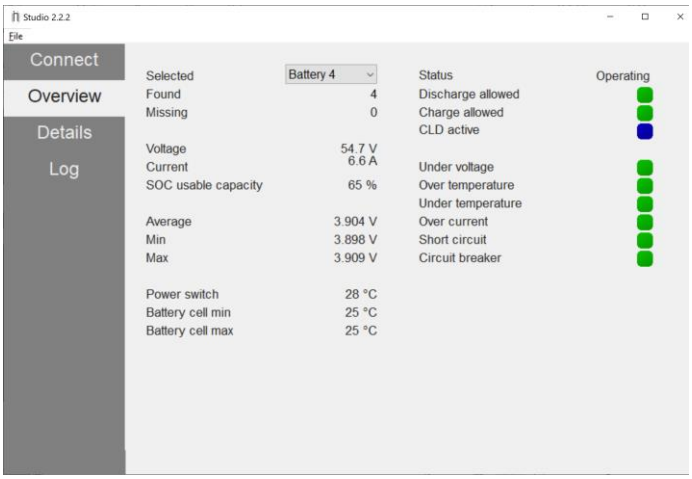
- Click "Open" to start communications with the Guardian battery system. Both the red and green LED's on the serial cable should flash.

Guardian Battery System Data

Click the “Overview” tab on the left of the screen to view the Guardian battery system data. By default, this screen displays the aggregate data (total or average as appropriate) for all battery modules in the system as shown below.



In the above case battery balancing is occurring. The CLD on battery module 4 is active since its voltage and state of charge is significantly less than those of battery modules 1 to 3 which are in Charge-Stop Balancing mode. Data on each individual battery module can be viewed by changing the “Selected” field as shown below.



Maintenance and Storage

The Guardian Battery System and Polarium lithium-ion battery modules are designed to be maintenance-free. The system should be installed in a clean, dirt and liquid-free environment and must be kept clean. Keep the front door closed except when performing maintenance on the system.

Maintenance

The battery system should be checked regularly as part of the system maintenance program or at least every six months. The following should be checked.

- Check that the PACK STATUS LED on each battery module is either SOLID or BLINKING GREEN.
- Check that the COM STATUS LED on each battery module is OFF.
- Check that the SOC LED's on all battery modules show identical states of charge. Any SOC display is which is different from the rest of the system by two LED's indicates a problem.
- Check that the ventilation fan on the front door is free from obstructions. Clean if necessary.
- Remove any obstructions from around the cabinet which may reduce ventilation.
- Check for any foreign objects inside and outside the enclosure. If cleaning is required, follow the procedure below.
- Check cables and connections for any damage.

Cleaning

Should cleaning be required, the following procedure should be followed.

- Shut down the energy system per "Shutdown Procedure".
- Use a soft, dry brush or a dust collector to remove the dust.
- Do not use liquids or solvents.
- Do not disconnect or contact any connectors.
- Any cleaning which requires disassembly of the battery system (eg. removal of the polycarbonate terminal cover or side covers) must be performed by a suitably qualified person.

Storage

Note that if the battery system is to be stored shut down for an extended period of time, self-discharge will occur. The battery system may be stored shut down for up to six months without detrimental effects if the following conditions are met.

- Before storing the battery system, recharge all battery modules to at least state of charge (SOC) ≥ 80% using charging parameters per "PCE Configuration - Generic PCE Parameters".
- To prevent degradation of performance store the battery system in a dry, cool environment.
- Storage Temperature: -20°C to 60°C
- Check the SOC of each battery module every six months.
- If a battery module SOC ≤ 20%, recharge all battery modules simultaneously to ≥ 80% using charging parameters per "PCE Configuration - Generic PCE Parameters". This prevents self-discharge to a level from which battery modules do not permit recovery.

Warranty

Solar Energy Australia battery systems come with a 10 year warranty.

See our warranty documentation for more information.

Troubleshooting

Diagnosis of many problems can be performed using the LED's on the front of each battery module as detailed in the table below. Troubleshooting should be performed by a suitably qualified person.

Reference: Polarium Energy Solutions AB. "Installation and Operation Instructions – Generation 5 Lithium Battery." *Product 770-00114 rev 6.1,* Section 5.13 "Maintenance and Troubleshooting".

FAULT Condition	Indication	Cause	Troubleshooting Steps
No DC Power from battery system	MCCB1 (Battery Isolator) is OFF.	Battery system has been overloaded due to an excessive load on the DC output.	1. Shut down system per "Shutdown Procedure" and restart system per "Normal Startup from PCE after Battery System Shutdown" or "Startup from Battery System – If required". 2. Confirm that the battery system size is at least the smallest compatible Guardian model for the installed PCE as specified in "PCE Compatibility". 3. Contact SEA service.
	One or more PACK STATUS LED's = Steady RED 	Any error condition preventing battery module from being discharged. (DSG alarm)	If this alarm condition is triggered, wait five (5) minutes before performing any troubleshooting steps. Possible causes and troubleshooting steps are detailed below.
		Battery module has been overloaded due to an excessive load on the DC output.	1. Shut down system per "Shutdown Procedure" and restart system per "Normal Startup from PCE after Battery System Shutdown" or "Startup from Battery System – If required". 2. Confirm that the battery system size is at least the smallest compatible Guardian model for the installed PCE as specified in "PCE Compatibility". 3. Contact SEA service.
		Battery module is low SOC or low cell voltage	1. Shut down system per "Shutdown Procedure" and restart system per "Normal Startup from PCE after Battery System Shutdown" or "Startup from Battery System – If required". 2. Confirm that the PCE low DC voltage shutdown is set correctly so that all load PCE shuts down at or above the battery's recommended minimum end of discharge voltage. 3. Contact SEA service.

FAULT Condition	Indication	Cause	Troubleshooting Steps
		Battery module has overheated.	1. Wait until the battery module has cooled down, at least two hours. 2. If necessary, shut down system per “Shutdown Procedure” and restart system per “Normal Startup from PCE after Battery System Shutdown” or “Startup from Battery System – If required 3. Check that the ventilation fan on the front door is free from obstructions. Clean if necessary. 4. Remove any obstructions from around the cabinet which may reduce ventilation. 5. Check that the ventilation louvres on the sides, rear and front door are free from obstructions. 6. Confirm that the separation distance between the battery system and any adjacent surfaces is provided per “Location and Environment 7. Confirm that the maximum charge current is less than or equal to the battery system’s recommended maximum charge current including ambient temperature derating. 8. Contact SEA service.
		The circuit breaker on the front panel of a battery module is OFF. Possibly caused by an overvoltage transient on the DC system.	1. Close the circuit breaker on the front of the battery module. 2. If necessary, shut down system per “Shutdown Procedure” and restart system per “Normal Startup from PCE after Battery System Shutdown” or “Startup from Battery System – If required”. 3. If an overvoltage condition is suspected, confirm that voltage settings of PCE are less than the maximums per battery system specifications. 4. Contact SEA service.
	All LED’s on all battery modules are OFF.	All battery modules have been shut down.	1. Restart system per “Normal Startup from PCE after Battery System Shutdown” or “Startup from Battery System – If required”
	All LED’s on one battery module are OFF.	Battery module has been shut down and front panel circuit breaker is OFF	1. Check connections to battery module. 2. Turn battery module front panel circuit breaker ON. If system is operating, battery module should automatically start up. 3. Contact SEA service.
Various	One or more PACK STATUS LED’s = Steady WHITE 	Internal failure in the battery module.	Contact SEA service.
	One or more PACK STATUS LED’s = Flashing GREEN 	Battery module is undergoing balancing operation. This is a normal function.	A battery module’s PACK STATUS LED will always flash when the module is undergoing charge balance operations. No troubleshooting steps are required.

FAULT Condition	Indication	Cause	Troubleshooting Steps
	One or more PACK STATUS LED's = Alternating RED & GREEN 	Can occur during manual shutdown. Battery module is unable to shut down.	1. Switch front panel circuit breaker on battery module to OFF. 2. Wait five minutes and retry shutdown. 3. If alternating RED & GREEN LED continues, this can indicate an internal fault with the battery module. Contact SEA service.
	One or more COM STATUS LED's = Flashing BLUE	Normal operation if only one battery module is operating. Other battery module(s) are shut down.	Normal indication. No troubleshooting steps are required.
		Communication failure between battery module and other battery modules.	1. Verify RJ45 RS485 COM cables are installed and secured correctly. 2. Verify RJ45 RS485 COM terminators are installed on both ends of the RS485 string. In a single system, these terminators are installed in COM1 and COM4 in the termination box. 3. Check for damage to RS485 COM cables. 4. Contact SEA service.
	Damage to battery system components or wiring. Overheating of cables or terminations.	Incorrect or inappropriate installation of battery system. Incorrect torquing of electrical connections.	Review system design and installation. Damage is not covered by system warranty.

Replacement of a Battery Module

Polarium battery modules are not user-serviceable and must be returned to Solar Energy Australia for service. Any attempt to repair a battery module will void its warranty. Contact SEA service

Replacement of a battery module is as follows.

- If a removed battery module is to be transported (eg. returned to SEA for repair), discharge the battery module to state of charge less than 30%.
- Shut down the battery system per “Shutdown Procedure”.
- Lock MCCB1 (System Battery DC Isolator) in the OFF position.
- If it is not possible to lock MCCB1, disconnect the DC output from the battery system from the remainder of the installation by unplugging the Amphenol 10.3m plugs from the sockets in the termination box (Red = +, Black = -).
- Remove the polycarbonate busbars cover from the busbar cover supports by removing the 4 x M6 x 16mm button head screws. Use a 4mm Allen key or screwdriver. Retain the busbar cover and fasteners.
- If necessary, (ie. if replacing B1 or B4), remove the appropriate busbar cover support by removing the 2 x M5 x 20mm Philips pan head screws with captive fasteners holding this in place. Use a No. 2 Philips screwdriver. Retain the busbar cover support and fasteners.
- Open the isolation cover on the battery module.
- Disconnect the RJ45 communications cable from the “A” and “B” sockets on the battery module. It is best to completely remove these cables from the system and retain them so that they are not damaged during removal and re-installation of the battery module.
- Remove the busbars from the battery module to be replaced and the battery module(s) or SII adjacent to it by removing the M8 bolts and wave washers holding these in place. Use a 13mm socket. Retain the busbars. Reinstall the M8 bolts and wave washers loosely to the battery module being removed.
- Close the isolation cover.
- Disconnect the battery module protective earth cable using a T30 Torx screwdriver. Move the protective earth cable out of the way so that it is not damaged during removal of the battery module. Retain the M6 shake-proof washer for installation on the replacement battery module. Reinstall the M6 screw loosely on the battery module being removed.
- Remove bottom mounting screws (2 x M5 x 20mm Philips pan head screws with captive washers) if replacing either B2 or B3. Use a No. 2 Philips screwdriver. Retain these fasteners.
- Remove the top mounting screws (2 x M6 x 16mm Pozidriv cage screws and retaining cup washers using a No. 3 Pozidriv screwdriver. Retain these fasteners.
- SLB48-250-146-2S battery modules are heavy (66kg each). If available, use a battery lifter or forklift when removing a battery module. Align the top of this equipment in front of the battery module to be removed, at or slightly below the bottom of the battery module. By pulling on the sides of the battery module, gradually slide the battery module onto the lifter.
- If the battery module is to be removed manually, at least two people are required. Follow workplace health and safety regulations.

- To install the replacement module(s) follow the installation procedure earlier in this manual starting at “Battery Module Safety Checks Before Installation”.
- Recommission the system with the replacement module(s) following “Setup and Commissioning”. Note that the state of charge of the replacement battery module does not need to be matched with the other battery modules in the system. The BMS’s in the battery modules determine the relative states of charge of the battery modules and automatically control charging to achieve balanced states of charge. During this charge balancing state, the PACK STATUS LED on one or more battery modules can BLINK GREEN. This does not indicate of a fault. The inclusion of the current limiting device on each

module ensures that all battery modules are charged without stress during this process and that tight state of charge balancing is achieved and maintained.

- After all battery modules are fully charged, check that the SOC LED's on all battery modules show identical states of charge.

Disposal of Battery Module or Battery System at End of Life

When a battery module reaches the end of its service life or becomes defective and cannot be repaired, it will need to be disposed of or recycled. There are dedicated recycling facilities for lithium-ion batteries.

Battery module disposal or recycling must be carried out by qualified personnel only.

- Follow local and national regulations associated with lithium-ion batteries.
- NOHSC:1008 Risk Phrase S56[7] – Dispose of this material and its container at a hazardous waste or special waste collection point.
- Do not disassemble battery modules. Battery modules can contain very high levels of energy which can result in both personal injury such as burns or electrical shock or resulting in fire or combustion of the battery cells.
- Do not dispose of battery modules with household waste.

[7] Henrik Lundgren. “Polarium Safety Data Sheet”, §15

Specifications

All specifications T_a = 25°C unless otherwise marked. Specifications subject to change without notice.

MODEL	GUARDIAN26	GUARDIAN38	GUARDIAN50
BATTERY MODULE	SLB48-250-146-2S 250Ah, 50.8Vdc, 12700Wh 51P, 14S	SLB48-250-146-2S 250Ah, 50.8Vdc, 12700Wh 51P, 14S	SLB48-250-146-2S 250Ah, 50.8Vdc, 12700Wh 51P, 14S
NUMBER OF MODULES	2	3	4
LITHIUM CHEMISTRY	NMC	NMC	NMC
CAPACITY [Ah][*1]	500	750	1000
NOMINAL ENERGY [Wh][*1]	25400	38100	50800
NOMINAL VOLTAGE [VDC]	50.8	50.8	50.8
CHARGE VOLTAGE [VDC]			
Maximum[*2]	58.8	58.8	58.8
Recommended maximum - warranty[*3]	57.4	57.4	57.4
END OF DISCHARGE VOLTAGE [VDC]			
Minimum[*4]	35.0	35.0	35.0
Recommended minimum – warranty[*5]	43.4	43.4	43.4
DISCHARGE CURRENT [Arms]			
Maximum / 60 seconds	200	300	400
Maximum / continuous	160	240	250[*6]
DISCHARGE OVERCURRENT CUTOFF[Arms][*7] 60 seconds	≥200	≥300	≥400
CHARGE CURRENT [ADC]			
Maximum	190	250	250
Recommended maximum – warranty[*8]	100	150	200
EFFICIENCY [%][*9]	>95		
SCALABILITY	Maximum 26 battery modules in parallel with a single RJ45 communications monitor loop.		
ELECTRICAL SAFETY	Complies with Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – Version 1.0, 06 July 2018		
SAFETY STANDARDS	IEC 62619 / IEC 62368-1 / UN38.3 (Battery modules)		
EMC STANDARDs	ETSI EN 300 386 1.6.1 (2012-09)		
BATTERY DESIGNATION[*10]	INR22/71[102P14S]M/-20+50/70	INR22/71[153P14S]M/-20+50/70	INR22/71[204P14S]M/-20+50/70
PROSPECTIVE SHORT CIRCUIT CURRENT $I_{SC} = I_{bf}$ [A]	2600	3900	5200
Arcing time, T_{arc} [µS]	85	85	85
OPERATING AMBIENT TEMPERATURE [°C]			
Charging [*11]	0 to 50		
Discharging	-20 to 60		
OPERATING RELATIVE HUMIDITY [%]	0-95: According to ETSI 300 019-1-3 class 3.2		
COOLING METHOD			
Battery Modules	Natural Convection		
Enclosure	Forced air – Thermostatically-controlled fan on front door – Airflow direction: Exhaust		
DIMENSIONS [wxdxh] [mm]			
Enclosure only	665 (w) x 714 (d) x 1280 (h)		
Overall	685 (w) x 763 (d) x 1280 (h)		
WEIGHT [kg]			
Battery Modules Not Installed	200		
Battery Modules Installed	332	393	454
PROTECTION CLASS	IP20		
TERMINATIONS			
DC Power			
Enclosure	Amphenol SurLok Plus 10.3mm Receptacles / +: Red, 180° / -: Black, 90°		
Mating Cable	2 x 1.5m 95mm² Flexible Double Insulated / R-E-110 Insulated, V90HT Sheath / Orange or equiv., to AS/NZS 5000.1 – 0.6/1kV Amphenol SurLok Plus 10.3mm Right Angle Plugs / +: Red, 180° / -: Black, 90° Supplied with unit.		
Protective Earth	M8 Stud		

MODEL	GUARDIAN26	GUARDIAN38	GUARDIAN50
Communication	4 x RJ45 CAT5E F/UTP COM1: RJ45, RS485, MODBUS, CAN – Daisy Chaining, MCU Access via Polarium Studio COM2: RJ45, RS485, MODBUS, CAN – Communication with / Control of PCE COM3: RJ45, Ethernet, SNMPV2, TCP/IP, MODBUS, Remote update of firmware COM4: RJ45, RS485, MODBUS, CAN – Daisy Chaining		
Terminal Box Location*12	B: Rear (Default) / L: Left / R: Right		
BATTERY DC ISOLATOR	Noark Electrics Ex9MD2B TM DC250 2P / Ics=Icu=25kA, In=250A, Ue=DC500, IEC/EN 60947-2 Overcurrent release: Thermo-magnetic Overload (Thermal) trip: Ir = In = 250A, T_a = 40°C Short-circuit (Magnetic) trip: Ii = 10In = 2500A MCCB1: Located on front panel inside door		
INDIVIDUAL BATTERY MODULE PROTECTION	Refer to System Block Diagram Sophisticated Battery Management System (BMS) 100A BMS-Controlled single pole circuit breaker on front panel BMS-Controlled electronic charge and discharge switches Charge Current Limiting Device (CLD)		

*1 Discharge: 0.2C, 25°C to 35Vdc.
*2 SOC = 100%
*3 SOC = 90%. Mandatory maximum for warranty.
*4 Cut off when one cell reaches 3.0V.
*5 PCE DC input low shutdown. SOC = 10%. Mandatory minimum for warranty.
*6 Limited by 250A MCCB1.
*7 Theoretical value with perfect battery module discharge current sharing. Actual value will be less depending on battery module balancing. Individual battery module's 60 second discharge overcurrent cutoff ≥ 100Arms.
*8 Derate per derating curve. Mandatory maximum for warranty.
*9 Discharge / Charge: 0.2C/0.2C.
*10 Per IEC62620
*11 Derate above 30°C per Guardian Battery System – Charging current limit temperature derating curve
*12 Part number subscript. Viewed facing front of enclosure.

Reference

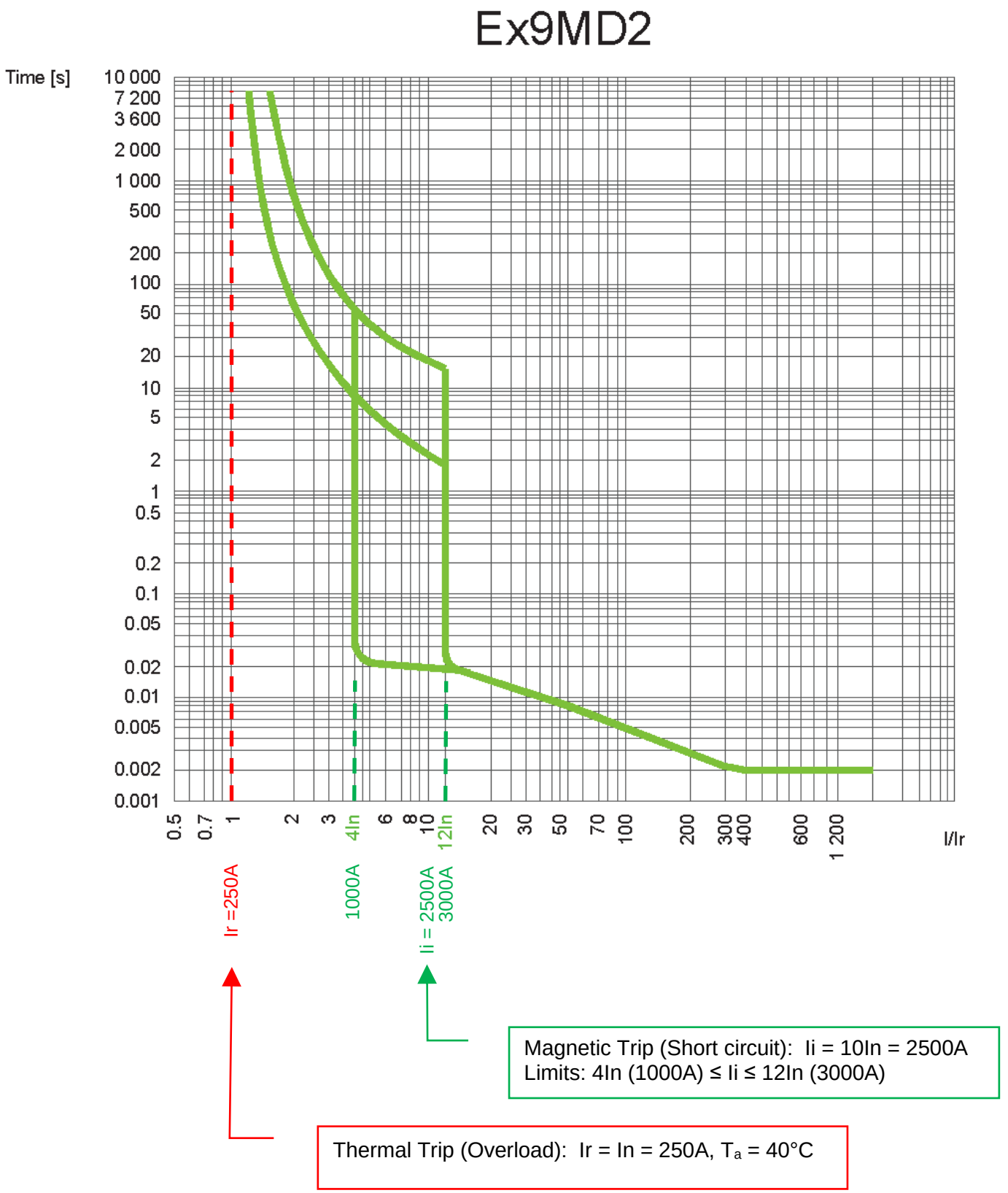
Torques

The following torques must be applied when tightening electrical connections in Guardian Battery Systems.

Connection	Fastener	Location(s)	Tool(s) Required	Torque [Nm]
DC Power	M8 Bolt with wave washer	SLB48-250-146-2S Battery modules: -48V & 0V connections Solar Inverter Interface (SII): -48V Battery, 0V, -48V Load connections	Torque wrench with 13mm socket.	15.0
Protective Earth	M6 Screw and internal star washer	SLB48-250-146-2S Battery Modules: Protective earth terminals	Torque screwdriver with T30 Torx drive	6.0
Protective Earth	M8 Full Nut with internal star, flat and spring washers	System protective earth terminal in termination box.	Torque wrench with 13mm socket	11.0
DC Power (system internal connections)	M6 x 25mm socket cap screw with 2 x spring washers, 2 x 19mm dia. flat washers and Nylok nut.	J1 and J2, Amphenol 10.3mm receptacles: busbar connections to internal 95mm^2 cabling.	5mm Allen Key, 10mm socket, Torque screwdriver or torque wrench.	4.0
DC Power (system internal connections)	M8 Bolt	MCCB1: Noark MCB connections to internal 95mm^2 cabling.	Torque screwdriver or torque wrench with 6mm Allen key	11.0
Protective Earth (system internal connections)	M6 Nylok Nut and star washer	Protective earthing cable connections for: Front door (both ends of cable), Left side cover, Right side cover, Rear cover, Top hat.	Torque screwdriver or torque wrench with 10mm socket	6.0
Protective Earth (system internal connections	M8 Nylok Nut and star washer	Internal system protective earth cable connection at termination box. Internal protective earth cable at enclosure base.	Torque wrench with 13mm socket.	11.0
Protective Earth (system internal connections)	M5 Brass Screws	Internal earth bar on right side. 2 x screws for each tunnel.	Torque screwdriver with No. 1 phillips or 5.5mm slot	2.0
Protective Earth (system internal connections)	M8 Bolt	Internal earth bar on right side. Main protective earth connection from termination box.	Torque wrench with 13mm socket	3.5
Protective Earth (system internal connections)	M4 x 25mm countersunk screw	Internal earth bar mounting to right side frame (2 x screws)	Torque screwdriver with No. 2 pozidriv	2.0

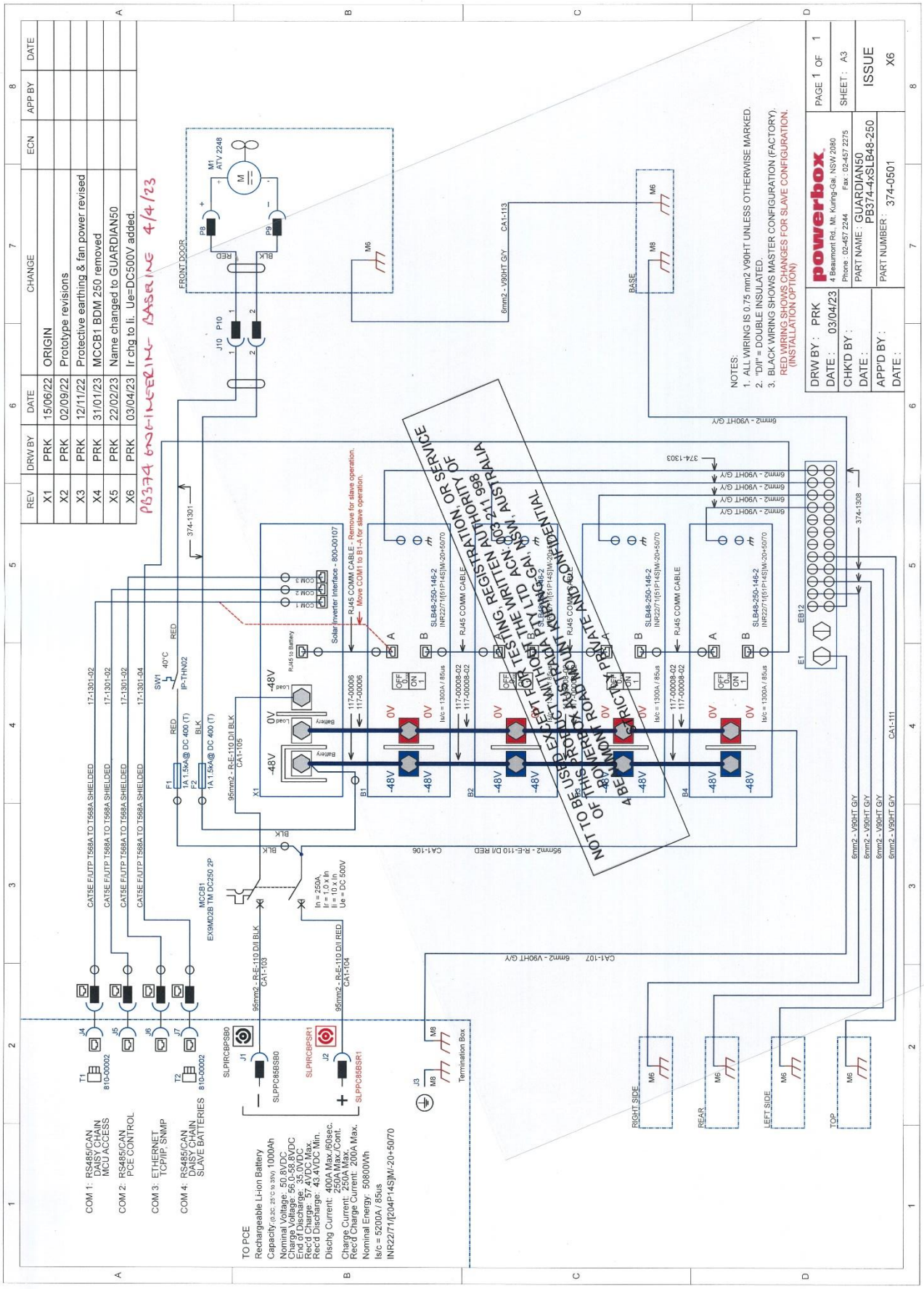
MCCB1 Trip Curve

Rated current: In = 250A

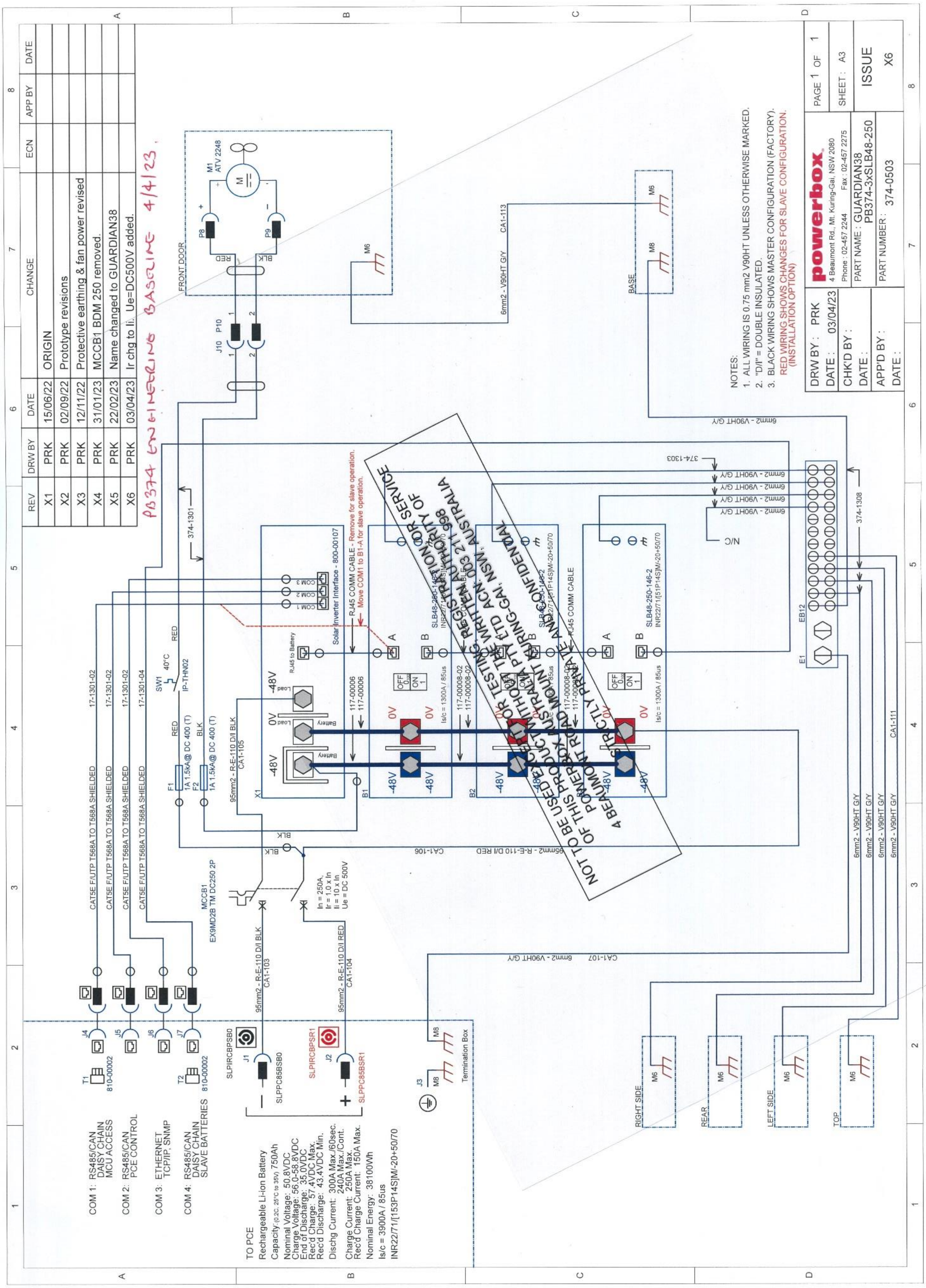


Wiring Diagrams

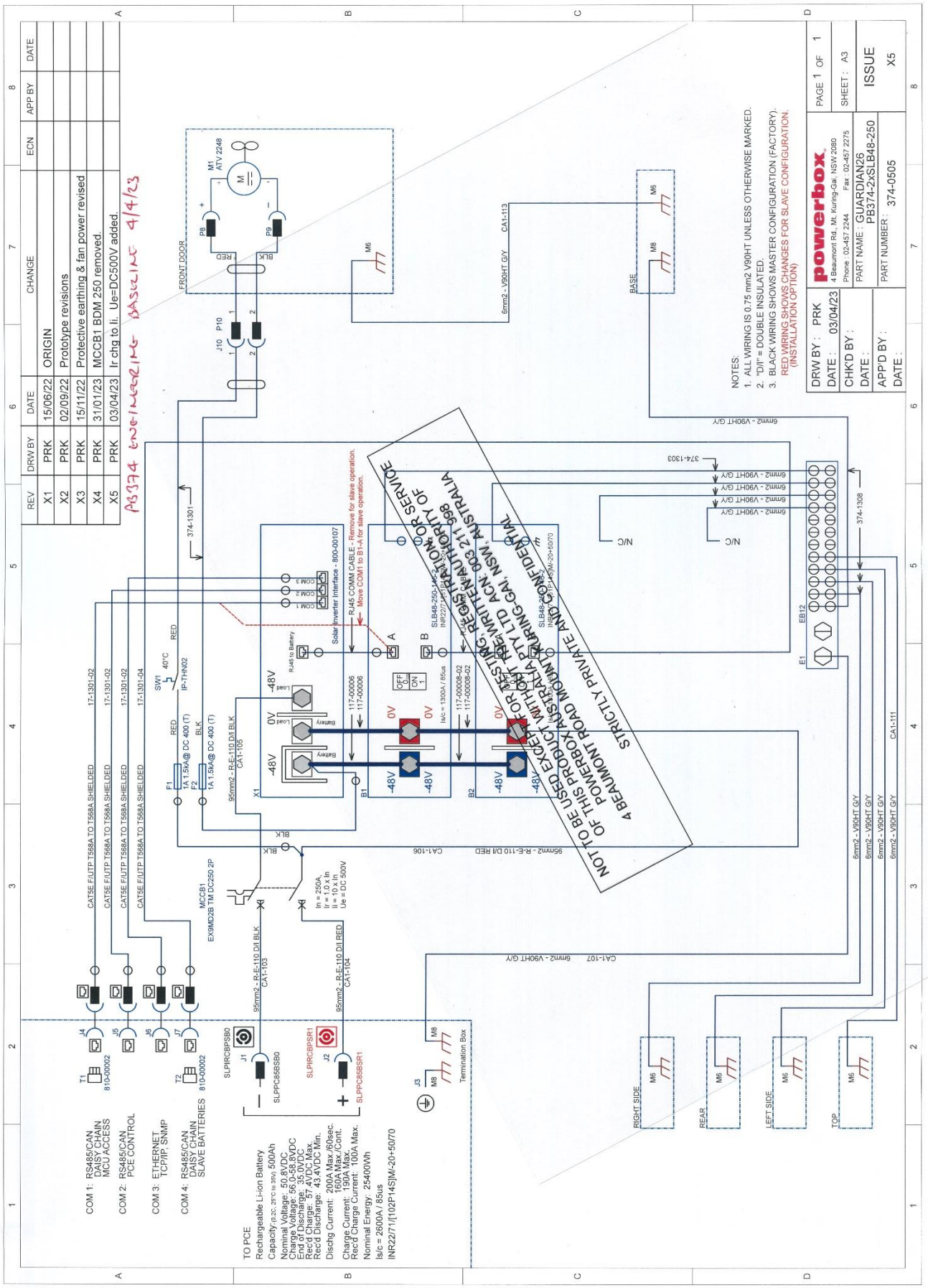
Guardian 50



Guardian 38



Guardian 26



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Contact

Solar Energy Australia
4 Beaumont Rd
Mount Kuring-Gai
NSW, 2080
Australia
sales@solaraustralia.com.au
1300 251 380