INSTALLATION GUIDE
AND USER MANUAL
L3 SERIES LIMITLESS LITHIUM™

L3 HVR

Effective Date: Oct. 10, 2025

READ THE INSTRUCTIONS COMPLETELY BEFORE OPERATING THE EQUIPMENT

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This manual is for only the **L3 Series Limitless Lithium™ Outdoor Battery Energy Storage System**.

For support, contact:

(USA) +1 (972) 575-8875 ext. 2

support@sol-ark.com

Contents

Important Safety Instructions

This manual provides crucial information for the installation and operation of the L3 Series Limitless Lithium™ Battery Energy Storage System. Qualified and authorized personnel are required to conduct the installation and maintenance procedures, adhering to all safety standards and system requirements outlined in this document.

This manual is applicable to countries that comply with the certification requirements. Standards and legal requirements of other countries might differ from the specifications outlined in this manual.

Symbols in this Document

WARNING: This symbol indicates information that, if ignored, could cause serious injury, equipment damage, or death.

CAUTION: This symbol indicates information that, if ignored, could result in minor injury or equipment damage.

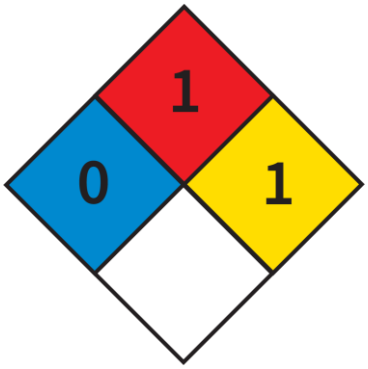
NOTE: This symbol indicates relevant information that is not related to hazardous situations.

Symbols on the Equipment

- **CAUTION**: Indicates risk of injury or equipment damage.
- **RISK OF ELECTRIC SHOCK**: Indicates components that present risk of electrical shock.
- **DO NOT INCINERATE**: Do not dispose of product by incineration.
- **RISK OF EXPLOSION**: Physical damage, fire, or over charging may cause Li-ion batteries to ignite and/or explode.
- **RECYCABLE**: Product is recyclable. Proper disposal is required.

REFER TO INSTRUCTIONS: User must refer to operating and installation instructions before proceeding.

- **cSGSus**: SGS marking indicates NRTL product testing and certification for compliance with standards for North America and Canada.
- **DO NOT THROW AWAY**: Proper disposal of inverters and/or batteries is required.



NFPA 704: The NFPA 704 diamond, often called the "fire diamond," is a system from the National Fire Protection Association (NFPA) to quickly communicate the hazards associated with a material.

It provides crucial information to emergency responders, such as firefighters, about the potential risks involved, enabling them to make informed decisions during emergencies.

Colors indicate the type of warning:

Blue	Health
Red	Flammability
Yellow	Reactivity
White	Space for additional Information
Numbers	Indicates the severity from **0** - no special hazard to **4** – severe hazard.

Notices

ATTENTION: Read all instructions and cautionary markings in this guide and on the equipment before installing the L3 HVR. Failure to do so may result in equipment damage, electric shock, serious injury, or loss of life. Failing to follow any of these instructions may also void the warranty.

All installations must conform to the laws, regulations, codes and standards applicable in the jurisdiction of installation. Before starting an installation, consult a local building or electrical inspector for current requirements. Local codes may vary but are adopted and enforced to promote safe electrical installations. A permit may be needed to do electrical work, and some codes may require an inspection of the electrical work.

When installed in the US, electrical installations are required to follow the National Electrical Code (ANSI/NFPA 70) adopted by their local AHJ (Authority Having Jurisdiction) including any local amendments.

General

WARNING: Risk of electric shock. Risk of fire. Only qualified electrical personnel should install, troubleshoot, service, or replace the equipment.

WARNING: Risk of electric shock. Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices during installation and service. Turn off all power supplying this equipment before working on or inside equipment. Always use a properly rated voltage-sensing device to confirm power is off. Replace all devices, covers, and doors before turning on power to the equipment.

WARNING: Inspect the equipment for damage before installing. Do not install the equipment if it has been damaged in any way.

WARNING: Do not insert foreign objects into any part of the equipment.

WARNING: Do not expose the equipment or any of its components to direct flame.

WARNING: Do not attempt to open, disassemble, repair, tamper with, or modify the equipment other than what is permitted in this manual. The equipment contains no user-serviceable parts. Contact the installer who installed the equipment for any repairs.

WARNING: Do not connect life-support systems, other medical equipment, or any other use where product failure could lead to injury to persons or loss of life.

CAUTION: Do not use solvents to clean the equipment or expose the equipment to flammable or harsh chemicals or vapors. Do not allow petroleum-based paints, solvents, or sprays to contact nonmetallic parts of the equipment.

CAUTION: Do not use parts or accessories other than those specified for use with the equipment.

Installation and Use

WARNING: Risk of electric shock. Risk of fire. Only use electrical system components approved for dry locations.

WARNING: Risk of electric shock. Risk of fire. Ensure that all wiring is correct and none of the wires are pinched or damaged.

WARNING: Risk of electric shock. Risk of fire. Before making any connections verify that the DC disconnect(s) are in the off position. Double check all wiring before applying power.

WARNING: Risk of electric shock. Improper servicing of the equipment or its components may result in a risk of shock or fire. To reduce these risks, disconnect all wiring before attempting any maintenance or cleaning.

WARNING: Risk of electric shock. Always de-energize the equipment before servicing.

WARNING: Risk of electric shock. Do not use equipment in a manner not specified by the manufacturer. Doing so may cause injury or loss of life, or damage to equipment.

Note: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Environmental Conditions

WARNING: This equipment is intended for operation in an environment having a minimum temperature of -20°C (-4°F) and a maximum temperature of 50°C (122°F).

WARNING: Install the equipment in a location that prevents damage from flooding. Ensure that no water sources are above or near the equipment, including downspouts, sprinklers, or faucets

Transportation and Handling

WARNING: To protect the equipment and components from damage when transporting, handle with care. To help prevent damage, leave all equipment in its shipping packaging until it is ready to be installed.

WARNING: Risk of physical injury or death. The battery rack is not designed for transportation with modules installed. Do not attempt to lift a fully installed rack using any lifting device.

WARNING: Risk of physical injury or death. Vehicles used to transport Lithium-ion batteries must comply with all Department of Transportation (DOT) regulations surrounding Class 9 hazardous freight.

WARNING: Risk of physical injury or death. Use caution when using lifting equipment to move battery modules and components.

WARNING: Risk of physical injury or death. Boxed battery module stacks should not exceed 8 units.

WARNING: Risk of physical injury or death. Each battery module weighs 44 kg (97 lbs). Use appropriate transport and lifting equipment for safe handling and transport.

Requirements for Installation Personnel

All work MUST comply with local code, regulations, and industry standards. The L3 HVR must be installed by professionals with appropriate qualifications as determined by the local AHJ.

Product Recycling

Due to its considerable size, the L3 HV series battery storage system requires special handling to be recycled properly.

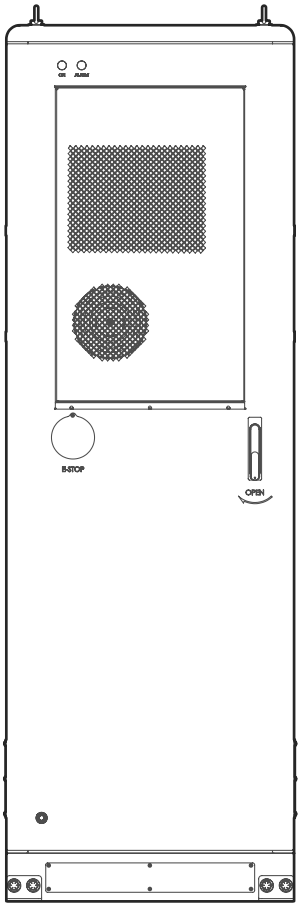
Proper recycling is crucial for lithium storage batteries. It keeps hazardous waste out of landfills and allows reusable materials like lithium and other metals to be recovered and repurposed. As the owner of the system, you are responsible for ensuring proper end-of-life recycling takes place through a certified lithium battery recycling program.

You must not attempt disposal via normal waste collection or abandon the battery at a public facility.

See Sol-Ark's recycling instructions when your energy storage system reaches the end of its usable life.

1. L3 Series: At First Glance

The L3 HVR Series Limitless Lithium™ is a high-performance lithium-ion battery system designed for outdoor energy storage applications. It offers reliable and efficient power solutions for time-of-use management, peak shaving, backup power, and micro-grid integration.



L3-HVR

Advanced Battery Management System (BMS)

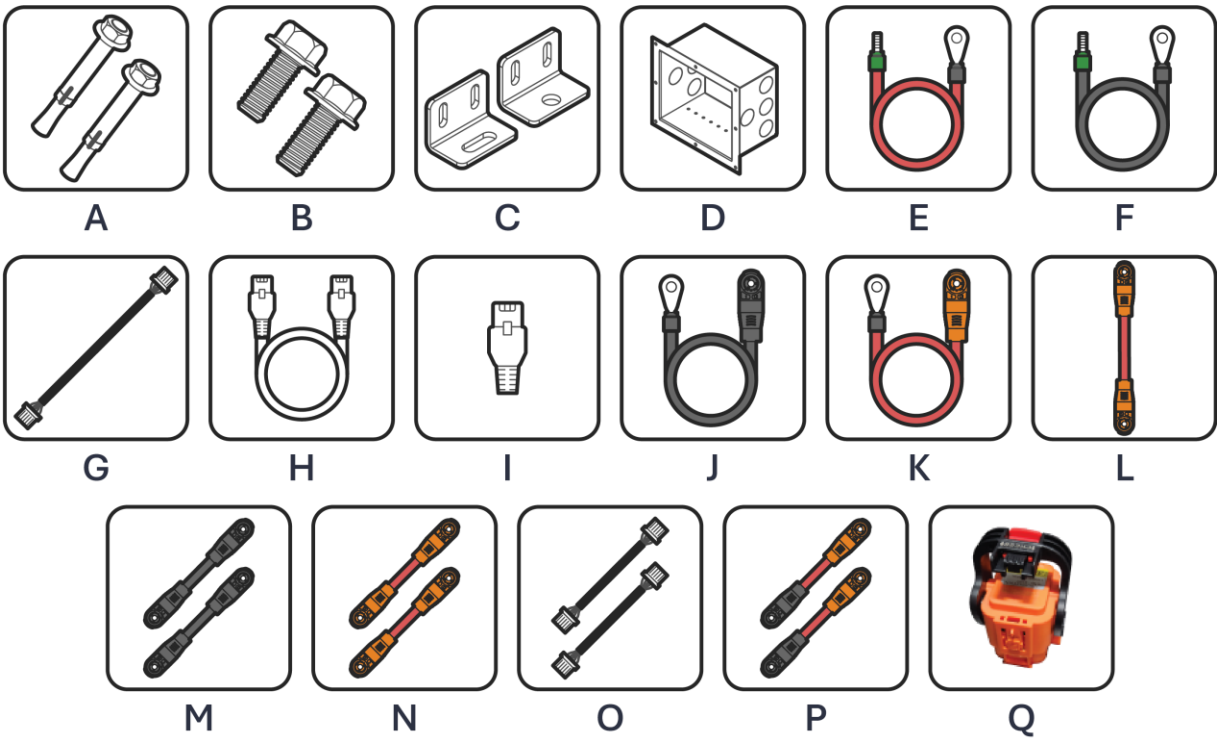
The HVR Series is equipped with a sophisticated automotive-grade, contactor-based BMS. This advanced system continuously monitors and manages the voltage, current, and temperature of all battery modules and cells, ensuring optimal performance and safety.

Comprehensive Fire Safety Features

Safety is a top priority in the design of the L3 HVR Series. The system incorporates built-in aerosol fire suppression systems in both the cabinet and battery modules. It also features smoke, heat, and CO2 detection mechanisms, providing multiple layers of protection against fire hazards.

1.2 What's in the box

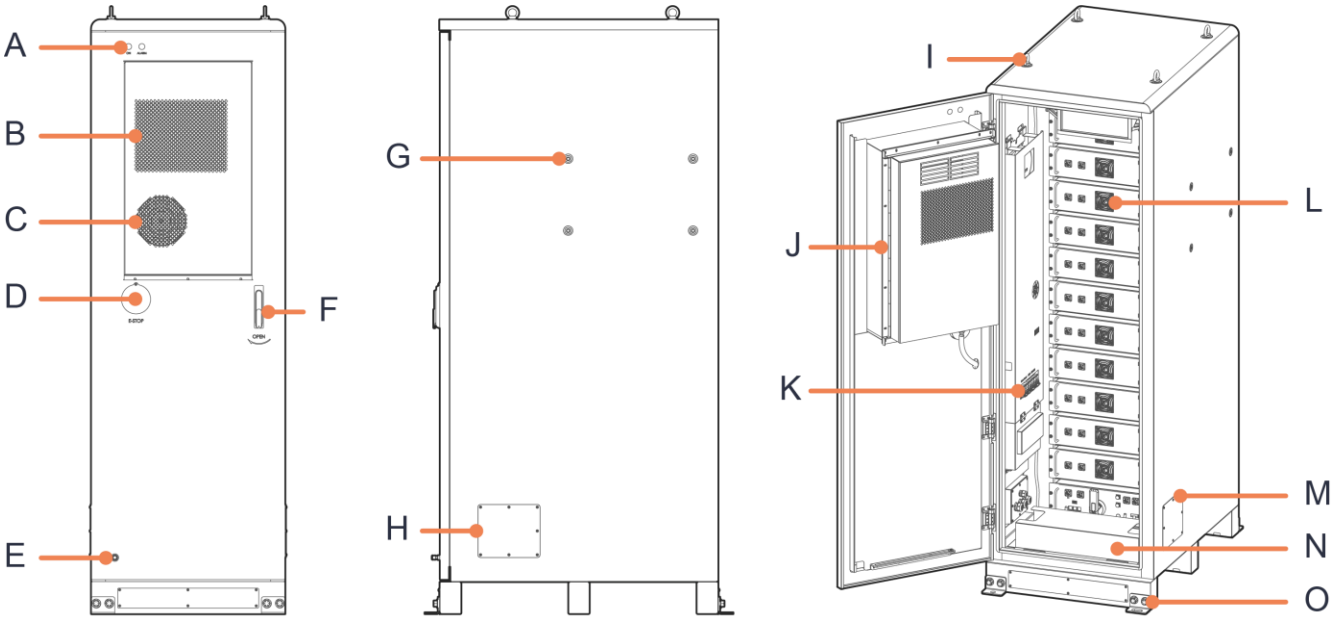
The box should include all items shown in the components list below. If there are damaged or missing parts, immediately call Sol-Ark Technical Support at +1 (972) 575-8875 ext. 2.



Component	Description	Quantity
A	M10x25 mm Bolts for Mounting Feet	8
B	M10 Battery mounting screws	4
C	Mounting Feet (2 Hole & 2 Slotted)	
D	R/L Cabinet Conduit Entry Knockout Box	2
E	9.8 ft (300 cm) P+ Inverter Cable (Red)	2
F	9.8 ft (300 cm) P- Inverter (Black)	2
G	BMS-to-Battery Module Communication Cable	1
H	16 ft (500 cm) Cabinet-to-Cabinet Ethernet Communication Cable	1
I	PCS Communication Port – 120 Ω Terminating Resistor	1
J	BMS-to-Busbar P- Cable (Black)	1
K	BMS-to-Busbar P+ Cable (Red)	1
L	BMS-to-Battery Module B+ Cable	1
M	Parallel Connection - Battery Module B- Cable (Black)	6
N	Parallel Connection - Battery Module B+ Cable (Red)	6
O	Series Connection - 4.3 in (110 mm) Battery Module Communication Cable	11
P	Series Connection - 8.5 in (215 mm) Battery Module Power Cable	11
Q	Manual Service Disconnect (MSD) Plug for Battery Negative	1

1.2 L3 HVR Components

The L3 HVR battery energy storage system includes the following components:



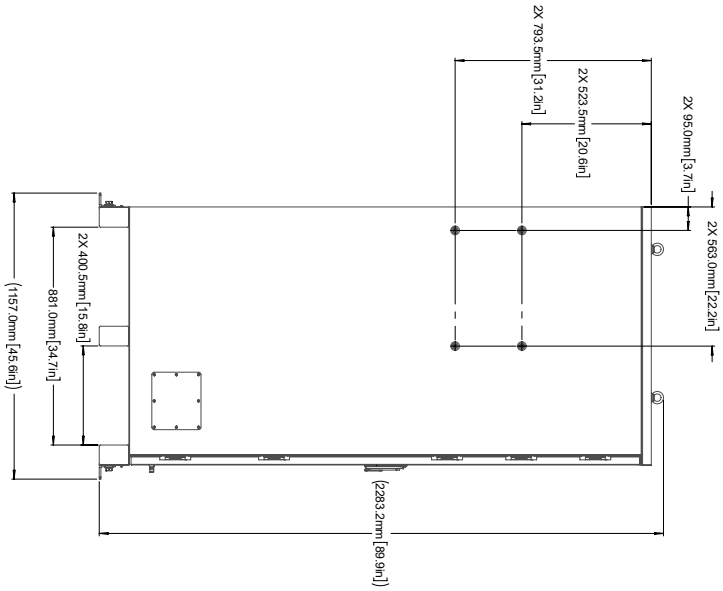
Component	Name
A	Indicator Lights (ON & ALARM)
B	HVAC Unit Air Outlet
C	HVAC Unit Air Intake
D	Emergency Stop Button (shuts down battery output)
E	HVAC Condensation Drain Outlet
F	Keyed Cabinet Door Handle
G	Inverter Carrier Mounting Holes
H	R/L Side Conduit Entry Cover
I	Lifting Points
J	HVAC Unit (Heating/Cooling)
K	Auxiliary Power Input Terminals and Internal Systems Breakers
L	12x L3 HVR-5.1 kWh Battery Modules
M	1x L3 HVR BMS-750 V - Battery Management System (BMS)
N	Safety Cover for Built-in DC Busbar
O	Cabinet Mounting Feet

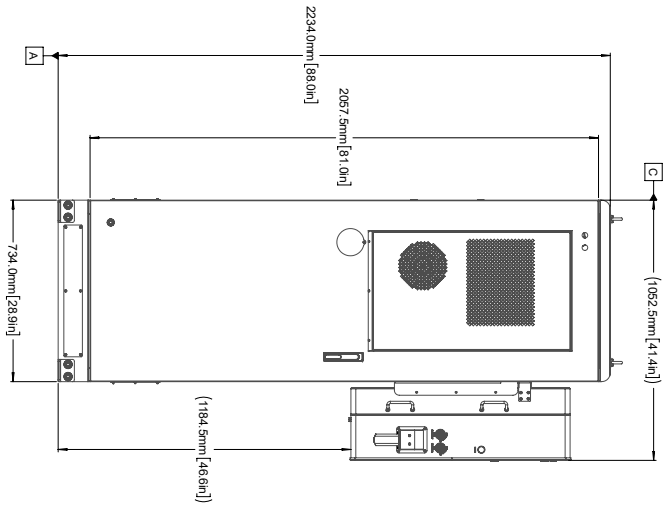
1.3 L3 HVR Fastener Torque Values

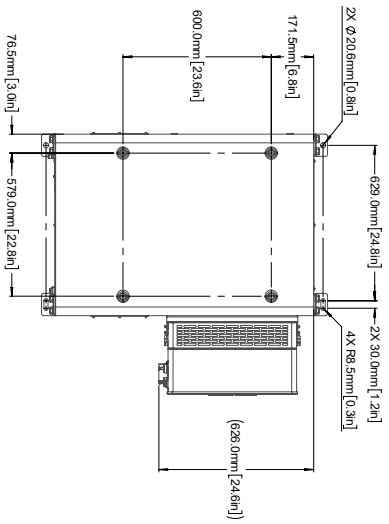
> ⚠ Do not use impact drivers to tighten any fasteners on the cabinet or inverter

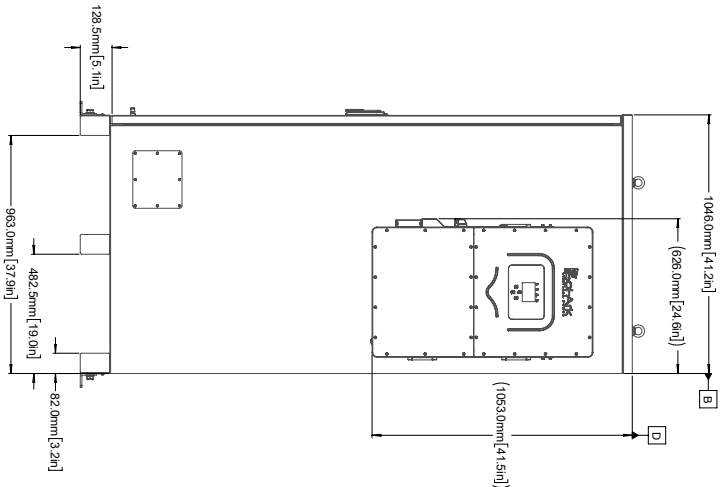
Connection	Torque [ft-lb or in-lb]	Torque [Nm]
M10 - Mounting Foot Bolts	37 ft-lb	51 N-m
M6 - Internal Busbar +/- Connections	7.7 ft-lb	10.5 N-m
M10 - Ext. Grounding Screws	37 ft-lb	51 N-m
M12 - Inverter Mounting Carrier Bolts	74 ft-lb	100 N-m
M4 - Inverter to Carrier Socket Screws	12 in-lb	1.37 N-m

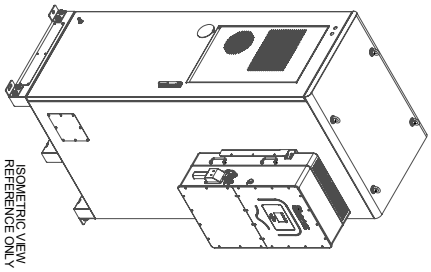
1.4 Specifications











L3 Series Limitless Lithium™

L3-HVR-60KWH

1.4.1 HVAC Unit Specifications

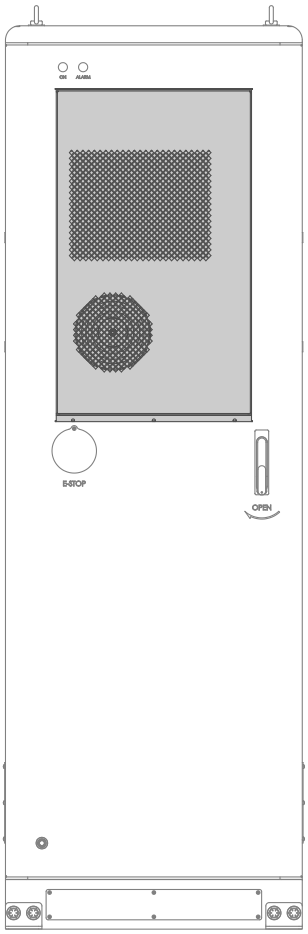


Figure 1: HVAC

HVAC Unit Specifications	
HVAC Unit Model Name:	DY-CNA20-BP (US)
Rated Input Voltage:	208 Vac or 240 Vac
Rated Frequency:	60 Hz
Max. Cooling Capacity:	7,165 BTU/hr
Max. Heating Capacity:	5,630 BTU/hr
Rated Power Input (Cooling):	900 W
Rated Power Input (Heating):	1,700 W
Rated Input Current (Cooling):	4.15 A
Rated Heating Current (Heating):	7.9 A
Max. Auxiliary Input Power (Wac):	1,800
Max. Auxiliary Input Current (Aac):	8.3
Max. Suction Pressure:	392 psi (2.7 Mpa)
Max. Discharge Pressure:	232 psi (1.6 Mpa)
Max. Air Flow Volume:	370 cfm (630 m^3/h)
Ingress Protection Rating:	IP55
Refrigerant Type:	R134a/330 g
Dimensions (W x H x D):	478 x 796 x 306 mm (18.8 x 31.3 x 12 in)
Unit Net Weight:	48.5 kg (107 lb)

DATASHEET

L3 HVR

SKU: **L3-HVR-60KWH**

60K-3P-480V Inverter 30K-3P-208V Inverter

System Data		
Compatible Inverter Model	Sol-Ark 60K-3P-480V	Sol-Ark 30K-3P-208V
Cell Chemistry	Lithium Iron Phosphate	Lithium Iron Phosphate
Nameplate Energy Capacity (DC)	61.44 kWh	61.44 kWh
Usable Energy Capacity (DC) 1	55.30 kWh	55.30 kWh
Built-In DC Disconnect Rating	200A	200A
Internal Fuse Rating	160A	160A
Max. # Battery Units Per Inverter	6	6
Max. # Inverters in Parallel	6	6
Recommend Depth of Discharge	90%	90%
Roundtrip Efficiency Charge/Discharge (DC)	94% (25C, 0.5C)	94% (25C, 0.5C)
System Nominal Voltage (DC)	614.4V	307V
System Operating Voltage (DC)	588V-672V	294V - 336V
Battery Pack Internal Configuration	12s1p	6s2p
Charge/Discharge Current (DC): [2]		
- Recommended	100A	100A
- Max. Continuous	100A	100A
- Peak Discharge (60 sec @ 25°C)	125A	125A
Battery Max. Continuous Charge/Discharge Power (DC)	61.44kW	61.44kW
ESS Max. Cont. Charge/Discharge Power (AC)	60kW	30K
Fault Current Contribution per Battery	4,200A / 1.47ms	4,200A / 1.47ms
Mechanical Specifications		
Product Dimensions (WxDxH)	76x107x226 cm (30x42x89 in)	76x107x226 cm (30x42x89 in)
Net Weight	950 kg (2,095 lbs)	950 kg (2,095 lbs)
Mounting Type	Outdoor Enclosure	Outdoor Enclosure
Material and Finish	Steel – Corrosion Resistant Powder Coat	Steel – Corrosion Resistant Powder Coat
Operating Temperature[3] and Humidity	-20°C – 50°C (-4°F – 122°F) – 5%–85% RH	4°C – 43°C (40°F – 110°F) – 5%–85% RH
Operating Altitude [4]	3000m (9,843 ft)	3000m (9,843 ft)
Storage Conditions [5]	-4°F – 95°F – Up to 85% RH (non-condensing) and State of Charge (SOC) 30%	
Ingress Rating	IP55 (NEMA 3R)	IP55 (NEMA 3R)
Noise Level @ 1m	75 dBA at 30°C (86°F)	75 dBA at 30°C (86°F)
Seismic Mounting	Up to Category F	Up to Category F
Communication Ports	CAN2.0/RS485	CAN2.0/RS485
Battery Module Specifications		
Battery Module Nominal Energy Capacity	5.12kWh	
Battery Module Nominal Voltage & Capacity	51.2V / 100Ah	
Terminal Type	Amphenol SurLok - Push Lock Connector	
Warranty and Certification		
Performance Warranty [6]	10 years or 196MWh Throughput	10 years or 130MWh Throughput
Product Warranty	10 years	10 years
Certifications	UL1973, UL9540, UL9540a, UN38.3, FCC, Prop 65	

1. DC usable energy, test conditions: 90% DOD, 0.3C charge and discharge at 25°C. System usable energy may vary due to system configuration parameters.
2. Output current is affected by battery temperature and SOC.
3. Temperature is based on average cell temperature measured by the BMS. Charging is disabled below 0°C (32°F). Derating occurs above 45°C (113°F). Contact Sol-Ark for Technical Sales for outdoor sites.
4. Battery will operate at a maximum 1C charge/discharge up to 2000m, above 2000m maximum output is derated to 0.8C, contact Sol-Ark for details.
5. Storage temperature of the battery with no charge or discharge
6. EOL (End of Life) 70% retained capacity. See L3 Series warranty document for details.

Sol-Ark has a policy of continuous improvement and reserves the right to modify its specifications at any time and without prior notice. See sol-ark.com for the latest information.

2. Installation

2.1 Transportation and Lifting

Forklift

If the installation site has a flat surface level, you can use an outdoor-rated forklift for transport, provided it has a rated load capacity of more than **1500 kg (3300 lb)** and its fork length meets the requirements shown in the illustration below. The bottom of the L3 HVR cabinet has special openings designed for forklift transport.

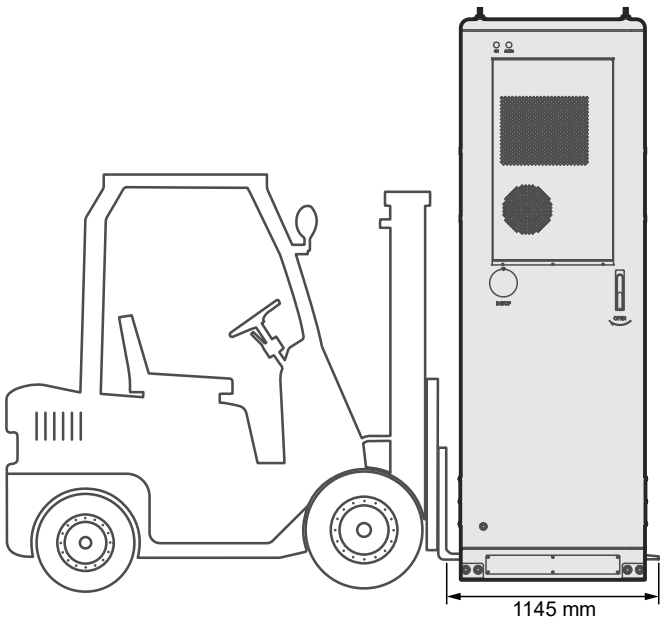


Figure 2: Forklift Transportation

Overhead Hoisting

When hoisting, a 25-ton crane with a lifting arm between 126 to 133 feet (38.5 to 40.5 m) in length should be used. The following requirements must be met when lifting the L3 HVR:

- Follow all local, state, and federal safety requirements for rigging during the installation process.
- A professional rigging operator should be present during the hoisting process.
- The strength of the sling should be able to withstand the weight of the L3 HVR battery cabinet and modules with appropriate safety factor.
- Make sure that all sling connections are safe and reliable, and that the lengths of the slings connected to the eye bolts are equal.
- Adjust the length of the sling appropriately according to the requirements of the site.
- During the lifting process, the devices must be stable and not skewed.
- Lift the L3 HVR only from the mounting locations shown below.

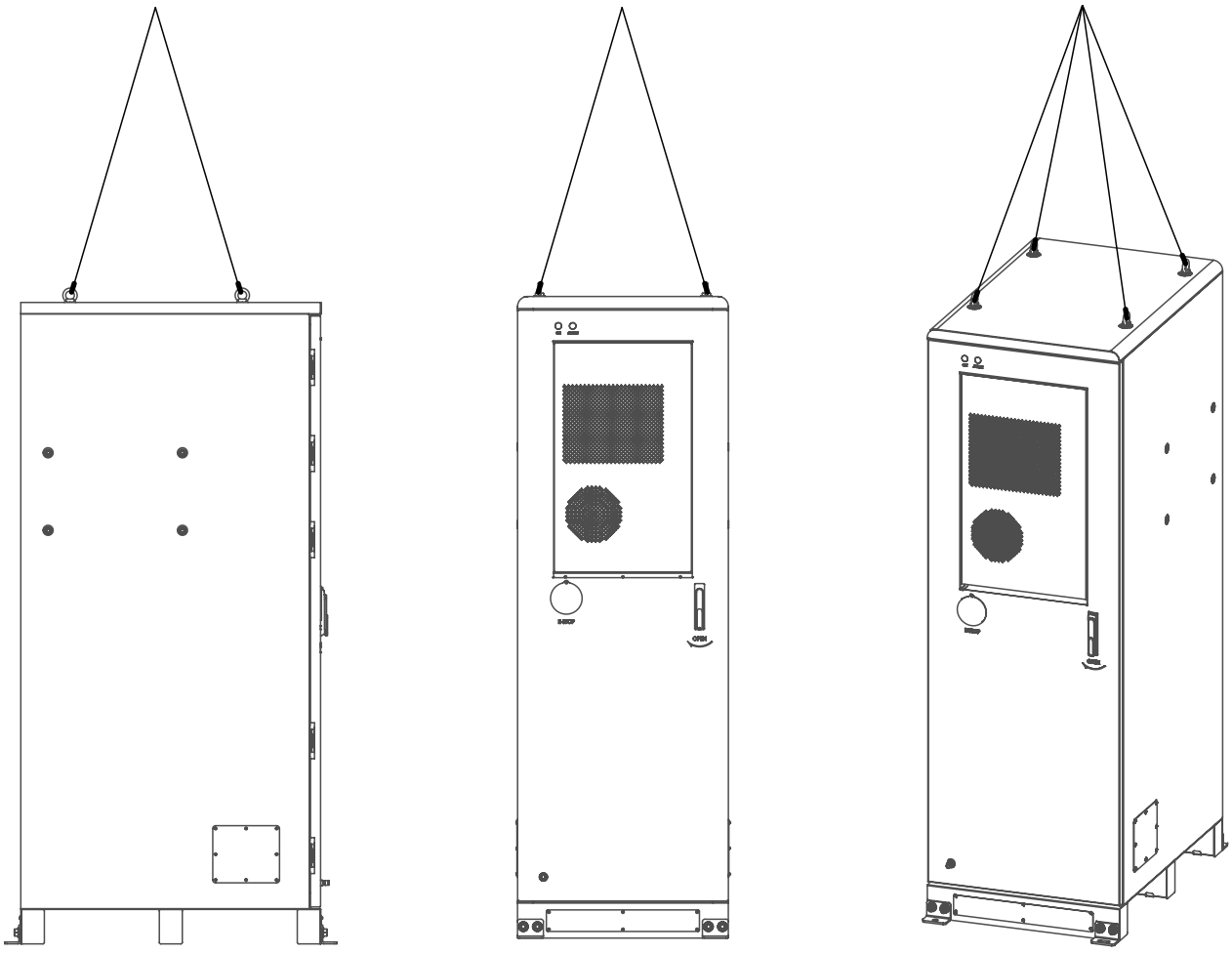


Figure 3: Overhead Hoisting

2.2 Site Preparation

Basic Installation Requirements

The battery energy storage system must be installed on a level, solid foundation that can safely bear the total weight of the system when fully loaded with battery modules.

- The installation location must provide adequate clear space around the system for ventilation, cooling, maintenance access, and clearances according to this documentation and the National Electrical Code® Art. 110.26, or other local requirements for energy storage systems.
- Fully-enclosed or indoor installations require additional ventilation and/or fire protection systems according to local codes.

Outdoor Installation Requirements

- The foundation should be constructed with proper drainage sloping away from the foundation to prevent pooling of water near the cabinet base.
- The foundation pad should extend at least 24 inches beyond the footprint of the system on all sides to facilitate maintenance and repairs. Evaluate smaller distances on a site-by-site basis.
- The installation must be located away from potential flood zones, drainage areas, or other areas prone to standing water.
- Shaded locations are preferable to reduce cooling load on the HVAC system.
- The area should have adequate fencing and lighting as required by local building and mechanical code or other requirements for energy storage systems.

Foundation Details

This section includes illustrations of various methods for mounting the L3 HVR Series. The diagrams show typical foundation layouts and anchoring techniques that could be used across many different site locations.

> ⚠ These drawings are for **illustration only** and should not be used as direct design examples. Always consult applicable local building codes, electrical standards, and engineering specifications before designing or implementing any foundation or mounting system for L3 Series energy storage systems.

Each illustration includes general dimensions, material suggestions, and key components. However, specific requirements will vary based on factors such as:

- Local seismic activity
- Soil conditions
- Environmental factors (such as flood plains or extreme weather)

Single Cabinet Foundation Detail

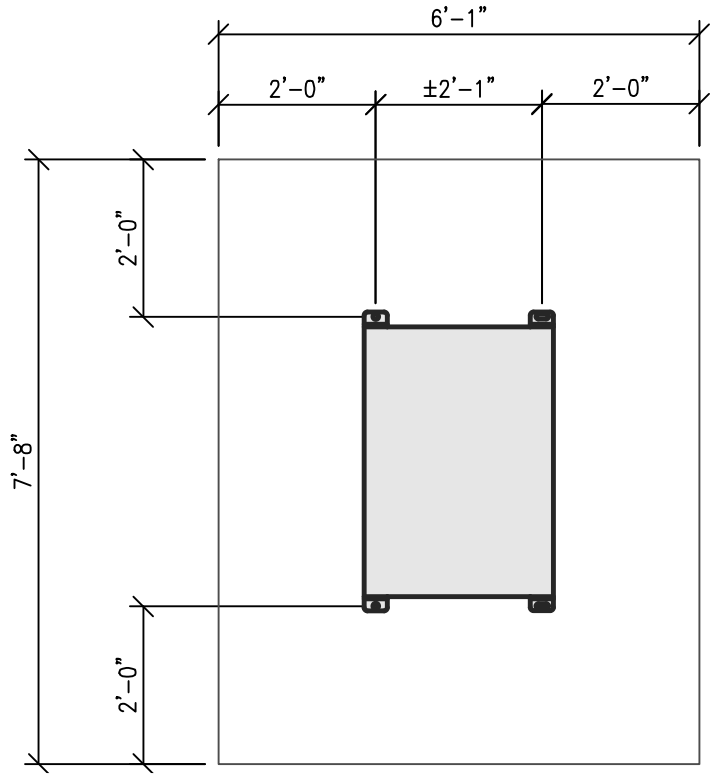


Figure 4: Overview Single Cabinet Foundation

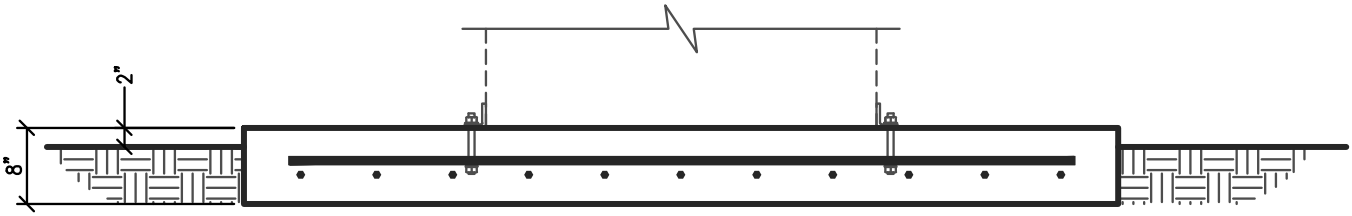


Figure 5: Side View - Single Cabinet Foundation

Multi-Cabinet Foundation Detail (Option A)

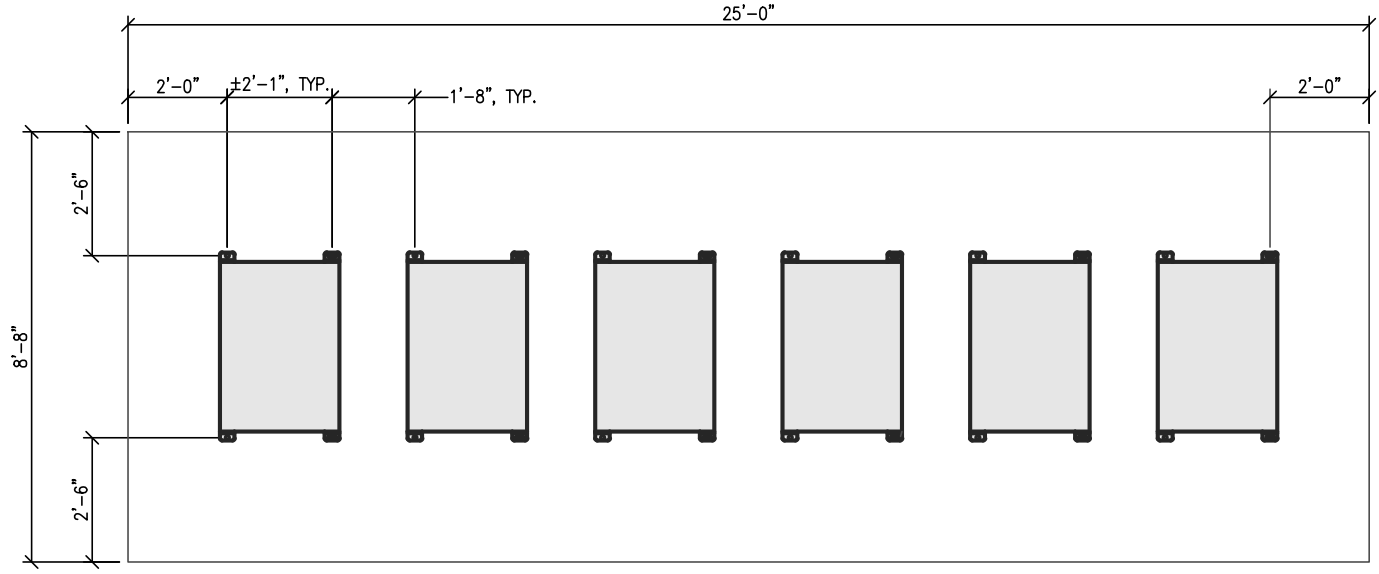


Figure 6: Six Cabinet - Foundation Overview (Option A)

Multi-Cabinet Foundation Detail (Option B)

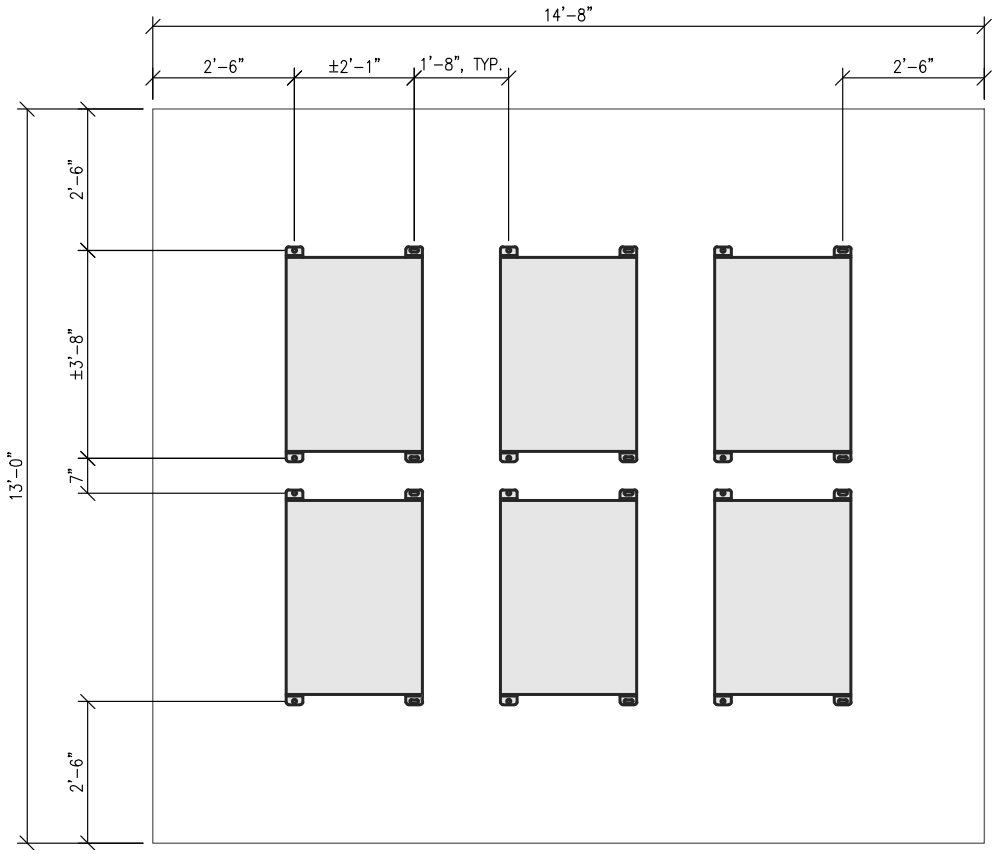


Figure 7: Six Cabinet - Overview Foundation (Option B)

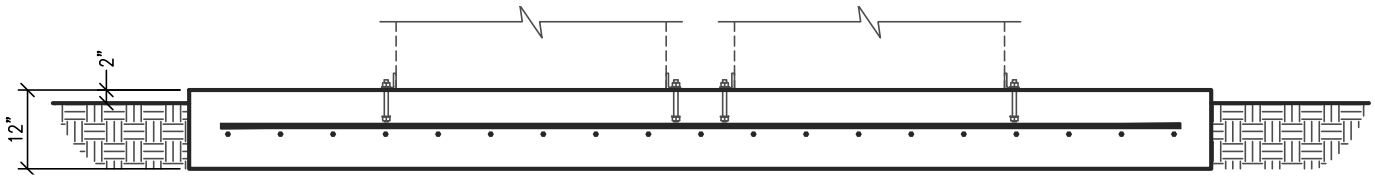


Figure 8: Side View of Foundation (Option B)

2.3 Equipment Clearance Guidelines

The minimum clearances shown below between neighboring systems and surrounding walls are derived from Sol-Ark's UL9540A testing for the L3 HVR series. It's essential to maintain these minimum distances to ensure compliance with the UL9540A test report. This is particularly important in areas where it's mandatory to adhere to NFPA 855 or similar local fire codes, such as the IFC.

> ⚠ Clearances may need to be increased depending on where the Sol-Ark 30K or 60K inverter is mounted on the L3 HVR cabinet. Ensure a minimum clearance of 20 in (500 mm) from the front surface of the inverter to another wall or obstruction, or according to the specifications in the inverter installation manual.

1. Sides/Rear

- Maintain at least **60 cm [23.6 in]** of clearance between the battery sides and any walls or other barriers.
- Maintain at least **10 cm [4 in]** of clearance between the battery cabinet and the sides or back of other batteries.
- The rear requires **60 cm [23.6 in]** of clearance between the battery and any walls or barriers.

2. Front

- **60 cm [23.6 in]** clearance is required in front of the battery cabinet to be able to open the door or install battery modules.
- Clearance may need to be increased if the doors of two cabinets face each other.

3. Ceiling Height

- Do not install the cabinet in areas with an overhead clearance height of less than **244 cm [96 in]** measured from the bottom of the cabinet.
- Ceiling access is not required for this system.

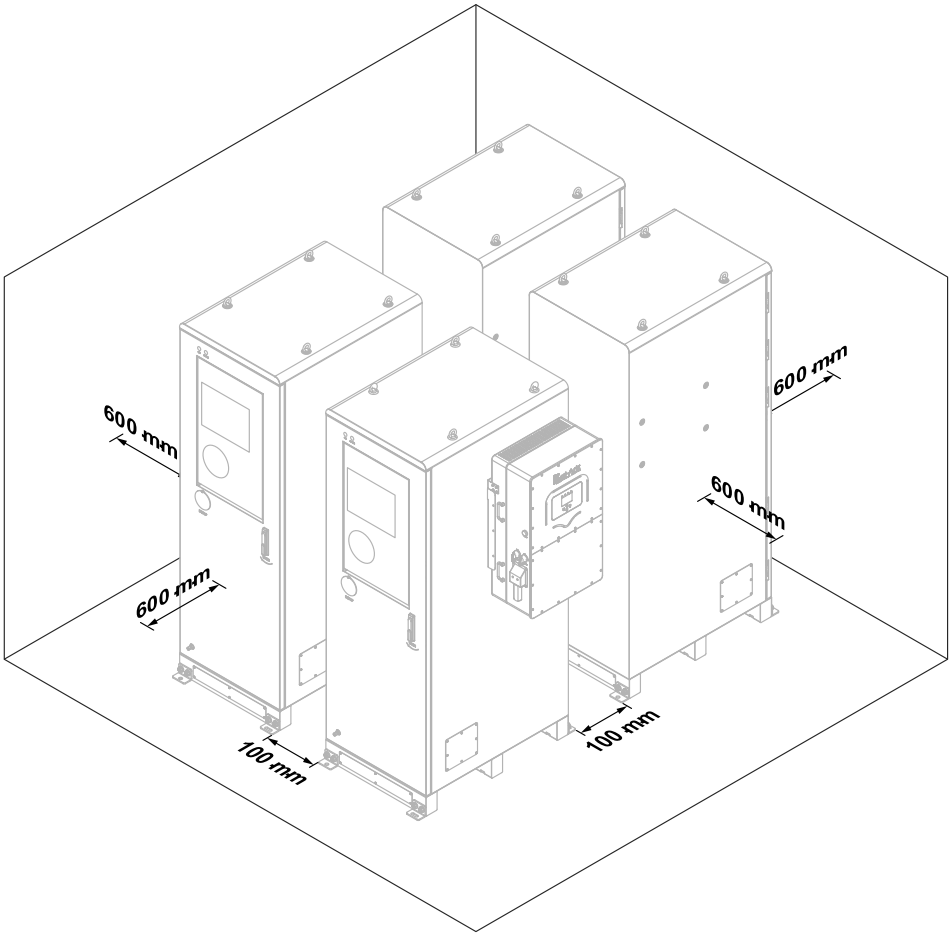


Figure 9: Example Showing Minimum Cabinet Clearances per UL9540A

2.4 Mechanical Assembly

1. Install the Mounting Feet

After lifting the cabinet into its final location, attach the included L-shaped mounting feet to the cabinet using the provided bolts (M10x30 mm) **[Step 1]** and tighten to **37 ft-lb** (51 N-m) **[Step 2]** as shown here:

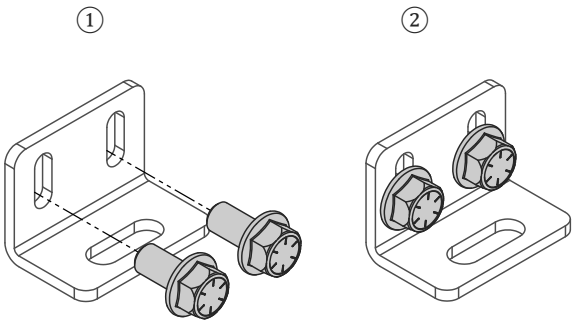


Figure 10: Mounting Foot Installation

2. Anchor the Cabinet to the Foundation

Secure the cabinet mounting feet to the concrete foundation using one of the two methods shown in the following figures, or using a method with equivalent strength as determined by a licensed design professional.

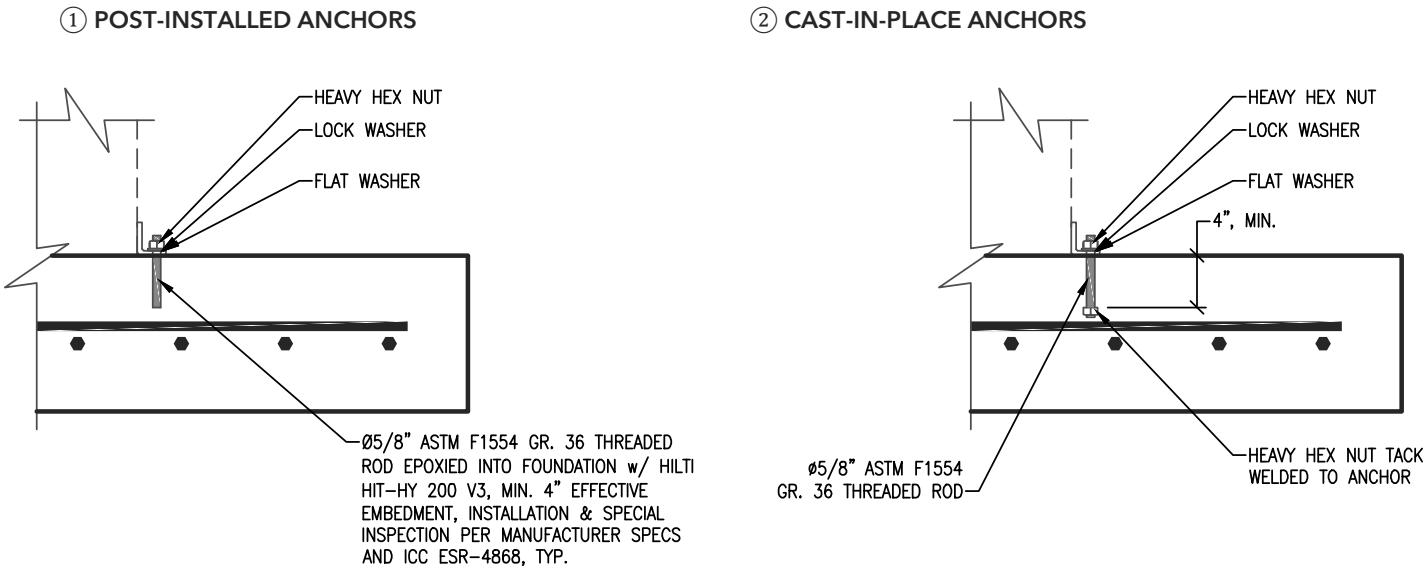


Figure 11: Cabinet Anchoring Methods

3. Mount the Inverter

Method A – Direct installation

Follow these steps to install the inverter directly to the L3 HVR cabinet:

1. Remove the M12 bolts on the cabinet exterior using a 12mm wrench and install the inverter mounting carrier onto the wall of the cabinet as shown below. Tighten to a torque of 74 ft-lb (100 N-m).
2. Lift the inverter on the carrier, then secure the inverter to the mounting carrier with 6 of the M4x12 mm socket head screws provided. Tighten to a torque of 12 in-lb (1.37 N-m).

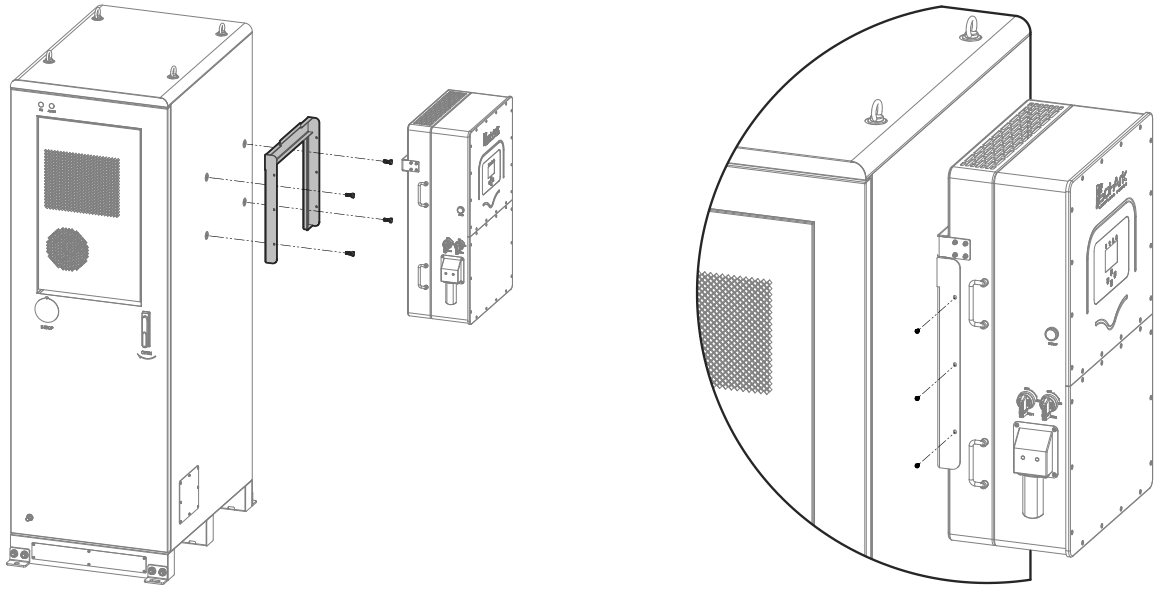


Figure 12: Inverter Mounting

Method B – External installation

Follow these steps to install the L3 HVR externally.

1. Use screws or anchors suitable for the mounting surface that can support the weight of the inverter **176 lb** (80 kg).
   - *Concrete or Masonry Mounting:* Use a minimum of **4** M12x60 mm expanding anchors (not included).
   - *Wood Frame Mounting:* Use a minimum of **4** ½-inch lag screws with flat washers (not included), making sure to anchor into at least 2 framing members.
   - *Metal Framing Mounting:* Use a minimum of **4** ¼-inch self-tapping metal screws with flat washers (not included).
   - If a different anchoring method is required, calculate the number of anchor points needed to properly hold the weight of the equipment.
2. Secure the inverter to the mounting carrier with **6** of the M4x12 mm socket head screws provided, then tighten to a torque of **12 in-lb** (1.37 N-m).

System Access

To access the inside of the L3-HVR cabinet:

1. Rotate the cover to see the keyhole.
2. Use the included key to open the latch.
3. Open the unlocked door by pulling the handle out and rotating to open.

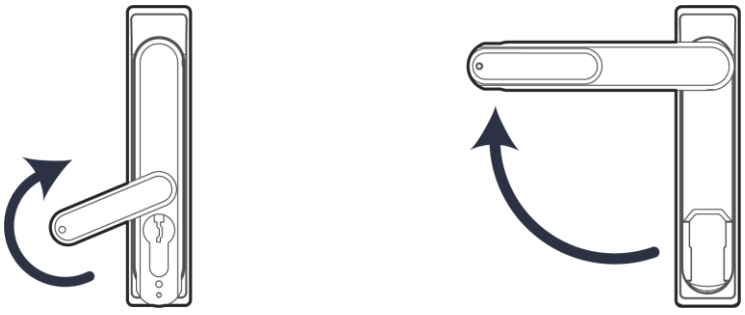


Figure 13: Door Latch

2.5 Seismic Installation Guidelines

When installing the L3 HVR cabinet, it's important to follow all attachment requirements outlined in this manual to ensure structural integrity during a seismic event. The installation contractor should consult their local AHJ or licensed design professional for specific installation requirements for their site or area.

DO NOT USE concrete screws (such as Tapcon) or wedge/expanding anchors to attach the Sol-Ark cabinet to a concrete foundation. The supplied cabinet mounting feet must be secured to the foundation according to the installation methods in "2.4 Mechanical Assembly" on page 14.

After completing the cabinet assembly, the total weight of the battery energy storage system is 950 kg (2,095 lbs).

NOTICE: For information on pre-engineered stamped designs for use in Category E seismic areas and above, contact Sol-Ark Technical Support at +1 (972) 575-8875 ext. 2.

2.6 System Overview

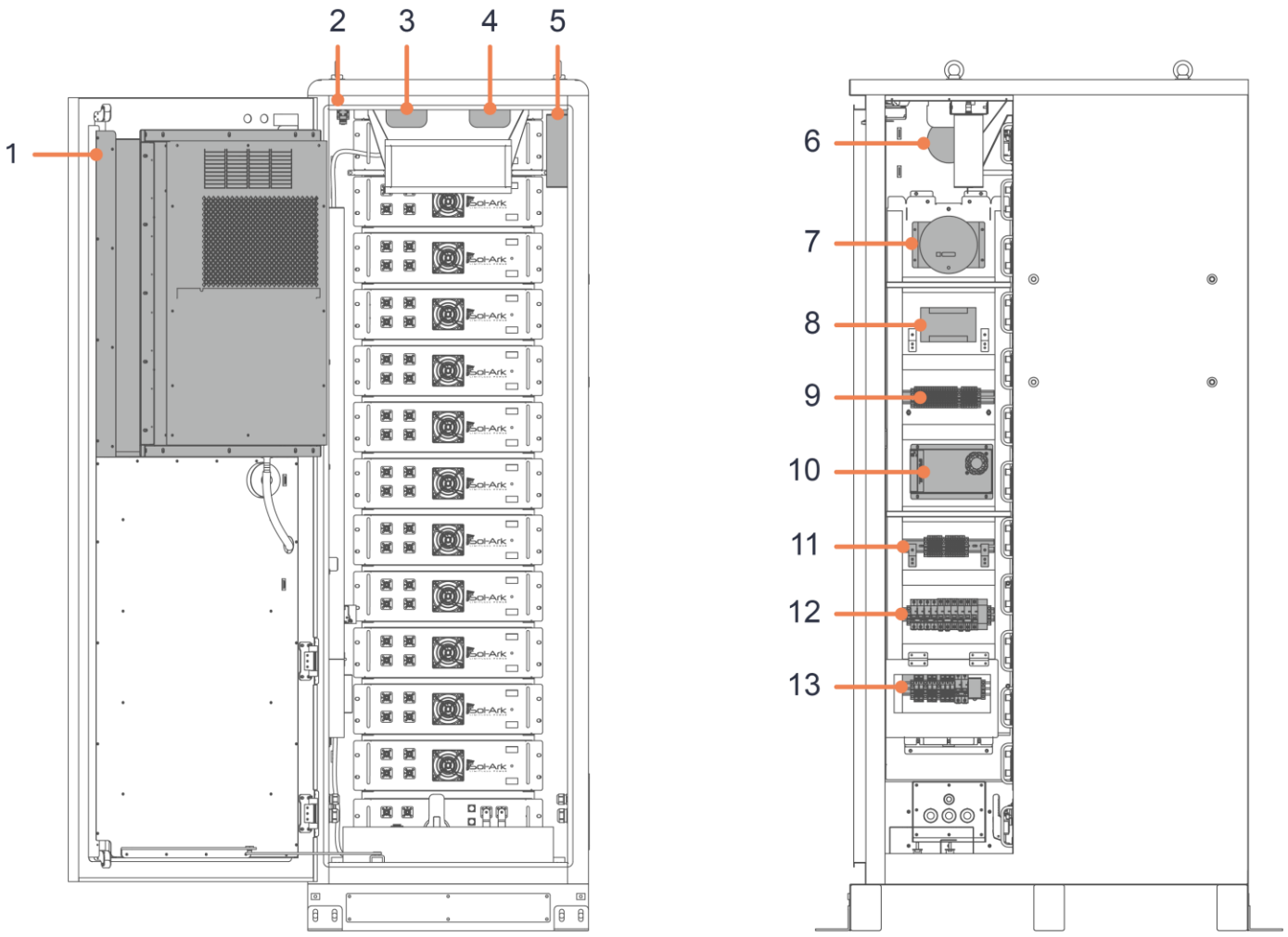


Figure 14: Internal Components

No.	Name	Description
1	HVAC System	Heating & cooling system for battery cabinet powered by the Auxiliary AC input
2	Door Limit Switch	Safety interlock to detect if door is open
3	Smoke Detector	Smoke detection with audible alarm
4	Heat Detector	Heat detection with audible alarm
5	Aerosol Fire Extinguishing System	Aerosol suppression agent that is deployed in the event of significant heat or smoke inside the cabinet
6	Deflagration Vent	Prevents the buildup of hazardous gas during a thermal runaway event
7	CO2/Combustible Gas Sensor	Detect hazardous gases to activate fire suppression system and ventilation
8	Integrated System Controller	Internal, manages cabinet sensor inputs and activates fire or ventilation systems
9	Signal and 24V Power Distribution	Internal, pre-wired sensor power and signal distribution
10	24V Power Supply	Internal, pre-wired power supply unit for HVAC, indicators, and other support systems in the cabinet
11	I/O and Power Distribution	Internal, pre-wired terminals to supply power and signals throughout the cabinet
12	Cabinet Circuit Breakers	Circuit breakers for cabinet power circuits (Main, BMS, HVAC)
13	Auxiliary Input Wiring Area	User wiring area with screw terminals for cabinet Auxiliary AC power input

2.7 Battery Overview

BMS (Battery Management System)

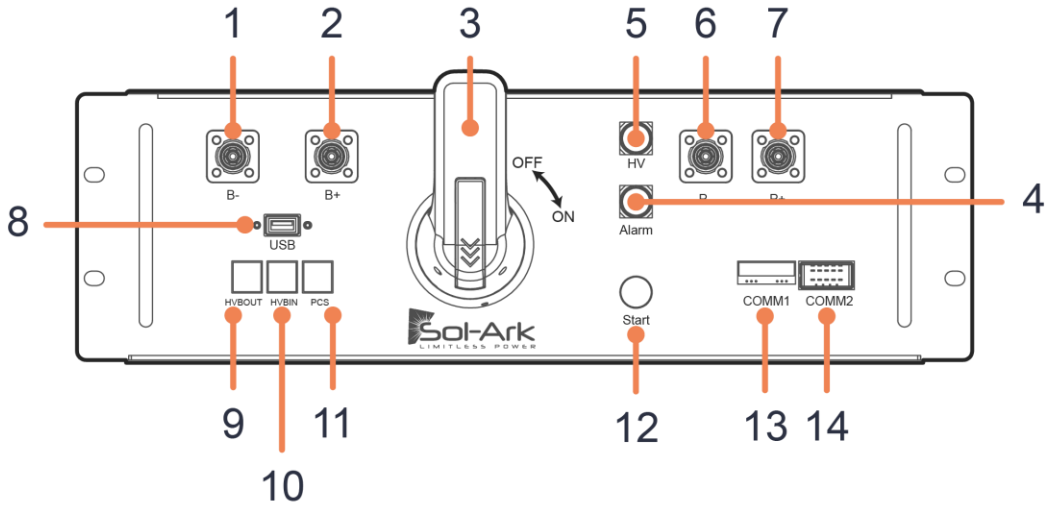


Figure 15: BMS

No.	Name	Description
1	B-	Battery Stack Negative (-) Input
2	B+	Battery Stack Positive (+) Input
3	DC Disconnect	200A Dual Pole DC disconnect for the battery output (P+/P-)
4	ALARM Indicator	System Fault Indicator (red)
5	HV Indicator	High Voltage Present Indicator (yellow)
6	P-	BMS - Inverter Negative (-) Output
7	P+	BMS - Inverter Positive (+) Output
8	USB	USB2.0 port for data logging or firmware updates
9	HVBOUT	Communication output port to next L3 cabinet BMS
10	HVBIN	Communication input port for previous L3 cabinet BMS
11	PCS	RJ45 port for BMS - Inverter closed-loop communication
12	START	Power switch for 12V BMS power supply
13	COMM1	BMS Diagnostics Communication Port [OUTPUT]
14	COMM2	Inter-battery communication port for battery module directly overhead [INPUT]

Battery Module

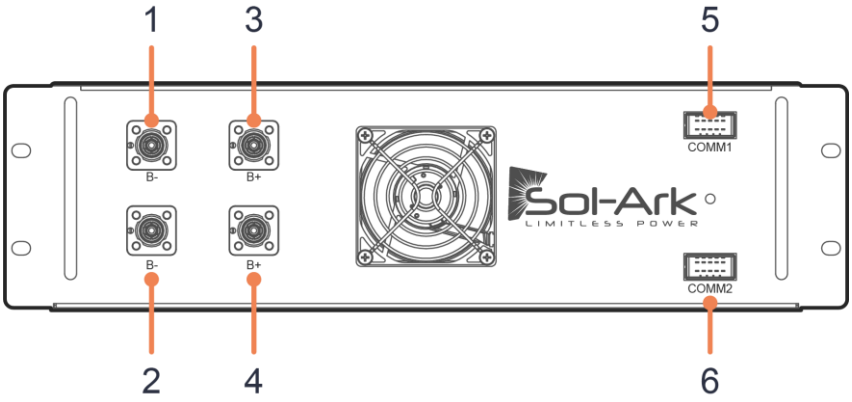


Figure 16: Battery Module

No.	Name	Description
1, 2	B-	Battery Module Negative (-) Output
3, 4	B+	Battery Module Positive (+) Output
5	COMM1	Communication Port to battery module directly overhead
6	COMM2	Communication Port to battery module (or BMS) below

2.8 Wiring

Warning: Before wiring the system, ensure the DC disconnect switch of the BMS is turned OFF and the MSD is disconnected

Danger: High Voltage Risk of Electric Shock. Always de-energize the equipment before servicing

DC Battery Wiring

Overview

The L3 HVR-60 cabinet arrives from the factory partially configured with twelve L3 HVR-5.1 kWh battery modules, pre-installed alongside the L3 HVR BMS-750 V Battery Management System unit.

For ease of installation, the top battery module has a pre-wired pack negative cable installed. This cable is securely connected to one of the twelfth module's **Negative** Pushlok connectors.

The other end of this cable extends to the bottom of the cabinet, where it connects to the BMS **B-** input on the Battery Management System unit, completing one side of the DC battery circuit.

- **B-** is a **black** connector
- **B+** is an **orange** connector

Depending on the inverter selection, complete the remaining positive connections as outlined in the *Configuration* section below.

Configuration

The L3 HVR-60 cabinet is designed to work with two specific inverter models: the Sol-Ark 30K-3P-208V and the Sol-Ark 60K-3P-480V. Each inverter model has different operating voltage requirements and limits, so it's crucial to configure the battery modules correctly during the installation process to match the inverter.

For the Sol-Ark 60K-3P-480V inverter: Wire according to Configuration 1 on page 21, which uses a **12S1P** (12 series, 1 parallel) wiring arrangement. This setup delivers a nominal voltage of **636Vdc** and a capacity of **100Ah**. This configuration is specifically designed to meet the higher voltage requirements of the 60K inverter.

For the Sol-Ark 30K-3P-208V inverter: Wire according to Configuration 2 on page 22, which uses a **6S2P** (6 series, 2 parallel) wiring arrangement. This configuration provides a nominal voltage of **318Vdc** and a capacity of **200Ah**. This lower voltage is tailored to the operational range of the 30K inverter.

Connect the cabinet ground points as marked, either inside or outside the cabinet, to the equipment grounding conductor for the battery system.

Configuration 1: 60K-3P-480V (12S1P Wiring)

1. Install the 220mm BMS-to-battery jumper from the positive Pushlok connector **(B+)** of the BMS to the bottom right-most Pushlok connector **(B+)** of the first battery module (from the bottom of the cabinet).
2. Install the 200 mm series battery jumpers between modules as shown in the figure below. Be sure to create a series connection from the **Negative** Pushlok connector **(B-)** of the first battery module to the **Positive** Pushlok connector **(B+)** of the next battery module.
   - **B-** is a **black** connector
   - **B+** is an **orange** connector
3. Connect the remaining battery conductors in the same way until all modules have been connected.

Note: All battery modules are automatically bonded to the ground of the cabinet by the rack mounting tabs on either side of the module.

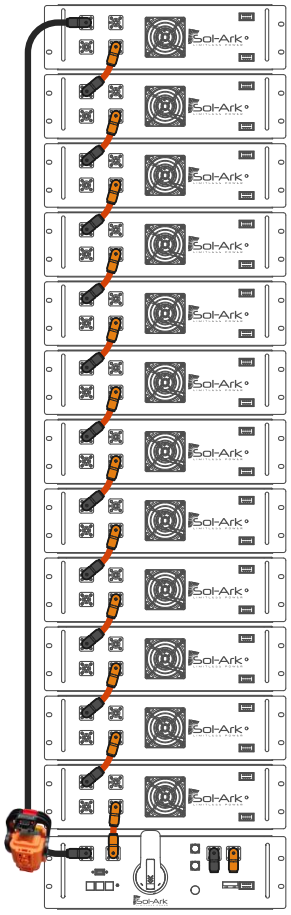


Figure 17: 60K Wiring Configuration - 12S1P

Configuration 2: 30K-3P-208V (6S2P Wiring)

1. Install the 220mm BMS-to-battery jumper from the **Positive** Pushlok connector of the BMS to the bottom right Pushlok connector **B+** of the first battery module (from the bottom of the cabinet).
2. Install the 200 mm battery jumpers from module to module as shown below.

   Every two modules will be connected in parallel, then those two modules are connected to the next module in the stack with a series connection.

   - **B-** is a **black** connector
   - **B+** is an **orange** connector
3. Connect all battery jumpers until all modules have been connected.

Note: All battery modules are automatically bonded to the ground of the cabinet by the rack mounting tabs on either side of the module.

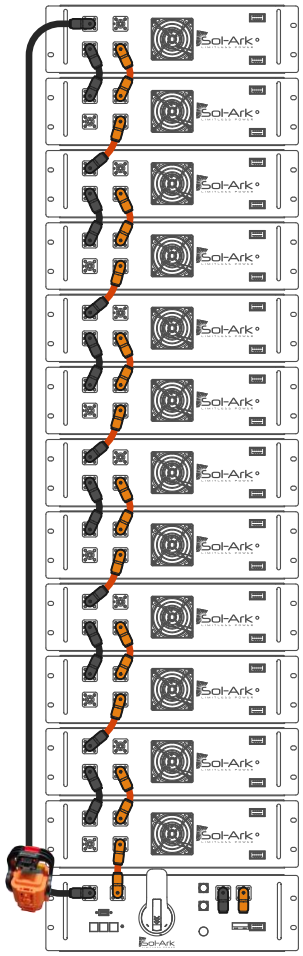


Figure 18: 30K Wiring Configuration - 6S2P

Communications Wiring

Module-to-Module Communication

1. Connect one end of the BMS-to-battery communication cable to the **COMM2** communication port of the BMS. Then connect the other end to the **COMM2** communication port of the first battery module (the one directly above the BMS).
2. Locate 11 pieces of the 110mm (4.3in) inter-battery communication cables that daisy-chain the battery modules together.
3. Connect each cable from the **COMM1** communication port of the first battery module to the **COMM2** communication port of the next battery module (the module directly overhead).
4. Connect all remaining 110mm (4.3in) communication cables for the rest of the battery modules as shown below.
5. Fill the remaining **COM** port, using the included terminator plug.

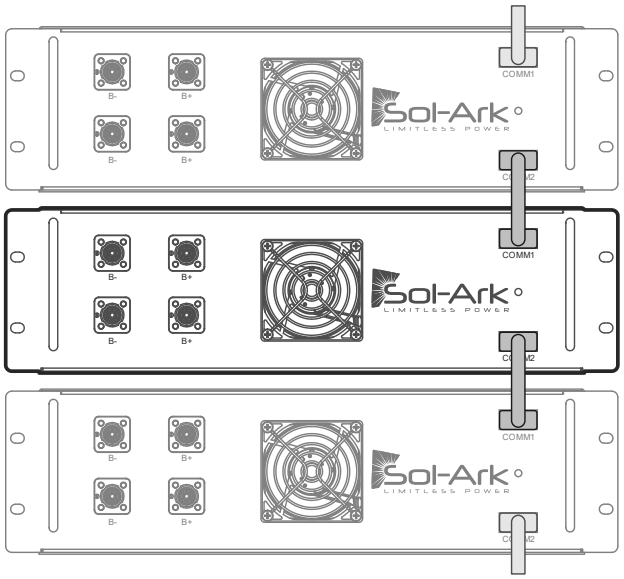


Figure 19: Inter-Module Communication Wiring

BMS Communications Ports

1. The BMS has a pre-installed Ethernet cable starting from its **PCS** port going to **SPD1** (Surge Protection Device 1) inside the cabinet wiring area.
2. To complete the communications wiring for the required closed loop battery-to-inverter communication, run a CAT5e or better Ethernet cable *(user supplied)* from the output of the **SPD1** to the **BMS1** port of the Sol-Ark inverter.
3. See "2.10 Cabinet-to-Inverter Wiring" on page 28 for more BMS wiring details.

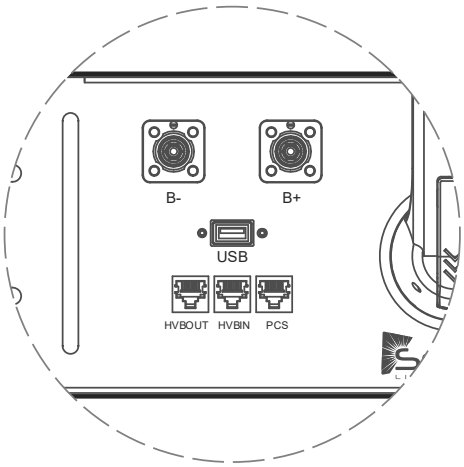


Figure 20: Battery Module Communication Ports

Pin	HV OUT	HV IN	PCS
1	BMS_CANL	BMS_CANL	485B-
2	BMS_CANH	BMS_CANH	485A+
3	DI+	DI+	--
4	DI-	DI-	PCANH
5	--	--	PCANL
6	--	--	--
7	--	--	485A+
8	--	--	485B-

2.9 Auxiliary Power and Communications Wiring

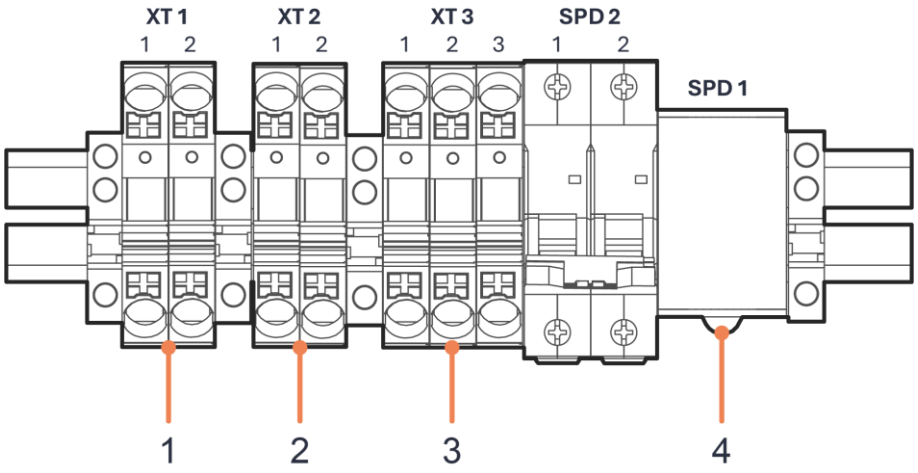


Figure 21: Auxiliary Wiring Terminal Block

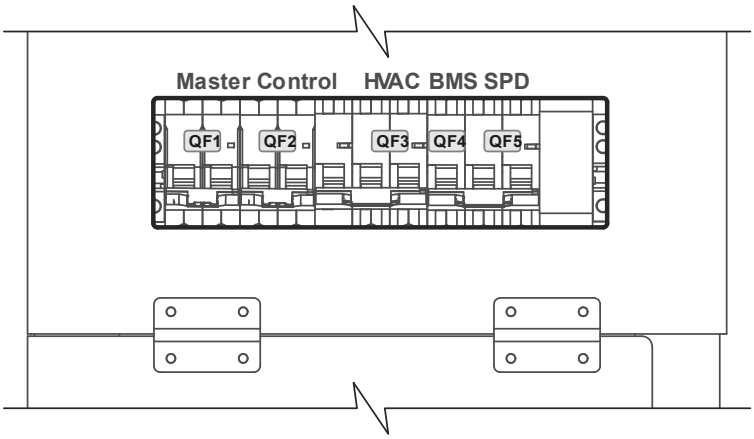
No.	Name	Description
1	XT1	L1 Input Terminal (208VL-L or Split Phase 240VL-N) [INPUT/OUTPUT]
2	XT2	L2 Input Terminal (208VL-L or Split Phase 240VL-N) [INPUT/OUTPUT]
3	XT3	AC Auxiliary Power Ground Terminal Block [INPUT/OUTPUT]
4	SPD1	Surge Protection Device to protect the incoming Ethernet cable [INPUT]

The Auxiliary input supplies power to the cabinet's support systems such as the HVAC unit, sensors (smoke, heat, liquid), and indicator lights.

⚠ When using a 60K-3P-480V inverter which natively supplies **277/480Vac** output, the installer needs to provide a 208 Vac or 240Vac power source to the XT1 and XT2 terminals to avoid damaging the cabinet. If required, use one or more step-down transformers with a rating of no less than 3kVa (per cabinet) to provide a 208V or 240V supply voltage to the respective cabinets.

⚠ Failure to follow these instructions could result in **permanent damage** to the battery cabinet.

Auxiliary Power Breakers Overview



Name	Description
QF1	Main Breaker
QF2	Auxiliary Power Supply
QF3	HVAC
QF4	BMS Power Supply
QF5	Surge Protection Device 2

Auxiliary Power Wiring Requirements

The minimum wire size recommendations shown below are suggestions based on typical installation scenarios. It is important to note that these recommendations may not be suitable for all installations. Always adhere to the National Electrical Code (NEC) or other local electrical codes and regulations when determining the appropriate wire size for your installation.

Grounding conductors should be sized in accordance with NEC Table 250.122 or similar local electrical codes. The minimum grounding conductor allowed is 12 AWG Cu with a 15 A OCPD protecting the Auxiliary power circuit.

> ⚠ Use Only 75°C Rated Copper (CU) Stranded or Solid Core Wire.
> Fine stranded wires must use an appropriate crimp-on ferrule.

The number of parallel cabinets shown in the table refers to the number of additional cabinets that are fed from the Auxiliary terminal of first cabinet.

Port	Number of Parallel Cabinets	Minimum Wire Size	Maximum OCPD Rating
XT1 XT2 – L-L or L-N	1	12 AWG	20A
	2-3	10 AWG	30A
	4-5	8 AWG	60A
	6	4 AWG	70A
XT3 - Ground	1	14 AWG	15A
XT3 - Ground	2-5	10 AWG	15A
SPD1	1 - 6	RJ45 - CAT5e or better	

Parallel Wiring of Cabinets – External Power Source

XT1 and XT2 (L1/L2 Input/Output Terminals)

- Connect **L1** of the AC power source to the ***XT1, Port 1*** input terminal of the first cabinet.
- Connect **L2** of the AC power source to the ***XT2, Port 1*** input terminal of the first cabinet.
- Run a wire from the ***XT1, Port 2*** of the first cabinet to the ***XT1, Port 1*** input of the next cabinet.
- Run a wire from the ***XT2, Port 2*** of the first cabinet to the ***XT2, Port 1*** input of the next cabinet.
- Repeat this process for up to 6 cabinets, ensuring a secure and reliable connection at each terminal.

XT3 (Ground Terminals)

- Connect a green **Ground** wire from the AC source circuit to the ***XT3, Port 1*** input of the first cabinet.
- Run a wire from the ***XT3, Port 2*** of the first cabinet to the ***XT1, Port 1*** input of the next cabinet.
- Repeat this process for up to 6 cabinets, ensuring a secure and reliable connection at each terminal.

SPD1 (BMS Communication Wire)

- Connect a field-supplied CAT5e RJ45 cable from the open port of ***SPD1*** to the ***BMS1*** input of the Sol-Ark inverter.

2.10 Cabinet-to-Inverter Wiring

1. Begin wiring the battery by first removing the inner and outer busbar covers, using a Phillips screwdriver, as shown below.

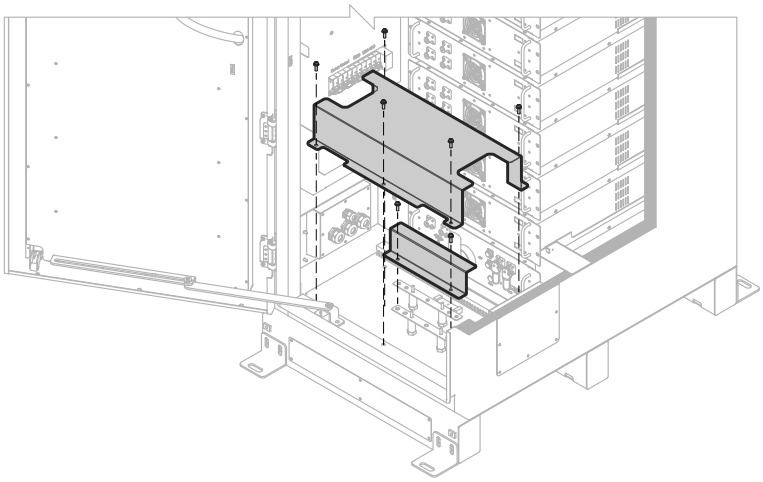
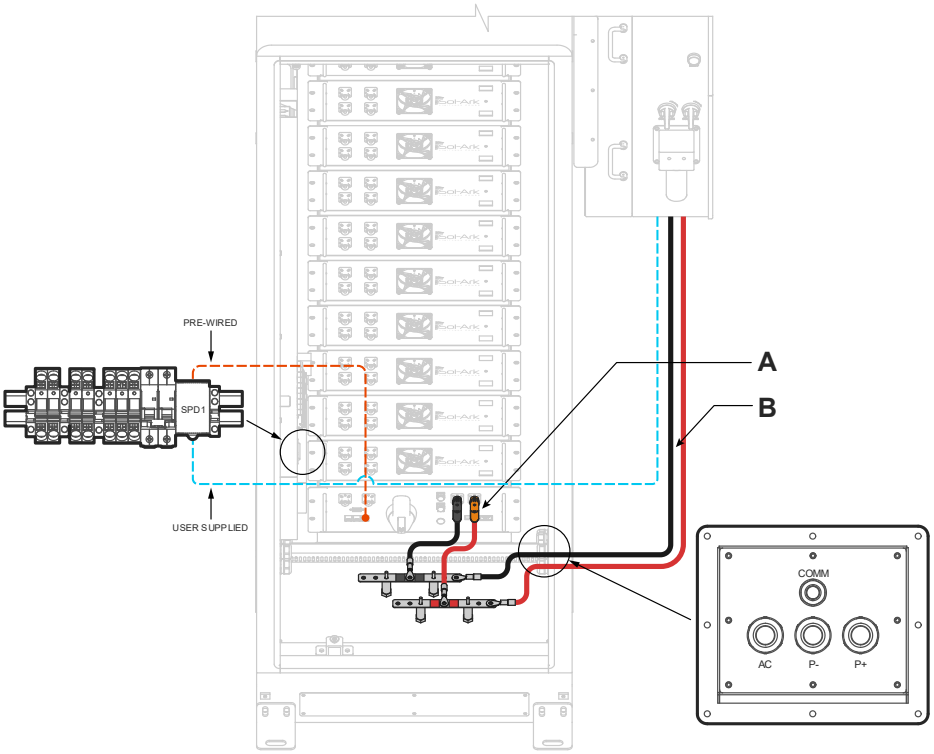


Figure 22: Removing the Busbar Wiring Area Cover

2. Using the included Pushlok-to-ring terminal cables, connect each cable to their respective PCS+ and PCS- ports of the BMS as shown in Figure 23 **(A)**.
3. Using the same cables, connect the ring terminal side to the positive and negative battery busbar as shown in Figure 23 (**A**).
4. Connect the included 9.8ft (300cm) red cable from the positive busbar to the positive terminal of the inverter as shown in Figure 23 **(B)**.
5. Connect the included 9.8ft (300cm) black cable from the negative busbar to the inverter's negative terminal as shown in Figure 23 **(B)**.
6. Plug in the **MSD** (Manual Service Disconnect) in the bottom left corner of the battery bank.
7. Secure the MSD by rotating the black handle down to a horizontal position. The MSD will complete the negative circuit, allowing for proper operation of the L3 HVR.

WARNING: Before doing any maintenance procedure, disconnect the MSD device to prevent electric shock.



Conduit hole dimensions	
COMM	20.5 mm
AC	25.5 mm
P-	25.5 mm
P+	25.5 mm

Figure 23: Wiring the Cabinet to the Inverter

Note: 2x 9.8 ft (300cm) cables are included with the L3 HVR for the "B" connection shown above (battery busbar to Sol-Ark inverter). These can be extended using suitable terminal blocks or wire connectors rated for the voltage and current of the battery.

2.11 Multi-Unit Wiring

1. To parallel the L3 HVR battery with another unit, connect the previous L3 HVR's **positive** and **negative** busbars to the subsequent L3 HVR's busbar by using field-supplied wiring, sized in accordance with the NEC, and in conduit or a raceway suitable for wet locations to maintain the cabinets' ingress protection rating.
2. Using a CAT5e or better ethernet cable, connect the master battery **HVBOUT** port to the **HVBIN** port of the next battery in the multi-unit system.
3. On the last battery in the stack install the 120Ohm RJ45 terminator into the **HVBOUT** port.

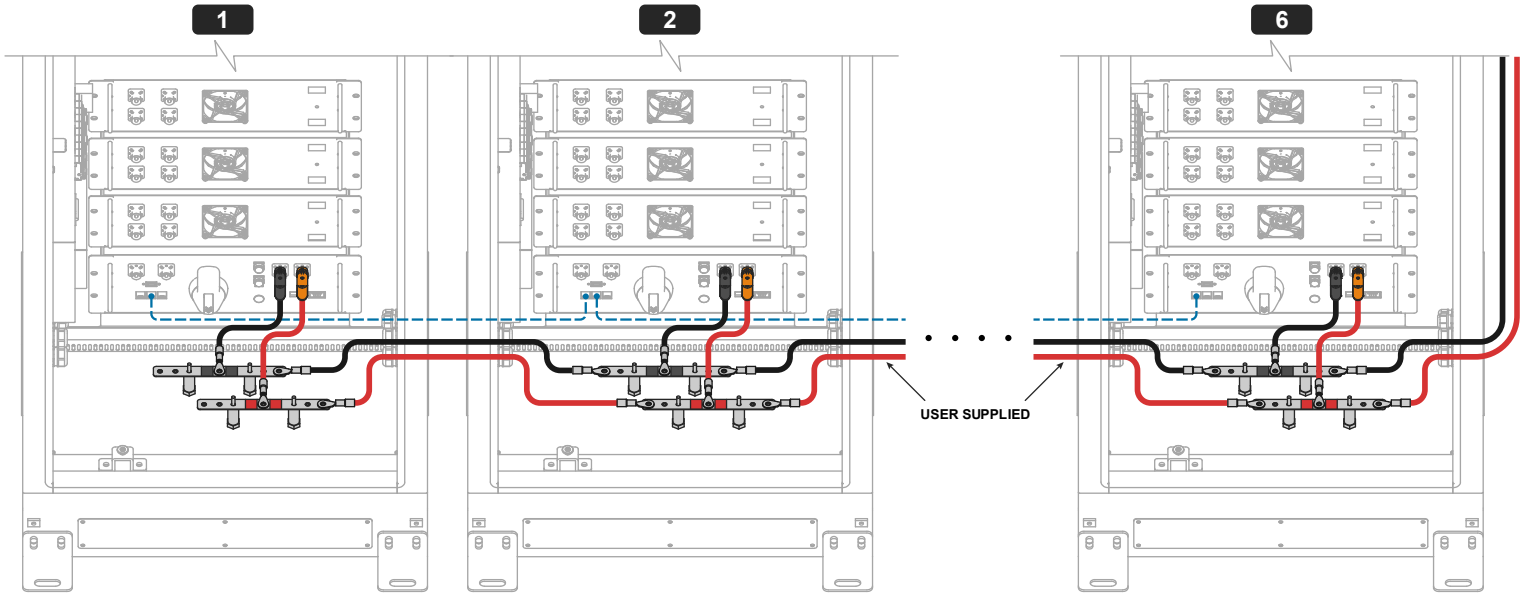


Figure 24: Illustration of Wiring for a Multi-Cabinet System

2.12 System Startup and Commissioning

> **CAUTION**: Follow proper safety measures, including lock-out tag-out and wearing any OSHA required PPE, when powering up and testing the system.

Verify Battery Module Voltage

The nominal voltage of each 5.1 kWh battery module is 51.2 V, any voltage within a range of 50 V to 56 V is considered normal.

1. Use a digital multimeter to verify proper DC voltage between the B+ and B- connectors of the first battery module.
2. Repeat the measurement across **ALL** battery modules to confirm consistent voltage levels.
3. **DO NOT** commission a pack with a module-to-module voltage delta (between the highest and lowest) of more than **0.2Vdc**
   a. If you have a module delta above 0.2V, contact Sol-Ark Technical Support at +1 (972) 575-8875 ext. 2 for the next steps.
4. After you verify all battery modules h to be within 0.2Vdc, use a digital multimeter measure and verify that you get the correct **pack level voltage** between the B- connector of the first battery module and B- connector of the last battery module.

This voltage is calculated according to the following equation: $V_{pack} = N_{series} \times V_{module}$

   a. For a 60K configuration this should be between 600-672Vdc
   b. For a 30K configuration this should be between 300-336Vdc

5. Re-attach the cables and make sure that all Pushlok connectors are properly seated.

System Startup

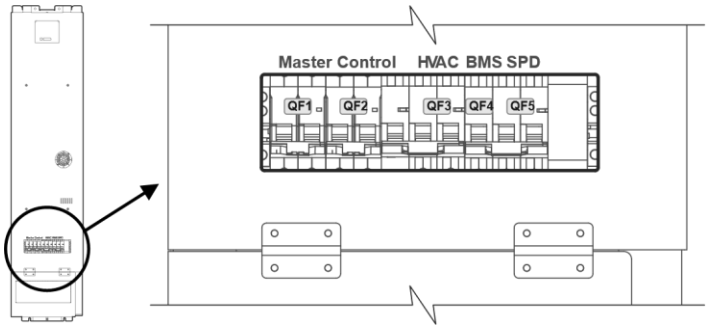


Figure 25: Location of Control Systems Breakers

1. During initial commissioning, follow these steps to make sure the MSD (Manual Safety Disconnect) is properly installed.

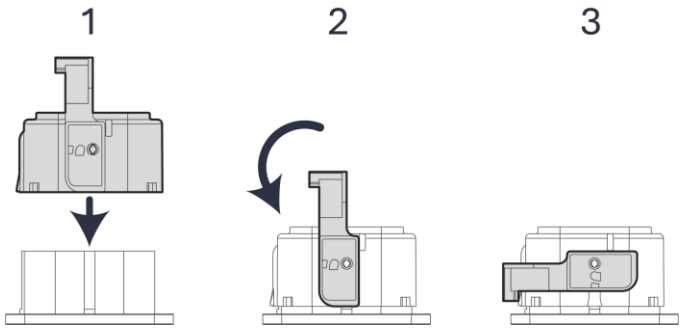


Figure 26: MSD Installation Steps

2. Make sure the **SPD2** (Surge Protection Device 2) breaker - **QF5** is ON.
   ⚠ SPD2 should remain ON even during a power cycle.
3. Turn ON the Main Breaker – **QF1**.
4. Turn ON the Auxiliary PSU breaker – **QF2**.
5. Rotate the **DC disconnect** handle clockwise to the ON position. The DC disconnect switch will click and latch in place.

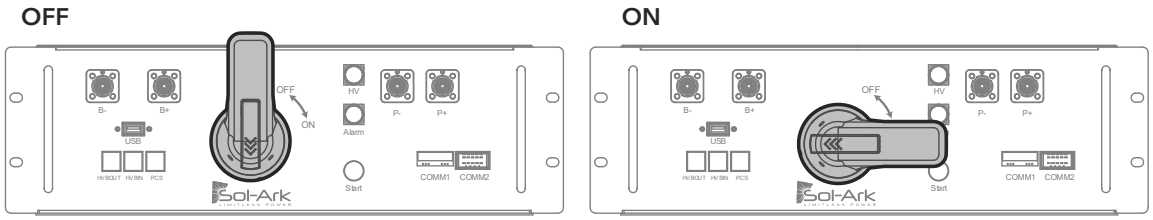


Figure 27: Operation of the BMS DC Disconnect

Note: The DC disconnect features a red, built-in locking tab that can be used to lock out the disconnect in the OFF position for service and maintenance.

6. Turn the BMS **START** button to the ON position.
7. Turn ON the BMS PSU breaker – **QF4**.
8. Turn ON the HVAC breaker – **QF3**.

9. Reverse the steps to turn OFF the unit.
   ⚠ SPD2 Should always stay ON.

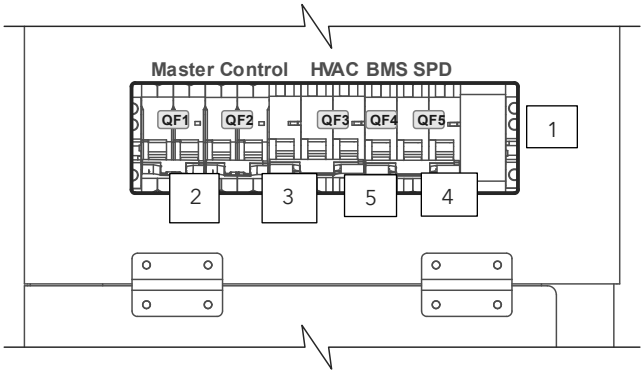


Figure 28: System Startup Breaker Sequence

2.13 Power Cycle Sequence

If you need to do a power cycle during troubleshooting or maintenance of the HVR cabinet systems, follow these steps.

> ⚠ **WARNING**: **DO NOT** attempt a power cycle with the battery or inverter under full load.

1. Turn OFF the HVAC breaker – **QF3**.
2. Turn OFF the BMS PSU breaker – **QF4**.
3. Press the **START** button of the BMS to the OFF position.
4. Rotate the **DC disconnect** handle counter-clockwise to the OFF position.
5. Turn OFF the Auxiliary PSU breaker – **QF2**.
6. Turn OFF the Main Breaker – **QF1**.
7. Check that there is proper connectivity among ALL battery modules, the BMS, and the inverter within the L3 system.
8. To turn on the L3 system, follow the steps in “System Startup” on page 32.

3. Operation and Maintenance

3.1 Maintaining the L3 System

WARNING: Before any disassembly or maintenance, make sure that L3 system is powered off and you follow appropriate lock-out-tag-out procedures. Failure to do so could result in injury or death.

For safe operation, it's essential to thoroughly inspect all components of the L3 system, including but not limited to system conductors, connectors, wiring between modules, BMU, and ground. The following annual maintenance tasks and inspections should be performed by a qualified professional.

- Make a basic visual inspection of the system. Verify the tightness of all electrical connections, including any torque values listed in "1.4 Specifications" on page 5.
- Keep the unit clean and free of any dust and debris.

Note: To clean any part of the battery enclosure, BMS, or modules, use a soft, damp cloth to wipe down any surfaces. No harsh solvents or cleaning products should be used. Make sure that the battery connections remain free from any moisture.

Maintenance Schedule

Task	Frequency	Procedure
Exterior - Visual Mechanical Inspection	12 months	See "Appendix A: Service Maintenance Procedures" on page 40.
Interior - Visual Mechanical Inspection	12 months	
Inspection of Cabinet Ventilation Ports Operation	6 months	
Verification of Battery Equipment Grounding	12 months	
Replacement of HVAC Intake Air Filter	6 to 12 months	
Inspection of HVAC Condensation Drain	6 to 12 months	

3.2 Fire Suppression System

The L3 HVR series features an integrated aerosol-based fire suppression system at the battery module and cabinet level. In the rare event of a thermal runaway, the aerosol canisters will rapidly deploy, filling the battery module and cabinet interiors with a non-toxic agent to suppress any potential fire before spreading. This unique, industry-leading safety capability from Sol-Ark ensures maximum protection for commercial and industrial users.

Module Level Fire Suppression

Contained in each module is a 12-gram aerosol agent canister, dispensing in a proprietary system which activates automatically when heat inside the module reaches potentially unsafe levels due to thermal runaway or external fires (185°C ±10°C).

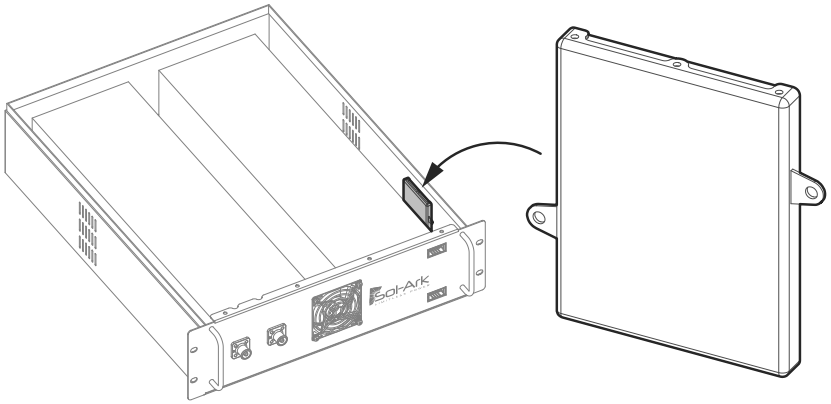


Figure 29: Module-Level Aerosol Agent Canister

Cabinet Level Fire Suppression

A larger, 300-gram aerosol canister is located in the top right corner inside each cabinet. This unit is electronically activated based on signals from the fire detection sensors inside the cabinet. Smoke, heat, and CO2/gas sensors will detect abnormal operating conditions and deploy the aerosol from the canister, filling the inside of the cabinet.

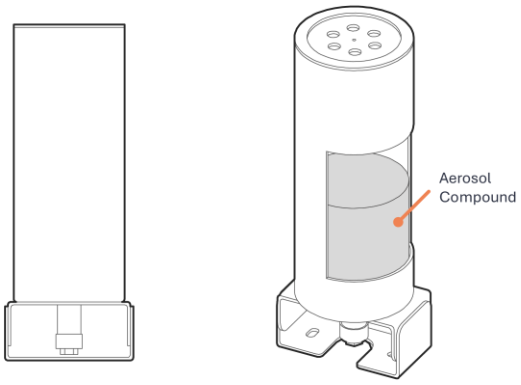


Figure 30: Cabinet-Level Aerosol Agent Canister

Both suppression canisters have a warranted 10-year service life under normal conditions. However, it is important to avoid subjecting the canister to external impacts and corrosive or wet environments which could damage the units and impair their operation.

Deflagration Protection

When the CO2/hazardous gas detector **A** shown below detects flammable gas in the cabinet, the system fire suppression controller will activate two resettable deflagration vents (***"B" depicts the upper vent)***. The deflagration vents will open under spring force to exhaust any flammable gases outside the cabinet, preventing pressure buildup inside the cabinet.

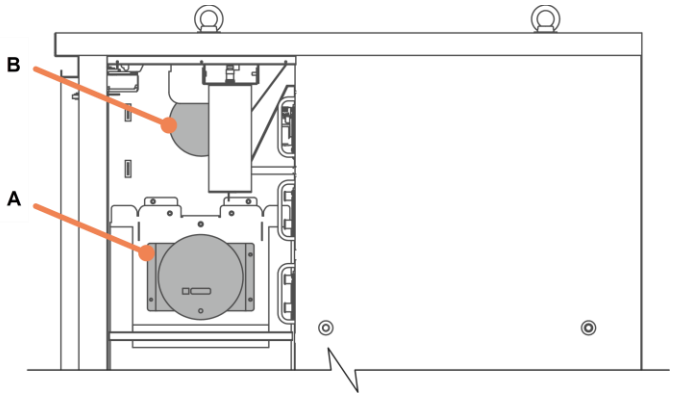


Figure 31: Deflagration Vent and Gas Sensor

3.3 Recharging Over-Discharged Batteries

The Battery Management Unit (BMU) is designed to receive power directly from the battery stack. If the battery is left without a charging source for an extended time, the BMU and other system device standby power consumption could lead to an over-discharge of the batteries, reaching below the required input voltage for BMU operation.

If this happens, follow the steps below to restore power to the BMU.

Step 1: Before the recharge process

1. Turn off the battery stack by pressing the BMS power button and turning BMS disconnect to the "OFF" position.
2. Confirm that the battery module has reached an over-discharge state by removing the power cable and measuring voltage across positive and negative terminals.
3. If the voltage across any battery module is <49V, remove the batteries from the stack by disconnecting power cables.
4. Charge the rest of the battery modules to 100% SOC using the inverter in normal operation.

Step 2: Recharge batteries that are over-discharged

1. Connect a 48V charger to the **B-** and **B+** inputs of the overly-discharged battery module that you removed.
2. Make sure that the polarity is correct from the charger to the inputs.
3. Confirm that the 48V charger is capable of charging the module to 54Vdc (this may require a 54V charger).
4. Make sure that no more than 10A of current is charging the battery module.
5. Charge the battery module to the recommended 54Vdc from the charger, then confirm with a multimeter.

Step 3: After the battery recharge process

1. Replace the batteries in the cabinet.
2. Charge the battery stack to 100%.

Note: Make sure the difference between the minimum and maximum cell voltage doesn't exceed 15mV across the stack.

3.4 BMS Firmware Update Process

The USB port of the BMS allows for upgrading firmware and logging battery data.

1. To update the firmware, first format a USB 2.0 drive as FAT32, no larger than 8GB in size.
2. In the root directory of the USB drive create a new folder called "**upgrade**" (all lowercase).
3. Place the .bin file provided by Sol-Ark in the **upgrade** folder on the USB drive.
4. Turn on the battery by following the steps in "2.12 System Startup and Commissioning" on page 31.
5. Insert the USB drive once the battery has completely turned on.
6. Within 5 seconds after you insert the USB drive, the blue light around the **Start** button will blink during the update process.

After the light turns off, remove the USB drive to complete the upgrade.
Do not power off the battery during the process using the Start button or DC disconnect.

7. After the blue light around the **Start** button lights up again, the update should be complete.
8. Verify the battery firmware version number by checking the version number on the inverter's **Lithium Battery Info** screen or by using the BMS diagnostic software.

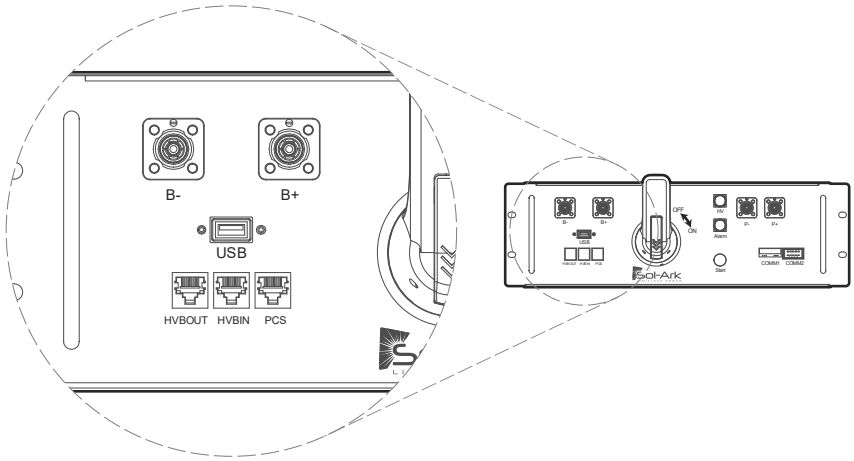


Figure 32: Close-up of USB Upgrade Port

3.5 Long-Term Battery Storage

When storing the assembled battery system for longer than two weeks, the following steps are recommended:

- To maximize battery lifespan, maintain a storage temperature between 13°C – 30°C (55°F – 86°F).
- Power on and charge the battery at least once every 6 months to maintain the state of charge (SOC) within a range of 30-50%.
- To minimize BMS self-discharge, follow the steps in "2.13 Power Cycle Sequence" on page 33 to power down the cabinet systems.
- In addition, disconnect the orange MSD from the battery. This interrupts the power supply to the BMS, preventing the BMS from discharging the battery stack.

4. Error Codes

System Faults

Fault	Potential Fault Cause
OT (Over Temperature)	BMS negative connector overtemperature
	BMS positive connector overtemperature
	Pre-charge resistor overtemperature level 2 alarm
	Heating film overtemperature level 2 alarm
	Charge overtemperature level 2 alarm
	Discharge overtemperature level 2 alarm
UT (Under Temperature)	Charge under temperature level 2 alarm
	Discharge under temperature level 2 alarm
OC (Over Current)	Charge overcurrent level 2 alarm
	Discharge overcurrent level 2 alarm
DV (Differential Voltage)	Excessive differential voltage level 2 alarm
DT (Differential Temperature)	Excessive differential temperature level 2 alarm
OV (Over Voltage)	Total charge voltage too high
	Cell overvoltage level 2 alarm
UV (Under Voltage)	Charge voltage too low
	Total discharge voltage too low
	Cell undervoltage level 2 alarm
OF (Other Fault) **Note**: For more information, contact Sol-Ark Technical Support: +1 (972) 575-8875 ext. 2	Abnormal number of Battery Module Units (BMU)
	BMU lost
	Real Time Clock (RTC) fault
	Current module fault
	SCHG total voltage acquisition fault
	Abnormal RS485 communication
	RS485 communication failure
	PCS-CAN Bus communication failure
	Repeated BMS address fault
	Repeated BMU address fault
	Abnormal power supply voltage
	Heating relay adhesion
	SOC too low
	SOC too high
	Fuse blown
	Charge relay welded
	Discharge relay welded
	Master positive relay welded
	Temperature acquisition failure
	Cell voltage acquisition fault
	Inter-battery communication failure
	Pre-charge failure
	Insulation level 2 alarm
	External total voltage acquisition fault
	Internal total voltage acquisition fault
	Current acquisition fault
	Limit protection
	EEPROM failure
ISO	Insulation level 2 fault alarm

Fault Diagnostic Table

Fault Type	Common Causes
Charge Over-current Alarm	More than 105A for 2s; more than 125A for 5s; or more than 140A for 2s Or if the battery is operating below 5°C (41°F) then: 52.5A for 2s; more than 62.5A for 5s; or more than 70A for 2s
Charge Over-current Protection	
Discharge Over-current Alarm	
Discharge Over-current Protection	
Charge Overtemperature Alarm	Charge temperature exceeds the set alarm value and time parameters (default: >45°C, 2s)
Charge Overtemperature Protection	Charge temperature exceeds the set protection value and time parameters (default: >50°C, 2s)
Discharge Overtemperature Alarm	Discharge temperature exceeds the set alarm value and time parameters (default: >50°C, 2s)
Discharge Overtemperature Protection	Discharge temperature exceeds the set protection value and time parameters (default: >55°C, 2s)
Charge Under Temperature Alarm	Temp. falls below the set alarm value parameter beyond the set time parameter (default: <5°C, 2s)
Charge Under Temperature Protection	Falls below the set protection value parameter beyond the set time parameter (default: <0°C, 2s)
Discharge Under Temperature Alarm	Temp. falls below the set alarm value parameter beyond the set time parameter (default: <-10°C, 2s)
Discharge Under Temperature Protection	Falls below the set protection value parameter beyond the set time parameter (default: <-20°C, 2s)
Excessive Differential Voltage Alarm	Differential voltage exceeds the set alarm value and time parameters (default: >500mv, 2s)
Excessive Differential Voltage Protection	Differential voltage exceeds the set protection value and time parameters (default: >800mv, 2s)
Excessive Differential Temperature Alarm	Differential temperature exceeds the set alarm value and time parameters (default: >10°C, 2s)
Excessive Differential Temperature Protection	Differential temperature exceeds the set protection value and time parameters (default: >15°C, 2s)
Cell Overvoltage Alarm	To maintain consistency, cut off the charging immediately when the full charge calibration rated voltage of 3.6V is reached. When the voltage drops to 3.35V, restart it with the turned-off red light indicator. All protective red light indicators are always on!
Cell Overvoltage Protection	
Cell Undervoltage Alarm	
Cell Undervoltage Protection	
Pre-charge Resistor Overtemperature Alarm	Resistor temperature exceeds the set alarm value and time parameters (default: >55°C, 2s)
Pre-charge Resistor Overtemperature Protection	Resistor temperature exceeds the set protection value and time parameters (default: >65°C, 2s)
Insulation Level 1	Resistance falls below the set alarm value parameter beyond the set time parameter
Insulation Level 2	Resistance falls below the set protection value parameter beyond the set time parameter
Heating Film Overtemperature Alarm	Heating film temperature exceeds the set alarm value and time parameters (default: >75°C, 2s)
Heating Film Overtemperature Protection	Heating film temperature exceeds the set protection value and time parameters (default: >80°C, 2s)
BMS Connector Overtemperature Alarm	BMS Connector temperature exceeds the set alarm value and time parameters
BMS Connector Overtemperature Protection	BMS Connector temperature exceeds the set protection value and time parameters
BMU Connector Overtemperature Alarm	BMU Connector temperature exceeds the set alarm value and time parameters
BMU Connector Overtemperature Protection	BMU Connector temperature exceeds the set protection value and time parameters
Power Loop Overtemperature Alarm	Power loop temperature exceeds the set alarm value and time parameters
Power Loop Overtemperature Protection	Power loop temperature exceeds the set protection value and time parameters
SOC Too Low	Battery SOC falls below the set value parameter beyond the set time parameter
Total Voltage Too High Alarm	Total battery pack series voltage exceeds the set alarm value and time parameters
Total Voltage Too High Protection	Total battery pack series voltage exceeds the set protection value and time parameters
Total Voltage Too Low Alarm	Total voltage falls below the set alarm value parameter beyond the set time parameter
Total Voltage Too Low Protection	Total voltage falls below the set protection value parameter beyond the set time parameter
Discharge Relay Adhesion	Discharge relay adhesion state detected
Charge Relay Welded	Charge relay adhesion state detected
Heating Relay Welded	High voltage detected after disconnecting the heating relay
Limit Protection	Exceeding the parameter set value and set time
Abnormal Power Supply Voltage	Power supply voltage exceeds the set value and time parameters
Master Positive Relay Welded	Master positive terminal relay adhesion state detected
Fuse Blown	No high voltage detected after the positive terminal relay is closed
Repeated BMU Address Fault	BMU with the same number
INTER-CAN Bus Communication Failure	Loss of communication between BMS units
PCS-CAN Bus Communication Failure	The heartbeat message from the inverter has not been received for a long time
RS485 Communication Failure	Inverter RS485 has not been received for a long time
Abnormal RS485 Communication	C
External Total Voltage Acquisition Fault	/
Internal Total Voltage Acquisition Fault	The difference between the acquired internal total voltage and the accumulated internal total voltage exceeds the set value
SCHG Total Voltage Acquisition Fault	/
Cell Voltage Acquisition Fault	A battery cell voltage has been reported as 0
Temperature Acquisition Failure	The temperature acquired is -40℃
Current Acquisition Fault	/
Current Module Fault	Abnormal Hall effect current sensor voltage
EEPROM Storage Failure	EEPROM write failure during self-test
RTC Clock Fault	The external RTC failed to enable the charging function
Pre-charge Failure	Battery pre-charge timeout
Charging Voltage Too Low	The minimum cell voltage is lower than the set value
BMU Lost	BMU message has not been received for a long time
Abnormal Number of BMU	The number of BMU addresses detected is different from the number of set parameters

Appendix A: Service Maintenance Procedures

General Safety Requirements

WARNING: Before performing any maintenance, make sure that the L3 HVR system is completely powered off and appropriate lockout-tagout procedures have been followed. Failure to do so could result in serious injury or death.

Maintenance Personnel Requirements

- Must follow all safety precautions and use necessary tools and personal protective equipment
- Must not wear jewelry, watches, or other metal accessories during maintenance

General Safety Precautions

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices
- Turn off all power supplies before working on or inside equipment
- Use a properly rated digital multimeter (DMM) device to confirm power is off
- Never touch high voltage positive and negative terminals with both hands
- Do not wash the system directly with water - use vacuum cleaner if necessary
- Insert and remove cables with care - trying to force an operation can cause damage
- After maintenance completion, clean all tools and materials and verify no metal objects remain inside or on top of the system

A.1 System Overview Maintenance Schedule

Task	Frequency	Reference Section
Exterior Visual Mechanical Inspection	12 months	A.2
Interior Visual Mechanical Inspection	12 months	A.3
Deflagration System Inspection	6 months	A.4
Battery Equipment Grounding Verification	12 months	A.5
HVAC Intake Inspection and Cleaning	6-12 months	A.6
HVAC Condensate Drain Inspection	6-12 months	A.7
Battery System Maintenance	6 months / 12 months / 24 months	A.8
Electrical System Maintenance	12 months	A.9

A.2 Exterior Visual Mechanical Inspection (Annual)

A.2.1 Cabinet Exterior Assessment

Check for and immediately correct the following:

- Flammable objects on top of the battery energy storage system
- Damage, flaking paint, or signs of oxidation on the enclosure
- Proper operation of cabinet door lock mechanism
- Secure mounting of sealing strips
- Damage or deformation of the container structure
- Proper visibility and condition of warning labels and marks

A.2.2 Foundation and Mounting

- Verify mounting feet bolts are properly torqued (37 ft-lb / 51 N-m)
- Check foundation for cracks, settling, or water pooling
- Ensure proper drainage sloping away from the foundation
- Verify clearance is maintained around all sides of the cabinet per installation guidelines or system installation plans.

A.2.3 Environmental Conditions

- Confirm installation location remains suitable for operation
- Check for new obstructions that may affect ventilation

A.3 Interior Visual Mechanical Inspection (Annual)

A.3.1 Interior Environment Assessment

- Check for foreign objects, dust, dirt, and condensed water inside the system
- Verify internal temperature and humidity are within normal ranges
- Clean equipment if dust accumulation is excessive
- Check for abnormal noise during operation of internal devices
- Verify air inlet and outlet are not blocked

A.3.2 Battery Module Inspection

- Visually inspect all 12 L3 HVR-5.1kWh battery modules for:
  - Physical damage or deformation
  - Loose mounting on baseplate
  - Signs of corrosion on modules or mounting hardware
  - Foreign bodies, dust, dirt, or condensation around modules
- Verify fire suppression canisters are not damaged or corroded

A.3.3 Internal Components

- Inspect Battery Management Unit (BMU) for damage or overheating signs
- Check internal busbar connections and safety covers
- Verify all internal components are securely mounted
- Inspect for any signs of water ingress or moisture damage

A.4 HVAC & Deflagration System Inspection (Semi-Annual)

A.4.1 HVAC Unit Inspection

- Check HVAC unit air inlet area (Component C) and outlet area (Component B) for obstructions
- Verify proper airflow volume
- Check for adequate spacing (>300mm from equipment, >1000mm from obstacles)
- Inspect condensate drain outlet (Component E) for proper drainage

A.4.2 Deflagration System Function

- Inspect deflagration ports on both side of the cabinet for damage
- Verify that nothing is blocking operation of the ports from opening

A.5 Battery Equipment Grounding Verification (Annual)

A.5.1 Grounding System Inspection

- Verify grounding connection is correct and secure
- Measure grounding resistance - must not exceed 4Ω (BESS) or 0.4Ω (individual components)
- Check equipotential connections inside the integrated system
- Inspect external grounding screws for proper torque (37 ft-lb / 51 N-m)

A.5.2 Grounding Connection Points

Verify that ground wire connections are NOT connected to:

- Water pipes
- Gas pipes
- Sewage pipes
- Other unreliable grounding locations

A.6 HVAC Intake Inspection and Cleaning (Semi-Annual to Annual)

A.6.1 Inspection and Cleaning

- Power off HVAC system before accessing
- Remove and inspect air inlet for dust accumulation and damage
- Ensure there are no foreign bodies, dust or dirt on the condenser coil
- If required, use a vacuum or compressed air to remove debris from the coil
- Usage of non-corrosive coil cleaning solutions is allowed, do not use any kind of pressure washer, only low-pressure water rinse.

A.7 HVAC Condensate Drain Inspection (Semi-Annual to Annual)

A.7.1 Drain System Check

- Verify condensate drain outlet flows freely
- Check for blockages in drain line
- Ensure proper drainage to prevent water accumulation
- Inspect drain pan for standing water or damage

A.7.2 Waterproofing Verification

- Perform waterproofing test around HVAC unit mounting
- Check flange sealing between unit and cabinet
- Verify sponge gaskets are properly installed and not deteriorated
- Test for leaks that could cause condensation or water damage

A.8 Battery System Maintenance

A.8.1 Semi-Annual Battery Inspection

Functional Testing

- Test DC contactor operation with by switching off the BMS unit using the Start button
- Measure output voltage to verify it falls within specification range

A.8.2 Annual Battery System Inspection

Electrical Connections

- Verify tightness of all electrical connections per relevant torque specifications:
  - M6 Internal Busbar +/- Connections: 7.7 ft-lb (10.5 N-m)
- Check copper busbars for looseness and proper torque
- Inspect power cables and communication cables for damage

Component Inspection

- Check battery modules are fixed on baseplate and not corroded
- Inspect for combustible materials on top of battery clusters
- Verify all wire inlets and outlets are properly sealed
- Check for internal water seepage

A.8.3 Bi-Annual Battery System Maintenance

Comprehensive System Review

- Inspect battery modules and internal devices for damage or deformation
- Check for abnormal noise during operation
- Verify internal temperature is not excessively high (>45°C)
- Assess internal humidity and dust levels - clean if necessary
- Check HVAC air inlet and outlet for blockages
- Inspect warning signs and labels for legibility - replace if necessary
- Inspect for internal oxidation or rust

Fan System Maintenance

- Check battery module fans for faults (locked rotor, stalling)
- Listen for abnormal noise during fan operation
- Inspect fan impeller condition
- Verify fans are securely installed and do not contact other components

A.9 Electrical System Maintenance (Annual)

A.9.1 Electrical Connections Inspection

- Perform visual inspection of all electrical connections

A.9.2 Control System Maintenance

- Clean dust and dirt from electrical control components using:
  - Brush combined with electronic dust remover, OR
  - Dry compressed air for dusting electrical components
- Check and secure all terminals:
  - Display board to main control board connections
  - Control board to interface board connections
  - Control board to load connections
- Verify user terminal connections to control board

A.9.3 Wiring and Cable Assessment

Power Supply Verification

- Check rated voltage of input AC power supply
- Verify power supply is within specified range (240V ± 10% or per nameplate)
- Confirm wiring installation follows applicable electrical codes

Cable Condition Check

- Inspect all wiring for loose connections or damage
- Check communication lines for proper shielding and grounding
- Verify cable routing prevents stress on terminals
- Replace damaged cables with manufacturer-specified replacements

Circuit Protection

- Verify impedance values of connected power supply system per specifications
- Check surge protection devices (SPD) and fuses are properly fastened

A.10 Fire Suppression System Maintenance

A.10.1 Module-Level Fire Suppression

- Verify canisters are not subjected to corrosive or wet environments

A.10.2 Cabinet-Level Fire Suppression

- Inspect 300-gram aerosol canister in top right corner of cabinet
- Check canister mounting and connections

A.10.3 Fire Suppression Service Life

- Track canister installation/service dates
- Plan for replacement at 10-year service intervals
- Document any environmental conditions that may affect service life

A.11 Maintenance Documentation Requirements

A.11.1 Record Keeping

Required Documentation

- Maintenance completion dates and personnel
- Inspection results and any deficiencies found
- Corrective actions taken
- Replacement parts used with part numbers
- Test results and measurements
- Environmental condition logs

A.11.2 Maintenance Reporting

- Report significant findings to Sol-Ark customer service
- Maintain warranty compliance through proper documentation

A.11.3 Parts and Materials

- Use only manufacturer-approved replacement parts
- Verify part numbers and compatibility before installation

A.12 Troubleshooting and Emergency Procedures

A.12.1 Emergency Shutdown

- Emergency stop button (Component D) immediately shuts down battery output
- Use lockout-tagout procedures for maintenance safety
- Contact Sol-Ark Technical Support
- Do not attempt unauthorized repairs