

# **AES 42-48-6650 LiFePO<sub>4</sub> INSTALLATION AND OPERATION MANUAL**

READ AND SAVE THESE INSTRUCTIONS

**BATTERY MODEL**  
900-0028



<b>INTRODUCTION</b>	<b>3</b>
<b>1. AUDIENCE, WARNINGS, MESSAGES, GENERAL SAFETY, PERSONAL PROTECTIVE EQUIPMENT</b>	<b>3</b>
1.1 Audience	3
1.2 Warning, Caution, Notice, and Note Messages	3
1.3 General Warnings	4
1.4 Safe Handling Procedures	5
1.5 Personal Protective Equipment	5
<b>2. ITEMS SHIPPED IN THE BOX</b>	<b>6</b>
<b>3. SPECIFICATIONS</b>	<b>6</b>
3.1 Electrical Specifications	6
3.2 Mechanical Specifications	7
3.3 Environmental Specifications	7
3.4 Protection Specifications	7
3.5 Regulatory	9
<b>4. TRANSPORTATION</b>	<b>9</b>
<b>5. HANDLING</b>	<b>9</b>
<b>6. FEATURES</b>	<b>10</b>
6.1 Internal Battery Fuse	10
6.2 ON/OFF Key	10
6.3 Battery Communication	11
6.4 Equipment Ground	11
<b>7. THEORY OF OPERATION</b>	<b>12</b>
7.1 Ingress Protection IP55	12
7.2 Battery Management System	12
7.3 AEBus (LYNK) Network Communication	13
<b>8. OPTIONAL ACCESSORIES</b>	<b>14</b>
<b>9. INSTALLATION</b>	<b>14</b>
9.1 Tools	14
9.2 Location	15
9.3 DC Cables	16
9.4 Protection	16
9.5 Securing the Battery	17
9.6 Installing the Battery	18
9.7 Installing Batteries in Parallel Battery Wiring	19
9.8 AEBus (LYNK) Network	21
<b>10. OPERATION</b>	<b>23</b>
10.1 Low Voltage Cut-Off	23
10.2 State of Charge	23
10.3 Charging	23
10.4 Charging Profile	25
<b>11. ROUTINE INSPECTION</b>	<b>26</b>
<b>12. STORAGE</b>	<b>27</b>
<b>13. BATTERY MODULE FIRMWARE AND DATA LOGS</b>	<b>27</b>
<b>14. TROUBLESHOOTING</b>	<b>28</b>
<b>15. RELATED INFORMATION</b>	<b>28</b>
<b>16. GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS</b>	<b>28</b>

## Introduction

The AES LiFePO<sub>4</sub> is a battery that can operate on its own or in a battery bank configuration where multiple batteries are connected in parallel.

This manual covers serial numbers for part number 42-48-6650 greater than DET424820275xxxx.

## 1. AUDIENCE, WARNINGS, MESSAGES, GENERAL SAFETY, PERSONAL PROTECTIVE EQUIPMENT

### 1.1 Audience

Configuration, installation, service, and operating tasks should only be performed by qualified personnel in consultation with local authorities having jurisdiction and authorized dealers. Qualified personnel should have training, knowledge, and experience in the:

- Installation of electrical equipment
- Application of applicable installation codes
- Analysis and reduction of hazards involved in performing electrical work
- Installation and configuration of batteries
- Installation and configuration of systems activated by relays

### 1.2 Warning, Caution, Notice, and Note Messages

Messages in this manual are formatted according to this structure.



Additional information concerning important procedures and features of the product. Read all the instructions before installation, operation, and maintenance.



Important information regarding hazardous conditions.

#### **WARNING**

Important information regarding hazardous conditions that may result in personal injury or death.

#### **CAUTION**

Important information regarding hazardous conditions that may result in personal injury.

#### **NOTICE**

Important information regarding conditions that may damage the equipment but not result in personal injury.

#### **NOTE**

Ad hoc information concerning important procedures and features unrelated to personal injury or equipment damage.

### 1.3 General Warnings



Do not crush, disassemble, or dispose of the battery in a fire or the garbage.



This product is made of recyclable materials and must be recycled.



#### **⚠ WARNING**

##### **ELECTRIC SHOCK AND FIRE HAZARD**

- This equipment must only be installed as specified.
- Do not install the batteries in series.
- Do not disassemble or modify the battery.
- If there is damage to the battery case, do not touch exposed contents.
- There are no user-serviceable parts inside.

**Failure to follow these instructions may result in death or serious injury.**

#### **⚠ WARNING**

##### **CHEMICAL HAZARD**

Do not touch the exposed contents of a Lithium cell.

**Failure to follow these instructions may result in death or serious injury.**

#### **⚠ WARNING**

##### **ELECTRIC SHOCK AND FIRE HAZARD**

Do not lay tools or other metal parts on the battery or across the terminals.

**Failure to follow these instructions may result in death or serious injury.**

#### **⚠ CAUTION**

##### **ELECTRIC SHOCK HAZARD**

- Do not touch the energized surfaces of any electrical component in the battery system.
- Before servicing the battery, follow all procedures to fully de-energize the battery system.
- Follow the ["Safe Handling Procedures"](#) below when working with the battery.

**Failure to follow these instructions may result in injury.**

## **NOTICE**

- The AES Battery has a Battery Management System (BMS) with an integrated solid-state relay that reduces the fire risk.
- The primary suppression for a lithium battery fire is water. The secondary suppression is CO<sub>2</sub> powder and halon.

### **1.4 Safe Handling Procedures**

Before using the battery, read all instructions and cautionary markings on the unit and all appropriate sections of this manual.

- Use personal protective equipment when working with batteries.
- Do not dispose of the battery in a fire.
- Promptly dispose of or recycle used batteries following local regulations.
- Do not disassemble, open, crush, bend, deform, puncture, or shred.
- Do not modify, re-manufacture, or attempt to insert foreign objects into the battery, immerse or expose the battery to water or other liquids, fire, explosion, or other hazards. If the user suspects damage to the battery due to water, heat, or other reason, take it to a service center for inspection.
- Only use the battery for the system for which it is specified.
- Do not lift or carry the battery while in operation.
- The battery is heavy. When lifting the battery, follow appropriate standards.
- Only lift, move, or mount following local regulations.
- Take care when handling battery terminals and cabling.
- Do not expose the battery to high temperatures.
- Do not submerge the battery.
- Do not install the battery module with the top face pointed down.
- Only use the battery with a charging system that meets specifications. Using a battery or charger that does not meet specifications may present a risk of fire, explosion, leakage, or other hazards.
- Do not short-circuit a battery or allow metallic conductive objects to contact battery terminals.
- Replace the battery with only another one that meets the system's specifications. Using a battery that does not meet specifications may present a risk of fire, explosion, leakage, or other hazards.
- Do not drop the device or battery. If the device or battery is dropped, especially on a hard surface, and the user suspects damage, take it to a service center for inspection.

### **1.5 Personal Protective Equipment**

When handling or working near a battery:

- Use Personal Protective Equipment, including clothing, glasses, insulated gloves, and boots.
- Do not wear rings, watches, bracelets, or necklaces.

## 2. ITEMS SHIPPED IN THE BOX

Table 2-1, AES LiFePO<sub>4</sub> box contents

Items	Description
1	Battery
1	RJ45 Terminator Kit
1	RJ45 Y-Adapter
1	Terminal cover (black)
1	Terminal cover (red)
2	M8x16 bolt
1 set	Safety warning decals

## 3. SPECIFICATIONS

All specifications in this document are published @25°C / 77°F.

### 3.1 Electrical Specifications

Table 3-1, AES LiFePO<sub>4</sub> Electrical Specifications

Electrical Specifications	42-48-6650   900-0028
Nominal Voltage	51.2 V
Nominal Energy	7.39 kWh
Usable DOD	90%
Rated Wh Capacity (1C)	6.65 kWh
Rated Ah Capacity (1C)	130 Ah
Charge Bulk Voltage - Bulk VDC	55.2 Vdc
Charge Absorption Voltage - U1 MAX	55.2 Vdc
Charge Float Voltage - U2	55.2 Vdc
Charge Termination Current <sup>(a)</sup>	2 A
Low Voltage Disconnect Recommended	48.0 V
Low Voltage Disconnect <sup>(b)</sup>	40.0 V
Max. Continuous Discharge Current <sup>(c)</sup>	130 Adc
Max. Continuous Charge Current <sup>(c)</sup>	130 Adc
Peak Discharge Current (3 seconds)	300 Adc
Fuse (Provides backup overcurrent protection)	200 A
Maximum short circuit fault current	6.0 kA / 5.5 ms
Arc Flash Incident Energy IEm	0.1 cal/cm <sup>2</sup>
Arc Flash Incident Energy AFB	9.4 cm
<sup>(a)</sup> Charge termination current is permitted to be less than specified. <sup>(b)</sup> Under load, low Voltage Disconnect is based on 2.5VPC. In no load conditions, do not allow the battery to self-discharge below 3.0 VPC. <sup>(c)</sup> The effects of AC Ripple must be taken into consideration when sizing and configuring the system.	

### 3.2 Mechanical Specifications

**Table 3-2, AES LiFePO<sub>4</sub> Mechanical Specifications**

<b>Mechanical Specifications</b>	<b>42-48-6650   900-0028</b>
Chemistry	LiFePO <sub>4</sub>
Cell Modules	16S 26P
Length	471.5 mm (18.56 in)
Width	347.5 mm (13.68 in)
Height	375 mm (14.76 in)
Terminal <sup>(1)</sup>	M8
Weight	87.0 kg (191.8 lb)
IP Rating	IP55
Case Material	Powder Coated Cold Rolled Steel

<sup>(1)</sup> TERMINAL TORQUE: 9 Nm +/- 3 (6.64 ft-lb) to a maximum depth of 14 mm (0.55 in).

### 3.3 Environmental Specifications

**Table 3-3, AES LiFePO<sub>4</sub> Environmental Specifications**

<b>Environmental Specifications</b>	<b>42-48-6650   900-0028</b>
Rated Altitude	Altitude does not significantly affect operating characteristics up to 2,000 m (6,561 ft)
Charge Operating Temperature Range <sup>(a)(b)</sup>	0°C to 45°C (32°F to 113°F)
Discharge Operating Temperature Range <sup>(a)</sup>	-20°C to 50°C (-4°F to 122°F)
Storage Temperature <sup>(c)</sup>	-20°C to 45°C (-4°F to 113°F)

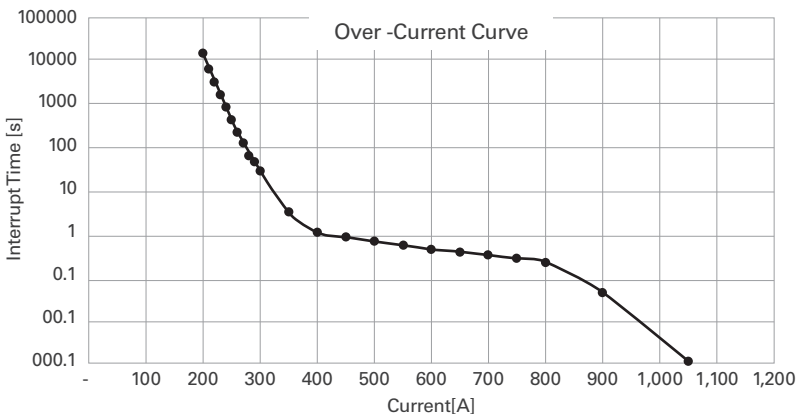
<sup>(a)</sup> Specifies the temperature of the cells and not the ambient temperature. Ambient temperature and cell temperature may not be the same.  
<sup>(b)</sup> The Battery Management System (BMS) does not allow the charging of cells when it is below 0°C (32°F).  
<sup>(c)</sup> Storage outside of specified temperatures will result in permanent capacity loss and void the warranty.

### 3.4 Protection Specifications

**Table 3-4, AES LiFePO<sub>4</sub> Protection Specifications**

<b>Protection Specifications</b>	<b>42-48-6650   900-0028</b>
<b>Overvoltage</b>	
Protection <sup>(a)</sup>	Greater than 58.4 V for 3 seconds
Recovery <sup>(a)</sup>	Recovery after 120 seconds. Charge is permitted at 53.6 V or less.
<b>Undervoltage</b>	
Protection <sup>(b)</sup>	Less than 40 V for 5 seconds
Recovery <sup>(b)</sup>	No automatic recovery. The battery shuts down after 120 seconds.

<b>Over-Charge Current</b>	
Protection	Greater than 143 A for 10 seconds
Recovery	Recovery after 120 seconds
<b>Over-Discharge Current</b>	
Protection <sup>(c)</sup>	300 A (3 seconds)
Recovery <sup>(c)</sup>	Recovery after 120 seconds
<b>Over-temperature in Discharge</b>	
Protection <sup>(d)</sup>	Cell temperature above 60°C (140°F) for 5 seconds
Recovery <sup>(d)</sup>	Cell temperature below 50°C (122°F)
<b>Under-temperature in Discharge</b>	
Protection <sup>(d)</sup>	Cell temperature below -20°C (-4°F) for 5 seconds.
Recovery <sup>(d)</sup>	Cell temperature above -18°C (0°F)
<b>Over-temperature in Charge</b>	
Protection <sup>(d)</sup>	Cell temperature above 60°C (140°F) for 5 seconds
Recovery <sup>(d)</sup>	Cell temperature below 50°C (122°F)
<b>Under-temperature in Charge</b>	
Protection <sup>(d)</sup>	Cell temperature below 0°C (32°F) for 5 seconds and charge current detected.
Recovery <sup>(d)</sup>	Charge recovery temperature above 2°C (36°F) Note: Discharge is available to -20°C (-4°F)
<p><sup>(a)</sup> Overvoltage protection monitors individual cell voltages. Protection is triggered when any cell is over 3.65 VPC and recovers after 120 seconds. Charge is permitted when VPC is 3.35 or less. Voltages are provided for guidance only.</p> <p><sup>(b)</sup> Undervoltage protection monitors the voltage of individual cells. Protection is triggered for any cell below 2.5 VPC for 5 seconds, and the battery is automatically set OFF after 120 seconds. Manually set the battery ON to recover. Voltages are provided for guidance only.</p> <p><sup>(c)</sup> For time versus current interrupt details, see Figure 2, Over-Discharge Protection Time Current Curve.</p> <p><sup>(d)</sup> Specifies the temperature of the cells and not the ambient temperature. Ambient temperature and cell temperature may not be the same.</p>	



**Figure 1. Over-Discharge Protection Time Current Curve**



### 3.5 Regulatory

**Table 3-5, 42-48-6650 Regulatory**

<b>Regulatory</b>
UN 38.3 Transportation
IEC 62133
UL 1973
UL 2271
UL 9540 <sup>(1)</sup>
CE
<sup>(1)</sup> Applies when the battery is used with Schneider Electric XW PRO inverter-chargers.

### EMC

The battery has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. The battery generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If the battery does cause harmful interference to radio or television reception, which can be determined by turning the battery off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the battery and receiver.
- Connect the battery to an electrical circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### 4. TRANSPORTATION

If the battery is not installed in the equipment, transport it in the original package or equivalent. Per the UN Handbook of Tests and Criteria, batteries are tested to part III, subsection 38.3 (ST/SG/AC.10/11/ Rev. 5). For transportation, the battery belongs to category UN3480, Class 9.

### 5. HANDLING

Before handling:

- Keep the battery away from sparks and flames
- Disconnect the cables from the battery
- Protect battery terminals from short-circuiting and touch
- Do not lift or carry the battery while it is in use or in operation
- Do not lift the battery by the attached battery cables

## 6. FEATURES

	Item	Description
	1	Battery negative (-) black, M8 female
	2	ON/OFF key
	3	Battery positive (+) red, M8 female
	4	Xanbus Port
	5	AEBus Port (LYNK Port)
	6	USB Port (Type B)
	7	Mounting Points
8	Handles	

Figure 2. AES Battery

### 6.1 Internal Battery Fuse

The internal battery fuse provides backup overcurrent protection and should only be replaced by qualified personnel trained in the installation of electrical equipment.

#### NOTE

Additional external DC fusing is required to protect the battery cables from DC overcurrent and to meet installation codes.

### 6.2 ON/OFF Key

Press the battery's ON/OFF key for 2 to 3 seconds to switch the battery either ON or OFF. The LED illuminates when the battery is ON and darkens when the battery is OFF.



#### ⚠ WARNING

##### ELECTRIC SHOCK HAZARD

- Always assume the battery's main relay is ON (Closed), even if the LED for the ON/OFF key is not illuminated.
- Verify the terminal voltage with a voltmeter before handling and installing the battery.

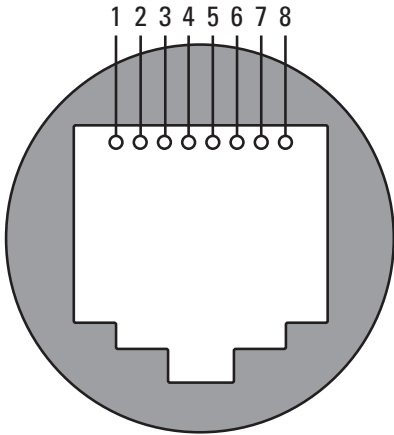
**Failure to follow these instructions may result in death or serious injury.**

ON/OFF LED	Description
Dark	The battery's main relay is OFF (Open).
Illuminated	The main relay is ON (Closed), and the battery is ready for operation.
Flashing at 1 second intervals	The main relay is OFF (Open). The flashing indicates protection has been triggered as one or more operating parameters (voltage, current, temperature) have exceeded their fault threshold. Refer to <a href="#">Table 3-4, AES LiFePO4 Protection Specifications</a> , for information on faults that trigger protection.

### 6.3 Battery Communication

The AEBus Port (LYNK port) enables multiple Discover Energy Systems batteries to communicate and interact in a closed-loop network. The AEBus Port also enables AES LiFePO<sub>4</sub> batteries to be networked in a closed-loop system with other networked devices, such as external power conversion and motor control devices. A closed-loop system enhances safety and optimizes system performance.

#### 6.3.1 AEBus Port (LYNK Port) Communication RJ45 Pin Assignment

 <p><b>Figure 3. AEBus Port (LYNK Port) Communication RJ45 pin assignment</b></p>	Pin Number	Function
	1 (1)	Reserved. Do not use.
	2 (1)	Reserved. Do not use.
	3 (1)	Reserved. Do not use.
	4	CAN Low
	5	CAN High
	6 (1)	Reserved. Do not use.
	7	CAN Ground
8	CAN Ground	
<small>(1) Do not populate. Do not terminate to power. Do not terminate to ground. Do not terminate to CAN_L or CAN_H.</small>		

### NOTICE

- Isolate unused pins. Crossing pin functions may cause system damage.
- Do not terminate unused wires to ground, power, or other functions.
- Mixing the AEBus Network with other networks may result in equipment malfunction and damage.

### 6.4 Equipment Ground

Grounding the battery is not required.

## 7. THEORY OF OPERATION

### 7.1 Ingress Protection IP55

Ingress protection rates the degree of protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact, and water under specified conditions. The IP55 rating indicates that the product is touch-proof, protected from limited dust ingress, and protected from low-pressure water jets from any direction.

IP codes guide suitability for use under different IP environmental conditions. IP ratings do not indicate fitness for purpose or confer a performance guarantee.

### 7.2 Battery Management System

#### 7.2.1 Battery Management System Protections

The Battery Management System's (BMS) primary function monitors cell module voltage, temperature, and battery current. The BMS uses this information to maintain cell operation within operating specifications. If a parameter falls outside of operating specifications, the BMS will disconnect and protect the battery from:

1. **Overvoltage:** Charge voltage that is too high for the battery or for an individual battery cell.
2. **Undervoltage:** Discharge voltage that is too low for the battery or for an individual battery cell.
3. **Overcurrent:** Current is too high when powering up a load (high inrush current) or from a sustained charging or discharging current above the specified limit.
4. **Over-temperature:** Cell temperature that is too high during charge and discharge.
5. **Under-temperature:** Cell temperature that is too low during charge and discharge.

For trigger and recovery values, refer to [Table 3-4, AES LiFePO4 Protection Specifications](#).

The BMS reconnects when it hits recovery thresholds. Manually switch the battery ON if the BMS disconnects due to low voltage protection. A physical disconnect switch is recommended to reconnect the battery if the system has a constant parasitic draw.

#### NOTE

- Charge and discharge have different operating temperature limits. For information, refer to [3.4 Protection Specifications](#).
- If the BMS disconnects in response to temperature or current limits, wait for the temperature or current to reach normal operating limits before switching the battery ON.

#### 7.2.2 BMS Pre-Charge System

Turn on all the batteries in the battery bank before energizing any inverter-chargers to prevent blowing a fuse while trying to pre-charge the system.

The battery has a Pre-Charge System to energize external capacitive loads before switching the main relay ON. The maximum input capacitance for a single battery should not exceed the values in [Table 3-1, AES LiFePO4 Electrical Specifications](#).

## NOTICE

When switching ON batteries, the inrush current may cause the batteries to fault as they energize external capacitive loads. To resolve this, switch the batteries ON again.

### 7.2.3 Battery Charge and Discharge Settings

In an open-loop configuration, use the specifications provided in this manual to set up the charge and discharge settings manually at the time of installation through the controller of the Power Conversion device. This system contrasts with a closed-loop configuration where the BMS specifies charging and safety settings through a connection with the Power Conversion device.

Closed-loop communication with a Power Conversion device requires using the LYNK II Communication Gateway device from Discover Energy Systems. Refer to the LYNK II Installation and Operation Manual (805-0033) from the [www.discoverlithium.com](http://www.discoverlithium.com) website, or contact your Discover Energy Systems provider for assistance.

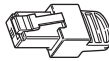
Refer to the appropriate Application Note available from [www.discoverlithium.com](http://www.discoverlithium.com) for the set up of closed-loop parameters and integration with specific brands of solar inverter-chargers, solar charger controllers, mobile inverter-chargers, and industrial chargers.

### 7.3 AEBus (LYNK) Network Communication

Discover Energy System batteries use CAN communication over the AEBus (LYNK) Network to coordinate performance with other batteries and communicate with accessories such as the LYNK Communication Gateway.

## NOTICE

Termination resistors are required when deploying the battery in an AEBus (LYNK) Network.



**Figure 4. Termination Resistor**

#### 7.3.1 AEBus (LYNK) Network Power

The Discover battery provides power for the AEBus (LYNK) Network through the AEBus (LYNK) Port. For information, refer to 5.5 Power Sources for LYNK II, [LYNK II Installation and Operation Manual \(805-0033\)](#).

## NOTICE

Do not use an external power source to power devices over the AEBus (LYNK) Network.

### 7.3.2 AEBus (LYNK) Network Size

One AEBus (LYNK) Network can support up to 13 AES LiFePO<sub>4</sub> batteries.

### 7.3.3 AEBus (LYNK) Network Cable

Use CAT5 or higher cables for batteries on the AEBus (LYNK) Network.

## 8. OPTIONAL ACCESSORIES

The following optional accessories are available for the AES LiFePO<sub>4</sub> battery.

Accessory	Part Number
LYNK II Communication Gateway	950-0025
AES LiFePO <sub>4</sub> Wall-Mount Bracket	950-0018

## 9. INSTALLATION

### WARNING

#### ELECTRIC SHOCK HAZARD

- This equipment must only be installed as specified.
- Do not disassemble or modify the battery.
- If the battery case has been damaged, do not touch exposed contents.
- There are no user-serviceable parts inside.

**Failure to follow these instructions may result in injury.**

### CAUTION

#### HEAVY OBJECT

Two-person lift is recommended for the battery.

**Failure to follow these instructions may result in injury.**

### NOTICE

- Some chargers and inverters support temperature-compensated charging. Disable temperature-compensated charging on the charger or inverter.
- Do not use or install a battery temperature sensor. If updating an existing system that uses temperature sensors, remove them.

### NOTE

The installer is responsible for meeting all applicable installation requirements and standards.

### 9.1 Tools

- Insulated tools sized to match nuts, bolts, and cables
- RMS type Voltmeter
- Post cleaner and wire brush
- Personal protective equipment

## 9.2 Location

### WARNING

#### FIRE HAZARD

Do not install the battery in living or working areas.

**Failure to follow these instructions may result in death or serious injury.**

Install the battery in locations that meet the following requirements:

1. **Do not install in direct sunlight.** Avoid installing the battery in an area with high ambient temperature or an area exposed to UV rays.
2. **Moderate temperature.** The ambient temperature should be between 0°C and 40°C (32°F and 104°F). Ambient temperatures of 15°C to 25°C (59°F to 77°F) are ideal for extending LiFePO<sub>4</sub> battery life. Do not install near a generator or other component that produces significant heat, as this could expose the battery to temperatures greater than 40°C (104°F).
3. **Ventilation.** Do not install in zero-clearance compartments.  
When installing a single battery, allow spacing of at least 25 mm (1 in) around the perimeter of the battery.  
When installing multiple batteries, allow spacing of at least 10 mm (0.4 in) between batteries.  
When installing multiple batteries vertically in tiers, allow at least 25 mm (1 in) between a battery and the rack above it, except for the top tier of batteries. Allow a clearance of at least 150 mm (5.9 in) between the top battery and the enclosure's roof.  
In the room housing the batteries, add vents to allow airflow to the outdoors.
4. **Away from water.** Protect from exposure to water, including water sprayed from nozzles. In a wall-mounted configuration, mount the batteries at least 50 mm (2 in) off the ground.  
If installing near the ocean, keep away from salt spray and use dielectric grease on all connectors.
5. **Orientation.** Install the battery in any direction other than face down. Do not install face-down.
6. **Indoor or outdoor.** Suitable for use indoors. Refer to [3.3 Environmental Specifications](#), for temperature ranges in which the battery can operate.

### NOTE

Using this product in a location that does not meet requirements will void the warranty.

### 9.3 DC Cables

#### CAUTION

##### FIRE HAZARD

Undersized cables can become hot and may potentially catch fire.

**Failure to follow these instructions can result in minor to moderate injury.**

The DC battery cables should meet the following requirements:

1. **Copper-stranded cable.** DC cables must be stranded, copper, and rated 90 °C minimum. Terminate the cables with lugs that fit the DC terminals.  
If near the ocean, use tinned copper-stranded cables to minimize corrosion.
2. **Minimum cable lengths.** Select a location that minimizes the length of battery cables to reduce voltage drop from the impedance leading to reduced performance.
3. **Appropriate cable gauge.** The cables should be capable of carrying the normally expected current, plus a margin of safety.
4. **Proper polarity.** Positive (+) is connected to positive (+), and negative (-) is connected to negative (-). Verify the polarity of all connections before energizing batteries.
5. **Minimum cable lengths.** Select a location that minimizes the length of battery cables to reduce voltage drop from the impedance leading to reduced performance. Use the same length cables between all the batteries so they charge and discharge equally, which helps maintain battery bank capacity and performance.

### 9.4 Protection

#### CAUTION

##### FIRE HAZARD

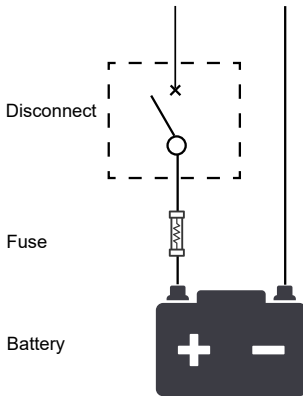
- Undersized fuses, disconnects, and buses may become overloaded and potentially cause a fire.
- Fuses and breakers are required to open before the cable reaches its maximum current carrying capability.

**Failure to follow these instructions can result in minor to moderate injury.**

Additional DC overcurrent protection (rated for 58 volts on 48V batteries) and a DC disconnect switch are required to protect the system and DC battery cables.

1. **Appropriate size.** Size the fuses and disconnects following local codes to protect the wiring in the system and are required to open before the cable reaches its maximum current carrying capability.
2. **Install disconnect in the positive cable.** The disconnect should be located close to the battery's positive cable.





**Figure 5. Example disconnect**

3. **Install fuse protection in the positive cable.** The fuse should be located close to the battery and installed in the positive cable. Local codes may limit how far the protection can be from the battery.

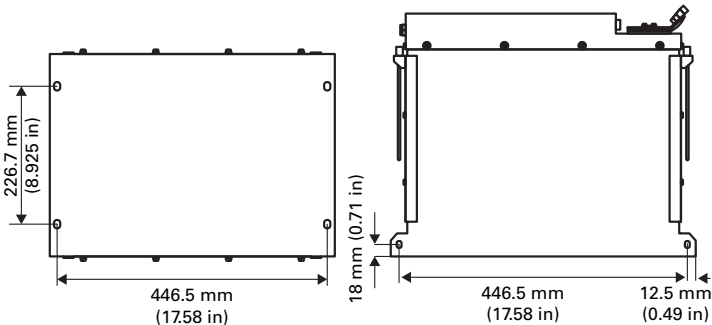
**NOTE**

- Local codes and regulations may require the disconnect in both the positive and negative cables. Refer to the Local Authority Having Jurisdiction.
- AC circuit breakers and DC circuit breakers are not interchangeable. Check the label on the circuit breaker to ensure it is the correct type and rating. Use only DC circuit breakers.

**9.5 Securing the Battery**

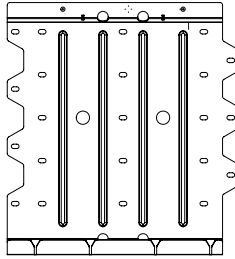
Use one of the methods below to secure the battery:

- Strap the battery in place with non-conductive nylon straps.
- Use screws in the hold-down brackets at the base of the 42-48-6650 model.



**Figure 6. 42-48-6650 screw holes**

- Secure with a Discover AES Wall-Mount Bracket (p/n 950-0018), available for use with the 42-48-6650 model.



**Figure 7. AES Wall-Mount Bracket (p/n 950-0018)**

## 9.6 Installing the Battery

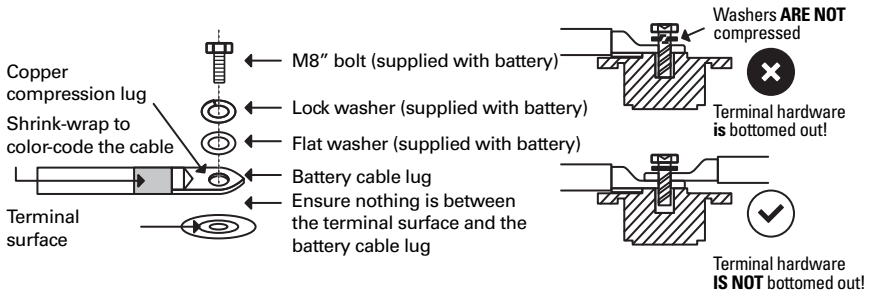
Battery cables must be sized to the specifications required by the inverter-charger and installed in accordance with the standards set by the authority having local jurisdiction. Do not use or install a battery temperature sensor.

Battery terminals are button-type, M8 female. The recommended torque is 9.0 Nm (6.64 ft-lb) to a maximum depth of 14 mm (0.55 in). For information on connecting battery cables, see [Figure 6. Battery Cable Terminal Connection](#).

1. Switch the battery OFF.
2. If the battery circuit has a disconnect, open the disconnect to isolate the battery.
3. Ensure the cable connections are clean and in good working order.
4. Install and secure the new battery.
  - Take precautions to avoid bridging the terminals.
  - Do not contact the terminals with metal mountings, fixtures, or body parts.
5. Connect battery cables.
  - Connect the negative cable last to avoid sparking.
  - Short circuits may damage the battery and void the warranty.
6. If using the LYNK II Communication Gateway, attach a CAT5 cable to the AEBus (LYNK) Port on the battery and attach the other end to the LYNK II.
  - Refer to [9.8 AEBus \(LYNK\) Network](#), for instructions.
7. If the battery circuit has a disconnect, close the disconnect to reconnect the battery.
8. Switch the battery ON.

### NOTICE

Installing AES batteries in a series configuration will void the warranty. Do not install AES batteries in a series configuration.



**Figure 8. Battery Cable Terminal Connection**

### NOTE

All cable ends must be connected to battery terminals without any washers between terminal bushings and cable ends.

Terminal burnout is caused by:

- Discharge currents exceeding allowable limits
- Improper cable installation
- Improper cable sizing
- Improper terminal torque

### NOTE

Without exception, a product experiencing terminal burnout will void the warranty.

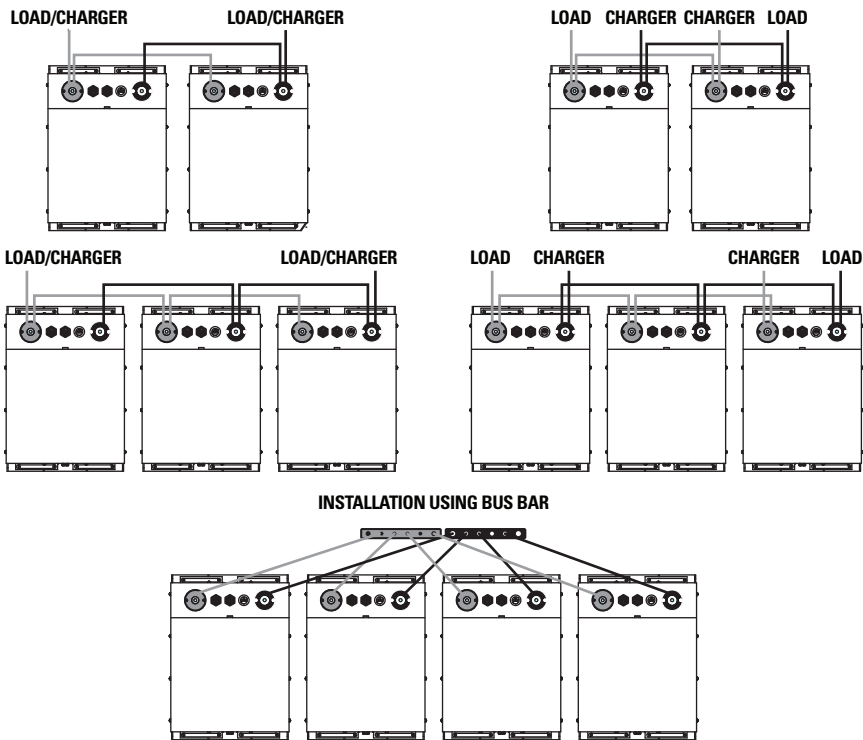
## 9.7 Installing Batteries in Parallel Battery Wiring

For proper balancing and load sharing between parallel batteries, refer to [Figure 7. Batteries in Parallel Installation](#). Lithium batteries are susceptible to voltage, and undersized battery cables impede battery and system performance. The thickness (cross-section) of cables should exceed the recommended minimum for the inverter-charger installation.

When installing four or more batteries in parallel, use a busbar configuration. In a busbar configuration, use the same length cable for all battery cable sets, regardless of the battery's proximity to the busbar (or combiner box). Actual wiring requirements may vary. Consult with the authority having local jurisdiction.

### NOTE

Install a maximum three batteries using battery interconnection cables. When connecting four or more AES batteries in parallel, using a battery combiner or central bus bar is recommended.



All parallel cables should be the same length

**Figure 9. Batteries in Parallel Installation**

### NOTE

- Whenever replacing a battery in a parallel installation, use a battery of the same age, model, capacity, and voltage.
- Before installing the battery in parallel, ensure each battery is charged to 100% SOC.

#### 9.7.1 Commissioning a Parallel Battery System

In a parallel battery system, charge all batteries to 100% State of Charge (SOC) before switching the batteries ON. Before energizing power electronics, switch all batteries ON.

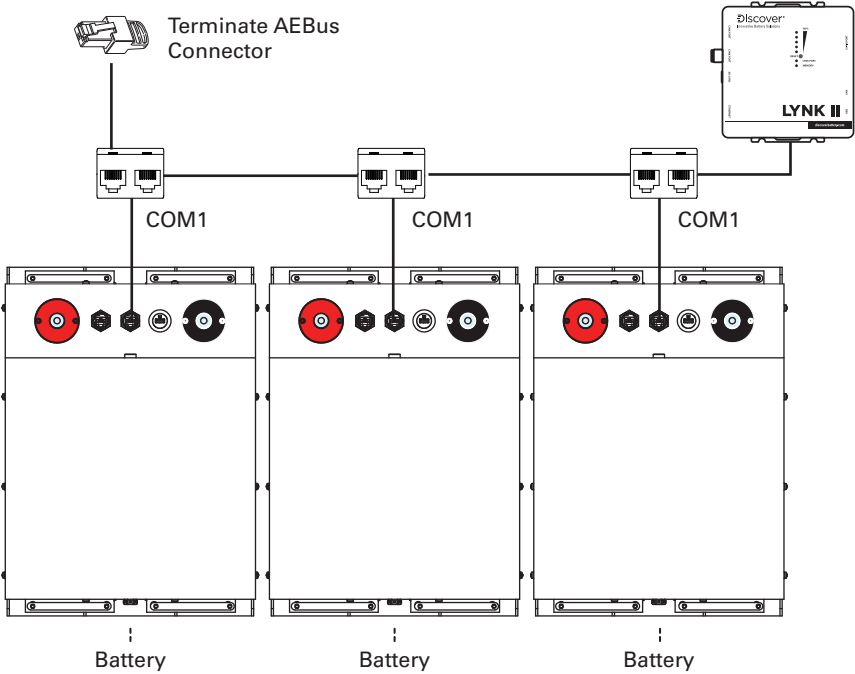
### NOTICE

Failure to ensure all batteries are at equal SOC when commissioning a paralleling system may result in blown battery fuses.

## 9.8 AEBus (LYNK) Network

### 9.8.1 Network Layout

AES batteries use the AEBus (LYNK) Network to coordinate voltage, temperature, and current data. Network terminators are required for the AEBus (LYNK) Network to function correctly.



**Figure 10. Batteries connected to AEBus (LYNK) Network**

### 9.8.2 Configuration with Power Conversion and Monitoring Devices

Set up AES batteries to work with Power Conversion and Monitoring devices in either an Open-Loop or Closed-Loop configuration. Set up the charge and discharge settings in an Open-Loop configuration through the Power Conversion device's controller at the time of installation. In a Closed-Loop configuration, the BMS of the AES Battery dynamically controls charge and discharge settings over a connection with the Power Conversion device. Closed-Loop communication on a Power Conversion device network requires using the LYNK II Communication Gateway (p/n 950-0025) available from Discover Energy Systems.

For information on Closed-Loop and Open-Loop configuration with a Power Conversion device, refer to the appropriate Application Note for your Power Conversion device, available from [www.discoverlithium.com](http://www.discoverlithium.com), or contact your Discover Energy Systems provider for assistance.

## NOTE

- Schneider Electric XW PRO and XW+ devices communicate over Xanbus, forming a closed-loop configuration through the Xanbus Port on the AES battery, and do not require the LYNK II Communication Gateway (p/n 950-0025). For instructions on using Xanbus, refer to [Application Note 885-0013 Closed-Loop Integration with Xanbus Enabled Schneider Electric Conext Products](#).
- The Xanbus port on the 42-48-6650 is internally terminated so the RJ45 Terminator Kit and RJ45 Y-Adapter are not required to connect to the Xanbus network.
- Older Xantrex and Schneider Electric XW inverter-chargers cannot communicate with Discover Lithium batteries over Xanbus in a closed loop.

### 9.8.3 Network Installation

Networking Guidelines:

- **Separate data and power cables.** Allow for separation between data and power cables. Avoid data interference caused by running network cables bundled with power cables.
- **Allow for AEBus (LYNK) Network cable slack.** Ensure that AEBus (LYNK) Network cables are slack and not in tension.
- **Isolate the AEBus (LYNK) Network.** Do not mix other networks with the AEBus (LYNK) Network.

## NOTICE

Mixing the AEBus (LYNK) Network with other networks may result in equipment malfunction and damage.

### 9.8.4 Installation Procedure

1. Before beginning a network installation, mount the devices according to their instructions.
2. Attach a CAT5 cable to the AEBus (LYNK) Port on a battery.
3. Connect the other end of the CAT5 cable to the AEBus (LYNK) Port of the following battery.
4. Repeat until all batteries are connected.
5. Add a terminator to the last battery in the AEBus (LYNK) Network.
6. Network with other devices and accessories as needed.

### 9.8.5 Testing and Verification of the AEBus Network

Perform network verification with the **950-0025 LYNK II Communication Gateway**.

- If the LYNK II Network Bus indication LED is illuminated, power and communication for the AEBus (LYNK) Network are active.
- Use LYNK ACCESS software through a computer to confirm the number of batteries in the AEBus (LYNK) Network.

## 10. OPERATION

The BMS prevents battery operation outside of specified operating conditions. Understand each of these protections and set up the system accordingly.

Refer to [Table 3-4, AES LiFePO4 Protection Specifications](#).

NOTICE
Intentionally bypassing the BMS to operate the battery outside maximum and minimum limits voids the warranty.

### 10.1 Low Voltage Cut-Off

Program the low voltage cut-off at or above the Low Voltage Disconnect as shown in [Table 3-1, AES LiFePO4 Electrical Specifications](#). This action disconnects the load before the BMS enters low voltage protection.

NOTICE
Storing or leaving the battery at 0% SOC will lead to irreversible damage and void the warranty.

### 10.2 State of Charge

A voltage-based battery meter designed for lead-acid batteries will not provide an accurate state-of-charge (SOC) for lithium batteries. The following device, available from Discover Energy Systems, can communicate an accurate state of charge to other devices.

- LYNK II Communication Gateway

### 10.3 Charging

Each electrical system will have different characteristics and balance-of-system components. Charger settings may require modifications to optimize system performance.

NOTICE
<ul style="list-style-type: none"><li>• Always confirm that the charging device cannot produce transient spikes that exceed the published terminal voltage limits for the battery.</li><li>• Always confirm the charging curve meets the battery's charging requirement.</li></ul>



NOTICE
Never charge a visibly damaged or frozen battery.

#### 10.3.1 Closed-Loop Charging

Closed-loop charging is a charging method whereby the battery communicates with a charger and controls the charge voltage and current. Closed-loop charging is available with compatible chargers directly connected to the AEBus (LYNK) Port or through the LYNK II Communication Gateway. Closed-loop charging reduces charge time and increases balancing efficiency compared to open-loop charging.

Refer to the appropriate Application Note available from [www.discoverlithium.com](http://www.discoverlithium.com) for the set up of closed-loop parameters and integration with specific brands of solar inverter-chargers, solar charger controllers, mobile inverter-chargers, and industrial chargers.

### 10.3.2 Open-Loop Charging

Open-loop charging is a charging method of where the battery and charger do not communicate. The charger must be configured manually with appropriate settings for open-loop charging.

For charging parameters, refer to [Table 3-1, AES LiFePO4 Electrical Specifications](#).

#### NOTICE

When using open-loop charging, use a voltmeter to calibrate inverter-chargers to match the battery terminal voltage. The cable length and size of battery cables can cause a voltage drop and the batteries may not charge properly if the inverter-chargers are not calibrated.

### 10.3.3 When to Charge the Battery

- **Opportunity charging is OK:** Charging the battery after every use will not reduce its cycle life.
- **Partial State-of-Charge is OK:** If the battery SOC is greater than 10% at the end of discharge, it does not require an immediate charge. However, do not continually leave the battery in a partial state of charge as that will reduce its performance as battery cells become unbalanced.

Every 4 cycles, fully charge the battery so the inverter-charger reaches the charge termination criteria. This is required so the BMS can perform its balancing function.

- **Charge if below 10% SOC:** If the battery is discharged below 10% SOC, it must be charged within 24 hours to avoid permanent damage to the battery. Otherwise, irreversible damage to the battery cells will occur in a very short period of time.
- **Low charge current extends life.** Charging at 50% of nominal current or lower helps extend the battery cycle life.
- **Charge within the proper temperature range.** Ensure charging is within the temperatures specified in [Table 3-3, AES LiFePO4 Environmental Specifications](#).

#### NOTICE

- The battery must be charged within 24 hours if discharged below 10% SOC. Otherwise, irreversible damage to the battery cells will occur in a very short period of time and void the warranty.
- Do not continually leave the battery in a partial state of charge, as that will unbalance the battery cells. Fully charge the battery every 4 cycles so the BMS can perform its balancing function. If the charge termination criteria is not regularly performed, multiple balancing charges may be required to balance the battery cells. The following are two ways to perform a balancing charge.
  - Reduce charge termination to 100 mA and maintain 54.4 V for 10 hours.
  - Charge in a closed-loop configuration.



## 10.4 Charging Profile

Charge with a Lithium charge profile matching the specifications for the AES LiFePO<sub>4</sub> battery.

Standard open-loop charging for the battery should include both Bulk and Absorption phases.

Refer to [Table 3-1, AES LiFePO<sub>4</sub> Electrical Specifications](#), for open-loop charging parameters.

Refer to the appropriate Application Note available from [www.discoverlithium.com](http://www.discoverlithium.com) for the set up of closed-loop parameters and integration with specific brands of inverter-chargers and battery chargers.

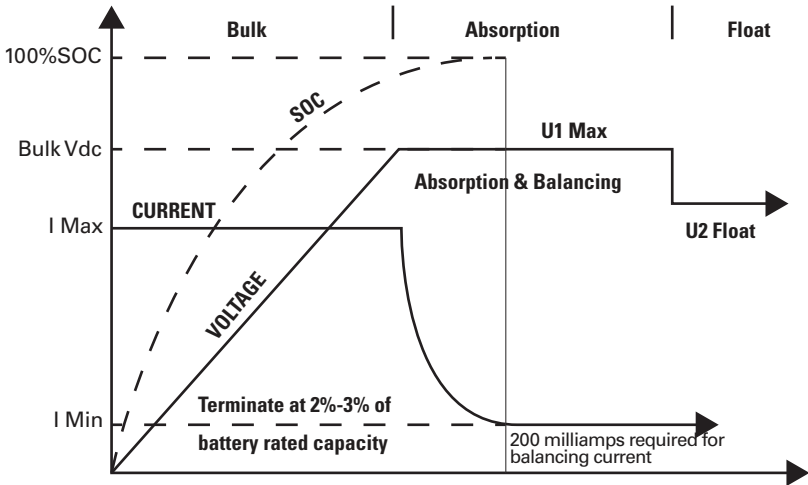


Figure 11. Charge Graph

### NOTICE

- Charge with a Lithium charge profile matching the specifications for the AES LiFePO<sub>4</sub> battery.
- Do not charge using a lead-acid charging profile. Charging using a lead-acid profile will void the warranty.

### NOTE

Charging at 50% or lower of the nominal current will extend the battery cycle life.

### 10.4.1 Bulk Charge

**Bulk phase.** The Bulk Charge is the first phase of the charging process, also called the constant current phase. This phase is when the charger's maximum current is directed to the battery until reaching the desired voltage. The Bulk phase will recharge the battery to approximately 90-95% SOC.

If the charging source is a generator or other charge source that is not efficient at low output current, a single-stage charge may be appropriate. A single-stage charge will only complete the Bulk phase portion of the charge curve. This method should return the battery to 90-95% SOC.

Refer to [Table 3-1, AES LiFePO4 Electrical Specifications](#), for charging parameters.

#### 10.4.2 Absorption Charge

**Absorption phase.** The second phase of the charging process is Absorption Charge, also called the constant voltage phase. In this phase, the charger reduces current to maintain the desired voltage.

Refer to [Table 3-1, AES LiFePO4 Electrical Specifications](#), for charging parameters.

#### 10.4.3 Equalization Charge

### ⚠ CAUTION

#### FIRE AND BURN HAZARD

Do not perform an equalization charge on the AES LiFePO<sub>4</sub> battery.

**Failure to follow these instructions may result in minor to moderate injury.**

**Do not equalize charge the AES LiFePO<sub>4</sub> battery.** Equalization charging is intended only for lead-acid batteries. An equalization charge is a purposeful overcharge that targets a voltage above the standard charge voltage to remove sulphate crystals that form on lead-acid plates over time.

#### 10.4.4 Float Charge

**Float phase.** Float charge, the third phase of charging, is optional. During this stage, the battery is maintained at 100% SOC for extended periods, counteracting any self-discharge or parasitic loads.

- **Not necessary.** Float charging is not required.

Refer to [Table 3-1, AES LiFePO4 Electrical Specifications](#), for float parameters if needed.

## 11. ROUTINE INSPECTION

Periodically inspect the battery.

1. Ensure that all DC cables are secure and fasteners are torqued properly.
2. Inspect and clean network and battery connectors of dirt and debris.
3. Ensure all networking cables and connectors are secure and tight.
4. Ensure that the installation location is clean and free from debris.
5. Inspect for cracks or bulging in the battery case.
6. Replace any damaged batteries.
7. Replace any damaged cables.

The battery is ready for use after the inspection is complete.

## 12. STORAGE

Leaving the battery connected to a trickle load or power electronics will cause the battery to discharge during storage. Without any load, the battery will self-discharge by approximately 3% per month while in storage. After storage, charge the battery to 100% SOC and perform at least one full discharge and charge cycle before returning the battery to service.

1. **Store at 95% SOC or more.** To store the battery for up to 6 months, store the battery at 95% SOC or more. It must remain disconnected from all loads and power electronics during storage.
2. **Switch OFF the battery.** Set the battery to OFF.
3. **Check SOC every 6 months.** Recharge the battery to above 95% SOC at least every 6 months.
4. **Proper storage temperature.** Ensure storage is within the temperatures specified below.
  - -20°C to 45°C (-4°F to 113°F)

### NOTICE

Leaving the battery connected to a load or power electronics during storage may subject the battery to discharge, resulting in irreversible damage and voiding the warranty.

### NOTICE

- Storing the battery outside specified temperatures will result in irreversible damage and void the warranty.
- Storing or leaving the battery at 0% SOC will result in irreversible damage and void the warranty.
- Allowing the battery to self-discharge below an open-circuit voltage of 3.0 VPC will cause irreversible damage and void the warranty.

## 13. BATTERY MODULE FIRMWARE AND DATA LOGS

Always ensure all the batteries in the battery bank are using the latest firmware. AES Dashboard PC software is required to update the battery firmware and to download data logs from the battery. Get the latest software and battery operating firmware from the Discover Energy Systems website at [www.discoverlithium.com](http://www.discoverlithium.com).

## 14. TROUBLESHOOTING

Accurate troubleshooting and warranty claims require data logs from each battery. Use AES Dashboard diagnostic software to download data logs one battery at a time.

Confirm you have the latest version of Dashboard, which was AES Dashboard 70.6\_win64 at the time of publishing. System owners are encouraged to install the AES Dashboard software on a laptop to troubleshoot their system.

### NOTICE

If you encounter issues with the battery, please promptly contact the service center. Leaving a battery in an error state for an extended period of time could cause the battery to become unrecoverable and void the warranty.

A battery is unrecoverable once battery cells are below 2 VPC — when the battery voltage is 32 V.

## 15. RELATED INFORMATION

For warranty information, refer to 885-0046 Discover AES LiFePO<sub>4</sub> Battery Warranty Policy, available from the Discover Energy Systems website at [www.discoverlithium.com](http://www.discoverlithium.com).

## 16. GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS

<b>AFB</b> Arc Flash Boundary	<b>RMS</b> Root Mean Square
<b>BMS</b> Battery Management System	<b>SOC</b> State of Charge
<b>DOD</b> Depth of Discharge	<b>VPC</b> Volts Per Cell
<b>LFP</b> LiFePO <sub>4</sub> Lithium Iron Phosphate	