



Power. On Your Terms.



## PHI 3.4™ BATTERY

# INSTALLATION MANUAL

Optimized Energy Storage & Management for Residential & Commercial Applications Utilizing Efficient, Safe, Non-Toxic, Energy Dense Lithium Ferrous Phosphate (LFP) Chemistry.

# SimpliPhi Your Power Security and Independence

**and gain control of your own power.**

SimpliPhi helps you manage your power as a personal resource. Anytime. Anywhere. SimpliPhi energy storage optimizes integration of renewable power with the grid and protects your home and mission-critical business functions from power outages and intermittency. SimpliPhi storage technology eliminates operating temperature constraints, toxic coolants and the risk of thermal runaway and fire.

SimpliPhi's clean storage technology utilizes the industry's most environmentally benign chemistry combined with proprietary architecture and power electronics (BMS) that eliminate the need for cooling or ventilation to create products that provide energy security and resiliency—all with a 98% efficiency rate.

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*SimpliPhi Power offers proprietary, commercially available energy storage and management systems that are safe, non-toxic, reliable, durable, efficient, highly scalable, and economical over the lifetime of the battery.*

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# The SimpliPhi Power PHI 3.4™ Technical Overview:

## PHI 3.4™ Battery Safety Protocol and Protective Features

### Safety Protocol:



**IMPORTANT NOTE:** Circuit Breakers, Disconnects and Fuses should be employed throughout several points of a power storage and generation installation to effectively isolate and protect all components of the system to safeguard against faults, short circuits, polarity reversals or a failure of any component in the overall system. Fuses, breakers, wiring ratings and values should be determined by established standards and evaluated by certified electricians, licensed installers, and regional code authorities. Although each PHI 3.4™ Battery contains both an 80 Amp circuit breaker and an internal BMS with circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge and excessive load amperage, the PHI 3.4™ Batteries must always be installed with a charge controller and the appropriate settings to protect the PHI 3.4™ from open PV voltage and other high voltage charging sources. The PHI 3.4™ Battery Management System (BMS) and internal circuit breaker alone will not protect the PHI batteries from these extreme electrical phenomena. Failure to adhere to installation protocol will void the Warranty.



**CAUTION:** Verify polarity at all connections with a standard volt meter before 1) energizing the system and 2) turning the PHI 3.4 80 Amp breaker “ON/OFF” switch to the “ON” position. **Reverse polarity** at the battery terminals will void the Warranty and destroy the batteries.

PHI 3.4™ Batteries pose some risk of shock or sparking during the installation and initial wiring and connection process. This is consistent with all other battery based storage formats. Be sure to turn the built-in 80 Amp breaker to the “OFF” position to minimize the risk of shock or sparks during the installation and commissioning of the system. Use of insulated gloves, clothing and footwear is always recommended when working in close proximity to electrical devices. Cover, restrain or remove jewelry or conductive objects (metal bracelets, rings, belt buckles, metal snaps, zippers, etc.) when working with any electrical or mechanical device. Cover or restrain long hair and loose clothing when working with any electrical or mechanical device.

PHI 3.4™ Batteries do not vent any harmful gasses, and do not require special ventilation or cooling.

PHI 3.4™ Batteries are not capable of thermal runaway. If the cells are severely damaged due to physical abuse incurred outside of warranted specifications, which can cause electrolyte leakage and other failures, as with any battery, the electrolyte can be ignited by an open flame. However, unlike other lithium ion batteries (LCO) there are no hazardous or toxic materials in the electrolyte or the material components of PHI 3.4™ Batteries. See MSDS for chemical analyses (Page 23).



**CAUTION:** Charging LFP batteries at temperatures below freezing.

Do not attempt to charge the battery below 32 F (0 degrees C). Although cold temperatures do not harm PHI batteries, attempts to charge at subfreezing temperatures can adversely affect SOH and cycle life, and will void the Warranty. If the battery must be charged below 32 F (0 degrees C), the rate of charge must be at no more than 5% of the battery's rated capacity (C/20).



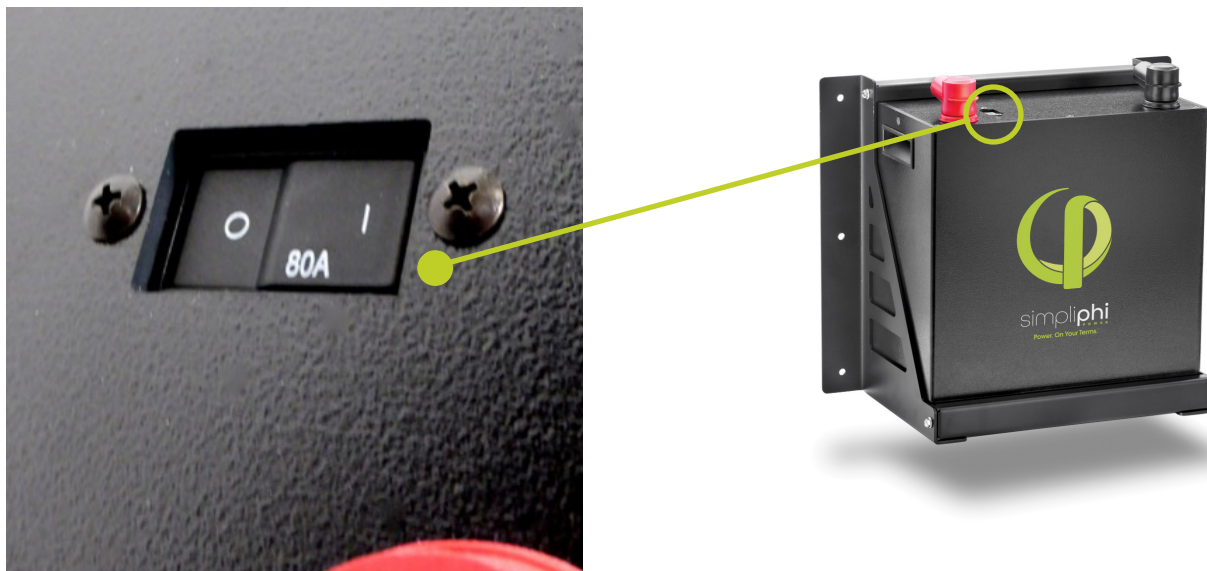
Only use a SimpliPhi approved LFP charger if ancillary charging is required before installation, testing or troubleshooting. Failure to use a SimpliPhi approved LFP charger will damage the battery and void the warranty.

### **SimpliPhi Power PHI 3.4™ Protective Features:**

PHI 3.4™ Batteries are manufactured utilizing Lithium Ferrous Phosphate (LFP) cells, which are produced under exclusive patented licensed technologies, as well as proprietary materials, architecture, assembly methods and battery management system (BMS). This assures the highest grade and quality, longest cycle-life, greatest efficiency and freedom from material impurities, toxicity and hazardous risk.

Each PHI 3.4™ Battery contains circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge and excessive load amperage. If the values specified are exceeded, the protective circuitry will shut down the flow of electricity to/from the PHI 3.4™ Batteries. In some cases this will result in the need to re-initialize an inverter charger. Often, inverter system settings will be saved within the inverter memory storage and will not need to be reset. This is not an absolute standard but is common amongst most inverter chargers and should be anticipated if the PHI 3.4™ Batteries go into a state of self-protection and shut down the flow of electricity.

In addition, the PHI 3.4™ Battery is equipped with a built in 80 Amp breaker that effectively works as an “ON/OFF” switch to be used during shipping and installation. The breaker works in conjunction with the built in battery management system (BMS) and creates additional safety, efficiency and functionality to the overall power storage system.



*Figure 1.0 Photo depicts “On Position”*

## SimpliPhi Power PHI 3.4™ Battery Performance Parameters and Sizing Calculations:

PHI 3.4™ Batteries perform at full rated capacity in most operating environments. No increase in sizing, no special compensations, no burying procedure or insulation needs to be considered when determining the size of the energy storage and management system under the following circumstances and conditions. See specific inverter manufacturer program settings for optimizing system integration.

PHI 3.4	24V	48V
DC Voltages - Nominal	25.6	51.2
Amp Hours	134	67
Wh Capacity	3,440	
Max Output Capacity	60 Amps	
Max Charge Current	45 Amps	33 Amps
DC Voltage Range	20 to 28.8	40 to 57.6
Depth of Discharge	up to 100%	
Operating Efficiency	98%	
Operating Temp	-4° to 140°F (-20° to 60°C)	
Charge Temp	32° to 120°F (0° to 49°C)	
Self-Discharge Temp	<1% loss per month	
Memory Effect	None	
Warranty Period	10 Years	
Cycle Life	10,000+	

*Note: There is less than 1% loss of energy during charging.*

*PHI 3.4™ Batteries do not need to be de-rated unless running continuously at more than 90% capacity, at temperatures below 0 degrees Celsius, or above 60 degrees Celsius. To achieve higher cycles of 10,000+, please refer to operating temperatures and inverter settings on page 16 of the manual. Further details are available on request from SimpliPhi Power.*

# Installation Procedure and Diagrams

## System Sizing for Your Installation

The number of PHI 3.4™ Batteries should be specified in terms of total storage capacity before the initial installation based on the goals and objectives of the project. All PHI 3.4™ Batteries are balanced during final production and testing stages. Following proper wiring guidelines ensures that a system will not require any manual balancing processes.

**DO NOT COMBINE PHI 3.4™ BATTERIES WITH OTHER BRANDS OR CHEMISTRIES**

**DO NOT MIX PHI BATTERIES FROM DIFFERENT INSTALLATIONS, CLIENTS, OR JOB SITES**

## System Configuration - Basic Concepts

Safe and reliable installation requires trained and certified technicians. The following discussion of PHI Battery configurations is a basic primer. Due to the variety of systems and components in the field, all possible scenarios are not covered. This is not the purpose of this section of the manual. Refer to professional installers regarding your system and its components and specifications. We encourage you or your installer to contact us with any specific questions for technical support. We are committed to working with you and your installation team to achieve a safe, reliable storage system that will provide years of maintenance free service.



*Figure 2.0* - PHI 3.4™ 48 Volt, 60 Amp, Batteries: 17kWh Residential Installation

**PHI BATTERIES ARE DESIGNED FOR PARALLEL OPERATION ONLY - DO NOT ARRANGE IN SERIES FOR INCREASED VOLTAGE**

### System Wiring Basics

Refer to published electrical wiring specifications and ratings. All wire should be an appropriate gauge and construction to handle the loads that will be placed upon it. Heavy gauge, high strand copper wire is the industry standard due to its stability, efficiency and overall quality. A qualified installer should understand this and must adhere to the industry standard and published electrical guidelines.

### For All Installations

- Maintain identical wire lengths from each PHI 3.4™ Battery terminal to the common bus.
- Use identical wire construction from each PHI 3.4™ Battery terminal to the common bus.

All PHI 3.4™ Batteries are outfitted with an 80A hydraulic/magnetic circuit breaker which will show a white base when tripped. This breaker increases safety during installations and allows the battery to effectively be turned “off” or “on.”

All PHI 3.4™ Batteries are designed to serve at a fixed voltage range in parallel arrangements for maximum available amperage and storage capacity. **PHI 3.4™ Batteries are not designed to be arranged in series for increased voltage.** Series arrangements can result in damage to the Battery’s protective circuitry and **will void the Warranty.**



## Simple Parallel Arrangements

**Storage Capacity** and total available **Amperage** is increased by **Parallel** arrangements. The following illustration shows two PHI 3.4™ Batteries in **Parallel**. For example, assume that these are 24V Batteries.

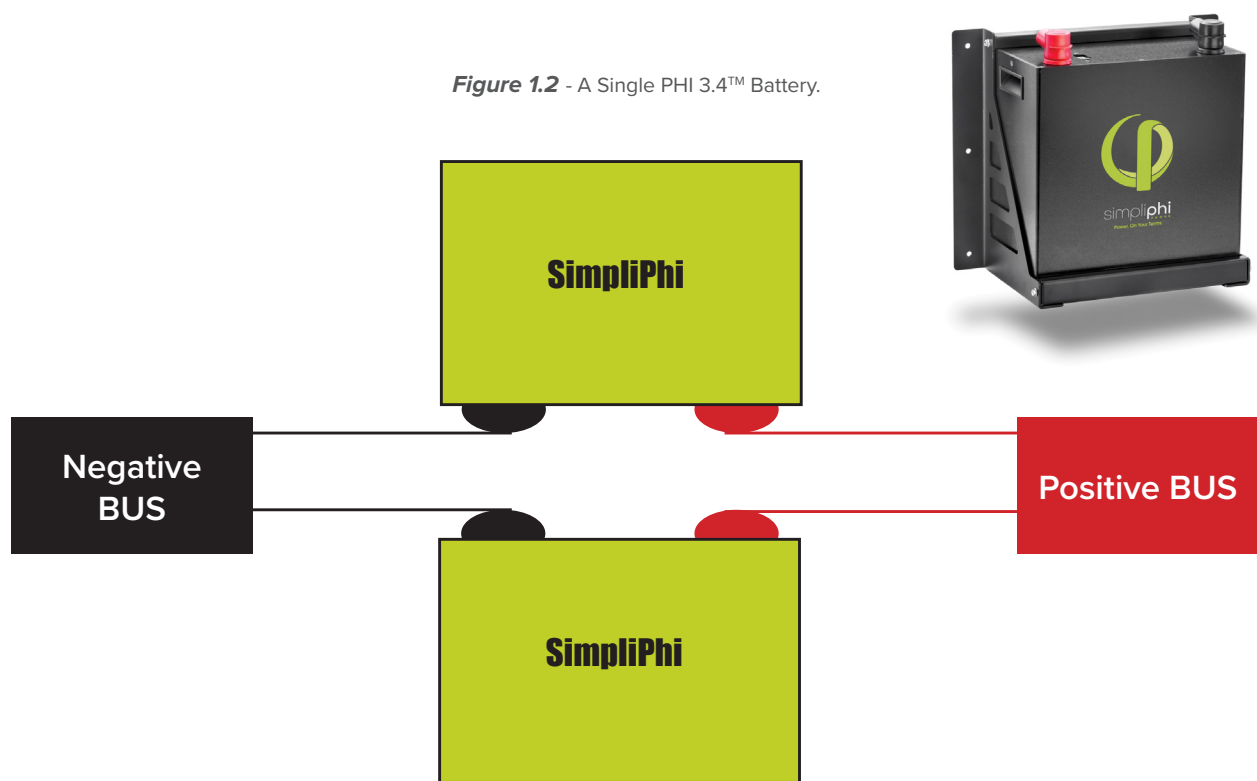
**Note** the overall Voltage range is not changed. The arrangement remains at 24 Volts, the available AH capacity, or ability to provide 24 Volt power over time, has been doubled. The available amperage from the system has been doubled. The same configuration should be applied to other parallel arrangements, whether they are 24V or 48V. See Figure 1.2.

### Simple Parallel Arrangements:

**Storage Capacity** and total available **Amperage** is increased by **Parallel** arrangements. The following illustration shows two PHI 3.4™ Batteries in Parallel.

**PHI BATTERIES ARE DESIGNED FOR PARALLEL OPERATION ONLY - DO NOT ARRANGE IN SERIES FOR INCREASED VOLTAGE**

**WIRING IN SERIES WILL VOID WARRANTY**

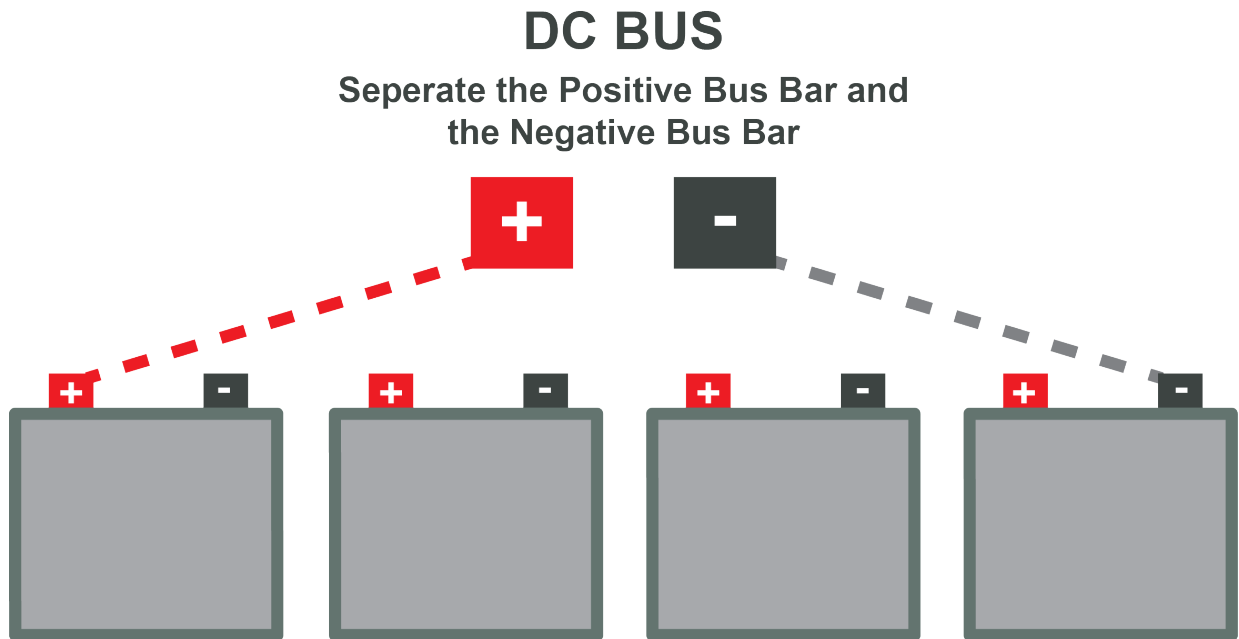


*Figure 1.3*

Figure 1.3 represents two PHI 3.4™ Batteries in Parallel. Wire lengths from PHI Batteries should be **identical** in length and gauge in order to balance the load across both (all) PHI Batteries in the installation. **Identical wiring length is a critical feature of parallel power storage systems that must be adhered to throughout all parallel wiring instructions.**

## Increasing Capacity with Parallel PHI Battery Configurations

Special attention should be paid for parallel installations. Correct wiring is essential to insure optimum performance and system longevity. All wire “runs” should utilize **identical wiring gauge** and **identical wire lengths** between PHI 3.4™ Batteries and the common negative or positive “Bus” or Load.



Use identical length and gauge wire to balance the load across the batteries.

### Helpful Tips:

- Determine the cable length for the battery terminal farthest from the bus.
- Make all Battery cables a matching length.
- Additional cabling or slack that remains with the shorter distance runs can be coiled and secured with Zip Ties.

**Figure 1.4**

Figure 1.4 depicts one of four PHI 3.4™ Batteries that will have been wired in Parallel. The wiring arrangement will be repeated to connect all four PHI 3.4™ Batteries in parallel. The completion of this configuration will require **8 identical lengths of appropriately heavy gauge copper wire**.

Alternate wiring schemes are also effective. The “Cross Diagonal” method is perhaps less common but has been evaluated in outside facilities and found to be very effective. The Cross diagonal method can minimize copper wire runs to a degree and can also serve as a tool in complex wiring schemes where space is at a minimum or system layouts are complex or irregular. For more information on cross diagonal wiring methods, and the benefit of correct wiring configurations, refer to:

[http://www.smartgauge.co.uk/batt\\_con.html](http://www.smartgauge.co.uk/batt_con.html)

## Mounting Hardware

The SimpliPhi Power Mounting Brackets (sold separately) are designed to secure one PHI 3.4™ Battery to a load bearing surface. SimpliPhi Power Batteries can be mounted in practically any orientation (Terminals Up, Down, On Side). The brackets can be mounted directly to a wall or can be arranged on strut channels for ease of positioning. A qualified installer should be familiar with accomplishing this with the appropriate load bearing requirements.

**Mounting Bracket Hardware is also included:** 1/4-20 x 5/8" Hex Washer Head Machine Screw - Slotted.  
18-8 Stainless Steel

For ease of measuring, arranging and mounting your PHI Battery array, a drawing of the PHI3.4™ Mounting Brackets with dimensions is provided (page 12):

During mechanical testing, individual PHI 3.4™ Mounting Brackets were exposed to 200 pounds each of downward pressure along the bracket's outer edge. During this test, a deflection of approximately 30 thousandths of an inch was measured. Combined bracket sets can easily bear weights in excess of 400 pounds. Bracket sets are designed to hold one PHI 3.4™ Module, with a weight of 75.5 pounds.

## PHI 3.4™ Battery Weight

PHI 3.4™ Batteries weigh 75.5 pounds. The Wall Mount Bracket Assemblies weigh 8 Pounds. The SimpliPhi Power Mounting Brackets should be mounted into load bearing beams, studs or solid posts. Check with your installer to select an appropriate wall space or surface.

## PHI 3.4™ Battery Wall Mount + Bracket Dimensions

### PHI 3.4™ Battery

**Width:** 13.5"

**Height:** 15.5" (including 1.5" terminal height)

**Depth:** 8"

**Weight:** 75.5 Pounds

### PHI 3.4™ Battery with Bracket

**Width:** 13.7"

**Height:** 15.5" (including 1.5" terminal height)

**Depth:** 9.16"

**Weight:** 83.5 pounds



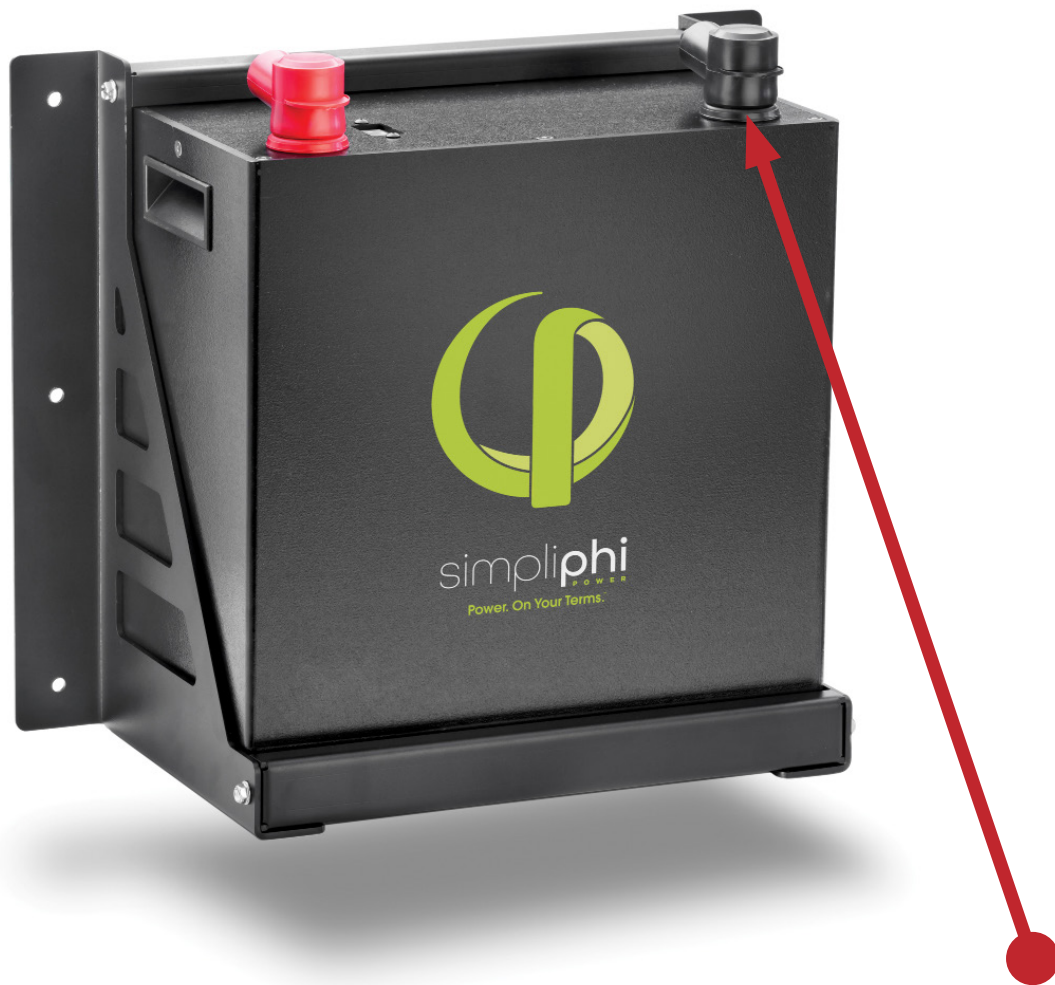
## KEY POINTS

1. Each PHI 3.4™ Battery contains circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge, excessive charge and load amperage. If the values specified are exceeded, the Batteries will enter a protective shut down state. In some cases this will result in the need to re-initialize an inverter charger or other pieces of equipment in the installation. Often, inverter system settings will be saved within the inverter memory storage and will not need to be reset. This is not an absolute standard but is common among most inverter chargers. Check your inverter manufacturer specifications.
2. If PHI 3.4™ Batteries enter a self protective mode, negligible voltage readings will be present until the units reset. In some instances, after a prolonged shut down, a charge might need to be manually applied to the energy storage bank. Should this occur, please contact SimpliPhi Power for technical support. The PHI batteries are designed to remain robust and safe under most circumstances.
3. Although each PHI 3.4™ Battery contains circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge and excessive load amperage, the PHI 3.4™ Batteries must always be installed with a charge controller and the appropriate settings to protect the PHI 3.4™ from open PV and other high voltage sources. The PHI 3.4™ Battery alone will not protect the batteries from these extreme electrical phenomena.
4. **GRID TIED SYSTEMS:** Once the PHI 3.4™ Batteries have been installed, turn on the entire system to test, but **once testing has been completed please disconnect the PHI 3.4™ Battery Bank from the load center until your local Utility Inspector is ready to turn on the entire system.** The charge controllers and inverter monitoring systems can drain the PHI 3.4™ Batteries over an extended period of time when the entire system is not fully operational due to the electrical draw of the system components.
5. **OFF GRID SYSTEMS: Do not connect the PHI 3.4™ Batteries until the entire system is ready to turn on and is fully operational. Install with the 80 Amp breaker in the “OFF” position.**
6. See Charge Controller Settings in the Appendix of this manual. PHI 3.4™ Batteries are compatible with almost all Inverter Chargers and Charge Controllers. Please contact SimpliPhi Power for recommended settings for any device not expressly covered in this manual.
7. Only use a SimpliPhi approved LFP charger if ancillary charging is required before installation, testing or troubleshooting. Failure to use a SimpliPhi approved LFP charger will damage the battery and void the warranty.
8. **CAUTION: Charging PHI LFP batteries at temperatures below freezing.**

**Do not attempt to charge the battery below 32 F (0 degrees C). Attempts to charge at subfreezing temperatures can adversely affect SOH and cycle life, and will void the warranty.**

**If the battery must be charged at temperatures below freezing the rate of charge must be at no more than 5% of the battery's rated capacity (C/20).**

# Connecting SimpliPhi Power PHI3.4™ Batteries: Terminal Specs and Hardware



**CAUTION: DO NOT ATTEMPT TO LOOSEN THE LARGE BRASS NUT AT THE BASE OF THE TERMINALS.**

## PHI 3.4™ Battery Connection Terminals

The PHI 3.4™ Batteries are equipped with two 3/8" threaded studs with a lock washer and nut. The right hand stud resides in a red colored high temperature molded insert. This connection is for the positive lead. The left hand stud resides in a black colored high temperature insert. This connection is for the negative lead. **Do not reverse polarity. It will void the warranty. Use a volt meter to check polarity before connecting terminals.**

Water Resistant Cable Boots are also included and will be in place when your units arrive. The boots are to be placed over the cable terminations and will stretch to form a water resistant seal around the base of the molded inserts and terminal connections.

# Connecting Cable Leads to the PHI 3.4™ Batteries:

## **NOTICE: SPARK MAY BE PRESENT WHEN CONNECTING WIRES TO PHI 3.4™ TERMINALS**

A brief small spark is often present when connecting the second of two leads to a battery. Example: If the Positive has been connected, a small spark will likely be present when connecting the Negative lead. **This is a normal occurrence.** Complete all connections in a clean, ventilated, well lit area. To avoid any spark or electrical event when connecting the terminal leads on the PHI 3.4™ Battery, turn the 80 Amp breaker “ON/OFF” switch to “OFF” position.

Power Cabling for the PHI 3.4™ Battery is not included. Your qualified installer or application specifications will determine the wire gauge for your system.

## **Considerations for Power Cable Terminations**

- PHI 3.4™ Battery Mounting Stud Size: 3/8”
- Power Cable Wire Gauge: Generally anywhere from 6 AWG to 2/0 AWG or larger.

High amperage rated ring terminals can be found for these and other common dimensions. Your installer can source these or we can provide them based on the specifications you provide.

## **Protection from the Environment**

Anticorrosive compounds or epoxies are occasionally used in harsh or marine climate installations. Please contact your Electrician or Qualified Installer to determine if this is advisable, and if so, what solution best suits your application.

# Final Connection of the Installation

Final installation and operation guidelines will be dictated by your Electrician and Installer based on the overall properties of and procedures for the equipment in your installation and any code requirements that apply to your region. SimpliPhi Power, Inc. technicians and sales staff are available to provide any additional information on the PHI 3.4™ Battery as needed. Please contact SimpliPhi Power for any technical support at your convenience. SimpliPhi Power, Inc. is committed to providing safe, reliable energy storage and management that is maintenance free, non-toxic and long-lasting. This commitment extends to our customers, valued installers, partners, and to the community at large. Please be aware of the potential electrical hazards before interacting with any and all electrical or mechanical devices. Please take all necessary precautions in your projects and installations. Please refer to page 4 for safety guidelines.

PHI Batteries feature a Low Battery Voltage Cut Off (LBCO). This is a self protection mechanism that prevents over discharge. The LBCO will cause the battery to turn off once batteries approach Zero Capacity or 100+ percent depth of discharge.

Most, if not all, inverters have related features. These features are often referred to as “Load Disconnect”, “Load Shedding” or similar. These features are there to protect the battery bank from excessive discharge. In instances of low battery voltage, when there is no incoming energy to recharge the battery bank, the inverter will disconnect the load and remain in standby until the battery bank is recharged.

For Off Grid installations, where charge energy is only provided by PV arrays, Inverter “Load Disconnects” are generally set at a value that will allow a system to remain online and in standby for at least 24 hours (10% at top of charge and 10% at bottom of charge). This allows a system to stay online until at least one full day of sun can recharge the battery bank.

In any application, off-grid or grid-tied, if your PHI3.4™ battery bank is reaching the LBCO, load disconnects or load shedding set points may need to be adjusted.

In case of LBCO, cycle the DC Battery Disconnect (inverter), in order to reset the system. Only complete this procedure when there is a charge source available, otherwise, the system will simply reach LBCO in a short time period and shut down again.

## **SimpliPhi Power GUIDE FOR OPERATING PARAMETERS PER WARRANTY**

**Although SimpliPhi batteries are capable of performing at very high rates and depths of discharge within a very wide temperature range, in order to achieve extended life cycles and to comply with the Warranty, the following guidelines should be followed:**

**Discharge/Charge Rate: C/2 (2 hour)**

**Recommended Programmed Voltages of Ancillary Equipment For 5,000 Cycles:**

- Recharge or Low Cut-Off Voltage: PHI 24V: 23.2V; PHI 48V: 46.4V
- Absorb or High Cut-Off Voltage: PHI 24V: 28.8V; PHI 48V: 57.6V

**Recommended Programmed Voltages of Ancillary Equipment For 10,000 Cycles:**

- Recharge or Low Cut-Off Voltage: PHI 24V: 24.5V; PHI 48V: 48.9V
- Absorb or High Cut-Off Voltage: PHI 24V: 28V; PHI 48V: 56V

**Rates of Continuous Discharge and Charge:**

- Discharge: 30 Amps
- Charge: 30 Amps
- Storage must be equal to or more than twice the rated output of the Inverter

**Operating Temperature Range Per Warranty:**

- 23°F to 120°F (-5°C to 49°C) for 5,000 cycles
- 32°F to 110°F (0°C to 43°C) for 10,000 cycles

**Cycle Life**

- Equivalent to 80% Retained Capacity



**Caution: Verify polarity at all connections before energizing system. Reverse polarity at the battery terminals will void the Warranty and destroy the batteries.**

**Before commissioning the system the appropriate controller and inverter settings must be programmed per the manufacturer’s recommendations. Consult the manufacturer’s manuals and/or access technical support (Schneider, SMA, Magnum, Outback, etc). The following Charge Controller Integration tables are for general reference only.**



# Charge Controller Integration Per Manufacturers Recommendations

## 24-Volt System

<b>PRODUCT: PHI 3.4™ - 24V</b>	<b>5,000 Cycles</b>	<b>10,000 Cycles</b>
Description	3440 Watts, 24V/134Ah	Same
System Type	Residential/Commercial/Stationary	Same
Solar System Voltage	24V	24V
Wind System Voltage	24V	24V
Charge Controllers	SMA. Schneider. Outback (and others)	Same

<b>SMA</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	23.2V	24.5V
Bulk Voltage	27V	27V
Absorb Voltage	28.8V	28V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

<b>Schneider</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	23.2V	24.5V
Bulk Voltage	27V	27V
Absorb Voltage	28.8V	28V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

<b>Outback</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	23.2V	24.5V
Bulk Voltage	27V	27V
Absorb Voltage	28.8V	28V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

# Charge Controller Integration Per Manufacturers Recommendations

## 48-Volt System

<b>PRODUCT: PHI 3.4™ - 48V</b>	<b>5,000 Cycles</b>	<b>10,000 Cycles</b>
Description	3440 Watts, 48V/67Ah	Same
System Type	Residential/Commercial/Stationary	Same
Solar System Voltage	48V	48V
Wind System Voltage	48V	48V
Charge Controllers	SMA. Schneider. Outback (and others)	Same

<b>SMA</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	46.4V	48.9V
Bulk Voltage	55V	55V
Absorb Voltage	57.6V	56V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

<b>Schneider</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	46.4V	48.9V
Bulk Voltage	55V	55V
Absorb Voltage	57.6V	56V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

<b>Outback</b>		
Equalized Support	Off	Off
Capacity Limit	45 to 90A	45 to 90A
Equalized Voltage	Off	Off
Recharge Volts	46.4V	48.9V
Bulk Voltage	55V	55V
Absorb Voltage	57.6V	56V
Float Voltage	If used on a daily, weekly, or monthly use case then Off. Self-Discharge is <1% per month	

# PHI Lithium Ferrous Phosphate (LFP) BMS Features and Specifications

## Model Numbers: PHI 3.4™ 24V, PHI3.4™ 48V

### Feature Overview: BMS and 80 Amp Breaker

- Over Charge Voltage Protection
- Over Discharge Protection
- Over Current Protection for Discharge Via Thermal Control
- Short Circuit Protection
- Cell Balancing
- ON/OFF Switch

### Cell Pack Configuration

- 3440Wh, 24V, 134 Amp Hours
- 3440Wh, 48V, 67 Amp Hours

### Cell Voltage Parameters

#### Max Charge Voltage 3.65V per Cell

- 28.8 Max Charge Voltage for 8s/24V
- 57.6 Max Charge Voltage for 16s/48V

#### Load Disconnect 2.25V per Cell

- 20V Low Voltage Cut Off for 8s/24V
- 40V Low Voltage Cut Off for 16s/48V

### Recommended Output Current Parameters

- 24V and 48V: 30Amps Continuous; 60 Amps Max

### Recommended Input Current Parameters

- 24V and 48V: 30Amps Continuous; 60 Amps Max

### Short Circuit Protection Parameters

- <0.5 Millisecond detection, Release upon Load Cut and Clear Short

### Cell Balancing Parameters

- 0-100mA per cell Balancing Current

### Fault Current Rating

- 24V PHI 3.4™ 2520 Amps
- 48V PHI 3.4™ 1260 Amps

**All SimpliPhi Power products are designed to work exclusively in parallel.  
Never connect in series to achieve higher voltages.**

## PHI 3.4™ Battery Units

Safety Attributes and Certifications/Green Characteristics

### SAFETY ATTRIBUTES AND CERTIFICATIONS

#### Intrinsically Safe Operation and Installation

The PHI Lithium Ferrous Phosphate (LFP) battery cell component is made with an intrinsically safe cathode material (iron phosphate). This creates a strong molecular bond, which withstands extreme conditions, prolongs cycle life, and maintains integrity with little or no maintenance over extended periods of time. There is virtually no danger of Thermal Runaway, as there may be with Lead Acid, NiCd, and Lithium Cobalt type batteries. No venting or cooling is required. No precautions or special structural considerations are necessary when installing PHI 3.4™ Batteries.

#### There are No Safety Hazards due to Off-Gassing, Exposure to Acids or Thermal Runaway as there are with Lead Acid AGM type batteries

PHI 3.4™ Batteries do not vent dangerous gasses, such as hydrogen and oxygen, because there are no chemicals used in the creation of the electrical energy, in contrast to Lead Acid and other battery chemistries. There are no dangers of exposure to sulfuric acid because PHI 3.4™ Batteries do not have caustic electrolytes. Thermal runaway is not an issue with PHI products due to the basic nature of Lithium Ferro Phosphate cell chemistry utilized in all our power storage products.

#### PHI3.4™ Battery Control and Protective Circuitry

SimpliPhi Power Inc. utilizes balancing, voltage regulation, thermal, current controls, as well as other protective measures, in its PHI 3.4™ Battery Management System (BMS). This protective circuitry is embedded in the architecture of each PHI 3.4™ Battery.

#### UN DOT Certified Cells

The Lithium Ferrous Phosphate (LFP) cells are independently certified to withstand the UN DOT T1-T8 testing guidelines with no special circuitry added. These tests include short circuit, over-voltage, overcharging, extreme temperature, high altitudes, shock and extreme vibration testing.

#### UL Compliance

The Lithium Ferrous Phosphate cells within the PHI 3.4™ Batteries fully comply with the safety testing parameters of UL 1642.

#### RoHS Compliant

SimpliPhi Power Batteries are RoHS compliant. Any RoHS compliant component is tested for the presence of Lead (Pb), Cadmium (Cd), Mercury (Hg), Hexavalent chromium (Hex-Cr), Polybrominated biphenyls (PBB), and Polybrominated diphenyl ethers (PBDE). For Cadmium and Hexavalent chromium, there must be less than 0.01% of the substance by weight at raw homogeneous materials levels. For Lead, PBB, and PBDE, there must be no more than 0.1% of the material, when calculated by weight at raw homogeneous materials. Any RoHS compliant component must have 100 ppm or less of mercury and the mercury must not have been intentionally added to the component. In the EU, some military and medical equipment are exempt from RoHS compliance.

# Green Characteristics, Environmental and Ecological considerations

## Materials

The primary materials (lithium, iron, phosphate) that make up PHI 3.4™ Batteries are environmentally benign and pose very few polluting or environmentally degrading by-products in the harvesting and refinement processes. This is especially true when compared to those of lead acid, NiCad, and NiMH batteries.

## By Products

There are no toxic by-products associated with the assembly or use of PHI 3.4™ Batteries, such as off-gassing hydrogen, sulfuric acid spillage, lead contamination, or explosive chemicals.

## Operation

There is no need for maintenance, such as adding water or chemicals, nor is there corrosion of terminals or containment facilities, or dispersion of fumes as with other battery types. Once installed, PHI 3.4™ Batteries are maintenance free.

## Life Cycles

PHI 3.4™ Batteries are designed for thousands of cycles while maintaining 80 percent or more of their initial capacity.

## Disposal

PHI products are non-hazardous, may be disposed of without damage to the ecosystem, and returned to the earth, while easily recombining with the elements without harmful by-products. The outer casing and brackets contain steel, aluminum, copper, cardboard, and recyclable plastic. Lithium Ferrous Phosphate (LFP) materials can also be recycled through established battery centers if desired.

## Lithium Ferrous Phosphate Batteries and the Environment

As the use of this battery chemistry in larger batteries becomes more common, questions of sustainability and environmental impact inevitably arise. Of the lithium ferrous phosphate chemistries being considered for large format batteries, SimpliPhi Power believes that batteries based on our proprietary lithium ferrous phosphate chemistry and circuitry offer a clear advantage, not only over alternate Li-ion chemistries (lithium cobalt oxide), but all battery chemistries that are currently commercially available. This belief is based on the minimal environmental impact associated with the manufacturing of PHI 3.4™ Batteries, the extended cycle life and the significantly smaller end-of-life footprint that results from the use of PHI 3.4™ Batteries.

# Summary

The Lithium Ferrous Phosphate (LFP) cells utilized throughout the entire PHI and LibertyPak product lines are classified as non-hazardous by OSHA and WHMIS. They are non-toxic, unlike NiMH, NiCad or Lead Acid types of batteries (including AGM). The PHI 3.4™ Batteries contain the least amount of toxic metals, and are the most eco friendly of all common battery types. Lithium easily combines into harmless compounds when disposed of. The PHI 3.4™ Batteries are the least polluting rechargeable batteries on the market today – no fumes, leaking, or gas discharge and no chemicals or acids to worry about.

*Designed and Assembled in the USA Using Exclusive American Patented Technologies.*

# Appendix

## MATERIAL SAFETY DATA SHEET

### SECTION 1 – PRODUCT IDENTIFICATION

**Product Name:** Electronically Managed Energy Storage Device (Battery)

**Models:** PHI 2.6™, PHI 3.4™

**Product Use:** Electric Power Supply - Harmony Code #8504.40.9540, Foreign Trade Schedule B

**Manufacturer:** SimpliPhi Power, Inc., Ojai Ca. U.S.A. 805 640 6700

### SECTION 2 - COMPOSITION AND INGREDIENT INFORMATION

Under normal use, this battery dPHI not expose the user to hazardous ingredients.

**USA:** This battery is an article pursuant to 29 CFR 1910.1200 and, as such, is not subject to the OSHA Hazard Communication Standard Requirement.

The information contained in this Material Safety Data Sheet contains valuable information critical to the safe handling and proper use of the product. This MSDS should be retained and available for employees and other users of this product.

**Canada:** This is not a controlled product under WHMIS. This product meets the definition of a “Manufactured Article” and is not subject to the regulations of the Hazardous Products Act.

### SECTION 3 - HAZARDS IDENTIFICATION

Common Chemical Name	CAS #	Percent of Content (%)	Classification & Hazard Labeling
Lithium Ferrophosphate (LiFePO <sub>4</sub> )	15365-14-7	25-35	Eye, Skin, Respiratory Irritant
Carbon, as Graphite	7440-44-0	12-18	Eye, Skin, Respiratory Irritant
Aluminum metal	7429-90-5	3-7	Inert
Copper metal	7440-50-8	5-9	Inert
Electrolyte		12-17	Mixture: Flammable; Reactive; Sensitizer;
Ethylene carbonate	96-49-1		Eye, Skin & Respiratory
Dimethyl carbonate	616-38-6		
Ethyl methyl carbonate	623-53-0		
Lithium Hexafluorophosphate	21324-40-3		

**Preparation Hazards and Classification:** Not dangerous with normal use. The battery should not be disassembled or incinerated. Exposure to the ingredients contained within or their combustion products could be harmful.

Appearance, Color, and Odor: Solid object, no odor.

**Primary Route(s) of Exposure:** Risk of exposure will only occur if the battery or cell is mechanically, thermally or electrically abused and the enclosure is compromised. If this occurs, exposure to electrolyte solutions contained within the battery or cell may occur by inhalation, eye contact, skin contact and ingestion.

## POTENTIAL HEALTH EFFECTS

**Inhalation:** Inhalation of material from a sealed battery is not an expected route of exposure. Vapors or mists from a ruptured battery may cause respiratory irritation.

**Ingestion:** Swallowing of material from a sealed battery is not an expected route of exposure. Swallowing mists from a ruptured battery may cause respiratory irritation, chemical burns of the mouth and gastrointestinal tract irritation.

**Skin:** Contact between the battery and skin will not cause any harm. Skin contact with positive and negative terminals of high voltages may cause burns to the skin. Skin contact with a ruptured battery can cause skin irritation.

**Eye:** Contact between the battery and eye will not cause any harm. Eye contact with the contents of a ruptured battery can cause severe irritation to the eye.

Medical Conditions Aggravated by Exposure: Not Available

## SECTION 4 – FIRST AID MEASURES

**Skin Contact:** Wash affected area with lukewarm water for at least 30 minutes. If irritation or pain persists, seek medical attention.

**Eye Contact:** Wash affected eye with lukewarm water for at least 30 minutes. Rinse with saline solution if possible. Seek medical attention.

**Inhalation:** Move victim to fresh air and remove source of contamination from area. Seek medical attention.

**Caution:** In all cases if irritation persists, seek medical assistance at once.

## SECTION 5 – FIRE FIGHTING MEASURES

**Extinguishing Media:** Water, carbon dioxide, dry chemical powder and foam are most effective means to extinguish a Lithium Ferrous Phosphate (LFP) battery fire.

**Fire Fighting Procedure:** Put on fully protective gear, including self-contained breathing apparatus, goggles, fireproof jacket and gloves.

**Unusual Fire and Explosion Hazards:** Exposing battery pack or cell to excessive heat, fire or over voltage condition may cause a leak, fire, hazardous vapors and hazardous decomposition products. Damaged or opened cells can result in rapid heating and the release of flammable vapors



## SECTION 6 – ACCIDENTAL RELEASE MEASURES

The material contained within the batteries or cells is only expelled under abusive conditions. Use a shovel and cover battery with sand or vermiculite, place in an approved container and dispose in accordance with section 13.

## SECTION 7 – HANDLING AND STORAGE

**Handling:** Do not expose battery or cell to extreme temperatures or fire. Do not disassemble, crush or puncture battery.

**Storage:** Insulate positive and negative terminals to avoid short circuit. Store in a cool and well - ventilated area and avoid direct sunlight. Elevated temperatures can result in reduced battery life.

## SECTION 8 – EXPOSURE CONTROLS AND PERSONAL PROTECTION

**Respiratory Protection:** Not necessary under normal use. In case of battery or cell rupture, use a self-contained full-face respiratory mask.

**Eye Protection:** Not necessary under normal use. Wear safety goggles if handling a ruptured or leaking cell or battery pack.

**Hand Protection:** Not necessary under normal use. Wear rubber gloves when if handling a ruptured or leaking cell or battery pack.

**Skin Protection:** Not necessary under normal use. Wear rubber apron and rubber gloves if handling a ruptured or leaking cell or battery pack.

## SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State</b>	Solid
<b>Odor Type</b>	Odorless
<b>Appearance</b>	Battery
<b>Odor Threshold</b>	Not Applicable
<b>pH</b>	Not Applicable
<b>Evaporative Rate</b>	(n-Butyl Acetate = 1) Not Applicable
<b>Relative Density</b>	Not Applicable
<b>Auto Ignition Temperature(C°)</b>	Not Applicable
<b>Boiling Point</b>	Not Applicable
<b>Flammability Limits (%)</b>	Not Applicable
<b>Melting Point</b>	Not Applicable
<b>Vapor Pressure</b>	(mm Hg @ 20 C°) Not Applicable
<b>Viscosity</b>	Not Applicable
<b>Vapor Density</b>	(Air = 1) Not Applicable
<b>Oxidizing Properties</b>	Not Applicable
<b>Solubility in Water</b>	Insoluble
<b>Flash Point and Method (C°)</b>	Not Applicable
<b>Water/ Oil distribution coefficient</b>	Not Applicable

## SECTION 10 – STABILITY AND REACTIVITY

<b>Stability</b>	Stable
<b>Conditions to Avoid</b>	Avoid exposing battery to high temperatures over 452 degrees F. Do not incinerate, deform, mutilate, crush, pierce, short circuit or disassemble
<b>Materials to Avoid</b>	Not Applicable
<b>Hazardous Decomposition Products</b>	Combustible vapors may be released if exposed to fire
<b>Possibility of Hazardous Reactions</b>	Not available

## SECTION 11 - TOXICOLOGICAL INFORMATION

<b>Irritation</b>	Risk of irritation only occurs if cells or batteries are mechanically, thermally or electrically abused and the enclosure is compromised.
<b>Neurological Effects</b>	Not Applicable
<b>Sensitization</b>	Not Applicable
<b>Teratogenicity</b>	Not Applicable
<b>Reproductive Toxicity</b>	Not Applicable
<b>Mutagenicity (Genetic Effects)</b>	Not Applicable
<b>Toxicologically Synergistic Materials</b>	Not Applicable

## SECTION 12 – ECOLOGICAL INFORMATION

<b>Bioaccumulative potential</b>	Not available
<b>Persistence and degradability</b>	Not available
<b>Mobility</b>	Not available
<b>Ecotoxicity</b>	Not available
<b>Other adverse effects</b>	Not available

## SECTION 13 – DISPOSAL CONSIDERATIONS

<b>Waste Disposal Method</b>	Recycling is encouraged. Dispose of in accordance with local, state and federal laws and regulations.
<b>USA</b>	Dispose of in accordance with local, state and federal laws and regulations
<b>Canada</b>	Dispose of in accordance with local, state and federal laws and regulations
<b>EC</b>	Dispose of in accordance with relevant EC Directives

## SECTION 14 – TRANSPORT INFORMATION

### Hazardous Classifications:

PHI Batteries, PHI 2.6™ and PHI 3.4™ are categorized in the following manner and should be packaged, labeled, documented and declared accordingly:

UN3481, Lithium ion batteries contained in equipment, 9, II.

In all cases, the SHIPPER bears the responsibility to prepare all shipments in accordance with the requirements set forth and/or enforced by United Nations Comity of Experts (UNCOE), the International Civil Aviation Organization (ICAO), FAA, U.S. Department of Transportation (DOT), and International Maritime Organization (IMO).

### NOTE:

- Shipping guidelines are updated over time. Please refer to the most up to date requirements.
- Parcel Carriers will have their own guidelines and requirements that must be observed. Contact your carrier for specific guidelines and requirements.

The following website may be helpful for HazMat Guidelines, within the US.

<http://www.phmsa.dot.gov/hazmat>

<http://www.dot.gov/>

Please contact SimpliPhi Support for additional documentation, if required.

The battery cells contain no metallic lithium and pass the tests defined in UN model regulation section 38.3. Do not expose to temperatures over 452 degrees F. or direct flame. Lithium Ferrous Phosphate based batteries are incapable of thermal runaway, or spontaneous ignition under any condition and are non-hazardous. The cells in PHI 2.6™ cases are UN DOT certified regulation 38.3 safe for transport.

#### California Prop 65

This product does not contain chemicals know to the State of California to cause cancer or reproductive toxicity  
This product has been classified in accordance with the hazard criteria of the Controlled Products

#### Canada

Regulations and the MSDS contain all the information required by the Controlled Products Regulations  
Not Controlled

#### WHMIS Classification

#### New Substance Notification Regulations

All ingredients in the product are listed, as required, on Canada's Domestic Substance List

#### NPRI Substances (National Pollutant Release Inventory):

This product does not contain any NPRI chemicals

#### EC Classification for the Substance/ Preparation

#### Symbol

This product is not classified as dangerous according to Directive 1999/45/EC and it's amendments

#### Risk Phrases

None

#### Safety Phrases

S2: Keep out of the reach of children

## CONTACTING SimpliPhi

For technical support, please contact us as follows:

805.640.1874

[techsupport@simpliphipower.com](mailto:techsupport@simpliphipower.com)

