



Power. On Your Terms.



PHI 3.8™, PHI 2.9™, PHI 1.4™ & PHI 730™ Battery Models

INSTALLATION MANUAL

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

SimpliPhi Your Energy Security and Independence

and gain control of your own power.

SimpliPhi Power helps you manage your power as a personal resource. Anytime. Anywhere. SimpliPhi energy storage optimizes integration of any power generation source – solar, wind, generator – on or off 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. Safe lithium ferrous phosphate (LFP). No cobalt. No hazards.

SimpliPhi's battery 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.

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 PHI Battery.

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1.0 – Important Safety Information



1.1 – Safety Instructions

1. Before using the PHI Batteries, read all instructions and cautionary markings on the PHI Batteries, and all appropriate sections of this manual.
2. PHI Batteries must be fully charged before commissioning (i.e. before connecting loads). Failure to do so will void the Warranty.
3. Use of accessories not recommended or sold by the manufacturer may result in a risk of fire, electric shock, or injury to persons and will void the Warranty.
4. Verify system settings are in compliance with the PHI Battery Warranty and this PHI Battery Installation Manual (which take precedence). Violating Warranty conditions specified in these documents will void the Warranty on the PHI Batteries.
5. Consult the Integration Guide for Inverter and Charge Controller programming settings for relevant warnings and notices. Violating Warranty conditions specified in those Inverter Integration Guides will void the Warranty on the PHI Batteries, not just the inverter equipment. Consult SimpliPhi Power Technical Support regarding any inconsistencies with other referenced documents.
6. Although each PHI Battery contains an internal BMS with circuitry that protects the PHI Battery cells from overcharge, over-discharge and extreme load amperage, the PHI Batteries must always be installed with appropriate inverter and charge controller settings and power electronics to protect the PHI Battery from open PV voltage and other high voltage charging sources. Do not attempt to replace existing power electronics without SimpliPhi's written approval. Failure to adhere to installation protocol will void the Warranty.
7. Verify polarity at all connections with a standard volt meter before 1) energizing the system and 2) on batteries with threaded stud connections, before switching the built-in circuit breaker to the "ON" position. Reverse polarity at the PHI Battery terminals will void the Warranty and destroy the PHI Batteries.
8. PHI 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. For batteries with threaded stud connections, be sure the built-in circuit breaker is in the "OFF" position to minimize the risk of shock or sparks during the installation and commissioning of the system.
9. To avoid a risk of fire and electric shock, make sure that existing wiring is in good condition and that wire is not undersized. Do not operate the unit with damaged or substandard wiring.
10. Do not operate if the PHI Battery has been damaged in any way during shipping or otherwise.
11. Only use a SimpliPhi approved LFP battery charger if ancillary charging is required before installation, testing or troubleshooting. Failure to use a SimpliPhi approved LFP battery charger will damage the PHI Battery and void the Warranty. See Appendix C for a complete list of approved chargers.
12. To reduce the chance of short-circuits, always use insulated tools when installing or working with this equipment.
13. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with electrical equipment.



1.2 – Safety & Protective Features

1.2.1 – Breaker

Each PHI battery with threaded stud connections is outfitted with a hydraulic/magnetic circuit breaker. This breaker increases safety during shipping and installations and allows the battery to effectively be turned “OFF” or “ON.” 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.

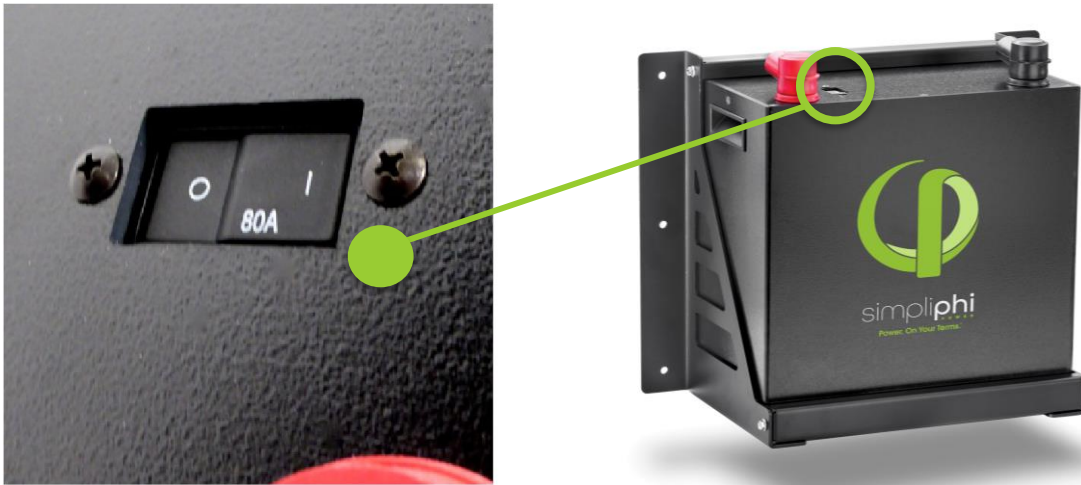


Figure 1.0 - PHI 3.8 kWh 48V Circuit Breaker

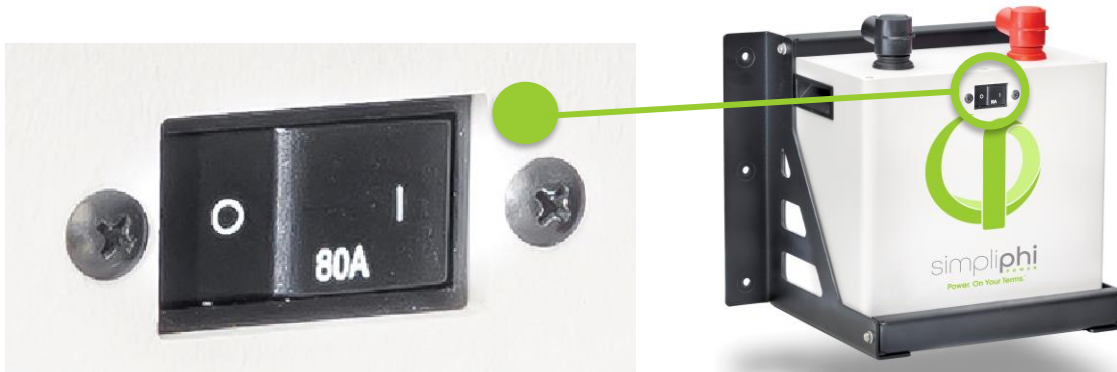


Figure 2.0 - PHI 2.9 kWh 48V Circuit Breaker



CAUTION: 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 Battery contains an internal BMS with circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge and extreme load amperage, the PHI Batteries must always be installed with a charge controller and the appropriate settings to protect the PHI Battery from open PV voltage and other high voltage charging sources. The PHI 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) on batteries with threaded stud connections, before switching the circuit breaker to the “ON” position. **Reverse polarity** at the battery terminals will void the Warranty and destroy the PHI Batteries.

PHI 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. For batteries with threaded stud connections, be sure the built-in breaker is in 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 Batteries do not vent any harmful gasses, and do not require special ventilation or cooling.

PHI Batteries are not capable of thermal runaway. As with any battery, if the cells are severely damaged due to physical abuse, reverse polarity, high voltage, unmitigated current or other electrical phenomenon incurred outside of Warranted specifications, it can cause electrolyte leakage and other failures. The electrolyte can be ignited by an open external flame. However, unlike other lithium ion batteries with cobalt oxides (e.g. LCO, NCM and NCA), the PHI LFP Batteries’ electrolyte and other material components generate a limited amount of heat and do not go into a state of “thermal runaway” or propagate fires. The SimpliPhi UL 1973 Battery Certification verifies “No Thermal Runaway”. See MSDS for chemical analyses.

1.2.2 – Charging at Temperatures Below Freezing

It is important to take necessary steps to determine the temperature of the PHI Battery prior to charging the battery, as the battery may otherwise be adversely impacted.



CAUTION: Do not attempt to charge the PHI Battery below 32° F (0° 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 PHI Battery must be charged below 32° F (0° C), the rate of charge must be at no more than 5% of the PHI Battery’s rated capacity (C/20).



CAUTION: 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 PHI Battery and void the Warranty. See Appendix C for more details on approved chargers.

1.2.3 – Battery Management System (BMS)

PHI Batteries are manufactured utilizing Lithium Ferrous Phosphate (LFP) cells, which are produced under exclusive patented licensed technologies, as well as proprietary materials, architecture, manufacturing processes 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 Battery contains circuitry that protects the Lithium Ferrous Phosphate cells from overcharge, over-discharge and extreme load amperage. If the values specified are exceeded, the protective circuitry will shut down the flow of electricity to/from the PHI 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 Batteries go into a state of self-protection and shut down the flow of electricity. Refer to SimpliPhi's inverter integration guides for inverter charge controller settings or contact the inverter manufacturer directly.

1.2.4 – PHI Battery Connection Terminals

The largest PHI Battery sizes are equipped with two 3/8" threaded studs with a lock washer and nut. The red colored high temperature molded insert connection is for the positive lead. The black colored high temperature insert connection is for the negative lead.



CAUTION: Do not attempt to loosen the large brass nut at the base of the terminals; doing so will damage the PHI battery and void the Warranty.

The two smallest PHI Battery sizes are equipped with SB 50 Anderson connectors utilizing P/N 5900 #6 HD contacts.

- 12V connections are YELLOW
- 24V connections are RED



CAUTION: 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.

1.3 – Explosive Gas Precautions

This equipment is not ignition protected. To prevent fire or explosion, do not install this product in locations that require ignition-protected equipment. This includes any confined space containing vented batteries, or flammable chemicals such as, natural gas (NG), liquid petroleum gas (LPG) or gasoline (Benzine/Petrol).

Do not install in a confined space with machinery powered by flammable chemicals, or storage tanks, fittings, or other connections between components of fuel or flammable chemical systems.

2.0 – Product Description

2.1 – Overview

The PHI deep-cycle Lithium Ferro Phosphate (LFP) Battery is optimized with proprietary cell architecture, power electronics, BMS, manufacturing materials and processes. It is modular, light-weight and scalable. The PHI Battery provides power security and seamless integration of renewable and traditional sources of energy in conjunction with or independent of the grid: net zero, peak shaving, emergency back-up, portable and mobile.

2.2 – Specifications

Please review Table 1.0 below for PHI Battery specifications, including physical dimensions, Warranty period, and technical data.

Table 1.0 - PHI Battery Specifications

	PHI 3.8™		PHI 2.9™		PHI 1.4™		PHI 730™	
	24V	48V	24V	48V	24V	12V	24V	12V
DC Voltages - Nominal	25.6 VDC	51.2 VDC	25.6 VDC	51.2 VDC	25.6 VDC	12.8 VDC	25.6 VDC	12.8 VDC
Amp-Hours	151 Ah	75 Ah	115 Ah	57 Ah	57 Ah	115 Ah	28.5 Ah	57 Ah
Rated Capacity @ C/2	3.8 kWh DC	3.8 kWh DC	2.9 kWh DC	2.9 kWh DC	1.4 kWh DC	1.4 kWh DC	730 Wh DC	730 Wh DC
MAX Discharge Rate (10 minutes)	60 Amps DC (1.53 kW DC)	60 Amps DC (3.07 kW DC)	60 Amps DC (1.53 kW DC)	60 Amps DC (3.07 kW DC)	60 Amps DC (1.53 kW DC)	60 Amps DC (768 W DC)	25 Amps DC (640 W DC)	50 Amps DC (640 W DC)
MAX Continuous Discharge & Charge Rate	45 Amps DC (1.15 kW DC)	37.5 Amps DC (1.92 kW DC)	45 Amps DC (1.15 kW DC)	28.5 Amps DC (1.45 kW DC)	28.5 Amps DC (729.6 W DC)	45 Amps DC (576 W DC)	14 Amps DC (358.4 W DC)	28.5 Amps DC (364.8 W DC)
DC Voltage Range ¹	24 to 28 VDC	48 to 56 VDC	24 to 28 VDC	48 to 56 VDC	24 to 28 VDC	12 to 14 VDC	24 to 28 VDC	12 to 14 VDC
Depth of Discharge ¹	up to 100%							
Operating Efficiency	98%							
Charging Temperature ¹	32° to 120° F (0° to 49° C)							
Operating Temperature ¹	-4° to 140° F (-20° to 60° C)							
Storage Temperature	6 months: 14° to 77° F (-10° to 25° C) 3 months: -4° to 113° F (-20° to 45° C)							
Self-Discharge Rate	< 1% per month							
Cycle Life	10,000+ cycles (@ 80% DOD)							
Memory Effect	None							
Warranty Period	10 Years							
Weight	78.24 lbs. (35.5 kg)		61.06 lbs. (27.7 kg)		33.28 lbs. (15.1 kg)		17.73 lbs. (8 kg)	
Dimensions (W x H x D)	13.5 x 14 x 8 in. (15.5" H w/terminals) / 0.88 ft³ (34.3 x 35.6 x 20.3 cm / 0.025 m³)		11.25 x 11 x 9.5 in. (12.75" H w/terminals) / 0.68 ft³ (28.6 x 27.9 x 24.1 cm / 0.019 m³)		11.25 x 9.25 x 6.25 in. / 0.37 ft³ (23.5 x 28.6 x 15.9 cm / 0.011 m³)		11.25 x 5.25 x 6.25 in. / 0.21 ft³ (28.6 x 13.3 x 15.9 cm / 0.006 m³)	
			Lo-Profile: 17.5 x 14 x 5 in. / 0.71 ft³ (44.45 x 35.56 x 12.7 cm / 0.92 m³)					

Notes:

- ¹ Max operating ranges. Refer to Warranty for recommended conditions.
- Specifications are typical/nominal. Subject to change without notice.
- There is less than 1% loss of energy during charging.

3.0 – Pre-Installation

The information within this section covers pre-installation procedures & considerations, namely, PHI Battery performance parameters to be aware of during the design process, guidance on system sizing, as well as mounting hardware and PHI Battery weight to protect the PHI Battery and Warranty.

3.1 – PHI Battery Performance Parameters and Sizing Calculations

PHI Batteries are designed to operate at a continuous C/2 rate across a large operating temperature range, as seen in Table 1.0 above. The PHI Batteries do not need an increase in sizing or special compensations when determining the size of the energy storage and management system under the circumstances and conditions seen in Table 1.0 above. See specific inverter manufacturer program settings for optimizing system integration.

PHI Batteries do not need to be de-rated unless running continuously at more than 90% capacity, at temperatures below 0 degrees Celsius, or above 45 degrees Celsius. To achieve higher, warranted cycles of 10,000+, the PHI Batteries are typically operated at 80% maximum Depth of Discharge. Please contact SimpliPhi Power Technical Support if alternative settings are desired. Please also refer to operating temperatures and inverter settings in the Programming section of this Manual.

3.2 – System Sizing for Your Installation

The number of PHI 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 Batteries are balanced during final production and testing stages. Following proper wiring guidelines ensures that a system will not require any manual balancing processes.



CAUTION: Do not combine PHI Batteries with other brands or chemistries. This will void the Warranty.



CAUTION: Do not mix PHI Batteries from different installations, clients or job sites. This will void the Warranty.

3.3 – Mounting Hardware

The SimpliPhi Power Mounting Brackets (sold separately) are designed to secure one PHI 3.8 or PHI 2.9 Battery to a load bearing surface. The PHI 3.8 and PHI 2.9 Batteries can be mounted in practically any orientation (terminals up or on any side), with no impact to the performance of the PHI Battery. Do not install them upside down. The brackets can be mounted directly to a wall or can be arranged on strut channels for ease of positioning (mounting hardware not included). A qualified installer should be familiar with accomplishing this with the appropriate load bearing requirements.

For ease of measuring, arranging and mounting your PHI 3.8 or PHI 2.9 Battery array, a drawing of the PHI 3.8 and 2.9 Battery Mounting Brackets with dimensions is provided below (**Figures 2.0 and 3.0**).

During mechanical testing, individual PHI 3.8 and PHI 2.9 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. Bracket sets are designed to hold one PHI 3.8 Module with a weight of 78.24 pounds or one PHI 2.9 Module with a weight of 61.06 pounds.

3.4 – Battery Weight

PHI 3.8 Batteries weigh 78.24 pounds and PHI 2.9 Batteries weigh 61.06 pounds. The Wall Mount Bracket Assemblies weigh 9 Pounds (with bolts). The SimpliPhi Power Mounting Brackets should be mounted into load bearing beams, studs or solid materials with appropriate fasteners. SimpliPhi Power is not liable for damage caused by inappropriate installation mounting of brackets.

3.5 – Battery Wall Mount + Bracket Dimensions

Please see the tables below for physical dimensions of the PHI 3.8 and PHI 2.9 Battery both with, and without, the SimpliPhi Power Mounting Bracket, as well as a diagram that provides guidance on Mounting Bracket assembly.

Table 2.0 – Specifications: PHI 3.8 Battery v. PHI 3.8 Battery w/ Mounting Bracket

	PHI 3.8 Battery	PHI 3.8 Battery w/ Mounting Bracket
Width	13.5"	13.7" (18" with mounting flanges)
Height	15.5" (including 1.5" terminal height)	15.75" (including 1.5" terminal height)
Depth	8"	9"
Weight	78.24 Pounds	86.24 pounds

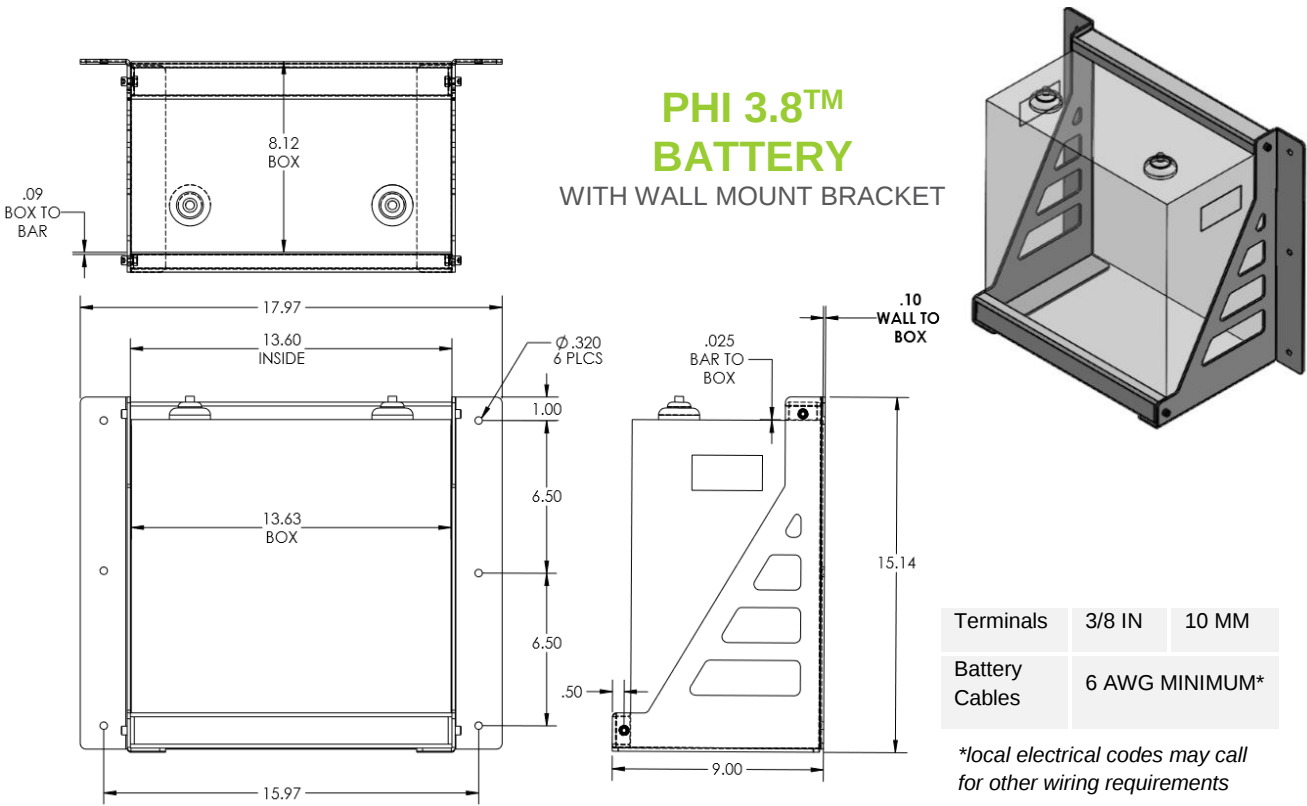


Figure 2.0 – PHI 3.8 Mounting Bracket Assembly

Table 3.0 – Specifications: PHI 2.9 Battery v. PHI 2.9 Battery w/ Mounting Bracket

	PHI 2.9 Battery	PHI 2.9 Battery w/ Mounting Bracket
Width	11.25"	13.7" (15.5" with mounting flanges)
Height	12.75" (including 1.75" terminal height)	13" (including 1.75" terminal height)
Depth	9.5"	10.5"
Weight	61.06 Pounds	70.06 pounds

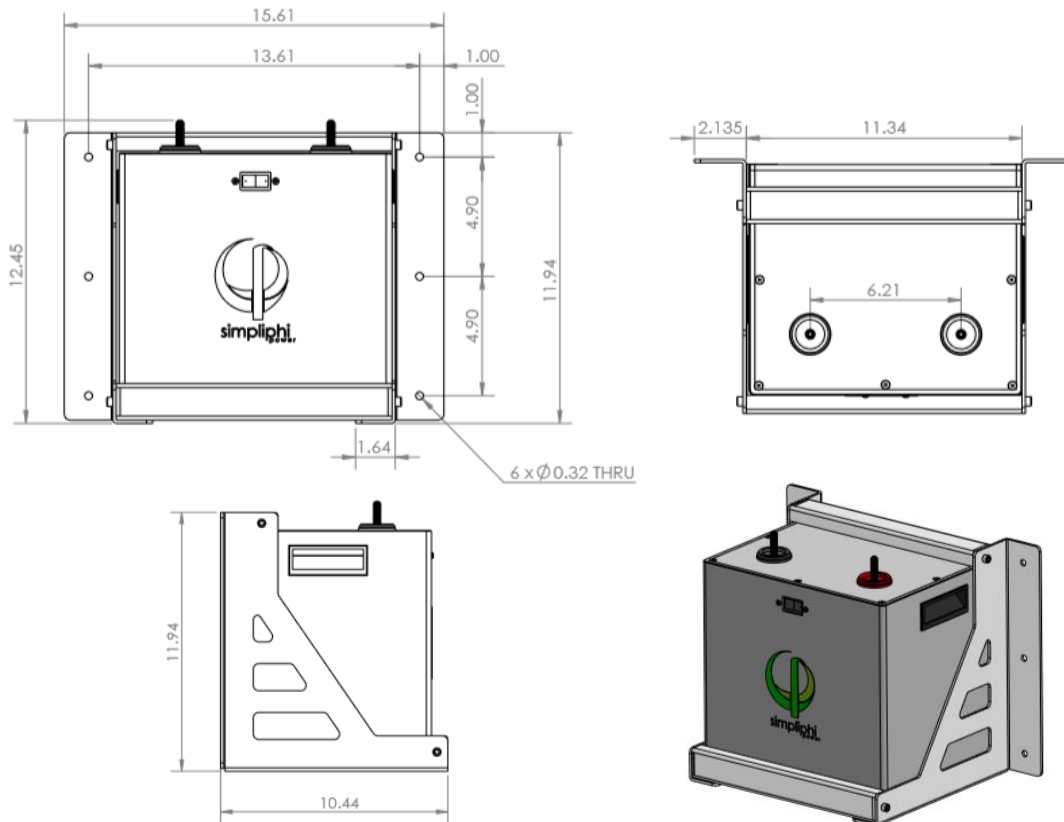


Figure 3.0 – PHI 2.9 Mounting Bracket Assembly

4.0 – Installation & Wiring

This section covers basic concepts of system configuration as well as how to increase storage capacity by wiring in parallel.

4.1 – Basic System Configuration 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.

4.1.1 – 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 Battery terminal to the common bus.
- Use identical wire construction from each PHI Battery terminal to the common bus.

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

4.1.2 – Increasing Storage Capacity & Simple Parallel Arrangements

Storage Capacity and total available **Amperage** is increased incrementally with the number of units in Parallel arrangements. The following illustration (**Figure 4.0**) shows two PHI Batteries in **Parallel**. For example, assume that these are 24V PHI 3.8 Batteries.

Note: The overall Voltage range is not changed. For this example, the arrangement remains at 24 Volts, while the available AH capacity (ability to provide 24 Volt power over time) has been doubled with the addition of a second PHI 3.8 Battery. The same configuration and calculation should be applied to other parallel arrangements, whether they are 12V, 24V or 48V. See Figure 4.0.



CAUTION: PHI Batteries are designed for parallel operation only. Do not arrange in series for increased voltage. Wiring in series will void the Warranty.

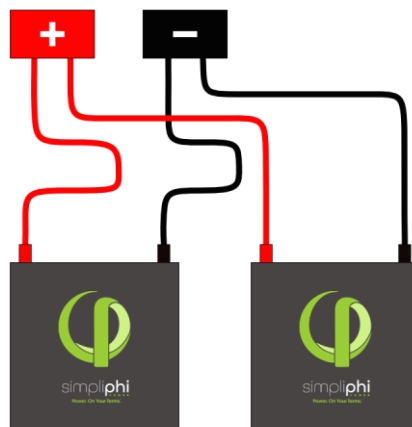


Figure 4.0 – Two PHI Batteries in Parallel

Figure 4.0 represents two PHI Batteries in Parallel. Wire lengths from PHI Batteries should be **identical** in length and gauge in order to balance the load across (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. Failure to wire in parallel will void the Warranty.**

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 Batteries and the common negative or positive “Bus” or Load. Figure 5.0 depicts four PHI Batteries that have been wired in Parallel. This configuration requires **8 identical lengths of appropriately heavy gauge copper wire**.

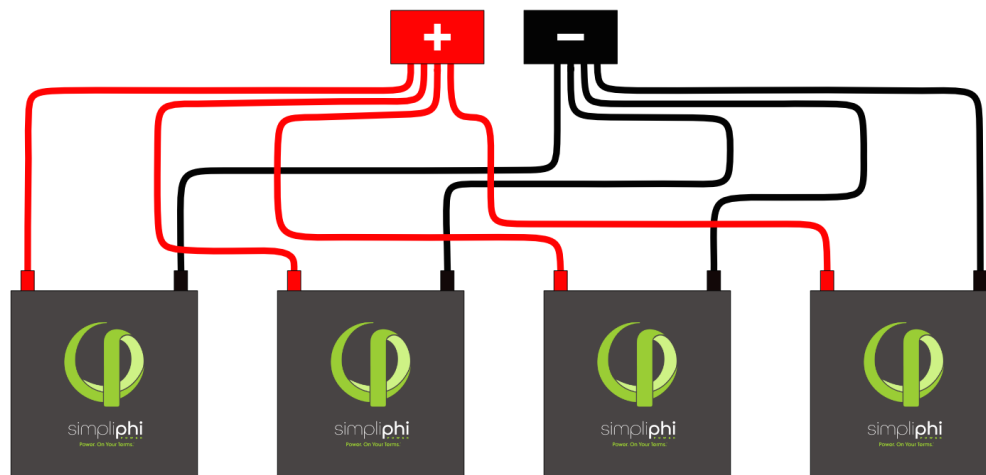


Figure 5.0 - Four PHI Batteries in Parallel

Helpful Tips:

- Use identical length and gauge wire to balance the load across the PHI Batteries.
- Determine the cable length for the PHI Battery terminal farthest from the bus first.
- Make all PHI Battery cables a matching length.
- Additional cabling or slack that remains with the shorter distance runs can be coiled and secured with Zip Ties.

Wiring Methods:

1. For 1 to 8 units: Wire directly to inverter & charge controller equipment.
2. For 6 to 20 units: Use a DC combiner or panelboard.
3. For 20+ units: Connect the PHI Battery terminals directly to a common bus.
4. Positive wire runs should be separated from negative wire runs in separate conduit.

4.2 – Torque Values

For the terminals on the PHI Batteries with threaded stud DC terminals, torque to 160 in-lbs. (13.3 ft-lbs.).

4.3 – Battery Wiring Methods

4.3.1 – Connecting Cable Leads to the PHI Batteries

Before connecting the cable leads to the PHI Battery, please be aware of the following information concerning power cabling, considerations for power cable terminations as well as installation environments.



CAUTION: Spark may be present when connecting wires to PHI terminals.



CAUTION: Do not reverse polarity. It will void the Warranty. Use a volt meter to check polarity before making connections to battery terminals or Anderson Connectors. A brief small spark is often present when connecting the second of two leads to a PHI Battery terminal. 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, make the connection with the circuit breaker in the “OFF” position. To avoid any spark or electrical event when connecting batteries with Anderson Connectors, turn the accompanying equipment off, connect cables with appropriate battery mating connectors to the equipment, and then make final connections via connectors to the batteries before turning on the system’s accompanying equipment.

Power Cabling for the PHI Battery is not included. Your qualified installer or application specifications will determine the wire gauge for your system. Connection to the PHI Battery should only be made using appropriately sized ring terminals or mating connectors. Your installer can source these.

Considerations for Power Cable Terminations

Please factor in the below information for power cable terminations:

- PHI Battery models with threaded studs – Stud Size: 3/8”
- PHI Battery models using SB50 Anderson Connectors
 - 12V connections are YELLOW
 - 24V connections are RED
- Power Cable Wire Gauge: Generally anywhere from 6 AWG to 2/0 AWG or larger

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.

4.3.2 – 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 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 Section 1 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 PHI Battery to turn off once batteries approach Zero Capacity or 100% 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 PHI Battery bank from excessive discharge. In instances of low battery voltage, when there is no incoming energy to recharge the PHI Battery bank, the inverter will disconnect the load and remain in standby until the PHI Battery bank is recharged.

For off grid installations, where charge energy is only provided by renewable energy such as 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 PHI Battery bank.

In any application, off-grid or grid-tied, if your PHI Battery bank is reaching the LBCO, load disconnects or load shedding set points may need to be adjusted. Refer to Programming section.

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.

4.4 – Battery Bank Expansion

New SimpliPhi batteries that are added to an existing SimpliPhi battery bank must be of the same nameplate voltage form factor. The battery bank's total energy capacity is the sum of the differently-rated batteries. For example, a battery bank composed of one PHI 3.5 battery and one PHI 3.8 battery has a total energy storage capacity of 7.3 kWh for the bank (3.5 kWh + 3.8 kWh).



CAUTION: Do not combine PHI Batteries with other brands or chemistries. This will void the Warranty.

Add new additional SimliPhi batteries to an existing SimpliPhi battery bank within the first three years or the original SimpliPhi battery bank's commissioning date. Consult SimpliPhi Power Technical Support if you wish to expand a SimpliPhi battery bank beyond the three year mark.

In addition to adhering to all other Installation Manual instructions, refer to the following guidelines when expanding upon an existing SimpliPhi battery bank:

1. Charge the existing battery bank ("Bank A") according to normal charging procedure (PHI batteries charge to 54.4V / 27.2V / 13.6V and "rest" at approximately 52.5 - 53.5V / 26.1V - 26.7V / 13.1 - 13.3V after being taken off a charge).
2. Disconnect Bank A from the system, by either
 - a. Disconnecting all battery cables leading from Bank A's batteries to the battery combiner box, panelboard, or inverter's power panel, OR
 - b. Turning off the 80A breakers included in each of Bank A's batteries
3. Connect the additional batteries (Bank B) to the system, following all wiring instructions and torque specifications outlined in previous sections of segment 4.0 in this manual.
4. Modify the settings in the system's inverter/charger(s) or charge controller(s), whichever device will be used to initially charge Bank B.
 - a. Adjust the charge rate in accordance with the number of batteries in Bank B
5. Charge Bank B fully, making sure all loads are disconnected at the time of initial charge
6. Wire all Bank A batteries and Bank B batteries in parallel, adhering to the wiring methods outlined in Section 4.3 above.
 - a. Ensure that DC Positive common bus and DC Negative common bus ratings are appropriate for the new larger quantity of batteries in the bank.
7. Reprogram all inverter/charger and/or charge controller equipment for the new larger battery bank capacity.
 - a. New charging current parameters for the expanded bank should be appropriate for the oldest included PHI battery model. For example, a battery bank composed of one PHI 3.5 battery with a maximum continuous charge rate of 34 Amps DC and one PHI 3.8 battery with a maximum continuous charge rate of 37.5 Amps DC has a combined maximum continuous charge rate of 68 Amps DC (not 71.5 Amps DC).

5.0 – Programming

5.1 – Operating Parameters per Warranty

Although the PHI 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 operating parameters, indicated in Tables 4.0 and 5.0 below, must be applied based on desired Warranty/cycle life. Refer to the manufacturer-specific Integration Guide from SimpliPhi's Product Documentation web page for a complete list of settings: <https://simpliphipower.com/product-documentation/>.

Table 4.0 – Warranty Operation Parameters

Recommended Operating Conditions for 10 Year Warranty									
Equivalent to 80% Retained Capacity	10,000 cycles			5,000 cycles			3,500 cycles		
Discharge/Charge Rate ^{1,2}	C/2								
DoD ⁴	80%			90%			100%		
Operating Temperature °F (°C)	32 to 120 (0 to 49)								
Programming Settings for Ancillary Equipment	12V	24V	48V	12v	24V	48V	12V	24V	48V
Absorb / High Cut-Off Voltage (V) ³	13.6	27.2	54.4	13.6	27.2	54.4	14	28	56
Absorb Time	1 Hour			1 Hour			1 Hour		
Recharge / Low Cut-Off Voltage (V) ³	12.6	25.1	50.2	12.4	24.8	49.6	12	24	48

The **charge cycle** should be programmed to **2 Stage / No Float**. Utilizing a Float Charge is permissible only in charge controllers' programming. Refer to the relevant charge controller Integration Guide for complete charge controller settings.

Table 5.0 – Operating Limitations

Notes / Operating Limitations for PHI Batteries								
	PHI 3.8		PHI 2.9		PHI 1.4		PHI 730	
Limitations by Model	24V	48V	24V	48V	24V	12V	24V	12V
Continuous Discharge Rate (A)	45	37.5	45	28.5	28.5	40	14	28.5
Continuous Charge Rate (A)	45	37.5	45	28.5	28.5	40	14	28.5

- 60A Discharge/Charge Rate (10 minutes maximum)
- Levels are typically @ 25°C and may need adjusting at temperature extremes.
- When performing rapid deep charge/discharge cycles, the PHI Battery should be allowed to "rest" 15 mins in between.

Although the PHI battery charges to the voltages outlined above, the battery “rests” at approximately 13.3V / 26.7V / 53.3V. Refer to Table 6.0 below for a complete Battery Voltage versus State of Charge (SOC) gauge.

Table 6.0 – Battery Voltage VS. State of Charge (SOC)

SOC	12V	24V	48V
100%	> 13.13 VDC	> 26.25 VDC	> 52.5 VDC
95%	12.93	25.9 VDC	51.7 VDC
90%	12.91	25.8 VDC	51.65 VDC
75%	12.85	25.7 VDC	51.4 VDC
50%	12.75	25.5 VDC	51.0 VDC
20%	12.55	25.1 VDC	50.2 VDC
10%	12.38	24.8 VDC	49.5 VDC
0%	12.0	24.0 VDC	48.0 VDC



CAUTION: Verify polarity at all connections before energizing system. Reverse polarity at the PHI Battery terminals will void the Warranty and destroy the PHI Batteries.



CAUTION: 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 the Integration Guides listed on SimpliPhi’s [Product Documentation web page](#) (Schneider, Magnum, Outback, etc.). The following Charge Controller Integration tables are for general reference only.



CAUTION: All SimpliPhi Power Core Power and Peak Power products are designed to work exclusively in parallel. Never connect in series to achieve higher voltages.

6.0 – SimpliPhi Technical Support

For technical support related to your PHI Battery, please contact us as follows:

805.640.6700

techsupport@simpliphipower.com

Appendix A – PHI Battery Safety & Green Attributes, Certifications

This Appendix section covers the PHI Battery safety attributes and certifications, such as the lack of thermal runaway and off-gassing, UN DOT certification and UL compliance and certification. It also covers the PHI Battery's green attributes – from products to materials to disposal, as well as relevant environmental and ecological considerations.

B.1 – Safety Attributes and Certifications

B.1.1 – 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 (NCA, NMC, LCO). No venting or cooling is required. No precautions or special structural considerations are necessary when installing PHI Batteries.

B.1.2 – No Safety Hazards due to Off-Gassing, Exposure to Acids, Thermal Runaway

PHI 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 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.

B.1.3 – PHI Battery Control and Protective Circuitry

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

B.1.4 – 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.

B.1.5 – UL Compliance

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

B.1.6 – RoHS Compliant

SimpliPhi Power 3.8 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.

B.2 – Green Attributes, Environmental & Ecological Considerations

B.2.1 – Materials

The primary materials (lithium, iron, phosphate) that make up PHI 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, NMC, NCA, LCO, NiCad, and NiMH batteries.

B.2.2 – By Products

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

B.2.3 – 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 Batteries are maintenance free.

B.2.4 – Life Cycles

PHI Batteries are designed for thousands of cycles while maintaining 80 percent or more of their initial capacity. To achieve this, it is critical to follow the operating conditions outlined in the Warranty.

B.2.5 – 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.

B.2.6 – 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 Batteries, the extended cycle life and the significantly smaller end-of-life footprint that results from the use of PHI Batteries.

B.3 – 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 NMC, NCA, LCO, NiMH, NiCad or Lead Acid types of batteries (including AGM). The PHI 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 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 Manufactured in the USA Using Exclusive American Patented Technologies.

Appendix B – PHI Approved External Chargers

This Appendix section covers the PHI Battery's approved external / plug-in chargers.

Typically, ancillary charging of SimpliPhi's batteries **is not required**, and charging using any of the charge controllers and/or inverter/chargers listed in the "Integration Guides" section of the SimpliPhi web site's [Product Documentation](#) page is acceptable. However, ancillary charging may be necessary in the following situations:

1. No charge controller or inverter/charger is available
2. Increasing the battery's State of Charge (SoC) after an extended storage period and prior to installation
3. For recharge purposes when the battery's voltage is below the minimum required voltage for charge controller and/or inverter/charger equipment to turn on

C.1 – Recommended 48V Charger

The 54.6V 4A 13 Series 48V LiFePO4 Smart Charger from WAOUKS is recommended and available online for purchase [at this link](#).

The 58.4V 5A 16 Series 48V LiFePO4 Smart Charger from WAOUKS is recommended and available online for purchase [at this link](#).

C.2 – Recommended 24V Charger

The 29.2V 7A 8 Series 24V LiFePO4 Smart Charger from WAOUKS is recommended and available online for purchase [at this link](#).

C.3 – Recommended 12V Charger

The 14.6V 20A 4 Series 12V LiFePO4 Smart Charger from WAOUKS is recommended and available online for purchase [at this link](#).

When placing your order, specify the connection type to match your battery model. PHI 3.8 and PHI 2.9 model batteries require a charger with alligator clips or crocodile clips, whereas PHI 1.4 and PHI 730 model batteries require a charger with Anderson Connectors.

C.4 – Alternative Chargers

If the above listed chargers are unavailable or undeliverable to your specific location, SimpliPhi also approves of Iota Engineering's battery chargers ([link here](#)) to increase the PHI battery's voltage. These chargers should only be used in order to increase battery voltage enough to regain system operability; these chargers should not be used to regularly and fully charge the PHI battery.

Appendix C – PHI Legacy Battery Parameters

SimpliPhi's legacy batteries have previously been associated with different operating conditions and limitations than those outlined in Section 5.0 of this manual. While PHI Battery operation according to those previously published parameters is not harmful to the PHI Battery and does not void legacy batteries' warranties, SimpliPhi recommends the following operating conditions for increased PHI Battery system optimization:

Table C.1 – Recommended Operation Parameters

Recommended Operating Conditions									
Equivalent to 80% Retained Capacity	10,000 cycles			5,000 cycles			3,500 cycles		
Discharge/Charge Rate ^{1,2}	C/2								
DoD ⁴	80%			90%			100%		
Operating Temperature °F (°C)	32 to 120 (0 to 49)								
Programming Settings for Ancillary Equipment	12V	24V	48V	12v	24V	48V	12V	24V	48V
Absorb / High Cut-Off Voltage (V) ³	13.6	27.2	54.4	13.6	27.2	54.4	14	28	56
Absorb Time	1 Hour			1 Hour			1 Hour		
Recharge / Low Cut-Off Voltage (V) ³	12.6	25.1	50.2	12.4	24.8	49.6	12	24	48

The **charge cycle** should be programmed to **2 Stage / No Float**. Utilizing a Float Charge is permissible only in charge controllers' programming. Refer to the relevant charge controller Integration Guide for complete charge controller settings.

Table C.2 – Operating Limitations

Notes / Operating Limitations for PHI Batteries								
	PHI 3.5		PHI 2.7		PHI 1.3		PHI 675	
Limitations by Model	24V	48V	24V	48V	24V	12V	24V	12V
Continuous Charge & Discharge Rate (A)	45	34	45	26	26	40	13	26

	PHI 3.4		PHI 2.6	
Limitations by Model	24V	48V	24V	48V
Continuous Charge & Discharge Rate (A)	45	33	45	25

- 60A Discharge Rate (10 minutes maximum)
- Levels are typically @ 25°C and may need adjusting at temperature extremes.
- When performing rapid deep charge/discharge cycles, the PHI Battery should be allowed to "rest" 15 mins in between.