



**Power. On Your Terms.**



# **SimpliPhi AccESS with Sol-Ark 12K**

UL 9540 Certified for Residential Applications

## **INSTALLATION MANUAL**

Optimized Energy Storage & Management for Residential Applications Requiring Units in 20kWh Increments. 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. Safe lithium ferrous phosphate. 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.

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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 AccESS.*

# Table of Contents

1.0 – Important Safety Information.....	4
1.1 – Safety Instructions.....	4
1.2 – Safety & Protective Features .....	5
1.3 – Limitations of Use.....	7
1.4 – Explosive Gas Precautions.....	7
1.5 – Regulatory Specifications.....	7
2.0 – Product Description.....	8
2.1 – Overview .....	8
2.2 – Specifications.....	8
2.3 – Inside the AccESS NEMA-3R Rated Cabinet .....	12
3.0 – Pre-Installation .....	13
3.1 – PHI 3.8 Battery Performance Parameters and .....	13
Sizing Calculations.....	13
3.2 – System Sizing for Your Installation.....	13
3.3 – Installation Tools and Materials.....	14
3.4 – Installation Site Location .....	14
3.5 – Clearance Requirements.....	15
3.6 – Knock Out Locations .....	17
3.7 – Pad Mounting.....	17
3.8 – Wire Run Lengths.....	19
3.9 – Sub-panel or Transfer Switch Kit Installation & Wiring.....	19
4.0 – Installation & Wiring.....	20
4.1 – Basic System Configuration Concepts .....	20
4.2 – PHI 3.8 Battery Installation within the AccESS.....	20
4.4 – Communications and Network Preparation.....	25
4.5 – Wiring the AccESS .....	29
5.0 – Programming .....	41
5.1 – Depth of Discharge .....	41
5.2 – Operating Parameters Per Warranty .....	41
5.3 – Configuring the Sol-Ark to a Specific Application .....	46
6.0 – SimpliPhi Technical Support .....	51

# 1.0 – Important Safety Information



THE ACCESSUNIT AND PHI BATTERIES CONTAINED WITHIN THE UNIT MUST BE INSTALLED ACCORDING TO THE PROCEDURES OUTLINED IN THIS INSTALLATION MANUAL AND THE PHI BATTERY INSTALLATION MANUAL. ALL ACCESS UNIT OPERATION MUST BE IN ACCORDANCE WITH THE SETTINGS AND CONFIGURATION OUTLINED IN THIS MANUAL. FAILURE TO ADHERE TO EITHER THE ACCESS INSTALLATION MANUAL OR THE PHI BATTERY INSTALLATION MANUAL WILL VOID YOUR WARRANTY. ALL ACCESS UNITS ARE PRE-PROGRAMMED FOR BATTERY CAPACITY ORIGINALLY INSTALLED. IF ADDITIONAL CAPACITY IS NEEDED, CONTACT YOUR ORIGINAL INSTALLER AND LOCAL CERTIFYING BODY PRIOR TO PROCEEDING.



## 1.1 – Safety Instructions

1. Before using the unit, read all instructions and cautionary markings on the unit, the PHI batteries, and all appropriate sections of this manual.
2. PHI batteries must be fully charged before commissioning the AccESS unit (i.e. before turning on connected 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 Battery Warranty and 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 Sol-Ark equipment settings as well as relevant warnings and notices. All Integration Guides are posted on SimpliPhi's Product Documentation web page (<https://simpliphipower.com/product-documentation/>). Violating Warranty conditions specified in the Sol-Ark Integration Guide will void the Warranty on the entire AccESS unit, not just the Sol-Ark equipment.
6. Each AccESS system contains PHI 3.8 batteries. Although each PHI 3.8 battery contains both a circuit breaker and an internal BMS with circuitry that protects the PHI 3.8 battery cells from overcharge, over-discharge and excessive load amperage, the PHI batteries must always be installed with appropriate Balance of System equipment settings and power electronics to protect the PHI 3.8 from open solar 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 voltmeter before 1) energizing the system and 2) turning the PHI 3.8 circuit breaker's "ON/OFF" switch to the "ON" position. Reverse polarity at the PHI 3.8 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. Be sure to turn the built-in circuit breaker to 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 AccESS unit with damaged or substandard wiring. This will void the Warranty.
10. Do not operate the AccESS unit if it 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 3.8 battery and void the Warranty. Refer to the PHI 3.8 Manual for details regarding SimpliPhi-approved ancillary charging equipment.
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.
14. The AccESS unit does not have any user-serviceable parts. Do not disassemble the inverter except where noted for connecting wiring and cabling. See your Warranty for instructions on obtaining service. Attempting to service the components inside the AccESS unit yourself may result in a risk of electrical shock or fire and void the Warranty. Internal capacitors remain charged after all power is disconnected – wait 10 minutes before servicing.
15. To reduce the risk of electrical shock, disconnect both AC and DC power from the AccESS unit before attempting any maintenance or cleaning or working on any components connected to the inverter.

## 1.2 – Safety & Protective Features

### 1.2.1 – Battery Breaker

All PHI 3.8 batteries within the AccESS unit are outfitted with an hydraulic/magnetic circuit breaker which will show a white base when tripped. This breaker increases safety during shipping and installations and allows the PHI 3.8 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.

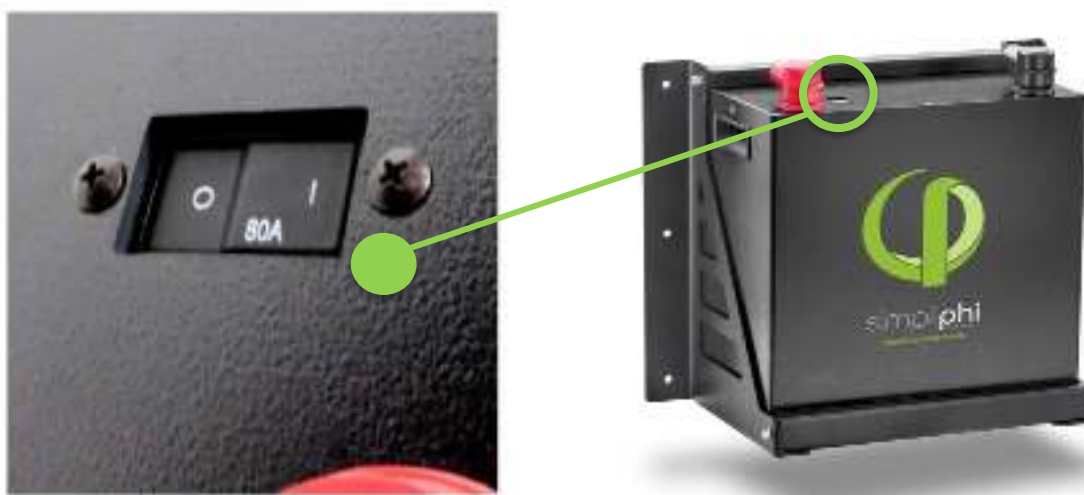


Figure 1.0 - PHI 3.8 kWh 51.2V<sub>nom</sub> Circuit Breaker



**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 3.8 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 batteries must always be installed with a charge controller and the appropriate settings to protect the PHI 3.8 battery from open PV voltage and other high voltage charging sources. **The PHI 3.8 Battery Management System (BMS) and built-in circuit breaker alone will not protect the PHI batteries from extreme electrical conditions.** Failure to adhere to installation protocol will void the Warranty.



**CAUTION:** Verify polarity at all connections with a standard voltmeter before 1) energizing the system and 2) turning the PHI 3.8 circuit breaker's "ON/OFF" switch 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. Be sure to turn the built-in circuit 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 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 incurred outside of warranted specifications, it can cause electrolyte leakage and other failures. The electrolyte can be ignited by an open flame. However, unlike other lithium ion batteries (e.g. LCO, NCM, and NCA), the PHI batteries' electrolyte and other material components generate a limited amount of heat.

## 1.2.2 – Charging at Temperatures Below Freezing

It is important to take necessary steps to determine the temperature of the PHI 3.8 battery prior to charging the battery, as the battery may otherwise be adversely impacted.



**CAUTION:** Do not attempt to charge the PHI 3.8 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 3.8 battery must be charged below 32° F (0° C), the rate of charge must be at no more than 5% of the PHI 3.8 battery's rated capacity (C/20).



**MISE EN GARDE:** Ne pas charger la Batterie PHI en dessous de 0° C (32° F). Tout chargement à des températures de congélation peuvent nuire à l'état de santé et la durée de vie de la batterie, et Annuleront la Garantie. Dans le cas ou la Batterie PHI doit être chargée en dessous de 0° C (32° F), le taux de charge ne doit pas dépasser 5 % de la capacité nominale de la Batterie PHI (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 3.8 battery and void the Warranty. Refer to the PHI 3.8 Manual for details regarding SimpliPhi-approved ancillary charging equipment.

## 1.2.3 – Battery Management System (BMS)

The PHI 3.8 batteries within the AccESS unit 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 3.8 battery within the AccESS unit 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 batteries. In some cases, this will result in the need to manually turn the batteries and inverter back on. 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.



**CAUTION:** While the BMS and internal circuit breaker protect the PHI battery from extreme electrical scenarios, neither will prevent the PHI battery from operating outside the recommended operating parameters. Rely on Balance of System equipment programming to operate the battery according to recommended parameters, as outlined in the [Sol-Ark Integration Guide](#).

## 1.2.4 – PHI 3.8 Battery Connection Terminals

The PHI 3.8 batteries 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. This will void the Warranty.

**MISE EN GARDE:** Ne pas desserrer le gros écrou en laiton à la base des bornes; cela endommagerait la Batterie PHI et Annulerait la Garantie.



**CAUTION:** Do not reverse polarity. It will void the Warranty. Use a voltmeter to check polarity before connecting terminals.

**MISE EN GARDE:** Ne pas inverser la polarité. Inverser la polarité Annulera la Garantie.

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 – Limitations of Use

The Sol-Ark equipment built into the SimpliPhi Power AccESS is not intended for use in connection with life support systems or other medical equipment or devices.

## 1.4 – 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.

## 1.5 – Regulatory Specifications

Sol-Ark equipment has been tested and found to comply with the following:

- Electronics certified safety by SGS labs to NEC and UL specifications: NEC 690.4B & NEC 705.4/6.
- Grid interactivity requirements UL1741-2010/2018, IEEE1547a-2003/2014, FCC 15 class B, UL1741SA, UL 9540, CA Rule 21 and HECO Rule 14H.

These standards provide regulation for acceptable output voltage ranges, acceptable output frequency and anti-islanding performance.

## 2.0 – Product Description

### 2.1 – Overview

The SimpliPhi Sol-Ark AccESS offers industry leading renewable energy storage technology to provide energy security and power resiliency in a pre-assembled, pre-programmed system that is suitable for installation inside and outside. The AccESS serves all of the common residential scale renewable energy applications: Off-Grid and Grid-Tied with Battery Back Up (in both AC Coupled and DC Coupled system configurations), and Self Consumption – with Zero Export and Time Of Use (TOU) arbitrage for utility charge reduction (in DC Coupled system configurations only).

### 2.2 – Model Numbers

SimpliPhi offers the Sol-Ark AccESS unit in several variations for residential use:

- **A-4PHI-SA:** one (1) AccESS cabinet that include one (1) Sol-Ark-12K inverter with integrated dual MPPT charge controllers, four (4) PHI 3.8 core power batteries contained within the cabinet, with a Maximum Rated Capacity of 15.48 kWh.
- **A-5PHI-SA:** one (1) AccESS cabinet that include one (1) Sol-Ark-12K inverter with integrated dual MPPT charge controllers, five (5) PHI 3.8 core power batteries contained within the cabinet, with a Maximum Rated Capacity of 19.35 kWh.
- **BOSS.6-R:** (Optional Configuration): Sol-Ark 12K mounted externally to enclosure with a BOSS.6 cabinet housing either four (4) or five (5) PHI 3.8 core power batteries contained within the cabinet, with a Maximum Rated Capacity of 15.48 kWh or 19.35 kWh respectively.

### 2.3 – Specifications

Please review Tables 1.0 and 2.0 below for Sol-Ark AccESS unit specifications, including physical dimensions, warranty period, and technical data.

Table 1.0 – Sol-Ark AccESS Specifications for Each Unit

SPECIFICATIONS	
General	
Dimensions	29.5" W x 76" H (w/feet) x 20" D / 75 cm W x 193 cm H x 51 cm D
Weight	600 lbs. (270 kg.) w/o batteries
Enclosure Rating	NEMA 3R Outdoor Rated
Operating Temperature	-4°F to 122°F (-20°C to 50°C)
Mounting	Free-standing or Pad-mounted
Enclosure Warranty Period	2 years
Certifications	UL1741SA Rule 21, HECO Rule 14H, PREPA approved and Rapid Shutdown compliant, UL9540, Included batteries ETL certified and certified to UL 1973
Inverter	
Sol-Ark	Sol-Ark-12K
Application	On or Off-Grid
AC Connections	1 Bi-Directional Grid Port (63A double-pole), 1 UPS Load Output (50A double-pole)



	1 Bi-Directional Generator Port (63A double-pole); can be used for Smart Loads output
Output Frequency (selectable)	60 Hz or 50 Hz (50 Hz available upon request)
Output Voltage	L-N: 120VAC; L-L: 240VAC   L-L: 208VAC (2/3 phases)   230VAC
Off-Grid Output Power	9 kW Continuous
On-Grid Output Power	9 kW Continuous
Solar PV Continuous Power Delivered to Battery & AC Output	12 kW   To Grid: 9kW per Sol-Ark 12K MAX Continuous Batttery Power
Max Battery Charging Current	185 ADC
CEC Efficiency	96.5% (97.5% Peak)
Standard Warranty Period	10 years
Other Features	EMP hardened upon request (against Nuclear EMP and Solar Flare) does not include batteries Smart Load capabilities (2 x CTs included)
Solar PV	
DC Coupled	
Sol-Ark Dual MPPT	1 - 6 PV String Inputs (3 max per MPPT)
Max Connected PV Power	13 kW (12 kW max simultaneous utilization)
Min PV Array Starting Voltage	175 VDC
Max Open Circuit PV Array Voltage	500 V <sub>oc</sub> per PV String
MPPT Voltage Range	150 – 425 VDC
Max Array Short Circuit Current	33A per MPPT
Max Array Operating Current	20A per MPPT @ 300V   18A per MPPT @ 400V
AC Coupled	
Max AC Coupled Input	9.6 kW (string or micro-inverters)
DC & AC Coupled	
Best Combined Input Combination	3 kW AC + 11 kW DC (9 kW sell)
Good Combined Input Combination	2 kW AC + 12 kW DC (9 kW sell)
OK Combined Input Combination	4 kW AC + 7 kW DC
Other Features	
Internet Connected (Computer or Phone App)	PowerView ES Monitor and Programming
Automatic Generator Start	Two-wire automatic generator start
Batteries	
Max Rated Unit kWh Capacity @ C/2	4 Battery: 15.48 kWh   5 Battery: 19.35 kWh
Usable Unit kWh Capacity @ 80% DoD	4 Battery: 12.38 kWh   5 Battery: 15.48 kWh
Max Combined Output Power	Limited by the inverter to 9 kW
Max Combined Charge Current	Limited by the Sol-Ark to 185A
Charge Temperature	32°F to 120°F (0°C to 49°C)
Discharge Temperature	-4°F to 140°F (-20°C to 60°C)
Depth of Discharge	Up to 100% DoD
Cycle Life	10,000+ cycles (@ 80% DoD)
Warranty Period	10 years
DC Connections	5-point terminal busbars, 3/8" lugs, 650 ADC

Note: Inverter power will be derated at 45° Celsius (113° F).

## 2.4–Inside the AccESS NEMA 3R Rated Cabinet

The AccESS system is enclosed within a NEMA-3R rated cabinet. Within, the internal layout provides easy access to clearly labeled wiring points and includes the necessary overcurrent devices, breakers and disconnects. The heart of the AccESS is the SimpliPhi Power PHI 3.8 kWh 51.2V<sub>nom</sub> energy storage modules. Additional storage capacity can be achieved by adding another BOSS.6 in parallel, side by side, with 4 or 5 of the PHI 3.8 kWh 51.2V<sub>nom</sub> batteries with a Maximum Rated Capacity of 15.48 kWh and 19.35 kWh respectively.

Additional Sol-Ark equipment features also include automatic generator start, remote system monitoring (in the case of both AccESS Sol-Ark models) and remote system.

### 2.4.1–AccESSCoreComponents

The core components within the AccESS unit include the below listed products. See Figures 2.0 & 3.0 for detail.

- Sol-Ark-12K ([manual linked here](#)), includes:
  - Solar Panel MC4 Connector Tool
  - WiFi Plug



Rain hood(s) optional



- 2 Limiter Sensors (10' long wires included extendable up to 50' upon direct request to Sol-Ark: 972-575-8875, sales@sol-ark.com)



## 3.0 – Pre-Installation

The information within this section covers pre-installation procedures & considerations, namely, PHI 3.8 battery performance parameters to be aware of during the design process, guidance on system sizing, as well as installation site requirements and pad mounting.

### 3.1 – PHI 3.8 Battery Performance Parameters and Sizing Calculations

The PHI 3.8 batteries within the Sol-Ark AccESS are designed to operate at a continuous discharge rate of 11.4 kW<sub>DC</sub> across a large operating temperature range, as seen in Table 1.0 above. The SimpliPhi AccESS does not require an increase in sizing nor any special compensations when determining the size of the energy storage and management system under the circumstances and conditions seen in Table 1.0 above. Each AccESS unit comes pre-programmed to maximize the performance of the PHI 3.8 battery bank. Settings are password protected and require access to the lockout password by a qualified installer for modification.

PHI 3.8 batteries within the AccESS unit do not need to be de-rated unless running continuously at more than 90% capacity, at temperatures below 0° C, or above 45° C. To achieve higher, warrantied cycles of 10,000, the PHI 3.8 batteries are operated at 80% maximum Depth of Discharge (DOD). The AccESS comes pre-programmed for 80% DOD. Please contact SimpliPhi Power Technical Support if alternative settings are desired. Please also refer to operating temperatures and inverter settings in this Manual's Programming section.

#### 3.1.1 – Design Parameters: Maximum Sizing Guidelines

Below are the maximum sizing guidelines for installations of the AccESS:

- Maximum AC Grid input / output OCPD = 50 A double-pole
- Maximum DC coupled PV array = 13 kW<sub>DC</sub> (per Sol-Ark-12K)
- Maximum AC coupled PV array = 9.6 kW<sub>AC</sub> (per Sol-Ark-12K)

### 3.2 – System Sizing for Your Installation

The number of PHI 3.8 batteries within the AccESS unit(s) should be specified in terms of total rated storage capacity and instantaneous power rating before the initial installation based on the goals and objectives of the project. All PHI 3.8 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 3.8 batteries with other brands or chemistries.



**CAUTION:** Do not mix PHI 3.8 batteries from different installations, clients or job sites.



**MISE EN GARDE:** Ne pas associer les Batteries PHI avec d'autres marques et/ ou autres produits chimiques. Ne pas mélanger les Batteries PHI provenant de différentes installations, différents clients ou différents sites de travail. L'un ou l'autre de ces mélanges Annulera la Garantie.

### 3.3 – Installation Tools and Materials

- Digital Multi Meter
- AC/DC Clamp-On Current Meter
- Wire Stripper
- Impact Driver
- Masonry Bolts

### 3.4 – Installation Site Location

The AccESS may be installed indoors, such as a garage, or outdoors mounted onto a concrete pad. The cabinet is rated for NEMA-3R use. Please see Figure 3.0 below for physical AccESS dimensions, as this may impact the site location.

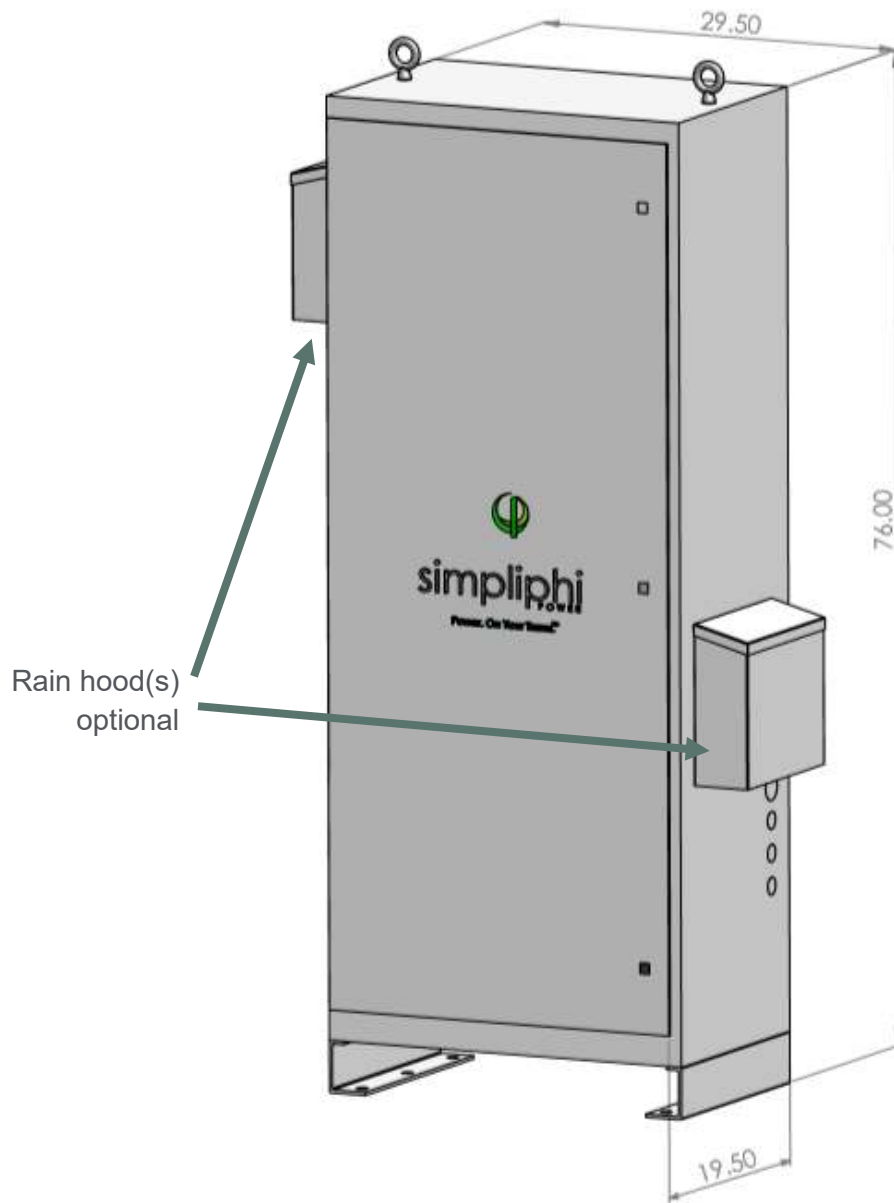


Figure 3.0 – AccESS Unit Dimensions

### 3.5 – Clearance Requirements

The AccESS should be installed with 3-inch (7.62 cm) clearance to the sides and 3 feet (0.91 m) clearance to the front to allow for the cabinet door to be opened during installation. Please see Figure 4.0 for details. All installations should comply with local code requirements and/or the local AHJ, which may exceed the requirements shown.

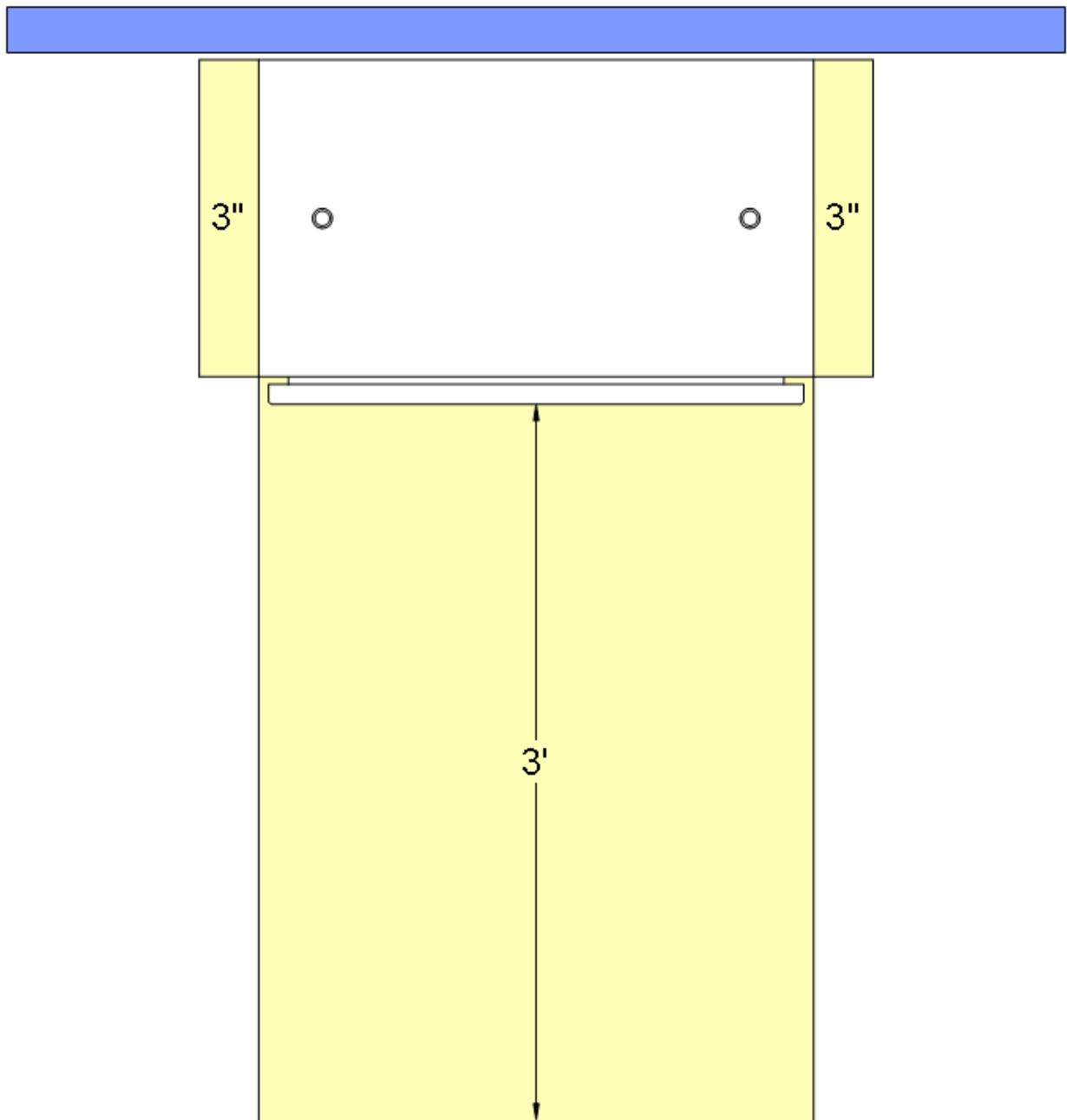


Figure 4.0 – AccESS Unit Clearances

## 3.6 – Knock Out Locations

Three 1.375-inch OD knockouts and one 2-inch OD knockout are located on both sides of the AccESS cabinet. They can be used for AC or DC inputs. Not all knockouts must be used.

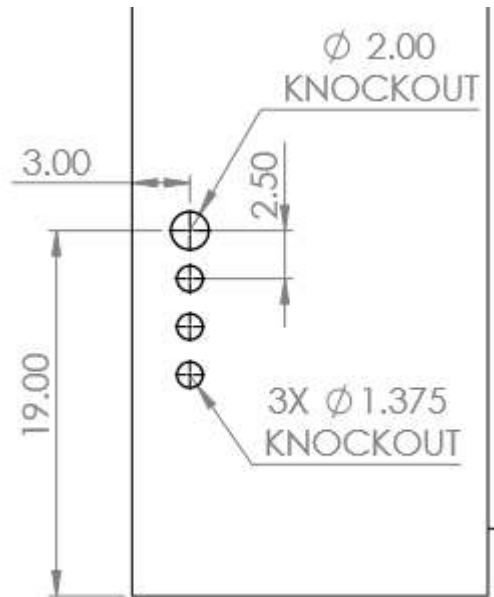


Figure 5.0 – AccESS Cabinet Knockouts (sides)

## 3.7 – Pad Mounting

### 3.7.1 – Pad Requirements

The AccESS must be installed and secured on level concrete. For a pre-cast concrete pad, a 4" minimum thickness is required. The pad should be 3" wider than the AccESS on all sides (34" x 22" x 4").

The AccESS is not suited for wall mounting. Any attempt to wall mount the AccESS unit will Void the Warranty.

### 3.7.2 – Pad Mounting the SimpliPhi AccESS

Six 1-inch knockouts are located in the base of the AccESS for tool accessibility when mounting the AccESS to the concrete pad. Cover knockout holes with sealing tape after pad mount installation, and prior to installing the PHI 3.8 Batteries into the base of the cabinet. Not all knockouts have to be used, depending on the different assets built into the AccESS system to meet the customer's needs. Any attempt to wall mount the AccESS unit will void the Warranty.

Secure the AccESS to the concrete with concrete anchors, such as threaded rods, masonry bolts, or carriage bolts, minimum ½" diameter. Existing concrete floors in the garage or other areas are adequate "mounting pads" if the thickness meets the 4" minimum thickness. See Figure 5.0 below for details.

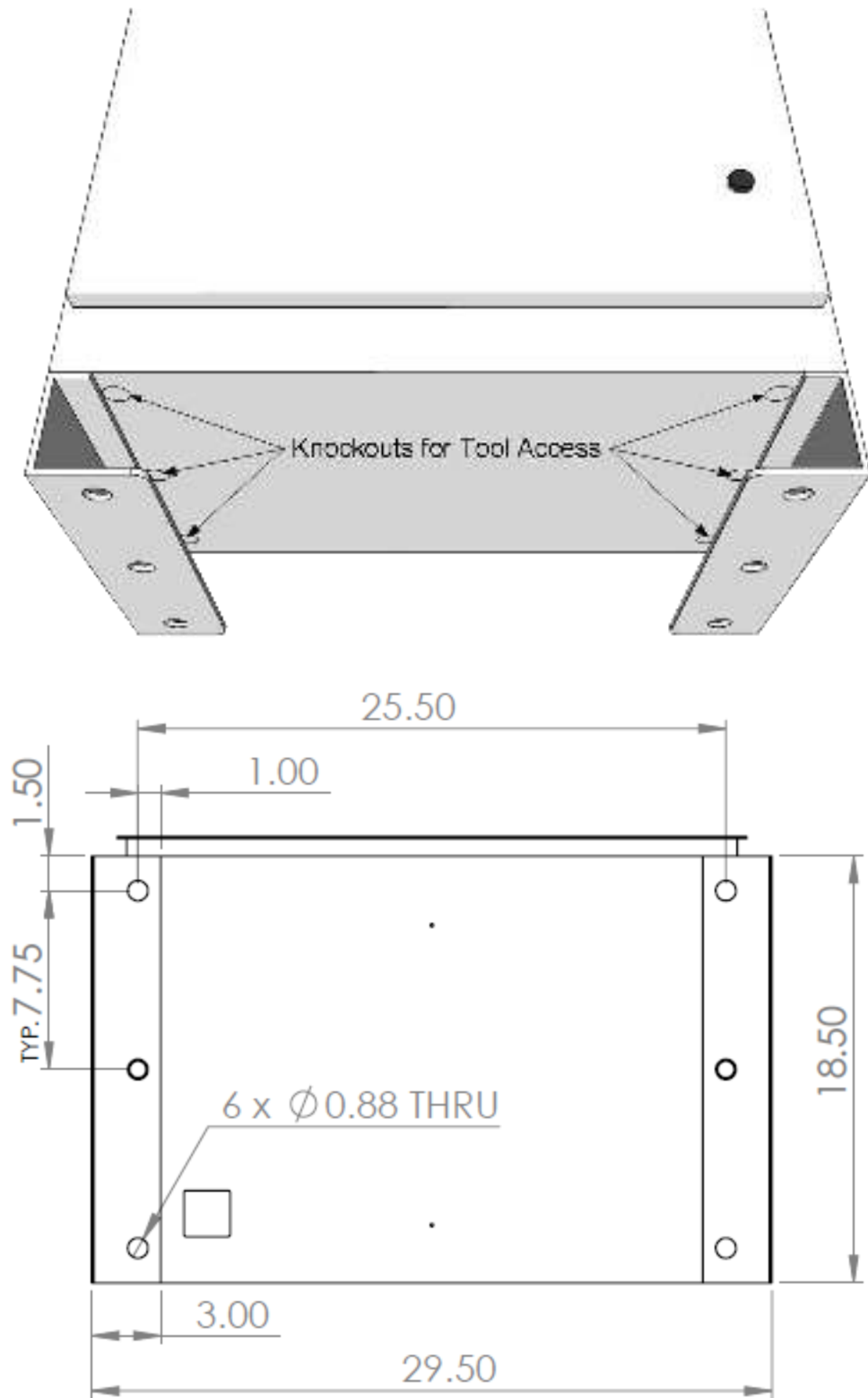


Figure 6.0 – AccESS Unit Knockouts (Bottom)



## 3.8 – Wire Run Lengths

Two limiter sensors are included with the AccESS Sol-Ark. The limiter sensor wires are 10 feet long, and are extendable up to 50 feet using equipment from Sol-Ark (contact Sol-Ark directly at 972-575-8875; [sales@sol-ark.com](mailto:sales@sol-ark.com)). Consider this distance when deciding the Sol-Ark AccESS unit's location relative to the home's main breaker panel.

## 3.9 – Sub-panel or Transfer Switch Kit Installation & Wiring

All AccESS Sol-Ark systems must incorporate either an Essential Loads sub-panel or the 10-circuit transfer switch kit available directly from Sol-Ark (see Figure 7.0). In the case of off-grid systems, all the home's loads are on the Essential Loads panel, thereby making the Essential Loads panel the main house breaker panel. Any distance is permissible between the AccESS Sol-Ark and the Essential Loads panel or Sol-Ark transfer switch kit, provided wire sizing and voltage drop is in accordance with local codes.



Figure 7.0 – Transfer Switch Kit

Prior to the AccESS Sol-Ark's installation, determine which of the home's circuits will be located either on the Essential Loads panel or the Sol-Ark transfer switch kit. Consider the following:

- The Sol-Ark's Load Output is protected by a 63 Amp double-pole breaker.
  - When grid-connected, the maximum continuous power the Sol-Ark can deliver to the Essential Loads panel is 40 Amps at 240VAC (9.6 kW<sub>AC</sub>).
  - When off-grid, the maximum power the Sol-Ark can deliver to the Essential Loads panel (also considered the main house breaker panel in an off-grid application) is 33 Amps continuous at 240VAC (7.92 kW<sub>AC</sub>) and 83 Amps peak at 240VAC (19.92 kW<sub>AC</sub>) for 5 seconds.
- The Sol-Ark transfer switch kit (if used instead of an Essential Loads panel) can house a maximum of 10 circuits, all of which must use non-GFI breakers. Contact Sol-Ark (972-575-8875, [sales@sol-ark.com](mailto:sales@sol-ark.com)) for transfer switch kit purchase and installation instructions; It is **not** included in the AccESS Sol-Ark.

## 4.0 – Installation & Wiring

This section covers how to install the PHI 3.8 batteries within the AccESS unit, torque values, communications and network preparation and how to wire the AccESS unit. It also provides guidance on how to install optional AccESS unit components/accessories.

### 4.1 – Basic System Configuration Concepts

Safe and reliable installation requires trained and certified technicians. The following discussion 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.

### 4.2 – PHI 3.8 Battery Installation within the AccESS

1. Mount the AccESS unit on level concrete.
2. **Make sure all PHI battery module circuit breakers are in the OFF position.** Prepare the battery modules for installation by removing all plastic terminal covers, 11/16" stainless steel hex nuts and 3/8" lock washers from the batteries' terminals and set aside.

**CAUTION:** Do not attempt to loosen the large brass nuts at the base of the battery terminals.



**MISE EN GARDE:** Ne pas desserrer le gros écrou en laiton à la base des bornes; cela endommagerait la Batterie PHI et Annulerait la Garantie.

3. Place two PHI 3.8 batteries in the bottom of the cabinet and arrange two or three PHI 3.8 batteries on the AccESS's internal shelf. Orient the modules so that the battery terminals point toward the AccESS door, with the negative posts nearest the bottom of the AccESS enclosure. Refer to Figure 11.0a and 11.0b below:

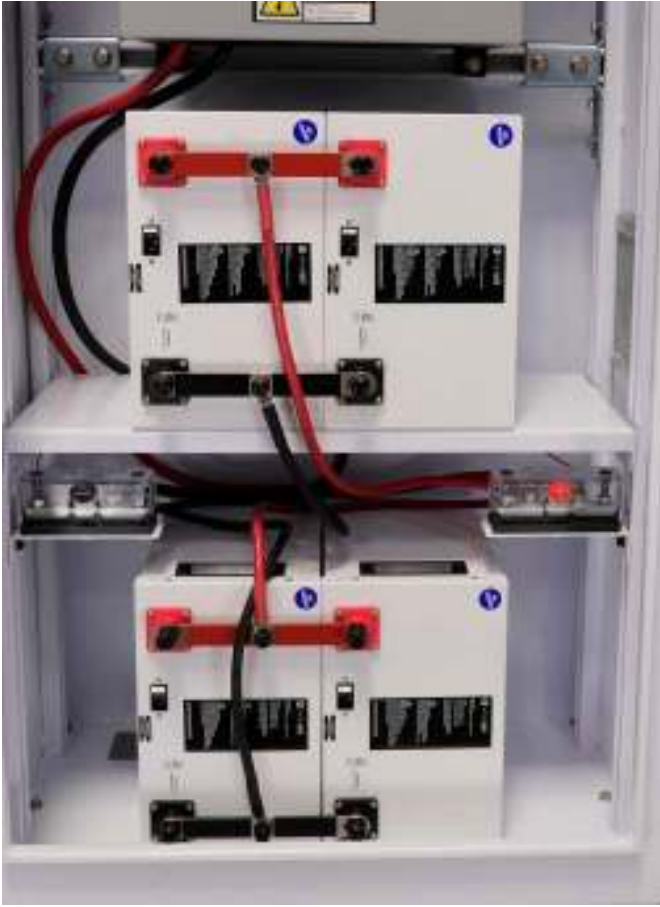


Figure 11.0a– Four PHI Battery Orientation

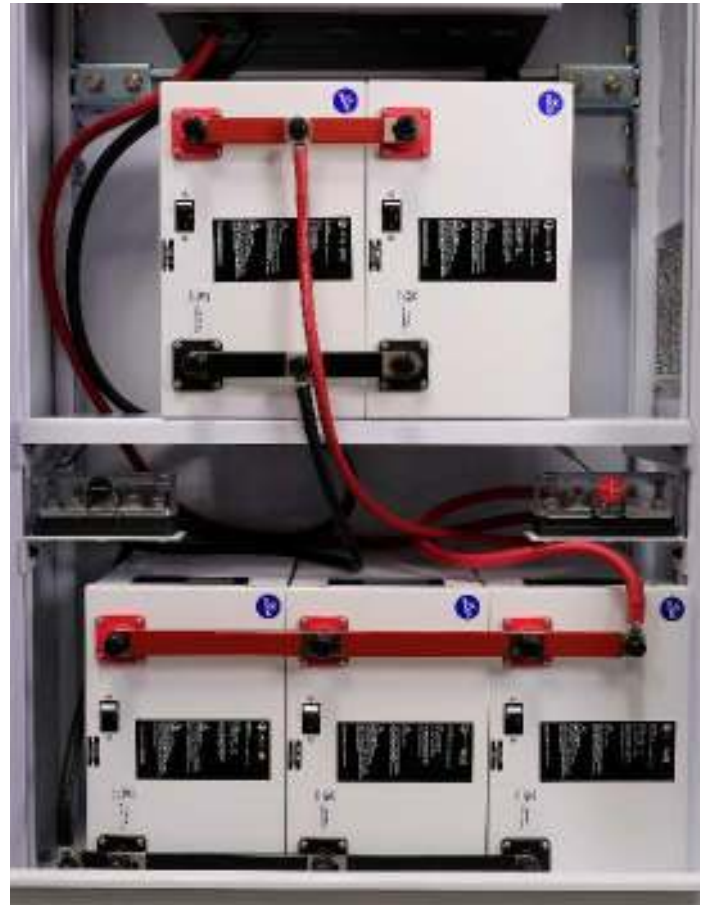


Figure 11.0b–Five PHI Battery Orientation

4. Attach interconnecting busbars onto the batteries' terminals. Each positive busbar parallels one set of two or three batteries (positive to positive to positive), and each negative busbar parallels one set of two or three batteries (negative to negative to negative). **2 battery interconnecting busbars utilize a 31", 2 AWG cable. 3 battery interconnecting busbars utilize a 25", 2/0 cable.**
5. Secure the busbars to the batteries' terminals using a 11/16" wrench socket to tighten the 3/8" lock washers and 11/16" stainless steel hex nuts (originally included on the batteries). Tighten the nuts to 160 in-lbs.
6. Connect the included cables from the interconnecting busbars (secured to the batteries) to the 5-point terminal busbars (see above). All connections are in parallel: each positive cable connects from each interconnecting positive busbar to the positive 5-point terminal busbar, and each negative cable connects from each negative busbar to the negative 5-point terminal busbar (refer to Figure 11.0a and 11.0b above).
7. Leave the PHI 3.8 batteries' built-in breakers in the "OFF" position until the basic functional test.



The PHI batteries' charging regimen is not temperature compensated; do not include a Battery Temperature Sensor (BTS) wiring connection.

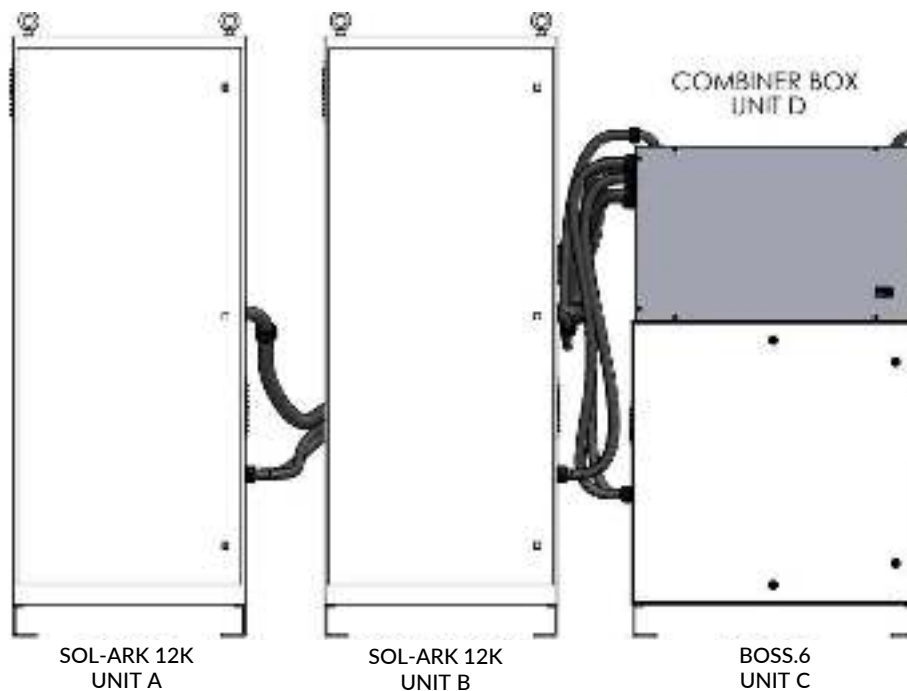
**CAUTION:** Adhere to all battery installation instructions as outlined in the PHI Battery Installation Manual; this manual does not substitute the PHI Battery Installation Manual.

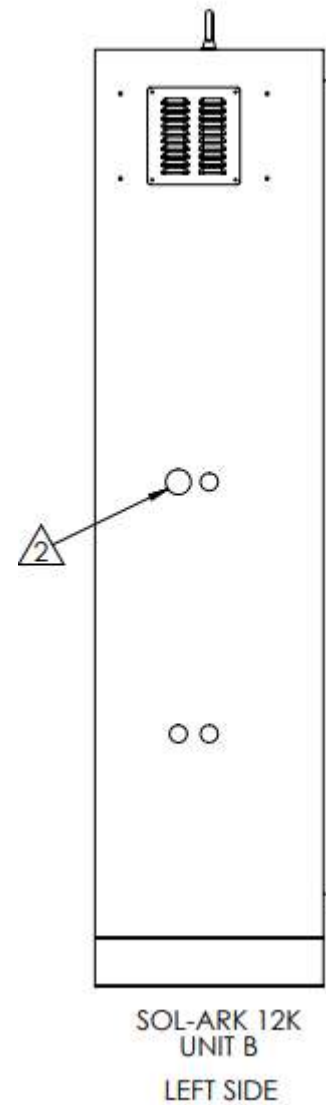
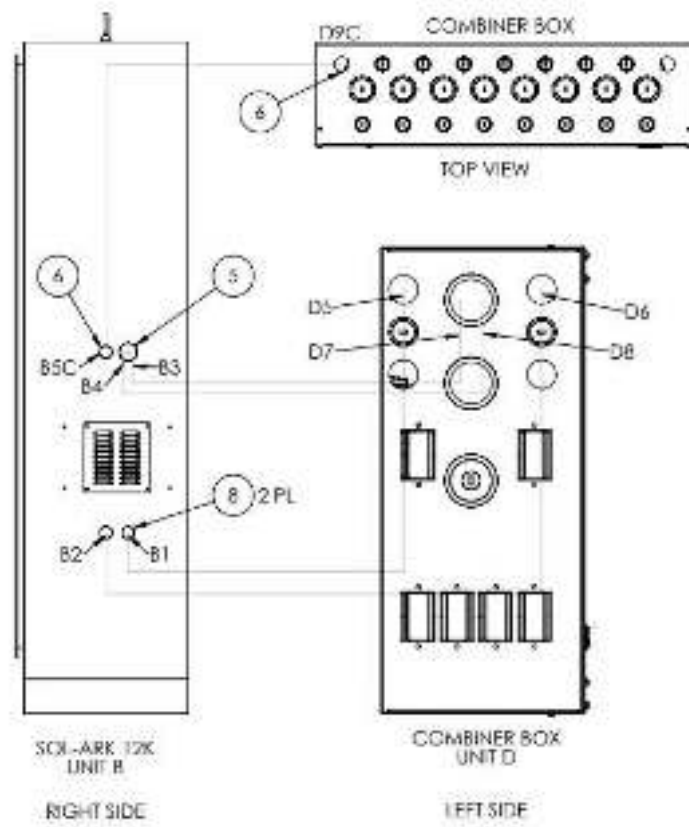
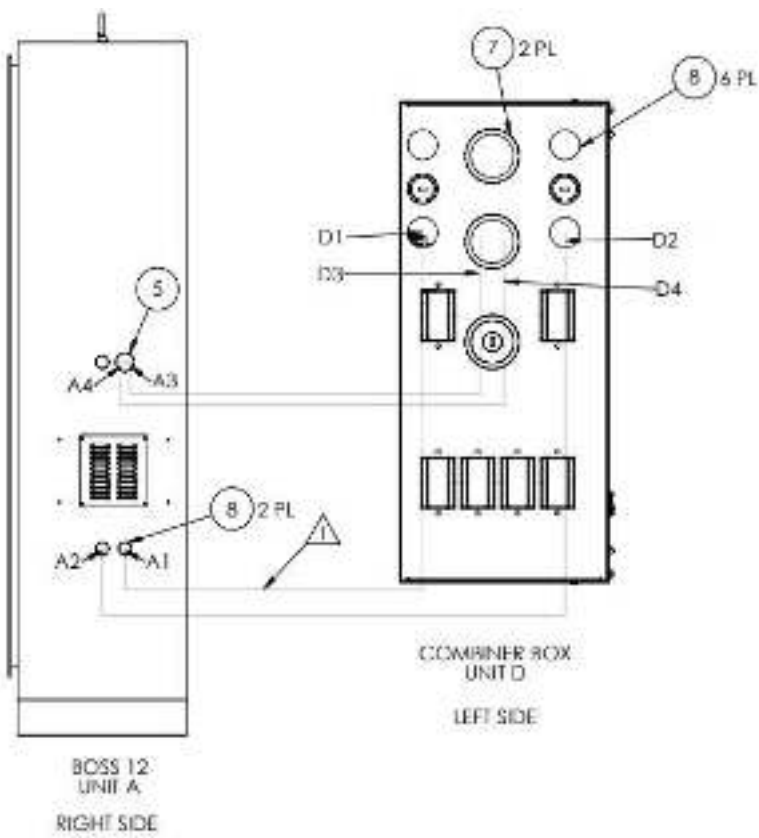
**CAUTION:** PHI 3.8 Batteries must be fully charged before commissioning the AccESS unit (i.e. before connecting loads for the first time). Failure to do so will void the Warranty.

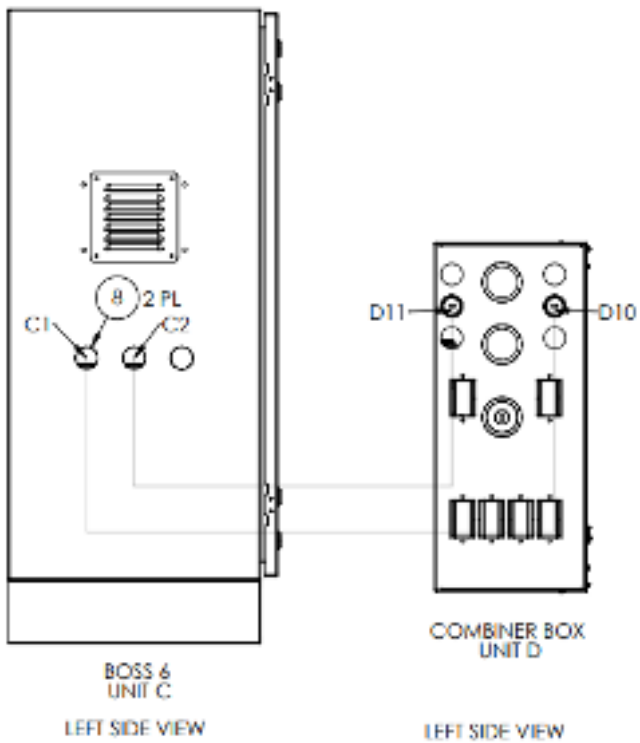
**CAUTION:** SimpliPhi does not require that the PHI 3.8 batteries within the AccESS be grounded. If a DC system ground is required, ensure that the system bonding is done in one location only, and that all conductors and connections comply with all applicable NEC and local installation codes.

## 4.4 – Combining Connections

Example: Two, A-5PHI-SA with added BOSS.6 with 4 or 5 PHI 3.8 batteries configured for residential use that does not exceed 80 kWh. Each unit has 15.48 kWh or 19.38 kWh Maximum Rated Capacity x 3 units for a total Maximum Rated Capacity of 46.44 kWh or 58.14 kWh.







## 4.5 – Communications and Network Preparation

The AccESS System includes system-level monitoring and programming via PowerView ES Monitor and Programming software.

For online guidance regarding the Sol-Ark's WiFi setup, watch this video:

[https://www.youtube.com/watch?v=0H0OZfZz\\_kQ&feature=youtu.be](https://www.youtube.com/watch?v=0H0OZfZz_kQ&feature=youtu.be)

Step-by-step WiFi setup instructions with screenshots and troubleshooting tips are included on pages 19 – 22 of the Sol-Ark-12K Manual. These excerpts also appear in Appendix A of this Manual.

## 4.5 – Wiring the AccESS

### 4.5.1 – Wiring Diagrams

Please reference the below listed DC coupling and AC coupling diagrams, where applicable.

#### DC Coupled System

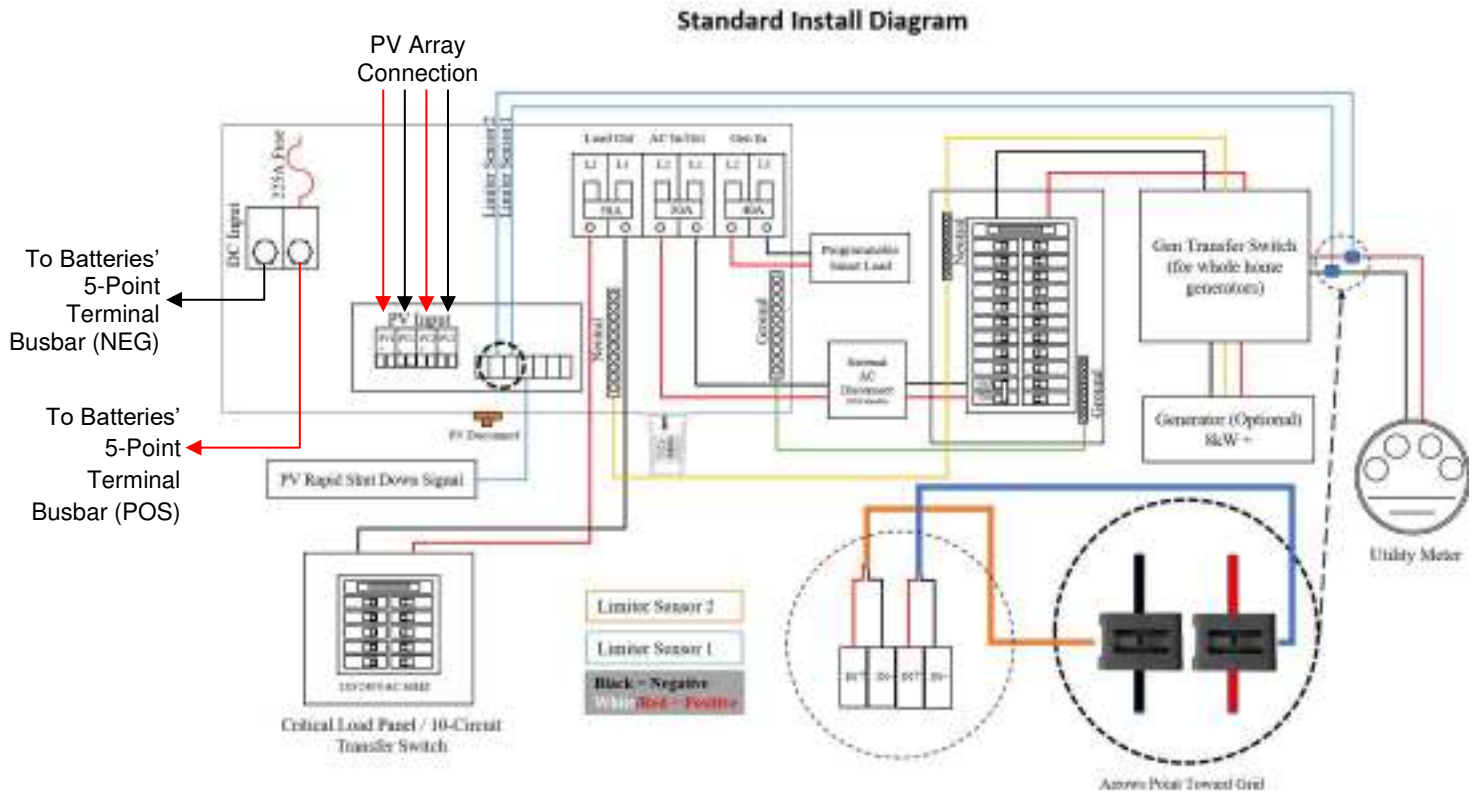


Figure 12.0 – DC Coupled AccESS Sol-Ark Wiring Diagram



## AC Coupled System

### Portable Generator / AC Coupling / SmartLoad Diagram

## AC Coupled PV Array Connection

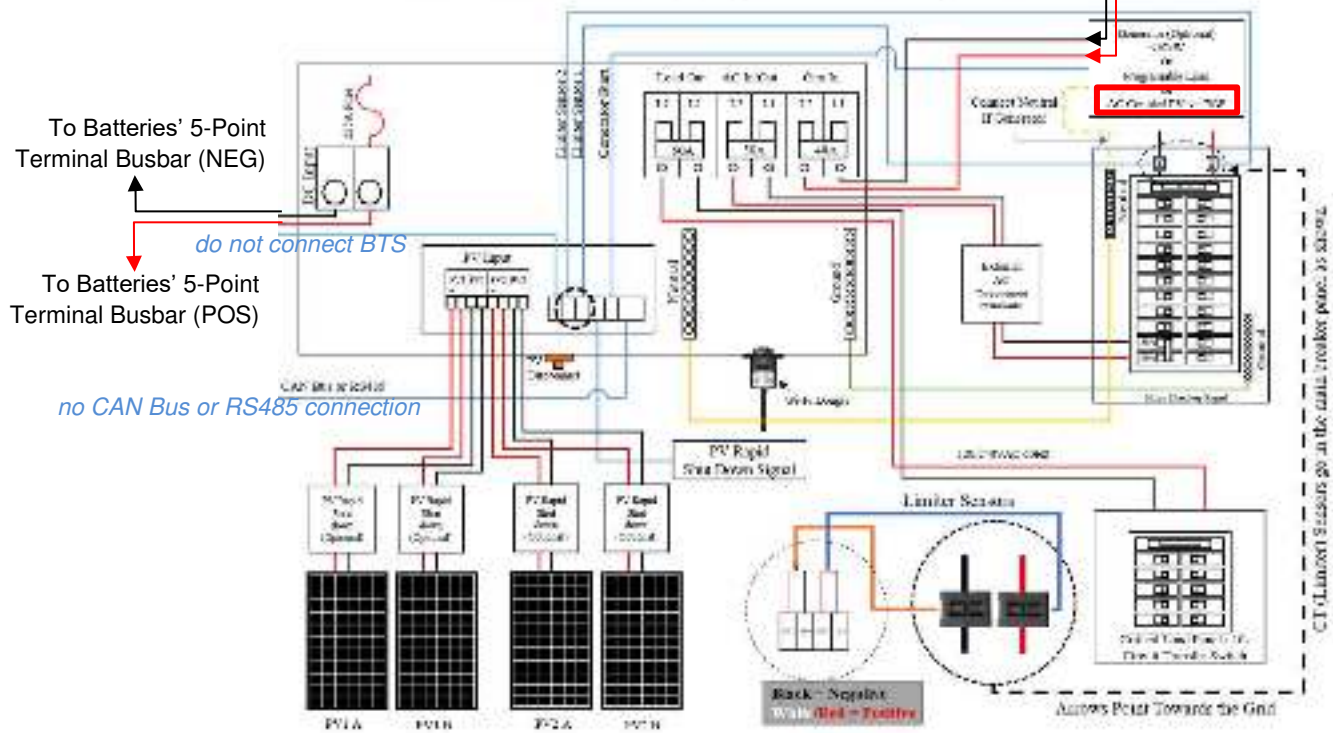


Figure 13.0 – AC Coupled AccESS Sol-Ark Wiring Diagram



## 4.5.2 – Making AC Connections

### AC Landing Points – Terminal Blocks

The AccESS is equipped with multiple knockouts on either side of the unit for accessibility to the Sol-Ark's AC connections. All AC connections are rated at 120/240 VAC. The bi-directional grid port can also support two out of three phases of a 208 VAC grid connection (the two phases being L1 and L2, 120° out of phase).

The Sol-Ark equipment includes the following:

- Bi-directional Grid Port (AC In/Out): 63A double-pole breaker
- Bi-directional Generator Port: 63A double-pole breaker
- Load Output (AC Out): 650A double-pole breaker

Figure 14.0 below shows the “Grid,” “Generator,” and “Load” connection locations. Also highlighted are the neutral and ground AC terminal blocks.

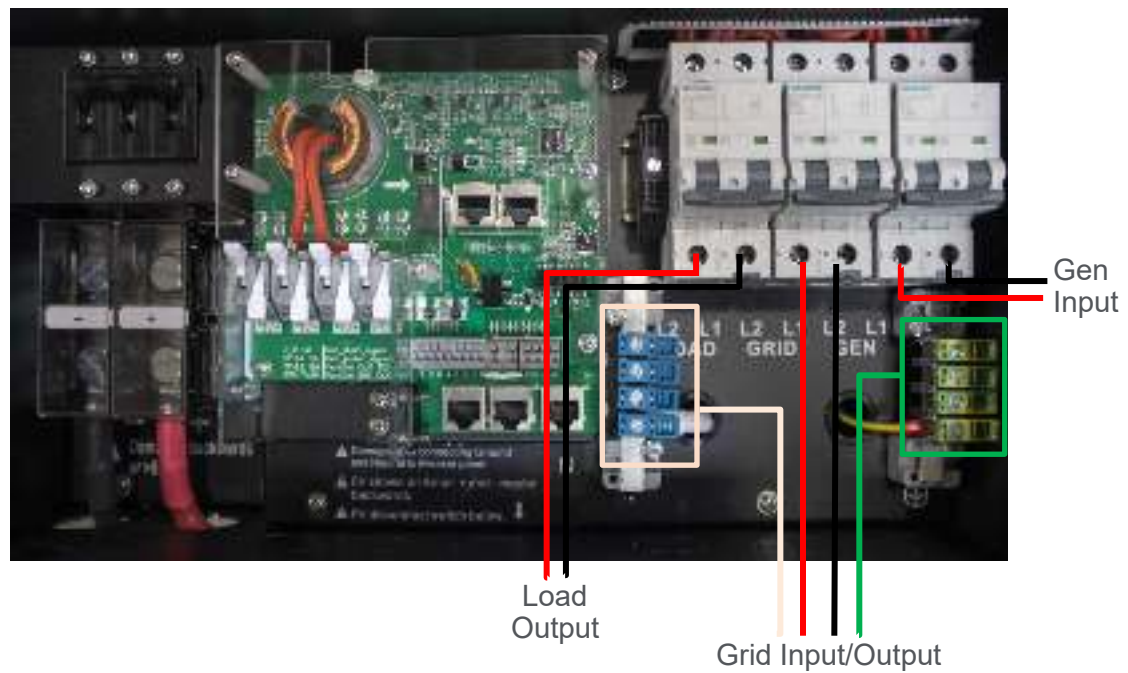


Figure 14.0 - AC Power Input/Output Wiring Connection Points

### Grid AC Wiring

1. Install a double pole 50A breaker in the main house breaker panel. Best practice dictates that this 50A 2P breaker be installed at the opposite end of the busbar from the main breaker (typically at the bottom of the main house breaker panel).
2. Include an External AC Disconnect (with handle) between the 50A 2P breaker in the main house breaker panel and the Sol-Ark's “Grid” port.
  - The External AC Disconnect must be sized larger than 50A and include a knife blade switch.

## Generator AC Wiring

Generators wired to the Sol-Ark Split-Phase systems must be rated at **240VAC**. **Generators wired to the Sol-Ark Three-Phase systems must be rated at 208VAC**. Installations outside North America that incorporate generators rated at 230VAC / 50Hz can be wired to the Sol-Ark, provided there is no Neutral wiring connection.

Generators can either be wired to the Sol-Ark's Generator Input Port or to the Sol-Ark's Bi-directional Grid Port.

In grid-connected systems, generators cannot be wired to the Grid Port. However, the Sol-Ark's Generator Input Port may need to be utilized for purposes other than the generator's connection. AC Coupled systems or systems utilizing the Sol-Ark's Smart Load functionality are wired to the Sol-Ark's Generator Input Port. In such scenarios, a whole-home generator transfer switch is necessary to incorporate a generator into the system:

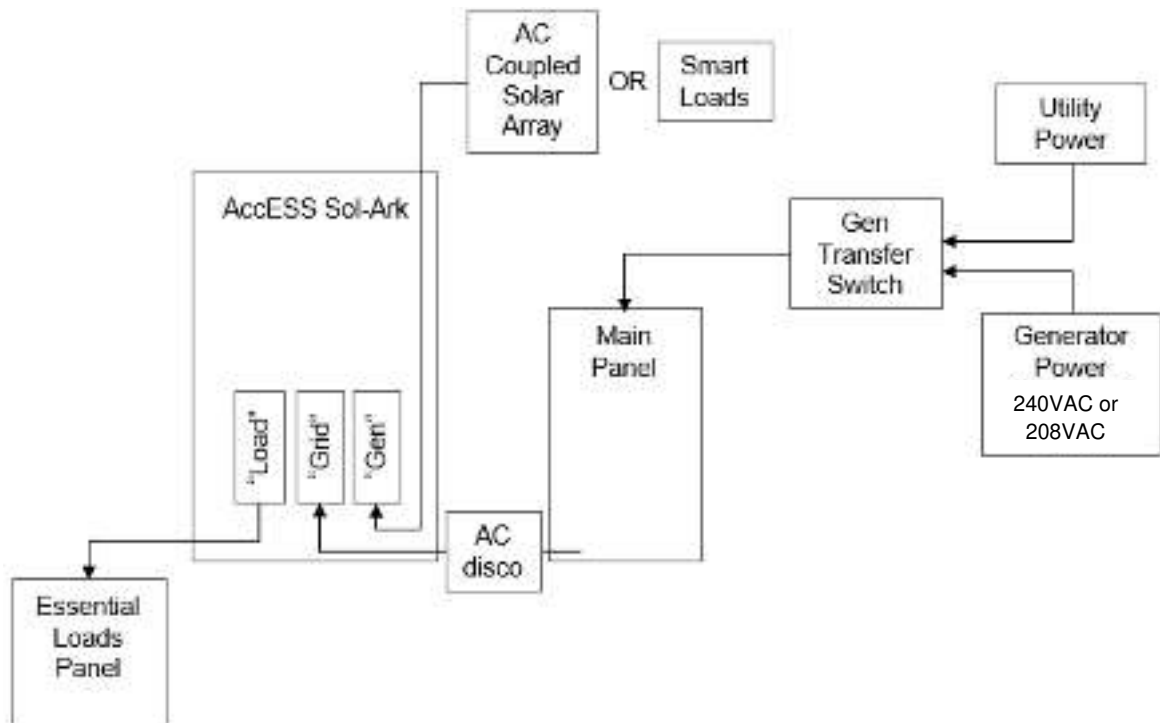


Figure 15.0 - Generator Wiring in Grid-Connected AC Coupled Systems

It is also acceptable, but not required, to use a whole-home generator transfer switch when the Generator Input Port does not need to be utilized for an AC Coupled solar PV array or Smart Loads. This setup is typical for larger (10-30 kW) generators.

In off-grid systems, Sol-Ark recommends that the Grid Port be used for generator connections.



**CAUTION:** Adhere to the programming instructions in the “Generators” sub-section of Section 5.3 (Configuring the Sol-Ark) in this Manual when incorporating a generator into the system.

## Inverter Charger Grounding

The Sol-Ark includes a ground busbar (outlined in Figure 14.0). A wiring connection must be made between the Sol-Ark's ground busbar and earth ground using appropriately sized equipment grounding conductors. The Sol-Ark's ground busbar accepts wire sizes up to **4 AWG**. System grounding must be done according to all applicable NEC and local installation codes.

## 4.5.3 – AC System Bonding

### Multiple AC Neutral-to-Ground Bonds

Verify that only **one** neutral-to-ground bond exists in the system. Having more than one neutral-to-ground bond in a system violates local electrical codes, may create a shock or fire hazard, and may cause some sensitive equipment to malfunction. The Sol-Ark's neutral busbar accepts wire sizes up to **4 AWG**.

**Failure to follow these instructions can result in death or serious injury and will void the Warranty.**

System bonding refers to connection (bonding) of one of the current-carrying conductors of an electrical system to ground. This creates a "grounded conductor" or "neutral" that is at ground potential but is separate from the equipment ground conductor. System bonding must be done at only one location. Procedures for system bonding vary between on-grid and off-grid systems.

#### System bonding for on-grid systems

The Sol-Ark does not include a connection between neutral and ground. The AC input neutral is already bonded to ground by the incoming utility grid system. Do not connect the neutral to ground in any additional location.

The Sol-Ark does not switch or disconnect the AC neutral in any mode of operation, so even in invert (back-up) mode, the inverter load sub-panel neutral is bonded to ground by the utility grid system. It must not be grounded again in the inverter's load sub-panel.

#### System bonding for off-grid systems

In a system without a generator, or with a generator that does not provide a grounded neutral, you must make the connection from neutral to ground in the Essential Loads panel (the inverter's load sub-panel), which is actually the home's main house breaker panel in an off-grid system.

In a system with a generator that provides a grounded neutral, no additional connection from neutral to ground is needed. In this case, do not connect neutral to ground in the Essential Loads panel (the inverter's load sub-panel).

## 4.5.4 – Making DC Connections

The Sol-Ark contains two built-in MPPT charge controllers, each containing two solar PV input ports (for a total of four PV string input ports per Sol-Ark). Adhere to the relevant Sol-Ark model's charge controller specifications when sizing the paired solar PV array (explained further in this section of the Manual).



**CAUTION:** All solar PV strings wired to the same charge controller must be rated at the same voltage.

1. Before connecting the solar PV, verify the cable polarity and mark the cable accordingly as Positive or Negative.
2. The AccESS Sol-Ark is equipped with multiple knockouts (see Figure 16.0 on the following page). Utilize any one of these to feed the PV wiring from the PV disconnect into the AccESS enclosure.

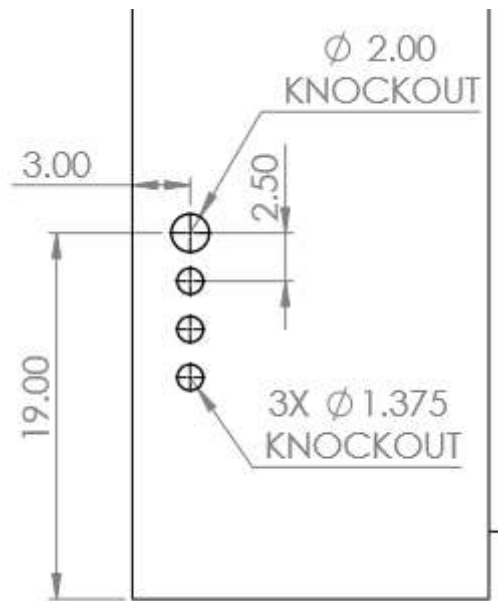


Figure 16.0 - AccESS Cabinet Knockouts (Sides)

3. Strip 0.5" of insulation from the PV conductors, and insert into the appropriate charge controller port.

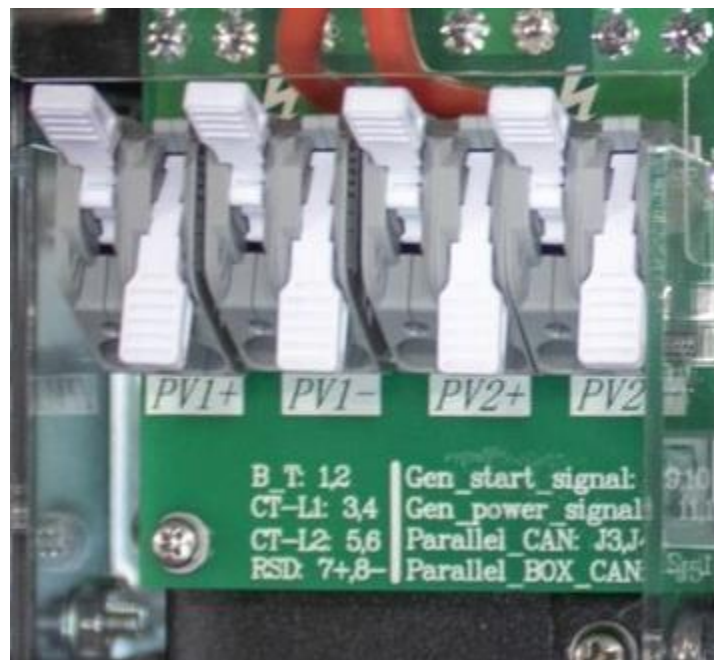


Figure 17.0 - PV Array Connection Points (DC Coupled Systems)

4. Ground the solar PV array by panel frame grounding to any ground connection in the home using 12 AWG wire. Solar PV mounting structures typically bond frames together, so only one ground wire is needed.

## AccESS Sol-Ark System Solar PV Array Sizing

The Sol-Ark-12K's built-in MPPT charge controller specifications are:

- Quantity of built-in MPPT charge controllers per Sol-Ark-12K = 2
  - Quantity of PV ports per MPPT charge controller = 2
  - Total quantity of PV ports per Sol-Ark-12K = 4
- MPPT charge controller starting voltage = 175V<sub>DC</sub>
- Maximum DC Voltage input per MPPT charge controller = 500V<sub>DC</sub>
- MPPT charge controller voltage range = 150-425V<sub>DC</sub>
- Maximum I<sub>SC</sub> current input per MPPT charge controller = 33A
- Maximum operating current input per MPPT charge controller = 20A
- Maximum battery charging current per Sol-Ark-12K = 185A



**CAUTION:** It is critical that the solar PV string's voltage does not exceed 500V<sub>OC</sub>; voltage greater than 550V<sub>DC</sub> will damage the Sol-Ark equipment.

To properly configure solar PV modules to the Sol-Ark's built-in charge controllers:

1. Due to the charge controller's starting voltage of **175V<sub>DC</sub>**, calculate the minimum number of solar panel modules needed to meet this target voltage at the module's maximum power voltage (V<sub>MP</sub>).

In this example, consider the Canadian Solar KuPower CS3K-300 solar PV module with a V<sub>MP</sub> of **32.5V** at Standard Test Conditions (STC).

- **Six** modules in series are required to meet the charge controller's minimum MPPT tracking voltage requirement:  $175V \div 32.5V = 5.4$  (round up to the next whole number).
2. The charge controller's maximum DC voltage input is **500V<sub>DC</sub>**. Temperature affects the solar PV module's voltage output: voltage increases as temperature decreases. To calculate the maximum number of solar panel modules in series per PV string, consider the module's open circuit voltage (V<sub>OC</sub>) rating, temperature coefficient and lowest expected temperature at the installation site.

In this example, the KuPower 300W module has a V<sub>OC</sub> of **39.3V** at STC, a STC temperature of **25°C**, and a V<sub>OC</sub> temperature coefficient of **-0.29%/°C**.

To calculate the solar module's V<sub>OC</sub> in an extreme low temperature condition of, say, -10°C:

$$V_{OC-MAX} = V_{OC} \times \{1 + [(Temp_{LOW} - Temp_{STC}) \times (V_{OC}TempCoefficient)]\}$$

$$V_{OC-MAX} = 39.3V_{OC} \times \{1 + [(-10^{\circ}C - 25^{\circ}C) \times (-0.29\%/^{\circ}C)]\}$$

Remember to convert the percentage value given as the V<sub>OC</sub> temperature coefficient to a decimal.

$$V_{OC-MAX} = 39.3V \times \{1 + [(-10^{\circ}C - 25^{\circ}C) \times (-0.0029/^{\circ}C)]\}$$

$$V_{OC-MAX} = 39.3V \times \left\{1 + \left[(-35^{\circ}C) \times \left(\frac{-0.0029}{^{\circ}C}\right)\right]\right\}$$

$$V_{OC-MAX} = 39.3V \times \{1 + [(0.1015)]\}$$

$$V_{OC-MAX} = 39.3V \times 1.1015$$

$$V_{OC-MAX} = \mathbf{43.3V}$$

- **Eleven** modules is the maximum allowable number of modules in series to prevent the solar PV string from exceeding the charge controller's maximum voltage input rating even in the coldest weather conditions at the installation site:  $500V \div 43.3V = 11.6$  (round down to the next whole number).

- Eleven modules in series at the KuPower 300W module's  $V_{MP}$  rating of 32.5V at STC also equates to 357.5V, well within the charge controller's 150-425V<sub>DC</sub> maximum power point tracking range.
- 3. The charge controller's maximum short circuit current ( $I_{sc}$ ) input is **33A<sub>DC</sub>**. Temperature also slightly affects the solar PV module's current output: current increases as temperature increases. However, because the temperature coefficient is negligible, it is acceptable to simply use the module's  $I_{sc}$  rating at STC for the following calculation.

To calculate the maximum number of solar PV strings per charge controller in this example, consider the KuPower 300W module's  $I_{sc}$  at STC: **9.82A**.

- According to this calculation, **three** solar PV strings is the maximum allowable number of strings per charge controller:  $33A \div 9.82A = 3.4$  (round down to the next whole number).
  - Although the Sol-Ark contains only two solar PV string inputs, more than two strings in parallel can be wired to the Sol-Ark. If more than two strings are connected in parallel to a single charge controller, each string must be fused (refer to page 9 of the [Sol-Ark-12K Manual](#)).
  - Three solar PV strings in parallel at the KuPower 300W module's  $I_{MP}$  rating of 9.24A equates to **27.72A** at STC, above the charge controller's operating current input limit of 20A. Whereas two solar PV strings in parallel at the KuPower 300W module's  $I_{MP}$  rating of 9.24A equates to **18.48A** at STC, well within the limits of the charge controller's operating current input limit of 20A. Therefore, wiring two strings in parallel instead of three per charge controller will work better.

Based on calculations #2 and #3 above, a maximum three parallel strings of eleven KuPower 300W modules in series can be wired to each of the Sol-Ark-12K's two charge controllers, and wiring a maximum two parallel strings of eleven KuPower 300W modules in series to each charge controller will eliminate power clipping.

- 4. The charge controller can be paired with a maximum 8,000 Watts of solar PV Wattage.

In this example, the KuPower 300W module has a Maximum Power ( $P_{MAX}$ ) rating of **300W** at STC.

- **26** modules are the maximum allowable number of modules that can be paired per charge controller:  $8,000W \div 300W = 26.7$  (round down to the next whole number).
- 5. The Sol-Ark-12K (with two built-in charge controllers) can be paired with a maximum 16,500 Watts of solar PV Wattage.

In this example, the KuPower 330W module has a Maximum Power ( $P_{MAX}$ ) rating of **300W** at STC.

- **55** modules are the maximum allowable number of modules that can be paired per Sol-Ark-12K:  $16,500W \div 300W = 55$ .

Considering all five of the above calculations, the optimal solar module configuration in this example is wiring a maximum **two parallel strings of eleven** KuPower 300W modules in series to each of the Sol-Ark-12K's two charge controllers, for a total of 44 modules paired with the Sol-Ark-12K.



## 4.5.5 – Limiter Sensor Wiring Connections

The Sol-Ark AccESS installation may include limiter sensors. Limiter sensors are required in the following applications:

- Limited to Home mode
- Time of Use Selling mode
- Systems that include both a generator and grid connection

Install limiter sensors on incoming electrical service wires L1 and L2, at the top of the main house breaker panel (refer to Sol-Ark's diagram within their manual).

Verify the limiter sensors' proper sense and direction by adhering to the Sol-Ark manual's "Testing and Powering Up Sol-Ark" instructions in the Sol-Ark Manual. If applicable, perform the following checks *after* completing Steps 1 and 2 outlined in the Basic Functional Test Section 4.5.6 below:

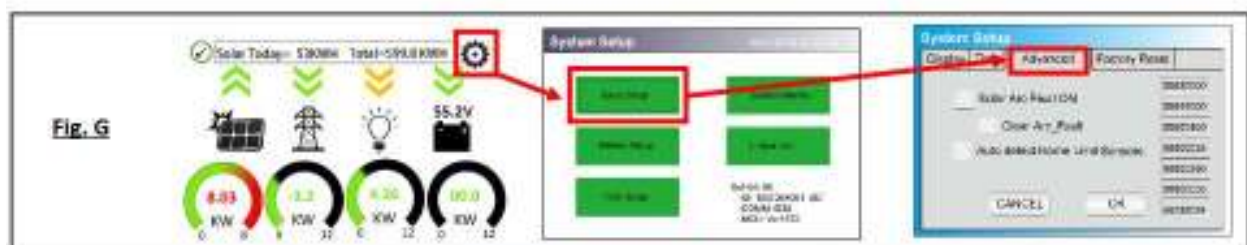
*If MCU SW = 1654 or higher, an auto learn function avoids all this.*

- Using AC multi-meter, verify L1 voltage on AC in/out is 0Vac with main L1 connection in panel. Same for L2.
- To verify sensor connections to Sol-Ark, try removing one sensor from the main L1 connection. The power should drop to 0W.
- To verify proper sensor direction, with any loads in the home, the HM: +watts will be positive. If you turn on solar panels and turn enable Grid Sell, you should see HM: -watts if you are producing more power than the loads are consuming. And if you turn on limited power to Home mode, then HM: ~0 watts to zero the meter (system matches the loads to within 99%).

From p the Sol-Ark-12K Manual:

### Limiter Sensor Automatic Setup

- 1) Install limiter sensors as described on page 28 (shown on page 11 as well). Battery and grid connections also required before starting auto-setup.
- 2) Navigate to the "Advanced" Tab of the Basic Setup screen (follow the directions below to get there).
  - a) Touch the gear icon → Touch the Basic Setup button → Select the Advanced tab (see Fig. G).
- 3) Select "Auto detect Home Limit Sensors" and press ok.
- 4) Wait for the Sol-Ark to finish its learning process (Sol-Ark will alternate sell back between legs and magnitude automatically determining the correct settings for the sensors).
- 5) Verify sensors were correctly configured (see Fig. H).



**Fig. H**

In Limited To Home Mode HM values will be close to zero. HM values should never be negative. If negative, the Limiter Sensors are not installed properly.

Wire	Dir	Wp	Load	HM
EV	SW	0V	0V	0W
L1: EV	117V	110V	110V	11.13V
0.0A	117V	0.0A	0.0A	1.36A
0W	117V	0W	0W	0.0C
L2: EV	117V	110V	110V	11.13V
0.0A	117V	0.0A	0.0A	1.36A
0W	117V	0W	0W	0.0C

**Possible Limiter Sensor issues:**

- Sensors are facing wrong direction
- Sensors are on the wrong wire(s)
- Sensors are not fully closed on wire(s)
- Sensor Polarity is wrong (White = + BLK = -)

## 4.5.6 – Basic Functional Test

The following procedure should be followed once the installation is complete and before it is put into service.

### Step 1: Confirm All Connections

After the AC and DC wiring has been installed and connected, check that all connections are correct and secure.

### Step 2: Apply Battery Power to the Inverter

1. Measure the voltage and check polarity at all battery connection points. Measure the entire PHI battery bank's voltage and polarity on the Sol-Ark's DC Positive and DC Negative connection points, outlined in Figure 18.0 below.

Note: The Sol-Ark includes a 250ADC Disconnect breaker.



Figure 18.0 – Inverter & DC Power Supply ON/OFF Button

2. Supply DC power to the Sol-Ark inverter by turning ON the ON/OFF button on the front of the Sol-Ark unit. The inverter will power up and the inverter display panel will turn on.

### Step 3: Verify Inverter Programming

Although the AccESS Sol-Ark is pre-programmed to the correct battery charging parameters, the Sol-Ark equipment offers different functionality based on various other settings. Refer to this Manual's Programming section 5.0 for more information.

### Step 4: Apply DC and AC Power to the Inverter

Turn all relevant DC and AC disconnects ON. When first commissioning the system, leave the Sol-Ark's Load Output breaker OFF, and all circuits in the main house breaker panel OFF (if the Sol-Ark is programmed to a mode of operation in which the batteries discharge to the main house breaker panel; refer to Section 5.3 of this Manual for more information on the Sol-Ark's modes).



## Step 5: Fully Charge the Battery Bank Prior to Powering on Loads

A connection to an AC power source will result in the Sol-Ark automatically charging the batteries from that power source when the Sol-Ark is turned ON.

If the system does not include any AC power source, and only solar PV as the batteries' charging source, turn on the PV disconnect and wait until the PHI battery bank has had a chance to charge fully via solar power before turning on any loads.

For DC Coupled systems, the solar PV array's ON/OFF switch is on the left hand side of the Sol-Ark unit.

## Step 6: Turn on Loads

Fully charged PHI batteries will reach a charging voltage of 54.4 – 56 VDC and will then “rest” at approximately 53.3 VDC as soon as they are no longer actively charging. At this point, turn on the Sol-Ark's Load Output breaker and main house breaker panel circuits, if applicable.

## 4.5.7 – Lockout / Tagout

### Step 1: Detailed procedures for equipment

Begin by making sure you've identified the equipment correctly and accurately, including its specific location. Next, determine the correct procedure for shutting down and restarting the equipment. Detail that procedure, step by step, in writing. Consider all of the energy sources that may be connected to the equipment. Be very specific, because ambiguous language could lead to an incorrect or even dangerous action.

### Step 2: Notify affected employees

When maintenance is going to be performed, all of the employees that may be affected should be notified. Let them know the timing of the work, and how long the equipment may be unavailable. If the unavailability of the equipment requires a change in work processes, be sure they are familiar with the steps to be taken.

### Step 3: Shut down equipment properly

Explain the shutdown process in detail. It's not enough to say something like “disconnect the machine.” To ensure everyone's safety and reduce the potential for damage, the shutdown instructions should be detailed. Spell out the exact actions to be taken and the correct sequence for performing those actions.

### Step 4: Disconnect all primary energy sources

Although this may seem fairly self-explanatory, once again, it's important to be very detailed. Whether the primary energy sources include electricity, steam, water, gas, compressed air, or others, don't assume that the person performing maintenance will know the correct procedure to follow. Again, explain exactly what needs to be done.

### Step 5: Address all secondary sources

While disconnecting the primary energy sources may remove much of the potential danger, it's possible that there sources of residual energy, such as trapped heat in a thermal system, fumes that may need to be vented, or even tension in a spring assembly. Identify the process that will relieve any remaining pressure or other energy. Also consider other hazards, such as moving equipment that must be secured before work begins.

**Step 6: Verify the lockout**

Once you've disconnected all primary and secondary sources of energy, attempt to start the equipment to verify that the lockout has been successful. Before you try to start it, verify that nobody is in a position where they could be hurt. Assuming that the procedures have been successful, return all switches and other equipment back to their "off" positions so the machine won't start unexpectedly when the energy sources are reconnected. Once you've verified the lockout, attach a lockout or tagout device to the equipment to ensure that it cannot be started without removing the device.

**Step 7: Keep it in force during shift changes**

The equipment must remain in lockout/tagout condition across shift changes, so that workers arriving at the site are aware that the equipment is out of service. If individual locks or tags are used, the individual responsible for designating the lockout/tagout and the individual responsible for it during the next shift must both be present as the locks or tags are switched.

**Step 8: Bring the equipment back online**

When the work is done and all tools and other materials have been removed, the machine can be brought back into operation. Here again, the procedure should spell out the exact steps that are involved, along with the correct sequence. For example, you may need to open a particular machine's discharge valves before you open the inlet, so any unexpected water or steam remaining in the lines has a place to go.

**Bonus step: Keep procedures up to date**

Equipment and operating procedures tend to change over time, and your lockout/tagout program needs to reflect those changes. Sometimes, the changes may be so minor that only the people working directly with the equipment are aware of them. That's why it's a good idea to review all your lockout/tagout procedures regularly to verify that they're still accurate. A company with just a small number of machines may be able to check all of them every year, while a larger organization may need to study a certain number or a random sample every year. Another benefit of regular review is that it gives you an opportunity to deploy newer and better ideas or more accurate descriptions.

## 5.0 – Programming

### 5.1 – Depth of Discharge

The AccESS Sol-Ark comes pre-programmed for a maximum 80% depth of discharge (DoD) on the PHI batteries. This qualifies the batteries for the 10-year / 10,000 cycle Warranty.

To change the batteries' DoD to the 5,000-cycle Warranty or 3,500-cycle Warranty, modify the State of Charge (SoC) percentages as outlined in this Operating Parameters section of this Manual.

If a firmware update is executed on the AccESS, please verify all PHI custom settings are still in place.

### 5.2 – Operating Parameters Per Warranty

#### Inverter/Charge Controller Settings

For online programming guidance, refer to Sol-Ark's **Menus and Programming** video (<https://www.youtube.com/watch?v=mcXXzfRT90&t=1497s>) when programming those settings outlined in Table 2.0 on the following page.

Press the gear icon to get to the **Settings** menu (Figure 19.0), then press **Battery Setup** (Figure 20.0) to program the parameters in Table 2.0.

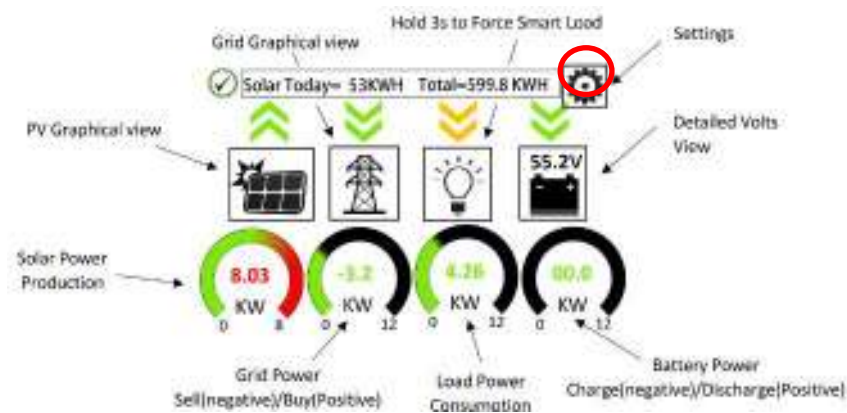


Figure 19.0 – Sol-Ark Home Screen (Touchscreen)



Figure 20.0 – Sol-Ark System Setup Screen

Table 2.0 – Sol-Ark AccESS Battery Settings

System Setup > Battery Setup	80% DoD (10k cycle warranty)	90% DoD (5k cycle warranty)	100% DoD (3.5k cycle warranty)
> Batt Tab			
Batt Capacity <sup>1</sup>	75 Ah per PHI 3.8 battery		
Max A Charge <sup>1,2</sup>	37.5 ADC per PHI 3.8 battery (20 ADC per battery for reduced stress)* *The Sol-Ark's maximum PV charging output is limited to 185 ADC.		
Max A Discharge <sup>1</sup>	37.5 ADC per PHI 3.8 battery		
TEMPCO	0 mv/C/Cell (disabled)		
Use Batt V Charged	do not check this box		
Use Batt % Charged	check this box		
No Battery	do not check this box		
BMS Lithium Batt	do not check this box		
Activate Battery	do not check this box		
> Charge Tab	80% DoD	90% DoD	100% DoD
Start V	Use Start % instead of Start V when using Batt % Charged instead of Batt V Charged (in the Batt tab)		
Start % <sup>3</sup>	21%	11%	1%
A <sup>1,4</sup>	37.5 ADC per PHI 3.8 battery (20 ADC per battery for reduced stress)* *The Sol-Ark's maximum AC power charging output is limited to 100 ADC.		
Gen Charge / Grid Charge <sup>5</sup>	Check the Gen Charge box when a generator is connected to the Gen Input breaker.		
	Check the Grid Charge box when a generator is connected to the Grid Input breaker, or when a grid connection is utilized to charge the batteries.		

Float V	54 V		
Absorption V <sup>6</sup>	56 V		
Equalization V <sup>7</sup>	56 V		
	30 days		
	2 hours		
> Discharge Tab	80% DoD (recommended)	90% DoD	100% DoD
Shutdown	20% (50.2 V)	10% (49.5 V)	0% (48 V)
Low Batt	30% (50.5 V)	20% (50.2 V)	10% (49.5 V)
Restart	97% (52 V)	97% (52 V)	97% (52 V)
Batt Resistance	Resistance mOhms = $96 \div (4 \times \text{PHI 3.8 battery quantity})$		
Batt Charge Efficiency	99%		
> Smart Load Tab			
Use Gen input as load output	<i>check this box if the Smart Load feature applies (refer to Section 5 of this Guide)</i>		
Smart Load OFF Batt <sup>8</sup>	95% (51.7 V)		
Smart Load ON Batt <sup>9</sup>	100% (52.5 V)		
	<i>Wattage value is used in grid-connected systems only. This value represents the minimum power required of the solar array before the Smart Loads are powered.</i>		
For Micro inverter input	<i>check this box for AC coupled systems</i>		
Smart Load OFF Batt <sup>10</sup>	100% (52.5 V)		
Smart Load ON Batt <sup>11</sup>	30 – 95%		

Notes:

1. These settings are calculated by multiplying the per-battery value by the number of batteries in the connected battery bank.
2. **Max A Charge** refers to the maximum charge rate from the solar PV array. Programming this value to the maximum value versus the reduced-stress value does not impact the PHI Battery Warranty.
3. If the Auto Generator Start is utilized, the AGS is triggered when the batteries reach this set State of Charge (SoC) percentage. Once triggered, the generator charges the batteries until they reach approximately 95% SoC, at which point the generator turns off. This 95% SoC parameter is not programmable.
4. **A** refers to the maximum charge rate from the grid or the generator. If the Sol-Ark is connected to both the grid and a standby generator, the Sol-Ark prioritizes the grid as the batteries' charging source. Programming the **A** value to the maximum value versus the reduced-stress value does not impact the PHI Battery Warranty.
5. By default, battery charging from the solar PV array is prioritized over generator or grid charging.
6. When the battery has reached the Absorption voltage setpoint, the Sol-Ark utilizes constant-voltage regulation to maintain the battery at the programmed Absorption voltage. The Absorption phase lasts until the batteries charge at 2% of the programmed Ah size. For example, one PHI 3.8-51.2V<sub>nom</sub> battery (rated at 75 Ah), will remain in the Absorption charging phase until the number of Amps used to charge the battery decreases to 1.5 Amps DC (2% of 75Ah).

7. While the PHI Battery does not require an Equalization charge, programming Equalization to the voltage, frequency and duration outlined in the table above ensures that the Sol-Ark's internal SoC meter re-sets to 100% SoC every 30 days.
8. Smart Loads are no longer powered via solar and/or batteries when the batteries' SoC level drops below this programmed **Smart Load OFF Batt** value.
9. Smart Loads are powered via solar and/or batteries when the batteries' SoC level exceeds this programmed **Smart Load ON Batt** value.
10. The Sol-Ark stops charging the batteries and powering the loads from the AC Coupled solar PV array once the batteries' SoC level reaches the **Smart Load OFF Batt** value.
11. The Sol-Ark triggers the AC Coupled solar PV array to produce power (powering the loads and charging the batteries) when the batteries' SoC level exceeds this programmed **Smart Load ON Batt** value.



**CAUTION:** When PHI battery quantities change, the capacity & charge/discharge current settings must be reassessed. Failure to do so will Void the Warranty. Modification to original factory settings can only be accessed by using installer password.

## Grid Setup Settings

The Sol-Ark's **Grid Setup** menu includes many advanced features (refer to Section 5 of this Guide). Regardless of the features used, the PHI battery bank should never discharge more than its maximum continuous discharge rate. Furthermore, to maintain the PHI batteries' Warranty at a 10,000-cycle level, also do not discharge the battery bank to a State of Charge (SoC) level less than 20%. These details are controlled in the **Grid Setup** menu's **Limiter** tab.



Figure 21.0 – Limiter Tab in Grid Setup Menu

The **power (W)** column in Figure 21.0 above dictates the maximum amount of power pulled from the batteries and should be set to the PHI battery bank's maximum discharge rate in AC Watts. To calculate the connected PHI battery bank's maximum discharge Watts (AC):

1. Multiply the number of batteries in the bank by the maximum discharge rate (ADC) per battery
  - a. PHI 3.8-51.2V<sub>nom</sub> battery max. discharge rate = 37.5 ADC per battery
2. Convert the battery bank's DC discharge current to DC discharge watts.
3. Apply the discharge efficiency.

Populate the **Batt** column to the right of the **power (W)** column according to the degree to which you wish to discharge the battery bank. Again, to maintain the PHI batteries at the 10,000-cycle Warranty level, do not populate the **Batt** column with any value less than 20%.

## 5.3 – Configuring the Sol-Ark to a Specific Application

The Sol-Ark is capable of many different modes of operation via configurable settings (more than one mode can be used simultaneously). This section of the Manual will outline the system programming and setup basics for common use cases. However, refer also to the Sol-Ark Manual for all installation requirements relevant to the application at hand.

Table 4.0 –AccESS Sol-Ark System Grid Settings

System Setup > Grid Setup	80% DoD (10k cycle warranty)	90% DoD (5k cycle warranty)	100% DoD (3.5k cycle warranty)
> Limiter Tab			
Grid Sell	check this box when exporting solar PV power to the grid (Net Energy Metering agreement required)		
	set the numerical value to the maximum number of exporting Watts		
Limited Power to Home	check this box when powering both the essential loads sub-panel and the main house breaker panel using solar and/or battery, without exporting energy to the grid (limiter sensors required)		
Limited power to load	check this box when powering the essential loads sub-panel using solar and/or battery		
Time of Use Selling	check this box when discharging the batteries during set times (either the Grid Sell or Limited Power to Home box must also be checked)		
Time	sets the time at which the batteries discharge to power both the essential loads sub-panel and the main house breaker panel (limiter sensors required)		
power (W)	sets the maximum amount of power discharged from the batteries during the set time		
	do not exceed the Wattage values listed in Tables 2 or 3 above		
Batt	the percentage SoC to which the batteries discharge during the set time		
	20%	10%	0%
Grid Charge	check this box to allow for grid-to-battery charging during the set time		
GEN	check this box to allow for gen-to-battery charging during the set time		
> Sell Control Tab	80% DoD	90% DoD	100% DoD
General Standard	check this box when a generator is wired to the Grid Input or to use the <b>Protect Param</b> settings listed in the <b>Grid Input</b> tab		
UL 1741 & IEEE 1547	check this box for grid sell compliant functionality (default)		
CA Rule 21	check this box for compliance with CA Rule 21		
UL 1741SA	check this box for compliance with HECO Rule 14H and/or PREPA		
GEN connect to Grid input	check this box when a generator is wired to the Grid Input		
> Grid Input Tab			
Grid Frequency	select 50 Hz or 60 Hz		
Grid Type	select 120/240V split phase (North America), or contact SimpliPhi to special-order 220V single phase or 120/208V 3 phase		

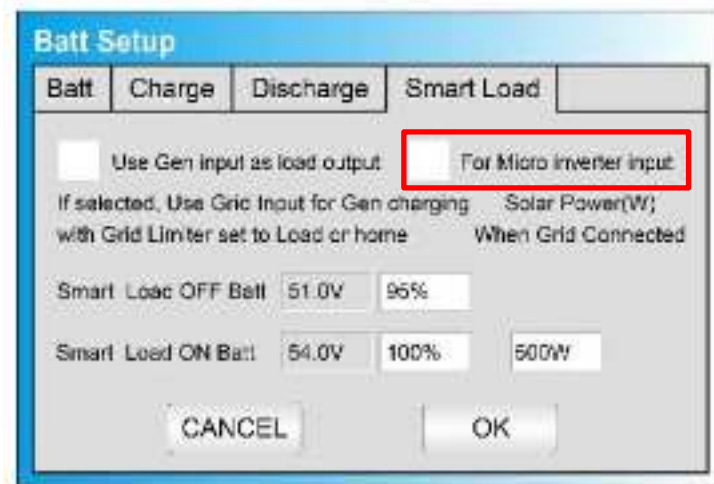


Protect Param	leave as default values when UL 1741 & IEEE 1547 are enabled frequency values may change when a generator is wired to the Grid Input
> FreqVolt tab	refer to the Sol-Ark Manual for Puerto Rico or Kauai-specific settings

## AC Coupled

In an AC Coupled system setup, the grid-tie inverter(s) output – string or micro-inverters – is wired to the Sol-Ark's Generator Input (63A double-pole breaker) and the **For Micro inverter input** box in the **Smart Load** tab of the **Battery Setup** menu must be checked:

Figure 22.0 – Smart Load Tab in Batt Setup Menu



The Sol-Ark-12K is limited to 7.6 kW of AC Coupled solar.

AC Coupled systems can operate in Grid Sell / Grid-Tied with Battery Backup, Limited to Home, Limited to Load, or Time of Use Selling modes.

## Grid Sell / Grid-Tied with Battery Backup

A net energy metering agreement with the utility company is required in order to sell energy from the solar PV array to the grid. In this mode, the Sol-Ark prioritizes powering all loads (on both the essential loads sub-panel and the main house breaker panel) from solar PV first (if available), then (2) grid, (3) generator, and (4) batteries. In the event of a grid failure, the batteries will power the essential loads sub-panel only. Take care to size the battery bank; accordingly, in a grid failure scenario, the Sol-Ark does not limit the batteries' maximum current output. The maximum power draw (kW) on the essential loads sub-panel should not exceed the maximum continuous discharge rate of the PHI battery bank. Refer to the Discharge Calculation in Section 3 of this Guide:

$$B_{\#Inv} \geq \frac{Inv_{kW} \div Inv_{eff}}{Bat_{kW}}$$

Discharge Example:

- Circuits on the essential loads sub-panel amount to a maximum potential power draw of 30 Amps at 240 VAC, or 7.2 kW<sub>AC</sub>
- Sol-Ark-12K inverter DC-to-AC efficiency is 95.5%
- PHI 3.8 kWh-51.2V<sub>nom</sub> battery has a maximum continuous discharge rate of 1.92 kW<sub>DC</sub>

$$B_{\#Inv} \geq \frac{7.2_{kW} \div 0.955_{eff}}{1.92_{kW}} = 3.9$$

A properly sized PHI battery bank based on the maximum draw of the essential loads sub-panel has a minimum of 4 batteries, even in this Grid-Tied with Battery Backup application. Note also that during a grid failure, the essential loads' maximum energy draw (kWh) is also limited by the battery bank's capacity.

### Limited to Home

Checking the **Limited power to Home** box in the **Limiter** tab of the Sol-Ark's **Grid Setup / Grid Param** menu allows for all loads\* (on both the essential loads sub-panel and the main house breaker panel) to be powered using the connected solar PV and/or batteries. The Sol-Ark prioritizes powering these loads from solar PV first (if available), then (2) grid, (3) generator, and (4) batteries. To prioritize the batteries' use over the grid or generator during specific set times, also use the **Time of Use Selling** mode.

\*While the **Limited to Home** mode allows for all loads to be powered using solar PV and/or batteries, the Sol-Ark prioritizes powering loads on the essential loads sub-panel first, and loads on the main house breaker panel are offset by solar (and/or batteries, during Time of Use Selling mode times) *as much as possible*. If the loads' draw exceeds the available power from the solar PV array and (with **Time of Use Selling** mode also in play) the batteries have also discharged to their minimum programmed SoC percentage level, the Sol-Ark will then resort to powering loads using grid power.



**CAUTION:** In Limited to Home mode, limiter sensors are required to ensure that the home's main breaker panel circuits are powered without exporting energy to the grid.

### Limited to Load

Checking the **Limited power to load** box in the **Limiter** tab of the Sol-Ark's **Grid Setup / Grid Param** menu discharges the battery to power the essential loads sub-panel's loads. The **Limited to Load** mode does not allow for any solar or battery energy to power the main house breaker panel and it does not allow for any solar or battery energy to be exported to the grid.

Figure 23.0 – Limiter Tab in Grid Setup Menu

Time	power(W)	Batt	Charge
06:00	8000	50%	
08:20	8000	50%	
10:00	8000	50%	
12:30	8000	50%	
03:50	8000	50%	
08:50	8000	50%	

### Time of Use Selling / Energy Arbitrage

Discharge batteries to power circuits during specific set times. Program these times to coincide with the utility company's peak pricing times to avoid high energy charges from the utility.

Homeowners who have a net energy metering agreement with the utility company can use both **Grid Sell** and **Time of Use Selling** modes to sell solar PV and battery energy (until the minimum programmed SoC percentage level) back to the grid during peak sun-hour times and then discharge the batteries during programmed times, usually in the afternoon and evening. Depending on whether **Limited power to load** or **Limited Power to Home** is enabled, the batteries will power either the essential loads sub-panel only (**Limited to Load**) or the essential loads sub-panel and the main house breaker panel (**Limited to Home**) during the **Time of Use Selling** time period. Make sure to size the battery accordingly. (Refer to the Discharge Example in the **Grid Sell / Grid-Tied with Battery**

**Backup** section of this Guide for battery bank sizing when batteries power the essential loads sub-panel only. Refer to the Discharge Example in Section 3 of this Guide for battery bank sizing when the batteries power both the essential loads sub-panel and the main house breaker panel.)

Homeowners who do not have a net energy metering agreement use both **Limited Power to Home** and **Time of Use Selling** modes to prioritize powering all loads (circuits both on the essential loads sub-panel and the main house breaker panel) from the solar and/or batteries during programmed times. Refer to the Discharge Example in Section 3 of this Guide for battery bank sizing when the batteries power both the essential loads sub-panel and the main house breaker panel.



**NOTE:** Either the Grid Sell or the Limited Power to Home mode (check the appropriate box in the Grid Setup / Grid Param menu) must be used in conjunction with Time of Use Selling.

During **Time of Use Selling** times, loads are powered from solar first (if available), batteries second, and the grid third (if batteries have discharged to their programmed minimum SoC percentage level).

Make sure the **GridCharge** box is unchecked during peak pricing times so that the batteries do not charge when energy from the utility company is most expensive (see Figure 7).

Figure 24.0 – Limiter Tab in Grid Setup Menu

Limiter	Sell Control	Grid Input	Freq/Volt	PowFac
<input checked="" type="checkbox"/> Grid Sell	3000			
<input type="checkbox"/> Limited Power to Home				
<input type="checkbox"/> Limited power to load				
<input type="checkbox"/> Time of Use Selling				
		Time	power(W)	Batt
		01:00	3000	9%
		08:20	3000	9%
		10:00	3000	9%
		12:30	3000	9%
		03:50	3000	9%
		08:50	3000	9%

CANCEL OK

## Off-Grid

The Sol-Ark automatically operates in **Off-Grid** mode when it does not detect a grid connection.

In an Off-Grid system setup, all the home's loads are connected to the Sol-Ark's Load Output (50A double-pole breaker).

Do not use the Sol-Ark's **Grid Sell** and **Limited to Home** modes in an off-grid system setup.

Check the **Limited power to load** box in the **Limiter** tab of the Sol-Ark's **Grid Setup / Grid Param** menu to allow for the batteries' power to discharge to the connected loads.

## Generators

The Sol-Ark's built-in Auto Generator Start functions as a 2-wire automatic switch.

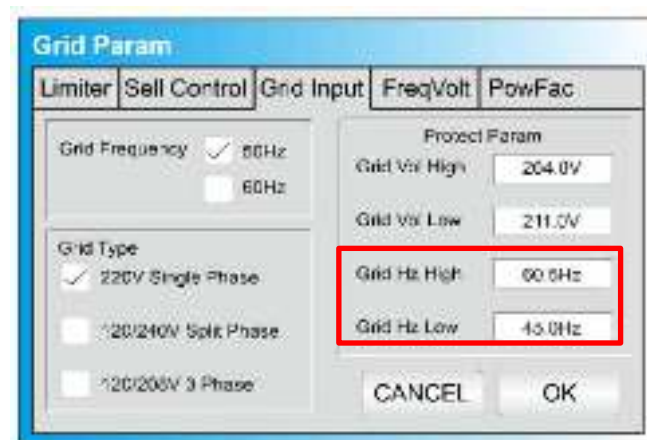
The Sol-Ark's Grid Input breaker can be used as the generator's input breaker. In this scenario, check the **General Standard** box and the **GEN connect to Grid input** box in the **Grid Param** menu's **Sell Control** tab:

Figure 25.0 – Sell Control Tab in Grid Setup Menu



Due to the fact that many generators' output frequency is usually less precise than the grid's, the frequency parameters in the **Grid Param** menu's **Grid Input** tab may also need adjustment to accommodate a wider frequency range:

Figure 26.0 – Grid Input Tab in Grid Setup Menu



Homeowners who wish to include a grid connection, generator, and Smart Load functionality can install a transfer switch allowing for either grid or generator to connect to the Sol-Ark's Grid Input. This frees up the Sol-Ark's Generator Input to be used as an output for Smart Loads (see the following Smart Loads section for more details).

In an AC Coupled system setup that includes a generator, using a transfer switch for a grid-or-generator connection to the Sol-Ark's Grid Input also frees up the Sol-Ark Generator Input for connection to the AC Coupled solar PV array.

If the system includes both a generator and a grid connection, limiter sensors are required. While smaller generators (less than 10 kW) can be wired to the Sol-Ark's Generator Input, Sol-Ark recommends wiring larger generators to a whole home transfer switch instead of using the inverter's Generator Input.

## Smart Load

The Smart Load feature allows the homeowner to run higher power non-essential appliances (hot water, dehumidifier, heat pump, irrigation pump, etc.) on solar when excess solar power is available. This setup involves connecting these higher power non-essential loads to the Sol-Ark's Generator Input. To partially protect the batteries against over-discharge, set the **Smart Load Off Batt** and **Smart Load ON Batt** parameters to the batteries' acceptable SoC percentage range while in this mode. However, note that no programmable parameter exists to regulate the batteries' over-discharge from a current perspective.

For example, an off-grid system with home loads totaling a maximum instantaneous power draw of 8 kW might include 5 PHI 3.8 batteries, with a maximum combined continuous power output of 9.6 kW<sub>DC</sub> / 9.168 kW<sub>AC</sub>. With both the **Smart Load** and **Limited to Load** modes enabled and the **Smart Load ON Batt** parameter set to 100% SoC, the Sol-Ark will begin powering the Smart Loads (in addition to all the home loads) when the batteries are at 100% SoC. If the Smart Load power draw exceeds 9.168 kW<sub>AC</sub>, (38.2 Amps at 240VAC), the batteries will then be operating beyond their maximum continuous power output capabilities. While the batteries have a maximum surge discharge capability of 60 Amps DC per battery (15.36 kW<sub>DC</sub> / 14.669 kW<sub>AC</sub> for the 5-battery bank), the batteries cannot surge at this power level for more than 10 minutes. A Smart Load drawing more than 9.168 kW<sub>AC</sub> for more than 10 minutes will very likely result in the batteries' SoC level reaching the **Smart Load OFF Batt** parameter, if it is set to 95%. However, feel free to reach out SimpliPhi Power Technical Support ([TechSupport@SimpliPhiPower.com](mailto:TechSupport@SimpliPhiPower.com)) if the Smart Load feature will be used and battery bank sizing clarification according to Smart Load-specific loads needs to be clarified.

Note that in a grid-connected system that utilizes the **Smart Load** feature, the Wattage value to the right of the **Smart Load ON Batt** parameter in the **Smart Load** menu tab (see Figure 5) represents the minimum power required of the solar PV array before the Smart Loads are powered. Therefore, that Solar PV Wattage value can be added to the battery bank's maximum output power rating when comparing maximum available solar and battery power available, against the Smart Load power draw: ***Smart Load Draw (kW) ≤ Solar PV (kW) + Battery Bank MAX Output Power (kW).***

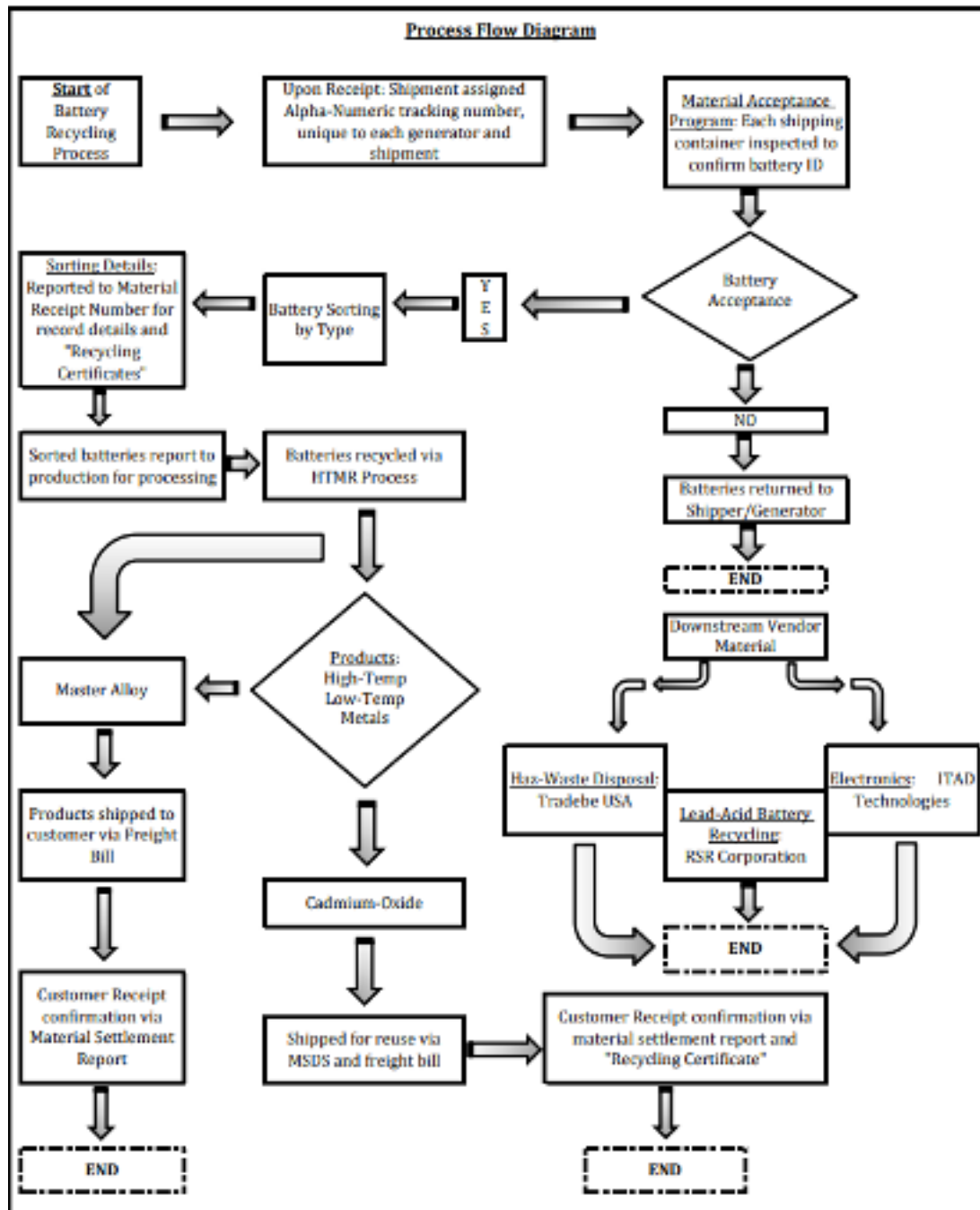


**CAUTION:** Smart Loads' maximum power draw cannot exceed the Generator Input breaker's 40 Amp / 240VAC rating.

## 6.0 – Battery Recycling

Our recycling company recycle majority of our battery parts, cells and support business and retail customers alike by keeping them in full compliance with federal, state, municipal, EPA and DOT regulations governing the recycling of waste batteries and select electronics.

By recycling LiFePo4 batteries, we reduce waste in our landfills, stop harmful chemicals from contaminating our soil and water, and preserve our environment by decreasing the need for new raw materials from the Earth.



# Appendix A: Sol-Ark WiFi Setup

## Sol-Ark-12K Manual Excerpt (pg. 19-22)

- a. WIFI (Via Cell Phone or computer)
  - i. Plug WIFI dongle into Sol-Ark
  - ii. Using your device look for WIFI networks and select the one that matches the PN number on your dongle(Example: EESW-D200-00)
    - Password: 12345678
  - iii. Once Connected to the Dongle
    - Follow this instruction on the following pages
  - iv. Note: Sol-Ark 12K is not compatible with wired ethernet connections for monitoring or updates, you must use the included WIFI dongle.

Once Setup is complete, Dongle will have a solid green LED and a solid Red light

### WiFi Setup Instructions

#### 1. Download the App:



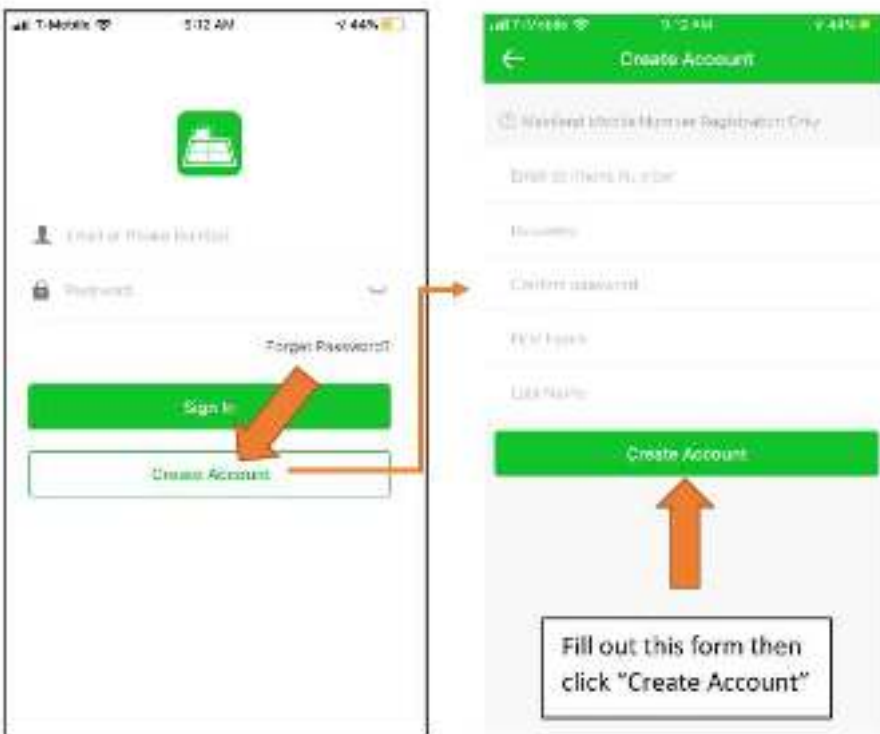
iPhone: <https://apps.apple.com/us/app/powerview-es/id1460941008>

Android: <https://esem.cc/login>

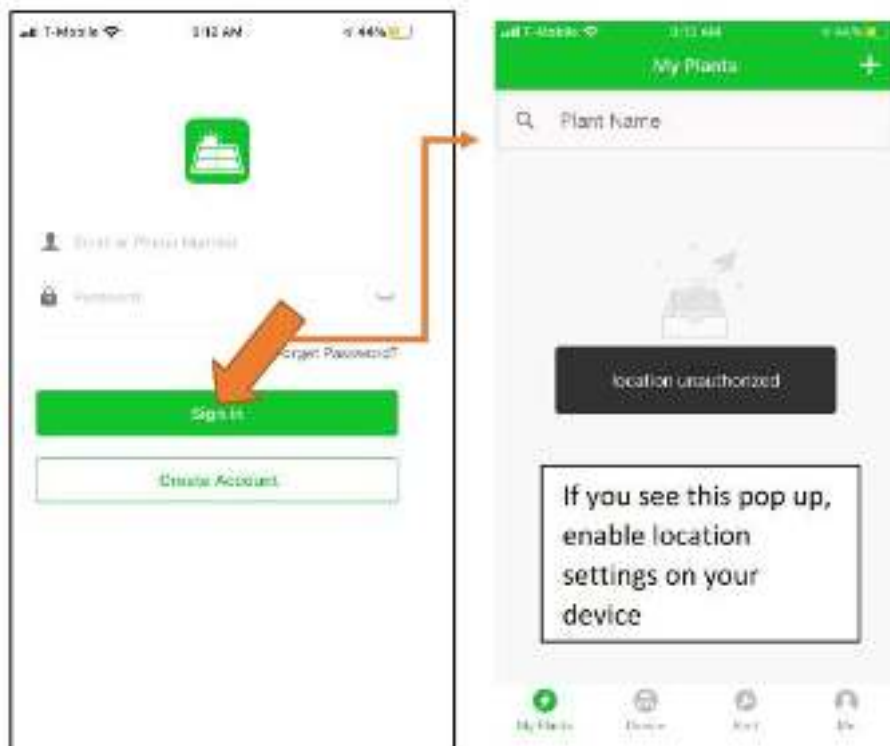
#### 2. Open App



### 3. Create an Account



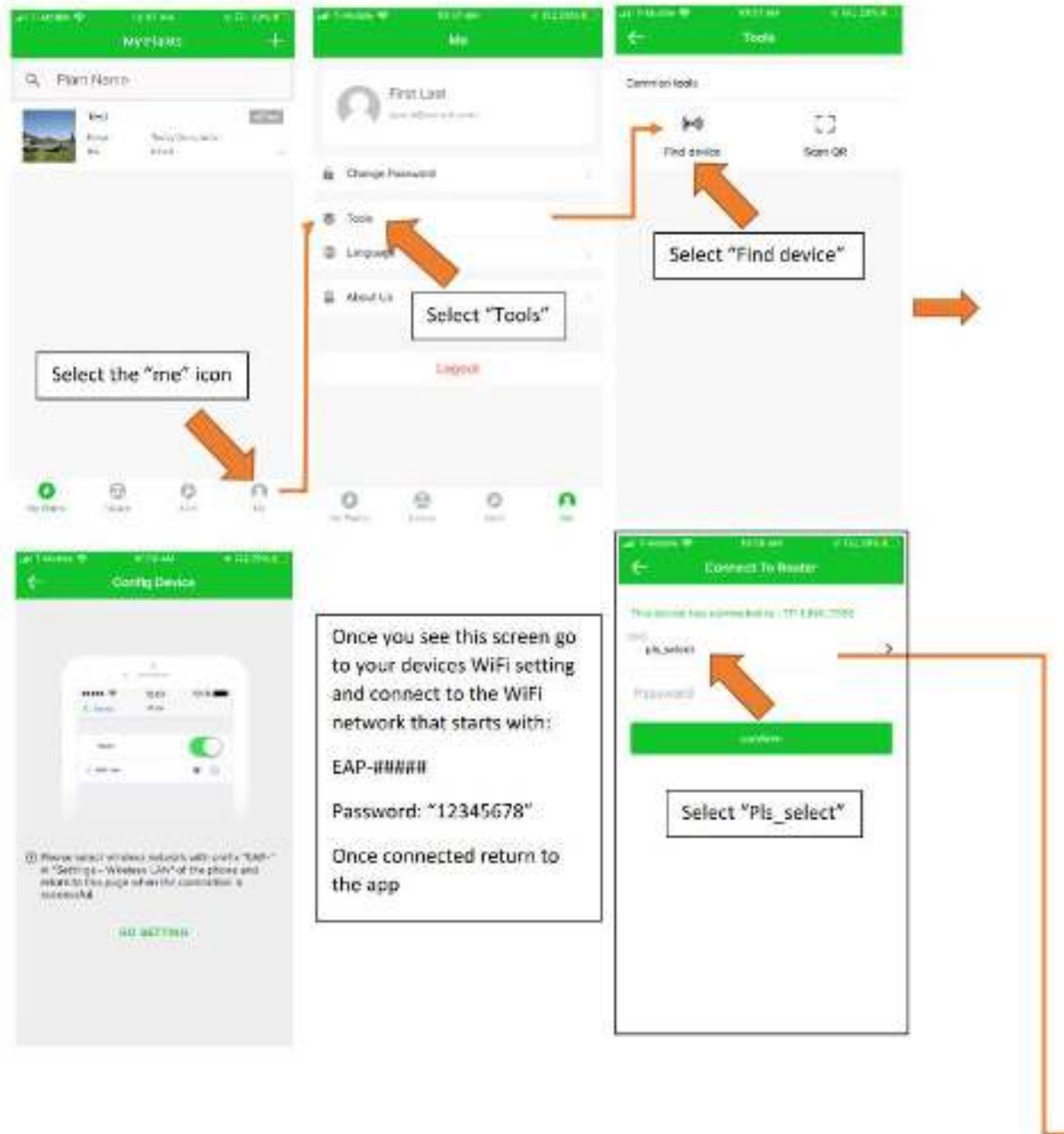
### 4. Sign in

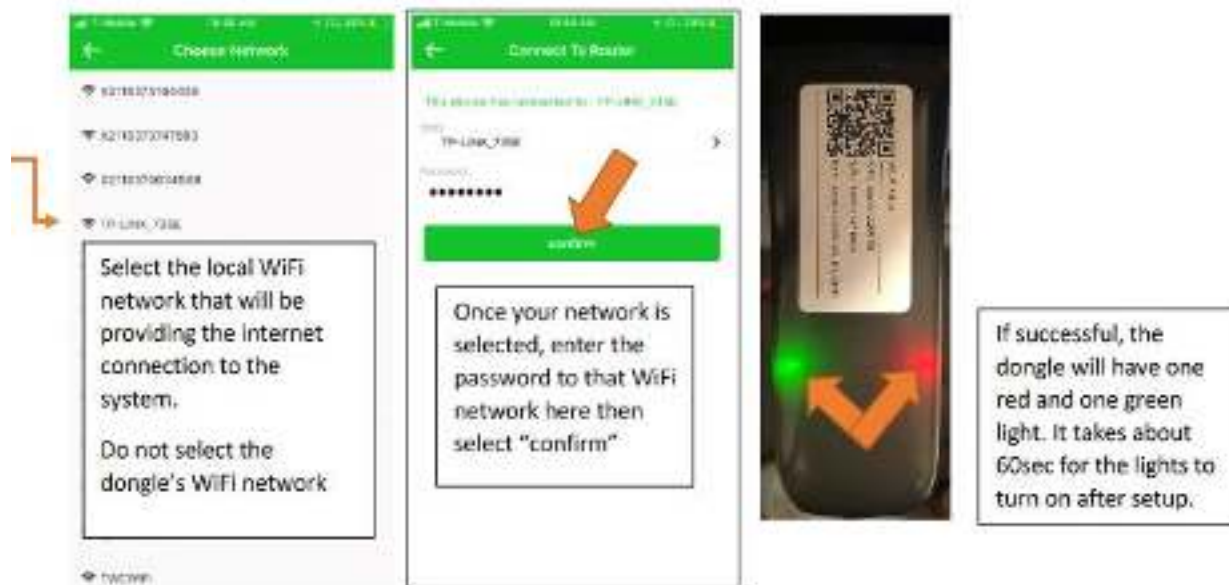




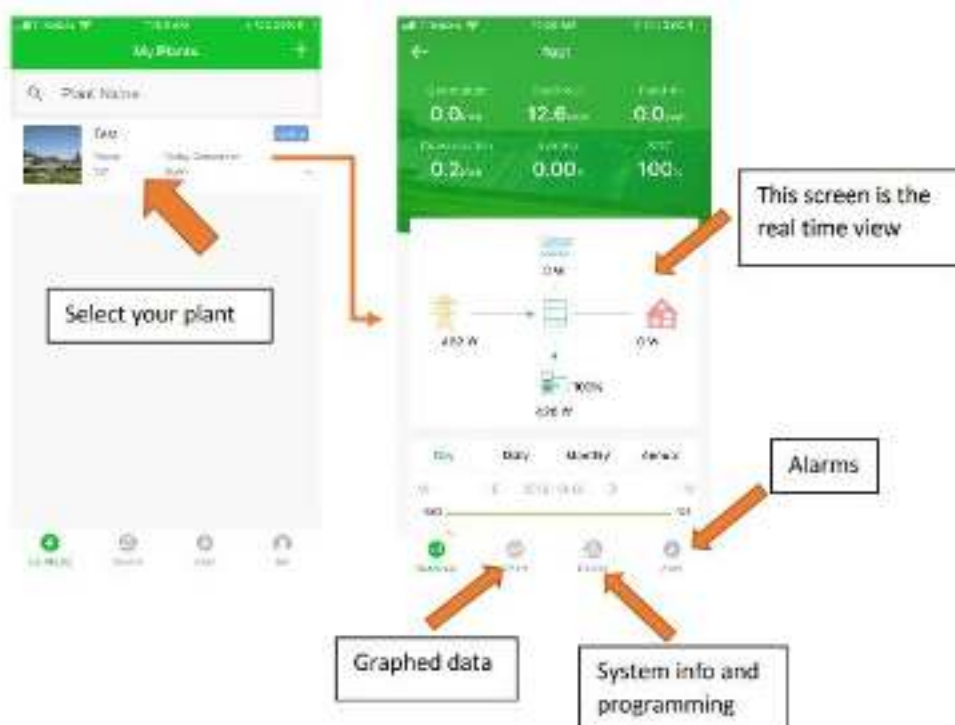


## 6. Connect your system to the internet



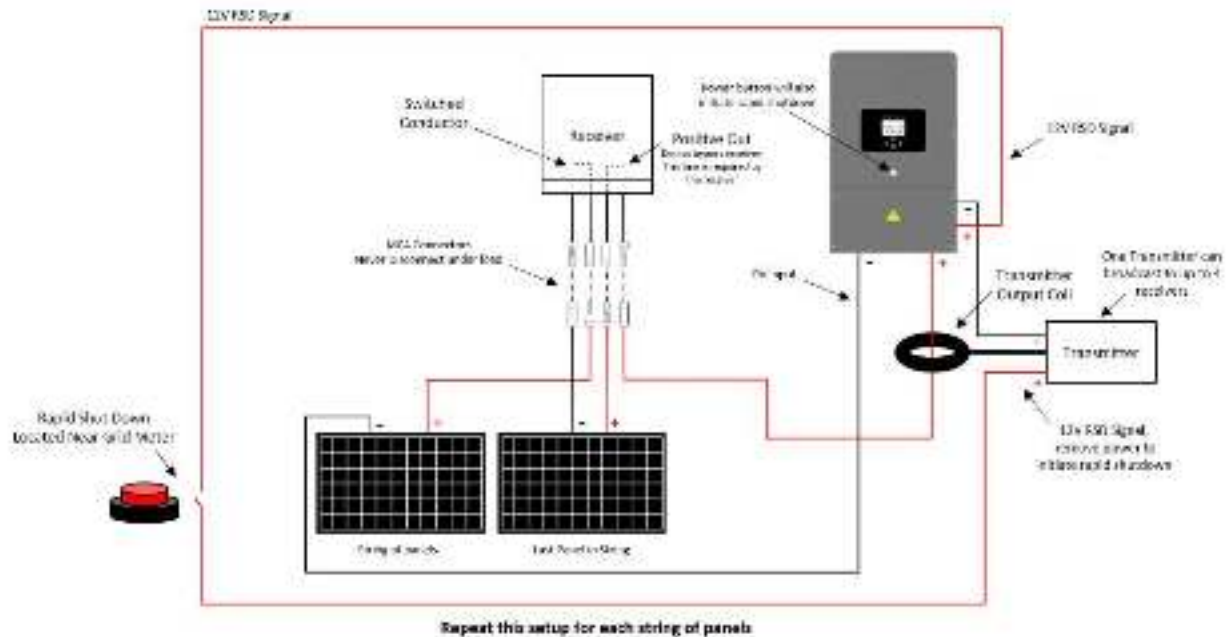


## 7. Start Monitoring



## Sol-Ark Manual Excerpt

**Rapid Shutdown Hardware Diagram (Midnight RSD per PV string)**

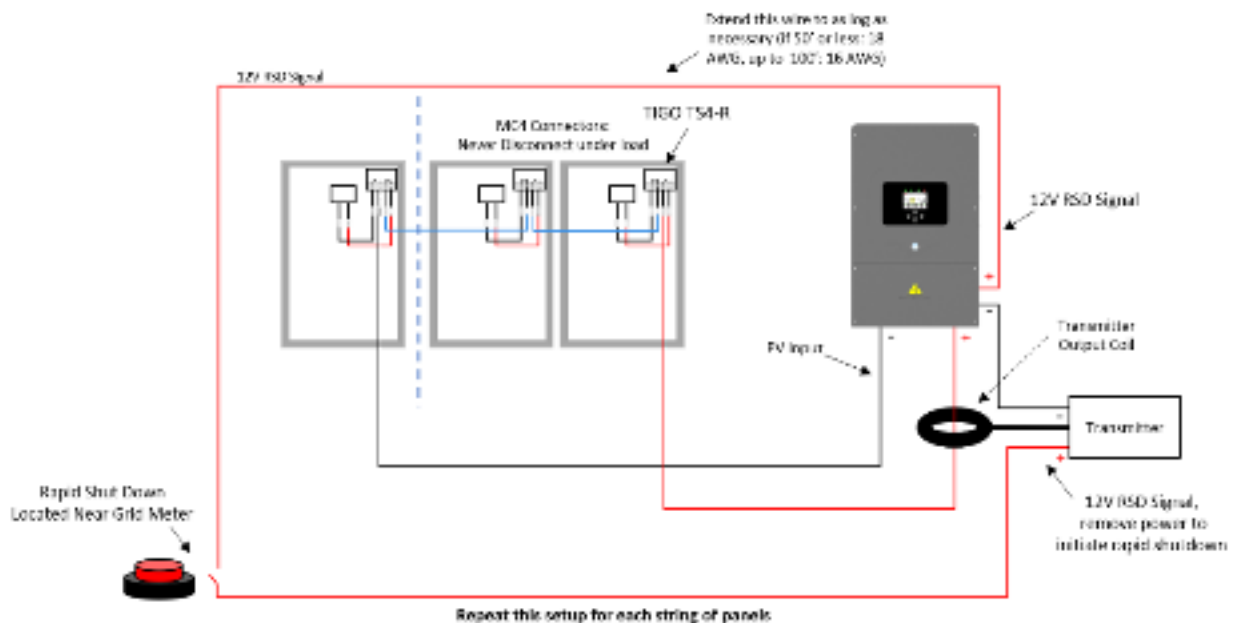


Note: If parallel systems: the RSD Signals for all systems must be in parallel and pass through the same RSD button

*Note: Transmitter fits inside the user area of the Sol-Ark 12K*

If String Level rapid shutdown is required for your install, each string of panels must have its own receiver module.

### Rapid Shutdown Hardware Diagram (TIGO RSD per PV Module)



# Compatibility Reference Guide

(This list is for reference only and is not exhaustive)

- Rapid Shutdown:
  - String Level
    - Midnite MNL50B-R1-600
  - Module Level
    - TIGO TS4-A-O
    - TIGO TS4-A-F
    - TIGO TS4-O
    - TIGO TS4-O-DUO
- Disconnect / Transfer Switches
  - 200A Non-Fused Transfer Switch Model # TC10324R (GE)
  - 200A Fused Transfer Switch Model #DG224NRK (Eaton)
- PV Fuses
  - 15A PV MC4 in-line fuse holder (ZOOKOTO or DPJ)