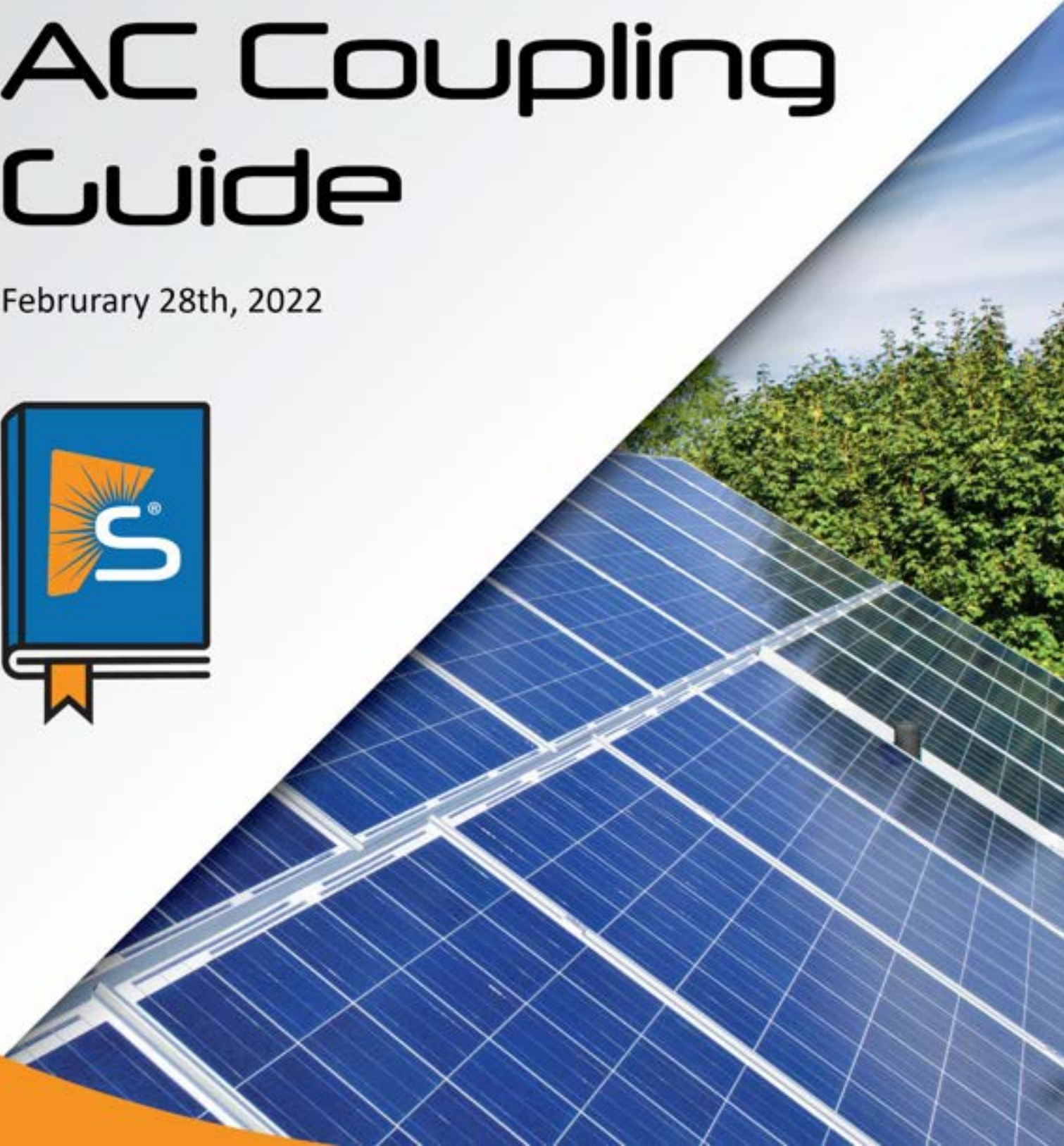




# AC Coupling Guide

February 28th, 2022



## Overview

AC coupling is the act of wiring solar panels into an AC coupled solution and then installing that solution into a few possible locations on your Sol-Ark inverter. AC coupled solutions include microinverters, string inverters, other battery-based inverters, and possibly even another Sol-Ark inverter. The AC coupled solution inverts DC power from the solar panels into 240V AC output which the Sol-Ark can use to charge batteries (after inverting back to DC), power loads, and sell to the grid (mandatory if grid is present).

DC coupling is the act of wiring solar panels directly into the Sol-Ark inverters' MPPTs. The Sol-Ark will pass through the DC power directly to the batteries as needed and invert any necessary DC power into AC to power loads and sell to the grid (only if programmed to do so).

## When Should I Consider Using AC Coupled Solutions?

The most common use case for AC coupling is retrofit applications. If microinverters, string inverters, or even another battery-based inverter is already installed in the home/business, it may be cheaper to keep that AC coupled solution than to install a new solar array or rewire the entire solar array so it can be DC coupled directly into the Sol-Ark.

If there is no existing system on the home/business, then we do not recommend AC coupling and instead, we recommend DC coupling the solar panels into the Sol-Ark inverters' MPPTs. These are a few reasons why DC coupling is recommended:

- **Greater Ability to Control Production** – Sol-Ark inverters cannot control the power of AC coupled solutions, the AC coupled power is either on and producing or totally off. If AC coupling in a grid down scenario, the Sol-Ark inverters must shut down AC coupled solutions when the batteries get near a full SOC%/V. However, if you are DC coupled instead, the Sol-Ark inverters can curtail PV production to match loads if the batteries become full, this way you can utilize as much solar power as possible.
- **Efficiency** - There are additional efficiency losses when using AC coupled power to charge your batteries (DC → AC → DC) and the additional losses will vary depending on the specific solution that you are using. If DC coupling into the Sol-Ark inverters' MPPTs, charging the batteries with solar power is 97.5% efficient (DC → DC).
- **Cost** – It is cheaper to DC couple solar panels into the Sol-Ark inverters' MPPTs as there is less hardware needed.

There exist a few situations where AC coupling may prove beneficial, here are a couple of reasons:

- **Increased Sell Power** – Sol-Ark inverters can sell more power to the grid if an AC coupled solution is present. For example, a 12K outdoor unit can normally only output 9kW of AC power from DC sources, but with AC coupling, the output raises up to 11kW. If you have a particularly beneficial net-metering agreement and would like to get the most credit possible, AC coupled solutions could help. We would recommend DC + AC coupling into your inverter in this situation (chart below) to get the benefits of DC coupling and AC coupling.
- **Solar Panel Production Monitoring** – Some AC coupled solutions can track individual/string level panel production which Sol-Ark inverters are not capable of by default. If you or the customer



would like this type of information AC coupled solutions could prove beneficial, but keep in mind that products like TIGO Optimizers (TS4-A-O) also have these benefits for a likely lower cost. Make sure to see what option is most cost-effective by checking with your distributor of choice.

- **Retrofit Applications** – As mentioned previously, retrofitting can save money depending on installation costs and allow the usage of older equipment. Not every existing system should be retrofit, so if you have any questions, let your installer or Sol-Ark technical support know to ensure you come to an informed decision.

## How Much AC Coupled Solar Can I Have?

The max AC coupled input on all Sol-Ark inverters is 9.6kW. This is a hard limit if you are AC coupling on the Gen Breaker and highly recommended to follow if you are trying to AC couple on the Load Breaker.

The max combined input with DC coupled panels on MPPTs and AC coupled input is listed below per inverter model:

**15K:** 17kW DC coupled + 19.2kW AC coupled = 36.2kW Total\*

**12K:** 13kW DC coupled + 3kW AC coupled = 16kW Total

**8K:** 11kW DC coupled + 4kW AC coupled = 15kW Total

**5K:** 6.5kW DC coupled + 5.5kW AC coupled = 12kW Total

*\*Subject to change*

## What Can I Use as an AC Coupled Power Source?

You can use several different inverters as AC Coupled sources for the Sol-Ark: string inverters, micro inverters, other battery-based inverters, and even another Sol-Ark.

Regardless of the inverter that is used, all need to be either UL 1741SA certified, or UL 1741 certified. This certification confirms the inverters' ability to disconnect from the grid based on frequency and shows that the Sol-Ark will safely be able to frequency shift to control the AC Coupled inverter's production. This ability to frequency shift is why the Sol-Ark is considered to be grid forming.

## Where Can I Connect My AC Coupled Power Source?

There are three options for where to connect AC coupled solutions to Sol-Ark inverters. AC coupling can tie into the Gen breaker, into the critical load panel connected to the Load breaker, or on the Grid side (aka main service panel).

### Gen Breaker (Recommended)

AC coupling on the Gen breaker will give Sol-Ark inverters monitoring capability of the AC coupled production (on outdoor models) and the most control over the AC coupled input from our Sol-Ark inverter, including accepting power from AC coupled solutions during grid outages.





## Load Breaker

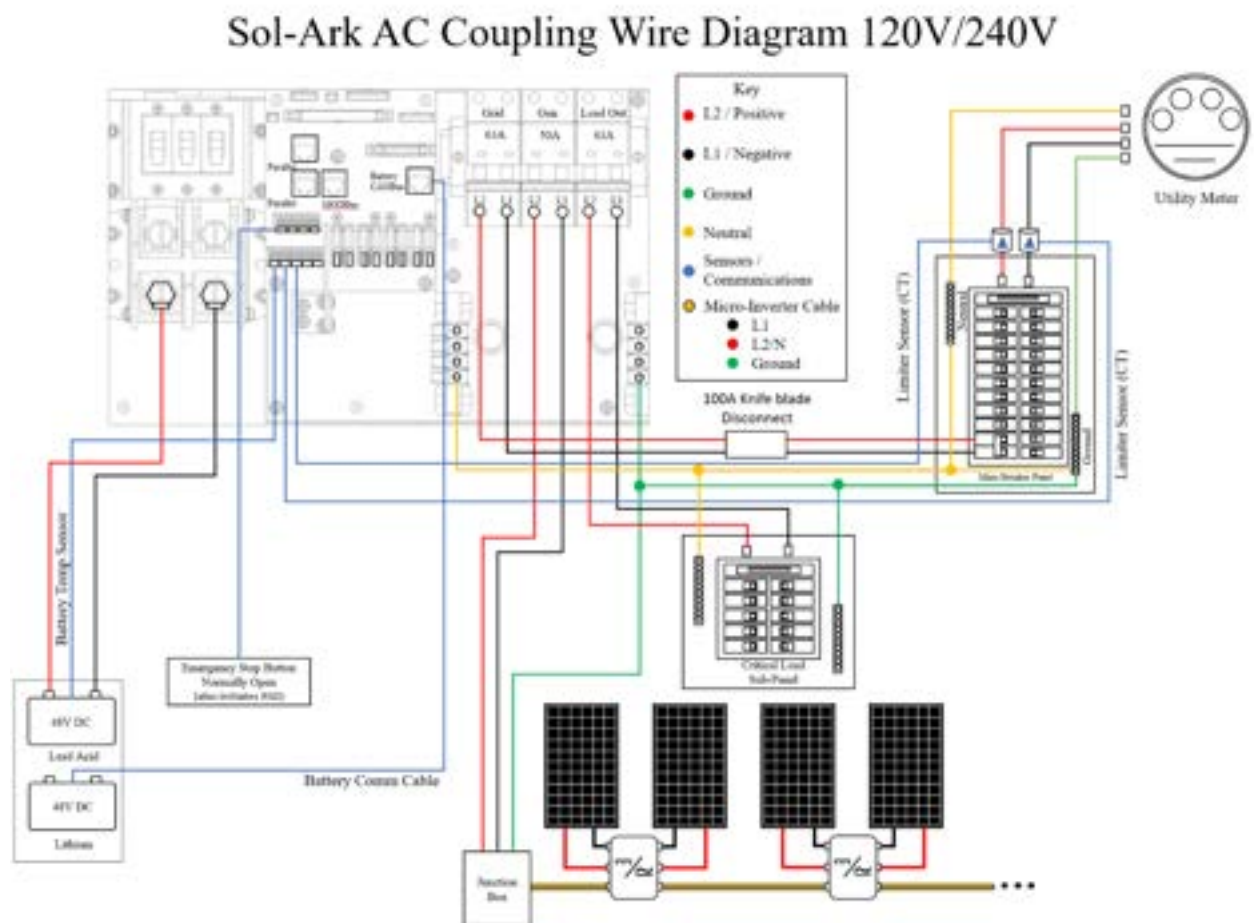
AC coupling on the Load breaker will not give Sol-Ark inverters the ability to monitor the total production of the AC coupled input but will still accept power from the AC coupled solution in the event of a grid outage. The Gen breaker cannot be used if AC coupled system is connected to the Load side of the Sol-Ark under any circumstance.

*If you AC couple on the Load breaker of the Sol-Ark inverter, 4ms transfer time is lost in the event of a grid failure. The new transfer time becomes 2 seconds to ensure that power from the AC coupled solution does not damage the batteries.*

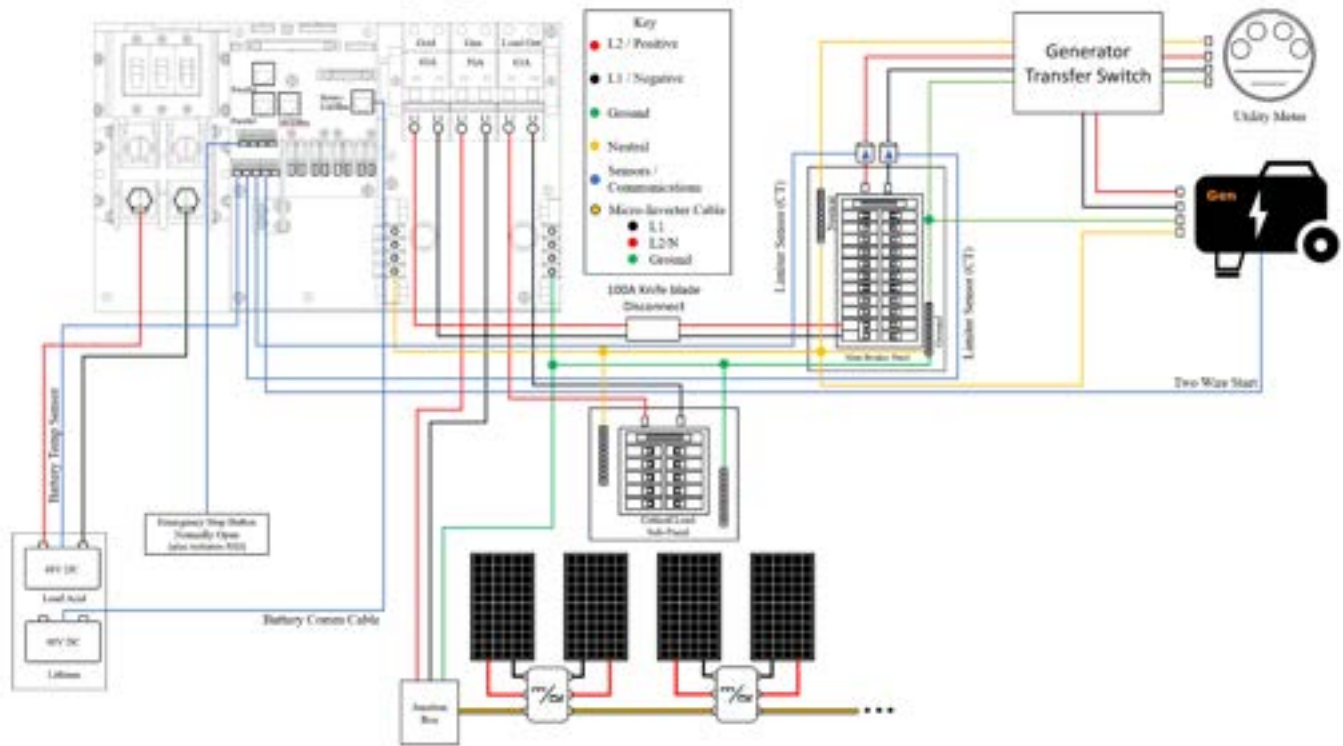
## Grid Side (Main Service Panel)

AC coupling on the Grid side means that the AC coupled system is independent of our Sol-Ark inverter. The AC coupled solution will produce as much as possible when the grid is available and push all the power back to the grid (except what is consumed by loads on the main service panel); **However, when the grid is down, the AC coupled system will shut down and will not be able to produce at all.**

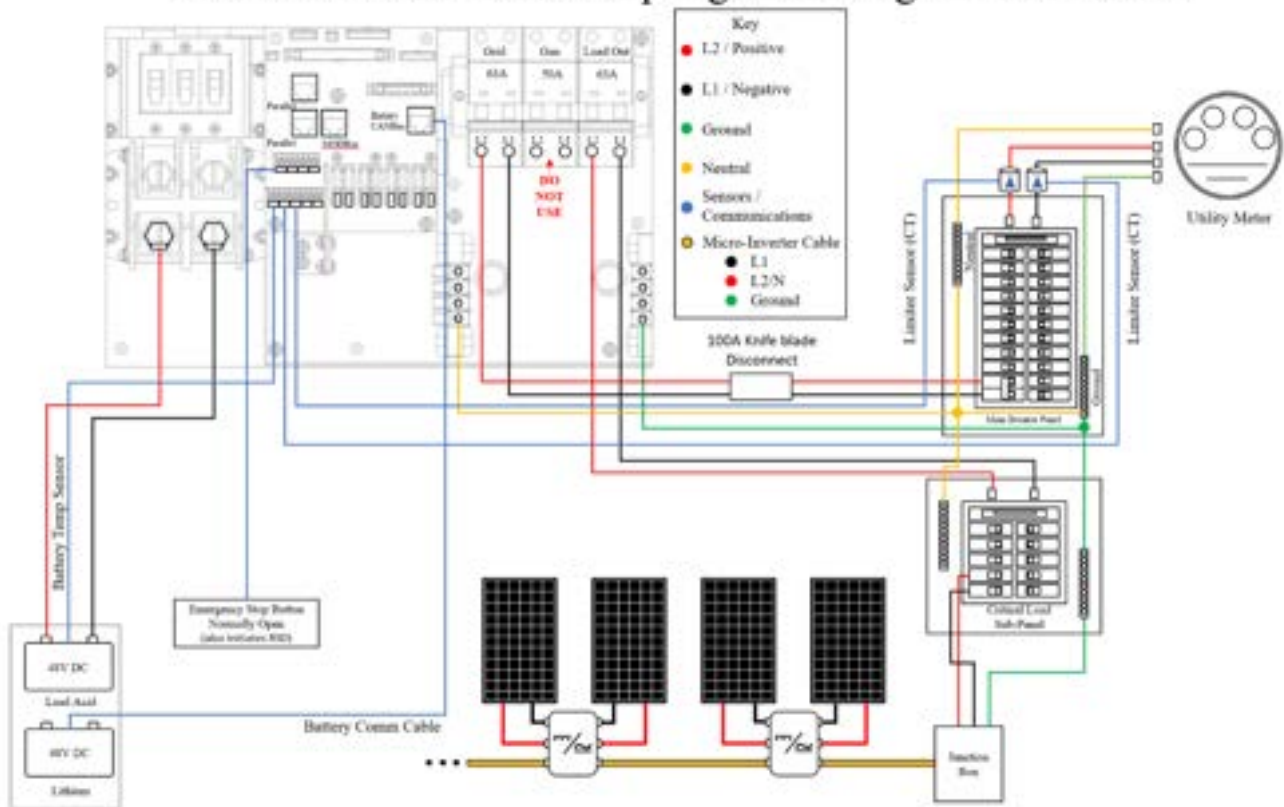
## How Do I Install AC Coupling Solutions into the Sol-Ark?



### Sol-Ark AC Coupling + Whole Home Generator Wire Diagram 120V/240V

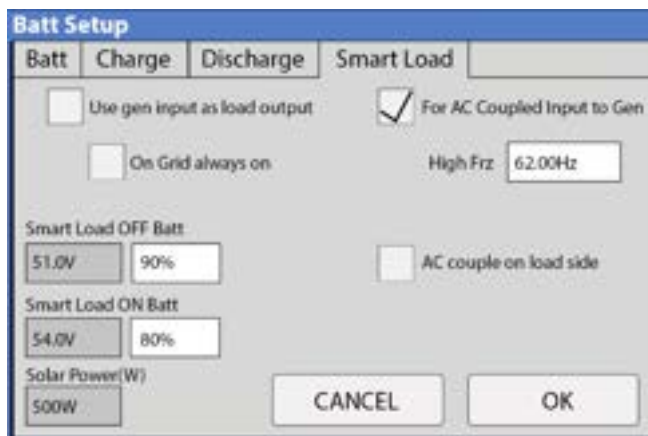


### Sol-Ark Load Side AC Coupling Wire Diagram 120V/240V



## How Do I Program for AC coupling on Grid Connected Systems?

### Battery Setup - Smart Load



Example setting for the Smart Load menu when AC coupling into the Gen breaker

#### For AC coupled input to Gen

This setting will tell Sol-Ark inverters to expect an AC coupled solution to be connected to the Gen breaker. When enabled, this setting also changes the meaning of the Smart Loads OFF/ON Batt (explained below).

#### AC couple on load side

This setting will tell Sol-Ark inverters to expect an AC coupled solution to be connected to the Load breaker. When enabled, this setting also changes the meaning of the Smart Loads OFF/ON Batt (explained below) and disables the use of the Gen breaker completely.

#### High Frz

This setting controls the frequency curtailment of the AC coupled input, or in other words, how high Sol-Ark inverters will raise the frequency when the Smart Load OFF Batt value is reached. If your AC coupled source is UL 1741SA certified, it is recommended to set this parameter to 62 Hz and if your AC coupled source is UL 1741 certified, it is recommended to set this parameter to 65 Hz.

#### Smart Load OFF/ON Batt

These settings no longer control the Smart Load function if either AC coupled input option is checked and they instead become setpoints for controlling the AC coupled solution in the event of a loss of grid power. When the grid power is lost, Sol-Ark inverters will enter off-grid mode which will shut down AC coupled input dependent on battery SOC or Voltage to prevent overcharging the battery.

With an AC coupled input setting selected, the **Smart Load OFF Batt** value becomes the setpoint for AC coupled input to turn off in the event of a loss of grid to prevent overcharging the battery. The **Smart**

**Load ON Batt** value becomes the setpoint for AC coupled input to turn on the AC coupled solution to power the load and charge the batteries.

It is recommended to set the “Smart Load ON Batt” to 60%-70% SOC or equivalent battery voltage and set the “Smart Load OFF Batt” to 80%-90% SOC or equivalent battery voltage.

**NEVER** set **Smart Load OFF Batt** to be lower than **Smart Load ON Batt**. This will confuse the Sol-Ark and will likely damage the batteries in a loss of grid event.

### When AC Coupling on the Gen breaker:

- Select **For AC Coupled Input to Gen**
- Uncheck **Use gen input as load output** and **On Grid always on**.
- Set the **Smart Load OFF Batt** value to between 80 – 90% (SOC) or equivalent voltage (if in Batt-V mode).
- Set the **Smart Load ON Batt** value to between 60 – 70% (SOC) or equivalent voltage (if in Batt-V mode).

### When AC Coupling on the Load breaker (sub panel):

- Select **AC couple on load side**
- Uncheck **Use gen input as load output** and **On Grid always on**.
- Set the **Smart Load OFF Batt** value to between 80 – 90% (SOC) or equivalent voltage (if in Batt-V mode).
- Set the **Smart Load ON Batt** value to between 60 – 70% (SOC) or equivalent voltage (if in Batt-V mode).

### When AC Coupling on the Grid side:

- You do not need to setup AC coupling settings on the Sol-Ark as the AC coupled solution is independent and no interaction is needed.

## Grid Setup - Limiter

When a system is on-grid with an AC coupled input (**NOT on the Grid side**), the Sol-Ark needs the Grid Sell option enabled. This means the system is either on Grid Sell only mode or in Limited to Load / Limited to Home with solar sell enabled.

Grid Param						
Limiter	Sell Control	Grid Input	FreqVolt	PowFac		
		Time	Power(W)	Batt	Charge	Sell
<input checked="" type="checkbox"/>	Grid Sell 09000	01:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Limited Power to Home	05:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Limited Power to Load	09:00AM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Time of Use <input type="button" value="Setup"/>	01:00PM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
		05:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
		09:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="button" value="CANCEL"/>		<input type="button" value="OK"/>				

Grid sell must be enabled - Limited Power to Home/Load and Time of Use are optional



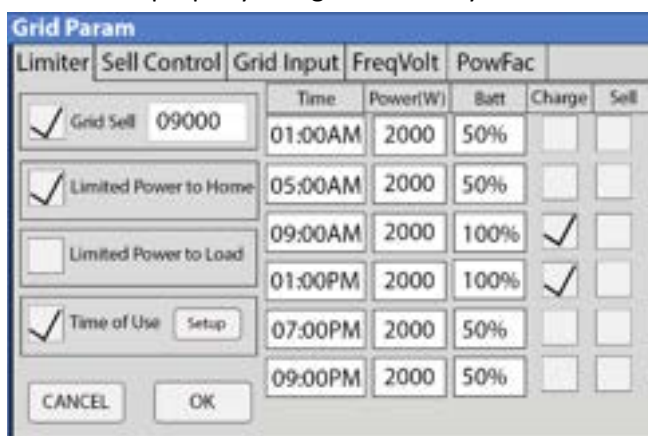


When the grid is available and connected to the Sol-Ark inverter, the AC coupled input will produce as much as possible. Part of the AC coupled input power will cover the loads, charge the battery, and the any excess will be sold back to the grid.

## Grid Setup – Limiter – Time of Use

If you are utilizing AC coupled solutions and want to use the Time of Use function on Sol-Ark inverters, there is special guidance needed to properly allow the AC coupled solution to power loads and charge the battery correctly.

It is highly Recommended to use **Limited Power to Home** and to install the CT sensors that came included with the Sol-Ark inverter to properly charge the battery.



Grid Param	Time	Power(W)	Batt	Charge	Sell
<input checked="" type="checkbox"/> Grid Sell 09000	01:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Limited Power to Home	05:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Limited Power to Load	09:00AM	2000	100%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Time of Use Setup	01:00PM	2000	100%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	07:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
	09:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>

*In this example, the AC coupled panels are being told to charge the batteries between 9:00 AM and 7:00 PM until the batteries reach 100% SOC.*

To charge the battery using AC coupled solutions with Time of Use enabled, the “Charge” boxes in the above screen need to be checked at the desired time slots in order to charge the battery using an AC power source (i.e., Grid or AC coupled input). However, to avoid charging from the grid under this configuration, please make sure the “Grid Charge” box under “Batt Setup” menu “Charge” tab is NOT checked.

## How Do I Integrate a Generator with My AC Coupled Input?

When a system has both AC coupled solutions and a backup generator the AC coupled solutions have to be connected to the Gen breaker and the generator has to be connected to the grid breaker. To connect the generator to the grid breaker you may need an ATS in conjunction with the grid.

Keep in mind that only the AC coupled solution, or the generator can be connected to the Sol-Ark inverter at any given time. There are built in relays in Sol-Ark inverters allowing only one AC source to be present at any given time to ensure the safety of the generator.



## How Do I AC Couple If I'm Off-Grid?

It is **NOT** recommended to have only AC coupled inputs in an off-grid situation. It would be beneficial to DC couple solar panels directly into our MPPTs as the Sol-Ark inverter will have better control over the production of DC coupled PV power. Gen breaker or subpanel AC coupling will work in the same way that the AC coupled solutions behave in a loss of grid scenario.

In order for dark start capabilities to work properly, please set “batt setup” option “Discharge” tab and “Shutdown” value to around 20% SOC or 20% SOC equivalent voltage to preserve enough battery power to dark start the inverter when solar become available the next morning.

## AC Coupling with Parallel Stack Sol-Ark system

When AC coupling with multiple parallel Sol-Ark installs, make sure the AC coupled input is tied to all of the parallel Sol-Ark inverters either on the Gen breakers or on the load panel.

Author / Editor	Changelog	Version	Latest Software Version Upon Release
Fernando & Vincent	Initial Creation	1.0	MCU XX10    COMM 1430

