

# Multi-System Installs

How to Stack Sol-Ark 12K Systems for More Power

By Dylan Hillman



- Mission:
  - A Veteran owned engineering company dedicated to helping families be less dependent on our vulnerable Power Grid in an affordable way
- No customer returns in 7 years of business
- Sol-Ark 8K/12K: most efficient & affordable Solar Storage inverter in the world



U.S. DEPARTMENT OF ENERGY  
**2020 Semi-Finalist**



**S&P GLOBAL PLATTS**  
GLOBAL ENERGY AWARDS  
2018 FINALIST



# Agenda

- Welcome
- Why Stack Systems?
- Master Slave Assignment
- Wire Diagrams
- Programming
- FAQs Support gets about Paralleling
- How to buy
- Q&A





# Why Stack?

- More Solar Panels
- More Power
- Back up the whole house
- True 3 phase 208V battery backup

# Stacking @ 120V/240V

- 1-8 12Ks
- Continuous power stacks linearly
- Peak power per system when stacked:
  - 2 systems = 18KWpk (36kWpk total)
  - 4 = 16KWpk (64kWpk total)
  - 6 = 14KWpk (84kWpk total)
  - 8 = 12KWpk (96kWpk total)



# Stacking @ 120V/240V

|   | <b>Continuous On Grid (kW)</b> | <b>Continuous Off Grid (kW)</b> | <b>Pass Through (kW)</b> | <b>Peak 5sec (kW)</b> |
|---|--------------------------------|---------------------------------|--------------------------|-----------------------|
| 1 | 9                              | 8                               | 12                       | 20                    |
| 2 | 18                             | 16                              | 24                       | 36                    |
| 3 | 27                             | 24                              | 36                       | 51                    |
| 4 | 36                             | 32                              | 48                       | 64                    |
| 5 | 45                             | 40                              | 60                       | 75                    |
| 6 | 54                             | 48                              | 72                       | 84                    |
| 7 | 63                             | 56                              | 84                       | 91                    |
| 8 | 72                             | 64                              | 96                       | 96                    |

# Master Slave Assignment @ 120V/240V



Modbus Address = 1-8  
(cannot skip numbers)

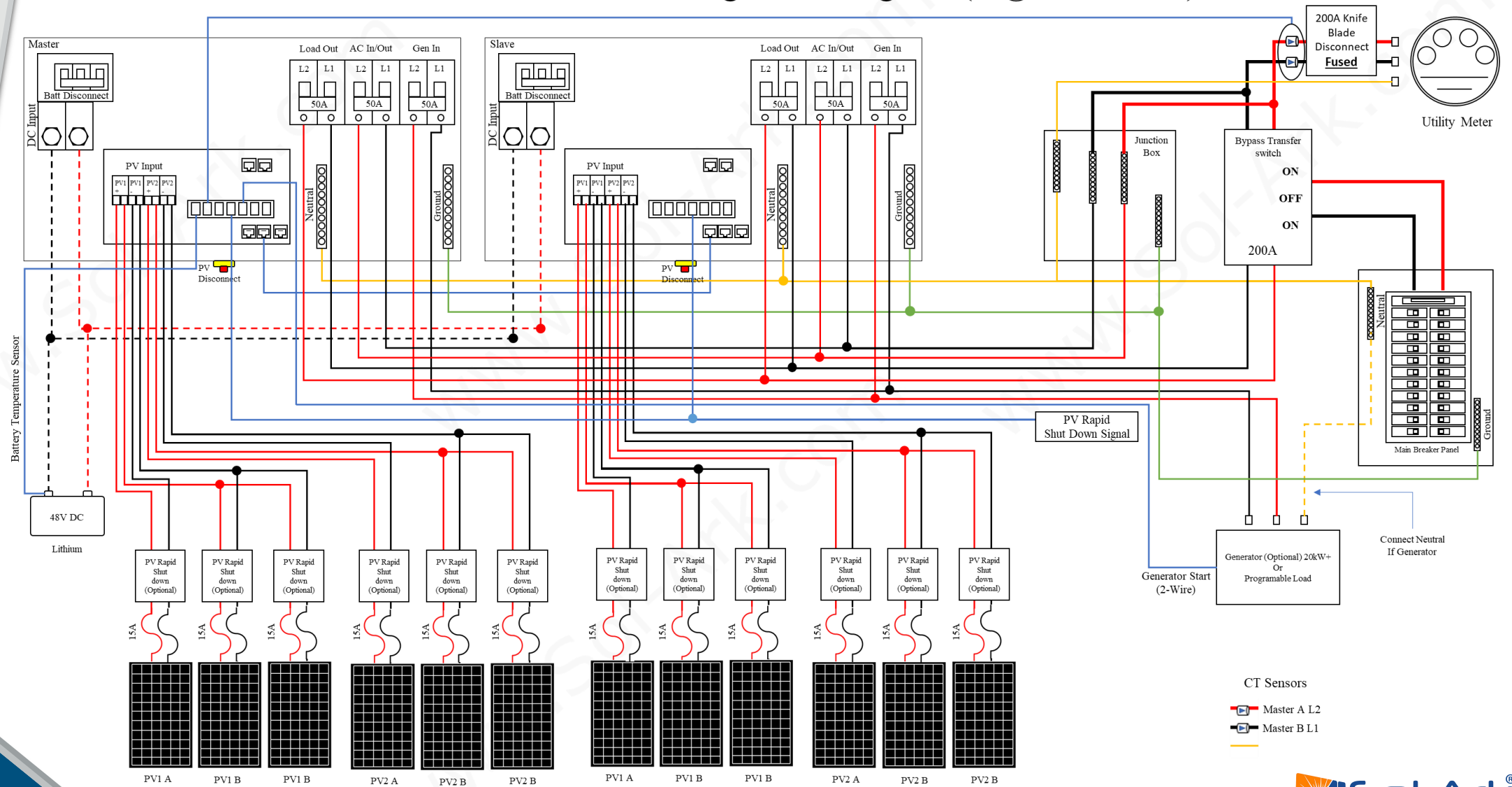


= Master



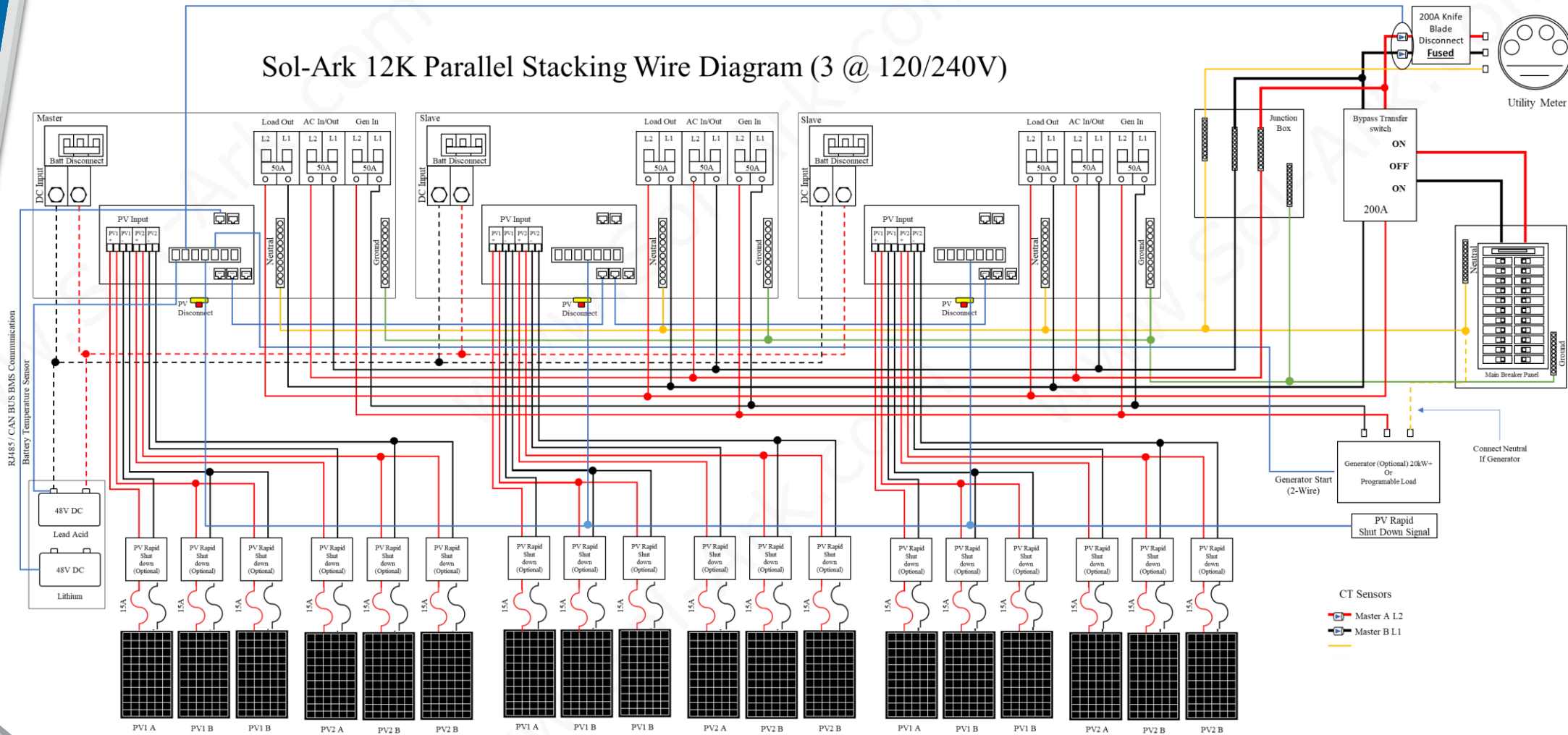
= Slave

# Sol-Ark 12K Parallel Stacking Wire Diagram (2 @ 120/240V)





# Sol-Ark 12K Parallel Stacking Wire Diagram (3 @ 120/240V)



# Stacking @ 120V/208V

- 1\*,2,3,6,9 12Ks
- Continuous power stacks linearly
- Peak power per system when stacked:
  - 2 systems = 18KWpk (36kWpk total)
  - 4 = 16KWpk (64kWpk total)
  - 6 = 14KWpk (84kWpk total)
  - 8 = 12KWpk (96kWpk total)



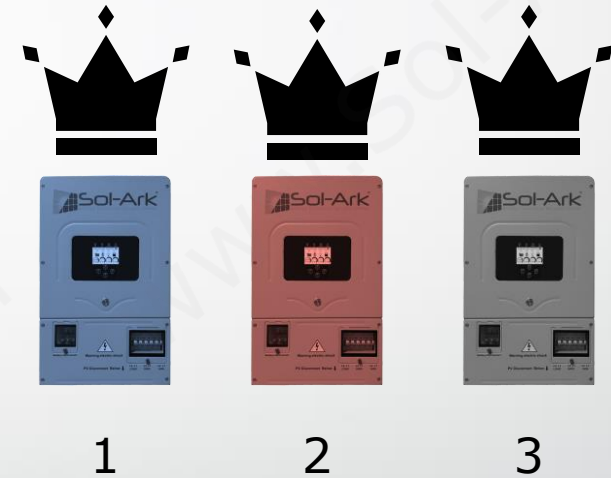
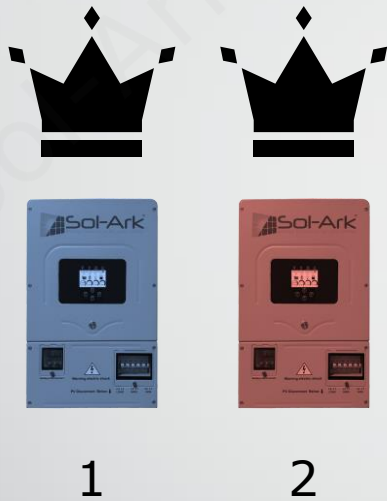
# Stacking @ 120V/208V

|     | Continuous On Grid (kW) | Continuous Off Grid (kW) | Pass Through (kW) | Peak 5sec (kW) |
|-----|-------------------------|--------------------------|-------------------|----------------|
| 1*  | 9                       | 8                        | 12                | 20             |
| 2** | 18                      | 16                       | 24                | 36             |
| 3   | 27                      | 24                       | 36                | 51             |
| 4   | NA                      | NA                       | NA                | NA             |
| 5   | NA                      | NA                       | NA                | NA             |
| 6   | 54                      | 48                       | 72                | 84             |
| 7   | NA                      | NA                       | NA                | NA             |
| 8   | NA                      | NA                       | NA                | NA             |
| 9   | 81                      | 72                       | 108               | 108            |

\* 2 legs only

\*\*3 legs but some unbalanced (4.8KW/4.8KW/8.4KW)

# Master Slave Assignment @ 120V/208V



Modbus Address = 1-2 or 1-3

Phase: A B C



= Master



= Slave

CT Sensors: 2 on Master A and 1 on Master B (L2)  
(Auto-learn CT's only does direction, not line)

# Master Slave Assignment @ 120V/208V



Modbus Address = 1-6

Phase: A B C

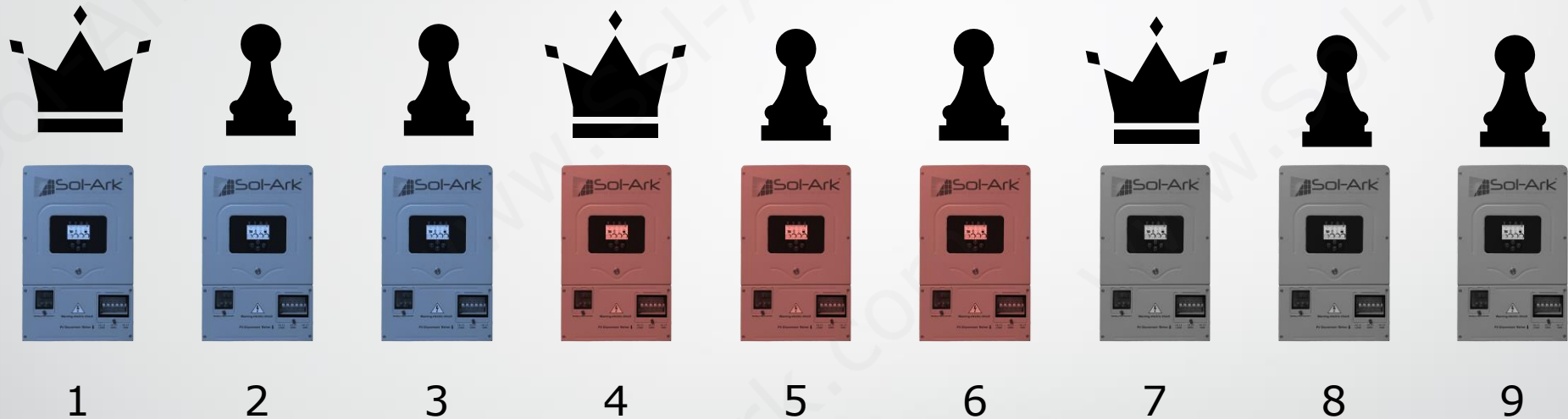


= Master



= Slave

# Master Slave Assignment @ 120V/208V



Modbus Address = 1-9

Phase: A B C

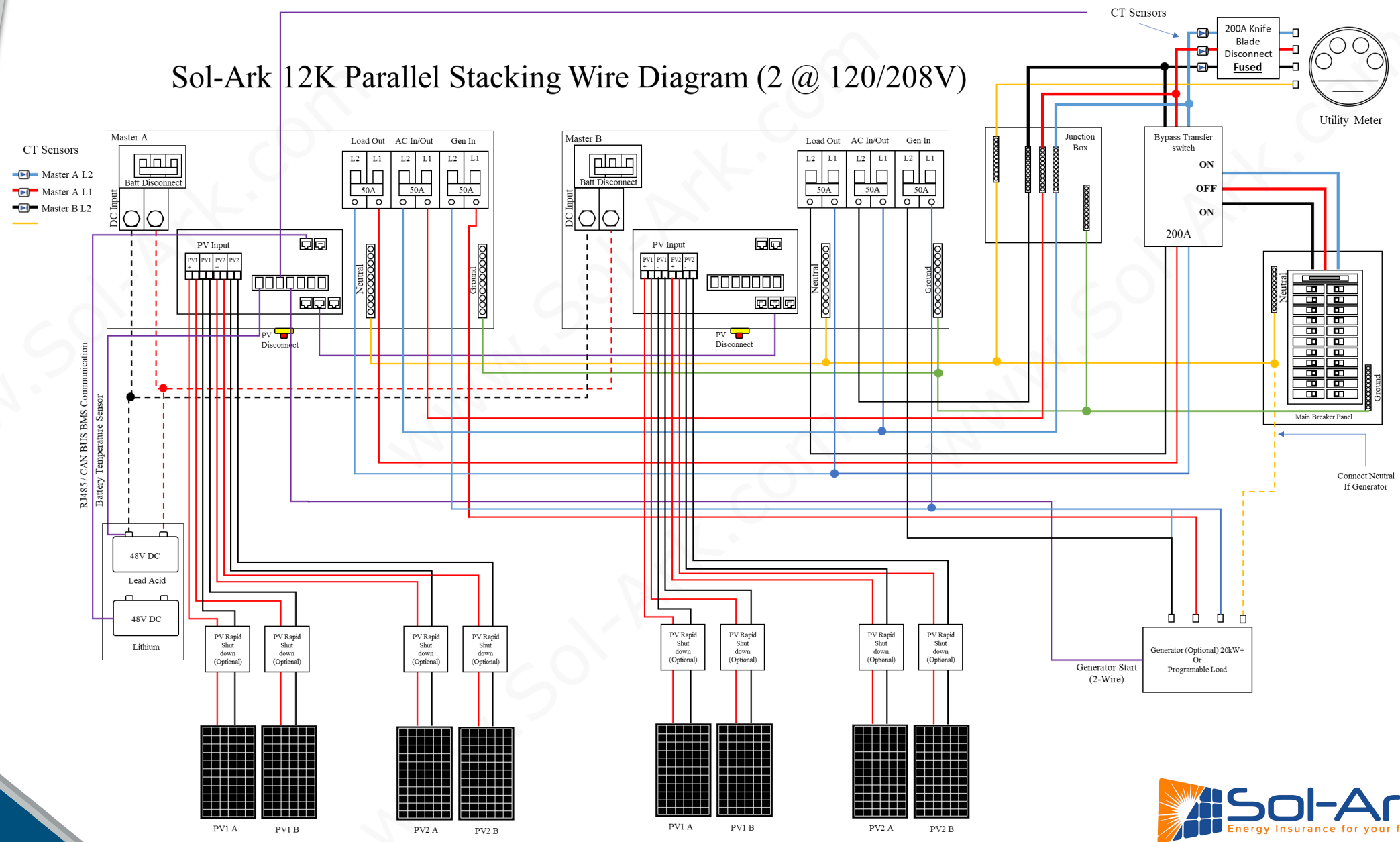


= Master

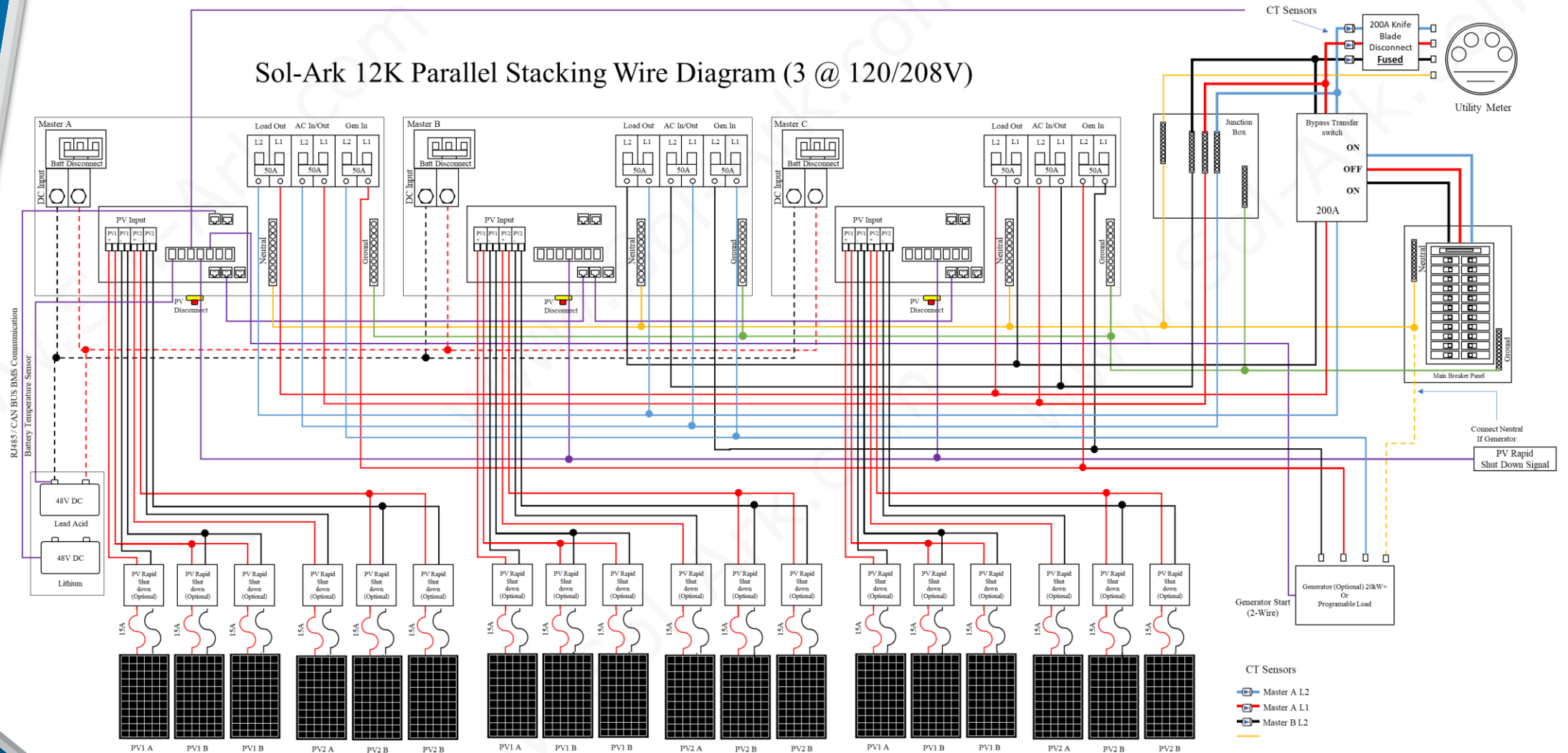


= Slave

# Sol-Ark 12K Parallel Stacking Wire Diagram (2 @ 120/208V)



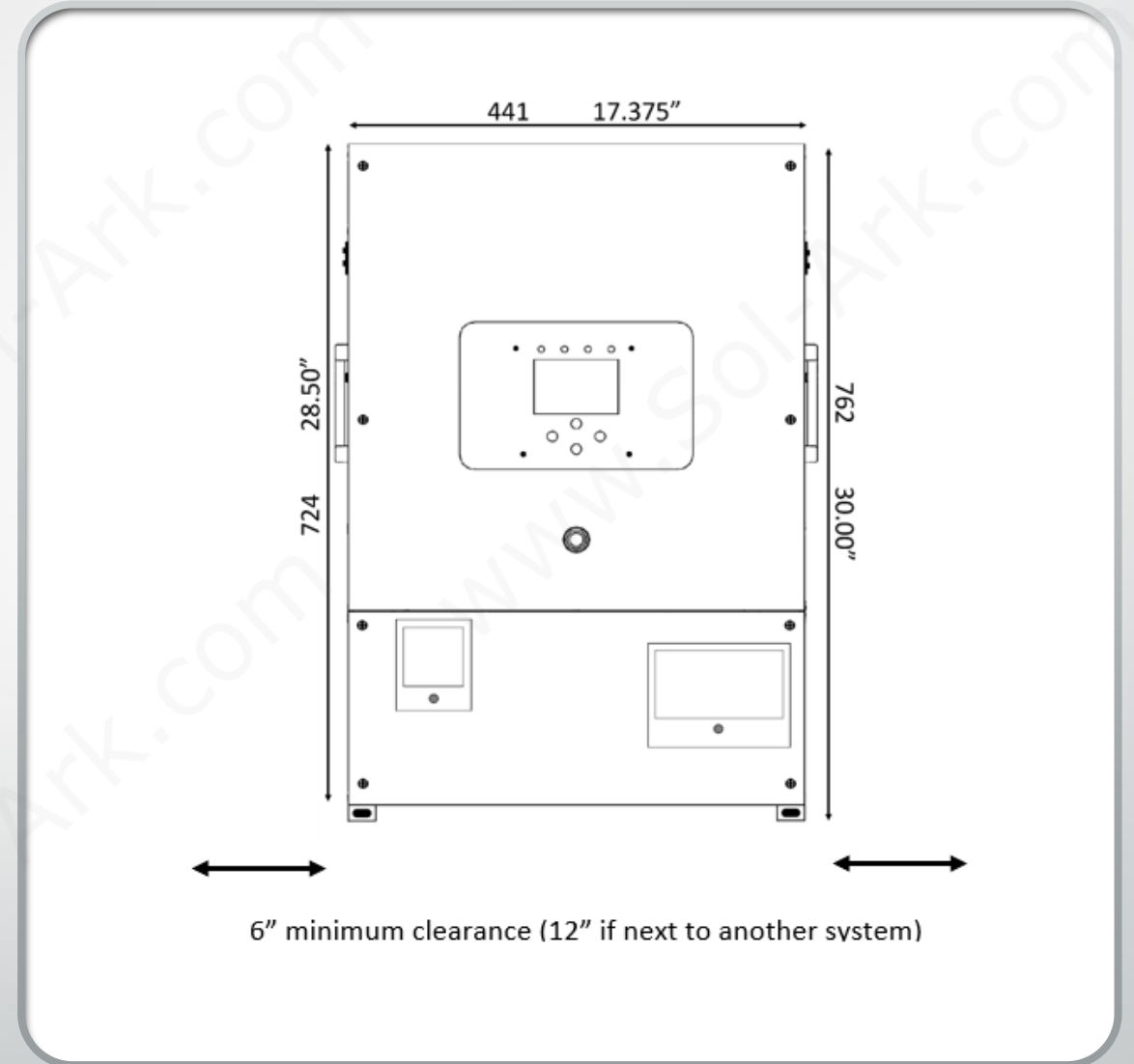
# Sol-Ark 12K Parallel Stacking Wire Diagram (3 @ 120/208V)





# System Layout

- 12" minimum distance between systems
- Indoor Installs Only



## Solar Panels & Stacked Systems

- AC Coupling
  - 9.6kW per system on Load side
  - 7.6kW per system on Gen side
- DC Coupling
  - 16.5kW per system
  - 500V @ 18A / 450V @ 20A



# Large System Tips

- Blue board 4ms
  - Replaceable relays
- Generators must be connected to all systems in parallel in the same way
- Bus Bars for battery bank
  - Parallel connectors need to be able to accommodate max discharge
- Joining of Lines
  - AC distribution panel / junction boxes / Multitap



# How many Batteries do you need given your loads and system count?

- Minimum battery for max inverter output
  - 200Ah @ 48V & 1C (some lithium batteries)
  - 400Ah @ 48V & 0.5C (most chemistries can manage this)
- Minimum battery for off-grid operation
  - 50Ah @ 48V Per system
- Maximum battery size
  - 9900Ah @ 48V Total

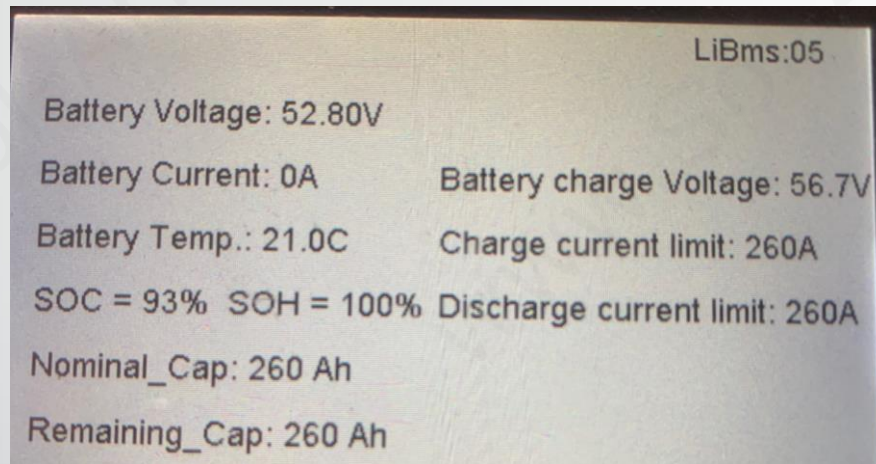


# How to program the Sol-Arks for your battery bank

- Batt Capacity: Ah of your battery bank (Master A Only)
  - = Ah of each string of batteries in parallel
  - Set as the whole bank on Master
- Max A Charge (Divide between systems)
  - = what the spec sheet for your battery says
- Max A Discharge (Divide between systems)
  - = what the spec sheet for your battery says
- Tempco (Master A Only)
  - = -5mV/C/Cell for lead acid batteries, 0 for lithium

| Batt Setup                            |             |                                   |  |
|---------------------------------------|-------------|-----------------------------------|--|
| Batt                                  | Charge      | Discharge                         | Smart Load   |
| Batt Capacity                         | 400Ah       |                                   | <input type="checkbox"/> Use Batt V charged            |
| Max A Charge                          | 40A         |                                   | <input checked="" type="checkbox"/> Use Batt % Charged |
| Max A discharge                       | 60A         |                                   | <input type="checkbox"/> No Battery                    |
| TEMPCO                                | -5mV/C/Cell |                                   | <input type="checkbox"/> BMS Lithium Batt 01           |
|                                       |             |                                   | <input checked="" type="checkbox"/> Activate Battery   |
| <input type="button" value="CANCEL"/> |             | <input type="button" value="OK"/> |  |

# Battery Comms: Let the Battery Program the Sol-Ark



**Batt Setup**

| Batt            | Charge     | Discharge | Smart Load                          |                    |
|-----------------|------------|-----------|-------------------------------------|--------------------|
| Batt Capacity   | 260Ah      |           | <input type="checkbox"/>            | Use Batt V charged |
| Max A Charge    | 185A       |           | <input checked="" type="checkbox"/> | Use Batt % Charged |
| Max A discharge | 185A       |           | <input type="checkbox"/>            | No Battery         |
| TEMPCO          | 0mV/C/Cell |           | <input checked="" type="checkbox"/> | BMS Lithium Batt 0 |
|                 |            |           | <input checked="" type="checkbox"/> | Activate Battery   |

CANCEL OK

**Batt Setup**

| Batt    | Charge                              | Discharge                                       | Smart Load     |           |
|---------|-------------------------------------|---|----------------|-----------|
| Start V | 49.0V                               | 49.0V   | Float V        | 56.7V     |
| Start % | 30%                                 | 30%   | Absorption V   | 56.7V     |
| A       | 40A                                 | 60A   | Equalization V | 56.7V     |
|         | <input type="checkbox"/> Gen Charge | <input checked="" type="checkbox"/> Grid Charge |                | 90 days   |
|         |                                     |   |                | 2.0 hours |

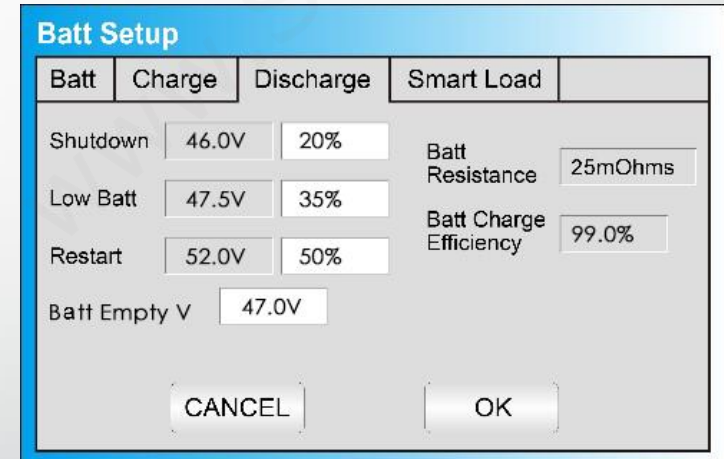
CANCEL OK

- Dynamic Values from BMS: (Master A Only)
  - Charge Voltage, Max Charge Amps, Max Discharge Amps, Temp, SOC.
  - Divides Max Amps per parallel inverter automatically
  - System uses lower of programmed Max Amp Charge/Discharge
- May: Discover & Blue Ion, July: Fortress

# How to program the Sol-Ark for your battery bank

## Continued

- Shutdown V / % (Master A)
  - When the inverter stops AC output
- Low Batt (Master A)
  - Highlights battery icon in yellow
- Restart (Master A)
  - When AC output resumes is shutdown happened
- Batt Resistance (Master A)
  - Accounts for voltage drop under load
- Batt Charge Efficiency (Master A)
  - Depends on type of battery, LFP and Carbon AGM are usually 99%
- Master #1 copies settings to parallel inverters



The screenshot shows the 'Batt Setup' menu with the following settings:

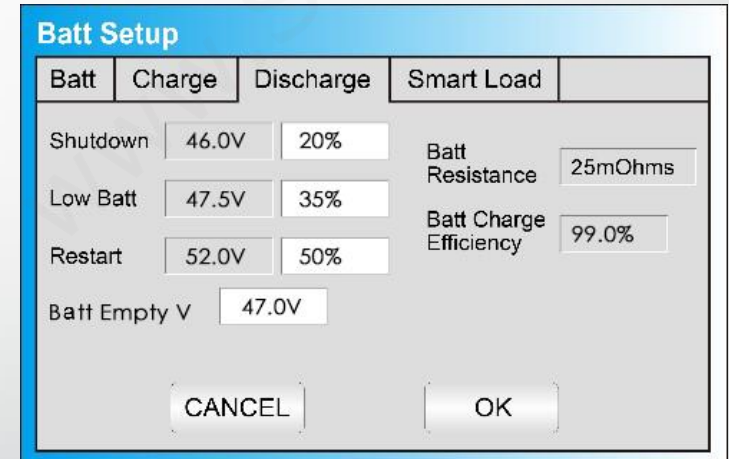
| Batt         | Charge | Discharge | Smart Load |                              |
|--------------|--------|-----------|------------|------------------------------|
| Shutdown     | 46.0V  | 20%       |            | Batt Resistance 25mOhms      |
| Low Batt     | 47.5V  | 35%       |            | Batt Charge Efficiency 99.0% |
| Restart      | 52.0V  | 50%       |            |                              |
| Batt Empty V | 47.0V  |           |            |                              |

Buttons: CANCEL, OK

# How to program the Sol-Ark for your battery bank

Continued

- Batt Empty V (Master A only)
  - Used to prevent damage to inverter and battery when off grid
  - Determines “floor” for battery SOC calculations
  - Typically 47V for Lead Acid
  - Not used with battery communication



The screenshot shows the 'Batt Setup' menu with the following settings:

| Batt         | Charge | Discharge | Smart Load |
|--------------|--------|-----------|------------|
| Shutdown     | 46.0V  | 20%       |            |
| Low Batt     | 47.5V  | 35%       |            |
| Restart      | 52.0V  | 50%       |            |
| Batt Empty V | 47.0V  |           |            |

Additional settings on the right side of the screen:

- Batt Resistance: 25mOhms
- Batt Charge Efficiency: 99.0%

Buttons: CANCEL, OK



# Gen Charging Notes

- Gen Connected to Grid input
  - Must check box in Sell Control Tab
- To improve Generator Connectivity
  - Set to General Standard Mode
  - Widen Frequency Range to 55hz-65hz

**Grid Param**

| Limiter                                     | Sell Control | Grid Input   | FreqVolt | PowFac |
|---|--------------|--|----------|--------|
| <input type="checkbox"/> General Standard   |              | Grid Reconnect Time                                |          | 60s    |
| <input type="checkbox"/> UL 1741 & IEEE1547 |              | Power Factor                                       |          | 1.000  |
| <input type="checkbox"/> CA Rule 21         |              | <input type="checkbox"/> GEN connect to Grid input |          |        |
| <input type="checkbox"/> UL 1741SA          |              |  |          |        |
|   |              | CANCEL   |          | OK     |

**Grid Param**

| Limiter        | Sell Control | Grid Input  | FreqVolt      | PowFac |        |
|----------------|--------------|---|---------------|--------|--------|
| Grid Frequency |              | <input checked="" type="checkbox"/> 50Hz              | Protect Param |        |        |
|                |              | <input type="checkbox"/> 60Hz                         | Grid Vol High |        | 264.0V |
| Grid Type      |              | <input checked="" type="checkbox"/> 220V Single Phase | Grid Vol Low  |        | 211.0V |
|                |              | <input type="checkbox"/> 120/240V Split Phase         | Grid Hz High  |        | 60.5Hz |
|                |              | <input type="checkbox"/> 120/208V 3 Phase             | Grid Hz Low   |        | 45.0Hz |
|                |              |   | CANCEL        |        | OK     |

# Grid/Generator Peak Shaving (Gen-Assist)

- Use Battery to Clip Peaks in Power Usage
- Perfect for small generator situations and off-grid
- CT's needed for Grid Shaving
- Set up on Master A only



### System Setup

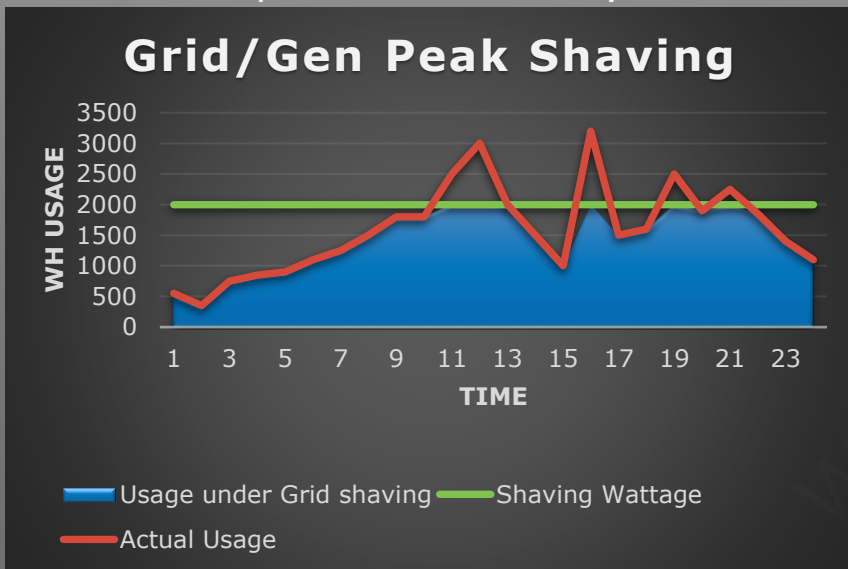
| Display                             | Time                           | Advanced                 | Alarms&Safety   | Factory Reset | Parallel |
|-------------------------------------|--------------------------------|--------------------------|-----------------|---------------|----------|
| <input type="checkbox"/>            | Solar Arc Fault ON             | <input type="checkbox"/> | Clear Arc_Fault |               |          |
| <input checked="" type="checkbox"/> | Gen peak-shaving               | Power                    | 7000W           |               |          |
| <input type="checkbox"/>            | Grid peak-shaving              | Power                    | 4000W           |               |          |
| <input type="checkbox"/>            | Auto detect Home Limit Sensors |                          |                 |               |          |

CANCEL OK

### Grid Param

| Limiter                             | Sell Control          | Grid Input | FreqVolt | PowFac |            |                                     |
|-------------------------------------|-----------------------|------------|----------|--------|------------|-------------------------------------|
|                                     |                       | Time       | power(W) | Batt   | GridCharge | GEN                                 |
| <input checked="" type="checkbox"/> | Grid Sell             | 8000       |          |        |            |                                     |
| <input checked="" type="checkbox"/> | Limited Power to Home | 01:00AM    | 2000     | 40%    |            |                                     |
| <input checked="" type="checkbox"/> | Limited Power to Home | 05:00AM    | 2000     | 40%    |            | <input checked="" type="checkbox"/> |
| <input type="checkbox"/>            | Limited power to Load | 09:00AM    | 2000     | 40%    |            | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | Time of Use Selling   | 01:00PM    | 2000     | 40%    |            | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | Time of Use Selling   | 05:00PM    | 2000     | 40%    |            | <input checked="" type="checkbox"/> |
| <input type="checkbox"/>            | Time of Use Selling   | 09:00PM    | 2000     | 40%    |            | <input type="checkbox"/>            |

CANCEL OK



Cannot Auto detect Grid CT's without batteries

# TOU to Home + Grid Sell Lithium Batt

- Set on Master A Only
- PV will charge batteries to 100% & excess PV will be sold to Grid
- Up to 2,000W from the battery to zero the whole home meter (Total Power out of batteries from all systems)
- Batteries will discharge to a maximum of 40% S.O.C while grid is present (will discharge further if grid outage)

### Grid Param

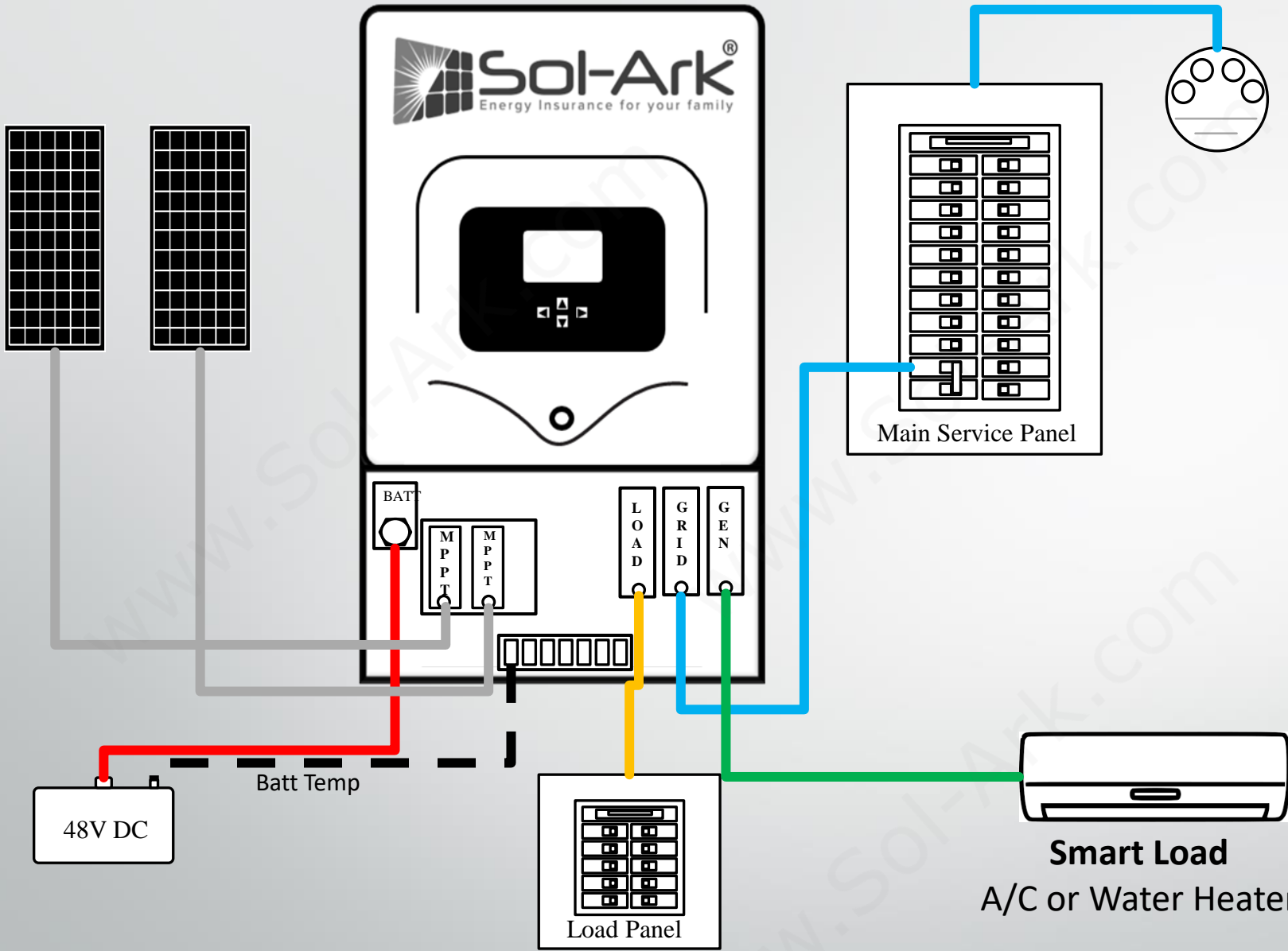
| Limiter   | Sell Control | Grid Input | FreqVolt | PowFac |            |     |
|---|--------------|------------|----------|--------|------------|-----|
| <input checked="" type="checkbox"/> Grid Sell             | 8000         | Time       | power(W) | Batt   | GridCharge | GEN |
| <input checked="" type="checkbox"/> Limited Power to Home |              | 01:00AM    | 2000     | 40%    |            |     |
| <input type="checkbox"/> Limited power to Load            |              | 05:00AM    | 2000     | 40%    |            |     |
| <input checked="" type="checkbox"/> Time of Use Selling   |              | 09:00AM    | 2000     | 40%    |            |     |
|   |              | 01:00PM    | 2000     | 40%    |            |     |
|   |              | 05:00PM    | 2000     | 40%    |            |     |
|   |              | 09:00PM    | 2000     | 40%    |            |     |

CANCEL OK

### Batt Setup

| Batt         | Charge | Discharge | Smart Load                    |
|--------------|--------|-----------|-------------------------------|
| Shutdown     | 46.0V  | 20%       | Batt Resistance: 25mOhms      |
| Low Batt     | 47.5V  | 35%       | Batt Charge Efficiency: 99.0% |
| Restart      | 52.0V  | 50%       |                               |
| Batt Empty V | 47.0V  |           |                               |

CANCEL OK



## Example Settings

**Batt Setup**

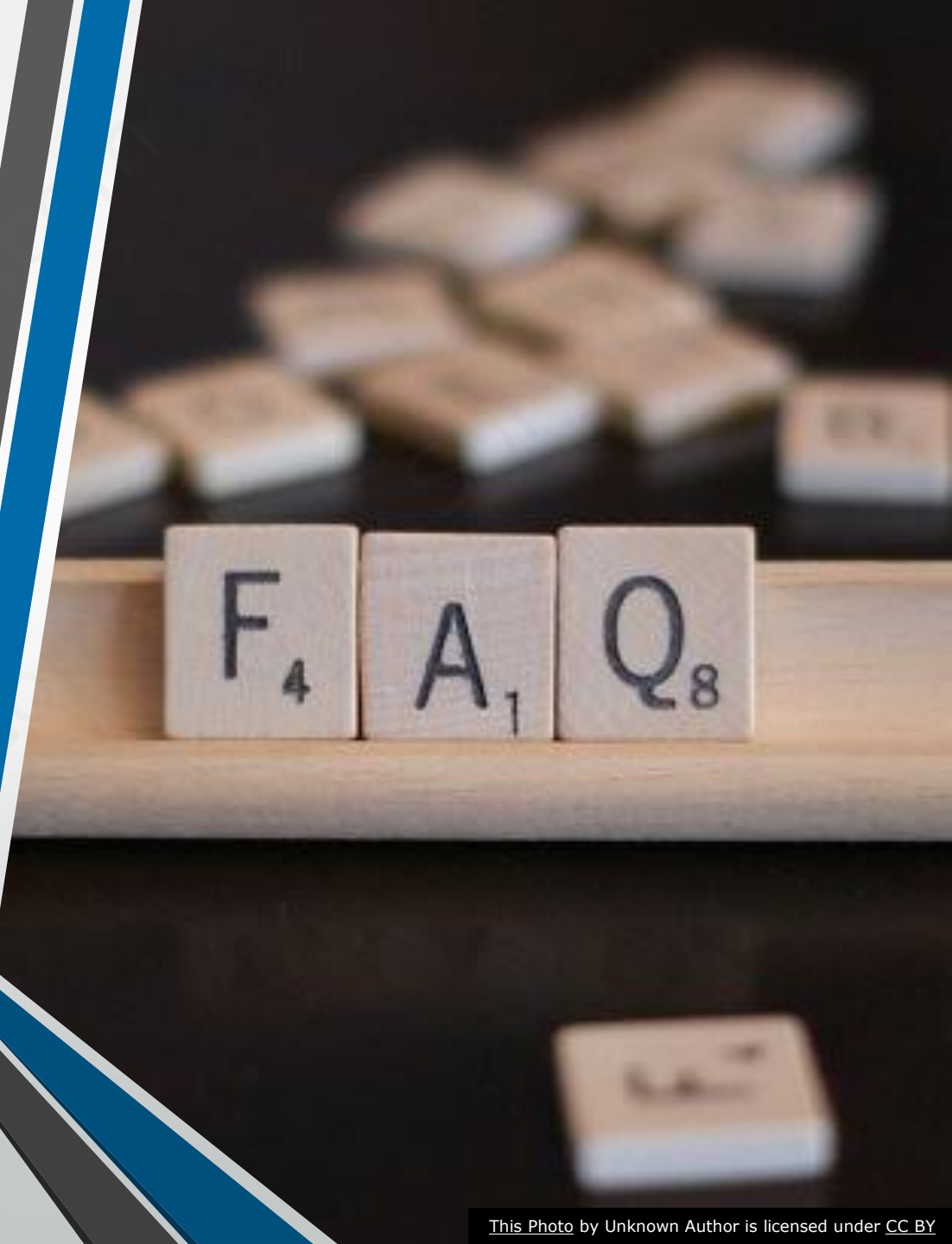
| Batt   | Charge                   | Discharge                | Smart Load               |
|--|--------------------------|--------------------------|--------------------------|
| <input checked="" type="checkbox"/>  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Use Gen input as load output   |                          | For Micro inverter input |                          |
| If selected, Use Grid Input for Gen charging with Grid Limiter set to Load or home |                          |                          |                          |
|  |                          | Solar Power(W)           | When Grid Connected      |
| Smart Load OFF Batt  | 51.0V                    | 80%                      |                          |
| Smart Load ON Batt   | 54.0V                    | 90%                      | 500W                     |
| CANCEL   |                          | OK                       |                          |

### Smart Load Output (Per 12K)

- Automatic Load Shedding controlled by SOC and/or PV Production for On Grid or Off Grid
- Reduces battery size 10-40%. Waits for batteries to be charged before using PV for big appliances.
- Programming PV watts = 0 will turn on Smart Load if Grid present
- Uses AC coupling input

# Stacking FAQs

- Which system do the CT sensors connect to?
  - 120V/240V installs = only Master 01
  - 120V/208V installs = 2 on Master **A**, 1 on Master **B**
- Can I use separate battery banks?
  - Nope, all batteries must be connected to all parallel systems
- Battery Temperature Sensor Placement
  - Tape to the side of battery, or in between batteries
  - Note sensor has no polarity
  - Master A Only



# Where to get more information?

- [www.sol-ark.com/support](http://www.sol-ark.com/support) --> documents, manuals etc.
- YouTube channel
- Contact us anytime
- 972-575-8875

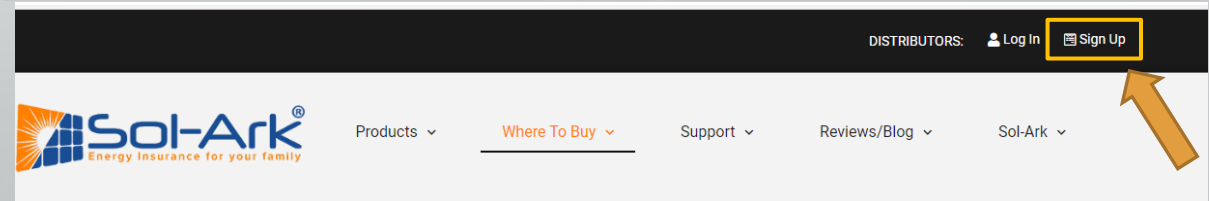
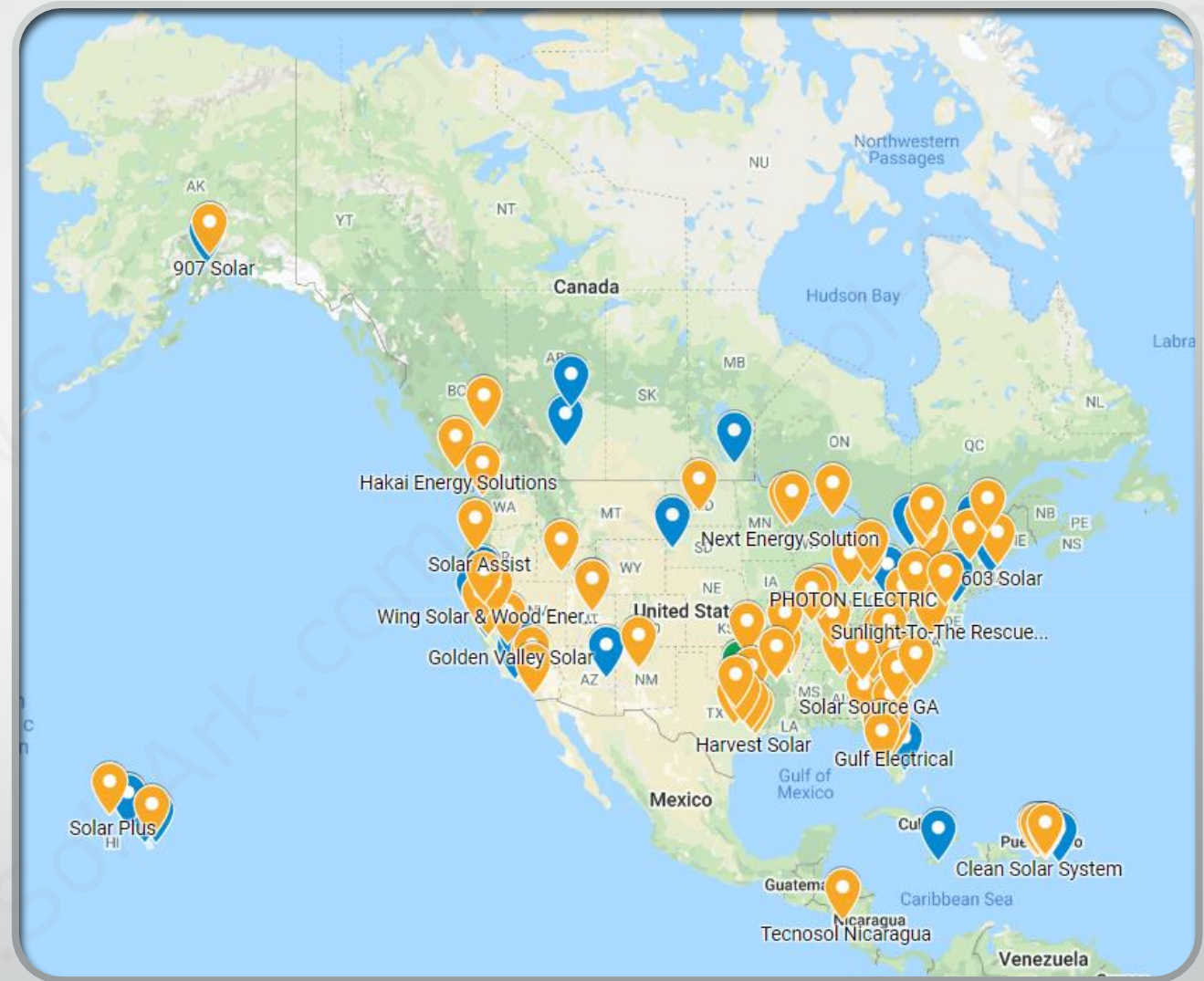


# Benefits of being a Sol-Ark customer

- 7 day/week Support – worth \$\$ in hourly, as a thank-you for being our customer
- Fast delivery – lead times 7-10 business days
- Flexible network – adding new distributors and accepting more

## Purchasing Sol-Arks

- Blue pins on our website map carry Sol-Ark
- Yellow pins are installers
- Join our Network





# Are We Still Open?

- Operational
- Adding production and inventory
- Webinars every Friday @  
12:00PM EST / 11:00AM CST



# Q & A

