



# Settings for Sanctuary 2 and Sanctuary 3

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# Settings Guide Organization

The order of settings in this document follows the layout in the settings page [smart.lionenergy.com](http://smart.lionenergy.com) > product > settings. The settings here are listed by sections in the same order as the web page. Additional settings that are not yet available on the web app are at the end of this document. Access to different settings varies by user role. The Lion Energy ESS support team has access to all the settings. Installers are responsible for checking the AHJ required settings and making sure the inverter is set accordingly.

Sanctuary 3 settings are mostly the same as Sanctuary 2 but have different ranges due to the power difference between the two inverters (12kW vs. 8kW).

The Sanctuary must be connected to the internet to change settings online. Settings changes are handled through the Lion Energy communicator (either a WCM or EMS-C).

This document includes the setting name, description, writeable range, default setting, units (where applicable), and access level.

## Access Levels

There are three different access levels for settings. The user level access is limited to changing internet, operating mode, and battery reserve percentage. The abbreviations for settings access levels are as follows: U = user; I = installer; LE = Lion Energy internal access only.

## Settings Ranges

The writeable range is not always the effective range of the setting. For example, over-frequency deadband has a writeable range of 0 to 5000, but an effective range of 17 to 1000 (units = 0.001Hz). This extra range is there to accommodate different models of inverters. The notation convention used in this document to represent a range of 0 to 5000 is [0, 5000].

The units for settings on the web page may differ from the units in this document because the units in this document show the precision that is available for the setting. One example is frequency. The 16 bit number stored in the setting for frequency typically ranges from 4000 to 7000, representing 40.00 to 70.00 Hz and the units are 0.01 Hz. The website may use Hz for the setting's unit instead of 0.01 Hz as in this document.

## **Inverter Settings Set Only During Commissioning**

These settings are set during commissioning and don't ever change unless the system configuration needs to change.

- Number of inverters in parallel
- Individual inverter parallel place assignment
- Modbus ID (communication address)
- Number of batteries

## **Web App Info**

This list of web app information is collected during commissioning but can also be changed in "Edit Info" without needing to recommission.

- Customer name, address, phone number, password.
- Installer
- Shared access by email
- Third party owner
- Servicing company
- On or off-grid
- PV total watts
- PV location (ground/rooftop)

## **User-Accessible Settings**

The following settings are accessible to the homeowner and anyone the product was shared with.

### **Change Internet**

This allows the user to change the SSID/password for their WiFi. Use a laptop with Bluetooth and follow the on-screen prompts.

### **Operating Mode**

The user can select from three different operating modes.

1. Normal Mode (default) is the best to minimize power purchased from the grid. This corresponds to "Limit Grid Consumption" in "System Work Mode" under Advanced Settings, with "Battery Priority" disabled.

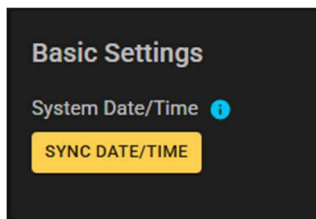
2. Emergency mode keeps the battery full and ready for a power outage. Power from solar can't be stored or used from the battery while in this mode. This corresponds to "Limit Grid Consumption" in "System Work Mode" under Advanced Settings, with "Battery Priority" enabled.
3. Battery Sell Mode will prioritize selling power back to the grid down to the battery reserve percentage. Once the battery is discharged down to the reserve percentage, then only excess solar power can be sold to the grid. It is rarely advantageous to use this mode. If this mode is used, it is recommended to set the "Grid Sell Power Limit" to the level of power you wish to sell. Also, set the TOU settings to specify when to sell power to the grid, and how much power during each time slot.

### Battery Reserve Percentage

This sets all six TOU slots to the selected reserve percentage. If you prefer to have different percentages for each time slot, do not change this setting. Instead, change the TOU settings in Advanced Settings.

## Advanced Settings

### Basic Settings



### Sync System Date/Time

This button is essentially obsolete because the EMS-C automatically synchronizes the inverter's clock with the internet time every minute. If there are any time sync issues, check the time zone setting first. Also, check to make sure the EMS-C can connect to the internet. Having the correct time is necessary for TOU settings to work at the right times. It also ensures the correct times appear in the alarm history.

Values = year 2000 to 2099, month, day, hour, minute, second. Default = current time. Access = I.

## ARC Setup

Enable or disable arc detection in the PV connections. There is an arc detector module mounted near the PV connectors inside the inverter. The PV lines go through the arc detector module which detects RF noise.

Enabled: When arcing is detected, it shuts down PV current to avoid fires.

Values = [disabled, enabled]. Default = enabled. Access = LE.

## Clear ARC Alarm

To clear an arc alarm, the communicator writes a 1 to this setting. This “setting” will be moved to the command requests section soon.

Access = LE.

## On/Off Button

This setting is mainly used for troubleshooting.

Enable: Either the on/off button or the RSS can turn off the inverter.

Disable: Neither the on/off button nor the RSS can turn off the inverter.

Values = [disabled, enabled]. Default = enabled. Access = LE.

## Battery Settings

### Battery Type

This is always set to Lithium. No other settings are supported in the Sanctuary firmware.

0 = DC Supply

1 = Lead-Acid

2 = Lithium

Values: [0,2]. Default = 2: Lithium. Access = LE.

### Inverter Max Charge Current

This is the maximum battery charging current supplied by the inverter when running as a single inverter. For example, you can set this value to 100A and that will be divided among the batteries. This setting is not effective for parallel inverter systems. For parallel inverters, use “System Charge Current”.

Values = [0,190]. Default = 150. Units = Amps. Access = I.

### On-Grid Battery Restart Percent

When the state of charge (SoC) drops to the target level, the inverter will use solar to charge the battery up to this percent above the target. For example, if the target SoC is 30% and on-grid battery restart percent is 5%, then once the battery discharges down to 30%, it

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will start charging from solar and then stop charging at (30% + 5% = 35%). Once it reaches 35%, it will allow discharging again down to the target SoC.

Values = [0,100]. Default = 0. Units = percent. Access = I.

### **Off-Grid Battery Restart Percent**

When off-grid, after the battery discharge exceeds the off-grid DoD setting and the inverter turns off the load power, this is how much battery percent it needs to charge back up before turning the load power back on. At default settings, the load power will turn back on when the battery reaches 20%. When the SOC drops below (100 - "off-grid DoD"), the inverter will trigger an alarm for low battery (A1\_4). If on-grid DoD is the same or less than off-grid DoD, then it will also trigger the battery under capacity alarm (A1\_3).

Values = [5,95]. Default = 10. Units = percent. Access = I.

### **On Grid Depth of Discharge**

Once the state of charge drops below (100 - "On Grid DoD"), the inverter will stop using power from the battery and start using power from the grid. This can override time of use settings if the DoD calculates a higher SoC than the TOU setting. On-grid DoD should be less than or equal to off-grid DoD, otherwise it thinks you made an error and will use the higher DoD for off-grid and the lower one for on-grid.

Values = [10,90]. Default = 90. Units = percent. Access = I.

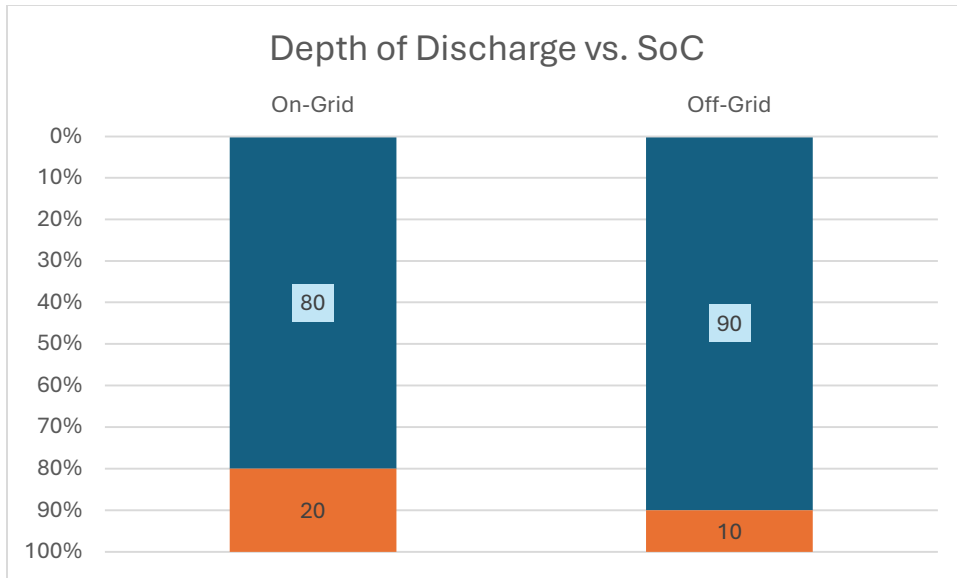
### **Off Grid Depth of Discharge**

This is how far you can discharge the batteries when off-grid before it will turn off load power. If on-grid DoD is unexpectedly more than off-grid DoD, it will only alarm A1\_4 (battery low capacity) until the SoC drops below the on-grid DoD limit and then it will shut off load power and trigger alarm A1\_3 (battery under capacity) also. Off-grid DoD should be at least as much as on-grid DoD.

Values = [10,90]. Default = 90. Units = percent. Access = I.

This chart illustrates the difference between DoD and SoC. For example, when you're at 90% depth of discharge, you're at 10% state of charge.

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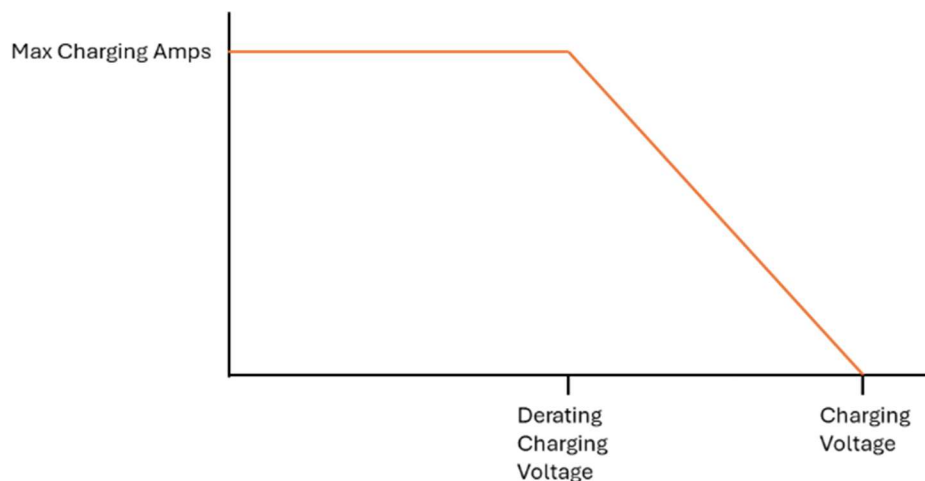
### Charging Voltage

This is the battery charging voltage for the constant voltage portion of the charging curve. The inverter will push current to the batteries until this voltage is reached and will then enter constant voltage mode. This setting is effective for RS-485 batteries. This setting is not effective for Sanctuary 3 CAN batteries. On Sanctuary 3, the charging voltage is requested by the BMS.

Values = [0,650]. Default = 558. Units = 0.1V. Access = LE.

### Derating Charging Voltage

The inverter will taper off charging current when the battery is between this voltage and the charging voltage, which is max. If the two are too close, then the inverter tends to oscillate the current up and down. This setting is effective for RS-485 batteries, but not for CAN batteries.



Values = [0,650]. Default = 545. Units = 0.1V. Access = LE.

### **Battery Max Charge Current**

This is the maximum battery charging current per battery. The inverter will monitor the BMS and limit charging so that no battery goes above this current level. This is effective for RS-485 batteries, but not for CAN batteries. This setting is effective for single inverter systems. For parallel inverter systems, see “System Charge Current”.

Values = [0,190]. Default = 140. Units = amps. Access = I.

### **Battery Max Discharge Current**

This is the on-grid maximum discharge current. It does not limit battery discharge current when off-grid. The inverter will limit total battery discharge current to no more than the value of this setting times the number of batteries. Any remaining power demand will come from the grid. Unfortunately, it doesn't use the BMS data to limit the amount of power generated so that no single battery exceeds this current level. This setting is effective for single inverter systems. For parallel inverter systems, see “System Discharge Current”.

Values = [0,190]. Default = 190. Units = Amps. Access = I.

### **Battery Cell Voltage Maximum**

If any cell exceeds this limit, charging will stop. Charging will taper off when the maximum cell voltage is between the “Battery Cell De-rating Voltage” and the “Battery Cell Voltage Maximum”.

Values = [0,4000]. Default = 3640. Units = mV. Access = LE.

### **Battery Cell Voltage Minimum**

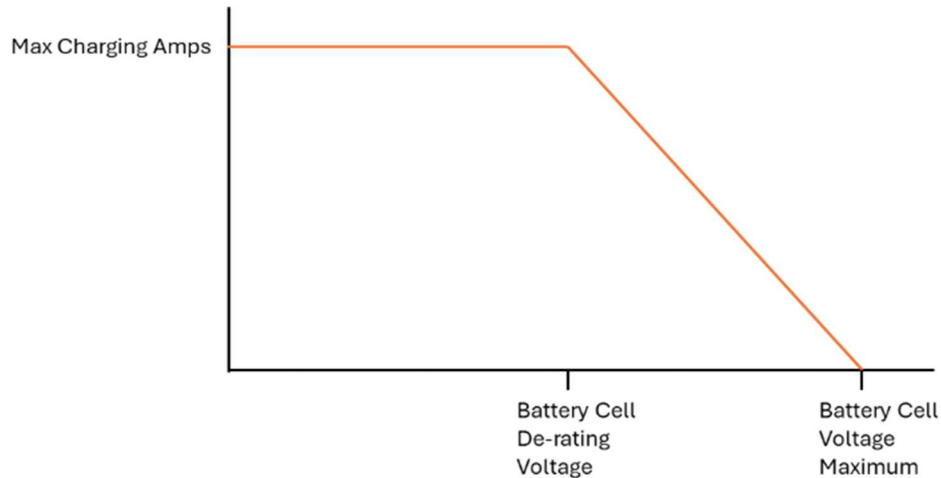
If any cell drops below this value, discharging will stop. Charging will still work.

Values = [0,4000]. Default = 2650. Units = mV. Access = LE.

### **Battery Cell De-rating Voltage**

The inverter tapers off charging current when the maximum cell voltage of any battery is between this value and cell voltage maximum. Maximum charging current can only happen when the maximum cell voltage is below this value.

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Values = [0,4000]. Default = 3450. Units = mV. Access = LE.

### Battery Cell Max Voltage Difference (Delta)

This delta is the difference between the highest cell in all the batteries to the lowest cell in all the batteries. If the maximum cell voltage to minimum cell voltage difference is greater than this amount, it will not charge the battery or discharge the battery. If any battery gets too discharged, it's likely that the cell difference will exceed this value and the inverter will not charge the batteries. Note: From the factory, the BMS units were programmed with Cell V Difference Charging Lockout = 700 mV by default. Our recommended setting is 1000 mV.

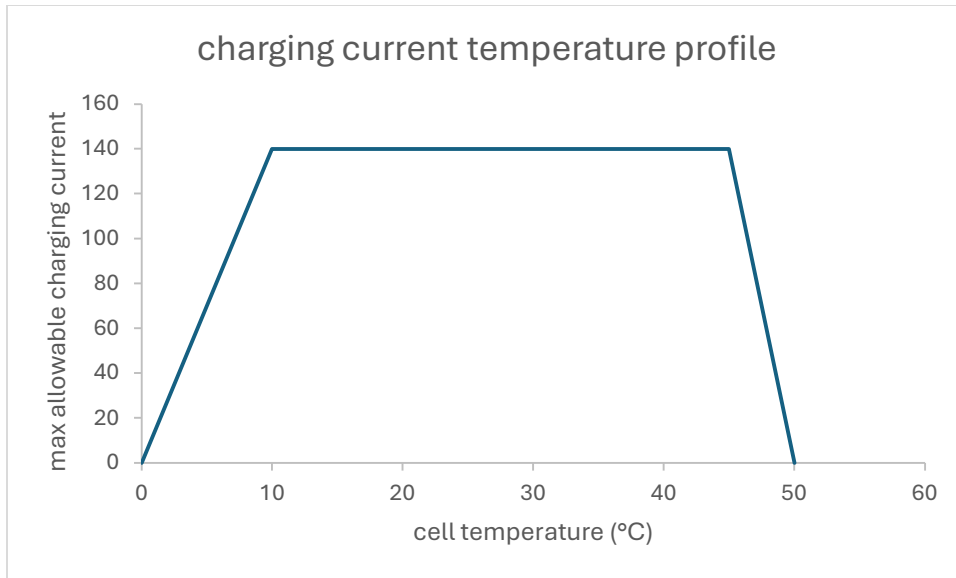
Values = [0,4000]. Default = 900. Units = mV. Access = LE.

### [Charging Temperatures]

The inverter reduces or stops charging when the battery temperature gets too hot or too cold. When the cell temperature is below "Charging Temperature Low Minimum", the inverter will not charge the batteries. Between low minimum and low maximum, the inverter will linearly derate the charging. Between "Charging Temperature Low Maximum" and "Charging Temperature High Minimum", the inverter will allow charging up to the maximum allowable current.

When the cell temperature is above "Charging Temperature High Maximum", the inverter will not charge the batteries. Between high minimum and high maximum, the inverter will linearly derate the charging. The following settings correspond to the graph below:

- Charging Temperature "Low" Minimum
- Charging Temperature "Low Maximum
- Charging Temperature High" Minimum
- Charging Temperature "High" Maximum



### **Charging Temperature “Low” Minimum**

Values = [-100,100]. Default = 0. Units = °C. Access = LE.

### **Charging Temperature “Low” Maximum**

Values = [-100,100]. Default = 10. Units = °C. Access = LE.

### **Charging Temperature High” Minimum**

Values = [-100,100]. Default = 45. Units = °C. Access = LE.

### **Charging Temperature “High” Maximum**

Values = [-100,100]. Default = 50. Units = °C. Access = LE.

### **BMS Temperature Derate (Sanctuary 2 only)**

When the BMS gets hotter than this temperature, the inverter will start decreasing the battery current. When on-grid, both charging and discharging will be limited. When off-grid, only charging is limited. The charging or discharging will decrease linearly until the BMS cutoff temperature is reached, at which point both charging and discharging will be disabled.

Values = [0,65535]. Default = 75. Units = °C. Access = LE.

### **BMS Temperature Cutoff (Sanctuary 2 only)**

If the BMS temperature reaches this value, the inverter will stop battery current.

Values = [0,65535]. Default = 79. Units = °C. Access = LE.

### **Charging strategy (Sanctuary 2 only)**

When this setting is enabled, it will allow the inverter to disable charging on the pack at 100% and continue charging the rest of the batteries.

To re-enable charging, the pack SoC needs to be less than “Charge Enable SoC” and the maximum cell voltage needs to be less than “Charge Enable Cell Voltage”.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Charge Enable Cell Voltage (Sanctuary 2 only)**

After being disabled due to high cell voltage, the max cell voltage on this pack must decrease below this value before charging is re-enabled.

Values = [1,4000]. Default = 3500. Units = mV. Access = LE.

### **Charge Enable SoC (Sanctuary 2 only)**

After being disabled due to high cell voltage, the SoC on this pack must drop below this value before charging is re-enabled.

Values = [1,100]. Default = 100. Units = percent. Access = LE.

### **Discharging strategy (Sanctuary 2 only)**

When this register is 1, it will allow the inverter to disable discharging on the pack with cell voltage under the minimum defined in “Battery Cell Voltage Minimum” and continue discharging the rest of the batteries.

To re-enable discharging, the pack SoC needs to be greater than “Discharge Enable SoC” and the minimum cell voltage needs to be greater than “Discharge Enable Cell Voltage”.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Discharge Enable Cell Voltage (Sanctuary 2 only)**

After being disabled due to low cell voltage, the minimum cell voltage on this pack must increase above this value before discharging is re-enabled.

Values = [1,4000]. Default = 2750. Units = mV. Access = LE.

### **Discharge Enable SoC (Sanctuary 2 only)**

After being disabled due to low cell voltage, the SoC on this pack must increase above this value before discharging is re-enabled.

Values = [1,100]. Default = 10. Units = percent. Access = LE.

## System Work Mode Settings

### System Work Mode

0 = Disable: This sets it to use the basic work mode register instead, which is not available on the web app. This setting is not used by Lion Energy.

1 = Sell First: Sell the battery power back to the grid at the wattage specified by the time of use discharge power. If time-of-use is disabled, it won't sell back battery power to the grid. Sell-back stops when the battery gets down to the SoC setting in the TOU slot.

2 = Limit Grid Consumption: This is the normal mode, also known as SBU (solar-battery-utility). Solar power covers loads first. Excess power is used to charge the battery. When not enough solar is available, use battery power down to the target SoC, and then use grid power.

3 = Zero Export: It will not sell solar power back to the grid.

Values = [0,4]. Default = 2. Access = I.

### CT Limit Power

Used in "limit grid consumption" mode. This is power per inverter. This is how much power loads can draw from the grid before the inverter starts contributing power from the battery.

Values = [0,30000]. Default = 0. Units = Watts. Access = I.

### On-Grid AC Output Limit

This limits the DC to AC power per inverter. The total output power can be limited. Any load demand above and beyond this power comes from the grid. Since the inverter is connected to both its load port and grid port at the same time while on-grid, it can only limit the total power output, not the power delivered to either port individually. Power drawn from one panel affects how much power the inverter can supply to the other panel. If the loads on the load port draw the maximum power, the inverter can't send any power to the grid port. Conversely, if there are no loads on the load port, then the power going to the grid port won't exceed this setting. For example, if this is set to 50%, inverter output power never exceeds 4kW on an 8kW inverter, or 6kW from a 12kW inverter. This limitation applies to the total power sent to both the load port and the grid port.

See also "Grid Sell Power Limit". That setting is for users that have DC solar connected to the inverter or that use sell-first mode and need to limit the power sold to the grid. Unlike this setting, "Grid Sell Power Limit" does not limit inverter power to the breaker panels; it only limits power sold to the grid (past the CTs).

Values = [0,100]. Default = 100. Units = percent. Access = I.

## Battery Discharge Percent (of 8kW)

When on-grid, you can limit the amount of power the battery contributes to loads. For example, 20% will limit the battery discharge to 1600W and the grid or solar will cover the rest of the load power demand. This does not affect off-grid battery discharge power. You can still draw the full 8kW of battery power when off-grid if the loads demand it.

Values = [0,100]. Default = 100. Units = percent. Access = LE.

## Zero Export Power Adjustment

Make this higher to reduce the amount of power the inverter generates so that you target zero grid power. Make this lower to increase the amount of power the inverter generates so that you hit zero grid export power. Only adjust when battery SoC is significantly greater than the time-of-use SoC and there is no solar being generated. This is when the inverter is targeting zero sell-back but also powering loads.

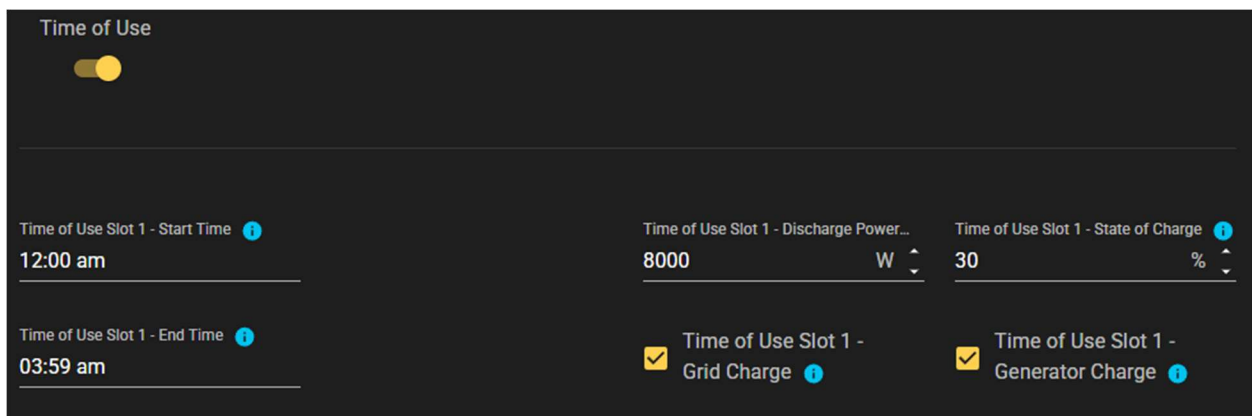
Values = [-500,500]. Default = 0. Units = Watts. Access = LE.

## Grid Selling

If enabled, the inverter may sell excess DC solar power to the grid. If disabled, the inverter will not sell power to the grid. The CTs must be installed correctly or else the inverter may sell to grid even when grid selling is disabled. The inverter will try to generate enough power to make the CT current read zero (if “CT Limit Power” is zero) so that loads are covered, but no excess power is sold to the grid. If the inverter is in sell-first mode, it will sell to the grid no matter what this register is set to. Disabling grid selling does not disable AC solar connected to the generator port.

Values = [disabled, enabled]. Default = (set during commissioning). Access = I.

## Time of Use



If “Time of Use” (TOU) is enabled, the inverter will use the TOU settings. See also “Time of Use Enable Day of Week”. With TOU, the inverter can change its behavior based on the time

of day. This is especially useful if your utility has peak billing hours. There are six time slots. Each time slot must be sequential and not overlap.

Values = [disabled, enabled]. Default = enabled. Access = I.

### **Time of Use Slot 1 – Start Time**

If the inverter's time clock is between the start and end time of this time slot, then the four settings for this time slot are effective. The first time slot should start at 12:00 AM. Warning: If start and end times overlap, TOU will not work correctly or will effectively be disabled.

Values = [12:00 AM, 11:59 PM]. Default = 12:00 AM. Access = I.

### **Time of Use Slot 1 – End time**

Note: Time slot 6 (the last time slot) should end at 11:59 PM.

Values = [12:00 AM, 11:59 PM]. Default = 3:59 AM. Access = I.

### **Time of Use Slot 1 – Discharge power**

This is the amount of battery power available to cover loads while on-grid during this time slot. Any load demand beyond this power will come from the grid and solar.

This setting does not limit battery power consumption when disconnected from the grid.

Values = [0, 30000]. Default = 8000. Units = Watts. Access = I.

### **Time of Use Slot 1 – State of Charge**

This is the minimum target state of charge for the battery in this time slot. Solar can still fully charge the battery to 100% in this time slot if there is enough solar power.

If the battery is below this SoC, the inverter will charge the battery up to this value using grid power if "Grid Charging" is enabled and grid charging for this time slot is enabled and "Limit Grid Charging" is not enabled. If the battery SoC is greater than the slot target SoC, the inverter can use battery power to reduce or avoid grid consumption.

If solar power is not enough to cover loads, it will allow the battery to discharge down to this level to cover loads. After the battery has been used down to the target SoC, battery discharge stops and then solar (if any) and grid will provide power to the loads.

Values = [0, 100]. Default = (set during commissioning). Units = percent. Access = I.

### **Time of Use Slot 1 – Grid Charge**

This enables or disables grid charging in this time slot. If you have AC solar external to the Sanctuary, consider leaving this enabled even during the peak billing time slot. That way it can charge the batteries from your other solar inverters instead of just letting them sell

## Settings Guide

back to the grid. If grid charging is disabled, the Sanctuary won't charge from the grid or from other solar that's connected to your home.

Values = [disabled, enabled]. Default = enabled. Access = I.

### Time of Use Slot 1 – Generator Charge

For old firmware, this setting was to enable generator charging in this time slot. On new firmware, it's for enabling sell-first mode during the time slot.

Values = [disabled, enabled]. Default = enabled. Access = I.

## Grid Settings

Setting	Value	Unit
Grid Mode/Standard	United States	
Grid Type	120V/240V	
Grid Capacity Power	12000	W
Power Factor	1	
Grid Voltage Max	260	V
Grid Voltage Min	220	V
Grid Frequency Max	70	Hz
Grid Frequency Min	40	Hz
Grid Standard	UL1741&IEEE1547.2020	
Grid Reconnection Delay	s	
Battery Grid Charge Limit	8000	W
Grid Sell Power Limit	8000	W
Grid Selling Current	34	A
Phase Wiring Detection Control	<input checked="" type="checkbox"/>	

### Grid Mode/Standard

Only the United States grid standard is used by default.

Values = [0,26]. Default = 8 (US). Access = LE.

### Grid Type

0 = single phase (not used)

1 = 120/240V (split phase – standard residential)

2 = US 208V (three phase)

3 = Mexico 127/220

This setting is set during commissioning and normally should not be changed. When using parallel inverters in three-phase, also set the inverter parallel control word to the correct three-phase parallel settings. That setting is also set during commissioning and normally should not be changed afterwards.

Values = [0,3]. Default = 1. Access = I.

## **Grid Capacity Power**

The inverter may decrease battery charging power from the grid so that load power + battery charging power does not exceed this value per inverter. When grid demand exceeds this value, the batteries won't charge from the grid. This also affects generator power to the battery. If this register is set to 0, then the generator won't charge the battery. But it will even if it's set to 1W, but it will fluctuate.

Values = [0,30000]. Default = (set during commissioning). Units = Watts. Access = I.

## **Power Factor**

When the inverter is set up to sell back power at a constant power factor, this is the power factor it uses. This is effective when "Reactive Type" is set to 0 (constant power factor).

Some jurisdictions might require setting this to -0.90 or -0.95 PF to absorb VARs when selling back power. Other utility companies such as HECO (Hawaii) will usually use a different mode such as Volt-VAR, so this setting won't matter when "Reactive Type" is not set to constant power factor mode.

Values = [-99,100]. Default = 100. Units = 0.01 PF. Access = LE.

## **Grid Voltage Max**

When a generator is connected to the grid port, if the grid port voltage exceeds this value, the inverter will disconnect from the generator. This setting is effective only when a generator is connected to the grid port.

Values = [2200, 2800]. Default = 2600. Units = 0.1V. Access = LE.

## **Grid Voltage Min**

When a generator is connected to the grid port, if the grid port voltage drops below this value, the inverter will disconnect from the generator. This setting is effective only when a generator is connected to the grid port.

Values = [1500, 2300]. Default = 2200. Units = 0.1V. Access = LE.

## **Grid Frequency Max**

When a generator is connected to the grid port, if the grid port frequency exceeds this value, the inverter will disconnect from the generator. This setting is effective only when a generator is connected to the grid port.

Values = [4000, 7000]. Default = 7000. Units = 0.01 Hz. Access = LE.

### **Grid Frequency Min**

When a generator is connected to the grid port, if the grid port frequency drops below this value, the inverter will disconnect from the generator. Effective only when a generator is connected to the grid port.

Values = [4000, 7000]. Default = 4000. Units = 0.01 Hz. Access = LE.

### **Grid Standard**

When changing this setting, it changes many DER smart inverter settings. The following profiles are pre-programmed into the inverter.

0	UL1741&IEEE1547.2020
1	Rule21
2	SRD-UL1741 1.0
3	UL1741 SB
4	UL1741 SA
5	Heco 2.0
6	Puerto Rico

Values = [0,6]. Default = 0. Access = LE.

### **Grid Reconnection Delay**

Some utilities require a time delay after the grid comes back up before selling power back to the grid. This delay satisfies that requirement. The inverter adds about 50s to the time. The minimum is 33s. If you set it below 33s, it will take longer (around 172s).

Values = [1,6000]. Default = 3000. Units = 0.1 s. Access = LE.

### **Battery Grid Charge Limit**

This limits the maximum power each inverter can draw from the grid to charge the batteries. To calculate the total grid power limit, multiply this times the number of parallel inverters in the system.

Values = [0, 30000]. Default = 8000. Units = Watts. Access = I.

### **Grid Sell Power Limit**

This is how much power can be sold back to the grid per inverter. It is especially useful for situations where there is a limit on the amount of power that can be sold back to the

## Settings Guide

grid. The inverter can only limit sell-back from DC solar and battery. It can't limit AC solar sell-back. See also "Grid Selling Current". The inverter uses whichever is lower.

Values = [0,16000]. Default = 8000. Units = Watts. Access = I.

### Grid Selling Current

This is how much current per inverter can be sold back to the grid. It is especially useful for situations where there is a limit on the amount of current that can be sold back to the grid. See also "Grid Sell Power Limit". The inverter uses whichever is lower.

Values = [0,550]. Default = 340. Units = 0.1A. Access = I.

### Phase Wiring Detection Control

Enables/disables the check for grid and load wiring errors in parallel systems.

Enabled: When the inverters are powered on, the parent inverter will send voltage to the load port. If the child inverter doesn't detect that voltage or if the voltage is out of phase, the inverters will shut off the load power and set the load wiring error alarm. This alarm requires a power-cycle to clear.

If the grid voltage phases don't all match the correct parallel configuration, the inverter will set the grid wiring error alarm. This alarm requires a power-cycle to clear. It is assumed that you'll need to shut off the inverters to correct the wiring errors.

Values = [disabled, enabled]. Default = enabled. Access = LE.

## Generator Settings

The screenshot displays the "Generator Settings" interface with the following parameters and values:

- Generator Input:** Toggle switch (ON)
- Start Percent:** 40 %
- Stop Percent:** 80 %
- Battery Charge Current:** 204 A
- Operating Time:** 24 hr
- Cooling Time:** 0 hr
- Generator Power:** 21000 W
- Charge Priority SOC:** 80 %
- Generator Voltage Max:** 260 V
- Generator Voltage Min:** 200 V
- Generator Frequency Max:** 70 Hz
- Generator Frequency Min:** 40 Hz
- Generator Warmup Time:** 60 s
- Generator Stop Duty Cycle Percentage:** 0 %
- Generator Stop Buffer Time:** 10 min
- Generator Start Buffer Time:** 3 min
- Generator Dynamic Voltage High Value:** 127 V
- Charge from Generator:**
- Auto Start:**
- Generator as Grid Input:**

## Generator Input

Enabled: allow generator use while the grid is down

Disabled: the inverter will not use any generator power from the generator port.

Values = [disabled, enabled]. Default = (set during commissioning). Access = I.

## Start Percent

When the inverter is off-grid and the battery SOC gets down to this level, the inverter will command the generator on if it's set to auto-start. It will then run the generator until a stop condition is reached.

Values = [10,100]. Default = (set during commissioning). Units = %. Access = I.

## Stop Percent

When the inverter is off-grid and the generator is charging the battery, when the battery SoC reaches this level, the inverter will command the generator to turn off if it's set to auto-start. There are other stop conditions that may turn off the generator before the SoC reaches this level.

Values = [10,100]. Default = (set during commissioning). Units = %. Access = I.

## Battery Charge Current

This is the total battery charging current (DC current on the battery bank). For a parallel inverter system, this is the total battery charging current from all inverters added together. If the "Generator Power" is less, then that takes precedence. For example, "Generator Power" = 2000W will limit the power more than setting "Battery Charge Current" to 60A. As a starting point, set the battery charge current to about half of the generator's continuous power rating. For example, if your generator is rated at 8000W, set the battery charge current to  $4000W/51.8V = 77A$ . The ideal value depends on individual setup and use conditions. **Important note:** This setting will limit battery charge current total. The battery charger can't distinguish where the power comes from. Solar will not add to the charging current when the generator is on. If you have more power available from solar, then turn off the generator so you can charge your batteries faster.

Values = [0,200]. Default = 50. Units = Amps. Access = I.

## Operating Time

This is the maximum continuous operating time the generator will be allowed to run. If it's set to 24 hours, it won't be shut off before another stop condition is met. This setting is effective when auto-start is enabled.

Values = [0,240]. Default = 240. Units = 0.1 hours. Access = I.

## Cooling Time

After the generator shuts off, it will not auto-start again for at least this amount of time before being allowed to auto-start again. This setting is effective when auto-start is enabled.

Values = [0,240]. Default = 0. Units = 0.1 hour. Access = I.

## Generator Power

This is the maximum continuous power that the inverter may draw from the generator. The inverter will limit battery charging so that charging and loads don't exceed this power level. Do not use the advertised peak generator power rating. It's best to set this a little less than the maximum continuous power rating of the generator.

Values = [0,30000]. Default = (set during commissioning). Units = Watts. Access = I.

## Charge Priority SOC

If there is solar power present (meaning MPPT voltage is more than 120V DC), the generator will stop when the battery SoC is above this percent.

Values = [0,100]. Default = 50. Units = %. Access = I.

## Generator Voltage Max

Above this value, the inverter disconnects from the generator or won't connect to the generator. This is the generator's line-to-line voltage.

Values = [0,3000]. Default = 2600. Units = 0.1V. Access = LE.

## Generator Voltage Min

Below this value, the inverter disconnects from the generator, or won't connect to the generator. This is the generator's line-to-line voltage.

Values = [0,3000]. Default = 2000. Units = 0.1V. Access = LE.

## Generator Frequency Max

If the generator frequency is above this value, the inverter will disconnect from the generator, or won't connect to the generator.

Values = [4000,7000]. Default = 7000. Units = 0.01Hz. Access = LE.

## Generator Frequency Min

If the generator is below this frequency, the inverter will disconnect from the generator, or won't connect to the generator.

Values = [4000,7000]. Default = 4000. Units = 0.01Hz. Access = LE.

## **Generator Warmup Time**

This is the time delay between starting the generator and when the inverter connects to the generator to draw power from it.

Values = [0,65535]. Default = 60. Units = seconds. Access = I.

## **Generator Stop Duty Cycle Percentage**

If the generator load drops below this fraction of the generator's rated power for the amount of time in "Generator Stop Buffer Time", it will shut off for the amount of time in "Generator Start Buffer Time". The purpose of this setting is to avoid running the generator for long periods of time at low power levels.

Values = [0,100]. Default = 5. Units = percent. Access = I.

## **Generator Stop Buffer Time**

When the generator power drops below "Generator Stop Duty Cycle Percentage", it starts a timer. If the generator doesn't exceed "Generator Stop Duty Cycle Percentage" for "Generator Stop Buffer Time" minutes, then the inverter will turn off the generator. It will not turn the generator back on until "Generator Start Buffer Time" minutes have passed and conditions also demand the generator turn back on.

Values = [0,65535]. Default = 5. Units = minutes. Access = I.

## **Generator Start Buffer Time**

When the generator power drops below "Generator Stop Duty Cycle Percentage", it starts a timer. If the generator doesn't exceed "Generator Stop Duty Cycle Percentage" for "Generator Stop Buffer Time" minutes, then the inverter will turn off the generator. It will not turn the generator back on until "Generator Start Buffer Time" minutes have passed and conditions also demand the generator turn back on.

Values = [0,65535]. Default = 30. Units = minutes. Access = I.

## **Generator Dynamic Voltage High Value**

This setting needs to be just higher than the generator's no-load voltage value (on a single leg).

Values = [100,150]. Default = 127. Units = Volts. Access = LE.

## **Charge from Generator**

Enabling this allows the generator to charge the batteries in addition to covering load power. Lion Energy recommends enabling this setting. It is more efficient to charge from the generator than to run the generator at low power for long periods of time.

Values = [disabled, enabled]. Default = enabled. Access = I.

## Auto Start

Enabled: the generator two-wire start signal will be sent to the generator when conditions for starting the generator are met. The inverter will only accept generator power when the inverter is calling for generator.

Disabled: The generator must be manually started. The inverter will accept generator power when off-grid.

Values = [disabled, enabled]. Default = (set during commissioning).

## Generator as Grid Input

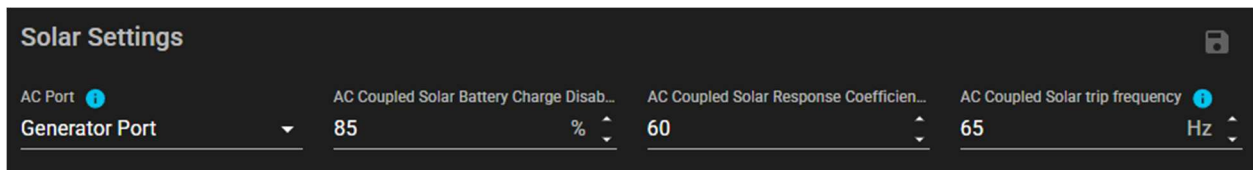
For off-grid applications, it is best to connect the generator to the grid port. This way, the inverter can turn on from a dark start and send 12V power to the rapid shutdown transmitter.

Enabled: This relaxes the grid requirements, allowing the generator to be connected to the grid input. The generator port is not used in this case.

Disabled: grid voltage & frequency limits are applied to the grid input. Generator (if used) needs to be connected to the generator port.

Values = [disabled, enabled]. Default = (set during commissioning). Access = I.

## Solar Settings



### AC Port

This selects whether the generator port is used for AC solar or generator input. If “generator port” is selected, the generator port connects to grid through internal relays. Note: The configuration with AC solar connected to the load port is not supported.

Values = [disabled, generator port]. Default = (set during commissioning). Access = I.

### AC Coupled Solar Battery Charge Disable SoC

When off-grid and running on AC solar, the AC solar will try to push the maximum power possible. There must be somewhere for the power to go. If the battery can’t take the full amount of power, then the inverter needs to reduce the power from solar. To avoid needing to increase the frequency, the inverter can turn off the generator port. After the battery decreases 10% below this setting, the inverter will close the generator port relays and turn on AC solar again. Because battery charging slows down near the top of charge, it’s best to keep this setting near 85%

Values = [0,100]. Default = 85. Units = percent. Access = I.

### **AC Coupled Solar Response Coefficient**

If the inverter needs to reduce power from the solar panels, it will increase the frequency. This is how quickly it adjusts. Lower is faster.

Values = [1,100]. Default = 60. Access = I.

### **AC Coupled Solar Trip Frequency**

When the inverter raises the frequency, it will turn off the generator port if it reaches this frequency.

Values = [4000,7000]. Default = 6500. Units = 0.01 Hz. Access = I.

## **Advanced Settings**

(This is the Advanced Settings section on the Advanced page.)

### **System Charge Current**

In parallel inverter systems, this is the total amount of current supplied to charge the batteries. It is divided among the inverters. Example: If you set this to 300A in a three-inverter system, each inverter will supply 100A. This setting is only effective in parallel inverter systems. For single inverter systems, see “Inverter Max Charge Current”.

Values = [0,1000]. Default = 150 per inverter. Units = Amps. Access = I.

### **System Discharge Current**

This is the maximum total battery discharge current while on-grid. This setting is only effective in parallel inverter systems. For single inverter systems, see “Battery Max Discharge Current”.

Values = [0,1000]. Default = 180 per inverter. Units = Amps. Access = I.

### **Battery Communication Type**

Select between RS-485 or CAN battery communication. The firmware only allows RS-485 for the 8k inverters. The 12k inverters only do CAN. This is automatically set during commissioning.

Values = [1=CAN,2=RS485]. Access = LE.

### **Current Transducer Ratio**

Two different sizes of CTs have been supplied with Sanctuary inverters. One is 90A/90mA for a 1000:1 ratio, used on Sanctuary 2 rev1 and rev2 inverter hardware. The other is 200A/100mA for a 2000:1 ratio used on Sanctuary 2 rev3, rev4, and Sanctuary 3.

Values = [1000,30000]. Default = (selected during commissioning). Access = LE.

### **Fault Reset Time**

Time in seconds to wait before trying to recover from a fault after the fault condition is no longer detected.

Values = [0,1000]. Default = 300. Units = seconds. Access = LE.

### **Solar Input Type**

The default setting is “independent”. This assumes that each MPPT has its own string. “Parallel” and “constant voltage source” are for testing purposes.

0 = independent (normal operation, default)

1 = parallel

2 = constant voltage source

3 = dual MPPT: (NEW) In this mode, you can connect one string to both MPPT1 & 2, and you can connect another string to both MPPT3 & 4. This is useful if you have a string that can supply more than 13A or more than 3500W. With this setting, you can only connect two strings: one connects to both MPPT1 & 2, while the other connects to both MPPT3 & 4. The 500V open circuit maximum voltage limit still applies. If you use dual MPPT, you must connect the string to both MPPT inputs.

Values = [0,3]. Default = 0. Access = LE.

### **Inverter Shutdown SOC**

If BMS auxiliary management is enabled, when there is no grid, no solar, and no generator power (when running off the batteries only), and the batteries get down to this SoC, the inverter will tell the batteries to disable discharging. This setting was added for off-grid applications of Sanctuary 2 rev1 where the controller would stay on when the power button was shut off and drain the batteries down to 0%.

Values = [0,100]. Default = 5%. Units = percent. Access = I.

### **Inverter Force Charge SOC**

Trigger a charge from grid after the batteries get down to this SoC.

Values = [0,100]. Default = 8%. Units = percent. Access = I.

### **Common Battery Bank**

Enabled: parallel inverters are connected to the battery bank in parallel.

Disabled: each inverter connects to its own battery. (This configuration is not supported.)

Values = [disabled, enabled]. Default = enabled for parallel; disabled for single. Access = LE.

## Common Grid CT

**Enabled:** all parallel inverters use the CT values read from the master inverter’s RJ45 grid CT port. The CTs should be installed on the main lines from the utility billing meter feeding the main panel. The inverter will be able to send power to cover loads on the main panel.

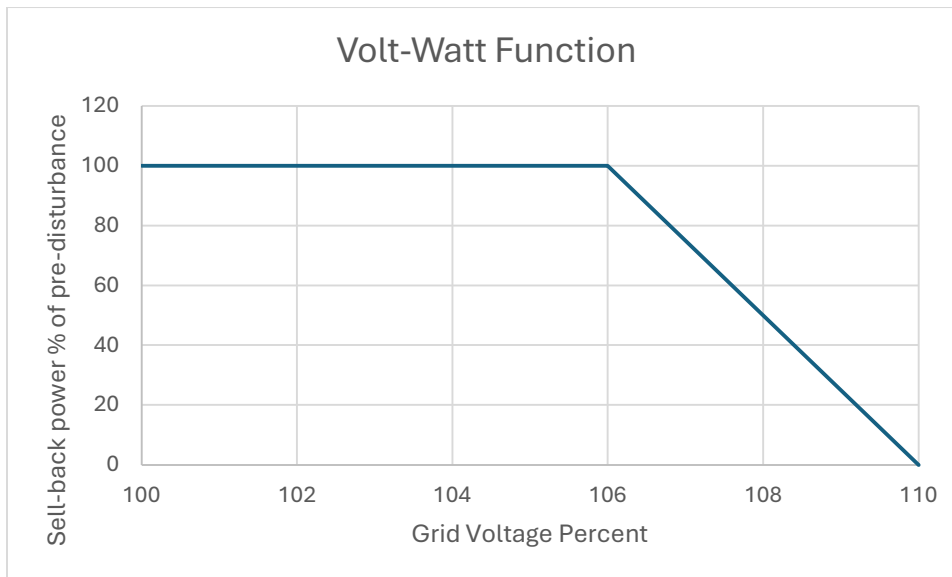
The grid current values are divided among the inverters. For example, if the line 1 CT reads 30A and there are three parallel inverters, then each inverter’s grid current on L1 will report 10A.

**Disabled:** Each inverter uses the CT current values read from its own CT port. The CTs will be installed on the grid lines at each inverter. This is typical in a whole-home backup configuration. The inverters will not sense any loads upstream of the CTs.

Values = [disabled, enabled]. Default = enabled for parallel inverter systems. Access = I.

## Power Voltage Response

Also known as Volt-Watt. See also “Grid Interactive Power Functions”.

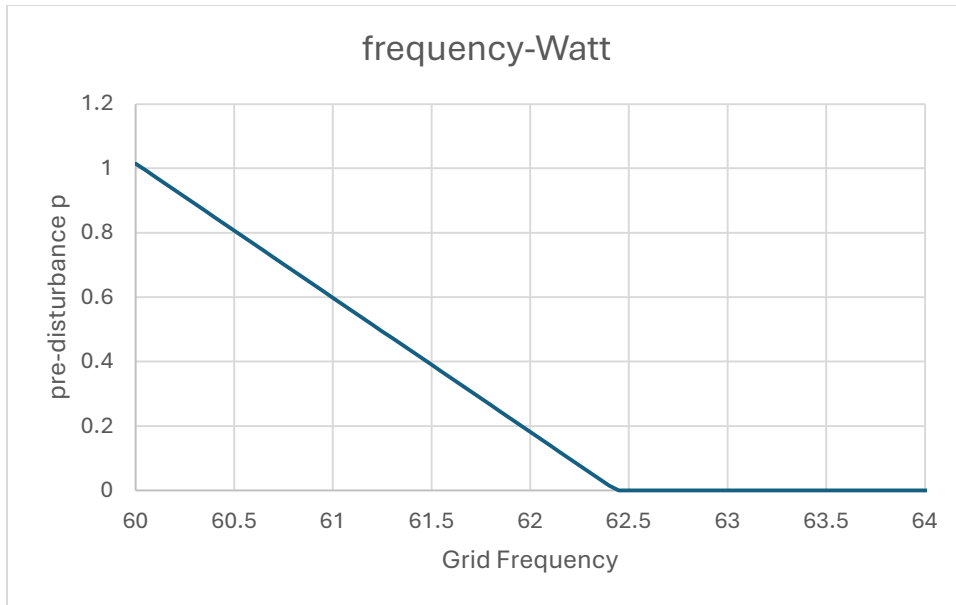


**Enabled:** Reduce grid sell-back power in response to grid over-voltage. Default settings have it start reducing sell-back power starting at 106% of normal grid voltage and taper down to zero sell-back at 110% of normal grid voltage.

Values = [disabled, enabled]. Default = enabled. Access = LE.

## Power Frequency Response

Also known as frequency-Watt. See also “Grid Interactive Power Functions”.



This needs to be enabled for AC solar. If the grid frequency increases more than the “Over-frequency Dead-Band dbOF” value, sell-back power will decrease according to the slope defined by “Over-frequency Droop kOF”. If frequency increases beyond the end of the sell-back slope, the inverter disconnects from the grid. The sell-back power remains zero until the grid frequency decreases by the “Over-frequency Recovery Deadband”.

Values = [disabled, enabled]. Default = disabled; enabled if AC solar is enabled. Access = LE.

### Charging Voltage Response

Battery charging power depends on grid voltage.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### Charging Frequency Response

Battery charging power depends on grid frequency.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### Anti-Islanding

Anti-islanding means that the inverter modifies its behavior while on-grid to prevent staying connected to the grid when a grid island forms. A grid island is when an area disconnects from the grid, but self-generation continues and keeps that isolated portion of the grid energized. The inverter uses grid voltage detection to generate an output current reference which is called forward feedback in the grid tied control algorithm. Without anti-islanding, the system may keep the grid relays closed when the grid gets disconnected. This could happen if the inverter power matches the load power right before being disconnected from

## Settings Guide

the grid, but this situation is unlikely to occur in real grid use because the balance is not easy to achieve.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Leakage Current Detection**

Enabled: Detects DC current leakage from the solar panels to ground. The nominal reading is around 10mA or less. If a jump of 30mA is detected, or if the leakage slowly increases to over 300 mA, the inverter will have a “GFCI over” alarm (A1\_10).

Disabled: the inverter will not shut down despite ground fault leakage.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **PV Insulation Detection**

When enabled, the PV insulation check happens once per day when on-grid, or only once after start-up when off-grid. The first check happens 2 minutes after the inverter turns on. When on-grid, this will put the inverter in internal bypass (grid stays connected to load, but the inverter disconnects from grid and load) for about 30s once every 24 hours to run a check on the PV insulation. When on-grid, it can do the check without losing power to the loads. When off-grid, only the first check is performed and it won't do the check every 24 hours so that you don't lose power once per day for 30s. Old firmware would do the check every day when off-grid.

Values = [disabled, enabled]. Default = disabled. Access = I.

### **LVRT (low voltage ride-through)**

Low voltage ride-through allows the inverter to stay connected to the grid longer during voltage dips.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### **HVRT (high voltage ride-through)**

High voltage ride-through allows the inverter to stay connected to the grid longer during voltage surges.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### **CT L1 Reverse**

Inverts the signal from the L1 CT. It has the same effect as changing the direction of the arrow on the CT. Currently, this setting does not get reset when recommissioning.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### **Home Load**

If the CTs are above the main panel, enable this bit to calculate the entire home load.

Enabled: Include main panel loads in the load kWh calculation.

Disabled: Only loads connected to the inverter load port are reported in kWh totals.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Battery Free Mode**

Disables battery warnings for PV-only systems.

This allows the inverter to operate without a battery connected. Maybe the only difference is that it won't alarm when it senses a disconnected battery.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### **BMS Auxiliary Management**

Since the Nov 2023 FW release, this allows the inverter to manage the charge & discharge MOSFETs in the batteries.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Limit Grid Charging**

When the battery is lower than the DOD, loads will be powered by the grid and it disables battery charging from the grid. The battery will only be charged from solar. Battery priority won't make it charge from the grid either. When solar charges it above the DOD, then grid charging can also contribute. But if you lose solar, grid charging is still disabled until the SoC reaches the TOU setting. After reconnecting solar, it waits for the grid reconnection time before grid charging again.

Values = [disabled, enabled]. Default = disabled. Access = LE.

### **Backup Enable**

Enabled: When the grid goes down, the inverter will use available solar, battery, and generator to power loads.

Disabled: When the grid goes down, loads will turn off.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Grid Voltage “Fast” Check**

This bit is labeled “ban fast check of grid V”.

Disabled: ban fast check of grid Voltage.

Enabled: allow fast checking of Grid Input Voltage (decreases time for transition from On-Grid to Off-Grid). But when tested, it's not different either way. The switch time is about the same both ways.

Values = [disabled, enabled]. Default = disabled. Access = LE.

## **10 Minute Average Over Pressure**

This setting is 10 Minute Over-Voltage Average. This is used in European inverter certification.

Values = [disabled, enabled]. Default = disabled. Access = LE.

## **Grid Charging**

Enabled: Allows batteries to charge using grid power.

Values = [disabled, enabled]. Default = (set during commissioning). Access = I.

## **PV Optimizer**

This is used when each solar panel has an optimizer. There's no problem running it with this setting enabled when there are no optimizers on the panels.

Values = [disabled, enabled]. Default = enabled. Access = I.

## **Battery Priority**

Enabled: Use the grid to charge and keep the battery at 100% SoC when the grid is on. It is recommended to not use this for more than a week at a time. This should remain disabled except for short-term use.

Disabled: The inverter can use the battery if the other settings permit it.

Values = [disabled, enabled]. Default = (set during commissioning). Access = I.

## **Solar Charge Only**

Enabled: The inverter will not charge from grid power or from generator power. Enabling this setting will also limit solar power to less than 500W when using a generator. When enabled, full solar power only will be available when the generator is off.

Disabled: Allow batteries to charge from grid when battery SOC < target SOC.

Values = [disabled, enabled]. Default = disabled. Access = I.

## **Double Overload**

Enabled: This allows the inverter to power not quite double (~14kW) the 8k EPS load power for about 9 seconds while off-grid.

Disabled: The inverter shuts down when the EPS load exceeds 8kW off-grid.

Values = [disabled, enabled]. Default = enabled. Access = LE.

## **Test Command 3**

This function has changed over the firmware revisions. Since the July 2023 FW release, it's "L1 L2 independent adjust". This allows the inverter to adjust power output for each line independently. When one line is drawing more than 4kW, it can send power

## Settings Guide

from the other line back through the grid transformer to power the line that needs it. Conditions: self-consume mode (using battery power with grid on), with grid sell-back allowed.

Example: 5kW load on L1, 0kW load on L2. Inverter sells back 2.5kW on L2, back through the grid transformer, and draws 2.5kW on L1 from the grid. (Selling back on L2 and drawing the same amount of power on L1 equals zero grid power draw.) The inverter generates 2.5kW on L1 while also drawing 2.5kW from grid L1 to send 5kW to the load on L1.

When disabled, self-consume can only produce up to 4kW per line (8kW total). The power produced by each inverter line goes directly to the load. Each inverter line is limited to 4kW maximum. Any more than that will come from the grid. So if L1 has 5kW load and L2 has 0kW load, then the inverter will generate 4kW in L1 and draw 1kW from the grid on L1.

Inverter L2 and grid L2 will be 0W since load = 0W.

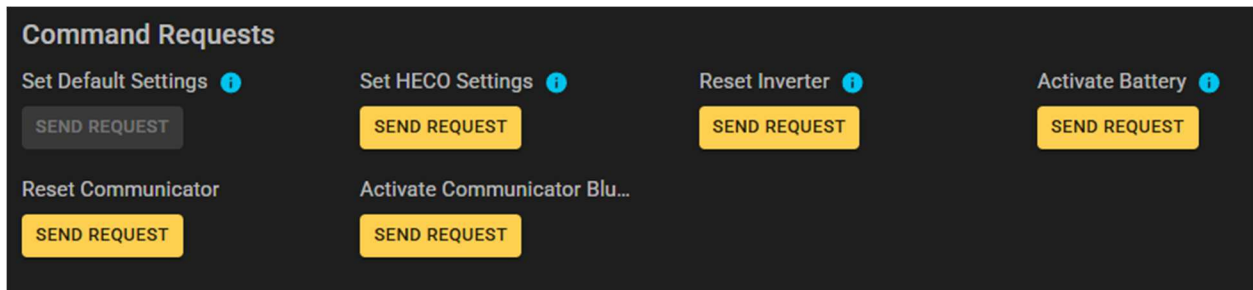
Values = [disabled, enabled]. Default = disabled. Access = LE.

### Ignore Battery Low Voltage

Can ignore low battery voltage warnings.

Values = [disabled, enabled]. Default = disabled. Access = LE.

## Command Requests



### Set Default Settings

This is only available for single inverter systems. This sends a command to the WCM to set the inverter settings to default. The reason it's not available for parallel inverters is that it would take the inverters out of parallel. Access = LE.

### Set HECO Settings

This loads the default grid interactive setting values as required by HECO (Hawaii Electric). This sends a command to the communicator to load these settings into the inverter(s). Access = LE.

## Reset Inverter

The communicator sends a series of commands to reboot the DSP processor. The ARM processor is not rebooted with this command. Access = LE.

## Activate Battery

A single inverter with a single battery can draw enough current when first connected to the battery to trigger the BMS short-circuit protection. Charging the capacitors can draw well over 300A for a short time. If the BMS has disabled discharging, the battery port on the inverter may drop to around 11V if the grid is on. When this command is sent, the inverter will wait one minute and then increase the battery port voltage to about 48.5V. If the battery internal voltage is higher than this, it won't receive charging current. The inverter will reset this register to 0 about a minute after you write a 1 to this register. If the battery keeps discharging disabled, then the voltage might fall back down to 11V.

Values = [0,1]. Default = 0. Access = LE.

## Reset Communicator

Reboots the communicator. The communicator will also read all the inverter settings and upload them. Access = LE.

## Activate Communicator Bluetooth

This only works if the communicator is online and able to receive the command from the internet. This puts the communicator in Bluetooth pairing mode. If no Bluetooth connection is made after a certain time, it times-out and will reconnect to WiFi. Access = LE.

## Communicator Settings - SoC Drift

The screenshot shows a settings interface for 'Communicator Settings - SoC Drift'. It features a dark background with white text and several adjustable parameters. A 'SoC Drift Auto Reset' checkbox is checked. The parameters are arranged in a grid:

Parameter	Value	Unit
Drift Minimum Cell Voltage Threshold	3420	mV
Drift Maximum Cell Voltage Threshold	3550	mV
Auto Reset Drift SoC Threshold	98	%
Manual Reset Drift SoC Threshold	88	%
Drift Battery Current Upper Threshold	1	A
Drift Battery Current Lower Threshold	-5	A

## SoC Drift Auto Reset

The SoC Drift Reset function is only effective on Sanctuary 2. This enables the communicator to send a command to reset a battery to 100% if it detects that the battery should be reporting 100% but is reading less than the “Auto Reset Drift SoC Threshold”. If

this is disabled, then it can reset the SoC to 100% if the battery is reading less than the “Manual Reset Drift SoC Threshold” when it should be reporting 100%.

Values = [disabled, enabled]. Default = enabled. Access = LE.

### **Drift Minimum Cell Voltage Threshold**

If the minimum cell voltage is greater than this value for more than five minutes while the battery current is between the “Drift Battery Current Upper Threshold” and the “Drift Battery Current Lower Threshold”, then the communicator can send the command to reset that battery’s SoC to 100%.

Values = [3000,3650]. Default = 3420. Units = mV. Access = LE.

### **Drift Maximum Cell Voltage Threshold**

If the maximum cell voltage is greater than this value for more than five minutes while the battery current is between the “Drift Battery Current Upper Threshold” and the “Drift Battery Current Lower Threshold”, then the communicator can send the command to reset that battery’s SoC to 100%.

Values = [3000,3650]. Default = 3550. Units = mV. Access = LE.

### **Auto Reset Drift SoC Threshold**

If a battery SoC reads less than this value and “SoC Drift Auto Reset” is enabled, the communicator can send a request to the inverter to set the battery’s SoC to 100% if it meets the reset criteria.

Values = [0,100]. Default = 98. Units = percent. Access = LE.

### **Manual Reset Drift SoC Threshold**

If a battery SoC reads less than this value, the communicator can send a request to the inverter to set the battery’s SoC to 100% if it meets the reset criteria.

Values = [0,100]. Default = 88. Units = percent. Access = LE.

### **Drift Battery Current Upper Threshold**

The battery must be between the upper and lower current thresholds for five minutes before the communicator will send a battery SoC reset command to the inverter.

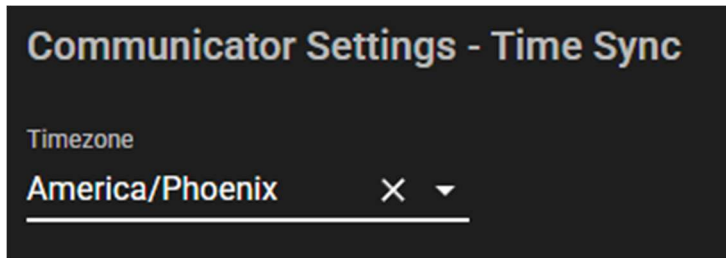
Values = [-327.68, 327.67]. Default = 1. Units = Amps. Access = LE.

### **Drift Battery Current Lower Threshold**

The battery must be between the upper and lower current thresholds for five minutes before the communicator will send a battery SoC reset command to the inverter.

Values = [-327.68, 327.67]. Default = -5. Units = Amps. Access = LE.

## Communicator Settings – Time Sync



### Timezone

Select the time zone that the Sanctuary is in.

Values = [time zones]. Default = (set during commissioning). Access = l.

## Settings Requiring Lion Energy Support

All the settings from here to the end of the document are not in the web app but are accessible by the Lion Energy ESS support team.

### On-Grid to Off-Grid Adjustment Time

When the grid goes down, the relays take a certain amount of time to open after power to the coil is turned off. This takes about 16ms on a Sanctuary 2 rev4. A positive value adds to the default delay, while a negative value subtracts from the delay. The factory default time isn't long enough in some cases, so the default setting is 4ms. If the inverter has an over-current alarm and shuts off the load power for five minutes when the grid goes down, try increasing this value by a couple milliseconds. Note: turning off the breaker cannot test for this time delay.

Values = [-40, 40]. Default = 4.

### Generator disconnect adjustment time

When the generator turns off, the relays take a certain amount of time to open after power to the coil is turned off. A positive value adds to the default delay, while a negative value subtracts from the delay. If the time isn't long enough, it can cause the inverter to over-current and fault when turning off the generator.

Values = [-40, 40]. Default = 4.

### Generator Ramp Enable (Grid Func W3b1)

Enabled: ramp the generator demand load by 1kW/s ramp rate. This allows the generator time to adjust the throttle to help prevent low RPM / low frequency cut-out. Battery-to-

inverter power is used to enable this feature. Once the generator is covering loads, then the battery can resume charging.

Disabled: The inverter doesn't use any battery power while the generator is on.

### **CT L2 reverse (Grid Func W3b13)**

Enabled: reverse the signal from grid CT line 2 (same as changing the direction of the arrow). Default = disabled.

### **CT self-test trigger (Grid Func W3b14)**

Writing to this bit starts the CT self-test. The bit value is not stored. The battery must be able to charge from the grid or the test will not run. The test draws 1kW from grid L1 for 10s and then draws 1kW from grid L2 for 10s. Test results can be read from the CT Test Result register.

### **Sell-First Mode Enable (Grid Func W4b7, Sanctuary 3 only)**

Enabled: Allow sell-first mode. If this bit isn't set, sell-first mode won't sell battery power to the grid.

Default = disabled.

### **CT L1/L2 Swap (Grid Func W4b9)**

Enabled: has the same effect as swapping the CTs between L1 and L2.

Default = disabled.

### **SPI auto-reset enable (Grid Func W4b10)**

This setting was for troubleshooting a chip communication issue in previous firmware.

Default = disabled.

### **Time of Use Enable Day of Week**

This specifies what days to use TOU settings. Bit 0 is for Sunday (1 = enable). Bit 1 for Monday . . . bit 6 for Saturday.

Values = [0,127]. Default = 127.

### **Accept BMS Force Charge Command [Sanctuary 3 only]**

If the BMS issues a force charge command, enabling this will cause the inverter to charge the battery until the force charge command turns off.

Values = [disabled, enabled]. Default = disabled.

### **Generator Low Frequency Fast Trip**

If the generator falls below this frequency, the inverter will disconnect the generator.

Values = [4000,7000]. Default = 5200. Units = 0.01 Hz.

### **Generator Low Frequency Fast Trip Confirm Time**

If the generator falls below this frequency for this amount of time, the inverter will disconnect the generator.

Values = [0,10000]. Default = 4. Units = ?

## **Grid Interactive Settings**

Most electric utility companies have their own set of values they require these settings to be set to. Please check with your utility company for their requirements. As an example, Rocky Mountain Power in Utah requires these settings: ([link](#)).

### **MT\_NP\_NORMAL\_OP\_CAT-APP**

Category B is required for voltage regulation performance and reactive power capability requirements (Refer to IEEE 1547-2018, Clause 5).

Values = [0=Cat\_A, 1=Cat\_B]. Default = Cat\_B.

### **MT\_NP\_ABNORMAL\_OP\_CAT-APP**

Category III for disturbance ride-through requirements (Refer to IEEE 1547-2018, Clause 6)

Values = [0=cat I, 1=cat II, 2=cat III]. Default = 2 (cat III).

### **Enter service after trip parameters (UL ctl word b7)**

Default = enabled.

### **AP\_LIMIT\_ENABLE (UL ctl word b8)**

Default = enabled.

### **ES\_PERMIT\_SERVICE (UL ctl word b9)**

This is an IEEE2030.5 setting.

Values = [enabled, disabled]. Default = enabled.

## **Enter Service**

### **ES\_V\_LOW**

This is the minimum grid voltage at which the inverter will reconnect to the grid. 1000 = 100% = 240V

Values = [800,1200]. Default = 917 (0.917 \* nominal voltage). Units = 0.1%

## **ES\_V\_HIGH**

This is the maximum voltage at which the inverter will reconnect to the grid.  
Values = [800,1200]. Default = 1050 (1.05 \* nominal voltage). Units = 0.1%

## **ES\_F\_LOW**

This is the minimum frequency at which the inverter will reconnect to the grid.  
Values = [4000,7000]. Default = 5950. Units = 0.01 Hz.

## **ES\_F\_HIGH**

This is the maximum frequency at which the inverter will reconnect to the grid.  
Values = [4000,7000]. Default = 6010. Units = 0.01 Hz.

## **ES\_RANDOMIZED\_DELAY**

This has been implemented as a fixed time delay. Some utilities will accept a randomized delay instead of a fixed 5 minute delay.  
Values = [0,6000]. Default = 0. Units = 0.1s.

## **ES Ramp Rate (Normal start rate)**

This is the ramp rate to full power that is used when the grid has been on. For example, when you start selling back power when extra solar power is available.  
Values = [0,10000]. Default = 333. Units = 0.01% P/s

## **ES\_RAMP\_RATE**

This is the ramp rate to full power that is used when the grid comes back on and the inverter wants to start selling power. Higher numbers result in a faster ramp rate. For example, if there's 4kW of power and "Soft Start Rate" = 33 (0.33% of 8kW per second = 26.4 W/s ramp rate), it will take 151.5 seconds to ramp up to 4kW of sell-back.  
Values = [0,10000]. Default = 33. Units = 0.01% P/s

## **Reactive Power Settings**

Inverters up to 15kW are required to be capable of producing reactive power at up to 44% of the real power level.

### **Lock-out Power**

When real power output is below this percentage of the inverter's maximum power rating, no reactive power is produced. Reactive power is only produced above this active power level. For the default level of 5% on an 8kW inverter, this means that reactive power can start being produced when the inverter is producing more than 400W real power.

## Settings Guide

Values = [0,1000]. Default = 50. Units = 0.1%

### **Lock-in Power**

When real power output is above this percentage of the inverter's maximum power rating, the inverter can produce reactive power up to 44% of the real power levels. Reactive power is tapered between the lock-in and lock-out real power levels. For the default level of 20% on an 8kW inverter, this means that the 44% of reactive power is available when producing at least 1600W of real power.

Values = [0,1000]. Default = 200. Units = 0.1%

### **Reactive Type**

This selects between one of four reactive power modes. See each section for more details.

0: Constant Power Factor mode

1: Constant Reactive Power mode

2: Volt-VAR mode

3: Watt-VAR mode

Values = [0,3]. Default = 0 (Const power factor mode).

### **CONST\_PF**

This setting is effective when "Reactive Type" = 0 (constant power factor mode). In this mode, power is sold back at a constant power factor such as -0.95 or 1.00. A constant power factor of 1.00 is the default setting for inverters that don't need to produce any reactive power. When selling back power, the inverter will adjust the power factor to this setting.

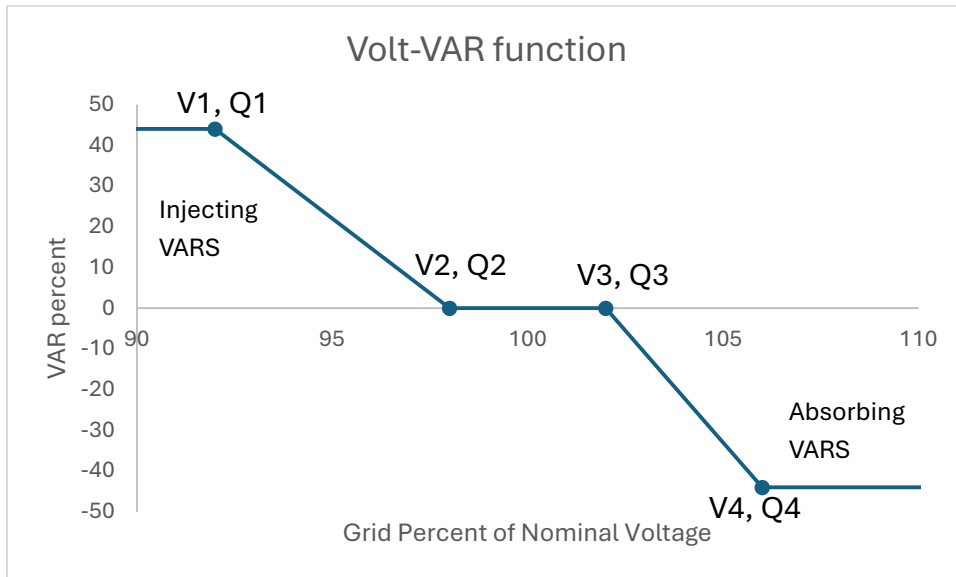
Values [-99,100]. Default = 100. Units = 0.01 PF (power factor).

### **CONST\_Q**

This is the percent of reactive power to inject or absorb when "Reactive Type" = 1 (reactive power mode). For example, if this is -10, then the inverter will sell back 10% reactive power, absorbing VARs. If this is +10, then the inverter will sell back 10% reactive power, injecting VARs. The active part of the total VARs is 90%, while the reactive part is 10%. For our size inverter, this is never required to be more than 44%.

Values = [-70, 70]. Default = 0. Units = percent.

## Volt-VAR Mode



The Volt-VAR mode will allow the inverter to adjust injecting or absorbing VARs based on the grid voltage. This helps grid stability when there are a lot of inverters on the grid generating power. The Volt-VAR settings are part of UL 1741 SA.

### QV\_VREF

Per unit value based on NP\_AC\_V\_NOM (voltage base)

Values [0,1500]. Default = 1000. Units = 0.1%\*Vpu

### QV\_VREF\_AUTO\_MODE

Autonomous Vref adjustment enable.

Values [disabled, enabled]. Default = disabled.

### QV\_VREF\_TIME

Vref adjustment time constant in seconds as specified by the area EPS operator.

Values = [0,65535]. Default = 3000. Units = 0.1 s

### QV Curve Points

QV\_CURVE\_V1: Values = [800,1200]. Default = 920. Units = 0.1%\*Vpu

QV\_CURVE\_V2: Values = [800,1200]. Default = 980. Units = 0.1%\*Vpu

QV\_CURVE\_V3: Values = [800,1200]. Default = 1000. Units = 0.1%\*Vpu

QV\_CURVE\_V4: Values = [800,1200]. Default = 1060. Units = 0.1%\*Vpu

QV\_CURVE\_Q1: Values = [100,700]. Default = 440. Units = 0.1%\*Vpu

QV\_CURVE\_Q2: Values = [0,700]. Default = 0. Units = 0.1%\*Vpu

## Settings Guide

QV\_CURVE\_Q3: Values = [0,700]. Default = 0. Units = 0.1%\*Vpu

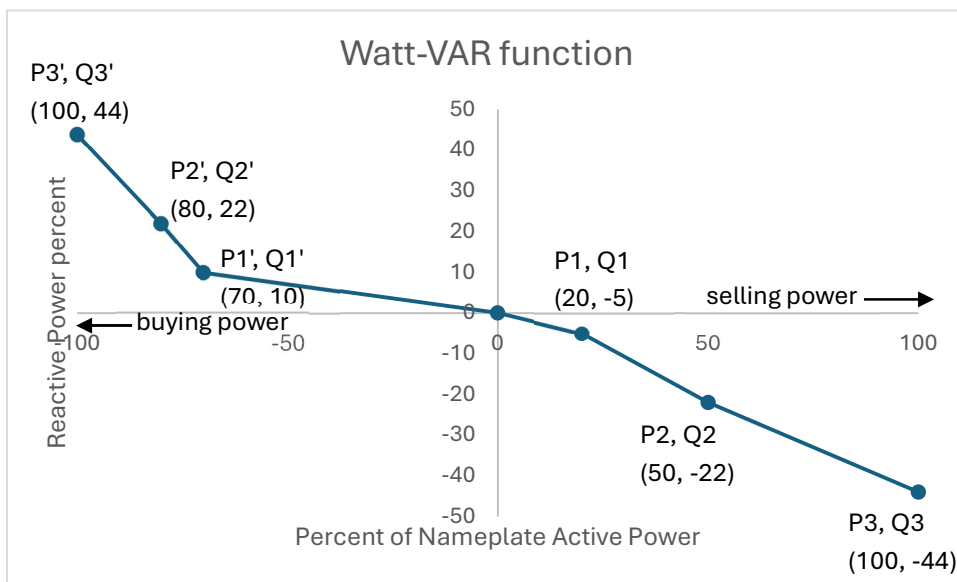
QV\_CURVE\_Q4: Values = [100,700]. Default = 440. Units = 0.1%\*Vpu

### QV\_OLRT

This is the Q curve response time. It's how long it takes to change the Q curve from the existing value to the target value. Default for HECO is 5 seconds. For example, you're selling back at PF=1 because the voltage is 240V. If the grid voltage changes suddenly to 250V, it will steadily adjust the VAR absorption until the target value is reached in 5 seconds.

Values = [100,30000]. Default = 500. Units = 0.01s

## Watt-VAR Mode



This mode changes the reactive power based on how much power the inverter is selling back to the grid or using to charge the batteries. When charging the batteries, the inverter injects VARs. When selling power to the grid, the inverter absorbs VARs. This function should only be enabled if the utility company requires it.

### QP Points

QP\_CURVE\_P1\_GEN: Values = [0,100]. Default = 20. Units = %

QP\_CURVE\_P2\_GEN: Values = [0,100]. Default = 50. Units = %

QP\_CURVE\_P3\_GEN: Values = [0,100]. Default = 100. Units = %

QP\_CURVE\_P1\_LOAD: Values = [0,100]. Default = 70. Units = %

QP\_CURVE\_P2\_LOAD: Values = [0,100]. Default = 80. Units = %

QP\_CURVE\_P3\_LOAD: Values = [0,100]. Default = 100. Units = %

QP\_CURVE\_Q1\_GEN: Values = [0,450]. Default = 440. Units = %

## Settings Guide

QP\_CURVE\_Q2\_GEN: Values = [0,450]. Default = 440 (change to 0). Units = %

QP\_CURVE\_Q3\_GEN: Values = [0,450]. Default = 440 (change to 0). Units = %

QP\_CURVE\_Q1\_LOAD: Values = [0,450]. Default = 440 (change to 0). Units = %

QP\_CURVE\_Q2\_LOAD: Values = [0,450]. Default = 440 (change to 0). Units = %

QP\_CURVE\_Q3\_LOAD: Values = [0,450]. Default = 440 (change to -440). Units = %

### QP\_OLRT

This is how long the inverter waits to react to changes in reactive power based on the real power change. This is effective when the “Reactive Type” is set to Watt-VAR mode.

Values = [1,6000]. Default = 100. Units = 0.1s

## Power Voltage Response

When the grid voltage exceeds V1, the inverter reduces sell-back linearly until V2, at which point sell-back power is zero. The decrease is based on the sell-back value at the time the voltage went above V1. These Volt-Watt settings are part of UL 1741 SA.

### VP Curve Points

PV\_CURVE\_V1: Values = [105,109]. Default = 106. Units = %

PV\_CURVE\_V2: Values = [106,115]. Default = 110. Units = %

PV\_CURVE\_P1: Values = [0,100]. Default = 100. Units = %

PV\_CURVE\_P2: Values = [0,100]. Default = 0. Units = %

PV\_OLRT: Values = [50, 30000]. Default = 50. Units = 0.01s

## Power Frequency Response Settings

The frequency-Watt function is part of UL 1741 SA. If this mode is enabled, the sell-back power will be reduced when the grid is over-frequency. See also Advanced Settings > “Power Frequency Response”.

### PF\_DBOF

Over frequency deadband offset from nominal frequency in Hz. Frequency values shall be reported to 3 decimal places. This is how much higher than 60Hz the grid can go before the inverter starts tapering off the sell-back. The max writeable value is 5000, but it's only effective up to 1000 (1Hz). The sell-back tapers off according to the slope in “Over-frequency Droop kOF”.

Values = [0,1000]. Default = 36. Units = 0.001 Hz

### **PF\_DBUF**

Under frequency deadband offset from nominal frequency in Hz. Frequency values shall be reported to 3 decimal places. This is how much lower than 60Hz the grid can go before the inverter changes its sell-back power levels.

Values = [17,1000]. Default = 36. Units = 0.001 Hz

### **PF\_KOF**

Over frequency per unit frequency change corresponding to a 1 per unit power change (frequency droop). The lower the number, the faster the drop-off of sell-back as frequency rises. At “Over-frequency Droop kOF”=300, the taper-off is the most gradual. The sell-back power above the over-frequency deadband is limited by the pre-disturbance sell-back power level.

Values = [1,300]. Default = 40. Units = 0.001 Hz

### **PF\_KUF**

Under frequency per unit frequency change corresponding to a 1 per unit power change (frequency droop). This is the slope of how fast the sell-back can increase as the grid frequency decreases below 60Hz – dbUF.

Values = [1,50]. Default = 40. Units = 0.001 Hz

### **PF\_OLRT**

Frequency-Watt open loop response time

Values = [5,3000]. Default = 50. Units = 0.01 s

## **Voltage Trip Points (HVRT & LVRT)**

When the grid voltage goes beyond one of the trip points, the inverter will disconnect from the grid after the time specified in the corresponding register. These voltage ride-through settings are part of UL 1741 SA.

### **OV3\_TRIP\_V**

Values = [1000,1400]. Default = 1200. Units = 0.1%

### **OV3\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01s

### **OV2\_TRIP\_V**

Values = [100,1500]. Default = 1200. Units = 0.1%

### **OV2\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01s

### **OV1\_TRIP\_V**

Values = [1000,1400]. Default = 1100. Units = 0.1%

### **OV1\_TRIP\_T**

Values = [0,30000]. Default = 130. Units = 0.1s

### **UV1\_TRIP\_V**

Values = [0,1000]. Default = 880. Units = 0.1%

### **UV1\_TRIP\_T**

Values = [0,30000]. Default = 210. Units = 0.1s

### **UV2\_TRIP\_V**

Note: UV2\_TRIP\_V must be  $\leq 88\%$  for it to function.

Values = [0,1000]. Default = 100. Units = 0.1%

### **UV2\_TRIP\_T**

Values = [0,30000]. Default = 200. Units = 0.01s

### **UV3\_TRIP\_V**

Values = [0,1000]. Default = 100. Units = 0.1%

### **UV3\_TRIP\_T**

Values = [0,32767]. Default = 16. Units = 0.01s

## **Frequency Trip Points**

When the grid voltage or frequency goes beyond one of the trip points, the inverter will disconnect from the grid after the time specified in the corresponding register. These frequency ride-through settings are part of UL 1741 SA.

### **OF3\_TRIP\_F**

Values = [4000,7000]. Default = 6500. Units = 0.01 Hz.

### **OF3\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01 s.

### **OF2\_TRIP\_F**

Values: [4000,7000]. Default = 6500. Units = 0.01 Hz.

### **OF2\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01s.

### **OF1\_TRIP\_F**

Values = [4000,7000]. Default = 6300. Units = 0.01 Hz

### **OF1\_TRIP\_T**

Values = [0,30000]. Default = 1800. Units = 0.1 s

### **UF1\_TRIP\_F**

Note that UF1 can only be effective up to 59.99 Hz. If it's set above that value, it won't work.

Values = [4000,7000]. Default = 5700. Units = 0.01 Hz

### **UF1\_TRIP\_T**

Values = [0,30000]. Default = 1800. Units = 0.1 s

### **UF2\_TRIP\_F**

Values = [4000,7000]. Default = 5000. Units = 0.01 Hz

### **UF2\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01s

### **UF3\_TRIP\_F**

Values = [4000,7000]. Default = 5600. Units = 0.01 Hz

### **UF3\_TRIP\_T**

Values = [0,30000]. Default = 16. Units = 0.01 s.

## **Calibration**

If any of the following voltage or current readings are noticeably wrong, they can be calibrated.

- Inverter battery port voltage, current
- Grid port voltage, current

## Settings Guide

- Load port voltage, current
- MPPT voltage, current
- Generator port voltage, current, power

# Settings Guide



385.375.8191  
Monday – Friday  
9:00 AM – 5:00 PM MST



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