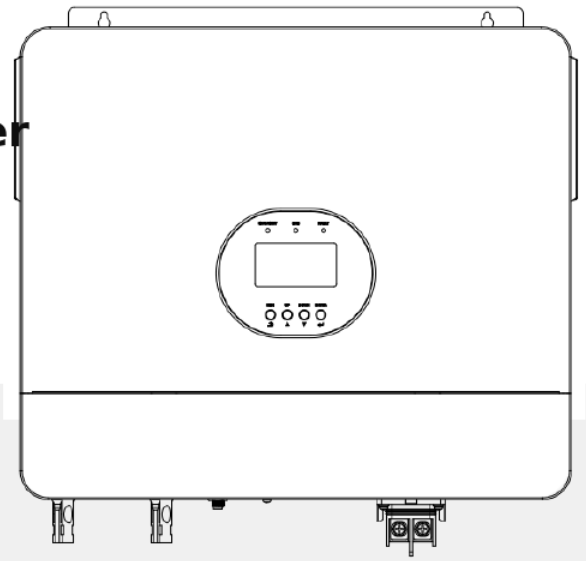
# User Manual

## Off Grid Power Converter

## SPF 6000 ES PLUS



Version: 1.0

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# Information on this Manual

## Validity

This manual is valid for the following devices:

- SPF 6000 ES PLUS

## Scope

This manual describes the assembly, installation, operation and troubleshooting of this unit. Please read this manual carefully before installations and operations.

## Target Group

This document is intended for qualified persons and end users. Tasks that do not require any particular qualification can also be performed by end users. Qualified persons must have the following skills:

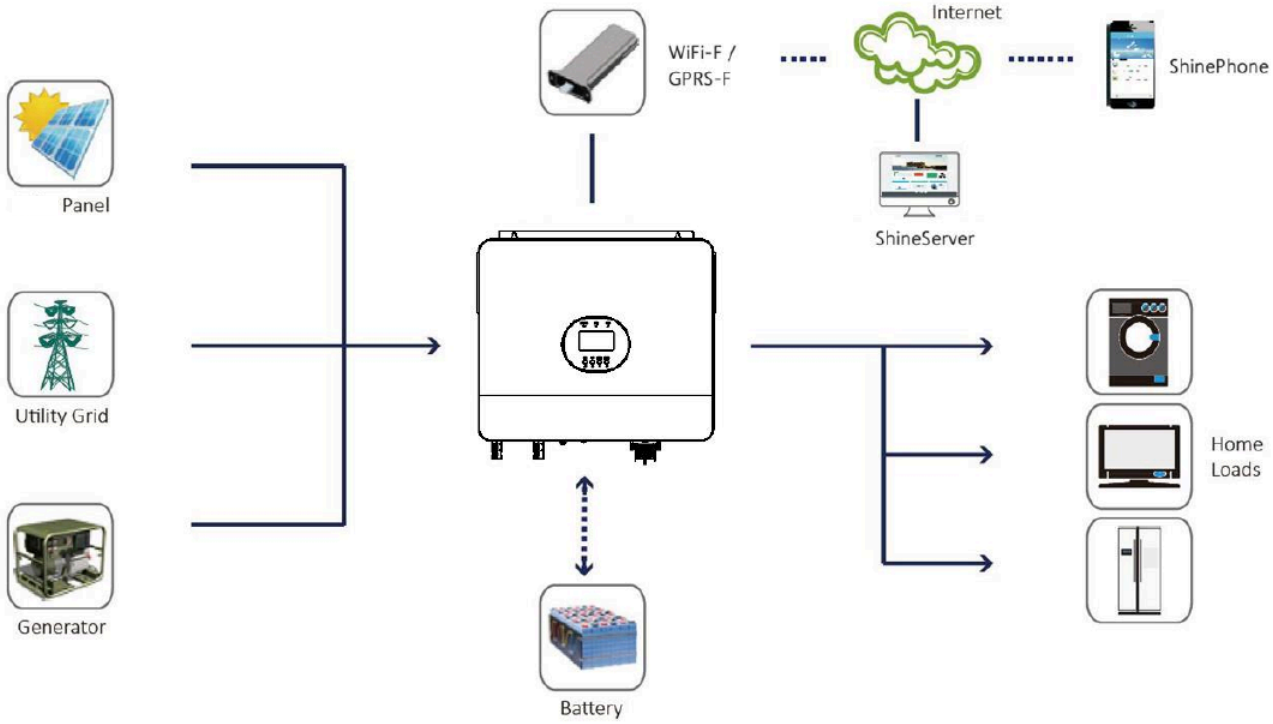
- Knowledge of how an power converter works and is operated
- Training in how to deal with the dangers and risks associated with installing and using electrical devices and installations
- Training in the installation and commissioning of electrical devices and installations
- Knowledge of the applicable standards and directives
- Knowledge of and compliance with this document and all safety information

## Safety Instructions

⚠ **WARNING: This chapter contains important safety and operating instructions. Read and keep this manual for future reference.**

1. Please be clear which kind of battery system you want, lithium battery system or lead-acid battery system, if you choose the wrong system, energy storage system can't work normally.
2. Before using the unit, read all instructions and cautionary marking on the unit, the batteries and all appropriate sections of this manual. The company has the right not to quality assurance, if not according to the instructions of this manual for installation and cause equipment damage.
3. All the operation and connection please professional electrical or mechanical engineer.
4. All the electrical installation must comply with the local electrical safety standards.
5. When install PV modules in the daytime, installer should cover the PV modules by opaque materials, otherwise it will be dangerous as high terminal voltage of modules in the sunshine.
6. **CAUTION-**To reduce risk of injury, charge only deep-cycle lead-acid type rechargeable batteries and lithium batteries. Other types of batteries may burst, causing personal injury and damage.
7. Do not disassemble the unit. Take it to a qualified service center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire.
8. To reduce risk of electric shock, disconnect all wirings before attempting any maintenance or cleaning. Turning off the unit will not reduce this risk.
9. **NEVER** charge a frozen battery.
10. For optimum operation of this power converter. please follow required spec to select appropriate cable size. It's very important to correctly operate this power converter.
11. Be very cautious when working with metal tools on or around batteries. A potential risk exists to drop a tool to spark or short circuit batteries or other electrical parts and could cause an explosion.
12. Please strictly follow installation procedure when you want to disconnect AC or DC terminals. Please refer to INSTALLATION section of this manual for the details.
13. GROUNDING INSTRUCTIONS -This power converter should be connected to a permanent grounded wiring system. Be sure to comply with local requirements and regulation to install this power converter.
14. **NEVER** cause AC output and DC input short circuited. Do NOT connect to the mains when DC input short circuits.
15. Make sure the power converter is completely assembled, before the operation.

# Introduction




Hybrid Power System

This is a multifunctional off grid power converter. integrated with a MPPT charge controller, a high frequency pure sine wave power converter and a UPS function module in one machine, which is perfect for off grid backup power and self-consumption applications. This power converter can work with or without batteries.

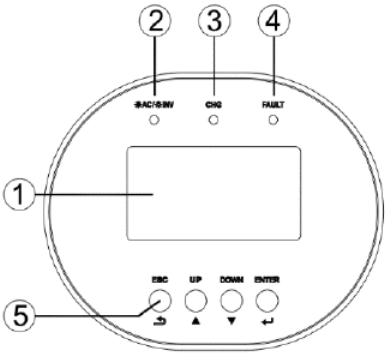
The whole system also need other devices to achieve complete running such as PV modules, generator, or utility grid. Please consult with your system integrator for other possible system architectures depending on your requirements. The WiFi / GPRS module is a plug-and-play monitoring device to be installed on the power converter. With this device, users can monitor the status of the PV system from the mobile phone or from the website anytime anywhere.

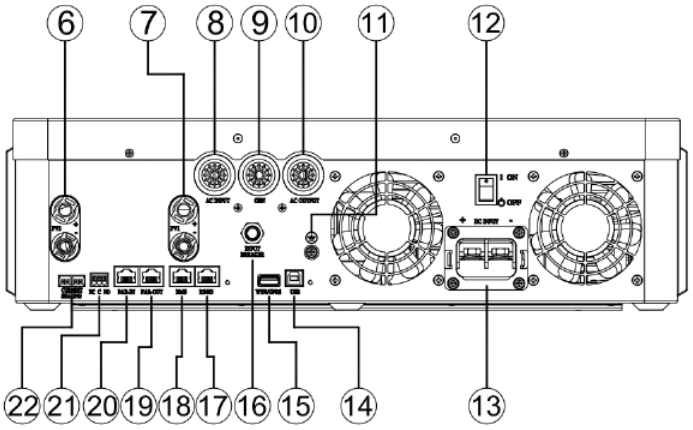
## Features

- Rated power 6KW, power factor 1
- MPPT ranges 120V~450V, 500Voc
- High frequency power converter with small size and light weight
- Pure sine wave AC output
- and utility grid can power loads at the same time
- With CAN/RS485 for BMS communication
- With the ability to work without battery
- Parallel operation up to 6 unit (only with battery connected)
- WIFI/ GPRS remote monitoring (optional)

# Product Overview





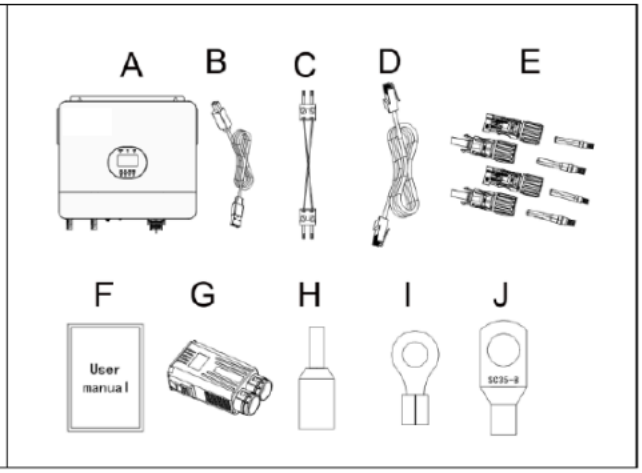

1. LCD display
2. Status indicator
3. Charging indicator
4. Fault indicator
5. Function buttons
6. PV2 input
7. PV1 input
8. AC input
9. Generator input
10. AC output
11. GND
12. Power on/off switch
13. Battery input
14. USB communication port
15. WiFi/GPRS communication port
16. Circuit breaker
17. RS485 communication port (for expansion)
18. BMS communication port (support CAN/RS485 protocol)
19. Parallel communication ports (PAR-OUT)
20. Parallel communication ports ((PAR-IN)
21. Dry contact
22. Current sharing ports

# Installation

## Unpacking and Inspection

Before installation, please inspect the unit. Be sure that nothing inside the package is damaged. You should have received the following items in the package:

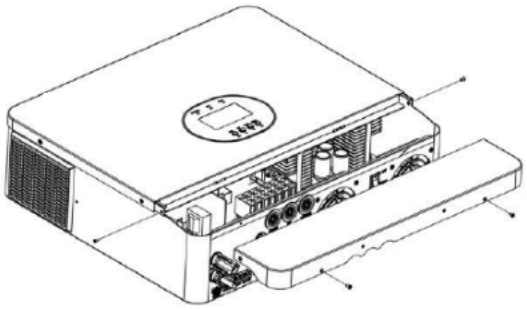
| Part List | | |
|---|---|---|
| Item | Item Name | Qty |
| A | The unit | 1 |
| B | Communication cable | 1 |
| C | Current sharing cable | 1 |
| D | Parallel communication cable | 1 |
| E | MC4 connector | 4 |
| F | User manual | 1 |
| G | Protective shell | 1 |
| H | Tubular terminal | 7 |
| I | R-type terminal | 1 |
| J | O-type terminal | 2 |




Note: The Software CD is no longer provided, if necessary, please download it from the official website www.ginverter.com

## Preparation

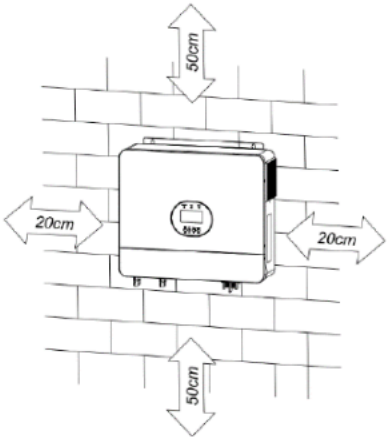
Before connecting all wiring, please take off bottom cover by removing four screws as shown below.



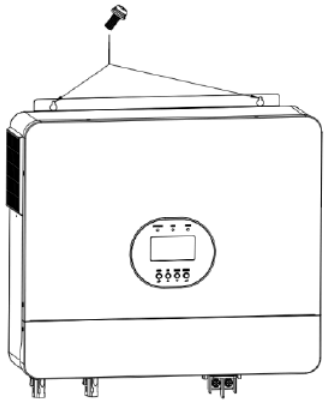
## Mounting the Unit

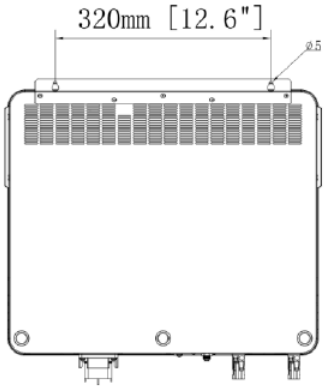
Consider the following points before selecting where to install:

- Do not mount the power converter on flammable construction materials.
- Mount on a solid surface
- Install this power converter at eye level in order to allow the LCD display to be read at all times.
- The ambient temperature should be between 0°C and 55°C to ensure optimal operation.
- The recommended installation position is to be adhered to the wall vertically.
- Be sure to keep other objects and surfaces as shown in the right diagram to guarantee sufficient heat dissipation and to have enough space for removing wires.



**SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY.**






Install the unit by screwing three screws. It's recommended to use M4 or M5 screws.

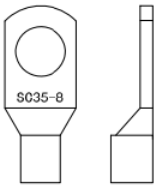
# Battery Connection

## Lead-acid Battery Connection

User can choose proper capacity lead acid battery with a nominal voltage at 48V. Also, you need to choose battery type as "AGM(default) or FLD"

**CAUTION:** For safety operation and regulation compliance, it's requested to install a separate DC over-current protector or disconnect device between battery and power converter. It may not be requested to have a disconnect device in some applications, however, it's still requested to have over-current protection installed. Please refer to typical amperage in below table as required fuse or breaker size.

**O-type terminal:**




**WARNING!** All wiring must be performed by a qualified person.
**WARNING!** It's very important for system safety and efficient operation to use appropriate cable for battery connection. To reduce risk of injury, please use the proper recommended cable and terminal size as below.

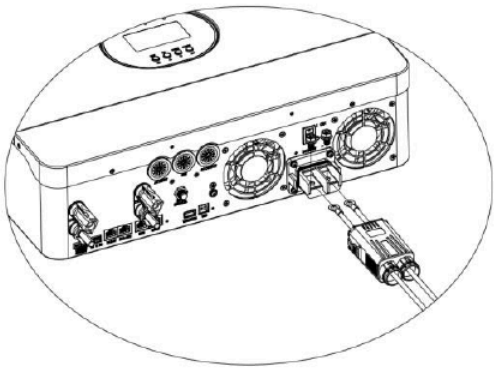
### Recommended battery cable and terminal size:

| Model | Wire Size | Torque value |
|---|---|---|
| SPF 6000 ES PLUS | 1 * 2 AWG | 2-3 Nm |

**Note: For lead acid battery, the recommended charge current is 0.2C(C→battery capacity)**

Please follow below steps to implement battery connection:

1. Assemble battery ring terminal based on recommended battery cable and terminal size.
2. Connect all battery packs as units requires. It's suggested to connect at least 200Ah capacity battery for SPF 6000 ES PLUS.
3. Frist，pass the battery cable through the protective shell，and then insert the ring terminal of battery cable flatly into battery connector of power converter and make sure the bolts are tightened with torque of 2Nm. Make sure polarity at both the battery and the power converter/charge is correctly connected and ring terminals are tightly screwed to the battery terminals.Last，insert the protective shell.



| | |
|---|---|
| ⚠ | **WARNING: Shock Hazard**<br>Installation must be performed with care due to high battery voltage in series. |

| | |
|---|---|
| ⚠ | **CAUTION!!** Do not place anything between the flat part of the power converter terminal and the ring terminal. Otherwise, overheating may occur.<br>**CAUTION!!** Do not apply anti-oxidant substance on the terminals before terminals are connected tightly.<br>**CAUTION!!** Before making the final DC connection or closing DC breaker/disconnector, be sure positive (+) must be connected to positive (+) and negative (-) must be connected to negative (-). |

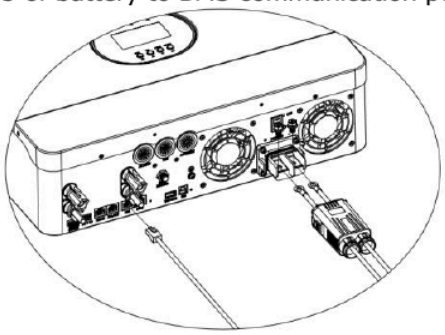
## Lithium Battery Connection

If choosing lithium battery for SPF 6000 ES PLUS, you are allowed to use the lithium battery only which we have configured. There're two connectors on the lithium battery, RJ45 port of BMS and power cable.

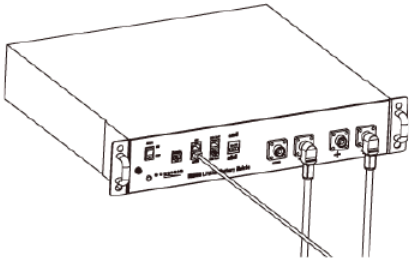
Please follow below steps to implement lithium battery connection:
1. Assemble battery ring terminal based on recommended battery cable and terminal size (same as Lead acid, see section Lead-acid Battery connection for details) .

2. Frist, pass the battery cable through the protective shell, and then insert the ring terminal of battery cable flatly into battery connector of power converter and make sure the bolts are tightened with torque of 2Nm. Make sure polarity at both the battery and the power converter/charge is correctly connected and ring terminals are tightly screwed to the battery terminals.Last, insert the protective shell.

3. Connect the end of RJ45 of battery to BMS communication port(RS485 or CAN) of power converter.



4. The other end of RJ45 insert to battery communication port(RS485 or CAN).



**Note:** If choosing lithium battery, make sure to connect the BMS communication cable between the battery and the power converter. You need to choose battery type as "lithium battery".

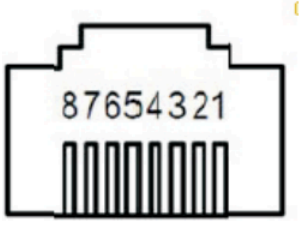
## Lithium battery communication and setting

In order to communicate with battery BMS, you should set the battery type to "LI" in Program 5. Then the LCD will switch to Program 36, which is to set the protocol type. There are several protocols in the power converter. Please get instruction from to choose which protocol to match the BMS.

**1. Connect the end of RJ45 of battery to BMS communication port of** power converter

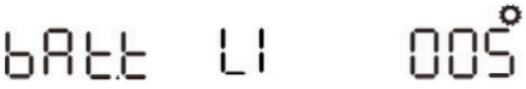
Make sure the lithium battery BMS port connects to the power converter is Pin to Pin, the power converter BMS port pin and RS485 port pin assignment shown as below:

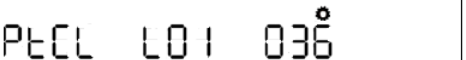
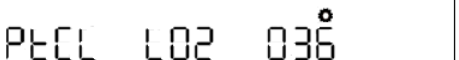
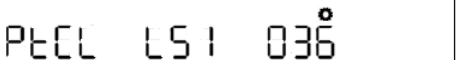
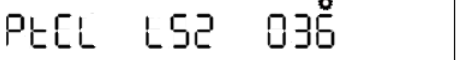
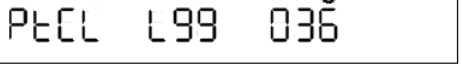
| Pin number | BMS port | RS485 port (for expansion) |
|---|---|---|
| 1 | RS485B | RS485B |
| 2 | RS485A | RS485A |
| 3 | -- | -- |
| 4 | CANH | -- |
| 5 | CANL | -- |
| 6 | -- | -- |
| 7 | -- | -- |
| 8 | -- | -- |



## LCD setting

To connect battery BMS, need to set the battery type as "LI" in Program 05.
After set "LI" in Program 05, it will switch to Program 36 to choose communication protocol. You can choose RS485 communication protocol which is from L01 to L50, and you can also choose CAN communication protocol which is from L51 to L99.

| | | |
|---|---|---|
| 05 | Battery type | AGM (default)<br><br> |
| | | Flooded<br><br> |
| | | Lithium (only suitable when communicated with BMS)<br><br> |
| | | User-Defined<br><br><br>If "User-Defined" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21. |
| | | User-Defined 2（suitable when lithium battery without BMS communication）<br><br><br>If "User-Defined 2" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21. It is recommended to set to the same voltage in program 19 and 20(full charging voltage point of lithium battery). The power converter will stop charging when the battery voltage reaches this setting. |

| | | | |
|---|---|---|---|
| 36 | RS485<br>Communication protocol | Protocol 1 | <br> |
| | | Protocol 2 | <br> |
| | | ⋮ | ⋮ |
| | | Protocol 50 | <br> |
| | CAN<br>Communication protocol | Protocol 51 | <br> |
| | | Protocol 52 | <br> |
| | | ⋮ | ⋮ |
| | | Protocol 99 | <br> |

**Note:** When the battery type set to Li, the setting option 12, 13, 21 will change to display percent.
**Note:** When the battery type set as "LI", the Maximum charge current can't be modified by the user. When the communication fail, the power converter will cut off output.

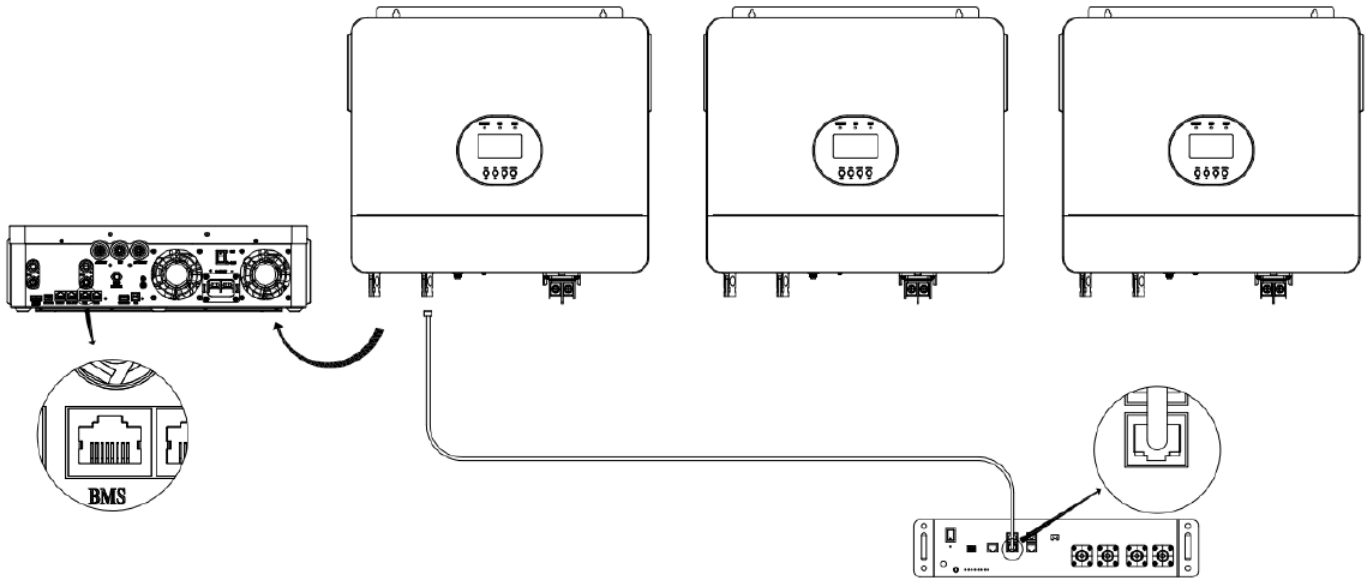
| | | |
|---|---|---|
| 12 | Setting SOC point back to utility source when selecting "SBU priority" or " first" in program 01 | b2AC 50% 012<br>Default 50%, 6%~95% Settable |
| 13 | Setting SOC point back to battery mode when selecting "SBU priority" or " first" in program 01 | AC2b 95% 013<br>Default 95%, 10%~100% Settable |

| | | |
|---|---|---|
| 21 | Low DC cut-off SOC<br>If "LI" is selected in program 5, this program can be set up | CUt4 20% 021<br>Default 20%, 5%~50% Settable |

**Note:** Any questions about communicating with BMS, please consult with

## Communicating with battery BMS in parallel system

If need to use communicate with BMS in a parallel system, you should make sure to connect the BMS communication cable between the battery and one power converter of the parallel system. It's recommended to connect to the master power converter of the parallel system.



# AC Input/GEN/Output Connection

**CAUTION!!** Before connecting to AC input power source, please install a **separate** AC breaker between power converter and AC input power source. This will ensure the power converter can be securely disconnected during maintenance and fully protected from over current of AC input. The recommended spec of AC breaker is 50A for SPF 6000 ES PLUS .

**CAUTION!!** There are three terminal blocks with "AC INPUT", "GEN"and "AC OUTPUT" markings. Please do NOT mis-connect input and output connectors.

**WARNING!** All wiring must be performed by a qualified personnel.

**WARNING!** It's very important for system safety and efficient operation to use appropriate cable for AC input connection and GEN connection. To reduce risk of injury, please use the proper recommended cable size as below.

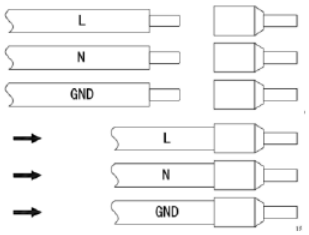
**Suggested cable requirement for AC wires**

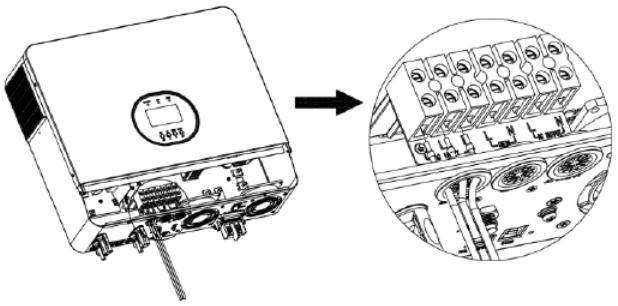
| Model | Gauge | Torque Value |
|---|---|---|
| SPF 6000 ES PLUS | 1 * 8 AWG | 1.2-1.6 Nm |

Please follow below steps to implement AC input/GEN/AC output connection:

1. Before making AC input/GEN/AC output connection, be sure to open DC protector or disconnector first.
2. Remove insulation sleeve 10mm for seven conductors. And shorten phase L and neutral conductor N 3 mm. Then press in the tubular terminal
3. Insert AC input wires according to polarities indicated on terminal block and tighten the terminal screws. Be sure to connect PE protective conductor ⏚ first.

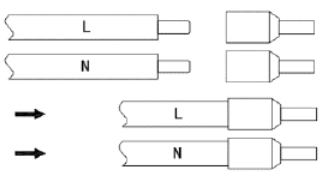
   ⏚**→Ground (yellow-green)**
   **L→LINE (brown or black)**
   **N→Neutral (blue)**

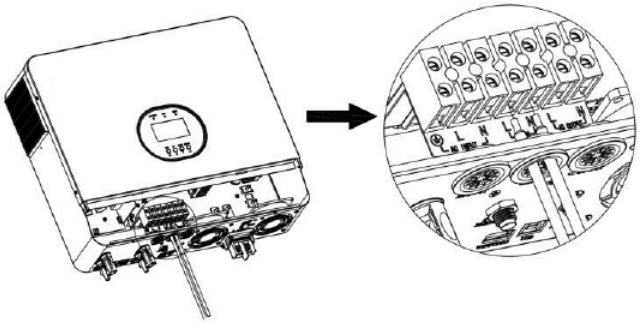


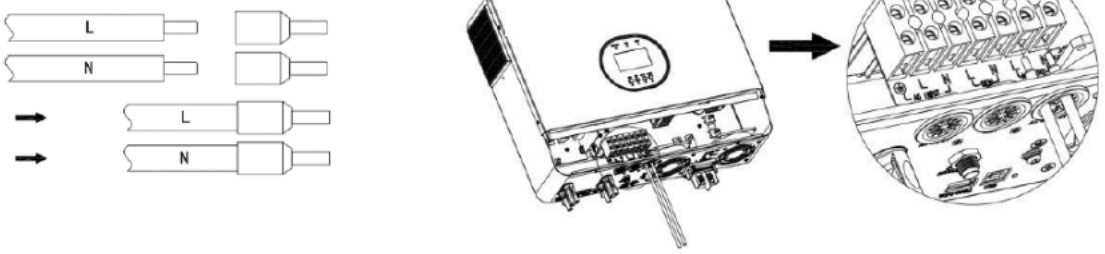
| | |
|---|---|
| ⚠ | **WARNING:**<br>Be sure that AC power source is disconnected before attempting to hardwire it to the unit. |

4. Then,insert GEN wires according to polarities indicated on terminal block and tighten the terminal screws.
   **L→LINE (brown or black)**
   **N→Neutral (blue)**



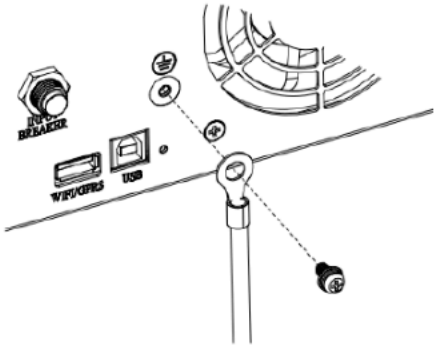
5. Last, insert AC output wires according to polarities indicated on terminal block and tighten terminal screws.
   **L→LINE (brown or black)**
   **N→Neutral (blue)**

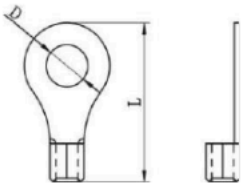



6. Make sure the power converter metal housing is grounded.

   **R-type terminal:**

   **→Ground (yellow-green)**




7. Make sure the wires are securely connected.

   **CAUTION: Important**

   Be sure to connect AC wires with correct polarity. If L and N wires are connected reversely, it may cause utility short-circuited when these power converters are worked in parallel operation.

**CAUTION:** Appliances such as air conditioner are required at least 2~3 minutes to restart because it's required to have enough time to balance refrigerant gas inside of circuits. If a power shortage occurs and recovers in a short time, it will cause damage to your connected appliances. To prevent this kind of damage, please check with manufacturer of air conditioner that if it's equipped with time-delay function before installation. Otherwise, this off grid power converter will trig overload fault and cut off output to protect your appliance but sometimes it still causes internal damage to the air conditioner.

## PV Connection

**CAUTION:** Before connecting to PV modules, please install **separately** a DC circuit breaker between power converter and PV modules.

**WARNING!** All wiring must be performed by a qualified personnel.
**WARNING!** It' very important for system safety and efficient operation to use appropriate cable for PV module connection. To reduce risk of injury, please use the proper recommended cable size as below.

| Model | Wire Size | Torque value |
|---|---|---|
| SPF 6000 ES PLUS | 1 * 12 AWG | 1.2-1.6 Nm |

## PV Module Selection:

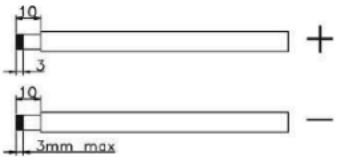
When selecting proper PV modules, please be sure to consider below parameters:

1. Open circuit Voltage (Voc) of PV modules not exceeds max. PV array open circuit voltage of power converter.
2. Open circuit Voltage (Voc) of PV modules should be higher than start-up voltage.

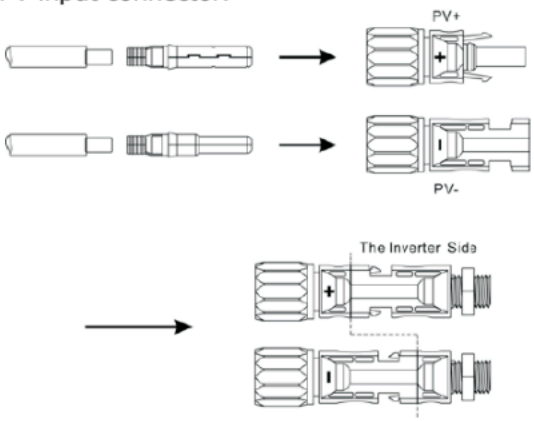
| POWER CONVERTER **MODEL** | SPF 6000 ES PLUS |
|---|---|
| **Max. PV Array Open Circuit Voltage** | 500Vdc |
| **Start-up Voltage** | 150Vdc |
| **PV Array MPPT Voltage Range** | 120Vdc~450Vdc |

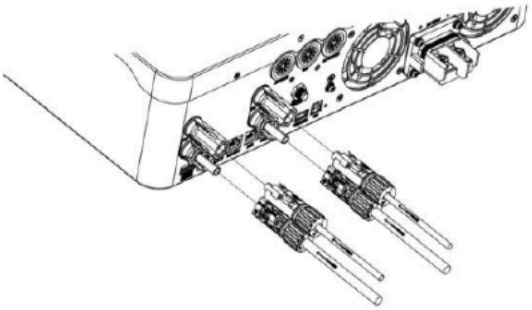
Please follow below steps to implement PV module connection:

1.Remove insulation sleeve 10 mm for positive and negative conductors.




2.Insert PV panel positive and negative cables into MC4 terminal, then connect positive pole(+)of connection cable to positive pole(+)of PV input connector, connect negative pole(-)of connection cable to negative pole(-) of PV input connector.

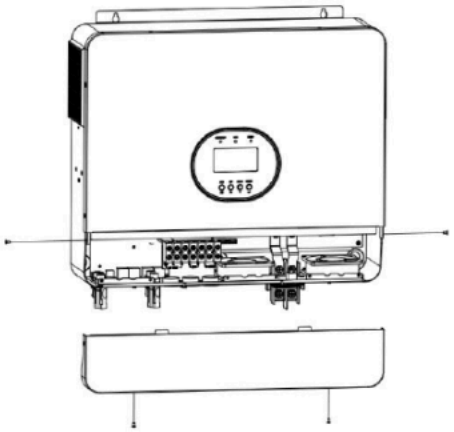


3.Make sure the wires are securely connected.

# Final Assembly

After connecting all wiring, please put bottom cover back by screwing four screws as shown below.



# Communication Connection

Please use supplied communication cable to connect to power converter and PC. Follow on-screen instruction to install the monitoring software. For the detailed software operation, please check user manual of software. The monitoring software is downloadable from our website www.ginverter.com.

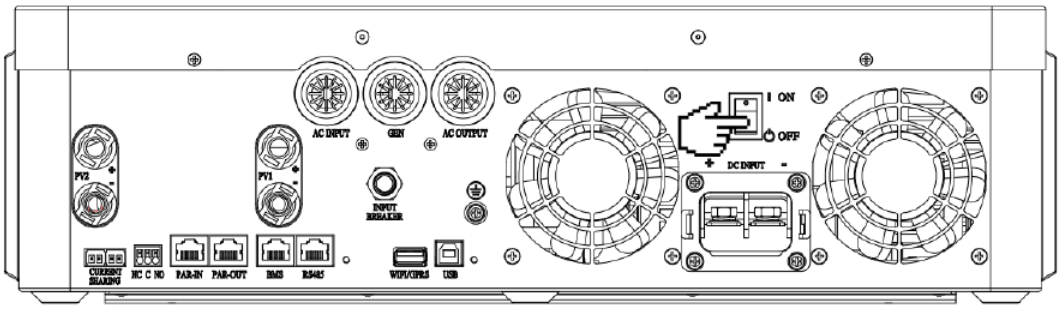
## Dry Contact Signal

There is one dry contact(3A/250VAC) available on the rear panel. It could be used to deliver signal to external device when battery voltage reaches warning level.

<table>
<tr><td rowspan="2">Unit Status</td><td colspan="3" rowspan="2">Condition</td><td colspan="2">Dry contact port:<br><br>NC C NO</td></tr>
<tr><td>NC & C</td><td>NO & C</td></tr>
<tr><td>Power Off</td><td colspan="3">Unit is off and no output is powered</td><td>Close</td><td>Open</td></tr>
<tr><td rowspan="5">Power On</td><td colspan="3">Output is powered from Utility</td><td>Close</td><td>Open</td></tr>
<tr><td rowspan="4">Output is powered from Battery or</td><td rowspan="2">Program 01 set as Utility first</td><td>Battery voltage (SOC)< Low DC warning voltage(SOC)</td><td>Open</td><td>Close</td></tr>
<tr><td>Battery voltage(SOC) > Setting value in Program 13 or battery charging reaches floating stage</td><td>Close</td><td>Open</td></tr>
<tr><td rowspan="2">Program 01 is set as SBU or first</td><td>Battery voltage (SOC)< Setting value in Program 12</td><td>Open</td><td>Close</td></tr>
<tr><td>Battery voltage (SOC)> Setting value in Program 13 or battery charging reaches floating stage</td><td>Close</td><td>Open</td></tr>
</table>

# Operation

## Power ON/OFF

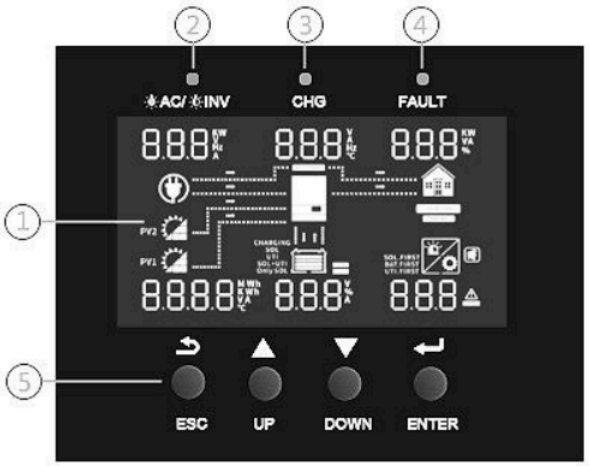



Once the unit has been properly installed and the batteries are connected well, simply press On/Off switch (located on the button of the case) to turn on the unit.

## Operation and Display Panel

The operation and display panel, shown in below chart, is on the front panel of the power converter. It includes three indicators, four function keys and a LCD display, indicating the operating status and input/output power information.

1. LCD display
2. Status indicator
3. Charging indicator
4. Fault indicator
5. Function buttons



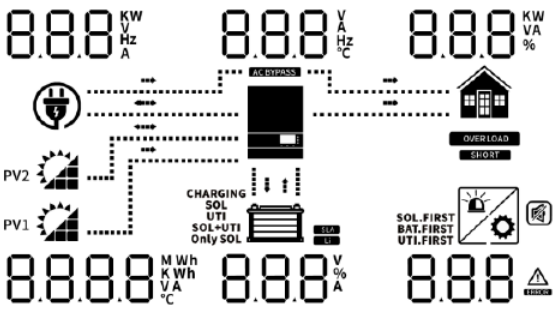

### LED Indicator

| LED Indicator | | | Messages |
|---|---|---|---|
| AC / INV | Green | Solid On | Output is powered by utility in Line mode. |
| | | Flashing | Output is powered by battery or PV in battery mode. |
| CHG | Green | Solid On | Battery is fully charged. |
| | | Flashing | Battery is charging. |
| ⚠ FAULT | Red | Solid On | Fault occurs in the power converter. |
| | | Flashing | Warning condition occurs in the power converter. |

### Function Buttons

| Button | Description |
|---|---|
| ESC | To exit setting mode |
| UP | To go to previous selection |
| DOWN | To go to next selection |
| ENTER | To confirm the selection in setting mode or enter setting mode |

# LCD Display Icons



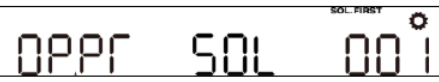
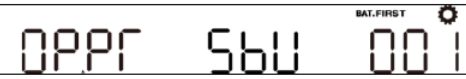
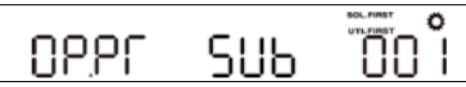
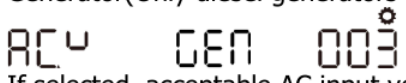

| Icon | Description |
|---|---|
| **AC Input Information** | |
| | AC input icon |
| KW V Hz A | Indicate AC input power, AC input voltage, AC input frequency, AC input current |
| AC BYPASS | Indicate AC power loads in bypass |
| **PV Input Information** | |
| PV1 PV2 | Left：PV1 input icon Right：PV2 input icon |
| M Wh K Wh V A °C | Indicate PV power, PV voltage, PV current, etc |
| **Output Information** | |
| | Power Converter icon |
| V A Hz °C | Indicate output voltage, output current, output frequency, power converter temperature |
| **Load Information** | |
| | Load icon |
| KW VA % | Indicate power of load, power percentage of load |
| OVER LOAD | Indicate overload happened |
| SHORT | Indicate short circuit happened |
| **Battery Information** | |
| | Indicate battery level by 0-24%, 25-49%, 50-74% and 75-100% in battery mode and charging status in line mode. |
| V % A | Indicate battery voltage, battery percentage, battery current |
| SLA | Indicate SLA battery |
| Li | Indicate lithium battery |
| CHARGING SOL SOL+UTI Only SOL | Indicate charging source priority: first, and utility, or only |
| **Other Information** | |
| SOL.FIRST BAT.FIRST UTI.FIRST | Indicate output source priority: first, utility first, SBU mode or SUB mode |
| ERROR | Indicate warning code or fault code |
| | Indicate a warning or a fault is happening |
| | Indicate it’s during setting values |
| | Indicate the alarm is disabled |

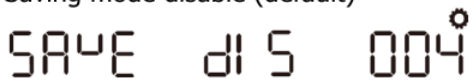
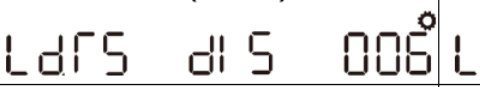
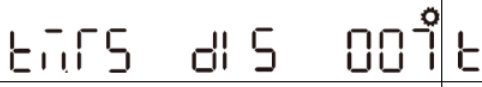
| In AC mode, battery icon will present Battery Charging Status | | |
|---|---|---|
| Status | Battery voltage | LCD Display |
| Constant Current mode / Constant Voltage mode | <2V/cell | 4 bars will flash in turns. |
| | 2 ~ 2.083V/cell | Bottom bar will be on and the other three bars will flash in turns. |
| | 2.083 ~ 2.167V/cell | Bottom two bars will be on and the other two bars will flash in turns. |
| | > 2.167 V/cell | Bottom three bars will be on and the top bar will flash. |
| Floating mode. Batteries are fully charged. | | 4 bars will be on. |

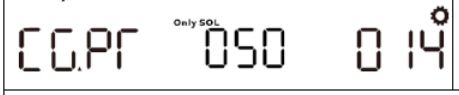
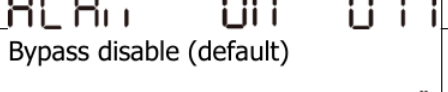
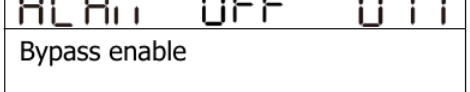
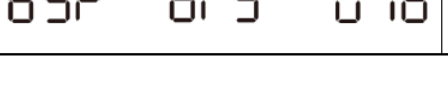
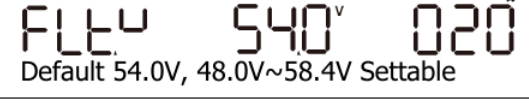
| In battery mode, battery icon will present Battery Capacity | | |
|---|---|---|
| Load Percentage | Battery Voltage | LCD Display |
| Load >50% | < 1.717V/cell |  |
| | 1.717V/cell ~ 1.8V/cell |  |
| | 1.8 ~ 1.883V/cell |  |
| | > 1.883 V/cell |  |
| 50%> Load > 20% | < 1.817V/cell |  |
| | 1.817V/cell ~ 1.9V/cell |  |
| | 1.9 ~ 1.983V/cell |  |
| | > 1.983 |  |
| Load < 20% | < 1.867V/cell |  |
| | 1.867V/cell ~ 1.95V/cell |  |
| | 1.95 ~ 2.033V/cell |  |
| | > 2.033 |  |

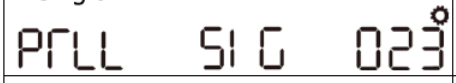
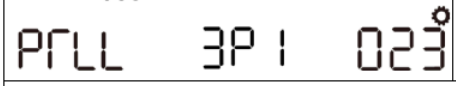
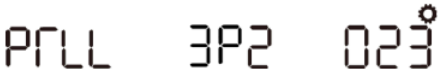
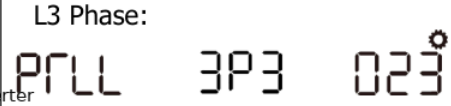
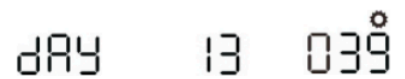
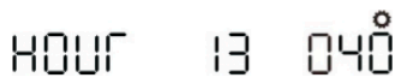
## LCD Setting

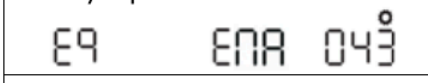
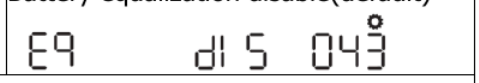
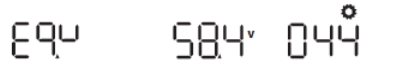
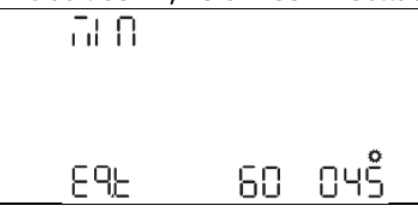
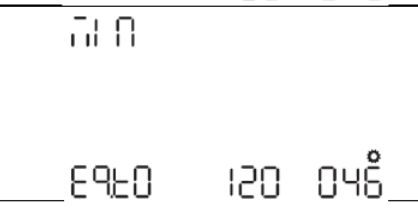
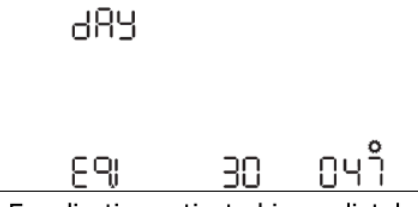
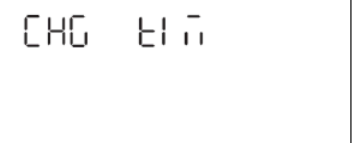
After pressing and holding ENTER button for 3 seconds, the unit will enter setting mode. Press "UP" or "DOWN" button to select setting programs. Then press "ENTER" button to confirm the selection or ESC button to exit.

| Program | Description | Setting Option |
|---|---|---|
| 01 | Output source priority: To configure load power source priority | first  |
| | | energy provides power to the loads as first priority.<br>If energy is not sufficient to power all connected loads, battery energy will supply power the loads at the same time.<br>Utility provides power to the loads only when any one condition happens:<br>- energy is not available<br>- Battery voltage drops to either low-level warning voltage or the setting point in program 12. |
| | | Utility first (default)  |
| | | Utility will provide power to the loads as first priority.<br>and battery energy will provide power to the loads only when utility power is not available. |
| | | SBU priority  |
| | | energy provides power to the loads as first priority.<br>If energy is not sufficient to power all connected loads, battery will supply power to the loads at the same time.<br>Utility provides power to the loads only when battery voltage drops to either low-level warning voltage or the setting point in program 12. |
| | | SUB priority  |
| | | energy provides power to the loads as first priority.<br>If energy is not sufficient to power all connected loads, and utility will power loads at the same time.<br>Battery provides power to the loads only when energy is not sufficient and there is no utility. |
| 02 | Maximum charging current: set total charging current for and utility chargers. (Max. charging current = utility charging current + charging current) | <br>Default 60A, 10A~100A Settable<br>(If LI is selected in Program 5, this program can't be set up) |
| 03 | AC input voltage range | Appliance (default)<br><br>If selected, acceptable AC input voltage range will be within 90~280VAC |
| | | UPS<br><br>If selected, acceptable AC input voltage range will be within 170~280VAC |
| | | Generator(Only diesel generators allowed)<br><br>If selected, acceptable AC input voltage range will be within 90~280VAC.<br>**Note:** When connecting generator, the generator should be no less than 10KVA(no less than 20KVA for three phase parallel system), and the power converters should be no more than 2 units in one phase. |

| | | | |
|---|---|---|---|
| 04 | Power saving mode enable/disable | Saving mode disable (default)<br><br>If disabled, no matter connected load is low or high, the on/off status of power converter output will not be effected. | |
| | | Saving mode enable<br><br>If enabled, the output of power converter will be off when connected load is pretty low or not detected. | |
| 05 | Battery type | AGM (default)<br> | |
| | | Flooded<br> | |
| | | Lithium (only suitable when communicated with BMS)<br> | |
| | | User-Defined<br><br>If "User-Defined" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21. | |
| | | User-Defined 2（suitable when lithium battery without BMS communication）<br><br>If "User-Defined 2" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21. It is recommended to set to the same voltage in program 19 and 20(full charging voltage point of lithium battery). The power converter will stop charging when the battery voltage reaches this setting. | |
| 06 | Auto restart when overload occurs | Restart disable (default)<br> | Restart enable<br> |
| 07 | Auto restart when over temperature occurs | Restart disable (default)<br> | Restart enable<br> |
| 08 | Output voltage<br>*This setting is only available when the power converter is in standby mode (Switch off). | 230V (default)<br> | 220V<br> |
| | | 240V<br> | 208V<br> |
| 09 | Output frequency<br>*This setting is only available when the power converter is in standby mode (Switch off). | 50Hz (default)<br> | 60Hz<br> |
| 10 | Number of series batteries connected | <br>(e.g. Showing batteries are connected in 4 series) | |

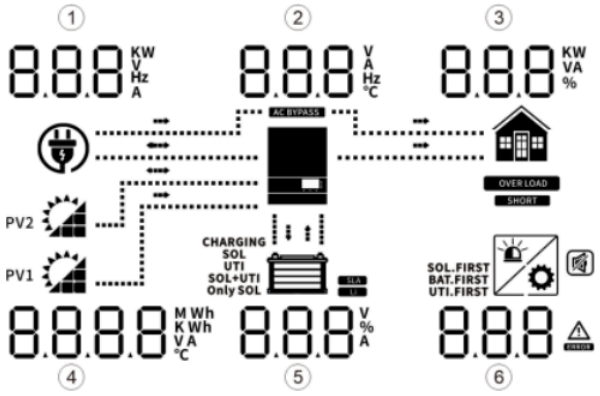
| | | | |
|---|---|---|---|
| 11 | Maximum utility charging current |  Default 30A, 0A~80A Settable<br>Note: If setting value in Program 02 is smaller than that in Program 11, the power converter will apply charging current from Program 02 for utility charger | |
| 12 | Setting voltage point back to utility source when selecting "SBU priority" or " first" in program 01 |  Default 46.0V, 44.0V~51.2V Settable | |
| 13 | Setting voltage point back to battery mode when selecting "SBU priority" or " first" in program 01 |  Default 54.0V, 48.0V~58.0V Settable | |
| 14 | Charger source priority:<br>To configure charger source priority | If this off grid power converter is working in Line, Standby or Fault mode, charger source can be programmed as below: | |
| | | first  | energy will charge battery as first priority.<br>Utility will charge battery only when energy is not available. |
| | | and Utility  | energy and utility will both charge battery. |
| | | Only  | energy will be the only charger source no matter utility is available or not. |
| | | If this off grid power converter is working in Battery mode or Power saving mode, only energy can charge battery. energy will charge battery if it's available and sufficient. | |
| 15 | Alarm control | Alarm on (default)  | Alarm off  |
| 16 | Backlight control | Backlight on (default)  | Backlight off  |
| 17 | Beeps while primary source is interrupted | Alarm on (default)  | Alarm off  |
| 18 | Overload bypass:<br>When enabled, the unit will transfer to line mode if overload occurs in battery mode. | Bypass disable (default)  | Bypass enable  |
| 19 | C.V. charging voltage.<br>If self-defined is selected In program 5, this program can be set up |  Default 56.4V, 48.0V~58.4V Settable | |
| 20 | Floating charging voltage.<br>If self-defined is selected in program 5, this program can be set up |  Default 54.0V, 48.0V~58.4V Settable | |

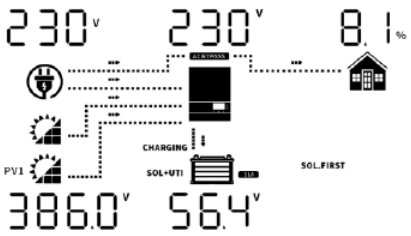
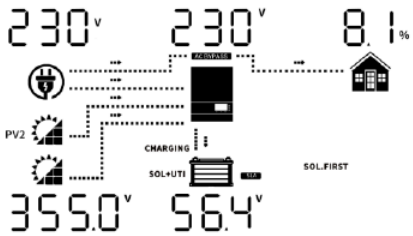
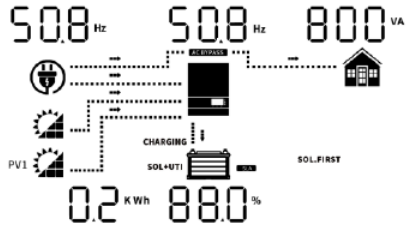
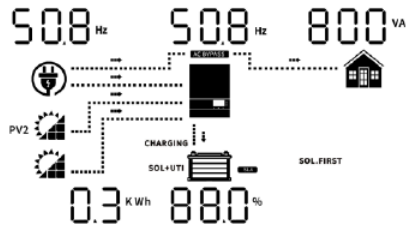
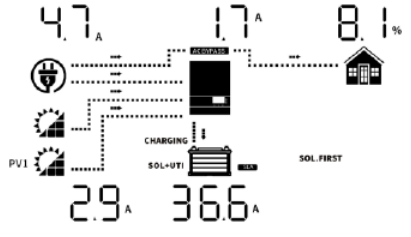
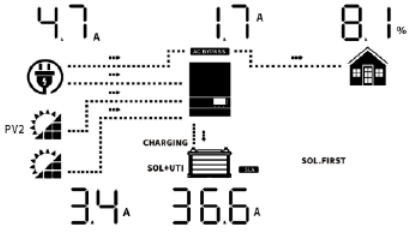
| | | | |
|---|---|---|---|
| 21 | Low DC cut-off voltage.<br>If self-defined is selected in program 5, this program can be set up.<br>Low DC cut-off voltage will be fixed to setting value no matter what percentage of load is connected. | <br>Default 42.0V, 40.0V~48.0V Settable<br><br>When reach Low DC cut-off voltage:<br>1) If battery power is only power source available, power converter will shut down.<br>2) If PV energy and battery power are available, power converter will charge battery without AC output.<br>3) If PV energy, battery power and utility are all available, power converter will transfer to line mode and provide output power to loads, and charge the battery at the same time. | |
| 23 | AC output mode<br>*This setting is only available when the power converter is in standby mode (Switch off).<br>**Note:** Parallel operation can only work when battery connected | Single:<br><br>Parallel:<br><br>L1 Phase:<br><br>L2 Phase:<br><br>L3 Phase:<br><br>When the units are used in parallel with single phase, please select "PAL" in program 23.<br><br>It requires 3 power converters to support three-phase equipment, 1 power converter in each phase.<br>Please select "3P1" in program 23 for the power converters connected to L1 phase, "3P2" in program 23 for the power converters connected to L2 phase and "3P3" in program 23 for the power converters connected to L3 phase.<br><br>Be sure to connect share current cable to units which are on the same phase.<br>Do NOT connect share current cable between units on different phases.<br>Besides, power saving function will be automatically disabled. | |
| 28 | Address setting<br>(for expansion) | <br>Default 1, 1~255 Settable | |
| 37 | Real time setting---Year |  | Default 2018, range 2018~2099 |
| 38 | Real time setting---Month |  | Default 01, range 01~12 |
| 39 | Real time setting---Date |  | Default 01, range 01~31 |
| 40 | Real time setting---Hour |  | Default 00, range 00~23 |
| 41 | Real time setting---Minute |  | Default 00, range 00~59 |
| 42 | Real time setting---Second |  | Default 00, range 00~59 |

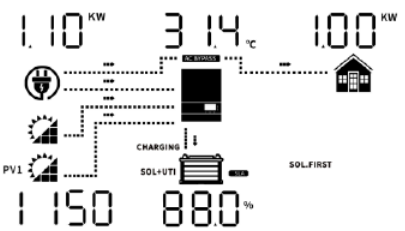
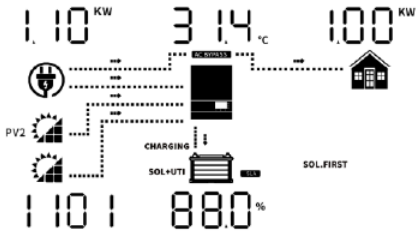
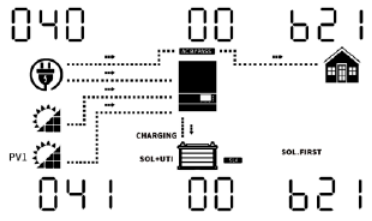
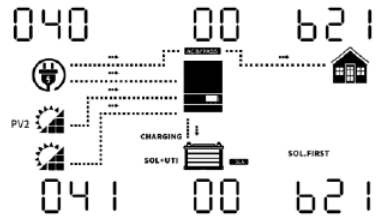
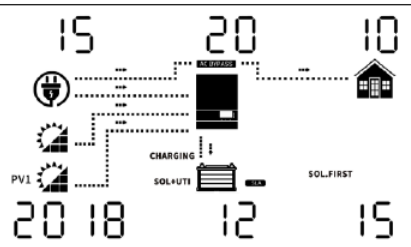
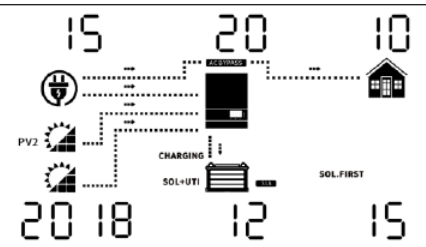
| | | | |
|---|---|---|---|
| 43 | Battery equalization | Battery equalization enable<br><br> | Battery equalization disable(default)<br><br> |
| | | If "Flooded" or "User-Defined" is selected in program 05, this program can be set up. | |
| 44 | Battery equalization voltage | <br><br>Default 58.4V, 48.0V~58.4V Settable | |
| 45 | Battery equalized time | <br> | Default 60min, 5min~900min Settable |
| 46 | Battery equalized timeout | <br> | Default 120min, 5min~900min Settable |
| 47 | Equalization interval | <br> | Default 30days, 1 days~90 days Settable |
| 48 | Equalization activated immediately | Equalization activated immediately on<br><br> | Equalization activated immediately off(default)<br><br> |
| | | If equalization function is enabled in program 43, this program can be setup. If "On" is selected in this program, it's to activate battery equalization immediately and LCD main page will shows "E9". If "Off" is selected, it will cancel equalization function until next activated equalization time arrives based on program 47setting. At this time, "E9" will not be shown in LCD main page. | |
| 49 | Utility charging time | 0000(default)<br>Allow utility to charge the battery all day run.<br><br> | The time allows utility to charge the battery.<br>Use 4 digits to represent the time period, the upper two digits represent the time when utility start to charge the battery, setting range from 00 to 23, and the lower two digits represent the time when utility end to charge the battery, setting range from 00 to 23.<br>(eg: 2320 represents the time allows utility to charge the battery is from 23:00 to the next day 20:59, and the utility charging is prohibited outside of this period) |
| 50 | AC output time | 0000(default)<br>Allow power converter to power the load all day run.<br><br> | The time allows power converter to power the load.<br>Use 4 digits to represent the time period, the upper two digits represent the time when power converter start to power the load, setting range from 00 to 23, and the lower two digits represent the time when power converter end to power the load, setting range from 00 to 23.<br>(eg: 2320 represents the time allows power converter to power the load is from 23:00 to the next day 20:59, and the power converter AC output power is prohibited outside of this period) |

# Display Information

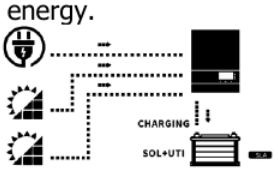
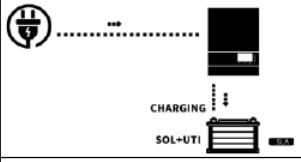
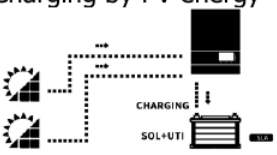
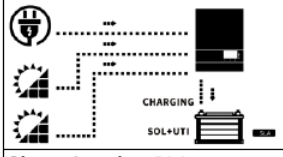
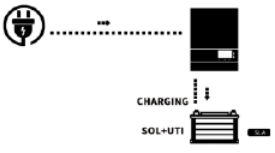
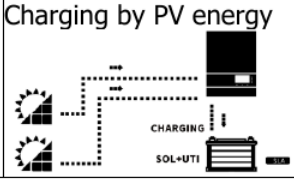
The LCD display information will be switched in turns by pressing "UP" or "DOWN" key. The selectable information is switched as below order: voltage, frequency, current, power, firmware version.

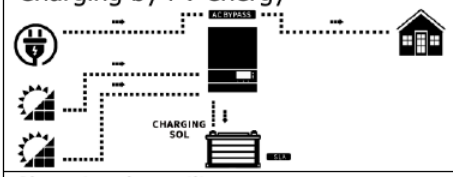
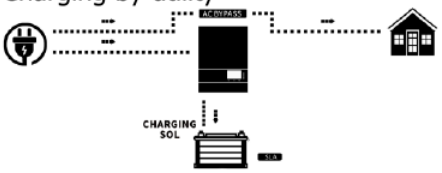
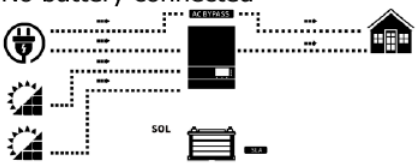
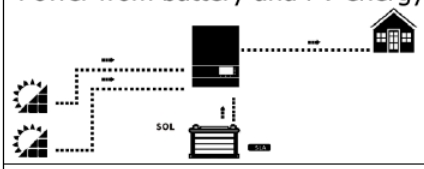
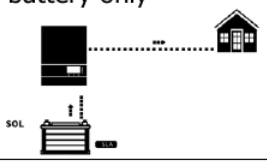



| Setting Information | LCD display | |
|---|---|---|
| ① AC Input voltage<br>（If it flashes, it indicates that the input voltage of the generator is displayed at this time, and the current, power and frequency displayed after turning the page are also the input parameters of the generator.)<br>② Output voltage<br>③ Load percentage<br>④ Left：PV1 input voltage<br>Right: PV2 input voltage<br>⑤ Battery voltage<br>⑥ Warning or Fault code<br>(Default Display Screen) |  |  |
| ① AC Input frequency<br>② Output frequency<br>③ Load power in VA<br>④ Left：PV1 energy sum in KWH<br>Right: PV2 energy sum in KWH<br>⑤ Battery percentage<br>⑥ Warning or Fault code |  |  |
| ① AC Input current<br>② Output current<br>③ Load percentage<br>④ Left：PV1 input current<br>Right：PV2 input current<br>⑤ Battery charging current<br>⑥ Warning or Fault code |  |  |

| | | |
|---|---|---|
| ① AC input power in Watts<br>② Power Converter temperature<br>③ Load power in Watts<br>④ Left：PV1 input power in Watts<br>Right：PV2 input power in Watts<br>⑤ Battery percentage<br>⑥ Warning or Fault code |  |  |
| Firmware version<br>(CPU1: 040-00-b21; CPU2:041-00-b21) |  |  |
| Time<br>(15:20:10, December 15, 2018) |  |  |

## Operating Mode Description

| Operation mode | Description | LCD display | |
|---|---|---|---|
| Standby mode / Power saving mode<br>**Note:** *Standby mode: The power converter is not turned on yet but at this time, the power converter can charge battery without AC output.<br>*Power saving mode: If enabled, the output of power converter will be off when connected load is pretty low or not detected. | No output is supplied by the unit but it still can charge batteries. | Charging by utility and PV energy.<br> | Charging by utility<br> |
| | | Charging by PV energy<br> | No charging<br> |
| Fault mode<br>Note:<br>*Fault mode: Errors are caused by inside circuit error or external reasons such as over temperature, output short circuited and so on. | PV energy and utility can charge batteries. | Charging by utility and PV energy<br> | Charging by utility<br> |
| | | Charging by PV energy<br> | No charging<br> |

<table>
<tr><td rowspan="3">Line Mode</td><td rowspan="3">The unit will provide output power from the mains. It can also charge the battery at line mode.</td><td>Charging by PV energy<br></td></tr>
<tr><td>Charging by utility<br></td></tr>
<tr><td>No battery connected<br></td></tr>
<tr><td rowspan="2">Battery Mode</td><td rowspan="2">The unit will provide output power from battery and PV power.</td><td>Power from battery and PV energy<br></td></tr>
<tr><td>Power from battery only<br></td></tr>
</table>

# Parallel Installation Guide

## Introduction

This power converter can be used in parallel with two different operation modes.

1. Parallel operation in single phase with up to 6 units.
2. Maximum 6 units work together to support 3-phase equipment. Four units support one phase maximum.

## Package Contents

In parallel kit, you will find the following items in the package:



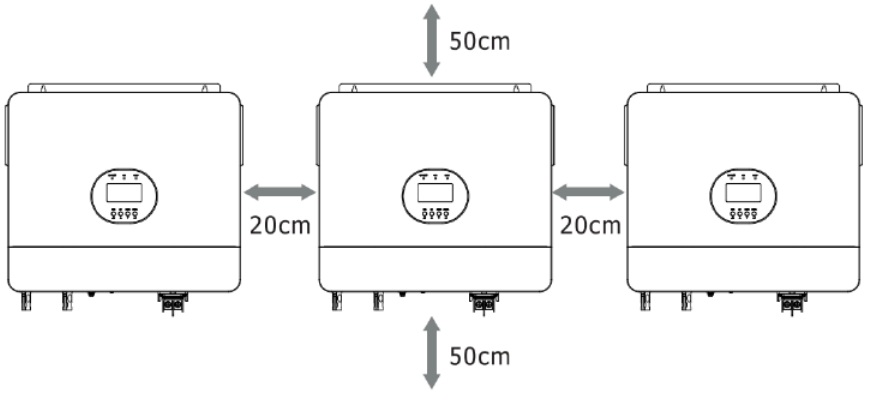
Parallel communication cable



Current sharing cable

## Mounting the Unit

When installing multiple units, please follow below chart.




**Note:** For proper air circulation to dissipate heat, allow a clearance of approx. 20cm to the side and approx. 50 cm above and below the unit. Be sure to install each unit in the same level.

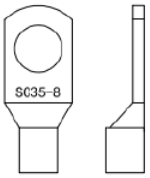
## Wiring Connection

The cable size of each power converter is shown as below

Recommended battery cable and terminal size for each power converter:

| Model | Wire Size | Torque value |
|---|---|---|
| SPF 6000 ES PLUS | 1 * 2 AWG | 2-3 Nm |

**O-type terminal:**




**WARNING:** Be sure the length of all battery cables is the same. Otherwise, there will be voltage difference between power converter and battery to cause parallel power converters not working.

You need to connect the cables of each power converter together. Take the battery cables for example: You need to use a connector or bus-bar as a joint to connect the battery cables together, and then connect to the battery terminal. The cable size used from joint to battery should be X times cable size in the tables above. "X" indicates the number of power converters connected in parallel.

Regarding AC input and output, please also follow the same principle.

Recommended AC input and output cable size for each power converter:

| Model | Gauge | Torque Value |
|---|---|---|
| SPF 6000 ES PLUS | 1 * 8 AWG | 1.2-1.6 Nm |

**CAUTION!!** Please install the breaker at the battery and AC input side. This will ensure the power converter can be securely disconnected during maintenance and fully protected from over current of battery or AC input.

Recommended breaker specification of battery for each power converter:

| Model | 1 unit* |
|---|---|
| SPF 6000 ES PLUS | 200A / 60VDC |

*If you want to use only one breaker at the battery side for the whole system, the rating of the breaker should be X times current of 1 unit. "X" indicates the number of power converters connected in parallel.

Recommended breaker specification of AC input with single phase:

| Model | 2 units | 3 units | 4 units | 5 units | 6 units |
|---|---|---|---|---|---|
| SPF 6000 ES PLUS | 100A/230VAC | 150A/230VAC | 200A/230VAC | 250A/230VAC | 300A/230VAC |

**Note1:** You can use 50A breaker for SPF 6000 ES PLUS for only 1 unit, and each power converter has a breaker at its AC input.

**Note2:** Regarding three phase system, you can use 4 poles breaker, the rating is up to the current of the phase which has the maximum units. Or you can follow the suggestion of note 1.

Recommended battery capacity

| Power Converter parallel numbers | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Battery Capacity | 400AH | 600AH | 800AH | 1000AH | 1200AH |

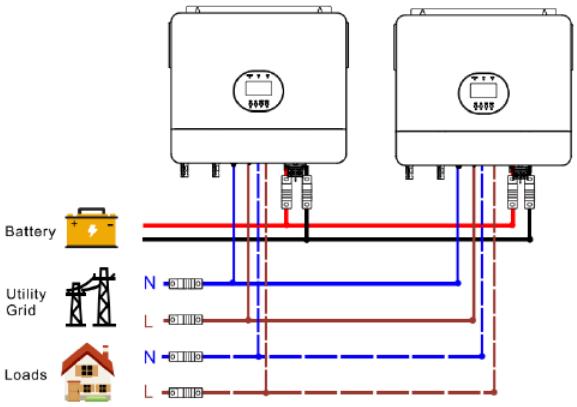
**WARNING!** Be sure that all power converters will share the same battery bank. Otherwise, the power converters will transfer to fault mode.

# Parallel Operation in Single Phase

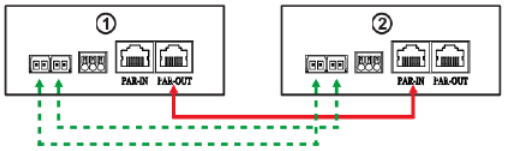
**WARNING!** All power converters must be connected to the same batteries and ensure each group of cables from the power converters to the batteries in the same length.

Two power converters in parallel:

**Power Connection**



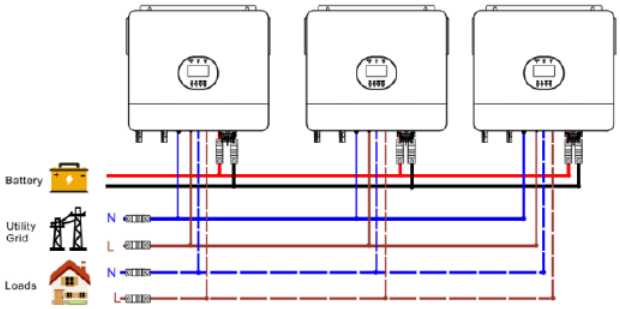

**Communication Connection**



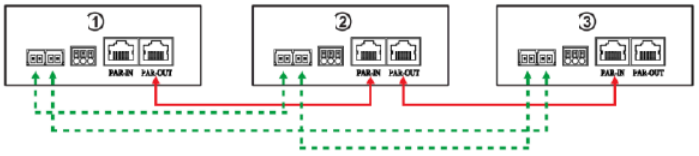

**WARNING!** Make sure that PAR-OUT of one power converter is connected to the PAR-IN of another power converter. No matter single or three-phase parallel, it is not allowed to connect the PAR-OUT of one power converter with the PAR-OUT of another power converter,or it is not allowed to connect the PAR-IN of one power converter with the PAR-IN of another power converter. Otherwise, the communication is abnormal.The PAR-IN of the first power converter and the PAR-OUT of the last power converter are not allowed to connect other power converters.

Three power converters in parallel:

**Power Connection**

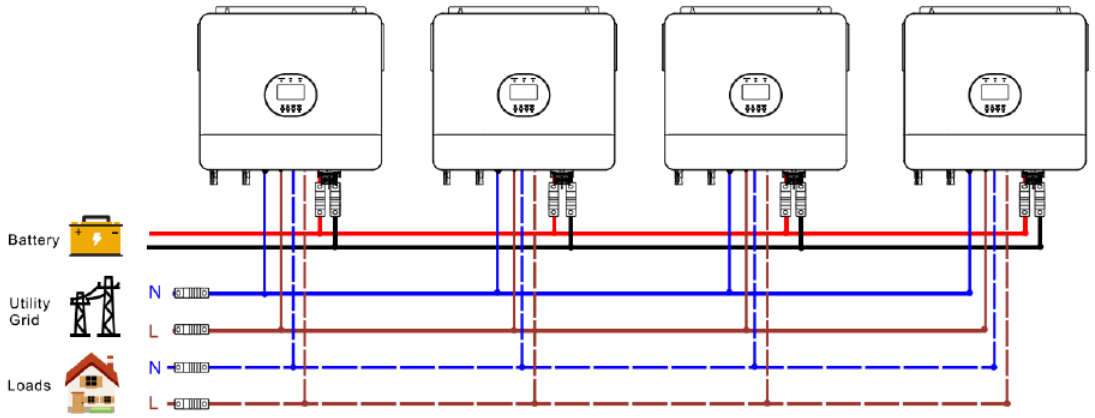



**Communication Connection**

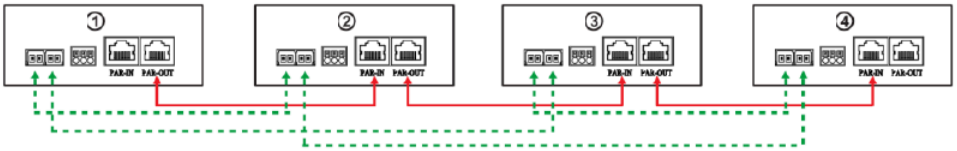


Four power converters in parallel:

**Power Connection**

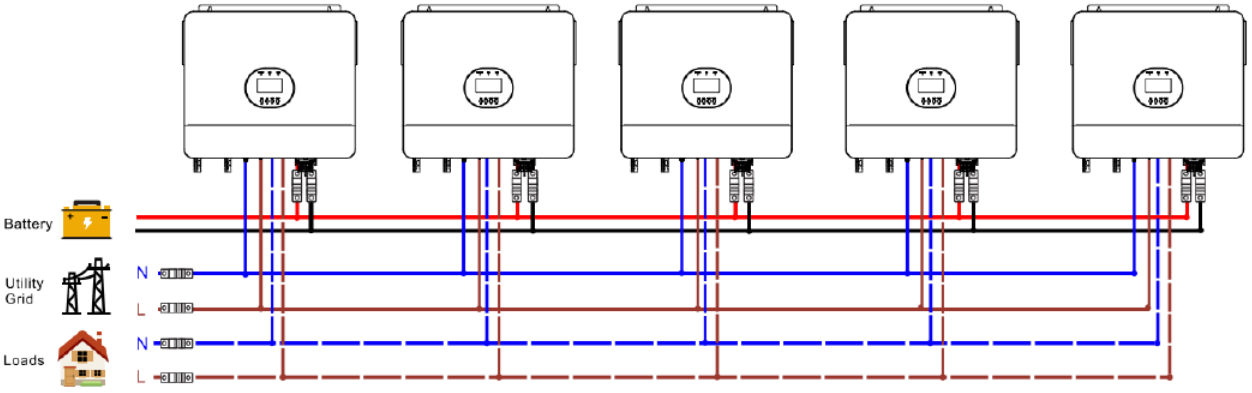



**Communication Connection**




Five power converters in parallel:

**Power Connection**

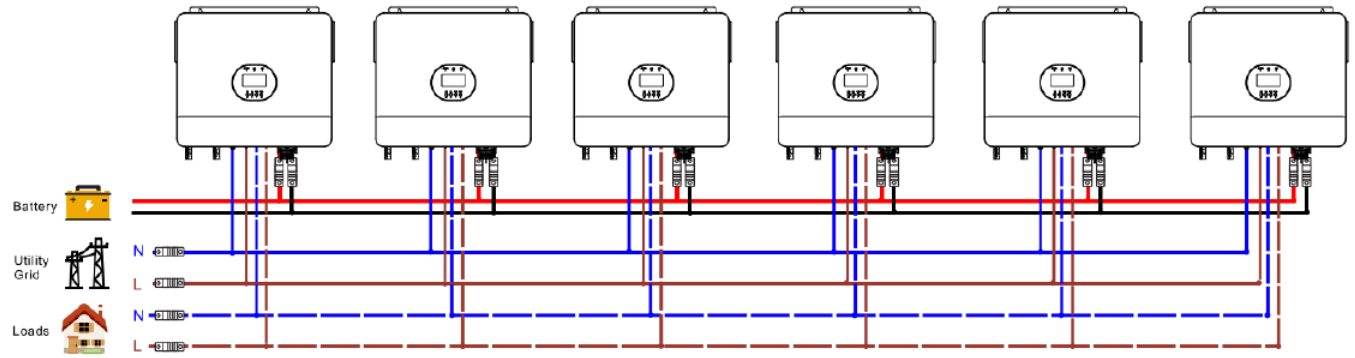



**Communication Connection**

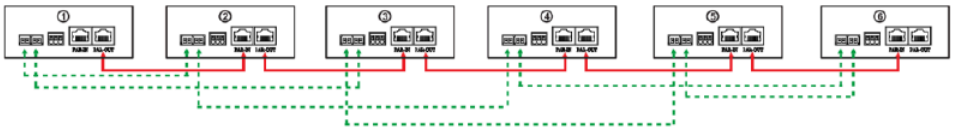


Six power converters in parallel:

**Power Connection**




**Communication Connection**

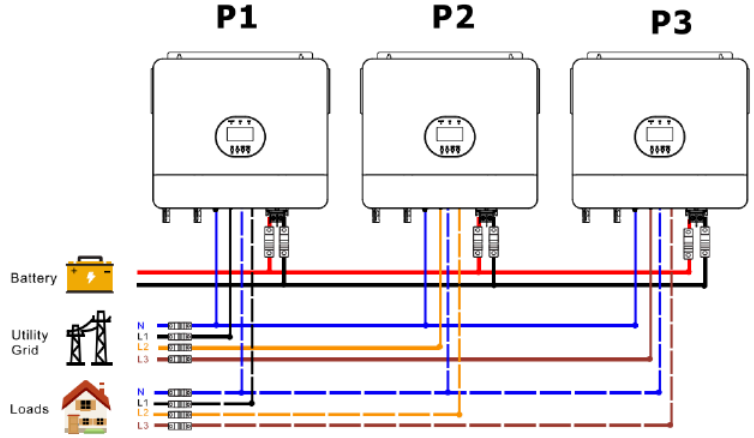


## Parallel Operation in Three Phase

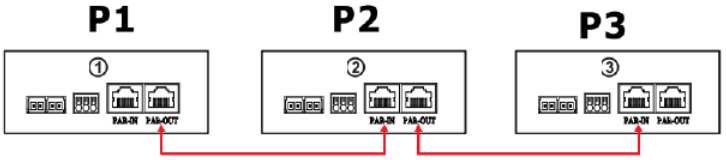
**WARNING!** All power converters must be connected to the same batteries and ensure each group of cables from the power converters to the batteries in the same length.

One power converter in each phase:

**Power Connection**

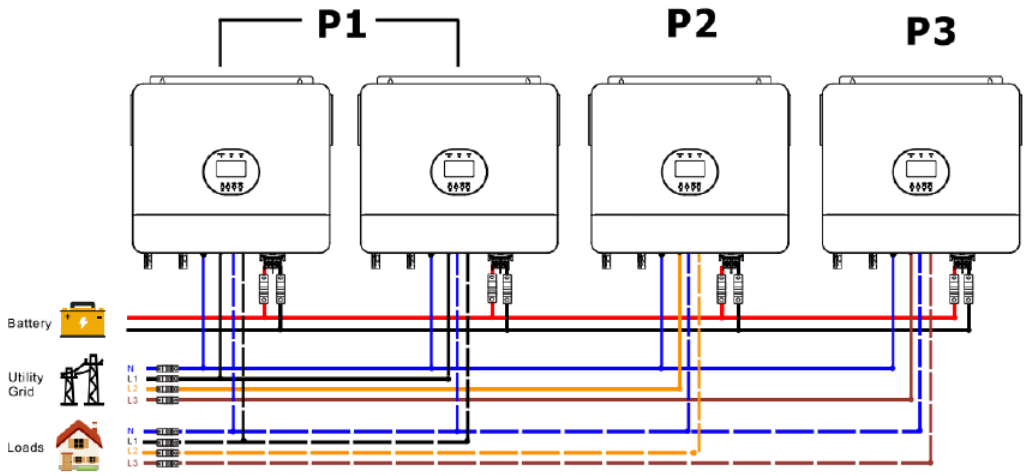



**Communication Connection**

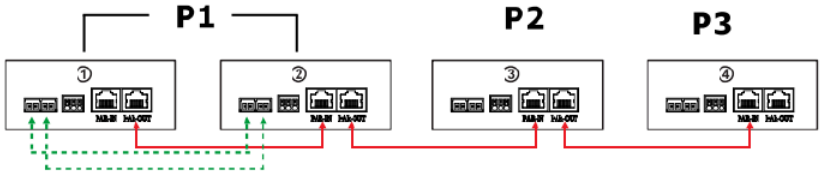


Two power converters in one phase and only one power converter for the remaining phases:

**Power Connection**

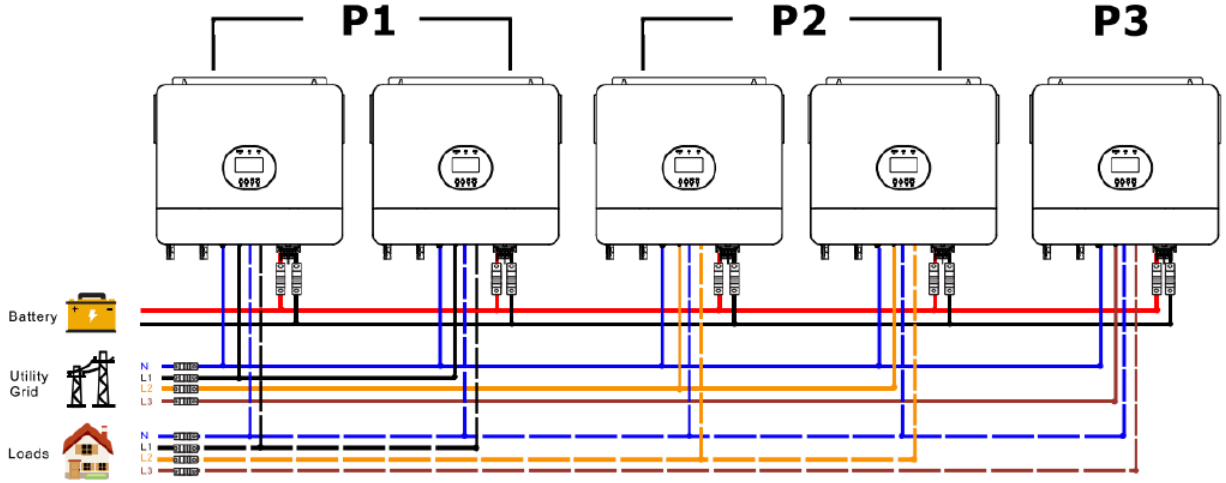



**Communication Connection**

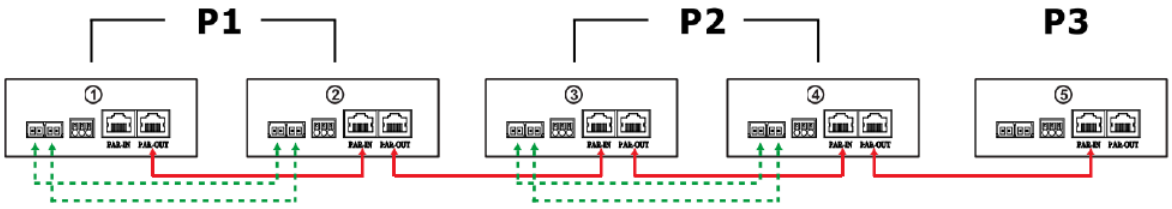



Two power converters in two phases and only one power converter for the remaining phase:

**Power Connection**

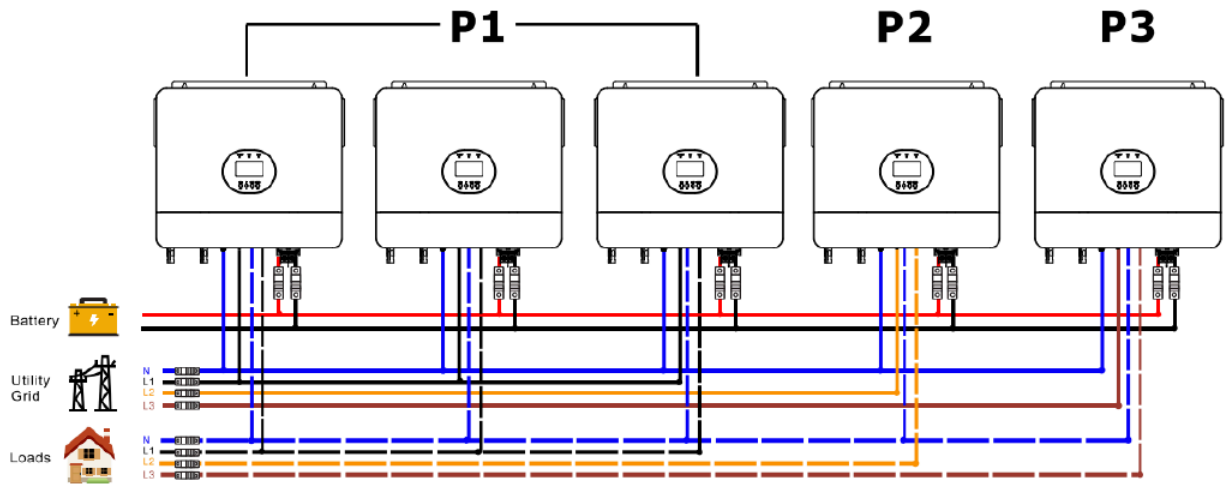



**Communication Connection**

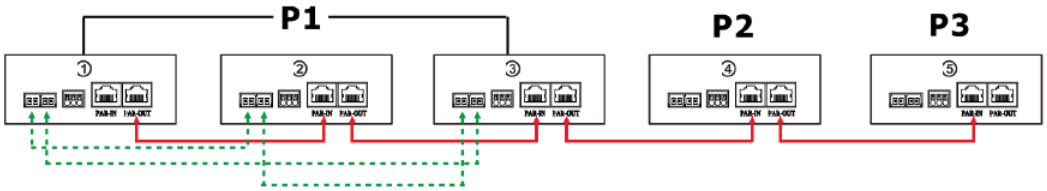


Three power converters in one phase and only one power converter for the remaining two phases:

**Power Connection**

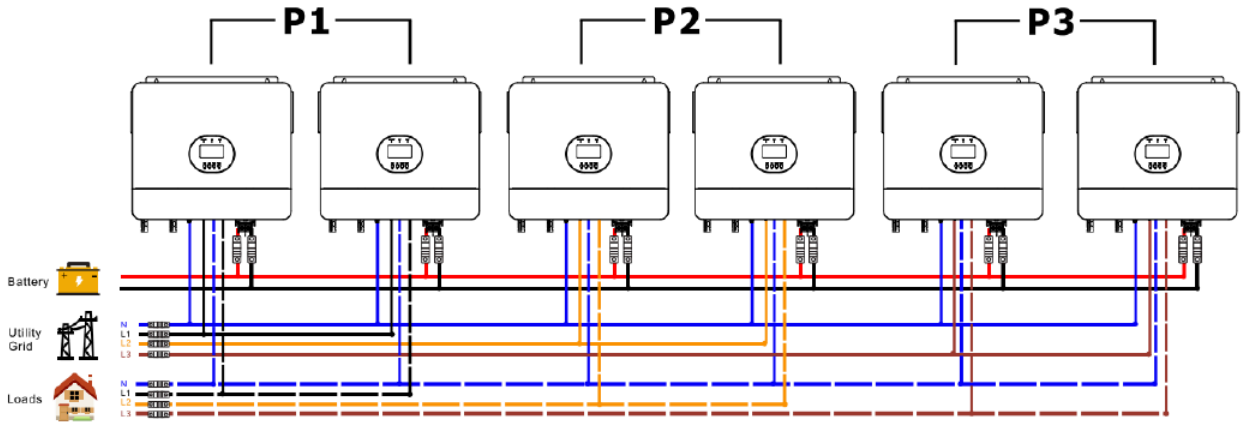



**Communication Connection**

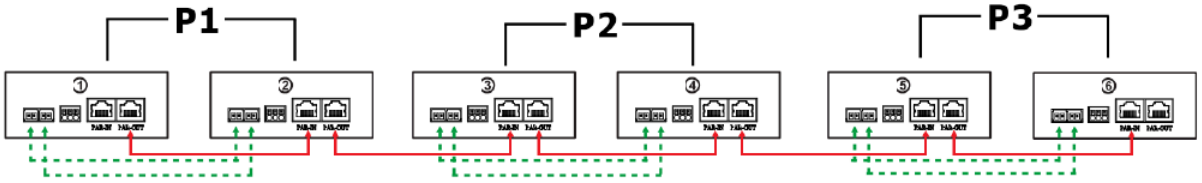



Two power converters in each phase:

**Power Connection**

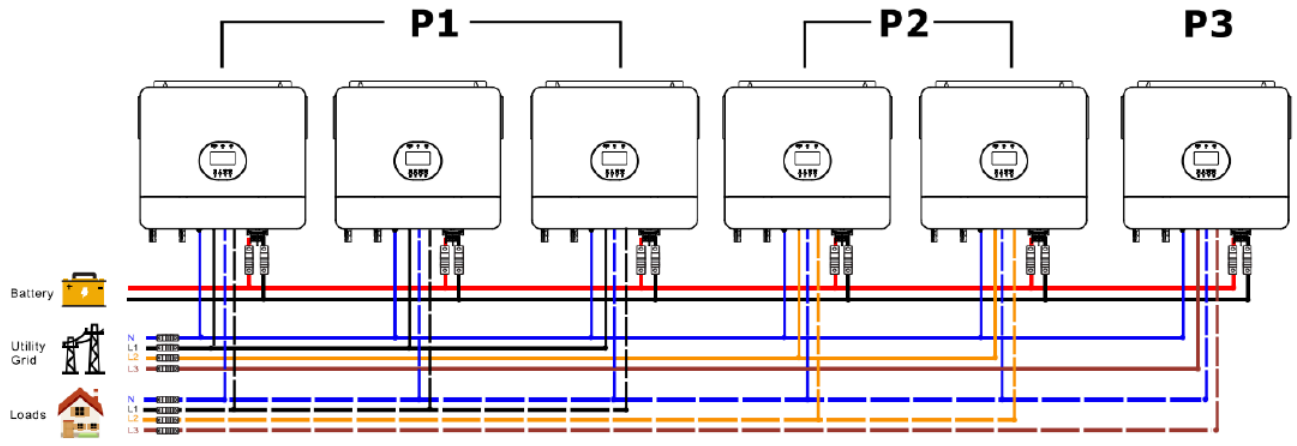



**Communication Connection**

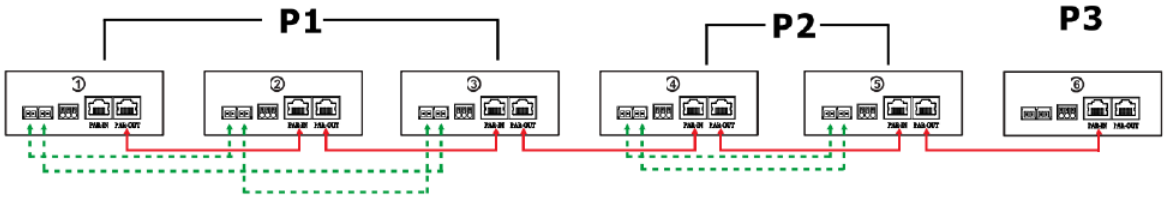


Three power converters in one phase, two power converters in second phase and one power converter for the third phase:

**Power Connection**

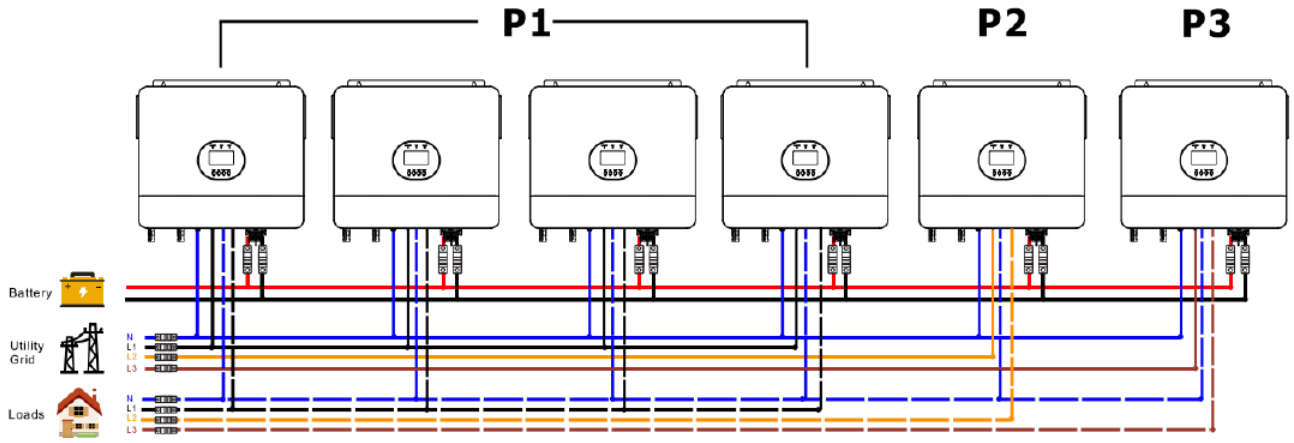



## Communication Connection

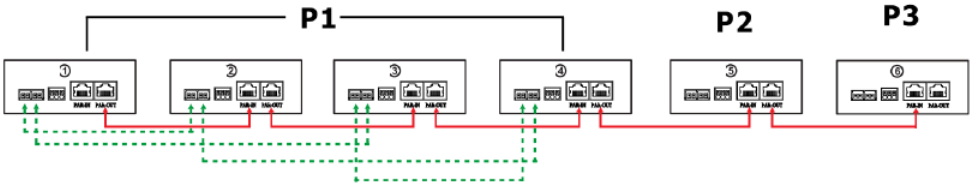



Four power converters in one phase and one power converter for the other two phases:

**Power Connection**




## Communication Connection




**WARNING:** Do not connect the current sharing cable between the power converters which are in different phases. Otherwise, it may damage the power converters.

# PV Connection

Please refer to user manual of single unit for PV Connection on Page 12.

**CAUTION:** Each power converter should connect to PV modules separate.

# LCD Setting and Display

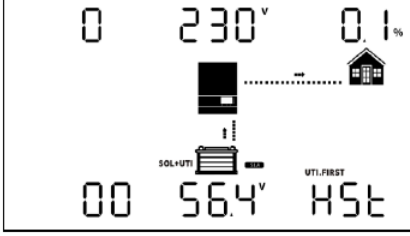
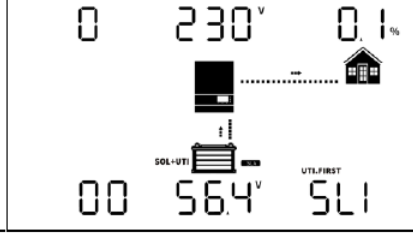
Refer to Program 23 on Page 20

## Parallel in Single Phase

Step 1: Check the following requirements before commissioning:

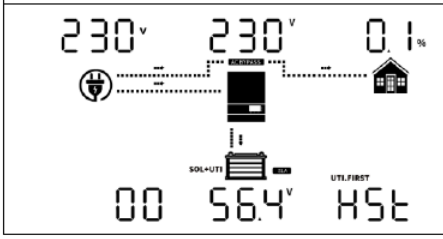
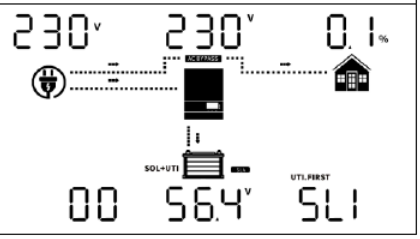
- Correct wire connection
- Ensure all breakers in Line wires of load side are open and each Neutral wires of each unit are connected together.

Step 2: Turn on each unit and set "PAL" in LCD setting program 23 of each unit. And then shut down all units.
**Note:** It's necessary to turn off switch when setting LCD program. Otherwise, the setting can not be programmed.
Step 3: Turn on each unit.

| LCD display in Master unit | LCD display in Slave unit |
|---|---|
|  |  |

**Note:** Master and slave units are randomly defined.

Step 4: Switch on all AC breakers of Line wires in AC input. It's better to have all power converters connect to utility at the same time. If not, it will display warning 15.

| LCD display in Master unit | LCD display in Slave unit |
|---|---|
|  |  |

Step 5: If there is no more fault alarm, the parallel system is completely installed.
Step 6: Please switch on all breakers of Line wires in load side. This system will start to provide power to the load.

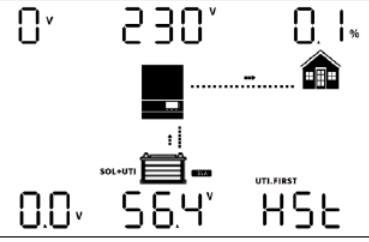
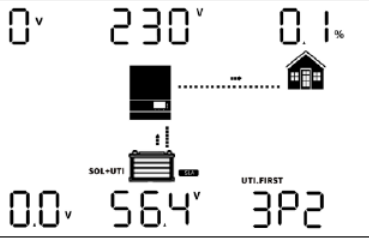
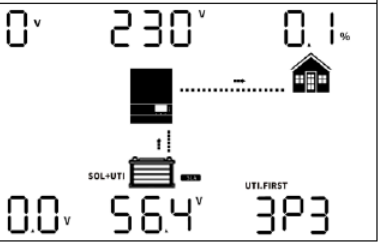
## Parallel in Three Phase

Step 1: Check the following requirements before commissioning:

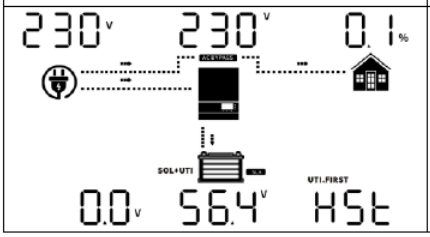
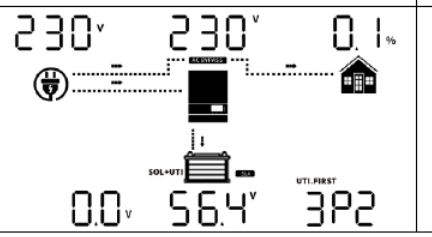
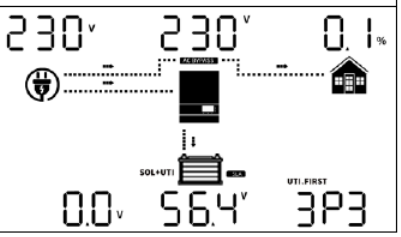
- Correct wire connection
- Ensure all breakers in Line wires of load side are open and each Neutral wires of each unit are connected together.

Step 2: Turn on all units and configure LCD program 23 as P1, P2 and P3 sequentially. Then shut down all units.
**Note:** It's necessary to turn off switch when setting LCD program. Otherwise, the setting can not be programmed.

Step 3: Turn on all units sequentially. Please turn on HOST power converter first, then turn on the rest one by one.

| LCD display in L1-phase unit | LCD display in L2-phase unit | LCD display in L3-phase unit |
|---|---|---|
|  |  |  |

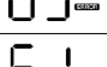
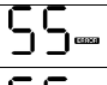
Step 4: Switch on all AC breakers of Line wires in AC input. If AC connection is detected and three phases are matched with unit setting, they will work normally. Otherwise, they will display warning 15/16 and will not work in the line mode.

| LCD display in L1-phase unit | LCD display in L2-phase unit | LCD display in L3-phase unit |
|---|---|---|
|  |  |  |

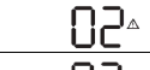
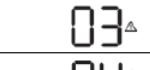
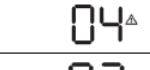
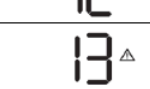
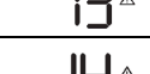
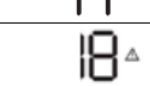
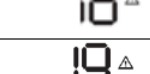
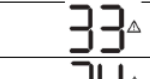
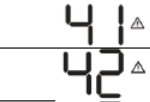
Step 5: If there is no more fault alarm, the system to support 3-phase equipment is completely installed.
Step 6: Please switch on all breakers of Line wires in load side. This system will start to provide power to the load.

**Note 1:** If there's only one power converter in L1-phase, the LCD will show as "HST". If there is more than one power converter in L1-phase, the LCD of the HOST power converter will show as "HST", the rest of L1-phase power converters will show as "3P1".
**Note 2:** To avoid overload occurring, before turning on breakers in load side, it's better to have whole system in operation first.
**Note 3:** Transfer time for this operation exists. Power interruption may happen to critical devices, which cannot bear transfer time.

# Fault Reference Code

| Fault Code | Fault Event | Icon on |
|---|---|---|
| 01 | Fan is locked |  |
| 02 | Over temperature |  |
| 03 | Battery voltage is too high |  |
| 04 | Battery voltage is too low |  |
| 05 | Output short circuited |  |
| 06 | Output voltage is too high. |  |
| 07 | Overload time out |  |
| 08 | Bus voltage is too high |  |
| 09 | Bus soft start failed |  |
| 51 | Over current or surge |  |
| 52 | Bus voltage is too low |  |
| 53 | Power Converter soft start failed |  |
| 55 | Over DC voltage in AC output |  |
| 56 | Battery connection is open |  |
| 57 | Current sensor failed |  |
| 58 | Output voltage is too low |  |
| 60 | Negative power fault |  |
| 61 | PV voltage is too high |  |
| 62 | Internal communication error |  |
| 80 | CAN fault |  |
| 81 | Host loss |  |

# Warning Indicator

| Warning Code | Warning Event | Audible Alarm | Icon flashing |
|---|---|---|---|
| 01 | Fan is locked when power converter is on. | Beep 3 times every second |  |
| 02 | Over temperature | Beep once every second |  |
| 03 | Battery is over-charged | Beep once every second |  |
| 04 | Low battery | Beep once every second |  |
| 07 | Overload | Beep once every 0.5 second |  |
| 10 | Output power derating | Beep twice every 3 seconds |  |
| 12 | charger stops due to low battery | Beep once every second |  |
| 13 | charger stops due to high PV voltage | Beep once every second |  |
| 14 | charger stops due to overload | Beep once every second |  |
| 15 | Parallel input utility grid different | Beep once every second |  |
| 16 | Parallel input phase error | Beep once every second |  |
| 17 | Parallel output phase loss | Beep once every second |  |
| 18 | Buck over current | Beep once every second |  |
| 19 | Battery disconnect | No beep |  |
| 20 | BMS communication error | Beep once every second |  |
| 21 | PV power insufficient | Beep once every second |  |
| 22 | Parallel forbidden without battery | Beep once every second |  |
| 25 | Parallel power converters' capacity different | Beep once every second |  |
| 33 | BMS communication loss | Beep once every second |  |
| 34 | Cell over voltage | Beep once every second |  |
| 35 | Cell under voltage | Beep once every second |  |
| 36 | Total over voltage | Beep once every second |  |
| 37 | Total under voltage | Beep once every second |  |
| 38 | Discharge over voltage | Beep once every second |  |
| 39 | Charge over voltage | Beep once every second |  |
| 40 | Discharge over temperature | Beep once every second |  |
| 41 | Charge over temperature | Beep once every second |  |
| 42 | Mosfet over temperature | Beep once every second |  |
| 43 | Battery over temperature | Beep once every second |  |
| 44 | Battery under temperature | Beep once every second |  |
| 45 | System shut down | Beep once every second |  |

# Battery Equalization

Equalization function is added into charge controller. It reverses the buildup of negative chemical effects like stratification, a condition where acid concentration is greater at the bottom of the battery than at the top. Equalizationalso helps to remove sulfate crystals that might have built up on the plates. If left unchecked, this condition, called sulfation, will reduce the overall capacity of the battery. Therefore, it's recommended to equalize battery periodically.

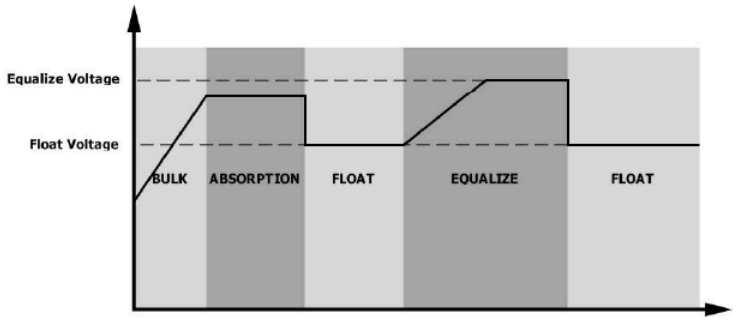
- **How to Apply Equalization Function**

  You must enable battery equalization function in monitoring LCD setting program 43 first. Then, you may apply this function in device by either one of following methods:

  1. Setting equalization interval in program 47.
  2. Active equalization immediately in program 48.

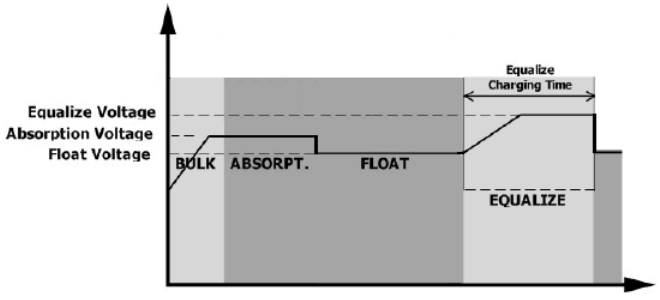
- **When to Equalize**

  In float stage, when the setting equalization interval (battery equalization cycle) is arrived, or equalization is active immediately, the controller will start to enter Equalize stage.

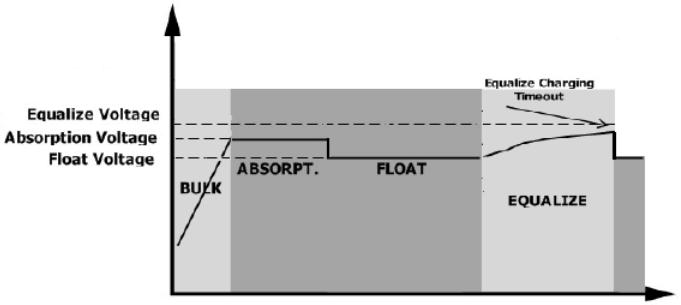



- **Equalize charging time and timeout**

  In Equalize stage, the controller will supply power to charge battery as much as possible until battery voltage raises to battery equalization voltage. Then, constant-voltage regulation is applied to maintain battery voltage at the battery equalization voltage. The battery will remain in the Equalize stage until setting battery equalized time is arrived.




However, in Equalize stage, when battery equalized time is expired and battery voltage doesn't rise to battery equalization voltage point, the charge controller will extend the battery equalized time until battery voltage achieves battery equalization voltage. If battery voltage is still lower than battery equalization voltage when battery equalized timeout setting is over, the charge controller will stop equalization and return to float stage.



# Specifications

Table 1 Line Mode Specifications

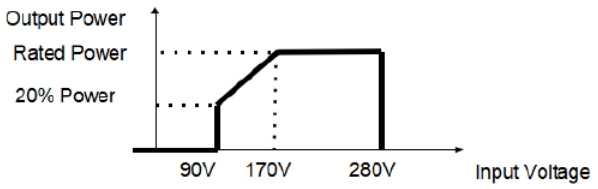
| POWER CONVERTER **MODEL** | **SPF 6000 ES PLUS** |
|---|---|
| **Input Voltage Waveform** | Sinusoidal (utility or generator) |
| **Nominal Input Voltage** | 230Vac |
| **Low Loss Voltage** | 170Vac±7V (UPS); 90Vac±7V (Appliances) |
| **Low Loss Return Voltage** | 180Vac±7V (UPS); 100Vac±7V (Appliances) |
| **High Loss Voltage** | 280Vac±7V |
| **High Loss Return Voltage** | 270Vac±7V |
| **Max AC Input Voltage** | 300Vac |
| **Nominal Input Frequency** | 50Hz / 60Hz (Auto detection) |
| **Low Loss Frequency** | 40±1Hz |
| **Low Loss Return Frequency** | 42±1Hz |
| **High Loss Frequency** | 65±1Hz |
| **High Loss Return Frequency** | 63±1Hz |
| **Output Short Circuit Protection** | Circuit Breaker |
| **Efficiency (Line Mode)** | >95% ( Rated R load, battery full charged ) |
| **Transfer Time** | 10ms typical, 20ms Max@ Single<br><30ms @ Parallel |
| **Output power derating:**<br>When AC input voltage drops to 170V, the output power will be derated. |  |

Table 2 Power Converter Mode Specifications

| POWER CONVERTER **MODEL** | **SPF 6000 ES PLUS** |
|---|---|
| **Rated Output Power** | 6KVA/6KW |
| **Output Voltage Waveform** | Pure Sine Wave |
| **Output Voltage Regulation** | 230Vac±5% |
| **Output Frequency** | 50Hz |
| **Nominal Output Current** | 27A |
| **Overload Protection** | 5s@≥150% load; 10s@110%~150% load |
| **Surge Capacity** | 2* rated power for 5 seconds |
| **Nominal DC Input Voltage** | 48Vdc |
| **Cold Start Voltage(Lead-Acid Mode)** | 46.0Vdc |
| **Cold Start SOC(Li Mode)** | Default 30%, Low DC Cut-off SOC +10% |
| **Low DC Warning Voltage (Lead-Acid Mode)** | 44.0Vdc @ load < 20%<br>42.8Vdc @ 20% ≤ load < 50%<br>40.4Vdc @ load ≥ 50% |
| **Low DC Warning Return Voltage (Lead-Acid Mode)** | 46.0Vdc @ load < 20%<br>44.8Vdc @ 20% ≤ load < 50%<br>42.4Vdc @ load ≥ 50% |
| **Low DC Cut-off Voltage (Lead-Acid Mode)** | 42.0Vdc @ load < 20%<br>40.8Vdc @ 20% ≤ load < 50%<br>38.4Vdc @ load ≥ 50% |
| **Low DC Cut-off Voltage (Li Mode)** | 42.0Vdc |
| **Low DC Warning SOC (Li Mode)** | Low DC Cut-off SOC +5% |
| **Low DC Warning Return SOC (Li Mode)** | Low DC Cut-off SOC +10% |
| **Low DC Cut-off SOC(Li Mode)** | Default 20%, 5%~50% settable |
| **High DC Recovery Voltage** | 56.4Vdc(C.V. charging voltage) |
| **High DC Cut-off Voltage** | 60.8Vdc |
| **No Load Power Consumption** | <70W |

Table 3 Charge Mode Specifications

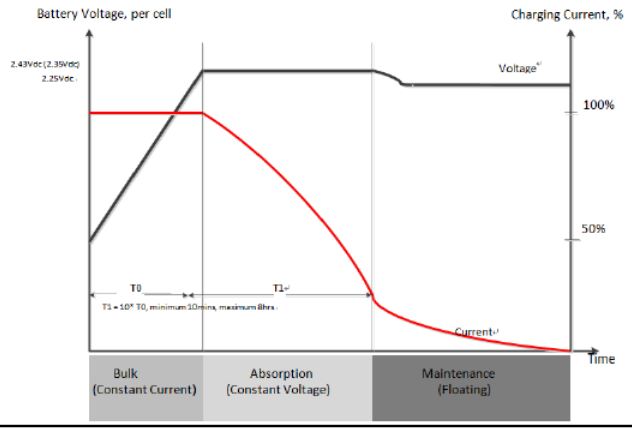
| **Utility Charging Mode** | | |
|---|---|---|
| **POWER CONVERTER MODEL** | | **SPF 6000 ES PLUS** |
| **Charging Algorithm** | | 3-Step |
| **Max. AC Charging Current** | | 80Amp(@$V_{I/P}$=230Vac) |
| **Bulk Charging Voltage** | **Flooded Battery** | 58.4Vdc |
| | **AGM / Gel Battery** | 56.4Vdc |
| **Floating Charging Voltage** | | 54Vdc |
| **Charging Curve** | |  |
| **MPPT Charging Mode** | | |
| **Max. PV Array Power** | | 4000W+4000W |
| **Max. PV Input Current** | | 16A+16A |
| **Start-up Voltage** | | 150Vdc±10Vdc |
| **PV Array MPPT Voltage Range** | | 120Vdc~450Vdc |
| **Max. PV Array Open Circuit Voltage** | | 500Vdc |
| **Max. Power Converter Back Feed Current To The Array** | | 0A |
| **Max. PV Charging Current** | | 100A |
| **Max. Charging Current (AC Charger Plus Charger)** | | 100A |

Table 4 General Specifications

| **POWER CONVERTER MODEL** | **SPF 6000 ES PLUS** |
|---|---|
| **Safety Certification** | CE |
| **Operating Temperature Range** | 0℃ to 55℃ |
| **Storage temperature** | -15℃~ 60℃ |
| **Humidity** | 5% to 95% Relative Humidity (Non-condensing) |
| **Altitude** | <2000m |
| **Dimension(D*W*H), mm** | 460*395*132 |
| **Net Weight, kg** | 13.5kg |

# Trouble Shooting

| Problem | LCD/LED/Buzzer | Explanation | What to do |
|---|---|---|---|
| Unit shuts down Automatically during startup process. | LCD/LEDs and buzzer will be active for 3 seconds and then complete off. | The battery voltage is too low . (<1.91V/Cell) | 1. Re-charge battery.<br>2. Replace battery. |
| No response after power on. | No indication. | 1.The battery voltage is far too low. (<1.4V/Cell)<br>2.Battery polarity is connected reversed. | 1. Check if batteries and the wiring are connected well.<br>2. Re-charge battery.<br>3. Replace battery. |
| Mains exist but the unit works in battery mode. | Input voltage is 0 on the LCD and green LED is flashing. | Input protector is tripped. | Check if AC breaker is tripped and AC wiring is connected well. |
| | Green LED is flashing. | Insufficient quality of AC power (Shore or Generator) | 1.Check if AC wires are too thin and/or too long.<br>2.Check if generator (if applied) is working well or if input voltage range setting is correct. (UPS→Appliance) |
| | Green LED is flashing. | Set "Battery First" or " First" as the priority of output source. | Change output source priority to Utility first. |
| When it's turned on, internal relay is switching on and off repeatedly. | LCD display and LEDs are flashing | Battery is disconnected. | Check if battery wires are connected well. |
| Buzzer beeps continuously and red LED is on. (Fault code)<br><br>Buzzer beeps once every second, and red LED is flashing. (Warning code) | Fault code 01 | Fan fault. | 1.Check whether all fans are working properly.<br>2.Replace the fan. |
| | Fault code 02 | Internal temperature of component is over 100°C. | 1. Check whether the air flow of the unit is blocked or whether the ambient temperature is too high.<br>2. Check whether the thermistor plug is loose. |
| | Fault code 03 | Battery is over-charged. | Restart the unit, if the error happens again, please return to repair center. |
| | | The battery voltage is too high. | Check if spec and quantity of batteries are meet requirements. |
| | Warning code 04 | The battery voltage/SOC is too low. | 1. Measure battery voltage in DC input.<br>2. Check battery SOC in LCD when use Li battery<br>3. Recharge the battery. |
| | Fault code 05 | Output short circuited. | Check if wiring is connected well and remove abnormal load. |
| | Fault code 06/58 | Output abnormal (Power Converter voltage is higher than 280Vac or lower than 80Vac). | 1. Reduce the connected load.<br>2. Restart the unit, if the error happens again, please return to repair center. |
| | Fault code 07 | The power converter is overload 110% and time is up. | Reduce the connected load by switching off some equipment. |

| | | | |
|---|---|---|---|
| Buzzer beeps continuously and red LED is on. (Fault code)<br><br>Buzzer beeps once every second, and red LED is flashing. (Warning code) | Fault code 08 | Bus voltage is too high. | 1. If you connect to a lithum battery without communication, check whether the voltage points of the program 19 and 21 are too high for the lithum battery.<br>2. Restart the unit, if the error happens again, please return to repair center. |
| | Fault code 09/53/57 | Internal components failed. | Restart the unit, if the error happens again, please return to repair center. |
| | Warning code 15 | The input status is different in parallel system. | Check if AC input wires of all power converters are connected well. |
| | Warning code 16 | Input phase is not correct. | Change the input phase S and T wiring. |
| | Warning code 17 | The output phase not correct in parallel. | 1.Make sure the parallel setting are the same system(sigle or paralle; 3P1,3P2,3P3).<br>2.Make sure all phases power converters are power on. |
| | Warning code 20 | Li battery can't communicate to the power converter. | 1. Check whether communication line is correct connection between power converter and battery.<br>2. Check whether BMS protocol type is correct setting. |
| | Fault code 51 | Over current or surge. | Restart the unit, if the error happens again, please return to repair center. |
| | Fault code 52 | Bus voltage is too low. | |
| | Fault code 55 | Output voltage is unbalanced | |
| | Fault code 56 | Battery is not connected well or fuse is burnt. | 1. If you connect to a lithum battery without communication, check whether the voltage points of the program 19 and 21 are too high for the lithum battery.<br>2. If the battery is connected well, restart the unit. If the error happens again, please return to repair center. |
| | Fault code 60 | Negative power fault | 1. Check whether the AC output connected to the grid input.<br>2. Check whether Program 8 settings are the same for all parallel power converters<br>3. Check whether the current sharing cables are connected well in the same parallel phases.<br>4. Check whether all neutral wires of all parallel units are connected together.<br>5. If problem still exists, contact repair center. |
| | Fault code 80 | CAN fault | 1. Check whether the parallel communication cables are connected well.<br>2. Check whether Program 23 settings are right for the parallel system.<br>3. If problem still exists, contact repair center |
| | Fault code 81 | Host loss | |

Note: To restart the power converter, all power sources need to be disconnected. After the LCD screen light is off, only use the battery to boot.