Off Grid Solar Inverter
SPF 3000TL LVM

Version: 2.0

Table Of Contents

Information on this Manual

Validity

This manual is valid for the following devices:

▶ SPF 3000TL LVM-24P
▶ SPF 3000TL LVM-48P

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 inverter 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. **CAUTION –** Only qualified personnel can install this device with battery.
2. Before using the unit, read all instructions and caution marks on the unit, understand the batteries and all appropriate sections of this manual.
3. **NEVER** cause AC output and DC input short circuited. Do NOT connect to the mains when DC input short circuits.
4. **NEVER** charge a frozen battery.
5. 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.
6. To reduce risk of electric shock, disconnect all wiring before attempting any maintenance or cleaning. Turning off the unit will not reduce this risk.
7. Be very cautious when working with metal tools on or around batteries. A potential risk, such as dropping a tool to spark or short circuit batteries or other electrical parts, could cause an explosion.
8. For optimum operation of this off grid solar inverter, please follow required spec to select appropriate cable size. It's very important to correctly operate this off grid solar inverter.
9. 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.
10. GROUNDING INSTRUCTIONS –This off grid solar inverter should be connected to a permanent grounded wiring system. Be sure to comply with local requirements and regulation to install this inverter.
11. Fuses are provided as over-current protection for the battery supply.
12. **Warning!!** Only qualified service persons are able to service this device. If errors still persist after following troubleshooting table, please send this off grid solar inverter back to local dealer or service center for maintenance.
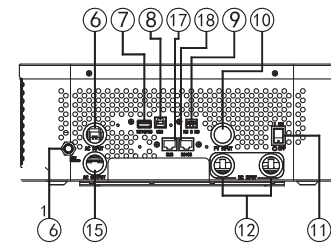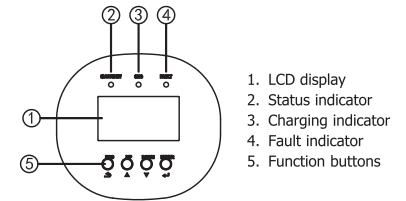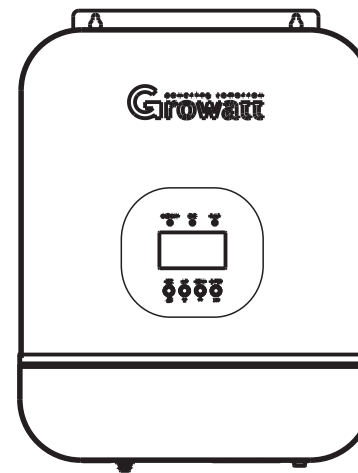
Introduction

Hybrid Power System
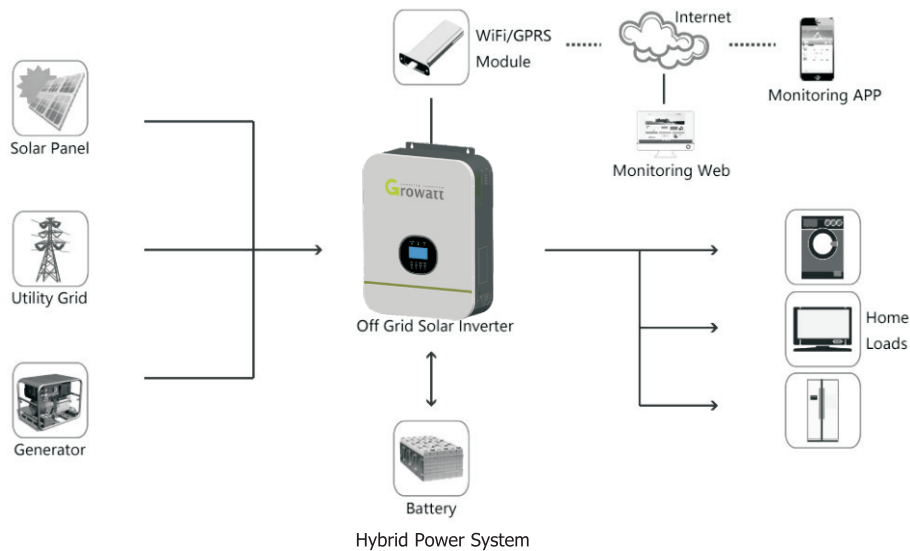
This is a multifunctional off grid solar inverter, integrated with a MPPT solar charge controller, a high frequency pure sine wave inverter and a UPS function module in one machine, which is perfect for off grid backup power and self-consumption applications. The transformerless design provides reliable power conversion in compact size.

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 inverter. With this device, users can monitor the status of the PV system from the mobile phone or from the website anytime anywhere.
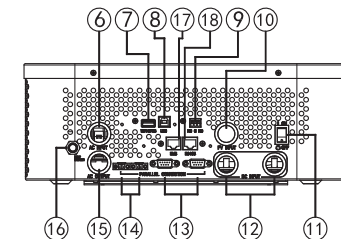
Features

‣ 24V/48V battery system

‣ Pure sine wave output 3KW

‣ Inbuilt MPPT 80A

‣ High frequency inverter with small size and light weight

‣ Overload, short circuit and deep discharge protection

‣ Compatible to mains voltage or generator power

‣ Parallel operation up to 6 unit

‣ WIFI/ GPRS remote monitoring (optional)

Product Overview

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

Single Model

Parallel Model

6. AC input

7. WiFi/GPRS communication port

8. USB communication port

9. Dry contact

10. PV input

11. Power on/off switch

12. Battery input

13. Parallel communication ports (only for parallel model)

14. Current sharing ports (only for parallel model)

15. AC output

16. Circuit breaker

17. BMS communication port (only supported the RS485 protocol)

18. Rs485 communication port (for expansion)

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:

- The unit x 1
- User manual x 1
- USB communication cable x 1
- Software CD x 1
- Current sharing cable (parallel model available)
- Parallel communication cable (parallel model available)

Preparation

Before connecting all wiring, please take off bottom cover by removing two screws as shown below.
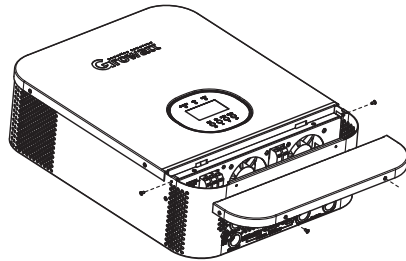
Mounting the Unit

Consider the following points before selecting where to install:

- Do not mount the inverter on flammable construction materials.
- Mount on a solid surface
- Install this inverter 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.
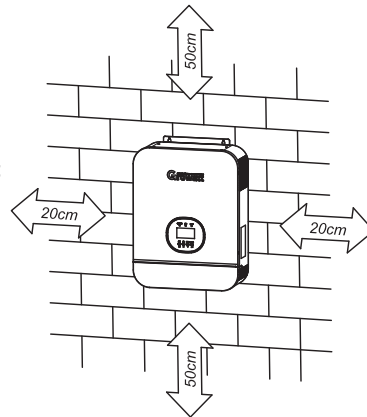
⚠ **SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY.**

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

180mm [7.09"]
430mm [16.93"]
270mm [10.63"]
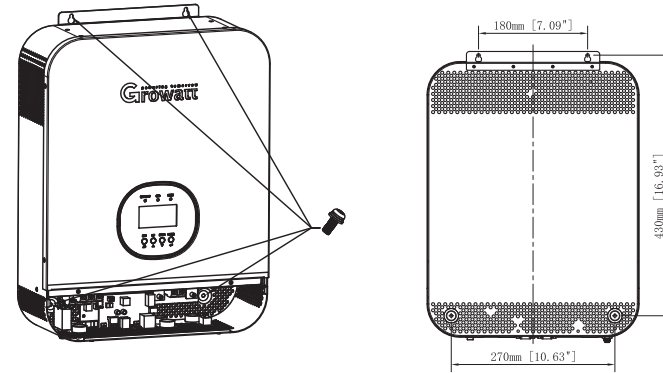
Battery Connection
## Lead acid battery connection

User can choose proper capacity lead acid battery with a nominal voltage at 48V for 48V model and at 24V for 24V model. 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 inverter. 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.

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.
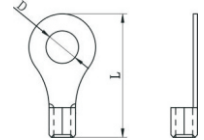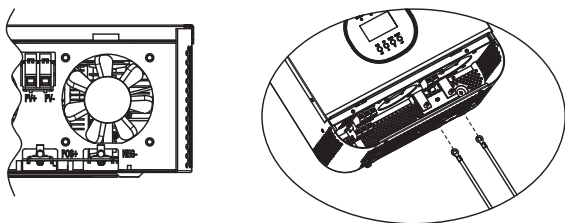
Ring terminal:

Recommended battery cable and terminal size:

Model	Maximum Amperage	Battery Capacity	Wire Size	Ring Terminal			
				Cable mm^2	Dimensions		Torque value
					D (mm)	L (mm)	
SPF 3000TL LVM-24P	164A	200AH	1*2AWG	38	6.4	39.2	2~ 3 Nm
			2*6AWG	28	6.4	33.2	
SPF 3000TL LVM-48P	82A	100AH 200AH	1*4AWG	22	6.4	39.2	2~ 3 Nm
			2*8AWG	16	6.4	33.2	

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 100Ah capacity battery for 3KVA/48V model and at least 200Ah capacity battery for 3KVA/24Vmodel.
3. Insert the ring terminal of battery cable flatly into battery connector of inverter and make sure the bolts are tightened with torque of 2-3 Nm. Make sure polarity at both the battery and the inverter/charge is correctly connected and ring terminals are tightly screwed to the battery terminals.

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

| ⚠	**CAUTION!!** Do not place anything between the flat part of the inverter terminal and the ring terminal. Otherwise, overheating may occur. **CAUTION!!** Do not apply anti-oxidant substance on the terminals before terminals are connected tightly. **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 Growatt SPF series products, 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)
2. Insert the ring terminal of battery cable flatly into battery connector of inverter and make sure the bolts are tightened with torque of 2-3Nm. Make sure polarity at both the battery and the inverter/charge is correctly connected and ring terminals are tightly screwed to the battery terminals.
3. Connect the end of RJ45 of battery to BMS communication port of inverter.
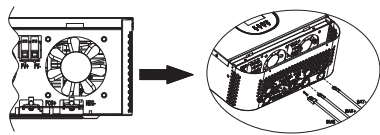
4. The other end of RJ45 insert to battery comm port.
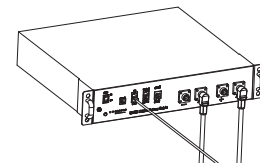
Note: if choosing lithium battery, make sure to connect the BMS communication cable between the battery and the inverter. You need to choose battery type as "lithium battery"

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 four RS485 protocols in the inverter. Basic protocol Protocol 1 is defined by Growatt. Protocol 2, Protocol 3 and protocol 4 are other customized protocols. Any questions about communicating with BMS , please consult with Growatt.

1. Connect the end of RJ45 of battery to BMS communication port of inverter
Make sure the lithium battery BMS port connects to the inverter is Pin to Pin, the inverter BMS port pin assignment shown as below:

Pin number	BMS port
1	RS485B
2	RS485A
3	--
4	--
5	--
6	--
7	--
8	--

2. 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 battery type. There will be 4 options under Program 36.

05	Battery type	AGM (default)	Flooded
		AGM 05	FLd 05
		Lithium (only suitable when communicated with BMS)	
		LI 05	
		User-Defined	
		USE 05	
		If "User-Defined" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21.	

36	Protocal to communicate with battery BMS	Protocol 1	P t C L I 1 3 6
		Protocol 2	P t C L I 2 3 6
		Protocol 3	P t C L I 3 3 6
		Protocol 4	P t C L I 4 3 6

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 inverter will cut off output.

| 12 | Setting SOC point back to utility source when selecting "SBU priority" or "Solar first" in program 01 | 50 %   1 2
Default 50%, 20%~50% Settable |
| 13 | Setting SOC point back to battery mode when selecting "SBU priority" or "Solar first" in program 01 | 95 %   1 3
Default 95%, 60%~100% Settable |

| 21 | Low DC cut-off SOC . If Li is selected in program 5, this program can be set up | C O u
20 %   2 1
Default 20%, 5%~30% Settable |

Communicating with battery BMS in parallel system

If need to use communicate with BMS in a parallel system, an external RS485/CAN HUB is needed to converge the communication cables from the parallel inverters to lithium battery.
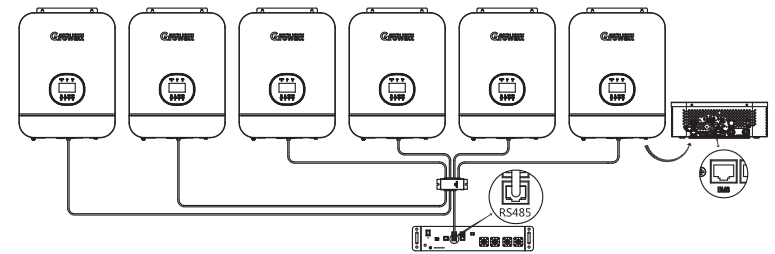
RS485/CAN Hub:
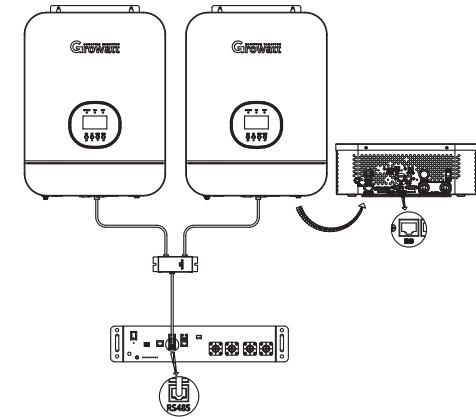
Note: If inverters parallel as split phase or 3 phase system, only need to connect L1-Phase inverters with lithium battery to communicat with BMS.When inverters on L1-Phase are more than 2 units, it would need an extra RS485/CAN HUB to converge inverters on L1-Phase to connect with lithium battery to communicate with BMS.

AC Input/Output Connection

CAUTION!! Before connecting to AC input power source, please install a **separate** AC breaker between inverter and AC input power source. This will ensure the inverter can be securely disconnected during maintenance and fully protected from over current of AC input. The recommended spec of AC breaker is 40A for 3KVA.

CAUTION!! There are two terminal blocks with "IN" and "OUT" 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. 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 3000TL LVM	8 AWG	1.4~ 1.6Nm

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

1. Before making AC input/output connection, be sure to open DC protector or disconnector first.
2. Remove insulation sleeve 10mm for six conductors. And shorten phase L and neutral conductor N 3 mm.
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)**
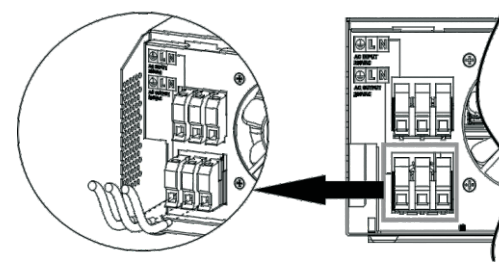   **L→LINE (brown or black)**
    N→Neutral (blue)
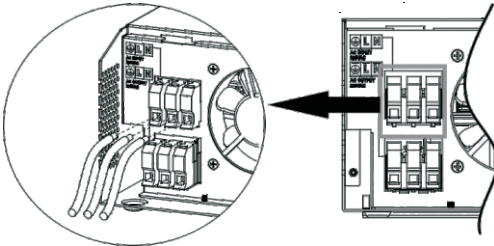
> ⚠ **WARNING:**
> Be sure that AC power source is disconnected before attempting to hardwire it to the unit.

4. Then, insert AC output wires according to polarities indicated on terminal block and tighten terminal screws. Be sure to connect PE protective conductor ⏚ first.

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

5. 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 inverters 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 solar inverter will trigger 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 inverter 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	Typical Amperage	Cable Size	Torque
SPF 3000TL LVM	80A	6 AWG	1.4~1.6 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 inverter.
2. Open circuit Voltage (Voc) of PV modules should be higher than min. battery voltage.

| Solar Charging Mode		
INVERTER MODEL	SPF 3000TL LVM-24P	SPF 3000TL LVM-48P
Max. PV Array Open Circuit Voltage	145Vdc	145Vdc
PV Array MPPT Voltage Range	30~115Vdc	60~115Vdc
Min. battery voltage for PV charge	17Vdc	34Vdc

Please follow below steps to implement PV module connection:
1. Remove insulation sleeve 10 mm for positive and negative conductors.
2. Check correct polarity of connection cable from PV modules and PV input connectors. 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.
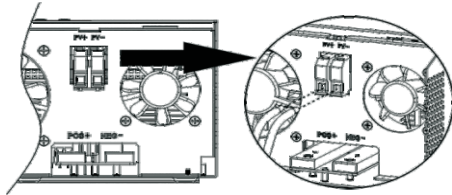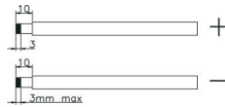
3. Make sure the wires are securely connected.

Final Assembly

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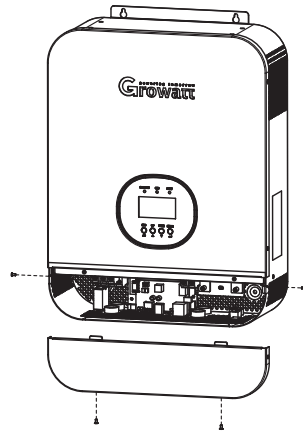
Communication Connection

Please use supplied communication cable to connect to inverter and PC. Insert bundled CD into a computer and follow on-screen instruction to install the monitoring software. For the detailed software operation, please check user manual of software inside of CD.

Dry Contact Signal

There is one dry contact available on the rear panel. When program 24 is set as "disable", it could be used to deliver signal to external device when battery voltage reaches warning level. When program 24 is set as "enable" and the unit is working in battery mode, it could be used to trigger the grounding box to connect neutral and grounding of AC output together.

When program 24 is set as "disable" (default setting):

Unit Status	Condition		Dry contact port: NC C NO	
			NC & C	NO & C
Power Off	Unit is off and no output is powered.		Close	Open
Power On	Output is powered from Utility.		Close	Open
	Output is powered from Battery or Solar.	Program 01 set as Utility	Battery voltage < Low DC warning voltage	Open	Close
			Battery voltage > Setting value in Program 13 or battery charging reaches floating stage	Close	Open
		Program 01 is set as SBU or Solar first	Battery voltage < Setting value in Program 12	Open	Close
			Battery voltage > Setting value in Program 13 or battery charging reaches floating stage	Close	Open

When program 24 is set as "enable":

| Unit Status	Condition	Dry contact port: NC C NO	
		NC & C	NO & C
Power Off	Unit is off and no output is powered.	Close	Open
Power On	Unit works in standby mode, line mode or fault mode	Close	Open
	Unit works in battery mode or power saving mode	Open	Close

Operation

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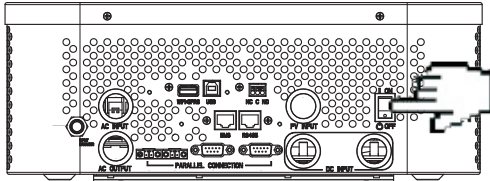
Once the unit has been properly installed and the batteries are connected well, simply press On/Off switch (located on the button of the case) to turn on the unit.

Operation and Display Panel

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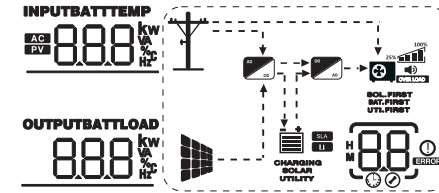

1. LCD display

2. Status indicator

3. Charging indicator

4. Fault indicator

5. Function buttons
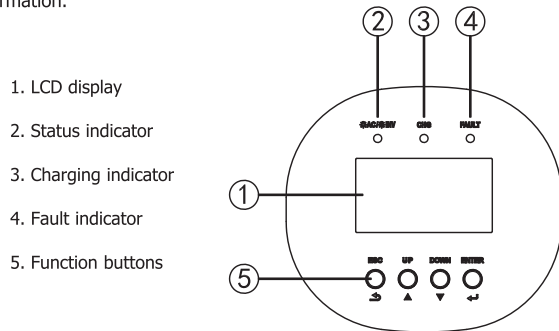
LED Indicator

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 inverter.
		Flashing	Warning condition occurs in the inverter.

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	Function Description
Input Source Information	
AC	Indicates the AC input.
PV	Indicates the PV input
INPUT 888 kw%VAHz	Indicate input voltage, input frequency, PV voltage, battery voltage and charger current.
Configuration Program and Fault Information	
88	Indicates the setting programs.
88	Indicates the warning and fault codes. 88 Warning: flashing with warning code. 88 Fault:lighting with fault code
Output Information	
OUTPUTBATTLOAD 888 kw%VAHz	Indicate output voltage, output frequency, load percent, load in VA, load in Watt and discharging current.
Battery Information	
CHARGING	Indicates battery level by 0-24%, 25-49%, 50-74% and 75-100% in battery mode and charging status in line mode.
SOLAR UTILITY	These two signs indicate the charge priority. SOLAR indicates solar first. UTILITY indicate utility first. SOLAR blinking indicates solar only; SOLAR and UTILITY both on indicates combined charging.

In AC mode, it 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, it 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	

Load Information

OVER LOAD	Indicates overload.
	Indicates the load level by 0-24%, 25-49%, 50-74% and 75-100%.

0%~24%	25%~49%	50%~74%	75%~100%

Mode Operation Information

	Indicates unit connects to the mains.
	Indicates unit connects to the PV panel.
BYPASS	Indicates load is supplied by utility power.
	Indicates the utility charger circuit is working.
	Indicates the DC/AC inverter circuit is working.
SOL.FIRST BAT.FIRST UTI.FIRST	These three signs indicate the output priority. SOL.FIRST indicates solar first. BAT.FIRST indicates battery first. UTI.FIRST indicates utility first.

Mute Operation

	Indicates unit alarm is Enabled.

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. And then, press "ENTER" button to confirm the selection or ESC button to exit.

Setting Programs:

Program	Description	Setting Option	
01	Output source priority: To configure load power source priority	Solar first — **SOL 01**	
		Solar energy provides power to the loads as first priority. If solar energy is not sufficient to power all connected loads, battery energy will supply power the loads at the same time. Utility provides power to the loads only when any one condition happens: - Solar energy is not available - Battery voltage drops to either low-level warning voltage or the setting point in program 12.	
		Utility first (default) — **UtI 01**	
		Utility will provide power to the loads as first priority. Solar and battery energy will provide power to the loads only when utility power is not available.	
		SBU priority — **SbU 01**	
		Solar energy provides power to the loads as first priority. If solar energy is not sufficient to power all connected loads, battery energy will supply power to the loads at the same time. Utility provides power to the loads only when battery voltage drops to either low-level warning voltage or the setting point in program 12.	
02	Maximum charging current: To configure total charging current for solar and utility chargers. (Max. charging current = utility charging current + solar charging current)	**80 A 02** 24V model: default 60A, 10A~140A Settable 48V model: default 60A, 10A~120A Settable (If Li is selected in program 5,this program can't be set up	
03	AC input voltage range	**APL 03** Appliance (default)	If selected, acceptable AC input voltage range will be within 90~280VAC
		UPS 03 UPS	If selected, acceptable AC input voltage range will be within 170~280VAC
		GEN 03 Generator	If selected, acceptable AC input voltage range will be within 90~280VAC

04	Power saving mode enable/disable	**SdS 04** Saving mode disable (default)	If disabled, no matter connected load is low or high, the on/off status of inverter output will not be effected.
		SEN 04 Saving mode enable	If enabled, the output of inverter will be off when connected load is pretty low or not detected.
05	Battery type	**AGM 05** AGM (default)	**USE 05** User-Defined
		FLd 05 Flooded	If "User-Defined" is selected, battery charge voltage and low DC cut-off voltage can be set up in program 19, 20 and 21.
		LI 1 05 Lithium Lithium (only suitable when communicated with BMS)	
06	Auto restart when overload occurs	**Lrd 06** Restart disable (default)	**LrE 06** Restart enable
07	Auto restart when over temperature occurs	**trd 07** Restart disable (default)	**trE 07** Restart enable
08	Output voltage	**120ᵛ 08** 120V (default)	**110ᵛ 08** 110V
		100ᵛ 08 100V	
09	Output frequency	**60Hz 09** 60Hz (default)	**50Hz 09** 50Hz
10	Number of series batteries connected	**BATTT NO. 4 10** (e.g. Showing batteries are connected in 4 series)	
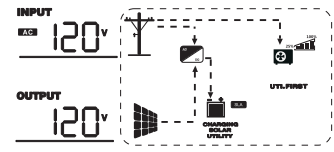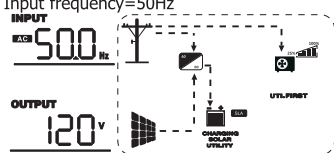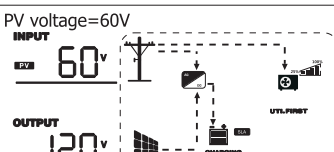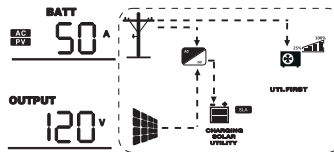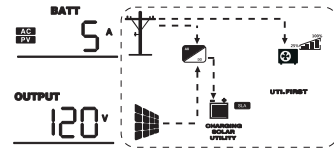
11	Maximum utility charging current	**30^ 11** 24V model: default 30A, 10A~60A Settable 48V model: default 30A, 10A~40A Settable (If Li is selected in program 5,this program can't be set up	
12	Setting voltage point back to utility source when selecting "SBU priority" or "Solar first" in program 01	**46.0ᵛ 12** 24V model: default 23.0V, 22.0V~25.6V Settable 48V model: default 46.0V, 44.0V~51.2V Settable	
13	Setting voltage point back to battery mode when selecting "SBU priority" or "Solar first" in program 01	**54.0ᵛ 13** 24V model: default 27.0V, 24.0V~29.0V Settable 48V model: default 54.0V, 48.0V~58.0V Settable	
14	Charger source priority: To configure charger source priority	If this off grid solar inverter is working in Line, Standby or Fault mode, charger source can be programmed as below:	
		CSO 14 Solar first	Solar energy will charge battery as first priority. Utility will charge battery only when solar energy is not available.
		CUt 14 Utility first	Utility will charge battery as first priority. Solar energy will charge battery only when utility power is not available.
		SNU 14 Solar and Utility	Solar energy and utility will both charge battery.
		OSO 14 Only Solar	Solar energy will be the only charger source no matter utility is available or not.
		If this off grid solar inverter is working in Battery mode or Power saving mode, only solar energy can charge battery. Solar energy will charge battery if it's available and sufficient.	
15	Alarm control	**bON 15** Alarm on (default)	**bOF 15** Alarm off
16	Backlight control	**LON 16** Backlight on (default)	**LOF 16** Backlight off
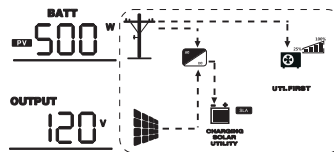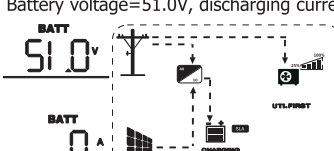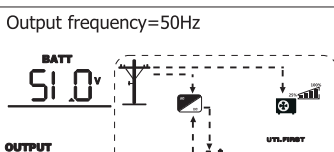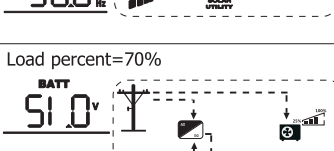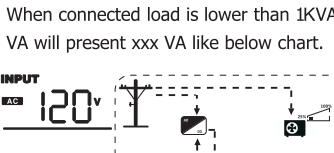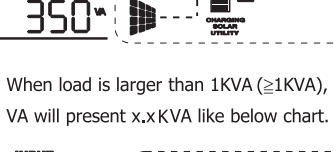
17	Beeps while primary source is interrupted	Alarm on (default) **AOn 17**	Alarm off **AOF 17**
18	Overload bypass: When enabled, the unit will transfer to line mode if overload occurs in battery mode.	Bypass disable (default) **bYd 18**	Bypass enable **bYE 18**
19	Bulk charging voltage (C.V voltage). If self-defined is selected in program 5, this program can be set up	**Cᵛ 56.4ᵥ 19** 24V model: default 28.2V, 24.0V~29.2V Settable 48V model: default 56.4V, 48.0V~58.4V Settable	
20	Floating charging voltage. If self-defined is selected in program 5, this program can be set up	**FLᵛ 54.0ᵥ 20** 24V model: default 27.0V, 24.0V~29.2V Settable 48V model: default 54.0V, 48.0V~58.4V Settable	
21	Low DC cut-off voltage. If self-defined is selected in program 5, this program can be set up	**COᵛ 42.0ᵥ 21** 24V model: default 21.0V, 20.0V~24.0V Settable 48V model: default 42.0V, 40.0V~48.0V Settable	
22	Solar power balance. When enabled, solar input power will be automatically adjusted according to connected load power.	Solar power balance enable (Default): **SbE 22**	If selected, solar input power will be automatically adjusted according to the following formula: Max. input solar power = Max. battery charging power + Connected load power.
		Solar power balance disable: **Sbd 22**	If selected, the solar input power will be the same to max. battery charging power no matter how much loads are connected. The max. battery charging power will be based on the setting current in program 2. (Max. solar power = Max. battery charging power)
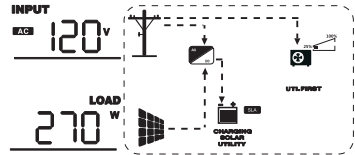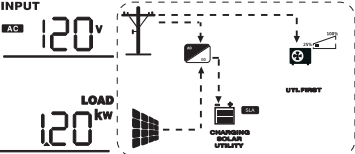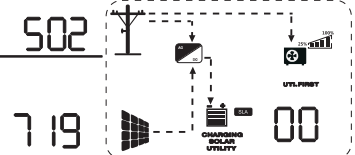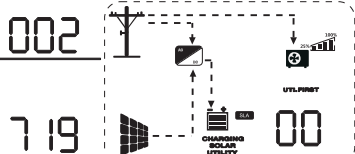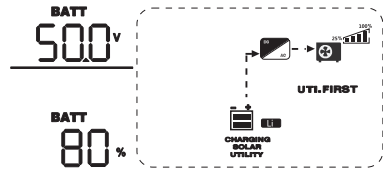
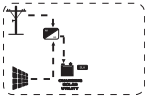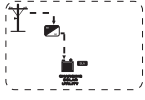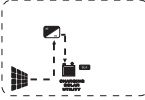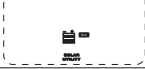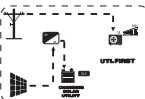| 23	AC output mode *This setting is only available when the inverter is in standby mode (Switch off). Power saving function will be automatically disabled when in parallel operation.	Single: **SIG 23** — When not in parallel operation
		Single phase **PAL 23** — When the units are used in parallel with single phase
		Three phase: 3P1, 3P2, 3P3 **3P1 23 3P2 23 3P3 23**
		It requires at least 3 inverters to support three-phase equipment, 1 inverter in each phase. Please select "3P1" for the inverters connected to L1 phase, "3P2" for the inverters connected to L2 phase and "3P3" for the inverters connected to L3 phase. Do NOT connect share current cable between units on different phases.
		Split phase: 2P0, 2P1, 2P2 **2P0 23 2P1 23 2P2 23**
		Select "2P0" for the inverters connected to L1 phase; If connect split phase 120V/208V, select "2P1" for inverters connected to L2 phase; If connect split phase 120V/240V, select "2P2" for inverters conected to L2 phase Do NOT connect share current cable between units on different phases.
24	Allow neutral and grounding of AC output is connected together: When enabled, inverter can deliver signal to trigger grounding box to short neutral and grounding (for expansion)	Disable: Neutral and grounding of AC output is disconnected. (Default) **nEC dIS 24**
		Enable: Neutral and grounding of AC output is connected. **nEC EnA 24**
		This function is only available when the inverter is working with external grounding box. Only when the inverter is working in battery mode, it will trigger grounding box to connect neutral and grounding of AC output.

Display Setting
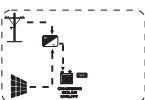
The LCD display information will be switched in turns by pressing "UP" or "DOWN" key. The selectable information is switched as below order: input voltage, input frequency, PV voltage, MPPT charging current, MPPT charging power, battery voltage, output voltage, output frequency, load percentage, load in VA, load in Watt, DC discharging current, main CPU Version and second CPU Version.
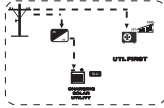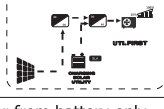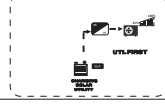
Setting Information	LCD display
Input voltage/Output voltage (Default Display Screen)	Input Voltage=120V, output voltage=120V
Input frequency	Input frequency=50Hz
PV voltage	PV voltage=60V
Charging current	Current ≧10A Current < 10A
MPPT Charging power	MPPT charging power=500W
Battery voltage/ DC discharging current	Battery voltage=51.0V, discharging current=0A
Output frequency	Output frequency=50Hz
Load percentage	Load percent=70%
Load in VA	When connected load is lower than 1KVA, load in VA will present xxx VA like below chart. When load is larger than 1KVA (≥1KVA), load in VA will present x.x KVA like below chart.

	When load is lower than 1KW, load in W will present xxx W like below chart.
Load in Watt	When load is larger than 1KW (≥1KW), load in W will present x.x kW like below chart.
Main CPU version checking	Main CPU version 502-00-719
Secondary CPU version checking (For models with MPPT controller)	Secondary CPU version 002-00-719
Battery SOC	Battery SOC=80%

4.4 Operating Mode Description

Operation mode	Description	LCD display
Standby mode / Power saving mode **Note:** *Standby mode: The inverter is not turned on yet but at this time, the inverter can charge battery without AC output. *Power saving mode: If enabled, the output of inverter 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. Charging by utility. Charging by PV energy. No charging.
Fault mode Note: *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. Charging by utility. Charging by PV energy. No charging.
Line Mode	The unit will provide output power from the mains. It will also charge the battery at line mode.	Charging by PV energy

		Charging by utility
Line Mode	The unit will provide output power from the mains. It will also charge the battery at line mode.	
Battery Mode	The unit will provide output power from battery and PV power.	Power from battery and PV energy.
		Power from battery only.

Parallel Installation Guide

Introduction

This inverter 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 three-phase equipment. Four units support one phase maximum.

NOTE: If the package includes share current cable and parallel cable, the inverter is default supported parallel operation. You may skip section 3. If not, please purchase parallel kit and install this unit by following instruction from professional technical personnel in local dealer.

Package Contents

In parallel kit, you will find the following items in the package:
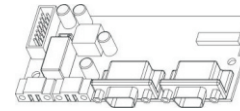
Parallel board   Parallel communication cable   Current sharing cable

Parallel board installation

Step 1: Remove wire cover by unscrewing all screws.
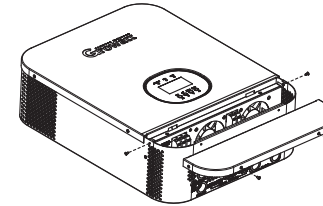
Step 2: Remove communication board by unscrewing two screws as below chart.
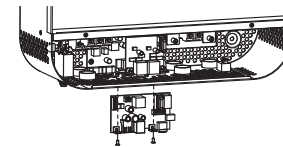
Step 3: Remove Rs485 communication board by unscrewing two screws as below chare.
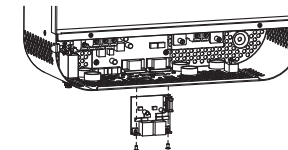
Step 4: Remove two screws as below chart and remove 2-pin and 14-pin cables. Take out the board under the communication board.
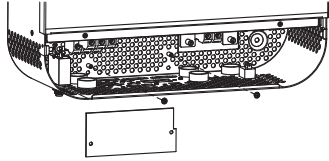
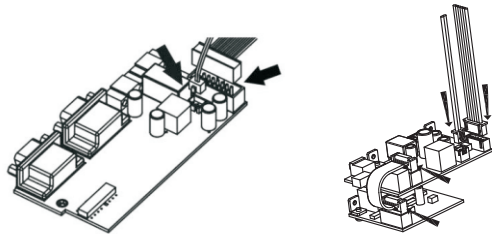**Step 5:** Remove two screws as below chart to take out cover of parallel communication.
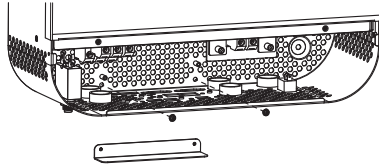
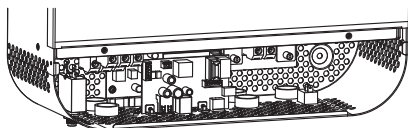**Step 6 :** Install new parallel board with 2 screws tightly.
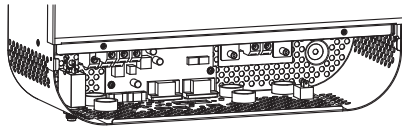
Step 7 : Re-connect 2-pin and 14-pin to original position.
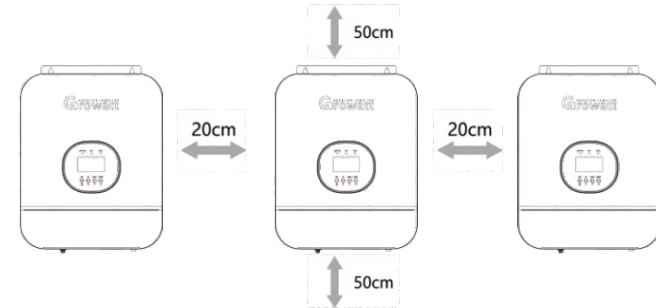
Parallel board   **Communication board**

Step 8 : Put communication board back to the unit.

Step 9 : Put wire cover back to the unit. Now the inverter is providing parallel operation function.

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 inverter is shown as below:
Recommended battery cable and terminal size for each inverter:

| Model | Wire Size | Ring Terminal | | | Torque value |
| | | Cable mm^2 | Dimensions | | |
			D (mm)	L (mm)	
SPF 3000TL LVM-24P	1*2AWG	38	6.4	39.2	2~ 3 Nm
	2*6AWG	28	6.4	33.2	
SPF 3000TL LVM-48P	1*4AWG	22	6.4	39.2	2~ 3 Nm
	2*8AWG	16	6.4	33.2	

Ring terminal:
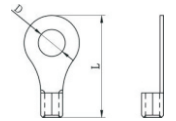
WARNING: Be sure the length of all battery cables is the same. Otherwise, there will be voltage difference between inverter and battery to cause parallel inverters not working.

Recommended AC input and output cable size for each inverter:

Model	AWG no.	Torque
SPF 3000TL LVM	8 AWG	1.4~1.6Nm

You need to connect the cables of each inverter 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 inverters connected in parallel.
Regarding AC input and output, please also follow the same principle.
CAUTION!! Please install the breaker at the battery and AC input side. This will ensure the inverter can be securely disconnected during maintenance and fully protected from over current of battery or AC input.

Recommended breaker specification of battery for each inverter:

Model	1 unit*
SPF 3000TL LVM-24P	150A / 32VDC
SPF 3000TL LVM-48P	100A / 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 inverters connected in parallel.

Recommended breaker specification of AC input with single phase:

Model	2 units	3 units	4 units	5 units	6 units
SPF 3000TL LVM	100A/120VAC	150A/120VAC	200A/120VAC	250A/120VAC	300A/120VAC

Note1: Also, you can use 50A breaker for only 1 unit, and each inverter 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

Inverter parallel numbers	2	3	4	5	6
Battery Capacity	400AH	600AH	800AH	1000AH	1200AH

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

Parallel Operation in Single phase

Two inverters in parallel:
Power Connection
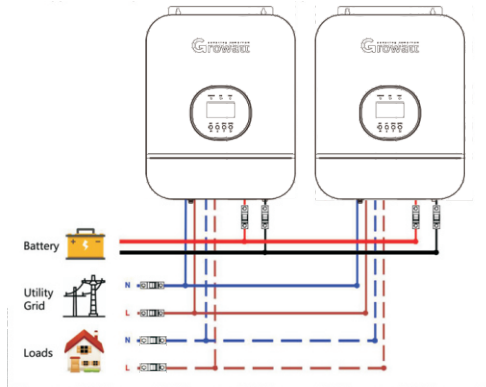
Communication Connection
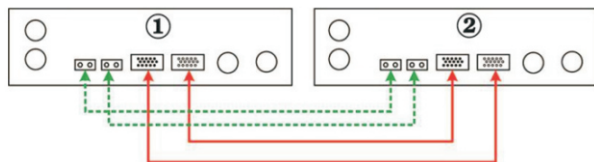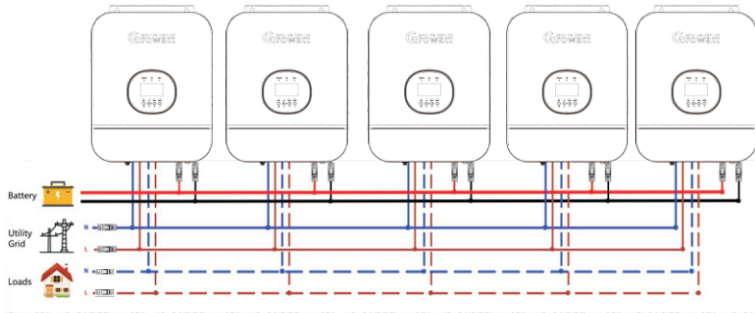

Three inverters in parallel:
Power Connection
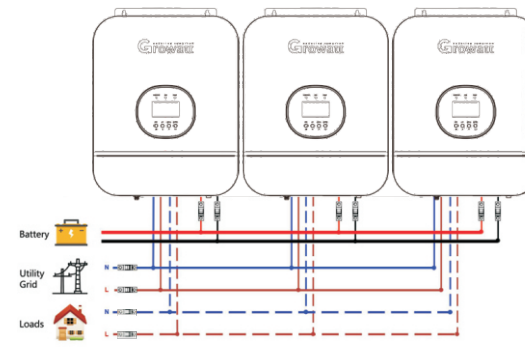
Communication Connection
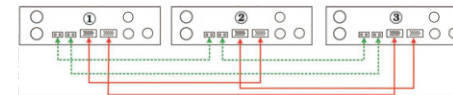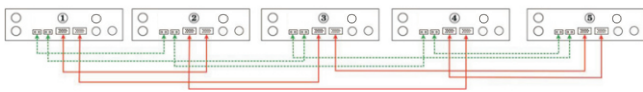

Four inverters in parallel:
Power Connection
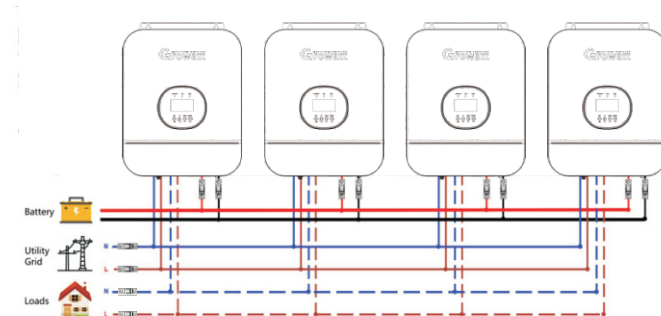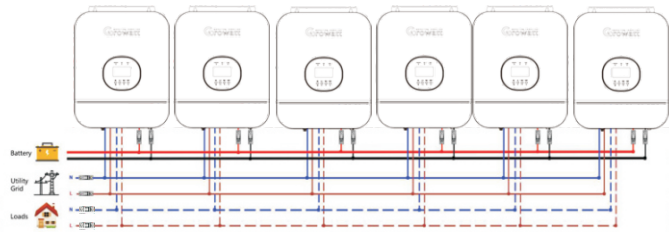

Communication Connection
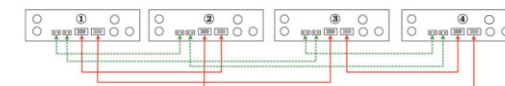
Five inverters in parallel:
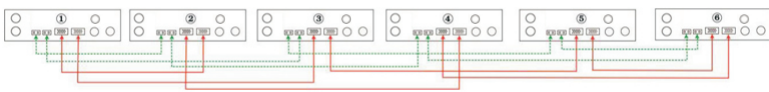**Power Connection**

Communication Connection

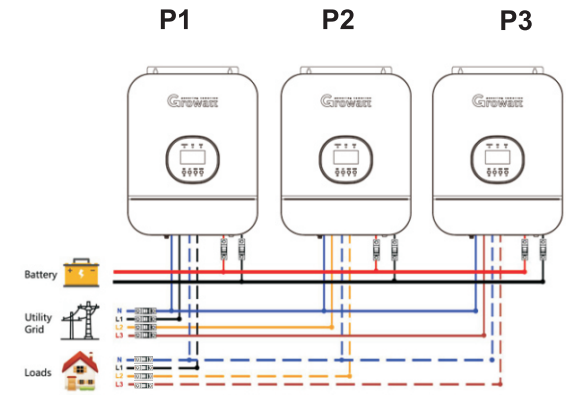## Six inverters in parallel:
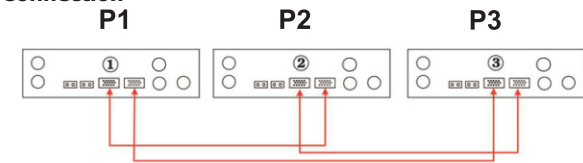**Power Connection**

Communication Connection

Parallel Operation in Three Phase

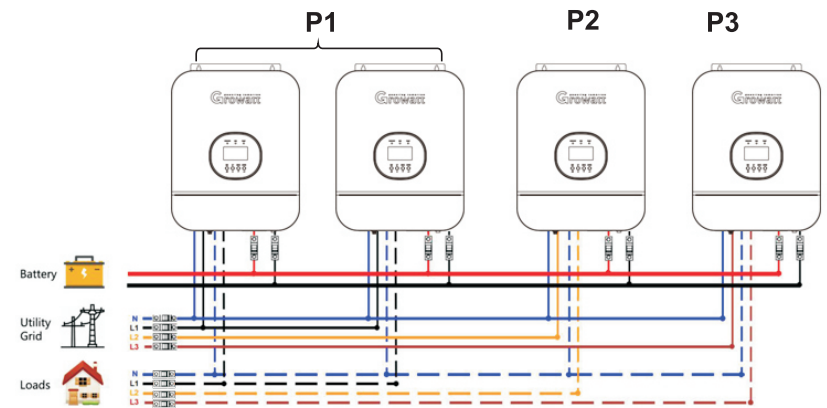One inverter in each phase:

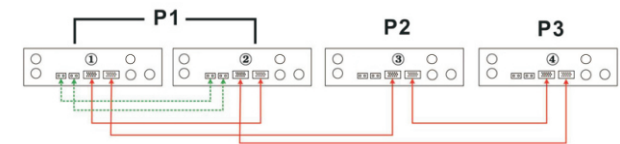**Power Connection**

P1   P2   P3

Communication Connection

P1   P2   P3

Two inverters in one phase and only one inverter for the remaining phases:

Power Connection

P1   P2   P3

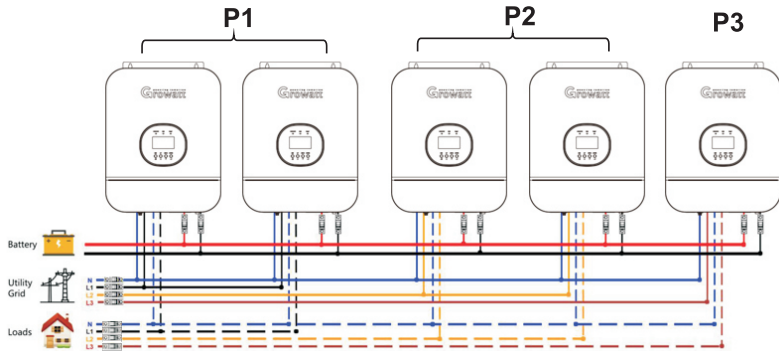**Communication Connection**

P1   P2   P3

Two inverters in two phases and only one inverter for the remaining phase:
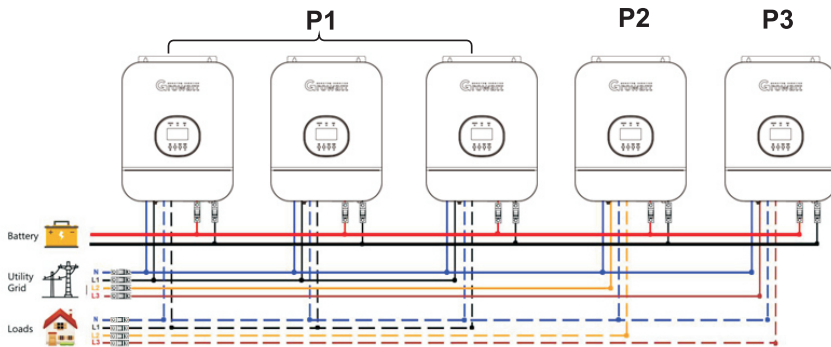
Power Connection

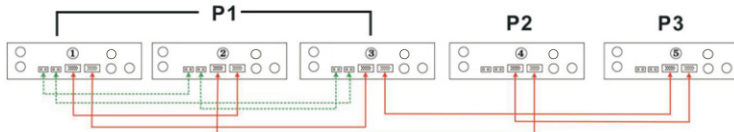P1   P2   P3

Communication Connection

P1   P2   P3
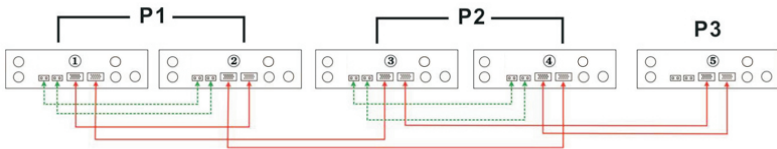
Three inverters in one phase and only one inverter for the remaining two phases:
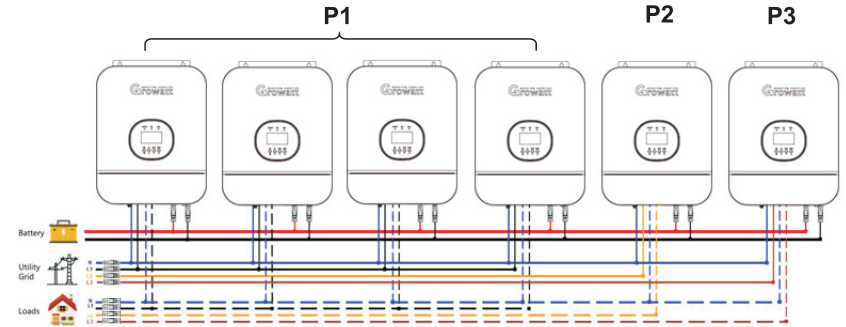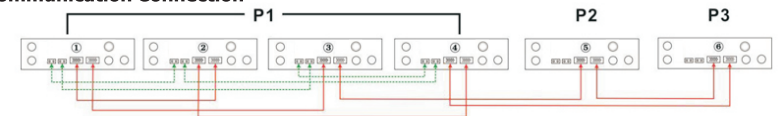
Power Connection

P1   P2   P3

Communication Connection

P1   P2   P3

Four inverters in one phase and one inverter for the other two phases:

Power Connection

P1   P2   P3

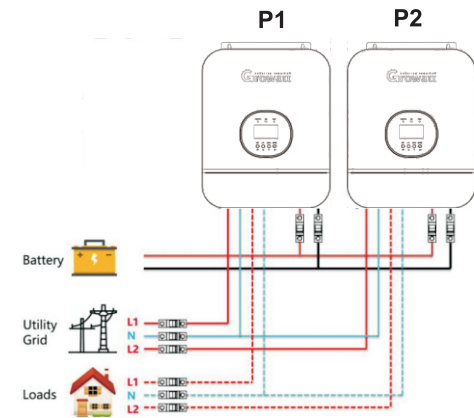**Communication Connection**

P1   P2   P3

WARNING: Do not connect the current sharing cable between the inverters which are in different phases.

Parallel Operation in Split Phase

One inverter in each phase:

Power Connection

P1   P2

Communication Connection

Two inverters in each phases:

Power Connection

Communication Connection

Three inverters in each phases:

Power Connection

Communication Connection

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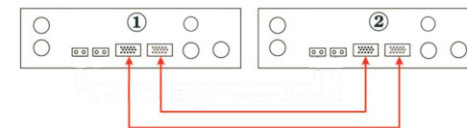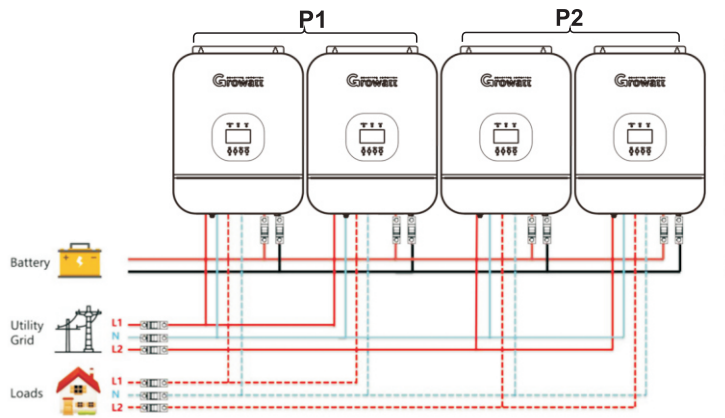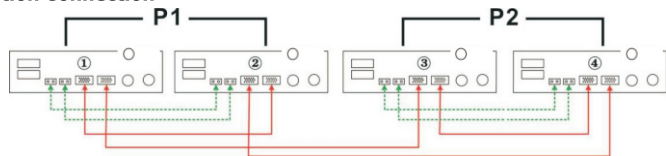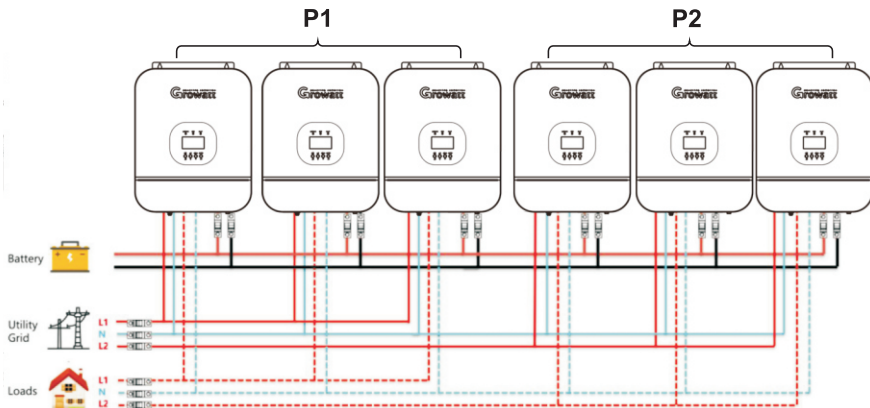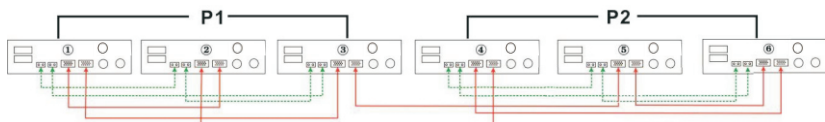
Otherwise, it may damage the inverters.

PV Connection

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

CAUTION: Each inverter should connect to PV modules separate

LCD Setting and Display

Setting Program: Please refer to program 23

Commissioning

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.

NOET: 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 inverters 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 3P1, 3P2 and 3P3 sequentially. Then shut down all units.
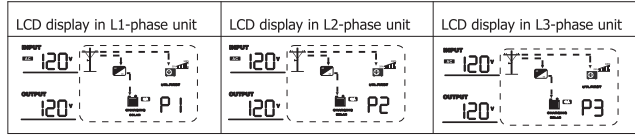
NOET: It's necessary to turn off switch when setting LCD program. Otherwise, the setting can not be programmed.

Step 3: Turn on all units sequentially.

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, if will display warning 15/16 and they 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.
lStep 6: Please switch on all breakers of Line wires in load side. This system will start to provide power to the load.

Note 1: To avoid overload occurring, before turning on breakers in load side, it's better to have whole system in operation first.
Note 2: Transfer time for this operation exists. Power interruption may happen to critical devices, which cannot bear transfer time.

Parallel in split 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.
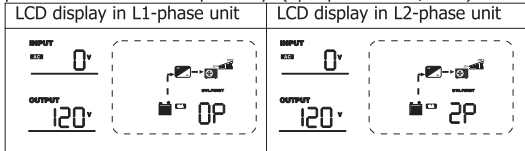Step 2: Turn on all units and configure LCD program 23 as 2P0 on phase1 units, then set as 2P2 (or 2P1) on phase2 units
   **2P0 + 2P1: split phase 120V/208V**
      2P0 + 2P2: split phase 120V/240V
NOET: It's necessary to turn off switch when setting LCD program. Otherwise, the setting can not be programmed.
Step 3: Turn on all units sequentially. (Split phase 120V/240V)

LCD display in L1-phase unit	LCD display in L2-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, if will display warning 15/16 and they will not work in the line mode. (Split phase 120V/240V)
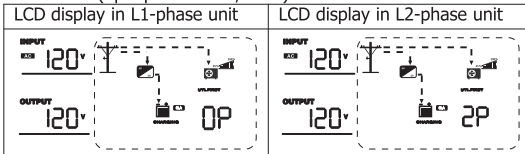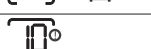
LCD display in L1-phase unit	LCD display in L2-phase unit

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

Note 1: To avoid overload occurring, before turning on breakers in load side, it's better to have whole system in operation first.
Note 2: 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 is detected by internal converter components.	
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	Inverter 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	
80	CAN fault	
81	Host loss	

Warning Indicator

Warning Code	Warning Event	Audible Alarm	Icon flashing
01	Fan is locked when inverter is on.	Beep three times every second	01
02	Over temperature	Beep once every second	02
03	Battery is over-charged	Beep once every second	03
04	Low battery	Beep once every second	04
07	Overload	Beep once every 0.5 second	07
10	Output power derating	Beep twice every 3 seconds	10
12	Solar charger stops due to low battery	Beep once every second	12
13	Solar charger stops due to high PV voltage	Beep once every second	13
14	Solar charger stops due to overload	Beep once every second	14
15	Parallel input utility grid different	Beep once every second	15
16	Parallel input phase error	Beep once every second	16
17	Parallel output phase loss	Beep once every second	17

New warning codes after communicating with BMS

Warning code	Warning event	Audio alarm	Icon flashing
20	Bms communication error	Beep once every second	20
33	Bms communication loss	Beep once every second	33
34	Cell over voltage	Beep once every second	34
35	Cell under voltage	Beep once every second	35
36	Total over voltage	Beep once every second	36
37	Total under voltage	Beep once every second	37
38	Discharge over current	Beep once every second	38
39	Charge over current	Beep once every second	39
40	Discharge over temperature	Beep once every second	40
41	Charge over temperature	Beep once every second	41
42	Mosfet over temperature	Beep once every second	42
43	Battery over temperature	Beep once every second	43
44	Battery under temperature	Beep once every second	44
45	System shut down	Beep once every second	45

Specifications

Table 1 General Specifications

INVERTER MODEL	SPF 3000TL LVM
Safety Certification	CE
Operating Temperature Range	0°C to 55°C
Storage temperature	-15°C~ 60°C
Humidity	5% to 95% Relative Humidity (Non-condensing)
Altitude	<2000m
Dimension, mm	455 x 350 x 130
Net Weight, kg	11.5

Table 2 Line Mode Specifications

INVERTER MODEL	SPF 3000TL LVM
Input Voltage Waveform	Sinusoidal (utility or generator)
Nominal Input Voltage	120Vac
Low Loss Voltage	95Vac±5V (UPS); 65Vac±5V (Appliances)
Low Loss Return Voltage	100Vac±5V (UPS); 70Vac±5V (Appliances)
High Loss Voltage	140Vac±5V
High Loss Return Voltage	135Vac±5V
Max AC Input Voltage	150Vac
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 (UPS); 20ms typical (Appliances)
Output power derating: When AC input voltage drops to 95V, the output power will be derated.	Output Power / Rated Power / 20% Power — 65V 95V 140V Input Voltage

Table 3 Inverter Mode Specifications

INVERTER MODEL	SPF 3000TL LVM–24P	SPF 3000TL LVM–48P
Rated Output Power	3KVA/3KW	
Output Voltage Waveform	Pure Sine Wave	
Output Voltage Regulation	120Vac ±5%	
Output Frequency	50Hz/60Hz(default)	
Peak Efficiency	93%	
Overload Protection	5s@≥150% load; 10s@110%~150% load	
Surge Capacity	2* rated power for 5 seconds	
Nominal DC Input Voltage	24Vdc	48Vdc
Cold Start Voltage (Only Lead-Acid)	23.0Vdc	46.0Vdc
Cold Start SOC (Only Li)	30%	
Low DC Warning Voltage (Only Lead-Acid)	22.0Vdc @ load < 20% 21.4Vdc @ 20% ≤ load < 50% 20.2Vdc @ load ≥ 50%	44.0Vdc @ load < 20% 42.8Vdc @ 20% ≤ load < 50% 40.4Vdc @ load ≥ 50%
Low DC Warning Return Voltage (Only Lead-Acid)	23.0Vdc @ load < 20% 22.4Vdc @ 20% ≤ load < 50% 21.2Vdc @ load ≥ 50%	46.0Vdc @ load < 20% 44.8Vdc @ 20% ≤ load < 50% 42.4Vdc @ load ≥ 50%
Low DC Cut-off Voltage (Only Lead-Acid)	21.0Vdc @ load < 20% 20.4Vdc @ 20% ≤ load < 50% 19.2Vdc @ load ≥ 50%	42.0Vdc @ load < 20% 40.8Vdc @ 20% ≤ load < 50% 38.4Vdc @ load ≥ 50%
Low DC Cut-off Voltage (Only Li)	21.0Vdc	42.0Vdc
Low DC Warning SOC (Only Li)	Low DC Cut-off Soc+5%	
Low DC Warning Return SOC (Only Li)	Low DC Cut-off Soc+10%	
Low DC Cut-off SOC (Only Li)	Default 20%,5%~30% Settable	
High DC Recovery Voltage	28.2Vdc	56.4Vdc
High DC Cut-off Voltage	30.4Vdc	60.8Vdc
No Load Power Consumption	<50W	

Table 4 Charge Mode Specifications

Utility Charging Mode		
INVERTER MODEL	SPF 3000TL LVM−24P	SPF 3000TL LVM−48P
Charging Current (UPS) @ Nominal Input Voltage	10A/20/30A/40A/50A/60A	10A/20/30A/40A
Bulk Charging Voltage — Flooded Battery	29.2Vdc	58.4Vdc
Bulk Charging Voltage — AGM / Gel Battery	28.2Vdc	56.4Vdc
Floating Charging Voltage	27Vdc	54Vdc
Overcharge Protection	30Vdc	60Vdc
Charging Algorithm	3-Step	
Charging Curve		

Charging Curve labels: Battery Voltage, per cell; Charging Current, %; 2.43Vdc (2.35Vdc) 2.25Vdc; Voltage; 100%; 50%; T0; T1; T1＞10* T0, minimum 10mins, maximum 8hrs; Current; Time; Bulk (Constant Current); Absorption (Constant Voltage); Maintenance (Floating)

Solar Charging Mode		
INVERTER MODEL	SPF 3000TL LVM−24P	SPF 3000TL LVM−48P
Efficiency	98.0% max.	
Max. PV Array Open Circuit Voltage	145Vdc	
PV Array MPPT Voltage Range	30~115Vdc	60~115Vdc
Min battery voltage for PV charge	17Vdc	34Vdc
Max PV Charging Current	80A	
Battery Voltage Accuracy	+/-0.3%	
PV Voltage Accuracy	+/-2V	
Charging Algorithm	3-Step	
Joint Utility and Solar Charging		
Max Charging Current	140Amp	120Amp
Default Charging Current	60Amp	

Trouble Shooting

Problem	LCD/LED/Buzzer	Explanation / Possible cause	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. 2. Replace battery.
No response after power on.	No indication.	1. The battery voltage is far too low. (<1.4V/Cell) 2. Battery polarity is connected reversed.	1. Check if batteries and the wiring are connected well. 2. Re-charge battery. 3. Replace battery.
Mains exist but the unit works in battery mode.	Input voltage is displayed as 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. 2. Check if generator (if applied) is working well or if input voltage range setting is correct. (UPS⇨Appliance)
	Green LED is flashing.	Set "Solar First" as the priority of output source.	Change output source priority to Utility first.
When the unit is turned on, internal relay is switched 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 01	Fan fault	Replace the fan.
	Fault code 02	Internal temperature of component is over 100°C.	Check if the air flow of the unit is blocked or the ambient temperature is too high.
	Fault code 03	Battery is over-charged.	Return to repair center.
	Fault code 03	The battery voltage is too high.	Check if spec and quantity of batteries are meet requirements.
	Fault code 05	Output short circuited.	Check if wiring is connected well and remove abnormal load.
	Fault code 06/58	Output abnormal (Inverter voltage below than 190Vac or is higher than 260Vac)	1. Reduce the connected load. 2. Return to repair center
	Fault code 07	Overload error. The inverter is overload 110% and time is up.	Reduce the connected load by switching off some equipment.
	Fault code 08/09/53/57	Internal components failed.	Return to repair center.
	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.	If the battery is connected well, please return to repair center.
	Fault code 60	Negative power fault	1. Check whether the AC output connects to the Grid. 2. Check whether the output voltage setting in program 8 of all the Inverters in parallel are the same. 3. Check whether the current sharing cables are connected well in the same parallel phases. 4. Check whether all the neutral wires of each unit in a parallel system are connected tog ether. 5. If the problem still exists, please return to repair center.
	Fault code 80	CAN fault	1. Check whether the parallel communication cables are connected well. 2. If the problem still exists, please return to repair center.
	Fault code 81	Host loss	