



PV Master App



SEMS Portal App



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www.semsportal.com



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YOUR SOLAR ENGINE



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340-00201-03

ET SERIES USER MANUAL

HYBRID INVERTER

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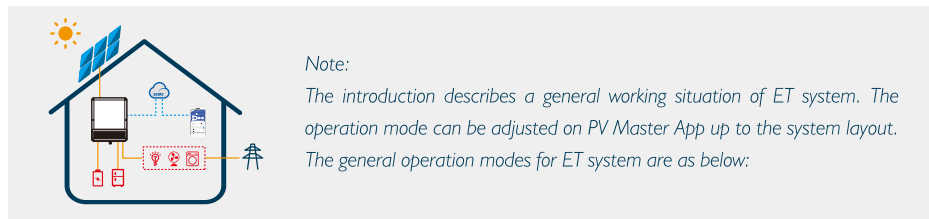
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01 INTRODUCTION

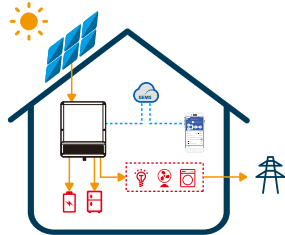
The ET series, also called hybrid or bidirectional solar inverters, can be applied to solar system with participation of PV, battery, loads and grid system for energy management. The energy produced by PV system shall be used to optimize household loads, the excess energy charges the battery, once the battery is fully charged any more access could be exported to the grid.

Battery shall discharge to support loads when PV power is insufficient to meet self-consumption needs. If battery power is not sufficient, the system will take power from grid to support loads.



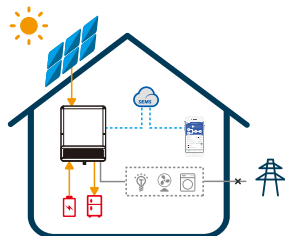
1.1 Operation Modes Introduction

ET system normally has the following operation modes based on your configuration and layout conditions.



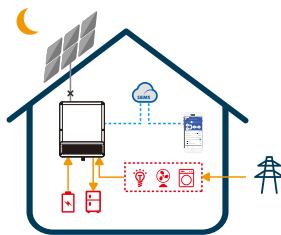
Mode I

The energy produced by the PV system is used to optimize self-consumption needs. The excess energy is used to recharge the batteries, any more access are then exported to the grid.



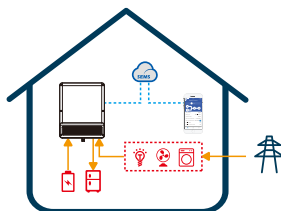
Mode III

When the grid fails, the system will automatically switches to back-up mode. And the back-up loads can be supplied by both PV and battery energy.



Mode II

When there is no PV and the battery is sufficient, it can supply the load with the grid together.



Mode IV

Battery could be charged by grid, and charge time/power could be set to various options on the PV Master App.

1.2 Safety & Warning

The ET series of inverters from Jiangsu GoodWe Power Supply Technology Co., Ltd. (which can be called Goodwe) strictly complies with related safety rules for product design and testing. Please read and follow all the instructions and cautions on the inverter or user manual during installation, operation or maintenance, as any improper operation might cause personal or property damage.

Symbols explanation



Caution!
Failure to observe a warning indicated in this manual may result in injury.



Danger of high voltage and electric shock!



Danger of hot surface!



Components of the product can be recycled.



This side up! The package must always be transported, handled and stored in such a way as the arrows always point upwards.



No more than six (6) identical packages being stacked on each other.



Products should not be disposed as household waste.



Fragile - The package/product should be handled carefully and never be tipped over or slung.



Refer to the operating instructions.



Keep dry! The package/product must be protected from excessive humidity and must be stored under cover.



This symbol indicates that you should wait at least 5mins after disconnecting the inverter from the utility grid and from the PV panel before touching any inner live parts.



CE mark

Safety warning

Any installation and operation on inverter must be performed by qualified electricians, in compliance with standards, wiring rules or requirements of local grid authorities or companies (like AS 4777 and AS/NZS 3000 in Australia).

Prohibit inserting or pulling the AC and DC terminals when the inverter is running.

Before any wiring connection or electrical operation on inverter, all DC and AC power must be disconnected from inverter for at least 5 minutes to make sure inverter is totally isolated to avoid electric shock.

The temperature of inverter surface might exceed 60°C during operation, so please make sure it has cooled down before touching it, and make sure the inverter is out of reach of children.

Do not open the inverter's cover or change any components without manufacturer's authorization, otherwise the warranty commitment for the inverter will be invalid.

Usage and operation of the inverter must follow instructions in this user manual, otherwise the protection design might be impaired and warranty commitment for the inverter will be invalid.

Appropriate methods must be adopted to protect inverter from static damage. Any damage caused by static is not warranted by manufacturer.

PV negative (PV-) and battery negative (BAT-) on inverter side is not grounded as default design. Connecting PV- or BAT- to EARTH are strictly forbidden.

PV modules used on the inverter must have an IEC61730 class A rating, and the total open-circuit voltage of PV string/array is lower than the maximum rated DC input voltage of the inverter. Any damage caused by PV over-voltage is beyond warranty.

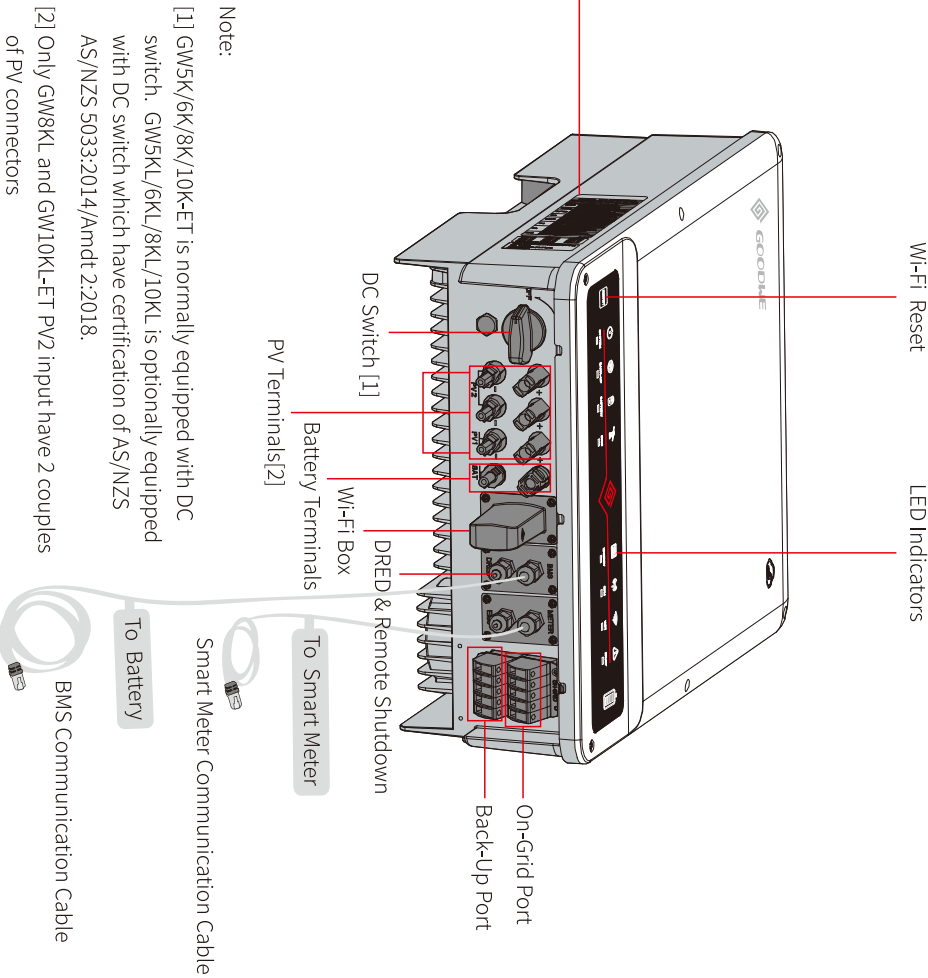
When exposed to sunlight, the PV array generates dangerous high DC voltage. Please operate according to our instructions, or it will result in danger to life.

The inverter, with built-in RCMU, will exclude possibility of DC residual current to 6mA, thus in the system an external RCD (type A) can be used(≥30mA).

In Australia, output of back-up side in switchbox should be labeled on "Main Switch UPS Supply". The output of normal load side in switch box should be labeled "Main Switch Inverter Supply".

1.3 Product Overview

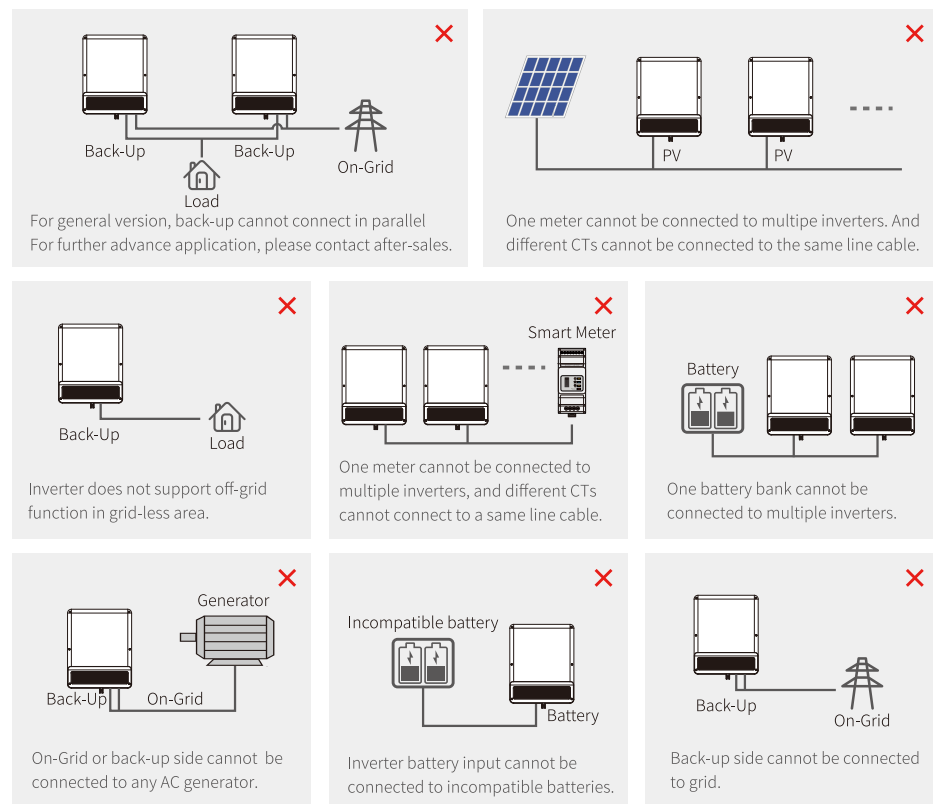
HYBRID LED INDICATORS					
INDICATOR	STATUS	EXPLANATION			
SYSTEM	BACK-UP BATTERY	GRID	ENERGY	COM	WIFI
SYSTEM	ON = System is ready	BLINK = System is starting up	OFF = System is not operating	ON = Back-up is ready / power available	OFF = Back-up is off / on power available
BACK-UP	ON = Battery is charging	BLINK 1 = Battery is discharging	BLINK 2 = Battery is low / soc is low	OFF = Battery is disconnected / not active	ON = Grid is active but not connected
BATTERY	ON = Grid is active	BLINK = Grid is active but not connected	OFF = Grid is not active	ON = Consuming energy from grid / buying	BLINK 1 = Supplying energy to grid / selling
ENERGY	ON = Grid not connected or system not operating	BLINK 1 = Meter communication ok	BLINK 2 = BMS communication fail	OFF = BMS and meter communication fail	ON = WiFi connected / active
COM	ON = WiFi not active	BLINK 1 = WiFi system resetting	BLINK 2 = WiFi not connect to router	BLINK 4 = WiFi server problem	OFF = Fault has occurred
WIFI	ON = Fault has occurred	BLINK 1 = Output / reduce load	BLINK 4 = CT wiring fault	OFF = No fault	
FAULT					



Note:
[1] GW5K/6K/8K/10K-ET is normally equipped with DC switch. GW5KL/6KL/8KL/10KL is optionally equipped with DC switch which have certification of AS/NZS AS/NZS 5033:2014/Amtd 2:2018.
[2] Only GW8KL and GW10KL-ET PV2 input have 2 couples of PV connectors

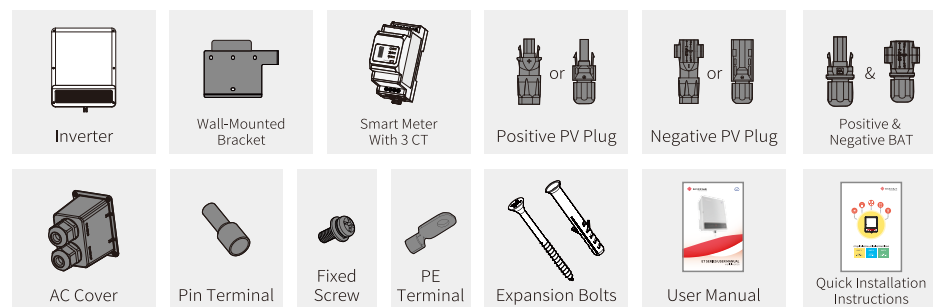
2.1 Unacceptable Installations

Please avoid the following installations, which will damage the system or the Inverter.



2.2 Packing List

Upon receiving the hybrid inverter, please check if any of the components as shown below are missing or broken.



2.3 Mounting

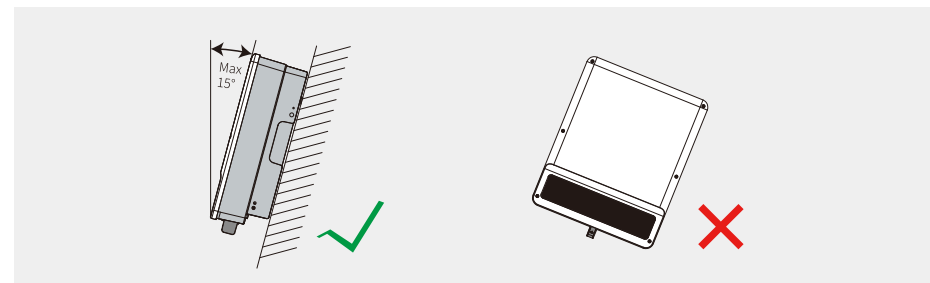
2.3.1 Select Mounting Location

For inverter's protection and convenient maintenance, mounting location for inverter should be selected carefully based on the following rules:

Any part of this system shouldn't block the switch and breaker from disconnecting the inverter from DC and AC power.

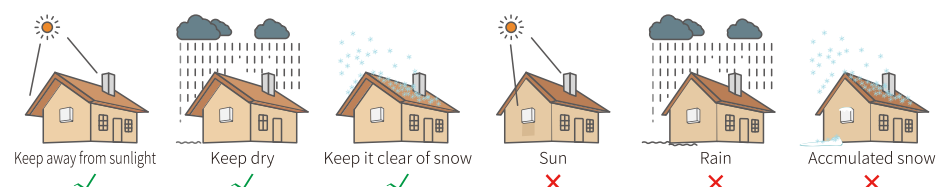
Rule 1. Inverter should be installed on a solid surface, where it is suitable for inverter's dimensions and weight.

Rule 2. Inverter should be installed vertically or lie on a slope by a max of 15°.



Rule 3. Ambient temperature should be lower than 45°C.
(High ambient temperature will cause power derating of inverter.)

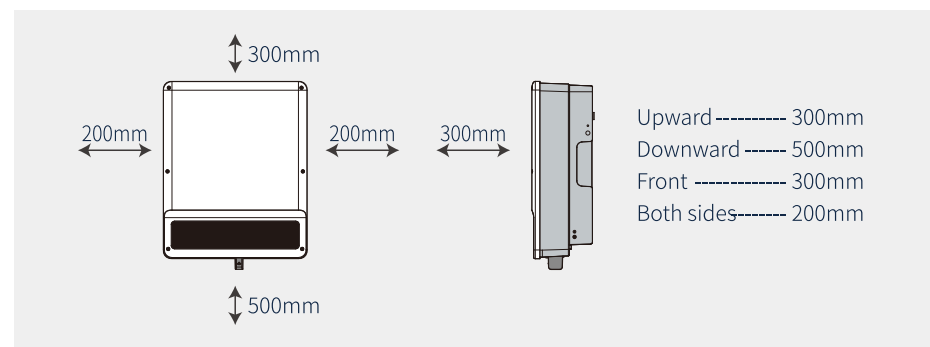
Rule 4. The inverter installation should be protected under shelter from direct sunlight or bad weather like snow, rain, lightning etc.



Rule 5. Inverter should be installed at eye level for convenient maintenance.

Rule 6. Product label on inverter should be clearly visible after installation.

Rule 7. Leave enough space around the inverter according to the below figure.



2.3.2 Mounting



Inverter cannot be installed near flammable, explosive or strong electro-magnetic equipment.

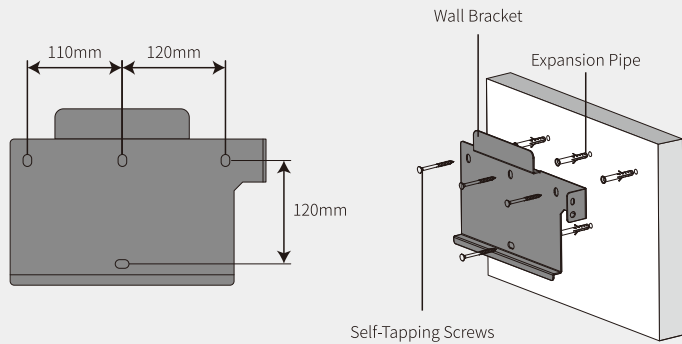
The inverter is suitable for mounting on concrete or other non-combustible surface only.

Step 1

Please use the mounting bracket as a template to drill 4 holes in the right positions (10mm in diameter, and 80mm in depth).

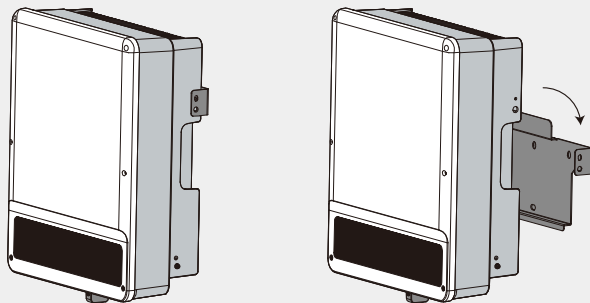
Use expansion bolts in accessory box and fix the mounting bracket onto the wall tightly.

Note: Bearing capacity of the wall must be higher than 25kg, otherwise it may not be able to keep the inverter from dropping.



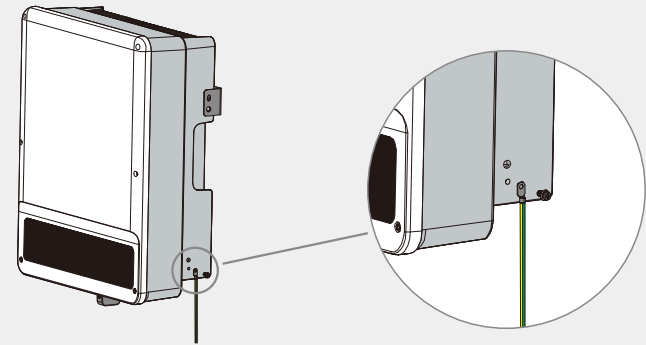
Step 2

Carry the inverter by holding the heatsink on two sides and place the inverter on the mounting bracket.



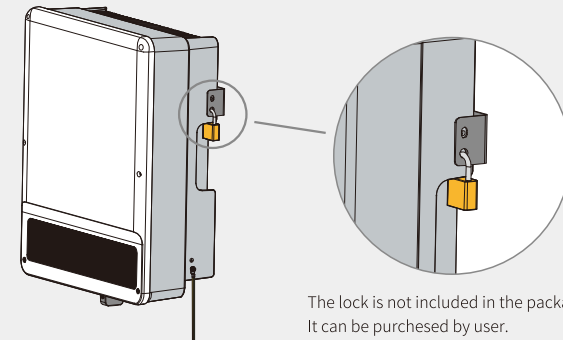
Step 3

Ground cable shall be connected to ground plate on grid side.



Step 4

Inverters could be locked for anti-theft purposes if it is necessary for individual requirements.



The lock is not included in the package.
It can be purchased by user.

2.4 Electrical Wiring Connection

2.4.1 PV Wiring Connection

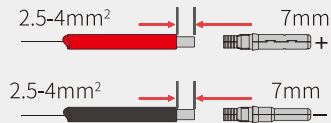
Before connecting PV panels/strings to inverter, please make sure requirements are followed as below:

- The total short-circuit current of PV string must not exceed inverter's max DC current. (For GW8KL-ET and GW10KL-ET model, PV2 have 2 pairs of PV connectors which can accept 2 PV strings with total short-circuit current of no more than 22A)
- The minimum isolation resistance to ground of the PV string must exceed **19.33k** in case of any shock hazard.
- PV string could not connect to earth/grounding conductor.
- Use the right PV plugs in the accessory box. (BAT plugs are similar to PV plugs, please confirm before use it.)

Note: There will be MC4 or QC4.10 or Amphenol plugs in accessory box. The details of connection are as below.

Step 1

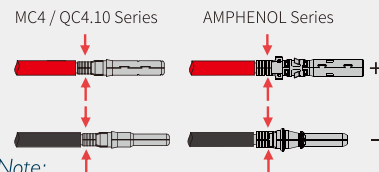
Prepare PV cables and PV plugs.



- Note:*
1. Please use PV plugs and connectors from accessory box.
 2. PV cable should be standard 2.5-4mm².

Step 2

Connect PV cable to PV connectors.

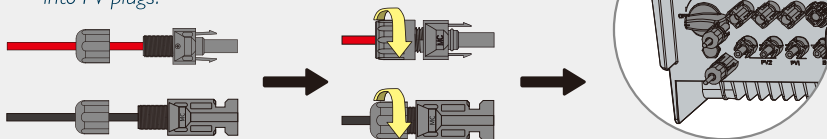


- Note:*
1. PV cable must be tightly crimped into the connectors.
 2. For Amphenol connector, the limit buckle cannot be pressed.
 3. There will be a click sound if connectors are inserted correctly into PV plugs.

Step 3

Screw the cap on and plug it onto inverter side.

Note: There will be a click sound if connectors are inserted correctly into PV plugs.



The polarity of PV strings cannot be connected reversely, otherwise the inverter could be damaged.

For GW8KL-ET and GW10KL-ET model, use two separated PV plugs if the short current is higher than 15A of the PV array which is connected to inverter's PV2 input.

2.4.2 Battery Wiring Connection

Please be careful about any electric shock or chemical hazard.

For battery without build-in DC breaker, make sure there is an external DC breaker ($\geq 40A$) connected.

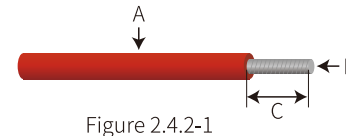


Make sure that the battery switch is off and battery nominal voltage meets ET series' specification before connecting battery to inverter. Make sure inverter is totally isolated from PV and AC power.

Please follow the requirements and steps below strictly. Using improper wires may cause bad contact and high impedance, which is dangerous to the system.

Use the right BAT plugs from the accessory box.

The maximum battery current is 25A, please use the tin-plated cables of which the cross section ranges from 4 to 6 mm² (AWG 10). Battery cable requirements are as Figure 2.4.2-1.

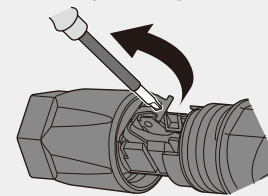


Grade	Description	Value
A	Outside diameter insulation	5.5-8.0 mm
B	Conductor core section	4-6 mm ²
C	Conductor core length	15 mm

Battery wiring connection process

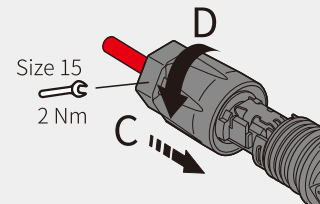
Step 1

Open the spring by using a screwdriver.



Step 3

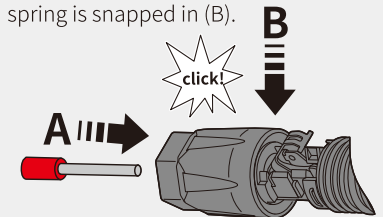
Insert the cable gland into the sleeve (C). Tighten the cable gland to 2 Nm (D). Use a suitable and calibrated torque wrench, size 15. Use an open-jaw wrench, size 16, to hold the connector in place.



Step 2

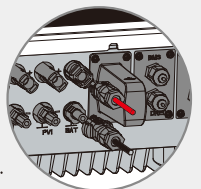
Carefully insert the stripped wire with twisted litz wires all the way in (A). The litz wire ends have to be visible in the spring.

Close the spring. Make sure that the spring is snapped in (B).



Step 4

Insert two BAT connector to the inverter BAT input. There will be a click sound if connectors are inserted correctly.



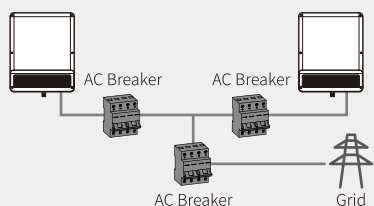
2.4.3 On-Grid & Back-Up Connection

An external AC breaker is needed for on-grid connection to isolate from grid when necessary. The requirements of on-grid AC breaker are shown below.

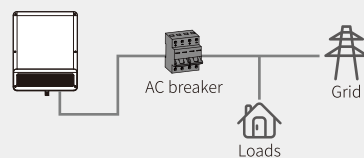
Inverter model	AC breaker specification
GW5K/GW5KL-ET	25A / 400V (e.g. DZ47-60 C25)
GW6K5/GW6KL-ET	25A / 400V (e.g. DZ47-60 C25)
GW8K/GW8KL-ET	32A / 400V (e.g. DZ47-60 C32)
GW10K/GW10KL-ET	32A / 400V (e.g. DZ47-60 C32)

Note: The absence of AC breaker on back-up side will lead to inverter damage if an electrical short circuit happens on back-up side.

1. Use separated AC breaker for individual inverter.



2. On the AC side, the individual breaker should be connected between inverter and Grid but before loads.



AC cable is required to connect to both on-grid and back-up side.



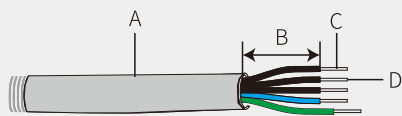
Make sure the inverter is totally isolated from any DC or AC power before connecting AC cable.

Note:

1. Neutral cable shall be blue, line cable shall be black or brown (preferred) and protective earth cable shall be yellow-green.
2. For AC cables, PE cable shall be longer than N&L cables, so in case that the AC cable slips or is taken out, the protecting earth conductor will be the last to take the strain.

Step 1

Prepare the terminals and AC cables according to the right table.

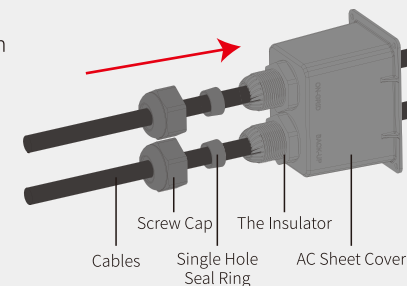


Grade	Description	Value
A	Outside diameter	13-18 mm
B	Separated wire length	20-25 mm
C	Conductor wire length	7-9 mm
D	Conductor core section	4-6 mm ²

Step 2

Put AC cable through terminal cover as shown in the figure.

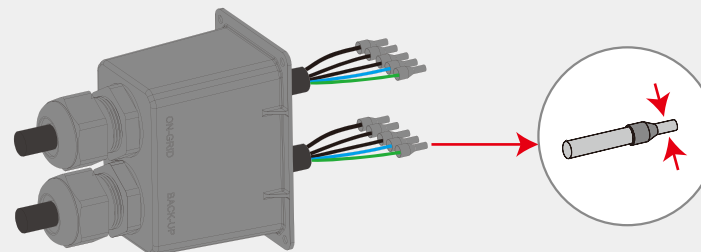
Note: Please use the terminals in in accessory box.



Step 3

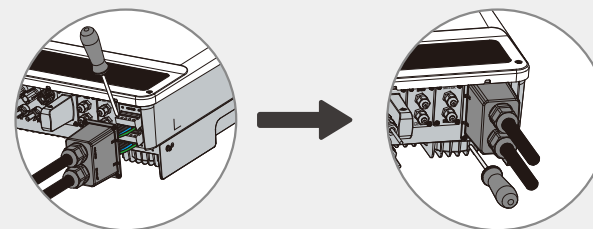
Press the 10 connectors on cable conductor core tightly.

Note: Make sure cable jacket is not locked within the connector.



Step 4

Screwing torque
2.0-2.5N.m



1. Connect the assembled AC cables into AC terminals with fastening torque about 2.0-2.5N.m.

Note: Connect back-up terminals before connecting on-grid terminals. Make sure it is not connected to a wrong side.

2. Lock the cover and screw the cap.

Special adjustable setting

The inverter has a field where the user could set functions, such as trip points, trip time, time of reconnection, active and invalid of QU curve and PU curve. Functions can be adjusted through special software. If interested, please contact after-sales.

Declaration for back-up function

The back-up output of ET hybrid inverters have over load ability.

For details please refer to the technical parameters of ET series inverter section (Page 21).

And the inverter has self-protection derating at high ambient temperature.

The below statement lays out general policies governing the energy storage inverters of the series EH, EM, ES, ET, BH, BT and SBP.

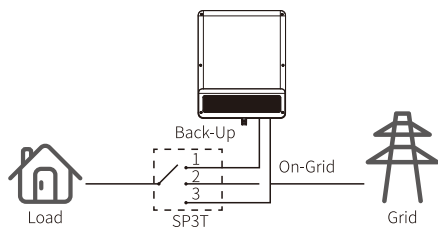
1. For Hybrid inverters (Series EH, EM, ES and ET), the standard PV installation typically consists of the connection of the inverter with both panels and batteries. In the case where the system is not connected to the batteries, the back-up function is strongly not advised for use. Manufacturer shall not cover the standard warranty and be liable for any consequences arising from users not following this instruction.
2. Under normal circumstances, the back-up switching time is less than 10 ms (the minimal condition to be considered as the UPS level). However, some external factors may cause the system failing on back-up mode. As such, we recommend the users to be aware of conditions and follow the instructions as below:
 - Do not connect loads when they are dependent on a stable energy supply for a reliable operation.
 - Do not connect the loads which may in total exceed the maximum back-up capacity.
 - Try to avoid those loads which may create very high start-up current surges such as inverter air-conditioner, high-power pump etc.
 - Due to the condition of the battery itself, battery current might be limited by some factors including but not limited to the temperature, weather etc.

Accepted loads as below:

- Inductive Load: 1.5P non-frequency conversion air-conditioner can be connected to back-up side. Two or more non-frequency conversion air-conditioner connected to back-up side may cause UPS mode to be unstable.
- Capacitive Load: Total power $\leq 0.6 \times$ nominal power of model. (Any load with high startup current at start-up is not accepted.)
- For complicated application, please contact after-sales.

Note:

For convenient maintenance, please install a "4Pole3Throw" on back-up and on-grid side. Then it is adjustable to support load by back-up or by grid or default settings.



1. Back-up load is supplied from back-up side.
2. Back-up load is isolated.
3. Back-up load is supplied from grid side.

Declaration for back-up overload protection

Inverter will restart itself if overload protection triggers. The preparation time for restarting will be longer and longer (one hour at most) if overload protection repeats. Take following steps to restart inverter immediately.

Decrease back-up load power within maximum limitation.

On PV Master App → Advanced Setting → Click "Reset Back-Up Overload History".

2.4.4 Smart Meter & CT Connection



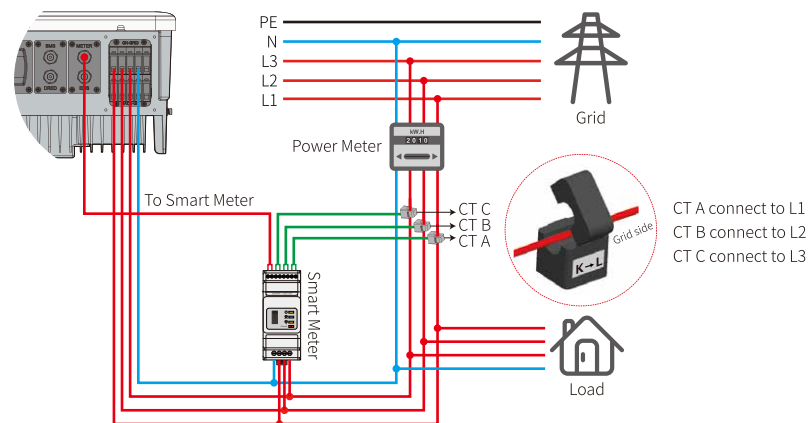
Make sure AC cable is totally isolated from AC power before connecting Smart Meter & CT.

The Smart Meter with CT in product box is compulsory for ET system installation, used to detect grid voltage and current direction and magnitude, further to instruct the operation condition of ET inverter via RS485 communication.

Note:

1. The Smart Meter with CT is well configured, please do not change any setting on Smart Meter.
2. One Smart Meter can only be used for one ET inverter.
3. Three CTs must be used for one Smart Meter, and must be connected on the same phase with Smart Meter power cable.

Smart Meter & CT connection diagram



Note:

1. Please use the Smart Meter with 3 CTs in product box.
2. CT cable is 3m as default, could be extended to maximum of 5m.
3. Smart Meter communication cable (RJ45) is attached on the inverter ("To Smart Meter" cable), could be extended to max 100m, and must use standard RJ45 cable and plug, as below:

Detailed pin function of each port on ET

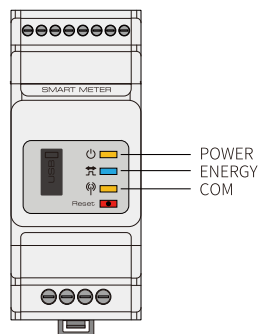
BMS: CAN communication is configured by default. If 485 communication is used, please contact after-sales to replace with the corresponding communication line.

Position	Color	BMS Function	Smart Meter Function	EMS
1	Orange&white	485_A2	NC	485_A
2	Orange	NC	NC	485_B
3	Green&white	485_B2	485_B1	485_A
4	Blue	CAN_H	NC	NC
5	Blue&white	CAN_L	NC	NC
6	Green	NC	485_A1	485_B
7	Brown&white	NC	485_B1	NC
8	Brown	NC	485_A1	NC



Smart Meter LED indications

STATUS	OFF	ON	Blinking
POWER	Not working	Working	/
ENERGY	/	Importing	Exporting
COM	Blink one time when it transfer data to inverter		



2.5 DRED(Remote shutdown) Connection

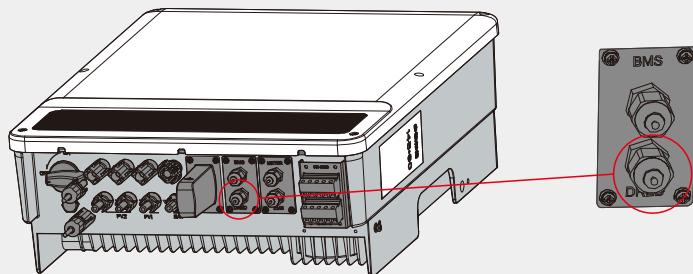
DRED (Demand response enabling device) is used for Australia and New Zealand installation (also used as remote shutdown function in European countries), in compliance with Australia and New Zealand safety requirements(or European countries). Inverter integrates control logic and provides an interface for DRED. The DRED is not provided by inverter manufacturer.

Detailed connection of DRED(REMOTE SHUTDOWN) is shown below:

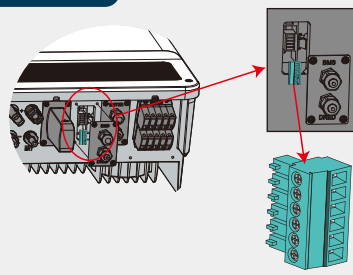
Step 1

Screw this plate off from the inverter.

Note: DRED should be connected through "DRED Port" as the figure shows.



Step 2



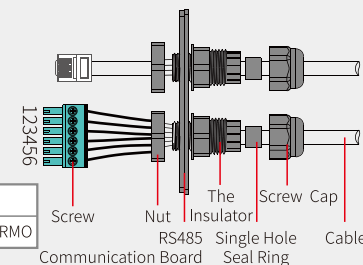
1. Plug out the 6-pin terminal and dismantle the resistor on it.
2. Plug the resistor out, leave the 6-pin terminal for next step.

Note: The 6-pin terminal in the inverter has the same function as DRED. Please leave it in the inverter if no external device is connected.

Step 3-1 For DRED

1. Put DRED cable through the plate.
2. Connect DRED cable on the 6-pin terminal. The function of each connection position is shown as below.

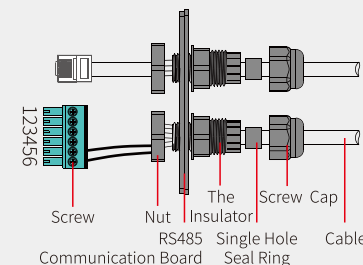
NO.	1	2	3	4	5	6
Function	DRM1/5	DRM2/6	DRM3/7	DRM4/8	REFGEN	COM / DRMO



Step 3-2 For Remote Shutdown

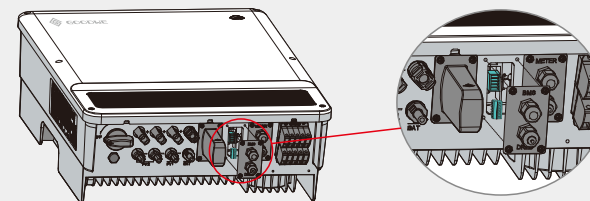
1. Put the cable through the plate.
2. Wiring from the No. 5 and 6 holes respectively.

NO.	5	6
Function	REFGEN	COM / DRMO



Step 4

Connect DRED terminal to the right position onto the inverter.

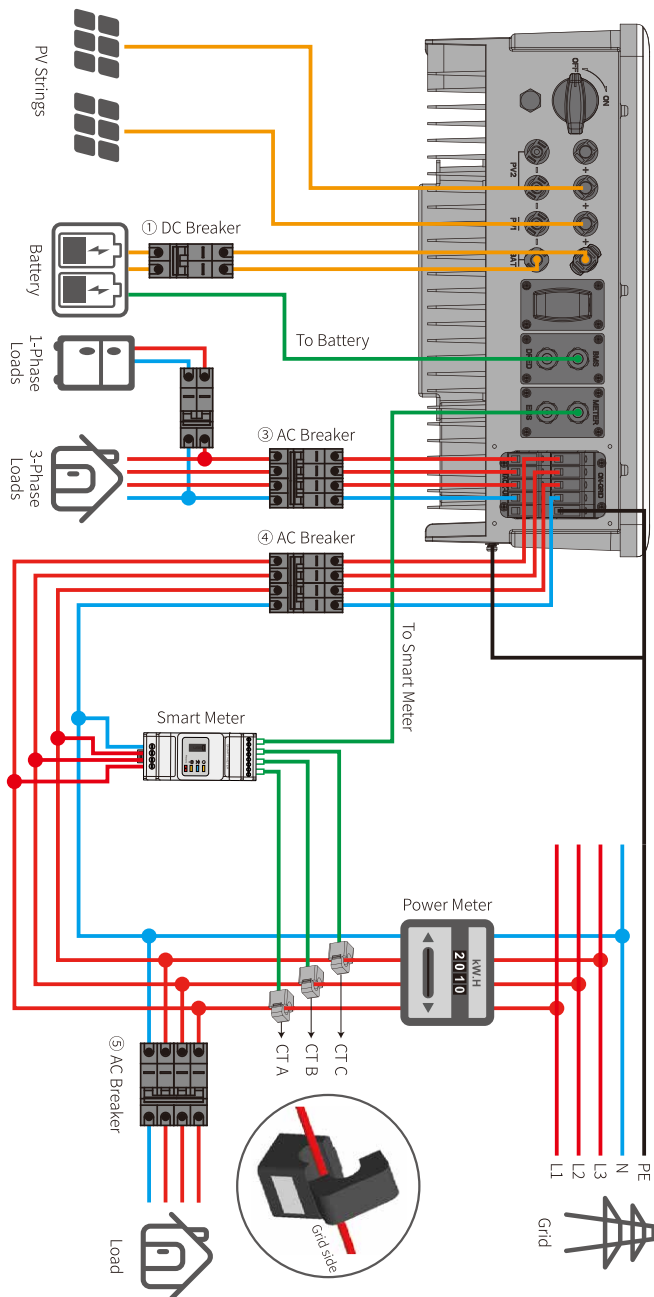


2.6 Earth Fault Alarm Connection

ET series inverter complies with IEC 62109-2 13.9. Fault indicator LED on inverter cover will light up and the system will email the fault information to customer.

Wiring system for ET series hybrid inverter

Note: This diagram indicates wiring structure of ET series hybrid inverter, not the electric wiring standard.



Please select Breaker according to the specification below

Inverter	①	②	③	④	⑤
GW5K/6K/ET	40A/600V DC Breaker	25A/400V AC breaker			Depends on household loads
GW8K/10K/ET		32A/400V AC breaker			
GW5K/6K5-ET		25A/400V AC breaker			
GW8K/10K-ET		32A/400V AC breaker			

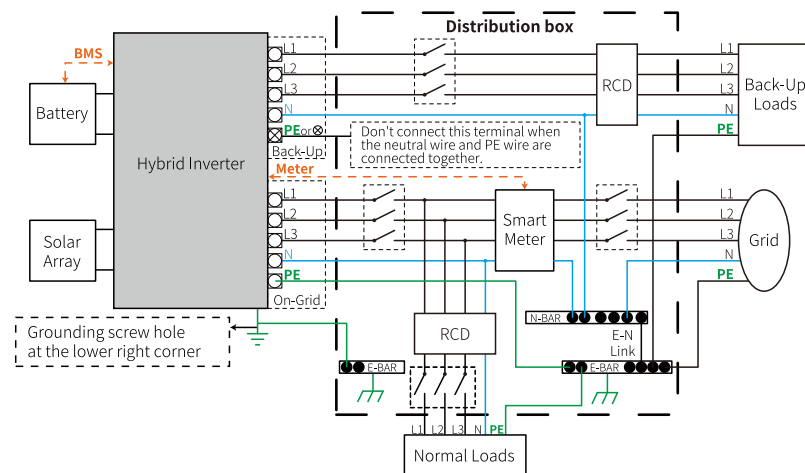
1. For batteries with attached breaker, the external DC breaker could be omitted.
2. Please use CT A for L1, CT B for L2 and CT C for L3. And follow "House(k) → Grid(L)" direction to do the connection. Otherwise there will be an error reminded by PV Master App.

System connection diagrams

Note: According to Australian safety country, the neutral cable of on-grid side and back-up side must be connected together, otherwise back-up function will not work.

This diagram is an example for application that Neutral connects together with PE in distribution box.

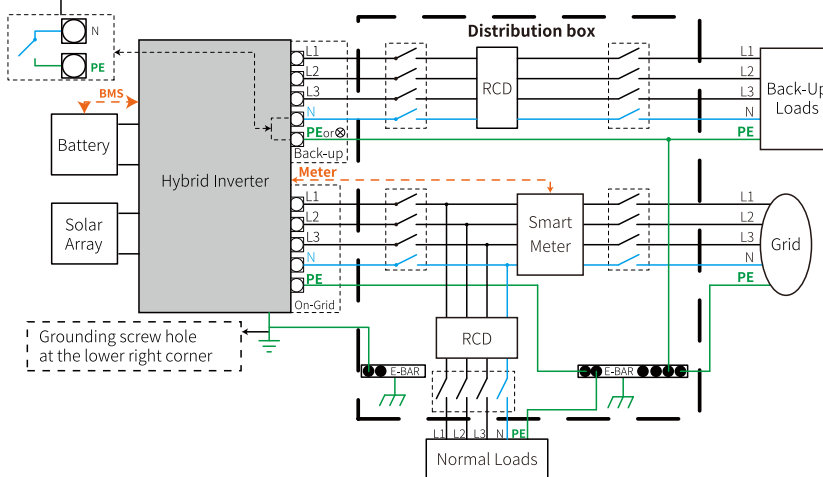
Such as: Australia, New Zealand, South Africa, etc. (Please follow local wiring regulations!)



This diagram is an example for application that Neutral separates with PE in distribution box.

Such as: China, Germany, Czech Republic, Italy, etc. (Please follow local wiring regulations!)

When the inverter is working in Back-up mode, neutral and PE on Back-up side are connected together via the internal relay. And this internal relay will be open when the inverter is working in the Grid-tied mode.



3.1 Wi-Fi Configuration

This part shows configuration on web page.

Wi-Fi configuration is absolutely necessary for online monitoring and maintenance.

Preparation:

1. Inverter must be powered up with battery or grid power.
2. Router with available internet access to the website www.semsportal.com is required.

Step 1

1. Connect Solar-WiFi* to your PC or smart phone (* its named the last 8 character of the inverter's serial No.).
2. Open browser and login 10.10.100.253 Admin (User): admin; Password: admin.
3. Then click "OK".

Step 2

1. Click "Start Setup" to choose your router.
2. Then click "Next".

Device information

Firmware version	1.6.9.3.38.2.1.38
MAC address	60:C5:A8:60:33:E1
Wireless AP mode	Enable
SSID	Solar-WiFi
IP address	10.10.100.253
Wireless STA mode	Disable
Router SSID	WiFi_Bum-in
Encryption method	WAP/WAP2-PSK
Encryption algorithm	AES
Router Password	WiFi_Bum-in

Cannot join the network, may be caused by:

No router / weak WiFi signal / password is not correct

★ Help: Wizard will help you to complete setting with one minute.

Start Setup

Please select you current wireless network

SSID	AUTH/ENCRY	RSSI	Channel
WiFi_Bum-in	WPA2PSK/WPA2PSK/TKIP/AES	66	1
WiFi_Bum-in	WPA2PSK/WPA2PSK/TKIP/AES	100	1
WiFi_Bum-in	WPA2PSK/WPA2PSK/TKIP/AES	70	1
WiFi_Bum-in2	WPA2PSK/WPA2PSK/TKIP/AES	72	1

Refresh

★ Help: When RSSI of the selected Wi-Fi network is lower than 15%, the connection may be unstable. Please select other available network or shorten the distance between the device and router. If your wireless router does not broadcast SSID, please click "Next" and add a wireless network manually.

Back

Next

Step 3

1. Fill in the password of the router, then click "Next".
2. Click "Complete".

Add wireless network manually

Network name (SSID)	WiFi-Test
Encryption method	WPA/WPA2-PSK
Encryption algorithm	AES

Please enter the wireless network password:

Password (8-63 bytes)	Router password
	show psk

Note: Case sensitive for SSID and password, Please make sure all parameters of wireless network are matched with router, including password.

Back

Next

Save success!

Click "Complete", the current configuration will take effect after restart.

If you still need to configure the other pages of information, please go to complete your required configuration.

Configuration is completed, you can log on the Management page to restart device by Click on "OK" button.

Confirm to complete?

Back

Complete

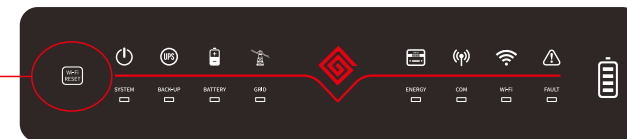
Note:

1. Please make sure the password, Encryption method / algorithm is the same as the router's.
2. If everything is right well, the Wi-Fi LED on inverter will change from double blink to quartic blink then to solid status, which means Wi-Fi has connected to the server successfully.
3. Wi-Fi configuration could also be done on PV Master App, details please check on PV Master App.

Wi-Fi reset & reload

Wi-Fi reset means restarting Wi-Fi module. Wi-Fi settings will be reprocessed and saved automatically. Wi-Fi Reload means setting Wi-Fi module back to default factory setting.

Wi-Fi Reset Button



Wi-Fi reset

Short press reset button.

Wi-Fi LED will blink for a few seconds.

Wi-Fi reload

Long press reset button (longer than 3s).

Wi-Fi LED will double blink until Wi-Fi configuration again.

Note:

Wi-Fi reset & reload function is only used when:

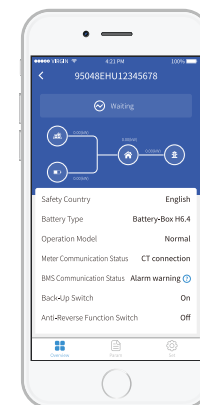
1. Wi-Fi loses connection to internet or cannot connect to PV Master App successfully.
2. Cannot find "Solar-WiFi signal" or have other Wi-Fi configuration problems.
3. Please do not use this button if Wi-Fi monitoring works well.

3.2 PV Master App

PV Master is an external monitoring/ configuration application for hybrid inverters, used on smart phones or tablet for both Android and iOS system. Main functions are as below:

1. Edit system configuration to make the system work as customer needs.
2. Monitor and check the performance of the hybrid system.
3. Wi-Fi configuration.

Please download "PV Master App" from www.goodwe.com or scan the QR code on the back of this user manual.



3.3 CEI Auto-Test Function

PV auto-test function of CEI is integrated in PV Master App for Italy's safety country requirements. For detailed instruction of this function please refer to "PV Master Operation Instructions".

4.1 Error Messages

The error messages below will be displayed on PV Master App or reported by e-mail if an error occurs.

ERROR MESSAGE	EXPLANATION	REASON	SOLUTIONS
Utility Phase Failure	The sequence of on-grid wire is wrong	Inverter detects that phase angle of L2 and L3 are reversed	Reverse connection order of L2 and L3 cable.
Utility Loss	Public grid power is not available (power lost or on-grid connection fails)	Inverter does not detect the connection of grid	1. Check (use multi-meter) if AC side has voltage. Make sure grid power is available. 2. Make sure AC cables are connected tightly and well. 3. If all is well, please try to turn off AC breaker and turn on again in 5 mins.
VAC Failure	Grid voltage is not within permissible range	Inverter detects that AC voltage is beyond the normal range required by the safety country	1. Make sure safety country of the inverter is set right. 2. Check (use multi-meter) if the AC voltage (Between L & N) is within a normal range (also on AC breaker side) a. If the AC voltage is high, then make sure the AC cable complies with that required on user manual and the AC cable is not too long. b. If the voltage is low, make sure the AC cable is connected well and the jacket of the AC cable is not compressed into the AC terminal. 3. Make sure the grid voltage of your area is stable and within normal range.
FAC Failure	Grid frequency is not within permissible range	Inverter detects that the grid frequency is beyond the normal range required by the safety country	1. Make sure the safety country of the inverter is set right. 2. If safety country is right, then please check on the inverter display if AC frequency (Fac) is within a normal range. 3. If FAC failure only appears a few times and is resolved soon, it should be caused by occasional grid frequency instability.
PV/BAT Over Voltage	PV or BAT voltage is too high	The total voltage (open-circuit voltage) of each PV string is higher than the max DC input voltage of the inverter, or the battery voltage is higher than the max BAT input voltage of the inverter	1. Check if PV string Voc is lower than Max PV input voltage of the inverter. If Voc of PV string is high, please decrease panels to make sure Voc is within the max DC input voltage of the inverter. 2. Check if battery voltage is lower than Max battery input voltage of the inverter. If battery voltage is high, please decrease battery pack to make sure the voltage is within the max battery input voltage of the inverter.
Over Temperature	Temperature inside of the inverter is too high	The inverter's working environment leads to a high temperature condition	1. Try to decrease surrounding temperature. 2. Make sure the installation complies with the instruction on inverter user manual. 3. Try to close the inverter for 15 mins, then start up again.
Isolation Failure	Ground insulation impedance of PV string is too low	Isolation failure could be caused by multiple reasons like that the PV panels are not grounded well, DC cable is broken, PV panels are aged or surrounding humidity is comparatively heavy, etc.	1. Use multi-meter to check if the resistance between earth & inverter frame is close to zero. If it's not, please ensure that the connection is well. 2. If the humidity is too high, isolation failure may occur. 3. Check the resistance between PV1+/PV2+/BAT+/PV- to earth. If the resistance is lower than 33.3k, check the system wiring connection. 4. Try to restart the inverter. Check if the fault still occurs. If not, it means it is caused by an occasional situation, or contact after-sales.
Ground Failure	Ground leakage current is too high	Ground failure could be caused by multiple reasons like that the neutral cable on the AC side is not connected well or the surrounding humidity is comparatively heavy, etc.	Check (use multi-meter) if there is voltage (normally should be close to 0V) between earth & inverter frame. If there is a voltage, it means the neutral & ground cables are not connected well on the AC side. If it happens only in the early morning/dawn /rainy days with higher air humidity and is recovered soon, it should be normal.
Relay Check Failure	Self checking of relay failure	Neutral & ground cables are not connected well on AC side or just an occasional failure	Check (use multi-meter) if there is high voltage (normally should be lower than 10V) between N & PE cable on the AC side. If the voltage is higher than 10V, it means the Neutral & ground cable are not connected well on AC side or restart inverter.
DC Injection High	/	The inverter detects a higher DC component in AC output	Try to restart the inverter, check if it still occurs. If not, it is just an occasional situation. Otherwise, contact after-sales immediately.
EEPROM R/W Failure	/	Caused by a strong external magnetic field etc.	Try to restart the inverter, check if it still occurs. If not, it is just an occasional situation. Otherwise, contact after-sales immediately.
SPI Failure	Internal communication fails	Caused by a strong external magnetic field etc.	Try to restart the inverter, check if it still occurs. If not, it is just an occasional situation. Otherwise, contact after-sales immediately.
DC Bus High	BUS voltage is over-high	/	Try to restart the inverter, check if it still occurs. If not, it is just an occasional situation. Otherwise, contact after-sales immediately.
Back-Up Over Load	Back-up side is over loaded	Total back-up load power is higher than the back-up nominal output power	Decrease back-up loads to make sure the total load power is lower than back-up nominal output power (please refer to page 11).

4.2 Troubleshooting

Checking Before Turning On AC Power

- **Battery connection:** Confirm the connection between ET and battery : polarities (+/-) are not reversed, refer to figure 4.2-1
- **PV input connection:** Confirm the connection between ET and PV panels: polarities (+/-) are not reversed, refer to figure 4.2-2.
- **On-grid & back-up connection:** Confirm on-grid connected to power grid and back-up connected to loads: polarities (L1/L2/L3/N are in sequence) are not reversed, refer to figure 4.2-3.
- **Smart Meter & CT connection:** Make sure Smart Meter & CT are connected between house loads and grid, and follow the Smart Meter direction sign on CT, refer to figure 4.2-4.

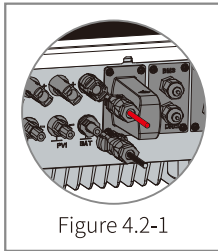


Figure 4.2-1

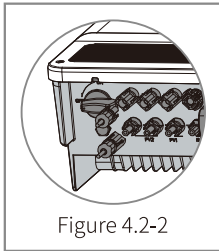


Figure 4.2-2

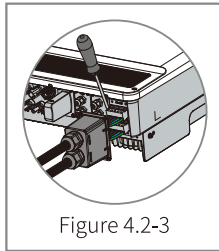


Figure 4.2-3

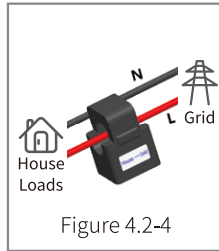
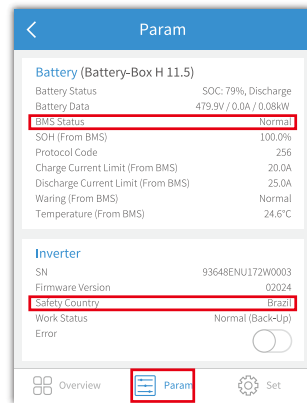
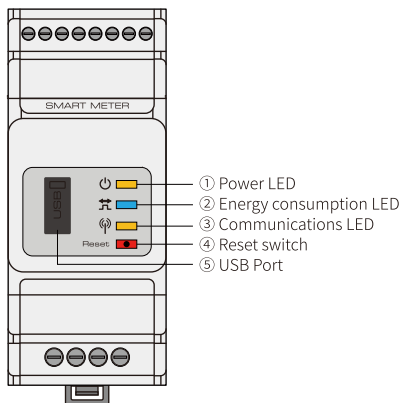


Figure 4.2-4

Checking As Start Et Up And Turn On AC Power

Battery settings, BMS communication and safety country:

After connecting Solar-WiFi* (*The Wi-Fi signal is named the last 8 characters of the inverter's serial No.), check on PV Master App "Param" to make sure battery type is the same as what you have installed, and "Safety Country" Setting is right. Please set it right in "Set" if the setting is not right.



Note: For compatible lithium batteries, BMS status will display "Normal" after selecting the right battery company.

Problems During Operation

ET does not start up with battery only

Solution:

Make sure the voltage of battery is higher than 180V, otherwise battery cannot start ET up.

ET not started up with PV only

Solution:

1. Make sure the voltage of PV is higher than 180V (need 230V to enter on-grid mode).
2. Make sure the connection between ET and PV panels: polarities are (+/-) not reversed.

ET hybrid inverter doesn't discharge or output without PV or when PV is lower than load power

Solution:

1. Check communication between ET and Smart Meter is OK or not.
2. Make sure load power is higher than 150W.
 - a. Battery will not discharge continuously unless load power is higher than 150W;
 - b. If battery does not discharge when Meter power is higher than 150W, please check Smart Meter & CT connection and direction;
3. Make sure SOC (State of discharge) is higher than 1-DOD (Depth of discharge). Or if battery discharges to below 1-DOD, battery will only discharge again when SOC charged to $(20\% + 1 - \text{DOD}) / 2$ and $\text{SOC} > 105\% - \text{DOD}$ (if the battery discharge is needed immediately, the user should restart battery).
4. Check on APP whether the charge time has already been set, as during charge time, battery will not discharge (battery will charge in priority during coincident time of charge/discharge).

Battery does not charge when PV power higher than load power

Solution:

1. Check the discharge time setting on App.
2. Check if battery is fully charged or not, or if battery voltage reaches "charge voltage" or not.

High power fluctuation on battery charge or discharge

Solution:

1. Check if there is a fluctuation on load power.
2. Check if there is a fluctuation on PV power.

Battery does not charge

Solution:

1. Make sure BMS communication is OK on PV Master App.
2. Check if CT is connected in the right position and connected to right direction as the user manual page 12
3. Check if the total load power is much higher than PV power.

Questions & Answers (Q & A)

About Wi-Fi Configuration

Q: Why can't I find the Solar-WiFi* signal on mobile devices?

A: Normally Solar-WiFi* signal could be searched right after inverter has powered up. But Solar-Wi-Fi signal will disappear when ET connects to internet. If changes to the setting are required, connect to the router for change. If you can't find the WiFi signal or connect to the router, then please try to reload Wi-Fi (please refer to ET user manual page 17).

Q: Why can't I connect Solar-WiFi* signal on my phone?

A: The Wifi module can only connect to one device at a time. If the signal is already connected to another device at the time for some reason, you cannot connect to the signal.

About Battery Operation

Q: Why does the battery not discharge when grid is not available, while it discharges normally when grid is available?

A: On the App, off-grid output and back-up function should be turned on to make battery discharge under off-grid mode.

Q: Why is there no output on back-up side?

A: For back-up supply, the "Back-Up Supply" on PV Master App must be turned on. Under off-grid mode or when grid power is disconnected, "Off-Grid Output Switch" function must be turned on as well.

Note: When turning "Off-Grid Output Switch" on, don't restart inverter or battery, otherwise the function will be switched off automatically.

Q: Why does the battery SOC suddenly jump to 95% on the Portal?

A: It normally happens when BMS communication fails on lithium battery. If battery enters float charge mode, SOC will be reset to 95% automatically.

Q: The battery cannot be fully charged to 100%?

A: Battery will stop charging when battery voltage reaches charge voltage set on PV Master App.

Q: Why battery switch always trip when it starts up (lithium battery)?

A: The switch of lithium battery normally trips because of following reasons:

1. BMS communication fails.
2. Battery SOC is too low, battery trips to protect itself.
3. An electrical short-cut happened on battery connection side. Or for other reasons please contact after-sales.

Q: Which battery should I use for ET?

A: For ET series inverter, it could connect lithium batteries which have compatibility with ET series inverter with nominal voltage from 180V to 600V. For compatible lithium batteries please refer to battery list in PV Master App.

About PV Master Operation And Monitoring

Q: Why can't I save settings on PV Master App?

A: It could be caused by losing connection to Solar-WiFi*.

1. Make sure you have already connected Solar-WiFi* (make sure no other devices connected) or router (if connected Solar-WiFi* to router). APP's homepage shows connection well.
2. Make sure you restart inverter 10mins after you change some settings because inverter will save settings every 10 mins under normal mode. We recommend to change setting parameters when inverter is in wait mode.

Q: Why are the data displayed on the homepage different from the param page, like charge/discharge, PV value, load value or grid value?

A: The data refresh frequency is different, so there will be a data inconformity between different pages on APP as well as between these on portal and App.

Q: Some columns show NA, like battery SOH, etc. Why does that happen?

A: NA means App does not receive data from inverter or server because of communication problem, such as battery communication, and communication between inverter and the App.

About Smart Meter And Power Limit Function

Q: How to activate output power limit function?

A: For ET system, the function could be realized by:

1. Make sure Smart Meter connection and communication well.
2. Turn on export power limit function and set the max output power to grid on App.

Note: Even if output power limit is set to 0W, there might still be a deviation of a max of 100W exporting to grid.

Q: Why is there still power exporting to grid after I set power limit as 0W?

A: Export limit could be 0W theoretically, but there will be a deviation of around 50-100W for ET system.

Q: Can I use other brand meter to take over Smart Meter in ET system or change some settings on Smart Meter?

A: No, because the communication protocol is integrated into inverter and Smart Meter, other brand Meter cannot communicate. Also any manual setting change could cause Meter communication failure.

Q: What is the maximum current allowed to go through CT on Smart Meter?

A: The max current for CT is 120A.

Other Questions

Q: Is there a quick way to make the system work?

A: For the shortest way, please refer to "ET Quick Installation Instructions" and "PV Master App Instruction".

Q: What kind of load can i use to connect on back-up side?

A: Please refer to user manual on page 12.

Q: Will the warranty of the inverter still be valid if for some special conditions we cannot 100% follow the user manual instructions on the installation or operation?

A: Normally we still provide technical support to problems caused from disobeying the instructions on the user manual, however we cannot guarantee any replacements or returns. So if there is any special conditions where you cannot 100% follow the instructions, please contact after-sales for suggestions.

4.3 Disclaimer

The ET series inverters are transported, used and operated under environmental and electrical conditions. Manufacturer has the right not to provide after-sales services or assistance under following conditions:

- Inverter is damaged during transfer.
- Inverter is out of warranty year and extended warranty is not bought.
- Inverter is installed, refitted or operated in improper ways without authority from manufacturer.
- Inverter is installed or used under improper environment or technical condition mentioned in this user manual, without authority from manufacturer.
- Installation or configuration of the inverter does not follow requirements mentioned in this user manual.
- The inverter is installed or operated against the requirements or warnings that are mentioned in this user manual.
- Inverter is broken or damaged by any force majeure like lightening, earthquake, fire hazard, storm and volcanic eruption etc.
- Inverter is disassembled, changed or updated on software or hardware without authority from manufacturer.
- Inverter is installed, used or operated against any related items in international or local policies or regulations.
- Any non-compatible batteries, loads or other devices connected to ET system.

Note: Manufacturer will keep the right to explain all the contents in this user manual. To insure IP66, inverter must be sealed well, please install the inverters within one day after unpacking, otherwise please seal all unused terminals / holes, unused terminals / holes are not allowed to be kept open, confirm that there is no risk of water or dust entering the terminals / holes.

Maintenance

The inverter requires periodical maintenance, details are shown below:

- Make sure inverter is totally isolated from all DC and AC power for at least 5 mins before maintenance.
- Heat sink: Please use clean towel to clean up heat sink once a year.
- Torque: Please use torque wrench to tighten AC and DC wiring connection once a year.
- DC breaker: Check DC breaker regularly, active the DC breaker 10 times in a row once a year.
- Operating DC breaker will clean contacts and extend lifespan of DC breaker.
- Water-proof covers: Check if water-proof covers of RS485 and other part are replaced once a year.

4.4 Technical Parameters

Technical Data	GW5KL-ET	GW6KL-ET	GW8KL-ET	GW10KL-ET
Battery Input Data				
Battery Type	Li-Ion			
Battery Voltage Range (V)	180~600			
Max. Charging Current (A)	25			
Max. Discharging Current (A)	25			
Charging Strategy For Li-Ion Battery	Self-Adaption To BMS			
PV String Input Data				
Max. DC Input Power (W)	6500	7980	10640	13300
Max. DC Input Voltage (V) [1]	1000	1000	1000	1000
MPPT Range (V) [2]	200~850	200~850	200~850	200~850
Start-Up Voltage (V)	180	180	180	180
MPPT Range for Full Load (V) [3]	240~850	285~850	260~850	320~850
Nominal DC Input Voltage (V) [4]	620	620	620	620
Max. Input Current (A)	12.5/12.5	12.5/12.5	12.5/22	12.5/22
Max. Short Current (A)	15.2/15.2	15.2/15.2	15.2/27.6	15.2/27.6
No. Of MPP Trackers	2	2	2	2
No. Of Strings Per MPP Tracker	1/1	1/1	1/2	1/2
AC Output Data (On-Grid)				
Nominal Apparent Power Output to Utility Grid (VA)	5000	6000	8000	10000
Max. Apparent Power Output to Utility Grid (VA) [5]	5500	6600	8800	11000
Max. Apparent Power from Utility Grid (VA)	10000	12000	15000	15000
Nominal Output Voltage (V)	400/380, 3L/N/PE	400/380, 3L/N/PE	400/380, 3L/N/PE	400/380, 3L/N/PE
Nominal Ouput Frequency (Hz)	50/60	50/60	50/60	50/60
Max. AC Current Output to Utility Grid (A)	8.5	10.5	13.5	16.5
Max. AC Current From Utility Grid (A)	15.2	18.2	22.7	22.7
Output Power Factor	~1 (Adjustable from 0.8 leading to 0.8 lagging)			
Output THDi (@Nominal Output)	<3%			
AC Output Data (Back-Up)(Optional)				
Max. Output Apparent Power (VA)	5000	6000	8000	10000
Peak Output Apparent Power (VA) [6]	10000, 60sec	12000, 60sec	16000, 60sec	16500, 60sec
Max. Ouput Current (A)	8.5	10.5	13.5	16.5
Nominal Output Voltage (V)	400/380	400/380	400/380	400/380
Nominal Ouput Frequency (Hz)	50/60	50/60	50/60	50/60
Output THDv (@Linear Load)	<3%	<3%	<3%	<3%
Efficiency				
Max. Efficiency	97.6%			
Max. Battery To Load Efficiency	97.5%			
Europe Efficiency	96.8%			
MPPT Efficiency	99.9%			

Technical Data	GW5KL-ET	GW6KL-ET	GW8KL-ET	GW10KL-ET
Protection				
Anti-Islanding Protection	Integrated			
PV String Input Reverse Polarity Protection	Integrated			
Insulation Resistor Detection	Integrated			
Residual Current Monitoring Unit	Integrated			
Output Over Current Protection	Integrated			
Output Short Protection	Integrated			
Battery Input Reverse Polarity Protection	Integrated			
Output Over Voltage Protection	Integrated			
General Data				
Operating Temperature Range (°C)	-35~60			
Relative Humidity	0~95%			
Operating Altitude (m)	≤4000			
Cooling	Nature Convection			
Noise (dB)	<30			
User Interface	LED & APP			
Communication with BMS	RS485; CAN			
Communication with Meter	RS485			
Communication with EMS	RS485 (Insulated)			
Communicaion with Portal	Wi-Fi			
Weight (kg)	24	24	25	25
Size (Width*Height*Depth mm)	516*415*180			
Mounting	Wall Bracket			
Protection Degree	IP66			
Standby Self Consumption (W) [7]	<15			
Topology	Transformerless			
Certifications & Standards				
Grid Regulation	AS/NZS 4777.2:2015			
Safety Regulation	IEC62109-1&2			
EMC	EN61000-6-1, EN61000-6-2, EN61000-6-3, EN61000-6-4, EN61000-4-16, EN61000-4-18, EN61000-4-29			

- [1] For 1000V system, maximum operating voltage is 950V. For AustraliaL(Max. DC Input Voltage 600V) safety regulation, there will be a warning if PV voltage > 600V.
- [2] For AustraliaL(Max. DC Input Voltage 600V) safety regulation, MPPT range is 200~550V.
- [3] For AustraliaL(Max. DC Input Voltage 600V) safety regulation, MPPT voltage upper limit is 550V.
- [4] For AustraliaL(Max. DC Input Voltage 600V) safety regulation, nominal DC input voltage is 450V.
- [5] According to the local grid regulation.
- [6] Can be reached only if PV and battery power is enough.
- [7] No back-up output.

Technical Data	GW5K-ET	GW6K5-ET	GW8K-ET	GW10K-ET
Battery Input Data				
Battery Type	Li-Ion			
Battery Voltage Range (V)	180~600			
Max. Charging Current (A)	25			
Max. Discharging Current (A)	25			
Charging Strategy For Li-Ion Battery	Self-adaption to BMS			
PV String Input Data				
Max. DC Input Power (W)	6500	8450	9600	13000
Max. DC Input Voltage (V)	1000	1000	1000	1000
MPPT Range (V)	200~850	200~850	200~850	200~850
Start-up Voltage (V)	180	180	180	180
MPPT Range for Full Load (V)	240~850	310~850	380~850	460~850
Nominal DC Input Voltage (V)	620	620	620	620
Max. Input Current (A)	12.5/12.5	12.5/12.5	12.5/12.5	12.5/12.5
Max. Short Current (A)	15.2/15.2	15.2/15.2	15.2/15.2	15.2/15.2
No. Of MPP Trackers	2	2	2	2
No. Of Strings Per MPP Tracker	1/1	1/1	1/1	1/1
AC Output Data (On-Grid)				
Nominal Apparent Power Output To Utility Grid (VA)	5000	6500	8000	1000
Max. Apparent Power Output To Utility Grid (VA) [1]	5500	7150	8800	11000
Max. Apparent Power From Utility Grid (VA)	10000	13000	15000	15000
Nominal Output Voltage (V)	400/380, 3L/N/PE	400/380, 3L/N/PE	400/380, 3L/N/PE	400/380, 3L/N/PE
Nominal Ouput Frequency (Hz)	50/60	50/60	50/60	50/60
Max. AC Current Output to Utility Grid (A)	8.5	10.8	13.5	16.5
Max. AC Current From Utility Grid (A)	15.2	19.7	22.7	22.7
Output Power Factor	~1 (Adjustable from 0.8 leading to 0.8 lagging)			
Output THDi (@Nominal Output)	<3%			
AC Output Data (Back-Up)(Optional)				
Max. Output Apparent Power (VA)	5000	6500	8000	10000
Peak Output Apparent Power (VA) [2]	10000, 60sec	13000, 60sec	16000, 60sec	16500, 60sec
Max. Ouput Current (A)	8.5	10.8	13.5	16.5
Nominal Output Voltage (V)	400/380	400/380	400/380	400/380
Nominal Ouput Frequency (Hz)	50/60	50/60	50/60	50/60
Output THDv (@Linear Load)	<3%	<3%	<3%	<3%
Efficiency				
Max. Efficiency	98.0%	98.0%	98.2%	98.2%
Max. Battery to Load Efficiency	97.5%	97.5%	97.5%	97.5%
Europe Efficiency	97.2%	97.2%	97.5%	97.5%
MPPT Efficiency	99.9%	99.9%	99.9%	99.9%

Technical Data	GW5K-ET	GW6K5-ET	GW8K-ET	GW10K-ET
Protection				
Anti-Islanding Protection	Integrated			
PV String Input Reverse Polarity Protection	Integrated			
Insulation Resistor Detection	Integrated			
Residual Current Monitoring Unit	Integrated			
Output Over Current Protection	Integrated			
Output Short Protection	Integrated			
Battery Input Reverse Polarity Protection	Integrated			
Output Over Voltage Protection	Integrated			
General Data				
Operating Temperature Range (°C)	-35~60			
Relative Humidity	0~95%			
Operating Altitude (m)	≤4000			
Cooling	Nature Convection			
Noise (dB)	<30			
User Interface	LED & APP			
Communication with BMS	RS485; CAN			
Communication with Meter	RS485			
Communication with EMS	RS485 (Insulated)			
Communicaion with Portal	Wi-Fi			
Weight (kg)	24			
Size (Width*Height*Depth mm)	516*415*180			
Mounting	Wall Bracket			
Protection Degree	IP66			
Standby Self Consumption (W) [3]	<15			
Topology	Transformerless			
Certifications & Standards				
Grid Regulation	CEI 0-21; VDE4105-AR-N; VDE0126-1-1; EN50549; G98, G99, G100			
Safety Regulation	IEC62109-1&2			
EMC	EN61000-6-1, EN61000-6-2, EN61000-6-3, EN61000-6-4, EN61000-4-16, EN61000-4-18, EN61000-4-29			

[1] According to the local grid regulation.

[2] Can be reached only if PV and battery power is enough.

[3] No back-up Output.

4.5 Other Test

For Australian requirements, in the THDi test, Zref should be added between inverter and mains.

RA, XA for Line conductvtr

RN, XN for Neutral conductor

Zref:

RA=0, 24; XA=j0,15 at 50Hz;

RN=0, 16; XN=j0,10 at 50Hz

4.6 Quick Check List To Avoid Danger

- 1. Inverter cannot be installed near flammable, explosive or strong electro-magnetic equipment, please refer to page 06
- 2. Remember that this inverter is heavy! Please be careful when lifting out from the package, please refer to page 07
- 3. Make sure battery breaker is off and battery nominal voltage meets ET specification before connecting battery to inverter and make sure inverter is totally isolated from PV and AC power, please refer to page 09
- 4. Make sure inverter is totally isolated from any DC or AC power before connecting AC cable, please refer to page 11
- 5. Make sure AC cable is totally isolated from AC power before connecting Smart Meter & CT, please refer to page 14

Appendix protection category defintion

Overvoltage category definition

Category I	Applies to equipment connected to a circuit where measures have been taken to reduce transient overvoltage to a low level.
Category II	Applies to equipment not permanently connected to the installation. Examples are appliances, portables tools and other plug-connected equipment.
Category III	Applies to a fixed equipment downstream and including the main distribution board. Examples are switchgear and other euiquipment in an industrial installation.
Category IV	Applies to equipment permanently connected at the origin of an installa-tion (upstream of the main distribution board). Examples are electricity meters, primary over-current protection equipment and other equipment connected directly to outdoor open lines.

Moisture location category definition

Moisture Parameters	Level		
	3K3	4K3	4K4H
Temperature Range	0~+40°C	-33~+40°C	~20~+55°C
Moisture Parameters	5%~85%	15%~100%	4%~100%

Environment category definition

Environment Condition	Ambient Temperature	Relative Humidity	Applied to
Outdoor	-20~50°C	4%~100%	PD3
Indoor Unconditioned	-20~50°C	5%~95%	PD3
Indoor conditioned	0~40°C	5%~85%	PD2

Pollution degree definition

Pollution Degree I	No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
Pollution Degree II	Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.
Pollution Degree III	Conductive pollution occurs, or dry, non-conductive pollution occurs, which becomes conductive due to condensation, which is expected.
Pollution Degree IV	Persistent conductive pollution occurs, for example, the pollution caused by conductive dust, rain or snow.