GESOLAR

Build and Beyond

Operating Manual

On Grid PV Inverters
Without Transformer

GES-3K3TL/3K8TL/4K6TL

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1. Introduction

1.1 General

The GESOLAR product family is a series of grid-connected photovoltaic inverters which are designed to convert DC power generated by photovoltaic arrays to AC power that is delivered to the home loads and then fed into the utility grid with any excess power. Currently, the GESOLAR family contains three (3) members which are GES-4K6TL, GES-3K8TL and GES-3K3TL. The overview of the grid-connected solar energy system with a three (3) panel strings inverter is shown in Figure 1.1.1. GESOLAR inverters comply with all VDEW (German Electricity Association) regulations for supplementary grid feeding to low voltage electricity grid of the utility. Additionally, GESOLAR inverters are also certified to comply with the latest regulations (Refer the certification lists of 1.2 Specifications).

The GESOLAR inverter is designed to support up to three (3) PV strings and operate automatically without any configuration once it is installed and commissioned according to the technical specifications. When at least one of the DC input voltages generated by the photovoltaic module goes above the pre-set threshold value setting and under the PV start voltage, the embedded controller is then woke up and stay at System Check mode because the PV start voltage is not reached yet. At this time, the GESOLAR inverter would not feed the AC power to the mains utility; instead, it keeps watching the input DC voltage. Once the input DC

voltage goes up above the PV start voltage and all other conditions necessary for grid connection are checked and fulfilled for a certain period of time, the GESOLAR inverter goes into the Grid/MPP mode that turns the AC relays on and begins feeding the AC power into the grid steadily. When all of the input DC voltages fall below the minimum MPP voltage setting which is 100 VDC, the GESOLAR inverter will then shut itself down. The GESOLAR inverter will be re-connected automatically when one or more of the input DC voltages go up above the PV start voltage setting.

It is very much appreciated that you choose GESOLAR inverters as your power conversion devices in the solar power system. This document contains the information you need for the installation and settings of the GESOLAR inverters. Therefore, it is strongly recommended to read this manual carefully before the GESOLAR inverter installations and settings.

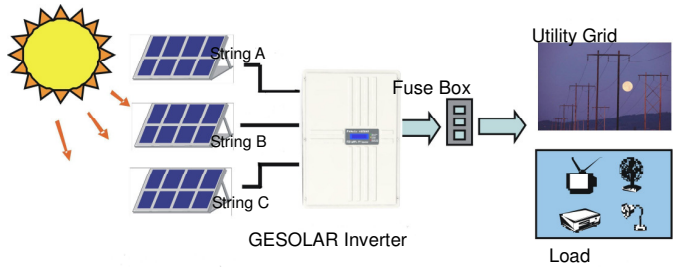


Fig1.1.1 Grid Connected Solar System Overview

1.2 Specifications

Model Name	GES-4K6TL	GES-3K8TL	GES-3K3TL
Grid Side (AC output)			
Grid Voltage, Nominal	230 VAC		
Grid Frequency, Nominal	50 / 60 Hz		
Nominal Output Power	4600 W	3800 W	3300 W
Maximum Output Power	5100 W	4400 W	3800 W
Nominal Output Current	20 A	16.52 A	14.35 A
Maximum Output Current	22 A	19.13 A	16.52 A
Output over current protection (recommended)	30 A	25 A	25 A
Waveform	True sine		
Power Factor	> 0.99		
THD	< 3%		
DC Component	< 0.5%		
Phase	Single phase		
PV Side (DC input)			
Maximum DC Power	4500W per input port		
MPP Voltage Range	100 ~ 450 V		
Maximum Input Voltage	500 VDC		
Maximum DC Current	10A per input port		
No. of DC Input Port	3	2	2
No. of MPP Tracker	1 ~ 3	1 ~ 2	1 ~ 2

Model Name	**GES-4K6TL**	**GES-3K8TL**	**GES-3K3TL**
General			
Maximum Efficiency	96.2% @350VDC	96.3% @350VDC	96.3% @350VDC
European Efficiency	95.4% @350VDC	95.1% @350VDC	95.2% @350VDC
Operating Ambient Temperature	-20℃ ~ 55℃		
Relative Humidity	Max. 95%		
Mechanical			
Enclosure	IP65 (ref. DIN EN60529)		
Cooling	Cooling Fan		
Weight	24 kg	23.5 kg	23.5 kg
Dimensions	580 x 422 x 182 (mm)		
Display	LED / LCD		
Interface			
Communication	RS232 and RS485		
Certifications			
EMC	EN 55022 (Class B) & C-Tick, EN 61000-6-2, EN 61000-6-3, EN 61000-3-11, EN 61000-3-12, EN 61000-3-2		
(2004/108/EC)	EN 61000-3-3, AS/NZS 61000.3.3, AS/NZS 61000.3.5		
Low Voltage Regulation	EN 50178 (covered by IEC 62103),		
(2006/95/EC)	AS/NZS 3100		
Network Monitoring	VDE 0126-1-1, RD 1663 / RD 661,		
	DK 5940 / Enel Connections Guide (2010), Section F,		
	AS 4777.2, AS 4777.3		
RoHS	2002/95/EC		

1.3 Adjustable Parameter Settings

Currently GESOLAR inverters have four models to fulfill the market needs for the countries of Germany, Italy, Spain and Australia.

Parameter	Germany	Italy	Spain	Australia
Standard	VDE0126-1-1	Enel Connection Guide (2010)	RD1663, RD661	AS 4777.2, AS 4777.3
Over-voltage (VAC)	260.0	262.0	253.0	265.0
Under-voltage (VAC)	198.0	188.0	196.0	205.0
Over-frequency (Hz)	50.19	50.3	51.0	50.99
Under-frequency (Hz)	47.51	49.7	49.0	49.01
Over-voltage clearing time (cycle)	8	5	5	90
Under-voltage clearing time (cycle)	8	10	10	90
Over-frequency clearing time (cycle)	5	3	2	90
Under-frequency clearing time (cycle)	5	3	2	90
Voltage quality monitoring* (VAC)	253.0	253.0	253.0	260.0
Voltage quality monitoring time* (s)	300	0 (NA)	0 (NA)	0 (NA)
Reconnect delay (s)	20	20	180	20
PV start voltage (VDC)	130.0	130.0	130.0	130.0

* The period of time for the GESOLAR inverter to disconnect from the grid and enter the Monitoring mode after the detection of the AC voltage that is higher than the **Voltage quality monitoring** setting and below the **Over-voltage** setting. This function is available only in the models of Germany type according to the VDE 0126-1-1, Clause 4.2.3.

1.4 Accessories

GES-4K6TL /3K8TL /3K3TL

- Operating Manual x1
- AC Connector x1
- RJ-45 plug x2
- DC Connector Sealing Cap (female) x1
- DC Connector Sealing Cap (male) x1
- Jumper (for MPPTs, see Figure 4.2.1) x2
- Auto Test CD(For Italian market only) x1

2. Safety

2.1 Safety Precautions/Safety Notes

Only the trained qualified electrical personnel are allowed to perform the electrical installation, wiring, opening, repair, and/or modification of GESOLAR inverters. Even when no external voltage is present, GESOLAR inverters can still contain high voltages and the risk of electrical shock.

The temperature of the heat sinks outside of the device can reach over 70℃ in normal operation. There is the risk of burn injury when these parts are touched.

The following general safety precautions must be observed during all phases of operation, service, installation, modification, and repair of this device. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the device. The manufacturer assumes no liability for the customer's failure to comply with these requirements.

2.2 Safety Symbols

To reduce the risk of injury and to ensure the continued safe operation of this product, the following safety instructions and warnings are marked in this manual.



Warning, risk of electric shock
Presents safety information to prevent injury or death to users and/or installers.



Earth ground symbol



Caution (refer to accompanying documents)
Presents information to prevent damage to this product.

2.3 Intended Use

GESOLAR inverters shall be installed according to the safety regulations applied for installations to meet the following qualifications:

- Electrical installation must be carried out correctly to meet the applicable regulations and standards;
- GESOLAR inverters shall be mounted in an enclosed and well ventilated environment to against rain, condensation, moisture and dust;
- GESOLAR inverters shall be able to be permanently installed;
- GESOLAR inverters shall be installed according to the instructions stated in this manual;
- GESOLAR inverters shall operate according to the technical specifications as stated in section 1.2;

2.4 General Safety Precautions

- Personnel must remove all conductive jewelry or personal equipment prior to installation or service of the device, parts, connectors, and/or

wiring.

- Trained qualified personnel are required to mount, operate, correct and/or repair this device.
- Licensed electrician is required to install permanently wired equipment.
- Stand on an insulated surface when working on the operating device (i.e., ensure that there is no grounding).
- Instructions in this manual must be precisely followed and all information on cautions or warnings must be adhered to.
- The list does not contain all measures pertinent to the safe operation of the device. If special problems arise which are not described in sufficient detail for the purposes of the buyer, contact your specialized dealer or technician.
- Use proper lifting tools whenever handling enclosure, equipment or parts.
- The inverter must be provided with an equipment-grounding conductor connected to the AC ground.

2.5 Safe Installation and Operation

- Installation of the device must be in accordance with the safety regulations (Refer the certification lists of 1.2 Specifications). and all other relevant national or local regulations. Correct grounding and over-current protection must be provided to ensure operational safety.
- Read all instructions and cautionary marks in the manual before installation of this device.
- Switch off the circuit breakers before installation and wirings. Never

stand on a wet location when work on installation and wirings.

- Check both of the AC and DC connections with a volt meter prior to any installation or removal procedures.
- Enclose the outer covering well before switch on the circuit breakers.
- Place the inverter in an environment with well ventilation and protection against rain, condensation, moisture and dust.
- Even no external voltage is presented; the GESOLAR inverter can still contain high voltages and the risk of electrical shock. Allow 5 minutes for the inverter to discharge completely after disconnecting the AC and DC sources from the inverter.
- Temperature of the heat sinks outside of the device can reach over 70℃ in normal operation. There is the risk of burn injury when these parts are touched. Pay attention on the high temperature components and sharp edges.
- Allow changes in your electrical system to be carried out only by qualified electricians.

2.6 Repair and Maintenance

The GESOLAR inverter contains no user serviceable parts. Only GESOLAR trained service staffs are authorized to carry out for repairs and maintenance of the unit. Please return the device for repair and maintenance.

3. Installation

3.1 Placement

- GESOLAR inverters may be located indoors or outdoors, according to protection class IP65.
- Avoid mounting the inverter on a location where is directly exposed to rains.
- Leave at least 50 cm of free space above and below the inverter for better ventilation (see Figure 3.1.1).
- Mount the inverter on a wall that shall be firm enough to sustain the inverter with 30Kg in weight.
- Avoid mounting the inverter on a location directly exposed to the sunshine to keep the ambient temperature of the inverter within -20 and 55℃.



WARNING!

Some parts of the cooling surface can reach temperature over 70℃. Keep the flammable and explosive materials an appropriate distance away from the inverter!



WARNING!

Do not expose the inverter to the corrosive liquids and/or gases.

- Humidity shall be within 0% and 95%.
- Keep DC and AC wiring as short as possible to minimize power loss.
- Mount bracket should be fastened on a concrete or a masonry wall

with the accessory anchors.

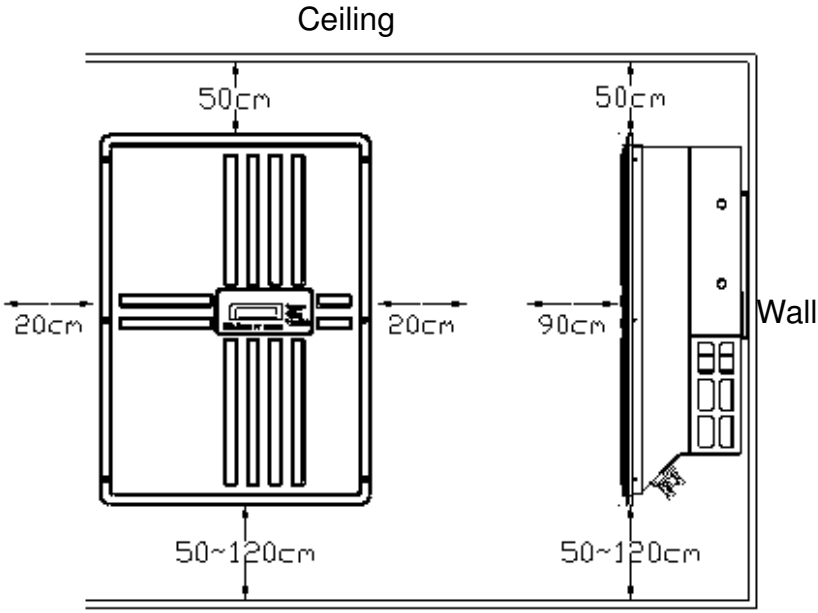


Fig 3.1.1 Clearances required for GESOLAR inverter installation

3.2 Mount

There are five main steps to mount the inverter on the wall:

1. First, loosen the two (2) side screws and take the bracket apart from the inverter as shown in the Figure 3.2.1 below.

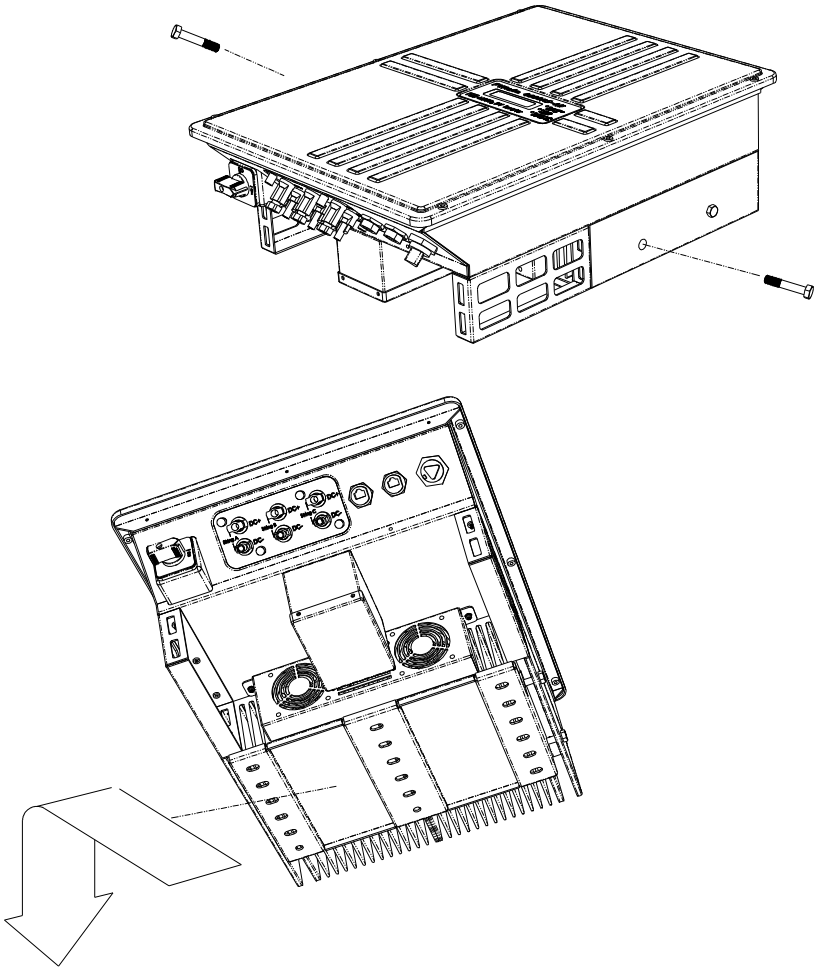


Fig3.2.1 Remove side screws and bracket

2. Use the mount bracket (Fig 3.2.2) as a template to mark the locations where holes shall be drilled. The holes shall be 50 mm depth into the wall with diameter of 8 mm.

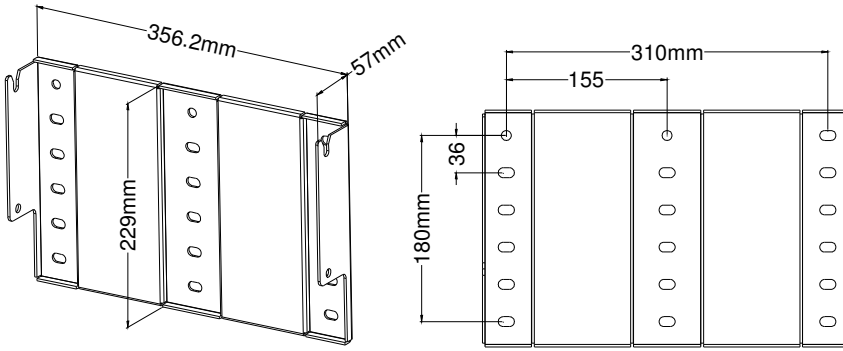


Fig 3.2.2 Mount bracket

3. After drill the holes, the mount bracket is then held against the wall and fastened on the wall with the anchors as shown in Figure 3.2.3.

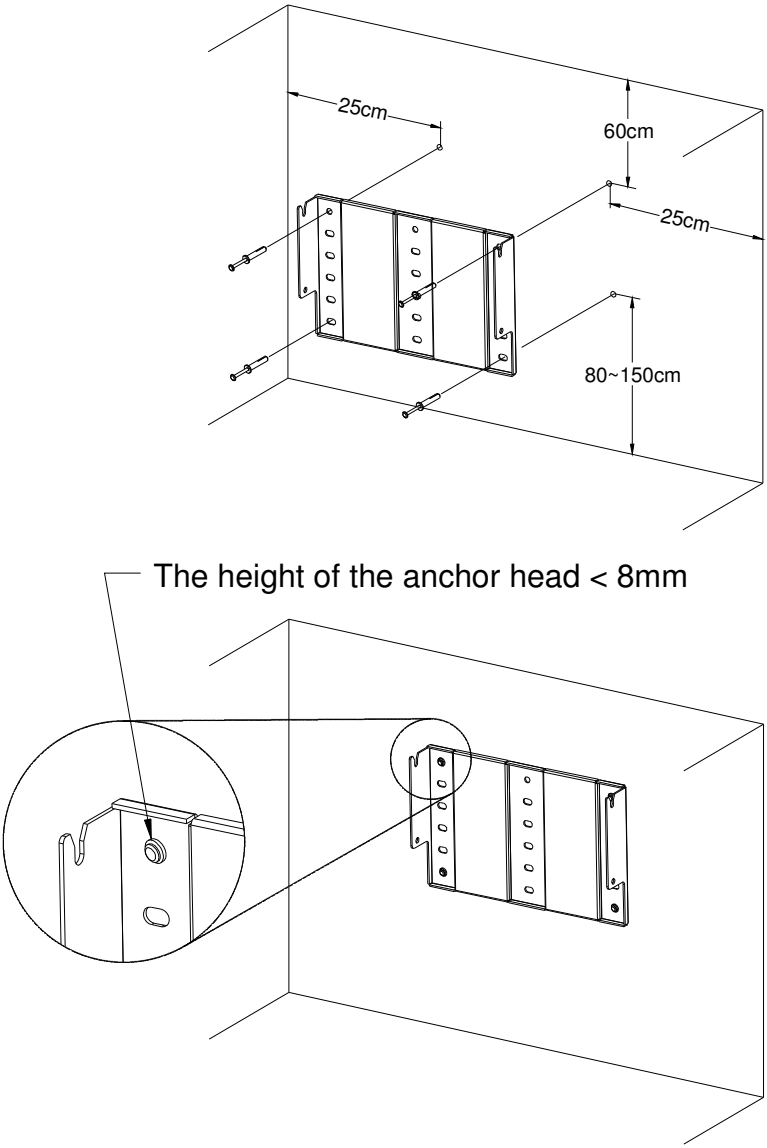


Fig 3.2.3 Fasten the mount bracket

4. Once the mount bracket is fastened, the inverter may be lifted up and hooked onto the bracket as shown in Figure 3.2.4.

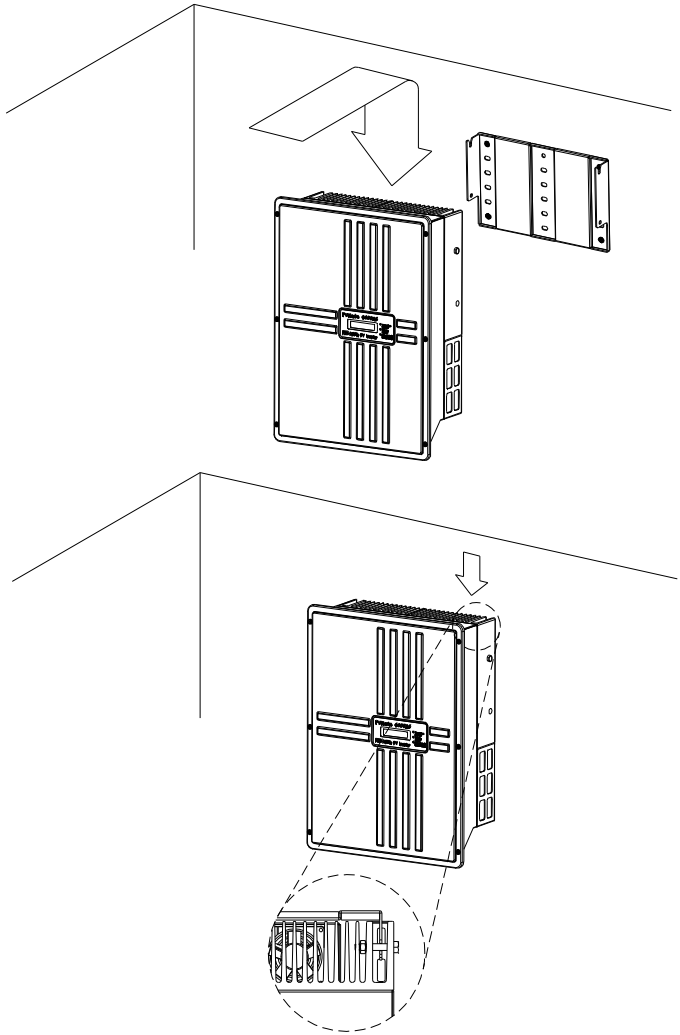


Fig 3.2.4 Hooking inverter onto the bracket

5. After the inverter is hooked on the bracket, it needs to fasten the inverter on the bracket with two side screws (see Figure 3.2.5) to prevent the inverter from pulling away from the bracket.

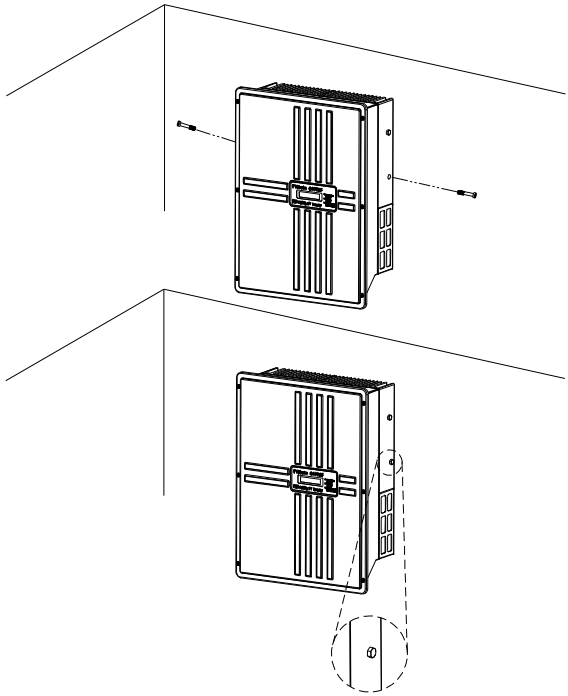


Fig 3.2.5 Fasten the inverter with two side screws

3.3 Wiring the inverter

First of all, the DC disconnect switch must be turned off as shown in Figure 3.3.1 before any installation and wiring work.



WARNING!

Always turn OFF all breakers and switches in the PV system before connecting or disconnecting the inverter to the PV array and the grid!

The following three sections describe the connections of wirings for the AC, DC, and communication ports. GES-4K6TL has three (3) pairs of DC connection terminals, string A, B, and C. GES-3K8TL and GES-3K3TL have only two (2) pairs of DC connection terminals, string A and C. All four models have two (2) RJ-45 connectors, and one (1) AC connection terminal on the bottom of the inverter shown in the Figure 3.3.1 and Figure 3.3.2. DC connection terminals are used to connect to PV strings through circuit breakers that shall be placed close to the inverter. RJ-45 connectors are used for external communication to a remote computer or terminal. AC connection terminal is used to connect to the mains utility through a circuit breaker that shall be closed to the distribution panel. Each pair of the DC connection terminals shall be connected to one PV string within the maximum rating listed in section 1.2. It is recommended to supply 350 VDC to each string although the MPP voltage range is within 100 and 450 VDC.

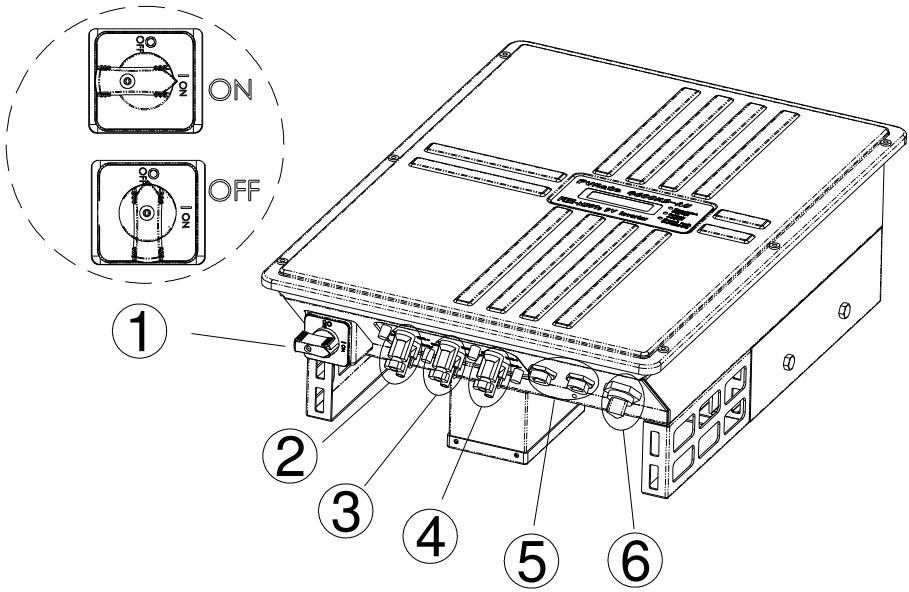


Fig 3.3.1 Wiring compartment front view

① DC disconnect switch

② String A

③ String B

④ String C

⑤ Communication ports

⑥ AC output plug

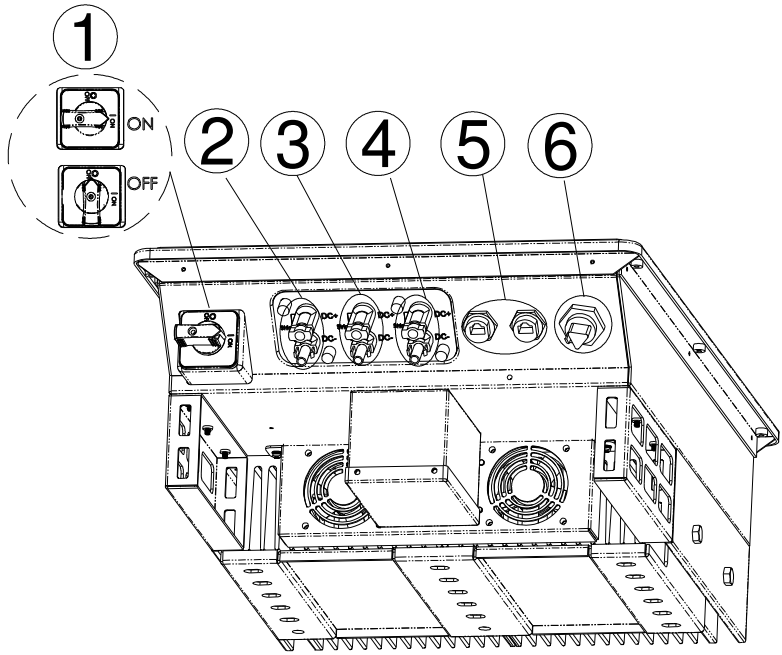


Fig 3.3.2 Wiring compartment bottom view

① DC disconnect switch

② String A

③ String B

④ String C

⑤ Communication ports

⑥ AC output plug

WARNING!

All electrical work shall be done in accordance with the local and national electrical codes and should follow the important safety instructions in this manual.



WARNING!

Make sure that you use suitable connecting cables for both the AC and DC wirings. The cable must be adequately dimensioned and suitably inert to temperature fluctuation, UV radiation and other possible hazards.

3.3.1 Connection of the AC cable

- Open the Fuse Box and switch off the circuit breaker used to connect the inverter to the grid.



WARNING!

Reconfirm that the circuit breaker to the main utility is switched OFF before connect the power cable from the breaker to the AC connector.

- Use the AC connector that was included in the shipping package to connect the AC power cable as illustrated in the Figure 3.3.1.1 below.

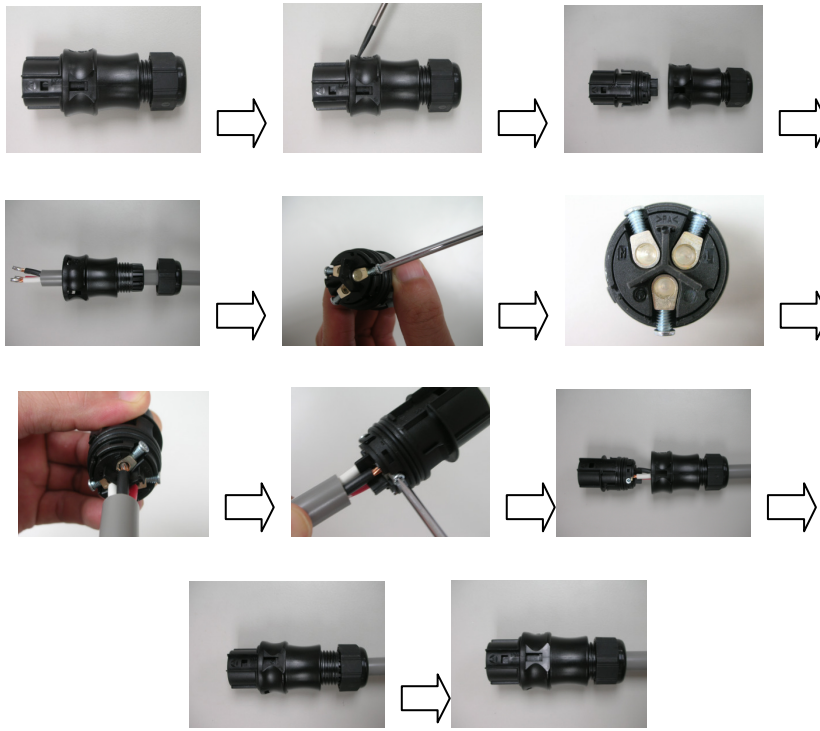


Fig 3.3.1.1 Assembly of the AC cable and the AC connector

CAUTION!

To ensure that the total impedance of the grid plus the interconnection AC power cable shall be less than 1.25Ω.

- The AC connector is suitable for cables with a cross-section of up to 4 mm^2**.**
- Connect the cable GND to the screw labeled ⏚ of the AC connector.

- Connect the cable N to the screw labeled N of the AC connector.
- Connect the cable L to the screw labeled L of the AC connector.
- Tighten the screws with a torque of 0.9Nm.



WARNING!

Each connection to a GESOLAR inverter must be installed with a separate circuit breaker. No other appliances may be connected to the circuit breaker.

- Reconfirm that all connections have been performed properly as described above and all screws are properly tightened.
- Plug the AC connector into the AC terminal to complete AC cable connection for the inverter.

3.3.2 Connection of the DC cable

There are three models of the GESOLAR inverters. The GES-4K6TL is designed to support up to three (3) independent PV strings, string A, B, and C. GES-3K8TL and GES-3K3TL are made to support up to two (2) PV strings, string A and C.

Each PV string shall provide a DC input voltage with maximum power of 4500W and maximum current of 10A. There are two (2) terminals, labeled “+” and “-”, per DC voltage input located on the bottom of the inverter used for the DC cable connections, shown in Figure 3.3.2.1, Figure 3.3.2.2, Figure 3.3.2.3.

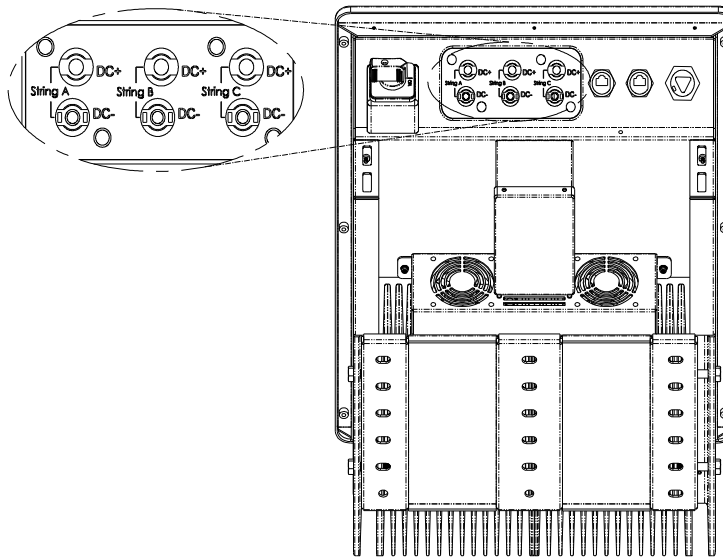


Fig 3.3.2.1 DC terminals for DC cable connection

(GES-4K6TL has string A/B/C, GES-3K8TL/3K3TL have string A/C)

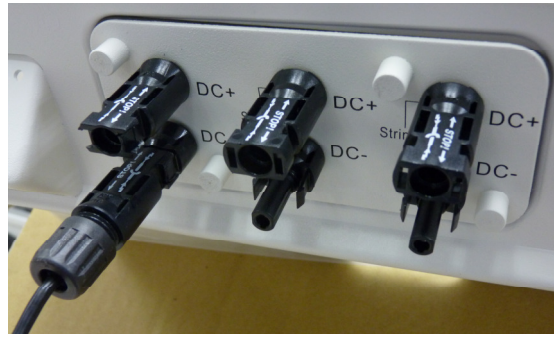


Fig 3.3.2.2 PV ”-“ terminal connection



Fig 3.3.2.3 PV "+" terminal connection

CAUTION!

Polarities of each DC input voltage from a PV string shall be precisely correctly connected to the "+" (positive) and "–" (negative) terminals of a pair respectively. The DC voltage must be less than 500V in any condition.

- The positive "+" cable of the DC input voltage shall be connected to the terminal labeled positive "+" and the negative "-" cable of the DC input voltage shall be connected to the terminal labeled negative "-".

WARNING!

Route the DC connection cables to the GESOLAR inverters away from any possible hazards that could damage the cables.

WARNING!

Hazardous voltage is still present on the device after disconnection of all PV DC inputs. Allow 5 minutes for the

inverter to discharge the energy completely.

3.3.3 Connection of the Communication cable

The GESOLAR inverter supports two common data interface standards, RS-232 and RS-485 that will be used to communicate to the remote computer or terminal. Only one of the communication interfaces can work at a time. The default setting is shown in the Figure 3.3.3.1.

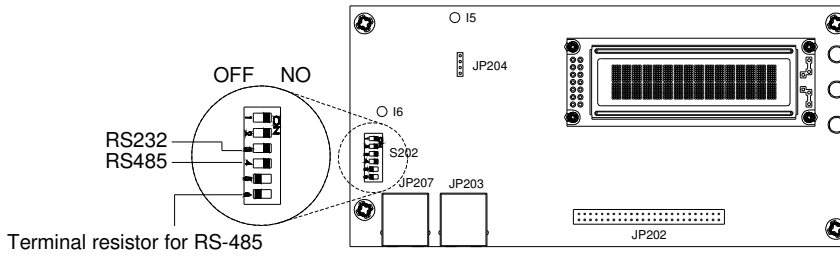


Fig 3.3.3.1 Communication default setting

As shown in the Figure 3.3.3.2 below, there are two RJ-45 connectors (RJ45-L and RJ45-R) located on the bottom of the inverter and respectively connected to JP207 and JP203 through two communication cables which are routed away from the common mode choke within the enclosure. The insulation voltage of the cables shall be more than 500 VDC.

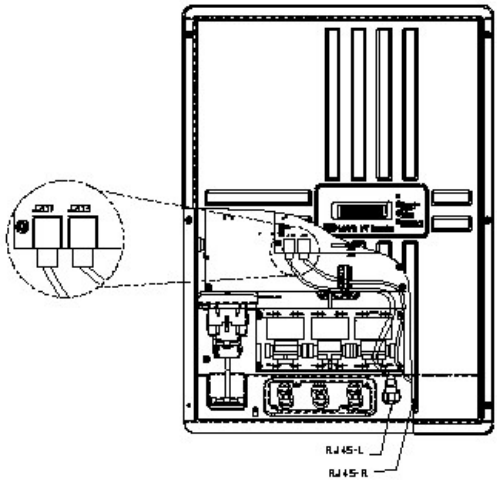


Fig 3.3.3.2 Communication cable inside the tube

The pin numbers of the RJ-45L and RJ-45R connectors and the corresponding signals are described in the Figure 3.3.3.3 below. The RS-232 signal pins, TXD and RXD, are only on the RJ45-L. Therefore, only the RJ45-L can be used to connect to one remote PC or terminal when the RS-232 interface is used. The cable with the part number of WABG-0918S, which is 180 cm (70.9 inches) in length, is dedicated for the RS-232 communications between GESOLAR inverter and a computer. Its wire connection between RJ45 and RS-232 is shown in the Figure 3.3.3.4.

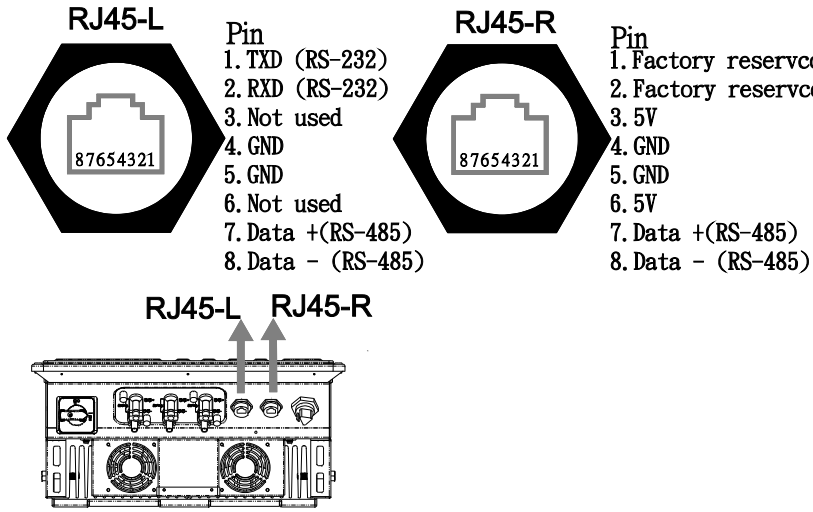


Fig 3.3.3.3 RJ-45 Pins and Signals

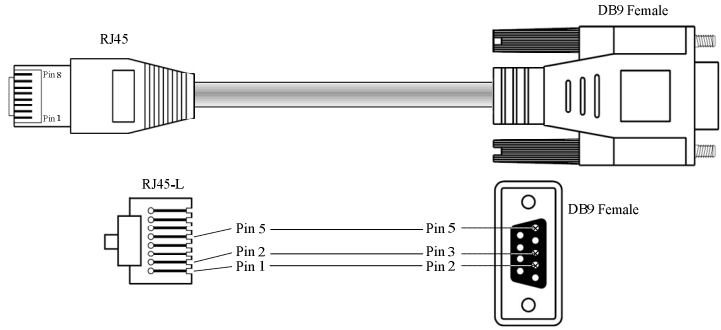


Fig 3.3.3.4 RS-232 connection

If the RS-485 interface is used as the external communication interface, both RJ-45 connectors will be used for the cascaded RS-485 connections as shown in the Figure 3.3.3.5. If the inverter is the last device within the RS-485 loop, then the termination resistor switch shall be put to ON position (shown in the Figure 3.3.3.5). Users shall open the front lid of the

wiring box to switch the termination resistor switch to ON position. The termination switch is default set to OFF position.

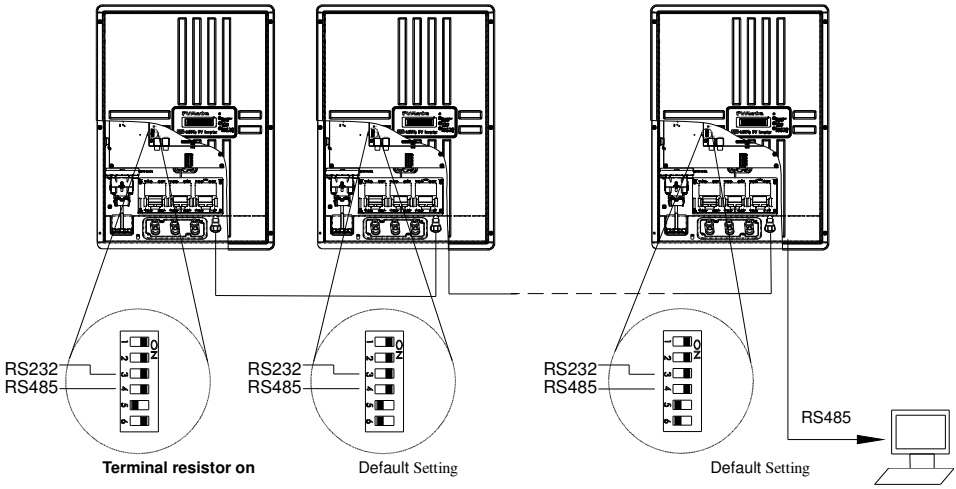


Fig 3.3.3.5 RS-485 connection

There are two waterproof RJ-45 plugs attached to the inverter. The assembly of the plug is shown in the Figure 3.3.3.6 and the pin numbers are shown in the Figure 3.3.3.7.

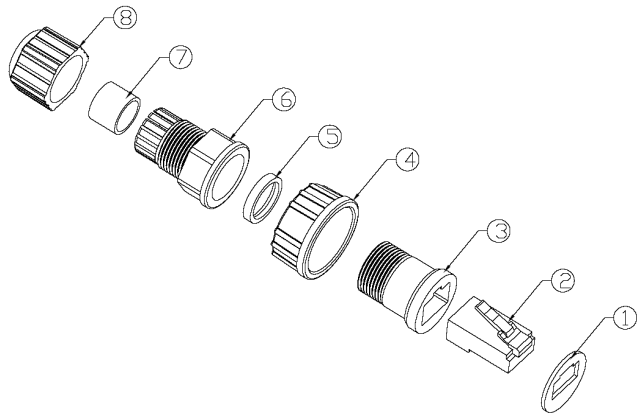


Fig 3.3.3.6 Assembly of the waterproof RJ-45 plug

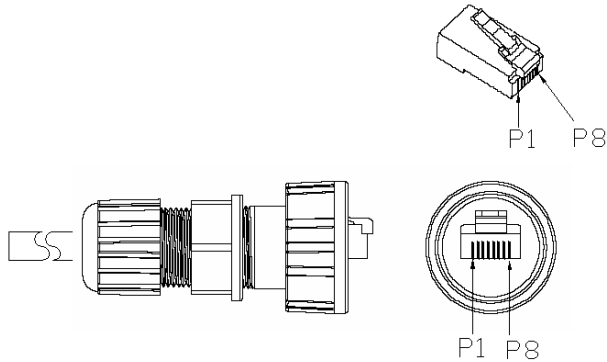


Fig 3.3.3.7 Pin number of the Waterproof RJ-45 plug

3.4 Wiring inverter in parallel

GESOLAR inverters can be connected in parallel when more power is

requested. In the parallel configuration, each inverter shall connect to its own PV array. It is not recommended to connect one PV array to more than one inverter. This may cause the inverter to work abnormally. The Figure 3.4.1 below shows the connections between inverters and PV arrays in parallel configuration.

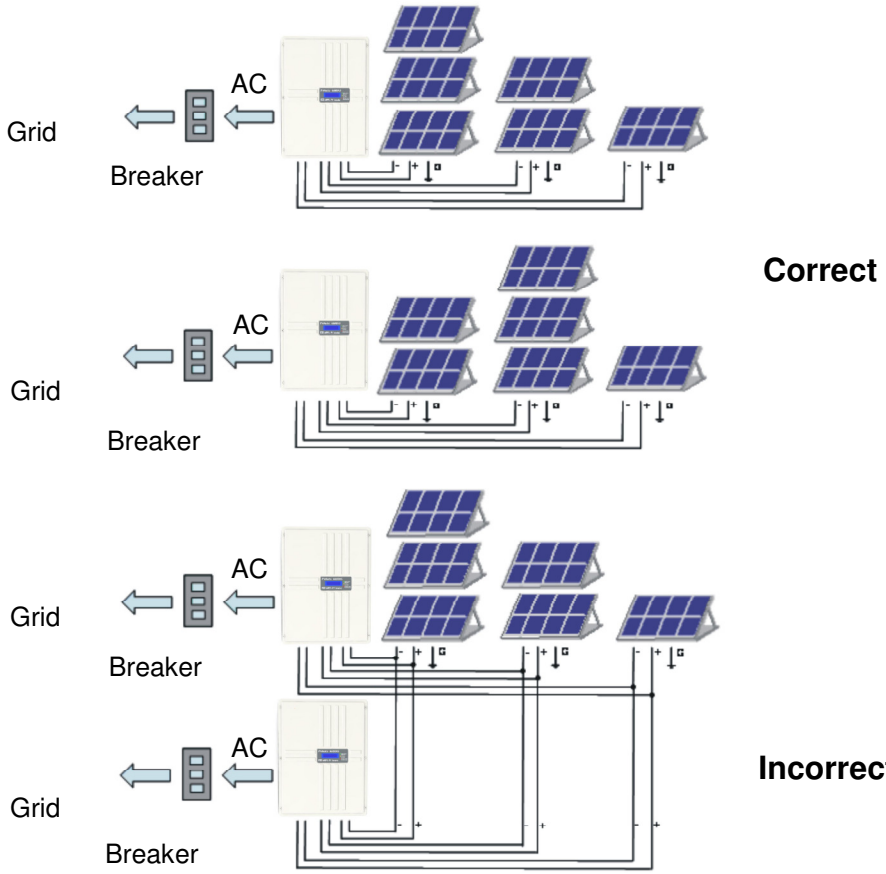


Fig 3.4.1 Parallel configuration of inverter

4. Operation

4.1 Overview

The GESOLAR inverter shall operate automatically. Once the solar radiation is strong enough to make the PV array generate DC input voltage that goes up and over the pre-set threshold value, the inverter turns itself on and feeds power into the mains after all necessary conditions are checked and fulfilled. The inverter goes into Monitoring mode from the Grid/MPP mode if the DC input voltage is under the minimum MPP voltage but above the pre-set threshold value. Once the DC input voltage falls below the pre-set threshold value, the inverter will shut down itself. There are five main operating modes described in detail below.

System Check : When the DC input voltage goes above the PV start voltage, the inverter is powered-up, and enters the System Check mode. In this operating mode, the inverter sets the initial values, runs diagnostic, and detects all parameters that will be stored for future use. This stage takes only a few seconds.

Monitoring : After System Check is done the inverter enters the monitoring mode. In this operating mode, the inverter monitors all parameters on both AC and DC sides in order to insure that connecting to the mains is safe. All conditions must be fulfilled and last for a certain period

of time, then the system will enter the Grid/MPP mode. It takes reconnect delay to complete the monitoring mode. If any parameter except the DC input voltage that is under the threshold value does not meet the criteria, the inverter goes to Fault mode.

Grid/MPP **:** After the monitoring mode, the GESOLAR inverter confirms that all conditions necessary for feeding the power into the mains utility are fulfilled. The inverter will turn on the AC relays and start feeding the AC power into the mains. In this operating mode, the inverter continues to convert the DC power generated by the PV array to the AC power that is then fed into the grid. The inverter may stop feeding the power and go back to monitoring mode once any condition for grid feeding mode is found not fulfilled.

Fault **:** When fault(s) occurs and been detected in the operating mode described above, the inverter will terminate the present state, stop feeding power to the grid, and then jump into the Fault mode that executes preset sequence. When the faults have been cleared for certain period of time, the inverter will leave Fault mode and enter System Check mode. Some faults, like component failure, will cause the inverter go into the Idle mode that will need service staff to clean the errors.

Idle : Once the inverter jumps into this operating mode, the inverter has detected a malfunction and has stopped feeding the power to the grid for safety reason. Normally this is a failure that cannot be removed on field. It needs service personnel coming to remove the problems and put the system back to operation.

4.2 Operation Feature

MPPTs:

Through the MPPTs (Maximum Power Point Trackers) feature, GESOLAR inverters may manage the PV strings in either the independent mode or the master/slave mode or both. The inverter is designed to support up to three independent PV strings. If each PV string is exposed and obtains the sun light enough to generate DC power and the DC voltages are different, then it is prefer to select independent mode that each PV string is tracked by its own MPPT. If any two or all three PV strings may be able to get same intensity of the sunshine and generate the same DC voltage, users can then, through the internal jumper (see Figure 4.2.1), select the Master/Slave mode that any two PV or all three PV strings can be connected in parallel internally. Through this feature, users can obtain a better efficient way of utilizing the solar energy during the weak sunshine. As shown in the Figure 4.2.1, if a jumper is placed between string A and B, the PV string A and B will be connected in parallel internally. If all three PV strings are requested to connect in parallel, it needs two jumpers that shall be placed between A and B as well as B and

C. For the models of GES-3K8TL and GES-3K3TL, there are only two (2) strings, string A and C, supported. Two jumpers, placed between A and B as well as B and C, are needed to put string A and C if parallel. There are two jumpers come with the inverter.

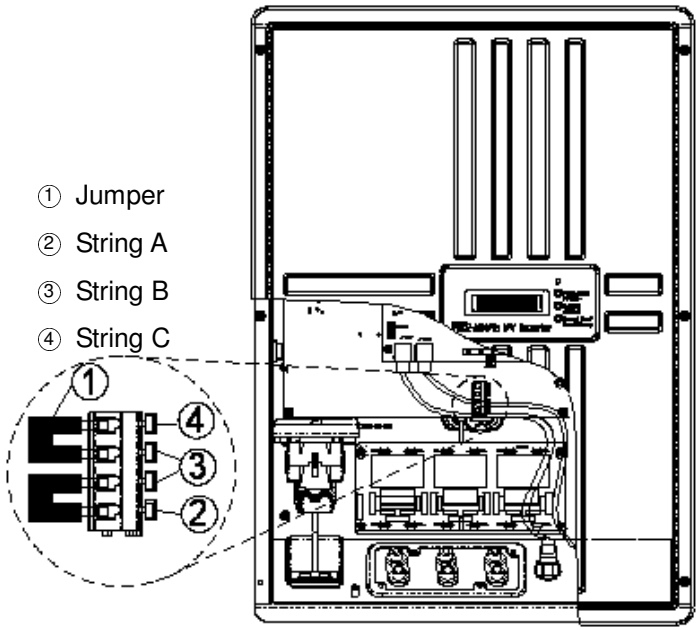


Fig 4.2.1 Master/Slave Mode Wirings

Anti-Island:

When an “island” condition is detected, the inverter will stop feeding the power to the grid and/or the load. The “island” is defined as a grid tied inverter maintaining operation and feeding power to a load that has been isolated from the utility power source. This refers to the automatic

shutdown of the inverter when there is an electrical disturbance on the utility grid. This is a safety feature which is primarily meant to prevent staffs who might be working on the grid wires from the electrical shock.

Unit Power Factor:

The GESOLAR inverter intents to feed the power with unit power factor (PF=1) to the utility during operation. The inverter continues sensing the phase of the utility voltage, and constructs the output current waveform in phase with the utility voltage.

Maximum Power Point Tracking:

In order to find the best efficient way of utilizing the solar energy, GESOLAR inverters are designed to track and absorb the maximum power from the PV array. The Maximum Power Point Tracking (MPPT) function is employed in the embedded control software to achieve this intent purpose.

4.3 LED indication

It may be needed to show the operating status during the operation. There are three LED's on the front panel of the GESOLAR inverter shown in Figure 4.3.1, used to indicate the operating status of the inverter. The detail explanations of the status and the corresponding LED indicators are described in the following table.



Fig 4.3.1 Front panel of the GESOLAR inverter

LED Indication Table

LED indicators		Operating status	On Grid	Description
Green Yellow Red	☼ ☼ ☼	Initialization	N	The GESOLAR inverter is in initial mode.
Green Yellow Red	☼ ● ●	System Check mode	N	The inverter is in System Check mode.
Green Yellow Red	☼ ● ●	Monitoring mode	N	The inverter is in Monitoring mode.
Green Yellow Red	○ ● ●	Grid/MPP mode	Y	The inverter is in Grid/MPP mode.
Green Yellow Red	☼ × ●	Power De-rating	Y	Power de-rating is performed.
Green Yellow Red	× ☼ ●	Warning	Y	Warning is detected.
Green Yellow Red	☼ ● ●	1.Low Insolation 2.Vac high	N	1.The inverter is in low insolation. 2.Vac is higher than the voltage quality monitoring setting.
Green Yellow Red	☼ ● ●	No AC connection	N	The inverter has no AC connection or the AC source is out of range.
Green Yellow Red	● ○ ×	Fault mode	N	The inverter is in Fault mode.
Green Yellow Red	× × ○	Ground Fault	N	Ground fault detected.
Green Yellow Red	○ ○ ×	Idle mode	N	The inverter is in Idle mode.
Green Yellow Red	● ● ●	Night Time	N	There is no DC power coming from PV array. System is powered off.

○ : LED ON ☼ : LED ON / OFF 0.1 / 0.9 Sec
● : LED OFF ☼ : LED ON / OFF 0.9 / 0.1 Sec
× : DON'T CARE ☼ : LED ON / OFF 0.25 / 0.25 Sec

4.4 LCD display

The GESOLAR inverter has a 16 x 2 LCD to show the operating status, input/output data, and error messages. As long as the DC input voltage is above the minimum MPP voltage, the LCD keeps display the information follow the process flow illustrated in the Figure 4.4.1.

The process flow could be the regular procedure, fault procedure, and idle procedure. The regular procedure is that the system goes from Initial, System Check, Monitoring, and then Grid/MPP mode without any fault condition detected. The inverter is expected to work in the regular procedure and feed the power to the grid. During the System Check and Monitoring mode and a fault condition that could be cleared automatically is detected then the system will go into the fault procedure. The system will return to regular procedure once the fault condition is cleared. One obvious example is that an “island” condition is detected due to the grid failure and later the fault condition is cleared when the power is recovery. If a fault occurs that does not clear on its own then the system will enter the idle procedure which needs a service staff to clean the fault and reset the system. These three procedures are illustrated in the Figure 4.4.1.

The following Figures explain how the display works for the regular procedure.

Initial Mode:

When the DC input voltage rises above the pre-set threshold value, the GESOLAR inverter is powered up and will show the company name and model name (GES-4K6TL in this example) on the LCD as shown below.

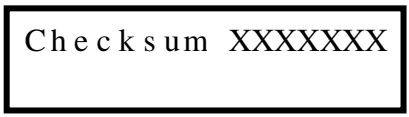


3 seconds ↓

After 3 seconds, software versions of two embedded CPU's, Sequential (SEQ) and Current (CUR) controllers, and the checksum will be displayed on the LCD. Afterward the serial number (S/N) the address for the communication port will be displayed.



3 seconds ↓



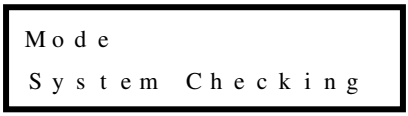
3 seconds



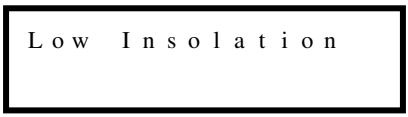
3 seconds ↓

System Check Mode:

After the basic information of the inverter is displayed, the system enters the System Check mode that is then indicated on the LCD.



During the System Check, if the DC input voltage is not reaching the point of the PV start voltage setting, then the following message will be shown on the LCD and the system will stay at this step.



During the System Check, if the grid is not connected to the inverter, then the inverter enters to Fault mode and following message will be shown on the LCD.



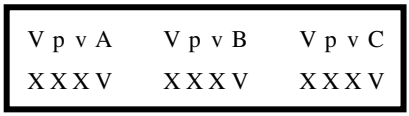
Monitoring Mode:

Once the System check is done, the inverter goes into the Monitoring mode. If all data needed for grid feeding is in the acceptable range, the system will keep monitoring those data for a period of time. The following information tells users that the system will go into the Grid/MPP mode in

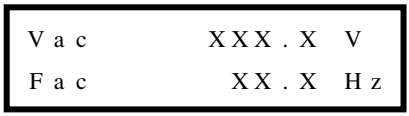
XXX seconds and then show the measured data of the three DC input voltages and the existing voltage and frequency on the grid side.



3 seconds ↓

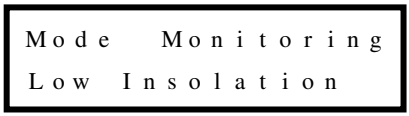


3 seconds ↓

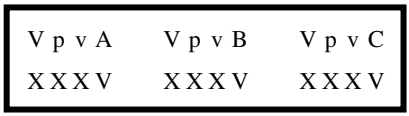


3 seconds ↓

During the Monitoring mode, if DC input voltages fall under the PV start voltage setting, the system stays in this mode and shows the information as follows. The system will still keep measuring the parameters of both DC and AC and display on the LCD.



3 seconds ↓



3 seconds ↓

Vac	XXX.X V
Fac	XX.X Hz

3 seconds ↓

Grid/MPP Mode:

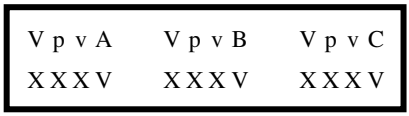
After the system enters the Grid/MPP mode, it will show the following information in order and repeatedly until the system goes to other operating mode.

The first screen shows the current operation mode.

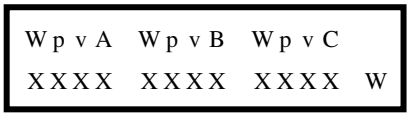
Mode
Grid/MPP

3 seconds ↓

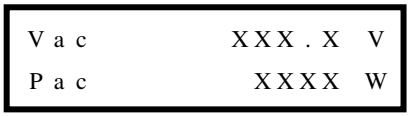
Next messages are the up-to-minute data of the input / output voltage and power. First two messages are for the PV arrays and the other two messages are for the output. VpvA, VpvB, and VpvC are the incoming voltages from PV array A, B and C. WpvA, WpvB, and WpvC are the incoming power of PV array A, B, and C in watts. Vac, Pac Iac, and Fac are the voltage, power, current, and frequency that the inverter feeds to the grid.



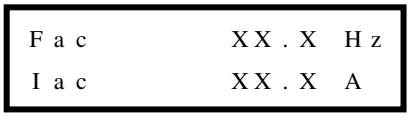
3 seconds ↓



3 seconds ↓

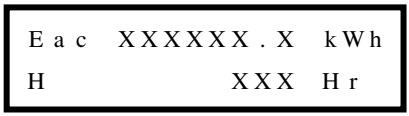


3 seconds ↓



3 seconds ↓

The next message shows the cumulated energy in kWh and period of time in hours for the inverter delivering the power to the grid up-to-date since the inverter has been installed and operated.

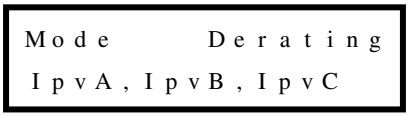


3 seconds ↓

Power De-Rating Message:

There are five possible de-rating displays which will be shown if power de-rating is detected in Grid/MPP mode. Only one occasion that causes de-rating could be detected at a time. Therefore, only one of the following messages will be displayed if power de-rating occurs. When Temp message is presented, the power de-rating is caused by the over temperature. The IpvA, IpvB, and/or IpvC message shows that the power de-rating is caused by restricting the DC input current to the maximum limit which is 10A per each PV string. The Iac and Pac messages illustrate the power de-rating is caused due to restriction of the maximum output AC current and power. The VacH message shows that the power de-rating is caused by the high AC voltage.





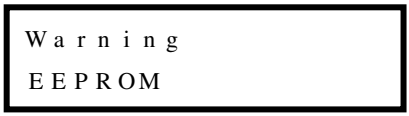


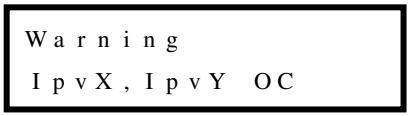


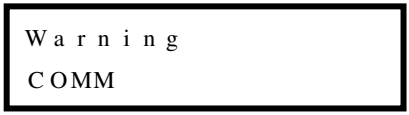


Warning Message:

There are three possible warning messages could be shown when situations occur in grid feeding mode. When EEPROM message displayed, the system has encountered a failure access to the EEPROM. If over current has been detected on one and/or two DC input sources, IpvX and/or IpvY OC message will be presented, where X and Y could be string A, B, or C. For the COMM message, it represents failure of the communication function. These warnings could be happening simultaneously.







Fault Mode:

The messages for the fault procedure are as follows. It shows the fault mode, serial number of the inverter, software versions of the sequential (SEQ) and current (CUR) controllers and then the error messages which

are listed in the Error Message Table on section 4.7.







Idle Mode:

The messages for the Idle mode are as follows. It shows the operating mode, serial number of the inverter, software versions of the sequential (SEQ) and current (CUR) controllers and then the error messages which are listed in the Error Message Table on section 4.7.







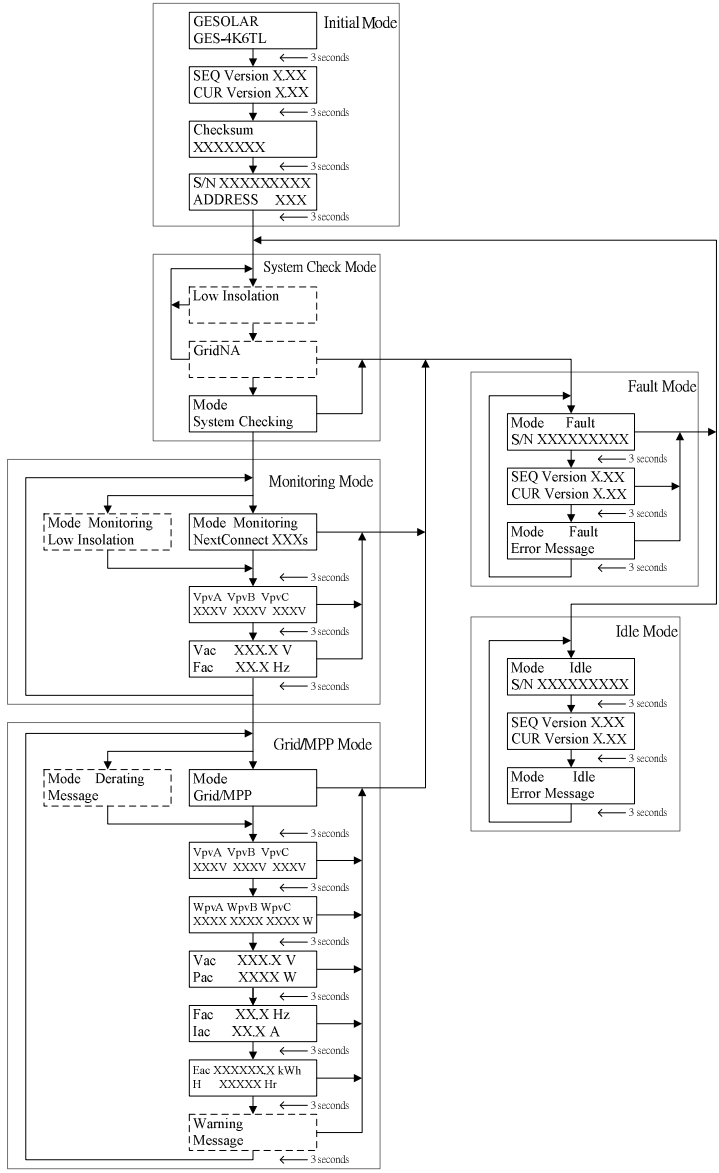


Fig 4.4.1 GESOLAR inverter LCD display lay-out

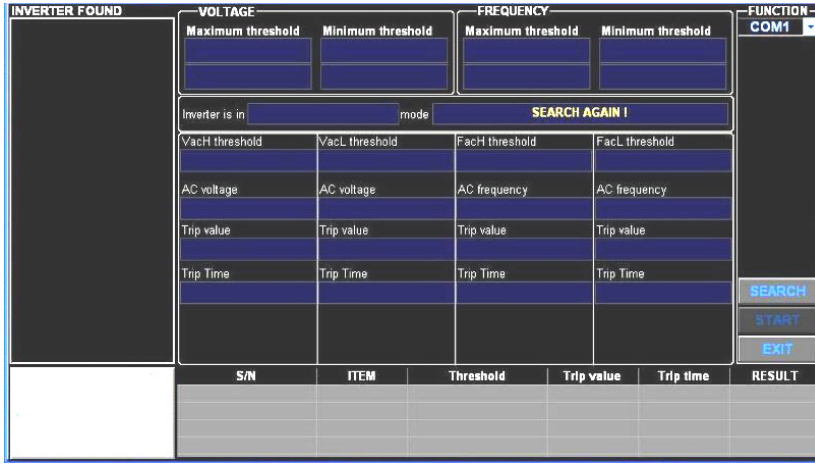
4.5 Auto Test

This Auto Test function is stipulated in accordance with the Italian Standard ENEL 2010. It enables verification of the voltage and frequency monitoring function. The Auto Testing software as an accessory provided with the inverter should be installed on a PC connected up the inverter through the RS-485 (or RS-232) port. Once the software is installed successfully, there is an execution file “GESOLAR Inverter Auto Test” created in the “Start\Programs menu”.

For the overall duration of this auto-test, the inverter never exports power to the AC grid. To begin with, the relays will close to conduct the max AC voltage threshold test as one of parts in auto-tests. Afterward the relays will open if this max AC voltage test is completed. Also, those remaining parts in auto-tests will repeat in this way in order to check the whole function and responses in case of fault condition. The Auto Test functionality and procedure is described as follows.

Double click the “GESOLAR Inverter Auto Test” and the software will search for all well-connected inverters with the PC.

NOTE: On the screen it appears **“search again”** warning in case the inverter fails found. Please confirm the correctness of communication and then click the “SEARCH” button for one more try.



It shows the serial number and the status of the inverter when communicated successfully. Whichever the preceding mode it is, clicking the "**START**" button is going to turn the inverter into the "Monitoring mode" automatically.



Choose one inverter to run the Auto Test by highlight its serial number if more than one inverter is found. And then click the "**START**" button to start the Auto Test, which performs in order,

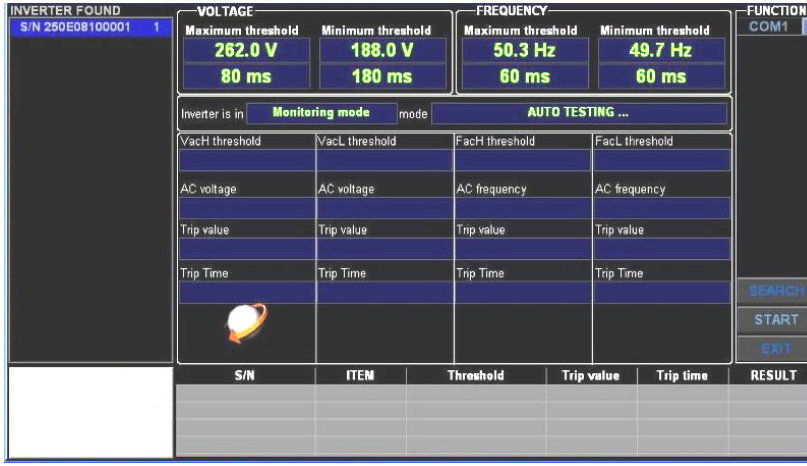
a. Maximum AC voltage threshold
b. Minimum AC voltage threshold
c. Maximum AC frequency threshold
d. Minimum AC frequency threshold

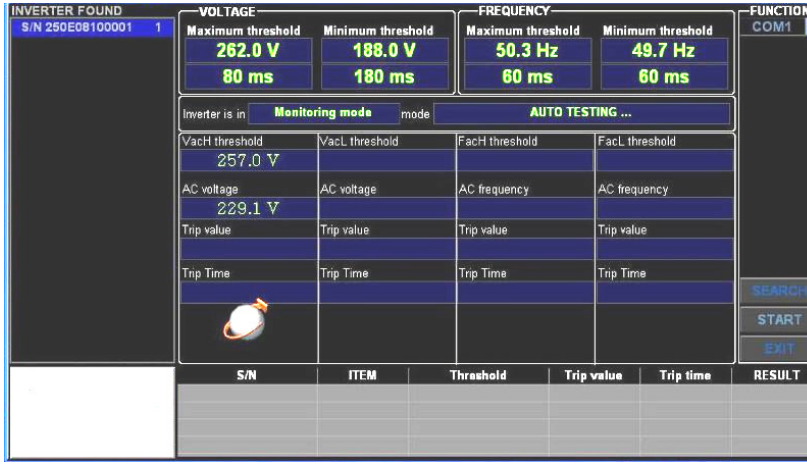
The standard threshold values and the trip time related to the specified sub test will be displayed on the PC screen before the Auto Test.

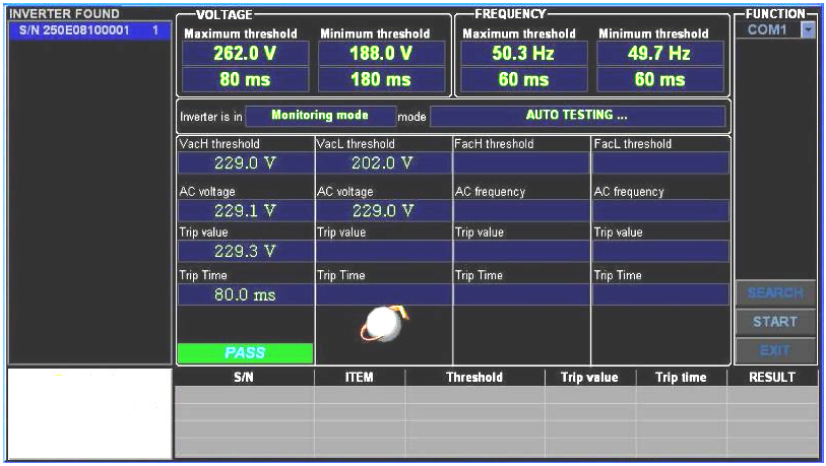
a. Maximum AC voltage threshold: 262 V; < 0.1 s
b. Minimum AC voltage threshold: 188 V; < 0.2 s
c. Maximum AC frequency threshold: 50.3 Hz; ≤ 0.06 s
d. Minimum AC frequency threshold: 49.7 Hz; ≤ 0.06 s

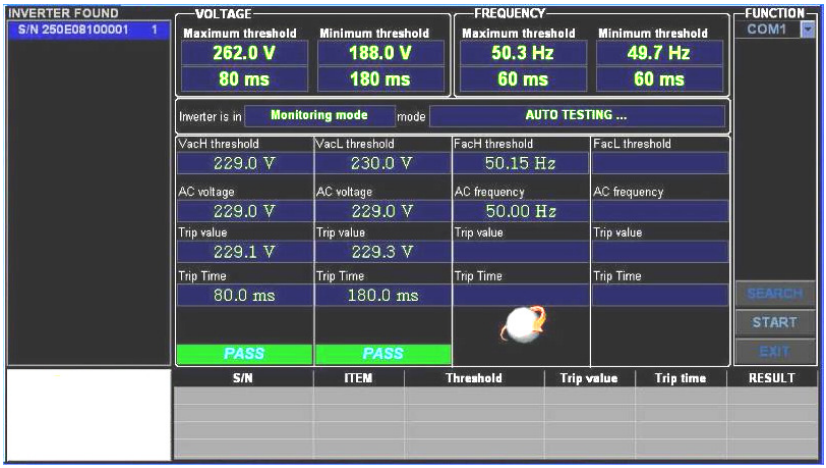
The slew rate of the threshold values, either increase or decrease, are ≤ 0.05 Hz/s for frequency and ≤ 1 V/s for voltage starting from the maximum (or minimum) threshold value. During the Auto Test the threshold value changes linearly and the measured values of the AC grid will be displayed on the PC screen.

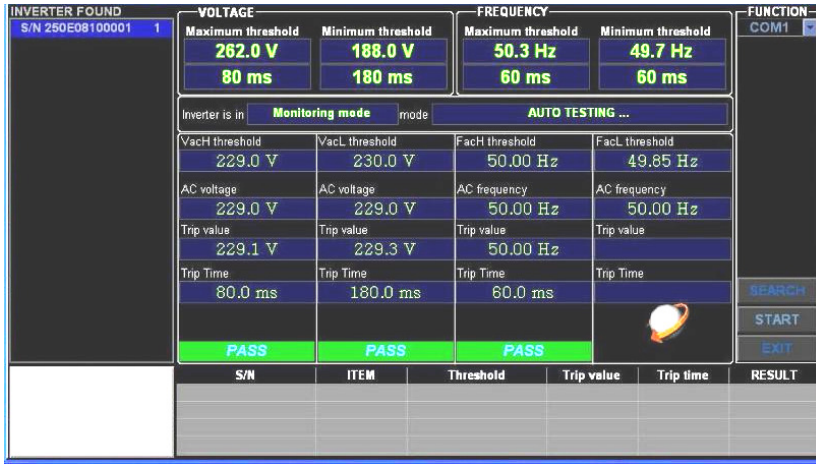
The threshold will move from the maximum (or minimum) threshold value toward the measured value of the AC grid. While this match occurs the inverter will disconnect the AC line and recognize if it disconnects.

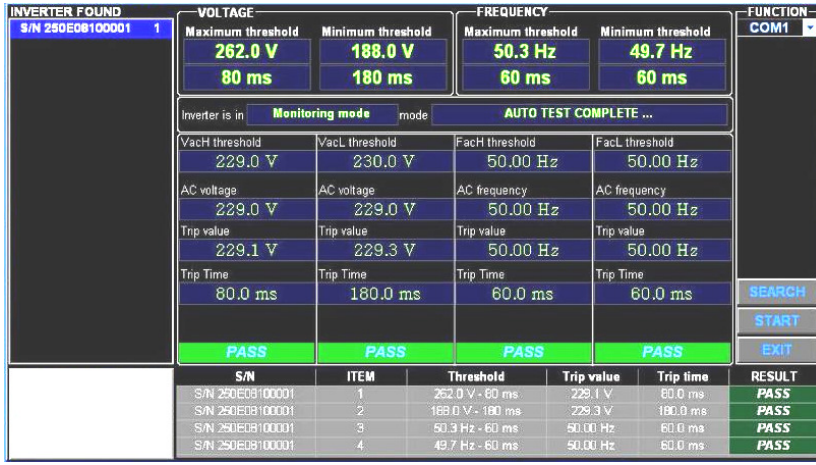

INVERTER FOUND
S/N 250E08100001 1
VOLTAGE
Maximum threshold
Minimum threshold
262.0 V
188.0 V
80 ms
180 ms
FREQUENCY
Maximum threshold
Minimum threshold
50.3 Hz
49.7 Hz
60 ms
60 ms
FUNCTION
COM1
Inverter is in
Monitoring mode
mode
AUTO TESTING ...
VacH threshold
VacL threshold
FacH threshold
FacL threshold
AC voltage
AC voltage
AC frequency
AC frequency
Trip value
Trip value
Trip value
Trip value
Trip Time
Trip Time
Trip Time
Trip Time
SEARCH
START
EXIT
S/N
ITEM
Threshold
Trip value
Trip time
RESULT


INVERTER FOUND
S/N 250E08100001 1
VOLTAGE
Maximum threshold
Minimum threshold
262.0 V
188.0 V
80 ms
180 ms
FREQUENCY
Maximum threshold
Minimum threshold
50.3 Hz
49.7 Hz
60 ms
60 ms
FUNCTION
COM1
Inverter is in
Monitoring mode
mode
AUTO TESTING ...
VacH threshold
257.0 V
VacL threshold
FacH threshold
FacL threshold
AC voltage
229.1 V
AC voltage
AC frequency
AC frequency
Trip value
Trip value
Trip value
Trip value
Trip Time
Trip Time
Trip Time
Trip Time
SEARCH
START
EXIT
S/N
ITEM
Threshold
Trip value
Trip time
RESULT

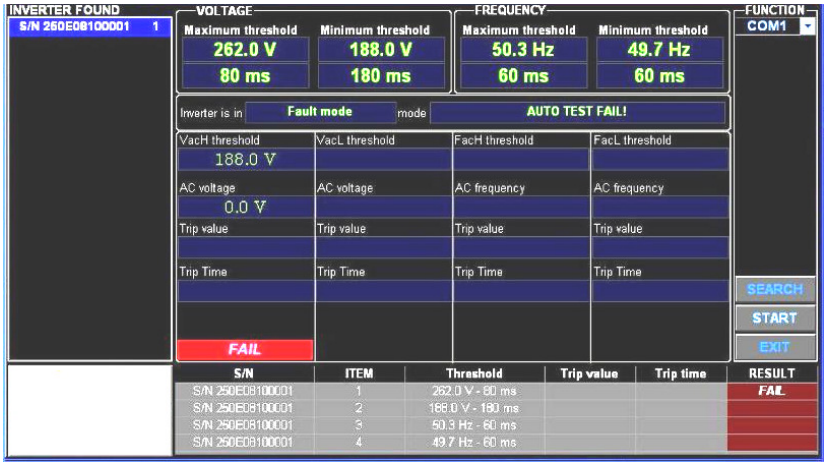

INVERTER FOUND
S/N 250E08100001 1
VOLTAGE
Maximum threshold
262.0 V
80 ms
Minimum threshold
188.0 V
180 ms
FREQUENCY
Maximum threshold
50.3 Hz
60 ms
Minimum threshold
49.7 Hz
60 ms
FUNCTION
COM1
Inverter is in
Monitoring mode
mode
AUTO TESTING ...
VacH threshold
229.0 V
VacL threshold
202.0 V
FacH threshold
FacL threshold
AC voltage
229.1 V
AC voltage
229.0 V
AC frequency
AC frequency
Trip value
229.3 V
Trip value
Trip value
Trip value
Trip Time
80.0 ms
Trip Time
Trip Time
Trip Time
SEARCH
START
EXIT
PASS
S/N
ITEM
Threshold
Trip value
Trip time
RESULT


INVERTER FOUND
S/N 250E08100001 1
VOLTAGE
Maximum threshold
262.0 V
80 ms
Minimum threshold
188.0 V
180 ms
FREQUENCY
Maximum threshold
50.3 Hz
60 ms
Minimum threshold
49.7 Hz
60 ms
FUNCTION
COM1
Inverter is in
Monitoring mode
mode
AUTO TESTING ...
VacH threshold
229.0 V
VacL threshold
230.0 V
FacH threshold
50.15 Hz
FacL threshold
AC voltage
229.0 V
AC voltage
229.0 V
AC frequency
50.00 Hz
AC frequency
Trip value
229.1 V
Trip value
229.3 V
Trip value
Trip value
Trip Time
80.0 ms
Trip Time
180.0 ms
Trip Time
Trip Time
SEARCH
START
EXIT
PASS
PASS
S/N
ITEM
Threshold
Trip value
Trip time
RESULT





Once a sub test fails, the inverter will turn “Monitoring mode” into “Fault mode” and stop the test until the “**START**” button is clicked to restart again. If a sub test passes, the inverter will continue the remaining sub tests automatically after 5 seconds.



When the inverter is under Auto Test, the following message will be shown on the LCD.



NOTE: If the Auto Test fails, the inverter will go into “Fault mode” and the error message will display on the LCD shown below.



4.6 Communication

There are two types of communication methods, RS232 and RS-485

supported in GESOLAR inverters that may be connected to the external computer or terminal equipped with RS-232 and/or RS-485. Only one type of the communication can be used at a time. The GESOLAR inverter will automatically switch to RS-232 or RS-485 depends on the external communication interfaces without manual setting. For the RS-485 interface, it allows multiple inverters that can be connected to an external computer. It allows only one inverter to be connected to an external computer if RS-232 interface is used. Please refer to the section 3.3.3, “Connection of the Communication Cable”, for the detail pin descriptions for both RS-232 and RS-485 interfaces.

4.7 Explanations of Error Messages

In the event of a fault, the inverter will stop feeding the AC voltage to the mains utility and display the error message on the LCD. Qualified service personnel shall do the analysis, measurement, and debug if needed according to the error message in order to resume normal conditions. It is recommended to screen out the fault condition(s) by referring to the table below and then remove the fault condition(s) to put the inverter return to normal condition and continue to feed AC voltage to the utility steadily. Please contact GESOLAR Industries Inc. if the same error message is persistent.

Error Message Table

Error Message	Description

GridNA	No AC voltage is detected on the grid side.
Drift Fac	Islanding is detected.
VacH	The AC voltage of mains utility is over the upper limit.
VacL	The AC voltage of mains utility is under the lower limit.
FacH	The frequency of AC voltage of the utility is over the upper limit.
FacL	The frequency of AC voltage of the utility is under the lower limit.
VpvH	The DC voltage of PV array is over the upper limit.
Imax_AC	Over current on the AC side.
DeltaZ	The rate of change of the AC grid impedance is higher than setting value.
Zac	The AC impedance of the grid is out of range.
InvTempMax	The internal temperature of the inverter exceeded the safe operating limit.
COMM	External communication failed.
EEPROM	EEPROM failed.
RelayX(X=1~4)	Grid connection relay failed.
FastEarthCurrent	The drastic change of the leakage current has been detected.
SlowEarthCurrent	The leakage current has exceeded a safe operating limit.
Error Message	Description
Riso	The insulation resistance between PV array and

	the ground is below the safe operating limit.
VdcbusH	Internal DC bus voltage is over the upper limit.
VdcbusL	Internal DC bus voltage is under the lower limit
Internal COMM	Internal communication failed.
Watchdog	Internal watchdog function triggered.
Idc Test	The DC injection current measurement function failed.
RCMA	The leakage current exceeded standard value.
RCMA Test	The leakage current measurement function failed.
IR Test	The insulation resistance measurement function failed.
Offset	Offset check for grid monitoring failed.
Temp. Sensor	The internal temperature sensor failed.
RAM Test	Memory failed
System Error	The system failed.
Version Error	The firmware version is not correct.
Delta Fac	Internal measurement comparison error or
Delta Vac	defective hardware
Delta Zac	
Delta If	
Delta Riso	
Delta Idc	
IpvA,IpvB,IpvC	Over current on the DC side
CalDataError	Calibration data is out of range
Cal Data Loss	Calibration data is lost.

5. Warranty information

Warranty Period

A period of 5 years is warranted from the date of your purchase of the GESOLAR inverters series Products.

Warranty Terms

GESOLAR hereby provides this written Limited Warranty covering the Products with the models **GES-4K6TL, GES-3K8TL and GES-3K3TL**, and if the Buyer discovers and notifies GESOLAR in writing of any defect in material or workmanship within the applicable warranty period stated above, then GESOLAR may, at its option: repair or replace the Product; or issue a credit note for the defective Product; or provide the Buyer with replacement parts for the Product.

The Buyer will, at its expense, return the defective Product or parts thereof to GESOLAR in accordance with the return procedure specified below.

GESOLAR will, at its expense, deliver the repaired or replaced Product or parts to the Buyer.

Exclusion of Liability

Any warranty of GESOLAR will not apply if the Buyer is in default under the Purchase Order Agreement or where the Product, any part or its original label thereof is

1. Damaged by misuse, accident, negligence or failure to maintain the same as specified or required by GESOLAR.
2. Damaged by external hazard or force majeure such as lightning strikes, storm, and/or fire.
3. Damaged by modifications, alterations or attachments thereto which are not authorized by GESOLAR.
4. Transported, installed or operated contrary to these instructions of GESOLAR.
5. Opened, altered, modified or disassembled in any way without GESOLAR's consent.
6. Used in combination with items, articles or materials not authorized by GESOLAR.

GESOLAR reserves the rights to determine whether the problem exists within the Product. The Buyer may not assert any claim that the Products are not in conformity with any warranty until the Buyer has made all payments to GESOLAR provided for in the Purchase Order Agreement.

Product Return Procedure

On-site Inspection & Repair

If a product requires warranty service, contact your merchant or GESOLAR directly. After your application is received, the service will be implemented by our qualified technician in the installation field. Problem isolation processes include,

1. Qualified service technician on site with digital measurement

equipments, including but not limited to digital voltmeter and current clamp meter.

2. Isolation of the inverter from the external electrical environment under the guidance of a qualified GESOLAR service representative.
3. Full declaration of the environmental conditions currently in place and historically preceding the failure, including but not limited to the utility grid connection and PV generator array configuration.

What Comes to Your Notice before Return

In case the product fails to function and requires a Factory Service after diagnosis, the product could be sent back using the proper shipping box and the packing materials. A copy of the original purchase invoice is also required to be included in the package. In addition, here are some documents which be attached with the return product. Please provide as much detail as possible.

1. Model number and serial number shown on the label.
2. Fault message on the panel and how it reproduces.
3. Detailed descriptions before & after the fault condition and the utility grid system connected.

How Our Factory Service Goes On

1. Replace the defective Product with a new unit if it is purchased within 90 days.
2. Replace the defective Product with a refurbished unit if it is purchased after 90 days.

NOTE: All **remaining** warranty periods will remain effective for the replacement inverter or parts.

NOTE: Unauthorized returns will not be accepted and will be returned at the shipper's expense.

NOTE: All component replacement and its service labor costs are covered by the warranty in effect. Once the warranty expires, a Product found upon inspection by GESOLAR, to be in specification is subject to an evaluation fee and applicable freight charges, if any.

WARRANTY REGISTRATION FORM

It is very important to you that you register the product. Changes in product technologies as well as new developments in software and features may make it necessary for us to notice you the related information about your inverter. Please register immediately after purchasing.

Company:_____ **Product Type:** _____

City, State Zip: _____ **Serial Number(s):** _____

Phone:_____ **Date Installed:** _____

E-mail: _____

System Description: PV array size/type, Connection…

Your comment:

6. Technical Documentation

6.1 Outline Drawing

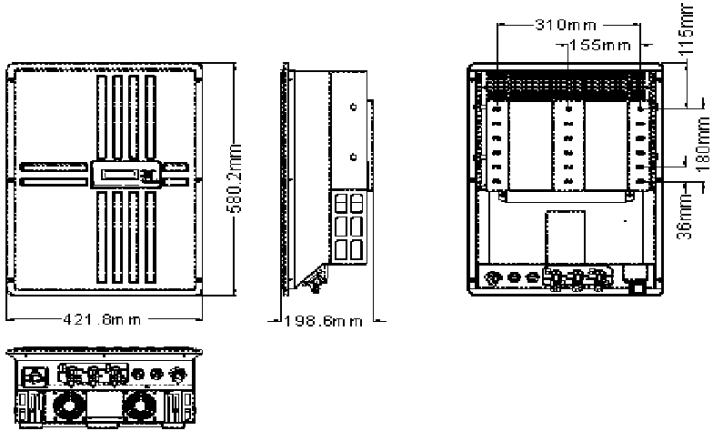


Fig 6.1.1 Outline Drawing (GES-4K6TL/3K8TL/3K3TL)

6.2 Efficiency

Efficiency of the GESOLAR inverters

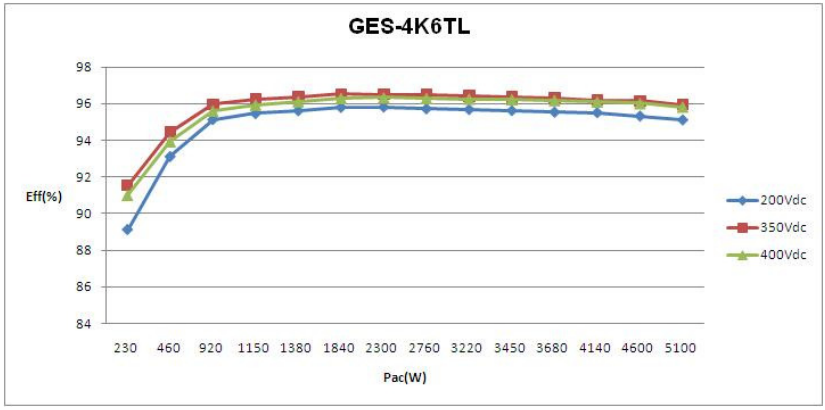


Fig 6.2.1 Efficiency of the GES-4K6TL

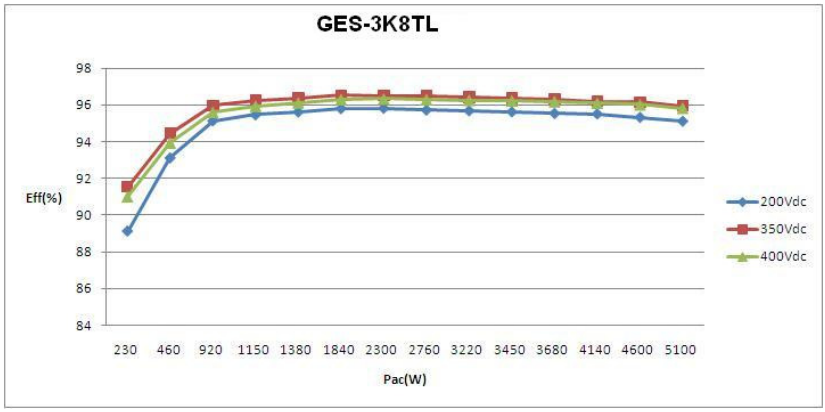


Fig 6.2.2 Efficiency of the GES-3K8TL

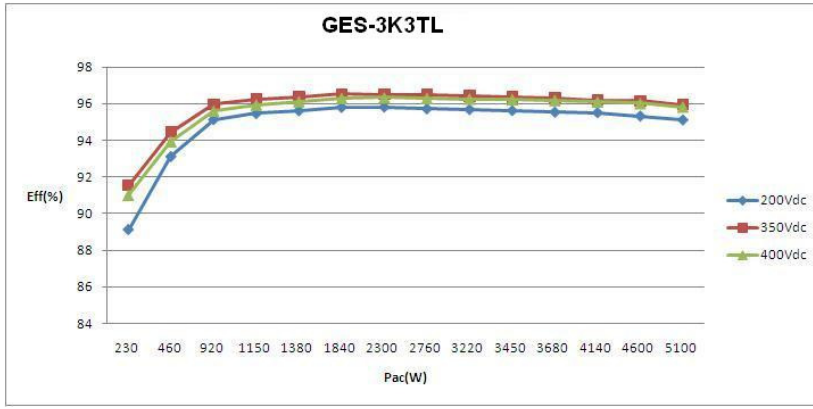


Fig 6.2.3 Efficiency of the GES-3K3TL

6.3 De-rating Operation

The occasions that the GESOLAR inverter will take into account and then regulate the output and/or restrict the input power to ensure the system is in a safe operation are described in detail below.

Temperature

The GESOLAR inverter will monitor the temperature on the heatsink. Once the temperature exceeds 72℃ the system will reduce the output power until the temperature drops under the critical value. The inverter will shut down the power output to the grid if the temperature reaches 80℃. If this occasion happens often, it needs to check whether the inverter is mounted at an appropriate place with good ventilation and not directly exposure to the sunshine, all temperature derating curves are illustrated in the Figure 6.3.1 ~ Figure 6.3.4.

Input DC current

When any input current from the PV strings is about to exceed 10A, the GESOLAR inverter will restrict it to the operating limit which is 10A per string in order to prevent damages to the inverter. If this occasion happens frequently, it needs to check whether the PV arrays are configured properly to supply the DC current within the maximum limit which is 10A to the inverter.

Output AC power

The maximum power that the GESOLAR inverter feeds to the grid is limited according to the specifications listed in Section 1.2. Even the output current does not reach the maximum current limit, the GESOLAR inverter will still automatically restrict the delivery output current to keep the output power within the maximum power limit when the output voltage is too high.

Output AC current

The maximum current that the GESOLAR inverter feeds to the grid is limited according to the specifications listed in Section 1.2. Even the output power does not reach the maximum power limit the inverter will still restrict the delivery output current within the maximum current limit when the output voltage is too low.

Output AC voltage

When the inverter is connected to a grid system with longer or thinner

wirings, its output voltage might be higher than the over voltage setting. This will cause disconnection due to the voltage deviation instead of abnormal voltage happened in the grid. GESOLAR inverter provides a setting of voltage quality monitoring which is less than the setting of over voltage. Once the AC voltage reach the voltage quality monitoring setting, GESOLAR inverter will restrict the output current to keep the AC voltage stay equal to or less than the setting of AC over voltage so that the inverter, instead of shut itself down, keeps output power to the grid although it is not the maximum output power.

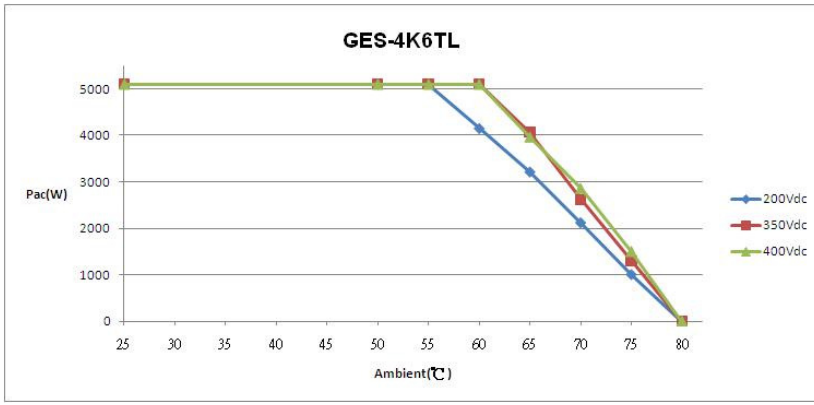


Fig 6.3.1 Temperature derating curve of GES-4K6TL

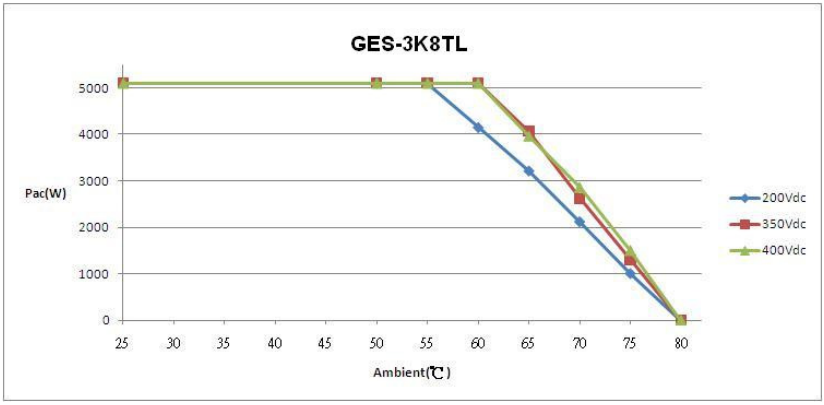


Fig 6.3.2 Temperature derating curve of the GES-3K8TL

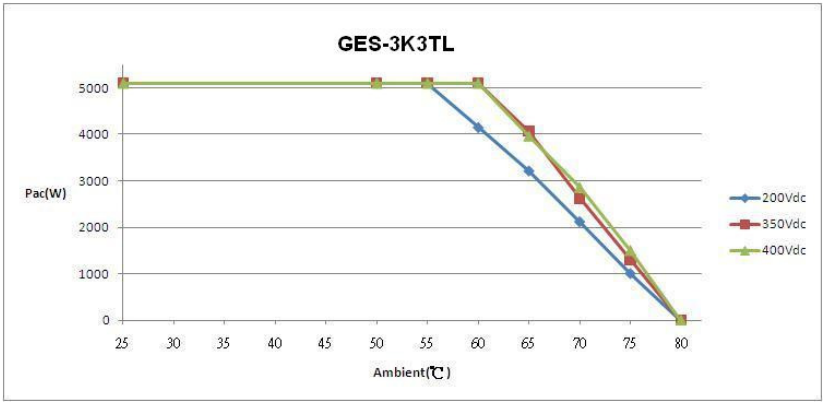


Fig 6.3.3 Temperature derating curve of the GES-3K3TL

GESOLAR

Build and Beyond

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