

# User Manual

ISMG 315 / ISMG 320

Three-Phase Solar Inverter



**CARLO GAVAZZI** 

© 2010 Carlo Gavazzi Automation All rights reserved

V1.4 October 2010

## **Safety**

KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE – This manual contains important instructions for Models ISMG 315 and ISMG 320 that shall be followed during installation and future maintenance of the ISMG inverter.

### **Safety Precautions/Safety Notes**

Only trained skilled and qualified electrical personnel shall carry out the electrical installation, wiring, opening of the ISMG inverters. Even when no external voltage is present, or the device is disconnected, the ISMG inverters can still store high voltages and cause of electric shocks.

The temperature of the external heat sinks of the device can reach over 70°C (158°F) in normal operation (Ambient temperature rating: 45°C / 113°F). There is high risk of burn injury if these parts are touched.

The following general safety precautions must be observed during all operation phases, service and installation of this device. Failure to comply with these safety precautions or 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.

## Safety Symbols

To reduce the risk of injury and to ensure the continued safe operation of this product, the safety related information, contained in this manual are marked with the below listed signs.



**Warning, risk of electric shock**

**These safety information prevent serious injuries or death to users and/or installers.**



**Earth ground symbol**



**Caution**

**These information prevent damage to the product.**

## Intended Use

ISM3 Series inverters shall be installed according to the specific norms and regulations of your local building and safety department to meet the following qualifications:

- Electrical installation must be carried out correctly to meet the applicable regulations and standards;
- ISM3 Series inverters shall be installed in a well ventilated environment and protected against rain, condensation, moisture and dust;
- ISM3 Series inverters shall be installed in a permanent location according to the instructions stated in this manual;
- ISM3 Series inverters shall operate according to the technical specifications stated in this manual.

## **General Safety Precautions**

- Remove all conductive jewelry or personal accessories prior to installation or service of the device, parts, connectors, and/or wirings.
- Only trained and qualified personnel is authorised to mount, reconfigure or repair this device.
- Only licensed electricians are entitled to install permanently wired equipments.
- Make sure of standing on an insulated surface when working on the operating device (i.e: avoid grounding of the person).
- Instructions and information on cautions contained in this manual must be carefully read and followed.
- Use proper lifting techniques whenever handling enclosure, equipment or parts.
- The ISMG3 inverter must be provided with an equipment-grounding conductor connected according to local norms and regulations.
- The AC Neutral connection is only for voltage sensing and shall be neither used to carry currents nor connected to ground inside the inverter.
- 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 local Carlo Gavazzi National Sales company or specialized dealer or technician.

## Safe Installation and Operation

- Installation of the device must be in accordance with the relevant national or local regulations. Correct grounding and short circuit protection must be provided to ensure operational safety.
- Read all instructions and caution remarks in the manual before installation.
- Switch off the circuit breakers before installation and wirings. Avoid standing on wet surfaces when working on the inverter.
- PV arrays will be energized when exposed to light. Cover the arrays with opaque (dark) material during installation and wiring. Always make sure the DC switch is on the OFF position.
- Check both of the AC and DC connections with a digital volt meter prior to any installation or removal procedures.
- Close the cover properly before switching on the circuit breakers.
- Not to install the inverter exposed to direct sunlight
- When no external voltage is present; the ISMG3 inverter can still contain high voltages. There is still risk of electrical shocks.
- Allow at least 5 minutes for the inverter to discharge completely after disconnecting the AC and DC sources from the inverter.
- External heat sinks can reach a relatively high temperature in normal operation and cause skin burn injury if touched. Pay attention to it.
- To prevent the risk of fire hazard, do not cover or obstruct the heat sink.
- Any modification to the electrical system shall be carried out only by qualified electricians.

## Wiring the inverter



### WARNING!

All electrical installation and the wiring methods shall be done in accordance with the relevant national or local electrical regulations 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 cables must be adequately dimensioned and suitably inert to temperature fluctuation, UV radiation and other possible hazards.



### WARNING!

Reconfirm that all connections have been performed properly and all screws are properly tightened.

## Connection of the DC cable

For DC Input Terminals, use wire size 10 to 16 mm<sup>2</sup> (#8 to #6 AWG), 90°C (194°F) Copper Wire.



### CAUTION!

Identify the different polarity of DC voltage on each PV string and connect respectively to the input terminals. Make sure the DC voltage that PV arrays generate is equal or less than 850 VDC in any case.



### WARNING!

Route the DC connection cables to the ISMG3 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.



### WARNING!

PV arrays will be energized when exposed to light. Cover the arrays with opaque materials during installation and wiring.

## Connection of the AC cable

For AC Output Terminals, use wire size 6 to 10 mm<sup>2</sup> (#10 to #8 AWG), 90°C (194°F) Copper Wire.



### **WARNING!**

Make sure that the circuit breaker of utility mains is switched OFF before connecting the power cables from the breaker to the AC connector.

## Interaction with the Utility Grid



### **CAUTION!**

The default interface protection has been verified according to the valid low-voltage national grid connection standards. Only the authorized installers can change the tripping-limit settings under the approval of the distribution network operator (DNO).



### **CAUTION!**

Confirm the grid connection standard is selected correctly before tied with the grid (Std. DK5940 for Italy, VDE0126-1-1 for Germany or RD1663 for Spain). Please refer to the Section 3.3.5 Setting Operation for the selection of the grid connection standards.



### **CAUTION!**

The default interface protection is saved permanently in the EEPROM and won't be erased even if the inverter shuts down.



## Repair and Maintenance

The inverter contains no user serviceable parts inside, except for the fans. Only CARLO GAVAZZI LOGISTICS SpA trained staff is authorized to repair the unit. Please return the equipment for further examination if the faults are not caused by fans.



### **WARNING!**

**Not to make alterations or tamper assembly in the inverter unless expressly specified elsewhere in this Manual. Doing so may result in injury, electric shock, or fire and of course void the warranty.**

# Contents

<b>1. INTRODUCTION</b>	<b>2</b>
1.1 GENERAL	2
1.2 SPECIFICATIONS	4
1.3 FEATURES	10
1.4 ACCESSORIES	10
<b>2. INSTALLATION</b>	<b>11</b>
2.1 PLACEMENT	11
2.2 MOUNTING	13
2.3 WIRING THE INVERTER	19
2.3.1 Connection of the AC cable.....	26
2.3.2 Connection of the DC cable.....	28
2.3.3 Connection of the Communication cable.....	31
2.4 WIRING INVERTER IN PARALLEL	34
<b>3. OPERATION</b>	<b>35</b>
3.1 OVERVIEW	35
3.2 OPERATION FEATURES	38
3.3 LCD DISPLAY	39
3.3.1 LCD Backlight Indication .....	40
3.3.2 Display messages flow .....	42
3.3.3 Produced Power Graphs.....	51
3.3.4 Error Messages.....	53
3.3.5 Setting Operation .....	54
3.4 AUTO TEST (ONLY FOR ISMG315IT AND ISMGT320IT)	56
3.4.1 Auto test PC Software .....	57
3.4.2 Use Self-testing.....	61

3.5	ERROR MESSAGES DESCRIPTION	63
3.6	TROUBLESHOOTING	67
<b>4.</b>	<b>TECHNICAL DOCUMENTATION</b>	<b>72</b>
4.1	OUTLINE DRAWING	72
4.2	EFFICIENCY	73
4.3	DE-RATING OPERATION	74
4.4	MPP EFFICIENCY	77
<b>5.</b>	<b>WARRANTY INFORMATION</b>	<b>79</b>

## List of Figures

<i>Fig1.1.1</i>	<i>Grid Connected Solar System Overview</i> .....	<i>3</i>
<i>Fig 2.1.1</i>	<i>Clearances required for ISMG3 inverter installation</i> .....	<i>12</i>
<i>Fig 2.2.2</i>	<i>Inverter mounting bracket</i> .....	<i>14</i>
<i>Fig 2.2.3</i>	<i>Fasten the mounting bracket</i> .....	<i>15</i>
<i>Fig 2.2.4</i>	<i>Hook the Inverter on the mounting bracket and then fasten the screw</i> <i>18</i>	
<i>Fig 2.3.1</i>	<i>Turn the DC disconnect switch OFF</i> .....	<i>19</i>
<i>Fig 2.3.2</i>	<i>Loosen the screws</i> .....	<i>20</i>
<i>Fig 2.3.3</i>	<i>Open the front lid of the wiring box</i> .....	<i>21</i>
<i>Fig 2.3.4</i>	<i>Removal of the covers for the cable through holes</i> .....	<i>22</i>
<i>Fig 2.3.5</i>	<i>Wiring box front view</i> .....	<i>23</i>
<i>Fig 2.3.6</i>	<i>Utility Grid Configuration</i> .....	<i>25</i>
<i>Fig 2.3.1.1</i>	<i>AC Terminal Block for AC cable connections</i> .....	<i>26</i>
<i>Fig 2.3.2.1</i>	<i>ISMG3 Inverter supports two (2) independent PV strings</i> .....	<i>28</i>
<i>Fig 2.3.2.2</i>	<i>PV Inverter Connections</i> .....	<i>29</i>
<i>Fig 2.3.2.3</i>	<i>PV Strings in Parallel</i> .....	<i>29</i>
<i>Fig 2.3.3.1</i>	<i>Positions of the communication ports and termination switch</i> .....	<i>31</i>
<i>Fig 2.3.3.2</i>	<i>RJ-45 Pins and Signals</i> .....	<i>32</i>
<i>Fig 2.3.3.3</i>	<i>RS-232 connection (ISMG-45S0918)</i> .....	<i>33</i>
<i>Fig 2.3.3.4</i>	<i>RS-485 connection</i> .....	<i>33</i>
<i>Fig 3.3.1</i>	<i>Front panel of the ISMG3 inverter</i> .....	<i>39</i>
<i>Fig 3.3.1.1</i>	<i>3 colours LCD backlight</i> .....	<i>40</i>
<i>Fig 3.4.1.1</i>	<i>Search for inverters</i> .....	<i>57</i>
<i>Fig 3.4.1.3</i>	<i>Auto-test process</i> .....	<i>60</i>
<i>Fig 4.1.1</i>	<i>Outline Drawing of ISMG3</i> .....	<i>72</i>
<i>Fig 4.2.1</i>	<i>Efficiency of the ISMG320 = 96.0%</i> .....	<i>73</i>
<i>Fig 4.2.2</i>	<i>Efficiency of the ISMG315 = 95.5%</i> .....	<i>73</i>

<i>Fig 4.3.1</i>	<i>Temperature de-rating curve of the ISMG320 .....</i>	<i>74</i>
<i>Fig 4.3.2</i>	<i>DC Power curve of the independent PV string of the ISMG320 .....</i>	<i>75</i>
<i>Fig 4.3.3</i>	<i>Output Power v.s. Grid voltage of the ISMG320.....</i>	<i>76</i>
<i>Fig 4.4.1</i>	<i>MPP Efficiency of the two PV strings in parallel.....</i>	<i>77</i>
<i>Fig 4.4.2</i>	<i>MPP Efficiency of the two PV strings in individual .....</i>	<i>77</i>

## **1. Introduction**

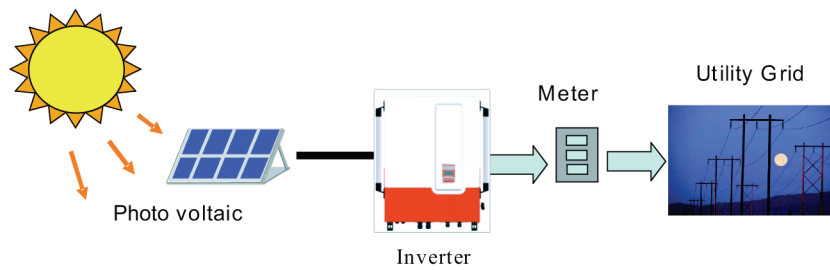
### **1.1 General**

The Carlo Gavazzi ISMG3 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 into the utility grid. The ISMG315 and ISMG320 are devices of the family with three (3) phases AC outputs for the European market. The overview of the grid-tied solar energy system is shown in Fig 1.1.1. ISMG3 inverters utilize the state-of-the-art technology to achieve the purpose of high reliability and ease of use. In addition, ISMG315 and ISMG320 comply with the requirements of VDE0126-1-1, RD1663/RD661 and DK5940 Standards. Furthermore the 3-phase ISMG3 inverters are certified to comply with the Standard EN50178 and EN55022 EMC Regulations with Class A device.

The ISMG3 inverter is designed to operate automatically once it is installed and commissioned correctly according to the technical specifications. When the DC input voltage generated by the photovoltaic arrays raises above the minimum MPPT voltage setting, the embedded controller starts and goes into the system initialization mode. If the DC input voltage goes above the PV Start voltage point, the inverter will go into Checking mode (Riso check) and monitor all parameters needed for grid connection. During this time, the ISMG3 inverter is not generating

AC power yet. Once all conditions necessary for grid connection are satisfied, the ISMG3 inverter goes into the Grid/MPP mode and begins feeding the AC power into the grid. When the input DC voltage falls below the pre-set threshold voltage setting, the ISMG3 inverter will then shut off the output AC power. And the inverter will shut down itself when the DC input voltage is under the minimum MPPT voltage setting. The ISMG3 inverter will be awakened again automatically when the input DC voltage rises above the minimum MPPT voltage point.

We appreciated your choice of Carlo Gavazzi ISMG3 inverters for your power conversion devices in your solar power system. This document contains the information you need for the installation and settings of the ISMG3 inverters. Therefore, it is strongly recommended to read this manual carefully before the ISMG3 inverter installation and settings.



*Fig1.1.1 Grid Connected Solar System Overview*

## 1.2 Specifications

### Specifications for ISMG315 and ISMG320

Name-Part number	ISMG 315	ISMG 320
<b>Grid output (AC)</b>		
Grid voltage, nominal	400VAC 3PH/N/PE	
Grid voltage, operating range	320 ~ 460VAC	
Grid frequency, nominal	50 Hz	
Grid frequency, operating range	48~52.5 Hz (adjustable)*	
Nominal Output Power	15,000 W	20,000 W (19,990W**)
Maximum output power	16,500 W	22,000 W
Nominal Output Current	21.8 A	29.0 A
Maximum Output Current	28.2 A	31.9 A (31.88A**)
Waveform	True sine	
Power factor	> 0.99 @ nominal power	
Total Harmonic Distortion	< 5 %	
DC Component	< 0.5 %	
Phase	Three Phase	
<b>Solar input (DC)</b>		
Maximum DC Power	17,300 W	23,100 W
Maximum input voltage	850 VDC	
Input voltage range	300 ~ 850 VDC	
MPP voltage range	400 ~ 850 VDC	
PV start voltage	400 VDC (adjustable)	
Nominal voltage	630 VDC	

Nominal input current	2x19.7A (39.4 A)	2x26.3A (52.5 A)
Maximum input current	2x21.6A (43.3 A)	2x28.9A (57.8 A)
<b>General</b>		
<b>Name-Part number</b>	<b>ISMG 315</b>	<b>ISMG 320</b>
Maximum efficiency	96.7 %	97.0 %
CEC efficiency	95.5 %	96.0 %
Night consumption	< 1W	
<b>Environmental</b>		
Operating temperature range	-25° ~ +60°C (-13° ~ +140°F)	
Storage temperature range	-25° ~ +70°C (-13° ~ +158°F)	
Maximum full power operating ambient	50°C (122°F)	45°C (113°F)
Relative humidity	Max. 95 %	
<b>Mechanical</b>		
Outdoor enclosure	IP55, ref. IEC 60529(2001)	
Cooling	Intelligent control fan	
Input & Output terminals	DC input - Accept wire size of 10 to 16 mm <sup>2</sup> (#8 to #6 AWG) AC output - Accept wire size of 6 to 10 mm <sup>2</sup> (#10 to #8 AWG)	
Weight/Shipping weight	75 kg / 85kg (165.3 lb / 187.3 lb )	
Dimensions (HxWxD)	890.5×751×245.5 mm (35.1×29.6×9.7 inches)	
Shipping dimensions (HxWxD)	1130×900×700 mm (44.6×35.5×27.6 inches)	
<b>Interface</b>		
Communication	RS232 and RS485	
Display	128 * 64 graphic display	



<b>Certifications</b>	
Electromagnet Compatibility	Directive 2004/108/EC EN 55022(1998) : IEC/CISPR22 EN 61000-6-2(2005) EN 61000-6-4(2007) EN 61000-3-11(2000) EN 61000-3-12(2004)
Low-Voltage Regulation	Directive 2006/95/EC EN 50178(1997), covered by IEC 62103(2003)
Network Monitoring	VDE 0126-1-1(2006), RD 1663(2000) / RD 661 (2007), DK 5940(2007) / Enel Connections Guide (2008), Section F
RoHS	Directive 2002/95/EC

\* Some factory settings can be re-configured with the approval of the local utility provider. This inverter is provided with adjustable trip limits and may be aggregated over 200kW on a single Point of Common Coupling.

\*\* The output power capacity is limited to 19.99 kW on the ISMG315IT and on the ISMG320IT according to the DK5940 for the Italian market only.

### Adjustable voltage, Frequency and Reconnection Settings (1)

Setting	DK5940		VDE0126-1-1	
	Range	Default	Range	Default
Over-frequency (Hz)	50.05~50.95	50.25	50.05~50.15	50.15
Over-frequency disconnection time (cycle)	1~3	3	1~8	8
Under-frequency (Hz)	49.05~49.95	49.75	47.55~49.95	47.55
Under-frequency disconnection time (cycle)	1~4	4	1~8	8
Over-voltage (Vac)	235~270	270	235~260	260
Over-voltage disconnection time (cycle)	1~4	4	1~8	8
Under-voltage (Vac)	188~225	188	188~225	188
Under-voltage disconnection time (cycle)	1~8	8	1~8	8
Dc injection tripping current (A)	0.10~0.60	0.60	0.10~0.80	0.80
Dc injection disconnection time (cycle)	1~4	4	1~8	8
Insulation resistance trip setting (MOhm)	0.5~10	1.0	0.5~10	1.0
PV start voltage (Vdc)	400~800	400	400~800	400
Reconnect delay* (s)	20~300	20	30~300	30

\* Once a grid failure occurred, the ISMG3 inverter waits 20~600 seconds before the next connection to the grid. The default setting is 20 seconds for DK5940 (Italy), 30 seconds VDE0126 (Germany) and 180 seconds for RD1663 (Spain).

## Adjustable voltage, Frequency and Reconnection Settings (2)

Setting	RD1663		User	
	Range	Default	Range	Default
Over-frequency (Hz)	50.05~50.95	50.95	50.05~54.50	50.95
Over-frequency disconnection time (cycle)	1~8	8	1~250	4
Under-frequency (Hz)	48.05~49.95	48.05	45.50~49.95	49.05
Under-frequency disconnection time (cycle)	1~8	8	1~250	4
Over-voltage (Vac)	235~249	249	235~276	264
Over-voltage disconnection time (cycle)	1~8	8	1~150	4
Under-voltage (Vac)	199~225	199	160~225	196
Under-voltage disconnection time (cycle)	1~8	8	1~150	4
Dc injection tripping current (A)	0.10~0.80	0.80	0.10~0.80	0.80
Dc injection disconnection time (cycle)	1~150	8	1~150	8
Insulation resistance trip setting (MOhm)	0.5~10	1.0	0.5~10	1.0
PV start voltage (Vdc)	400~800	400	400~800	400
Reconnect delay* (s)	180~300	180	20~600	20

\* Once a grid failure occurred, the ISMG3 inverter waits 20~600 seconds before the next connection to the grid. The default setting is 20 seconds for DK5940 (Italy), 30 seconds VDE0126 (Germany) and 180 seconds for RD1663 (Spain).

## Measurement precision

	Range	Resolution		Accuracy
		Display	Measurement	
Input voltage (VDC)	0~900V	0.1V	0.3V	±2V
Input Current (IDC)	0~50000mA	100mA	15mA	±500mA
Grid voltage (VAC)	0~300V	0.1V	0.3V	±1V
Grid current (IAC)	0~60000mA	100mA	30mA	±500mA
Grid frequency (Hz)	45~65Hz	0.01Hz	0.001Hz	±0.02Hz
Output power (W)	0~22000W	1W	1W	±50W
Energy yield (kWh)	0~65535×10 <sup>3</sup> kWh	0.1kWh	2.2×10 <sup>-6</sup> kWh	1%

### 1.3 Features

- ❑ High conversion efficiency
- ❑ Dual-MPP trackers (Can be connected in parallel)
- ❑ IP55 enclosure (Outdoor)
- ❑ Graphical display (Internal mini-datalogger)
- ❑ Three-phase balanced outputs
- ❑ Easy installation
- ❑ Smart self-diagnosis
- ❑ High power / small size ratio
- ❑ High reliability @ competitive price
- ❑ Conformity to VDE 0126-1-1 (ENS), RD1663/RD661
- ❑ DK5940/Enel Connections Guide (2008), Section F

### 1.4 Accessories

- |   |        |
|---|--------|
| • Operation Manual (incl. warranty page)        | 1 pcs  |
| • Mounting Bracket                              | 1 pcs  |
| • Fixing screws (bet. the inverter and bracket) | 2 pcs  |
| • Cross jumper (for input terminal)             | 1 pcs  |
| • Auto Test Software CD-ROM                     | 1 pcs  |
| • Mounting screws                               | 10 pcs |

## **2. Installation**

### **2.1 Placement**

- ISMG3 inverters, that must be vertically mounted, can be located indoor or outdoor according to protection degree of enclosure IP55.
- Leave at least 50 cm (19.7 inches) of free space above and 100 cm (39.4 inches) below the inverter when installed outdoor. Allow 20 cm (7.9 inches) between inverters when installing multiple inverters for better ventilation (see Fig 2.1.1).
- Mount the inverter on a wall that is strong enough to withstand the inverter with 75 kg weight.
- Avoid mounting the inverter on a location directly exposed to sunlight to maintain the ambient temperature of the inverter within -25° and 60 °C (-13° and 140°F). Humidity shall be within 0% and 95%.



**WARNING!**

Some parts of the cooling surface can reach temperatures over 70°C (158°F) when the inverter is in operation. Do not operate the inverter where it exposes to flammables, explosive atmospheres or close to combustibles or unknown materials that may result in fire/explosion danger.



**WARNING!**

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

- Keep DC wirings as short as possible to minimize power loss.
- The mounting bracket should be fastened on a concrete or a masonry wall with the recommended anchors.

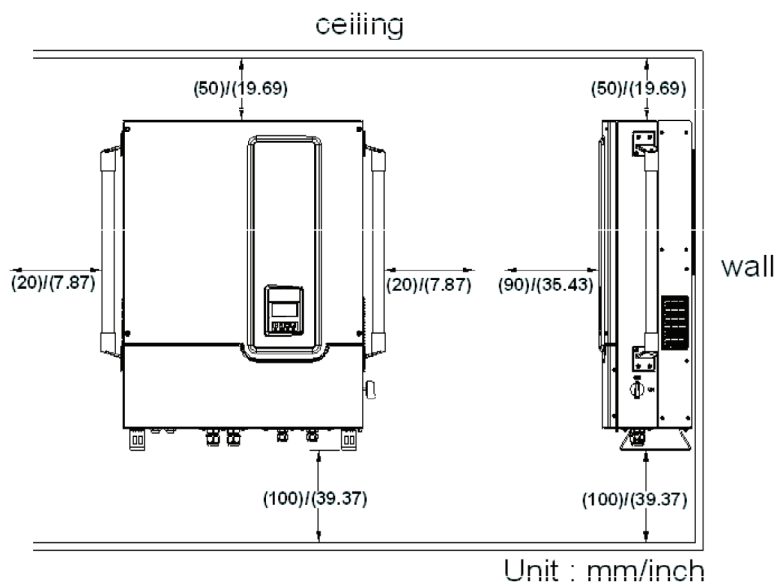
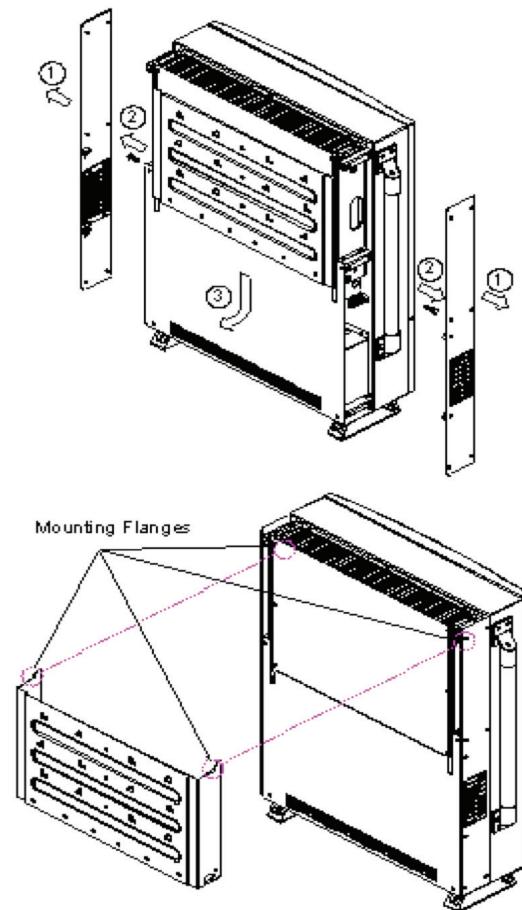


Fig 2.1.1 Clearances required for ISMG3 inverter installation

## 2.2 Mounting

The steps listed below describe how to mount the inverter on the wall:

1. After taking out the inverter from the carton, the attached mounting bracket shall first be removed from the inverter by following the steps shown in Fig 2.2.1 below.



*Fig 2.2.1 To remove the mounting bracket from the inverter*



- Use the mount bracket (Fig 2.2.2) as a template to mark the location of the holes to be drilled in the wall. After drilling the holes, the mounting bracket is then held against the wall and fastened to the wall with anchors as shown in Fig 2.2.3. (At least ten (10) screws required)

For mounting on wooden wall, the suggested diameter of screw is at least 6.35mm and the length is 25.4mm. The nut size needs to be at least 12.7mm.

A minimum of 10 screws are required to mount the bracket on wooden wall

For mounting on steal plate, the suggested screw size is M8x16. A minimum of 8 screws are required to mount the bracket on steel plate

For mounting on cement wall, the suggested anchor screw with outer diameter of 8mmx38.1mm is recommended. The nut size needs to be at least 12.7 mm. A minimum of 8 screws are required to mount the bracket on cement wall

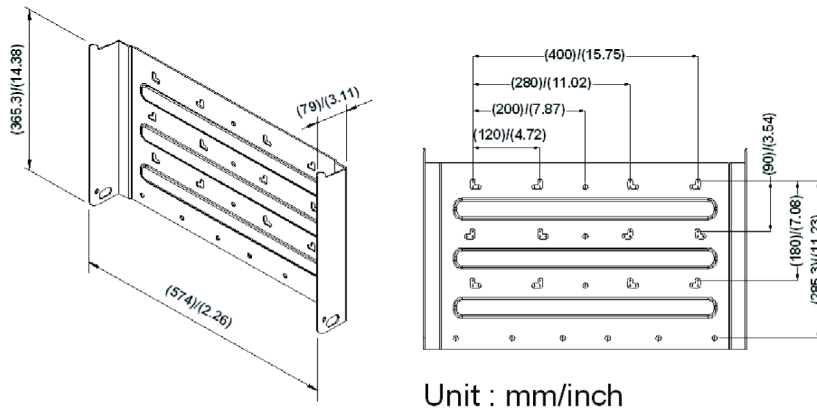


Fig 2.2.2 Inverter mounting bracket

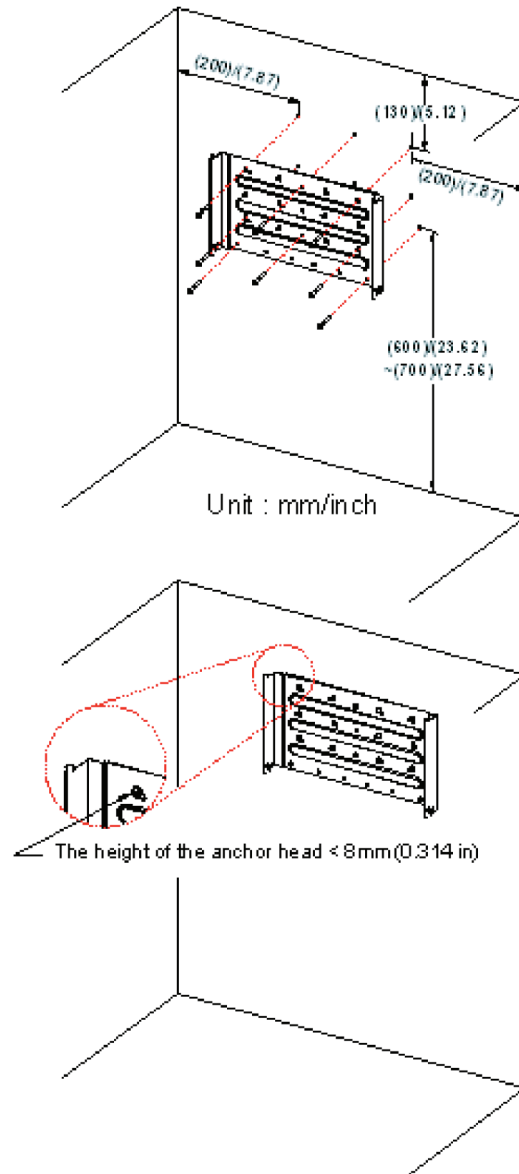
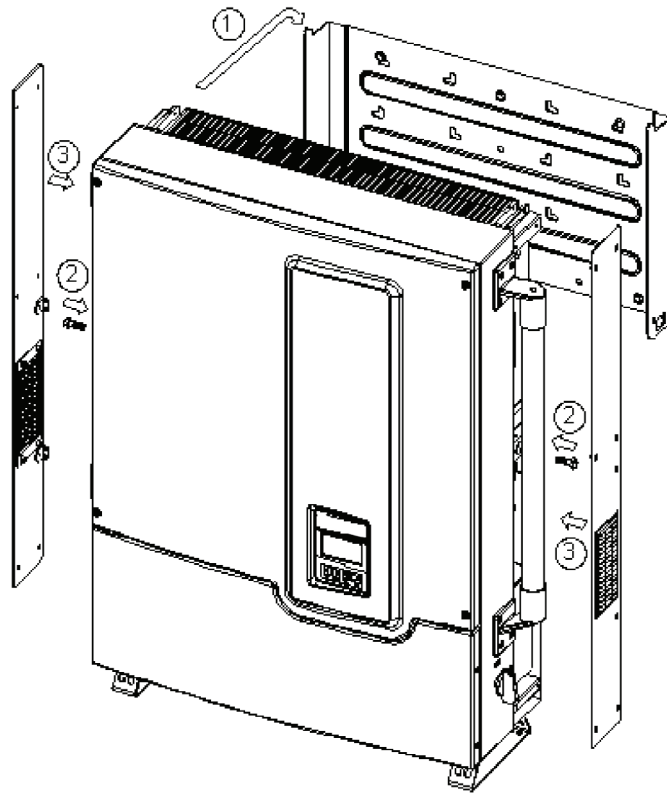
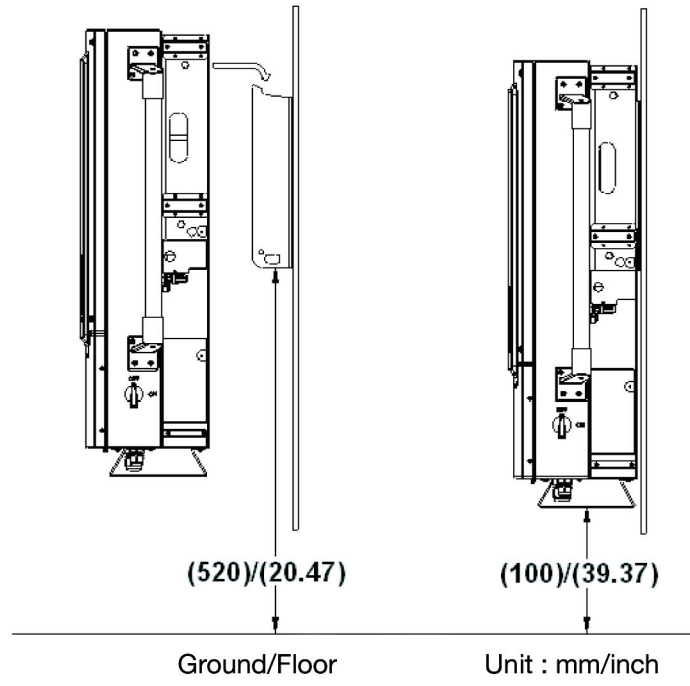
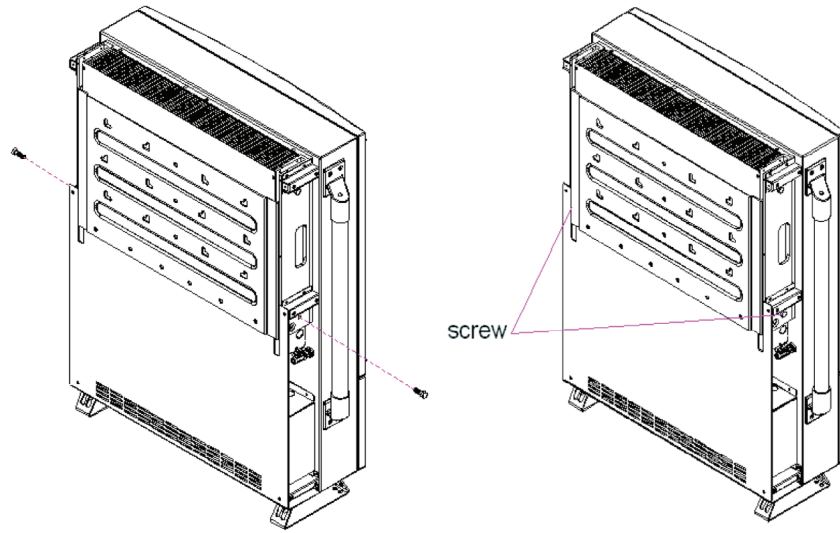


Fig 2.2.3 Fasten the mounting bracket

3. Once the mounting bracket is fastened to the wall, the inverter can be mounted and fastened on the bracket. Hook the inverter on the mounting bracket flanges and slip down carefully to lock it in place. And then fasten the inverter to the mounting bracket as shown in Fig 2.2.4.





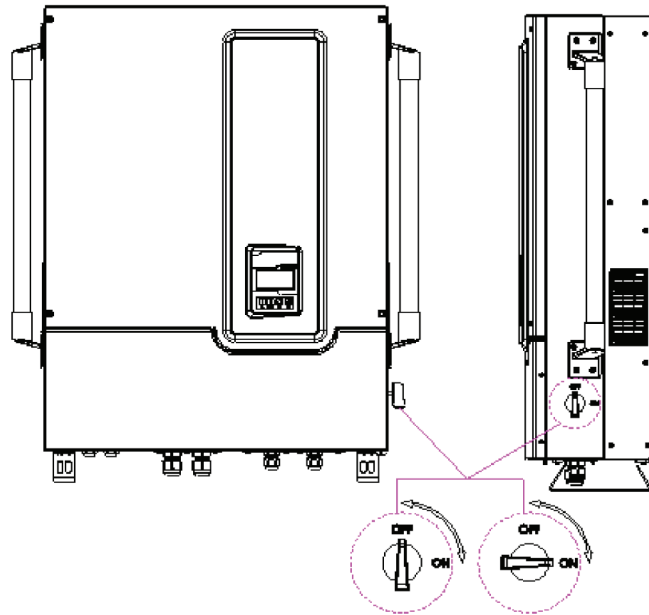


*Fig 2.2.4 Hook the Inverter on the mounting bracket and then fasten the screw*

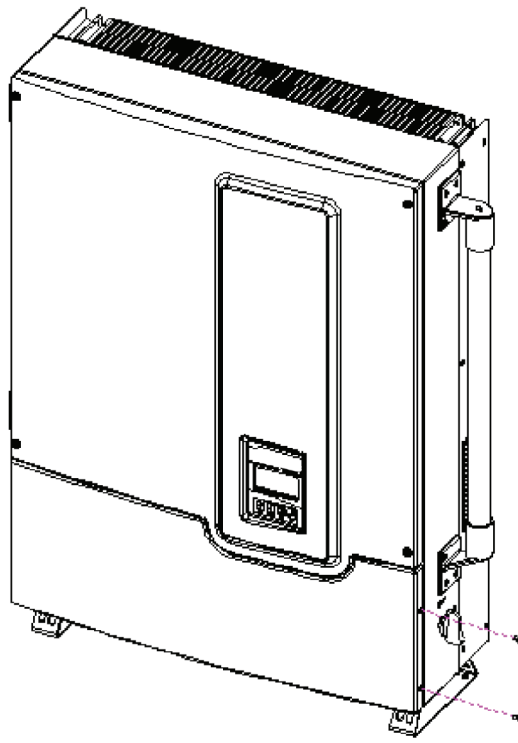
After the inverter has been hooked correctly on the bracket and fastened to the mounting bracket, it is then possible to proceed with the wiring.

### 2.3 Wiring the inverter

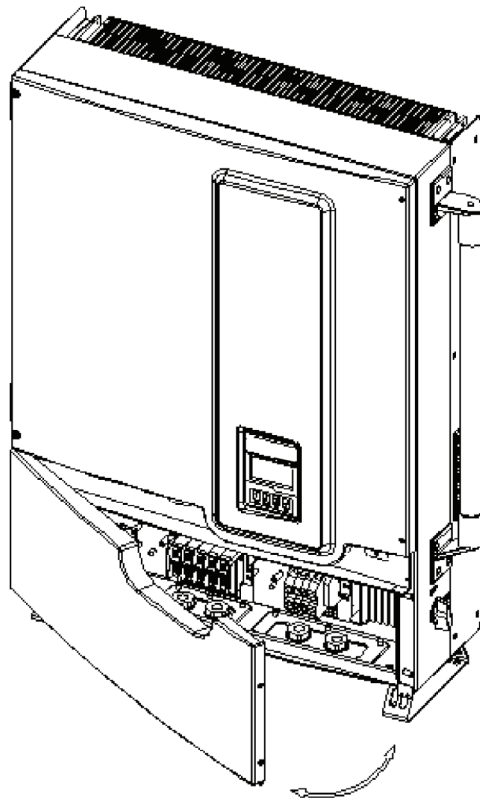
It is necessary to open the front lid of the wiring box before wiring the inverter. First, the DC disconnect switch must be turned OFF as shown in Fig 2.3.1. And then remove the two screws on the right hand side; open the red colour front lid of the wiring box as shown in the Fig 2.3.2 and Fig 2.3.3 below.



*Fig 2.3.1 Turn the DC disconnect switch OFF*



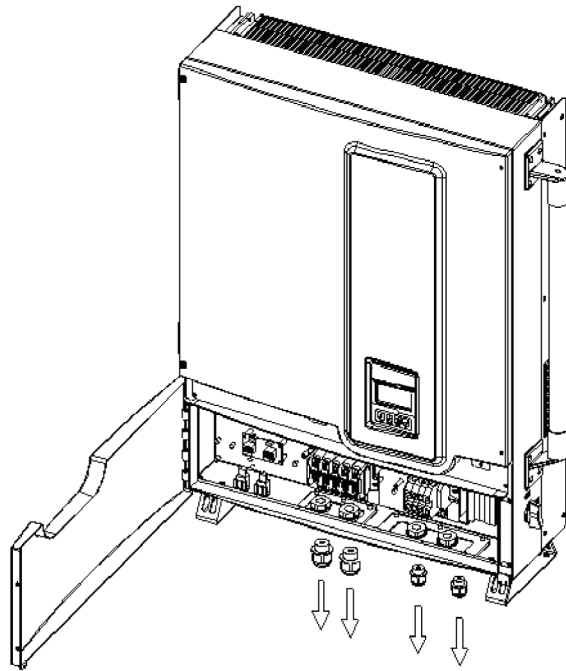
*Fig 2.3.2      Loosen the screws*



*Fig 2.3.3      Open the front lid of the wiring box*

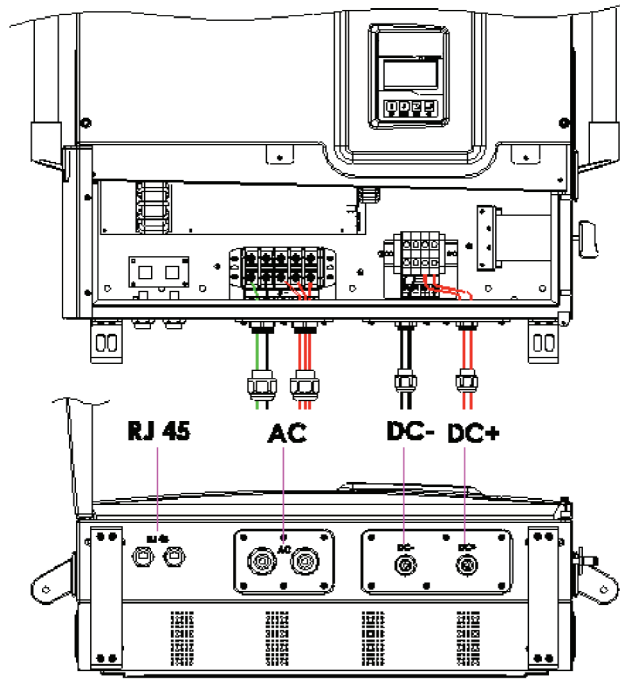
After the door is opened, it is then possible to remove the covers of the Threaded Conduit holes as shown in the Fig 2.3.4 for the DC and AC cables to be put through the threaded conduit holes in order to connect the inverter.





*Fig 2.3.4 Removal of the covers for the cable through holes*

The following three sections describe the wiring for the AC, DC, and communication ports. The wiring shall be carried out in the wiring box for the ISMG315 and ISMG320. There is a DC terminal block, two (2) RJ-45 connectors, and one (1) AC terminal block in the wiring box as shown in Figure 2.3.5. The DC terminal block is used to connect up to two (2) PV strings individually or in parallel in the wiring box. The RJ-45 connectors are used for external communication to a remote computer or terminal. The AC terminal block is used to connect to the utility grid, through a circuit breaker and distribution panel, according to national and local requirements.



*Fig 2.3.5      Wiring box front view*



**WARNING!**

All electrical work shall be carried out in accordance with the local and national electrical norms and should follow the important safety precautions contained in this manual.



**WARNING!**

Make sure that suitable connecting cables are used 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. For DC wiring connection to the ISMG3 inverter, use 10 to 16 mm<sup>2</sup> (#8 to #6 AWG), 90°C (194°F) copper wire; For AC wiring connection, use 6 to 10 mm<sup>2</sup> (#10 to #8 AWG), 90°C (194°F) copper wire.



**WARNING!**

PV arrays will be energized when exposed to light. Cover the arrays with opaque (dark) material during installation and wiring and make sure the DC switch is on OFF position (as in fig.2.3.1)

Before wiring the ISMG3 inverter, it is necessary to determine the utility configuration that the inverter will be connected to. The ISMG315 and ISMG320 inverters shall be used in three-phase utility interconnection with neutral as well as the ground as shown in Fig 2.3.6.

**Note:** When connecting the ISMG3 inverter to the utility, the grid voltage **must** be compatible.

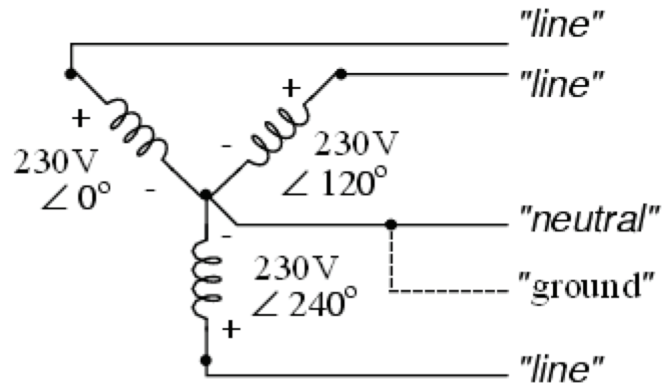


Fig 2.3.6 Utility Grid Configuration

### 2.3.1 Connection of the AC cable

Use the following procedures to wire the AC cables.

1. Open the Distribution panel and switch off the circuit breaker used to connect the inverter to the grid.
2. Use **6 to 10 mm<sup>2</sup> (#10 to #8 AWG)**, 90°C (194°F) copper wire for all AC wiring connections to the ISMG3 inverter.
3. Connect the cable GND to the ground terminal labeled  $\oplus$  or “PE”.
4. Connect the cable N to the terminal labeled N of the AC terminal block.

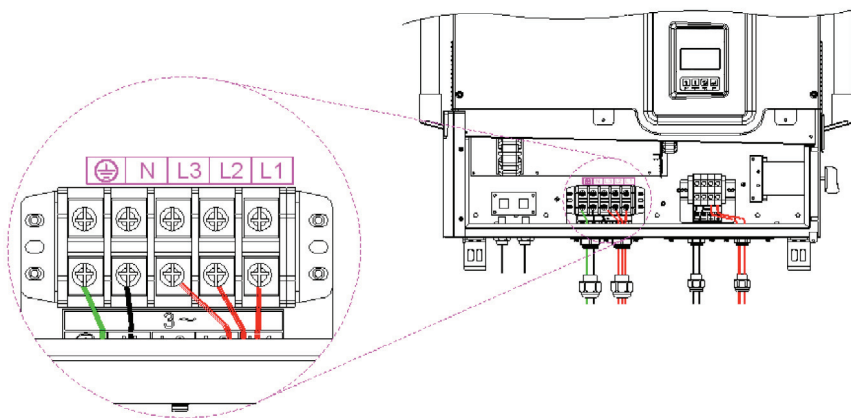


Fig 2.3.1.1 AC Terminal Block for AC cable connections

5. Connect the cables of the utility grid phases: L1, L2 and L3, to the terminals labeled “L1”, “L2” and “L3” of the AC terminal block correctly.
6. Tighten the screws with a torque of 3.0 Nm (27.6 lb-in).
7. Reconfirm that all connections have been performed properly as described above and all screws are properly tightened.



**WARNING!**

Make sure that the circuit breaker to the mains utility is switched OFF before connecting the power cable from the breaker to the AC terminal block.



**WARNING!**

Each connection to an ISMG3 inverter must be installed with a dedicated circuit breaker in the mains utility service panel. The breaker must be sized in order to handle the rated maximum output voltage and current of an ISMG3 Inverter. No other appliances may be connected to the circuit breaker.

### 2.3.2 Connection of the DC cable

The wiring box of the ISMG3 inverter is designed to support up to two (2) independent PV strings to be connected in the wiring box and then fed into the inverter.

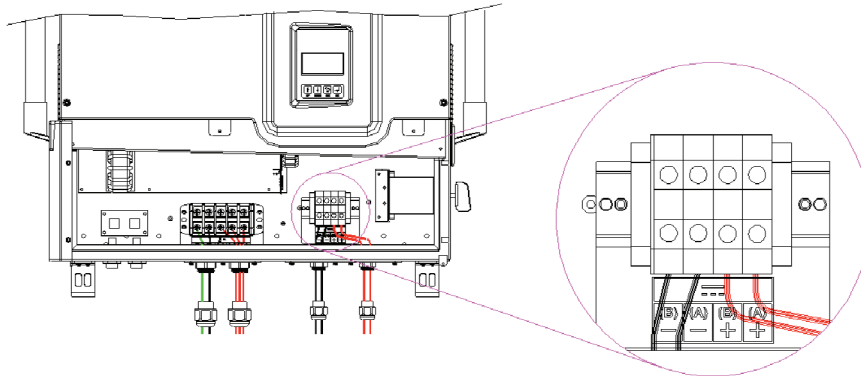


Fig 2.3.2.1 ISMG3 Inverter supports two (2) independent PV strings



#### CAUTION!

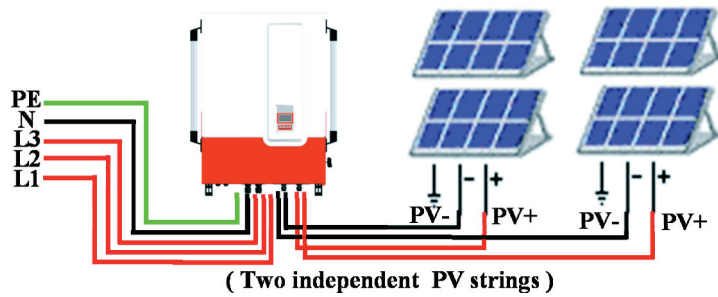
Overcurrent protection may be required depending on the type and ratings of the PV module configured in your system. The maximum DC input current is 43.3A for ISMG315 and 57.8A for the ISMG320. The maximum DC current allowed per string is 21.6A for ISMG315 and 28.9A for ISMG320.



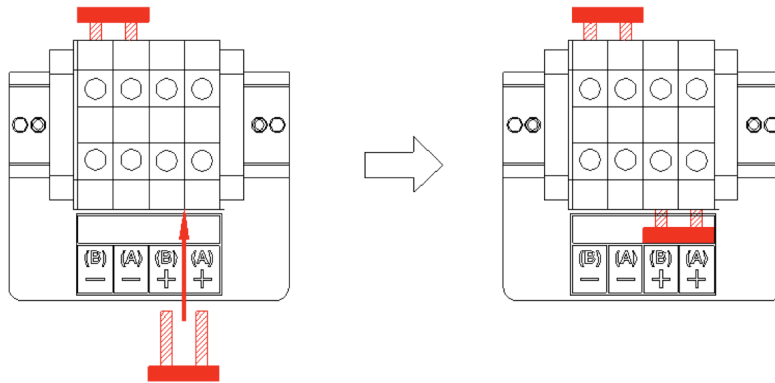
#### CAUTION!

The +PV and -PV cables of a PV string shall be connected to the DC terminals labeled "+" and "-" respectively. The capacity of the cables should be taken into account by system installers to determine the proper rating of the PV string fuse or a fire hazard may occur if there is short-circuit in a PV string.

There are two (2) terminals per PV string located inside the wiring box used for the DC cable connections. Up to two (2) independent PV strings are supported by the ISMG3 inverter. Therefore, there are four (4) terminals, two (2) of them are labeled with “+” and other two (2) are labeled with “-”, in the wiring box for DC cable connections as shown in Fig 2.3.2.2 and Fig 2.3.2.3. All the screws for the cable connections shall be tightened with a torque of 3.5 Nm (35.5 lb-in).



*Fig 2.3.2.2 PV Inverter Connections*



*Fig 2.3.2.3 PV Strings in Parallel*



**NOTE:** The ISMG3 inverter with Dual-MPP tracker is designed to be applied to a variety of different configurations. In most cases it is recommended to link the two PV strings into a single hole to obtain the highest efficiency. Please consult with your installation servicer and see how to connect, as show in Fig 2.3.2.3.



**CAUTION!**

PV arrays are energized when exposed to light. Use safe working practices when working on PV arrays.



**WARNING!**

Route the DC cables to be connected to the ISMG3 inverters away from any possible hazards that could damage the cables.



**WARNING!**

Hazardous voltage is still present on the ISMG3 inverter after disconnection of all PV DC inputs. Allow 5 minutes for the device to discharge the energy completely.



**CAUTION!**

Make sure that the DC input voltage generated by the PV arrays must be equal to or less than 850 VDC in any condition, especially in cold weather conditions, or it will cause damage to the ISMG3 inverter.

### 2.3.3 Connection of the Communication cable

The ISMG3 inverter supports two common data interface standards, RS-232 and RS-485 that will be used to communicate to a remote computer or terminal equipped with RS-232 or RS-485. Only one of the communication interfaces can work at a time. As shown in Figure 2.3.3.1, there are two RJ-45 connectors, RJ45-R and RJ45-L, which are located on the bottom of the enclosure. The pin numbers of the RJ-45 connectors and the corresponding signals are described in Figure 2.3.3.2 below. If the RS485 is used as the external communication interface and the inverter is the last device within the RS485 chain connections, then the termination switch shall be put to ON position (shown in Figure 2.3.3.4). Users shall open the front lid of the wiring box to switch the termination switch to ON position. The termination switch is default set to OFF position.

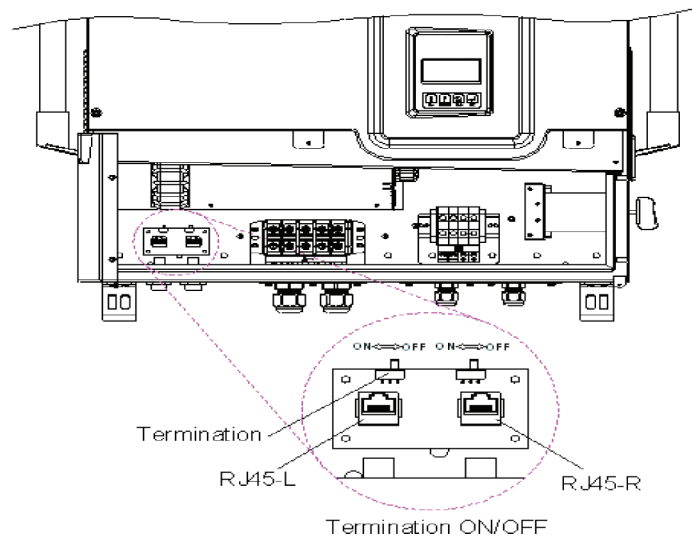
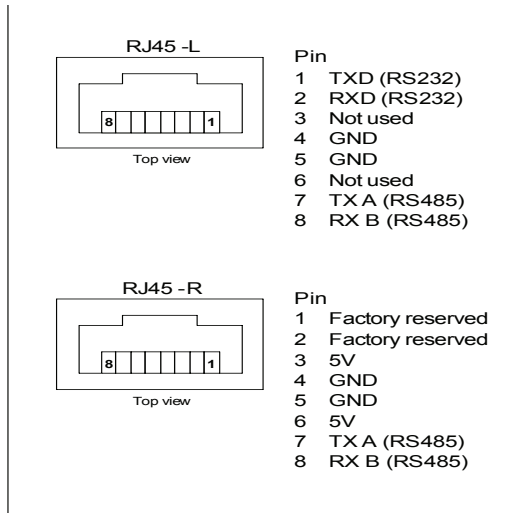


Fig 2.3.3.1 Positions of the communication ports and termination switch



*Fig 2.3.3.2 RJ-45 Pins and Signals*

As shown in Fig 2.3.3.2, 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 the remote PC or terminal when the RS-232 interface is selected. The cable with the part number of ISMG-RJ45S0918, which is 180 cm (70.9 inches) in length, is dedicated for the communications between a ISMG3 inverter and a computer when RS-232 interface is used. This cable has an RJ45 connector on one end and a RS-232 (DB9) connector on the other end as shown in Fig 2.3.3.3. If RS-485 interface is selected, then both RJ-45 connectors on the ISMG3 inverter can be used for the cascaded RS-485 connections shown in Fig 2.3.3.4.

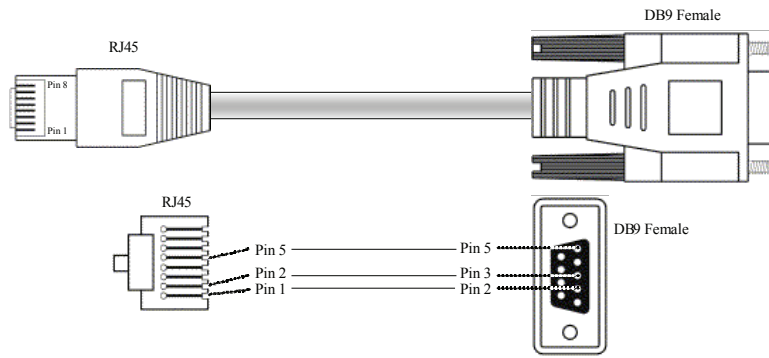


Fig 2.3.3.3 RS-232 connection (ISMG-45S0918)

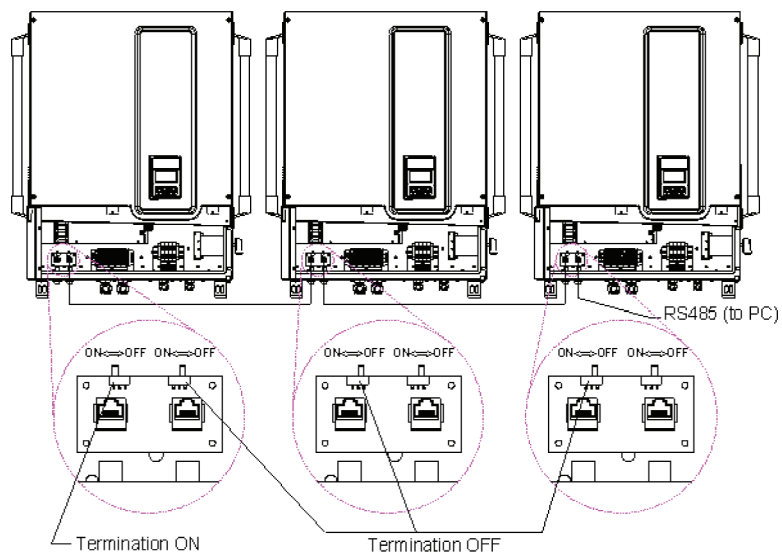


Fig 2.3.3.4 RS-485 connection

## 2.4 Wiring inverter in parallel

ISMG3 inverters can be connected in parallel when more power is required. 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 Fig 2.4.1 below shows the connections between inverters and PV arrays in parallel configuration.

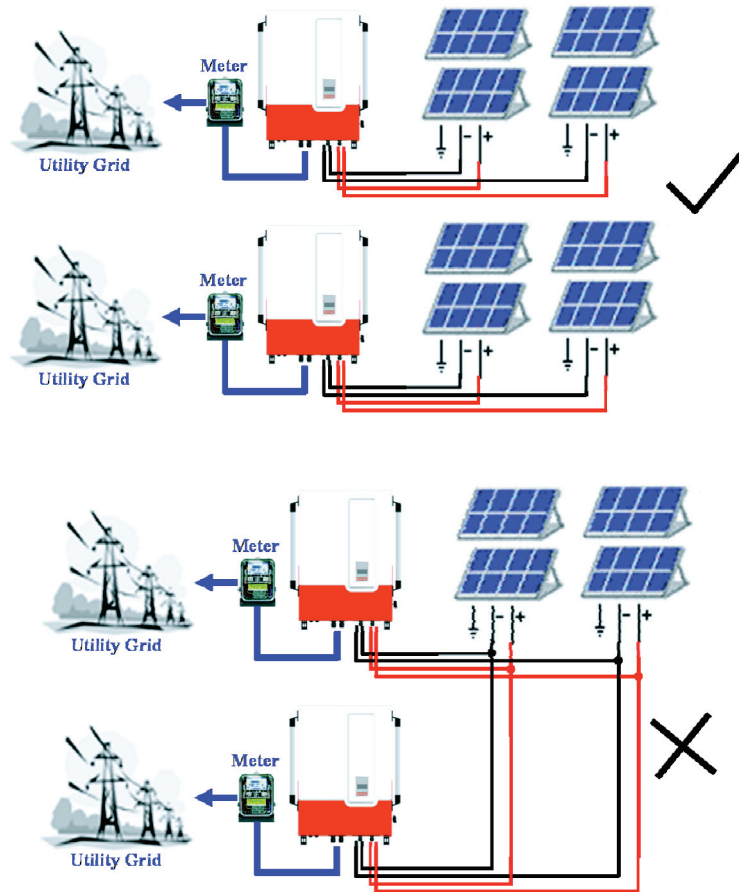


Fig 2.4.1 Parallel configuration of inverter

## 3. Operation

### 3.1 Overview

The control electronics will be active as soon as the DC (PV) voltage reaches “minimum MPPT” voltage point which is around 200VDC. The ISMG3 inverter is then powered up and will show “Illumination” on the LCD, complete the system initialization and wait for the DC voltage to reach the “PV start” voltage point which is 400VDC. When the DC voltage reaches the “PV start” voltage point, the inverter will enter “Checking” mode and then go on-line with the mains grid (“Grid/MPP” mode) if all necessary conditions for grid connection are checked and fulfilled. If the DC input voltage falls below the “pre-set threshold” point, the inverter will shut off its output AC power and go back to “Illumination Low” mode providing the DC voltage remains above the minimum MPPT voltage point. When the DC voltage goes under the “minimum MPPT” voltage point, the inverter will shut down itself.

There are five main operating modes described in detail below.

**Illumination:** When the DC input voltage goes above the “minimum MPPT” voltage point, the inverter is powered up, and enters the system initialization procedure with “Illumination” displayed on the LCD. In this operation mode, the inverter sets the initial values, runs diagnostics, and detects all parameters that will be stored for future use. This stage takes only a few seconds and then the inverter will wait until the DC input voltage reaches the “PV start” voltage point to enter the “Checking” mode.

- Checking:** In this operation mode, the inverter checks all parameters on both AC and DC sides to ensure 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. If any parameter, except the DC voltage that is under the “PV start” voltage, does not meet the criteria the inverter goes to “System Fault” mode.
- Grid/MPP:** The inverter will turn on the AC relays, turn the display backlight into green colour, and start feeding the AC power to the grid. In this operating mode, the inverter continues to convert the DC power generated by the PV array into AC power that is then fed into the grid. The inverter will stop feeding the power and go back to checking mode if any conditions for grid feeding mode is not satisfied anymore.
- System Fault:** When fault(s) occurs and are detected in the operating mode described above, the inverter will display “System Fault” on the LCD (the display backlight turns to red) and exit the current state, stop feeding power to the grid, and then jump into the fault mode which executes a preset sequence. When the faults have been cleared and do not appear anymore for a preset period of time, the inverter will exit system fault mode and enter checking mode. Some faults, like component failure, will cause the inverter going into the “System idle” mode. This condition requires maintenance staff operation in order to be cleared.
- System Idle:** Once the inverter has detected a major fault or malfunction,

it will go into the “System idle” mode and stop feeding the power to the grid for safety reasons. Normally this is a failure that cannot be removed by the user. This state requires maintenance staff operation in order to be reset and put the inverter back to normal operation.



## **3.2 Operation Features**

### **1. Anti-Islanding protection**

When an “islanding” condition is detected, for instance the utility grid falls or is disconnected by mean of the mains disconnecter, the inverter will stop feeding the power on the AC output. An “island” is defined as a grid tied inverter maintaining operation and feeding power to a load that is isolated from the utility power source. This situation on the ISMG inverters causes an automatic shutdown of the inverter. This is a safety feature which is primarily meant to prevent electric shock hazard to personnel who might have shut down the Utility grid in order to make maintainance operations on it.

### **2. Unitary Power Factor:**

The ISMG3 inverter intent is to feed the power with a unitary power factor ( $PF = 1$ ) to the utility during operation. The inverter continues sensing the phase of the utility voltage and builds the output current waveform in phase with the utility voltage.

### **3. Maximum Power Point Tracking:**

In order to find the most efficient way of utilizing the solar energy, ISMG3 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 intended purpose.

### 3.3 LCD Display

The ISMG3 inverter has a 128 x 64 graphic LCD Display with three (3) colours backlight, to display various information of the inverter such as the operating status/settings, input/output data, cumulated power, and error messages. furthermore, there is a keypad with 4 pushbuttons for users to select the information to be displayed on the LCD from one of the categories of “System Status”, “Energy Production”, and “Error Message”. The User can change, under a password protected menu, some of the settings by selecting the “Edit Settings”. As long as the DC input voltage is above the minimum MPPT voltage, the LCD continues to display the information, the flow is described below in this section.

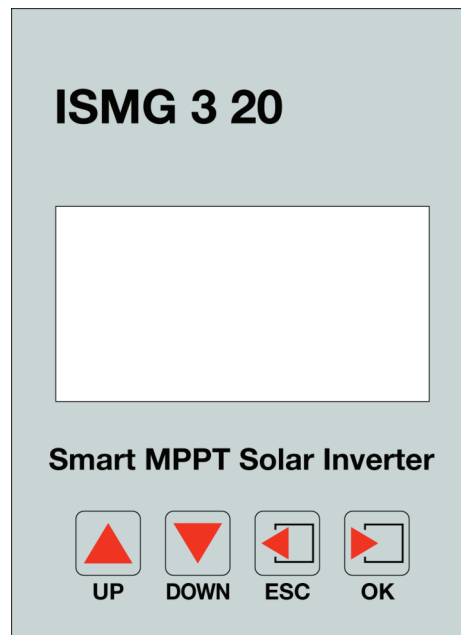


Fig 3.3.1 Front panel of the ISMG3 inverter




### 3.3.1 LCD Backlight Indication

There are three (3) colours: white, green, and red, of LCD backlight. The colour will change according to the inverter operation status as shown in Figure 3.3.1.1. The explanation of the status and the corresponding colours of the backlight are described in the following table.

<b>Mode</b> □ Illumination <b>Vac</b> □ 230/230/230V <b>Fac</b> □ 50.00Hz <b>Pac</b> □ 0W 03/27 06:50:25	<b>Mode</b> □ Grid/MPP <b>Vac</b> □ 230/230/230V <b>Fac</b> □ 50.00Hz <b>Pac</b> □ 20000W 03/27 13:50:25	<b>Mode</b> □ SystemFault <b>Vac</b> □ 230/230/230V <b>Fac</b> □ 50.00Hz <b>Pac</b> □ 0W 03/27 15:20:45
--	--	---

Fig 3.3.1.1 3 colours LCD backlight

**LCD Backlight Indication Table**

LCD backlight		Operating status	Description
<b>White</b>		Initialization	The inverter sets the initial values and detects all parameters.
		Illumination	The low Sun irradiation can not start the inverter.
		Checking	The inverter monitors all the system parameters.
<b>Green</b>		Grid/MPP	The Inverter is feeding AC power to the grid.
		Derating	Reduce the AC power feeding.
		Warning	The system has encountered a minor warning, but it continues to feed the AC power to the grid.
<b>Red</b>		SystemFault	The inverter has detected a recoverable failure and will re-start on its own as soon as normal condition is restored.
		SystemIdle	An unrecoverable failure occurred; The unit requires service personnel in order to verify the system and restore normal operation.
		Programming	The program is being updated.

### 3.3.2 Display messages flow

The display messages flow changes according to the procedure we are into. There are 3 main operation procedures: regular procedure, fault procedure or idle procedure.

The regular procedure is when the system goes from power-on (illumination low), system check, and then Grid/MPPT mode without any fault condition detected. If during the system check, a fault condition that could be cleared is detected, the system will turn to the fault procedure. The system will return to regular procedure as soon as the fault condition disappears. An example of this situation could be the "island" condition: if the grid voltage goes off and then after some time goes on again, the ISMG3 goes into fault state, but the fault condition is cleared when the power returns. If a fault cannot self restore, the system will enter the idle procedure and will need a service staff to clear the fault and reset the system. The following paragraphs explain how the display works in the different operating modes.

#### **Illumination:**

When the DC input voltage rises above the "minimum MPPT" voltage point but under the "PV start" voltage point, the ISMG3 inverter is powered up and will show the model name (e.g. ISMG315), serial number, firmware versions, and the complied standards, on the Display. After around five (5) seconds, the Main Menu with four (4) selections, System Display, Graphic Method, Error message, and Setting, that user can select through the up/down buttons will be displayed on the LCD. Three seconds later, if no selection is made, the "System Display" will automatically go to "Illumination" Mode on the LCD and stop there until the system goes into the "Checking" mode. Together with the Mode (Illumination),

the LCD also displays the three-phase AC voltages, Frequency, and AC output power on the AC side.

**PVMate 20E**  
**S/N □ 020010070001**  
**Ver. M00 & S00**  
**Std. DK5940**

5 seconds ↓

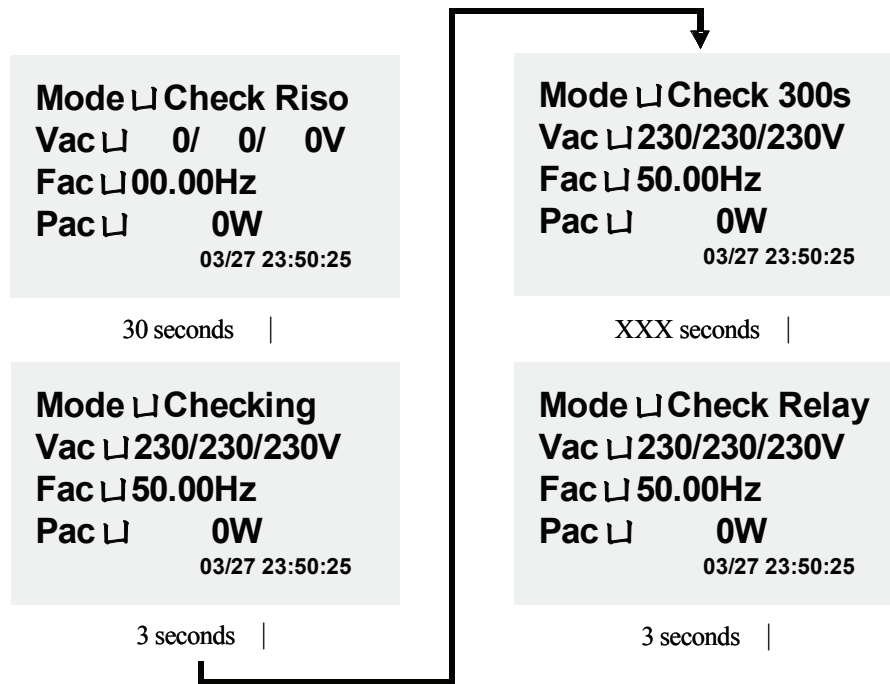
→ **System Display**  
**Graphic Method**  
**Error message**  
**Setting**

3 seconds ↓

**Mode □ Illumination**  
**Vac □ 230/230/230V**  
**Fac □ 50.00Hz**  
**Pac □ 0W**  
03/27 23:50:25

**Checking:**

When the DC input voltage reaches the “PV start” voltage point, the inverter goes into the “Checking” Mode. In this operation mode, the inverter will check “Riso”, all parameters on both AC and DC sides, and then the AC relay to ensure that connecting to the mains is safe. After all conditions are satisfied for a preset time, which can be set from 20 to 600 seconds, then the system will enter the Grid/MPP mode and feed AC power to the grid. During the Checking mode, the display will follow the information flow as shown in the diagram below.



**Grid/MPP:**

After the system has entered into the Grid/MPP (grid feeding) mode, the inverter will feed the AC power to the mains grid and show on the display, with green colour backlight, the operating mode, the actual AC voltage, frequency, and. The other data such as the cumulated energy, the DC input power of each PV string, and the AC output power of each phase, can be displayed on the LCD by press the "DOWN" button of the keypad as shown in the figure below.

By using the "UP", "DOWN", "ESC", and "OK" buttons, users may be able to view the data they want.

- (a) Press "UP" or "DOWN" key to select the monitoring parameter.
- (b) Press "ESC" key return to previous state.
- (c) Press "OK" key to confirm.



Mode □ Grid/MPP  
Vac □ 230/230/230V  
Fac □ 50.00Hz  
Pac □ 20000W  
03/27 23:50:25

Enter "DOWN" key |

Mode □ Grid/MPP  
Eac\_ty\_ 999kWh  
Eac\_to □ 999999kWh  
CO2\_rd □ 999999kg  
03/27 23:50:25

Enter "DOWN" key |

Mode □ Grid/MPP  
VPV\_A □ 630.0 V  
IPV\_A □ 18.2 A  
WPV\_A □ 11466 W  
03/27 23:50:25

Enter "DOWN" key |

Mode □ Grid/MPP  
VPV\_B □ 630.0 V  
IPV\_B □ 18.2 A  
WPV\_B □ 11466 W  
03/27 23:50:25

Enter "DOWN" key |

Mode □ Grid/MPP  
Vac\_L1\_ 230.0 V  
Iac\_L1 □ 31.8 A  
Pac\_L1 □ 7314 W  
03/27 23:50:25

Enter "DOWN" key |

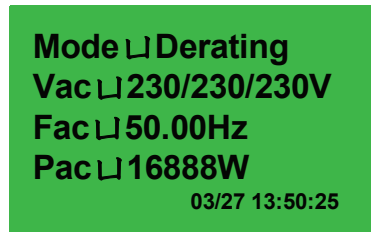
Mode □ Grid/MPP  
Vac\_L2\_ 230.0 V  
Iac\_L2 □ 31.7 A  
Pac\_L2 □ 7291 W  
03/27 23:50:25

Enter "DOWN" key |

Mode □ Grid/MPP  
Vac\_L3\_ 230.0 V  
Iac\_L3 □ 31.9 A  
Pac\_L3 □ 7337 W  
03/27 23:50:25

### **Derating:**

When power de-rating is detected, the “Derating” message will be displayed on the LCD as shown in the picture below. There are five possible situations that may cause output power derating. The ISMG detects only one derating situation at the time. Therefore, users shall also view other information through the RS485 interface if they want to precisely identify the reason that causes derating, when the “Derating” message is displayed. Please refer to **Section 4.3 De-rating Operation** for additional information regarding the situations that can cause power derating. The VDE0126 requires that if the maximum AC output power (110% of the rated power can normally occur together with VacH) lasts for 10 minutes, the inverter shall shut off the output. In the ISMG315/320 inverter, it is designed to lower the output power (output power de-rating) before shutting off the output. If the VacH message goes away, the inverter will not turn off the output. If the VacH message remains, the inverter will shut off its output according to the VDE0126 norm.

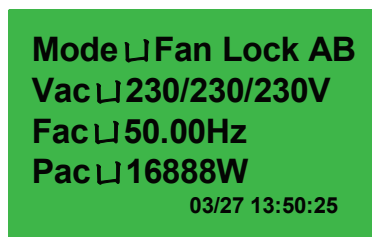


### **Warning:**

There are three possible warning messages that can be displayed on the Display when unexpected situations occur in Grid/MPP mode:

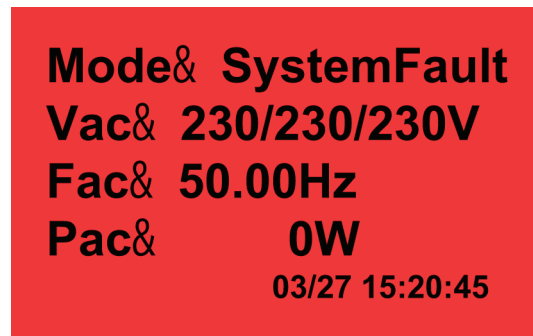
- ❑ When the system has encountered a problem in accessing to the internal EEPROM memory device, the “EEPROM” warning message will be displayed
- ❑ The ISMG3 has encountered a communication error with the external terminal, the “COMM” warning message will be displayed on the LCD;
- ❑ If one and/or two of the built-in fans stop running, the warning message, Fan Lock A, Fan Lock B or Fan Lock AB, will be displayed. If all warnings occur simultaneously, the warning messages will be displayed in the following order with three (3) seconds interval:

COMM => EEPROM => Fan Lock A (or B or AB)



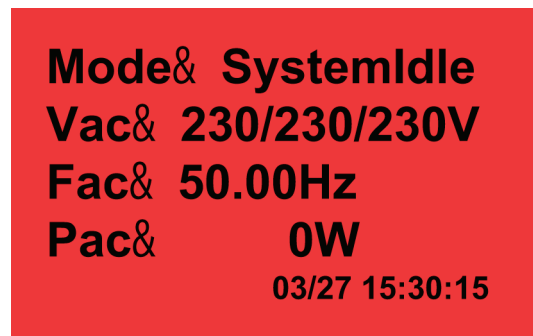
### **System Fault:**

When the system goes into the fault mode, it will shut off the output AC power, disconnect from the mains grid, and have the “System Fault” message displayed on the LCD with the backlight in red color as shown in the figure below. The fault(s) that cause the system going into the fault mode will be recorded. Users can press the “ESC” button to go into the main menu and then select the “Error message” to view the error message(s) of the fault(s). Users may refer to the Error Message Table on Section 3.6 for the explanations of the error messages. When the fault will clear, the inverter will automatically try to go into the Checking mode and then the Grid/MPP mode to feed AC power to the grid.



### **System Idle:**

When the ISMG3 inverter goes into the Idle mode, only service staff can clear this mode and reset the inverter. When in the idle mode, the ISMG3 inverter will shut off the output AC power, disconnect from the mains grid, and have the “System Idle” message displayed on the LCD with the backlight in red color as shown in the figure below. The fault(s) that cause the system going into the idle mode are recorded. Users can press the “ESC” button to go into the main menu and then select the “Error message” to view the error message(s) of the fault(s). Please refer to Error Message Table on Section 3.6 for explanations of error messages.

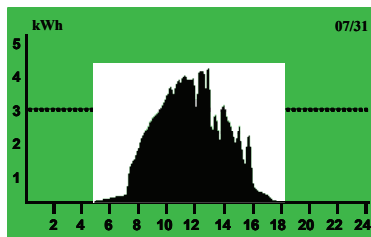


### 3.3.3 Produced Power Graphs

Press the “ESC” button to return to the main menu, then press the “Down” key until the “Graphic Method” is highlighted and then press the “OK” key to confirm the selection. The daily production graph will be displayed on LCD as shown in the figure below. This trend graph shows the output AC power produced on a specified date. The date is indicated on the upper right corner. In order to go to another date press the “OK” button first and then press the “DOWN” or “UP” until the required date is reached. The ISMG3 inverter has enough memory to record the daily chart for up to 31 days.

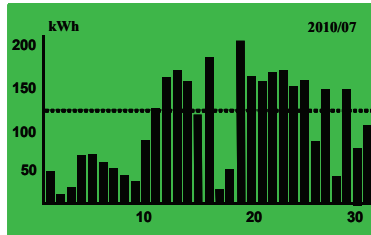


Press “OK” key ↓



Press “DOWN” key ↓

If order to display the monthly chart, first press "ESC" key and then press the "DOWN" key to change to the monthly chart as shown below. On the upper right corner, it shows the present month. To change month press "OK" first and then press "DOWN" or "UP" key to switch the months. The ISMG3 may record monthly charts for up to 12 months.



### 3.3.4 Error Messages

To review the recorded error messages, users shall select "Error Message", on the main screen, by pressing the "Down" or "Up" key from and then press the "OK" key to confirm. The LCD will then display the last error message recorded on the LCD with the date and time that the fault occurred. To see the next recorded error message, press "DOWN" or "UP" key to browse through the pages. The ISMG3 may record up to 99 error messages in the memory.



**System Display  
Graphic Method  
→ Error message  
Setting**

Press "OK" key ↓



**1. 2010 / 07 / 01  
17:45:35  
Error message**

Press "DOWN / UP" key



### 3.3.5 Setting Operation

Some of the Inverter parameters can be re-configured from the built in panel. To change the parameters select "Setting" from the main menu and then confirm by pressing the "OK", as shown below. The standard selection is password protected. The other settings such as the date, time, language, minimum start voltage, start-up time, buzzer ON/OFF, communication baud rate, and RS485 address, are not password protected. The interface protection standard change: DK5940, VDE 0126, or RD1663, shall be carried out by qualified and professional service staff. For this purpose a specific password is required. When the setting change is completed, the inverter must be restarted to have the new settings effectively executed.

The parameters that can be re-configured from the panel are described as follows:

- ❑ Date: Date setting.
- ❑ Time: Time setting.
- ❑ Language: Display language selection.
- ❑ Start V: Adjust the minimum startup voltage.
- ❑ Start Sec: Set the delay time at start-up.
- ❑ Alarm: Turn "ON" or "OFF" the buzzer.
- ❑ Standard: Interface protection standard setting according to local/national requirements.
- ❑ Baudrate: Set the communication serial port baud rate.
- ❑ RS485 Addr: Set the RS485 address.
- ❑ Auto Test: Perform auto-test function. (Only for ISMG315IT and ISMGT320IT)

**System Display**  
Graphic Method  
Error message  
➔ **Setting**

Press "OK" key |

**System Setting**  
  
**Password** □ 000000

Press "UP/DOWN/OK" key |

**System Setting**  
**Date** □ 2010/07/01  
**Time** □ 15:25:35  
**Language** □ English

Press "UP/DOWN/OK" key |

**System Setting**  
**Start V** □ 400.0V  
**Start Sec** □ 300S  
**Alarm** □ OFF

Press "UP/DOWN/OK" key |

**System Setting**  
**Standard** □ DK5940  
**Baudrate** □ 9600  
**RS485 Addr.** □ 250

Press "UP/DOWN/OK" key |

**System Setting**  
**Auto Test** □ OFF

Press "ESC" key |

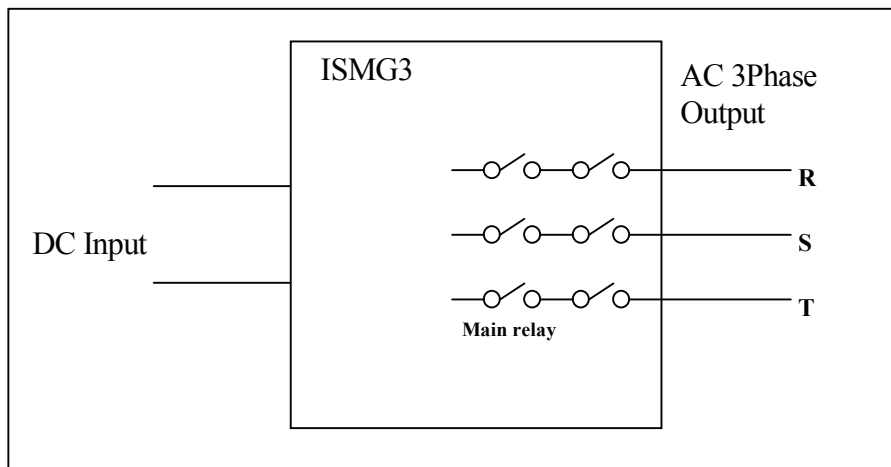
**EXIT Setting** □ YES

Press "DOWN/OK" key

### 3.4 Auto Test (Only for ISMG315IT and ISMG320IT)

This Auto Test function is required according to the Italian Standard DK5940. With the Auto Test function, users may be able to verify the AC voltage and frequency (grid side) monitoring function. When the Auto Test function is running, the inverter will not provide AC power to the mains grid. The Auto Test routine shall be in the order as:

- Maximum AC voltage threshold test for each phase
- Minimum AC voltage threshold test for each phase
- Maximum AC frequency threshold test for each phase
- Minimum AC frequency threshold test for each phase



There are two relays series connected for each phase of the AC output as shown above. The Main relay will be closed (activated) when running each threshold test for each phase. After the threshold test is complete the Main relay will be released (de-activated). The Auto Test functionality and procedure is described in the following sections.

### 3.4.1 Auto test PC Software

The Auto Test software as an accessory provided with the inverter and should be installed in a computer which is connected to the inverter through the “**RJ45-L port**” (the RJ45 port on the left-hand side of the Inverter). Once the software is installed successfully, the .EXE file “**ISMG315/320 Auto Test**” has been created in the sub-directory “**Start\Programs menu**”. Users may start the Auto Test function by double clicking “**ISMG315/320 Auto Test.exe**” file . The program starts with a search routine for all inverters connected to the computer, a pop-up window will appear on the PC screen: “**Search for inverters**” as shown in Figure 3.4.1.1. If no inverters are found, the “**Search again**” warning message will be displayed on the screen. A re-confirm that the connections are correct within the RS485 communication loop is required. Then click on the “**Search for inverters**” button to search again. If at least one inverter is found, the serial number and the status of the inverter will be shown on the screen as shown in Figure 3.4.1.2.

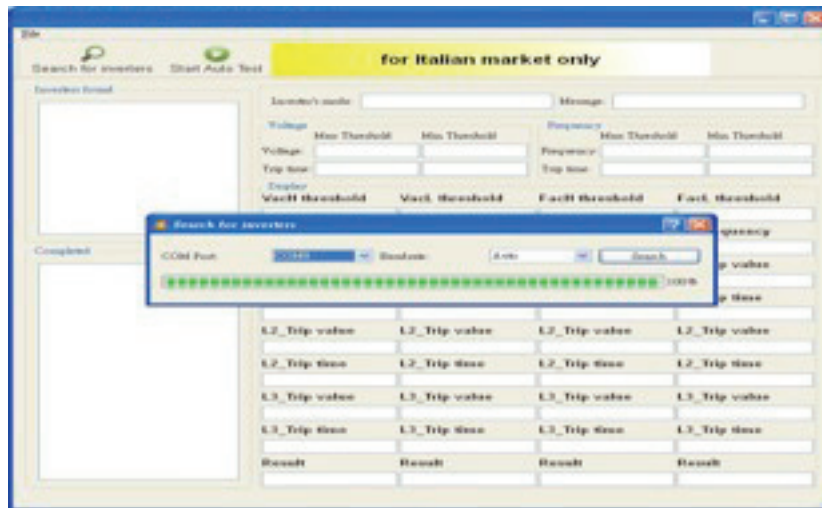
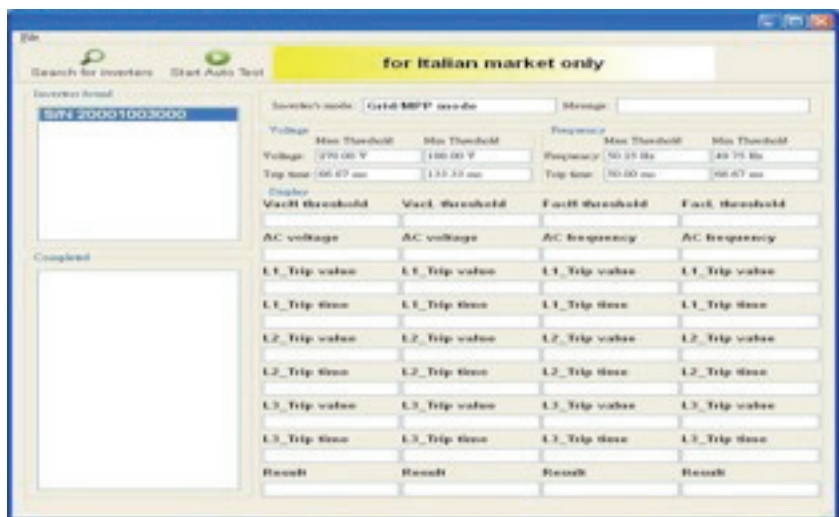


Fig 3.4.1.1 Search for inverters



Fig

3.4.1.2 Communicated successfully

Only one inverter at the time can be selected to run the Auto Test function even if more than one inverter is found. Users can choose the inverter by highlighting the serial number and then click the “Start Auto Test” button to run the Auto Test function, which will be performed in the order as shown in Figure 3.4.1.3 and described below.

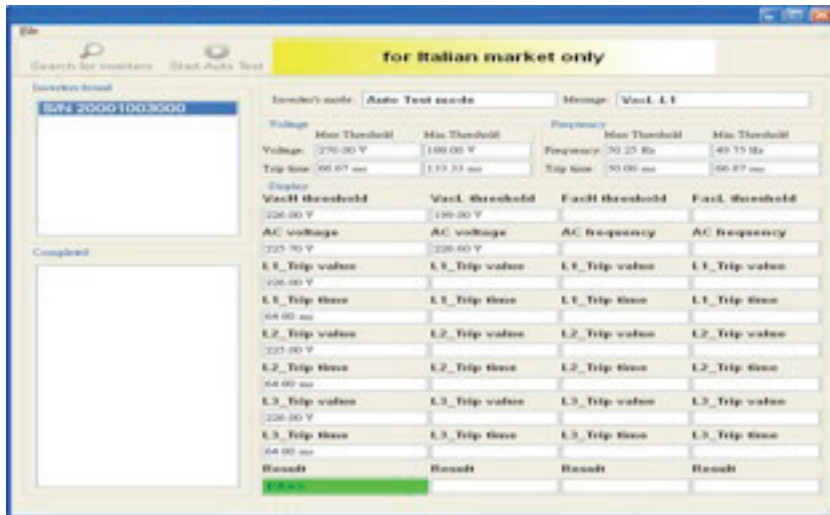
- a. Maximum AC voltage (VacH) threshold ( phase order: R → S → T )
- b. Minimum AC voltage (VacL) threshold ( phase order: R → S → T )
- c. Maximum AC frequency (FacH) threshold ( phase order: R → S → T )
- d. Minimum AC frequency (FacL) threshold ( phase order: R → S → T )

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 starts. The slew rate of the threshold values, either increase or decrease, are  $\leq 0.05$  Hz/s for frequency and  $\leq 1$  V/s for voltage starting from the maximum (or minimum) threshold value. During the Auto Test the threshold value changes linearly and the measured

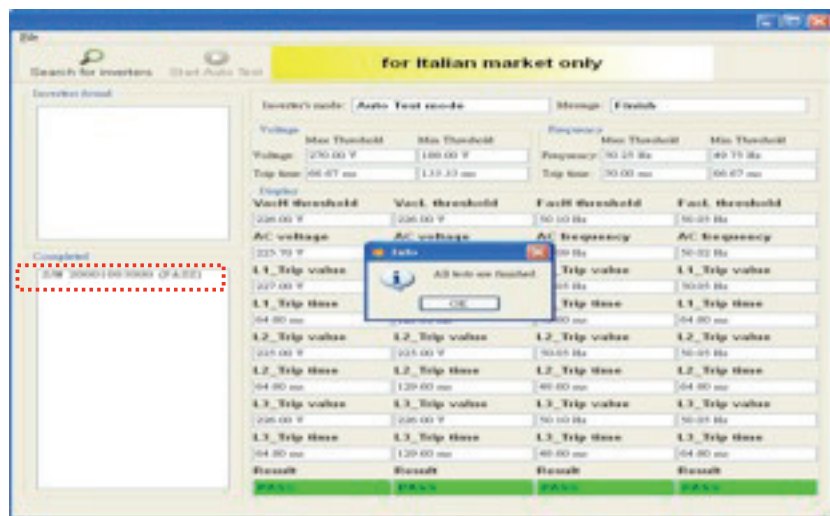
voltage or frequency of the AC grid will be displayed on the PC screen. The maximum/minimum threshold values and the accepted trip time defined in DK5940 are as follows:

- a. Maximum AC voltage threshold: 270 V; < 80 ms**
- b. Minimum AC voltage threshold: 188 V; < 160 ms**
- c. Maximum AC frequency threshold: 50.25 Hz;  $\leq$  60 ms**
- d. Minimum AC frequency threshold: 49.25 Hz;  $\leq$  80 ms**

The threshold value will decrease (or increase) from the maximum (or minimum) threshold value toward the measured value of the AC grid. When the threshold value reaches the measured AC voltage or frequency of the grid the inverter will disconnect the AC line by de-activate the Main relay. The inverter will measure the time duration when the command has been sent and the disconnection is recognized. This time duration must be less than the trip time defined.



(a) Start Auto-test



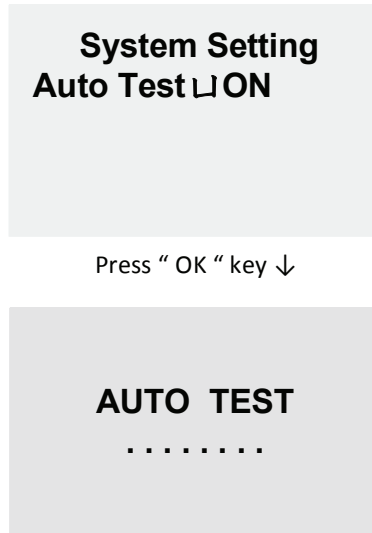
(b) Auto-test completed

Fig 3.4.1.3 Auto-test process

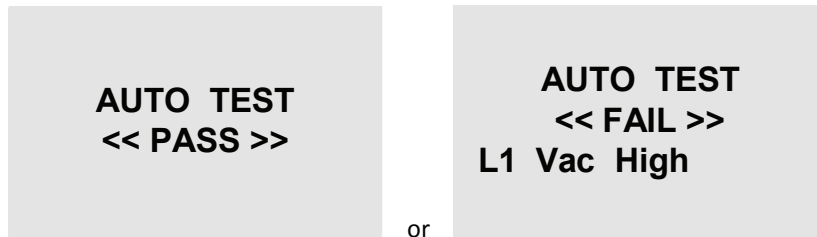
After all sub tests are completed, a popup window “All tests are finished” will appear on the PC screen and the “OK” key, on the PC screen, has to be pressed in order to stop the Auto Test software.

### 3.4.2 Use Self-testing

It is also possible to run the Auto Test function without a computer connected. From the main display menu, select "Setting" and then select "Auto Test" and press "OK" to perform the Auto Test function as shown below. (Please refer to Section 3.3.5)



When the Auto Test function starts running, the "AUTO TEST" message will be displayed on the Display as shown above and stay until the Auto Test function ends with "PASS" or "FAIL" message on the display. If the test fails, it will also show the tested item which didn't pass the threshold test.







**CAUTION!**

If any one of these sub tests fails, the inverter will go into the “fault mode” and stop the test. The inverter will stay in “fault mode” and will not restart unless the test is re-run and it is Passed



**CAUTION!**

The only purpose of the Auto Test function is only to check the operation of the interface protection functionality of the inverter. It will NOT change any actual threshold and trip setting.

### **3.5 Error Messages description**

when a fault occurs, the inverter will stop feeding the AC power to the utility grid and display the error message on the LCD. Qualified service staff shall analyse, measure, and if needed proceed with debugging, according to the error message, in order to restore normal operation. It is recommended to screen out the fault condition(s) by referring to the table below and then remove the fault condition(s) to have the inverter back to normal condition and continue to feed AC power to the utility. Please contact Carlo Gavazzi local National Sales Company, your distributor or service representative if the same error message persists.

## Error Messages Table

Error Message	Description
GridNA	No AC voltage is detected on the utility grid side.
VacH	The AC voltage of utility grid is over the upper limit.
VacL	The AC voltage of utility grid is under the lower limit.
FacH	The AC frequency of the utility grid is over the upper limit.
FacL	The AC frequency of the utility grid is under the lower limit.
Phase Loss	One or two phases are missing (AC voltage is not present on that / those phase).
L2, L3 Swap.	L2 and L3 phases are reversed.
Drift Fac	Islanding is detected.
FastEarthCurrent	The drastic change of the leakage current has been detected.
SlowEarthCurrent	The leakage current has exceeded a safe operating limit.
DCInjectCurH	The DC current injected into the AC grid is over the upper limit.
Iac_Max.	Over current on the grid side.
IacH	The AC current is over the upper limit.

Error Message	Description
Riso Low	The insulation resistance between PV array and the ground is below the safe operating limit.
VpvH	The DC voltage of PV array is over the upper limit.
IpvH	Over current on the DC side.
PpvH	Over power on the DC side.
VdcbusH	Internal DC bus voltage is over the upper limit.
VdcbusL	Internal DC bus voltage is below the lower limit.
Temp. High	The internal temperature of the inverter exceeded the safe operating limit.
CPUs diff.High	Internal measurements from both CPU's are differ from each other.
System Error	General system failure.
Relay Open	Output relay failure.
Relay Short	
Relay Fault	
Vdcbus Fault	DC/DC converter failure.

Error Message	Description
RCMU Fault	Leakage current measurement device failure.
I/P HCT Fault	Input/Output current sensor failure.
O/P HCT Fault	
HCT Fault	
Idc-inj. Fault	DC injection current monitoring function failure.
SPI Error	Internal communication failure.
EEPROM Fault	EEPROM test failed. *warning message
FanLock_A	Cooling fan / fans stopped running. *warning message
FanLock_B	
Comm. Error	External communication failed. *warning message
Offset Fault	Internal reference voltage failed, +1.5VA, +1.5VB.
CalDataLoss	Loss of the Calibration data.
Model Error	The hardware MODEL and the CPU software versions are not compatible.
Version Error	The firmware version is not correct.

### **3.6 Troubleshooting**

The error message(s) are displayed on the LCD and recorded in memory when the ISMG3 inverter has encountered a fault situation. Some critical faults will cause the inverter to automatically shut off the output AC power. For safety reason, the inverter will not re-start until the fault will be cleared. In general, we suggest to follow the steps described below to identify and solve the problems.

1. Make sure that the ISMG3 inverter is correctly connected to the mains utility and PV arrays following the connection procedures described in this manual.
2. Try to identify and solve the problem based on the troubleshooting table below.
3. If the problem cannot be identified and solved, please contact your local Carlo Gavazzi National Sales Company, distributor or service representative for assistance.

### Trouble Shooting Table

Error Message	Possible Causes	Disposal Measures
<b>Comm. Error</b>	<span style="border: 1px solid black; padding: 2px;">?</span> External communication malfunction	<span style="border: 1px solid black; padding: 2px;">✖</span> Restart the inverter again; Inform professional service staff if failure does not restore
<b>CPUs diff.High</b>	<span style="border: 1px solid black; padding: 2px;">?</span> Calibration parameters are deviated	<span style="border: 1px solid black; padding: 2px;">✖</span> Inform professional service staff in order to check the calibration parameters
	<span style="border: 1px solid black; padding: 2px;">?</span> Internal circuits malfunction	<span style="border: 1px solid black; padding: 2px;">✖</span> Restart the inverter again; Inform professional service staff if failure does not restore
<b>DCInjectCurH</b>	<span style="border: 1px solid black; padding: 2px;">?</span> AC current sensor malfunctions	
	<span style="border: 1px solid black; padding: 2px;">?</span> The default settings are inappropriate	<span style="border: 1px solid black; padding: 2px;">✖</span> Inform professional service staff to check the settings

<b>Error Message</b>	<b>Possible Causes</b>	<b>Disposal Measures</b>
<b>EEPROM Fault</b>	? EEPROM's parameters are unrecognized	✘ Inform professional service staff to update the EEPROM's parameters
<b>FanLock_A FanLock_B</b>	? Fan malfunction	✘ Inform professional staff to replace the fan
<b>FastEarthCurrent SlowEarthCurrent</b>	? DC or AC wires insulation is damaged and it causes high ground fault current	✘ Check the DC and AC wire insulation
<b>GridNA (Loss of Mains)</b>	? AC feed lines are disconnected	✘ Check the AC wirings
	? AC switch/breaker is open	✘ Close the AC switch/breaker after clearing the faults
	? Grid power blackout	✘ Wait until the grid is restored
<b>HCT Fault</b>	? DC or AC current sensor malfunctions	✘ Restart the inverter; Inform prof. staff if failure does not restore
<b>Iac_Max. IacH</b>	? Mains voltage drops suddenly	✘ If seldom occurring it can be ignored
	? The inverter malfunctions	✘ Inform professional staff if failure does not restore



<b>Error Message</b>	<b>Possible Causes</b>	<b>Disposal Measures</b>
<b>Idc-inj. Fault Offset Fault</b>	<b>?</b> Internal circuit malfunctions	<b>✘</b> Restart the inverter again; Inform professional staff if failure does not restore
<b>L2, L3 Swap.</b>	<b>?</b> L2 and L3 cables are wired reversed	<b>✘</b> L2 and L3 wirings shall be swapped
<b>Model Error</b>	<b>?</b> Default settings are wrong	<b>✘</b> Inform professional staff to replace the inverter
<b>Phase Loss</b>	<b>?</b> One of the AC wirings is disconnected	<b>✘</b> Check the AC wirings
<b>RCMU Fault</b>	<b>?</b> Residual current protective device malfunctions	<b>✘</b> Restart the inverter again; Inform professional staff if failure does not restore
<b>Relay Open Relay Short Relay Fault</b>	<b>?</b> AC relay malfunctions	
<b>Riso Low</b>	<b>?</b> Moisture or conductive matter between DC lines and earth.	<b>✘</b> Remove matter and or dry the wet area then restart the inverter again
<b>SPI Error</b>	<b>?</b> Internal communication malfunctions	<b>✘</b> Restart the inverter again and Inform professional staff if failure does not restore
<b>Temp. High</b>	<b>?</b> Insufficient Air circulation	<b>✘</b> Allow a clearance of at least 20cm at least from walls or other devices for air intake and exhaust
	<b>?</b> Ambient temperature is too high	<b>✘</b> Ensure the ambient temperature is below 60°C

<b>Error Message</b>	<b>Possible Causes</b>	<b>Disposal Measures</b>
<b>VacH</b> <b>VacL</b> <b>FacH</b> <b>FacL</b> <b>(Mains voltage or frequency is beyond the limit)</b>	<b>?</b> AC voltage or frequency exceeds the default settings	<b>✘</b> Wait until the grid is back to stable condition
	<b>?</b> Mains voltage or frequency is unstable	<b>✘</b> Request the utility supplier to improve and then inform professional staff to change the settings.
	<b>?</b> The settings are inappropriate	<b>✘</b> Inform professional staff to check the settings.
<b>VdcbusH</b> <b>VdcbusL</b> <b>Vdcbus Fault</b>	<b>?</b> The inverter malfunctions	<b>✘</b> Restart the inverter and Inform professional staff if failure does not restore
<b>Version Error</b>	<b>?</b> Firmware version is incompatible	<b>✘</b> Reinstall the firmware according to the instruction
<b>VpvH</b> <b>IpvH</b> <b>PpvH</b>	<b>?</b> PV array voltage exceeds the permissible value	<b>✘</b> Disconnect the DC source and inform the system installer to check the configuration of PV arrays

## 4. Technical Documentation

### 4.1 Outline Drawing

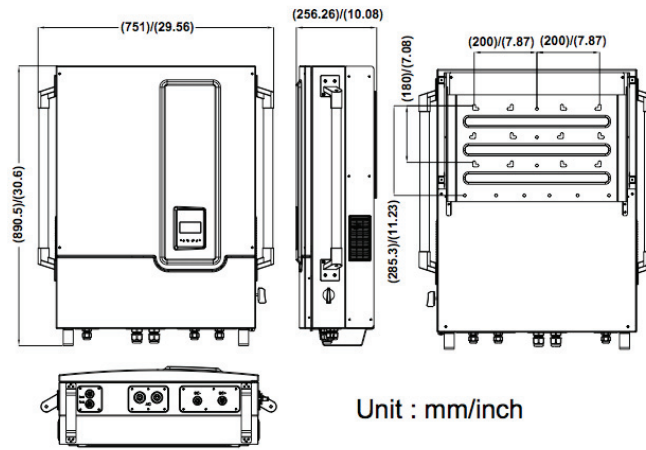


Fig 4.1.1 Outline Drawing of ISMG3

## 4.2 Efficiency

The efficiency of the ISMG315/320 is shown in Figure 4.2.1 and Figure 4.2.2 below.

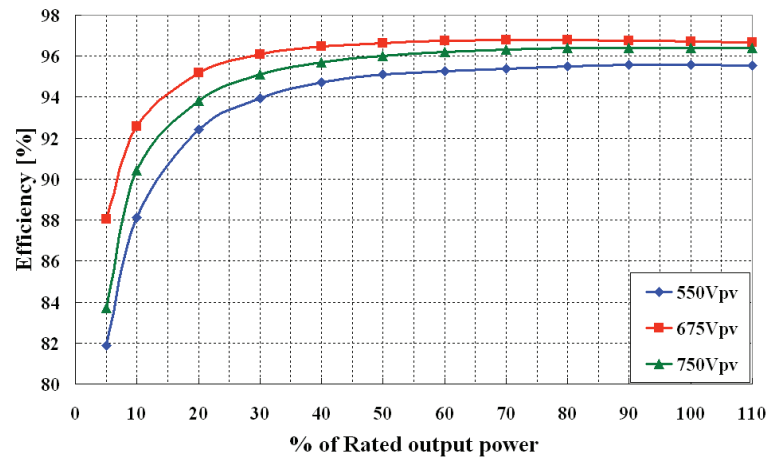


Fig 4.2.1 Efficiency of the ISMG320 = 96.0%

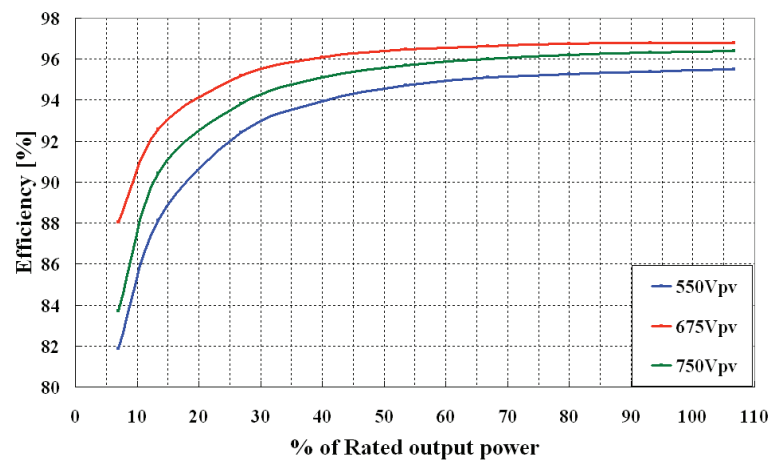


Fig 4.2.2 Efficiency of the ISMG315 = 95.5%

### 4.3 De-rating Operation

Here below are described the different situations in which the Inverter will limit the output power in order ensure the system operates in a safe condition.

#### Temperature

The ISMG3 inverter monitors the heat sink temperature. If the temperature exceeds 70°C (ambient temperature is around 45°C), the the output power will be reduced until the temperature falls under the critical value. The ISMG3 inverter will shut down the AC power output to the grid if the temperature reaches 85°C. If this situation occurs frequently, it is necessary to check whether the inverter is installed in an adequate location, with good ventilation and not exposed to direct sunlight.

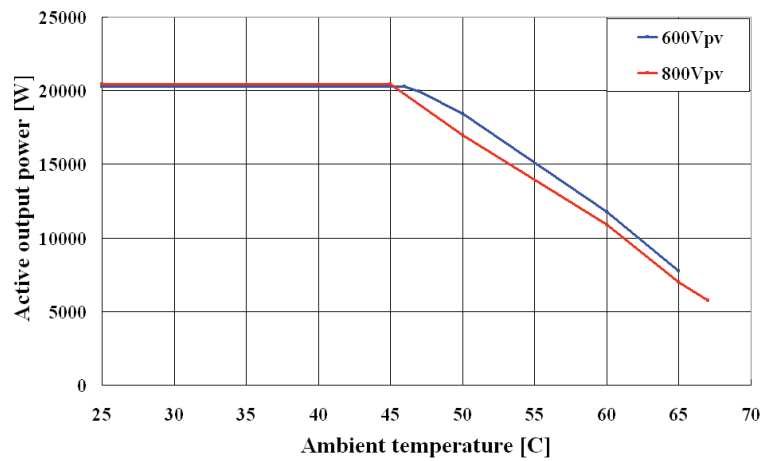


Fig 4.3.1 Temperature de-rating curve of the ISMG320

### Input DC current excess

When the input current from the PV strings is about to exceed the maximum value, the ISMG3 inverter will limit it to the safe operating value in order to prevent damages to the inverter. If this situation occurs frequently, it is necessary to check whether the PV arrays are properly configured according to the Inverter DC current limit.

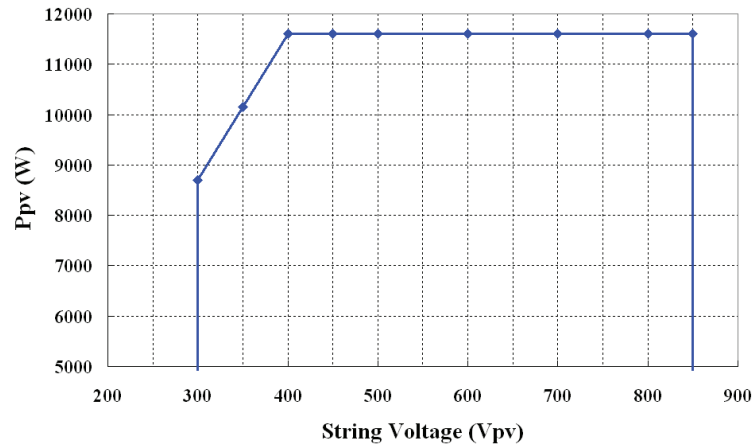


Fig 4.3.2 DC Power curve of the independent PV string of the ISMG320

### Output AC power excess

The maximum power that the ISMG3 inverter feeds to the grid is limited according to the specifications listed in Section 1.2. The Output current of is limited by the ISMG3 inverter is in case the AC voltage becomes too high in ordet to maintain the power within the specified limit.

### Output AC current

The maximum current that the ISMG3 inverter feeds to the grid is limited according to the specifications listed in Section 1.2.

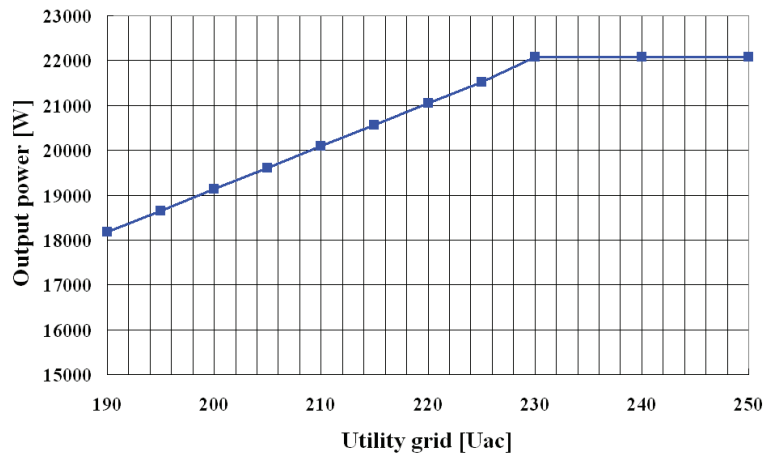


Fig 4.3.3 Output Power v.s. Grid voltage of the ISMG320

## 4.4 MPP Efficiency

The ISMG315/320 supports up to two (2) PV strings that can be either connected in parallel, feeding into a single MPP tracker, or connected individually to each MPP tracker. The efficiencies of the 2 configurations: two(2) PV strings connected in parallel and connected individually are shown in Figure 4.4.1 and Figure 4.4.2 respectively.

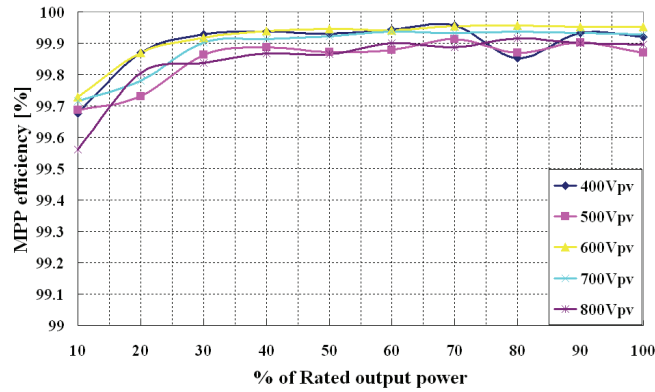


Fig 4.4.1 MPP Efficiency of the two PV strings in parallel

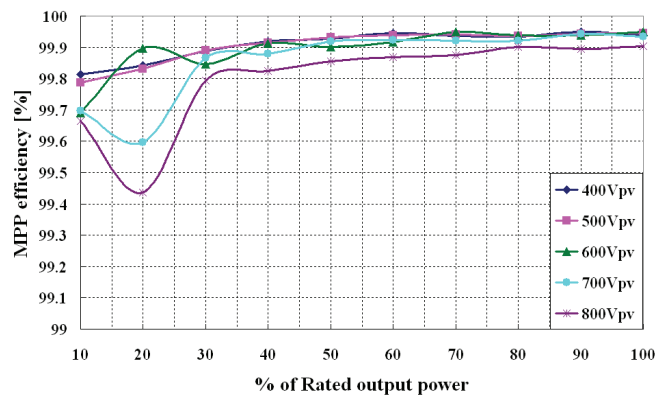


Fig 4.4.2 MPP Efficiency of the two PV strings in individual





**WARNING!**

PV arrays are always energized when exposed to light therefore hazardous voltage is still present on the terminal blocks and the PV string fuse holders even the DC disconnect switch is switched OFF. Please cover the PV arrays with opaque (dark) materials during the inverter removal. Keep covered until the inverter is hooked back and reconnected.



**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.



**WARNING!**

Check that all DC and AC switches are turned off for at least five (5) minutes before opening the front covers of the inverter and the wiring box and disconnect the DC and AC wires between them. The wires that have been disconnected shall be wrapped with an insulated material in order to prevent electrical shocks of the service personnel and to avoid short circuits.



**WARNING!**

Not to keep any spare parts inside the wiring box.

## **5. Warranty information**

### **Warranty Period**

A period of 5 years is warranted from the date of your purchase of the ISMG3 series Products.

Additional 5 years warranty: warranty extension up to 10years can be purchased separately within the term specified in the “warranty terms certificate” from purchase date of the unit

### **Warranty Terms**

The warranty terms of the ISMG3xx Inverters are specified in the “Warranty terms and certificate” leaflet enclosed in the package of purchased unit.

### **Product Return Procedure**

The product return procedure and terms are described in the “Warranty terms and certificate” leaflet enclosed in the package of purchased unit.

### **On-site Inspection & Repair**

The on-site Inspection & Repair procedure and terms are described in the “Warranty terms and certificate” leaflet enclosed in the package of purchased unit.

**Your Notes :**