Allis Electric Co., Ltd.

Installation Manual

Single-Phase Grid-Connected Photovoltaic Inverter

TOUGH - Series

These applied symbols are important for human safety. Violation of warnings may result in injury to persons or cause death.

WARNING !

RISK OF ELECTRIC SHOCK

WARNING !
RISK OF ELECTRIC SHOCK, ENERGY STORAGE TIMED DISCHARGE

WARNING !

RISK OF DANGER

WARNING !

HOT SURFACE

REFER TO THIS OPERATIONAL MANUAL

Safety Notes

General Cautions

Read and follow all instructions in this manual. Failure to comply with the warnings in this manual may violate safety standards. The manufacturer assumes no liability for the customer's failure to comply with these requirements.

Installation of the device must be in accordance with the relevant safety regulations. Correct grounding and over-current protection must be provided to ensure operational safety.

Pay attention to the high temperature components and sharp edges. The temperature of the heat sinks on the outside of the device can reach over 70°C in normal operation. There is the risk of burn injury when these parts are touched.

Warning, Risk of electric shock

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

Only the licensed and qualified electricians are allowed to perform the installation, wiring, maintenance or modification on the device.

Switch off the circuit breakers before installation and wirings. Never stand on a wet location when working on installation and wirings.

Even when no external voltage is presented; the 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.

The inverter must be provided with an equipment-grounding conductor connected to the AC ground.

Maintenance and Clean

Each inverter is well calibrated before shipment and needs no additional maintenance during normal operation.

Alterations are not to be made and no tampering with the assembly in the inverter without the manufacturer's authorization unless specified elsewhere in this manual. They may result in injury, electric shock, or fire and void the warranty.

The inverter contains no user serviceable parts inside. Only trained staff is authorized to repair the unit. Please contact the specialized dealer or system technician for further examination.

Wipe the enclosure and display lens with a soft cloth. Do not use aggressive detergent or cleaning solvents.

Switch the DC disconnect on and off at least once per month in order to clean the contacts of switch.

Contents

List of Figures

1 Introduction

1.1 General

The grid-connected inverter converts DC power yielded from solar array into AC power for household consumption. Furthermore, the remaining AC power can be transmitted and sold back to the utilities company. The inverter operates intelligently under normal conditions and provides no backup power in case of power cut. The configuration is straightforward as shown below. Connect the PV wires from floating (ungrounded) PV array to the DC input of the inverter; also, connect the AC output to the service entrance. Please consult with your installer for PV array ratings and external protective devices if the electrical codes are stipulated locally.

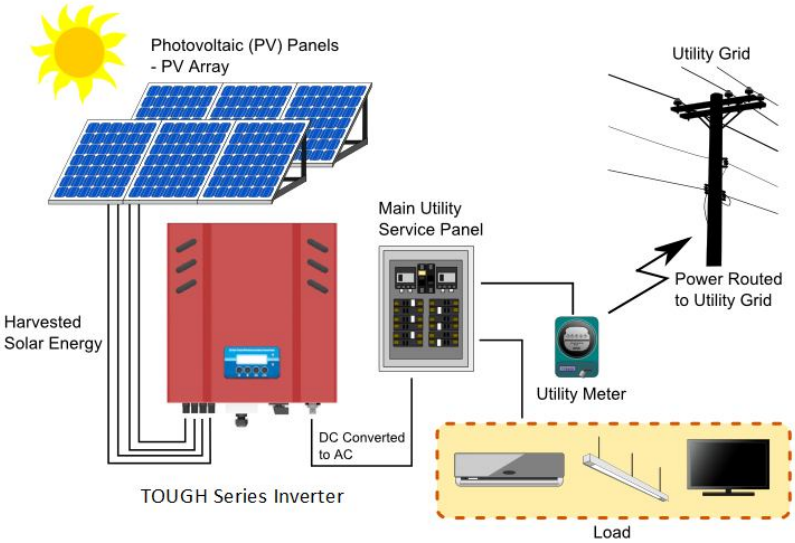


Fig 1: *Grid connected solar system overview*

1.2 Specifications

Model	TOUGH-3000
Output Data (AC)	
Maximum AC Output Power	3000 VA
Maximum AC Output Current	14.5 a.c.A
Nominal AC Voltage	230 a.c.V
Grid AC Frequency	50 / 60 Hz, auto-selection
Power Factor	> 0.99 @ 20% load
Reactive Power Factor	1 or adjustable from -0.9 to +0.9**
Total Harmonic Distortion	< 3%
Max. output fault current (Inrush)	26 A_{peak} / 200 µs
Max. output overcurrent protection	20 A
AC connection / Grid forms	Single-Phase / TN-C, TN-S, TN-C-S
Input Data (DC)	
Maximum DC Power	3200 W
Maximum DC Voltage	550 d.c.V
MPP Tracking Voltage Range	150-500 d.c.V
Peak Power Tracking Voltage	200-460 d.c.V
Maximum DC Input Current (IscPV)	16 d.c.A
Max. number of MPP Trackers	1
Efficiency	
Maximum Efficiency	96.5%
Euro. Efficiency	95.8%
Consumption: Operating (standby) / Night	< 12 W / < 0.2 W

General Specification	
Dimensions (W x H x D) in mm	405 x 442 x 152
Weight	18 Kg
Cooling Concept	Free Convection
Acoustic Noise Level	< 35 dB(A)
Maximum Operating Temperature	-20 to +45 °C (without derating)
Ambient Temperature Range Storage / Transportation Condition	-25 to +60 °C
Relative Humidity Storage / Transportation Condition	4 to 100%
Operating Altitude	2000 m
Pollution Degree	PD3
Protection Class of Enclosure	IP65
Protection Class	Class I
Overvoltage Category	OVC Ⅱ (PV) / OVC Ⅲ (Mains)
Topology	Transformerless
Features	
DC Connection	MC4, Tyco
DC Disconnect	yes
AC Connection	AC connectors
Display	LCD 16X2 screen
Communication Interface	RS232, RS485；Bluetooth (Option)
EMC & Low Voltage Directives	2004/108/EC & 2006/95/EC
Standards	IEC/EN 62109-1/-2, VDE-AR-N 4105
Warranty	5 years

Model	TOUGH-3300	TOUGH-4000	TOUGH-5000
Output Data (AC)			
Maximum AC Output Power	3300 VA	4000 VA	5000 VA*
Maximum AC Output Current	16.5 a.c.A	20 a.c.A	22 a.c.A*
Nominal AC Voltage	230 a.c.V		
Grid AC Frequency	50 / 60 Hz, auto-selection		
Power Factor	> 0.99 @ 20% load		
Reactive Power Factor	1 or adjustable from -0.9 to +0.9**		
Total Harmonic Distortion	< 3%		
Max. output fault current (Inrush)	26 A_{peak} / 200 µs		
Max. output overcurrent protection	20 A		
AC connection / Grid forms	Single-Phase / TN-C, TN-S, TN-C-S		
Input Data (DC)			
Maximum DC Power	3600 W	4300 W	5300 W
Maximum DC Voltage	650 d.c.V		
MPP Tracking Voltage Range	150-500 d.c.V		
Peak Power Tracking Voltage	200-460 d.c.V		
Maximum DC Input Current (IscPV)	2 x 10 d.c.A	2 x 13 d.c.A	2 x 15 d.c.A
Max. number of MPP Trackers	2		
Efficiency			
Maximum Efficiency	96.5%	96.8%	96.9%
Euro. Efficiency	96.1%	96.5%	96.6%
Consumption: Operating (standby) / Night	< 12.5 W / < 0.2 W		

* It is limited to 4600VA and 20A in accordance with the Germany Standard VDE-AR-N 4105.

** Adjustable from 0.95 overexcited to 0.95 underexcited with VDE-AR-N 4105.

General Specification	
Dimensions (W x H x D) in mm	405 x 442 x 165
Weight	25.8 Kg
Cooling Concept	Free Convection
Acoustic Noise Level	< 35 dB(A)
Maximum Operating Temperature	-20 to +55 °C (without derating)
Ambient Temperature Range Storage / Transportation Condition	-20 to +60 °C
Relative Humidity Storage / Transportation Condition	4 to 100%
Operating Altitude	2000 m
Pollution Degree	PD3
Protection Class of Enclosure	IP65
Protection Class	Class I
Overvoltage Category	OVC Ⅱ (PV) / OVC Ⅲ (Mains)
Topology	Transformerless
Features	
DC Connection	MC4, Tyco
DC Disconnect	yes
AC Connection	AC connectors
Display	LCD 16X2 screen
Communication Interface	RS232, RS485；Bluetooth (Option)
EMC & Low Voltage Directives	2004/108/EC & 2006/95/EC
Standards	IEC/EN 62109-1/-2, VDE-AR-N 4105
Warranty	5 years

Adjustable voltage, Frequency and Reconnection Settings

Setting	VDE-AR-N 4105	
	Range	Default
Over-frequency (Hz)	50.05~51.50 (60.05~61.50)*	51.5 (61.5)*
Over-frequency disconnection time (cycle)	1~10	8
Under-frequency (Hz)	47.50~49.95 (57.50~59.95)*	47.50 (57.50)*
Under-frequency disconnection time (cycle)	1~10	8
Over-voltage (Vac)	235~264.5	264.5
Over-voltage disconnection time (cycle)	1~10	8
Under-voltage (Vac)	184~225	184
Under-voltage disconnection time (cycle)	1~10	8
DC injection tripping current (A)	0.1~1.0	1.0
DC injection disconnection time (cycle)	1~150	8
Insulation resistance trip setting (MΩ)	0.5~10	0.5
PV start voltage (Vdc)	150~500	150
Reconnect delay** (s)	5~300	60

* This inverter product is compatible on the frequency of 50Hz or 60Hz.

** Once a grid failure occurs, the inverter waits 5~300 seconds before the next connection to the utility grid. The default setting is 60 seconds for VDE-AR-N 4105.

1.3 Functions and Features

- DSP (Digital Signal Processor) makes use of the advanced digital control technology to enhance the conversion efficiency and the added functions.
- Conformity to the EMC, Low Voltage Directives and Standards, e.g. 2004/108/EC, 2006/95/EC, IEC/EN 62109-1/-2 and VDE-AR-N 4105.
- Single/Dual MPPT (Maximum power point tracking), the range of MPPT: 150~500 Vdc.
- Maximum power exports @ 220~240 Vac.
- Maximum efficiency: higher than 96.5%.
- LCD displays the power status and the real-time information.
- Low acoustic noise while the inverter operates.
- Low loss unipolar configuration with high-frequency switching IGBT.
- Waterproof and quickly-installed connectors used.
- Monitor the power information and the system settings via a computer, the monitoring software and RS232 / RS485 / Bluetooth (optional) interfaces (please refer to the Installation Manual).
- The power generation system is interactive and complementary to the utility's power. When the power generation is insufficient, it can be supplied by the local utility's power; when power cut happens, disconnect the power automatically to maintain the personnel safety.

1.4 Accessories

Please check the inverter and accessories in the package. If there is some part incomplete or any pages missing from the manual, please contact the authorized agent. Please check the following items in the box:

A. Photovoltaic Inverter x 1

B. Mounting Bracket x 1

C. Female Cable Coupler Plus Key x 1 and Minus Key x 1

* For Dual MPPT：Plus Key x 2 and Minus Key x 2

D. AC Female Connector x 1

E. Fixing Screws (bet. the inverter and bracket) x 2

F. Operation Manual (incl. warranty page) x 1

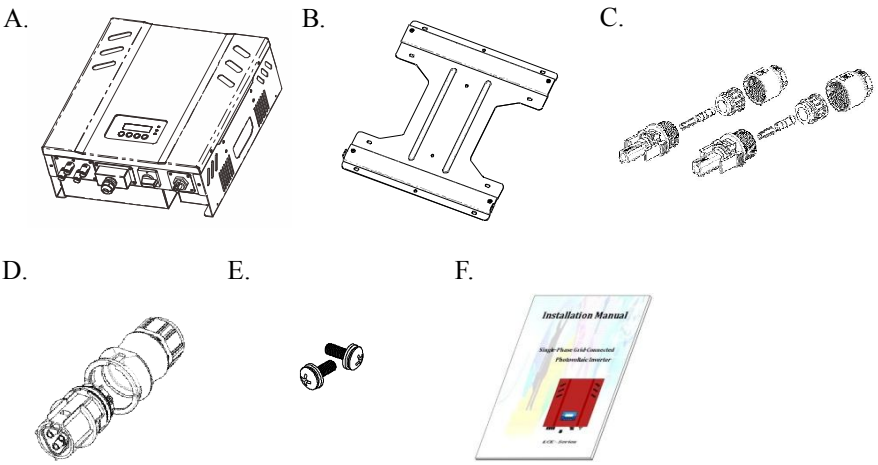


Fig 2: *Accessories in the package*

2 Installation

2.1 Placement

Please take the following points into consideration when installing the inverter and selecting the installation location:

- A solid and vertical wall is essential; not to hand it on a forward-tilting surface. The backward-tilting angle must be less than 30°.
- The installation location of the inverter must conform to the size and weight specifications (See the technical information on 1.2.).
- The inverter installation location must have the appropriate amount of space and be kept clear, and the inverter can be safely operated without the assistance of auxiliary tools (such as ladder or lift).
- The installation location of the inverter must have at least 20 cm of space. The environmental temperature must be kept at -25 °C ~ 60 °C.
- To obtain the best conversion efficiency, the DC and AC power connection prefer the shortest distance. If the distance exceeds 20m, it's recommended that the diameter is increased (according to the specifications of this inverter, the standard diameter of DC and AC power wires are 12 AWG.).
- In order to select the appropriate installation location for the inverter, please see the outline drawing.
- The inverters with IP65 rating can be installed outdoors. However, it's recommended to avoid direct sunlight and rain. If it can't be avoided, please install a rain shield to extend the lifetime of the inverter.

In theory this IP65 unit can be used in pollution degree 4. However, it is suggested to provide with means to reduce the micro-environment to pollution 1, 2 or 3.

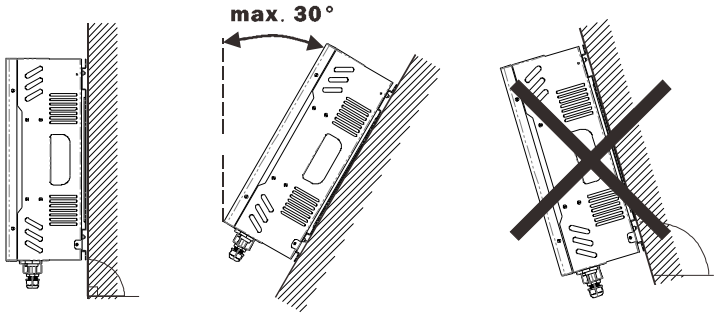


Fig 3: *Hanging surface*

2.2 Mounting

2.2.1 Safety Notes

Don't remove the external cover of the inverter. No parts inside the inverter are to be maintained by the user. If necessary, only qualified maintenance staff can carry out; The solar panel exposed to sunlight supplies DC power. Pay attention to electric shock when connecting the DC power to the inverter.

The inverter (not stand-alone type) is designed to connect in parallel with the utility network. In order to avoid damage, the AC output can't be connected to a power generator or the like.

Heat will generate when the inverter operates. Don't touch the heat sink or on top of the enclosure to avoid injury due to the hot surface.

2.2.2 Install Inverter on Wall

1. Select the appropriate space and the solid and vertical surfaces enough to support the inverter.
2. The space surrounding the inverter must be appropriate so that heat can be dissipated easily and maintained conveniently, as shown below.

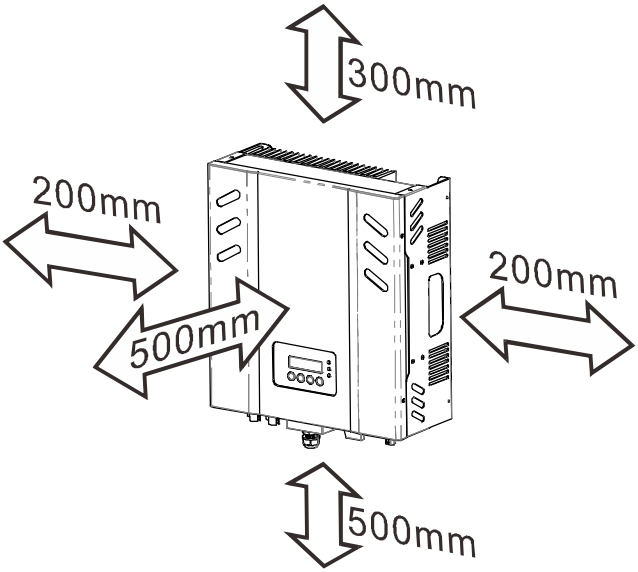


Fig 4: *Clearances required for installation*

3. The wall bracket is fixed on the wall by these 4～6 screws. The position of the fixing hole can be selected according to the wall condition. The construction can be referred in the following figure.

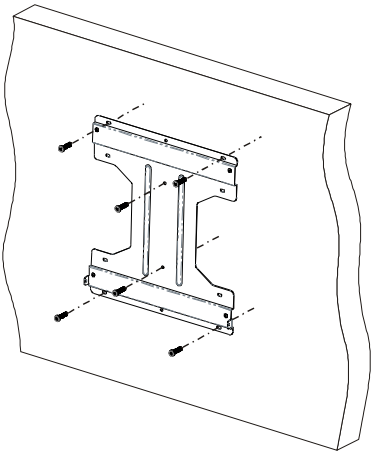


Fig 5: *Fasten the mounting bracket*

4. The four holes behind the inverter are simultaneously aligned with the four hooks on the bracket. Two persons are required to complete this step safely and correctly.

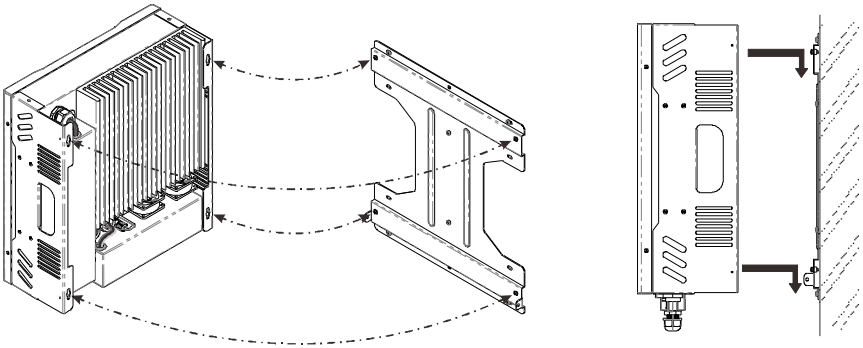


Fig 6: *Hook the inverter on the mounting bracket*

5. Finally, the screws (see Appendix F in 1.4) are used to lock in the holes on the left and right sides of the support, so that the inverter can be fixed on the wall rack.

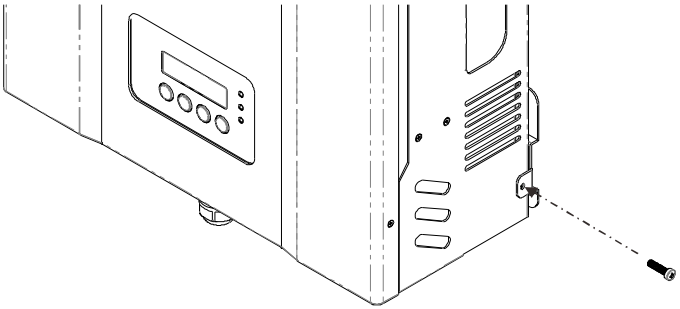


Fig 7: *Fasten the screws*

2.2.3 Check Installation Status

1. Ensure the backward tilting angle of the installation wall should not exceed 30°, and the inverter can't be installed on the walls which have forward-tilt.
2. Ensure the inverter is correctly fixed on the hooks at the four corners of hanger.
3. Ensure the two screws at the left and right sides of the inverter (safely fixed) have been indeed fastened.
4. Try to lift upward the inverter to ensure the firmness.
5. Ensure the LCD height is appropriate and the button can be conveniently operated.

Keep the wires as close or twist them together as you can. Also, run them in grounded conduit. This means the grounding path shall be as short as possible.

Try to keep antennas far from the inverters and house wirings. Some interference might be detected in close proximity to the potential noise source due to the disposal of system installation.

This inverter product complies with the requirements of the electromagnetic compatibility, IEC/EN 61000-6-2 and 61000-6-3. It's recommended to use household appliances with resistance to noise, which fulfills the interference immunity requirements, too.

2.3 Wiring the Inverter

2.3.1 Safety Notes

Avoid static discharge damaging inverter.

The parts inside the inverter could be damaged due to the electric static discharge. Please take the grounding measures prior to touching any internal parts and terminals.

2.3.2 Introduction

The inverter comprises DC input (connect to solar panel), AC output (connect to service entrance, utility power) and communication ports (monitor the inverter status). Please refer to the following figure.

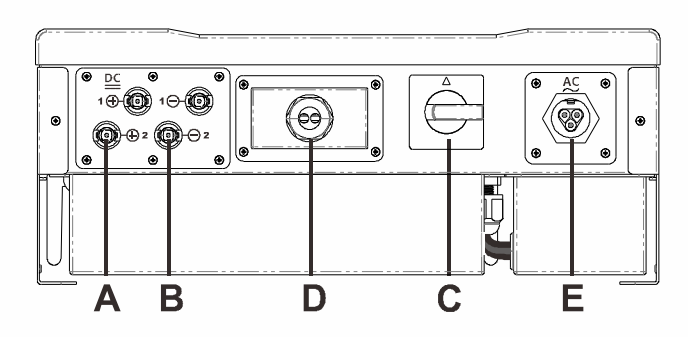


Fig 8: *Enclosure bottom view*

	Description
A	Connect the **positive polarity (+)** of DC wires from solar panel.
B	Connect the **negative polarity (-)** of DC wires from solar panel.
C	**DC disconnect switch** used for isolation the inverter from solar panel.
D	**RS232 and RS485** communication ports.
E	Connect **AC wires** to service entrance, utility power.

2.3.3 DC Input Wiring

2.3.3.1 Safety Notes

Touching the energized parts or the metal part of the connector may cause electric shock. The solar panel exposed to sunlight supplies hazardous DC voltage.

The maximum DC input current of this inverter is 16 A and the DC connector rating is up to 25 A. The diameter of the power wire shall be 12 AWG (4.0 mm^2) at least.

Ensure the open-circuited voltage (Voc) of your solar panels is less than 550 Vdc under any condition, lowest temperature especially.

Ensure the electrical polarity is correct prior to connection. The inverter will be damaged in case of miswiring.

2.3.3.2 Connect DC Connector

1. Take the DC connectors from the package, which includes 2 male connectors (positive and negative, see Appendix C in 1.4).
2. Peel the DC wires insulation about 8~10 mm and insert them into the metal terminals to the end. Then use a connector plier to press the terminals.

Fig 9: *Assemble your DC terminals - step 1*

3. Ensure the electrical polarity and loosen nuts on the connectors. Insert the pressed terminal to a locked extent, and try pulling back to check its tightness. Then tighten the nut.

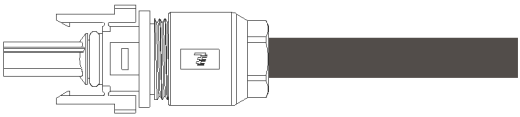


Fig 10: *Assemble your DC terminals - step 2*

4. Ensure both the DC disconnect switch and the external AC breaker are in OFF position.
5. Put the connecting fasteners (see Appendix D in 1.4) on the female connectors of the inverter. Pay attention to the installing direction and positions.

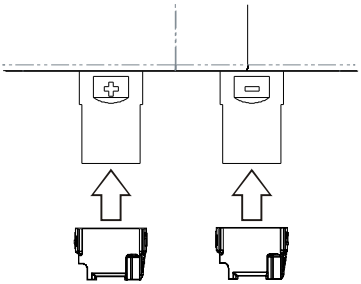


Fig 11: *Assemble your DC terminals - step 3*

6. Insert the pressed terminals to the female sockets. Only if the latch is in position does the DC wires connection be completed.

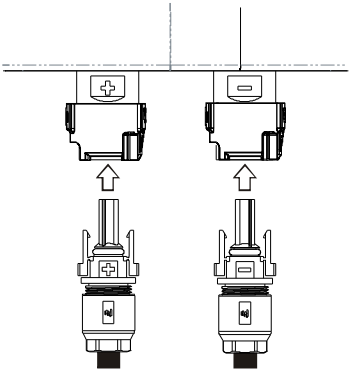


Fig 12: *Complete your DC terminals*

2.3.4 COM Line Connection

2.3.4.1 Instruction

The product is equipped with RS232 and RS485 interface. RS485 supports communication between multiple inverters in parallel so the two sets of RS485 pins are provided for this function. Please refer to the figure below as to the pins assignment.

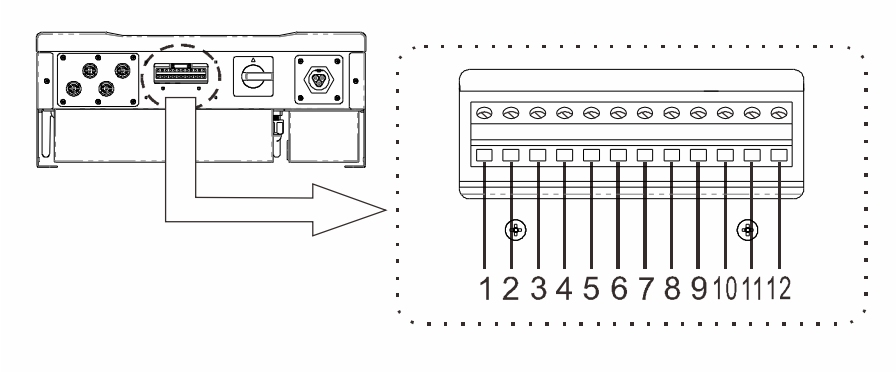


Fig 13: *RS485 pins assignment*

Item	Description
1	Master RX (RS232)
2	Master TX (RS232)
3	Slave RX (RS232)
4	Slave TX (RS232)
5	GND
6	+5V
7	TX A (485A)
8	RX B (485B)
9	TX A (485A)
10	RX B (485B)
11	CAN.H
12	CAN.L

Only one interface (RS232 or RS485) is functioning at a time.

2.3.4.2 Connection

1. Ensure both the DC disconnect switch and the external AC breaker are in OFF position; loosen the screws and remove the housing of COM port.

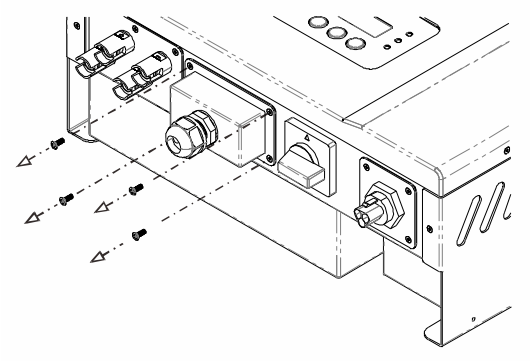


Fig 14: *Remove the RS485 port housing*

2. Counter-clockwise loosen the waterproof cable gland nut, remove waterproof plugs behind cable gland nut.

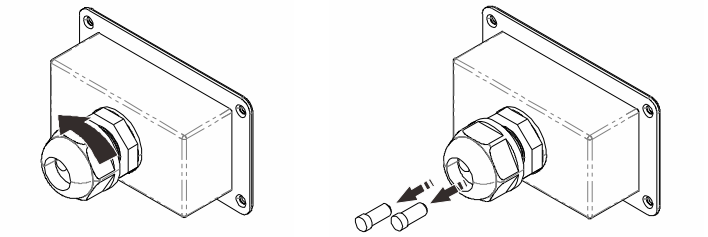


Fig 15: *Assemble the communication cable gland*

3. Loosen the rear nut on the gland and pass the communication cable through one of the rubber holes.

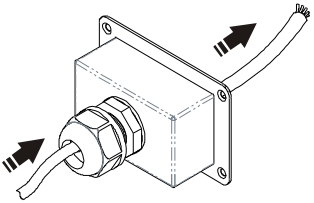


Fig 16: *Assemble the communication cable*

4. Connect each thread to the correct terminal contact (see 2.3.4.1) and lock the COM port housing back to the inverter.

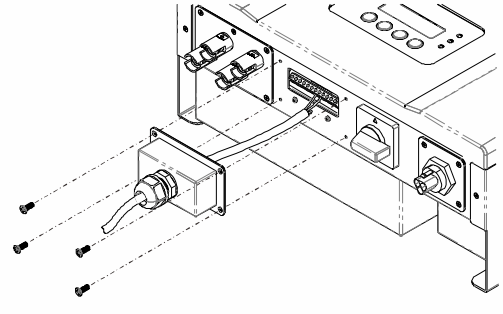


Fig 17: *Lock the RS485 port housing*

5. Check the cable length and tightness. Insert the waterproof plug into another hole. Fasten the waterproof cable gland nut.

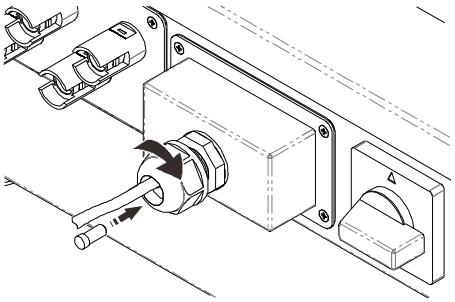


Fig 18: *Fasten the waterproof cable gland nut*

2.3.4.3 Connection in Parallel by RS485

For more than one inverter in a system, RS485 provides this convenient communication functions. The inverter provides two RS485 contacts. Basically one (contact) is of connecting to your monitoring device (e.g. PC); and the other one is for connecting with adjacent inverter.

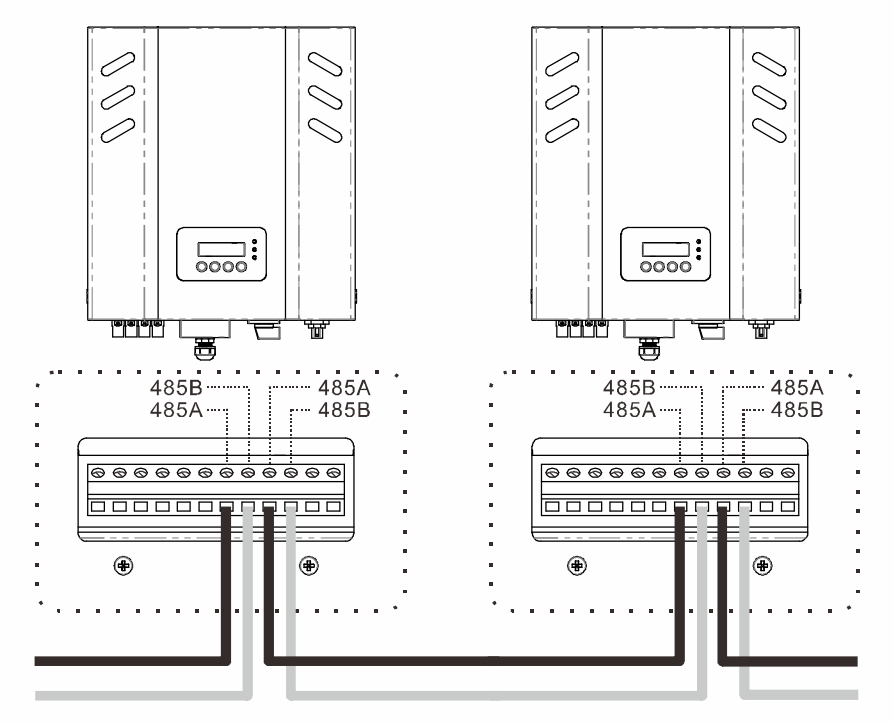


Fig 19: *Multi-inverter wiring by RS485*

2.3.5 AC Output Wiring

2.3.5.1 Safety Notes

Ensure both the DC disconnect switch and the external AC breaker are in OFF position.

The maximum AC output current of this inverter is 14.5 A and the AC connector rating is up to 25 A. The diameter of the power wire shall be 12 AWG (4.0 mm^2) at least.

The resistance of AC power line on utility network should be less than 1.25 Ω.

Ensure the local utility distribution prior to any connection. The nominal voltage and frequency shall be within the electrical specifications of the inverter.

2.3.5.2 Connecting AC Connector

1. Peel three AC wires insulation about 8~10 mm and insert them through the AC connector (see Appendix H in 1.4).

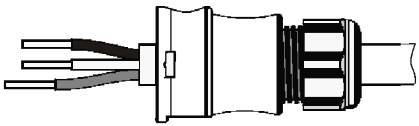


Fig 20: *Assemble your AC terminals*

2. Connect the AC wires **L** as live (brown or black), **N** as neutral (blue) and **Ground** (green with yellow stripes).

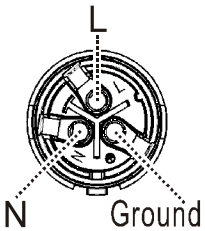


Fig 21: *Check the phase and ground terminals*

3. Align two smooth gaps over the connector when jointing. Push the connector until the latch is positioned. Then, fasten the gland nut to keep the waterproof usage.

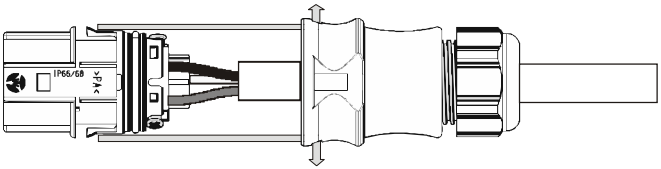


Fig 22: *Fasten the gland nut*

4. Insert AC connector to the socket on the inverter. Align the hook on male connector with the square hole on female socket when jointing. Push the connector until the latch is positioned.

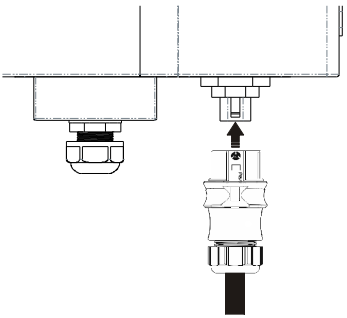


Fig 23: *Push the connector until the latch is positioned*

3 Operation

3.1 Overview

The DC (PV) voltage reaches a certain minimum voltage if sufficient insolation is available, the inverter will enter “grid-feed” mode. If, as nightfall approaches, the voltage drops below the minimum voltage value, grid-feed mode ends and the inverter will shut down itself.

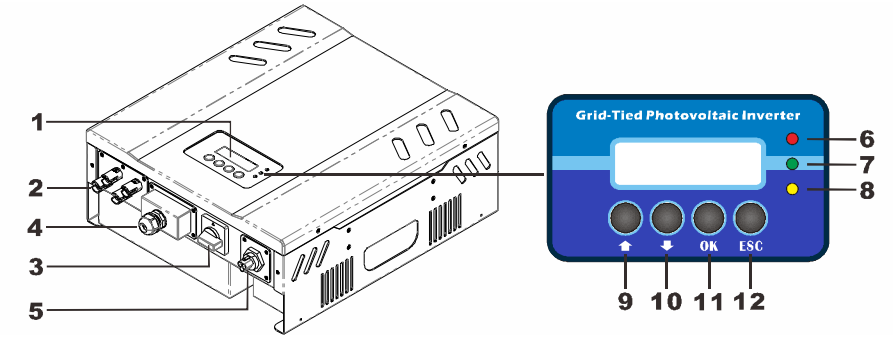


Fig 24: *Overview front panel of the inverter*

1	LCD Display	**7**	LED Display (Green)
2	DC connectors	**8**	LED Display (Yellow)
3	DC switch	**9**	“ UP ” Key
4	Communications ports	**10**	“DOWN” Key
5	AC connectors	**11**	“OK” Key
6	LED Display (Red)	**12**	“ ESC” Key

3.2 LED Indication

The inverter is equipped with three LEDs that give information about the various operating statuses as follows:

1. **LED (red): System Fault**

   The inverter was stopped when an unrecoverable failure occurred. (Refer to “error message table”) If the fault notification cannot be cleared, please contact your local service staff.

2. **LED (green): Normal**

   In this mode, the green LED shines when the inverter feeds power to the grid.

3. **LED (yellow): Recovery Fault**

   In some situations, such as abnormal voltage and frequency, the inverter has detected a recoverable failure and re-starts on its own.

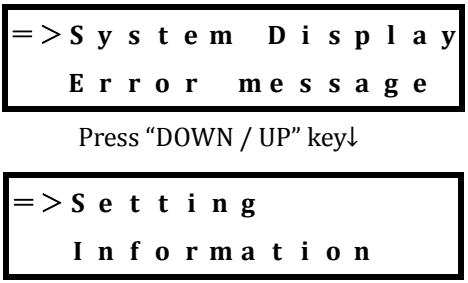
3.3 Buttons on Panel

By using the "UP," "DOWN," "OK," and "ESC" buttons, users may be able to view which measured value is to be displayed.

1. **"▲", "▼" key:** Press "UP" or "DOWN" key to switch the various displays for measured values and data.
2. **"OK" Key:** To configure settings.
3. **"ESC" Key:** Return to previous state.

3.4 LCD Display

The display menu is shown once the inverter starts up. Measured values and all of the information are displayed here. The LCD continues to display the information following the process flow described below in this section.



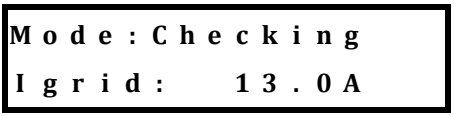
3.4.1 Operational Status

The following paragraphs explain how the display works in each mode.

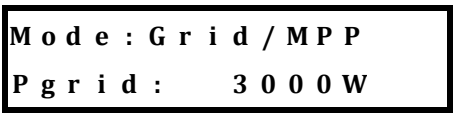
1. **Illumination:** Automatically the inverter shuts down in case of the low insolation.

2. **Standby:** The Inverter sets the initial values and it waits to start up automatically in case the PV array voltage is sufficient.

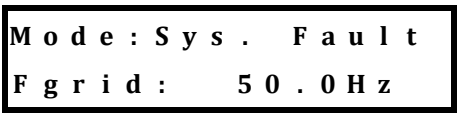
3. **Checking:** On both AC and DC side the inverter checks the system parameters and the 4 AC relays to ensure the safety of connection.



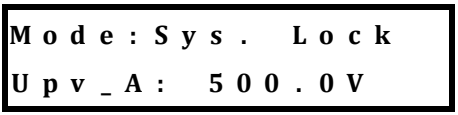
4. **Grid/MPP:** The inverter is feeding the AC power into the grid.



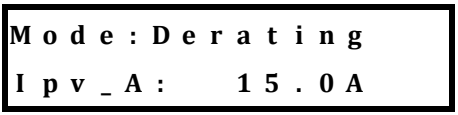
5. **Sys. Fault:** There is some recoverable failure detected. In abnormal situations the inverter re-starts on its own.



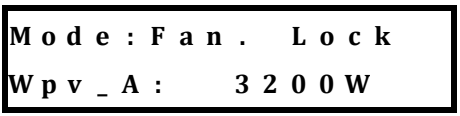
6. **Sys. Lock:** The inverter stops if an unrecoverable failure occurs; these some problem might be handled by technical service only.



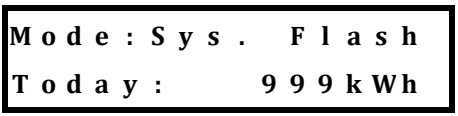
7. **Derating:** The inverter is limiting the maximum AC power feeding. This is not a malfunction.



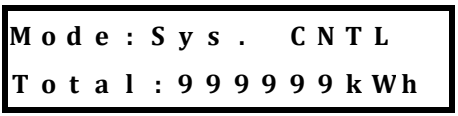
8. **Warning:** The system has encountered some minor warning, but it can continue to feed the AC power to the grid.



9. **Sys. Flash:** The firmware is being updated.



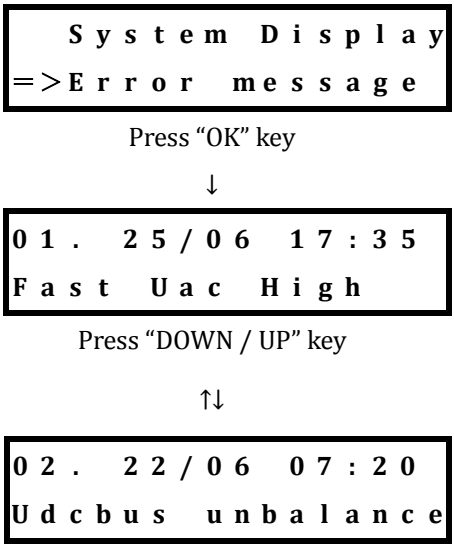
10. **Sys. CNTL:** The inverter is remote controlled by the external controller.



3.4.2 Check Error Message

When error messages display, users could select the "Error message" by press the “Down” or “Up” key from the main menu and then press the "OK" key to confirm. For each page, there are recorded error events as shown in the following figure. To see another recorded event, press “DOWN” and “UP” key to toggle the display. Please refer to clause 3.5 for more explanations as to error messages.

The last 99 failure information, including the date and real time clock, can be promptly read from the LCD display.



3.4.3 Setting before Operation

There are some parameters that can be re-configured from the panel. Users may select "Setting" from the main menu and press the "OK" key to enter system setting as shown below. Only the standard selection is password protected. Users may change the values for other settings, such as date, time, start-up voltage, communication baud rate, and RS485 address. When the setting is complete, the inverter must be restarted to have the new settings effectively executed. The parameters can be re-configured from the panel are described as follows:

The real date and local time should be manually reset when completing the system installation.

- **Date/ Time:** The date and time settings.
- **Start V:** Adjust the minimum startup voltage.
- **Std.:** The standard setting according to local requirements.
- **Baudrate:** Change the communication baud rate.
- **Address:** Change the RS485 address.

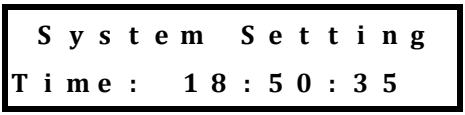
```
=>Setting
  Information
```

Press “OK” key ↓

```
  System Setting
Date:30/12/2011
```

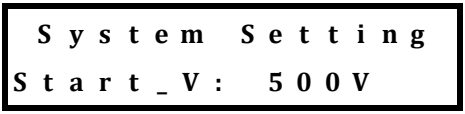
Press “DOWN / UP” key

↑↓



Press “DOWN / UP” key

↑↓

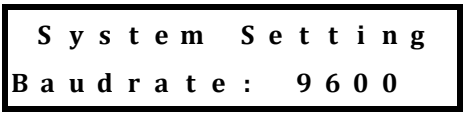


Press “DOWN / UP” key

↑↓

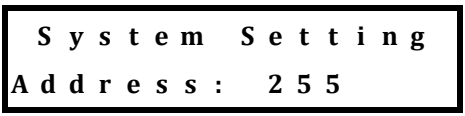
Press “DOWN / UP” key

↑↓



Press “DOWN / UP” key

↑↓



Press “DOWN / UP” key

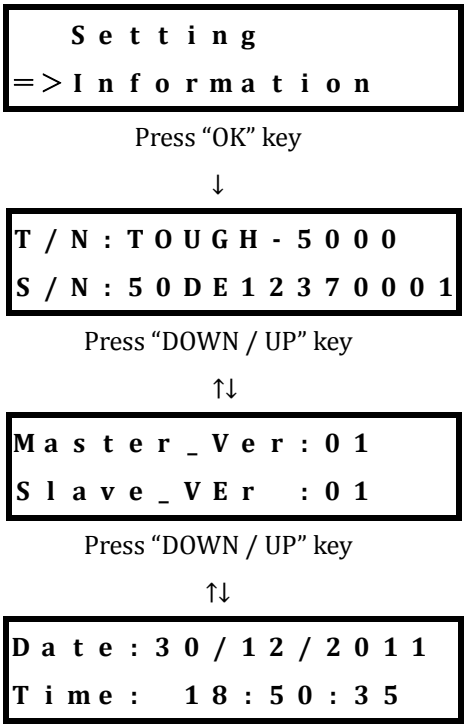
All the tripping-limit settings are protected by password. Only the authorized installers can adjust the protective functions under the approval of the distribution network operator (DNO).

The network and system protective values are readable via the communication interface or LCD display.

3.4.4 Information

Users may select the "Information" from the main menu and press the "OK" key to enter system information as shown below. The screen will display information of your inverter including firmware and etc.

- **T/N:** The model name of the inverter
- **S/N:** The serial number of the inverter
- **Master_Ver:** The firmware version of the main controller.
- **Slave_Ver:** The firmware version of the slave controller.
- **Date/Time:** The date and time in this inverter.



3.5 Descriptions of Error Messages

In the event of a fault, the inverter will stop feeding the AC power to the utility grid and display the error message on the LCD. Qualified service staff shall do the analysis, measurement, and debug, if needed, according to the error message in order to resume normal conditions. Please contact your service representative if the same error message is persistent.

Error Message Table

Error Message	Description
CalDataLoss	■ Internal calibration data is lost.
Comm. Error	■ External communication failed. *warning message
Drift Fac	■ Islanding is detected.
EEPROM Fault	■ An error occurred when reading or writing the EEPROM. *warning message
Fac High	■ The AC frequency of the utility grid is above the upper limit.
Fac Low	■ The AC frequency of the utility grid is under the lower limit.
Fan Lock	■ The fan stopped abnormally. *warning message

FastEarthCurrent	■ The drastic change of the leakage current has exceeded the allowable value.
Iac High Iac Max.	■ The AC current has exceeded the maximum permissible value.
Idc-inj. Fault	■ The DC injection detection circuit failed.
Idc-inj. High	■ The DC current injected into the utility grid side is too high.
IpvA HCT Fault (IpvB HCT Fault) Iac HCT Fault HCT Fault	■ The DC or AC current sensor is abnormal.
IpvA High IpvB High	■ The DC current has exceeded the maximum permissible value.
MCUs diff.High	■ Internal measurements from both CPU's are different from each other.
Model Error	■ The hardware and MCU firmware version does not match.
No Utility	■ The AC voltage of the utility grid side has not been detected.

Offset Fault	■ Internal reference voltage detection circuit failed.
PpvA High PpvB High	■ The DC power has exceeded the maximum permissible value.
RCMU Fault	■ The residual current monitoring unit is abnormal.
Relay Open Relay Short S1 (S2 or S3 or S4) Relay Fault	■ The output relay failed.
Riso Low	■ The insulation resistance between PV array and the ground is below the allowable value.
RTC Fault	■ The RTC is stopped abnormally. *warning message
SlowEarthCurrent	■ The leakage current detected by inverter has exceeded the maximum permissible value.
SPI Error	■ Internal communication between MCU inside is abnormal.

System Error	■ The system is not working properly.
Temp. High (Low)	■ The temperature inside the inverter exceeds the nominal operational range.
Uac High Fast Uac High	■ The AC voltage of utility grid is above the upper limit.
Uac Low Fast Uac Low	■ The AC voltage of utility grid is under the lower limit.
Uac offset fault	■ The AC voltage detection circuit failed.
Udcbus Fault	■ The DC/DC converter is not working properly.
Udcbus High	■ Internal DC bus voltage is too high.
Udcbus Low	■ Internal DC bus voltage is too low.
Udcbus unbalance	■ Internal DC bus voltage is unbalanced.
UpvA High UpvB High	■ The DC voltage of PV array is higher than the permissible 550 Vdc.
Version Error	■ The firmware version is not correct.

3.6 Troubleshooting

The Inverter requires very little maintenance. When the inverter has encountered an event of fault, the error message will be displayed on the LCD and recorded in memory. If you encounter problems with the inverter, refer to the tables in this chapter for probable causes and recommended solutions, and then remove the fault condition(s) to have the inverter return to normal condition and continue to feed AC power to the utility.

Troubleshooting Table

Error Message	Possible Causes	Disposal Measures
CalDataLoss	■ EEPROM's parameters is lost or incorrect	■ Inform professional service staff to update the EEPROM's parameters
Comm. Error	■ External communication malfunctions ■ Baud rate or protocol error has occurred	■ Check the external communication equipment ■ Check the baud rate and protocol format
Drift Fac	■ A transient loss of the utility grid ■ Inverter placed at weak points of the utility grid	■ Inform professional staff to update the firmware if the fault continues
EEPROM Fault	■ EEPROM's parameters are unrecognized	■ Inform professional service staff to update the EEPROM's parameters

Error Message	Possible Causes	Disposal Measures
Fan Lock	■ Fan is stuck ■ Fan malfunctions	■ Try to remove any lint or dust that may be stuck inside the fan ■ Replace the fan
FastEarthCurrent **SlowEarthCurrent**	■ Cables or wires insulation is damaged and it causes a high ground fault current	■ Make sure that the insulation rating is sufficient for the application
HCT Fault	■ Current sensor detection circuit is abnormal	■ Restart the inverter again if the fault continues ■ Inform professional staff if you fail to restore
Iac High **Iac Max.**	■ Utility voltage drops suddenly ■ Inverter is abnormal	■ Benign neglect if it seldom occurs ■ Inform professional staff if you fail to restore
Idc-inj. High	■ DC injection current detection circuit is abnormal ■ The default settings is inappropriate	■ Restart the inverter again if the fault continues ■ Inform the service to check the settings
Idc-inj. Fault **Offset Fault** **Uac offset fault**	■ Circuits inside inverter are abnormal	■ Restart the inverter again; Inform professional staff if you fail to restore

Error Message	Possible Causes	Disposal Measures
MCUs diff.High	■ Calibration parameters have deviated ■ Circuits inside inverter are abnormal	■ Restart the inverter again if failed to restore ■ Inform professional service staff to check the calibration parameters
Model Error	■ Default setting is wrong	■ Inform the service staff to replace the inverter
No Utility	■ The utility grid is disconnected ■ Grid power has blocked ■ AC switch/breaker between inverter and utility is opened ■ Incorrect AC connection	■ Wait until the grid is restored ■ Close the AC switch/ breaker after clearing the faults ■ Check the AC wirings
RCMU Fault	■ The residual current monitoring unit is abnormal.	■ Restart the inverter again; Inform professional staff if you fail to restore
Riso Low	■ Dew or some object exits between PV array and earth. ■ The insulation resistance is below the allowable value.	■ Check the impedance between PV(+), PV(-) and the ground must be more than 1MΩ. ■ Inform service staff to check the settings

Error Message	Possible Causes	Disposal Measures
Relay Open **Relay Short** **Relay Fault**	■ AC output relay is abnormal.	■ Restart the inverter again; Inform professional staff if you fail to restore
SPI Error	■ Internal communication is abnormal. ■ Circuits inside inverter are abnormal	■ Restart the inverter again if the fault continues ■ Inform service staff to update the firmware if you fail to restore
System Error	■ Internal PI controller is abnormal	■ Restart the inverter again if the fault continues ■ Inform service staff to update the firmware if you fail to restore
Temp. High **(Temp. Low)**	■ Ambient temperature is too high (low) ■ The natural air circulation is insufficient ■ If the inverter mounted fan, it may be stuck or broken	■ Make sure the ambient temperature of installation is within -20°C to 60°C ■ Remove any obstacle near heat sink ■ Check that the fan is working; if it is damaged, replace it

Error Message	Possible Causes	Disposal Measures
Uac High **Uac Low** **Fac High** **Fac Low** **Fast Uac High** **Fast Uac Low**	■ Main voltage or frequency exceeds the default settings ■ Main voltage or frequency is higher or lower than the permissible value ■ The settings are inappropriate	■ Wait until the grid is back to stable. ■ Request the utility supplier to improve and then inform professional staff to change the settings. ■ Inform professional staff to check the settings.
Udcbus High **Udcbus Low** **Udcbus Fault** **Udcbus unbalance**	■ Circuits inside inverter are abnormal	■ Restart the inverter again if the fault continues ■ Inform professional staff if you fail to restore
Upv High **Ipv High** **Ppv High**	■ PV array voltage, current or power exceeds the permissible value	■ Disconnect the DC source and inform the system installer to check the configuration of PV arrays
Version Error	■ Firmware version is incompatible	■ Inform professional staff to reinstall the firmware

4 Technical Documentation

4.1 Outline Drawing

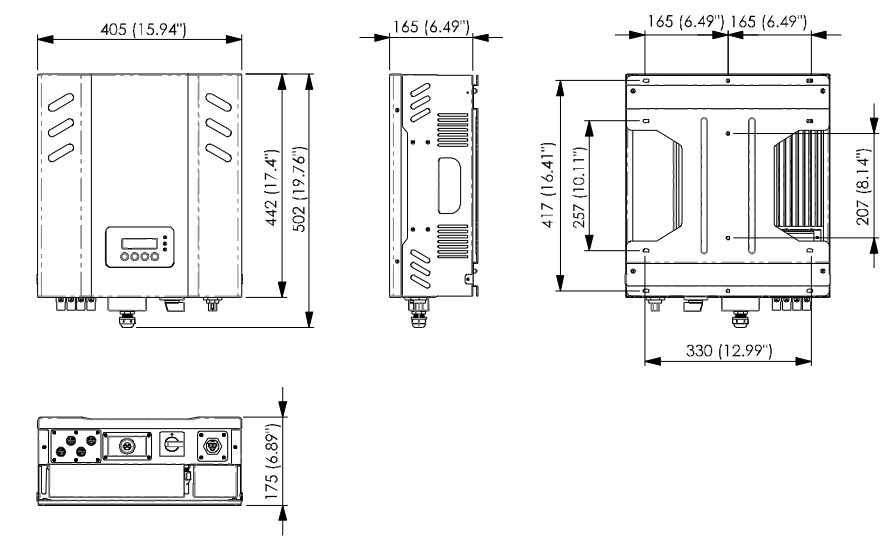


Fig 25: *Outline drawing*

4.2 Efficiency

The efficiency is shown below.

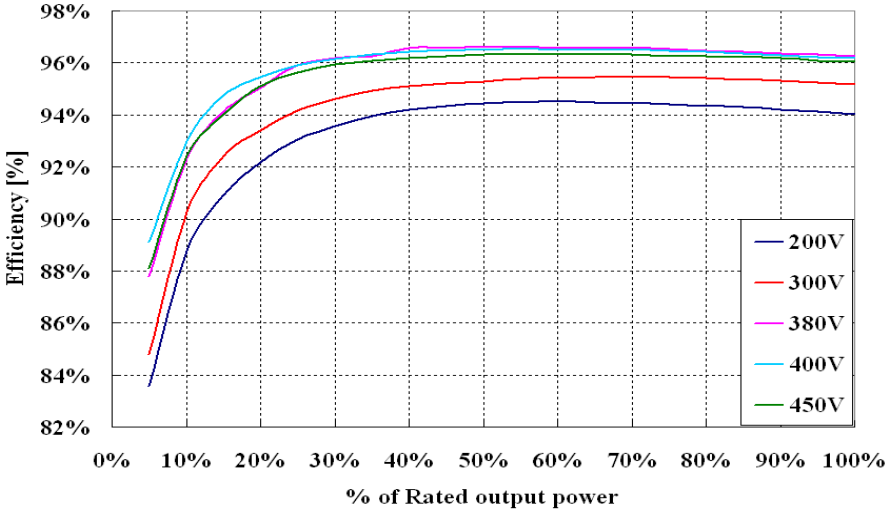


Fig 26: *Euro. Efficiency of the TOUGH-3000 = 95.83%*

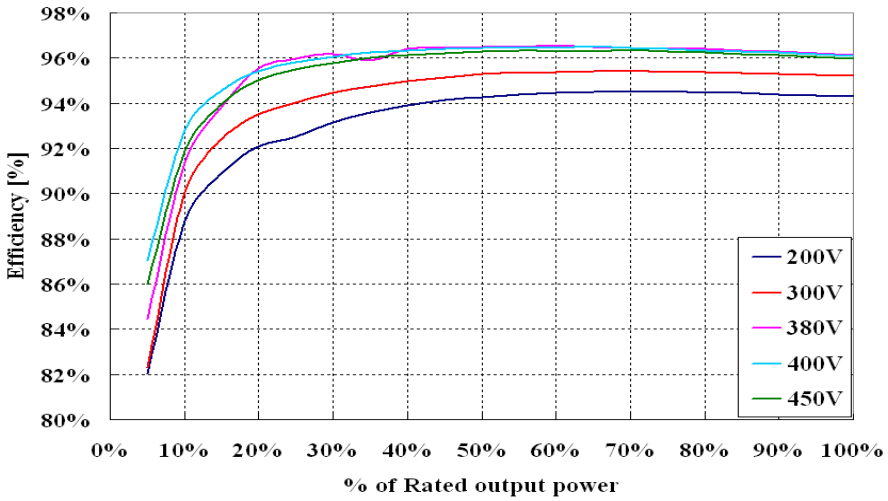


Fig 27: *Euro. Efficiency of the TOUGH-3300 = 96.1%*

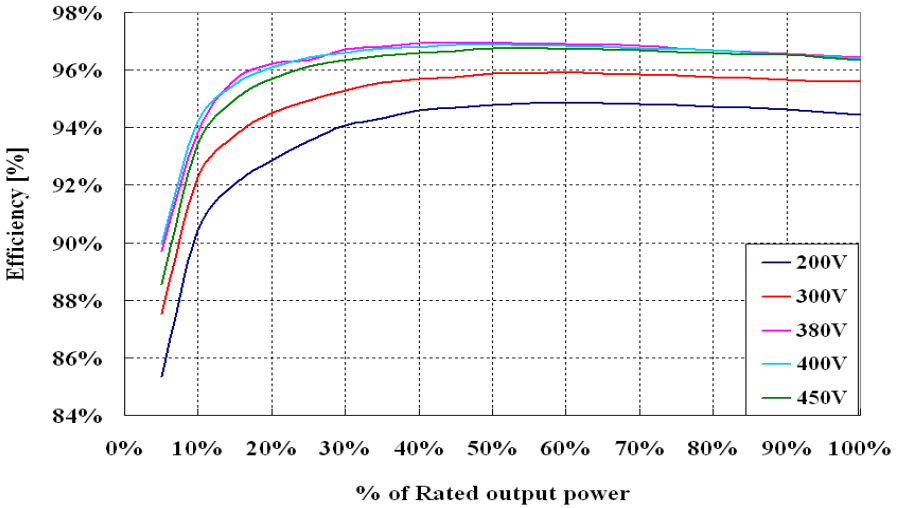


Fig 28: *Euro. Efficiency of the TOUGH-4000 = 96.5%*

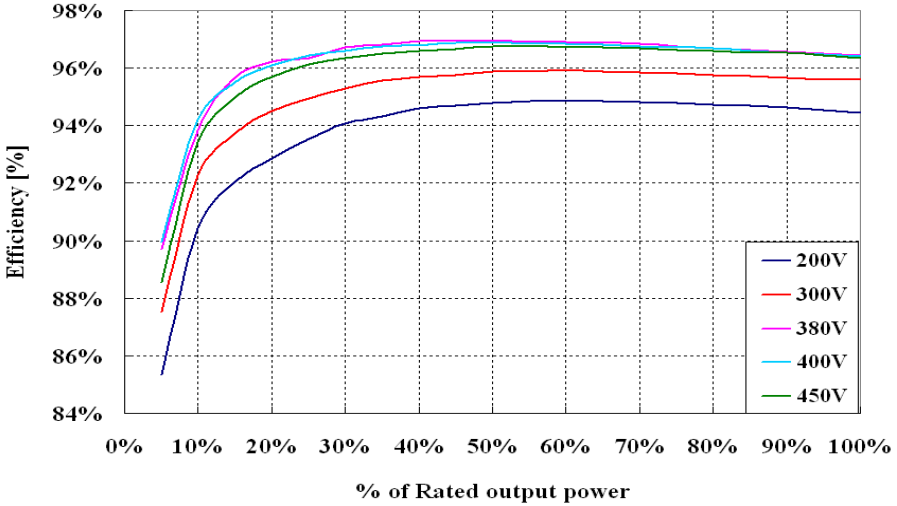


Fig 29: *Euro. Efficiency of the TOUGH-5000 = 96.6%*

4.3 MPP Efficiency

The MPP efficiency is shown below.

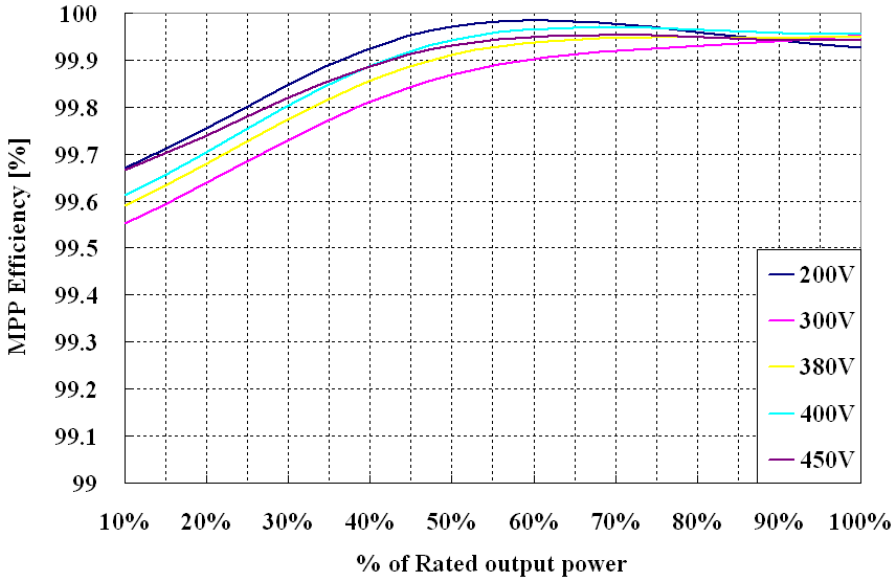


Fig 30: *MPP Efficiency of the TOUGH-SERIES*

4.4 De-rating Operation

The inverter will limit the input power to ensure that the system safely operates as described in detail below.

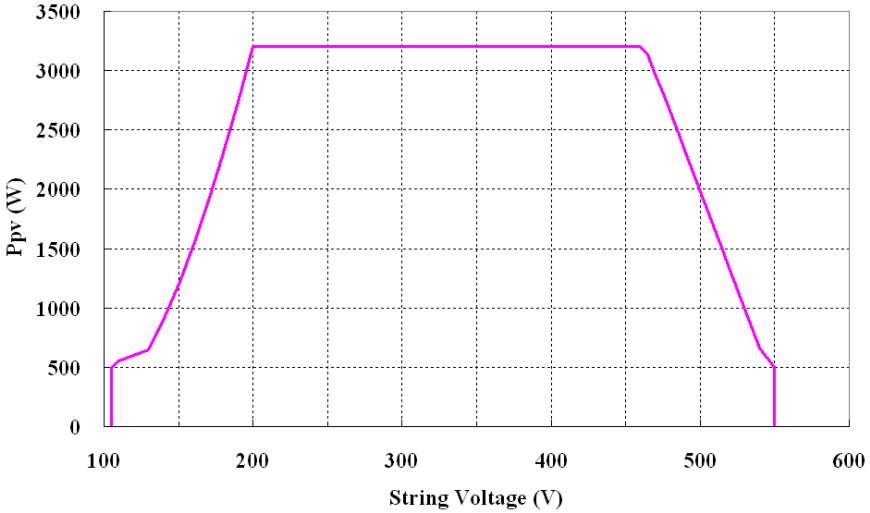


Fig 31: *DC power curve of the TOUGH-3000*

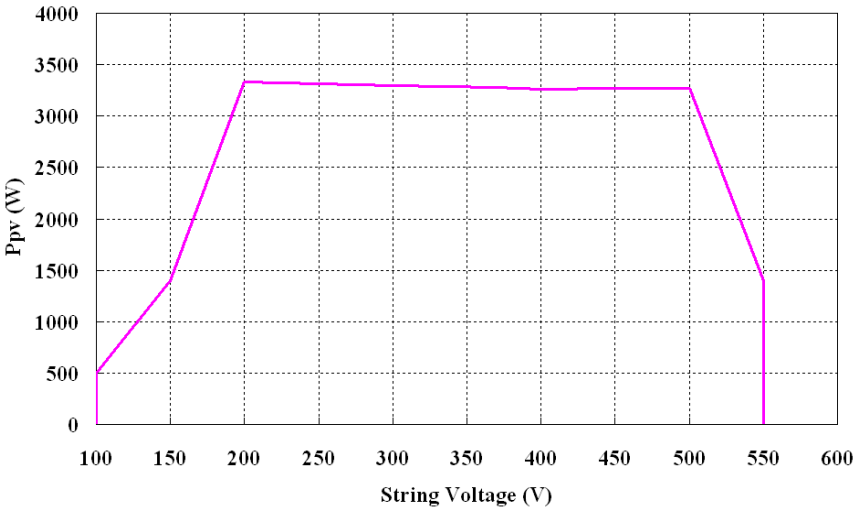


Fig 32: *DC power curve of the TOUGH-3300*

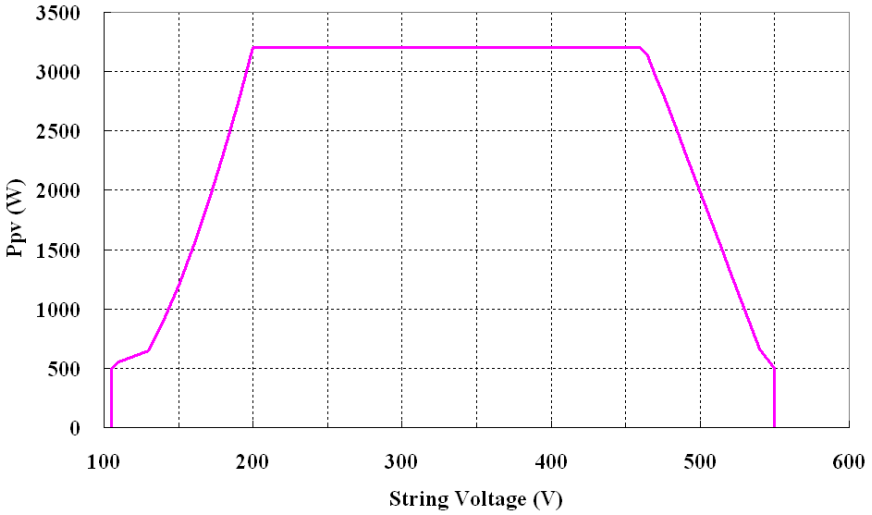


Fig 33: *DC power curve of the TOUGH-4000*

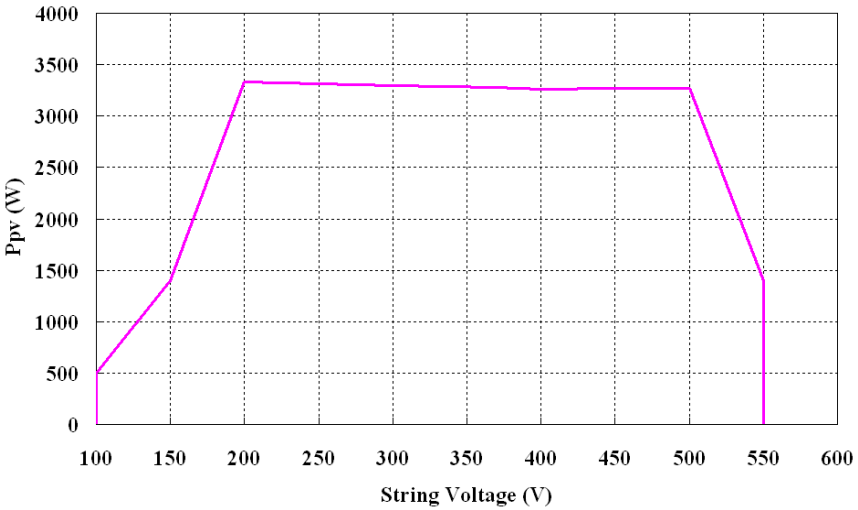


Fig 344: *DC power curve of the TOUGH-5000*

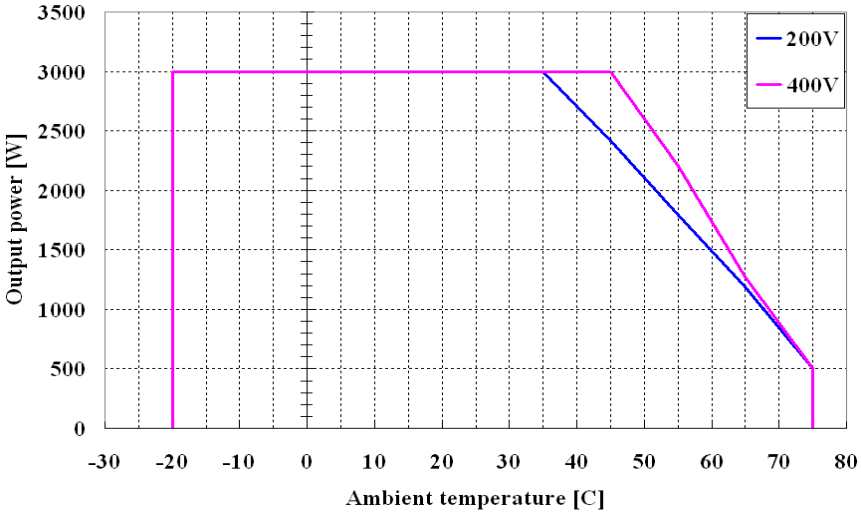


Fig 355: *Temperature de-rating curve of the TOUGH-3000*

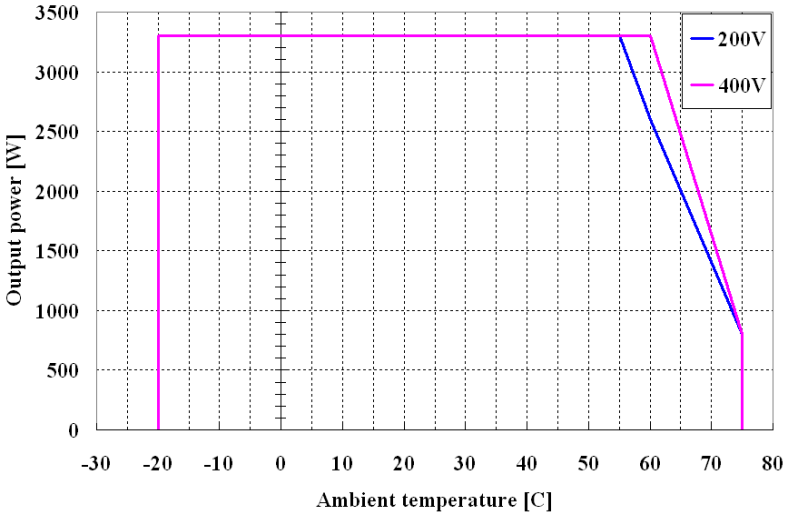


Fig 366: *Temperature de-rating curve of the TOUGH-3300*

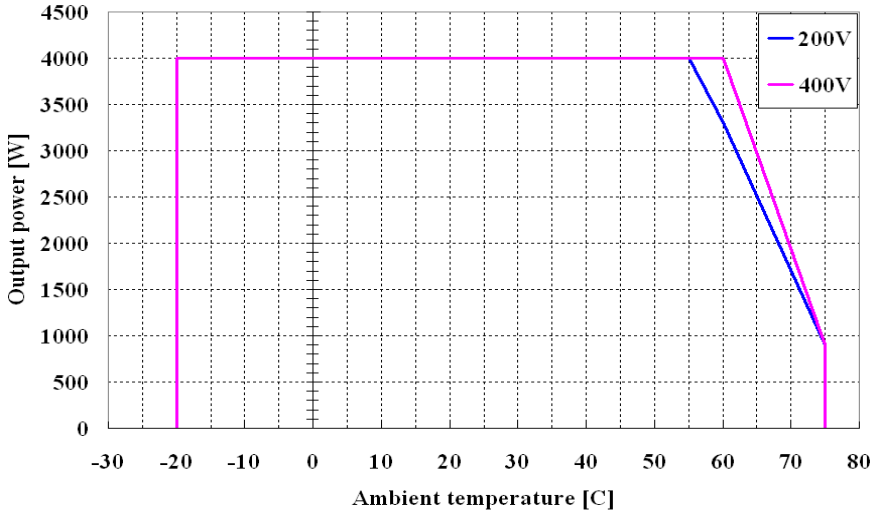


Fig 377: *Temperature de-rating curve of the TOUGH-4000*

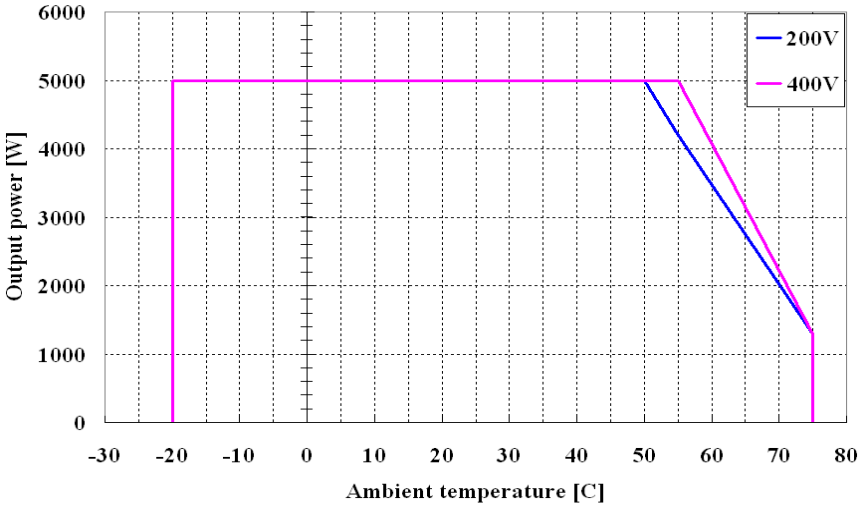


Fig 38: *Temperature de-rating curve of the TOUGH-5000*

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