

# EATON ETN1000 / ETN2000

## Grid PV-Inverter

### Installation and Operation Manual

Version 1.6 E 2010.06



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## Before you start...

Congratulations on choosing EATON ETN1000 / ETN2000 Grid PV-Inverter, a product from EATON Grid PV-Inverter is a highly reliable product due to its innovative design and perfect quality control. Such an inverter is used in high demand, grid-linked PV systems.

This manual contains important information regarding installation and safe operation of this unit. Be sure to read this manual carefully before using.



If you encounter any problems during installation or operation of this unit, first check this manual before contacting your local dealer or representative. Instructions inside this manual will help you solve most installation and operation difficulties.

Thank you again for choosing our product. Please keep this manual handy for quick reference.

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## Safety instructions

- Risk of Electric Shock

1. Do not remove the casing. Inverter contains no user serviceable parts. Refer servicing to qualified service personnel.



Both AC and DC voltage sources are terminated inside the PV-Inverter.

Please disconnect these circuits before servicing.

2. When a photovoltaic panel is exposed to light, it generates a DC voltage. When connected to this equipment, a photovoltaic panel will charge the DC link capacitors.
3. Energy stored in this equipment's DC link capacitors presents a risk of electric shock. Even after the unit is disconnected from the grid and photovoltaic panels, high voltages may still exist inside the PV-Inverter. Do not remove the casing until at least 30 minutes after disconnecting all power sources.
4. This unit is designed to feed power to the public power grid (utility) only. Do not connect this unit to an AC source or generator. Connecting Inverter to external devices could result in serious damage to your equipment.
5. Carefully remove the unit from its packaging and inspect for external damage. If you find any imperfections, please contact your local dealer.

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- Hot surfaces

Although designed to meet all safety requirements, some parts and surfaces of Inverter are still hot during operation.



To reduce the risk of injury, do not touch the heat sink at the back of the PV-Inverter or nearby surfaces while Inverter is operating.

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## Limited Warranty

Inverter comes with a limited warranty. This warranty includes all defects of design, components and manufacturing. Excluded from warranty are damages due to:

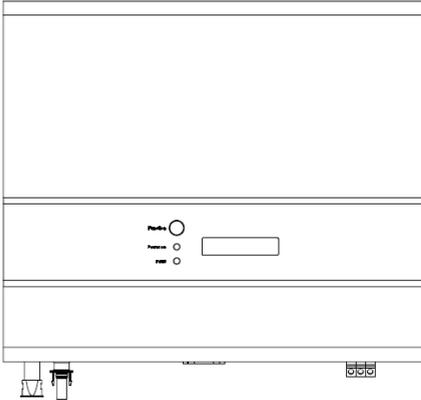
- Breaking the product seal (opening the casing)
- Improper transportation and delivery
- Unqualified persons opening the unit
- Improper installation
- Unauthorized modification, testing or repairing
- Use and application beyond the definition in this manual
- Application beyond the scope of safety standards
- Acts of nature such as lightning, fire, storm etc.

The right to repair and/or replace the unit is at the manufacturers' discretion. Any damages discovered during installation should be submitted via a written damage report within 5 working days of receiving the PV-Inverter. Otherwise EATON is not responsible for damages beyond the scope of this warranty.

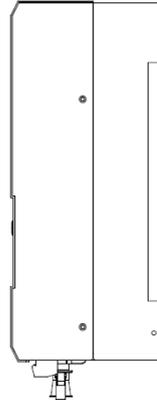
# 1. Overview

## 1.0 kW / 2.0kW Design Overview

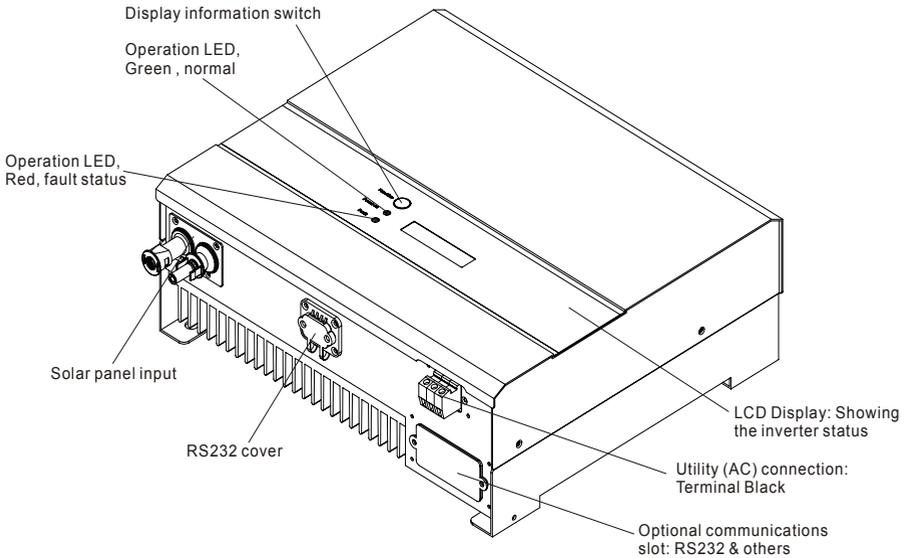
**Front View**



**Bottom View**



## Parts Description



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## 2. Features

- Very high conversion efficiency (up to 96%)
- MPPT (Maximum Power Point Tracking)
- Higher power capacity than similar products of the same size.
- Embedded LCD display showing complete status information
- Natural convection cooling. Quiet, fan-less design
- Stylish, modern casing
- Compact, small profile
- High reliability, and Easy to install
- Maintenance free
- Standard RS-232, optional RS-485 and others
- No external GFCI breaker is required

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## 3. Installation instructions

### Opening the package

After opening the package, please check the contents of the box. It should contain the following:

1. One Inverter
2. One Instruction manual
3. One mounting frame
4. 4 mounting screws
5. 2 safety-lock screws
6. One cable gland and TB cover for AC cable

### Before installation

Before starting installation please consider the following items:

This unit is designed for indoor usage. Do not expose the unit to wet, or moist conditions.



Do not expose the PV-Inverter to direct sunlight. Direct sunlight increases the internal temperature that may reduce conversion efficiency.



- ✓ Check the ambient temperature of installation is within specified range -20 ~ +55°C.
- ✓ The AC grid voltage is between 206 and 264VAC, 50/60Hz.
- ✓ Electric utility company has approved the grid connection.
- ✓ Qualified personnel are performing the installation.
- ✓ Adequate convection space surrounds the inverter.
- ✓ Inverter is being installed away from explosive vapors.
- ✓ No flammable items are near the inverter.

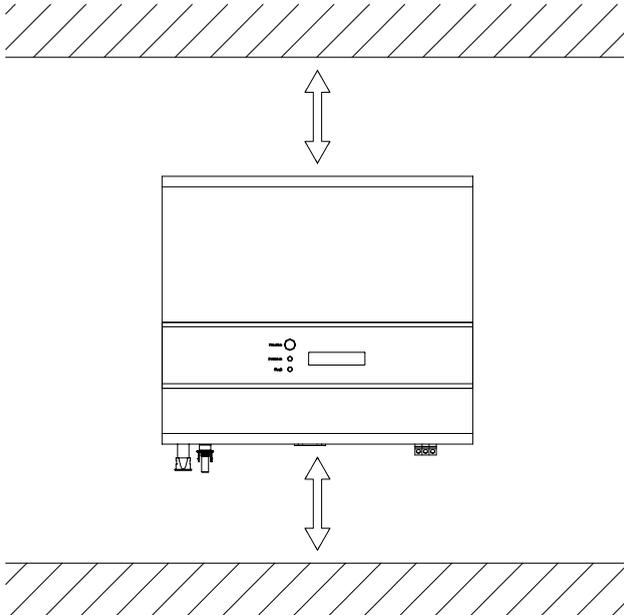


Inverter can be installed and operated at locations where the ambient temperature is up to 55°C. However, for optimal operation, it is recommended that Inverter is installed where the ambient temperature is between 0~40°C.

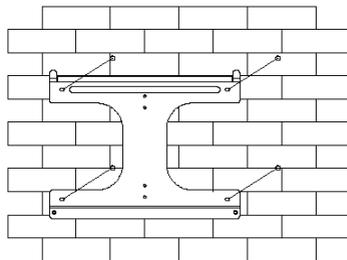
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## Mounting Inverter to the wall

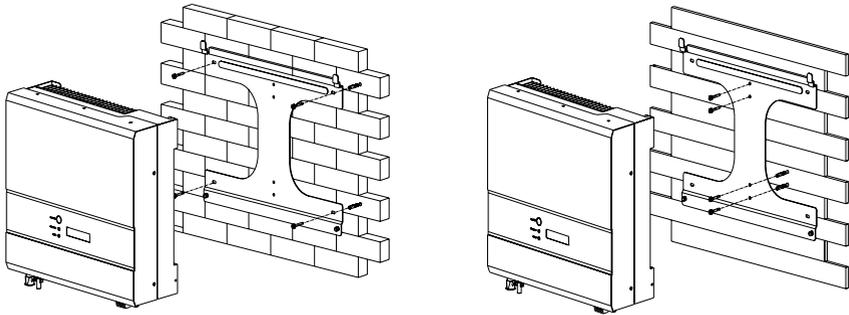
1. Select a wall or solid vertical surface that can support the PV-Inverter.
2. Inverter requires adequate cooling space. Allow at least 20cm space above and below the inverter.



3. Using the mounting frame as a template, drill 4 holes as illustrated in the following figures.
4. Fix the mounting frame as the figure shows.



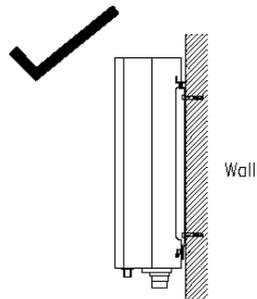
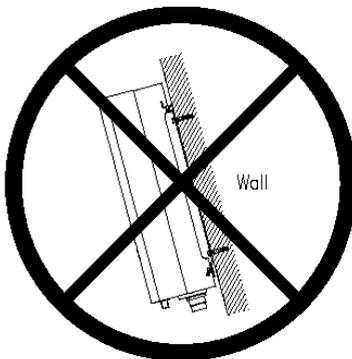
5. Hang the inverter on the mounting frame



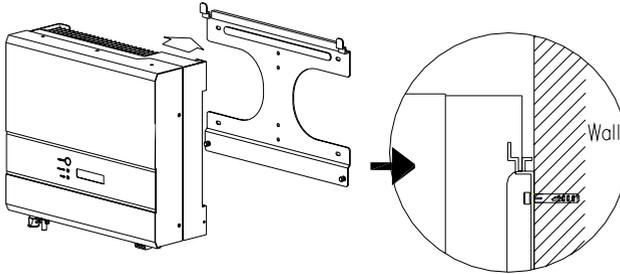
Select the installation location so that the status display can be easily viewed.  
Choose a strong mounting wall to prevent vibrations while inverter is operating.

6. Check the installation conditions

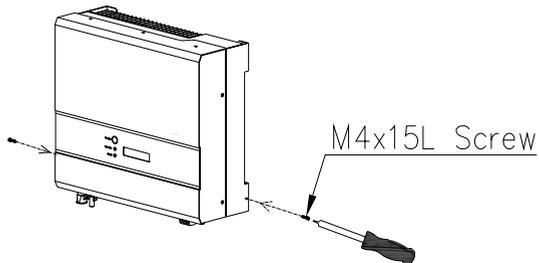
- a) Do not install the PV-Inverter on a slanted surface



- b) Check the upper straps of PV-Inverter and ensure it fits on to the bracket



- c) Insert safety-lock screws to the bottom leg to secure the inverter



Check the secure mounting of the PV-Inverter by trying to raise it from the bottom. The PV-Inverter should remain firmly attached.

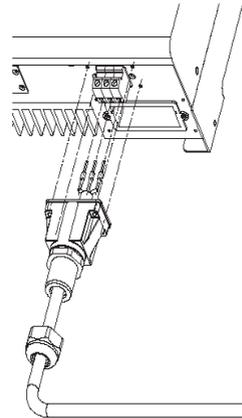
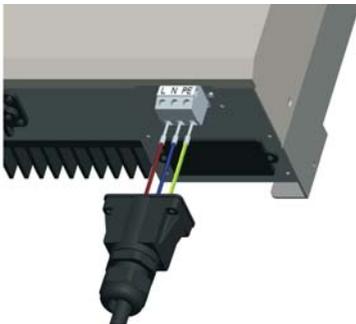


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## Connecting to the grid (AC utility)

1. Measure grid (utility) voltage and frequency. It should be 230VAC (or 220VAC), 50/60Hz, and single phase.
2. Open the breaker or fuse between PV-Inverter and utility.
3. For Inverter, connect AC wires as follows:

- Insert utility wires through cable gland. Connect wires according to polarities indicated on terminal block. L → LINE (brown), N → Neutral (blue) and → system ground (green).



- Fasten the gland plate in order to make sure cable is firmly fixed.



- Twist the gland, attached screws in order to seal the AC gland cover.



To prevent risk of electric shock, ensure the ground wire is properly earthed before operating the PV-Inverter.



4. Suggested cable width for AC wire.

Model	Diameter $\phi$ (mm)	Area (mm <sup>2</sup> )	AWG no.
EATON ETN1000 EATON ETN2000	$\geq 1.02$	$\geq 1.25$	$\leq 16$

### Connect to PV Panel (DC input)

1. Make sure the maximum open circuit voltage ( $V_{oc}$ ) of each PV string is less than  $500V_{DC}$  UNDER ANY CONDITION. We recommend  $V_{oc}$  less than  $360V_{DC}$  with ambient temperature of  $25^{\circ}C$ .
2. Use MC (Multi-contact<sup>®</sup>) connectors for PV array terminals.
3. Connect the positive and negative terminals from the PV panel to positive (+) terminals and negative (-) terminals on the PV-Inverter. Each DC terminal on Inverter can withstand up to  $5A_{DC}$  in 1.0kW and

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10A<sub>DC</sub> in 2.0kW.



Before connecting PV panels to DC terminals, please make sure the polarity is correct. Incorrect polarity connection could permanently damage the unit.

Please check the short-circuit current of the PV string. The total short-circuit current of the PV string should be less than the inverter's maximum DC current.



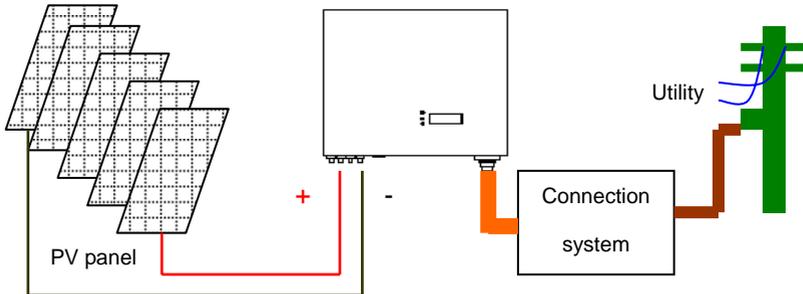
High voltages exist when the PV panel is exposed to the sun. To reduce risk of electric shock, avoid touching live components and treat connection terminals carefully.

### Checking

1. When the PV panels are connected and their output voltage is greater than 100 V<sub>DC</sub> but the AC grid is not yet connected, the message on the LCD display produce the following messages in order: "MODEL" -> "Waiting" -> "No Utility". The display repeats "No Utility" and the RED "fault LED" turns on.
2. Close the AC breaker or fuse between PV-Inverter and grid. The normal operating sequence begins.
3. Under normal operating conditions the LCD displays "Pac=xxxx.xW". That is the power fed to the grid. The green LED turns lights-up.
4. This completes the check.

## 4. System Diagram

The typical connection diagram for the entire PV system is shown in the following figure.



1. **PV Panel:** Provide DC power to inverter.
2. **EATON ETN1000 / ETN2000 PV Inverter** converts DC (Direct Current) power from PV panel(s) to AC (Alternating Current) power. Because Inverter is grid-connected it controls the current amplitude according to the PV Panel power supply. Inverter always tries to convert the maximum power from your PV panel(s).
3. **Connection system:** This “interface” between Utility and PV-Inverter may consist of electrical breaker, fuse and connecting terminals. To comply with local safety standards and codes, the connection system should be designed and implemented by a qualified technician.
4. **Utility:** Referred to as “grid” in this manual, is the way your electric power company provides power to your place. Please note that Inverter can only connect to low-voltage systems (namely, 220, 230VAC, 50/60Hz).

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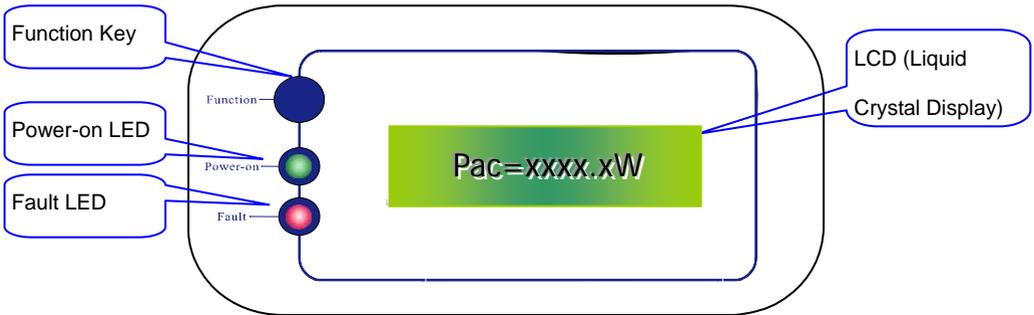
## 5. Operating Your PV-Inverter

### Modes of operation

There are 3 different modes of operation.

1. **Normal mode:** In this mode, Inverter works normally. Whenever the supplied power from PV panel is sufficient (voltage $>150\text{VDC}$ ), Inverter converts power to the grid as generated by the PV panel. If the power is insufficient, (voltage $<100\text{VDC}$ ) Inverter enters a “waiting” state. Whilst “waiting” Inverter uses just enough power from the PV panel monitor internal system status. In normal mode the green LED is on.
2. **Fault mode:** The internal intelligent controller can continuously monitor and adjust the system status. If Inverter finds any unexpected conditions such as grid problems or internal failure, it will display the information on its LCD and light up the red “Fault” LED.
3. **Shutdown mode:** During periods of little or no sunlight, Inverter automatically stops running. In this mode, Inverter does not take any power from the grid. The display and LED's on the front panel do not work.

## Front Panel arrangement



## LED

There are 2 LED's on Inverter, one is **green** and the other is **red**. Normally, only the green LED switches on during operation. Their indicated status is explained as follows:

1. Power on (green LED): It lights to indicate that Inverter is running.
2. Fault (red LED): Illuminates during a "fault" or "failure". Details of possible faults and their solutions can be found in Chapter 6, "Inverter Status".

## Function Key

Function Key is a key on PV-Inverter which can be pressed so as to rotate between each menu.

## Accuracy of the reading

Normally, the accuracy of LCD reading is around  $\pm 2\%$ . In all ranges of operation, the accuracy is up to  $\pm 5\%$ .

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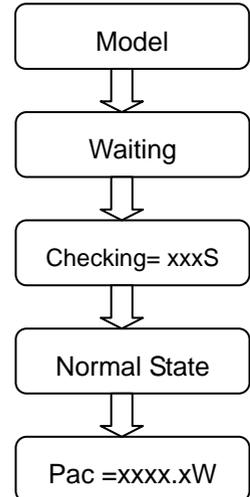
## Front Panel

Operating Inverter is quite easy. During normal operation, Inverter runs automatically. However, to achieve maximum conversion efficiency of Inverter, please read through the following information:

1. Automatic ON-OFF: Inverter starts up automatically when DC-power from the PV panel is sufficient. Once the PV-Inverter starts it enters one of the following 3 states:
  - **Standby:** The PV string can only provide just enough voltage to minimum requirements of the controller.
  - **Waiting:** When the PV string DC voltage is greater than 100V, Inverter enters a “waiting” state and attempts to connect to the grid.
  - **Normal operation:** When PV string DC voltage is greater than 150V, Inverter operates in the normal state.  
In this state, it feeds power to the grid.

Inverter automatically stops when the PV power is not enough.

2. Starting-up display sequence: Once the PV power is sufficient, Inverter displays information as shown in the flow chart to the right.
3. Change display information: During normal operation, LCD shows the detail of PV-Inverter. On the other hand, the display is setup to automatically indicate the supplying power to the grid. Each subsequent press changes the display by press the “Function” key on the front panel.
4. Hold display: If you want to hold a specific display.



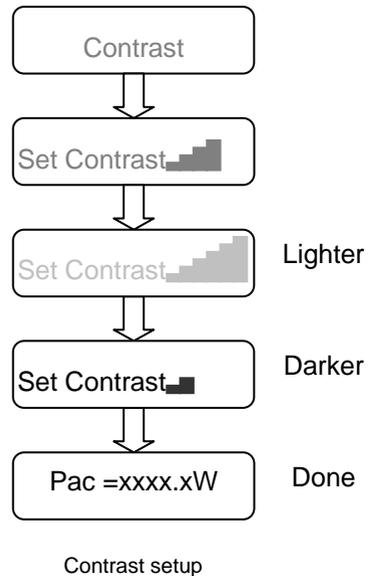
Information during start-up

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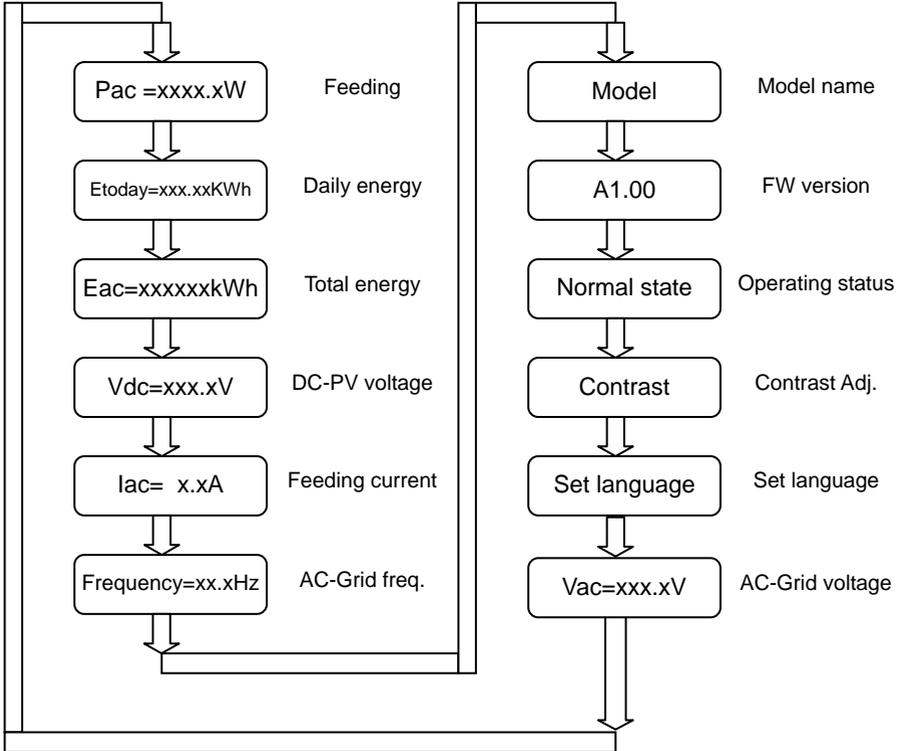
Repeatedly press the function key until the desired display is reached. Release the key and press again for more than 2 second until you see “Lock”, release the key; the information remains on the display. To change the display again, please press the key as indicated in above section 3. Change display information.

5. LCD backlight control: To save power, the LCD display’s backlight automatically turns off after 10 seconds. To enable it, press the “Function” key again.
  
6. Contrast control: A natural phenomenon of LCD displays is the background color is darker at higher temperatures. At higher temperatures, the characters may not be easily identified. In this case, the adjust the contrast as follows:

- a. Press the “Function” key repeatedly until “Contrast” shows in the display.
- b. Hold the “Function” key down for more than 2 seconds, until display shows “Set Contrast” and a bar graph on the right.
- c. Press the “Function” key repeatedly until the display’s contrast is acceptable.
- d. Release the key for more than 10 seconds, the display will show “Pac =xxxx.xW”.
- e. Setting completed.



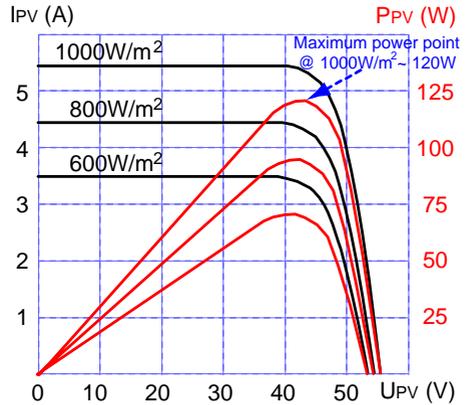
## LCD Display Sequence:



## Maximum Power Point Tracking (MPPT)

A good PV inverter must be able to convert the maximum power from any PV panel. Due to its advanced design, Inverter PV-Inverter can track the maximum power from your PV panel in any condition. When the displayed power on the LCD output does not change

dramatically, inverter is converting the maximum power from panels. When the LCD power reading is significantly changes, Inverter is tracking the power according to the varied sunlight.



When the PV panel's output is low, the feeding DC-power may drift slowly as does the AC power. It is because PV-Inverter is tracking maximum DC-power continuously.



## 6. Inverter Status

Inverter is designed to be user-friendly. Therefore, the status of the Inverter can be easily understood by reading the information that shown on the front panel display. All possible messages are shown in the following table.

### Display information

Operating conditions	In English	Description
<b>Normal Working Status</b>		
Power off	No display	PV inverter is totally shutdown, $V_{PV} < 70V$
Standby	Standby	$70V \leq \text{Input voltage} < 100V$
Initialization & waiting	Waiting	Input voltage range 100~150V during start-up. After PV voltage is higher than 100V, inverter is waiting for feeding to grid
Check grid	Checking xxxS	When PV voltage > 150V, inverter is checking feeding conditions
Feeding grid, MPPT	Normal	Inverter is feeding power. After 10 seconds of this display, LCD will show wattage.
FLASH	FLASH	FLASH firmware
<b>Monitoring Parameters</b>		
Instantaneous Output power	Pac =xxxx.xW	The real time output power in xxxx W
Accumulated energy information	Eac=xxxxxxkWh	Total energy that has been fed to grid since inverter was installed
Grid voltage	Vac = xxx.xV	Grid voltage in xxx.x VAC
Grid frequency	Frequency=xx.xHz	Grid frequency in xx.x Hz

Operating conditions	In English	Description
Feeding current	$I_{ac} = x.xA$	Feeding current amount in xx.x A
PV array voltage	$V_{dc} = xxx.x V$	Input voltage from PV array, xxx.x VDC
Daily Energy	$E_{today} = xxx.xxKW_h$	The accumulated kWh of that day
<b>System Fault</b>		
Isolation failure	Isolation fault	Earth fault of the PV-panels or failure of surge voltage protection
GFCI active	Ground I fault	Leakage current detected from ground conductor is too high
Grid failure	Grid fault	Grid measured data is beyond the specification (voltage & frequency)
No utility	No Utility	Utility is not available
Input voltage too high	PV over voltage	Input voltage is higher than the maximum input voltage
<b>Inverter Fault</b>		
Consistent failure	Consistent Fault	The readings of 2 microprocessors are not consistent. It could be caused by CPU and/or other circuit do not function well.
Temperature too high	Over temperature	The internal temperature of inverter is higher than normal value
Output relay failure	Relay Failure	The relay between inverter and grid is not functional
Output DC injection too high	DC INJ High	Output DC injection is higher than expected
EEPROM problem	EEPROM Failure	EEPROM inside has data access problem
Communication failure between microprocessors	SCI Failure	The communication between MCU inside is abnormal

Operating conditions	In English	Description
DC bus voltage is too high	High DC Bus	The DC BUS voltage is higher than expected
DC bus voltage is too low	Low DC Bus	The DC BUS voltage is lower than expected
2.5V reference voltage inside problem	Ref 2.5V Fault	The 2.5V reference inside are abnormal
Output DC sensor abnormal	DC Sensor Fault	Detection of DC output sensor is abnormal
GFCI detection problem	GFCI Failure	The GFCI detection circuit is abnormal
<b>System Information</b>		
Model display	EATON ETN1000 /ETN2000	Inverter model, xkW inverter
LCD contrast	Contrast	LCD contrast setting
LCD contrast setting	Set Contrast	Contrast setting of LCD display
LCD display lock	Lock	Hold the present display message
Waiting for reconnect to grid	Reconnect xxxS	The time that needs to reconnect grid power
Firmware version	Ver. xx.xx	F/W version information
Setting Language	Set Language	Set up of the display language

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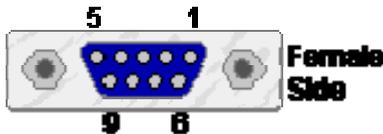
## 7. Communications

Inverter is equipped with a powerful communications interface and options. Use Inverter's EZ control to monitor the status of your PV-Inverter. Also, qualified personnel can upgrade the firmware using the RS232 port.

1. RS232: To use the RS232 port, remove the RS232 cover on the bottom side of Inverter. It is a DB9 socket. The pin definition is

Pin	Functional Description
1	N.C.
2	TxD
3	RxD
4	N.C.
5	Common
6	N.C.
7	N.C.
8	N.C.
9	N.C.

N.C. means "No Connection"



2. Optional communications port: It is a powerful extension that can accept a special card that designed for communication purpose such as RS485. The RS485 card can be used to work with Inverter's EZ logger as multiple monitoring applications.
3. Firmware upgrade: To up-to-date keep the firmware, use the RS232 port and supplied program to upgrade firmware. To do this, please contact EATON Customer Service.

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## **EATON Contact Information**

Telephone: 1300 3 EATON

Web: <http://www.Eatonelectric.com.au/>



To prevent risk of damage it is recommended that only authorized personnel perform firmware upgrades.

## 8. Trouble shooting

In most situations, the Inverter requires very little service. However, if Inverter is not able to work perfectly, please refer to the following instructions before calling your local dealer.

- Should any problems arise, the red (Fault) LED on the front panel turns on and the LCD displays the relevant information. Please refer to the following table for a list of potential problems and their solutions.

	Display	Possible actions
System Fault	Isolation Fault	<ol style="list-style-type: none"> <li>1. Check the impedance is between PV (+) &amp; PV (-) and the PV-Inverter is earthed. The impedance must be greater than 5MΩ</li> <li>2. If the problem persists please contact Eaton.</li> </ol>
	Ground I Fault	<ol style="list-style-type: none"> <li>1. The ground current is too high.</li> <li>2. Unplug the inputs from the PV generator and check the peripheral AC system</li> <li>3. After the cause is cleared, re-plug the PV panel and check PV-Inverter status.</li> <li>4. If the problem persists please contact Eaton.</li> </ol>
	Grid Fault	<ol style="list-style-type: none"> <li>1. Wait for 5 minutes, if the grid returns to normal, PV-Inverter automatically restarts.</li> <li>2. Make sure grid voltage and frequency meet the specifications</li> <li>3. If the problem persists please contact Eaton.</li> </ol>
	No Utility	<ol style="list-style-type: none"> <li>1. Grid is not connected.</li> <li>2. Check grid connection cables.</li> <li>3. Check grid usability.</li> </ol>
Inverter Failure	PV over Voltage	<ol style="list-style-type: none"> <li>1. Check the open PV voltage, see if it is greater than or too close to 450VDC</li> <li>2. If PV voltage is less than 450VDC, and the problem still occurs, please contact Eaton.</li> </ol>
	Consistent Fault	<ol style="list-style-type: none"> <li>1. Disconnect PV (+) or PV (-) from the input, restart the PV-Inverter</li> <li>2. If it does not work, please Contact Eaton.</li> </ol>

	Over Temperature	<ol style="list-style-type: none"> <li>1. The internal temperature is higher than specified normal value</li> <li>2. Find a way to reduce the ambient temperature.</li> <li>3. Or move the inverter to a cooler environment</li> <li>4. If it is not effective, please contact Eaton.</li> </ol>
	Relay Failure	<ol style="list-style-type: none"> <li>1. Disconnect <b>ALL</b> PV (+) or PV (-)</li> <li>2. Wait for few seconds</li> <li>3. After the LCD switches off, reconnect and check again</li> <li>4. If the message reappears, please contact Eaton.</li> </ol>
	DC INJ High	
	EEPROM Failure	
	SCI Failure	
	High DC Bus	
	Low DC Bus	
	Ref 2.5V Fault	
	DC Sensor Fault	
GFCI Failure		

- If there is no display on the panel, please check PV-input connections. If the voltage is higher than 150V, call your local service.
- During periods of little or no sunlight, the PV-Inverter may continuously start up and shut down. This is due to insufficient power generated to operate the control circuits.

## 9. Specifications

### Electrical

Model	EATON ETN1000	EATON ETN2000
Nominal AC power	1000W	2000W
Max. AC power (in 10 minutes)	1100W	2200W
<b>Input</b>		
Nominal DCV	360V <sub>DC</sub>	360V <sub>DC</sub>
Max. open DCV	500V <sub>DC</sub>	500V <sub>DC</sub>
MPPT range	150 to 450V <sub>DC</sub>	150 to 450V <sub>DC</sub>
Working range	100 to 500V <sub>DC</sub>	100 to 500V <sub>DC</sub>
Max. input current	5A <sub>DC</sub>	10A <sub>DC</sub>
<b>Output</b>		
Operational voltage range <sup>1</sup> (F/W Setting)	206~264 V <sub>AC</sub>	206~264 V <sub>AC</sub>
Operational frequency range <sup>2</sup> (F/W Setting)	49.25~50.75Hz	49.25~50.75Hz
Current distortion	<3%	<3%
Power factor	>0.99	>0.99
Maximum $\eta$	95%	96%
European $\eta$	93%	95%
<b>Environment</b>		
Protection degree	IP 43	
Operating temperature	-20 to 55°C	
Humidity	0 to 95%, non-condensing	
Heat Dissipation	Convection	
Power consumption	<7W	
Acoustic noise	<35dBA	
<b>Communication &amp; Features</b>		
LCD	1-Line, 16 characters	
Comm. Interface	RS232 standard, RS485 optional	
F/W upgrade	Yes, via RS232	
<b>Mechanical</b>		
W×D×H (mm)	305x302x120	
Weight (kg)	11.3	
<b>Normative references</b>		
Grid interface regulation	AS4777	
Safety	AS3100	
EMC: EMS/EMI	EN 61000-6-2 (2005) / EN 61000-6-3 (2007)	
CE	LVD: 2006/95/EC EMC: 2004/108/EC	

<sup>1</sup> Regulation voltage range is 200~270 V<sub>AC</sub> according to AS4777.

<sup>2</sup> Regulation frequency range is 45~55Hz according to AS4777.

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\*Product specifications are subject to change without notice