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GC1000 Grid-Connected Inverter Installation Manual

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6R03
Utility Interactive Photovoltaic Inverter

Thank you for purchasing the GC1000 Grid-Connected Inverter from Advanced Energy. We are pleased to offer a product of superior quality, design, and reliability. In order to ensure that the inverter performs as designed, installation of the GC-1000 must be undertaken by a licensed electrician and must include an AC lightning arrestor. The wiring instructions for the lightning arrestor are included in Appendix B. The installation manual provides detailed information on the GC-1000's performance capabilities and operations. If you have any questions regarding the operation or use of the GC1000, please contact our technical support staff at (603) 654-9322 x115.

Please complete the customer information on the Warranty, keeping the customer copy and returning the Advanced Energy copy to the AE address within thirty (30) days.

For further information about Advanced Energy and our other high-quality products, visit our web site at **www.advancedenergy.com**.

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FCC Title 47 Subpart 15 Class B Notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- **Reorient or relocate the receiving antenna.**
- **Increase the separation between the equipment and the receiver.**
- **Connect the equipment into an outlet on a circuit different from that to which the receiver is connected**
- **Consult the dealer or an experienced radio/TV technician for help.**

You may also find helpful the following booklet, prepared by the FCC: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402.

Changes or modifications to this unit not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

Canadian Department of Communications Notice

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de la class B prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Commmunications du Canada.

1. Important Safety Instructions

Warning
Before you install and use the AE GC1000 Grid-Connected Inverter, read these safety instructions. Save this manual for future reference.

General Safety Precautions

1. SAVE THESE INSTRUCTIONS. They contain important safety and operating information about the AE GC1000 Grid-Connected Inverter.

2. Do not attempt to repair or service the GC1000 Grid-Connected Inverter. Opening the case may result in a risk of fire, electric shock, or injury to persons. Repair or servicing of the GC1000 should be handled by certified technicians or electricians only.

3. To avoid risk of fire or electric shock, ensure that the inverter is installed with properly sized wire. AE requires that the GC1000 Grid-Connected Inverter be installed by a certified technician or electrician according to National Electric Code requirements.

4. The AC power must be disconnected at the distribution panel before servicing the GC1000 or disconnecting the inverter AC wiring. Cover all photovoltaic panels or disconnect DC wiring before servicing.

5. Do not install a GC1000 Inverter that appears to be physically damaged by shipping or handling. Return the inverter to an authorized service center for replacement.

6. To reduce risk of damage to the inverter, AE requires the use of an approved lightning arrestor at the AC distribution panel. The wiring instructions for the lightning arrestor are included in Appendix B.

2. Introduction

2.1 Scope of this Manual

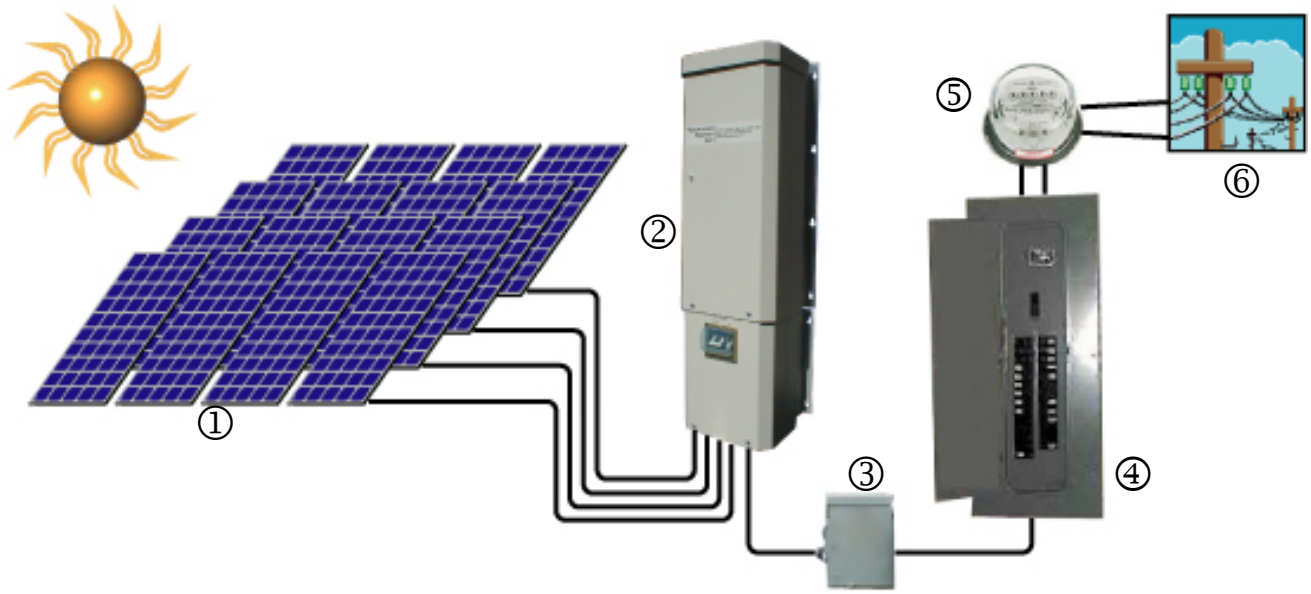
This manual contains the basic information needed to install the Advanced Energy GC1000 Grid-Connected Inverter for *photovoltaic applications*. If using the GC with other types of power generation (e.g., wind), please contact Advanced Energy Customer Service.

2.2 GC1000 Key Features

- UL-Listed and NEC Article 690 and 62.41-compliant
- Meets UL 1741, IEEEP929, and NYSERDA SI Requirements
- Tested to FCC class B (residential) requirements
- Uses maximum power point tracking for maximum module output
- 93% peak efficiency, no-load power consumption of only 2.4 Watts
- Weatherproof NEMA-3 case for both indoor and outdoor installation
- Tandem DC/GFI Disconnect disables array under ground fault conditions
- Optional AC Disconnect provides means for local inverter output disconnect
- Optional monitoring package available
- Certified by the California Energy Commission
- Approved for utility interconnection by the New York State PSC
- Rugged, industrial-rated components with low inverter parts count
- Standard five-year warranty

2.3 GC1000 Grid-Connected Inverter

The GC1000 Grid-Connected Inverter is a 1000W utility interactive inverter for use in photovoltaic systems. The GC1000 converts direct current into alternating current suitable for feeding into the utility grid as indicated schematically below in figure 1.



① PV Array
② GC1000 Grid-Connected Inverter
③ Lockable AC Disconnect (required by some utilities)
④ Utility Circuit Breaker Panel
⑤ Kilowatthour Meter (may turn backwards)
⑥ Utility Grid

Figure 1. Conceptual Layout of a Grid Connected Inverter System

The GC1000 Grid-Connected Inverter uses the utility grid as a giant battery system - no acid, no maintenance, no worn-out batteries. You put power into the grid when you produce more than you use, and draw power from the grid when you need it. Many utilities require that power-producing equipment be de-energized in the case of a brown out or loss of power. The GC1000 Grid-Connected Inverter has been independently certified by Underwriters Laboratories, Inc. to meet this requirement, ensuring the customer of the safest photovoltaic power generation possible. The GC1000 Inverter has also been tested to FCC class B requirements, in order to minimize radio and TV interference.

2.4 GC1000 Connection to Utility Grid

In order to connect directly to the utility's grid, the GC1000 must meet certain requirements. If the grid experiences brownout or blackout conditions, the utility company requires that all power generation sources be removed from the grid. This requirement – referred to as the "anti-islanding" feature – ensures that any electrician from the utility who may be working to restore normal operation to the grid will not receive an electrical shock from power generation devices (such as the GC1000) which export electricity to the grid. Normally this is accomplished by using a protective relay switch that opens if power loss or voltage / frequency fluctuations are experienced.

Because the GC1000 is microprocessor controlled, the need for a protective relay switch is eliminated. The GC1000 continually monitors the grid voltage, and can drop offline in less than 2 seconds if the grid is interrupted. The grid voltage limits defined by UL1741 are 106VAC and 130VAC, and are set as default factory settings in every GC1000 inverter. If the grid voltage drops below 106VAC, then the GC1000 will drop offline. The grid frequency limits are also factory set to the UL1741 requirements. If the grid frequency drops below 59.3Hz or rises above 60.5 Hz from the nominal 60Hz frequency, the inverter will drop offline within the required amount of cycles.

The GC1000 also uses a proprietary algorithm to sense grid loss when the load is perfectly matched to the output of the inverter. The GC1000 synchronizes to the grid frequency; without the grid, the line frequency will creep up until it hits the upper frequency boundary. In a matched-load situation, the GC1000 will shut down within 10 cycles (less than .2 seconds). Additionally, the GC1000 will drop offline in the case of disturbances on the line, such as large noise spikes caused by an inductive motor starting. When the grid has stabilized, the GC1000 will resume normal operation within 30 seconds.

The National Electric Code (NEC) requires that there be a DC disconnect between the inverter and the photovoltaic panels. Every GC1000 now includes a DC disconnect breaker. The DC disconnect is accessible from the outside of the GC1000 for easy access by utility, maintenance, or fire-protection personnel.

For certain installations, the NEC also requires a ground-fault interrupter (GFI). This is also included on the standard model GC1000, and is slaved to the DC disconnect breaker.

The UL1741 approval letter can be found in Appendix A.

2.5 GC1000 Overview

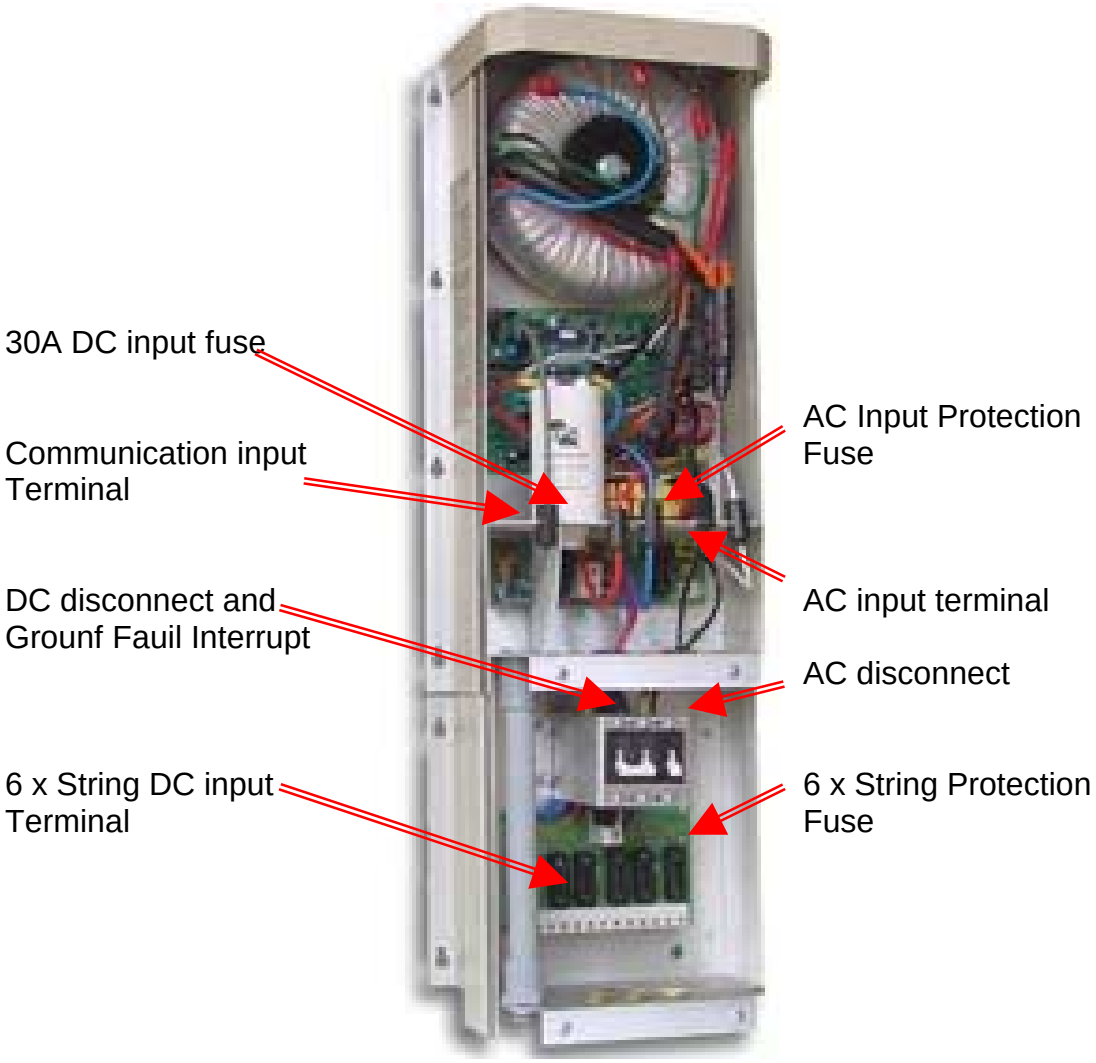


Figure 2. Major components of the GC1000.

The GC1000 is configured in the factory for polycrystalline photovoltaic panels. A 12- volt nominal polycrystalline PV panel has an open circuit voltage of about 19-22 Vdc. Four panels in series have a nominal voltage of 48V, and a maximum open circuit voltage (Voc) of 75-88 volts. Because thin-film panels have a much higher open circuit voltage (Voc), four thin-film panels in series would exceed the 100-volt maximum input voltage of the GC1000.

To allow the use of thin film or for parallel 36V nominal panels, the GC-1000L can be specified for an operating range of 44 – 75VDC. Please refer to section 3.9 for further details.

2.6 Optional Monitor Package: AM100

A separate data-monitoring package is available for theGC1000 that meets most basic monitoring requirements. The data package includes:

- monitoring for up to 6 inverters
- mounting distance from inverter: 200ft +
- 4 line x 20 character display
- RS232 computer interface and DOS based software (computer requirement 486 or higher)
- time-stamped event logging
- monitoring of AC volts, amps, watts, frequency, daily and cumulative kWh
- monitoring of inverter temperature and run time, DC volts, amps, watts
- 1 week of data storage for 10 inverters
- non-volatile storage of inverter KWh
- battery-backed time and date clock
- optional modem for remote data collection
- data downloads compatible to Campbell data logger format

Figure 3. Optional Monitoring Device: AM100

3. Installation

3.1 Installation Orientation

This section provides a detailed overview of the installation of a GC1000. Physical and wiring installation considerations are discussed and illustrated with photographs and diagrams.

The GC1000 contains eight 0.12" mounting holes on the outer edges of the inverter housing. The mounting holes accept a maximum screw/bolt size of #10, or metric M6. To maintain the water-tightness of the GC1000 cabinet, the inverter must be installed in the orientation shown in figure 4. This orientation is also essential for proper cooling of the unit, and correct operation of the sliding cover. Although the inverter's housing is outdoor rated, it is recommended that the inverter be mounted out of direct sunlight and away from heat sources. Most installers prefer to use a plywood base to mount the inverter to, although other mounting methods are accepted.

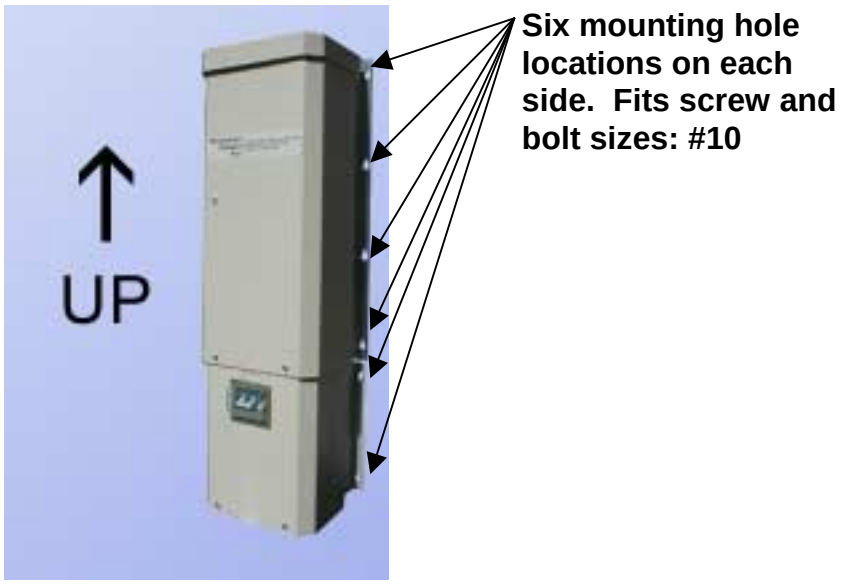


Figure 4. GC1000 Installation Orientation & Mounting

Note: Make sure that mounting screws and bolts do not interfere with any AC or DC wiring behind the inverter mounting location. This could cause shock and/or improper function of the inverter.

3.11 Cover Removal Notes

IMPORTANT: To avoid damage to the AC and DC disconnect breakers, remove the bottom cover carefully as shown in figure 5 below.

1. Remove the four screws from the top and bottom cover
2. The AC and DC disconnect breakers should be in the off position (down). Slide the cover down about a half-inch.
3. Pull the bottom of the cover away from the unit
4. The cover, now at an angle, should slowly be pulled down and away from the unit, **making sure that the circuit breakers are cleared**.

These instructions should be reversed for cover installation, again making sure that the circuit breakers are cleared.

Figure 5. Bottom Cover Removal (Steps 2-4)

3.2 String Combiner Overview

The GC1000 String Combiner is a standard feature with each inverter. It was designed to work with most types of photovoltaic panels, and includes the AC as well as the DC and Ground Fault Interrupt (GFI) ganged disconnects. Up to six strings of PV modules can be connected to the board terminals. Maximum wire size for this connection is # 10 AWG. Each string is protected by its own 10A fuse and backfeed protection diode. It does not matter which terminals are connected to the input strings; any combination of inputs can be used for the installation. However, the polarity of the inputs must match the polarity of the terminals.

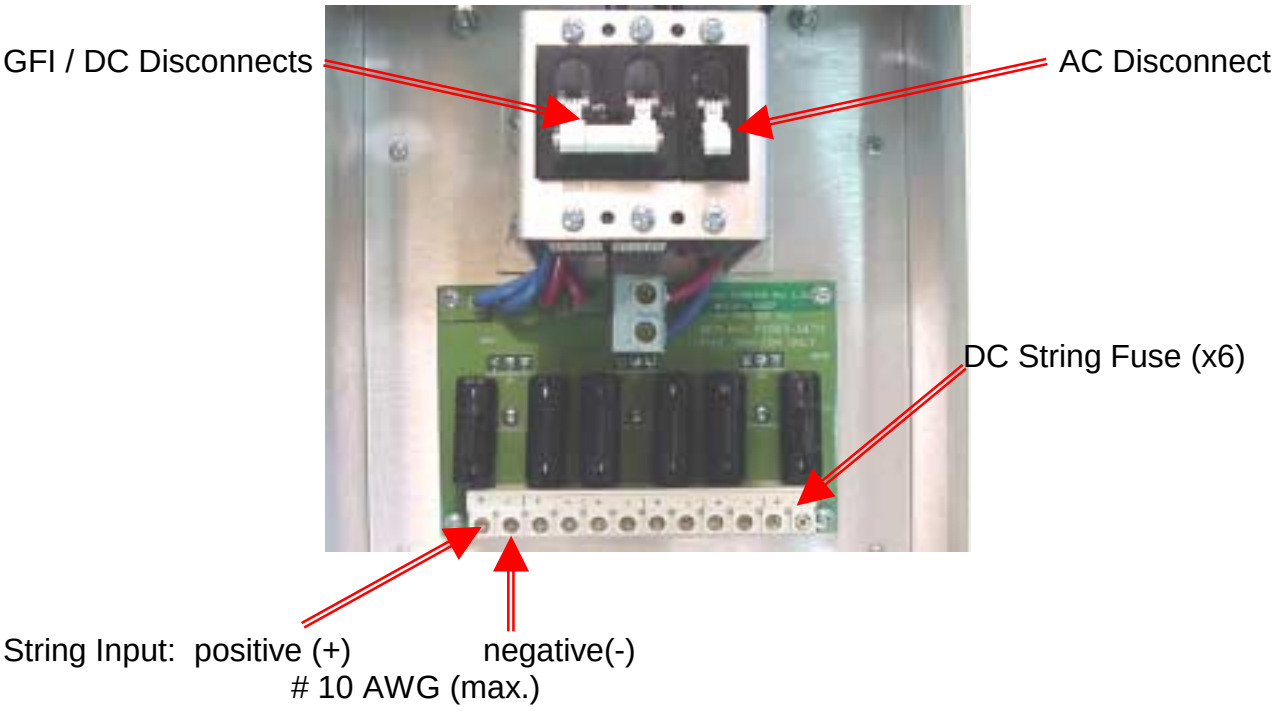


Figure 6. String combiner overview

3.3 Terminal Board Overview

The terminal board is the main input section for the inverter. It contains protection fuses for both the AC and combined DC inputs. In addition, the communications input to the GC is located on the left side of this board. Two RJ11(telephone-type) connectors are provide the communication interface to the AM100 monitor. Both of these connectors tie to the same wiring, therefore it does not matter which is used. The AC input terminal is located on the right side of the board. It is recommended that # 10 AWG wire be used to connect the GC1000 to the utility panel.

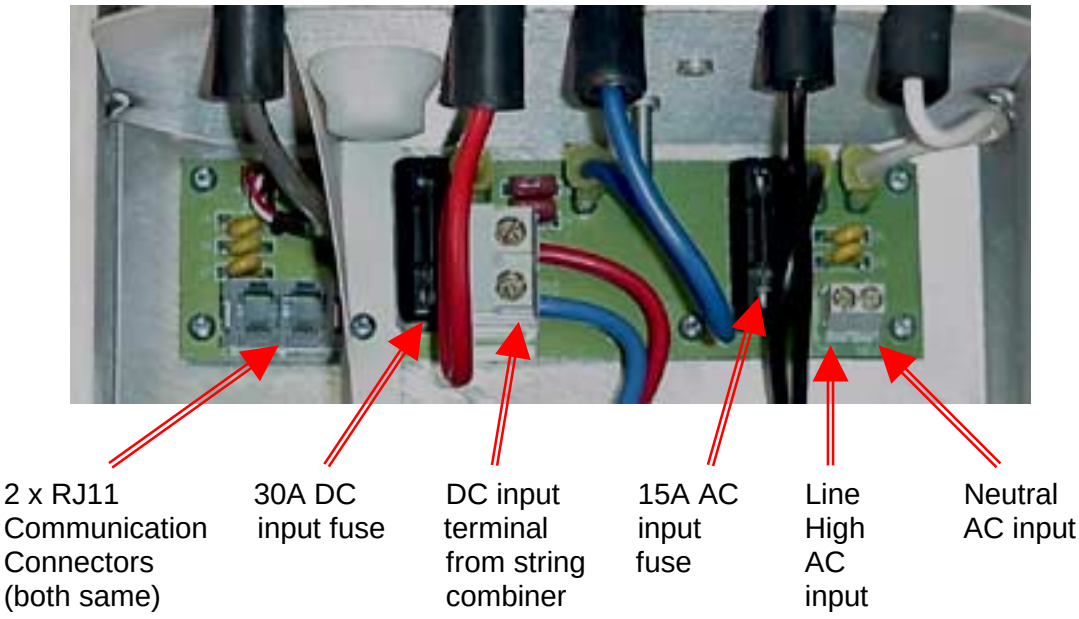


Figure 7. Terminal board overview

3.4 Fuse Replacement

The GC1000 includes protection fuses on both the AC and DC side of the inverter. All fuses are ceramic fast-acting fuses for the appropriate voltage and current rating. Table 1 indicates the rating for each type of fuse used in the GC1000. If an overcurrent has occurred and the fuses need to be replaced, the replacements should be chosen from the part numbers listed in table 1.

Required Fuse Rating	Quantity	Location	Littelfuse P/N	Bussmann P/N
10A, 125Vdc **15A, 125Vdc**	**6**	**String Combiner Board (F1 – F6)**	**314-010** **314-015**	**GBB-10** **GBB-15**
30A, 125Vdc	**1**	**Terminal Board DC input (F2)**	**314-030**	**GBB-30**
15A, 250Vac	**1**	**Terminal Board AC input (F1)**	**314-015**	**GBB-15**

Table 1. Fuse specification

Both Littelfuse and Bussmann fuses may be purchased from:

Digikey:	(800)344-4539	www.digikey.com
Newark Electronics:	(800)263-9275	www.newark.com
Mouser Electronics:	(800)346-6873	www.mouser.com

String combiner fuses:

The factory-installed fuses are rated at 10A. Contact the manufacturer of the specific PV modules you are using to determine the maximum fault current (Imf) rating before replacing the factory-installed 10A fuses with 15A or 20A fuses. Failure to do this could result in severe damage to your PV modules. When choosing replacement fuses, make sure that they are rated 125Vdc, and fast-acting. There are no DC fast-acting fuses that have glass housing. Often 125V DC fuses will be labeled 250V AC. It is therefore important to make sure that the selected fuse is also DC rated.

DC input fuse:

The Terminal Board houses another DC input protection fuse that is rated 30A 125Vdc.

AC input fuse:

The Terminal Board houses the AC input protection fuse that is rated 15A and 250Vac. When replacing fuses, make sure that they are properly installed in the fuse clips, and that the clips are adjusted so as to firmly grip the fuses (see Troubleshooting section for details).

3.5 Wiring Schematic for a 48V nominal system

The standard GC1000 is designed for a nominal input of 48V. Figure 8 illustrates how such a system should be wired. Ground wires are not shown, but should be connected on both the AC and DC side.

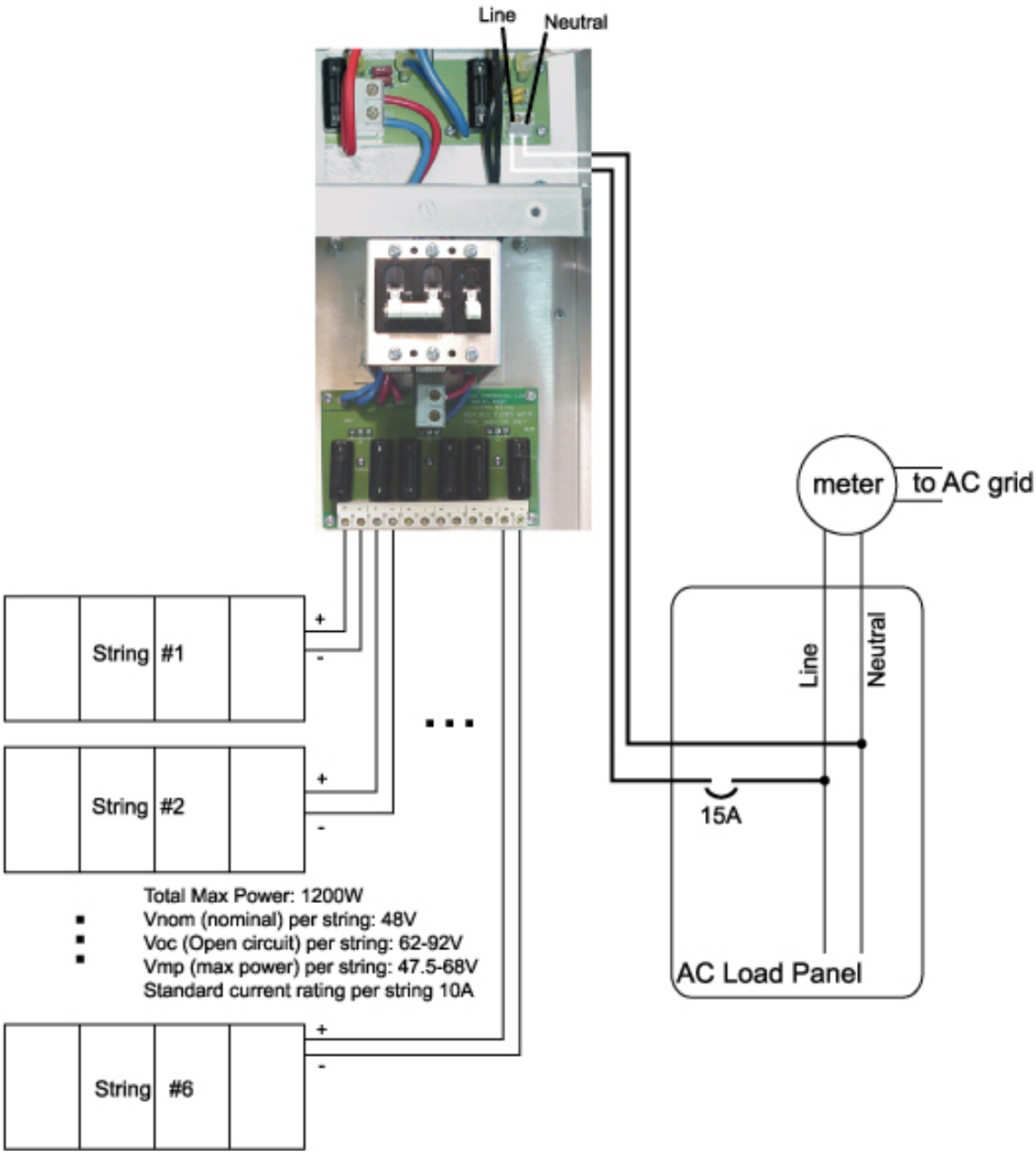


Figure 8. Wiring diagram for a 48 volt PV system.

3.6 Wiring Schematic for a 36V nominal system

The figure below shows the wiring schematic for the GC1000L using panels that cannot meet the voltage range of the standard 48V inverter. This is a nominal-36V system.

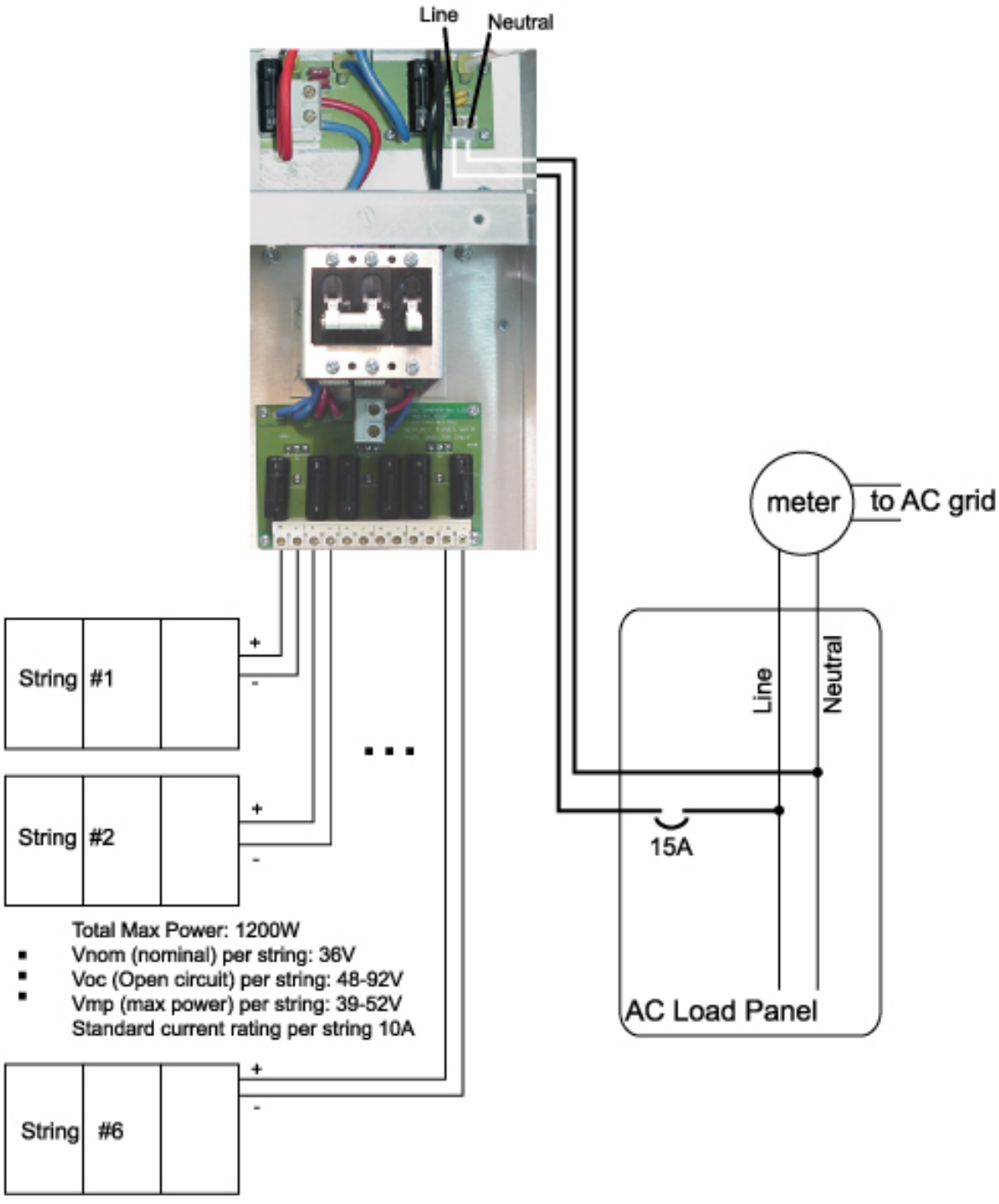


Figure 9. Wiring diagram for 36V system.

3.7 Wiring Schematic - Multiple Inverters

Multiple inverters can be used for systems larger than 1kW. No more than six inverters should be connected to one utility panel. When using two or more inverters, make sure that they are spread over the different available phases. In a regular residential split phase system this is easily done by choosing AC panel breakers that are connected to separate busses inside the utility panel.

Figure 10 shows the wiring diagram for installation of multiple inverters in a system.

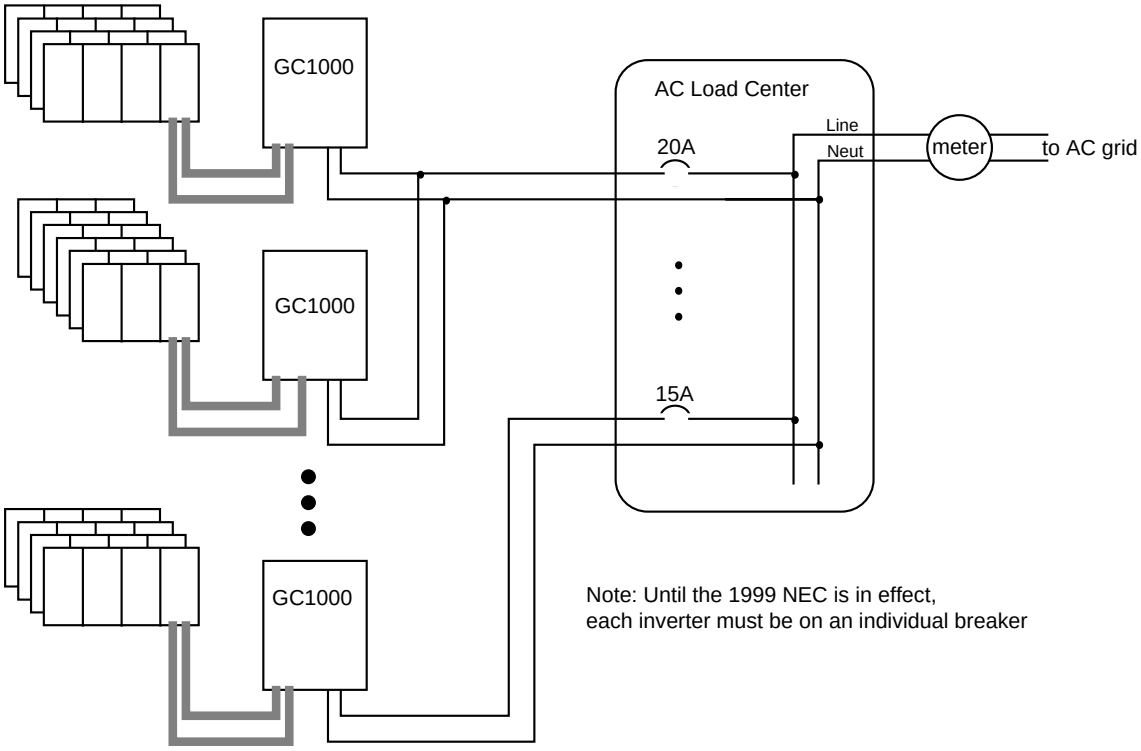


Figure 10. Wiring Diagram for Multiple Inverters

3.8 Pre Power-Up Checklist GC1000

Before turning on the GC1000 make sure that the following list has been checked.

1. The inverter input voltage has been checked and falls within the input voltage range: To do this, measure each input string and make sure that it reads within the calculated open circuit voltage (Voc) of the PV panels in use. A nominal 12V panel typically has a Voc of 21V (±1V). Therefore the Voc of each string should fall around 84V (±8V). The GC1000 needs at least 63V to start up. If using a low voltage inverter see section 3.9.
    a. !!! If voltages above 100V are measured, DO NOT turn on the DC breakers on the inverter. Disconnect the wires and check array wiring.
    b. If voltages fall below 63V, check the array wiring and module diodes. Low light conditions may exist at this point. The inverter will not power up in this configuration. A low voltage unit may be needed if this is the system's maximum Voc.

2. The AC input measures 120Vac (±10V). The GC1000 will function on an AC voltage range of 106-130Vac. If the measured grid voltage is close to either of the limits of this range, the local utility should be contacted to determine the cause of the over or under voltage.

Congratulations! You are now ready to power up the GC1000.

3.81 Power up the GC1000 in the following sequence

1. **Turn on the AC disconnect breaker**
2. **Turn on the DC disconnect breakers**

The breakers must be turned on in this sequence in order to bypass the 5 minute anti-islanding start-up delay. The inverter should turn on within ~30 seconds after the breakers are engaged.
You will notice that the inverter will start with 2 or 3 blinks, it will then briefly go into a 2 blink mode, followed by a quick single blink. The single blink will get longer when the inverter has fully powered up. It may take a little while for the inverter to level at its optimal performance level.

For trouble shooting, please refer to section 4.

3.9 Pre Power-Up Checklist for the Low Voltage GC1000

If your array includes PV panels outside the 12V nominal range, it may be necessary to use the Low Voltage version of the GC1000 inverter.

The operating values for the GC1000 standard versus the GC1000 LV are shown in table 2.

Operating Value	GC1000 Standard (Vdc)	GC1000 Low Voltage (Vdc)
Vdc required for start	63.0	48.0
Vdc nominal	60.0	45.0
Vdc MPPT range low	47.5	39.0
Vdc MPPT range high	68.0	52.0
Vdc shutdown	45.0	33.0
Vdc maximum	92.0	92.0

Table 2. GC1000 Standard vs. GC1000L - Low Voltage.

Please make sure that the modules you have chosen can be wired to produce power that falls within the voltage ratings of one of the two inverters.

The Pre-startup Checklist in the previous section should be the same except for the Voc rating which needs to fall within the range of 48V – 82V.

4. Troubleshooting Guide

This section enables the installer or electrician to determine whether the problem lies in:

§ 4.2 the PV array or PV array wiring
§ 4.3 the inverter
§ 4.4 the grid or grid wiring, or the utility's power supply

It is not possible to list all failure modes; therefore, it may be necessary to contact Advanced Energy Customer Service if the following section does not resolve the problem.

Required test equipment:

1. A multimeter capable of measuring AC and DC voltage, resistance and continuity
2. A clamp-on style AC amp meter capable of measuring 0-10Amps
3. A clamp-on style DC amp meter capable of measuring 0-30Amps

IMPORTANT
If the problem is within the inverter, please fill out the Problem Report found toward the end of this section, and return it with the unit. This will help our service department to serve you better and repair your unit more rapidly.

4.1 LED status code

The operational status of the GC-1000 is indicated by the frequency and number of flashes from the red LED on the front of the unit. To understand how the unit is operating, count the number of flashes occurring between the pauses, and refer to the table below. Further information about the status of the GC1000 Grid-Connected Inverter may be obtained by use of the optional monitor package, the AM100.

Number of Flashes	Definition	Corrective Action
One, variable length	The GC1000 is online. The ratio of ON to OFF time is proportional to the output power.	None required. The GC1000 is producing power.
Two	PV voltage out of range or low power. This will occur when the PV panel is operating under low-light conditions.	If condition persists during normal sunlight conditions, check the DC voltage connection.
Three	Grid voltage or frequency error.	Check that AC wiring is correct and the AC breaker is turned on.
Four	The inverter has been taken offline from the optional monitor interface	The GC1000 can be brought back online with the monitor program. See the GC1000 Monitor Package User's Manual for details.
Five	Over voltage/current, over temperature, or thermistor fail This warning will occur once if there is fault, such as a shorted AC connection or power fail.	If condition persists, contact a certified technician or electrician to service the GC1000.
Rapid flashing	The power has backed off because of high temperature.	None required. As the temperature of the GC1000 drops to a safe operating range, it will resume normal operation.

Table 3. LED status codes.

4.2 Problem in the PV array or DC wiring

If the inverter is not powering up (showing no LED blinks at all), then the inverter is not receiving proper DC input voltage.

1. Check input voltage for each string:
   - With the inverter breakers shut off, measure the voltage of each input string into the inverter. This value should be equal to the open circuit voltage (Voc) of the PV panel. If this is not the case, then check the PV wiring or array.
   - If the input string polarity is reversed, you are shorting out the whole array, and the inverter will not be receiving sufficient input voltage. The DC input wires must match the polarity as indicated on the string combiner board (note the "+" and "-" markings shown in figure 11). The inverter may not function at all until the polarity problem is corrected. If this problem has occurred, check all the fuses in the inverter (see section 2 below for this procedure) as well as the protection diodes in the PV panels.

Figure 11. Polarity on string input terminals

   - If the correct voltage is measured but the inverter still fails when the DC breakers are switched ON, then there is a problem in the DC side of the inverter.
2. Check all fuses in the inverter:
   - Pull out all six string fuses, and the left DC input fuse on the terminal board and check for continuity. Check fuses for proper rating.
   - Replace fuses only with properly rated ones.
   - If the fuses are loose once they are reseated in their clips, the U-shaped aluminum clips can be bent slightly closer together by gentle finger pressure. An insufficient connection here could cause arcing and possibly component melting.
3. Check that proper DC voltage reaches the inverter Power Board:
   - Trace the DC wires all the way to the top section of the inverter, measuring the DC voltage at a number of points. You can keep the negative lead of the multimeter on any of the negative polarity screws on the string input terminal, and change the positive lead location to the point at which you would like to measure the DC voltage.

4. Ground Fault Interrupt (GFI):
   - If the DC breaker trips right away without blowing any fuses, there is a Ground Fault Interrupt (GFI), and somewhere in the GC, most likely under one of the circuit boards, a component is shorting to the chassis. If there is a short in the DC wiring to the inverter, the GFI breaker could also trip.
5. Check for correct DC input voltage during power-up and inverter operation:

!!! INVERTER IS POWERED AT THIS POINT. BE CAREFUL FOR ELECTRIC SHOCK!!!

   - Measure the DC voltage on each input string while the inverter is powering up or has powered up. Make sure that it falls within the MPPT voltage range of the model inverter you are using. For a standard voltage unit this range is 47.5 to 68 volts. For a low voltage unit (these are special order items) the MPPT range is 35.5 to 52 volts.
   - The voltage here should be lower than the Voc mentioned earlier. As the inverter is powering up the DC voltage will be pulled down to within the MPPT voltage range.
   - During low light conditions, i.e. morning and evening, only low voltage will be available.
6. Check current flow through each input string during inverter operation:
   - If low power output is observed on the inverter, measure the DC current flowing through each input string. Each string should be providing an adequate amount of current. The currents may vary from panel to panel.
   - If any of the fuses are blown or connected incorrectly, no current will flow through the affected string input.

4.3 Problems in the grid or AC wiring

1. Check AC input voltage:

!!! INVERTER IS POWERED AT THIS POINT. BEWARE OF ELECTRIC SHOCK!!!

   - Measure the AC voltage at the terminal board input connector. Voltage should be between 106 and 130Vac (AC volts). In most situations the voltage should be approximately 120Vac. If deviations from this voltage are greater than 5V contact your local utility.
   - Measure Line H to chassis. Voltage should be 106-130Vac.
   - Measure Neutral to chassis. Voltage should be less than 0.7Vac. If it is higher, check for proper neutral to ground connection in wiring and a proper ground connection on the utility panel. Make sure that all connections, new and old, from the inverter and inside the utility panel are proper.
   - Check the AC Fuse:
   - Pull out the AC fuse on the right of the terminal board and check for continuity. Check fuse for proper rating.
   - Only replace fuse with one with the proper rating.
   - If the fuses seem at all loose once they are reseated in their clips, these U-shaped aluminum clips can be bent slightly closer together by gentle finger pressure. An insufficient connection here could cause arcing and possibly component melting.

2. Check inverter status:
   - If the proper voltages exist and the inverter is displaying AC problems (three blinks) then make sure that the inverter is not in the five minute start up delay. To do this, turn off both the DC and AC breakers. Wait until the LED stops blinking completely. This may take about 30 seconds. Then turn on the AC breaker first, followed by the DC breaker a few seconds later. The inverter should now power up without going into the start up delay.

3. Check for proper AC wiring:
   - If the proper voltage is measured at the AC terminal block, but no AC is detected by the inverter, check that the input terminal is not broken.
   - Check that all black and white wires are connected properly through the circuit breaker and into the power board.
   - Check the AC fuse.

4. Check for noise emanating from the power board:
   - Note that *it is normal* for the inverter to hum audibly; however, if the inverter makes a loud buzzing noise (admittedly a subjective measure here) or sparks, please notify Advanced Energy Customer Service.

4.4 Problems inside the inverter

To determine whether or not the power board or other components are causing the inverter to malfunction, please follow these steps:

1. Check that all wiring inside the inverter is connected properly
   - Ensure that all crimped connections to the power board and terminal board are making proper contact to the male connections on various boards. With the inverter power shut off, tug gently on the crimps to determine if there are any loose connections.
   - Check for any burn marks or broken components, especially at wire crimps.
2. Check for noise and sparks
   - If you notice any sparks, at any point during troubleshooting, please note on the Problem Report form the board location where the sparks were observed and return this form with the unit.
   - Please note at which point in the inverter's operation abnormal noises occur and which switch was last operated.
   - Please call Advanced Energy before returning any product.

4.5 Problem Report

Please take a few minutes to fill out this problem report to enable our technicians to better service your inverter. **In order to return any product for service you must FIRST obtain a Return Material Authorization (RMA) number by calling Advanced Energy Customer Service at 603-654-9322.** Please ship this form (and any additional pages necessary to describe the problem) along with the inverter to:

Advanced Energy Inc.
Attn: RMA#: ____
28 Riverview Mill
Wilton, NH 03086

The inverter must be carefully packaged (ideally in the original packing material).

Issued RMA number:_____

Inverter Serial Number:_____

Length of time inverter operated before problem developed:_____

LED status code (see section 4.1): _____

AM100 data (if system includes this optional monitor): _____

Explanation of problem:_____

_____

_____

_____

_____

_____

_____

Manufacturer and model of PV modules:_____

Array configuration (how many in series and parallel):_____

5. GC1000: Grid-Connected Inverter Specifications

Model Version	GC1000 Standard	GC1000 LV
Power Rating:	1000W nominal	
Input:		
Maximum input Power (Watts)	1200W	
Overall Input Voltage Minimum operating voltage Maximum operating voltage	 47.5 Vdc 92.0 Vdc	 39.0 Vdc 92.0 Vdc
Minimum Startup Voltage	63.0 Vdc	48.0 Vdc
Maximum **P**ower **P**oint **T**racking Range Low (Volts) High (Volts)	 47.5 Vdc 68.0 Vdc	 39.0 Vdc 52.0 Vdc
MPPT Nominal / Starting Voltage	60.0 Vdc	45.0 Vdc
Inverter Shutdown Voltage	45.0 Vdc	33.0 Vdc
Maximum Input Voltage	100 Vdc	
Max Connected Array Short Circuit Current	25 A	
Output:		
Nominal Voltage / Freq.	120Vac, 60Hz	
Operating Voltage Range	106-132 Vac	
Operating Frequency Range	59.3-60.5 Hz	
Maximum Output	8.0 Amperes	
Max Utility Backfeed Current	15 Amperes	
Max Output Fault Current	15 Amperes	
Maximum Current THD	5%	
Efficiency:		
Peak efficiency	93%	
Anti-Islanding:		
High/Low Frequency Dropout Time	Maximum 6 cycles	
High/Low Voltage Dropout Time	Maximum 2 seconds (120cycles)	
Utility Dropout, Matched Load	Maximum 10 cycles	
80% voltage, Dropout Time	<10 cycles	
Case dimensions: (Height x Width x Depth)		
Inverter	19” x 8” x 6.5”	
String Combiner	10.5” x 8” x 6.5”	
Combined Inverter / String Combiner	28.5” x 8” x 6.7”	
Weight: net	43 lbs.	
Ship	45 lbs.	

5.1 GC1000 Efficiency Curve

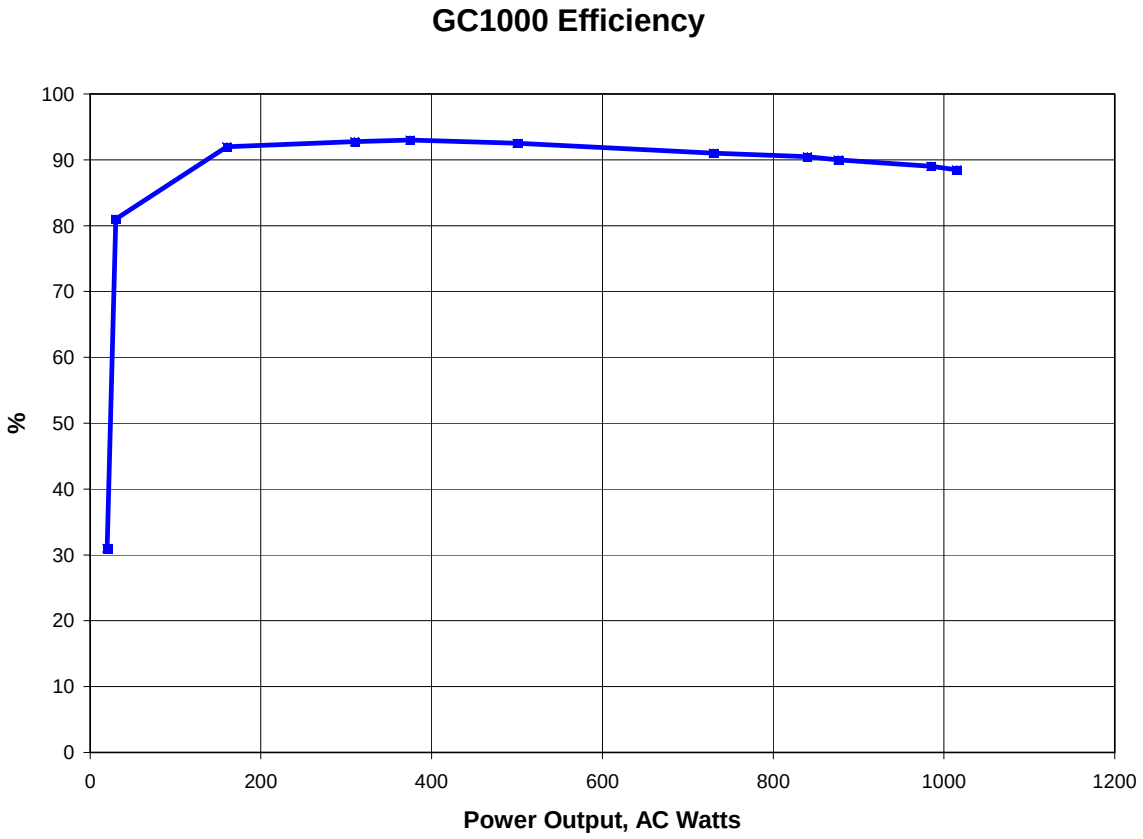


Figure 12. GC1000 efficiency curve.

6. New York Annual Verification Procedure

Once per year, the owner or his agent shall operate the load brake disconnect switch and verify that the power producing facility automatically shuts down and does not restart for five minutes after the switch is closed. The owner shall maintain a log of these operations for inspection by the connecting utility.

The inverter may be monitored for correct operation in one of three ways:

1. Using and Advanced Energy AM-100 inverter monitor, watch the inverter output current screen and ensure that no current is delivered to the grid until five minutes after the disconnect switch is closed.

2. Observing the indicator LED on the front of the unit. When AC power is lost, the one-second flash indicating normal operation (where the LED duty cycle corresponds to the percentage of rated power being delivered to the grid) should change to three rapid blinks (indicating AC power fail) and remain in that state for a period of five minutes after AC power is restored. The LED indicator is included in all inverters as a least cost monitoring capability.

3. If available, an AC clamp-on type current meter can also be used to monitor the inverter output current.

In all cases, the user will hear the grid relay release when AC power is lost, and re-close after the five minute delay.

Appendix A: UL 1741 Certification Letter

333 Pfingsten Road
Northbrook, Illinois 60062
United States Country Code
(847) 272-8800
FAX No. (847) 272-8129
http://www.ul.com

Underwriters Laboratories Inc.®

a century of public safety 1894-1994

March 24, 2000

Advanced Energy Systems
Attn: Dr. Robert Wills
28 Riverview Mill
P. O. Box 262
Wilton, NH 03086

Our Reference: E182866, 00NK12026

Subject: Evaluation of the Model GC1000 Inverter

Dear Bob:

This letter serves as a status update for the evaluation of the model GC1000 inverter. The subject unit is Listed in accordance with the standard for Safety of Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems, UL1741 draft edition, dated August 7, 1997.

The unit is being evaluated in accordance with select requirements, as designated below, of the New York State Energy Research and Development Authority (NYSERDA) Standard Interconnection Requirements (SIR), the Recommended Practice for Utility Interface of Photovoltaic Systems IEEE P929 Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits, IEEE C62.41-1991.

The following tests have been performed on the subject unit and have found to be in compliance with the above requirements:

Single Phase Waveform Testing:
Method A (Anti-islanding Test per IEEE P929)
Tested at 25%, 50%, 100% and 125% of the inverter's rated ouput.
Tested four units connected in parallel at 25% of the inverters' combined rated output.
Method B (Waveform Testing per SIR)
Tested in accordance with waveforms 1, 2, 3, 4 and 5.
Static Inverter Surge Test (IEEE C62.41-1991):
Tested at 50% and 100% of rated output power (location categories: B3 combination and ring).

Thank you for visiting our facility during the above testing. If you have any questions or comments on the information above, please contact me.

Sincerely,

Stephen T. Gardner
Senior Project Engineer
Conformity Assessment Services
E-mail: Stephen.T.Gardner@us.ul.com

A not-for-profit organization dedicated to public safety and committed to quality service

Appendix B: Lightning Arrestor Installation

LIGHTNING ARRESTORS, INC.

P. O. BOX 750 BIG SPRING, TEXAS 79721 (915) 267-1000

INSTALLATION

If there is a surge so strong that something must fail, we prefer that our arrestor fail rather than your equipment. Since we expect the arrestor might fail, install it in a regular electrical enclosure to protect personnel from accidental contact with live parts. When the arrestor fails it will not damage other components in the box. If the arrestor cannot be placed in an enclosure, consider using our vent valve model. Its case will not rupture. A small vent on the bottom of the case will open.

To protect a submersible pump motor, connect the black wires to the line terminals and the white wire to the casing and/or tubing.

To protect equipment on a radio tower or a drilling rig, mount the arrestor to a junction box at the bottom of each string of lights going up to the tower. Connect the black leads to the circuit conductors and the white wire to the rig steel. Arrange for the conductors feeding the junction box to be parallel with the earth. Connect an arrestor to the generator leads grounding the white wire to the generator frame. Connect an arrestor to each lighting panel connecting black wires to the circuit conductors, and the white wire to the box and rig frame.

To protect a house, the arrestor should be mounted on an outside switch or junction box, or in the breaker box. The black wires should be connected to the circuit. The white wire should be connected to the neutral, the box, and/or a solid ground. Model numbers G have a separate ground wire.

To protect electronic equipment such as computers, transmitters, receivers, etc., connect the black wires to the terminals of the device and the white wire to chassis. Mount the arrestor in the cabinet. Consider using a surge capacitor connected to the breaker feeding them.

To protect a watt-hour meter, connect the black wires to the line terminals, and the white wire to the meter box.

To protect an electric motor on machinery, connect the black wires to the motor leads and the white wire to the motor frame.

Where the switch and motor are within six feet of each other, one arrestor will protect both provided a solid ground wire is fastened to the switch box, motor frame, and arrestor white wire. However, optimum protection is afforded only when the arrestor is connected directly to the device to be protected.

To protect a motor control switch separately, connect the black wires to the line terminals and the white wire to the box.

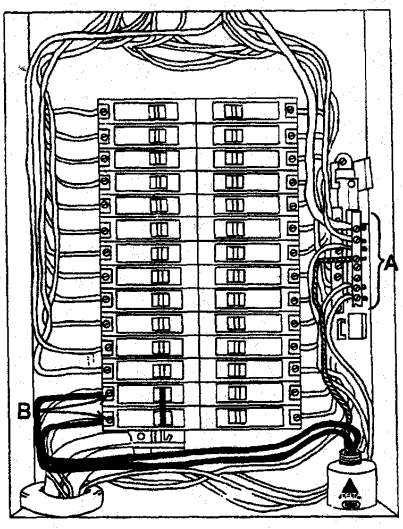
In all cases, it is the electrical insulation that is to be protected. Once in the circuit, the high voltage ruptures the insulation of the equipment in its effort to discharge to ground. The arrestor provides a parallel path to ground for the current discharge. Consequently, the black wires need to be connected to the circuit, and the white wires need to be connected to the metal frame of the machine or device to be protected. A mere ground connection will not necessarily provide protection; however, it should be used in addition to the frame connection.

GUARANTEE

Delta Lightning Arrestors guarantees and warrants to the end user that this arrestor is free from defects in workmanship and material. The arrestor is designed to conduct 60,000 amps of lightning or surge to ground without damage. When lightning or surge is in excess of 60,000 amps, the arrestor is expected to experience failure. In the event the arrestor should fail due to defects, return it to the factory with payment of four dollars to cover handling and it will be replaced. This guarantee is limited to replacement. There is no other warranty, expressed or implied.

DL-8

INSTALLATION INSTRUCTIONS LA 302-R LA-302 CA 302-R



Lightning Arrestor Wires
Black Wire
White Wire

A - Neutral Bus
B - 2 Pole Breaker
(Not necessarily in the exact position illustrated)

Caution! Electrical work can be dangerous and should only be attempted by persons experienced to do so. Accidental contact with electrically charged parts can cause injury or electrocution. Loose connections can cause over heating, damage to equipment, and fire.

Pull the main disconnect switch killing power to the panel. Remove the breaker box cover. Place the arrestor in the box. Remove a half inch of insulation from the wires. Connect the black wires to the load terminals of the main breaker. If those terminals are not accessible, connect the arrestor black wires to one of the 220 volt, two pole breakers. Connect the white wire to the neutral bus. Replace the cover, and turn the main switch back on. The arrestor remains good and functions properly as long as its enclosure is intact. If the arrestor ever goes bad the enclosure will burst. While it is not possible to achieve one hundred percent protection, the Delta Arrestor will greatly reduce problems due to lightning and power surge. This device is to be installed in accordance with all applicable requirements of the National Electrical Code.

DELTA LIGHTNING ARRESTORS, INC.
P. O. BOX 750
BIG SPRING, TEXAS 79721
(915) 267-1000