A Bergey WindPower Company Manual

POWERSYNC II INVERTER

Operator's Manual
&
Installation Instructions

Part No. MANPSII
Rev. 1.1
November 2014

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Permanently-connected, utility Interactive, single-phase, inverters

Model PSII12 WIND TURBINE INVERTER (240 VAC nominal output)
The phase angle between L1 and L2 is 180°. Line to Neutral is 120 VAC nominal.

Model PSII126208 WIND TURBINE INVERTER (208 VAC nominal output)
The phase angle between L1 and L2 is 120°. Line to Neutral is 120 VAC nominal.

ETL - Evaluated to the requirements of the Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, UL 1741, 2nd Edition, dated January 28, 2010.

CNL - Additionally evaluated to CAN/CSA C22.2 No. 107.1-1, "General Use Power Supplies." 3rd Edition, Dated September 1st, 2001 with revision through 2006.

The Bergey WindPower Company's model PSII12 and PSII126208 inverters are intended for variable frequency un-rectified 3-phase AC input from Wind Powered Turbines.

1. Table of Contents

2. Ratings

2.1. Input Rating

Input Voltage Maximum (3 Phase Input)	400 VAC
Input Start Voltage Minimum	30 VAC
Input Operating Voltage Range	200 to 400 VAC
Input Frequency Maximum	400 Hz
Input Current Maximum	40 Amps
AC Backfeed Current to Input Source	N/A

2.2. Output Rating

Model	PSII12	PSII126208
Continuous Output Power Maximum	12000 KW	10400 KW
Continuous Output Power Tolerance	±10%	
Output Voltage Nominal (Single Phase) Line-Line	240 VAC	208 VAC
Operating Voltage Range Line-Line	212-264	184-228
Output Voltage Nominal (Single Phase) Line-Neutral	120 VAC	
Operating Voltage Range Line-Neutral	106-132 VAC	
Continuous Output Current Maximum	50 Amps	
Continuous Output Current Tolerance	± 10%	
Voltage Measurement Tolerance	± 10 VAC	
Operating Frequency Nominal	60 Hz	
Operating Frequency Range	59.3 to 60.5 Hz	
Operating Frequency Measurement Tolerance	± 0.5 Hz	
Output Power Factor	0.95 ± 0.05	
Temperature Range Normal Operation	-4°F to 113ºF / -20ºC to 45ºC	
Output Over-Current Protection Maximum	80 Amps	
Synchronization In-Rush Current Maximum	6.3 Amps	
Utility Interconnection Trip Time	100 msec	
Time Measurement Tolerance	± 85 msec	

2.3. Other Specifications

Dimensions	32.9"H x 24.3"W x 9" D 836 x 607 x 230 mm
Weight	153 lbs. / 64 Kg
Enclosure	NEMA Type 1

NEMA 1 indicates that the enclosure is constructed for indoor use only. It provides protection to personnel against incidental contact with the enclosed equipment.

3. Important Safety Instructions

SAVE THESE INSTRUCTIONS

This manual contains important instructions for Models PSII12 and PSII126208 that shall be followed during installation and maintenance of the inverter.

The output field wiring terminal can be used for connection of a maximum of:
One 1/0 AWG wire per terminal (1 wire for each line)

The input field wiring terminal can be used for connection of a maximum of:
One 2 AWG wire per terminal (1 wire per phase per terminal provided).

The field-wiring terminals shall be connected using the following wire types:

Copper Conductors Only (Input connection)
Use No. 8 - 2 AWG, 75°C copper wire only

Copper, Aluminum or Copper-Clad Aluminum Conductors Only (Output connection)
Use No. 6 – 1/0 AWG, 75°C Copper Conductors
Use No. 4 – 1/0 AWG, 75°C Copper Clad Aluminum, or Aluminum Conductors.

The following symbols are used as markings on this product with the following meanings:

Equipment grounding conductor – 

This inverter is intended for operation in an indoor NEMA 1 compatible environment having a maximum ambient temperature of 45°C (113° F).

This unit or system is provided with fixed trip limits and shall not be aggregated above 30kW on a single Point of Common Connection

CAUTION

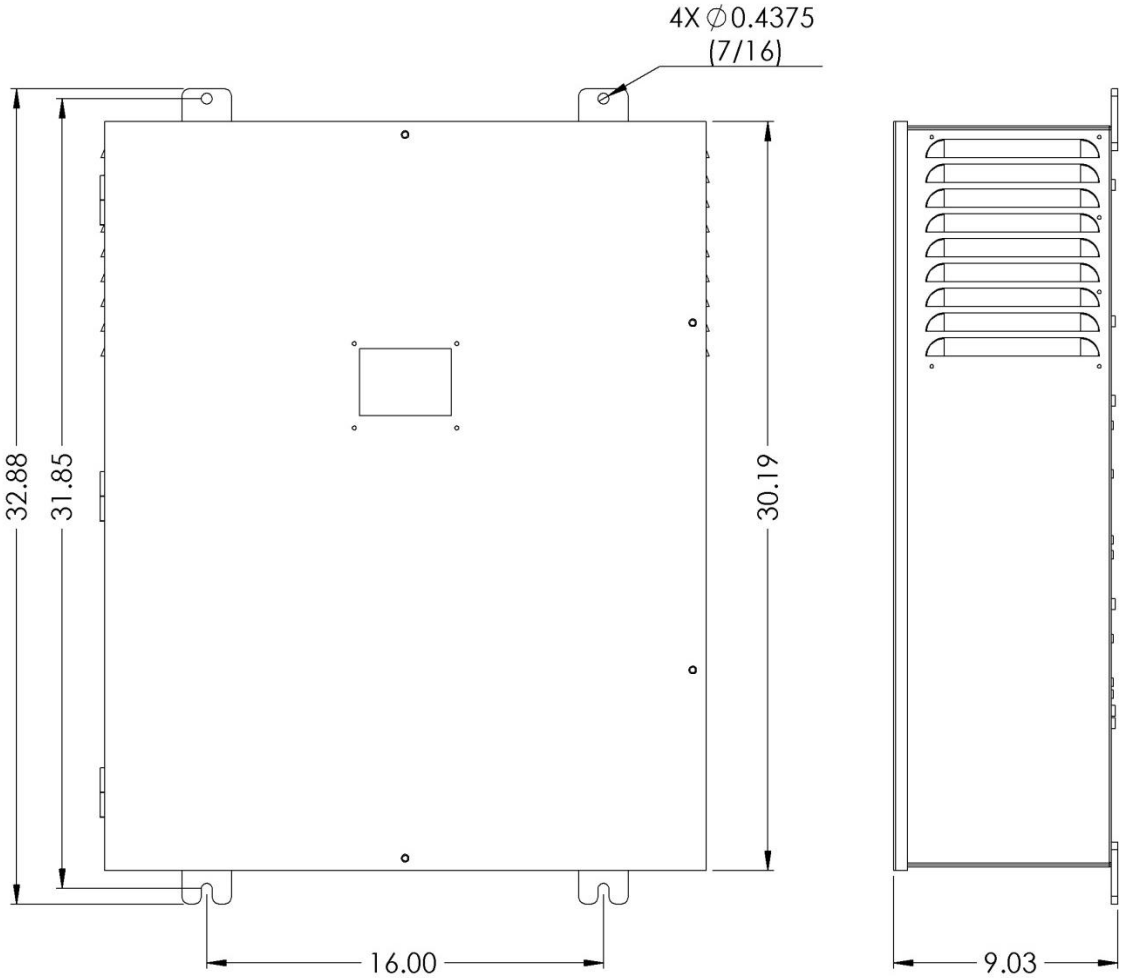
To reduce the risk of fire, connect only to a circuit provided with 80 amperes maximum branch-circuit over-current protection in accordance with the National Electrical Code, ANSI/NFPA 70.

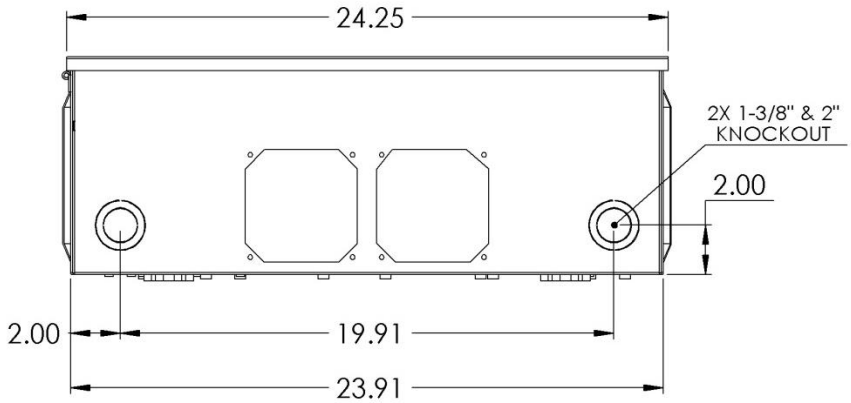
Hot surfaces – To reduce the risk of burns – Do not touch
The enclosure and the rear heatsink can exceed 70°C (150°F).

Note that the input and output circuits are isolated from the enclosure. In accordance with Clause 15.2.1.1 of CAN/CSA-C22.2 No. 107.1, system grounding, when required by the *Canadian Electrical Code, Part I,* is the responsibility of the installer.

4. Installation

4.1. Dimensions





4.2. Locating

- The inverter must be installed in a weather protected environment.
- The inverter emits audible noise when operating. Do not locate the inverter in living spaces or on walls directly connected to living spaces.
- For maximum energy production, avoid installing in direct sunlight or in locations that are likely to exceed 45ºC (113ºF) local ambient temperature.
- The inverter will automatically shut down if the temperature is below -20ºC (-68ºF). Protect from extreme cold exposure if this is undesirable.
- Enclosure ventilation is to be provided such that the following guidelines are satisfied.
    - Provide a minimum of 12 inches clearance to the bottom air inlet filters.
    - Provide a minimum of 6 inches clearance to the outlet side vents.
    - Use in a well-ventilated area within the maximum ambient temperature rating.
- If the inverter is installed in a small structure or out building, the structure must be provided with top and bottom venting of at least 100 square inches at each opening.

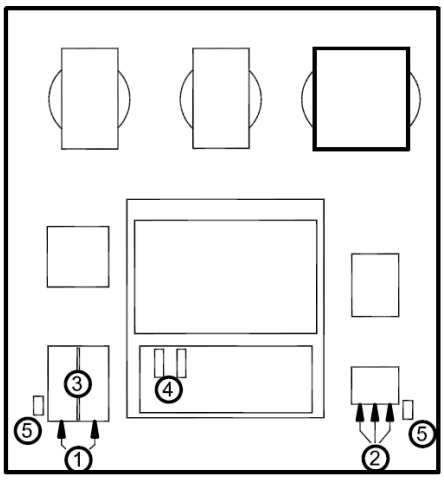
4.3. Mounting

- The enclosure, having a NEMA 1 rating, is designed for indoor installation.
- The enclosure is provided with four mounting feet with 7/16" dia. mounting holes.
- For mounting to a 0.10" thick metal surface, use M6, 3/8" bolts grade 3 or higher with nuts and flat washers.
- For mounting to concrete, use M6 or 3/8" bolts using concrete anchors with an 800 pound or greater tension rating.
- The required bolt length is such that the internal threads need to be 100% engaged.
- The enclosure is to be oriented with the conduit openings facing toward the floor.

4.4. Electrical Connections

- Connections are made to the unit via the holes provided in the bottom of the enclosure.
- Knockouts are sized for 1" and 1.5" conduit sizes. Wiring methods in accordance with the National Electrical Code, ANSI/NFPA 70 are to be used.
- It is recommended that at least 12" of flexible conduit be used below the inverter to make alignment easier.
- CUTTING ADDITIONAL HOLES IN THE ENCLOSURE IS NOT RECOMMENDED AND VOIDS THE WARRANTY ON THE ENCLOSURE AGAINST CORROSION AND WATER DAMAGE. ANY DAMAGE TO THE ELECTRONICS CAUSED BY THE MODIFICATION WILL BE **YOUR** RESPONSIBILITY.

Interconnection and Fuse Locaction Diagram



(1) 208/240VAC OUTPUT
Wire Size Requirements
No. 6 to 1/0 AWG, 90°C Copper
No. 4 to 1/0 AWG, 90°C Copper, Clad Aluminum, or Aluminum
Torque: 100 lb. in.

(2) TURBINE INPUT
Wire Size Requirements
No. 8 to 2 AWG, 90°C Copper
Torque 50 lb. in.
Copper Conductors Only

(3) OUTPUT FUSES
Class T
80A, 300VAC

(4) PRE-CHARGE FUSES
Class CC Time Delay
2.5A, 600VAC

(5) GROUND

WARNING: For Continued Protection Against Risk Of Fire, Replace Only With Same Type And Ratings Of Fuse.

4.5. AC Line (Output) Connection

- The AC line output is single phase and not bonded to ground.
- Connect the two single phase 240VAC or 208VAC wires from the distribution panel to the dual fuse block located on the lower left side of the enclosure.
- Tightening torque, allowable wire size, and type, for the Field-Wiring Terminals:
    - 6 AWG to a maximum of 1/0 AWG for Copper Conductors Only
    - 4 AWG to a maximum of 1/0 AWG for Aluminum Or Copper-Clad Aluminum Conductors Only
    - Wire rated 75°C minimum
    - 100 lbf-in tightening torque maximum

4.6. Turbine (Input) Connection

- Connect the three phase turbine wires to the terminal block located on the lower right side of the enclosure.
- The inverter's wind turbine input must be connected to a 3-phase "delta" or "wye" connection with the neutral not connected to earth ground (left floating).
- The inverter must be provided with 3, UL listed fuses rated, 600 VAC minimum, 50 Amp *maximum* for proper protection from the wind turbine input to the unit as well as an appropriate UL listed fuse holder to accommodate the fuses.
- Tightening torque, allowable wire size, and type, for the Field-Wiring Terminals:
    - 50 lbf-in tightening torque
    - 8 AWG - to a maximum of 2 AWG for Copper Conductors Only
    - Wire rated 75°C minimum

4.7. Earth Ground Connection

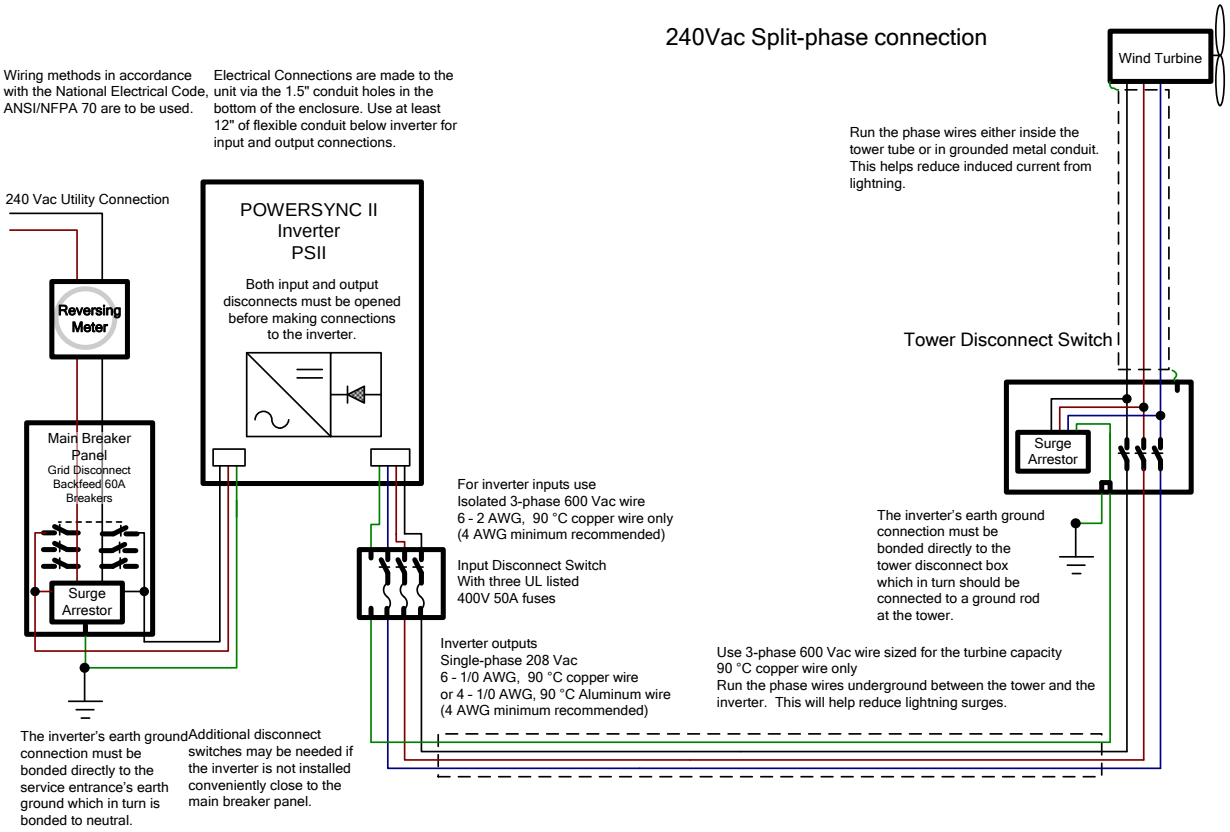
- Earth ground is to be connected to the two terminals provided inside the enclosure indicated by the earth ground equipment marking.

    - Allowable wire size range is 8 AWG – 4 AWG.
    - 50 lbf-in tightening torque
- The inverter's earth ground connections available on both the input and output terminals must be bonded directly to the service entrance's earth ground which in turn is bonded to neutral. With a second bond, the inverter's earth ground connection must be bonded directly to the tower disconnect ground lug which in turn is bonded to the tower's ground rod.
- The input and output circuits are isolated from the enclosure. System grounding when required by the *Canadian Electrical Code, Part I,* is the responsibility of the installer.

4.8. Fuse replacement

- **Warning:** For continued protection against risk of fire, replace only with same type and ratings of fuse.
- Two output fuses are located in the dual fuse block on the lower left side of the enclosure. Class T 80A, 300VAC (BUSSMANN JJN-80).
- Two pre-charge fuses are located on the Rectifier PCB board. Class CC Time Delay, 2.5A, 250VAC (BUSSMANN BK/GMD-2.5-R).
- Three input fuses are located in a separate fuse box provided by the installer. Fuse type may vary, but must be UL listed fuses rated, 400 VAC minimum, 50 Amp *maximum*.

4.9. Connection example



With the wind turbine tower sticking high into the air, lightning damage is a concern to most inverter customers; especially those customers in areas with frequent cloud to ground lighting. BWC's warranty does not cover lightning damage to the inverter. A direct lightning strike can easily be in excess of 100kV at 100kA. Proper grounding of the turbine to the tower and running the input wires down the tower in grounded metal conduit will take care of most of this energy. The standard inverter is capable of withstanding input line to ground surges of about 6kV at 3kA. Contact your distributor or BWC for application specific lightning surge suppression solutions.

5. Operation

This equipment is a UL 1741 certified Utility Interactive Inverter and complies with the requirements of IEEE1547 which is the standard for interconnecting distributed resources with electric power systems. It will not operate in an off-grid or backup power configuration.

The normal operation of the inverter is as follows: When single phase utility power is applied to the output of the inverter, the display will power up and a message stating that the unit is initializing is shown. If there are no faults, i.e. grid voltage and frequency are in tolerance, a countdown timer set for 5 minutes (300 seconds) starts before the inverter is ready to transfer power to the utility grid. The inverter will automatically transfer power to the utility when turbine input AC voltages is in the range of 30VAC to 400VAC.

As the heatsink heats up after exporting significant power for a period of time the internal cooling fans will activate. The inverter is be able to operate at full power continuously if provided with adequate ventilation and the local ambient temperature stays below 45ºC (113ºF). If the ventilation is compromised or the heatsink temperature exceeds 60°C, the inverter will automatically reduce its output power.

6. Touch Screen Display

The touch screen display located on the front panel of the enclosure provides manual over-ride and status of the inverter's operation. The touch screen display also provides a Stop and a Reset button. The Stop button is used when it is desired to disconnect the inverter from the power grid and the wind turbine. After Stop is pressed the inverter will remain in a powered-up stand-by mode until Reset is pressed or Grid voltage is removed. When Reset is pressed the inverter will resume normal operation.

The status of the inverter's operation is shown on the lines one and two of the display. The following table lists the status messages that may appear.

Status Message	Description
Waiting Initializing	The inverter has been reset or that the 5 minute countdown delay is in progress
Waiting For Wind	The voltage from the turbine is lower than the factory set auto-start voltage threshold
AC Running	The active rectifier is regulating the internal DC Boost voltage
Running	The inverter is transferring power to the utility grid
Fault	A fault has occurred. See fault messages
Manual Stop Press Reset	The manual stop button has been pressed
Fault Limit Press Reset	Three faults have occurred in an hours time

Status Message	Description
Disconnected	Indicates that a communication problem exists between the display and the inverter. Check for bad cable connection.
OV Power Limit	The inverter has detected that the output voltage is approaching the over voltage limit and is reducing its output to compensate for the less than ideal current carrying ability of grid connection.

The Up and Down arrow that is visible on the left side of the touch screen display is used to scroll through a list of parameters. The list of viewable parameters is as follows:

Parameter	Description
Grid Voltage	Magnitude of the connected single phase grid voltage
Grid Frequency	Frequency of the connected single phase grid voltage
Bus Voltage	Magnitude of the DC link bus voltage
DC Current	Averaged value of the DC current
Turbine Volts	Averaged value of the rectified DC voltage from the Input
Output Power	Output power displayed in Watts
Accumulated Energy	Output Energy (kW hours) accumulated over time of operation
VREF	Used for factory/installer setup
IREF	Used for factory/installer setup
Last Fault	Displays the last fault that occurred since the inverter was powered up along with a fault code that may be useful when troubleshooting.
Unit Code Rev	Indicates the firmware revision of the control DSP
Disp Code Rev	Indicates the firmware revision of the LCD display DSP

A hidden feature of the display is the contrast adjustment. The right side of the display has invisible up and down arrows that can be used to increase and decrease the contrast of the display.

Grid Voltage
This the voltage measured line to line on the output of the inverter. The voltage must be between 212 to 264Vac (184 to 228Vac for 208V units) for the inverter to operate. The line to neutral voltage is important as well, although it is not reported on the LCD screen. It must be between 106 and 142Vac for both 240V and 208V units.

Grid Frequency
This is the frequency of the grid and determined by the utility. The frequency must be between 59.4 and 60.4 Hz for the inverter to operate.

Bus Voltage
This is the voltage of the boosted DC link bus that is used to generate the output sine wave. This voltage should stay between 200 and 570 Vdc but will not trip off until it reaches 680Vdc.

DC Current
This is the input current measured after the 3-phase AC input has been rectified to DC. Idc = IREF / 9 This current should not exceed 58A.

Turbine Volts
This is the DC voltage of the input measured after the 3-phase AC input is rectified. The inverter will begin exporting power when this voltage exceeds 85Vdc. This voltage should never exceed 690Vdc. Vdc = Vac * 1.41

Output Power
This is how much real power in Watts the inverter is currently producing or consuming if it is waiting for wind. Standby power while waiting for wind is about -10W. This measurement is not completely accurate and may not agree with an external meter.

Accumulated Power
This is how much real power the inverter has produced or consumed since it was last calibrated at BWC. This measurement is not completely accurate and may not agree with an external meter.

VREF
VREF is the input rectified voltage as a raw value. VREF = Vdc * 2.52.
Vref is used as an index look-up into a virtual table used for a customizable 32 point power curve table.

IREF
IREF is the current request in counts for a given DC input voltage tracked by VREF. Using this configuration the inverter can be adjusted to provide any power curve required. IREF = Idc * 9

Last Fault
Fault messages are displayed when a fault occurs and when the last fault parameter is selected. The following table is a list of possible faults that may be displayed.

7. Trouble Shooting

Fault Message	Fault Code	Description
INTERNAL ERROR	10	IGBT or control logic fault. An occurrence of this fault requires that the unit be completely powered down to reset it. Frequent code 10 faults indicate that the unit should be returned to BWC for service.
DC OVER VOLT 1	1000	The DC Bus voltage has exceeded its maximum threshold. This occurs if the input power exceeds the output power. This may occur in exceptionally high winds especially if the OV Power limit is active or temperature throttling is occurring.
DC OVER VOLT 2	1500	The DC Input voltage has exceeded its maximum threshold. This may occur in exceptionally high wind conditions.
DC UNDER VOLT	1250	The internal DC Boost voltage has dropped below its minimum threshold. This usually indicates a configuration problem and is normally never seen.
AC OVER VOLT	2030	The AC line voltage has exceeded its maximum threshold. This occurs if OV limiting was not able to prevent the high grid voltage. Site issues should be investigated such as loose grid side connections, undersized wires or grid voltage flickers.

Fault Message	Fault Code	Description
AC UNDER VOLT	2280	The AC line voltage has dropped below its minimum threshold. It is normal to see this when the inverter has been disconnected from the grid. It may also occur momentarily when large equipment is turned on nearby.
TURBINE PHASE	2500	Indicates that there is a problem with one or more of the turbine input phases. The inverter shuts down to protect the turbine from potential damage. Check for bad connection(s), blown fuse and ground faults on the turbine side.
AC OVER CURRENT	3000	Grid output current on line 1 has exceeded its maximum current threshold. This can be caused by a sudden grid load change.
AC OVER CURRENT	3020	Grid output current on line 2 has exceeded its maximum current threshold. This can be caused by a sudden grid load change.
DC OVER CURRENT	3050	The DC Boost circuit has exceeded its maximum current threshold. Check for ground faults on the turbine side.
OVER TEMP	4000	The internal high temperature threshold has been exceeded. Check for obstructions in the intake (bottom) and exhaust vents (both sides), cooling fans are both working, proper ventilation is provided and no exposure to direct sunlight.
UNDER TEMP	4250	The internal low temperature threshold has been exceeded. Avoid exposing the unit to temperatures below -20ºC (-68ºF).
GROUND FAULT	7000	A grid side phase is shorted to chassis ground. It may require a a Megger to troubleshoot the fault.
AC OVER FREQ	8000	The frequency of the utility grid voltage went out of range. This can occur when large equipment is switched on/off, if the grid is disconnected or the grid flickers.
AC UNDER FREQ	8100	The frequency of the utility grid voltage went out of range. This can occur when large equipment is switched on/off, if the grid is disconnected or the grid flickers.

8. Equipment Maintenance

- Periodically check the ventilation screen for the cooling fans. When necessary, use a vacuum to clean the screen from the outside of the enclosure. Do not force air or spray water into the enclosure.
- The touch screen display may become dirty over time. To clean the display use clean water applied to a soft non-abrasive cloth. Water sprayed directly onto the display could possibly leak inside and cause damage. Dirt and fingerprints do not affect the operation of the touch screen display.

9. Return Shipment Information

If service or repair is required, please contact your distributor first. They may have warranty and service options available beyond BWC's standard warranty. If they are unable to help you, contact BWC's Service Department for a Return Material Authorization (RMA) number and shipping instructions. Note that inverters must be shipped freight on a pallet and can not be handled by standard carriers. If the product is out of warranty, or was damaged during shipment, a purchase order will be required for the repair. The product should be returned in its original shipping materials. Unapproved containers may cause further damage to your inverter. Contact BWC if replacement material is required. Seal the carton securely and ship prepaid to the following address with the RMA number on the label. Be sure to insure your inverter with your shipper.

Bergey WindPower Company
Service Department
2200 Industrial Blvd.
Norman, OK 73069
RMA# _____

To contact the Service Department:
Telephone: (405) 364-4212
Fax: (405) 364-2078
Email: service@bergey.com

Items determined to be covered under warranty will be returned freight prepaid. Items not in warranty will be returned freight collect, contact BWC's Service Department.

10. Revision History

Date	Revision	Summary of Corrections
April 7, 2014	1.0	Production Release
November 2014	1.1	Enclosure mounting / Fault code comments