



Radian Series Inverter/Charger

GS8048

Operator's Manual



About OutBack Power Technologies

OutBack Power Technologies is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, accessories, and assembled systems.

Contact Information

Address:	Corporate Headquarters 17825 – 59th Avenue N.E. Suite B Arlington, WA 98223 USA	European Office Hansastraße 8 D-91126 Schwabach, Germany
Telephone:	+1.360.435.6030 +1.360.618.4363 (Technical Support) +1.360.435.6019 (Fax)	+49.9122.79889.0 +49.9122.79889.21 (Fax)
Email:	Support@outbackpower.com	
Website:	http://www.outbackpower.com	

Disclaimer

UNLESS SPECIFICALLY AGREED TO IN WRITING, OUTBACK POWER TECHNOLOGIES:

(a) MAKES NO WARRANTY AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN ITS MANUALS OR OTHER DOCUMENTATION.

(b) ASSUMES NO RESPONSIBILITY OR LIABILITY FOR LOSS OR DAMAGE, WHETHER DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL, WHICH MIGHT ARISE OUT OF THE USE OF SUCH INFORMATION. THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK.

Warranty Summary

OutBack Power Technologies Inc. warrants that the products it manufactures will be free from defects in materials and workmanship for a period of five (5) years subject to the conditions set forth in the warranty detail, found on page 51 of this manual.

OutBack Power Technologies cannot be responsible for system failure, damages, or injury resulting from improper installation of their products.

Notice of Copyright

Radian Series Inverter/Charger Operator's Manual © October 2013 by OutBack Power Technologies. All Rights Reserved.

Trademarks

OutBack Power is a registered trademark of OutBack Power Technologies.

Date and Revision

October 2013, Revision B (firmware revision 001.004.xxx)

Part Number

900-0020-01-00 Rev B

Important Safety Instructions

READ AND SAVE THESE INSTRUCTIONS!

This manual contains important safety instructions for the Radian Series Inverter/Charger. Read all instructions and cautionary markings on the inverter and on any accessories or additional equipment included in the installation. Failure to adhere to these instructions could result in severe shock or possible electrocution. Exercise extreme caution at all times to prevent accidents.

Audience

This manual is intended for anyone required to operate the Radian Series Inverter/Charger. Operators must be familiar with all the safety regulations pertaining to operating this kind of equipment as dictated by local code. Operators must also have a complete understanding of this equipment's features and functions. Do not use this product unless it has been installed by a qualified installer in accordance with the *Radian Series Inverter/Charger Installation Manual*.

Symbols Used

	WARNING: Hazard to Human Life This type of notation indicates that the hazard could be harmful to human life.
	CAUTION: Hazard to Equipment This type of notation indicates that the hazard may cause damage to the equipment.
	IMPORTANT: This type of notation indicates that the information provided is important to the installation, operation and/or maintenance of the equipment. Failure to follow the recommendations in such a notation could result in voiding the equipment warranty.

Definitions

The following is a list of initials, terms, and definitions used in conjunction with this product.

Table 1 Terms and Definitions

Term	Definition
12V AUX	Auxiliary connection that supplies 12 Vdc to control external devices.
AC	Alternating Current; refers to voltage produced by the inverter, utility grid, or generator
AGS	Advanced Generator Start
CSA	Canadian Standards Association; establishes Canadian national standards and the Canadian Electrical Code, including C22.1 and C22.2
DC	Direct Current; refers to voltage produced by the batteries or renewable source

Important Safety Instructions

Table 1 Terms and Definitions

Term	Definition
DVM	Digital Voltmeter
ETL	Electrical Testing Laboratories; short for the company ETL Semko; refers to a certification issued by ETL to OutBack products indicating that they meet certain UL standards
GND	Ground; a permanent conductive connection to earth for safety reasons; also known as Chassis Ground, Protective Earth, PE, Grounding Electrode Conductor, and GEC
Grid-interactive, grid-intertie, grid-tie	Utility grid power is available for use and the inverter is a model capable of returning (selling) electricity back to the utility grid
HBX	High Battery Transfer; a function of the remote system display
IEEE	Institute of Electrical and Electronics Engineers; refers to a series of standards and practices for the testing of electrical products
LBCO	Low Battery Cut-Out; set point at which the inverter shuts down due to low voltage
NEC	National Electric Code
NEU	AC Neutral; also known as Common
Off-grid	Utility grid power <i>is not</i> available for use
PV	Photovoltaic
RELAY AUX	Auxiliary connection that uses switch (relay) contacts to control external devices.
RTS	Remote Temperature Sensor; accessory that measures battery temperature for charging
Split-phase	A type of utility electrical system with 2 "hot" lines that are 120 Vac with respect to neutral and 240 Vac between the "hot" lines; common in North America
System display	Remote interface device (such as the MATE3), used for monitoring, programming and communicating with the inverter; also called "remote system display"
UL	Underwriters Laboratories; refers to a set of safety standards governing electrical products
Utility grid	The electrical service and infrastructure supported by the electrical or utility company; also called "mains", "utility service", or "grid"

General Safety



WARNING: Limitations on Use

This equipment is NOT intended for use with life support equipment or other medical equipment or devices.



CAUTION: Equipment Damage

Only use components or accessories recommended or sold by OutBack Power Technologies or its authorized agents.



Table of Contents

Important Safety Instructions	1
Audience	1
Symbols Used	1
Definitions.....	1
General Safety	2
Introduction	5
Welcome to OutBack Power Technologies.....	5
MATE3 System Display and Controller	6
Commissioning	7
Functional Test.....	7
Pre-startup Procedures.....	7
Startup	7
Powering Down.....	8
Adding New Devices	8
Firmware Updates	8
Operation	9
Input Modes	9
Generator.....	9
Support.....	10
Grid Tied	11
UPS (Uninterruptible Power Supply).....	12
Backup	13
Mini Grid.....	13
Functions.....	15
Inverting	15
Search.....	16
Input	16
Generator.....	18
Transfer.....	18
Offset	19
Battery Charging.....	20
Charging Steps	20
Equalization	24
Battery Temperature Compensation	25
Multiple-Inverter Installations (Stacking)	26
Power Save Levels	27
Auxiliary Terminals.....	30
System Display-Based Functions.....	33
Advanced Generator Start (AGS)	33
High Battery Transfer (HBX)	33
Grid Use Time	34

Table of Contents

Troubleshooting.....	35
Basic Troubleshooting.....	35
Module Select	39
Error Messages	40
Warning Messages.....	41
Disconnect Messages	43
Sell Status.....	44
Specifications	45
Specifications for Model GS8048.....	45
Environmental Specifications	46
Regulatory Specifications.....	46
Firmware Revision.....	47
Default Settings and Ranges.....	47
Product Registration	49
Extended Warranty.....	50
Warranty.....	51
How to Arrange for Warranty Service	52
Contacting OutBack.....	52
Troubleshooting	52
Return Material Authorization (RMA)	52
Returning Product to OutBack	53
Out of Warranty.....	53
Index	55



Introduction

Welcome to OutBack Power Technologies

Thank you for purchasing the OutBack Radian Series Inverter/Charger. This product offers a complete power conversion system between batteries and AC power. It can provide backup power, sell power back to the utility grid or provide complete stand-alone off-grid service.

- Battery-to-AC inverting which delivers split-phase 120/240 Vac at 60 Hz
- AC-to-battery charging from any AC source
- Uses energy from photovoltaic arrays, wind turbines, and other renewable resources. Use of OutBack FLEXmax charge controllers will optimize power production from PV sources.
- Dual AC inputs allow direct connection to utility grid and AC generator
- Rapid transfer between AC source and inverter output with minimal delay time
- Six selectable input modes for different applications
 - ~ **Generator**
 - ~ **Support**
 - ~ **Grid Tied**
 - ~ **UPS** (Uninterruptible Power Supply)
 - ~ **Backup**
 - ~ **Mini Grid**
- 8000 watts (8 kW) continuous power at 48 Vdc
- 16.97 kVA peak surge capacity
- Stackable in parallel configuration up to 10 inverters
- Modular internal design allows low idle consumption and high efficiency at both high and low power operation
- Field-upgradeable firmware
- Certified by ETL to UL1741 and CSA C22.2
- Uses MATE3 System Display and Controller



Figure 1 GS8048 Inverter/Charger



IMPORTANT:

The Radian Series Inverter/Charger is not intended for use with the OutBack MATE or MATE2 System Display and Controller. It is only compatible with the MATE3 System Display and Controller.

MATE3 System Display and Controller

The Radian inverter/charger has no external controls. It can operate normally without an external control or interface. Basic modes and settings are pre-programmed at the factory. (See page 47 for default settings.) The Radian inverter has no display or LED indicators. It is not possible to monitor its status or operating mode without a metering device.

The MATE3 System Display and Controller (sold separately) is an OutBack product designed to accommodate programming and monitoring of an OutBack power system. The MATE3 provides the means to adjust the factory default settings to correctly match the installation where needed. It also provides the means to monitor system performance and troubleshoot fault or shutdown conditions.

Once settings are modified using a MATE3, the MATE3 can be removed from the installation. The settings are stored in the non-volatile memory of the Radian. However, it is highly recommended to include a MATE3 as part of the system. This provides the means to monitor system performance and respond quickly should it be necessary to correct a fault or shutdown condition.

The MATE3's Configuration Wizard is capable of automatically configuring inverters to a series of preset values. This is often more efficient than attempting to manually program each setting in each inverter. Affected fields include system type, battery charging, and AC source configuration. (For more information, see the *MATE3 Owner's Manual*).

NOTE: The Radian Series Inverter/Charger can only be used with MATE3 firmware revision 002.005.xxx or higher.



IMPORTANT:

Some functions are not based in the inverter, but are part of the MATE3 system display's firmware. They will not function if the system display is removed. These functions are listed beginning on page 33. For a detailed description of functions and programming, please see the *MATE3 Owner's Manual*.



Figure 2 MATE3 System Display and Controller



Commissioning

Functional Test



WARNING: Shock Hazard and Equipment Damage

The inverter cover must be removed to perform these tests. The components are close together and carry hazardous voltages. Use appropriate care to avoid the risk of electric shock or equipment damage.

Pre-startup Procedures

1. Ensure all DC and AC overcurrent devices are opened, disconnected, or turned off.
2. Double-check all wiring connections.
3. Inspect the work area to ensure tools or debris have not been left inside.
4. Using a digital voltmeter (DVM) or standard voltmeter, verify battery voltage. Confirm the voltage is correct for the inverter model. Confirm the polarity.
5. Connect the MATE3 system display, if present.



CAUTION: Equipment Damage

Incorrect battery polarity will damage the inverter. Excessive battery voltage also may damage the inverter. This damage is not covered by the warranty.

Startup

It is highly recommended that all *applicable* steps be performed in the following order. However, if steps are inapplicable, they can be omitted.

If the results of any step do not match the description, see the Troubleshooting section on page 35.

To start the system:

1. Close the main DC circuit breakers (or connect the fuses) from the battery bank to the inverter. Repeat for every inverter present.
2. Confirm that the MATE3 is operational, if present. (See the MATE3 Owner's Manual for a description of the menu items that appear on a correctly functioning display.)
3. Turn on the inverter using the MATE3 or external switch. Unlike previous OutBack inverters, this product's default condition is Off.
4. Using a DVM, verify 120 Vac between the L1 OUT and NEU terminals, and between the L2 OUT and NEU terminals. Verify 240 Vac between the L1 OUT and L2 OUT terminals. Do not turn on any AC circuit breakers at this time. (See page 35 for an illustration of AC test points.)
5. Using the MATE3, perform all programming for input modes, stacking, battery charging, AC current, generator starting, and any other functions. Refer to the Input Modes section beginning on page 9 and the Functions section beginning on page 15. Also refer to the MATE3 Owner's Manual and any other literature as needed.

Commissioning

After programming (if any) is completed, perform the following steps:

1. If other inverters are on the system, use a DVM to verify correct voltage from the L1 OUT terminal on one inverter to the next. When stacked in parallel, the wires from one inverter to the next should read 0 Vac (although individually they should still read 120 Vac with respect to neutral). Repeat for the L2 OUT terminal.
2. Close the AC output circuit breakers. If AC bypass switches are present, place them in the normal (non-bypass) position. *Do not connect an AC input source or close any AC input circuits.*
3. Use a DVM to verify correct voltage at the AC load panel.
4. Connect a small AC load and test for proper functionality.
5. Close the AC input circuit breakers and connect an AC source. Using a DVM, check the appropriate L1 and L2 IN terminals for 120 and 240 Vac. If a MATE3 system display is present, confirm that the inverter accepts the AC source as appropriate for its programming. Check the system display indicators for correct behavior.
6. If the battery charger has been enabled, confirm that it is charging by using the MATE3. The inverter will perform a full battery charge when first powered up. This may take several hours. If restarted after a temporary shutdown, the inverter may skip most or all of the charging cycle.
7. Test other functions which have been enabled, such as generator start, selling, or search mode.
8. Compare the DVM's readings with the MATE3 meter readings. If necessary, the system display's readings can be calibrated to match the DVM more accurately. AC input voltage, AC output voltage, and battery voltage can be calibrated.

Powering Down

If steps are inapplicable, they can be omitted. However, it is highly recommended that all *applicable* steps be performed in the following order.

To Power Down the System:

1. Turn off all load circuits and AC input sources.
2. Turn off all renewable energy circuits.
3. Turn each inverter OFF using the MATE3 system display or external switch.
4. Turn off the main DC overcurrent devices for each inverter.

Adding New Devices

When adding new devices to the system, first power down the system according to the preceding instructions. After adding new devices, perform another functional test, including programming.

Firmware Updates

Updates to the Radian's internal programming are periodically available. If multiple inverters are used in a system, all units must be upgraded at the same time. See the MATE3 Owner's Manual for details.



IMPORTANT:

All inverters will shut down during software updates. If it is necessary to run loads while updating the firmware, bypass the inverter with a maintenance bypass switch (if present). During this time, communication cables must remain connected and DC power must remain on. Interrupted communication will cause the update to fail and the inverter(s) may not work afterward. Inverters automatically update one at a time. Updating each inverter requires about 5 minutes.



Operation

Input Modes

The Radian inverter has two sets of input connections for multiple AC sources. (See the *Radian Series Inverter/Charger Installation Manual* for more information.) With the MATE3, each input can be programmed to a particular operating mode. Six modes are available, each with certain advantages which make it ideal for a particular application. Some modes contain functions unique to that mode.

Both of the Radian's inputs can be programmed for separate modes. The mode for the "Grid" input can be set in the **Grid AC Input Mode and Limits** menu. The second, "Gen", input can be set in the **Gen AC Input Mode and Limits** menu.

NOTE: The input terminals are labeled for grid and generator due to common conventions, not because of inverter requirements. Each input can accept any AC source as long as it meets the requirements of the Radian inverter and the selected input mode. If necessary, the **Gen** terminals can accept grid power. The opposite is also true.

When multiple inverters are stacked together (see page 26), the master inverter's input mode is imposed on all slave inverters. The slave menu settings are not changed; they retain any input mode that was previously programmed. However, the slave will ignore its own input mode and use that of the master. This also applies to any parameters in the mode menu (**Voltage Limit**, **Connect Delay**, and so on).

The following pages compare the various features of each input mode.

Generator

Generator allows a wide range of generators, even those with a rough or imperfect AC waveform. Normally a "noisy" or irregular waveform may not be accepted by the inverter. This mode allows these waveforms to be accepted. The charging algorithm of this mode is designed to work well with any AC generator regardless of power quality or regulation mechanism. The generator must still comply with the inverter's nominal input specifications in the Input section of this manual. See page 16.

CHARGING:

In this mode, when the charger is enabled, the Radian will use the AC source to charge the battery bank. (See page 20.) It will proceed through the battery charging cycle until it reaches the Float stage. It will then remain in the Float stage and maintain the batteries for as long as the AC source is present.

BENEFITS:

- The Radian inverter will charge the batteries from the generator even when the generator is undersized, of low quality, or has other problems. The recommended parameters for sizing a generator are listed on page 18.
- In cases where utility grid power is unstable or unreliable, **Generator** mode may allow the Radian inverter to accept the power.
- This mode has a programmable delay time which will allow a generator to stabilize before connection. In the MATE3, this menu item is **Connect Delay**. It is available in either the **Grid AC Input Mode and Limits** or the **Gen AC Input Mode and Limits** menu, depending on which input is being programmed.

Operation

NOTES:

- The Support, Offset, and grid-interactive functions of the Radian are unavailable in this mode.
- Any AC fluctuations that are accepted by the inverter will be transferred to the output. The loads will be exposed to these fluctuations. It may not be advisable to install sensitive loads under these conditions.
- In this mode, the Radian uses “diode charging”. This function uses exact control of the charger, allowing it to operate normally despite the quality of the input source. (Other modes may temporarily switch to diode charging, but **Generator** uses it exclusively.) The MATE3 indicates diode charging by displaying  in the Inverter soft key screen. (See the MATE3 owner’s manual for more information.) When diode charging, the GS8048 maximum charge rate is limited to 20 Aac (80 Adc).
- While charging, the charger will not go silent (see page 22). After completing the charge, it will remain in the Float charging stage unless this generator is stopped (either automatically or manually) or AC input power is otherwise removed.

Support

The **Support** mode is intended for systems that use the utility grid or a generator. In some cases, the amount of current available from the source is limited due to size, wiring, or other reasons. If large loads need to be run, the Radian inverter augments (supports) the AC source, adding inverter and battery power to ensure that the loads receive the power they demand.

In the MATE3 system display, the **Grid Input AC Limit** dictates the maximum AC draw for the Grid input. The **Gen Input AC Limit** sets the maximum draw for the Gen input. This function takes effect if the AC draw on the appropriate input exceeds its setting.

CHARGING:

In this mode, when the charger is enabled, the Radian will use the AC source to charge the battery bank. (See page 20.) It will proceed through the entire battery charging cycle. After the end of the Float timer, it will continue to alternate between Silent and Re-Float stages.

BENEFITS:

- The large loads on the system can be powered while staying connected to the input, even if the input is limited. Battery power prevents overload of the input source, while at the same time limiting the amount of battery power used.
- In this mode, the inverter will offset the loads with excess renewable energy if it is available from the batteries. (See page 19 for more information on the Offset function.)
- This mode has a programmable delay time which will allow an AC source to stabilize before connection. In the MATE3, this menu item is **Connect Delay**. It is available in either the **Grid AC Input Mode and Limits** or the **Gen AC Input Mode and Limits** menu, depending on which input is being programmed.

NOTES:



IMPORTANT:

If the AC loads exceed the amperage limit setting, the inverter will draw energy from the batteries. If the loads are sustained, the batteries may discharge to the point of Low Battery Cut-Out and the inverter may shut down with a Low Battery error. (See pages 15 and 40.) To prevent the loss of backup power, load use should be planned accordingly.

- The grid-interactive function of the Radian inverter is unavailable in this mode.
- Because the inverter limits the current draw from the AC source, it will reduce the charge rate as necessary to support the loads. If the loads equal the amperage setting, the charge rate will be zero.
- If the AC loads **exceed** the amperage setting, the charger will begin operating in reverse. It will take power **from** the batteries and use it to support the incoming AC current.

Grid Tied



IMPORTANT:

Selling power to the utility company requires the authorization of the local electric jurisdiction. The method used by the local utility company to accommodate this will depend on their policies on this issue. Some may pay for power sold; others may issue credit. Some policies may prohibit the use of this mode altogether. *Please check with the utility company and obtain their permission before using this mode.*

The **Grid Tied** mode allows the Radian inverter to become grid-interactive. This means that in addition to using power from the utility grid for charging and loads, it can also convert excess battery power and sell it to the utility grid. Excess battery power usually comes from renewable energy sources, such as PV arrays, hydroelectric turbines, and wind turbines.

In this mode, the inverter will offset the loads with excess renewable energy if it is available from the batteries. (See page 19 for more information on the Offset function.) If additional energy is available beyond what is consumed by the loads, the energy will be sold to the utility grid.

The grid-interactive function is referenced heavily in the Battery Charging section, as it is integrally tied with the battery charger. Where the charger draws power from the AC input and puts it into the batteries, the grid-interactive function removes power from the batteries (or the DC system) and returns it to the AC input. When a renewable source of energy raises the batteries above a designated reference point (or “target”), the inverter exports power in order to bring the voltage back down or to prevent it from rising further.

- The inverter uses several set points as targets for selling, particularly the battery charger settings. In the MATE3, the **Absorb Voltage**, **Float Voltage**, and **Equalize Voltage** settings are all used as target voltages.
- If the battery charger is not active, the target voltage used by the Radian inverter is **Sell Voltage** in the **Grid-Tie Sell** menu. (See page **Error! Bookmark not defined.** for more information on charging and selling. See the *MATE3 Owner's Manual* to change any of these settings.)
- Unlike the other target voltages, the Radian inverter cannot import AC power to raise the batteries to the **Sell Voltage** set point. It can only use excess DC power, if it is available, and export it as AC power.

CHARGING:

In this mode, when the charger is enabled, the Radian will use the AC source to charge the battery bank. (See page 20.) It will proceed through the entire battery charging cycle. After the end of the Float timer, it will continue to alternate between Silent and Re-Float stages, entering the Selling stage as appropriate.

BENEFITS:

- Excess power is returned to the utility grid.

NOTES:

- The Support function of the Radian inverter is unavailable in this mode.
- The inverter has a minimum five-minute delay before selling will begin. Upon initial connection to the utility grid, the inverter may be required to perform a full battery charge. This may delay the operation of the grid-interactive feature.
- The grid-interactive function only operates when excess DC (renewable) power is available.

Operation

- The grid-interactive function can only operate while the utility grid power is stable and within specific limits.
 - ~ If the AC voltage or frequency vary outside these limits, the inverter will stop selling. If the inverter stops selling, the MATE3 will show the reason. **Sell Status** messages are listed on page 44.
 - ~ If the AC voltage or frequency vary outside the maximum limits, the inverter will also disconnect from the utility grid. The Radian inverter's grid-interactive limits are specified on page 46. The AC source acceptance limits are specified on page 17. These numbers are not necessarily the same.
- When power is returned to the utility grid, it may possible to make the utility meter run backwards. The net result would be to sell power to the utility company. However, this depends on whether there are other loads in the system. Loads on the main panel (not on the inverter's output) may consume this power as fast as it is generated, preventing the meter from running backwards. In this case, the result of selling would be to reduce the consumption of AC power, not reverse it.
- The amount of power an inverter can sell is not equal to its specified output wattage. Its maximum selling output is 7.68 kW. However, output will vary with inverter temperature, battery type, and other conditions.
 - ~ A good guideline is that the renewable source should be sized to continuously deliver no more than 85% of the inverter's specified wattage (per inverter, in a multi-inverter system).
 - ~ This recommendation is specifically for the inverter's grid-interactive feature. In some cases, the source may be sized larger to account for environmental conditions or the presence of DC loads. This depends on individual site requirements.

UPS (Uninterruptible Power Supply)

In **UPS** mode, the Radian's parameters have been optimized to reduce the response and transfer times. If the utility grid becomes unstable or is interrupted, the Radian can transfer to inverting in minimal time. This allows the system to support sensitive AC loads without interruption.

CHARGING:

In this mode, when the charger is enabled, the Radian will use the AC source to charge the battery bank. (See page 20.) It will proceed through the entire battery charging cycle. After the end of the Float timer, it will continue to alternate between Silent and Re-Float stages.

BENEFITS:

- This mode will maintain constant power to the loads with virtually no drop in voltage or current.
- In this mode, the inverter will offset the loads with excess renewable energy if it is available from the batteries. (See page 19 for more information on the Offset function.)

NOTES:

- The Support and grid-interactive functions of the Radian inverter are unavailable in this mode.
- Due to the need for the Radian inverter to react quickly to AC source fluctuations, it must remain fully active at all times. The inverter requires a continuous consumption of 42 watts.
- For this reason, the Search function does not operate in this mode. (See page 16.)

Backup

This mode is intended for systems that have utility grid available as the primary AC source. This source will pass through the Radian inverter's transfer circuit and will power the loads unless utility power is lost. If utility grid power is lost, then the Radian inverter will supply energy to the loads from the battery bank. When the utility power returns, it will be used to power the loads again.

CHARGING:

In this mode, when the charger is enabled, the Radian will use the AC source to charge the battery bank. (See page 20.) It will proceed through the entire battery charging cycle. After the end of the Float timer, it will continue to alternate between Silent and Re-Float stages.

BENEFITS:

- In this mode, the inverter will offset the loads with excess renewable energy if it is available from the batteries. (See page 19 for more information on the Offset function.)
- This mode will continuously maintain the batteries in a fully-charged state, unlike the Support mode, and does not have the overhead consumption of the UPS mode.

NOTES:

- The Support and grid-interactive functions of the Radian inverter are unavailable in this mode.

Mini Grid

The Radian inverter can be programmed to automatically reject an AC source and run solely from battery (and renewable) energy. In **Mini Grid** mode, the inverter only connects to the AC source (usually the utility grid) when the batteries run too low.

In this mode, the Radian inverter runs on battery-supplied power for as long as the batteries can be sustained. It is expected that the batteries will also be charged from renewable sources such as PV. When the batteries become depleted, the system reconnects to the utility grid to operate the loads.

The inverter will reconnect to the utility grid if the battery voltage decreases to either the **Re-Float Voltage** set point (see page 22), or the Rebulk voltage (see page 23). Once it reconnects to the utility grid, if the charger is turned off, the Radian will use its transfer circuit to send grid power to the loads. If the charger is turned on, it will use the grid to charge the battery, as well as powering the loads.

While connected to the utility grid, any excess energy from the renewable source will be sent to the loads and used to "offset" the use of grid power. When the renewable energy is equal to or greater than the load demand, the utility grid will no longer be required. The Radian inverter will then disconnect from the utility grid and begin running from batteries again. It will not disconnect until these conditions are met.

CHARGING:

In this mode, the Radian inverter will wait for the batteries to pass through the charging stages until certain internal charger settings are met (see below). This is true regardless of whether the Radian or the renewable source is charging. This means that the regulator for the renewable source must be set to the same settings as the Radian (or higher). See the *MATE3 Owner's Manual* to locate the exact settings of the Radian inverter.

If the reconnection was triggered by the **Re-Float Voltage** set point, the inverter will only require the batteries to pass through the **Float Voltage** and **Float Time** settings (as well as Offset.) The inverter

Operation

will then enter Silent (see page 22) and continue repeating this part of the charging cycle until it disconnects from the utility grid.

If the reconnection was triggered by the Rebulk voltage setting, the inverter will require the charger to pass through the entire charge cycle, including the **Absorb Voltage**, **Absorb Time**, **Float Voltage**, and **Float Time** settings (as well as Offset). The inverter will continue repeating the Float part of the charging cycle until it disconnects from the utility grid.

See page 20 for more information on the battery charging cycle.

BENEFITS:

- **Mini Grid** mode allows a system to take full advantage of renewable energy. Dependence on the utility grid can be minimized or eliminated.
- In this mode, the inverter will offset the loads with excess renewable energy if it is available from the batteries. (See the previous page and page 19 for more information on the Offset function.)
- This mode is similar to the high-battery transfer (HBX) mode used by the MATE3 system display, but it has several differences (see below).

NOTES:

- The Support and grid-interactive functions of the Radian inverter are unavailable in this mode.
- This mode has similar priorities to the high-battery transfer (HBX) mode used by the MATE3 system display. However, it is not compatible with HBX mode and cannot be used at the same time. When using **Mini Grid** mode, HBX mode should be disabled to prevent conflicts.
- When deciding whether to use **Mini Grid** mode or HBX, the user should consider various advantages of each.
 - ~ **Mini Grid** logic is based in the Radian inverter and can function in the absence of the MATE3. HBX logic is based in the MATE3 and cannot function unless the MATE3 is installed and operating.
 - ~ **Mini Grid** can use utility grid power to fully recharge the batteries on reconnection. HBX can only do so under specific circumstances.
 - ~ HBX set points have a wide range of settings. **Mini Grid** uses settings which tend to prevent the batteries from excessive discharge; however, most of its settings are automatic and do not allow customization.
 - ~ HBX works more efficiently when the renewable source is larger, but there is no specific requirement for renewable size. **Mini Grid** is unable to work properly unless the renewable source is larger than the size of the loads. (See previous page.) If this condition is not met, **Mini Grid** will not disconnect the inverter from the utility grid.
 - ~ HBX can be combined with the settings of any other Radian input mode (**Generator**, **UPS**, etc.). The **Mini Grid** input mode is naturally limited to its own settings and does not have access to certain functions of other modes. (See the first bullet above.)
 - ~ See page 33 and the *MATE3 Owner's Manual* for more information on HBX.

Functions

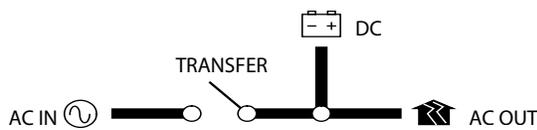
The items in this section are operations common to all Radian inverters. These are used in most or all of the input modes described in the preceding section. Some of the items in this section are functions which can be manually selected, enabled, or customized.

Other items are general topics or applications for the inverter. These items may not have their own menus, but their activity can still be influenced or optimized by changing certain settings.

Any of these items may need to be adjusted so that the inverter is best matched to a particular application. The operator should review these items to see which are applicable.

All items described as settable or adjustable have set points which can be accessed using the remote system display. (See the *MATE3 System Display and Controller Owner's Manual* for instructions on locating these set points.) The default settings and ranges of adjustment are listed beginning on page 47 of this manual.

Each distinct operation is accompanied by a symbol representing the inverter and that function:



These items represent the input from the AC source, the output to the AC loads, DC functions (inverting, charging, etc), and the transfer relay. Arrows on each symbol represent current flow.

The symbols for each operation may have other features depending on the operation.



Inverting

The Radian inverter converts DC voltage from batteries into AC voltage that is usable by AC appliances. It will continue to do this as long as the batteries have sufficient energy. The batteries can be supplied or recharged from other sources, such as solar, wind, or hydroelectric power.

The inverter's design uses two transformers and two high-frequency H-Bridge FET modules to achieve the required high-wattage output. When not in use, the dual design allows half the inverter to shut down for lower idle consumption.

The Radian inverter requires batteries to operate. Other sources may not maintain DC voltages that are consistent enough for the inverter to operate reliably.



CAUTION: Equipment Damage

Do not substitute other DC sources in place of the batteries. High or irregular voltages may damage the inverter. It is normal to use other DC sources in conjunction with the batteries and the inverter, but not in place of the batteries.

Certain features will affect the inverter's operation. These features only operate when the inverter is generating AC power on its own. They do not function when the inverter is being supplied by an AC source.

- **Low Battery Cut-Out:** This feature prevents the inverter from draining the batteries completely. It will stop functioning and give a **Low Battery V** error when the DC voltage drops below a specified level for 5 minutes. This appears as an Event on the MATE3 system display, as described in the *MATE3 Owner's Manual*. It is one of the Error messages described on page 40. This function is intended to protect both the batteries and the inverter's output. (Continuing to invert on a low DC voltage may produce a distorted waveform.) This item is adjustable.

Operation

- **Low Battery Cut-In:** The recovery point from Low Battery Cut-Out. When the DC voltage rises above a specified level for 10 minutes, the low battery error will clear and the inverter will resume functioning. This item is adjustable.
 - ~ Connecting an AC source to charge the batteries will also clear a low battery error.
- **Output Voltage:** The inverter's AC output voltage can be adjusted up or down by a certain amount to allow for conditions. This item is adjustable.
- The inverter is also controlled by a high battery cut-out function. If the DC voltage rises above a specified level, the inverter will immediately stop functioning and give a **High Battery V** error. This appears as an Event on the MATE3 system display, as described in the *MATE3 Owner's Manual*. This is one of the Error messages displayed on page 40 of this manual. (If the voltage drops below this point, the inverter automatically recovers.)

For the standard GS8048 inverter, the high battery cut-out voltage is 68 volts. It cannot be changed.

This function is intended to protect the inverter's output and loads. Continuing to invert on a high DC voltage may produce a distorted waveform. Note that the inverter's high battery cut-out does not alleviate or solve the high battery condition itself; the cause is an external condition.

Search

An automated search circuit is available to minimize the power draw when no loads are present. When enabled, the inverter does not always deliver full output. The output is reduced to brief pulses with a delay between them. These pulses are sent down the output lines to see if a resistance is present. Basically, the pulses "search" for a load. If a load is detected on either the L1 or L2 outputs, the inverter's output increases to full voltage so that it can power the load. When the load is turned off, the inverter "goes to sleep" and begins searching again.

The sensitivity of Search mode is in increments of approximately 0.1 Aac. The default is 6 increments, or about 0.6 Aac. A load which draws this amount or greater will "wake up" the inverter.

NOTE: Due to load characteristics, these increments are only approximate and may not function exactly as listed.

The pulse duration and the delay both have a time period that is measured in AC cycles. These two items and the load detection threshold are adjustable.

- Search mode may not be useful in larger systems with loads that require continuous power (e.g., clocks, answering machines, fax machines). Search mode may cause nuisance shutdowns, or it may sleep so rarely that there is no benefit.
- Some devices may not be easily detected by Search mode.

Input

When the Radian inverter input terminals are connected to a stable AC source, the inverter will synchronize itself with that source and use it as the primary source of AC power. (See AC Source Acceptance on page 17.) Its transfer relay will engage, linking the AC source directly with the inverter's output. It can also use the source to charge batteries. (See Transfer on page 18 and Battery Charging on page 20.)

- Two sets of AC input terminals are available. Both inputs are identical and can be used for any AC source. However, for easy reference, the first input has been labeled GRID (for the utility grid). The second input is labeled GEN (for a generator). These designations are also used in the menus of the MATE3 system display. Each input has a separate set of input criteria and input modes. The programming for each input also has identical content.

- The independent inputs are intended to simplify the connection to multiple AC sources; however, only one input can be used at a time. If both inputs are powered, the default setting is for the inverter to accept the GRID input. This can be changed. In the MATE3 system display, these priorities are selected using **Input Priority** in the **AC Input and Current Limit** menu.
- Six input modes are available which affect the Radian inverter's interactions with AC input sources. The **Grid Tied** mode allows the Radian to sell power using the input connection. The **Support** mode can use battery power to assist a smaller AC source. See page 9 for descriptions of these and other input modes.
- There are a number of considerations when selecting the type and size of an AC generator. (See the section entitled Generator on page 18.)
- The AC input current is used to power both loads and battery charging. The combined amount should not exceed the size of the AC overcurrent device or AC source. These devices should be sized appropriately during planning. (See AC Current Settings on the next page. See the *Radian Series Inverter/Charger Installation Manual* for more information.)
- The loads powered by the inverter **must not** exceed the size of the inverter's transfer relay. (See the section entitled "Transfer" on page 18.)



CAUTION: Equipment Damage

Current draw in excess of the inverter's transfer relay rating can damage the transfer relay. This damage is not covered by warranty.

AC Current Settings

The AC current settings control the amount of current that the inverter draws from the source(s). The amount of current is controlled by the grid or generator limit settings. These settings should be adjusted to match the size of the input circuit breaker. In the MATE3 system display, if the **Inverter Input Priority** or **AC Input and Current Limit** menus are set to **Grid**, the inverter uses the grid settings. If the menus are set to **Gen**, the inverter uses the generator settings.

- This is intended to protect a generator or source that may not be large enough to supply enough current for both charging and loads. If the combined charging and loads exceed this setting, the inverter will reduce its charge rate and give priority to the loads. If the loads exceed this number on their own, the charge rate will be reduced to zero.
- The **Support** input mode allows the Radian inverter to support the AC source with power from the batteries. See page 10.
- If multiple parallel inverters are installed with an AC source of limited amperage, the total combined amperage settings for all units must be less than the AC input circuit. The Configuration Wizard in the MATE3 can perform this calculation. However, the inverters do not perform this calculation. If the MATE3 or the Configuration Wizard are not used, it is necessary to divide the input size by the number of inverters and assign an equal part of the amperage to each port.

AC Source Acceptance

The input source must meet the following specifications to be accepted:

- L1 (to neutral) 120 Vac, ± 12 Vac (default setting), and
- L2 (to neutral) 120 Vac, ± 12 Vac (default setting), and
- 60 Hz, ± 6 Hz

When these conditions are met, the inverter will close its transfer relay and accept the input source. This occurs after a delay which is specified below. If the conditions are not met, the inverter will not accept the source. If it was previously accepted and then rejected, the inverter will open the relay and return to inverting power from the batteries.

- The voltage limits can be adjusted to allow (or exclude) a source with weak or irregular voltages. These items are adjustable in the appropriate menu of the MATE3 (**Grid AC Input Mode and Limits** or **Gen AC**

Operation

Input Mode and Limits). The settings are titled **Voltage Limit Lower** and **Upper**. When this setting is adjusted, it applies equally to L1 and L2.

There can be side effects to changing the range of allowed voltages. See page 18.

- Each of the AC inputs has a settable connection delay. This is intended as a warmup period which allows an input source to stabilize before connection.
 - ~ The default setting for the Grid input is 0.2 minutes (12 seconds).
 - ~ The default setting for the Gen input is 0.5 minutes (30 seconds).

These items are adjustable in the appropriate menu of the MATE3 (**Grid AC Input Mode and Limits** or **Gen AC Input Mode and Limits**).

NOTES:

- Certain input modes such as **Mini Grid** may prevent the inverter from accepting AC power even if electrical conditions are met. (See page 13.)
- Several items external to the inverter may prevent the inverter from accepting AC power even if electrical conditions are met. One is the High Battery Transfer mode, which is operated by the MATE3 system display. (See page 33 and the *MATE3 Owner's Manual*.) Another is the MATE3's **AC INPUT** hot key menu, which can order all inverters to disconnect when set to **Drop**. (See the MATE3 manual.)
- The inverter has additional criteria that control whether it sells power. The inverter may accept AC power but refuse to sell if the acceptance criteria are met, but the grid-interactive criteria are not. (See the **Grid Tied** input mode on page 11.)



A generator should be sized to provide enough power for all inverters, both for loads and for battery charging.

It is usually recommended that the generator be sized at twice the wattage of the inverter system. Many generators may not be able to maintain AC voltage or frequency for long periods of time if they are loaded more than 80% of rated capacity.

The generator is required to have a stable output before its power is accepted by the inverter. Some generators with less stable or uneven outputs may not be accepted. The use of the **Generator** input mode may assist with this problem.



The inverter uses a transfer relay to alternate between the states of inverting and of accepting an AC source. Until the relay energizes, the L1 and L2 output terminals are electrically isolated from the input that is in use. When it closes, the L1 input and output terminals become electrically common. The same is true for the L2 input and output terminals. (The terminals for the unused input remain isolated during this time.) When the relay changes states, the physical transfer delay is approximately 25 milliseconds.

The relay contacts are limited to 55 amps per phase or leg. The continuous loads on that output should never exceed this number. When connected to an AC source, the Radian inverter cannot limit the load current. An overload condition is possible.



CAUTION: Equipment Damage

Current draw in excess of the inverter's transfer relay rating can damage the transfer relay. This damage is not covered by warranty.

The inverter does not filter or clean up the power from the AC source. The voltage and power quality received by the output loads is the same as that of the source. If the voltage or quality do not meet the inverter's input requirements (see page 17), it will disconnect and return to the inverting mode.

- If the AC source meets the inverter's requirements but is irregular, any fluctuations will be transferred to the loads. If the loads are sensitive, it may be necessary to improve the quality of the AC source.
- To ensure a smoother transition, it may be advisable to raise the inverter's lower acceptance limit. The default setting is 108 Vac on each leg. A higher setting will cause the inverter to transfer sooner in the event of a quality problem.
- The **Generator** input mode is intended to accept irregular or unfiltered AC sources and is more likely to do so than other modes. Since it will transfer the irregular power to the output as noted above, this should be considered before using this mode with sensitive loads. (See page 9.)

In a stacked system, slaves are ordered to transfer at the same time as the master. If a slave does not sense an AC source at the same time as the master, it will continue inverting, and will experience a **Phase Loss** error (see page 40). This appears as an Event on the MATE3 system display, as described in the *MATE3 Owner's Manual*.



This function is designed to use excess battery energy to power the loads, even when an AC source is present. This allows the system to take advantage of renewable energy sources, in effect "offsetting" dependence on the AC source.

When a renewable source of energy raises the batteries above a designated reference point (or "target"), the inverter exports power to the loads in order to bring the voltage back down or to prevent it from rising further.

The inverter uses several set points as targets for the offset function, particularly the battery charger settings. In the MATE3, the **Absorb Voltage**, **Float Voltage**, and **Equalize Voltage** settings are all used as reference voltages. While the battery charger is operating, it will regulate the voltage at a level appropriate for the target setting.

If none of the battery charger's timers are active, the target voltage used by the Radian inverter is **Sell Voltage** in the **Grid-Tie Sell** menu. Unlike the other target voltages, the Radian inverter cannot import AC power to raise the batteries to the **Sell Voltage** set point. It can only use excess DC power, if it is available, and export it as AC power.

(See page **Error! Bookmark not defined.** for more information on how Offset relates to the battery charger. See the *MATE3 Owner's Manual* to change any of these settings.)

NOTES:

- If the Radian inverter is in the **Grid Tied** input mode and more renewable energy is available than can be offset by the loads, the inverter will sell the remainder to the utility grid. Although the inverter can use the **Sell Voltage** setting as a target in most input modes (see below), it is unable to sell power to the utility grid unless the **Grid Tied** mode is selected.
- If the inverter is in the **Support**, **UPS**, **Backup**, or **Mini Grid** input modes and more renewable energy is available than can be offset by the loads, it means the inverter is capable of running all of its loads using renewable energy. The inverter will disconnect from the AC source as long as the excess renewable energy is present.
- The Offset function is not active when the **Generator** input mode is selected.

Battery Charging



IMPORTANT:

Battery charger settings need to be correct for a given battery type. Always follow battery manufacturer recommendations. Making incorrect settings, or leaving them at factory default settings, may cause the batteries to be undercharged or overcharged.

The inverter uses a “three-stage” battery charging process. The three stages are Bulk, Absorption, and Float. These stages follow a series of steps, which are shown on graphs (see page 21).

NOTES:

- The process shown in Figure 3 also includes the step of selling power back to the utility, as this is integrally tied with the battery charger. This step is only applicable when the Radian inverter is in the **Grid Tied** input mode.
- The process shown in Figure 4 eliminates Silent, Float Timer, and other parts of the process. Figure 4 is only applicable when the Radian inverter is in the **Generator** input mode.
- The target points and time limits cited under various steps are also used by the inverter’s Offset function. (See page 19.) These items are settable using the MATE3 system display. (See the *MATE3 Owner’s Manual*.)

Charging Steps

No Charging

If the inverter is not charging, any of the following conditions may apply:

- The unit is inverting or not connected to a qualified AC source.
- The unit is connected to an AC source but is in a mode or stage that does not use the charger. (Silent mode is one example.)
- The unit is connected to an AC source but the charger has been turned off.

Bulk Stage

This stage activates the charger. This is the first stage in the three-stage charge cycle. It is a constant-current stage which drives the battery voltage up. This stage typically leaves the batteries at 75% – 90% of their capacity, depending on conditions.

Target point: *Absorb Voltage* setting. The default setting is 57.6 Vdc.

The initial DC current is the maximum current the charger can deliver. It will begin at the charger’s specified maximum, but will gradually decrease as the voltage increases. This is a tradeoff in wattage and is normal for the charger.

Absorption Stage

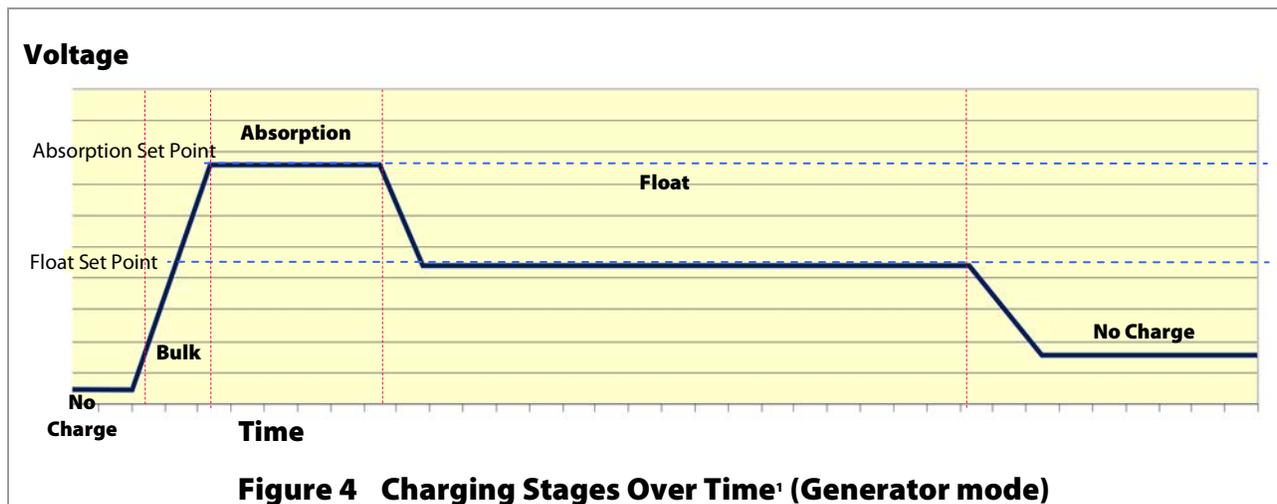
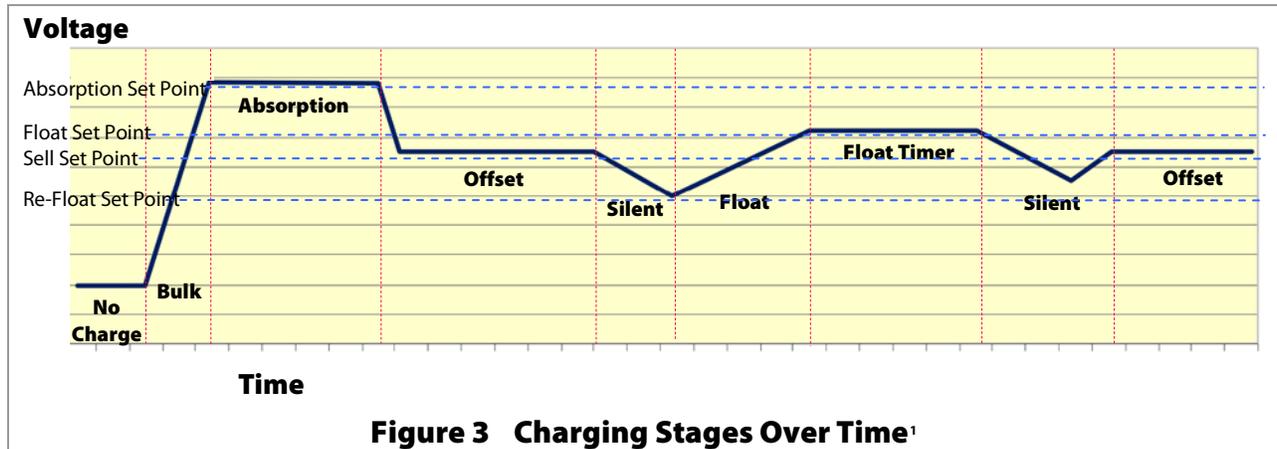
This is the second stage of charging. It is a constant-voltage stage. Current varies as needed to maintain the voltage, but will typically decrease to a very low number over time. This “tops off the tank”, leaving the batteries at essentially 100% of capacity.

Target point: *Absorb Voltage* setting.

Time limit: *Absorb Time* setting. This timer counts down from the inception of the Absorption stage until it reaches zero. The timer can be viewed. (See the MATE3 manual.)

For multiple inverters only:

The charging of multiple stacked inverters is synchronized and is governed by the master. When the master inverter reaches the end of Absorption (and other stages), the slaves will exit Absorption as



well, even if their timers have not expired. The remaining time for the slaves will be retained in the timer for each inverter.

The Absorption timer does not reset to zero when AC power is disconnected or reconnected. It only resets to zero if it runs out, or if an external STOP BULK command is sent. The rest of the time, it retains any remaining time. It adds more time to the Absorption period whenever the batteries fall below a certain voltage. (See page 23 for more information on how the timer works.)

Offset

This is not a charging stage. The Offset function is designed to use excess battery energy to power the loads, even when an AC source is present. Offset can operate in any stage of charging, but is shown in Figure 3 to display the function when no charging stages or timers are active. This function is described more fully on page 19.

Offset is a constant-voltage mode of operation. The inverter cannot import current to charge the batteries to a target voltage, but it can export any excess current to constantly hold them at this value. The target voltage used when no other stages are active, as shown in Figure 3, is the **Sell Voltage**

¹The points where the dark blue line intersects the vertical dotted line indicate a change from one step to the next. The points where they also intersect with a horizontal dotted line indicate that the charger has switched to a new target voltage.

Operation

setting. (Excess current typically comes into the batteries from a PV array, wind turbine, or similar renewable energy source.)

Target point: *Sell Voltage* setting. The default setting is 52.0 Vdc.

This setting is typically lower than the Float voltage setting. Although the batteries are not discharged, they are maintained at a somewhat lower voltage so that the maximum amount of power can be exported. It is recommended that this item be set at the batteries' natural rest voltage.

In the **Grid Tied** input mode, excess power is sent first to any loads on the inverter's output, using the Offset function (see page 19). If the exported power exceeds the load requirements, the excess is sold back to the utility grid, using the inverter's AC input terminals. The unit will maintain this activity for as long as excess power is available. See page 11 for more notes on the **Grid Tied** input mode.

Regardless of the input mode setting, if no renewable energy is present, the inverter will exit (or skip) this step and enter Silent.

Silent

This is not a charging stage, but a quiescent period between stages. The inverter remains on the AC source, but the charger is inactive. It enters this condition upon completing the Absorption stage and concluding (or skipping) Offset operation.

In Silent, the batteries are not in significant use by the inverter, but they are also not being charged. The battery voltage will naturally decrease when not maintained by another means such as a renewable source.

The term "Silent" is also used in the context of stacking inverters and Power Save levels. See page 27.

Target point: *Re-Float Voltage* setting. When the battery voltage decreases to this point, the charger becomes active again. The default set point is 50.0 Vdc.

NOTE: If the Radian inverter is placed in the **Generator** input mode, the charger skips Silent and proceeds directly to Float stage (see Figure 4 on page 21). It will remain in Float until AC power is disconnected, which usually means that the generator was stopped manually or automatically. See page 9 for more information on this mode.

Float Stage

This is the third stage of charging. It is a constant-voltage stage. Current varies as needed to maintain the voltage, but typically drops to a low number. This stage offsets the batteries' tendency to self-discharge (as well as offsetting the draw of any other DC loads), and maintains them at 100% of capacity.

Target point: *Float Voltage* setting. The default set point is 54.4 Vdc.

Time limit: *Float Time* setting.

NOTE: The remaining stages below do not apply in the **Generator** input mode. The next activity that can occur is a new charging cycle. The criteria for beginning a new cycle are described on page 23.

Float Timer

This is part of Float stage and is not a separate stage of charging. On the charts on page 21, it is marked as a separate step to note that the timer only begins running upon reaching the Float set point. It does **not** begin running at the beginning of Float stage. (The Float timer is reset to its maximum amount whenever the batteries drop to the Re-Float voltage.)

Repeated Silent

The unit re-enters the Silent stage as it did previously. The unit remains on the AC source, but the charger is inactive.

Target point: Re-Float Voltage setting. The default set point is 50.0 Vdc.

The unit will continue cycling between Float and Silent for as long as the AC source is present. However, if excess DC power is available and the battery voltage rises above the **Sell Voltage** set point, the unit can resume Offset activity as described on page 21.

The unit can only enter Offset when none of the timers are active. If any of the timers have accumulated time while in Silent, the unit will enter the highest stage with accumulated time and proceed from that point.

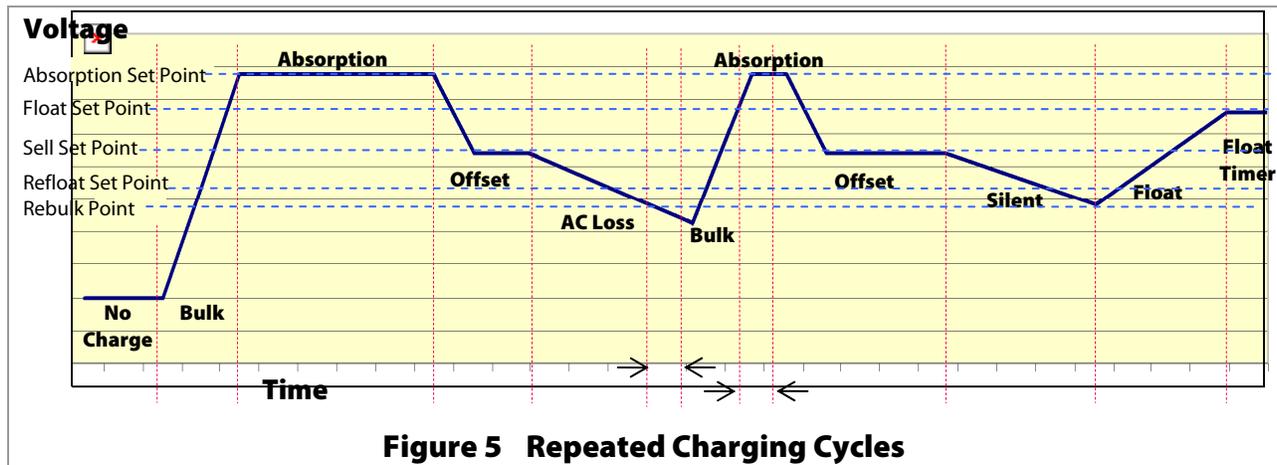


Figure 5 Repeated Charging Cycles

New Charging Cycle

If the AC source is lost or disconnected, the unit will return to inverting mode if enabled. The battery voltage will begin to decrease due to loads or natural loss. When the AC source is restored, the inverter will return to the charging cycle. If the batteries drop below the Rebulk voltage (see below), the inverter will restart the cycle, beginning at Bulk stage. If the batteries do not drop below Rebulk, the charger will not enter the Bulk stage and will return to its previous stage.

New Absorption Stage

When entering the second stage, Absorption, the charger will not necessarily run through its full duration. The timer will count down whatever time remains from the previous cycle, or whatever time it has accumulated since then.

Absorption Timer

The Absorption timer does not reset to its maximum like the Float timer does. Instead, the timer counts upward (gaining time) whenever the battery voltage drops below the Rebulk point. This means that the Absorption period may not always be the same, depending on how much time it has acquired.

The Rebulk voltage is 48.8 Vdc. This is a fixed setting and cannot be changed. For as long as the inverter remains below this voltage, the Absorption timer will gain an equal amount of time. This dictates the duration of the Absorption stage. Note that in Figure 5, the duration of time spent below the Rebulk voltage is the same as the subsequent Absorption period (as shown by the small arrows).

Operation

If the battery voltage drops below 48.0 Vdc, the timer increments (counts upward) at double the normal rate. For example, if the batteries spent 8 minutes below this voltage, 16 minutes would be added to the Absorption timer. Similarly, if the battery voltage drops below 47.2 Vdc, the timer increments at quadruple the normal rate.

The Absorption timer continues this behavior even if the charger is still on. For example, if the charger is in Float stage and there is a significant battery drain, the charger may not be able to maintain the batteries at the Float voltage. Once the batteries fall below the Rebulk point, the Absorption timer will begin accumulating time. (However, the accumulation will be minor, as this will also cause the charger to re-enter the Bulk stage.)

The timer will stop incrementing when it reaches the **Absorb Time** setting. This is the maximum duration of the Absorption stage. This means that regardless of the voltage, the timer will always run for the full Absorption period if the batteries dropped below the appropriate voltage for that amount of time. If significant battery drain caused the batteries to drop below the set points for doubling or quadrupling the rate, the charger may run for the full Absorption period even after a lesser amount of time.

The rest of the charging stages will proceed as described on the previous few pages.

Equalization

Equalization is a controlled overcharge that is part of regular battery maintenance. Equalization brings the batteries to a much higher voltage than usual and maintains this high voltage for a period of time. This has the result of removing inert compounds from the battery plates, and reducing stratification in the electrolyte.

Equalization follows the same pattern as standard three-stage charging, as shown in the figures on page 21. However, instead of the Absorption voltage and time set points, it is controlled by the **Equalize Voltage** and **Equalize Time** settings in the MATE3.

This process must be started manually using the MATE3. The inverter cannot be programmed for automatic battery equalization. This is a safety measure.

Equalization is normally performed only on flooded lead-acid batteries. The schedule for equalization varies with battery use and type, but it is usually performed every few months. If performed correctly, this process can extend battery life by a considerable amount.

Equalization is not normally performed on nickel-technology batteries or any sort of sealed battery.



CAUTION: Battery Damage

- Do not equalize OutBack EnergyCell batteries of any model.
- Do not equalize any sealed battery types (VRLA, AGM, Gel, or other) unless approved by the manufacturer. Some batteries may suffer severe damage from equalization.
- Contact the battery manufacturer for recommendations on equalization voltage, duration, schedule, and/or advisability. Always follow manufacturer recommendations for equalization.

Battery Temperature Compensation

Temperature compensation is a process that corrects for changes in battery performance caused by varying temperature.

When batteries are cooler than room temperature (77°F or 25°C), the electrolyte reaction slows down. This causes the battery to accept charging energy less readily. Delivering the usual amount of energy that would fully recharge a battery at room temperature will undercharge a cool one.

Conversely, when batteries are warmer than room temperature, the electrolyte reaction is somewhat hyper-reactive. It takes less energy than usual to charge them. Delivering the full (room-temperature) amount of energy would overcharge them and can be hard on them over time.

The Radian inverter, when equipped with the Remote Temperature Sensor (RTS) will compensate for changes in temperature. The RTS is attached to a single battery near the center of the bank, to achieve a representative temperature. If installed in a multiple-inverter system, only a single RTS is necessary. It must be plugged into the master inverter and will control the charging of all slaves and all charge controllers. (See the *Radian Series Inverter/Charger Installation Manual* for locating the RTS port.) This process is automatic.

When charging, an inverter system with an RTS will increase or decrease the charge voltage by 5 mV per degree Celsius per battery cell. This setting affects the Absorption, Float, and Equalization set points. The Sell Voltage and Re-Float Voltage set points are not temperature compensated. The Equalization set points are not compensated in OutBack charge controllers.

- In a 48 Vdc system (24 cells, 2 volts each), this means 0.12 volts per degree Celsius above or below 25°C. Maximum compensation is ± 2.4 Vdc.

EXAMPLES:

- A 48 Vdc system with batteries at 15°C will compensate its charging to 1.2 Vdc **higher** than the set points.
- A 48 Vdc system with batteries at 40°C will compensate its charging to 1.8 Vdc **lower** than the set points.

Some batteries require different amounts of compensation. The OutBack FLEXmax Extreme charge controller has an adjustable rate of compensation ("slope") and is not limited to 5 mV. The FLEXmax Extreme can be networked with the Radian with the HUB Communications Manager. If this is done, the Radian can import the slope setting from the charge controller. See the FLEXmax Extreme manual for more information.

Temperature compensation only applies to the battery charging function. Other set points in the inverter, such as the AUX functions, are not compensated for temperature.

Multiple-Inverter Installations (Stacking)

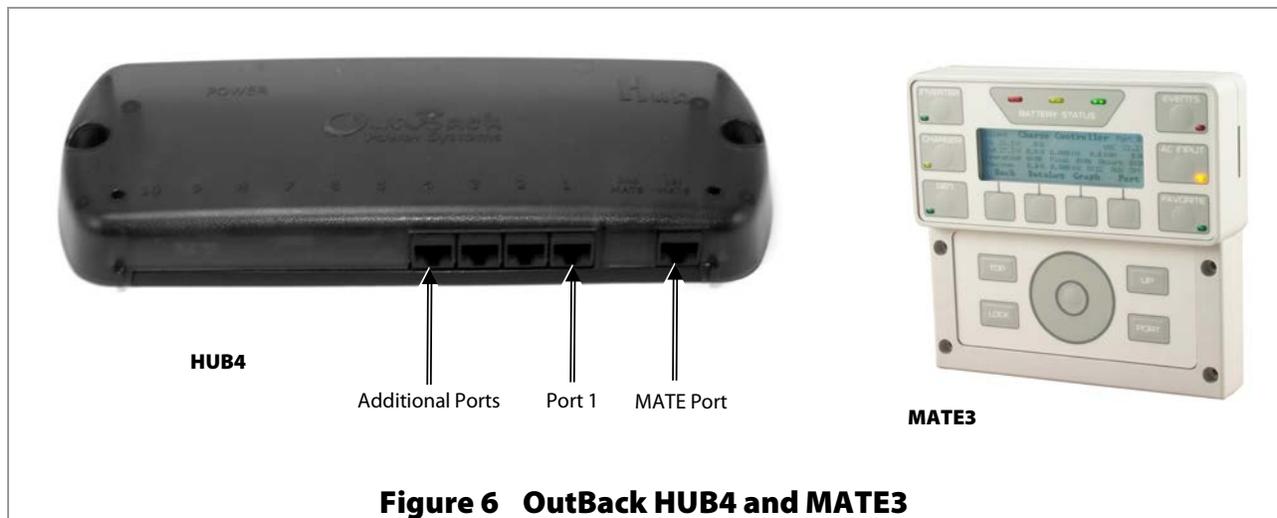
Multiple inverters in a single system can support larger loads than a single inverter can handle. Installing inverters in this configuration is called “stacking”. Stacking inverters refers to how they are wired within the system and then programmed to coordinate activity. Stacking allows all units to work together as one system.

The GS8048 inverter can be stacked in parallel to increase capacity. Up to ten units can be stacked to operate in a single system.

Stacking requires an OutBack HUB Communications Manager, as well as a MATE3 system display.

- A system of four or fewer units may use the HUB4.
- Systems of up to ten units require the HUB10 or HUB10.3.
- All interconnections between the products are made using CAT5 non-crossover cable. (See the *Radian Series Inverter/Charger Installation Manual* for more stacking instructions.)

Each inverter needs to be assigned a status — “master” or “slave”. The master is the primary and most heavily used unit. Slave inverters provide assistance when the loads are more than the master can handle alone. Programming involves using the MATE3 to assign a status and stacking value to the inverter on each port. See the MATE3 and HUB manuals for programming instructions.



IMPORTANT:

- The master inverter must always be connected to port 1 on the HUB. Connecting it elsewhere, or connecting a slave to port 1, will result in backfeed or output voltage errors which will shut the system down immediately.
- Installing multiple inverters without stacking them (or stacking them incorrectly) will result in similar errors and shutdown.
- Although stacking allows greater capacity, the loads, wiring, and overcurrent devices must still be sized appropriately. Additional terminations and bus bars may be required. Overloading may cause circuit breakers to open or the inverters to shut down.

In parallel stacking, two or more inverters are stacked to create a single, common 120/240 Vac bus.

- The master provides the primary output. The slaves are connected to the same output and assist the master.
- The slave inverters can be programmed to activate on demand, reducing idle-power consumption. They will remain off until the loads exceed a certain threshold.
- A two-inverter system can continuously power 16 kVA of loads.
- Up to ten inverters may be installed in a parallel arrangement.

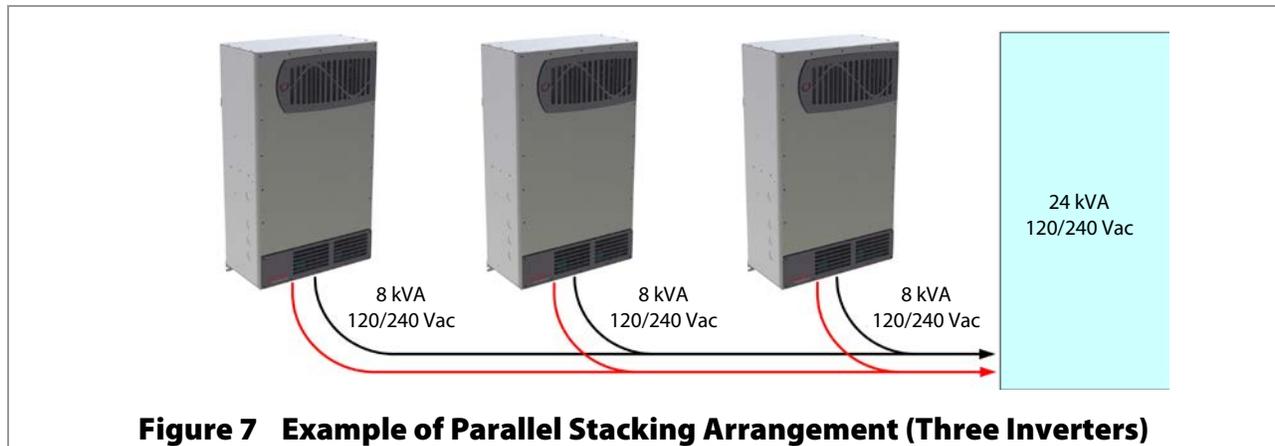


Figure 7 Example of Parallel Stacking Arrangement (Three Inverters)

Power Save Levels

Each inverter consumes approximately 30 watts of idle power while it remains on, even if it is not actively inverting or charging. The Power Save function allows the option to put part of a parallel system into a quiescent state known as Silent mode. This mode minimizes the idle consumption. The inverters will come on again when the loads require power. (The term “Silent” is also used in an unrelated context during battery charging. See page 22.)

- The GS8048 has two modules. The modules are controlled individually. The Power Save function will activate one module at a time, making an additional 4 kW of power available for every load increase of approximately 2.5 kW. Additional load increments of approximately 2.5 kW will activate additional modules.
- When the load decreases to a lesser wattage (as detected by the master), the modules deactivate and return to Silent mode.
- The first module in the master does not enter Silent mode. It remains active unless specifically turned off.
- The order in which additional modules activate (or return to Silent mode) is controlled by programming in the MATE3. The inverters are given a “rank”, or level number. Lower rank numbers activate when lesser loads are applied. Higher ranks only activate when the load increases to a high level.



IMPORTANT:

It is highly recommended to use the MATE3 Configuration Wizard to set up this function. It is essential to set the slave Power Save Levels in sequential order. Failure to set them up correctly will cause erratic system behavior. The Configuration Wizard automatically programs the correct priorities. (See the *MATE3 Owner's Manual*.)

Operation

If it is necessary to set these items manually without the Configuration Wizard:

In the MATE3 system display, the **Inverter Stacking** screen contains two **Power Save Level** menu items. These are **Master** and **Slave**. Both items have a settable range of values. (See the MATE3 manual for more information.)

- The first item, **Master Power Save Level**, must only be used when port P01 is selected with the <PORT> navigation key. This should be the master inverter. Although the item is still visible when other (slave) ports are available, it should not be programmed when other ports are selected. The range of rank numbers is 0 to 31. The default value is 0. The master is normally left at this value.
- The second item, **Slave Power Save Level**, must only be used when ports other than P01 are selected. Although the item is still visible when the P01 (master) port is selected, it should not be programmed for P01. The range of rank numbers is 1 to 31. The default value for all ports is 1.
- The ranks are prioritized so that lower-numbered ranks turn on sooner and higher ranks turn on later. The lowest-ranked unit will not go silent and will remain on unless ordered otherwise. The lowest-ranked unit is expected to be the master. The priorities are the same across both screens; thus, if P01 (master) is set at 0 and P02 (slave) is set at 1, the slave will turn on later. Since the **Master** item is the only one that goes to 0, it is easy to ensure that all other units besides the master go silent.



IMPORTANT:

Set the master rank at 0 and arrange the slave ranks in order (1, 2, 3, 4, etc.). Another order may defeat the purpose of Power Save mode. Leaving the master at 0 makes 4 kW of power available from the master; the other inverters should not be active. If a slave is ranked lower (prioritized higher) than the master, that slave will not go silent.

NOTE: Disregard this rule if the installation requires some of the slaves to be continuously active.



IMPORTANT:

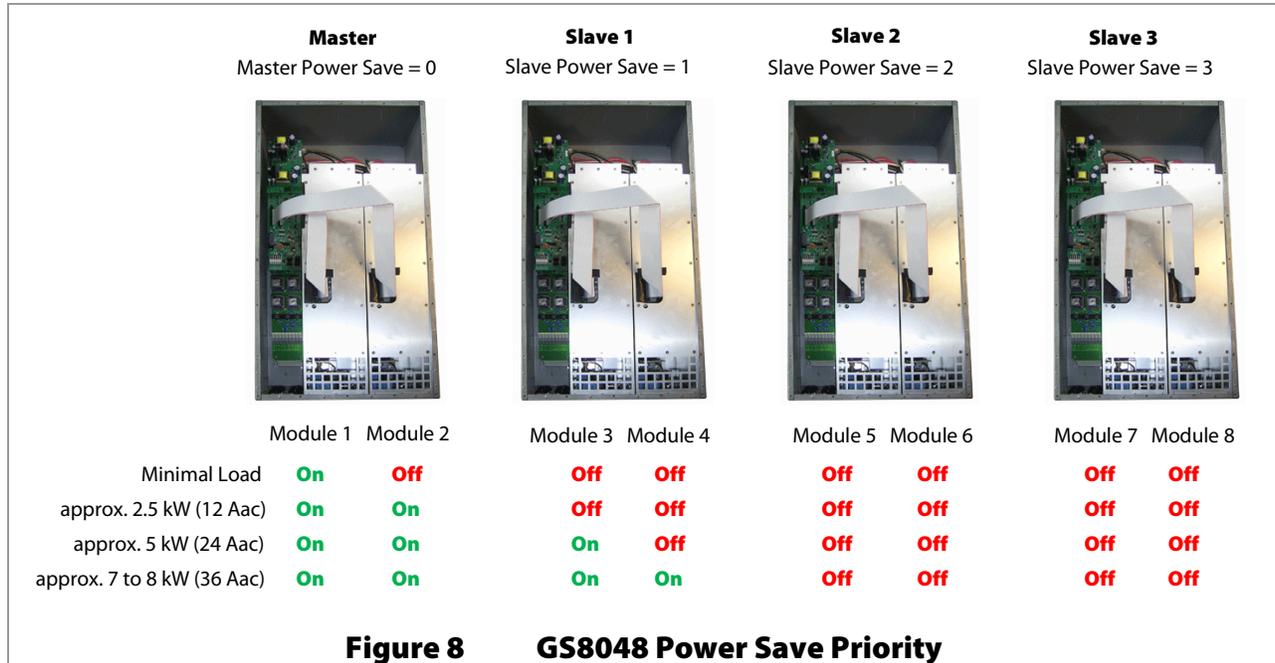
Do not give slave inverters the same rank numbers. If, for example, multiple slaves were all ranked at 1, they would all come on at the same time. Once they came on, the divided load would cause the master to detect a minimal load on its output, so it would shut off all the slaves, at which point the master would read a high load again. This could quickly escalate into a rapid on/off cycling of inverters and could cause long-term system problems.

Figure 8 shows a system of four GS8048A inverters (the master and three slaves) in a parallel system with a common load bus. The labels at the top indicate the ranking of each unit. The notations at the bottom show how the units are activated in sequence as loads of approximately 2.5 kW are applied.

- The first line shows little load and only the first module in Master is activated.
- The second line shows load beginning to be applied. The second module in Master is activated.
- The third line shows increasing load. The first module in Slave 1 is activated.
- The fourth line shows even higher load. Slave 1 is completely activated.

In general, roughly 5 kW of loads are applied to fully activate an additional slave inverter.

- In the example shown in Figure 8, an 8-kW load has been applied, fully activating the first slave.
- In this example, loads of approximately 17 to 18 kW would be needed to turn on all inverters.



Forcing Specific Slaves to be Active:

It is possible to raise the priority of a slave and force it to activate. This is done by setting the master rank higher than that slave. However, the **Master Power Save Level** scale is not the same as the **Slave** level. **Slave** level settings apply to the whole inverter. **Master** level settings are applied per module.

This means that increasing the master by one rank will only turn on one additional module. To completely turn on a slave inverter, the master must be increased two ranks. See the next page.

In Table 2, instead of loads, the number on the far left of each line shows the master increased by one rank. (This example is otherwise the same as Figure 8.)

The last line of the table shows the master increased to 3, which is the same as the rank of the highest slave. However, this only activates the first of the three slaves. The master would need to be set to rank 7 to activate all slaves.

Table 2 Changing Master Power Save Levels (GS8048)

Master			Slave 1			Slave 2			Slave 3		
Power Save	Module 1	Module 2	Power Save	Module 3	Module 4	Power Save	Module 5	Module 6	Power Save	Module 7	Module 8
0	On	Off	1	Off	Off	2	Off	Off	3	Off	Off
1	On	On	1	Off	Off	2	Off	Off	3	Off	Off
2	On	On	1	On	Off	2	Off	Off	3	Off	Off
3	On	On	1	On	On	2	Off	Off	3	Off	Off

Auxiliary Terminals

The Radian inverter has two sets of terminals which can respond to different criteria and control many functions. The 12V AUX terminals provide a 12 Vdc output that can deliver up to 0.7 Adc to control external loads. The RELAY AUX terminals are “dry” relay contacts with no voltage. Each set of terminals has its own set of programmed criteria. Each has identical options available. (When the options described below refer generically to the “AUX output”, it can mean either set of terminals.)

Each AUX output has three states available: continuous **Off**, continuous **On**, and **Auto**, which allows that output to be activated using the automatic auxiliary functions. (All functions on both sets of terminals are defaulted to **Off**.) These functions are based in the Radian inverter and accessed using the MATE3. The MATE3 and other devices also have programming, such as AGS, that can control the AUX outputs. To avoid conflicts, the output should be turned **Off** when the AGS function is active. (See page 33.)

For the Radian automatic functions, typical applications include signaling a generator to start, sending a fault alarm signal, or running a small fan to ventilate the batteries. See the *Radian Series Inverter/Charger Installation Manual* for more information on hooking up each set of terminals. See the *MATE3 Owner’s Manual* for instructions on programming each function.

The AUX terminals have a series of set points which are used by various functions. Both sets of terminals have the same options available, but they are programmed independently. Not all set points are used by all functions. Each AUX mode description below will detail the set points that are used for that mode.

- ~ Low DC voltage settings
- ~ High DC voltage settings
- ~ On delay settings, in increments of 0.1 minutes
- ~ Off delay settings, in increments of 0.1 minutes

None of these settings are compensated for temperature. The compensation function is only used for inverter battery charging.

There are nine functions, each geared toward a different application. The first item on this list may not be the default function displayed in either menu.

- **Load Shed** can perform load management. It is intended to turn off designated loads during low battery periods to conserve remaining battery power.
 - ~ When battery voltage rises above a settable high voltage level, the AUX output is activated after a settable delay. The AUX output is used to energize a larger external relay (normally open) which is connected to non-vital loads. The AUX output will be deactivated once the battery voltage falls below a low voltage setting for a settable delay period.
 - ~ **Load Shed** will also turn off when the inverter enters a high-temperature condition or when the AC output voltage drops below a specific AC voltage for more than 3 seconds. This voltage limit is 30 volts below the setting of the inverter’s output voltage. For the Radian’s default output voltage of 240 Vac, the limit is 210 Vac. (See Table 12 beginning on page 47.) The limit is not otherwise settable.
 - ~ **Load Shed** will also turn off if the input current exceeds the **Input AC Limit** setting while the inverter is using an AC source.
 - ~ Settable parameters include:
 - Low and high DC voltage
 - On and off delay

- Gen Alert is used as a controller for an AC generator with a remote start feature, although it has limited functionality. (The generator recharges batteries using the inverter's battery charger.)
 - ~ When the battery voltage falls to a low set point for a settable delay, the AUX output is activated. The AUX output is used to energize an external relay. The relay activates the remote start/stop circuit on the generator. (This is illustrated in the *Radian Series Inverter/Charger Installation Manual*.) The AUX output is deactivated once the battery voltage rises to a high voltage setting for a settable delay period.
 - ~ Settable parameters include:
 - Low and high DC voltage
 - On and off delay
 - ~ Gen Alert control logic is located in the inverter. It has the advantage of functioning when the system display is removed. However, it may not completely charge the batteries and does not have all the advantages of the Advanced Generator Start (AGS) feature that is found in the system display. For many users, the AGS feature may prove more useful than Gen Alert. Gen Alert, however, could be used as a literal "Generator Alert", a signal to the user to manually start a generator.
- **Fault** activates the AUX output when the inverter shuts down due to an error condition (see page 40). It can activate a light or alarm to show that the inverter has failed. With the appropriate devices, it could send an alarm signal through a radio, pager, or telephone dialer.
 - ~ This function does not have settable parameters.
- **Vent Fan** activates the AUX output in response to a high DC (battery) voltage set point. It can run a small fan to ventilate the battery compartment to eliminate gases that result from battery charging. (This is illustrated in the *Radian Series Inverter/Charger Installation Manual*.) When the voltage falls below this set point for a settable delay period, the AUX output turns off.
 - ~ Settable parameters include:
 - High DC voltage
 - Off delay
- **Cool Fan** activates the AUX output when the inverter reaches a high internal temperature. It is intended to trigger a small external fan for additional cooling. See the Warning Troubleshooting table on page 41 for a description of the fan criteria.
 - ~ This function does not have settable parameters.
- **DC Divert** activates the AUX output to divert (or "dump") excess renewable energy to a DC load, such as a resistor, a heater, or a fuel cell. This prevents overcharging of the batteries. This function can serve as rough charge regulation for an external charging source.
 - ~ When battery voltage rises above a settable high voltage level, the AUX output is activated after a settable delay. The AUX output controls a larger, external relay. When energized, the relay allows current to flow from the batteries to a dedicated DC load. (This is illustrated in the *Radian Series Inverter/Charger Installation Manual*.) The resistor or load must be sized to dissipate all of the energy from the renewable source if necessary. Diversion will turn off following a delay when a low DC voltage setting is reached.
 - ~ Settable parameters include:
 - Low and high DC voltage
 - On and off delay
- **GT Limits** activates the AUX output as an alert that the utility grid does not meet Grid Interface Protection parameters for the grid-interactive function (see page 11). It can activate a light or alarm to show that the grid-interactive function has shut down and that there may be problems with the grid. The AUX output will cycle on and off if grid parameters are met and the reconnection timer is counting down.

Operation

- ~ This function does not have settable parameters other than those of the **Grid Interface Protection** menu (see Table 12 beginning on page 47).
- **Source Status** activates the AUX output whenever the inverter accepts an AC source. It can activate a light or alarm to show that the utility grid is present or that a generator has started. Alternately, it could be used to show that the source has disconnected.
 - ~ This function does not have settable parameters.
- **AC Divert** activates the AUX output to divert (or “dump”) excess renewable energy to an AC load, usually an AC device powered by the inverter itself. This prevents overcharging of the batteries. This function can serve as rough charge regulation for an external charging source.
 - ~ When battery voltage rises above a settable high voltage level, the AUX output is activated after a settable delay. The AUX output controls a larger relay, which allows current to flow from the batteries to a dedicated AC load when energized. Diversion is usually used to regulate battery charging. The AC device is usually wired to the output or load panel and must be left on. It must be sized to dissipate all of the energy from the renewable source if necessary. Diversion will turn off following a delay when a low DC voltage setting is reached.
 - ~ The AUX output will automatically turn on to run the loads if the inverter accepts an AC source.
 - ~ Settable parameters include:
 - Low and high DC voltage
 - On and off delay
 - ~ During variable conditions, the AUX output is triggered no more than once per minute (if voltage conditions are still met). This prevents rapid nuisance cycling of the AC load in the event of rapidly changing conditions.
 - ~ AC Divert should not be used as the sole source of battery regulation. If the inverter shuts down or fails, the batteries could suffer severe damage. This function should be supported by an external regulator.
 - If the inverter shuts down due to overload, the AUX output will also shut down. If the inverter load exceeds 30 Aac, the AUX output will turn off to prevent an overload condition.
 - If either the FETs or the capacitors (see page 41) become too hot, the AUX will turn off due to diminished inverter wattage capacity.

Note that even if every function in the menu is set to **Off**, the AUX output may still be triggered by an external function such as AGS (see page 33).

System Display-Based Functions

A system display such as the OutBack MATE3 can provide functions not available in the Radian inverter. These functions are briefly described to provide a better idea of overall system capabilities. See the *MATE3 System Display and Controller Owner's Manual* for more information on all functions.

The system display must be present for these functions to operate. If a function is set up (or already in operation) but the system display is removed, the function will not operate.

Advanced Generator Start (AGS)

As noted under the **Gen Alert** feature (see page 31), the system is capable of starting a generator. **Gen Alert** simply starts and stops the generator based on battery voltage. For more advanced control, the inverter system can use the Advanced Generator Start (AGS) function, which runs through the entire three-stage charging cycle. It can start according to battery voltage, inverter load, time of day, and other criteria. AGS has a quiet time application which restricts the generator from starting at inconvenient times. Additional applications are also available.



IMPORTANT:

This function is higher-priority than **Gen Alert** or any other inverter function. It can activate the 12V AUX or RELAY AUX even if the inverter has disabled them. When AGS is in use, **Gen Alert** and other AUX functions should be disabled on that AUX output to avoid programming conflicts.

High Battery Transfer (HBX)

In HBX mode, the system is connected to an AC source such as the utility grid; however, it will use battery power as the first priority. The AC source is locked out until needed.

The system runs on battery-supplied power for as long as the batteries can be sustained. It is expected that the system will be supplied by renewable sources such as PV power. When the batteries become depleted, the system reconnects to the AC source to operate the loads.

The batteries may be recharged during this time using the renewable source. When the batteries are recharged to a high enough voltage, the system transfers back to the batteries as the primary source (hence the name High Battery Transfer).

NOTE: The inverter's charger should be off. High Battery Transfer mode is intended to use only the renewable source for charging batteries. Renewable charging is the motivator for returning to battery (and renewable) operation. Use of the inverter's charger interferes with this priority. It also may not charge effectively.

This mode has similar priorities to the **Mini Grid** input mode contained within the Radian inverter. Either mode may achieve similar results, but they are not identical. See page 14 for the advantages and disadvantages of each mode.

Because this is a system-wide function and not a function of individual inverters, the control logic for High Battery Transfer is based in the MATE3 system display.



Troubleshooting

Basic Troubleshooting

Table 3 is organized in order of common symptoms, with a series of possible causes. Each possible cause also shows possible troubleshooting remedies, including system display checks where appropriate.

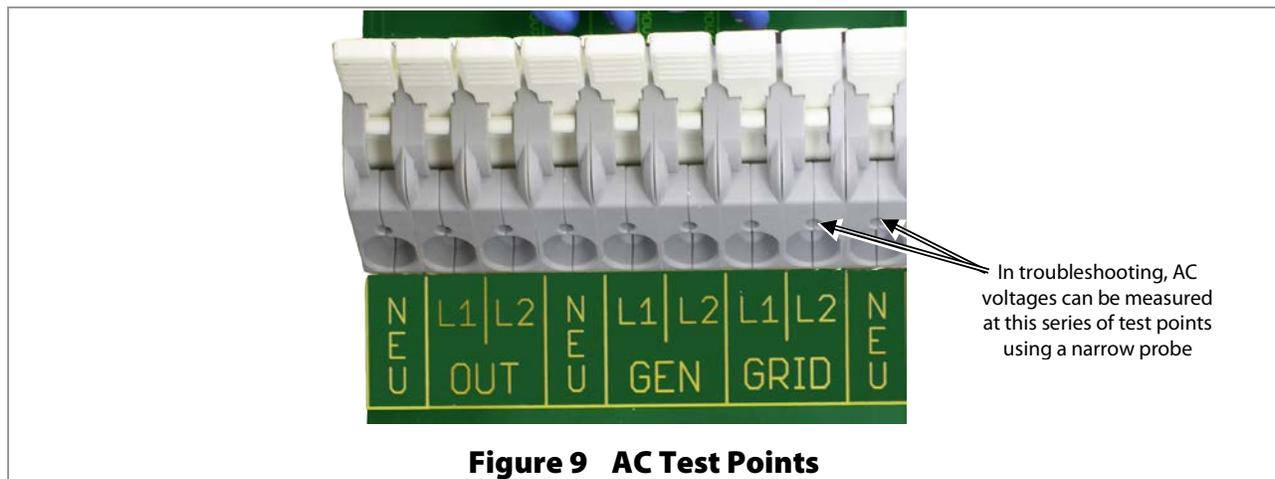


Figure 9 AC Test Points

Table 3 Troubleshooting		
Symptom	Possible Cause	Possible Remedy
No AC output (will not invert).	No DC Voltage.	Use a DC voltmeter to check the voltage directly on the DC terminals. If not present, the problem is external. If present, the inverter could be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
	Jumper J3 missing.	See the Installation Manual for the location of J3. Confirm the jumper is present. If missing, replace the jumper. Or follow the Installation Manual instructions to install an external switch.
	Unit defaulted off (No MATE3 present; initial install; J3 confirmed present).	The Radian inverter is given an initial OFF command in the factory. With DC present, use narrow pliers to remove jumper J3 from its pins. Once removed, install it again. This is the equivalent of "jiggling the switch."
	Inverter set to Off .	<i>MATE3 system display only:</i> Set to On with the INVERTER hot key.
	Inverter set to Search (Search mode).	<i>MATE3 system display only:</i> If constant power is required, set to On with the INVERTER hot key. (If this setting was intentional, then no action is required.)
One or more inverters will not invert while others do (in multi-inverter system).	Unit is slave and is in Power Save mode.	<i>MATE3 system display only:</i> Check Power Save levels in the Inverter Stacking menu and test with loads. Determine if the inverter comes on at the appropriate levels. (If this setting was intentional, then no action is required.)

Troubleshooting

Table 3 Troubleshooting		
Symptom	Possible Cause	Possible Remedy
Will not connect to the AC source.	No AC input.	Check the AC voltage on the inverter's input test points. (See page 35.) If not present, the problem is external. If present, the inverter could be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
	AC input not connected on both L1 and L2.	Check the AC voltage on the inverter's input test points. (See page 35.) Both L1 and L2 must have voltage. The inverter will not accept an input from only one leg.
	AC source is not 120/240 Vac split-phase, or the AC source neutral is not connected to the inverter.	Confirm the nature of the AC source. Check the AC voltage between L1, L2, and neutral on the inverter's input test points. (See page 35.) L1-neutral and L2-neutral voltages should be 120 Vac. L1-L2 voltage should be 240 Vac. Other voltages or combinations, such as two phases of a three-phase source (208 Vac), or 240 Vac without a neutral, will not be accepted.
	Inverter's L1 output has been connected to its L2 input, or the other way around. This problem is accompanied by shifts in frequency.	Disconnect the wires from the inverter's AC input terminals or AC output terminals, or both. If the problem immediately disappears, it is an external wiring issue. The inverter's input and output terminals must remain isolated from each other.
	AC source does not meet requirements.	<i>MATE3 system display only:</i> Check the Last AC Disconnect screen (using the AC INPUT hot key and the Discon selection) for the reason for disconnection. If the unit never originally connected, check the Warning menu (using the Inverter soft key from the Home screen). Confirm source voltage and frequency.
	AC source meets requirements but is "noisy" or irregular.	<i>MATE3 system display only:</i> The Generator input mode can accept irregular AC power. Select that mode for that input.
	Inverter was manually set to disconnect from AC.	<i>MATE3 system display only:</i> Change the AC Input Control setting from Drop to Use with the AC INPUT hot key. (If this setting was intentional, then no action is required.)
	Grid use function has disconnected from AC.	<i>MATE3 system display only:</i> If activated prematurely, check both the MATE3's Grid Use Time settings and the MATE3 clock settings in the System menu. (If this setting was intentional, then no action is required.)
	High Battery Transfer (HBX) mode has disconnected from AC.	<i>MATE3 system display only:</i> Check the AC INPUT hot key screen to see if HBX mode is in use. If activated prematurely, check the settings of HBX mode. (If this setting was intentional, then no action is required.)
	Mini Grid input mode has disconnected from AC.	<i>MATE3 system display only:</i> Check the Inverter part of the Settings menu to see if Mini Grid mode is in use. If activated prematurely, check the settings of Mini Grid mode. (If this setting was intentional, then no action is required.)
Offset function has caused the inverter to disconnect from AC. (Support , Backup , UPS , and Mini Grid input modes.)	The Offset function sends excess renewable energy to the loads to augment the AC source. If more renewable energy is produced than the loads can consume, the AC source is judged unnecessary and the inverter disconnects from it. (See page 19.)	
Conflicting programming.	<i>MATE3 system display only:</i> Check to see if more than one of the following are enabled: Mini Grid , HBX, Grid Use Time. These have conflicting priorities and only one can be used at a time.	

Table 3 Troubleshooting		
Symptom	Possible Cause	Possible Remedy
Low charge rate.	Charge complete or nearly complete.	Check the DC voltage and charging stage using the MATE3, if present. Confirm with DC voltmeter.
	MATE3's DC meter reads significantly higher than actual battery voltage.	Check the DC voltage on the inverter's DC terminals. If different from the MATE3 reading, the inverter could be damaged. Otherwise, check the DC voltage on batteries with a voltmeter. If different from the reading on the inverter, this could be a DC connection problem.
	High output loads. If total loads and charge exceed the AC input setting, charge rate decreases to give priority to the loads.	Turn off some of the output loads and test the charge rate again.
	Generator input mode in use.	Radian charge rate is limited in this mode (see page 9.)
Will not charge.	No AC input.	See "Will not connect to AC" category.
	Charger set to Off .	<i>MATE3 system display only:</i> Check the Charger Mode screen with the CHARGER hot key and set to On or Auto . (If this setting was intentional, then no action is required.)
Unusual voltage on hot or neutral output line.	System neutral and ground may not be bonded.	Test L1 OUT, L2 OUT, and NEU test points with AC voltmeter. (See page 35.) These measurements should give full voltage. Test NEU and ground connections. This measurement should read zero volts. Any other result means neutral and ground are not bonded correctly. If this is the case, usually the hot line reads 60-75 Vac and the neutral reads 45-60 Vac, with respect to ground.
Unusual and different voltages on AC hot input lines.	Input neutral is not connected correctly. The inverter also may not connect to the AC source.	Test L1 input and NEU connections with AC voltmeter. Test L2 input and NEU connections with AC voltmeter. (This can be on Grid or Gen input, depending where the symptoms appear.) Test L1 to L2 input. From hot to neutral should be approximately 120 Vac. L1 to L2 should be approximately 240 Vac. If the two legs are different voltages but still add up to 240 Vac, the neutral is not connected to the inverter.
Will not sell power to the utility grid.	Grid-tied function has been manually disabled.	<i>MATE3 system display only:</i> Check the Grid-Tie Enable setting in the Grid-Tie Sell menu. Confirm it is set to Y .
	Grid Tied mode not in use on the appropriate input.	<i>MATE3 system display only:</i> Check the Inverter part of the Settings menu to see if Grid Tied mode is in use. Confirm that it has been selected for the correct Radian input terminals.
	AC source does not meet requirements.	Verify grid voltage and frequency. Determine if they are within the inverter's approved limits. If not, the inverter is behaving correctly. Contact the utility company if necessary. <i>MATE3 system display only:</i> The program selections for limits are IEEE or user . They are found in the inverter's Grid-Tie Sell menu.
	Inverter priority.	<i>MATE3 system display only:</i> Check Sell Status screen using the Home screen's soft keys. The inverter may be behaving correctly.
	High output loads will consume power before it is returned to the utility grid.	Turn off some output loads and observe the sell function.

Troubleshooting

Table 3 Troubleshooting		
Symptom	Possible Cause	Possible Remedy
Reduced power sold to the utility grid.	AC source voltage is driven high when the inverter sells large amounts of power.	When the inverter senses a rise in grid voltage while selling, it reduces the sell current, to avoid forcing the voltage to unacceptable levels. Check AC input voltage while selling. The inverter may be behaving correctly.
Loads drop out or crash during transfer.	Erratic AC source voltage.	Check AC voltage on the inverter's input test points. (See page 35.) If not consistent, the problem is external. <i>MATE3 system display only:</i> AC source voltage may have dipped or hovered at a low enough point to crash a sensitive load before the inverter could take over. This can happen if the inverter's Grid AC Input Voltage Limits or Gen AC Input Voltage Limits were turned down to accommodate a problematic AC source. To make the inverter respond sooner, raise the lower limit setting in the appropriate menu. (If this setting was intentional, then no action is required.)
	Inverter set to Search (Search mode).	The unit will take a moment to come out of Search mode after transferring. <i>MATE3 system display only:</i> If constant power is required, set to ON with the INVERTER hot key. (If this setting was intentional, then no action is required.)
	Loads sensitive to inverter's transfer time. UPS mode not in use on the appropriate input.	<i>MATE3 system display only:</i> Most of the inverter's input modes feature a small but noticeable response time during transfer. Certain loads (such as highly sensitive computers) may not respond well. The UPS input mode has a faster response time. Select this mode for the appropriate input. (See page 12.)
	Loads too large.	The unit can transfer more power than it can invert. If loads are oversized, the unit will falter or crash when switching to batteries. Reduce the size of the loads.
	Undersized battery cables.	Battery cables smaller than recommended will cause a significant voltage drop when switching to batteries, acting like either an overload or a low-battery condition. Size all cables correctly.
Unit reads AC input, even though no source is present.	Internal transfer relay may be damaged.	Disconnect AC input wires and turn inverter on. Test the AC input and neutral test points with an AC voltmeter. (See page 35.) If voltage appears there, the transfer relay may be jammed. Contact OutBack Technical Support (see inside front cover of this manual). This problem is not common. If this occurs, it will likely occur on only the Grid or Gen input — not both.
Inverter clicks repeatedly. AC output voltage rises or drops to unusual levels with every click.	Inverter's output has been connected to its input. Voltage shifts are the result of trying to match its own voltage.	Disconnect the wires from the inverter's AC input or AC output terminals, or both. If the problem immediately disappears, it is an external wiring issue. The inverter's AC HOT IN and AC HOT OUT must remain isolated from each other.
	Low AC input voltage. Can be caused by weak AC source, or by faulty input connection.	Test AC hot and neutral input test points with an AC voltmeter. (See page 35.) If low or fluctuating, this is an external problem.
	A generator is connected to the input terminals while the unit is in the Grid Tied input mode.	The inverter is not intended to sell power to a generator. The selling activity will drive the generator voltage up to the disconnection point. It will then reconnect to the generator and try again. Change input modes, or move the generator to an input with a different mode selected.

Table 3 Troubleshooting

Symptom	Possible Cause	Possible Remedy
Inverter hums loudly. System display may show messages for high battery voltage, low battery voltage, or backfeed error.	Inverter output is being fed with an external AC source that is out of phase.	Disconnect AC output wires. Turn the inverter off and then on. If the problem clears, reconnect the AC output wires. If the problem recurs when reconnected, an external AC source is connected to the output.
	Inverter has been incorrectly stacked with another unit on the same output. All units come defaulted as master.	Check HUB ports and make certain the master inverter is plugged into port 1. <i>MATE3 system display only:</i> Check stacking settings in the Inverter Stacking menu. Only one master is allowed per system.
Generator, external fan, etc. fails to start when triggered by AUX output.	AUX output is not connected.	Test the generator or device to confirm functionality. Test the appropriate AUX terminals with a DVM. (If the RELAY AUX terminals are in use, test for continuity. If the 12V AUX terminals are in use, test for 12 Vdc.) If the proper results are present when the menu indicates the function is On (and the device still does not work), then there is an external connection problem. If the proper results are not present with the function On , the AUX circuit may be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
	Wrong AUX terminals have been programmed.	<i>MATE3 system display only:</i> Confirm that the AUX menu that was programmed matches the terminals that are in use. The Auxiliary Output menu programs the 12V AUX terminals. The Auxiliary Relay menu programs the RELAY AUX terminals.
	Wrong AUX terminals are in use.	If generator or external device requires 12 Vdc, confirm the 12V AUX terminals have been connected. The RELAY AUX terminals do not provide voltage.
Automatic Generator Start fails to trigger when conditions are met (or starts when conditions are not met).	<i>MATE3 system display only:</i> AGS function does not work if a valid input is present.	Check both inputs for a second AC source (utility grid). If the inverter detects an acceptable AC source, it will not allow AGS. This is true even if it is internally disconnected from the source (due to HBX mode, Mini Grid mode, or similar programming).
	MATE3 system display is not present.	AGS programming is located in MATE3 and cannot function if it is removed.

Module Select

The GS8048 uses two high-frequency H-Bridge FET modules. The dual design allows half the inverter to shut down for lower idle consumption. Normally this is automatically selected. If one module fails or if troubleshooting is otherwise needed, the module selection can be performed manually. The GS8048 can be directed to use a single, specified module (left or right), or it can be directed to turn on both modules continuously. This procedure should only be performed if directed by OutBack Technical Support (see inside the front cover of this manual).

The Module Select menu options are displayed as part of the table of defaults, which begins on page 47.

Error Messages

An Error is caused by a critical fault. In most cases when this occurs, the unit will shut down. The MATE3 system display will show an Event and a specific Error message. This screen is viewed using the MATE3 Home screen's soft keys. (See the MATE3 manual for more instructions.) One or more messages will display **Y** (yes). If a message says **N** (no), it is not the cause of the error.

NOTE: The Radian series has no external indicators and requires a system display to identify an Error. It is possible to clear an error by resetting the inverter. The inverter must be turned off, and then on, to reset it. Other possible steps are shown below (although it is still necessary to reset the inverter).

Table 4 Error Troubleshooting

Message	Causes	Possible Remedy
Low Output Voltage	Inverter's AC regulation cannot be maintained under high load conditions.	Check loads and measure current draw. Remove loads as necessary.
AC Output Shorted	Inverter exceeded its maximum surge current due to severe overload.	Check the loads and wiring. This issue is usually the result of a wiring problem (a short), as opposed to a poorly-sized load.
AC Output Backfeed	Usually indicates another AC power source (out of phase with the inverter) was connected to the unit's AC output.	Disconnect the AC OUT wires from the inverter. Check the wires (not the inverter) with an AC voltmeter. If an AC source is present, shut it off.
Stacking Error	Programming problem among stacked units. (Often occurs if there is no master.) Can also occur when AC Output Backfeed occurs.	Check stacking programming and designation of master. (See page 26.) Check for output backfeed from an external source. Disconnect output if necessary.
Low Battery V	DC voltage is below low battery cut-out set point, usually due to battery discharge. This error can be triggered by other causes. It can appear along with Low Output Voltage , AC Output Shorted , or AC Output Backfeed errors.	If this error accompanies other errors, treat those conditions as appropriate. If it occurs by itself: Recharge the batteries. The error will clear automatically if an external AC source is connected and the inverter's charger comes on.
High Battery V	DC voltage exceeded acceptable level (specified on page 15).	Check the charging source. This problem is usually the result of external charging. This error will clear automatically if conditions are removed.
Over Temperature	Inverter has exceeded its maximum allowed operating temperature.	Allow the inverter to remain off for a short time to reduce the temperature, or add external cooling.
Phase Loss	A slave was ordered to transfer to AC by the master, but no AC is present. The unit continues inverting. This is the only "Error" that is not accompanied by a shutdown.	Check the AC voltage on the inverter input terminals. If AC voltage is not present, problem is external. If AC voltage is present, the unit may be damaged. Contact OutBack Technical Support (see inside front cover of this manual).

Warning Messages

A Warning message is caused by a non-critical fault. When this occurs, the unit will not shut down, but the MATE3 system display will show an Event and a specific Warning message. This screen is viewed using the MATE3 Home screen's soft keys. (See the MATE3 manual for more instructions.) One or more messages will display **Y** (yes). If a message says **N** (no), it is not the cause of the warning.

NOTE: The Radian series has no external indicators and requires the MATE3 system display to identify a Warning.

Some warnings can become errors if left unattended. Frequency and voltage warnings are meant to warn of a problematic AC source. Often the inverter will disconnect from the source. This will occur if the condition lasts longer than the inverter's transfer delay settings. If the inverter disconnects, the warning will display as long as the source is present, accompanied by a Disconnect message. (See next page.)

Warning screens can only display warnings; they cannot clear them. The way to correct the fault may be obvious from the message.

Table 5 Warning Troubleshooting

Message	Definition	Possible Remedy
<i>AC Freq Too High</i>	The AC source is above the upper acceptable frequency limit (66 Hz) and prevents connection.	Check the AC source. If it is a generator, reduce its speed.
<i>AC Freq Too Low</i>	The AC source is below the lower acceptable frequency limit (54 Hz) and prevents connection.	Check the AC source. If it is a generator, increase its speed.
<i>Voltage Too High</i>	The AC source is above the upper acceptable voltage limit on either L1 or L2 (132 Vac default setting) and prevents connection.	Check the AC source. The inverter's acceptance range is adjustable. NOTE: Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<i>Voltage Too Low</i>	The AC source is below the lower acceptable voltage limit on either L1 or L2 (108 Vac default setting) and prevents connection.	Check the AC source. Check the AC wiring. The inverter's acceptance range is adjustable. NOTE: Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<i>Input Amps > Max</i>	AC loads are drawing more current from the AC source than allowed by the input setting.	Check the loads. Oversized loads can open circuit breakers. If they exceed the inverter's transfer relay size, the relay can be damaged. This issue is usually the result of a poorly-sized load, as opposed to a wiring problem.
<i>Temp Sensor Bad</i>	An internal inverter temperature sensor may be malfunctioning. One of the three internal sensor meters may give an unusual reading.	In the MATE3, the three readings are labeled Transformer , Output FETs , and Capacitors . These values are given in degrees Celsius. See next page.
<i>Comm Fault</i>	The inverter has suffered an internal communication failure.	Unit still functions, but may require repair. Contact OutBack Technical Support (see inside front cover of this manual).

Troubleshooting

Table 5 Warning Troubleshooting

Message	Definition	Possible Remedy
Fan Failure	The inverter's internal cooling fan is not operating properly. Lack of cooling may result in derated inverter output wattage.	Turn the battery disconnect off, and then on, to determine if the fan self-tests. After this test, contact OutBack Technical Support for the next step. (The next step will depend on the results of the test.) NOTE: The system can continue to operate if the inverter can be run at reasonable levels. External cooling may also be applied.
Transformer (in Temps menu)	Displays the ambient temperature around the inverter's transformer.	In the MATE3, these values are given in degrees Celsius.
Output FETs (in Temps menu)	Displays the temperature of the FETs (Field Effect Transistors) and heat sink.	If any reading does not seem to reflect the inverter's temperature or conditions, contact OutBack Technical Support (see inside front cover of this manual).
Capacitors (in Temps menu)	Displays the temperature of the inverter's ripple capacitors.	

Disconnect Messages

Disconnect messages explain the reason that the inverter rejected an AC source. The unit returns to inverting mode if turned on. This screen is viewed using the **AC INPUT** hot key on the MATE3. (See the MATE3 manual for more instructions.) One or more messages will display **Y** (yes). If a message says **N** (no), it is not the cause of the disconnection. The MATE3 system display may generate a concurrent Event and Warning message following the disconnection. (See previous page.) If the AC source is removed, the Warning will be blank, but the cause of the last disconnect will remain.

Disconnect messages only display the reason for the disconnection; they cannot correct it. It is usually the result of external conditions, not an inverter fault. If the condition is corrected, the inverter will reconnect. A few settings can be changed to accommodate problems with the AC source.

The reasons shown in the Sell Status menu for ceasing to sell power (see next page) are not the same as disconnect messages, although they may be caused by the same circumstance. A grid-interactive unit can stop selling and still remain connected to the utility grid.

Table 6 Disconnect Troubleshooting

Message	Definition	Possible Remedy
Frequency Too High	The AC source has exceeded 66 Hz.	Check AC source. If it is a generator, reduce speed.
Frequency Too Low	The AC source has dropped below 54 Hz.	Check AC source. If it is a generator, increase speed.
Voltage > Maximum	The AC source has exceeded 140 Vac (default value) on either L1 or L2.	Check AC source. The inverter's acceptance range is adjustable. NOTE: Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Voltage < Minimum	The AC source has dropped below 108 Vac (default value) on either L1 or L2.	Check AC source. The inverter's acceptance range is adjustable. NOTE: Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Backfeed	Usually indicates another AC power source (out of phase with the inverter) was connected to the unit's AC output. Can also occur if an out-of-phase AC source is connected to the inverter's AC input.	Disconnect the AC OUT wires. Check the wires (not the inverter) with an AC voltmeter. If an AC source is present, shut it off. (This is more often accompanied by an AC Output Backfeed error.) Check input source and wiring. This can be caused by a source with phase problems. It can also be caused by transferring from one AC source to another before the inverter can synchronize itself.
Phase Lock	The unit cannot remain in phase with an erratic AC source. NOTE: This is not an "Error" as defined on page 40 and is not accompanied by a shutdown.	Check AC source. This can be caused by a generator with a poorly regulated output. Some generators behave this way when running out of fuel. If necessary, set the Radian inverter to the Generator input mode. (See page 9.)
Island Detect	The unit detects something other than normal grid conditions. This is usually the result of an open AC input circuit.	Check all input circuit breakers for an open circuit. This may (rarely) happen with a generator. If necessary, set the inverter to the Generator input mode. (See page 9.)

Sell Status

Sell Status messages describe conditions relating to the inverter’s grid-interactive mode. This screen is viewed using the MATE3 Home screen’s soft keys. (See the MATE3 manual for more instructions.) One or more messages will display **Y** (yes). If a message says **N** (no), it is not the cause of the disconnect.

If the inverter has stopped selling or charging unexpectedly, this screen may identify the reason. More often these messages are used by a normally functioning inverter to identify external conditions that are preventing selling or charging. (If nothing has stopped, the messages will indicate that as well.)

The acceptable limits for AC source voltage and frequency are displayed on page 47. If the AC source exceeds these limits, the inverter will stop selling and display the appropriate code. After the source returns to the acceptable range, the screen will begin a 5-minute timer. When the timer expires, the inverter will begin selling power again.

If the AC source is unstable, it may become unacceptable before the timer expires. This may cause the timer to continually reset. It is possible for brief fluctuations to occur that are too fast to be seen on a DVM. If this happens, the appropriate message will still appear on the system display for a short time to help troubleshoot the problem.

Additionally, undersized wires or bad connections can result in local voltage problems. If a **Voltage Too Low** or **Voltage Too High** message is accompanied by voltage changes that do not appear at the main utility connection, check the wiring.

Table 7		Sell Status Messages	
Sell Status		Definition	
<i>Selling Disabled</i>		The <i>Grid-Tie Enable</i> command has been set to N (no).	
<i>Qualifying Grid</i>		All utility grid conditions are acceptable. The inverter is running a 5-minute test during which it confirms the grid quality. The timer is shown on the screen. At the end of that time, the inverter may be ready to sell.	
<i>Frequency Too Low</i>		The utility grid’s AC frequency is below the acceptable range for selling. (See page 47.)	
<i>Frequency Too High</i>		The utility grid’s AC frequency is above the acceptable range for selling. (See page 47.)	
<i>Voltage Too Low</i>		The utility grid’s AC voltage is below the acceptable range for selling. (See page 47.)	
<i>Voltage Too High</i>		The utility grid’s AC voltage is above the acceptable range for selling. (See page 47.)	
<i>Battery < Target</i>		The battery voltage is below the target voltage for that stage (Float, Selling, etc.). No excess energy is available to sell.	



Specifications

Specifications for Model GS8048

Table 8 Electrical Specifications for Model GS8048

Specification	Value
Nominal DC Input Voltage	48 Vdc
Continuous Output Power at 25°C	8000 VA
AC Output Voltage	120/240 Vac
AC Output Frequency	60 hz
Continuous AC Output Current at 25°C	33.3 Aac at 240 Vac
Waveform	True Sinewave
CEC Weighted Efficiency	90%
Total Harmonic Distortion (maximum)	< 5%
Harmonic Distortion (maximum single voltage)	< 2%
Output Voltage Regulation	± 2 %
Maximum Output Current (1 ms peak)	100 Aac at 240 Vac, 200 Aac at 120 Vac
Maximum Output Current (100 ms RMS)	70.7 Aac at 240 Vac
Overload Capability (100 ms surge)	16.97 kVA
Overload Capability (5 second)	12 kVA
Overload Capability (30 minute)	9 kVA
Idle Consumption - Invert mode, no load	30 watts
Idle Consumption - Search Mode	9.9 watts
AC Input Voltage Range (Adjustable)	(L1 or L2) 108 – 132 Vac
AC Input Frequency Range	54 – 66 Hz
AC Input Current (Maximum)	55 Aac at 240 Vac
Grid-Interactive Voltage Range (Default)	(L1 or L2) 108 – 132 Vac
Grid-Interactive Frequency Range (Default)	(L1 or L2) 59.3 – 60.5 Hz
Battery Charger Maximum AC Input	30 Aac at 240 Vac
Battery Charger Maximum DC Output	115 Adc
DC Input Voltage Range	40 – 64 Vdc
DC Input Current at Rated Power	200 Adc
Maximum DC Input Current on Surge	424.2 Adc
Auxiliary Output	0.7 Adc at 12 Vdc
Auxiliary Relay	10 A at 250 Vac or 30 Vdc

Table 9 Mechanical Specifications for Model GS8048

Specification	Value
Inverter Dimensions (H x W x L)	16" x 28" x 8.75" (40.6 cm x 71.1 cm x 22.2 cm)
Shipping Dimensions (H x W x L)	21" x 34.5" x 14.5" (53.3 cm x 87.6 cm x 36.8 cm)
Inverter Weight	125 lbs (56.8 kg)
Shipping Weight	140 lbs (64 kg)
Accessory Ports	RJ11 (batt temp) and RJ45 (remote)
Non-volatile Memory	Yes
Neutral-Ground Bond Switching	No
Chassis Type	Vented

Environmental Specifications

Table 10 Environmental Specifications for Model GS8048

Specification	Value
Rated Temperature Range (meets all specifications)	32°F to 122°F (0°C to 50°C)
Operational Temperature Range (functions, but does not necessarily meet all specifications)	-40°F to 140°F (-40°C to 60°C)
Storage Temperature Range	-40°F to 140°F (-40°C to 60°C)

Regulatory Specifications

- Canadian Electrical Code, Part I (CSA C22.2 No. 107.1-01 (R2006)
- UL 1741, 2nd Edition, Revised January 28, 2010, Static Inverter and Charge Controllers for Use in Photovoltaic Power Systems

Inverters intended for grid-interactive use in the United States and Canada must comply with the established standards of UL 1741 and IEEE 1547 and 1547.1. These standards provide regulation for acceptable output voltage ranges, acceptable output frequency, total harmonic distortion (THD) and anti-islanding performance when the inverter is exporting power to a utility source.

The OutBack grid-interactive models are tested using the procedures listed in IEEE 1547.1 to the standards listed in both UL 1741 and IEEE 1547. The following specifications have been validated through compliance testing and refer to exporting power to a simulated utility source of less than 1% voltage total harmonic distortion (THD).

- The output of the Radian series exceeds the minimum power factor of 0.85 with a typical power factor of 0.96 or better.
- The individual harmonics do not exceed the limits specified in Table 3 of IEEE 1547 Section 4.3.3. The THD of the root mean square (RMS) current is less than 5%.
- The Radian inverters cease to export power to the simulated utility source under islanding conditions specified in IEEE 1547 Section 4.4.1.
- The Radian inverters also cease to export power to the simulated utility source after the output voltage or frequency of the simulated utility source are adjusted to each of the conditions specified in IEEE 1547 Section 4.2.3 Table 1 and Section 4.2.4 Table 2 within the times specified in those tables. All Radian inverters manufactured for use in the United States and Canada are tested to comply with the table below.

Table 11 Radian Series Interconnection Response Times to Abnormal Voltages or Frequencies (per leg)

Voltage Range (AC Volts)	Frequency (Hz)	Seconds Allowed	Cycles Allowed
$V < 60.0$	60.0	0.16	9.6
$60.0 \leq V < 105.6$	60.0	2.0	120.0
$105.6 \leq V \leq 132.0$	60.0	no cessation	no cessation
$132.0 < V < 144.0$	60.0	1.0	60.0
$V \geq 144.0$	60.0	0.16	9.6
120.0	< 59.3	0.16	9.6
120.0	> 60.5	0.16	9.6

The acceptance ranges are selected using the system display. In the MATE3, the options are **IEEE** and **user**.

- The **IEEE** option allows a range of 108 – 132 Vac at 59.3 – 60.5 Hz
- The **user** option does not have a fixed voltage setting. It follows the upper and lower limit settings in the Grid AC Input Mode and Limits menu. The default is a range of 108 – 132 Vac.

Reconnection delay is 6 seconds. Sell delay is 5 minutes. These settings are not adjustable.

Firmware Revision

This manual applies to Radian series inverter/chargers with a firmware version of 001.004.xxx or higher.

Default Settings and Ranges

Table 12 GS8048 Inverter Settings

Field	Item	Default	Minimum	Maximum
INVERTER Hot Key	Inverter Mode	Off	On, Off, or Search	
CHARGER Hot Key	Charger Control	On	On or Off	
AC Input Hot Key	AC Input Mode	Use	Drop or Use	
Search	Sensitivity (see page 16 for increments)	10	0	250
	Pulse Length	8 AC cycles	4 AC cycles	20 AC cycles
	Pulse Spacing	60 AC cycles	4 AC cycles	120 AC cycles
AC Input and Current Limit	Input Priority	Grid	Grid or Gen	
	Grid Input AC Limit	50 Aac	5 Aac	55 Aac
	Gen Input AC Limit	50 Aac	5 Aac	55 Aac
	Charger AC Limit	30 Aac	0 Aac	30 Aac
Grid AC Input Mode and Limits	Input Mode	Grid Tied	Generator, Support, Grid Tied, UPS, Backup, Mini Grid	
	Voltage Limit Lower	108 Vac	70 Vac	110 Vac
	(Voltage Limit) Upper	132 Vac	125 Vac	140 Vac
	Transfer Delay	6 AC cycles	0 AC cycles	240 AC cycles
	Connect Delay	0.2 minutes	0.2 minutes	15 minutes
Gen AC Input Mode and Limits	Input Mode	Generator	Generator, Support, Grid Tied, UPS, Backup, Mini Grid	
	Voltage Limit Lower	108 Vac	70 Vac	110 Vac
	(Voltage Limit) Upper	140 Vac	125 Vac	140 Vac
	Transfer Delay	6 AC cycles	0 AC cycles	240 AC cycles
	Connect Delay	0.5 minutes	0.2 minutes	15 minutes
AC Output	Output Voltage	240 Vac	220 Vac	260 Vac
Low Battery	Cut-Out Voltage	42 Vdc	36 Vdc	48 Vdc
	Cut-In Voltage	50 Vdc	40 Vdc	56 Vdc
Battery Charger	Absorb Voltage	57.6 Vdc	52 Vdc	64 Vdc
	(Absorb) Time	1.0 hours	0.0 hours	24.0 hours
	Float Voltage	54.4 Vdc	48 Vdc	60 Vdc
	(Float) Time	1.0 hours	0.0 hours	24.0 hours
	Re-Float Voltage	50 Vdc	48 Vdc	52 Vdc
Battery Equalize	Equalize Voltage	58.4 Vdc	56 Vdc	68 Vdc
	(Equalize) Time	1.0 hours	0.0 hours	24.0 hours
Auxiliary Output	Aux Control	Off	Off, Auto or On	

Specifications

Table 12 GS8048 Inverter Settings

Field	Item	Default	Minimum	Maximum
	Aux Mode	Vent Fan	Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, IEEE, Source Status, AC Divert	
	(Load Shed) ON: Batt >	56 Vdc	40 Vdc	72 Vdc
	(Load Shed ON) Delay	30 Secs	6 Secs	1500 Secs
	(Load Shed) OFF: Batt <	56 Vdc	48 Vdc	72 Vdc
	(Load Shed OFF) Delay	18 Secs	6 Secs	1500 Secs
	(Gen Alert) ON: Batt <	44 Vdc	40 Vdc	56 Vdc
	(Gen Alert ON) Delay	30 Secs	6 Secs	1500 Secs
	(Gen Alert) OFF: Batt >	56 Vdc	48 Vdc	72 Vdc
	(Gen Alert OFF) Delay	30 Secs	6 Secs	1500 Secs
	(Vent Fan) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
	(Vent Fan) Off Delay	18 Secs	6 Secs	1500 Secs
	(DC Divert) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
	(DC Divert ON) Delay	30 Secs	6 Secs	1500 Secs
	(DC Divert) OFF: Batt <	44 Vdc	40 Vdc	56 Vdc
	(DC Divert OFF) Delay	30 Secs	6 Secs	1500 Secs
	(AC Divert) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
	(AC Divert ON) Delay	30 Secs	6 Secs	1500 Secs
(AC Divert) OFF: Batt <	44 Vdc	40 vdc	56 Vdc	
(AC Divert OFF) Delay	30 Secs	6 Secs	1500 Secs	
Auxiliary Relay	Aux Control	Off	Off, Auto or On	
	Aux Mode	Gen Alert	Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, IEEE, Source Status, AC Divert	
	(Load Shed) ON: Batt >	56 Vdc	40 Vdc	72 Vdc
	(Load Shed ON) Delay	30 Secs	6 Secs	1500 Secs
	(Load Shed) OFF: Batt <	56 Vdc	48 Vdc	72 Vdc
	(Load Shed OFF) Delay	18 Secs	6 Secs	1500 Secs
	(Gen Alert) ON: Batt <	44 Vdc	40 Vdc	56 Vdc
	(Gen Alert ON) Delay	30 Secs	6 Secs	1500 Secs
	(Gen Alert) OFF: Batt >	56 Vdc	48 Vdc	72 Vdc
	(Gen Alert OFF) Delay	30 Secs	6 Secs	1500 Secs
	(Vent Fan) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
	(Vent Fan) Off Delay	18 Secs	6 Secs	1500 Secs
	(DC Divert) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
	(DC Divert ON) Delay	30 Secs	6 Secs	1500 Secs
	(DC Divert) OFF: Batt <	44 Vdc	40 Vdc	56 Vdc
	(DC Divert OFF) Delay	30 Secs	6 Secs	1500 Secs
	(AC Divert) ON: Batt >	56 Vdc	48 Vdc	72 Vdc
(AC Divert ON) Delay	30 Secs	6 Secs	1500 Secs	
(AC Divert) OFF: Batt <	44 Vdc	40 vdc	56 Vdc	
(AC Divert OFF) Delay	30 Secs	6 Secs	1500 Secs	
Inverter Stacking	Stack Mode	Master	Master, Slave	
Power Save (in Stacking Menu)	Master Power Save Level	0	0	31
	Slave Power Save Level	1	1	31
Grid-Tie Sell	Grid-Tie Enable	Y	Y or N	
	Sell Voltage	52 Vdc	40 Vdc	60 Vdc
	Grid-Tie Window	IEEE	IEEE or user	
Calibrate	Input Voltage	0	-7	7
	Output Voltage	0	-7	7
	Battery Voltage	0	-0.8	0.8



Product Registration

The purchase of an OutBack Power Technologies product is an important investment. Registering the products will help us maintain the standard of excellence you expect from us in terms of performance, quality and reliability.

Please take a moment to register and provide us with some important information.

Registration can be done as follows:

- Go to the following web site.
<http://www.outbackpower.com/resources/warranty/>
or
- Fill out the information on this form (pages 49 and 50) and return a paper copy using a postal service to the following address:

OutBack Power Technologies

Attn: Warranty Registration
P.O. Box 3353
Arlington, WA 98223 USA

Be sure to keep a copy for your records.

SYSTEM OWNER	
Name	
Address	
City, State, Postal or Zip Code	
Country	
Telephone Number	
E-mail	
SYSTEM PURCHASE	
Product Model Number	
Product Serial Number	
Sold by	
Purchase Date	

Product Registration

INSTALLATION INFORMATION

System Install/Commission Date	
System Array Size	
System Array Nominal Voltage	
Type of PV Modules	
System Battery Bank Size (Amp-Hours)	
Brand and Model of Batteries	
Does this system include an auxiliary AC generator?	
If yes, please specify brand and model of generator	

INSTALLER INFORMATION

Contractor Number	
Installer Name	
Installer Address	
Installer City, State, Postal or Zip Code, Country	
Installer Telephone/E-mail	

Please check ALL factors affecting purchase decision:

- Grid-Interactive Capability
- Product Reputation
- Back-up Capability
- Reputation of OutBack Power Technologies
- Value
- Looks
- Other

Extended Warranty

For areas where it is a requirement of local programs, OutBack Power Technologies offers a five-year (5) extension to the standard five-year (5) Limited Warranty for the Radian Series Inverter/Charger. To request a 5-year limited warranty extension for a total effective warranty coverage period of ten (10) years, please include a payment in the amount of **\$899** USD per inverter, payable to OutBack Power Technologies, Inc. along with the Product Registration. Please submit within 90 days of the first retail sale of the inverter(s). Please indicate the quantity of each product.

Be sure to keep a copy for your records.



Warranty

5-Year Limited Warranty for Radian Products

OutBack Power Technologies, Inc. (“OutBack”) provides a five-year (5) limited warranty (“Warranty”) against defects in materials and workmanship for its Radian Series products (“Product”) if installed in fixed location applications.

The term of this Warranty begins on the Product(s) initial purchase date, or the date of receipt of the Product(s) by the end user, whichever is later. This must be indicated on the invoice, bill of sale, and/or warranty registration card submitted to OutBack. This Warranty applies to the original OutBack Product purchaser, and is transferable only if the Product remains installed in the original use location. The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- Installation or Removal;
- Alteration or Disassembly;
- Normal Wear and Tear;
- Accident or Abuse;
- Corrosion;
- Lightning;
- Repair or service provided by an unauthorized repair facility;
- Operation or installation contrary to manufacturer product instructions;
- Fire, Floods or Acts of God;
- Shipping or Transportation;
- Incidental or consequential damage caused by other components of the power system;
- Any product whose serial number has been altered, defaced or removed;
- Any other event not foreseeable by OutBack.

OutBack’s liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack’s discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

How to Arrange for Warranty Service

During the warranty period beginning on the invoice date, OutBack Power Technologies will repair or replace products covered under this limited warranty that are returned to OutBack Power Technologies' facility or to an OutBack Power Technologies authorized repair facility, or that are repaired on site by an OutBack Power Technologies authorized repair person.



IMPORTANT:

For full Warranty description, see previous page.

Contacting OutBack

To request warranty service, contact OutBack Technical Support at **+1.360.435.6030** or direct at **+1.360.618.4363** or **support@outbackpower.com**. To ensure warranty coverage, this contact must be within the effective warranty period. If service is required, the OutBack Technical Support representative will issue a Return Material Authorization (RMA) number.

Troubleshooting

In the event of a Product failure, the customer will need to work with an OutBack Technical Support representative to perform the necessary troubleshooting. This is a required step before a return can be performed. Troubleshooting requires a qualified technician to be present at the site of the Product, with a quality voltmeter that measures both DC and AC. The OutBack representative will request voltmeter readings, Product error messages, and other information. Many problems can be resolved on-site. If the customer is not willing or able to provide these readings (or is not willing or able to visit the site), and the Product is found to have no problems upon return, OutBack may choose to charge additional labor and handling fees up to \$180.00 U.S.

Return Material Authorization (RMA)

A request for an RMA number requires all of the following information:

1. Product model and serial number;
2. Proof-of-purchase in the form of a copy of the original Product purchase invoice or receipt confirming the Product model number and serial number;
3. Description of the problem; and
4. Shipping address for the repaired or replacement equipment.

Upon receiving this information, the OutBack representative can issue an RMA number.

Returning Product to OutBack

After receiving the RMA number, the customer must pack the Product(s) authorized for return, along with a copy of the original purchase invoice and warranty certificate, *in the original Product shipping container(s) or packaging providing equivalent or reasonable protection*. The RMA number must be written on the outside of the packaging where it is clearly visible.

If Product is within the warranty period, OutBack will cover pre-paid shipping with prior arrangement.

The Product(s) must be shipped back to OutBack Power Technologies in their original or equivalent packaging, to the following address:

OutBack Power Technologies

RMA # _____
17827 – 59th Avenue N.E.
Arlington, WA 98223 USA

The customer must insure the shipment, or accept the risk of loss or damage during shipment. If a shipping box is needed for return of a Product, OutBack will send a shipping box upon request.

**IMPORTANT:**

OutBack is not responsible for shipping damage caused by improperly packaged Products, the repairs this damage might require, or the costs of these repairs.

If, upon receipt of the Product, OutBack determines the Product or Product part is defective and that the defect is covered under the terms of this Warranty, OutBack will then, and only then, ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable.

If Product fails in ninety (90) or fewer days from original purchase date, OutBack will replace with a new Product. If Product fails after ninety (90) days and up to expiration of warranty, OutBack will, at its discretion, either repair and return a Product, or ship a replacement Product. OutBack will determine whether a Product is to be repaired or replaced in accordance with Product age and model. OutBack will authorize advance shipment of a replacement based on Product age and model.

In cases where an OutBack dealer or distributor replaces a Product more than ninety (90) days old with a new Product, OutBack will NOT compensate that dealer or distributor with new stock unless the exchange was authorized in advance by OutBack.

Out of Warranty

If Product is out of warranty, OutBack will repair and return Product for a fee. Alternately, if applicable, OutBack will advance-ship replacement parts for a fee upon request.

If a shipping box is needed for return of out-of-warranty Product, OutBack will send a shipping box upon request. The customer is responsible for paying shipping to OutBack.

The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.

THIS PAGE INTENTIONALLY LEFT BLANK.



Index

I

10-year Warranty	50
12V AUX	30

A

Absorption Stage	20
AC Input	16
AC Source Acceptance	17, 47
AC Test Points	35
Adding New Devices	8
AGS	33
Audience	1
AUX	1
AUX	30
AUX Functions	
Cool Fan	31
Diversion Control	31
Fault	31
GenAlert	31, 33
GT Limits	31
LoadShed	30
Source Status	32
Vent Fan	31

B

Backup	13
Battery Charging	20, 21
Battery Charging Graph	21

C

Charging	
Absorption Stage	20
Float Stage	22
Float Timer	22
New Bulk	23
None	20
Compliance Testing	46
Cool Fan	31
CSA	1, 46

D

Default Settings	47
Definitions	1
Design	15
Disconnect	43
Diversion Control	31
DVM	7, 8

E

Equalization	24
Errors	40
ETL	1, 5
Extended Warranty	50

F

Features	5
Float Stage	22
Functional Test	7
Functions	
AC Input Limit	16
AC Transfer	18
Battery Charging	21
Inverting	15
LBCO	15
Offset	19
Search	16

G

GenAlert	31, 33
Generator	9
Sizing	18
Grid Tied	11
Grid Use Timer	34
Grid-Interactive	2
GT Limits	31

H

High Battery Cut-Out	15
High Battery Transfer (HBX)	13, 33

Warranty

I

IEEE.....	2, 46
Input Modes	5, 9, 16, 19, 21
Input Priorities	16
Inverting.....	15

L

LBCO (Low Battery Cut-Out).....	15
Levels, Power Save.....	27
LoadShed.....	30

M

MATE or MATE2.....	5
Mini Grid.....	33
Minigrid	13
Modes	5
Backup	13
Generator.....	9
Grid Tied.....	11
Mini Grid.....	33
Minigrid	13
Support.....	10
UP12	

O

Offset	19
--------------	----

P

Parallel Stacking.....	27
Power Save.....	27
Powering Down	8

R

Registration.....	49
Regulatory.....	46
RELAY AUX	30
Remote System Display	2
Remote Temperature Sensor (RTS)	25
Response Times	46
RTS.....	2

S

Safety.....	1
General	2
Search	16
Sell Status	44

Settings	47
Silent	27
Source Status	32
Specifications	
Electrical.....	45
Mechanical.....	45
Environmental	46
Regulatory.....	46
Stacking	26
Parallel	27
Startup.....	7
Support	10
Symbols Used	1
System Display.....	2

T

Target	19
Temperature	41, 46
Temperature Compensation	25
Terms and Definitions	1
Test Points	35
Three-Stage Charging	21
Timers	
Absorption.....	20, 23
Equalize.....	24
Float.....	22
Transfer Relay	16, 18
Troubleshooting.....	35, 52
Disconnect Messages	43
Error Messages	40
Sell Status Messages	44
Warning Messages.....	41

U

UL2, 5, 46	
UP (Uninterruptible Power)	12
Utility Grid.....	2

V

Vent Fan Control	31
------------------------	----

W

Warnings	41
Warranty	51
10-Year	50
Contacting	52
Extended	50
Registration	49
RMA	52
Shipping	53

THIS PAGE INTENTIONALLY LEFT BLANK.



Corporate Headquarters
17825 – 59th Avenue N.E.
Suite B
Arlington, WA 98223 USA
+1.360.435.6030

European Office
Hansastrasse 8
D-91126
Schwabach, Germany
+49.9122.79889.0