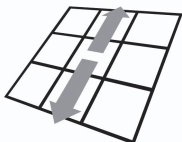




# Radian Series Inverter/Charger

**GS7048E**



**GRIDHybrid™**

DESIGNED FOR  
**FLEXgrid™**  
OPERATION

## 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, batteries, accessories, and assembled systems.

## Grid/Hybrid™

As a leader in off-grid energy systems designed around energy storage, OutBack Power is an innovator in Grid/Hybrid system technology, providing the best of both worlds: grid-tied system savings during normal or daylight operation, and off-grid independence during peak energy times or in the event of a power outage or an emergency. Grid/Hybrid systems have the intelligence, agility and interoperability to operate in multiple energy modes quickly, efficiently, and seamlessly, in order to deliver clean, continuous and reliable power to residential and commercial users while maintaining grid stability.

## Designed for FLEXgrid™ Operation

Selected OutBack Power products are designated as designed for FLEXgrid operation for their ability to support the design and operation of a Grid/Hybrid system. FLEXgrid products perform or manage functions including system communication, control, programming, charging, energy storage, and power conversion.

Only OutBack Power makes Grid/Hybrid systems and FLEXgrid products.

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# Introduction



## 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 required 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

	<b>WARNING: Hazard to Human Life</b> This type of notation indicates that the hazard could be harmful to human life.
	<b>CAUTION: Hazard to Equipment</b> This type of notation indicates that the hazard may cause damage to the equipment.
	<b>IMPORTANT:</b> 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.

## General Safety

	<b>WARNING: Limitations on Use</b> This equipment is NOT intended for use with life support equipment or other medical equipment or devices.
	<b>CAUTION: Equipment Damage</b> Only use components or accessories recommended or sold by OutBack Power Technologies or its authorized agents.

# Welcome to OutBack Power Technologies

Thank you for purchasing the OutBack Radian Series Inverter/Charger. Designed for FLEXgrid™ operation, it offers a complete power conversion system between batteries and AC power. As part of an OutBack Grid/Hybrid™ system, it provides grid-interactive service, selling excess renewable energy back to the utility. It can also provide backup power or complete off-grid service if necessary.



**Figure 1 GS7048E Inverter/Charger**

## Functions

- Designed for FLEXgrid operation as part of an OutBack Grid/Hybrid system
- Battery-to-AC inverting which delivers single-phase power (220 to 240 Vac at 50 or 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 or FLEXmax Extreme charge controllers will optimize PV power production as part of a Grid/Hybrid system.
- 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**
- 7000 watts (7 kW) continuous power at 48 Vdc
- 16.3 kVA peak surge capacity
- Stackable in parallel configuration up to ten inverters
- Stackable in three-phase configuration with three 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 IEC 62477-1
- Uses the MATE3 System Display and Controller (sold separately) for user interface as part of a Grid/Hybrid system



### 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.

**NOTE:** This product has a settable AC output range. In this book, many references to the output refer to the entire range. However, some references are made to 230 Vac or 50 Hz output. These are intended as examples only.

# 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 a Grid/Hybrid power system. The MATE3 provides the means to adjust the factory default settings to correctly match the installation where needed. It provides the means to monitor system performance and troubleshoot fault or shutdown conditions. It also has data logging and interface functions using the Internet.

Once settings are modified using a MATE3, the MATE3 can be removed from the installation. The settings are stored in the nonvolatile 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 002.010.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 32. 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**

It is necessary to remove the inverter cover 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.



### **IMPORTANT:**

Prior to programming (see step 5 below), verify the operating frequency of the utility or another AC source. This is necessary for correct AC operation. The default setting is 50 Hz, but this can be changed to 60 Hz.

## Startup

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

If the results of any step do not match the description, see the Troubleshooting section on page 33.

### **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. The Radian's default condition is Off.
4. Using a DVM, verify 230 Vac (or appropriate voltage) between the "L" and "N" OUT terminals. Do not turn on any AC circuit breakers at this time. (See page 33 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 “L” 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 full voltage with respect to neutral).
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 “L” and “N” input terminals for 230 Vac (or appropriate voltage). 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. The inverter may perform a full battery charge when first powered up. This can take several hours. If restarted after a temporary shutdown, the inverter may skip most or all of the charging cycle. If the battery charger has been enabled, confirm that it is charging by using the MATE3.
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. Settings that can be calibrated include AC input voltage, AC output voltage, and battery voltage.

## 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. These steps will completely isolate the inverter.

### 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 firmware 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. Lack of network 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

## Description of 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, **Grid** and **Gen**, 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 parameters for the **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

The **Generator** mode allows the use of any generator, even one with a rough or imperfect AC waveform. In other modes, 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:

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.
- A programmable delay time is available 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.

## NOTES:

- The Offset function of the Radian inverter is unavailable in this mode. (See page 19 for more information.)
- 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.)
- 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:

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.
- 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.)
- A programmable delay time is available 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 **Error! Bookmark not defined.** and 39.) To prevent the loss of backup power, load use should be planned accordingly.

- 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.
- The **Support** function is not usable in any other input mode.

## 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 integrally tied with the battery charger. (See page 20.) 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.
- The **Maximum Sell Current** can be adjusted between 5 and 30 amps, in the event that it is necessary to limit the power sold. This item is available in the **Grid Interface Protection** menu .
- The **Grid Interface Protection** menu also allows the inverter’s operating frequency to be changed between 50 and 60 Hz. This changes the inverter’s input acceptance parameters, as well as its output.

### CHARGING:

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 full 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 inverter has a delay before selling will begin. This delay has a default setting of one minute, although it is adjustable. 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 function.
- The grid-interactive function only operates when excess DC (renewable) power is available.
- The grid-interactive function is not available in any of the other input modes.

## Operation

- When power is returned to the utility grid, it may be 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 current is 30 Aac. The overall power will depend on the utility grid voltage. For example, if the voltage is 231 Vac, the inverter will sell 6.93 kVA. If the voltage is 242 Vac, the inverter will sell 7.26 kVA. Additionally, 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 function. 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.
- The grid-interactive function can only operate while the utility grid power is stable and within specific limits.
  - ~ In **Grid Tied** mode, the inverter will operate in accordance with the **Grid Interface Protection** settings. The default settings and ranges are listed in Table 10, which begins on page 47.

If the AC voltage or frequency vary outside the **Grid Interface Protection** limits, the inverter will disconnect from the utility grid to prevent selling under unacceptable conditions. These limits override the AC source acceptance limits described on page 17, which are used in other input modes.
  - ~ If the inverter stops selling or disconnects due to **Grid Interface Protection**, the MATE3 will show the reason. Sell Status messages are listed on page 43. Disconnect messages are listed on page 42. Often these messages will be the same.
  - ~ Due to varying requirements in different locations around the world, the grid-interactive settings are adjustable. However, this is only available to operators with installer-level access. There are firm rules concerning the acceptable voltage range, frequency range, clearance time during power loss, and reconnect delay when exporting power back to the utility. Generally it is expected that the settings cannot be altered by the end user. For this reason, it is necessary to change the installer password from the default in order to get access to these settings. Once this password has been changed, the settings can only be accessed by using the installer password. See pages 47 and 49 for more information.

Before operating in **Grid Tied** mode, contact the utility company that provides power to the installation. They can provide information regarding the rules that must be followed in order to export power back to the utility. The items below are the selectable options for **Grid Interface Protection**. It may be necessary to provide these options to the utility company to make certain their standards are met.

The utility may simply name a standard to be followed, as in AS 4777.3 for Australia. If this is the case, it may be necessary to look up the requirements for this standard and program them accordingly.

### STAGE 1 Voltage (basic settings)

- Over Voltage Trip (AC Voltage)
- Over Voltage Clearance Time (seconds)
- Under Voltage Trip (AC Voltage)
- Under Voltage Clearance Time (seconds)

### STAGE 2 Voltage (if required by utility)

- Over Voltage Trip (AC Voltage)
- Over Voltage Clearance Time (seconds)
- Under Voltage Trip (AC Voltage)
- Under Voltage Clearance Time (seconds)

### Frequency Trip

- Over Frequency Trip (Hertz)
- Over Frequency Clearance Time (seconds)
- Under Frequency Trip (Hertz)
- Under Frequency Clearance Time (seconds)

**NOTE:** The **Frequency Trip** settings are dependent on the inverter's operating frequency, which must be set correctly. See pages 7 and 49.

### Mains Loss

- Clearance Time (seconds)
- Reconnect Delay (seconds)

See Table 10 for the default settings and ranges.

## 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:

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 Absorption timer, it will continue to alternate between Silent and Re-Float stages.

### BENEFITS:

- Constant power is provided to the loads with virtually no drop in voltage or current.
- 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:

- 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.

## Backup

The **Backup** 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:

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 Absorption timer, it will continue to alternate between Silent and Re-Float stages.

### BENEFITS:

- 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. It does not have the overhead consumption of the **UPS** 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.

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 Re-Bulk 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.

## Operation

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:

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 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 Re-Bulk 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.
- 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:

- 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 intended to protect 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 32 and the *MATE3 Owner's Manual* for more information on HBX.

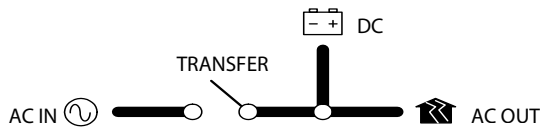


## Description of Functions

The items in this section are states of operation common to all Radian inverters. These functions can be used in most or all of the input modes described in the preceding section. Some can be manually selected or enabled; others are automatic.

All items identified as settable or adjustable have set points which can be accessed using the remote system display. (See the *MATE3 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.

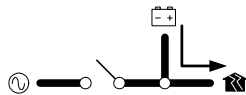
Each function is accompanied by a symbol representing the inverter and that function:



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 function may have other features depending on the function.

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

- **Low Battery Cut-Out:** This function prevents the inverter from draining the batteries completely. When the DC voltage drops below a specified level for 5 minutes, the inverter will stop functioning. The MATE3 will give a **Low Battery V** error. 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 39. 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.
- **Low Battery Cut-In:** The recovery point from Low Battery Cut-Out. When the DC voltage rises above this point 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 AC output voltage can be adjusted. Along with small changes, this allows the inverter to be used for different nominal (single-phase) voltages such as 220 Vac, 230 Vac, and 240 Vac.

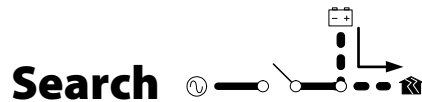
## Operation

**NOTE:** The inverter's operating frequency (and AC input acceptance frequency) can be changed, but this requires high-level access. (See page 11 and Table 10, which begins on page 47.)

- The inverter is also controlled by a high battery cut-out function. If the DC voltage rises above a certain 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 39 of this manual. (If the voltage drops below this point, the inverter automatically recovers.)

For the Radian 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 the 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.



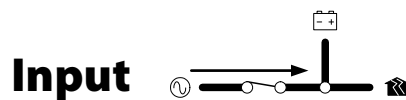
An automated search circuit is available to minimize the power draw when no loads are present. When enabled, the inverter does not always deliver full output. The output is reduced to brief pulses with a delay between them. These pulses are sent down the output lines to see if a resistance is present. Basically, the pulses "search" for a load. If a load is detected on the output, 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.



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. This is true in all modes except **Grid Tied** (see **NOTES** on page 18):

- Voltage: 208 – 252 Vac (default; see Table 10 on page 47)
- Frequency: If output frequency is set to 50 Hz, the input range of acceptance is 45 – 55 Hz. If the output frequency is set to 60 Hz, the input acceptance range is 55 – 65 Hz. (See Table 10.)

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. This occurs after a specified transfer delay, which is an adjustable menu item.

- 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 Input Mode and Limits**). The settings are titled **Voltage Limit Lower** and **Upper**. There can be side effects to changing the range of allowed voltages. See page 18.

## Operation

- Each of the AC inputs has a settable **Connect 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:

- The **Grid Tied** input mode does not use these acceptance limits and uses the **Grid Interface Protection** settings instead. (See page 11 for more information.) The inverter may not accept AC power if it meets the settings noted here but does not meet the **Grid Interface Protection** settings.
- 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 32 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.)
- AC Acceptance is controlled separately between the Radian inverter's two inputs. An AC source that is unacceptable on one input may be acceptable on the other if the input mode or settings are different.



A generator should be sized to provide enough power for all inverters, both for loads and for battery charging. The generator's voltage and frequency must match the inverter's acceptance settings.

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 output terminals are electrically isolated from the input that is in use. When it closes, the input and output terminals become electrically common. (The terminals for the unused input remain isolated during this time.) When the relay changes states, the physical transfer delay is *approximately* 25 milliseconds (with the exception of the **UPS** input mode).

The relay contacts are limited to 50 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

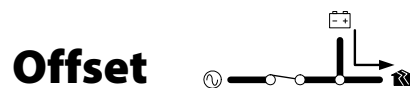
Current draw in excess of the inverter's transfer relay rating can damage the transfer relay. This damage is not covered by warranty.

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.

## NOTES:

- To ensure a smoother transition, it may be advisable to raise the inverter's lower acceptance limit. The default setting is 208 Vac. A higher setting will cause the inverter to transfer sooner in the event of a quality problem.
- 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.
- The **Generator** input mode is intended to accept irregular or unfiltered AC sources and is more likely to do so than other modes. 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 39). 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.

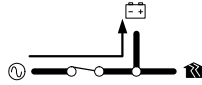
If none of the battery charger's timers are active, the target voltage used by the Radian inverter is **Sell Voltage** in the **Grid-Tie Sell** menu. Unlike the other target voltages, the Radian inverter cannot import AC power to raise the batteries to the **Sell Voltage** set point. It can only use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

# 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). A circle ○ indicates that the inverter has switched to a new target voltage. A square □ indicates that the inverter has reached the target voltage (a horizontal dotted line). A triangle △ indicates that the inverter has acquired a new target voltage, but is still inactive. (See Figure 5 on page 23.)

### 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 and Figure 3 are only applicable when the Radian inverter is in the **Grid Tied** input mode. See page 11.
- 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.

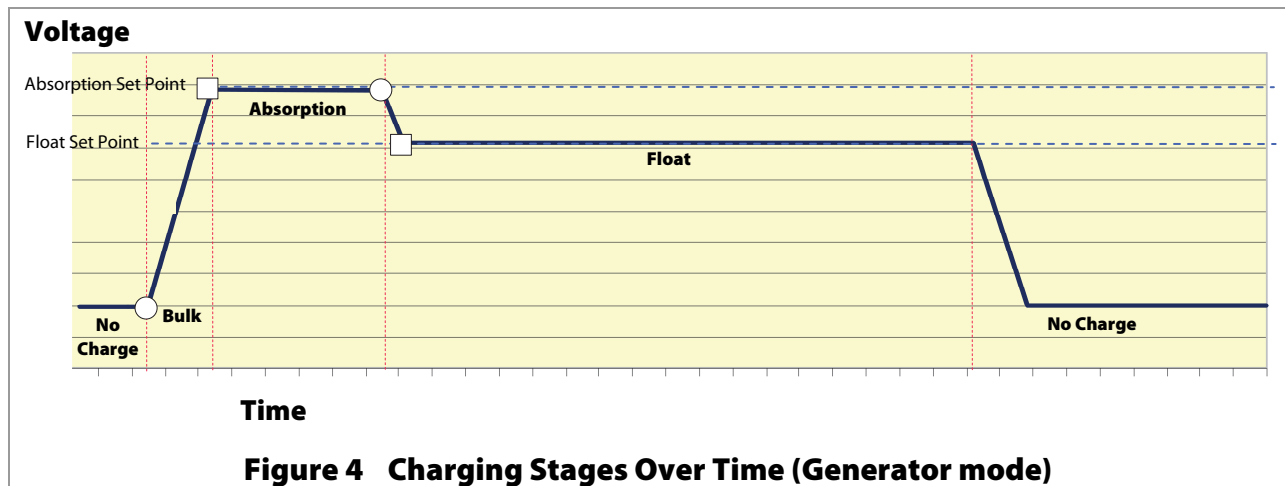
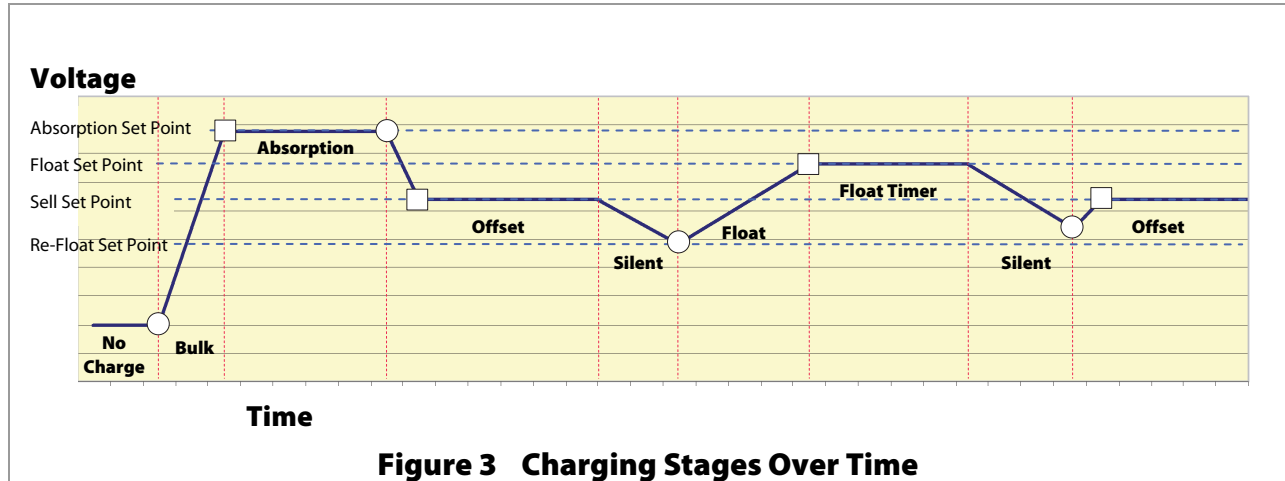
The initial DC current is the maximum current the charger can deliver. It will begin at the charger’s specified maximum, but will gradually decrease as the voltage increases. This is a tradeoff in wattage and is normal for the charger.

### 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**

## 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 28.

**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.

## 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 Re-Bulk voltage (see below), the inverter will restart the cycle, beginning at Bulk stage. (See the triangle symbol  $\triangle$  in Figure 5.) If the batteries do not drop below Re-Bulk, 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.

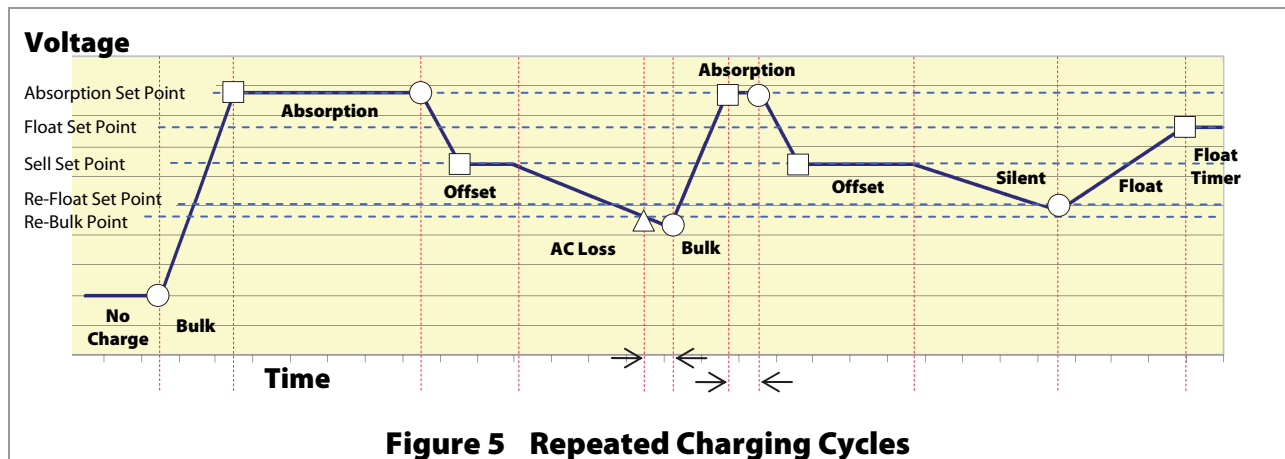


Figure 5 Repeated Charging Cycles

## 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 Re-Bulk point. This means that the Absorption period may not always be the same, depending on how much time it has acquired.

The Re-Bulk 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 Re-Bulk 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 Re-Bulk 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 **Error! Reference source not found.** 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 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

Battery performance will change when the temperature varies above or below room temperature (77°F or 25°C). Temperature compensation is a process that adjusts battery charging to correct for these changes.

When a battery is cooler than room temperature, its internal resistance goes up and the voltage changes more quickly. This makes it easier for the charger to reach its voltage set points. However, while accomplishing this process, it will not deliver all the current that the battery requires. As a result, the battery will tend to be undercharged.

Conversely, when a battery is warmer than room temperature, its internal resistance goes down and the voltage changes more slowly. This makes it harder for the charger to reach its voltage set points. It will continue to deliver energy as time passes until the charging set points are reached. However, this tends to be far more than the battery requires, meaning it will tend to be overcharged.

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  $\pm 2.4$  Vdc.

### EXAMPLES:

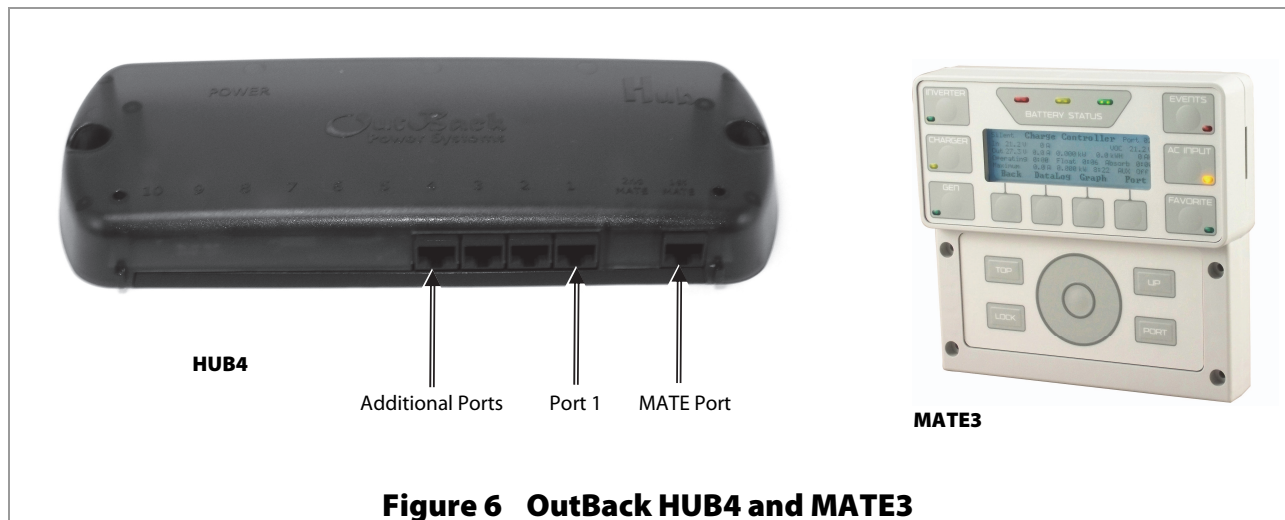
- A 48 Vdc system with batteries at 15°C will compensate its charging to 1.2 Vdc **higher** than the set points.
- A 48 Vdc system with batteries at 40°C will compensate its charging to 1.8 Vdc **lower** than the set points.

## 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 does not refer to physically placing one on top of another. It 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 GS7048E inverter/charger can stack up to ten units in parallel for increased capacity. Three units can be stacked for three-phase output.

Stacking requires an OutBack HUB product, as well as a MATE3 system display (sold separately). A system of four or fewer units may use the HUB4. Systems of up to ten units require the HUB10. All interconnections 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.



**Figure 6 OutBack HUB4 and MATE3**



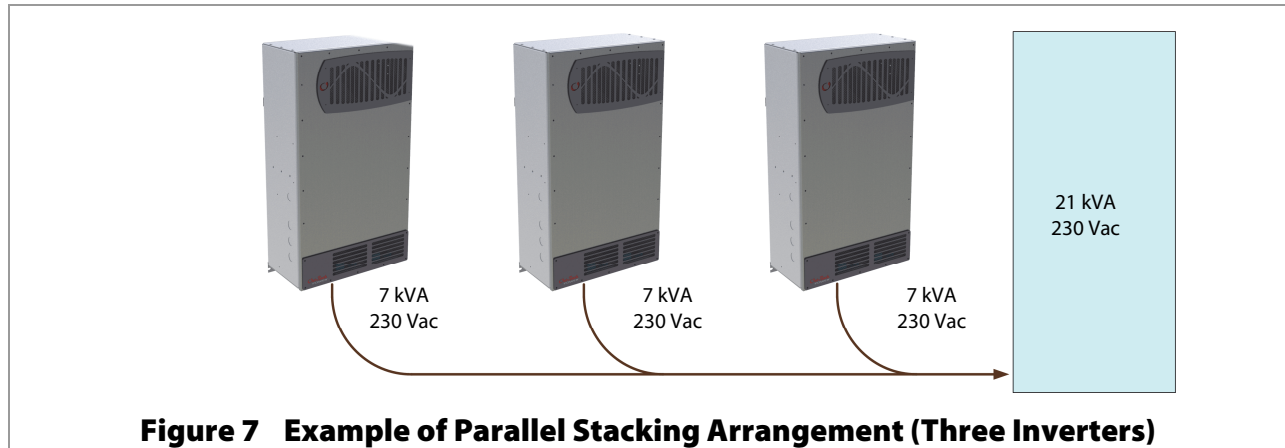
### IMPORTANT:

- 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.

## Parallel Stacking (Dual-Stack and Larger)

In parallel stacking, two or more inverters are stacked to create a single, common AC bus.

- All inverters share a common input (AC source) and run loads on a common output. The master inverter provides the primary output. The slaves are connected to the same output and assist the master.
- The slave outputs are controlled directly by the master and cannot operate independently.
- Slave inverters can go into Power Save mode when not in use. The master will activate individual slaves based on load demand. This reduces idle power consumption and improves system efficiency.
- Up to ten inverters may be installed in a parallel arrangement.

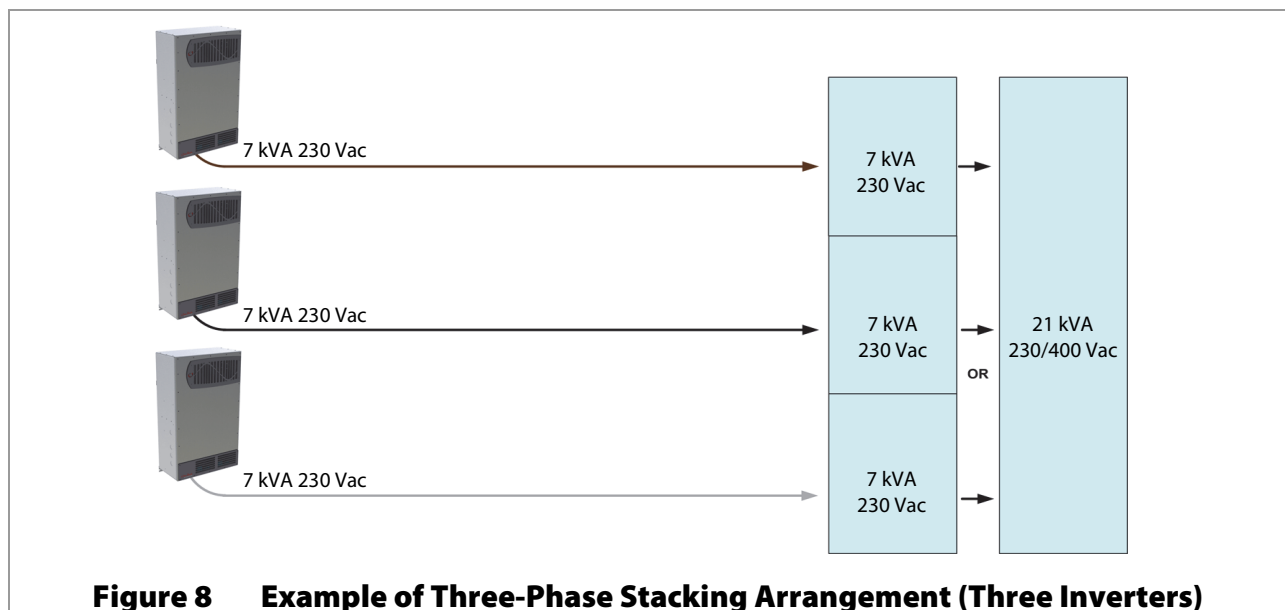


**Figure 7 Example of Parallel Stacking Arrangement (Three Inverters)**

## Three-Phase Stacking (Three Inverters)

In three-phase stacking, inverters are stacked to create three AC outputs in a wye configuration.

- The three outputs operate independently of each other. Each can run in independent Search mode if desired, although this does not normally occur when three-phase loads are connected.
- The output of each inverter is 120° out of phase from the others. Any two outputs produce 400 Vac between them. (This voltage is nominal and may vary with output settings.) The outputs can be used to power three-phase loads when all inverters work together.
- Only three inverters, one per phase, may be installed in a three-phase arrangement.



**Figure 8 Example of Three-Phase 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 some or all slave inverters into a quiescent state known as Silent mode. This mode minimizes the inverter's idle consumption. The inverters will come on again when the loads require power. (The term "Silent" is also used in the context of battery charging. See page 22.)

- The master inverter remains active unless specifically ordered to turn off. It does not enter Silent mode.
- When the majority of the inverter's wattage is consumed by loads, the master turns on one or more slaves for assistance. When the load drops back to a lesser wattage (as detected by the master), the slaves return to Silent mode.
- The order in which slaves turn on (or return to Silent mode) is controlled by programming in the MATE3. The slaves are given a "rank", or level number. The lower the number, the sooner a slave will be turned on.



#### 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*.)

If it is necessary to set these items manually:

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.
- **It is highly recommended to rank the slave inverters in order (1, 2, 3, 4, etc.).** Leaving the master at 0 automatically makes (approximately) 3.5 kW of power instantly available (from the master). If a slave is prioritized higher than the master (by raising the master level to 2 and the slave to 1, for example), that slave will not go silent. This will keep the power save mode from functioning. In general, setting the master higher than 0 will activate an additional (approximately) 3.5 kW of power for every increment. If the slave settings have not been programmed correctly, the master may override them and begin turning on unnecessary slaves. This defeats the purpose of the Power Save feature.

It is also recommended that slaves do not share 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.

## 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 32.)

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

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. 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 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 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 230 Vac, the limit is 200 Vac. (See page 49.) 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.

Parameters include:

- ~ Low and high DC voltage
- ~ On and off delay

## Operation

- **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 a relay. The relay contacts then activate the remote start/stop circuit on the generator. This is illustrated in the *Radian Series Inverter/Charger Installation Manual*.) The AUX output will be deactivated once the battery voltage rises to a high voltage setting for a settable delay period.

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 39). 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.
  - ~ This function is not triggered by the Phase Loss error, as that error does not shut down the inverter.

- **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. When the voltage falls below this set point for a settable delay period, the AUX output turns off.

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 40 for a description of the fan criteria.

- ~ This function does not have settable parameters.

- **DC Divert** activates the AUX output to divert excess renewable energy to a DC load, such as a resistor, a heater, or a fuel cell. 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 DC load when energized. (This is illustrated in the *Radian Series Inverter/Charger Installation Manual*.) Diversion is usually used to regulate battery charging. The resistor 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.

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.

- ~ This function does not have settable parameters other than those of the **Grid Interface Protection** menu (see Table 10 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 excess renewable energy to an AC load, usually an AC device powered by the inverter itself. 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.

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 40) 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 32).

# System Display-Based Functions

These functions require the presence of a system display such as the MATE or MATE3. 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) feature, which runs through the entire three-stage charging cycle. It can start according to battery voltage, inverter load, time of day, and other criteria. It has a quiet time feature which restricts the generator from starting at inconvenient times. Additional features are also available.

Because this is an advanced function with capabilities beyond the inverter's **Gen Alert**, the control logic for AGS is based in the MATE3 system display, not the inverter. See the *MATE3 Owner's Manual* for more information on programming and using the AGS mode.

## High Battery Transfer

In High Battery Transfer 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. See the *MATE3 Owner's Manual* for more information.

## Grid Use Time

The inverter system is capable of connecting to, or disconnecting from, the utility grid based on time of day. It can also be programmed to connect at different times on weekdays and on weekends.

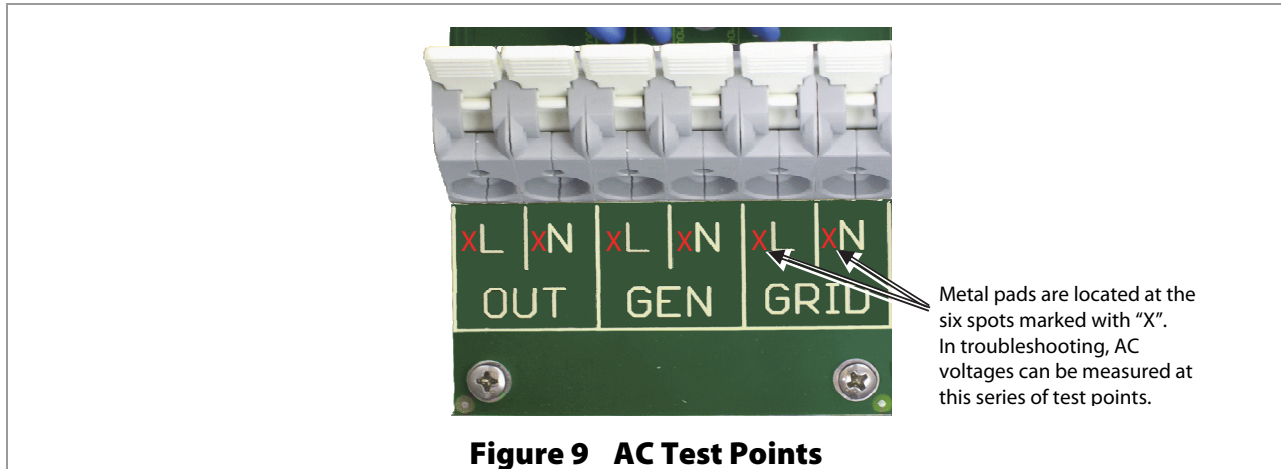
Because this is a system-wide function and not a function of individual inverters, the control logic for Grid Use Time is based in the MATE3 system display. See the *MATE3 Owner's Manual* for more information.



# Troubleshooting

## Basic Troubleshooting

Table 1 is organized in order of common symptoms, with a series of possible causes. Each cause also shows possible troubleshooting remedies, including system display checks where appropriate.



**Figure 9 AC Test Points**



### WARNING: Shock Hazard

During an error shutdown, the inverter's output terminals are not live. However, if the inverter recovers from a shutdown, the terminals will become live without notice. Several error shutdowns can be recovered automatically, including **Low Battery V**, **High Battery V**, and **Over Temperature**. See page 39.

**Table 1 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 <b>Off</b> .	<i>MATE3 system display only:</i> Set to <b>On</b> with the <b>INVERTER</b> hot key.
	Inverter set to <b>Search</b> (Search mode).	<i>MATE3 system display only:</i> If constant power is required, set to <b>On</b> with the <b>INVERTER</b> hot key. (If this setting was intentional, then no action is required.)

**Table 1 Troubleshooting**

<b>Symptom</b>	<b>Possible Cause</b>	<b>Possible Remedy</b>
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 <b>Inverter Stacking</b> 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.)
Will not connect to the AC source.	No AC input.	Check the AC voltage on the inverter's input test points. (See page 33.) 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).
	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 <b>Last AC Disconnect</b> screen (using the <b>AC INPUT</b> hot key and the <b>Discon</b> selection) for the reason for disconnection. If the unit never originally connected, check the <b>Warning</b> 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 <b>Generator</b> 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 <b>Drop to Use</b> with the <b>AC INPUT</b> 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 <b>Grid Use Time</b> settings and the MATE3 clock settings in the <b>System</b> 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 <b>AC INPUT</b> 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.)
	<b>Mini Grid</b> input mode has disconnected from AC.	<i>MATE3 system display only:</i> Check the <b>Inverter</b> part of the <b>Settings</b> menu to see if <b>Mini Grid</b> mode is in use. If activated prematurely, check the settings of <b>Mini Grid</b> mode. (If this setting was intentional, then no action is required.)
	Offset function has caused the inverter to disconnect from AC. ( <b>Support, Backup, UPS,</b> and <b>Mini Grid</b> 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: <b>Mini Grid</b> , HBX, Grid Use Time. These have conflicting priorities and only one can be used at a time.
	AC source does not meet requirements; <b>Grid Tied</b> mode has disconnected from AC.	See related entry under "Will not sell power to the utility grid" (next page).

**Table 1 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.
Will not charge.	No AC input.	See "Will not connect to AC" category.
	Charger set to <b>Off</b> .	<i>MATE3 system display only:</i> Check the <b>Charger Mode</b> screen with the <b>CHARGER</b> hot key and set to <b>On</b> or <b>Auto</b> . (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 "L" and "N" OUT test points with AC voltmeter. (See page 33.) These measurements should give full voltage. Test neutral and ground connections. This measurement should read zero volts. Any other result means neutral and ground are not bonded correctly. (If bonding is not required or prohibited by national or local codes, then no action may be required.)
Will not sell power to the utility grid.	Grid-tied function has been manually disabled.	<i>MATE3 system display only:</i> Check the <b>Grid-Tie Enable</b> setting in the <b>Grid-Tie Sell</b> menu. Confirm it is set to <b>Y</b> .
	<b>Grid Tied</b> mode not in use on the appropriate input.	<i>MATE3 system display only:</i> Check the <b>Inverter</b> part of the <b>Settings</b> menu to see if <b>Grid Tied</b> mode is in use. Confirm that it has been selected for the correct Radian input terminals.
	AC source does not meet requirements; this item is usually accompanied by disconnecting from the utility grid when in <b>Grid Tied</b> mode.	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 limits are found in the inverter's <b>Grid Interface Protection</b> menu. See the <b>Grid Tied</b> mode beginning on page 11 for more information on this menu.
	Inverter priority.	<i>MATE3 system display only:</i> Check <b>Sell Status</b> 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 1 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 33.) 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 <b>Grid AC Input Voltage Limits</b> or <b>Gen AC Input Voltage Limits</b> 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 <b>Search</b> (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 <b>ON</b> with the <b>INVERTER</b> hot key. (If this setting was intentional, then no action is required.)
	Loads sensitive to inverter's transfer time. <b>UPS</b> 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 <b>UPS</b> input mode has a faster response time. Select this mode for the appropriate input. (See page 13.)
	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.
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 IN and AC 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 33.) If low or fluctuating, this is an external problem.
	A generator is connected to the input terminals while the unit is in the <b>Grid Tied</b> 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.
Unit reads AC input, even though no source is present.	Internal transfer relay may be damaged. May be accompanied by <b>AC Relay Fault</b> error and shutdown.	Disconnect AC input wires and turn inverter on. Test the AC input and neutral test points with an AC voltmeter. (See page 33.) 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.

**Table 1 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 <b>Inverter Stacking</b> 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 <b>On</b> (and the device still does not work), then there is an external connection problem. If the proper results are not present with the function <b>On</b> , 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 <b>Auxiliary Output</b> menu programs the 12V AUX terminals. The <b>Auxiliary Relay</b> 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, <b>Mini Grid</b> 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 GS7048E 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 GS7048E 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 requires high-level access and 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 Table 10, 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 2 Error Troubleshooting**

<b>Message</b>	<b>Causes</b>	<b>Possible Remedy</b>
<b>Low Output Voltage</b>	Inverter's AC regulation cannot be maintained under high load conditions.	Check loads and measure current draw. Remove loads as necessary.
<b>AC Output Shorted</b>	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.
<b>AC Output Backfeed</b>	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.
<b>Stacking Error</b>	Programming problem among stacked units. (Often occurs if there is no master.) Can also occur when <b>AC Output Backfeed</b> occurs.	Check stacking programming and designation of master. (See page 26.) Check for output backfeed from an external source. Disconnect output if necessary.
<b>Low Battery V</b>	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 <b>Low Output Voltage</b> , <b>AC Output Shorted</b> , or <b>AC Output Backfeed</b> 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 AC source is connected and the inverter's charger comes on.
<b>High Battery V</b>	DC voltage exceeded acceptable level (specified on page 15).	Check the charging source. This problem is usually the result of external charging. The error clears automatically if conditions are removed.
<b>Over Temperature</b>	Inverter has exceeded its maximum allowed operating temperature.	Allow the inverter to remain off to reduce the temperature, or add external cooling.
<b>Phase Loss</b>	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).
<b>DC NEGATIVE IMBALANCE (L or R)</b>	Loose DC connection on left (L) or right (R) internal power module.	Tighten all DC connections between inverter and battery. If problem is not resolved, contact OutBack Technical Support.
<b>AC RELAY FAULT</b>	AC transfer relay damaged.	Contact OutBack Technical Support.

## 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 3 Warning Troubleshooting**

<b>Message</b>	<b>Definition</b>	<b>Possible Remedy</b>
<b>AC Freq Too High</b>	The AC source is above the upper acceptable frequency limit and prevents connection.	Check the AC source. If it is a generator, reduce its speed.
<b>AC Freq Too Low</b>	The AC source is below the lower acceptable frequency limit and prevents connection.	Check the AC source. If it is a generator, increase its speed.
<b>Voltage Too High</b>	The AC source is above the upper acceptable voltage limit and prevents connection.	Check the AC source. The inverter's acceptance range is adjustable. <b>NOTE:</b> Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<b>Voltage Too Low</b>	The AC source is below the lower acceptable voltage limit and prevents connection.	Check the AC source. Check the AC wiring. The inverter's acceptance range is adjustable. <b>NOTE:</b> Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<b>Input Amps &gt; Max</b>	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.
<b>Temp Sensor Bad</b>	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 <b>Transformer</b> , <b>Output FETs</b> , and <b>Capacitors</b> . These values are given in degrees Celsius. See next page.
<b>Comm Fault</b>	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).

**Table 3 Warning Troubleshooting**

<b>Message</b>	<b>Definition</b>	<b>Possible Remedy</b>
<b>Fan Failure</b>	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.)  <b>NOTE:</b> The system can continue to operate if the inverter can be run at reasonable levels. External cooling may also be applied.
<b>Transformer</b> (in <b>Temps</b> menu)	Displays the ambient temperature around the inverter's transformer.	In the MATE3, these values are given in degrees Celsius.
<b>Output FETs</b> (in <b>Temps</b> 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).
<b>Capacitors</b> (in <b>Temps</b> 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 disconnect. The MATE3 system display may generate a concurrent event and warning message following the disconnect. (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) may be the same as disconnect messages. If the Grid Interface Protection settings are exceeded (see page 12), the inverter will disconnect from the utility grid.

**Table 4 Disconnect Troubleshooting**

<b>Message</b>	<b>Definition</b>	<b>Possible Remedy</b>
<b>Frequency Too High</b>	The AC source has exceeded acceptable frequency levels.	Check AC source. If it is a generator, reduce speed.
<b>Frequency Too Low</b>	The AC source has dropped below acceptable frequency levels.	Check AC source. If it is a generator, increase speed.
<b>Voltage &gt; Maximum</b>	The AC source has exceeded acceptable voltage levels.	Check AC source. The inverter's acceptance range is adjustable. <b>NOTE:</b> Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<b>Voltage &lt; Minimum</b>	The AC source has dropped below acceptable voltage levels.	Check AC source. The inverter's acceptance range is adjustable. <b>NOTE:</b> Adjusting the range may accommodate a problematic AC source, but it will not fix it.
<b>Backfeed</b>	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 <b>AC Output Backfeed</b> 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.
<b>Phase Lock</b>	The unit cannot remain in phase with an erratic AC source.  <b>NOTE:</b> This is not an "Error" as defined on page 39 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 <b>Generator</b> input mode. (See page 9.)
<b>Island Detect</b>	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 <b>Generator</b> 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 controlled by the Grid Interface Protection settings, which are shown on page 49. If the AC source exceeds these limits, the inverter will stop selling and display the appropriate code. (At the same time it will disconnect from the utility grid, with an appropriate message in Table 4 as shown on page 42.) After the source returns to the acceptable range, the screen will begin its reconnection timer (with a default setting of one minute). When the timer expires, the inverter will reconnect to the utility grid and 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.

<b>Table 5</b>		<b>Sell Status Messages</b>
<b>Sell Status</b>	<b>Definition</b>	
<b><i>Selling Disabled</i></b>	The <b>Grid-Tie Enable</b> command has been set to <b>N</b> (no).	
<b><i>Qualifying Grid</i></b>	All utility grid conditions are acceptable. The inverter is running a timed 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.	
<b><i>Frequency Too Low</i></b>	The utility grid’s AC frequency is below the acceptable range for selling.	
<b><i>Frequency Too High</i></b>	The utility grid’s AC frequency is above the acceptable range for selling.	
<b><i>Voltage Too Low</i></b>	The utility grid’s AC voltage is below the acceptable range for selling.	
<b><i>Voltage Too High</i></b>	The utility grid’s AC voltage is above the acceptable range for selling.	
<b><i>Battery &lt; Target</i></b>	The battery voltage is below the target voltage for that stage (Float, Selling, etc.). No excess energy is available to sell.	





# Specifications

## Electrical Specifications

**Table 6 Electrical Specifications for Model GS7048E**

<b>Specification</b>	<b>Value</b>
Nominal DC Input Voltage	48 Vdc
Continuous Output Power at 25°C	7000 VA
AC Output Voltage (selectable)	230 Vac (210 – 250 Vac)
AC Output Frequency (selectable)	50 or 60 Hz
Output Type	Single-phase
Continuous AC Output Current at 25°C	30 Aac
Waveform	True Sinewave
Efficiency (typical)	92%
Total Harmonic Distortion (maximum)	< 5%
Harmonic Distortion (maximum single voltage)	< 2%
Output Voltage Regulation	± 2%
Appliance Protective Class (IEC)	Class I
Maximum Output Current (1 ms peak)	100 Aac
Maximum Output Current (100 ms RMS)	70.7 Aac
Overload Capability (100 ms surge)	16.3 kVA
Overload Capability (5 second)	11.5 kVA
Overload Capability (30 minute)	7.9 kVA
Short Circuit Current Rating (AC output)	109 Aac
Short Circuit Current Rating (DC input)	8975 Adc
Power Consumption (idle) – Invert mode, no load	34 watts
Power Consumption (idle) – Search mode	10 watts
Power Consumption – Off	4 watts
AC Input Voltage Range (adjustable)	170 – 290 Vac
AC Input Frequency Range (selectable)	45 – 55 Hz or 55 – 65 Hz
AC Input Current (Maximum)	50 Aac
Grid-Interactive Voltage Range (Default)	208 – 252 Vac
Grid-Interactive Frequency Range (Default)	47 – 51 Hz or 57 – 61 Hz
Battery Charger Maximum AC Input	30 Aac at 230 Vac
Battery Charger Maximum DC Output	100 Adc
DC Input Voltage Range	40 – 68 Vdc
DC Input Power (continuous)	7.634 kVA
Maximum DC Input Current on Surge	406.5 Adc
DC Output Voltage Range (Charging)	40 – 68 Vdc
Auxiliary Output	0.7 Adc at 12 Vdc
Auxiliary Relay	10 A at 250 Vac or 30 Vdc

## Mechanical Specifications

**Table 7 Mechanical Specifications for Model GS7048E**

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

## Environmental Specifications

**Table 8 Environmental Specifications for All Models**

Specification	Value
Rated Temperature Range (meets component specifications; however, please note that the inverter output wattage is derated above 25°C)	-20°C to 50°C (-4°F to 122°F)
Operational Temperature Range (functions, but does not necessarily meet all component specifications)	-40°C to 60°C (-40°F to 140°F)
Storage Temperature Range	-40°C to 60°C (-40°F to 140°F)
IP (Ingress Protection) Rating of Enclosure	20

## Regulatory Specifications

This product is certified by ETL to the following standards:

- IEC 61000-6-1 (EMC Standard: Immunity for Residential, Commercial, and Light-Industrial Environments)
- IEC 61000-6-3 (EMC Standard: Emissions for Residential, Commercial, and Light-Industrial Environments)
- IEC 61000-3-2 (EMC Standard: Limits on Harmonic Current Emissions)
- IEC 61000-3-3 (EMC Standard: Limitation of Voltage Changes, Voltage Fluctuations, and Flicker in Public Low-Voltage Supply Systems)
- IEC 62477 (Safety Requirements for Power Electronic Converter Systems and Equipment)
- AS3100 (General Requirements for Electrical Equipment)
- AS4777 (Grid Connection of Energy Systems via Inverters)

These inverter/charger models have grid-interactive functions. All models are tested to certain limits for acceptable output voltage ranges, acceptable output frequency, total harmonic distortion (THD) and anti-islanding performance when the inverter exports power to a utility source. The OutBack inverter/charger models listed in this document are validated through compliance testing. The following specifications refer to exporting power to a simulated utility source of less than 1% voltage total harmonic distortion (THD).

- The THD of the root mean square (RMS) current is less than 5%.
- The output of the Radian inverter exceeds the minimum power factor of 0.85 with a typical power factor of 0.96 or better.



The reconnection delay has a default setting of 1 minute. The grid-interactive default settings are shown in the **Grid Interface Protection Menu** portion of Table 10 on page 49.

The **Grid Interface Protection** settings are adjustable. However, this is only available to operators with installer-level access. The reason for this limitation is that there are firm rules concerning the acceptable voltage range, frequency range, clearance time during power loss, and reconnect delay when exporting power back to the utility. The rules differ in different locations around the world, although generally it is expected that the settings cannot be altered by the end user. For this reason, it is necessary to change the installer password from the default in order to get access to these settings. (See the MATE3 manual for details.) Once this password has been changed, the **Grid Interface Protection** settings can be accessed by using the installer password.

See the **Grid Tied** function on page 11 for more information.

To meet the standard AS4777.3 for installations in Australia, the acceptance settings shall not exceed the following. The factory default settings meet these requirements.

**Table 9 AS4777.3 Acceptance Settings**

Minimum Voltage	Maximum Voltage	Minimum Frequency	Maximum Frequency
200 Vac	270 Vac	45 Hz	55 Hz

## Firmware Revision

This manual applies to GS7048E inverter/chargers with a firmware version of 001.003.xxx or higher.

## Default Settings and Ranges

**NOTE:** Some items are retained at the present setting even when the inverter is reset to factory defaults. These items are noted with the letter "X" in the Item column.

**Table 10 GS7048E Inverter Settings**

Field	Item	Default	Minimum	Maximum
INVERTER Hot Key	Inverter Mode	<i>Off</i>	<i>On, Off, or Search</i>	
CHARGER Hot Key	Charger Control	<i>On</i>	<i>On or Off</i>	
AC Input Hot Key	AC Input Mode	<i>Use</i>	<i>Drop or Use</i>	
Search	<i>Sensitivity</i> (see page 16 for increments)	10	0	250
	<i>Pulse Length</i>	8 AC Cycles	4 AC Cycles	20 AC Cycles
	<i>Pulse Spacing</i>	60 AC Cycles	4 AC Cycles	120 AC Cycles
AC Input and Current Limit	<i>Input Priority</i>	<i>Grid</i>	<i>Grid or Gen</i>	
	<i>Grid Input AC Limit</i>	50 Aac	5 Aac	55 Aac
	<i>Gen Input AC Limit</i>	50 Aac	5 Aac	55 Aac
	<i>Charger AC Limit</i>	30 Aac	0 Aac	30 Aac
Grid AC Input Mode and Limits	<i>Input Mode</i>	<i>Grid Tied</i>	<i>Generator, Support, Grid Tied, UPS, Backup, Mini Grid</i>	
	<i>Voltage Limit Lower</i>	208 Vac	170 Vac	230 Vac
	(Voltage Limit) <i>Upper</i>	252 Vac	232 Vac	290 Vac
	<i>Transfer Delay</i>	6 AC Cycles	0 AC Cycles	240 AC Cycles
	<i>Connect Delay</i>	0.2 minutes	0.2 minutes	25 minutes
Gen AC Input Mode and Limits	<i>Input Mode</i>	<i>Generator</i>	<i>Generator, Support, Grid Tied, UPS, Backup, Mini Grid</i>	
	<i>Voltage Limit Lower</i>	208 Vac	170 Vac	230 Vac

# Specifications

**Table 10 GS7048E Inverter Settings**

Field	Item	Default	Minimum	Maximum
	(Voltage Limit) <b>Upper</b>	252 Vac	232 Vac	290 Vac
	<b>Transfer Delay</b>	6 AC Cycles	0 AC Cycles	240 AC Cycles
	<b>Connect Delay</b>	0.5 minutes	0.2 minutes	25 minutes
<b>AC Output</b>	<b>Output Voltage</b>	X	230 Vac	210 Vac
<b>Low Battery</b>	<b>Cut-Out Voltage</b>	42 Vdc	36 Vdc	48 Vdc
	<b>Cut-In Voltage</b>	50 Vdc	40 Vdc	56 Vdc
<b>Battery Charger</b>	<b>Absorb Voltage</b>	57.6 Vdc	52 Vdc	64 Vdc
	(Absorb) <b>Time</b>	1.0 hours	0.0 hours	24.0 hours
	<b>Float Voltage</b>	54.4 Vdc	48 Vdc	60 Vdc
	(Float) <b>Time</b>	1.0 hours	0.0 hours	24.0 hours
	<b>Re-Float Voltage</b>	50 Vdc	48 Vdc	52 Vdc
<b>Battery Equalize</b>	<b>Equalize Voltage</b>	58.4 Vdc	56 Vdc	68 Vdc
	(Equalize) <b>Time</b>	1.0 hours	0.0 hours	24.0 hours
<b>Auxiliary Output</b>	<b>Aux Control</b>	<b>Off</b>	<b>Off, Auto or On</b>	
	<b>Aux Mode</b>	<b>Vent Fan</b>	<b>Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, IEEE, Source Status, AC Divert</b>	
	(Load Shed) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Load Shed ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Load Shed) <b>OFF: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(Load Shed OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Gen Alert) <b>ON: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(Gen Alert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Gen Alert) <b>OFF: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Gen Alert OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Vent Fan) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Vent Fan) <b>Off Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(DC Divert) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(DC Divert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(DC Divert) <b>OFF: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(DC Divert OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(AC Divert) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(AC Divert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(AC Divert) <b>OFF: Batt &lt;</b>	44 Vdc	40 vdc	56 Vdc
	(AC Divert OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
<b>Auxiliary Relay</b>	<b>Aux Control</b>	<b>Off</b>	<b>Off, Auto or On</b>	
	<b>Aux Mode</b>	<b>Gen Alert</b>	<b>Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, IEEE, Source Status, AC Divert</b>	
	(Load Shed) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Load Shed ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Load Shed) <b>OFF: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(Load Shed OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Gen Alert) <b>ON: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(Gen Alert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Gen Alert) <b>OFF: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Gen Alert OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(Vent Fan) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(Vent Fan) <b>Off Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(DC Divert) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(DC Divert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(DC Divert) <b>OFF: Batt &lt;</b>	44 Vdc	40 Vdc	56 Vdc
	(DC Divert OFF) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(AC Divert) <b>ON: Batt &gt;</b>	56 Vdc	48 Vdc	72 Vdc
	(AC Divert ON) <b>Delay</b>	0.5 minutes	0.1 minutes	25 minutes
	(AC Divert) <b>OFF: Batt &lt;</b>	44 Vdc	40 vdc	56 Vdc

**Table 10 GS7048E Inverter Settings**

<b>Field</b>	<b>Item</b>	<b>Default</b>	<b>Minimum</b>	<b>Maximum</b>
	(AC Divert OFF) <i>Delay</i>	0.5 minutes	0.1 minutes	25 minutes
<b>Inverter Stacking</b>	<i>Stack Mode</i>	<i>Master</i>	<i>Master, Slave, B Phase Master, C Phase Master</i>	
<b>Power Save (in Stacking Menu)</b>	<i>Master Power Save Level</i>	0	0	31
	<i>Slave Power Save Level</i>	1	1	31
<b>Grid-Tie Sell</b>	<i>Grid-Tie Enable</i>	Y	Y or N	
	<i>Sell Voltage</i>	52 Vdc	40 Vdc	60 Vdc
<b>Module Control</b>	<i>Module Control</i>	<i>Auto</i>	<i>Auto, Left, Right, Both</i>	
<b>Calibrate</b>	<i>Input Voltage</i>	0	-7	7
	<i>Output Voltage</i>	0	-7	7
	<i>Battery Voltage</i>	0	-0.8	0.8
<b>Grid Interface Protection Menu</b>				
<b>Operating Frequency</b>	<i>Operating Frequency</i>	X	50 Hz	50 Hz, 60 Hz
<b>Stage 1 Voltage Trip</b>	<i>Over Voltage Clearance Time</i>	X	1.5 seconds	0.2 seconds 20 seconds
	<i>Over Voltage Trip</i>	X	252 Vac	240 Vac 300 Vac
	<i>Under Voltage Clearance Time</i>	X	1.5 seconds	0.2 seconds 20 seconds
	<i>Under Voltage Trip</i>	X	208 Vac	160 Vac 240 Vac
<b>Stage 2 Voltage Trip</b>	<i>Over Voltage Clearance Time</i>	X	0.2 seconds	0.2 seconds 20 seconds
	<i>Over Voltage Trip</i>	X	264 Vac	240 Vac 300 Vac
	<i>Under Voltage Clearance Time</i>	X	0.2 seconds	0.2 seconds 20 seconds
	<i>Under Voltage Trip</i>	X	196 Vac	160 Vac 240 Vac
<b>Frequency Trip</b>	<i>Over Frequency Clearance Time</i>	X	0.2 seconds	0.2 seconds 20 seconds
	<i>Over Frequency Trip</i> (50 or 60 Hz system)	X	51 Hz or 61 Hz	50.1 Hz or 60.1 Hz 54 Hz or 64 Hz
	<i>Under Frequency Clearance Time</i>	X	0.2 seconds	0.2 seconds 20 seconds
	<i>Under Frequency Trip</i> (50 or 60 Hz system)	X	49 Hz or 59 Hz	49.9 Hz or 59.9 Hz 46 Hz or 56 Hz
<b>Mains Loss</b>	<i>Clearance Time</i>	X	2 seconds	2 seconds 5 seconds
	<i>Reconnect Delay</i>	X	60 seconds	2 seconds 300 seconds
<b>Sell Current Limit</b>	<i>Maximum Sell Current</i>	X	30 Aac	5 Aac 30 Aac

## Definitions

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

**Table 11 Terms and Definitions**

<b>Term</b>	<b>Definition</b>
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
DC	Direct Current; refers to voltage produced by the batteries or renewable source
DVM	Digital Voltmeter
FLEXgrid™	Product technology which supports Grid/Hybrid systems
GND	Ground; a permanent conductive connection to earth for safety reasons; also known as Chassis

**Table 11 Terms and Definitions**

<b>Term</b>	<b>Definition</b>
	Ground, Protective Earth, PE, Grounding Electrode Conductor, and GEC
Grid/Hybrid™	System technology which optimizes both grid-interactive and off-grid options
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
IEC	International Electrotechnical Commission; an international standards organization
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
System display	Remote interface device (such as the MATE3), used for monitoring, programming and communicating with the inverter; also called "remote system display"
Utility grid	The electrical service and infrastructure supported by the electrical or utility company; also called "mains", "utility service", or "grid"



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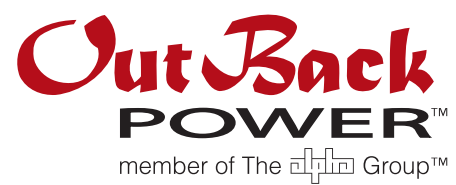
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