



Radian Series Inverter/Charger

GS8048

Installation Manual



About OutBack Power Technologies

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

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OutBack Power Technologies Inc. warrants that the products it manufactures will be free from defects in materials and workmanship for a period of five (5) years subject to the conditions set forth in the warranty detail, found in the *Radian Series Inverter/Charger Operator's Manual*.

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

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Part Number

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Important Safety Instructions

READ AND SAVE THESE INSTRUCTIONS!

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

Audience

These instructions are for use by qualified personnel who meet all local and governmental code requirements for licensing and training for the installation of electrical power systems with AC and DC voltage up to 600 volts.

Symbols Used

| Symbol | Description |
|---|-------------|
|  | Ground |
|  | AC Current |
|  | DC Current |
|  | Sine Wave |



WARNING: Hazard to Human Life

This type of notation indicates that the hazard could be harmful to human life.



CAUTION: Hazard to Equipment

This type of notation indicates that the hazard may cause damage to the equipment.



IMPORTANT:

This type of notation indicates that the information provided is important to the installation, operation and/or maintenance of the equipment. Failure to follow the recommendations in such a notation could result in voiding the equipment warranty.

Important Safety Instructions

Definitions

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

Table 1 Terms and Definitions

| Term | Definition |
|---|--|
| 12V AUX | Auxiliary connection that supplies 12 Vdc to control external devices. |
| AC | Alternating Current; refers to voltage produced by the inverter, utility grid, or generator |
| AGS | Advanced Generator Start |
| CSA | Canadian Standards Association; establishes Canadian national standards and the Canadian Electrical Code, including C22.1 and C22.2 |
| DC | Direct Current; refers to voltage produced by the batteries or renewable source |
| DVM | Digital Voltmeter |
| ETL | Electrical Testing Laboratories; short for the company ETL Semko; refers to a certification issued by ETL to OutBack products indicating that they meet certain UL standards |
| GFDI | Ground Fault Detector Interruptor; a safety device for PV systems |
| GND | Ground; a permanent conductive connection to earth for safety reasons; also known as Chassis Ground, Protective Earth, PE, Grounding Electrode Conductor, and GEC |
| Grid-interactive, grid-intertie, grid-tie | Utility grid power is available for use and the inverter is a model capable of returning (selling) electricity back to the utility grid |
| GSLC | GS Load Center; the wiring box for the Radian (GS) inverter |
| HBX | High Battery Transfer; a function of the MATE3 |
| HUB | A line of OutBack communications manager products |
| IEEE | Institute of Electrical and Electronics Engineers; refers to a series of standards and practices for the testing of electrical products |
| LBCO | Low Battery Cut-Out; set point at which the inverter shuts down due to low voltage |
| MATE3 | An OutBack system display, used for monitoring, programming and communicating with the inverter |
| 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 |

Table 1 Terms and Definitions

| Term | Definition |
|----------------|--|
| Split-phase | A type of utility electrical system with 2 “hot” lines that are 120 Vac with respect to neutral and 240 Vac between the “hot” lines; common in North America |
| System display | Remote interface device (such as the MATE3), used for monitoring, programming and communicating with the inverter; also called “remote system display” |
| UL | Underwriters Laboratories; refers to a set of safety standards governing electrical products |
| Utility grid | The electrical service and infrastructure supported by the electrical or utility company; also called “mains”, “utility service”, or “grid” |

General Safety



WARNING: Limitations on Use

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



CAUTION: Equipment Damage

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



IMPORTANT:

Do not attempt to install this equipment if it appears to be damaged in any way. See the Warranty section for instructions on returning the equipment.

Personal Safety



WARNING: Personal Injury

- This equipment weighs in excess of 125 lbs (57 kg). Use safe lifting techniques when lifting this equipment as prescribed by the Occupational Safety and Health Association (OSHA) or other local codes.
- Use standard safety equipment such as safety glasses, ear protection, steel-toed safety boots, safety hard hats, etc., as prescribed by the Occupational Safety and Health Association (or other local codes) when working on this equipment.
- Use standard safety practices when working with electrical equipment (e.g., remove all jewelry, use insulated tools, wear cotton clothing, etc.).
- Never work alone when installing or servicing this equipment. Have someone nearby that can assist if necessary.

Inverter Safety

| | |
|---|--|
|  | <p>WARNING: Lethal Voltage</p> <ul style="list-style-type: none">➤ Review the system configuration to identify all possible sources of energy. Ensure ALL sources of power are disconnected before performing any installation or maintenance on this equipment. Confirm that the terminals are de-energized using a validated voltmeter (rated for a minimum 1000 Vac and 1000 Vdc) to verify the de-energized condition.➤ Do not perform any servicing other than that specified in the installation instructions unless qualified to do so, or have been instructed to do so by OutBack Power Technologies Technical Support personnel. |
|  | <p>WARNING: Burn Hazard</p> <p>Internal parts can become hot during operation. Do not remove the cover during operation or touch any internal parts. Be sure to allow sufficient time for internal parts to cool down before attempting to perform any maintenance.</p> |
|  | <p>WARNING: Fire Hazard</p> <ul style="list-style-type: none">➤ Do not place combustible or flammable materials within 12 feet (3.7 m) of the equipment.➤ This product contains relays with moving parts and is not ignition-protected.➤ Ensure AC, DC, and ground cable sizes conform to local codes. See pages 24 through 26 for minimum size requirements. Ensure all conductors are in good condition. Do not operate the unit with damaged or substandard cabling. |
|  | <p>CAUTION: Equipment Damage</p> <p>When connecting cables from the inverter to the battery terminals, ensure the proper polarity is observed. Connecting the cables incorrectly can damage or destroy the equipment and void the product warranty.</p> |
|  | <p>CAUTION: Equipment Damage</p> <ul style="list-style-type: none">➤ Thoroughly inspect the equipment prior to energizing. Verify that no tools or equipment have been inadvertently left behind.➤ Ensure clearance requirements are strictly enforced. Keep all vents clear of obstructions that can prevent proper air flow around, or through, the unit.➤ Sensitive electronics inside the equipment can be destroyed by static electricity. Be sure to discharge any static electricity before touching the equipment and wear appropriate protective gear. |

Battery Safety



WARNING: Explosion, Electrocution, or Fire Hazard

- Use the battery types recommended by OutBack Power Technologies. Follow the battery manufacturer's recommendations for installation and maintenance.
- Ensure the cables are properly sized. Failure to size the cables properly can result in a fire hazard.
- Ensure clearance requirements are strictly enforced around the batteries.
- Ensure the area around the batteries is well ventilated and clean of debris.
- Never smoke near, or allow a spark or flame near, the batteries.
- Always use insulated tools. Avoid dropping tools onto batteries or other electrical parts.
- Keep plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
- Wear complete eye and clothing protection when working with batteries. Avoid touching bare skin or eyes while working near batteries.
- If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters the eye, immediately flood it with running cold water for at least 20 minutes and get medical attention as soon as possible.
- Never charge a frozen battery.
- Insulate batteries as appropriate against freezing temperatures. A discharged battery will freeze more easily than a charged one.
- If a battery must be removed, always remove the grounded terminal from the battery first. Make sure all devices are de-energized or disconnected to avoid causing a spark.
- If a remote or automatic generator control system is used, disable the starting circuit and/or disconnect the generator from its starting battery while performing maintenance to prevent accidental starting.



IMPORTANT:

Baking Soda neutralizes lead-acid battery electrolyte.
Vinegar neutralizes NiCad and NiFe battery electrolyte.
Have a supply of either substance readily available if using these types of batteries.

Regulatory Specifications

See the *Radian Series Inverter/Charger Operator's Manual* for all specifications and regulatory information, including certifications.

Required Resources

This product is required to be installed according to pertinent safety codes and standards. If installed in the United States, wiring practices must meet the requirements of the National Electrical Code (NEC). If installed in Canada, wiring practices must meet the requirements of the Canadian Electrical Code.

- National Electrical Code (NEC)/NFPA 70, Current Edition
- Canadian Electrical Code, C22.1, Current Edition

Additional Resources

The following are references which may be used when installing this equipment. Depending on the nature of the installation, it may be highly recommended to consult any or all of these resources.

- National Electrical Code (NEC)/NFPA 70 Handbook, Current Edition
- UL 1741, Current Edition, Static Inverter and Charge Controllers for Use in Photovoltaic Power Systems
- International Building Code (IBC), Current Edition
- Photovoltaic Power Systems and the 2005 National Electrical Code: Suggested Practices

Recycling Information



IMPORTANT: Recycle Electronics and Batteries

Batteries are considered hazardous waste and must be recycled according to local jurisdiction. Inverters and other electronics contain metals and plastics that should also be recycled. The following web sites and phone numbers provide additional information for recycling electronic products and batteries.

Earth 911, USA

Web site: www.Earth911.com
Address: 14646 N. Kierland Blvd., Suite 100
Scottsdale, AZ 85254
Phone: +1.480.337.3025 (direct)

Environmental Protection Agency, USA

Web site: www.epa.gov/recyclecity/
Email: r9.recyclecity@epa.gov
Phone: +1.415.947.8000
(Monday –Friday 8:00 AM to 12:00 PM and 1:00 PM to 4:00 PM PST)

Keep America Beautiful, USA

Web site: www.kab.org/
Email: info@kab.org
Address: 1010 Washington Boulevard
Stamford, CT 06901
Phone: +1.203.659.3000 (Main number)
Fax: +1.203.659.3001

OurEarth.org, USA

There is a place on the website for contacting OurEarth.org using email. No direct email address is provided.

Web site: <http://www.ourearth.org>
Address: P.O. Box 62133
Durham, NC 27715
Phone: +1.410.878.6485

National Institute of Recyclers, Mexico

Web site: <http://www.inare.org.mx/>
Email: a57841279@prodigy.net.mx, margarita@inare.org.mx
Phone: +1.55.57.85.9160
Fax: +1.55.57.84.1279

Natural Resources Canada

Address: 580 Booth, Ottawa, ON K1A 0E8
Web site: <http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/rec-rec-eng.htm>
Phone: +1.613.995.0947
TTY: +1.613.996.4397
(Phone and TTY: Monday to Friday, 8:30 a.m. to 4:30 p.m. ET)

Office of Waste Management, Canada

Web site: http://www.portaec.net/library/recycling/recycling_in_canada.html
Address: Office of Waste Management
Conservation and Protection
Environment Canada
Ottawa, Ontario K1A 0H3
Phone: +1.819.997.2800

EuroRecycle.net, Europe

The following website provides general information about recycling in Europe. It also provides a list of companies and organizations that provide recycling information or assistance.

Web site: <http://euro.recycle.net>
E-mail: <http://euro.recycle.net/cgi-bin/feedback1.cgi?w=27>
(This is an online form providing a means to contact the owners of the website.)



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Introduction

Welcome to OutBack Power Technologies

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

- Mounts easily with supplied mounting plate.
- All terminals exit at the bottom of the inverter. This allows the installer to use a single distribution box. The GS Load Center (GSLC) is specifically designed for this purpose and is sold separately.
- Uses spring-based AC terminals instead of screw-based terminals. This eliminates torque requirements and periodic re-tightening.
- Uses the MATE3 System Display and Controller (sold separately) for user interface.
- Features versatile mounting locations for the MATE3, HUB, and FLEXmax products, as well as the GSLC.
- The venting on the cover allows mounting of multiple Radian inverter/chargers side by side with zero clearance required between them.
- Up to 10 Radian Series Inverter/Chargers can be stacked together.



Figure 1 GS8048 Inverter/Charger



IMPORTANT:

This product is not compatible with the OutBack MATE or MATE2 System Display and Controller. Use of these products is not supported with the Radian Series.

Components and Accessories

Table 2 Components and Accessories

| Included in Box | |
|--|--|
| Radian Series Installation Manual | RTS (Remote Temperature Sensor) |
| Radian Series Operator's Manual | Hardware Kit |
| Mounting Bracket | |
| Optional Components for Attachment to Radian Inverter | |
| MATE3 System Display and Controller | FLEXmax 60 or FLEXmax 80 Charge Controller |
| FW-MB3 (MATE3 bracket) | FW-CCB or FW-CCB2 (charge controller brackets) |
| GSLC, GSLC175-120/240, or GSLC-PV-120-/240 (GS Load Centers) | OutBack HUB4 or HUB10 |

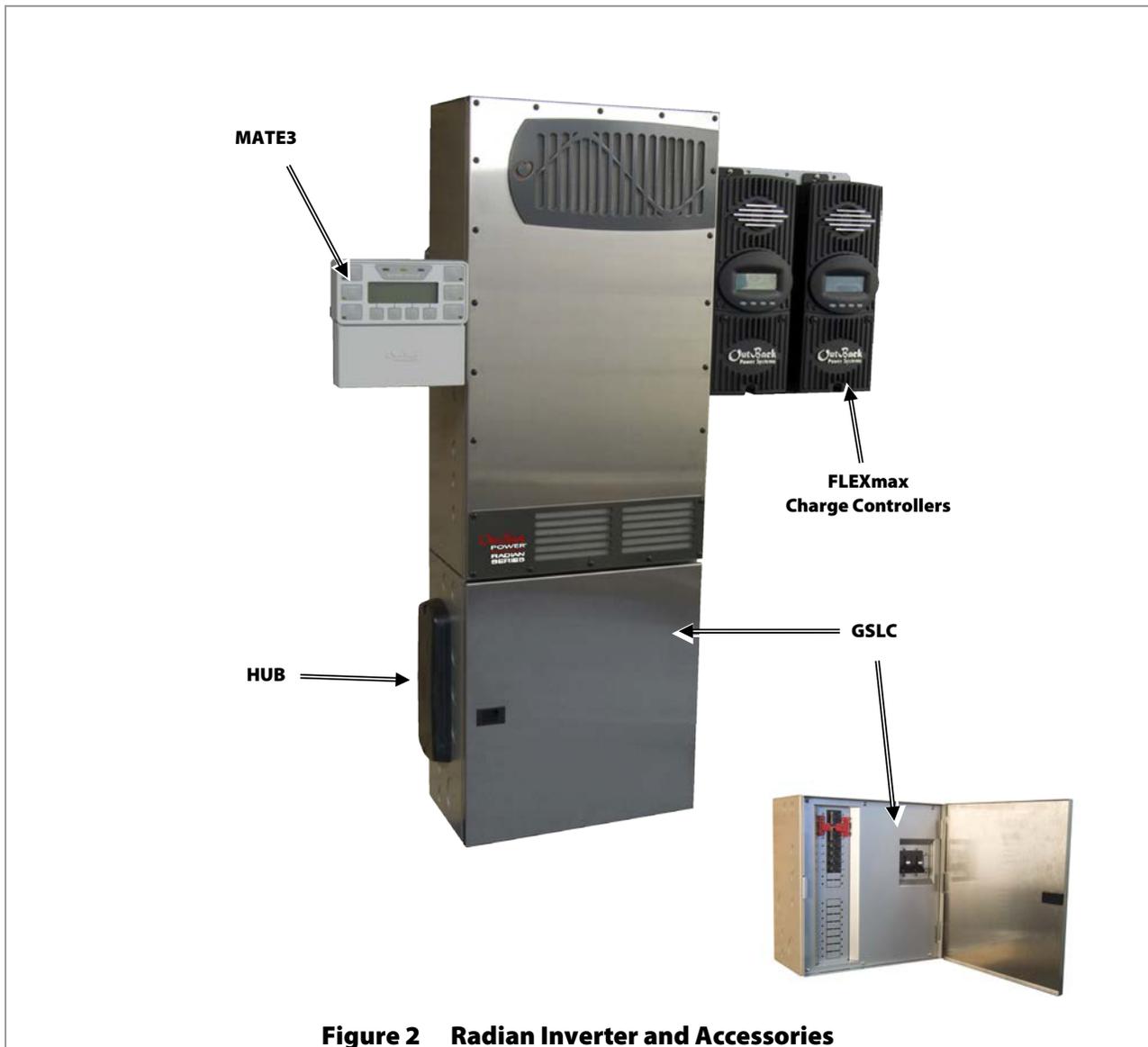


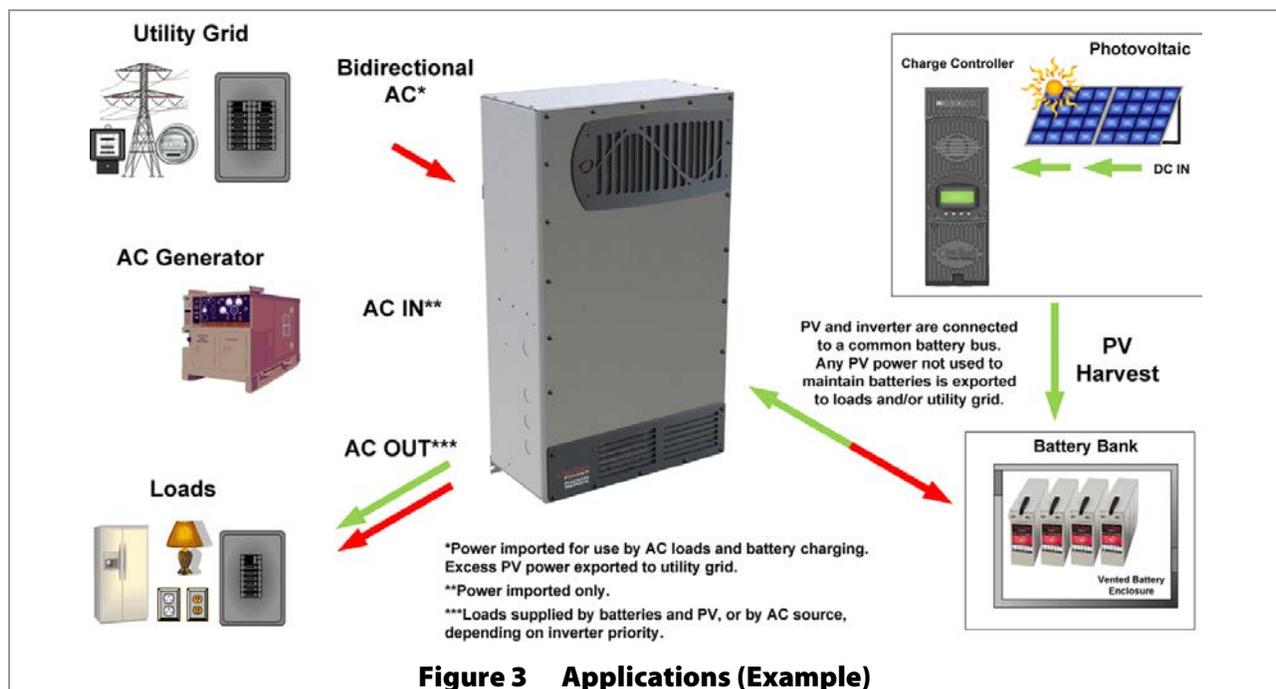
Figure 2 Radian Inverter and Accessories



Planning

Applications

The Radian Series Inverter/Charger is intended for both grid-interactive and off-grid applications. These inverters are designed to use a battery bank to store energy. They can work in conjunction with photovoltaic (PV) panels to harvest solar energy, as well as wind turbines and other renewable sources. These sources charge the battery, which in turn is used by the inverter.



The Radian inverter has six modes of operation. Each mode has functions and priorities that are intended for a designated application. Each of the Radian's two AC inputs can be set to a different operating mode, so that different applications can be supported.

NOTE: See the *Radian Series Inverter/Charger Operator's Manual* for additional information on these modes, including the benefits of using each mode.

- **Generator:** This mode is intended for a wide range of AC sources, including generators with a rough or imperfect AC waveform. The Radian will charge from the generator even when the generator is undersized or substandard.
- **Support:** This mode is intended for systems that use the utility grid or a generator. AC source size, wiring, or other limitations may require temporary assistance to run very large loads. The Radian adds inverter and battery power to the AC source to ensure that the loads receive the power they require.
- **Grid Tied:** This mode is intended for grid-interactive systems. When renewable energy sources charge the batteries above a selected "target" voltage, the Radian inverter will send the excess energy to any loads. If the loads do not use all the excess energy, then the Radian will return that energy to the utility grid.
- **UPS (Uninterruptible Power Supply):** This mode is intended for systems whose main focus is to maintain power to the loads without any interruption during a transfer to, or from, the AC input. The speed of

response in this mode has been increased so that if the AC input power is disconnected or a scheduled disconnect occurs the response time will be minimized.

- **Backup:** This mode is intended for systems that have the utility grid available. This source will flow through the Radian inverter to 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 until the power is back online.
- **Minigrid:** This mode is intended for systems that have the utility grid as an input and a sizable amount of renewable energy production. The system will run off the renewable energy production until the battery voltage falls to a specified low level. When this occurs, the Radian inverter will connect to the utility grid, which will power the loads. The Radian inverter will disconnect from the utility grid when the batteries are sufficiently recharged.

Renewable Energy

The Radian Series Inverter/Charger cannot connect directly to photovoltaic arrays, wind turbines, or other renewable sources. The batteries are the primary source of power. However, if these sources are used to charge the batteries, the inverter can use their energy by drawing it from the batteries.

The renewable source is always treated as a battery charger, even if all of its power is used immediately. The renewable source must have a charge controller or some way to prevent overcharging. OutBack Power's FLEXmax family of charge controllers can be used for this purpose, as can other products.

The GSLC will receive the mechanical and electrical connections for up to two FLEXmax charge controllers. It can receive the electrical connections for two FLEXmax Extreme charge controllers.

Battery Bank

When planning a battery bank, consider the following:

- **Cables:** Recommendations for battery cable size and length are shown on page 25. The maximum length will determine the placement of the battery bank. Other local codes or regulations may apply and may take priority over OutBack recommendations.
- **Battery Type:** The Radian inverter/charger works best with lead-chemistry batteries intended for deep discharge. These include batteries for marine, golf-cart, and forklift applications. They also include gel-cell batteries and absorbed glass-mat (AGM) batteries. OutBack Power recommends the use of batteries designed specifically for renewable energy applications. Automotive batteries are strongly discouraged and will have a short life if used in inverter applications. Nickel-based batteries are discouraged due to limitations in the Radian charger. Lithium-based batteries and other advanced battery technologies may require special considerations. Please contact OutBack Technical Support at **+1.360.618.4363** before implementing advanced battery technologies.
- The Radian inverter/charger is designed to work with a 48-volt battery bank. Before constructing a battery bank, confirm the nominal voltage of individual batteries.
- **Bank Size:** In backup or off-grid applications, the battery bank size should be calculated based on expected loads and run time.
 - ~ To prevent the inverter's charger from overcharging, the minimum recommended battery bank size is 350 amp-hours for every Radian inverter/charger installed on the system.
 - ~ If other charging devices are present, the minimum bank size should be determined by adding the inverter(s) charge rate to any other chargers and multiplying the result by five. Example: If the system's combined charge rate was 160 Adc, the minimum battery bank size should be 800 amp-hours.
- Systems intended to bridge short-term outages can use smaller battery banks. In these cases, the bank can be as low as 200 amp-hours per inverter. However, the charge rate must be decreased to half the inverter's maximum using the MATE3. (See the MATE3 manual.) One of the following conditions must also be true.
 - ~ The system is equipped with a backup generator that is programmed for automatic start, or

- ~ Typical grid loss is 30 minutes or less, or
- ~ The loads are less than 2 kW.

NOTE: If support time or load size are disproportionate to the bank size, they will cause inverter shutdown due to low battery voltage after a short time. These conditions could be detrimental to the life of a small battery bank. If this is true, the recommendations from the previous page apply instead.

- **Charger Settings and Maintenance:** A vented enclosure for the battery bank may be required by electric code and is recommended in most cases for safety reasons. It may be necessary to use a fan to ventilate the battery enclosure. (See the *Operator's Manual* for vent fan applications.)
- Batteries must be regularly maintained according to the instructions of the battery manufacturer.

| | |
|---|--|
|  | <p>IMPORTANT:</p> <p>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.</p> |
|  | <p>CAUTION: Hazard to Equipment</p> <p>Batteries can emit vapors which are corrosive over long periods of time. Installing the inverter in the battery compartment may cause corrosion which is not covered by the product warranty. (Sealed batteries may be an exception.)</p> |

Generator

The Radian inverter/charger has specific connections for a “split-phase” generator. It can work with any generator that delivers clean 120/240 Vac at 60 Hz. This product cannot work with a single-phase or three-phase generator.

- The Radian inverter/charger can provide a start signal to control an automatic start generator. If automatic generator starting is required, the generator must be an electric-start model with automatic choke and two-wire start capability. (See page 30.) For other configurations, additional equipment may be required.
- In all cases, the inverter may need to be programmed using the MATE3 according to the specifications of the generator and the requirements of the system. (See the *Radian Series Inverter/Charger Operator's Manual* and the *MATE3 Owner's Manual*.) Parameters to be programmed may include generator size, automatic starting requirements, and potential fluctuations in generator AC voltage.

Generator Sizing

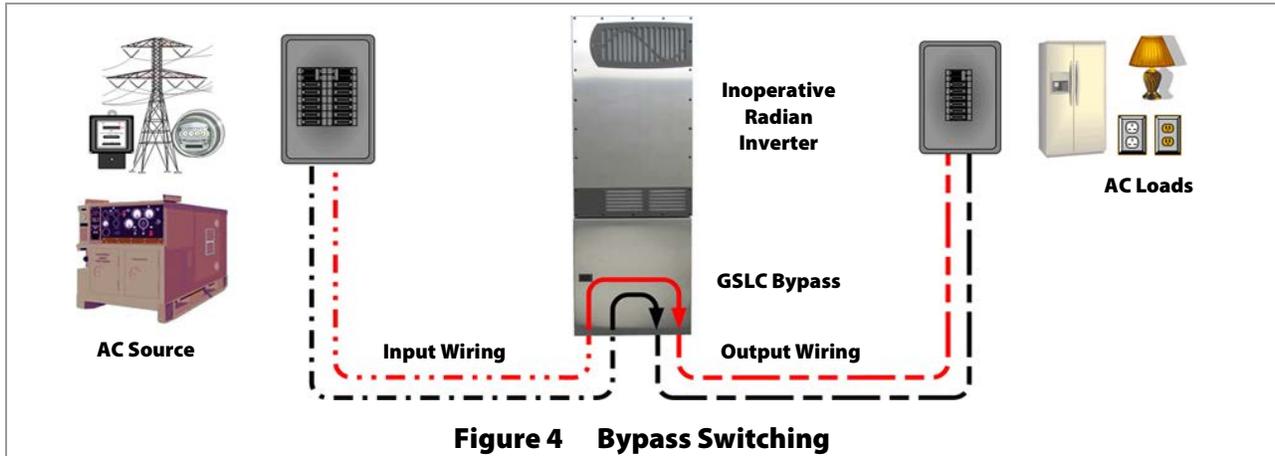
A generator should be sized to provide enough power for all the loads and the battery charger.

- Available generator power may be limited by ratings for circuit breakers and/or generator connectors. The maximum allowed AC circuit breaker size is 50 Aac per Radian inverter/charger.
- The generator must be able to provide current to all inverters. Minimum generator wattage¹ is usually recommended to be 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.
- A generator that is to be installed in a building should not have a bond between the neutral and ground connections. Installations in North America are expected to bond the neutral and ground at the main electrical panel.

¹This is the wattage value after de-ratings for peak versus continuous power, for load power factor considerations, for fuel type, for altitude, and for ambient temperature.

Maintenance Bypass Switching

Inverter systems are often equipped with AC maintenance bypass switches or interlocks. If the inverter system ever needs to be shut down or removed, the AC sources and loads must be disconnected. A bypass device allows the AC source to deliver power directly to the loads, bypassing the inverter. This can minimize disruption to the system and avoids the need for extensive rewiring.

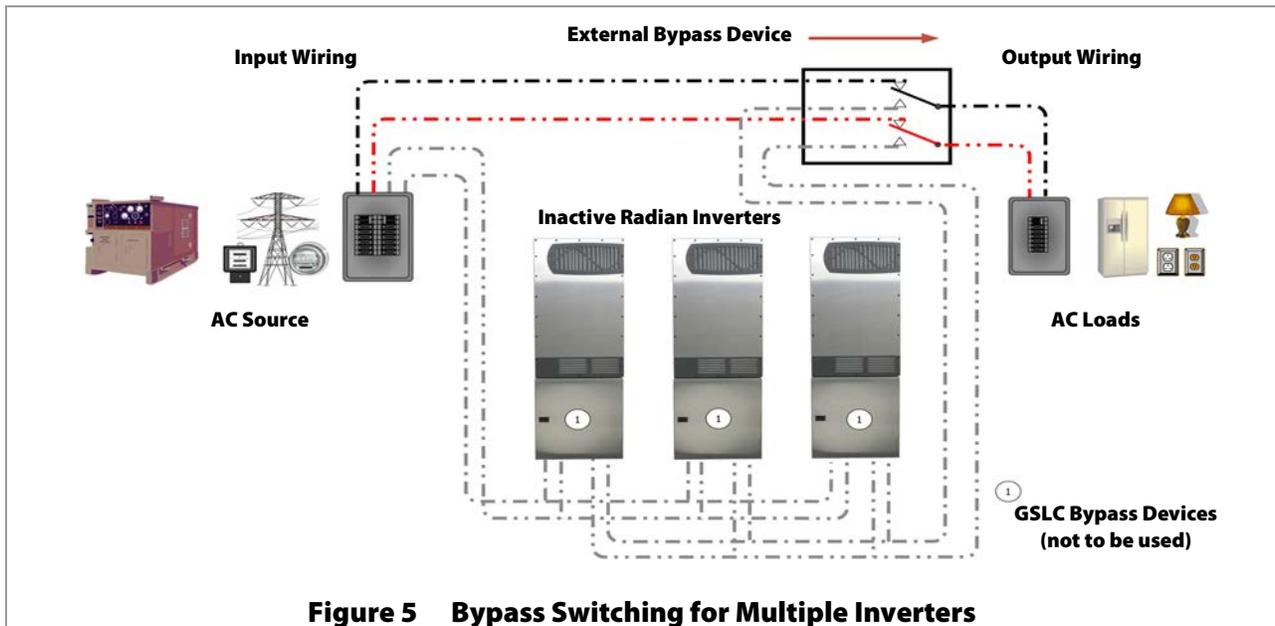


The GSLC (see page 12) can be equipped with bypass circuit breakers for this purpose. However, if multiple Radian inverters are stacked in a single system, then the bypass function must be simultaneous for all inverters. The GSLC bypass kits operate independently, not simultaneously, and should not be installed in this kind of application. Both manual and automatic double-pole, double-throw bypass switches are commonly available in a range of sizes and options. These are highly recommended for systems with more than a single inverter.



WARNING: Shock Hazard or Equipment Damage

Using independent bypass devices on multiple inverters can result in power being routed to inappropriate places. This could create an electric shock hazard or damage the equipment.





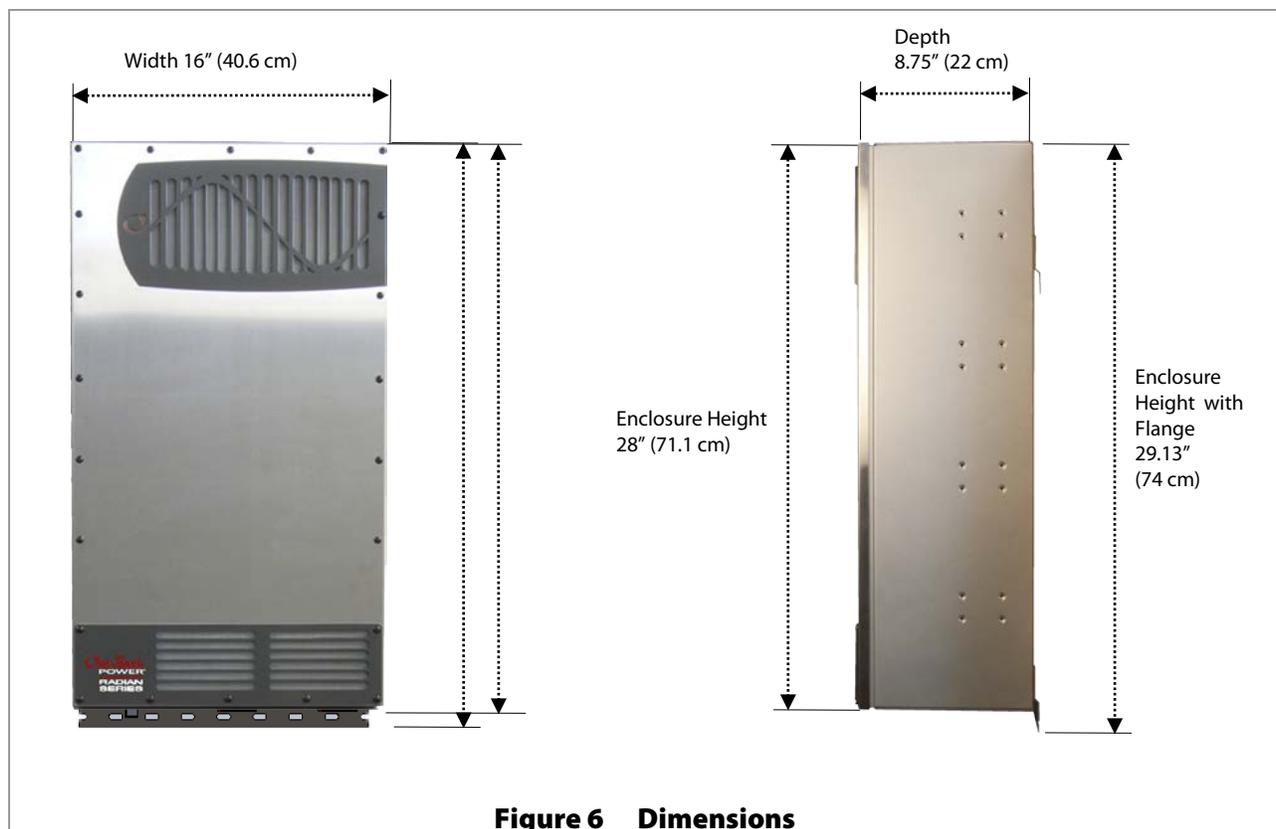
Installation

Location and Environmental Requirements

Radian Series Inverter/Chargers must be located in a weather-proof enclosure or enclosed area. These inverters are not designed for exposure to water or excessive wind-blown dust and debris.

- The Radian inverter must be wall-mounted in an upright position. The inverter is not approved for mounting in any other position or orientation.
- Recommended minimum clearance is 2 to 4 inches (5 to 10 cm) for the front and top of the inverter.
- The sides and bottom may be enclosed or obscured with no restriction when mounting accessory devices or one other Radian Series Inverter/Charger. If more than two Radian inverters are installed side by side with the GSLC, the inverters should be separated by at least 0.9 inches (2.3 cm) to accommodate the GSLC doors.
- The Radian inverter will function best if operated in a temperature range of 32°F to 77°F (–20°C to 25°C). At temperatures up to 122°F (50°C), all inverter components meet their specifications, but the inverter's power is derated. It can function in environments as cold as –40°F (–40°C) and as warm as 140°F (60°C), but it may not meet all component specifications. This temperature range also applies to storage.
- The specifications are listed in the *Radian Series Inverter/Charger Operator's Manual*.

Dimensions



Tools Required

The following tools may be required for this installation:

- Wire cutters/strippers
- Wrench and socket sets; should include torque and ratchet wrenches; also reversible (stubby) wrenches for narrow access
- Long-nose pliers
- DVM or Voltmeter
- Insulated screwdriver set; should include a #2 Phillips screwdriver 15-16" long

Mounting

- Two or more people may be needed to install the Radian inverter/charger due to its weight.
- Mount and secure each component before attaching any wiring. The bottom of the inverter must be enclosed to meet NEC requirements. The GS Load Center was specifically designed for this purpose.
- Avoid large air gaps behind the Radian inverter/charger and its mounting plate. These can result in louder mechanical noise during heavy inverting or charging. Mount the plate on a flat, solid mounting surface.



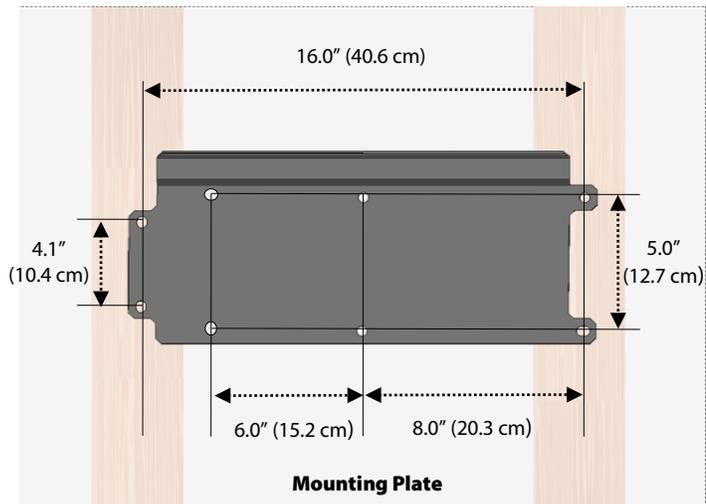
IMPORTANT:

Use correct fasteners to secure the mounting plate and the Radian inverter/charger to the mounting surface. OutBack cannot be responsible for damage to the product if it is attached with inadequate fasteners.

The Radian inverter/charger comes equipped with a mounting plate, as shown in Figure 7.

The Radian inverter is mounted using these steps.

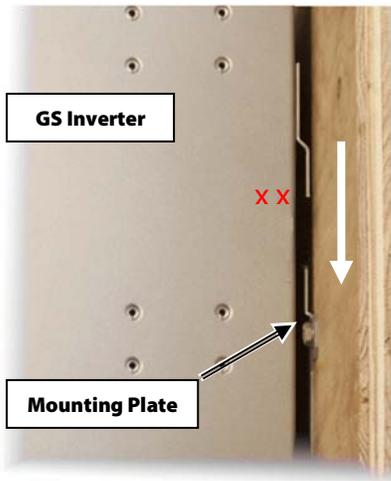
1. The mounting plate is to be screwed or bolted directly to a solid mounting surface such as wall studs. (See Figure 7.) Lag screws are provided for this purpose.
 - ~ The plate is designed to mount on wall studs with a spacing of 16" (40.6 cm). If the studs have a different spacing, plywood or similar material should be installed over the studs. This material should be 1/2" size or thicker. The mounting plate can be installed on the plywood surface.
 - ~ If multiple Radian inverter/chargers are being installed, all mounting plates should be installed first. The inverters can be mounted and secured one at a time when this is done.



Continued on the next page...

Figure 7 Installing the Mounting Plate

...continued from the previous page...



2. Place the Radian inverter against the wall and slide it directly over the upper lip of the mounting plate. The inverter's mounting flange should come to rest within the lip so that it hangs securely.

To assist in alignment, dimples have been placed on the side of the unit to mark the lower edge of the flange. In the picture to the left, the two X symbols show the location of the dimples.

3. Align the left edge of the inverter with the left edge of the mounting plate. This will expose the right edge of the plate, allowing easy installation of another Radian inverter/charger in the future. All additional inverters are mounted to the right of the existing unit.

The unit shown to the right is not aligned with the mounting plate, as the plate is still visible. In this example, it should slide to the left so that the plate is entirely covered.



NOTE: If the GSLC is used with the Radian inverter, the following step should be omitted.

4. Once aligned, secure the Radian inverter to the stud using a lag screw (provided) in the left corner of the inverter's bottom flange. Securing the inverter this way will prevent it from dislodging from the mounting plate in the event of an earthquake or similar event.

NOTE: The left corner is used for securing the inverter to a stud. If the Radian inverter is mounted on plywood or a similar wide-area mounting surface as shown, any of the slots in the mounting flange may be used.



WARNING: Shock Hazard

When the inverter is used with other metal chassis, make sure that all chassis are grounded appropriately. (See the grounding instructions on page 23.) Grounding other chassis may involve metal-to-metal contact, or separate ground wires.

Figure 8 Mounting the Inverter

Accessory Mounting

The top of the GS Load Center (GSLC) connects to the bottom of the Radian inverter using four keyhole slots. The keyhole slots fit over four screws on the bottom of the inverter that will secure the GSLC to the inverter when they are tightened.

(The long screwdriver recommended on page 18 may be needed to reach these screws.) The GSLC should be secured to the wall using screws or wall anchors. The GSLC also makes a mechanical connection to the Radian using bus bars that bolt to the inverter's DC terminals. Other connections are wired as necessary. For more information on these connections, see the *GS Load Center Installation Manual*.

Several system components can mount directly onto the Radian inverter or the GSLC. The MATE3 System Display and the HUB Communications Manager can easily be mounted on the left side of the system. Up to two FLEXmax 60 or 80 charge controllers can be mounted on its right side.

NOTE: The FLEXmax controller requires mounting brackets (see below). The conduit provided with these brackets is long enough to wire the FLEXmax directly to the GSLC. Additional conduit may be necessary when mounting on the inverter. The image on the right shows GSLC mounting. See Figure 2 on page 12 for other configurations.



For the MATE3:

To fit on the Radian inverter's left side, the MATE3 requires the FW-MB3 mounting bracket. Holes are provided on the upper and lower left side to attach the FW-MB3. For more information, see the FW-MB3 instruction sheet.

For the HUB:

To fit on the Radian inverter's left side, the HUB uses two mounting holes and three knockouts.

For the FLEXmax charge controller:

To fit on the Radian inverter's right side, the FLEXmax charge controllers require the FW-CCB or FW-CCB2 mounting brackets. To accommodate many possible mounting requirements, four sets of mounting holes have been provided for the brackets.

NOTE: The OutBack FLEXmax Extreme should be installed on the wall to either side of the GSLC for direct wiring access and does not require additional brackets.

Figure 9 Mounting for System Components

Removing Front Cover

The front cover must be removed in order to access the Radian inverter's AC terminals and other connections. These include the "Remote" and "Batt Temp" ports, as well as several sets of auxiliary terminals.

Twenty-two machine screws are located around the perimeter. Remove these screws with a Phillips screwdriver. Once they are removed, the cover can be lifted off.

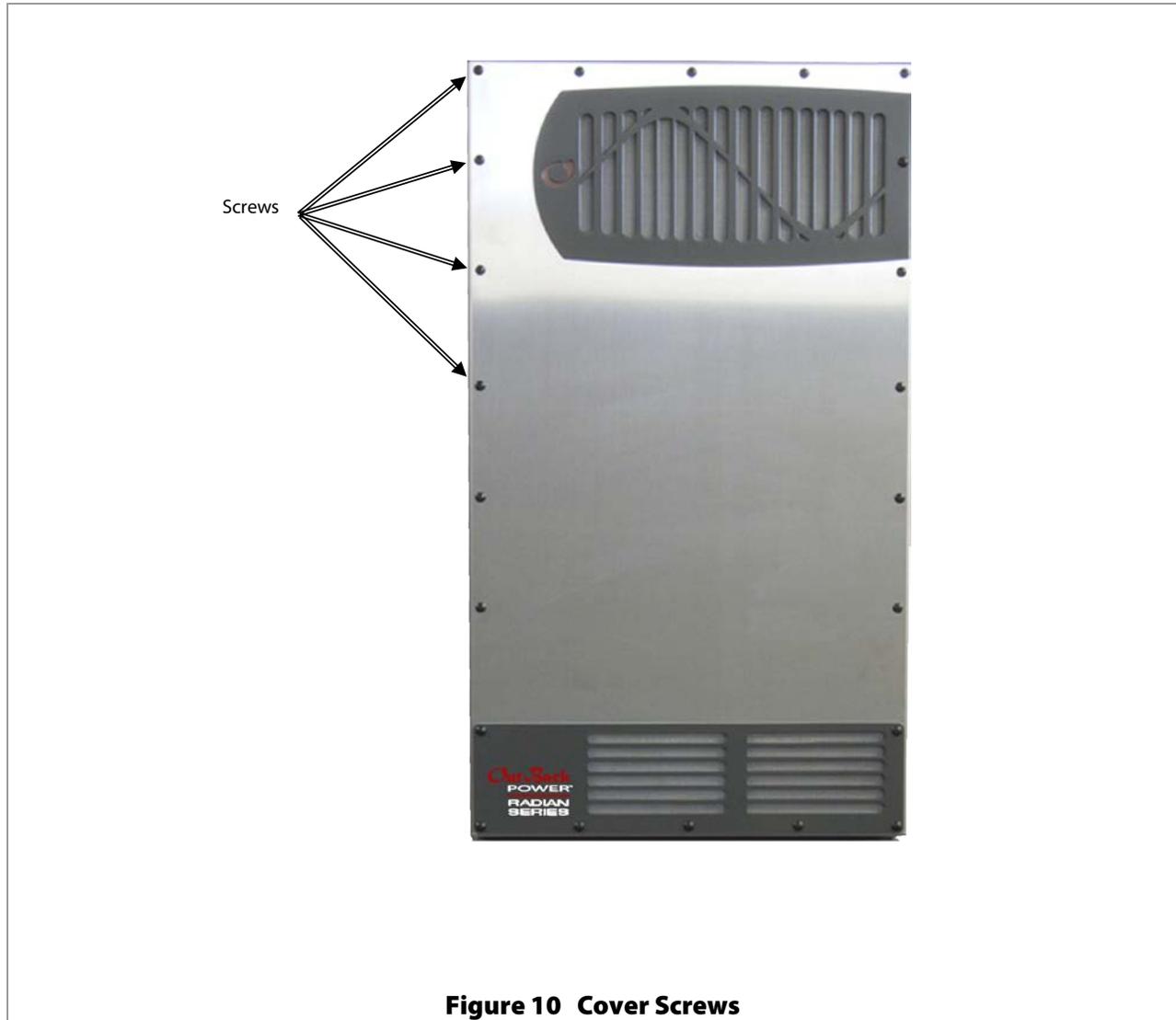
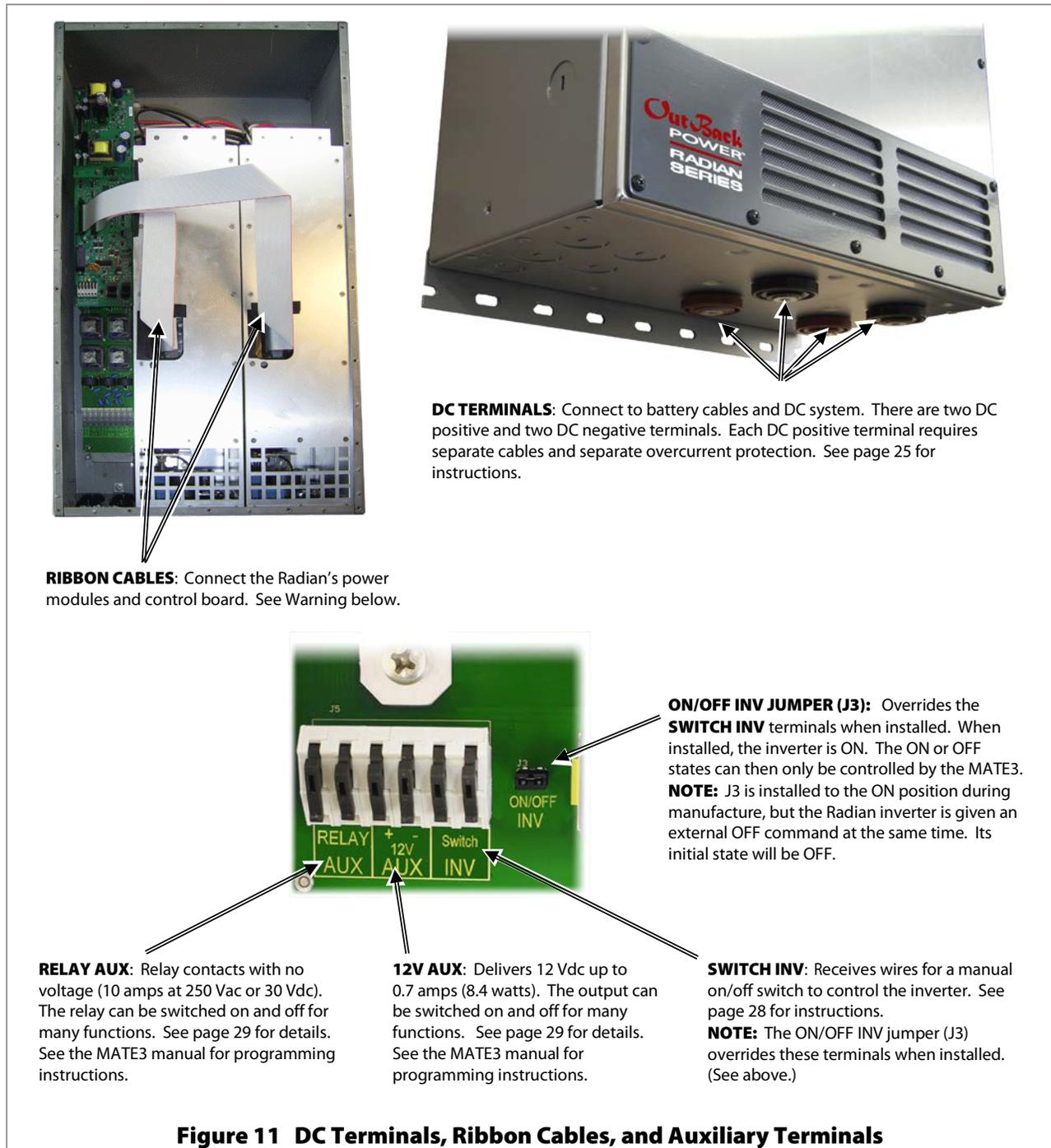


Figure 10 Cover Screws

NOTE: The Radian inverter may ship with only a few screws installed to make it easier to perform the initial installation. The remaining screws are included in the hardware kit.

Terminals and Ports



WARNING: Shock Hazard and Equipment Damage

It may be necessary to remove the ribbon cables in the course of servicing the Radian. (This is detailed in the Radian service manual.) The cables must never be removed until all power has been disconnected from the Radian for a minimum of one minute. If the cables are removed prematurely, the Radian's capacitors will retain a sizable charge, which can cause electrical shock or severe equipment damage during normal handling. This damage is not covered under the unit's warranty.

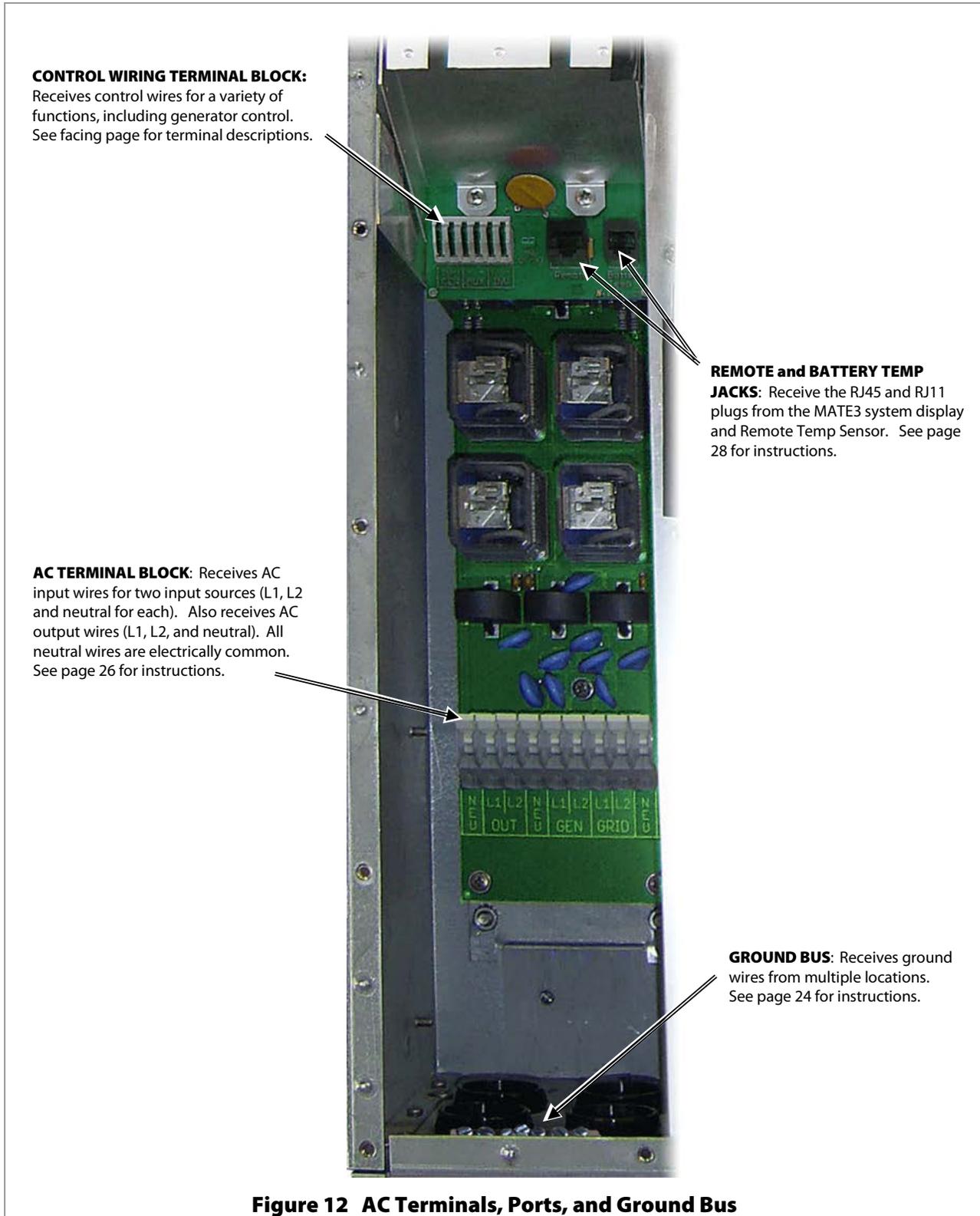


Figure 12 AC Terminals, Ports, and Ground Bus



WARNING: Shock Hazard

After installation, do not remove the covers while the inverter has any source of power. See the *Operator's Manual* for the shutdown procedure before removing the covers.

Grounding

| | |
|---|--|
|  | <p>WARNING: Shock Hazard</p> <p>The unit must be connected to a grounded, permanent wiring system. If a bond is made between neutral and ground, make sure only one bond is present in the AC system at any time. Some codes require the bond to be made at the main panel only. (The GSLC is equipped with its own bond, which may need to be removed.)</p> |
|  | <p>WARNING: Shock Hazard</p> <p>For all installations, the negative battery conductor should be bonded to the grounding system at only one point. If the OutBack GFDI is present, it can provide the bond. (The GSLC is also equipped with its own bond, which may need to be removed.)</p> |
|  | <p>IMPORTANT:</p> <p>OutBack products are not designed for use in a positive-grounded system. If it is necessary to build this system with OutBack products, contact OutBack Technical Support at +1.360.618.4363 before proceeding. Additionally, consult the online forum at www.outbackpower.com/forum/, where this subject has been discussed extensively.</p> |

Table 3 Ground Conductor Size and Torque Requirements

| Terminal Location | Minimum Conductor Size | Torque Requirements |
|-------------------|---|---------------------|
| Ground TBB | #8 AWG (0.013 in ²) or 10 mm ² | 25 in-lbs/2.8 Nm |

The inverter's ground terminal bus bar (TBB) is used for making all ground connections to other parts of the system. Examples include inverter equipment grounding, generator grounding, load panel grounding, and main earth ground wire.

This TBB accepts up to #4 AWG (0.033 in²) or 25 mm²wire.

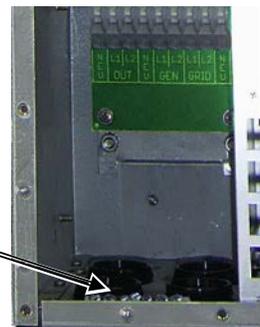


Figure 13 Chassis Ground TBB

DC Wiring

| | |
|---|--|
|  | <p>CAUTION: Equipment Damage</p> <p>Never reverse the polarity of the battery cables. Always ensure correct polarity.</p> |
|  | <p>CAUTION: Fire Hazard</p> <p>Always install a circuit breaker or overcurrent device on each DC positive conductor to protect the DC system.</p> |
|  | <p>IMPORTANT:</p> <p>The DC terminals must be encased in an enclosure to meet NEC requirements.</p> |

Table 4 DC Conductor Size and Torque Requirements

| Inverter | Nominal DC Amps (Minimum, per breaker) (Derated 125%) | Conductor Size (Minimum, per breaker) | Breaker Size |
|--------------------------|---|--|--------------|
| GS8048 | 104 | 2/0 AWG (0.105 in ²) or 70 mm ² | 175 Adc |
| Terminal Location | | Torque Requirements | |
| Inverter DC Terminals | | 60 in-lb (6.9 Nm) | |
| Battery Terminals | | See battery manufacturer's recommendations | |

When installing DC cables:

- Make certain DC circuit breakers are turned to the off position, or fuses are removed, before proceeding.
- Battery positive and negative cables should be no longer than 10 feet (3 meters) each, to minimize voltage loss and other effects.
- Note information in Table 4, but refer to NEC or applicable codes for absolute cable size recommendations.
- The modular construction of the Radian requires the use of two DC circuit breakers or fuses.
- The cables for each overcurrent device must **each** be sized appropriately. Alternately, a single cable or bus may be used if sized to the minimum total ampacity.
- The cables listed above are for each inverter in a system. In a system with multiple inverters, each inverter requires its own cables and overcurrent devices of the size indicated.
- Install all overcurrent devices on the positive cable.
- Tie, tape, or twist positive and negative cables together to reduce self-inductance. Run positive and negative cables through the same knockouts and conduit.
- The inverter's battery terminal is a threaded hole which accepts a hex bolt (provided). Install battery cable lug, washers, and bolt in the order illustrated. The battery cable lug must be the first item installed. It must make solid contact with the surface. It should have a 5/16 inch (0.79 cm) diameter hole.

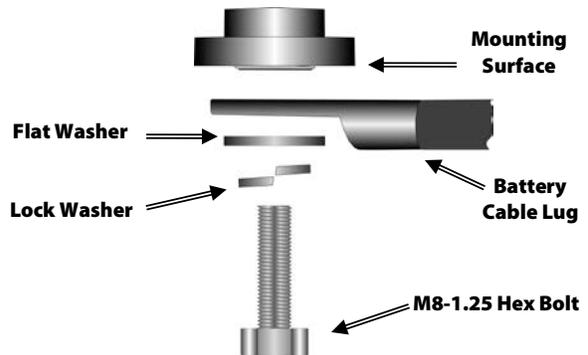


Figure 14 DC Cable Hardware (underside of inverter)



CAUTION: Fire Hazard

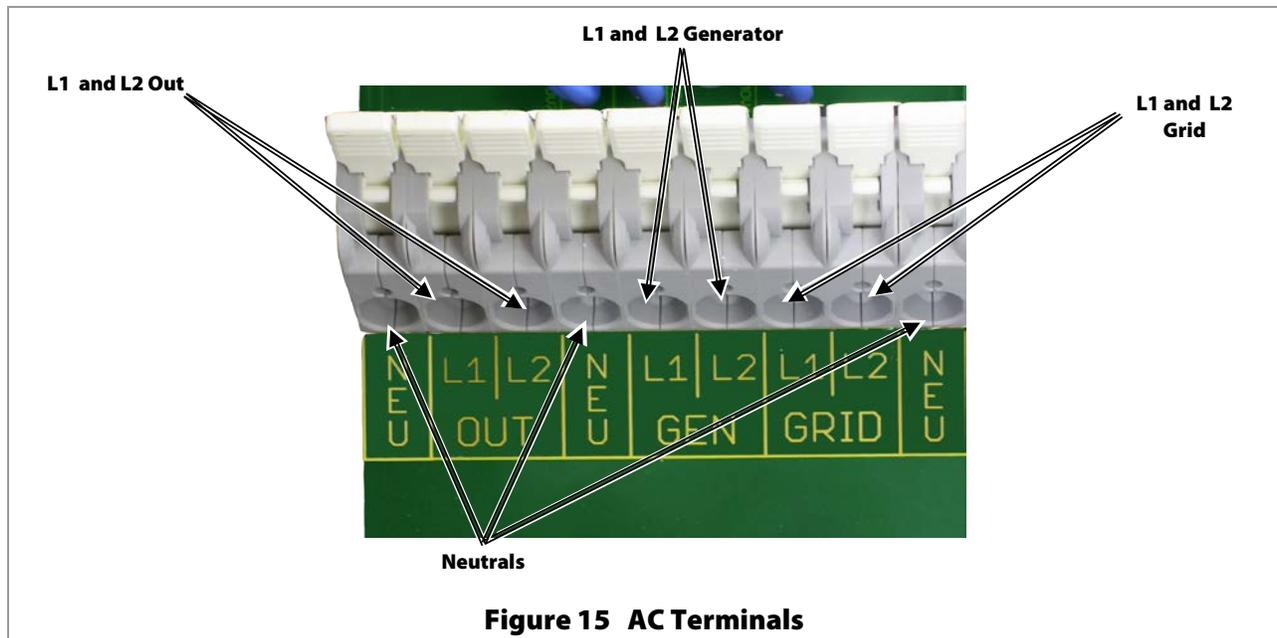
Never install extra washers or hardware between the mounting surface and the battery cable lug. The decreased surface area can build up heat.

AC Wiring

| | |
|---|--|
|  | <p>WARNING: Shock Hazard</p> <p>Ensure there is only one AC neutral-ground bond at any time. Some codes require the bond to be made at the main panel only. The GSLC is equipped with its own bond, which may need to be removed.</p> |
|  | <p>IMPORTANT:</p> <p>The AC input and output must be protected with branch-rated circuit breakers of up to 50 Aac maximum size to meet NEC or other code requirements.</p> |

The Radian inverter/charger's AC terminal block has nine positions for AC wires. The minimum recommended wire size is #8 AWG (0.013 in²) or 10 mm². Larger wire gauges may be required for specific conditions. The largest size that can be used with the terminals is #6 AWG (0.021 in²) or 16 mm² wire.

The inverter makes its AC connections using spring-loaded clamps. It is necessary to strip approximately ½ inch (1 cm) of insulation from the end of each wire. Other tools are not required.



The terminals labeled **L1** and **L2 Grid** are used to connect to the two utility grid “hot” wires. The L1 and L2 wires are usually black and red respectively, and read 120 Vac each when measured with respect to neutral. In a standard service, L1 and L2 are 180 degrees out of phase, and should read 240 Vac when measured from one to the other.

The **L1** and **L2 Gen** terminals are used to connect to the “hot” wires on a 120/240 Vac generator. All system wiring must comply with national and local codes and regulations.

NOTE: The 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. (See the *Operator's Manual*). If necessary, the **Gen** terminals can accept grid power. The opposite is also true.

The Radian cannot take voltage other than 120/240 Vac. If wires are 120 Vac each, but do not measure 240 Vac from one to the next (such as two legs of a 3-phase source), it will not accept the power.

The AC source(s) can power both battery charger and loads if sized correctly. Use the source amperage to determine actual maximum draw. Size input circuit breakers accordingly.

The terminals labeled **L1** and **L2 Out** are used to connect the Radian inverter to the load circuits. These terminals also transfer power from an input source if it is available. They can carry up to 55 amps using the inverter's transfer relay. Size load circuit breakers accordingly.

Three **Neu** terminals are available. These terminals are electrically common. Any of them can be used to connect to neutral wires from various parts of the system. The most common connections are to the neutral bus on the main panel or utility grid service, the neutral bus on the output load panel, the neutral bus in the GSLC, and the neutral wire from a generator.

A Ground TBB is also available if multiple ground connections are needed (see Figure 13 on page 24).

AC Sources

The inverter's transfer relay is normally set to provide inverter power to the output. When an AC source is present and accepted, the transfer relay switches to transfer the AC source power to the loads. (See the *Radian Series Inverter/Charger Operator's Manual* for the inverter's acceptance criteria.)

The Radian inverter has connections for two AC sources for ease of installation. Each source is transferred with a separate relay. However, internally it can only connect to one AC source at a time. It cannot use both utility grid and generator power at the same time. If presented with two sources of power, its default setting is to accept utility grid. (See the MATE3 manual for instructions on changing the source priority.)

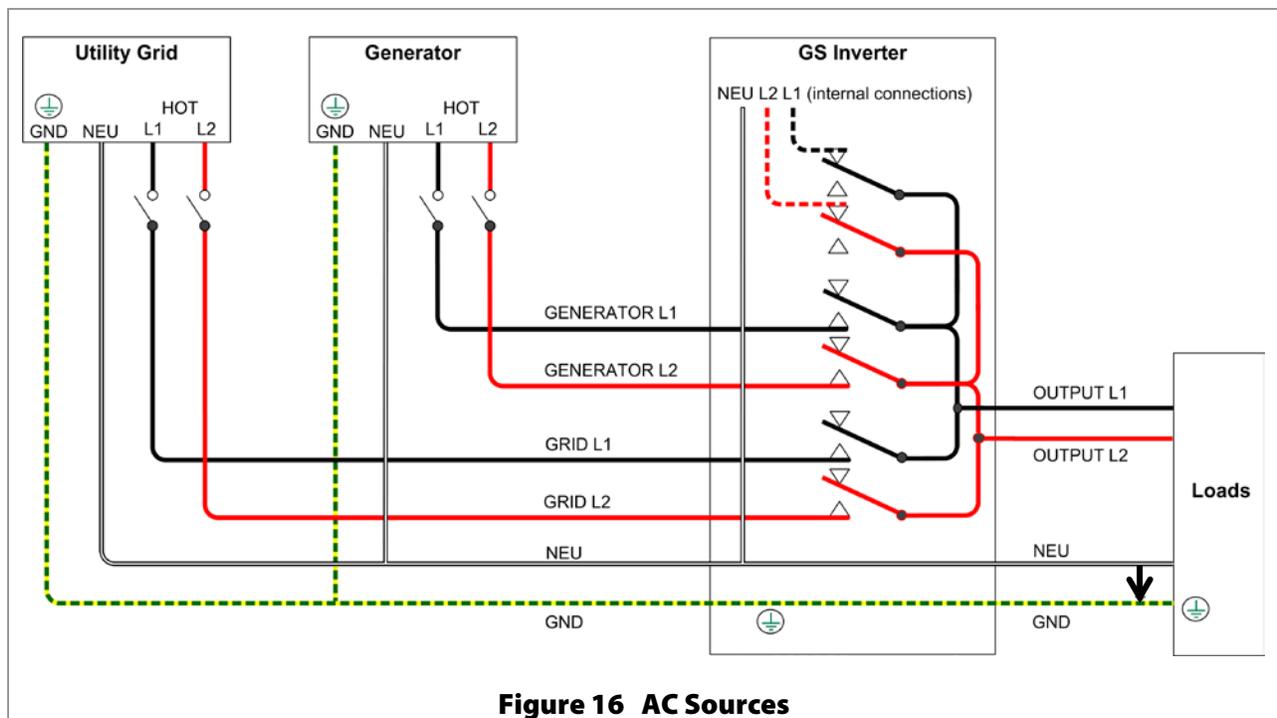
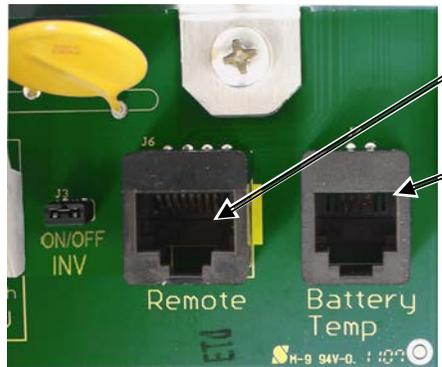


Figure 16 AC Sources

The arrow between the output neutral and ground wires indicates that these two wires have been bonded together, usually at the main electrical panel. Only one bond should be made between neutral and ground at any time. See page 26. If a generator is present in a building-based installation, the generator's neutral and ground should be isolated.

Accessory Wiring



Remote port
Battery Temp port

The upper board has ports for both the Remote Temperature Sensor (RTS) and the MATE3 system display. The system display port is labeled Remote. The RTS port is labeled Battery Temp.

If a HUB is in use, it occupies the inverter's Remote port.



MATE3 or HUB cable (RJ45, 8-conductor, CAT5 non-crossover)

RTS cable (RJ11, 4-conductor, telephone)

See the *Operator's Manual* for more information on the RTS.

Figure 17 Accessory Connections

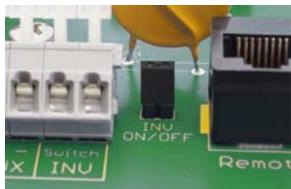


Additional Ports
MATE port

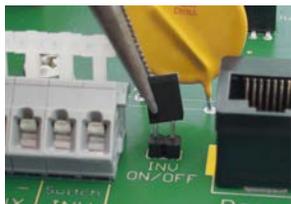
When a HUB occupies the inverter's Remote port, the MATE3 connects directly to the HUB's "MATE" port.

Inverters plug into ports 1 and above. Charge controllers and other devices plug into additional ports after the last inverter is connected. See *Stacking* on page 35 for information on connecting inverters. See the HUB manual for other devices.

The ON/OFF INV jumper bridges two pins. This jumper (J3) parallels the two Switch INV terminals on the terminal block. If either set of connections is closed, the inverter is ON. (Although the jumper is factory-installed to the ON position, the inverter is given an OFF command before leaving the factory and will initially be OFF.)



Jumper On
Jumper Off



Removing the jumper will turn the inverter OFF if it is not already. To remove the jumper, use long-nose pliers or a similar tool.

Once the plastic ON/OFF INV jumper has been removed, the Switch INV terminals on the terminal block can be used to wire a manual on/off switch.

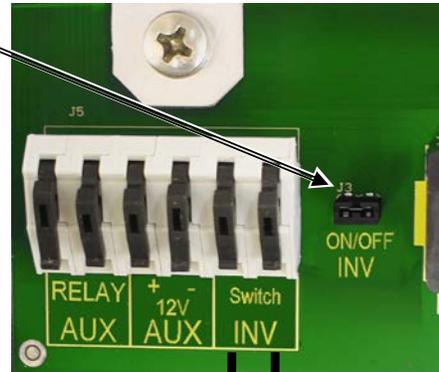


Figure 18 ON/OFF Jumper and Connections

AUX Wiring

The Radian inverter has two sets of terminals which can respond to different criteria and control many functions. These include cooling fans, vent fans, load diversion, fault alarms, and the Advanced Generator Start (AGS) function.

The 12V AUX terminals are a switched 12 Vdc power supply. They can control any of the Auxiliary Output functions available in the MATE3.

The 12V AUX terminals can supply up to 0.7 amps at 12 Vdc (8.4 watts). This is sufficient to drive a small fan or a relay controlling a larger device. The terminals accept wire up to #14 AWG (0.0032 in²) or 2.5 mm². This circuit contains electronic overcurrent protection, which resets after being overloaded. No additional fuses are required for the 12V AUX terminals.

The RELAY AUX terminals are “dry” relay contacts with no voltage. Their most common function is to serve as a switch for the start circuit of an automatic generator using the generator control functions. However, they can be programmed for other Auxiliary functions as well. These terminals can conduct up to 10 amps at up to 30 Vdc or 250 Vac.



CAUTION: Equipment Damage

This circuit has no overcurrent protection. A fuse of no larger than 10 amps must be installed to protect the circuit. Since the internal circuitry of the RELAY AUX terminals do not incorporate overcurrent protection, it is the responsibility of the installer to ensure the circuit is protected. Internal failure that results from lack of protection is not covered by the Radian warranty.

Each set of terminals has its own set of programmed criteria.

NOTE: The menus for each set of terminals have identical options available, but can control independent functions. For example, the RELAY AUX terminals can be used for generator control while the 12V AUX terminals can simultaneously be used to control a vent fan in the battery box.

Note also that the control logic for the terminals is not always located in the same device. The inverter’s Auxiliary Output functions are located within the inverter itself. Although they require the system display (MATE3) for programming, they will function even if the MATE3 is removed. However, the programming for AGS is located within the MATE3 and will not work if the MATE3 is removed. Other devices may be able to control the inverter’s terminals. See the appropriate manuals for more information.

For generator control, see page 31. For all other functions, see the *MATE3 Owner’s Manual* and the *Radian Series Inverter/Charger Operator’s Manual*.)

In this example, the 12V AUX terminals directly drive a 12-volt vent fan. The + and – wires on the fan are connected to the AUX terminals.

NOTE: If another device is used, such as a larger fan, it must not draw more than 0.7 amps.

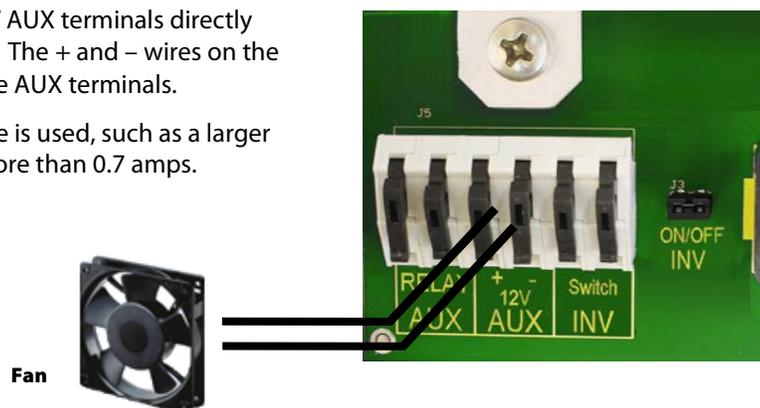
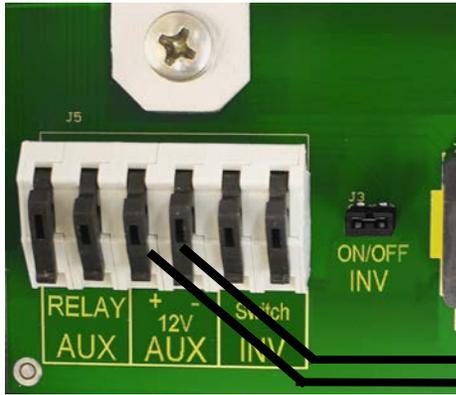
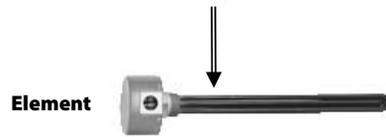
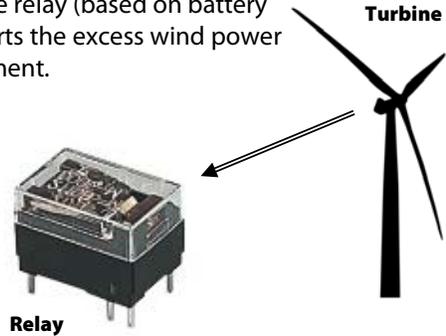


Figure 19 AUX Connections for Vent Fan (Example)

Installation



In this example, the 12V AUX terminals drive a relay that diverts wind power. The relay's coil is connected to the 12V AUX terminals. When the AUX function closes the relay (based on battery voltage), the relay diverts the excess wind power to a water heating element.



NOTE: Relays and elements shown are examples only and may vary depending on the installation.

Figure 20 AUX Connections for Diversion (Example)

Generator Control

The RELAY AUX terminals can most easily perform “two-wire” generator start. A two-wire-start generator is the simplest type, where the cranking and starting routine is automated. It usually has a single switch with two positions that is turned ON to start, OFF to stop.

Two-Wire-Start (RELAY AUX Terminals)

The RELAY AUX terminals can be wired in place of the generator’s start switch as shown below. This method is only advised if the generator’s starting circuit is triggered by continuity. (This circuit must use fewer than 10 amps.)



CAUTION: Equipment Damage

This circuit has no overcurrent protection. A fuse of no larger than 10 amps must be installed to protect the circuit. Since the internal circuitry of the RELAY AUX terminals does not incorporate overcurrent protection, it is the responsibility of the installer to ensure the circuit is protected. Internal failure that results from lack of protection is not covered by the Radian warranty.

In other cases, or in the case of a three-wire-start generator, the inverter should use the 12V AUX terminals instead, in conjunction with a three-to-two wire converter. (See pages 32 and 33.)

Either the MATE3 or the FLEXnet DC battery monitor can be programmed to perform automatic generator start using these terminals. See the MATE3 or FLEXnet manuals for programming instructions.



Figure 21 Two-Wire Generator Start (RELAY AUX)

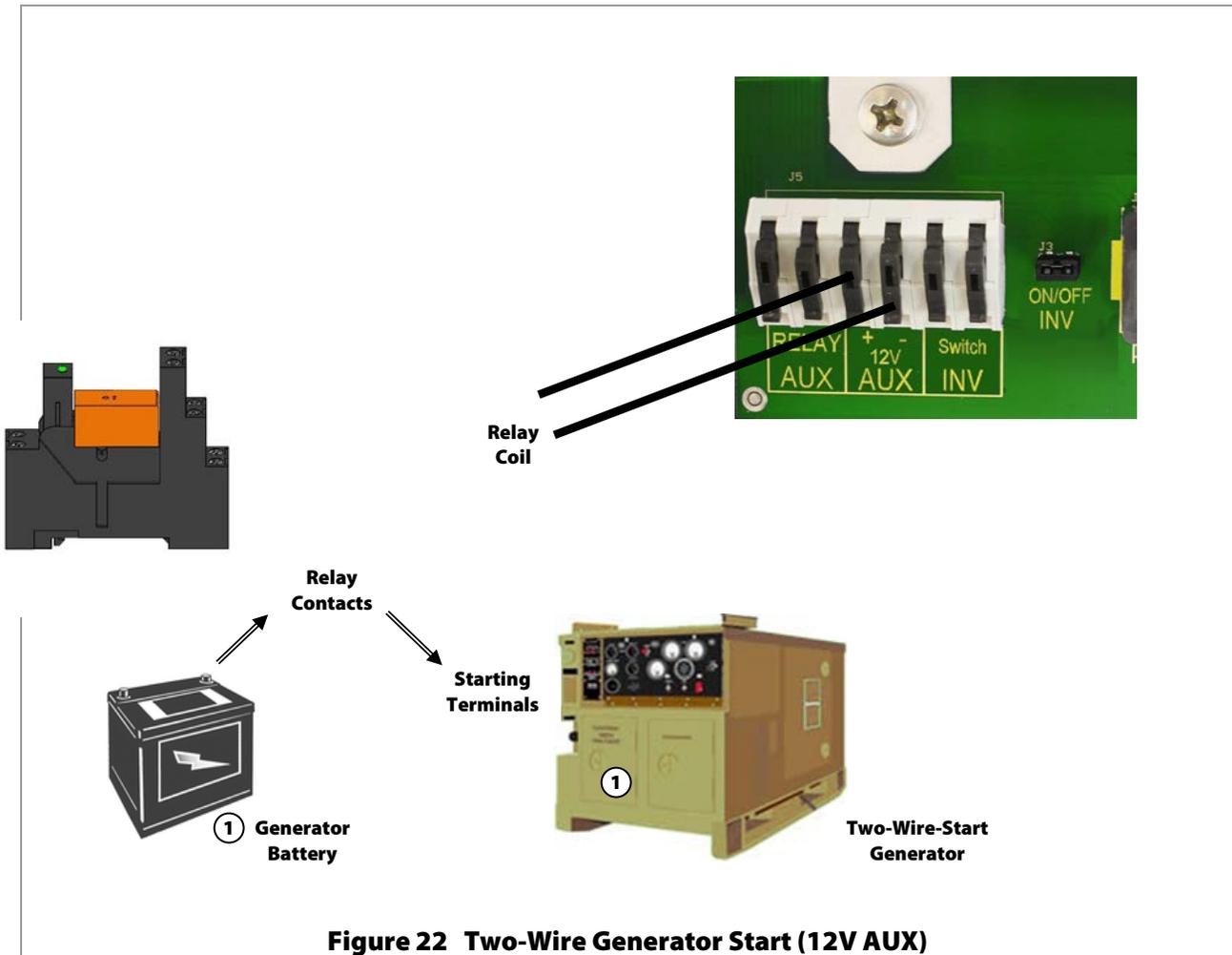
Installation

Two-Wire-Start (12V AUX Terminals)

The 12 Vdc signal provided by the 12V AUX terminals can be switched on and off to provide a start signal. It is not usually recommended to connect the AUX terminals directly to the generator, but to use the 12V AUX terminals to energize the coil of a 12 Vdc automotive or similar relay.

Depicted is the OutBack FLEXware Relay Assembly, which is sold for this purpose. The relay contacts can serve in place of the generator's start switch. The battery shown below is depicted for clarity. In most cases, it is part of the generator's internal starting circuit and is not an external component.

The drawing below is one example of a possible arrangement. Specific arrangements, relays, and other elements depend on the requirements of the installation and of the generator.



Three-Wire-Start

A “three-wire-start” generator has two or more starting circuits. It usually has a separate switch or position for cranking the generator. A three-wire generator has fewer automated functions than a two-wire. It usually requires multiple controls for starting, running, or stopping. The inverter terminals cannot control this type of generator without using a three-wire to two-wire conversion kit.

Atkinson Electronics (<http://atkinsolelectronics.com>) is one company that makes these kits. The Atkinson GSCM-Mini is intended to work with OutBack inverters.

NOTE: The conversion kit requires a 12-volt signal which the RELAY AUX terminals cannot provide. The 12V AUX terminals may be used to operate the conversion kit, as shown in Figure 23 .

If the AUX terminals are being used for another purpose, it may be necessary for the RELAY AUX terminals to control an external relay and 12-volt source in conjunction with the conversion kit. The wiring and requirements for this arrangement will depend on the circumstances.

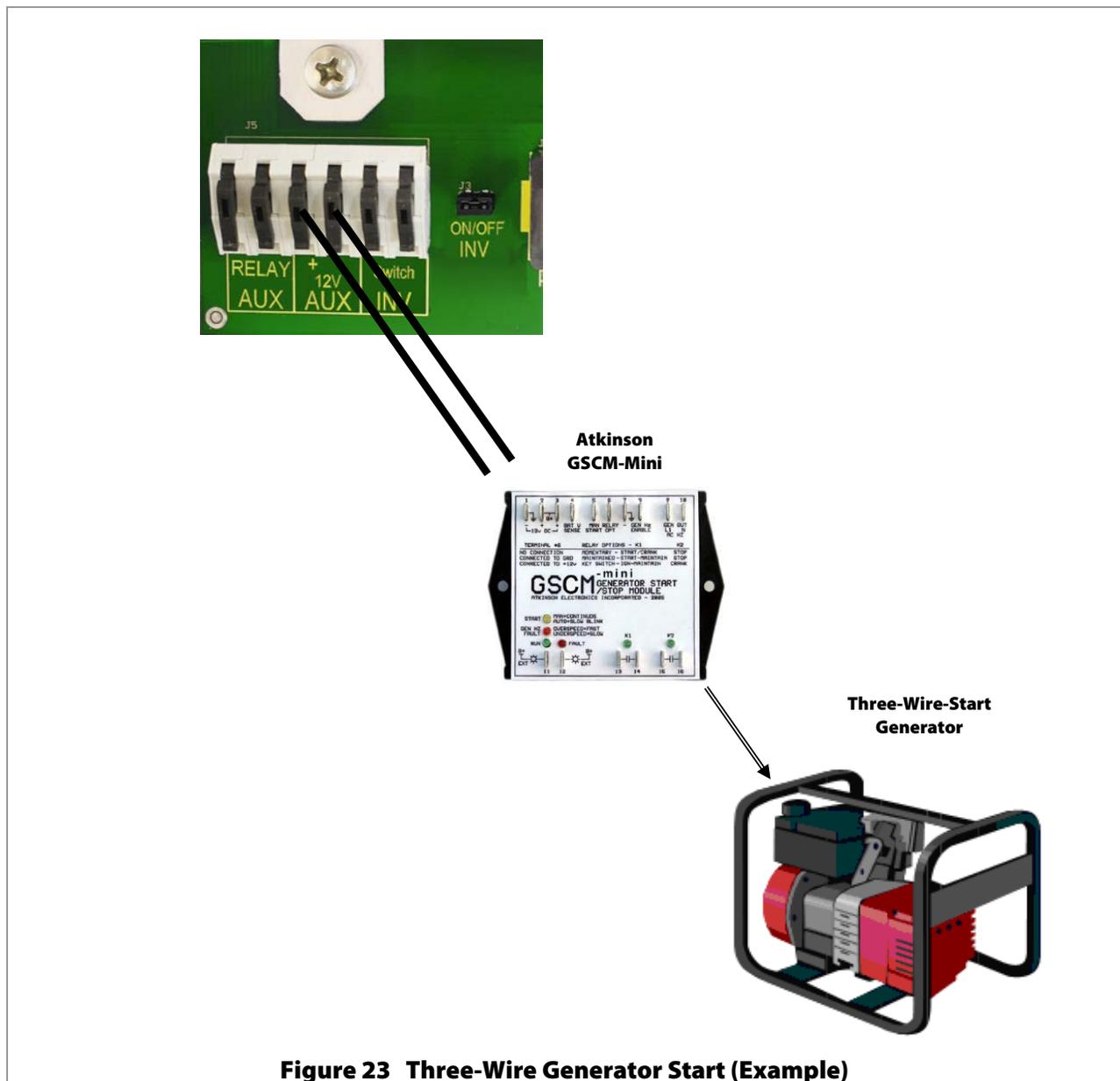
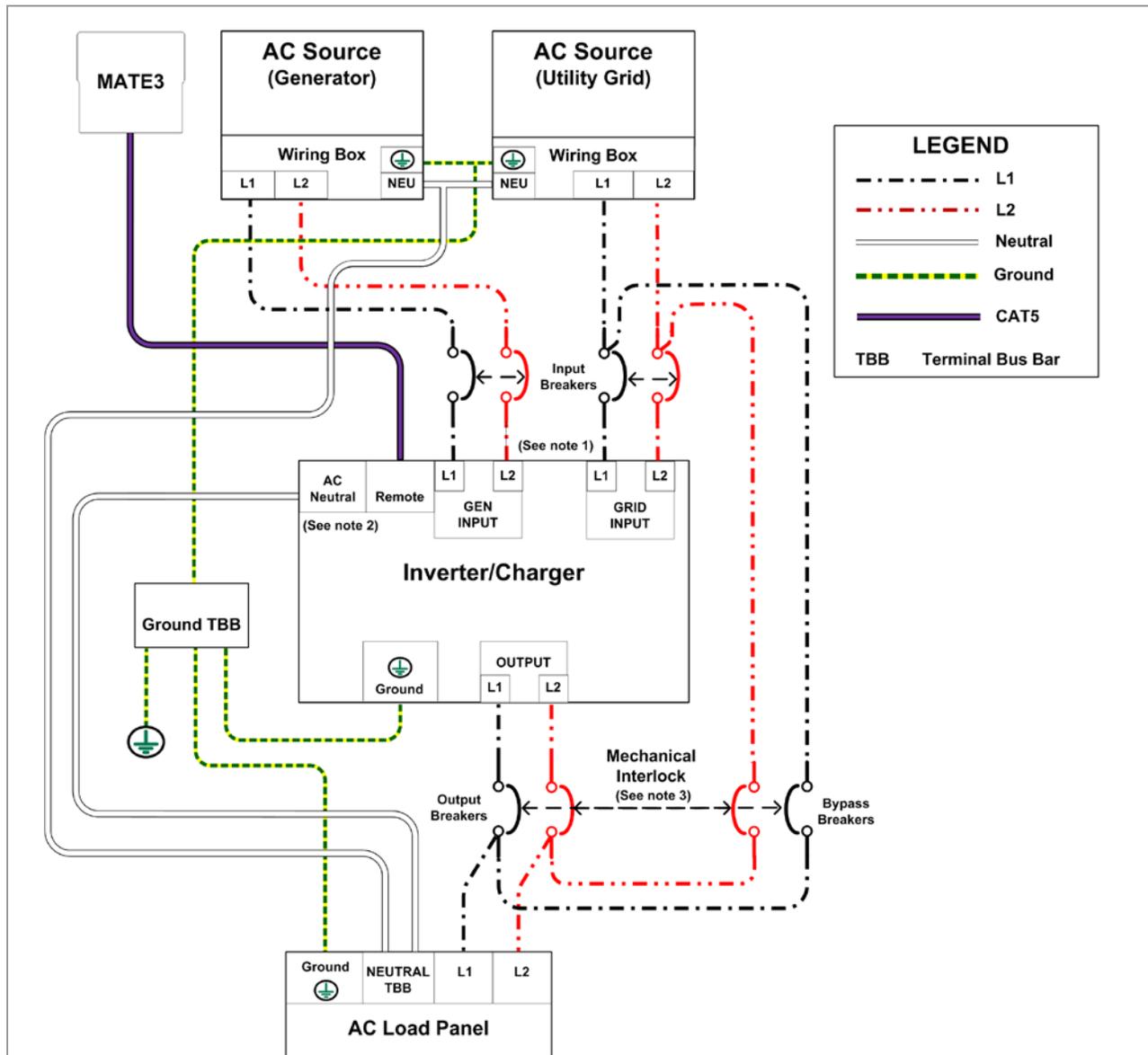


Figure 23 Three-Wire Generator Start (Example)

Single-Inverter AC Installations

When installing an inverter AC system, the following rules must be observed.

- All overcurrent devices in building-based installations must be sized for 50 Aac or less.
- All wiring in building-based installations must be sized for 50 Aac or more.
- All output circuit breakers must be sized appropriately for loads and inverter wattage.



NOTES:

- 1) The Radian inverter has L1 and L2 connections for two AC input sources, although the inverter can only accept one source at a time.
- 2) The Radian inverter has separate neutral connections for grid input, generator input, and output. These are electrically common. If an external neutral bus exists (as shown in the AC Load Panel above where the utility grid and generator share a common neutral), not all of the Radian neutral connections need to be made.
- 3) Maintenance bypass switching assemblies are commonly used so that the inverter can be taken offline, if necessary, without shutting down the entire system. These assemblies usually include an interlock mechanism that isolates AC lines from each other.
- 4) The GS Load Center (GSLC) can be used as both an input conduit box and an AC load center, with a common neutral terminal bus bar (TBB). It can also host maintenance bypass switches for one inverter.

Figure 24 Single-Inverter Wiring

Multiple-Inverter AC Installations (Stacking)

Installing multiple inverters in a single AC system supports larger loads than a single inverter can handle. This requires stacking. Stacking refers to how the inverters are wired within the system and then programmed to coordinate activity. Stacking allows all units to work together as a single system. The Radian Series GS8048 inverter/charger can stack up to ten units in parallel.

Stacking Connections

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

- A system of four or fewer units may use the HUB4.
- A system of up to ten units requires the HUB10 or HUB10.3.
- All interconnections between the products are made using CAT5 non-crossover cable.

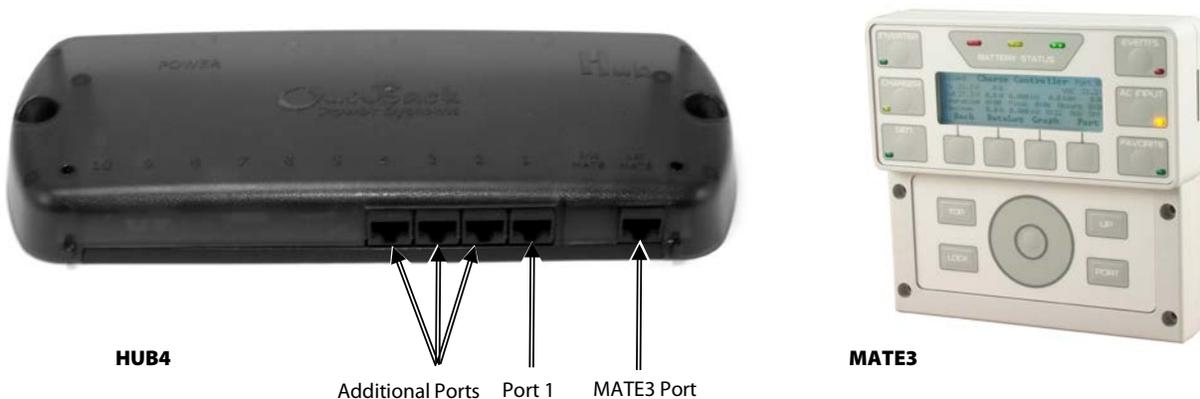


Figure 25 OutBack HUB4 and MATE3

Each inverter must be assigned a status — “master” or “slave”. The master is the primary and most heavily used unit. The master inverter’s Remote port must connect to port 1 on the HUB.

Slave inverters provide assistance when the loads are more than the master can handle alone. Slaves plug into ports 2 and above on the HUB. See the MATE3 manual for other port restrictions pertaining to stacking. In general, it is always important to keep track of units and ports for programming purposes.

Programming involves using the MATE3 to assign a status and stacking value to the inverter on each port. These assignments can be changed at any time as long as the master is plugged into port 1.



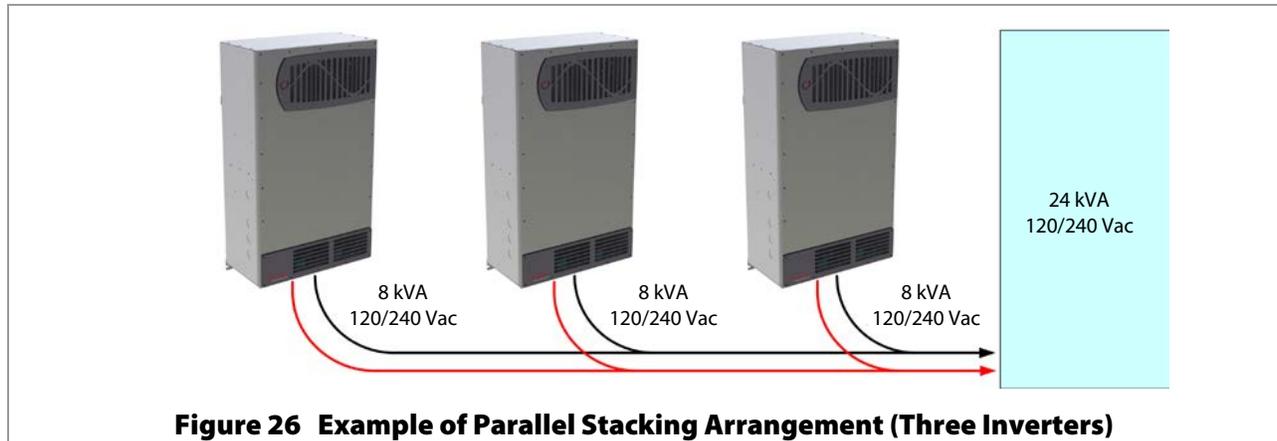
IMPORTANT:

- 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. Overloading may cause circuit breakers to open or the inverters to shut down.

Parallel Stacking (Dual-Stack and Larger)

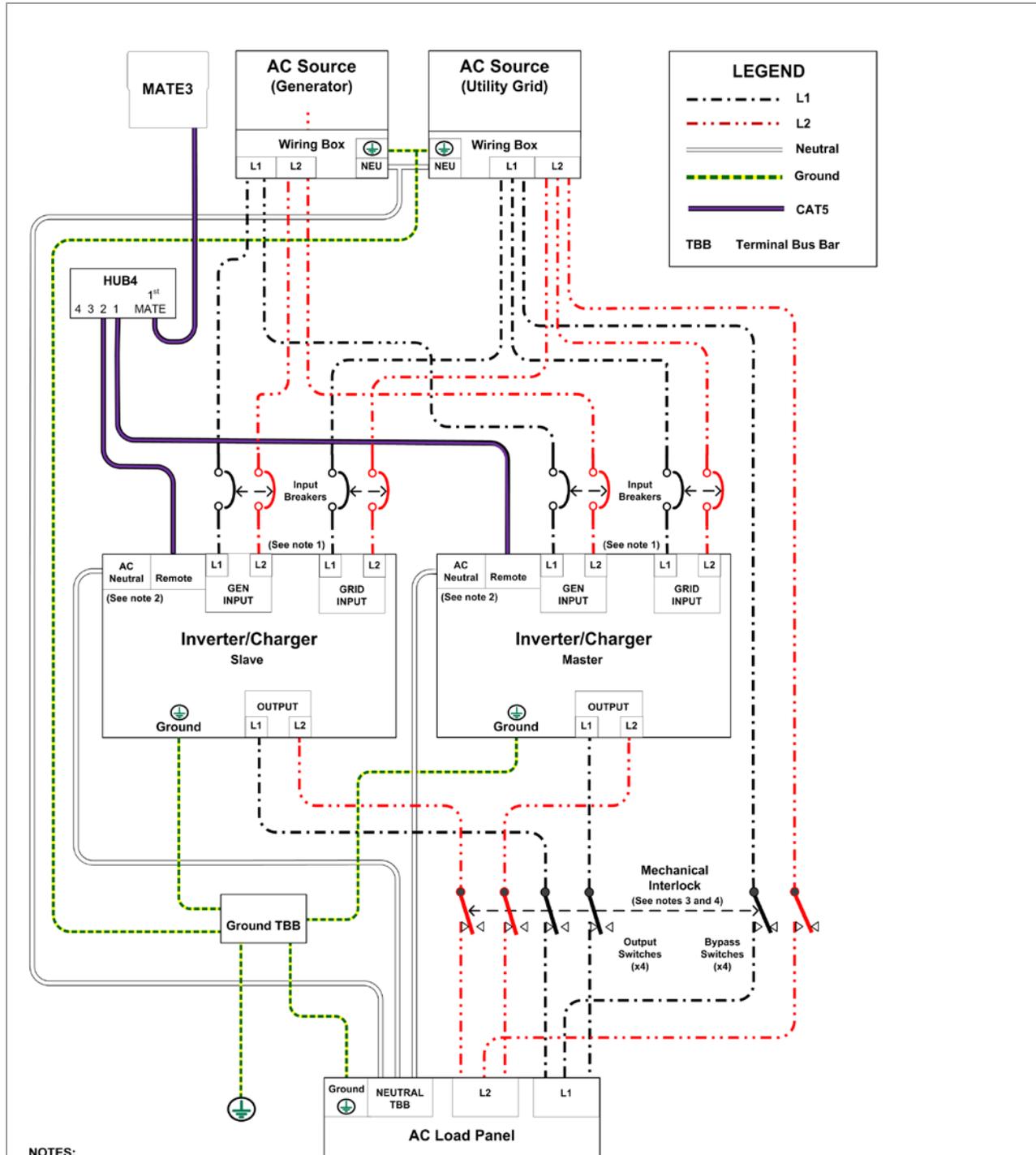
In parallel stacking, two or more inverters are stacked to create a single, common AC bus.

- The slave outputs are controlled directly by the master and cannot operate independently.
- All inverters share a common input (AC source) and run loads on a common output.
- 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. The example on this page shows three inverters. The wiring diagram on the next page shows two.



When installing a parallel system, the following rules must be observed.

- Parallel stacking requires the MATE3 system display and a communications manager.
- One inverter, and one inverter only, is always the master and is programmed as **Master**. This is the default setting. (See the MATE3 manual for programming.)
- The master must be connected to port 1 of the communications manager. Other inverters must not be selected as master.
- All slave inverters, regardless of number, should be selected as **Slave** during programming.
- All overcurrent devices must be sized for 50 Aac or less.
- All wiring must be sized for 50 Aac or more.
- All output circuit breakers must be sized appropriately for loads and inverter wattage.
- The AC input (generator or utility grid) must be 120/240 Vac at 60 Hz (split-phase).
- When wiring the AC source to the inverters, local codes may require the inverter circuits to be located at the opposite end of the panel from the main circuit breaker. This prevents overloading of the AC bus.



NOTES:

- 1) The Radian inverter has L1 and L2 connections for two AC input sources, although the inverter can only accept one source at a time.
- 2) The Radian inverter has separate neutral connections for grid input, generator input, and output. These are electrically common. If an external neutral bus exists (as shown in the AC Load Panel above), not all of the Radian neutral connections need to be made.
- 3) Maintenance bypass switching assemblies are commonly used so that the inverter can be taken offline, if necessary, without shutting down the entire system. These assemblies usually include an interlock mechanism that isolates AC lines from each other.
- 4) When multiple inverters are stacked, the GS Load Center (GSLC) for each inverter can be wired together to serve as a common input conduit box and AC load center. However, the GSLC bypass switching assemblies are only sized for single inverters and cannot work in conjunction. The GSLC bypass assemblies should not be used with multiple inverters present. An external bypass assembly must be used instead. Larger external assemblies are available from other manufacturers.

Figure 27 Parallel Wiring

Functional Test

Once the mounting, wiring, and other installation steps are completed, proceed to the *Radian Series Inverter/Charger Operator's Manual*. The *Operator's Manual* has steps for system commissioning. These include powering up and performing a functional test on the inverter system, as well as powering down and adding new devices to an existing system.

Refer to the *MATE3 Owner's Manual* for programming instructions and menus.



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