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DR1512
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Installation and Operations Manual

DR Inverter/Charger

www.xantrex.com

DR Inverter/Charger

Installation and Operation Manual

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About This Manual

Purpose

The purpose of this Installation and Operation Manual is to provide explanations and procedures for installing, operating, maintaining, and troubleshooting the DR Inverter/Charger.

Scope

The Manual provides safety guidelines, detailed planning and setup information, procedures for installing the inverter, as well as information about operating and troubleshooting the unit. It does not provide details about particular brands of batteries. You need to consult individual battery manufacturers for this information.

Audience

The Manual is intended for anyone who needs to install and operate the DR Inverter/Charger. Installers should be certified technicians or electricians.

Organization

This Manual is organized into four chapters and three appendices.

Chapter 1, “Introduction” contains information about the features and functions of the DR Inverter/Charger.

Chapter 2, “Installation” contains information about how to plan for and install the DR Inverter/Charger.

Chapter 3, “Operation” contains information about how to operate the DR Inverter/Charger.

Chapter 4, “Troubleshooting” contains information about how to troubleshoot possible error conditions while using the DR Inverter/Charger.

Appendix A, “Specifications” contains information about the electrical specifications and environmental specifications of the DR Inverter/Charger.

Appendix B, “Appendix B, “Battery Information” supplies general information about batteries such as battery types, battery bank sizing, battery configurations, and battery care. For detailed information, see your battery manufacturer or your system designer.”

Appendix C, “Multi-wire Branch Circuit Wiring” supplies information about Multi-wire Branch Circuit Wiring Precautions when using stand-alone 120 Vac inverters or generators.

Conventions Used

The following conventions are used in this guide.



WARNING

Warnings identify conditions or practices that could result in personal injury or loss of life



CAUTION

Cautions identify conditions or practices that could result in damage to the unit or other equipment.

Important: These notes describe things which are important for you to know, but not as serious as a caution or warning.

Abbreviations and Acronyms

AC	Alternating Current
ASC	Authorized Service Center
AHJ	Authority Having Jurisdiction
COM	COMmunications Port
CW	Clockwise (rotates to the right)
CCW	Counter-clockwise (rotates to the left)
DC	Direct Current
DR Inverter	DR Inverter/Charger
DRI	DR Interface (for stacking)
LED	Light Emitting Diode
PV	Photovoltaic
PVGFP	PV Ground Fault Protection
RE	Renewable Energy
RMA	Return Material Authorization

Related Information

You can find more information about Xantrex Technology Inc. as well as its products and services at www.xantrex.com.

Important Safety Instructions





SAVE THESE INSTRUCTIONS

This manual contains important instructions for all DR Inverter/Charger models that shall be followed during installation and maintenance of the inverter.

General

1. Before installing and using the DR Inverter/Charger, read all instructions and cautionary markings on the DR Inverter/Charger and all appropriate sections of this guide. Be sure to read all instructions and cautionary markings for any equipment attached to this unit.
2. This unit is designed for indoor use only. Do not expose the DR Inverter/Charger to rain, snow, or spray.
3. To reduce risk of fire hazard, do not cover or obstruct the ventilation openings. Do not install the DR Inverter/Charger in a zero-clearance compartment. Overheating may result.
4. Use only attachments recommended or sold by the manufacturer. Doing otherwise may result in a risk of fire, electric shock, or injury to persons.
5. To avoid a risk of fire and electric shock, make sure that existing wiring is in good condition and that wire is not undersized. Do not operate the DR Inverter/Charger with damaged or substandard wiring.
6. Do not operate the DR Inverter/Charger if it has received a sharp blow, been dropped, or otherwise damaged in any way. If the DR Inverter/Charger is damaged, see the Warranty section.
7. Do not disassemble the DR Inverter/Charger. It contains no user-serviceable parts. See Warranty for instructions on obtaining service. Attempting to service the DR Inverter/Charger yourself may result in a risk of electrical shock or fire. Internal capacitors remain charged after all power is disconnected.
8. The DR Inverter contains more than one live circuit (batteries and AC line). Power may be present at more than one source. To reduce the risk of electrical shock, disconnect both AC and DC power from the DR Inverter/Charger before attempting any maintenance or cleaning or working on any circuits connected to the DR Inverter/Charger. Turning off controls will not reduce this risk.
9. Use insulated tools to reduce the chance of short-circuits when installing or working with the inverter, the batteries, or a PV array.

Wiring Requirements

1. All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70 (Current Edition). When sizing conductors and conduits interfacing to the DR Inverter, both shall be in accordance with the National Electric Code ANSI/NFPA 70, as well as all state and local code requirements.
2. This product is intended to be installed as part of a permanently grounded electrical system per the National Electric Code ANSI/NFPA 70 (current edition). This is the single point earth ground for the inverter system.
3. Use copper conductors only with insulation rated for 75 °C.
4. The grounds on the DR Inverter are marked with this symbol: 
5. The AC voltage and current on the DR Inverter is marked with this symbol:

6. The DC voltage and current on the DR Inverter is marked with this symbol: 
7. Phase on the DR Inverter is marked with this symbol: 



WARNING Fire Hazard:

Do not install 120 volt AC stand-alone inverters onto 120/240 volt AC multi-branch circuit wiring. This could pose a fire hazard due to an overloaded neutral return wire in this configuration. See “Multi-wire Branch Circuit Wiring” on page C-1 for details.

Explosive gas precautions



WARNING: Explosion Hazard

Working in the vicinity of lead-acid batteries is dangerous. Batteries generate explosive gases during normal operation. Therefore, you must read this guide and follow the instructions exactly before installing or using your DR Inverter/Charger.

1. This equipment contains components which tend to produce arcs or sparks. To prevent fire or explosion, do not install the DR Inverter/Charger in compartments containing batteries or flammable materials, or in locations that require ignition-protected equipment. This includes any space containing gasoline-powered machinery, fuel tanks, as well as joints, fittings, or other connections between components of the fuel system.
2. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of the equipment in which the battery is installed.

Precautions When Working With Batteries



WARNING: Explosion or Fire Hazard

Follow all instructions published by the battery manufacturer and the manufacturer of the equipment in which the battery is installed.

1. Make sure the area around the battery is well ventilated.
2. Never smoke or allow a spark or flame near the engine or batteries.
3. Use caution to reduce the risk of dropping a metal tool on the battery. It could spark or short circuit the battery or other electrical parts and could cause an explosion.
4. Remove all metal items, like rings, bracelets, and watches when working with lead-acid batteries. Lead-acid batteries produce a short circuit current high enough to weld metal to skin, causing a severe burn.
5. Have someone within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
6. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
7. Wear complete eye protection and clothing protection. Avoid touching your eyes while working near batteries.
8. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters your eye, immediately flood it with running cold water for at least twenty minutes and get medical attention immediately.
9. If you need to remove a battery, always remove the grounded terminal from the battery first. Make sure all accessories are off so you don't cause a spark.
10. Always use identical types of batteries.
11. Never install old or untested batteries. Check each battery's date code or label to ensure age and type.
12. Batteries are temperature sensitive. For optimum performance, they should be installed in a stable temperature environment.
13. Always recycle old batteries. Contact your local recycling center for proper disposal information.

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1

Introduction

Chapter 1, “Introduction” contains information about the features and functions of the DR Inverter/Charger.

Introduction

Thank you for purchasing the DR Inverter/Charger from Xantrex Technology Inc. The DR Inverter is one of the finest inverter/chargers on the market today, incorporating state-of-the-art technology and high reliability.

The inverter features an AC pass-through circuit, powering your home appliances from utility or generator power while charging the batteries. When utility power fails, the battery backup system keeps your appliances powered until utility power is restored. Internal protection circuits prevent over-discharge of the batteries by shutting down the inverter when a low battery condition occurs. When utility or generator power is restored, the inverter transfers to the AC source and recharges the batteries.

The front panel features LEDs for reading system status, and controls to customize the inverter settings for your battery bank.

The DR Inverter is an economical product designed to provide a reliable supply of electricity to all the essential circuits in the home or business during a power outage. The critical loads can be powered for hours or days, depending on the size of the system battery bank. When utility grid power returns, the batteries are quickly recharged to ensure they will be ready to supply backup power during the next outage.

Accessories allow the DR Series to also serve as a central hub of a renewable energy system.

Modified Sine
Wave Power

The DR Inverter provide a modified sine wave output which operates most AC appliances and equipment.

Battery Charger/AC
Transfer Relay

The inverter/charger includes a 3-stage battery charger designed to recharge any type of battery in the shortest possible time. The built-in, fully automatic AC transfer relay automatically transfers power from the utility to the inverter and handles a full 60 amps of current at 120 Vac (30 amps for pass-through plus 20 to 30 amps for charging - depending on the model).

Simplicity

The DR Inverter is simple to operate. All inverter and battery charger controls are located on the front panel.

High Efficiency

The inverter/charger operates at over 90% efficiency through most of its power range in Invert-mode.

Low Power
Consumption

DR Inverter use extremely low current while in the search mode, consuming less than 1 watt of power. In the **ON** mode, the inverter/charger uses less than 12 watts of power.

Features

The following sections illustrate the features of the DR Inverter. Figure 1-1 shows the features of the front side of the DR Inverter and identifies the AC side from the DC side.

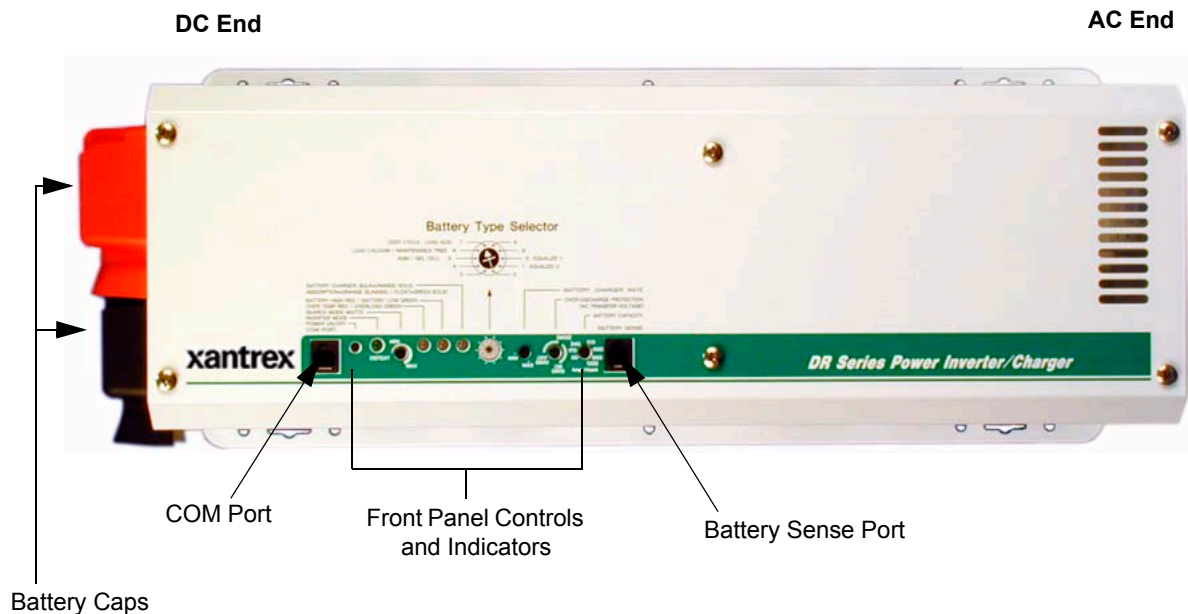


Figure 1-1 Front Panel Features

AC Side

The AC side of the DR Inverter has one 30-amp breaker for pass-thru AC Input, and one 30-amp (20 amp in certain models) breaker for charger AC input.



Figure 1-2 AC Side of the DR Inverter

DC Side

The DC side of the DR Inverter has the equipment ground lug, the positive (+) battery terminal, and the negative (-) battery terminal.

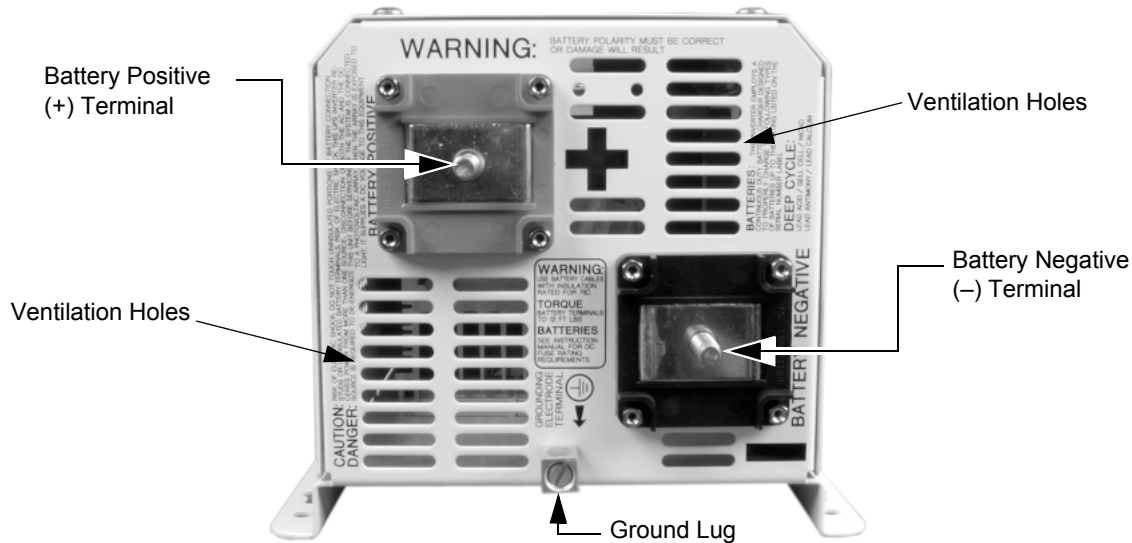


Figure 1-3 DC Side of the DR Inverter

Optional Equipment

The following options are available for the DR Inverter/Chargers.

Remote Control (RC8)

The RC8 allows the inverter to be switched ON or OFF remotely and includes an LED status indicator. This unit is also compatible with the RC4 (the predecessor to the RC8); although the RC4 is no longer available for purchase from Xantrex.

Stacking Interface (DRI)

The DRI stacking interface provides 3-wire 120/240 Vac at twice the power using dual DR Inverters (120 Vac/60 Hz units only).

Conduit Box (DRCB)

The DRCB conduit box connects to the DC side of the inverter and accepts a DC conduit run.

Unpacking and Inspection

Carefully unpack the inverter/charger from its shipping carton.

Important: The unit weighs 35–45 lb/15.9–20.4 kg (depending on model). Have additional help available if necessary, to assist in lifting the unit during installation.

- ❑ Verify all of the items listed on the packing material sheet are present. Please call Xantrex Customer Service at (800) 670-0707 if any items are missing.
- ❑ Save your proof-of-purchase. This is required if the unit should require warranty service.
- ❑ Save the original shipping carton and packing materials! If the inverter ever needs to be returned for service, it should be shipped in the original carton. This is also a good way to protect the inverter if it ever needs to be moved.
- ❑ Record the unit's model, serial number and date of purchase in the appropriate fields in section "Information About Your System" on page WA-4.

Important: Due to continual improvement through product updates, photographs and/or illustrations used in this manual may not *exactly* match your unit. Xantrex Technology Inc. reserves the right to update this product without notice or releasing an updated manual when *fit, form or function* are not affected.

Model Identification and Numbering Conventions

The DR Inverter is identified by the model/serial number labels. The Serial Number can be located on the mounting rail or inside the top cover. Model Number labels may be located on the bottom side of the front cover or possibly inside the front cover. All the necessary information is provided on the label such as AC output voltage, power and frequency (punch holes).

The inverter also has a letter designator followed by 4 or 5 digits (depending on revision). The model number describes the type of inverter, the output specifications, the required battery voltage and the output voltage and frequency

Table 1-1 Model Identification and Numbering Conventions

DR	indicates the type of inverter/charger - DR Series.
15	the first two digits of the numerical designator indicate the inverter's output power - 1500 Watts.
12	the second two digits indicate the required nominal battery bank voltage - 12 Vdc.
E	the letter suffix code indicates the output voltage and frequency of the inverter - 230 Vac/50 Hz.

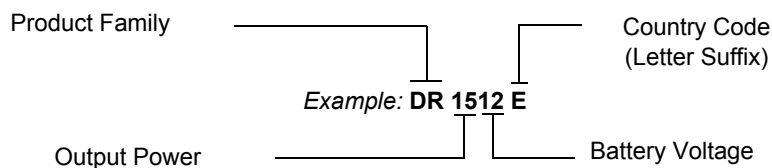
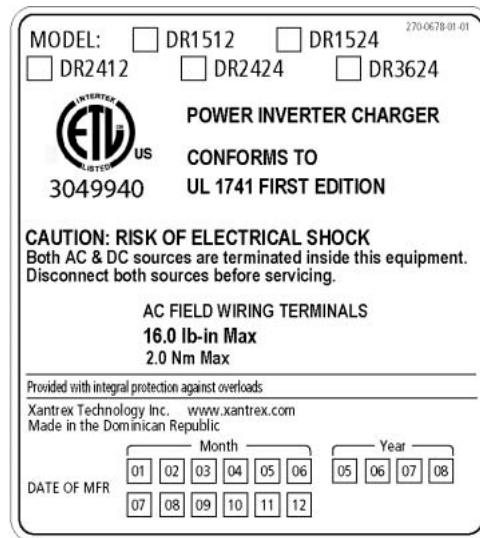


Figure 1-4 Product Identification

Table 1-2 Letter Suffix Code Definitions

Letter Suffix	Output Voltage	Output frequency
(no letter)	120 Vac	60 Hz
E	230 Vac	50 Hz
J	105 Vac	50 Hz
K	105 Vac	60 Hz
W	220 Vac	60 Hz

**Figure 1-5** Model Number Sticker

Regulatory

The 120 Vac/60 Hz models of the DR Series inverter/charger (models DR1512, DR1524, DR2412, DR2424, and DR3624) are ETL Listed to UL Standard 1741, (First Edition) *Power Conditioning Units for use in Residential and Commercial Photovoltaic Power Systems*.

These standards guarantee that the DR Inverter/Charger has been tested to nationally recognized safety standards (UL for the US) and have been found to be free from reasonably foreseeable risk of fire, electric shock and related hazards.

The DR Inverter/Charger is intended to be used for residential or commercial applications. Do NOT use this unit for applications for which it is not listed (i.e., land vehicles or marine craft). It may not comply with the safety code requirements or could possibly present other operational or safety hazards.

2

Installation

Chapter 2, “Installation” contains information about how to plan for and install the DR Inverter/Charger.

Pre-installation Planning

Important: Before installing and using the DR Inverter/Charger, read all instructions and cautionary markings on the DR Inverter/Charger and all appropriate sections of this guide. Be sure to read all instructions and cautionary markings for any equipment attached to this unit.

Take some time prior to installing the equipment to pre-plan the installation. Location, mounting, and ventilation should be taking into consideration before any cabling can be done.



CAUTION: Personal Injury

The inverter/charger can weigh up to 45 lbs (20.4 kg) depending upon configuration. Always use proper lifting techniques during installation to prevent personal injury.

Location

Inverters contain sophisticated electronic components and should be located in a well protected, dry environment away from sources of fluctuating or extreme temperatures and moisture. Exposure to saltwater is particularly destructive and potentially hazardous.

Locate the inverter as close to the batteries as possible in order to keep the battery cable length short. However, do not locate the inverter above the batteries or in the same compartment as vented batteries. Batteries generate hydrogen sulfide gas which is corrosive to electronic equipment. They also generate hydrogen and oxygen. If accumulated, an arc caused by connecting the battery cables or switching a relay could ignite this mixture. Mounting the inverter in a ventilated enclosure with sealed batteries is acceptable.



CAUTION: Corrosion Damage

If the inverter is installed in a location where it is exposed to a corrosive or condensing environment and fails due to corrosion, it will not be covered under warranty.

Important: Inverters can generate RFI (Radio Frequency Interference). Locate any sensitive electronic equipment susceptible to RFI as far away from the inverter as possible. This includes radios and TVs.

Mounting

The National Building Code requires the inverter be mounted on a vertical surface (or wall). The keyhole slots must not be used as the only method of mounting. The purpose of the wall mounting requirement is to orient the inverter so that its bottom cover, which has no holes, will not allow burning material to be ejected in the event of an internal fire. Use 0.25-inch diameter bolts for mounting. The mounting surface must be capable of supporting twice the weight of the inverter to comply with UL 1741.

Ventilation

Install the inverter in a well ventilated area/enclosure for proper operation. The inverter's thermal shutdown point will be reached sooner than normal in a poorly ventilated environment, resulting in reduced peak power output and surge capability, as well as shorter inverter life.

The inverter contains an internal fan. Ensure the air vents and intakes are not obstructed in any way. Provide a minimum clearance of 6 inches around the top and sides of the inverter for ventilation.

Tools Required

The following tools may be required to complete this installation.

- #2 Phillips screw driver
- Slotted screw driver
- Assorted open-end wrenches
- Socket wrench and fittings
- Multimeter (True rms)
- Hole saw
- Level
- Wire strippers
- Torque wrench
- Electrical tape
- Pencil
- Utility knife

Hardware / Materials Required

The following hardware or materials may be required to complete this installation.

- 4 ft. x 4 ft. sheet of 3/4" plywood or 2 x 4's studding material
- #12 wood screws (or 1/2" x 1-1/4" lag bolts)
- Conduit and appropriate fittings
- Wire nuts

Wiring Considerations

All wiring and installation methods should conform to applicable electrical and building codes.

Pre-plan the wire and conduit runs.

- The AC terminals accept cable sizes up to #6 AWG.
- The DC terminals accept cable sizes up to #4/0 AWG that use ring terminals with 5/16" holes.

For maximum safety, run both AC and DC cables in conduit.

DC Terminal Connections

Battery-to-inverter cabling should be only as long as required.

For Example: If #4/0 AWG cables are used, do not exceed 5 feet (one way) in 12 Vdc systems; do not exceed 10 feet (one way) in 24 Vdc systems.

For optimum performance, use pre-assembled battery cables designed specifically for this application (available from Xantrex).

Grounding Considerations

AC Grounding

The inverter/charger should be connected to a grounded, permanent wiring system. Neutral and ground conductors should only be bonded at the main electrical service panel.

DC Grounding

The negative battery conductor should be bonded to the grounding system at only one point in the system. The size for the conductor is usually based on the size of the largest conductor in the DC system.

Wire Routing

Determine all wire routes both to and from the inverter and which knockouts are best suited for connecting the AC conduits. Possible routing scenarios include:

- AC input wiring from the main electrical service panel to the inverter/charger (if used)
- AC input wiring from the generator to the inverter/charger (if used)
- DC input wiring from the RE to the inverter/charger (if used)
- DC input wiring from the batteries to the inverter/charger
- AC output wiring from the inverter/charger to the sub-panel
- Battery Temperature Sensor cable from the batteries to the inverter/charger (if used)
- Remote control cable to the inverter/charger (if used)
- DC ground from the batteries to an external ground rod
- Load circuit wiring rerouted from the main service panel to the sub-panel

Check for existing electrical or plumbing prior to making cuts in the walls. Cut holes in the walls at appropriate locations for routing wiring/cables.

Electrical Panels and Circuit Breaker Requirements

The following electrical panels and circuit breakers may be required for this installation.

AC Distribution Panel (Sub-Panel)

Loads backed up by the inverter will need to be rerouted from the main electrical panel to a sub-panel. This can be done several different ways, depending upon the installation. Always refer to electrical codes for safe wiring practices.

DC Disconnect

Install a DC disconnect breaker or fuse in the positive battery line. This breaker protects the DC wiring in the event of an accidental short. Size the breaker in accordance with the battery cables. Switch this breaker OFF whenever servicing the batteries.

Battery Considerations

The DR Inverter can support either 12-volt battery banks or 24-volt battery banks. The battery voltage **MUST** match the voltage requirements of the inverter. To determine the correct voltage for the system, check the last two digits on the inverter's model number. For example, the DR15**12** is a 12-volt inverter and requires a 12 Vdc battery system. The DR24**24** is a 24-volt inverter and requires a 24 Vdc battery system.

Battery Location

Locate the batteries in an accessible location. Two feet clearance above the batteries is recommended for access to the battery caps. They should be located as close to the inverter as possible without limiting access to the inverter's disconnects. Install the batteries to the left of a wall mounted inverter for easy access to the DC side of the inverter and shorter cable runs.

For safety and to limit access to the batteries, a lockable, ventilated, battery enclosure or dedicated room should be used. If an enclosure is used, it should be vented to the outside via a one inch vent pipe located at the top of the enclosure. Install an intake vent at the bottom of the enclosure to promote air circulation. These vents exhaust explosive hydrogen gases and must not be overlooked when designing an enclosure.

The enclosure should be made of an acid resistant material or have a finish that resists acid to prevent corrosion. It should be capable of holding the electrolyte from at least one battery should a leak occur.

Place a layer of baking soda on the shelves to neutralize any acid that may be spilled in the future (lead-acid batteries only).

Enclosures located outside must be rainproof and screened to prevent access by rodents or insects.

Battery Temperature

The battery enclosure should provide a fairly stable temperature for the batteries. If it is installed in a cold environment, insulation should be used to protect the batteries from the cold. The insulation also provides a more consistent temperature and better system performance.

The battery enclosure should not be installed in direct sunlight where the summer sun can overheat the batteries. Locate the enclosure where it will be protected from the afternoon sun and provide vents in the top and bottom of the enclosure to provide air flow. High battery temperatures greatly shortens the life of the batteries.

Basic Configurations

The following illustrations show basic applications for the DR Inverter/Charger. They include the following configurations.

- On-Grid Configuration - Utility Backup
- Off-Grid Configuration - Generator only
- On-Grid Configuration with Renewable Energy Sources
- Off-Grid Configuration with Renewable Energy Sources and a Generator

Consult with your system design for other possible configurations depending on site and code requirements.

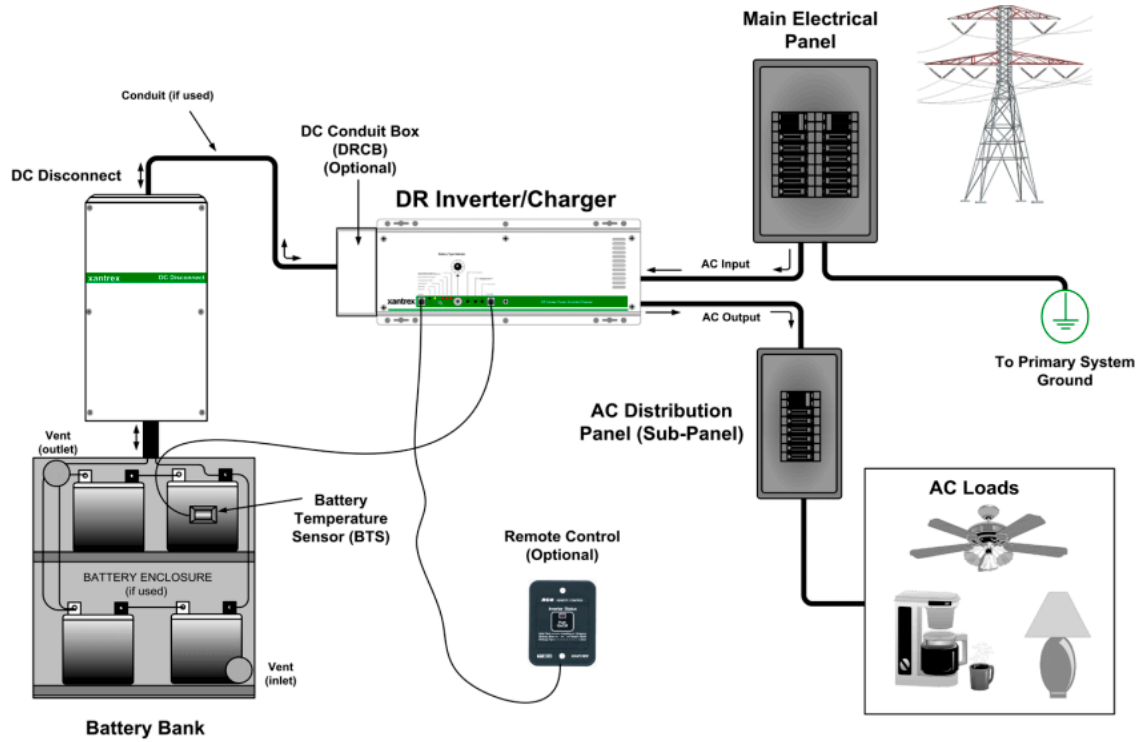


Figure 2-1 On-Grid Basic Configuration (Utility Backup)

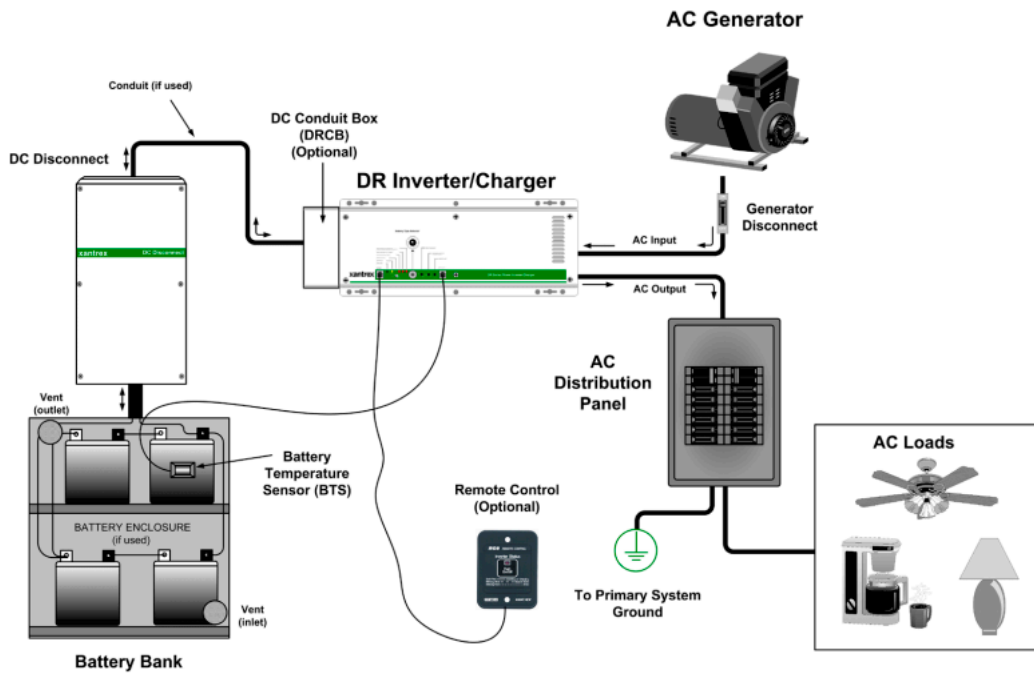


Figure 2-2 Off-Grid Configuration (Generator only)

Renewable Energy (RE) Sources

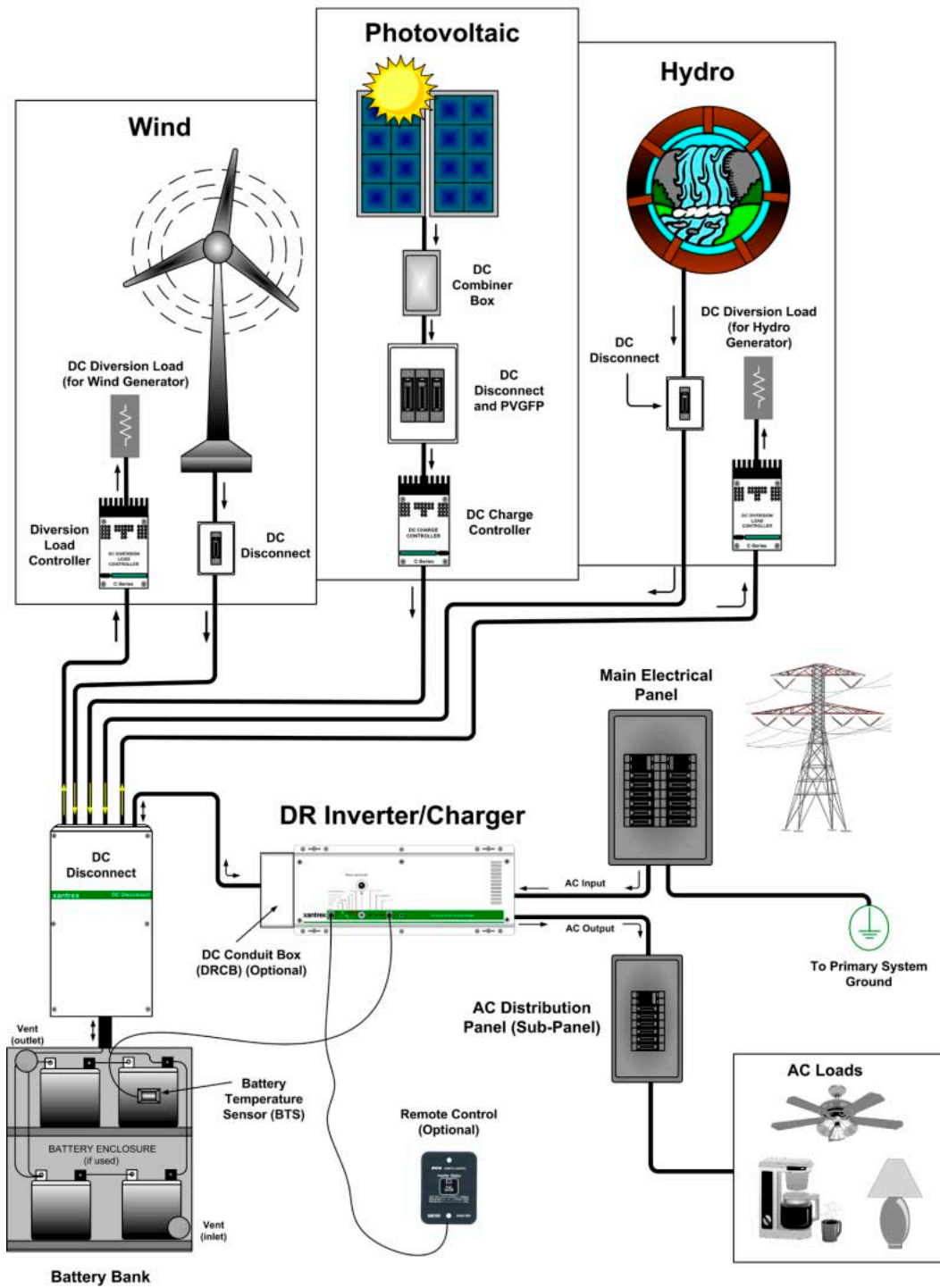


Figure 2-3 On-Grid Configuration - with Renewable Energy Sources

Renewable Energy (RE) Sources

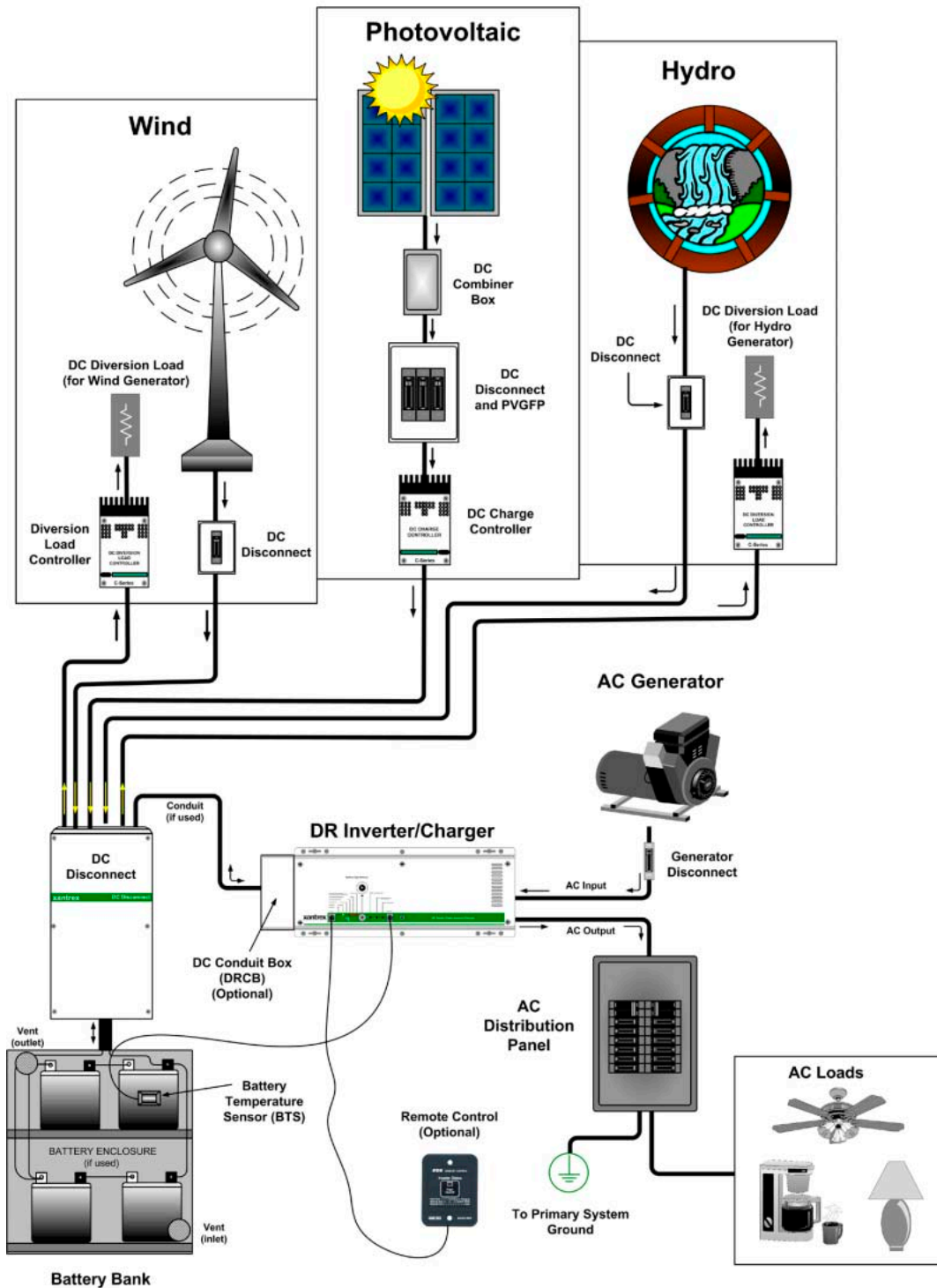


Figure 2-4 Off-Grid Configuration - with Renewable Energy Sources

Generators

An AC generator can be used as an input source instead of the utility power, or can be connected (using additional hardware) to power the loads when utility is not present (utility outage), and to charge the batteries. The generator must be of the permanently installed type and not a portable type unit used for emergency power. Small emergency type (lower power) generators may not have a stable enough voltage for the inverter to synchronize to or provide enough current to fully charge the batteries.

The maximum charge rate the battery charger can deliver is dependant upon the peak AC voltage available. Since the battery charger uses only the top portion of the input sine wave, small variations in peak voltage result in large variations in the amount of energy to the charger. The charger's rated output is based on a utility voltage of 120 Vac RMS (the usual measured value). This should have a peak voltage of 169 Vac_p. (230 Vac has a peak voltage of 325 Vac). For every 10 volts of peak lost, the charge rate is reduced by approximately half.

Size the generator appropriately for the system, including battery charge and load current (typically twice the wattage output of the inverter).

Table 2-1 and Figure 2-5 demonstrates how the peak voltage available affects the charging current.

Table 2-1 Peak Input Filtrate versus Charging Current

Peak Voltage Available	DR1512	DR2412	DR1524	DR242	DR3624
170 Vac _p	70 amps	120 amps	35 amps	70 amps	70 amps
160 Vac _p	35 amps	60 amps	17.5 amps	35 amps	35 amps
145 Vac _p	15 amps	25 amps	7 amps	15 amps	15 amps

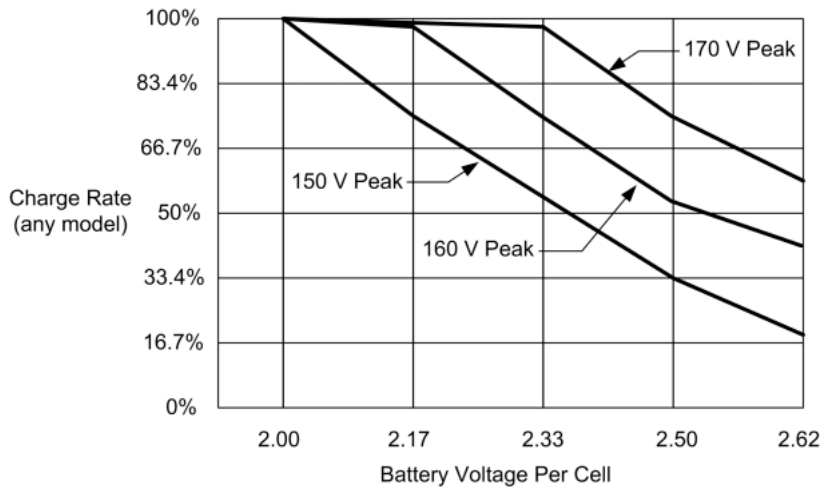


Figure 2-5 Charge Rate versus Peak AC Voltage

Inverter Mounting

The DR Series inverter can weigh as much as 45 lb. (20.4 kg). Wallboard is not strong enough to support its weight so additional support must be used or added. The inverter can be mounted directly to the wall studs if the wall studs are 16" apart. If not, then 2x4's or plywood can be used.



WARNING: Personal Injury

Use appropriate lifting techniques. Have extra people on hand to assist in lifting the inverter into position while it is being secured.

To secure the DR Inverter to the wall studs:

1. Locate the studs and mark their location on the wall.
2. Measure the desired height from the floor for the inverter to be mounted.
3. Using a level, run a horizontal line. The length of the line must span at least three studs.
4. Using the dimensions illustrated in Figure 2-6, drill mounting holes into the center of the studs for the inverter.
5. Secure the inverter to the studs using ¼ x 1½ inch lag bolts and washers.

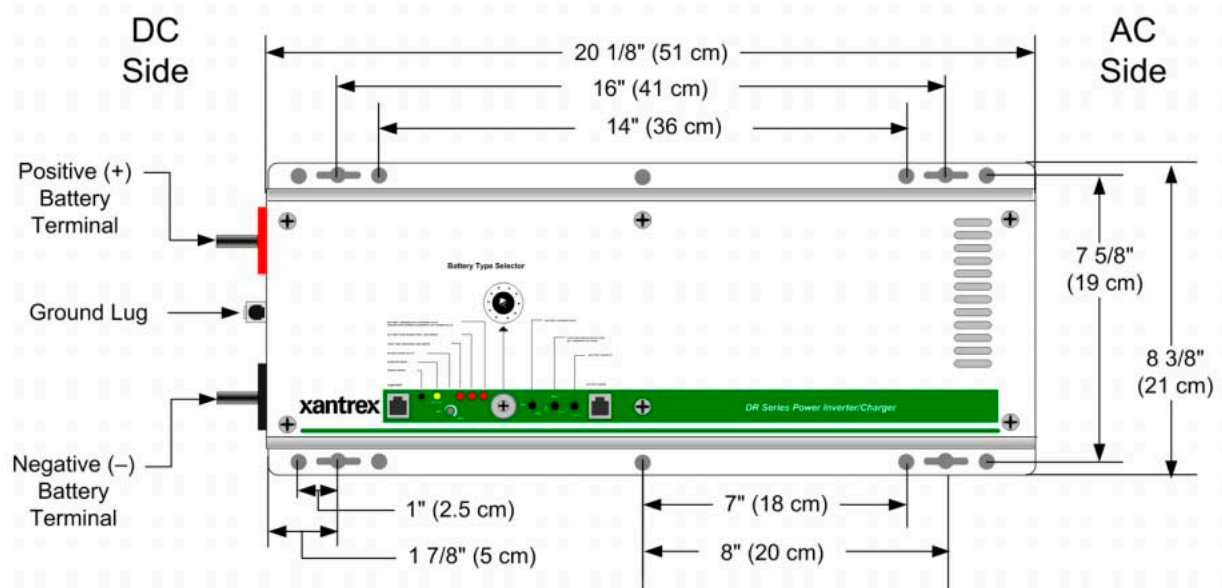


Figure 2-6 Dimensions (not to scale)

To secure the DR Inverter to the mounting location using 2 x 4's or plywood:

1. Repeat steps 1 through 3 above.
2. Place a pre-cut 2 x 4 (flat side against the wall) on the marked location and drill pilot holes through the 2 x 4's and studs.

3. Secure the 2 x 4 with #10 wood screws (length to penetrate 1½ inches into the studs) as shown in Figure 2-7.
4. Measure 7 5/8" from the center of the first 2 x 4 and draw another level line. Place the center of the second 2 x 4 over this line and secure to the wall as described in Step 5.
5. Using the dimensions illustrated in Figure 2-6, drill mounting holes into the center of the 2 x 4's for the inverter.
6. Secure the inverter to the 2 x 4's using ¼ x 1½ inch lag bolts and washers.

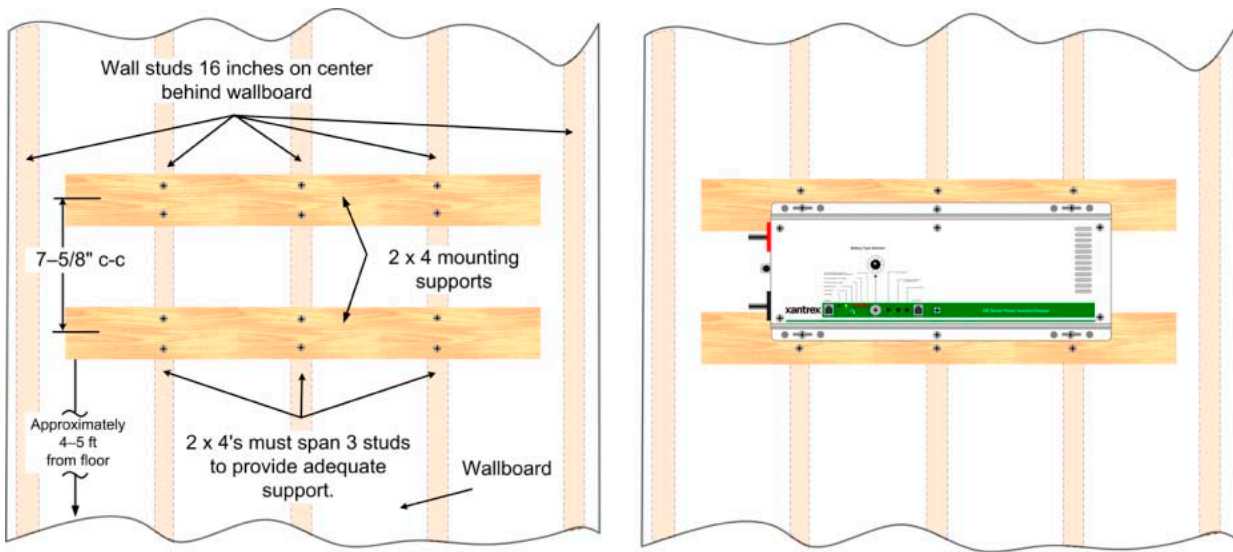


Figure 2-7 Suggested Mounting Method

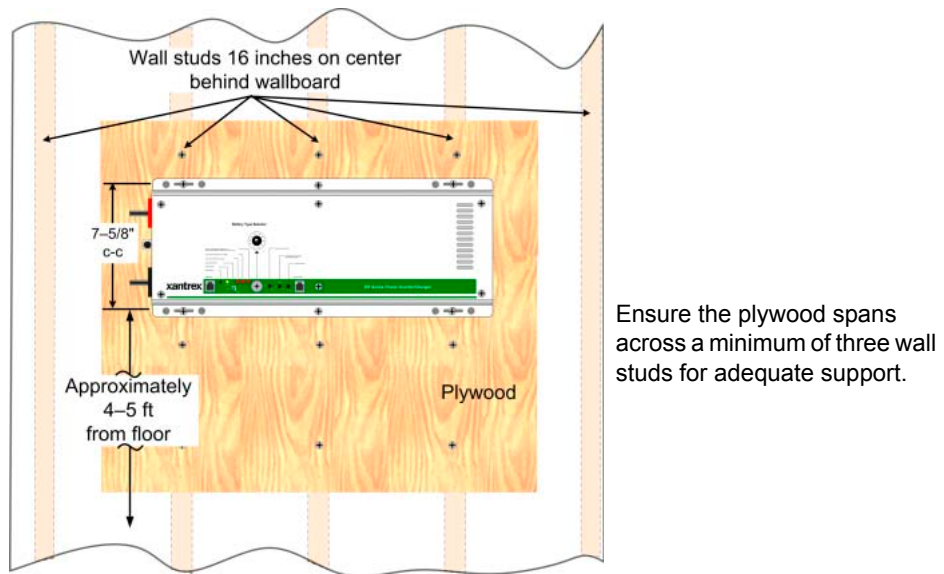


Figure 2-8 Mounting on Plywood

DC Wiring

This section describes the DC wiring requirements and how to make the connections. It provides the required cable and wire sizes, recommended lengths for cables, and disconnect/circuit breaker requirements.

DC Circuit Grounding

Grounding is an important part of the system installation and must be performed correctly to ensure safe operation of the equipment. Grounding requirements vary by country and application. Consult the NEC for specific requirements.

The ground conductor should be sized appropriately for the over-current protection device being used and according to NEC 250-95 (Ninth Edition) (see Table 2-2 below for a portion of the NEC code).

Table 2-2 Safety Ground Conductor Size

Size of Over-current Device Protecting the Conductor	Minimum Size of the Copper Ground Wire
30 or 60 amp	#10 AWG
100 amp	#8 AWG
200 amp	#6 AWG
300 amp	#4 AWG
400 amp	#3 AWG

General DC Grounding Requirements

This product is intended to be installed as part of a permanently grounded electrical system per the National Electric Code ANSI/NFPA 70 (current edition). This is the single point earth ground for the inverter system.

To ground the DC circuits:

1. Connect the negative (-) terminal of the battery bank to an appropriately sized conductor and connect it to the ground bus in the DC Disconnect.
2. Connect an appropriately sized conductor to the Ground bus in the DC Disconnect and connect it to the primary system ground.

The system ground is the same ground used by the AC side of the system.

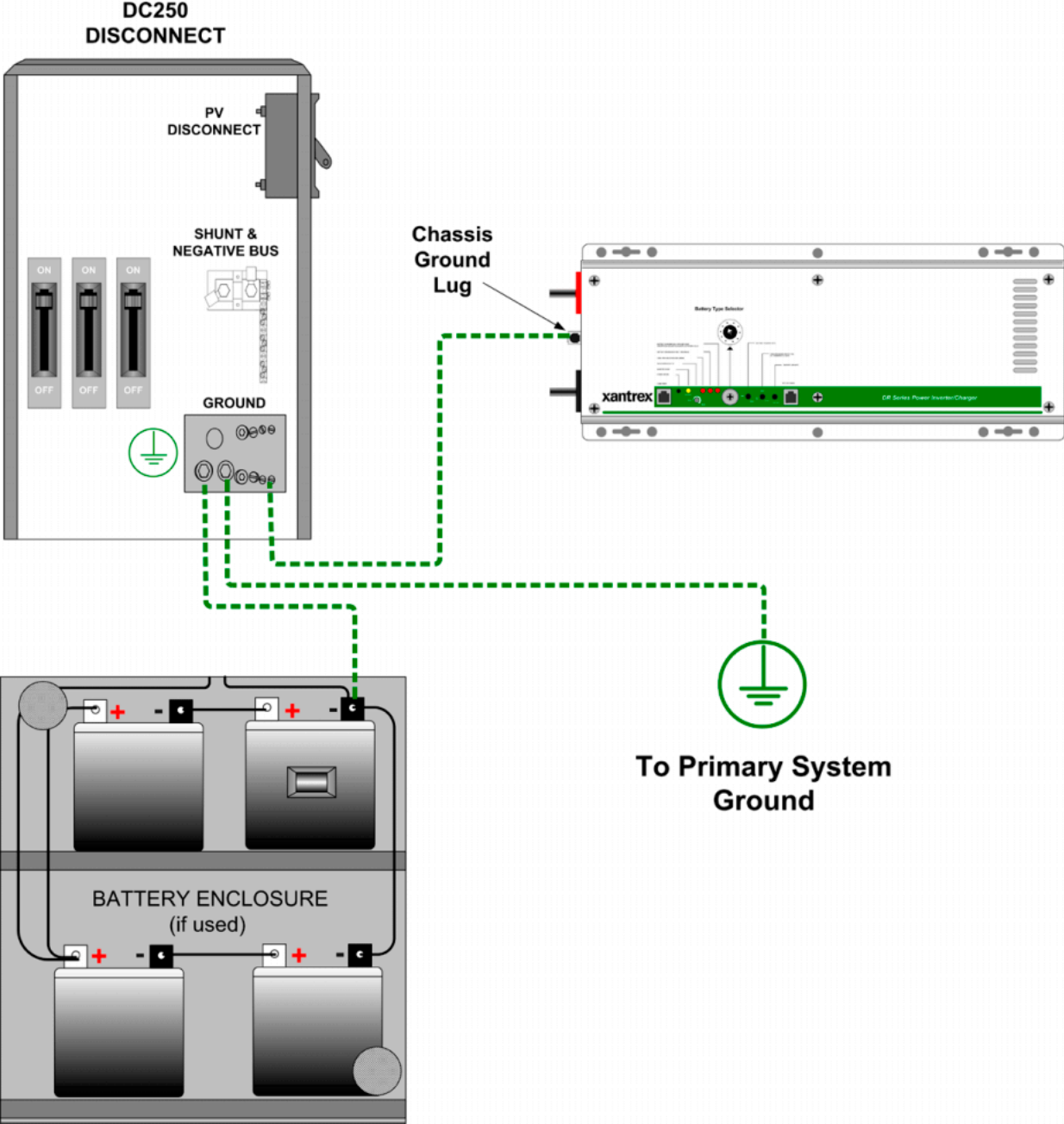


Figure 2-9 DC Grounding

Batteries

The DR Inverter can support either 12-volt battery banks or 24-volt battery banks. Before proceeding, ensure you have the appropriate sized batteries for this inverter.

Battery Types

Batteries are available in different sizes, amp-hour ratings, voltage, liquid or gel, vented or non-vented, chemistries, etc. They are also available for starting applications (such as an automobile starting battery) and deep discharge applications. Only the **deep discharge** types are recommended for inverter applications. Choose the batteries best suited for the inverter installation and cost. Use only the same battery type for all batteries in the bank. For best performance, all batteries should be from the same lot and date. This information is usually printed on a label located on the battery.

Additional information regarding batteries can be found in the Appendix B, “Battery Information”.

Battery Bank Sizing

The size of the battery bank determines how long the AC loads will operate in a backup mode without utility power. The larger the battery bank, the longer the run time. Size the battery bank to the AC load requirements and length of time required to run from the batteries. In general, the battery bank should not be discharged more than 50%. Additional DC charging devices such as solar, wind, hydro, etc., can provide longer run times by recharging the batteries in the absence of AC utility or generator power.

Additional details on estimating battery bank size and capacity can be found in “Battery Bank Sizing” on page B-4.

Battery Configuration

The battery bank must be wired to match the inverter’s DC input voltage specifications (12 Vdc, 24 Vdc, or 48 Vdc). In addition, the batteries can be wired to provide additional run time. The various wiring configurations are:

- **SERIES** - Wiring batteries in series increases the total bank output voltage (to match the inverter’s DC requirements).
- **PARALLEL** - Wiring the batteries in parallel increases the total run time the batteries can operate the AC loads.
- **SERIES-PARALLEL** - Series-parallel configurations increase both the battery voltage (to match the inverter’s DC requirements) and run-time for operating the AC loads.

For additional information on how to wire these battery-bank configurations, see “Battery Configurations” on page B-8.

Battery Cable Sizing

Proper cable sizing (diameter and length) is critical to the safe and efficient operation of an inverter system. Larger diameter cables (smaller AWG number) have less voltage drop and are, therefore, more efficient when transferring power to and from the batteries. If a cable is undersized (diameter too small), it could potentially overheat, creating a fire hazard.

Cable length is another important factor. Runs should be kept as short as practical. Longer cable runs increase resistance, thus lowering the overall efficiency of the system. This is especially true in lower voltage systems (i.e., 12 Vdc) where, depending upon the length of the cable run, it may be necessary to oversize the diameter of the wire, or parallel (double) the cables.

Important: Only use copper cables. Always use a properly sized cable and length rated for the amperage of the inverter and batteries.



WARNING: Fire Hazard

Undersized cables can overheat and melt, creating a fire hazard when subjected to heavy (peak) loads.

Table 2-3 provides recommended minimum cable sizes for various cable lengths and inverter amperages. These recommendations may not meet all local or NEC requirements.

Important: Run the positive and negative battery cables as close to each other as possible by taping them together. This reduces the effects of inductance and produces a better waveform thus increasing efficiency. See *Xantrex Technical Note 008 on the Xantrex website for additional information on Battery Cable Inductance.*

Table 2-3 Minimum Recommended Battery Cable Size versus Length

Inverter Model	Typical Amperage	1 to 3 feet (one-way)	3 to 5 feet (one-way)	5 to 10 feet (one-way)
DR1512	150 A	#2/0 AWG (67.4 mm ²)	#2/0 AWG (67.4 mm ²)	#4/0 AWG (107 mm ²)
DR2412	240 A	#4/0 AWG (107 mm ²)	#2/0 AWG (67.4 mm ²)	#2/0 AWG (67.4 mm ²)
DR1524	75 A	#2/0 AWG (67.4 mm ²)	#2/0 AWG (67.4 mm ²)	#2/0 AWG (67.4 mm ²)
DR2424	120 A	#2/0 AWG (67.4 mm ²)	#4/0 AWG (107 mm ²)	#4/0 AWG (107 mm ²)
DR3624	180 A	#4/0 AWG (107 mm ²)	#4/0 AWG (107 mm ²)	#4/0 AWG (107 mm ²)

Important: If the system includes a large battery bank or large DC source (such as a micro-hydroelectric plant or wind generator), increasing the size of the cables and disconnects will greatly reduce the number of nuisance outages associated with breaker tripping and open fuses.

DC Disconnect and Over-current Protection

For safety and to comply with regulations, battery over-current protection is required. Fuses and disconnects must be sized to protect the wiring in the system and are required to open before the wire reaches its maximum current carrying capability.

The National Electrical Code (NEC) requires both over-current protection and a disconnect switch for residential and commercial electrical systems. These items are not supplied as part of the inverter. However, Xantrex offers a DC rated, ETL Listed, circuit breaker disconnect module specifically designed for use with Xantrex™ inverters to meet NEC compliance. Two amperage ratings are available: a DC250 (250 amps) and a DC175 (175 amps) in either single or dual breaker configurations for single- or dual-inverter installations.

Important: Xantrex™ DC disconnects are not designed to accept doubled (paralleled) cables which may be required for long cable runs. Also, the plastic red and black covers on the DC inverter inputs are not designed to accommodate dual cables. If dual cables are used, the optional conduit box (DRCB) must be used.

Some installations may not require conduit or a disconnect device, although over-current protection is still required. Xantrex offers a fuse block (TFB) providing the code required inverter over-current protection for these applications. Refer to the table below for the proper size disconnect device for specific cable diameters.

Table 2-4 Battery Cable to Maximum Breaker/Fuse Size

Cable Size Required	Rating in Conduit	Maximum Breaker Size	Rating in “Free Air”	Maximum Fuse Size
#2 AWG	115 amps max	N/A	170 amps max	TFB200
#2/0 AWG	175 amps max	DC175	265 amps max	TFB300
#4/0 AWG	250 amps max	DC250	360 amps max	TFB400

Important: The NEC allows rounding to the next standard fuse size from the cable rating (i.e., 150 amp cable size rounds up to a standard 175 amp size). The term “free air” is defined by the NEC as cabling that is not enclosed in a conduit or a raceway. Cables enclosed in conduit or raceways have substantially lower continuous current carrying ability due to heating factors.

Battery Cable Connections

Battery cables must have crimped (or preferably, soldered and crimped) copper compression lugs unless aluminum mechanical lugs are used. Soldered connections alone are not acceptable. High quality, UL-listed battery cables are available from Xantrex in an assortment of lengths: 1½ to 10 feet, and in #2/0 AWG or #4/0 AWG sizes. These cables are color-coded with pressure crimped, sealed ring terminals.

Figure 2-10 illustrates the proper method to connect the battery cables to the DR Inverter's DC terminals.

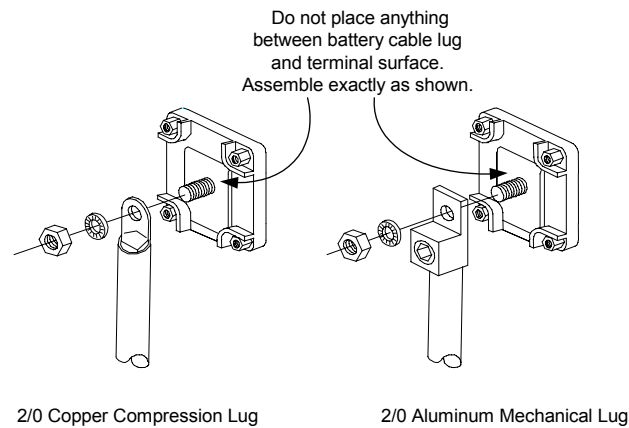


Figure 2-10 Battery Cable Connections



CAUTION: Equipment Damage

The inverter is not reverse polarity protected. Reversing the battery polarity on the DC input connections will cause permanent damage to the inverter which is not covered under warranty. Always check polarity before making connections to the inverter.



WARNING: Shock Hazard

Ensure the inverter is off before disconnecting the battery cables, and that AC power is disconnected from the inverter input.

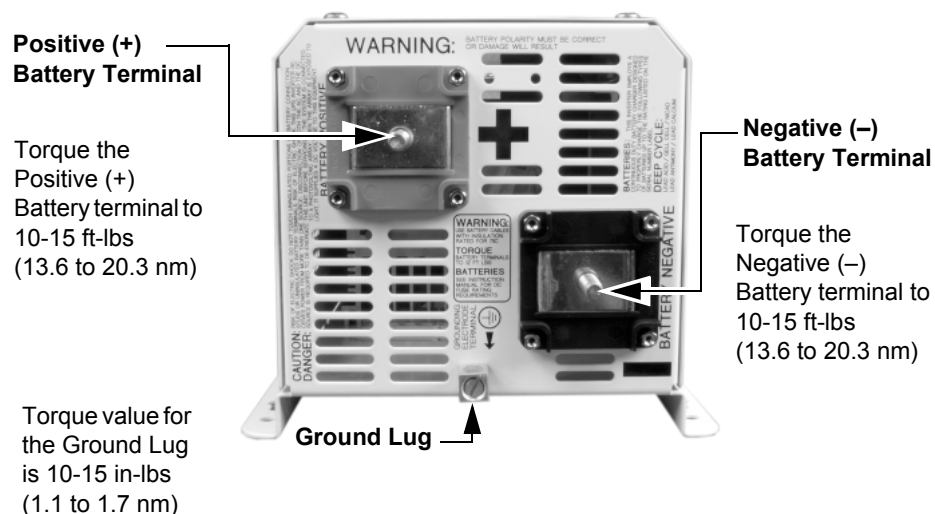


Figure 2-11 DC Terminals on the DR Inverter

Connecting the Battery Bank to the Inverter

Follow the procedure below to connect the battery bank to the inverter.



WARNING: Shock Hazard

Ensure the inverter is off before connecting or disconnecting the battery cables and that all AC power is disconnected from the inverter's inputs.

To connect the battery bank to the inverter:

1. Determine the correct size battery cable to use for installation from Table 2-3 on page 2-16.
2. Determine the correct size disconnect/fuse for installation from Table 2-4 on page 2-17.
3. Color code the cables with tape or heat shrink tubing. The standard colors are red for positive (+) and black for negative (-). (NEC requires white for the negative conductors.)
4. Connect the negative (-) cable to the battery's negative terminal (torque to manufacturer's recommendations).
5. Install the over-current device (fuse or circuit breaker) between the battery's positive terminal and the inverter's positive terminal (as close to the batteries as possible).
6. Connect the (short) positive cable to the battery's positive terminal (torque to manufacturer's recommendations).
7. Ensure the correct polarity of the cables with a DC voltmeter (DVM).

8. Observing battery polarity, connect the positive battery cable (from the over-current device) to the inverter’s positive terminal.

Important: The next step may cause a small spark and snapping sound when connecting the cable to the inverter. This is normal, and is caused by the inverter’s capacitors charging up.

9. Observing battery polarity, connect the negative battery cable to the inverter’s negative terminal.
10. Use an insulated ½ inch wrench or socket to tighten the 5/16 SAE nuts to **10-15 ft-lb (13.6 to 20.3 nm)** for each inverter input terminal.



CAUTION: Equipment Damage

Do not put anything between the cable ring terminal and the flat metal part of the terminal. Overheating of the terminal may occur. Do not apply any type of antioxidant paste until after the battery cable wiring is tightened.

11. Apply antioxidant paste to the battery and inverter terminals.
12. Install the battery terminal connection covers (red for positive, black for negative) over the inverter’s DC terminals and secure with the screws and washers provided.

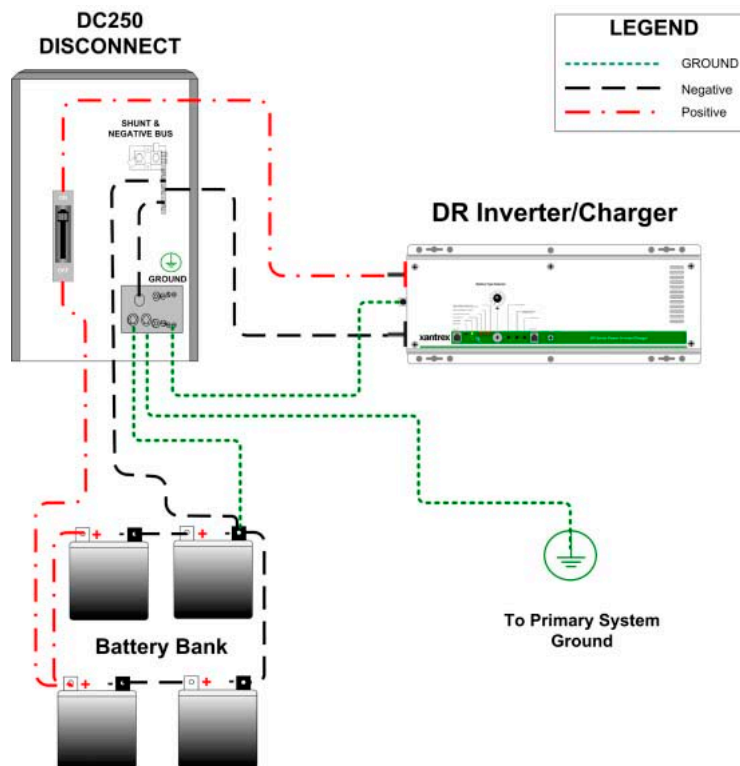


Figure 2-12 Connecting the Battery Bank to the DR Inverter/Charger

Installing a Battery Temperature Sensor

A battery temperature sensor (BTS) option can easily be installed in the system to ensure proper charging of the batteries based on temperature. Installing a BTS extends battery life by preventing overcharging in warm temperatures and undercharging in cold temperatures.

To install the Battery Temperature Sensor:

1. Run the battery temperature sensor wire in the DC conduit (if used) and route the RJ11 connector end to the BATTERY SENSE port located on the front of the inverter.
2. Secure the sensor to one of the batteries located in the center of the battery pack.

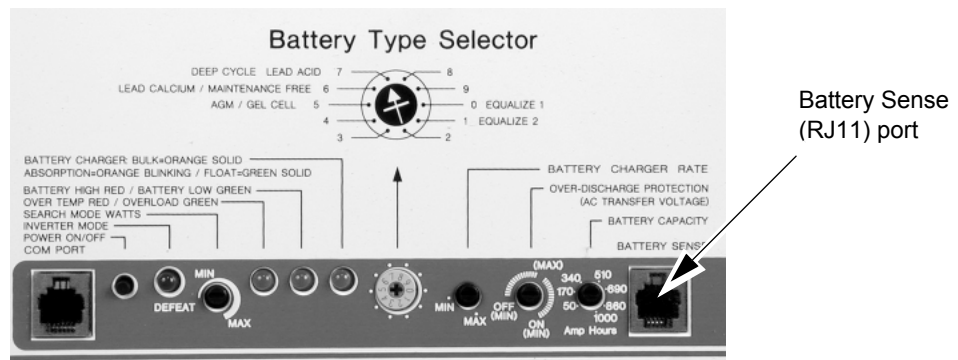


Figure 2-13 Battery Temperature Sensor (BTS) RJ11 Jack Location

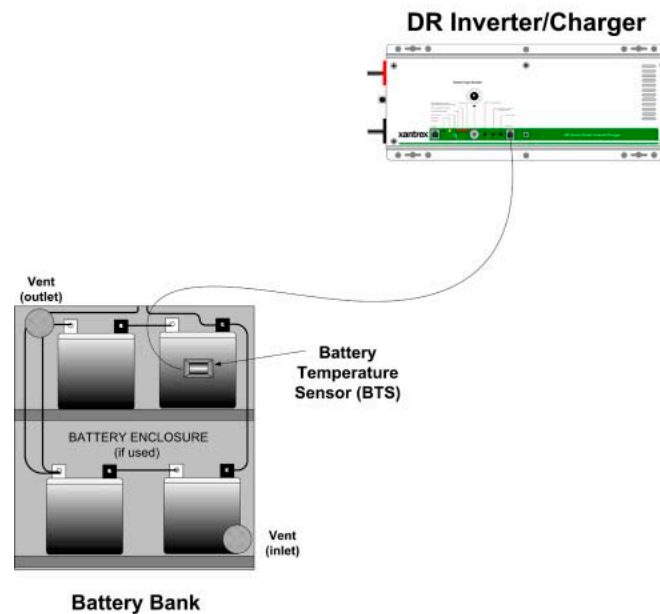


Figure 2-14 Connecting the BTS to the DR Inverter

AC Wiring

This section describes the AC wiring requirements and how to make the connections. It provides the required wire sizes, recommended lengths for conductors, and disconnect/circuit breaker requirements.

Important: The installation of sub-panels and wiring should be performed by a qualified person or a licensed electrician following all local and NEC codes.

AC Distribution Panel (Sub-panel) Mounting and Conduit Installation



WARNING: Shock Hazard

Disconnect the power from the utility's main breaker box before proceeding.

1. Determine the location of the sub-panel and install it according to the manufacturer's directions.
2. Install the AC conduit between the sub-panel (output) and inverter.
3. Install conduit between the inverter (input) and the main breaker box.
4. Determine which circuits require backup. Install the appropriate circuit breakers into the sub-panel.
5. Install an appropriately sized circuit breaker (30 amp maximum) in the sub-panel. This will later be wired to the inverter's output. If two inverters are being used in a stacked configuration, install a double-pole circuit breaker for 240 Vac service.

Accessing the AC Terminals



CAUTION: Equipment Damage

The inverter's AC output must never be wired to the utility or generator output. This will cause severe damage to the inverter which is not covered under warranty.

All AC wiring connects to the terminal block located on the right-hand side of the inverter.

To make the AC connections to the inverter:

1. To access the terminal block, remove the side cover panels (if installed) by removing the two (or three) Phillips screws. Units are shipped without the covers installed (packed in a small plastic bag with additional hardware).
2. Locate the AC input and output terminals on the block. Refer to Figure 2-15 on page 2-23.

Important: The lower AC cover varies depending on the model. DR24XX and DR36XX models are equipped with a conduit box and not a plate. The conduit box is required for the larger diameter wire providing ample bending radius.

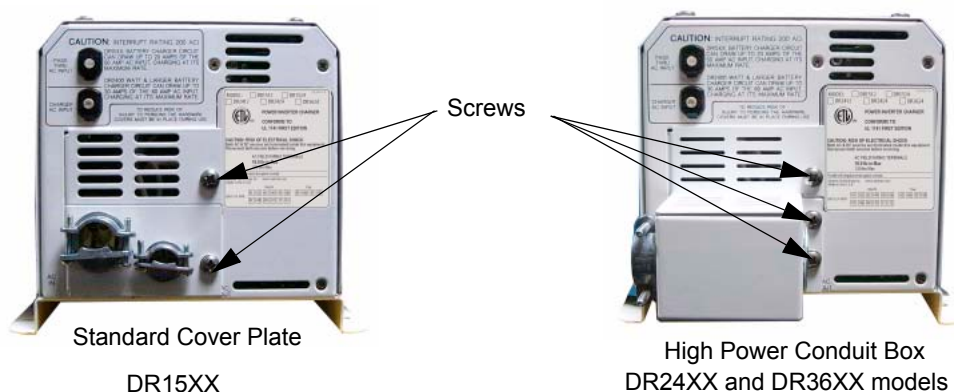


Figure 2-15 AC Side Cover Panels

Before wiring the input of the inverter, refer to Table 2-5 below for the minimum recommended wire size.

Important: Refer to the NEC for actual wire sizes for specific installations.

Table 2-5 Minimum Recommended Wire Size, Torque Values (Input and Output), and Maximum Output Breaker Size

Inverter Model	AC Input		AC Output		Torque Value for Terminal Connections	Maximum Output Breaker Size
	120 Vac	220-240 Vac	120 Vac	220-240 Vac		
DR1512	#8 or 6 AWG	#10 AWG	#10 AWG	#16 AWG	16 in-lbs (1.8 nm)	30 amps AC
DR2412	#6 AWG	#10 AWG	#10 AWG	#14 AWG	16 in-lbs (1.8 nm)	30 amps AC
DR1524	#8 or 6 AWG	#10 AWG	#10 AWG	#16 AWG	16 in-lbs (1.8 nm)	30 amps AC
DR2424	#6 AWG	#10 AWG	#10 AWG	#14 AWG	16 in-lbs (1.8 nm)	30 amps AC
DR3624	#6 AWG	Not Available	#8 AWG	Not Available	16 in-lbs (1.8 nm)	30 amps AC



WARNING: Fire Hazard

To reduce the risk of fire, connect only to a circuit provided with the maximum branch-circuit overcurrent protection noted above in accordance with the National Electrical Code, ANSI/FPA70.

Important: The U.S. requires conduit be used in this type of installation. Refer to the NEC and local codes. Conduit fittings can be replaced with strain reliefs where code permits.



WARNING: Shock Hazard

Disconnect the battery cables from the inverter if they are already connected.

To connect the AC Input to the Inverter:

1. Disconnect the main breaker at the main electrical service panel (if used) or disconnect the AC generator.
2. Install an appropriately sized circuit breaker in the electrical service panel. This will serve as both an AC disconnect and over-current protection. If using a generator only, use the circuit breaker in the generator.
3. Feed the HOT, NEUTRAL, and GROUND wires (using conduit) from the inverter to the AC source. Leave several inches of extra wire at each end.
4. Make the connections to the inverter first. Wiring to the AC source is performed after all connections have been made in the inverter.
 - a) Connect the GROUND (green) wire to the inverter's AC GROUND terminal.
 - b) Connect the NEUTRAL (white) wire from the AC source to the inverter's NEUTRAL INPUT terminal.
 - c) Connect the HOT (black) wire from the AC source to the inverter's AC HOT INPUT terminal.
5. **Torque all connections to 16 in-lbs (1.8 nm).**

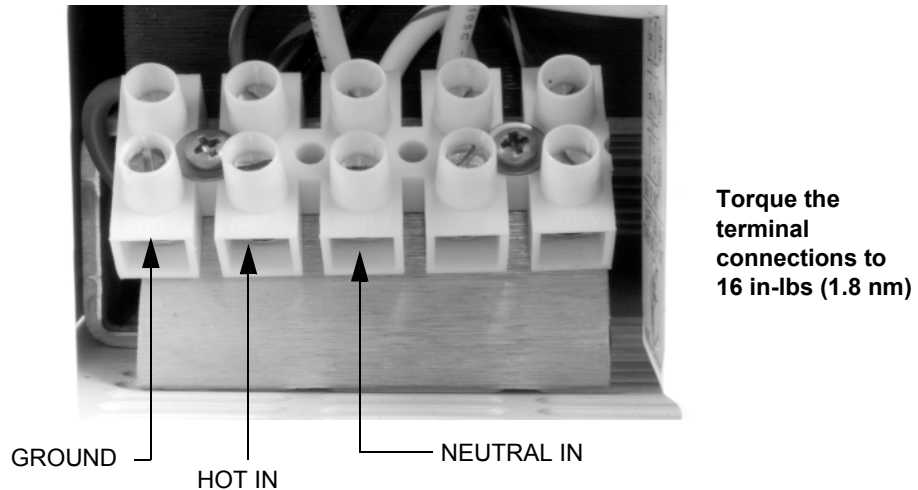


Figure 2-16 AC Terminals for AC Input to the Inverter

AC Output Wiring to the AC Distribution Panel (Sub-panel)

Important: The ground and neutral must be bonded at one place, and only one place, in the system. If the generator is the main source of power, (i.e., no utility grid power) then the neutral and ground connections are bonded at the generator. If the generator is acting as a backup for the utility grid, then the bond should be at the main utility service entrance box. In this case, ensure that no bond exists at the generator output.

To connect the AC output wiring to the sub-panel:

1. Connect the GROUND wire to the inverter's AC GROUND chassis terminal. Connect the other end of this wire to the GROUND bus in the sub-panel.
2. Connect the NEUTRAL (white) wire to the inverter's NEUTRAL OUTPUT terminal. Connect the other end of this wire to the NEUTRAL bus in the sub-panel.
3. Connect the HOT (black) wire to the inverter's terminal labeled AC HOT OUTPUT. Connect the other end of this wire to the sub-panel's input circuit breaker.
4. **Torque all inverter terminal block connections to 16 in-lbs (1.8 nm).**
5. Refer to the sub-panel manufacturer's specifications for wire torque requirements to sub-panel terminals.

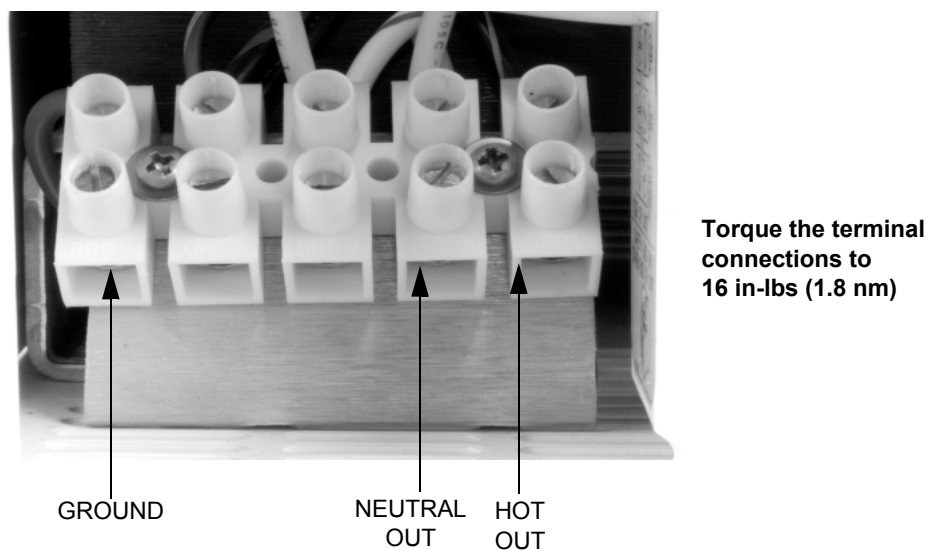


Figure 2-17 AC Terminals for AC output to the Sub-panel

Important: The two neutral connections (input and output) are common to one another and may be used in any combination.

The following diagrams illustrate the AC wiring for the following basic 120/240 Vac scenarios. Consult your system design for other possible configurations.

- On-Grid Application (See Figure 2-18)
- On-Grid using with a generator Backup (See Figure 2-19)
- On-Grid Dual-Inverter Application (See Figure 2-20)
- Off Grid Application using a 120 Vac Generator (See Figure 2-21)
- Off-Grid Application using a 240 Vac Generator (See Figure 2-22)
- Off-Grid Dual-Inverter Application (see Figure 2-23)

AC Input Wiring - On-Grid Applications

Follow the example below to complete the wiring for an on-grid application.

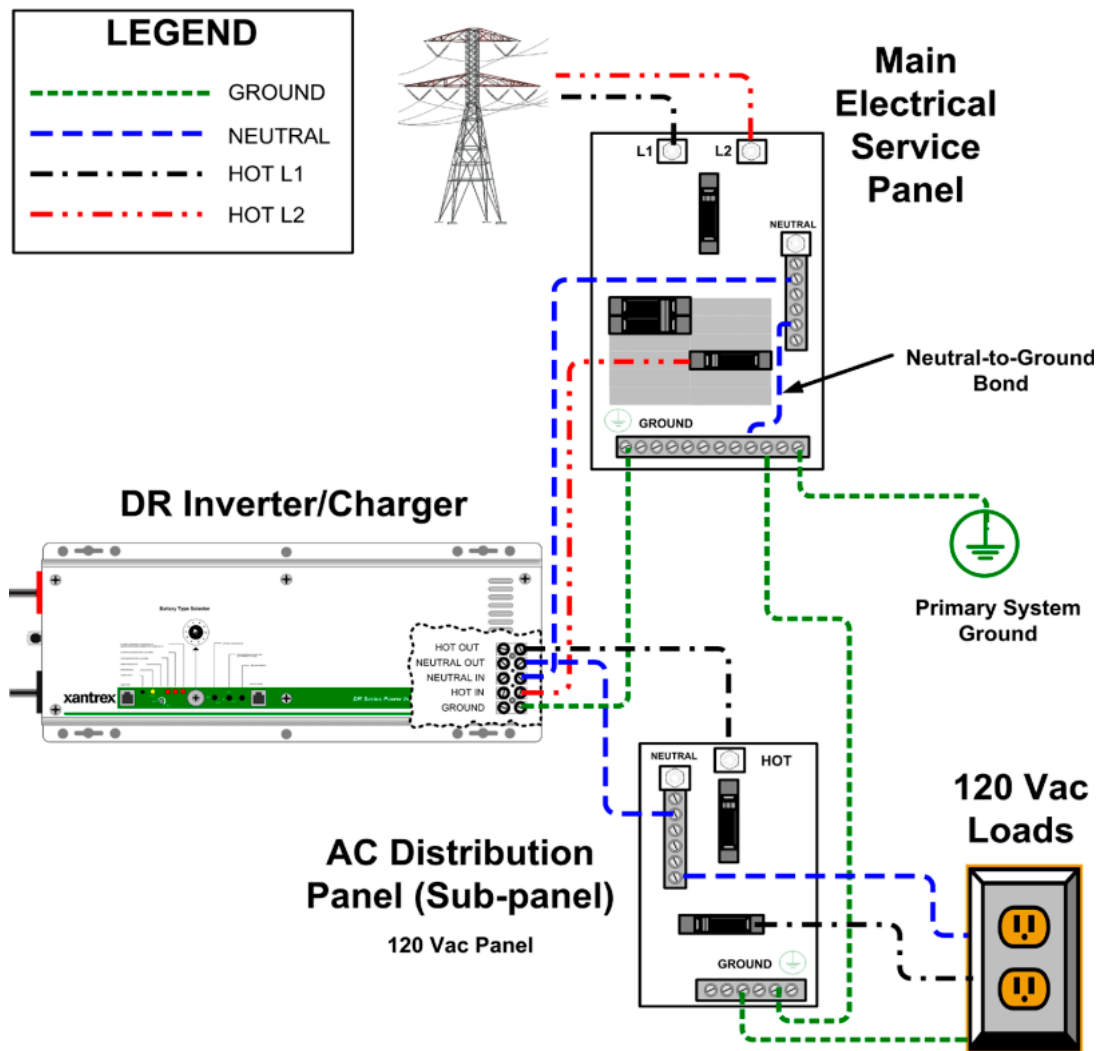


Figure 2-18 AC Wiring- On-Grid Application

AC Input Wiring using a Generator in an On-Grid Application

If a generator is used as a backup for the utility, then a manual transfer switch must be added to provide a means to switch the generator power to the inverter's inputs. The generator can be used during extended outages to recharge the batteries and provide pass through power for the loads. Start and stop the generator manually using the generator's pull-cord, ON/OFF switch, etc.

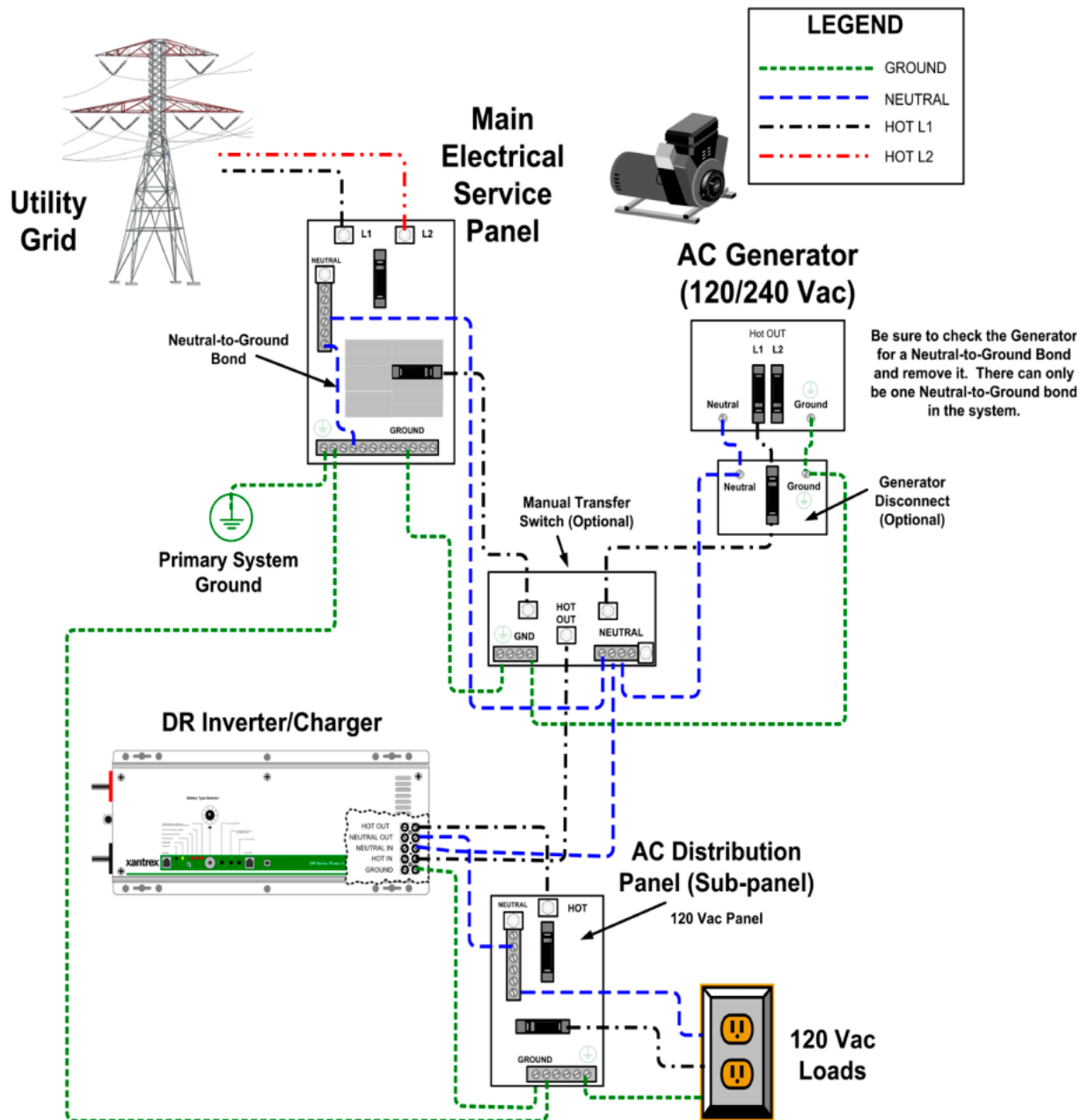


Figure 2-19 AC Wiring using a Generator - On-Grid Application

AC Input Wiring - Off-Grid Applications using a 120 Vac Generator

Follow the example below to complete the wiring for an off-grid application.

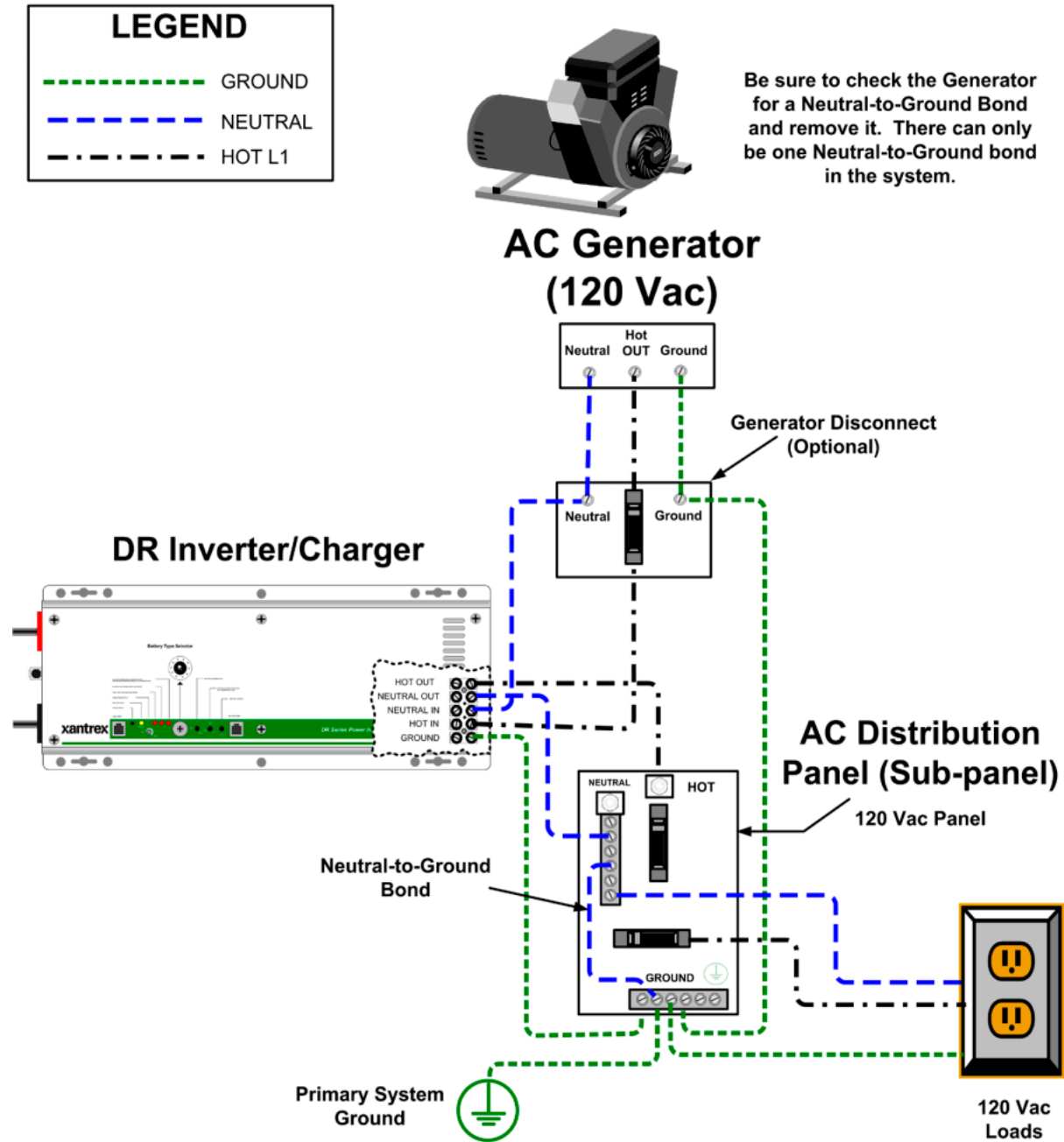


Figure 2-20 AC Wiring using a 120 Vac Generator - Off-Grid Application

AC Input Wiring - Off-Grid Applications using a 240 Vac Generator for 120 Vac Loads

Follow the example below to complete the wiring for an off-grid application.

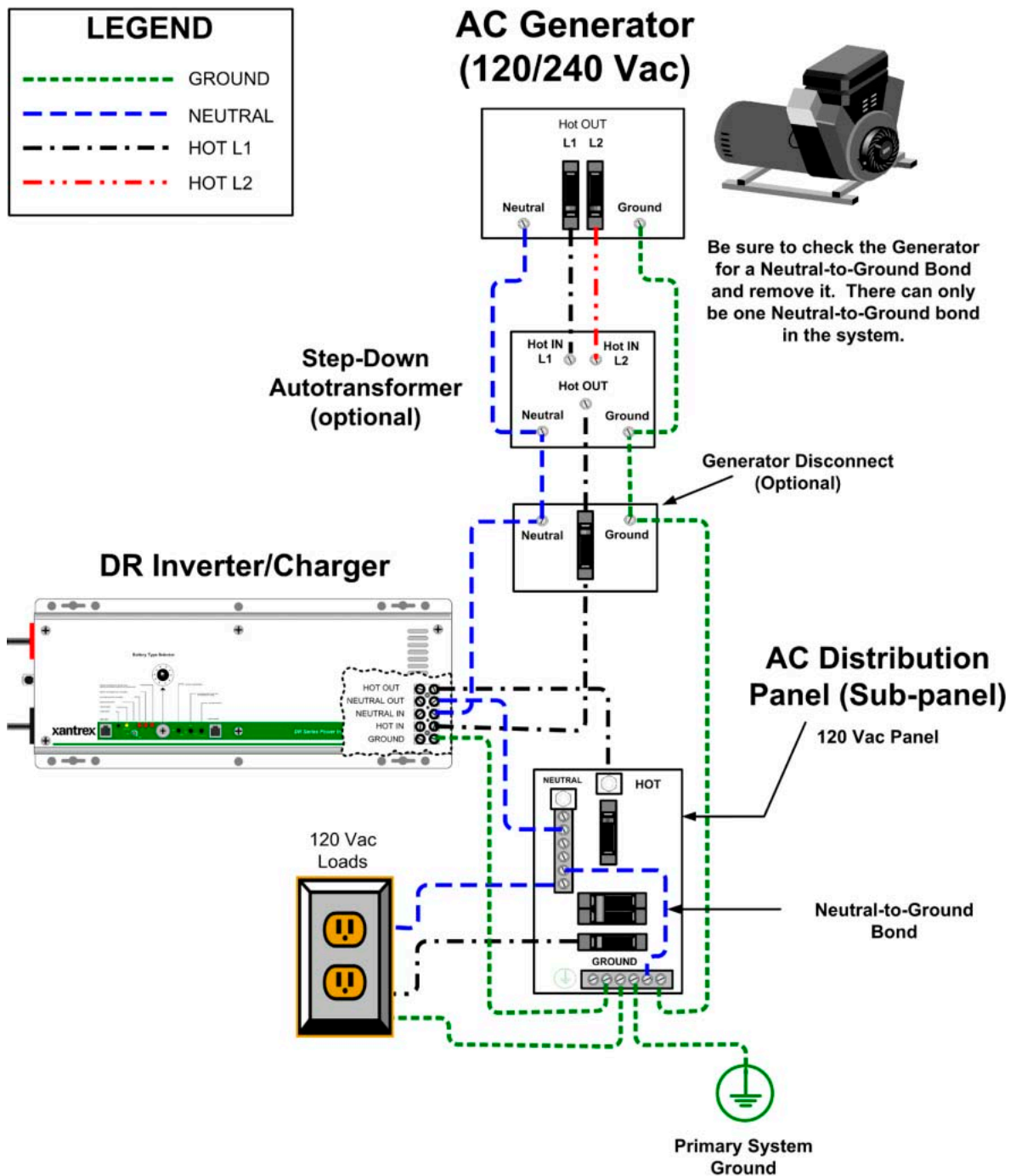


Figure 2-21 AC Wiring using a 240 Vac Generator with 120 Vac Loads only- Off-Grid Application

Series Stacking (120 Vac/60 Hz Models only)

This COM port allows two DR Inverters (120 Vac/60 Hz models only) to be used in the same system in a “SERIES” configuration to operate 240 Vac loads. Series stacking can also be used to connect to 240 Vac only power systems providing both 120 and 240 Vac outputs. A series stacking interface cable (DRI) is required to connect the series stacking port of the inverters.

In this mode, one of the inverters will function as the “primary” and the other inverter becomes the “secondary.” The *first* unit switched ON becomes the *primary* and ensures the secondary’s output is 180 degrees out of phase for 240 Vac operation. Both units can charge the batteries or provide battery backup power during a utility outage.

The following illustrations provide a general overview of AC configurations using stacked inverters. Detailed wiring and operating instructions are provided with the DRI interface kit available from Xantrex Technology Inc.

The following diagrams illustrate the AC Wiring for a basic On-Grid and Off-Grid application.

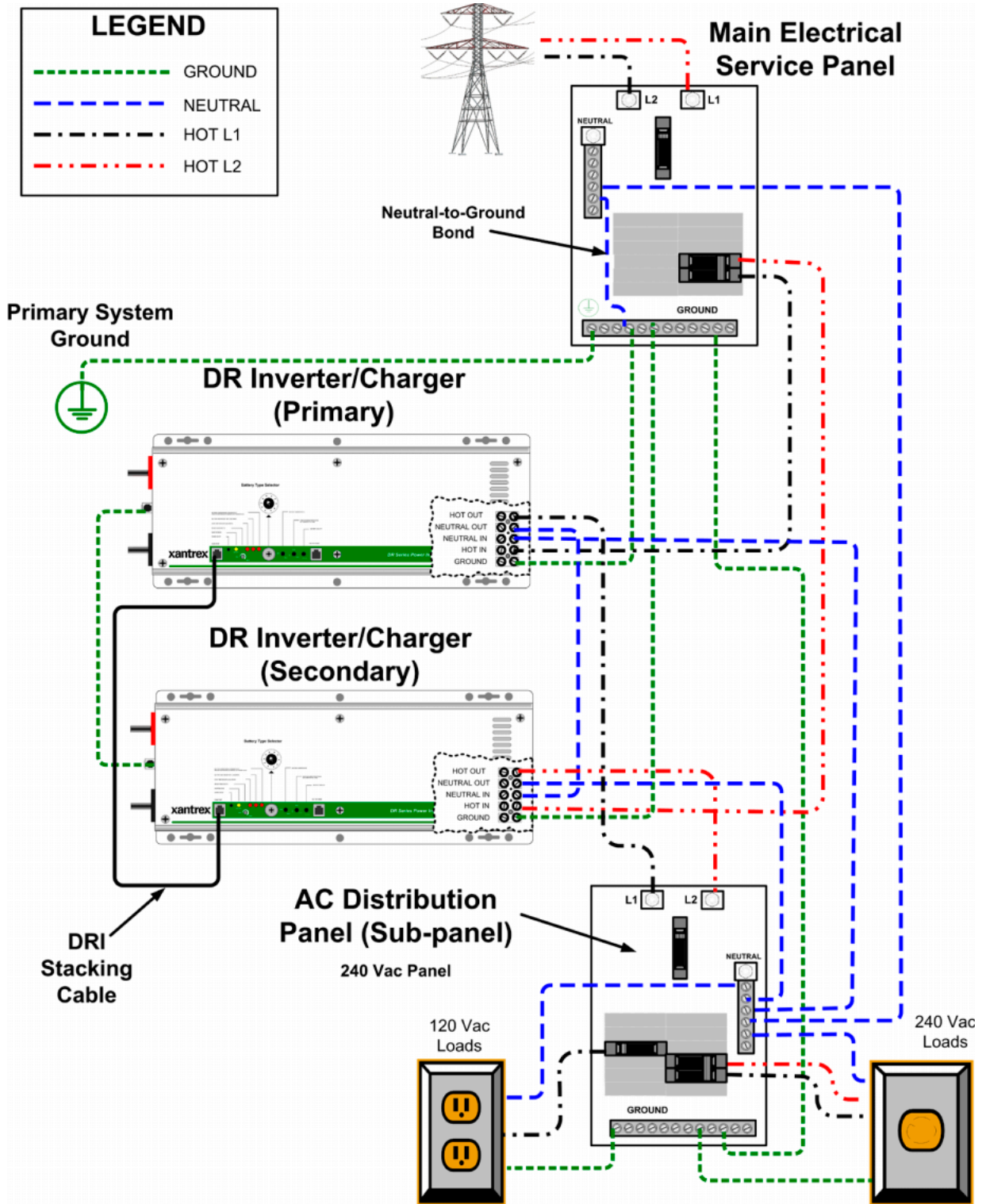


Figure 2-22 AC Wiring for dual-inverters - On-Grid Application (120 Vac models only)

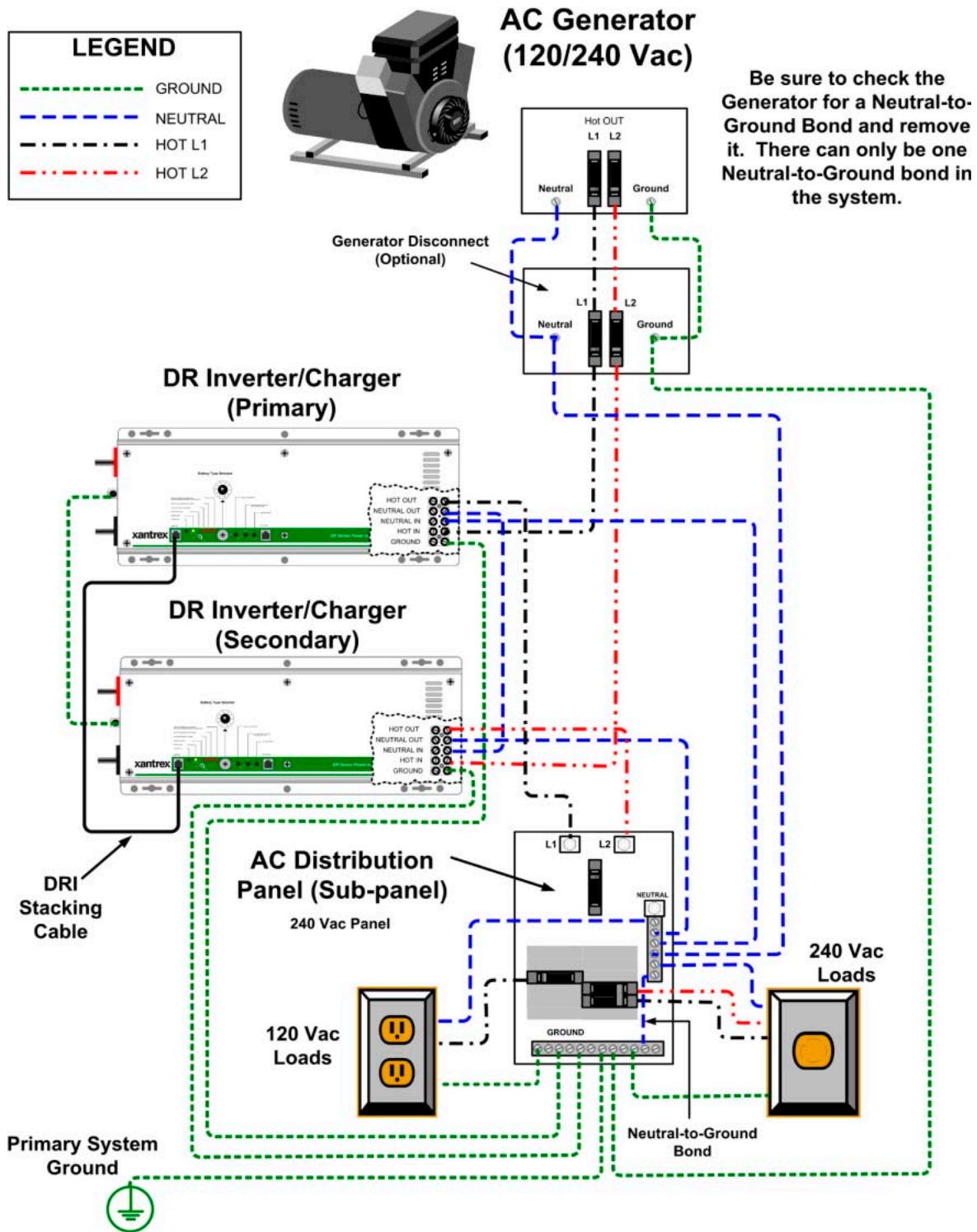


Figure 2-23 Wiring for dual-inverters - On-Grid Application (120 Vac models only)

3

Operation

Chapter 3, “Operation” contains information about how to operate the DR Inverter/Charger.

Front Panel Controls and Indicators

All operating controls, indicators and sense connectors are located on the front panel of the unit. The controls are easily accessible, and the LEDs provide inverter/charger status at a glance.

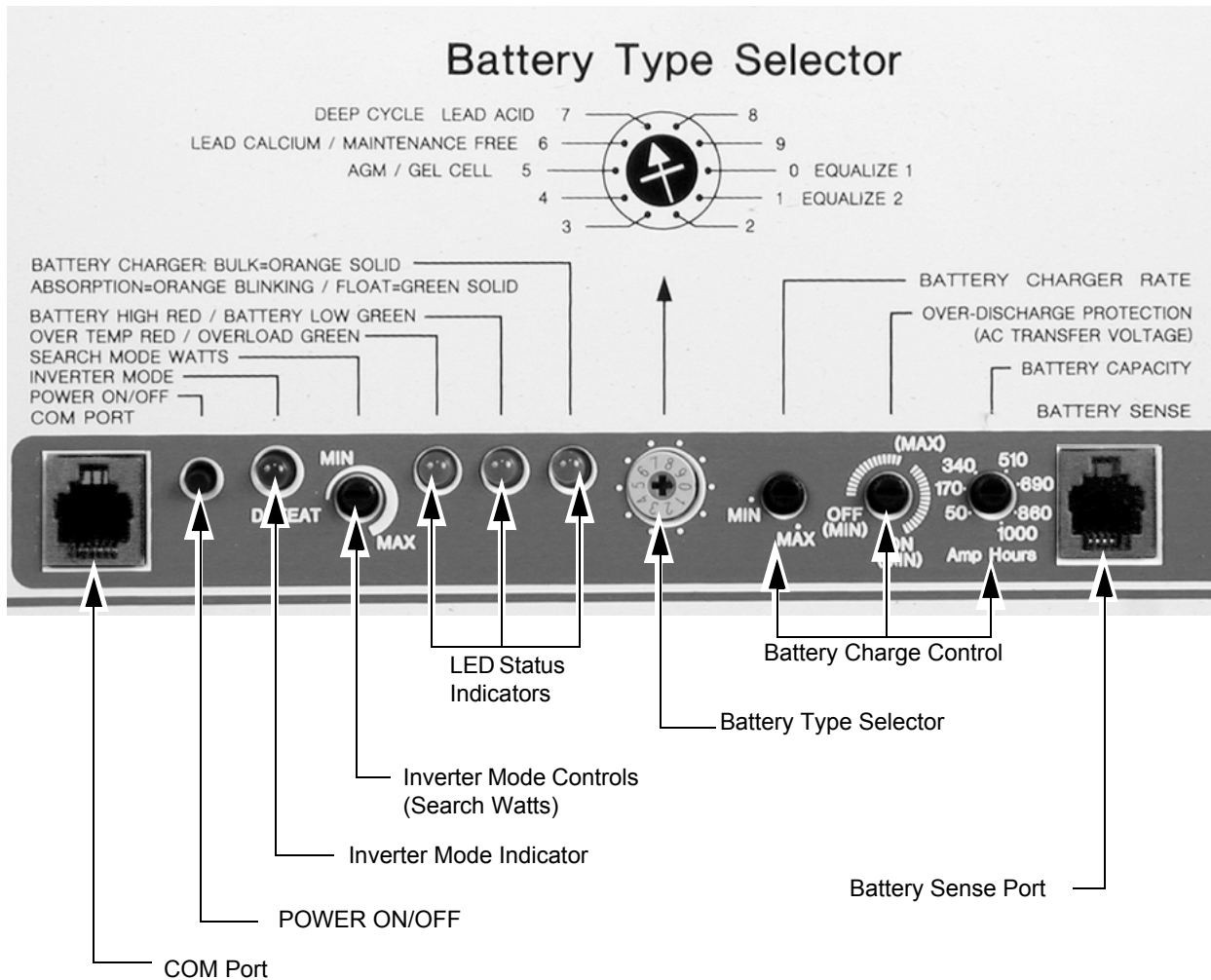


Figure 3-1 Front Panel Controls and Indicators

POWER ON/OFF Switch

The POWER ON/OFF control is a momentary contact switch that turns the inverter/charger ON or OFF by pressing it once. When the inverter is first connected to the batteries, it will run through a self test consisting of flashing the LEDs in sequence, operating the cooling fan momentarily and switching the transfer relay three times. Once the self test has successfully completed, the POWER ON/OFF switch is activated. Pressing the switch once turns the inverter ON. Another press turns the inverter OFF.

Ports

There are two ports on the inverter/charger. Both ports are RJ11 type telephone style connectors. One is used for connecting a remote control to the inverter. The other is used for regulating the charger voltage based on the temperature of the battery bank.

BATTERY SENSE Port

The BATTERY SENSE Port is used for connecting a battery temperature sensor (BTS) to control the charging rate based on battery temperature. The sensor should be taped onto the side of one of the batteries. The information received in this port adjusts the charger's output higher in cold temperatures, assuring the batteries receive a full charge, and lowers it during warm temperatures, reducing battery gassing and providing overcharge protection.

Important: The Battery Sense only adjusts charging voltage. It does not disable the charger.

Refer to the Installation section for the BTS location on the battery.

COM Port

COM PORT (J1) is a dual function RJ11 (6-pin) connector. Its primary function is to provide serial communications to an optional Xantrex™ remote control unit (RC4 or RC8). The port also acts as a stacking interface control when two DR Inverters are used in a series configuration. When two inverters are stacked, a remote control cannot be used with either unit.

Remote Controls (RC8/RC4)

DR Inverter are designed to operate with either an RC8 or RC4 remote control units. Both remotes incorporate a membrane switch with a single red LED display combination to start and stop the inverter, as well as provide overall system operating status.

- **Solid** - With AC line power present, the unit is charging the batteries while directing AC to the load. With no AC line power present, the inverter is running on the batteries and supplying AC to the load.
- **Blinking Slow** (1 to 3 flashes @ 1 second intervals) - The inverter is in search mode (no load connected).
- **Blinking Fast** (3 to 5 flashes @ 1 second intervals) - The inverter is charging the batteries.
- **Flickering** (3 to 5 flashes @ 1 second intervals) - The inverter has detected an over-current error. The LED (and inverter) will turn OFF whenever an over-current condition exceeds eight seconds.

- **Erratic Blinking** (0 to 3 and 2 to 5 flashes @ 2 second intervals) - The inverter has detected an error condition caused by overheating, low battery voltage, or high battery voltage.
- **OFF** - The inverter is OFF.

The remote control must be connected prior to switching the inverter ON; otherwise, the micro-controller will not recognize (or respond to) the remote. If the remote is not recognized, switch the inverter OFF and then ON using the inverter's front panel POWER ON/OFF switch.

Stacking Interface

Whenever two DR Series inverters are used in a series (stacked) configuration, one unit (primary) controls the other unit (secondary). Communication between the two inverters is done via the COM port (J1). The first unit switched ON, using its front panel POWER ON/OFF switch, becomes the controlling (primary) inverter.

Controls

There are several controls on the inverter's front panel that provide adjustments for the battery charger, and AC output energy saving mode.

Battery Type Selector

The Battery Type Selector is a 10 position rotary switch used to set the inverter's charger for the proper Float and Bulk voltage levels. These levels are selected depending on the type of batteries used.

There are also 2 positions (0 and 1) which allow the batteries to be equalized. Equalizing batteries should only be done on liquid lead acid batteries and *never* on gel batteries. Refer to the table below for the charge voltages in the various switch positions. Consult the battery manufacturer for optimum battery voltage charging settings.

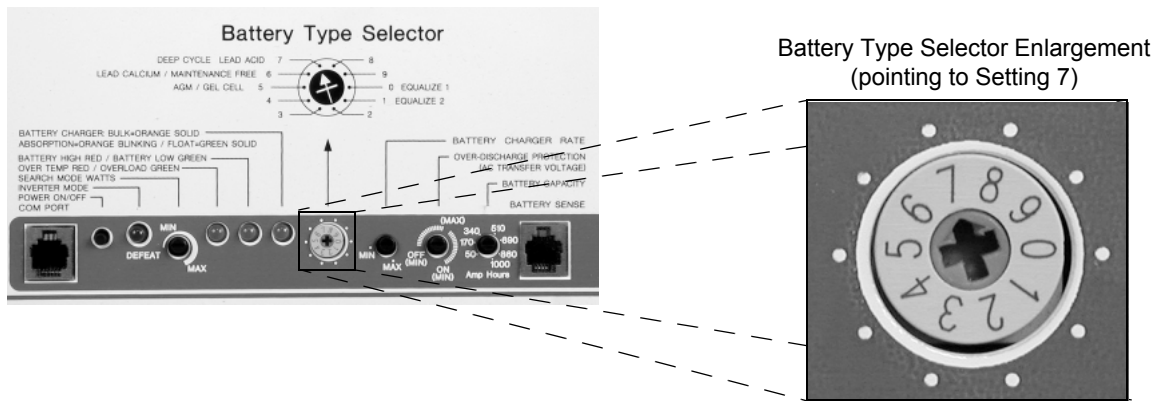


Figure 3-2 Battery Type Selector Adjustment

Table 3-1 Battery Type Selector Switch Settings

Switch Position	Description	12-volt Models		24-volt Models		Charge Function	
		Float Voltage	Bulk/Equalize*	Float Voltage	Bulk/Equalize*	Equalize Charge Rate	Equalize Time
0	Equalize 1 - equalizes at a rate equal to the battery bank capacity (in amp-hours) divided by 40.	13.2	*15.0	26.4	*30.0	Battery Capacity Setting (C/40)	6 hrs. minimum 12 hrs. maximum
1	Equalize 2 - charges at a rate set by the BATTERY CHARGER RATE control.	13.2	*15.5	26.4	*31.0	Battery Charger Rate Setting (manual)	6 hrs. minimum 12 hrs. maximum
2	Deep Cell Lead Acid 2	13.3	15.0	26.6	30.0	Provides an additional Float and Bulk settings for deep cycle, lead acid batteries. Refer to the battery manufacturer's recommendation for Float and Bulk settings.	
3	Not Specified	13.6	14.3	27.2	28.6	Provides an additional setting of Bulk and Float voltages.	
4	Gel Cel 2	13.7	14.4	27.4	28.8	Recommended for gel cell batteries that specify high float voltages. Check with the battery's manufacturer.	
5	Gel Cell 1	13.5	14.1	27.0	28.2	Typical gel cell setting.	
6	PcCa-lead Calcium	13.2	14.3	26.4	28.6	Use this setting for sealed type car batteries.	
7	Deep Cycle Lead Acid 1 (Default Setting)	13.4	14.6	26.6	29.2	Factory setting for typical deep cycle lead acid batteries.	
8	NiCad 1	14.0	16.0	28.0	32.0	Use for NiCad battery systems.	
9	NiCad 2	14.5	16.0	29.0	32.0	Recommended for use with nickel iron batteries.	

See Important notes that follow.

Important:

1. Switch positions “0” and “1” are for monthly battery maintenance only. Return the switch to the appropriate position for the system’s batteries when Equalize charging has completed. **NEVER EQUALIZE GEL BATTERIES!** Use together with BATTERY CHARGER RATE potentiometer (position 1) or BATTERY CAPACITY potentiometer (position 0).
 2. Equalize voltages are displayed in the table with an asterisk (*) - Switch positions “0” and “1” only.
 3. Switch position “7” is the default values as shipped from the factory.
 4. Always refer to the battery manufacturer’s specifications for equalization.
-

SEARCH MODE WATTS Potentiometer

The Search Mode Watts potentiometer adjusts the current threshold required to bring the inverter out of search mode into full wave operation. With search mode enabled, the inverter pulses the AC output looking for an applied load. With no load detected, the inverter goes into the search mode to minimize energy consumption. When a load is applied, the load current is sensed, bringing the inverter into full power operation. Disabling the threshold (setting the potentiometer fully CCW) causes the inverter to remain ON (in full power operation) regardless of an applied load.

To set the Search Mode Watts:

1. Remove the AC input source from the inverter. The inverter switches to battery operation. Ensure all inverter supported appliances are switched OFF.
2. Turn the potentiometer completely CW (to MAX).
3. Switch on the load which will trigger the inverter to full power. This could be a lamp located in a convenient location if the power goes out. The light may flicker as the inverter searches the line for a load. The green INVERTER MODE LED blinks 2-3 times a second, indicating the inverter is in the SEARCH MODE.
4. Slowly turn the potentiometer CCW (toward MIN) when the proper setting is found, the lamp and INVERTER MODE LED will light steady.
5. Turn the lamp OFF for a moment. The inverter should switch back to the SEARCH MODE. Turn the lamp ON. Ensure the inverter comes out of the Search Mode. Adjust the potentiometer up or down as necessary.

Important: The Search Mode only activates when the unit is operating in the inverter mode (from batteries) to prevent unnecessary battery discharge when electrical power is not required. If the inverter is supporting loads that must constantly be powered, turn the search mode OFF by setting the potentiometer fully CCW to the DEFEAT position.

Important: Some loads constantly draw power even though they are switched OFF. These include: TVs with instant-ON circuits, microwaves with digital displays, VCRs, etc. It is best to operate these devices from another circuit or install a switch to turn these OFF completely or don't use the Search Mode.

Important: When the SEARCH MODE is used with series stacked inverters, only 120 Vac loads connected to the "master" inverter will bring the unit out of the search mode. See "AC Transfer Voltage" on page 3-10.

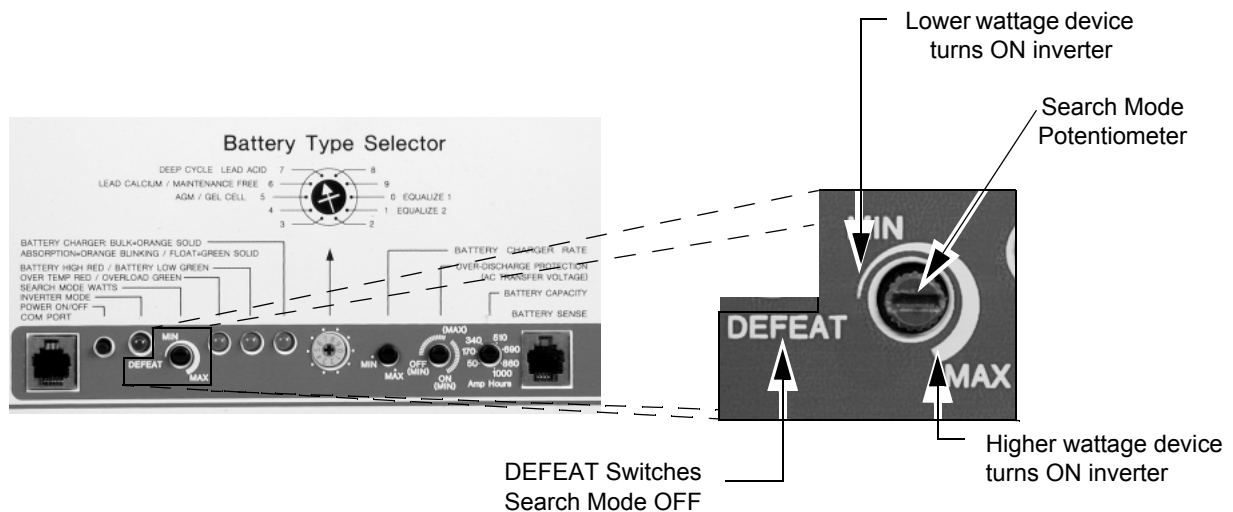


Figure 3-3 Battery Type Selector Adjustment

Battery Charger Rate

The Battery Charger Rate potentiometer sets the maximum charge current supplied to the battery bank and is also used to regulate constant current in the Bulk Charge Mode. The level should be adjusted to provide a charge rate less than or equal to the amp-hour capacity of the battery bank divided by a factor of five.

Example:

1. Inverter DR1512 has a maximum charge rate of 70 amps.
 - a) Battery bank amp-hour capacity = 500 amp-hours using gel cell batteries.
 - b) Divide the amp-hour capacity by 5 ($500/5 = 100$).
 - c) Set the potentiometer to MAX (70 amps) as it is less than 100.
2. Inverter DR1512 has maximum charge rate of 70 amps.
 - a) Battery bank amp/hour capacity is 250 amp-hours using gel cell batteries.
 - b) Divide the amp-hour capacity by 5 ($250/5 = 50$).
 - c) Set the potentiometer to approximately 71% (50 amps).

Use Table 3-2 to find the approximate setting of the Battery Charge Rate potentiometer. The settings do not need to be exact, but should be as close as possible to the actual value required.

Important: The potentiometer does not have an arrow to indicate its position. Use a small blade screwdriver and rotate the control completely CCW to find the start position. Rotate the potentiometer CW to the desired position (i.e., halfway between the stops for a 50% setting).

Table 3-2 Approximate Charge rate Setting/Amperage

Model	Percent of Potentiometer Rotation (between stops)				
	0% Min.	25%	50%	75%	100% Max
DR1512 DR2424 DR3624	0 amps	17.5 amps	35 amps	52.5 amps	70 amps
DR2412	0 amps	30 amps	60 amps	90 amps	120 amps
DR1524	0 amps	8.75 amps	17.5 amps	26.25 amps	35 amps

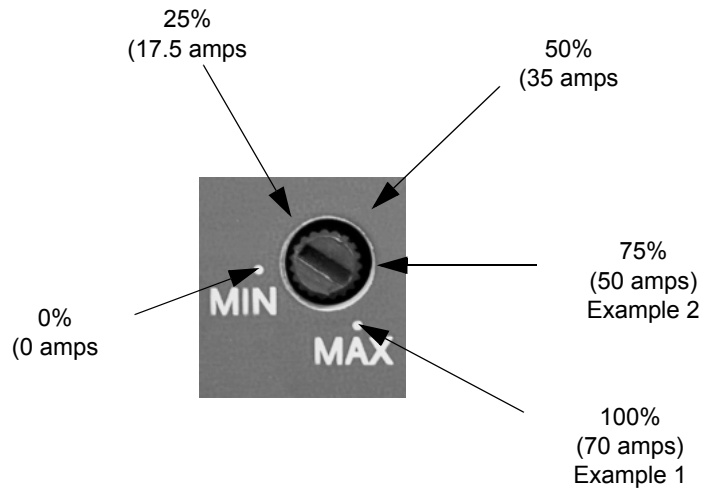


Figure 3-4 Battery Charger Rate Potentiometer (DR1512 values used)

Over Discharge Protection/AC Transfer Voltage

The Over Discharge Protection/AC Transfer Voltage potentiometer performs two related functions. When set between the 2 and 5 o'clock position (right), both ODP and the AC Transfer Voltage function simultaneously (see table on next page). When the potentiometer is set between the 9 and 1 o'clock position (left), only the AC Transfer Voltage is functional (ODP is disabled).

Important: The ODP is not scaled. It is either on or off. The min/max settings only refer the AC transfer function.

Over Discharge Protection (ODP)

When enabled, ODP shuts down the inverter at a specified voltage (low battery cutoff) to protect the batteries from over discharge damage. The inverter circuitry calculates the lowest (safe) DC voltage (leaving approximately 20% battery capacity) based on the position the Battery Type Selector switch and the amount of current drawn by the load. Under no-load conditions this level is typically between 11.8 and 12.0 Vdc (for a 12-volt battery bank).

Important: The range of set points between 2 and 5 o'clock also determine the low AC Transfer Voltage. This must be considered when adjusting this potentiometer with ODP enabled (see Table 3-3).

Important: When ODP is disabled (set points between 9 and 1 o'clock), the inverter is programmed to shut OFF when the batteries reach approximately 8.5 Vdc (1.4166 V/cell) for 12-Vdc systems (17 Vdc for 24-volt systems).

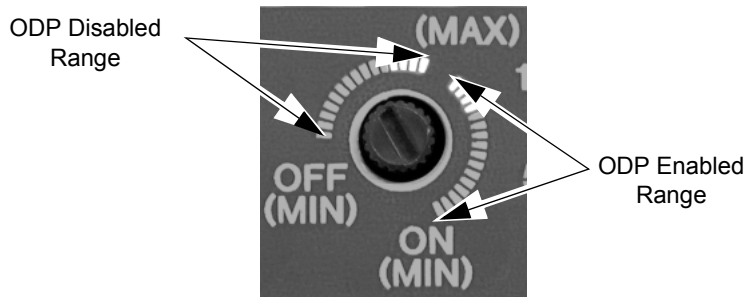


Figure 3-5 ODP Enabled/Disabled Positions

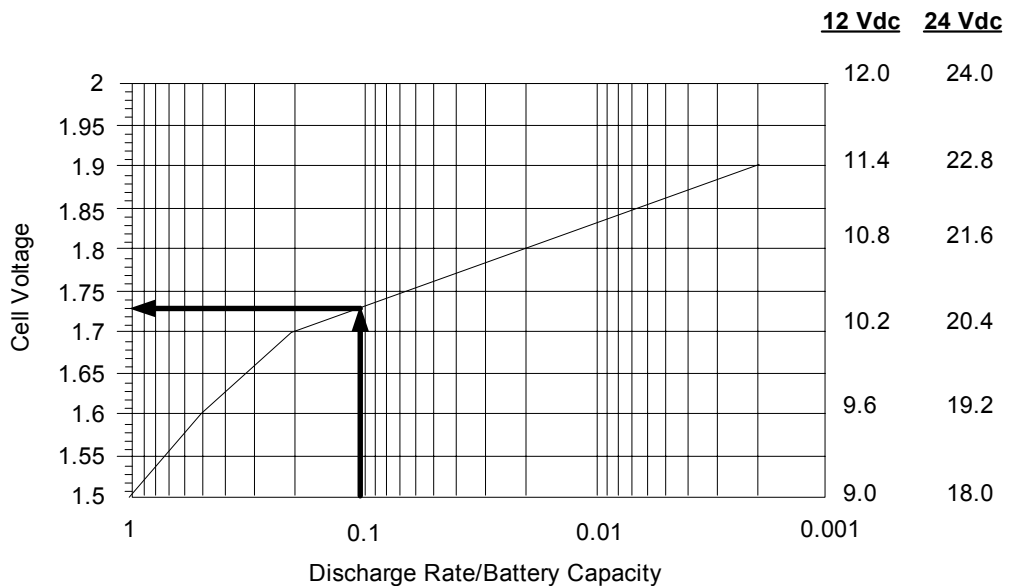


Figure 3-6 Automatically Calculated Discharge Cutoff Voltage per Cell

AC Transfer Voltage

During normal operation, the inverter supplies AC power to the applied loads through the pass-through circuit and simultaneously charges the system batteries. Whenever the external AC source drops **below** the AC Transfer Voltage (set by the potentiometer), the inverter switches to battery power in order to maintain the connected load.

Examples (120 Vac inverter system):













1. The AC Transfer Voltage potentiometer is set to 9:00 o'clock with ODP disabled. Whenever the incoming AC voltage drops to 40 volts or below, the inverter will switch to battery power.
2. The AC Transfer Voltage potentiometer is set to 2:00 o'clock with ODP enabled. Whenever the incoming AC voltage drops to 105 volts or below, the inverter will switch to battery power.

Important: ODP does not affect the operation of the AC Transfer Voltage. ODP is either ON or OFF, depending upon the position of the potentiometer.

Important: There are 6 settings available for the AC Transfer Voltage for both ODP OFF and ON as shown in the Table 3-3 below.

Important: To achieve the fastest transfer time (typically less than 16 ms), set the AC Transfer Voltage potentiometer near the 2:00 o'clock position (with the ODP enabled); or, near the 1:00 o'clock position (with the ODP disabled). If a high number of "nuisance transfers" caused by transients on the AC line occur, adjust the potentiometer from the maximum position toward the minimum position (i.e., 2 o'clock toward 5 o'clock with ODP enabled; or 1 o'clock toward 9 o'clock with ODP disabled).

Table 3-3 ODP/AC Transfer Voltage

ODP Adjustment		AC Transfer Voltage		
ODP Disabled	ODP Enabled	100 to 105 Vac (-J/-K Models)	120 Vac Models	220 to 230 Vac (-W /-E Models)
9:00 	5:00 	30 Vac	45 Vac	90 Vac
Approximate 	Approximate 	77 Vac	85 Vac	170 Vac
Approximate 	Approximate 	81 Vac	90 Vac	180 Vac
Approximate 	Approximate 	86 Vac	95 Vac	190 Vac
Approximate 	Approximate 	90 Vac	100 Vac	200 Vac
Approximate 	Approximate 	95 Vac	105 Vac	210 Vac

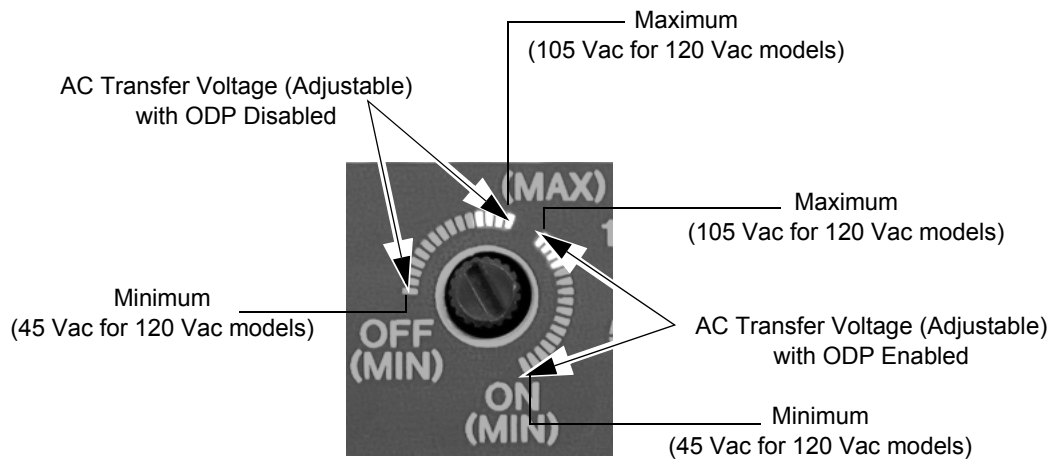
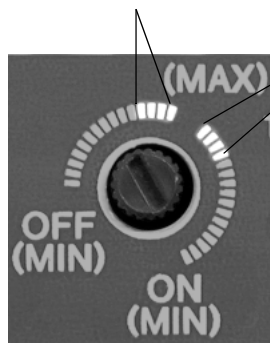


Figure 3-7 ODP Enabled/Disabled Positions

Important: Most AC appliances will operate properly with an AC pass-through voltage between 95 and 105 volts. Setting the AC Transfer Voltage potentiometer between these values will allow the incoming source voltage to drop to this level and still operate the connected appliances (load). If the appliances do not operate properly at the lower AC utility pass-through voltage, increasing the setting of the potentiometer (toward MAX) allows the inverter to transfer to battery power (providing full AC output) during these periods.

Important: When setting the AC Transfer Voltage potentiometer for generator applications, the setting may need to be lowered if high powered loads cause the generator voltage to momentarily drop.

Typical Setting Range for Utility Application (ODP OFF)



Typical Setting Range for Utility Application (ODP ON)

Figure 3-8 Typical Setting for Most Utility Application

Battery Capacity

The Battery Capacity potentiometer is used to set the correct charge profile for the battery capacity (amp-hours) used with the inverter (see illustration below). The setting allows the inverter to calculate over-discharge protection values and also the end of the Bulk/Absorption charge mode, at which point the inverter switches to the Float mode of battery charging.

The potentiometer should be adjusted as close as possible to the actual capacity of the battery bank for optimum charging. If the system's battery bank is larger than 1000 amp-hours, set the potentiometer for 1K.

Important: If using dual inverters configurations, set each charger for half the value.

Important: Most battery manufacturers list the amp/hour rating on the battery label.

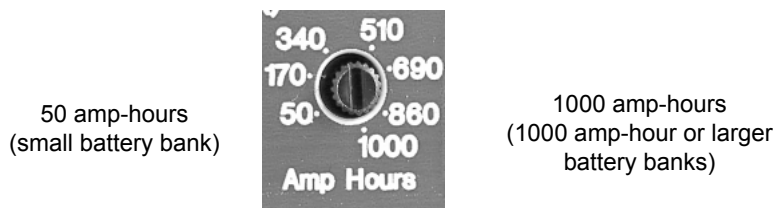


Figure 3-9 Battery Capacity Potentiometer (new)

Important: The Battery Capacity (Amp/Hrs) potentiometer values have changed between the minimum value of 50 Ah and 1 kAh. Please use the photo that matches your unit.

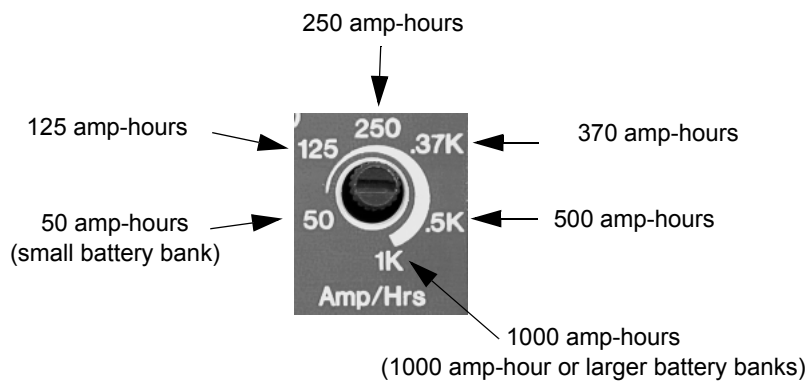


Figure 3-10 Battery Capacity Potentiometer (old)

LED Indicators

There are four LEDs on the inverter's front panel, indicating inverter status, battery condition, over temperature/overload conditions and charger status. These LEDs blink or change color depending on the condition or function they are displaying.

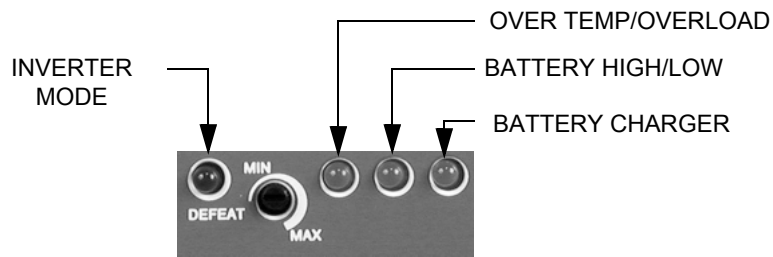


Figure 3-11 LED Indicators

Inverter Mode LED - Green

The green Inverter Mode LED lights (solid) to indicate the inverter is running on batteries (full wave operation). When the inverter is in search mode (no load applied) the LED flashes 2 to 3 times per second. During AC line operation, with AC passing directly through to the connected load, the LED remains OFF.

Over Temp / Overload LED - Red / Green (error condition)

The Over Temp / Overload LED is a dual color, dual function indicator. When the inverter's temperature is too high for safe operation, the LED lights (red) to indicate the Over Temp condition. When the temperature returns to a safe level, the LED turns OFF. If the condition persists, the inverter will shut down, cool and then restart.

Whenever the current draw exceeds a value programmed into the micro-controller, the LED lights (green) to indicate the Overload condition. The LED can remain ON for up to one hour (before inverter shutdown) if the condition is caused by a fault in the charger circuit. When the fault condition clears, the LED turns OFF. If the condition is caused by backfeed (connecting the AC line to the inverter's output) the LED will remain ON for approximately 10 seconds before the inverter shuts down.

Battery High/Battery Low LED - Red/Green (error condition)

The Battery Hi / Battery Low LED is a dual-color, dual-function indicator. Whenever battery voltage exceeds a safe value, the LED lights red to indicate the condition. This value is typically 15.5 volts DC for a 12 volt system (31 volts DC for a 24 volt system). If the condition persists, the inverter will shut down until the battery voltage returns to a safe level and then restart.

Important: In renewable energy applications (solar, wind, hydro, etc.) the DC charge controllers must be set to a level below the inverter's maximum input voltage or the inverter shuts OFF.

Whenever the battery voltage drops to its lowest (safe) level (as calculated by the ODP), the LED lights green to indicate the condition. If the condition persists, the inverter will shut down until the battery voltage returns to a safe level and then restart.

Important: The inverter automatically restarts when the following error conditions are detected: LOW/HIGH BATTERY, OVER TEMPERATURE, or a quick duration SHORTED OUTPUT or OVER-CURRENT. The inverter shuts OFF and requires a MANUAL restart if the following conditions are detected: a *prolonged* overload condition (approximately 10 seconds) or the inverter's output is connected directly to an AC power source (utility grid or generator).

Charger LED - Orange / Green

The Charger LED is a dual color (red/green), triple function indicator.

- When the charger is in Bulk mode, the LED lights orange.
- When the charger is in Absorption mode, the LED blinks orange.
- When the charger is in Float mode, the LED lights green.

Important: Orange is a flickering mix of red and green. It can look different depending on the angle at which the LED is viewed. It should never be a solid red.

Important: The battery charger control circuit operates from the battery voltage. If the battery voltage falls below 7 volts, the inverter/charger will not operate. The batteries must first be recharged using a stand-alone charger to bring the voltage up to a level where the inverter/charger can operate.

Audible Indicator (internal)

A buzzer is located on the control board as an audible alert to fault conditions such as Battery High/Battery Low, or Overload. Steady buzzing indicates an impending inverter shut down. A pulsing chirp indicates the inverter is temporarily off-line due to a fault condition (either within the inverter or related to the system).

Circuit Breakers

The DR Inverter contains two circuit breakers located on the right-hand side of the chassis, directly above the AC input terminal block. The pass-through AC input circuit breaker protects the AC wiring and connected load. The charger AC input circuit breaker protects the charger circuit. The breakers are rated for the maximum charge rate and pass-through current allowed according to the rating of the internal relay.

Table 3-4 AC Pass-through Circuit Breakers

Models	DR15XX	DR24XX	DR36XX
120 Vac	30 amps	30 amps	30 amps
210-230 Vac	15 amps	15 amps	N/A

Table 3-5 Battery Charger Circuit Breakers

Models	DR15XX	DR24XX	DR36XX
120 Vac	20 amps	30 amps	30 amps
210-230 Vac	8 amps	15 amps	N/A

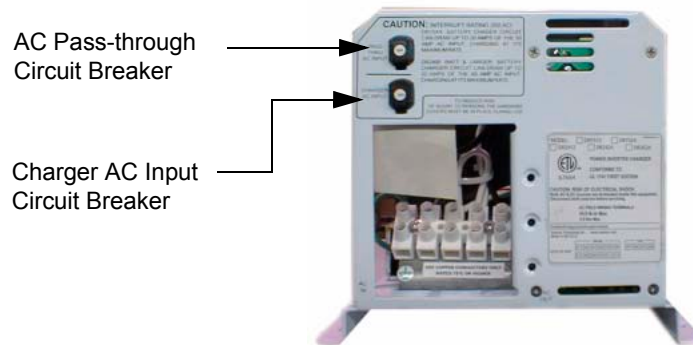


Figure 3-12 AC Pass-through and Charger AC Input Circuit Breakers

Start-up

Once the inverter is properly connected to the batteries, AC source, and loads (using a sub-panel) the inverter is ready for operation. Recheck the controls and ensure they are in the proper position. Recheck all wiring and ensure it is correct.

Starting the inverter:

1. Apply DC power to the inverter by switching on the DC disconnect circuit breaker. The inverter will go through a self-test and then shut OFF.
2. Press the ON/OFF button once. The inverter will sound an audible chirp.
3. Apply AC power to the inverter.
4. The inverter starts charging the batteries in the Bulk mode, indicated by the CHARGER LED illuminating a solid orange.
5. Using a true RMS AC voltmeter, check the output voltage of the inverter. This voltage can be checked at either the AC terminal block or in the sub-panel (between the HOT and NEUTRAL lines). The voltage should be 120 Vac (230 Vac for “E” models, 220 Vac for “W” models, or 105 Vac for “J” and “K” models). (Non-true RMS meters register from 90 to 110 Vac.)
6. Switch the AC disconnect circuit breaker to OFF. The inverter will go into the inverter mode (if a sufficient load is applied to the AC output while in the search mode). The green INVERTER MODE LED will light solid indicating the inverter is active. The voltage on the AC output of the inverter will remain the same as above ($\pm 5\%$ maximum).

Important: If the inverter is in the SEARCH MODE (INVERTER MODE LED flashing) and a sufficient load is not available to bring the inverter up to full voltage, turn the SEARCH MODE WATTS potentiometer fully CCW to defeat the search function.

7. Reapply the AC power by switching the AC disconnect to ON. Allow the batteries to fully recharge.

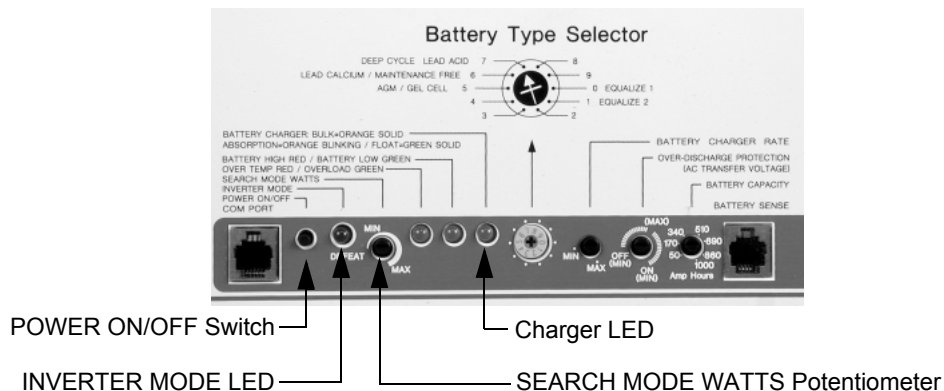


Figure 3-13 Startup Items

Important: The unit will not use renewable energy for AC output as long as AC input (utility or generator) is available to the inverter.

Charger Mode

3-Stage Charging Process

The charging cycle uses a 3-stage charging process to maintain the batteries. Whenever nominal AC is present at the inverter's input, it passes power through to the connected load and begins charging the batteries, indicated by the dual color BATTERY CHARGER LED.

Bulk Charge

Bulk charge is the first stage in the charging process and provides the batteries with a controlled, constant current. A **solid orange** BATTERY CHARGER LED indicates bulk charge. The bulk charge level is adjustable using the BATTERY CHARGER RATE potentiometer. Once the battery voltage rises to the bulk voltage threshold, the charger then switches to the absorption mode.

Absorption Charge

Absorption charge is the second stage of battery charging and provides the batteries a controlled, constant voltage for a set period of time. A **blinking orange** BATTERY CHARGER LED indicates absorption charge.

During this stage the current supplied to the batteries slowly decreases. When the current equals the programmed return amps value (battery bank capacity/40) set with the BATTERY BANK CAPACITY potentiometer, the charger switches to the third stage—float.

Important: If there are DC loads connected to the battery, the current may never decrease to the level to initiate the float stage. The inverter/charger incorporates a timer circuit which starts counting when AC voltage is applied. To ensure that the charger does not stay indefinitely in the absorption charge mode, the timer automatically switches to the float charge mode when 12 hours have elapsed.

Float Charge

Float charge, the final stage of battery charging, maintains a charge to the batteries whenever AC is present on the inverter's input. A **solid green** BATTERY CHARGER LED indicates float charging which reduces battery gassing, minimizes watering requirements (for flooded batteries) and ensures the batteries are in a constant state of readiness.

A new 3-stage charging cycle is initiated after an AC source is reapplied to the inverter's AC input terminals such as after a utility outage.

Important: The Float Charge is a very low-current charge, also called a “trickle-charge”. Some batteries may require higher current. Consult the battery manufacturer to determine if the batteries being used can handle a float charge. The inverter will adjust its charge rate to meet the battery requirement.

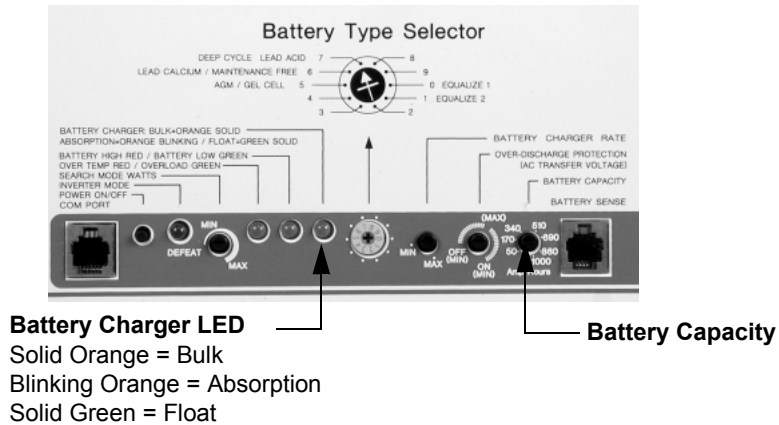


Figure 3-14 Charger Controls and Indicators

Equalize Charging

Equalize charging is a special mode of battery charging. During use, the battery’s cells can become unequal in the voltage and current they can deliver. This is due to a buildup of sulfate on the plates as well as stratified electrolyte. Sulfate prevents the cells from receiving or delivering full power. If the sulfate is left on the plates, it will harden, and permanently reduce the battery’s capacity. Stratification separates the heavier acid from the water, and the concentrated acid remains at the lower portion of the plates, eventually corroding them.

Equalize charging holds the battery at the Equalize voltage for a **minimum** of 6 hours. This stirs up the electrolyte, distributing the acid, and removing the sulfate from the plates. Equalizing the batteries every month or two (depending on usage) prolongs the life of the batteries and provides better battery performance.



CAUTION: Explosion Hazard

Only unsealed or vented batteries should be equalize charged. Since Hydrogen and oxygen gases are produced when equalized, provide adequate ventilation and remove all sources of ignition to prevent explosion. Remove DC loads while equalizing as they can be damaged by the higher battery voltage. Consult the battery manufacturer’s recommendation for equalize charging settings.

To Set the Equalize Charge:

1. Remove all DC loads connected to the batteries.
2. Remove all battery vent caps.
3. Check the battery water level, it should be just over the top of the plates (do not overfill). Use only distilled water for filling batteries.

Important: Recheck the water the level after equalize charging and refill if necessary.

4. Set the BATTERY TYPE SELECTOR switch to position “0” or “1”. To start the equalization charging process, cycle the AC power (i.e., disconnect and then reconnect the AC source). A **solid orange** BATTERY CHARGER LED indicates equalize charge.
 - a) Position “0” equalizes the batteries at the rate of the battery bank capacity divided by 40 (C/40) at a voltage of 15 volts for 12-volt systems or 30 volts for 24-volt systems. This is set with the BATTERY CAPACITY potentiometer.
 - b) Position “1” equalizes the batteries at the rate set with the BATTERY CHARGER RATE CONTROL at a voltage of 15.5 volts for 12-volt systems or 31 volts for 24-volt systems.

When the voltage condition is met and 6 hours have elapsed, the charger will switch to the float mode. If the condition is not met (i.e., the current draw is above the rate set with the BATTERY CAPACITY potentiometer (position “0”) or BATTERY CHARGER RATE potentiometer (position “1”)), the charger will continue until the condition is met, *or* for a maximum of 12 hours. At this point the charger switches to float at the *equalize 1* or *2* voltage setting (see Figure 3-1, “Battery Type Selector Switch Settings” on page 3–5).

5. Reset the BATTERY TYPE SELECTOR potentiometer to the appropriate setting for the system’s batteries when the Equalize charge has completed.

Important: Refer to “Battery Maintenance” on page B–13 for additional information.

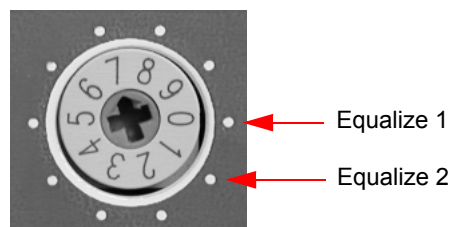


Figure 3-15 Equalize Positions on Battery Type Selector Switch



See Table 3-1 Switch Position "1".

Figure 3-16 Equalize 1 Battery Charger Rate Potentiometer (Position "1")



See Table 3-1 Switch Position "0".

Figure 3-17 Equalize 2 Battery Capacity Rate Potentiometer (Position "0")

4

Troubleshooting

Chapter 4, “Troubleshooting” contains information about how to troubleshoot possible error conditions while using the DR Inverter/Charger.

Troubleshooting the DR Inverter

Table 4-1 provides a list of possible error conditions that may occur, their possible causes, and possible solutions to resolve the error condition.

Table 4-1 Troubleshooting the DR Inverter

Error Condition	Possible Cause	Solution
No AC output voltage and no warning LEDs on ON.	Battery voltage at the inverter terminals is too high or low.	Check the battery voltage, fuses or breakers, and cable connections.
AC output voltage is low and the inverter turns loads ON and OFF.	Low Battery.	Check the condition of the batteries and recharge if possible. Replace the batteries.
AC output is low.	Loose or corroded battery connections.	Check and clean all DC connections.
	Loose AC output connections.	Check all AC output connections.
	Wrong voltmeter is being used.	Use a True RMS voltmeter.
Charger is inoperative.	AC voltage has dropped out-of-tolerance	Check the AC voltage for proper voltage and frequency (depending on model).
	Loose AC input connections.	Check all AC output wiring connections
Charger is supplying a lower charge rate.	Charger controls are improperly set.	Refer to the section on adjusting the “Charger Rate”.
	Low peak AC input voltage (169 Vac _p required for full charger output)	Use larger generator (increasing AC voltage/RPM’s may help).
	Loose or corroded battery connections.	Check and clean all DC connections.
	Loose AC input connections.	Check all AC output wiring connections.
	Generator is unstable - charger is losing synchronization.	Turn BATTERY CHARGER RATE potentiometer down to less than halfway until problem is gone.
AC LEDs flicker while charging.	Generator is unstable and charger is losing synchronization.	Turn BATTERY CHARGER RATE potentiometer down to less than halfway until problem is gone.

Table 4-1 Troubleshooting the DR Inverter

Error Condition	Possible Cause	Solution
<p>CHARGER LED:</p> <ul style="list-style-type: none"> - indicates charging, but no charge is going to the batteries. - is ON, but there is no output power. 	<ul style="list-style-type: none"> Circuit Breaker on the side of the inverter is open. No AC voltage on inverter’s AC terminal block. Good AC voltage on inverter’s AC terminal block. 	<ul style="list-style-type: none"> Reset the AC CHARGER circuit breaker on the side of the unit. Check “AC PASS-THRU” Circuit Breaker on the side of the inverter. Check for open AC output breakers or uses and AC wiring connections.
<p>Charger turns OFF while charging from a generator</p>	<p>High peak AC input voltages from the generator</p>	<ul style="list-style-type: none"> Load the generator down with a heavy load. Turn the generator output voltage down.

Problem Loads

The inverter can drive most loads, however, there are special conditions that can cause a load to behave differently than expected. The following describes some of the common problems encountered when using an inverter.

Ceiling Fans

Most large diameter, slow turning fans run correctly, but generate more noise than when connected to utility power. High speed fans tend to operate normally.

Cell Phones

Some cellular telephones experience interference in the form of a clicking sound.

Computers and Sensitive Electronics

Some computers and sophisticated electronics have power supplies that do not present a load until correct line voltage is available. When this occurs, each unit waits for the other to begin. This can usually be solved by plugging in an additional load (such as a lamp) to bring the inverter out of its search mode. Also, when using a computer, avoid starting large loads.

Consumer Electronics

AM radios tend to pick up inverter noise, especially on the lower half of their band. Inexpensive tape recorders are likely to experience noise as well. When using sensitive electronic devices, avoid starting large loads.

Clocks

The inverter's crystal controlled oscillator keeps the frequency accurate to within a few seconds a day; however, external loads in the system may alter the inverter's output waveform causing clocks to run at different speeds. There may be periods where clocks keep time and then mysteriously do not. This is because most clocks do not draw enough power to trigger the load sensing circuit. In order to operate, especially with no other loads present, the inverter's load sensing circuit will have to be defeated. Refer to the Operation/Search Mode Watts.

Decreasing Loads

If the amount of power a load draws decreases after it has been switched on (such as with a small motor) and its current draw becomes less than the load sensing threshold, it will be turned alternately ON and OFF by the inverter. This can usually be solved by plugging in an additional load (such as a lamp).

Dimmer Switches

Most dimmer switches lose their ability to dim the lights when used with an inverter and operate only in the fully ON or OFF position. Newer, microprocessor controlled dimmers tend to work better in inverter applications.

Fluorescent Lights

Some devices cannot be detected by the inverter's load sensor and will not operate. Small fluorescent lights are the most common example. This can usually be solved by plugging in an additional load. Also, try turning the lamps AC plug over.

Heavy Loads

If the battery bank cannot deliver the necessary amperage to drive a heavy load, the inverter will shut OFF. The battery voltage will then slowly rise back above the low voltage threshold causing the inverter to resume operation. As soon as the heavy load draws the batteries down, the cycle will continue unless the load is reduced or an additional source of power is added.

Microwave Ovens

Microwave ovens are sensitive to peak output voltages. The higher the voltage, the faster they cook. Since the inverter's peak output voltage is dependent upon battery voltage and load size, the microwave's cook time may need to be increased.

Printers

Most inkjet type printers work well in inverter applications. Laser printers, however, require high current for their fusing circuit and are not recommended for use with an inverter.

Rechargeable Devices

When first using a rechargeable device, monitor its temperature for 10 minutes to ensure it does not become abnormally hot. Excessive heat will indicate that it is incompatible with the inverter.

Undersized Loads

If the power consumed by a device is less than the inverter's search mode circuitry threshold, it will not run. This can usually be solved by plugging in an additional load such as a 100 watt light bulb.



CAUTION: Equipment Damage

Some products can be damaged when used with modified sine-wave power. If in doubt, check with the product's manufacturer.

A

Specifications

Appendix A, “Specifications” contains information about the electrical specifications and environmental specifications of the DR Inverter/Charger.

Specifications of the DR Inverter

Table A-1 provides the electrical specifications for the DR Inverter/Charger (120 Vac/60 Hz. models).

Table A-2 provides the electrical specifications for the DR Inverter/Charger (220 Vac/60 Hz. models).

Table A-3 provides the electrical specifications for the DR Inverter/Charger (230 Vac/50 Hz. models).

Table A-4 provides the environmental specifications for all models of the DR Inverter/Charger.

Table A-1 Electrical Specifications for the DR Inverter/Charger^a - 120 Vac/60 Hz Models

Model	DR1512	DR2412	DR1524	DR2424	DR3624
AC Input Voltage	120 Vac	120 Vac	120 Vac	120 Vac	120 Vac
AC Input Low Transfer Voltage	40-105 Vac	40-105 Vac	40-105 Vac	40-105 Vac	40-105 Vac
AC Input Current ^b	45 amps	55 amps	45 amps	55 amps	55 amps
Continuous Power (@ 25°C)	1500 VA	2400 VA	1500 VA	2400 VA	3600 VA
Continuous Output (@25 °C)	12.5 amps AC	20 amps AC	12.5 amps AC	20 amps AC	30 amps AC
Efficiency	94% max	94% max	94% max	95% max	95% max
AC Output Voltage (rms)	120 Vac	120 Vac	120 Vac	120 Vac	120 Vac
Frequency: (± 0.04% Crystal controlled)	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz
Surge Capability:					
5 sec Rating	2400 watts	4200 watts	3500 watts	6200 watts	7500 watts
1 mSec Rating	38 amps AC	77 amps AC	412 amps AC	80 amps AC	100 amps AC
100 mSec Rating	27 amps AC	55 amps AC	29 amps AC	58 amps AC	72 Amps AC
DC Input Current:					
Search Mode	0.045 amps	0.055 amps	0.030 amps	0.030 amps	0.030 amps
Full Voltage	0.700 amps	0.900 amps	0.350 amps	0.450 amps	0.500 amps
DC Current at Rated Power	165 amps	280 amps	80 amps	140 amps	210 amps
Short Circuit Current	400 amps	800 amps	280 amps	560 amps	720 amps

Table A-1 Electrical Specifications for the DR Inverter/Charger^a - 120 Vac/60 Hz Models

Model	DR1512	DR2412	DR1524	DR2424	DR3624
DC Input Voltage (nominal) ^c	12.6 Vdc	12.6 Vdc	25.2 Vdc	25.2 Vdc	25.2 Vdc
DC Input Voltage Range	10.8 to 15.5 Vdc	10.8 to 15.5 Vdc	21.6 to 31.0 Vdc	21.6 to 31.0 Vdc	21.6 to 31.0 Vdc
Auto Low Battery Protection enabled	11 V	11 V	22 V	22 V	22 V
DC Charger Rate (Adjustable)	0 to 70 amps	0 to 120 amps	0 to 35 amps	0 to 70 amps	0 to 70 amps
Common Specifications:					
Voltage Regulation (maximum)	± 5%				
Voltage Regulation (Typical)	±2. 5%				
Waveform	modified sine wave				
Load Power Factor (allowed)	0.5 to 1.0 (leading or lagging)				
Adjustable Load Sensing Range	5 watts minimum to 100 watts maximum				
Series Operation	Yes				
Force Air Cooling	Variable speed fan				
Automatic Transfer Relay	30 amps				
Number of Charging Profiles	10				
Three-stage Charging	Yes (float, absorption, bulk)				
Temperature Comp Probe (BTS)	optional				
Remote Control (RC8) ^d	optional				

a.Specifications subject to change without notice.

b.This is the minimum AC current required to obtain full pass-through and maximum battery charging.

c.Product may not meet voltage regulation specifications at other than "Input Nominal" at full-rated load.

d.Also compatible with the RC4.

Specifications

Table A-2 Electrical Specifications for the DR Inverter/Chargers^a - 220 Vac/60 Hz Models

Model	DR1512W	DR2412W
AC Input Voltage	220 Vac	220 Vac
AC Input Low Transfer Voltage	80 to 210 Vac	80 to 210 Vac
AC Input Current ^b	45 amps	55 amps
Continuous Power (@ 25°C)	1500 VA	2400 VA
Continuous Output (@25 °C)	6.8 amps AC	6.8 amps AC
Efficiency	94% max	94% max
AC Output Voltage (rms)	220 Vac	220 Vac
Frequency: (± 0.04% Crystal controlled)	60 Hz.	60 Hz.
Surge Capability:		
1 mSec Rating	20 amps AC	20 amps AC
DC Input Current:		
Search Mode	0.045 amps	0.055 amps
Full Voltage	0.700 amps	0.900 amps
DC Current at Rated Power	150 amps	80 amps
Short Circuit Current	400 amps	800 amps
DC Input Voltage (nominal) ^c	12.6 Vdc	12.6 Vdc
DC Input Voltage Range	10.8 to 15.5 Vdc	10.8 to 15.5 Vdc
Auto Low Battery Protection enabled	11 V	11 V
Charger Rate (Adjustable)	0 to 70 amps	0 to 120 amps
Common Specifications:		
Voltage Regulation (maximum)	± 5%	
Voltage Regulation (Typical)	±2. 5%	
Waveform	modified sine wave	
Load Power Factor (allowed)	0.5 to 1.0 (leading or lagging)	
Adjustable Load Sensing Range	5 watts minimum to 100 watts maximum	
Series Operation	NO	
Force Air Cooling	Variable speed fan	
Automatic Transfer Relay	20 amps	
Number of Charging Profiles	10	
Three-stage Charging	Yes (float, absorption, bulk)	

Table A-2 Electrical Specifications for the DR Inverter/Chargers^a - 220 Vac/60 Hz Models

Model	DR1512W	DR2412W
Temperature Comp Probe (BTS)	optional	
Remote Control (RC8) ^d	optional	

a.Specifications subject to change without notice.

b.This is the minimum AC current required to obtain full pass-through and maximum battery charging.

c.Product may not meet voltage regulation specifications at other than "Input Nominal" at full-rated load.

d.Also compatible with the RC4.

Table A-3 Electrical Specifications for the DR Inverter/Charger^a - 230 Vac/50 Hz Models

Model	DR1512E	DR1524E	DR1548E	DR2424E
AC Input Voltage	230 Vac	230 Vac	230 Vac	230 Vac
AC Input Low Transfer Voltage	80 to 210 Vac	80 to 210 Vac	80 to 210 Vac	80 to 210 Vac
AC Input Current ^b	55 amps	55 amps	55 amps	55 amps
Continuous Power (@ 25°C)	1500 VA	1500 VA	1500 VA	2400 VA
Continuous Output (@25 °C)	12.5 amps AC	20 amps AC	12.5 amps AC	20 amps AC
Efficiency	94% max	94% max	94% max	95% max
AC Output Voltage (rms)	230 Vac	230 Vac	230 Vac	230 Vac
Surge Capability:				
1 mSec Rating	20 amps AC	20 amps AC	20 amps AC	40 amps AC
DC Input Current:				
Search Mode	0.045 amps	0.055 amps	0.030 amps	0.030 amps
Full Voltage	0.700 amps	0.900 amps	0.350 amps	0.450 amps
DC Current at Rated Power	165 amps	280 amps	80 amps	140 amps
Short Circuit Current	400 amps	800 amps	280 amps	560 amps
DC Input Voltage (nominal) ^c	12.6 Vdc	25.2 Vdc	50.4 Vdc	25.2 Vdc
DC Input Voltage Range	10.9 to 15.5 Vdc	21.8 to 31 Vdc	43.6 to 62 Vdc	21.8 to 31 Vdc

Specifications

Table A-3 Electrical Specifications for the DR Inverter/Charger^a - 230 Vac/50 Hz Models

Model	DR1512E	DR1524E	DR1548E	DR2424E
Auto Low Battery Protection enabled	11 V	11 V	22 V	22 V
DC Charger Rate (Adjustable)	0 to 70 amps	0 to 35 amps	0 to 17.5 amps	0 to 70 amps
Common Specifications:				
Voltage Regulation (maximum)	± 5%			
Voltage Regulation (Typical)	±2. 5%			
Waveform	modified sine wave			
Load Power Factor (allowed)	0.5 to 1.0 (leading or lagging)			
Adjustable Load Sensing Range	5 watts minimum to 100 watts maximum			
Series Operation	NO			
Force Air Cooling	Variable speed fan			
Automatic Transfer Relay	20 amps			
Number of Charging Profiles	10			
Three-stage Charging	Yes (float, absorption, bulk)			
Temperature Comp Probe (BTS)	optional			
Remote Control (RC8) ^d	optional			

a.Specifications subject to change without notice.

b.This is the minimum AC current required to obtain full pass-through and maximum battery charging.

c.Product may not meet voltage regulation specifications at other than "Input Nominal" at full-rated load.

d.Also compatible with the RC4.

Table A-4 Environmental Specifications for the DR Inverter/Charger^a

Model	DR1512	DR2412	DR1524	DR2424	DR3624
Dimensions ^b	8.5" w x 7.25" H x 21" D (21.6 cm W x 18.4 cm H x 54.6 cm D)				
Unit Weight	35 lbs (16 kg)	45 lbs (21 kg)	35 lbs (16 kg)	40 lbs (16 kg)	45 lbs (21 kg)
“E” Models	38 lbs (18 kg)	N/A	39 lbs (18 kg)	(45 lbs (21 kg))	N/A
Ambient Temp Range (rated 0 to 25 °C):					
Operating	0 °C to +50 °C				
Storage	-55 °C to +75 °C				
Altitude:					
Operating	15,000 feet				
Non-operating	50,000 feet				
Mounting	Wall-mount (with 16" mounting centers) Shelf Mount				

a.Specifications subject to change without notice.

b.Allows for hardware extensions such as mounting rails, DC terminals, and front panel controls.

B

Battery Information

Appendix B, “Battery Information” supplies general information about batteries such as battery types, battery bank sizing, battery configurations, and battery care. For detailed information, see your battery manufacturer or your system designer.

Introduction

- Batteries** Batteries are available in different sizes, amp-hour ratings, voltage, liquid or gel, vented or non-vented, chemistries, etc. They are also available for starting applications (such as an automobile starting battery) and deep discharge applications.
- Recommendations** Consider the following recommendations for battery use.
- Use only the deep discharge types for inverter applications.
 - Use the same battery type for all batteries in the bank.
 - Use only batteries from the same lot and date in your battery bank. This information is usually printed on a label located on the battery.

Battery Types

There are two principal types of batteries: starting and deep-discharge (with several different types of chemistries). Batteries can be either sealed or non-sealed (vented).

- Deep discharge** The battery types recommended for use in an inverter system are: Flooded Lead Acid (FLA), Sealed Gel Cells (GEL), Sealed Absorbed Glass Mat (AGM); and alkaline types Nickel-iron (NiFe) and Nickel-Cadmium (NiCad).
- Starting** Automotive (starting) batteries are designed to provide high starting current for short periods of time and are not appropriate for inverter applications.

Deep-cycle Flooded Lead Acid (FLA)

Description A flooded lead acid battery is designed to be deep-discharged before being recharged, making it suitable for inverter applications. Flooded batteries require periodic maintenance consisting mainly of adding distilled water to the cells.

Attributes

Types of FLA Batteries	Attributes
Golf Cart	<ul style="list-style-type: none"> • Popular for smaller off-grid home systems • Many medium sized inverter systems use “L16” batteries • Rugged, long lasting • Typically rated at 6 volts (220 to 350 amp hours)
Industrial (electric forklift)	<ul style="list-style-type: none"> • Popular in large inverter systems • Extremely rugged - lasts up to 10 years or more in an inverter system • Typically 2 volt cells (1,000 amp hours or more)

Sealed Batteries (Gel and AGM)

Description Gel Cell and absorbed glass mat (AGM) batteries are sealed and do not require the addition of distilled water. Since these batteries are valve regulated, over-charging can cause irreversible damage.

Attributes Attributes of sealed batteries are:

Types of Sealed Batteries	Attributes
Gel Cell	<ul style="list-style-type: none"> • Gelled electrolyte instead of liquid • Long life (up to 1500 cycles, typical) • Low self-discharge
Absorbed Glass Mat	<ul style="list-style-type: none"> • Electrolyte is contained in glass-fibre mats between battery plates • Similar to gel cells in characteristics • Good low temperature performance

NiCad and NiFe Batteries

Disadvantages These types of batteries can be used but are not optimized for the DR Inverter for the following reasons:

- Alkaline batteries, such as NiCad and NiFe types, have a nominal cell voltage of 1.2 volts per cell.

Xantrex inverters and battery chargers are optimized for use with lead acid batteries having a nominal 2.0 volts per cell (that is, 12 cells for a 24-volt system and 24 cells for a 48-volt system).

The number of cells required in a battery bank for alkaline batteries must, therefore, be adjusted for a 24- and 48-volt system (i.e., 20 cells for a 24-volt system and 40 cells for a 48-volt system).

- Alkaline batteries require a higher charge voltage to fully recharge, and drop to a lower voltage during discharge compared to a similarly sized lead-acid type battery.

Other options Another option for 24 volt (only) alkaline battery banks is to use only 19 cells instead of 20. Fewer cells allow the battery charger to operate more closely to the settings used for lead-acid batteries. However, the battery voltage will drop to as low as 18 volts when discharging the batteries.

Consult the battery manufacturer or supplier regarding system requirements and battery charger settings for alkaline type batteries.

Understanding Battery Capacity Ratings

Discharge rate	Deep cycle batteries have their amp-hour rating expressed as “at the x-hour rate”. The hour rating refers to the time it takes to discharge the batteries. A faster hour rate (6 hour rate) means more current is withdrawn from the batteries during their discharge period. There is an inevitable amount of heat associated with the flow of current through a battery and the higher amount of current the greater the amount of heat will be generated. The heat is energy which is no longer available to the battery to power loads. a relatively long discharge rate (72 hour rate) will result in a larger number of amp-hours being available for electrical loads.
Calculation	<p>This calculation shows how to determine the level of current drawn from a battery at any given hour rate—battery capacity divided by the hour rate equals the current drawn from the battery. For example, a battery rated 220 Ah at a 6 hour rate would be discharged at 36 amps (220/6).</p> <p>For most residential applications of the DR Inverter the 72 hour rate is appropriate because on average a household uses low amounts of current (lights, TV, radio for example) with occasional bursts or higher consumption appliances like toasters or washing machines. For those installations where high continuous electrical consumption rates are anticipated it is more appropriate to use the 20 hour rate.</p>
CCA rating	The CCA rating (cold cranking amps) shown on starting batteries expresses battery capacity in terms of its ability to provide large amounts of current for intervals measured in minutes, not hours. This is why starting batteries are not appropriate for inverter systems.

Battery Bank Sizing

Running time and size	The battery bank’s size determines the length of time the inverter can supply AC output power. The larger the bank, the longer the inverter can run.
Depth of discharge	In general, the battery bank should be designed so the batteries do not discharge more than 60% of their capacity on a regular basis. Discharging up to 80% is acceptable on a limited basis, such as a prolonged utility outage. Totally discharging a battery can reduce its effective life or permanently damage it.
Days of autonomy	<p>For off-grid, stand-alone applications, design a battery bank that can power the loads for three to five days without requiring recharging. This design calculation assumes a worst case scenario where there is no recharging taking place during these days of autonomy.</p> <p>Days of autonomy may vary depending upon the availability of other charging sources, the critical nature of the load and other factors. If the system is to be powered by renewable energy sources such as solar, wind, and micro-hydro, determine the appropriate number of days of autonomy by allowing for cloudy or calm weather as well as other seasonal variations in available energy.</p> <p>If an engine generator is part of the system design, the days of autonomy can be determined by simply deciding how often you are prepared to run the generator. Significant battery cost reductions can be achieved by shortening the days of autonomy and allowing a generator to run for a schedule time period daily.</p>

Back up power systems which use utility power for recharging should use the estimated number of days of maximum power outage for determining days of autonomy.

Understanding Amp-hour Requirements

Amp-hours To estimate the battery bank requirements, you must first calculate the amount of power you will draw from the batteries during your period of autonomy. This power draw is then translated into amp hours (Ah)—the unit of measure to express deep-cycle battery capacity.

Amp hours are calculated multiplying the current drawn by the load by the length of time it will operate.

Watts to amps To calculate amps when the power consumption is expressed in watts, use the following equation:

$$A = W/V$$

where W = watts and V = volts DC

For example:

A 100 watt light bulb will draw approximately 8.33 amps

$$8.33 = 100 / 12$$

If the light runs for three hours it will consume (8.33 x 3) or 25 Ah of power.

Time and power

The length of time a load is operated will affect the power draw. In some cases, an appliance which draws a large wattage may not consume as many amp hours as a load drawing fewer watts but running for a longer period of time.

For Example:

A circular saw draws 1500 watts or 125 amps. It takes 5 seconds to complete a cross cut. Twelve such cuts would take a minute and you would consume 125

$$A \times 0.016^* \text{ hour} = 2 \text{ Ah}$$

$$*1/60 = 0.016$$

Observation The circular saw, while it draws more power, consumed fewer amp hours of electricity because it ran for a short period of time.

Calculating Amp Hours

Calculations To determine the amp hours you will consume, you need to list your anticipated loads and the length of time you will operate each one. Determine the number of hours per day and the number of days during the week you will use the appliance. For example, you use the microwave every day, but a breadmaker only once a week. If you use an appliance for less than an hour, express the time as a decimal portion of an hour.

Amps to watts All electrical appliances have labels which state their energy consumption. Look for an amps rating on motors and a watts rating on other appliances.

If the label plate has expressed power consumption in amps, multiply by volts for the watts required. (watts = volts x amps).

Battery Information

Considerations

When calculating battery bank size, consider the following:

- Motors typically require 3 to 6 times their running current when starting. Check the manufacturer's data sheets for their starting current requirements. If you will be starting large motors from the inverter, increase the battery bank size to allow for the higher start-up current.
- Refrigerators and ice-makers typically run only about 1/3 of the time, therefore, the running wattage is 1/3 of the total wattage of the appliance. Divide the total wattage of the appliance by 3 when determining the battery requirements.

Amp Hour Example Worksheet

Complete the following steps to calculate the amp-hour requirements per day for your system. Use and Table B-2 as examples to complete your own.

To calculate amp-hour requirements:

1. Determine the loads the inverter will power and enter their wattage in the watts column.
2. Determine the number of hours (or decimal portion of hours) the appliance is used each day. Enter this figure in the Hours column.
3. Determine the number of days the appliance will be used during the week. Enter this figure in the Days column.
4. Multiply Hours x Days for each load identified to determine the watt/hours per week.
5. Add the total watt/hours per week for all loads then divide by 7 to obtain the average total watt/hours per day.
6. Divide the total average per day by the DC nominal voltage.

This figure represents the average amp-hours per day that you will use.

Table B-1 Determining Average Daily Load in Amp-hours (Example)

Load	Watts	Hours per Day	Days per week used	Weekly watt-hours
5 lights: 15 W CFL	75 W	5	7	2625
Breadmaker	1200	0.75	2	1800
Energy-efficient refrigerator	200 x 0.3	24		10080
Laptop computer	50	6	5	1500
Total weekly watt-hours of AC load				16005 Wh
Divided by days per week				7
Average total watt-hours per day				2286
Divided by DC nominal voltage				24
Average amp-hours per day (Ah/d)				95

Battery bank size worksheet

Calculation To calculate the battery bank size, use the average amp-hours per day that you calculated using Table B-1, then make the other calculation shown in Table B-2 to calculate the battery bank size you need to support your loads.

Table B-2 Determining Battery Bank Size

Average amp hours per day	95
Divided by inverter efficiency (90%) for DR Inverter	0.9
Divided by battery efficiency (usually 0.75)	0.75
Adjusted hours per day	140
Divided by Depth of Discharge (usually 60%)	0.6
Multiplied by days of autonomy	5
Battery bank size required	1173 Ah

Worksheets Table B-1 and Table B-2 are examples only. Use the specifications noted on the label of each AC appliance and fill in the values specific for the appliances used in this installation on the a work sheet.

Table B-3 provides a typical wattage for selected appliances. However, you should try to find the exact wattage on the appliance label.

Table B-3 Typical Appliance Wattage

Appliance	Watts	Appliance	Watts
Fluorescent Type Light	10	Blender	400
Computer	200-300	Toaster	1000
Microwave (compact)	600-800	Hot Plate	1800
Microwave (full-size)	1500	Washer/Dryer	375-1000
Stereo or VCR	50	3/8" Drill	500
Color Television (19")	150	Hair Dryer or Iron	1000
Refrigerator (3 cu ft)	180	Vacuum Cleaner	1200
Refrigerator (12 cu ft)	480	Coffee Maker	1200

Battery Configurations

The battery bank must be wired to match the inverter’s DC input voltage specifications (12 or 24 Vdc). In addition, the batteries can be wired to provide additional run time. The various wiring configurations are:

- Series Wiring batteries in series increases the total bank output voltage. This voltage **MUST** match the DC requirements of the inverter or inverter and/or battery damage may occur.
- Parallel Wiring the batteries in parallel increases the total run time the batteries can operate the AC loads. The more batteries connected in parallel the longer the loads can be powered from the inverter.
- Series-Parallel Series-parallel configurations increase both the battery voltage (to match the inverter’s DC requirements) and run-time for operating the AC loads. This voltage must match the DC requirements of the inverter.

Batteries with more than two or three series strings in parallel often exhibit poor performance characteristics and shortened life.

Wiring Batteries in Series

- Effect Wiring the batteries in a series configuration increases the voltage of the battery string. Six-volt batteries can be combined to form 12-volt, 24-volt, or 48-volt battery banks. In the same way, 12-volt batteries connected in series form 24-volt battery banks. The total current capacity of the bank does not increase and remains the same amp-hour rating as it does for a single battery.
- Important The voltage must match the DC requirements of the inverter.

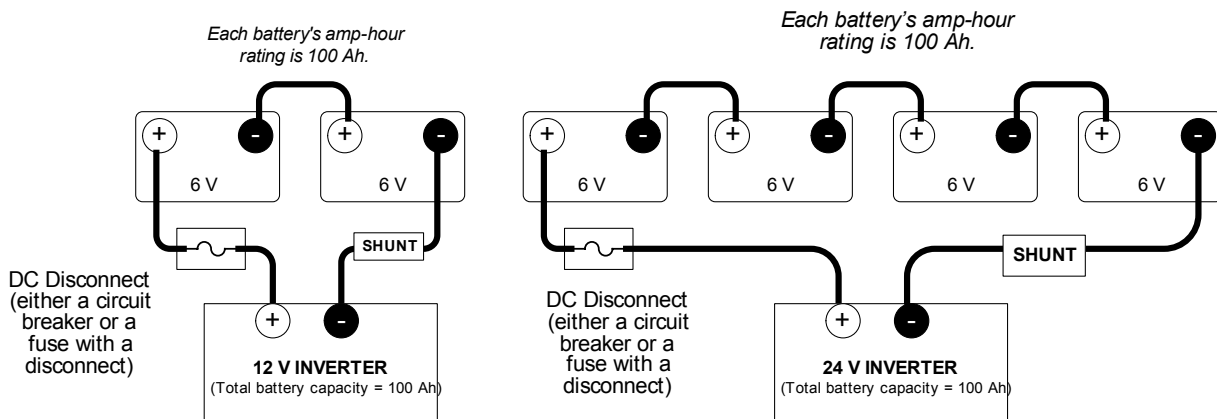


Figure B-1 6-volt Battery Wiring - "Series" Configuration

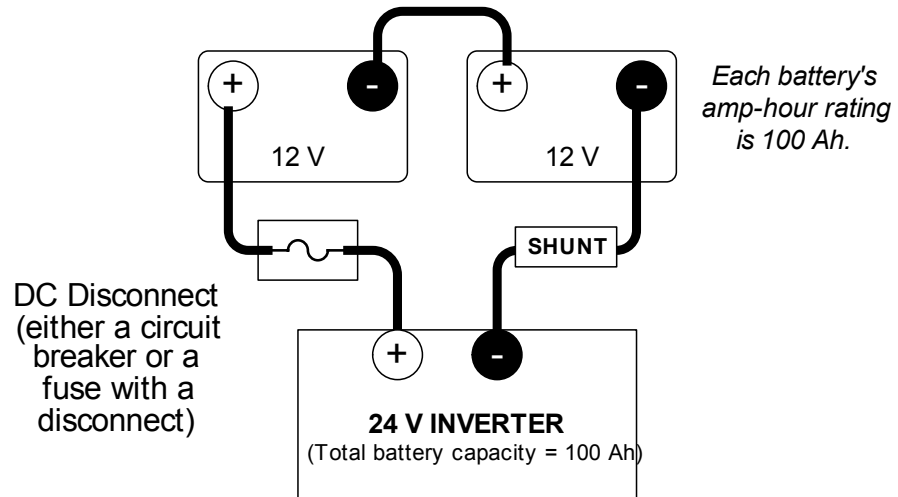


Figure B-2 12-volt Battery Wiring - "Series" Configuration

Wiring Batteries in Parallel

Effect

Wiring the batteries in a parallel configuration increases the current of the battery string. The voltage of the battery bank remains the same as an individual battery. "Parallel" configurations extend the run times of the AC loads by providing increased current for the inverter to draw from. In a parallel configuration, all the negative battery terminals are connected together and all the positive battery terminals are connected together.

Wiring example

Figure B-3 is an example of how to wire batteries in a parallel configuration.

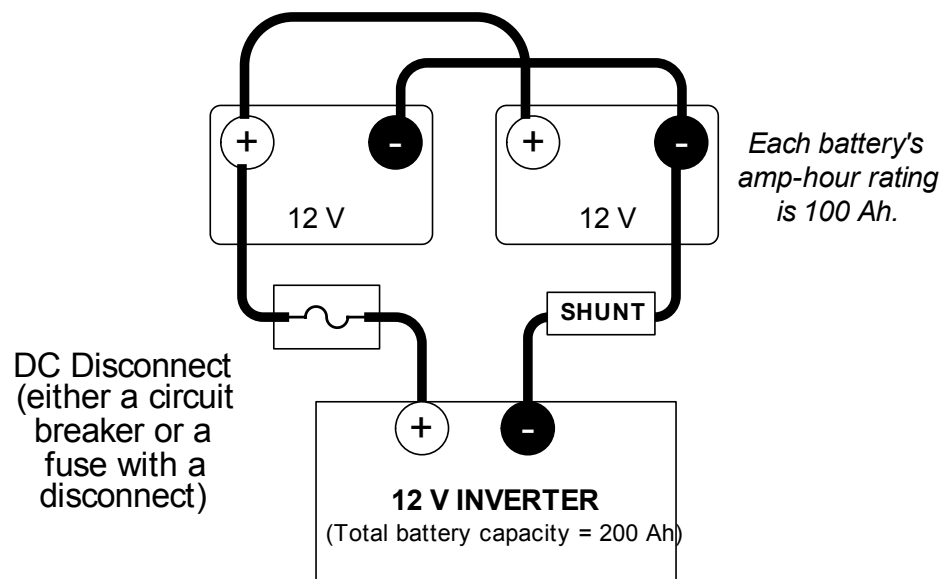


Figure B-3 Battery Wiring in Parallel

Wiring Batteries in Series-Parallel

Effect Wiring the batteries in a series-parallel configuration increases the current and voltage of the battery bank. “Series-parallel” wiring is more complicated and care should be taken when wiring these banks.

Steps It is done in three steps; wiring the batteries in series, wiring them in parallel, then wiring the string to the inverter.

Series wiring **To wire in series:**

1. First wire the batteries in “series” (voltage adds) with the positive terminal of one battery connected to the negative terminal of the next battery to meet the inverter’s DC input requirements (24 volts shown in Figure B-4 and Figure B-5.)
2. Repeat this step for the next battery string.
Two identical strings of batteries are now wired in series.

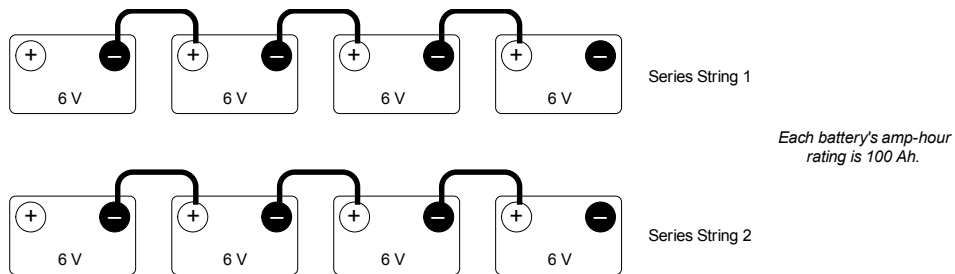


Figure B-4 Battery Wiring 24-volt - Parallel Configuration - Step 1

Parallel wiring

To wire the batteries in parallel:

1. Connect the positive terminal of the first battery string to the positive terminal of the second battery string.
2. Connect the negative terminal of the first battery string to the negative terminal of the second battery string.

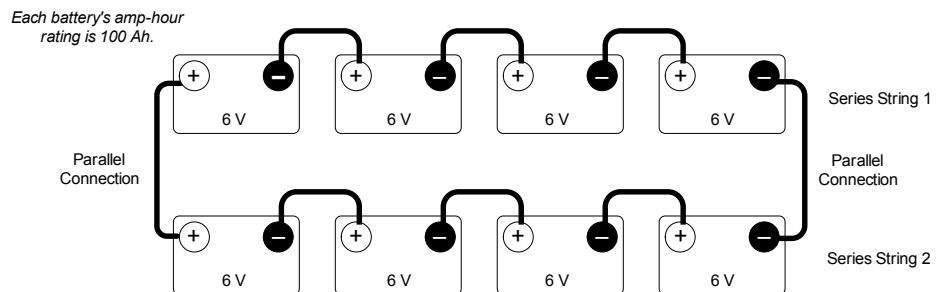


Figure B-5 Battery Wiring 24-volt - Parallel Configuration - Step 2

Connect to inverter

To connect to the inverter:

1. Connect a cable from the positive terminal of the first battery string to the inverter's positive DC terminal (via a fused device).
2. Connect the negative terminal of the last battery string to the negative terminal of inverter's DC terminal.

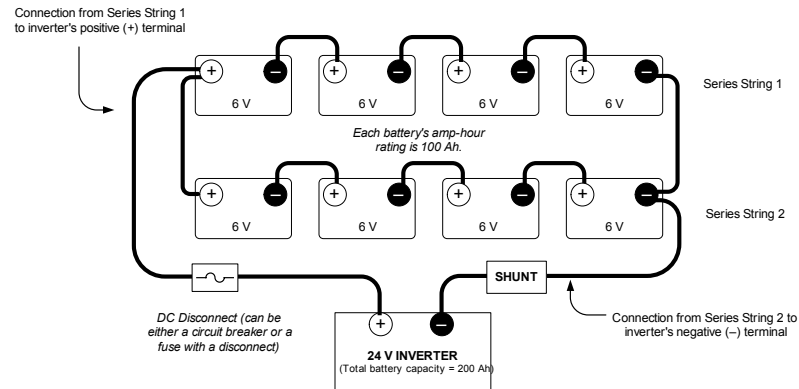


Figure B-6 Battery Wiring 24-volt - Parallel Configuration - Step 3

Important: Connecting the positive and negative wires to the inverter from different strings ensures a balanced charge/discharge through the batteries, resulting in longer run times and improved battery life.

Battery Connections for Stacked Inverters

When using inverters in a stacked configuration, the same battery bank must be used for both inverters. To ensure even charging of the batteries, each inverter must be connected to both strings (i.e., positive cable to string two, and negative cable to string one for inverter 1, and positive cable to string one and negative cable to string two for inverter 2) as shown in the diagram below.

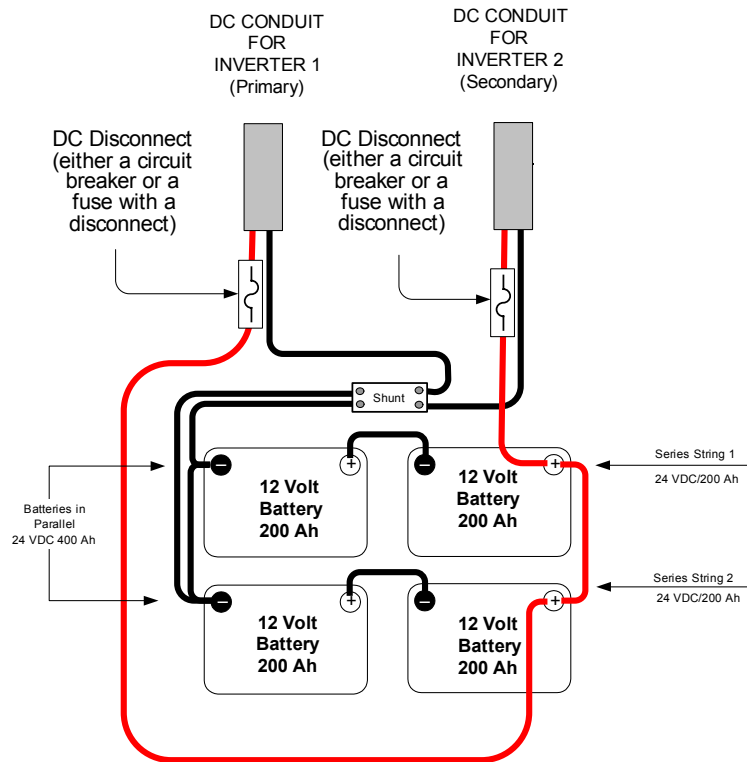


Figure B-7 Example of Battery Connections for Stacked Inverters (24 Vdc shown)

Battery Maintenance

Maintenance strategy	<p>To get the best performance from an inverter system, the batteries must be properly setup and maintained. This includes setting the proper voltages for Bulk and Float charging. See the “CAUTIONS” in the section on Equalization Charging that follows. In addition, the battery terminals should be inspected, cleaned, and re-torqued if necessary.</p> <p>Neglecting any of these items may result in poor inverter performance and greatly reduce battery life.</p>
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Battery Charging

Charge Rate	<p>The maximum safe charge rate is related to the size and type of the batteries. Flooded lead acid batteries (with removable caps) can be charged at a high rate. Small batteries may require a lower charge rate. Check with your battery vendor for the proper battery charging rate for the batteries used in the system.</p>
Bulk Voltage	<p>This is the maximum voltage the batteries will be charged to during a normal charge cycle. Gel cell batteries are set to a lower value and non-sealed batteries are set to a higher voltage setting.</p>
Float Voltage	<p>The Float voltage is set lower than the Bulk voltage and provides a maintenance charge on the batteries to keep them in a ready state.</p>
Temperature Compensation	<p>For optimal battery charging, the Bulk and Float charge rates should be adjusted according to the temperature of the battery. This can be accomplished automatically by using a BTS. The sensor attaches directly to the side of one of the batteries in the bank and provides precise battery temperature information.</p> <p>When battery charging voltages are compensated based on temperature, the charge voltage will vary depending on the temperature around the batteries. The following table describes approximately how much the voltage may vary depending on the temperature of the batteries.</p> <p>If you have liquid lead acid batteries (non-sealed), you may need to periodically equalize your batteries. Check the water level monthly to maintain it at the appropriate level.</p>

Table B-4 Variances in Charging Voltage based on Battery Temperature

Temperature (around the BTS)		12-volt units		24-volt units		48-volt units	
Celsius	Fahrenheit	Lead Acid (6 cells)	NiCad (10 cells)	Lead Acid (12 cells)	NiCad (20 cells)	Lead Acid (24 cells)	NiCad (40 cells)
60	140	-1.05	-0.70	-2.10	-1.40	-4.20	-2.80
55	131	-0.90	-0.60	-1.80	-1.20	-3.60	-2.40
50	122	-0.75	-0.50	-1.50	-1.00	-3.00	-2.00
45	113	-0.60	-0.40	-1.20	-0.80	-2.40	-1.60
40	104	-0.45	-0.30	-0.90	-0.60	-1.80	-1.20
35	95	-0.30	-0.20	-0.60	-0.40	-1.20	-0.80
30	86	-0.15	-0.10	-0.30	-0.20	-0.60	-0.40
25	77	0.00	0.00	0.00	0.00	0.00	0.00
20	68	0.15	0.10	0.30	0.20	0.60	0.40
15	59	0.30	0.20	0.60	0.40	1.20	0.80
10	50	0.45	0.30	0.90	0.60	1.80	1.20
5	41	0.90	0.60	1.20	0.80	2.40	1.60
0	32	0.75	0.50	1.50	1.00	3.00	2.00
-5	23	0.90	0.60	1.80	1.20	3.60	2.40
-10	14	1.05	1.20	2.10	1.40	4.20	2.80
-15	5	1.20	0.80	2.40	1.60	4.80	3.20
-20	-4	1.35	1.40	2.70	1.80	5.40	3.60
-25	-13	1.50	1.00	3.00	2.00	6.00	4.00
-30	-22	1.65	1.10	3.30	2.20	6.60	4.40
-35	-31	1.80	1.20	3.60	2.40	7.20	4.80
-40	-40	1.95	1.30	3.90	2.60	7.80	5.20

Temperature compensation is based on battery type — 5 mv/cell for lead acid type batteries and 2 mv/cell for alkaline type batteries (NiCad or NiFe). The temperature compensation calculations are derived from Table B-5.

Table B-5 Temperature Compensation Calculation

Battery Type	24-volt Systems	48-volt Systems
Lead Acid	0.060 volts (60 mV) per degree Celsius	0.120 Volts (120 mV) per degree Celsius
NiCad	0.040 volts (40 mV) per degree Celsius	0.080 volts (80 mV) per degree Celsius

Important: If the battery temperature is allowed to fall to extremely cold temperatures, the inverter with a BTS may not be able to properly recharge cold batteries due to maximum voltage limits of the inverter. Ensure the batteries are protected from extreme temperatures.

Equalization Charging

Purpose	An equalize charge helps to remove sulfate buildup on the battery plates and balances the charge of individual cells.
Effect	Equalize charging also produces gassing which stirs up the electrolyte mixture and helps distribute the acid more evenly.
Non-equalized batteries	Batteries that are not equalize charged can be damaged by sulfate accumulation, thus sealing off a percentage of the plates and reducing battery capacity. They may also have sulfuric acid accumulate at the bottom of the battery, potentially damaging the plates. At the same time, the electrolyte at the top of the battery gets watery. This effect is called stratification.
Frequency	Every month or two the batteries should be equalize charged.



CAUTION: Damage to DC Loads

The high voltages reached during an equalize charge may damage DC loads that are connected to the inverter. Disconnect any DC loads from the inverter before running an equalize charge.



CAUTION: Damage to Batteries

Equalization should be done for standard electrolyte vented batteries only. Sealed or GEL cell batteries should not be equalize charged. Consult your battery supplier for details on equalize charging for the battery type in your system.

General Maintenance

Water Levels	<p>Flooded lead acid batteries require periodic water refills in each battery cell. Only distilled water should be used in a battery, as tap or mineral water may contain contaminants which will upset the battery chemistry and may damage the battery.</p> <p>When filling the battery, clean the surface first to prevent dirt from entering the cell. Fill the cell to just above the plates or to the bottom of the internal collar inside the battery. Never fill the cells to the top or acid will leak out during charging.</p> <p>Check the water level in the batteries frequently when performing an equalize charge and add water if necessary. Always follow the safety steps covered in the front of the manual.</p>
Battery Cables and Posts	<p>Battery posts must be clean to reduce the resistance between the battery post and cable connection. A buildup of dirt or oxidation may eventually lead to the cable terminal overheating during periods of high current draw.</p> <p>Use a stiff wire brush and remove all dirt and corrosion from the battery terminals and cables. Use an alkaline solution of baking soda and water to clean the terminals and neutralize any battery acid on the terminals or cable lugs.</p>



WARNING: Shock Hazard

Before attempting to clean the battery posts, turn off the DC circuit breaker. Use only insulated tools and remove all jewellery.



CAUTION: Damage to Batteries

Never let a baking soda solution get into the battery as it will neutralize the acid resulting in permanent damage.

Torque Battery Connections	<p>After the terminals are clean, reassemble the cable to the battery terminal and torque the connections to the battery manufacturer's recommendations.</p> <p>Coat the battery terminals with an antioxidant compound.</p>
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State of Charge

The battery's state-of-charge should be checked often and only when the battery at a state of rest (when the battery is not powering loads or actively being charged). First thing in the morning is usually the best time to check the state of charge. If the batteries are readily accessible, measure the voltage across the individual battery terminals. There should be less than a 0.2 volt difference between each battery.

To determine the individual cell voltage, divide the voltage by the number of cells in the battery (25.2 volts divided by 12 cells = 2.1 volts per cell). If a greater difference is measured, the batteries may need to be equalized (liquid lead-acid types only) or replaced.

All batteries in the bank should measure the same voltage (this is not an accurate measurement for cross-tied batteries' as each battery is in parallel with another battery making individual battery measurements impossible).

The voltage should match the following table for the entire battery bank output. These values indicate the overall battery's state of charge for the entire bank. Individual cell voltages (if available) are also shown as a percentage of charge.

The values given are for a temperature of 77 °F (25 °C). Cooler temperatures produce lower voltage measurements.

Table B-6 Battery State-of-Charge

Percent of Full Charge	System Voltage			Individual Cell Voltage
	12 Volt	24 Volt	48 Volt	
100%	12.7	25.4	50.8	2.12
90%	12.6	25.2	50.4	2.10
80%	12.5	25.0	50.0	2.08
70%	12.3	24.6	49.2	2.05
60%	12.2	24.4	48.8	2.03
50%	12.1	24.2	48.4	2.02
40%	12.0	24.0	48.0	2.00
30%	11.8	23.6	47.2	1.97
20%	11.7	23.4	46.8	1.95
10%	11.6	23.2	46.4	1.93
0%	≤ 11.6	≤ 23.2	≤ 46.4	≤ 1.93

Important: Table B-6 only applies for batteries that have been at rest for a minimum of 3 hours (i.e., no inverting, no charging).

C

Multi-wire Branch Circuit Wiring

Appendix C, “Multi-wire Branch Circuit Wiring” supplies information about Multi-wire Branch Circuit Wiring Precautions when using stand-alone 120 Vac inverters or generators.



WARNING

A possible fire hazard can exist if 120 Vac only sources (such as inverters and generators) are wired incorrectly into 120/240 Vac panels containing multi-wire branch circuits. This section describes how to check for multi-wire branch circuits in the load center and presents some possible solutions to this wiring method.

Multi-wire Branch Circuits

Problem	A potential safety problem exists when installing stand-alone 120 Vac inverters into existing 120/240 Vac wired panels where multi-wire branch circuit wiring methods were used.
Legacy situation	Multi-wire branch circuits are wired differently from “home run” type wiring (Figure C-1) in that only one neutral wire is used to provide the neutral-return path for each circuit connected to both phases of the AC grid. This method has been employed by electricians in recent years to keep construction costs down by saving copper and labor costs involved in running a separate Romex™ for each circuit.
Normal condition	Under normal conditions, this technique is quite safe and meets code requirements. When used as originally installed, the current for each circuit is 180° out-of-phase with each other, so the neutral wire never receives more current than it was designed to handle as the current from each circuit subtracts (or cancels out, leaving only the difference current between the two circuits). Refer to Figure C-2.
Safety issue	A safety problem occurs when a stand-alone 120 Vac inverter is installed to power these circuits, causing the one neutral wire to now carry the in-phase currents for both circuits. Since the current is in-phase, the two circuits add instead of subtract, potentially doubling the current flow in the neutral return wire! Refer to Figure C-3. The branch circuit breakers do not protect the neutral wire from overload under this condition. This excess current will overheat the neutral wire, potentially creating a fire hazard.

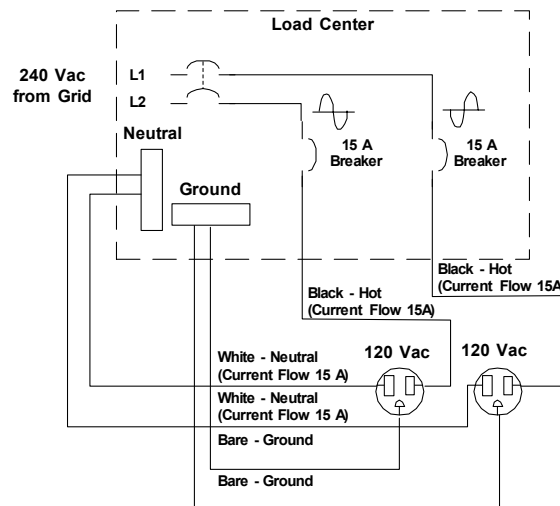


Figure C-1 Conventional Home-type Wiring

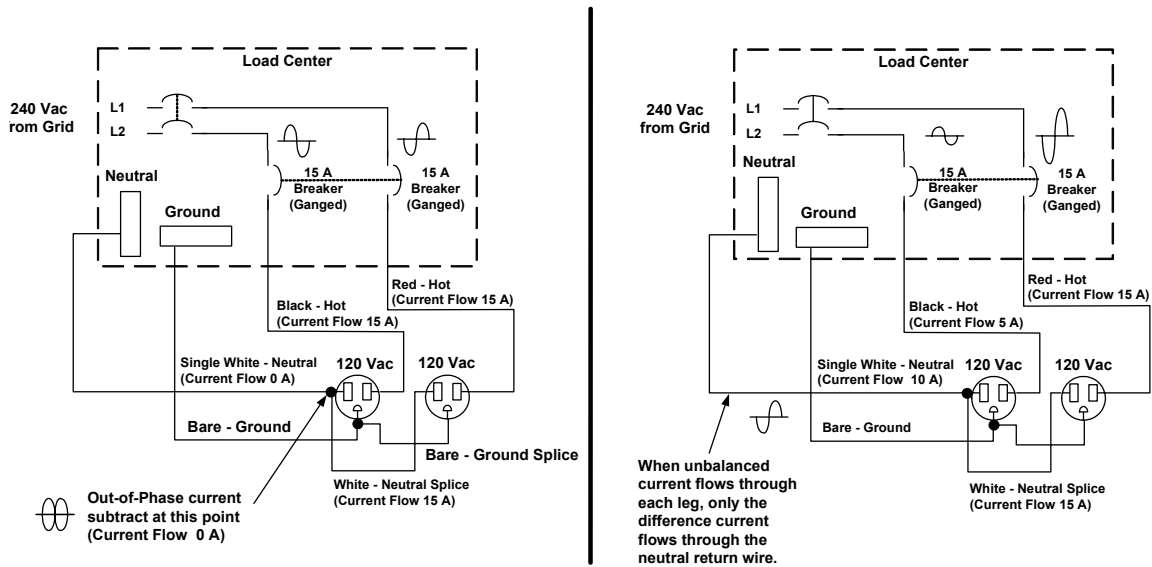


Figure C-2 Multi-wire Branch Circuit Wiring and Current Flow

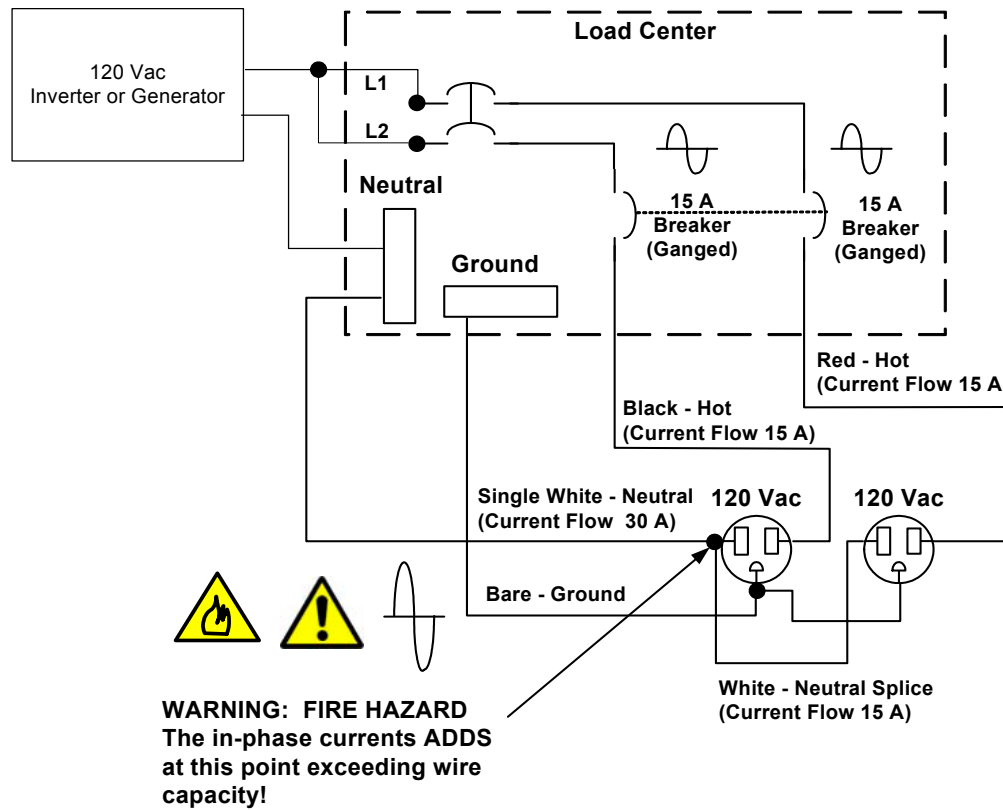


Figure C-3 120 Vac Inverter Incorrectly Wired in a Multi-wire Branch Circuit

Identifying Multi-wire Branch Circuits



WARNING: Shock Hazard

The next step involves opening the load center, exposing live circuits. This procedure should only be performed by qualified persons or electricians.

Identifying characteristic

Multi-wire branch circuits can be identified by removing the cover on the load center and inspecting the wiring. Conventional 120 Vac circuits are identified by a 2-wire-plus-ground (black, white, and copper) “romex” for each circuit. Multi-wire branch circuits use a 3-wire-plus-ground arrangement (black, red, white and copper) for each circuit run.

If this arrangement exists in the panel and it is being powered by a stand-alone 120 Vac inverter, a potential fire hazard exists! For safety, these circuits must be rewired to meet code.

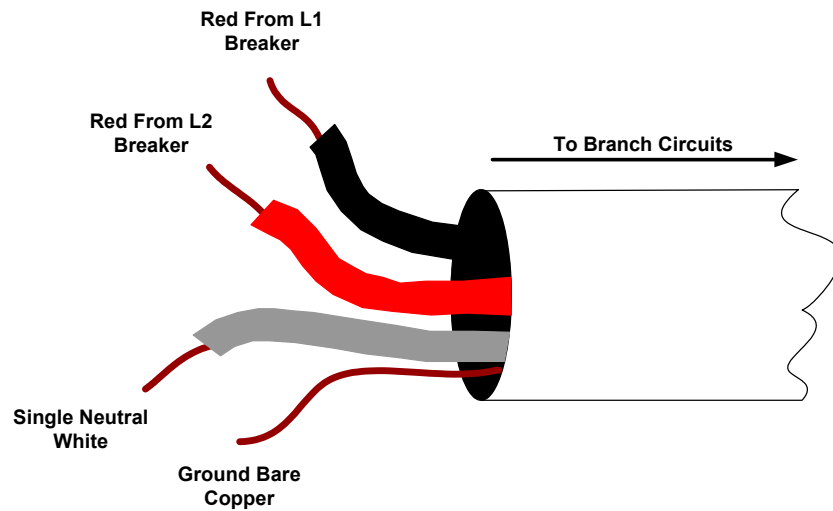


Figure C-4 Multi-wire Branch Circuit Wiring

Correcting Multi-wire Branch Circuit Wiring

Acceptable options	<p>Correcting multi-wire branch circuit wiring is not easy. Two options which will correct multi wiring branch circuit wiring are:</p> <ul style="list-style-type: none">• Rewire existing multi-wire branch circuits to conventional “home run” wiring. This requires a qualified electrician (knowledgeable about multi-wire branch circuit wiring) and is expensive. There may be multiple multi-wire branch circuits located throughout the structure, requiring complete rewiring.• Add a second inverter in a “series stacked” arrangement. This is an expensive solution, but would restore the original 240 Vac split-phase configuration. This solution may actually be less expensive than having an electrician re-wire the multi-wire branch circuits. It also provides increased power backup protection and can power 240 Vac loads.
Recommended option	<p>Add a step-down autotransformer to the output of the inverter to restore the split-phase configuration. This is the least expensive and easiest method to correct for multi-wire branch circuit wiring. Refer to Figure C-5. Using this method, half of the current is supplied to one leg of the circuit and half to the other in a split-phase arrangement (180° out-of-phase). This will restore the original functionality and safety to the multi-wire branch circuit.</p>



WARNING: Fire Hazard

Until one of the solutions above is implemented, a stand-alone 120 Vac inverter (or generator) must not be installed where multi-wire branch circuits exist.

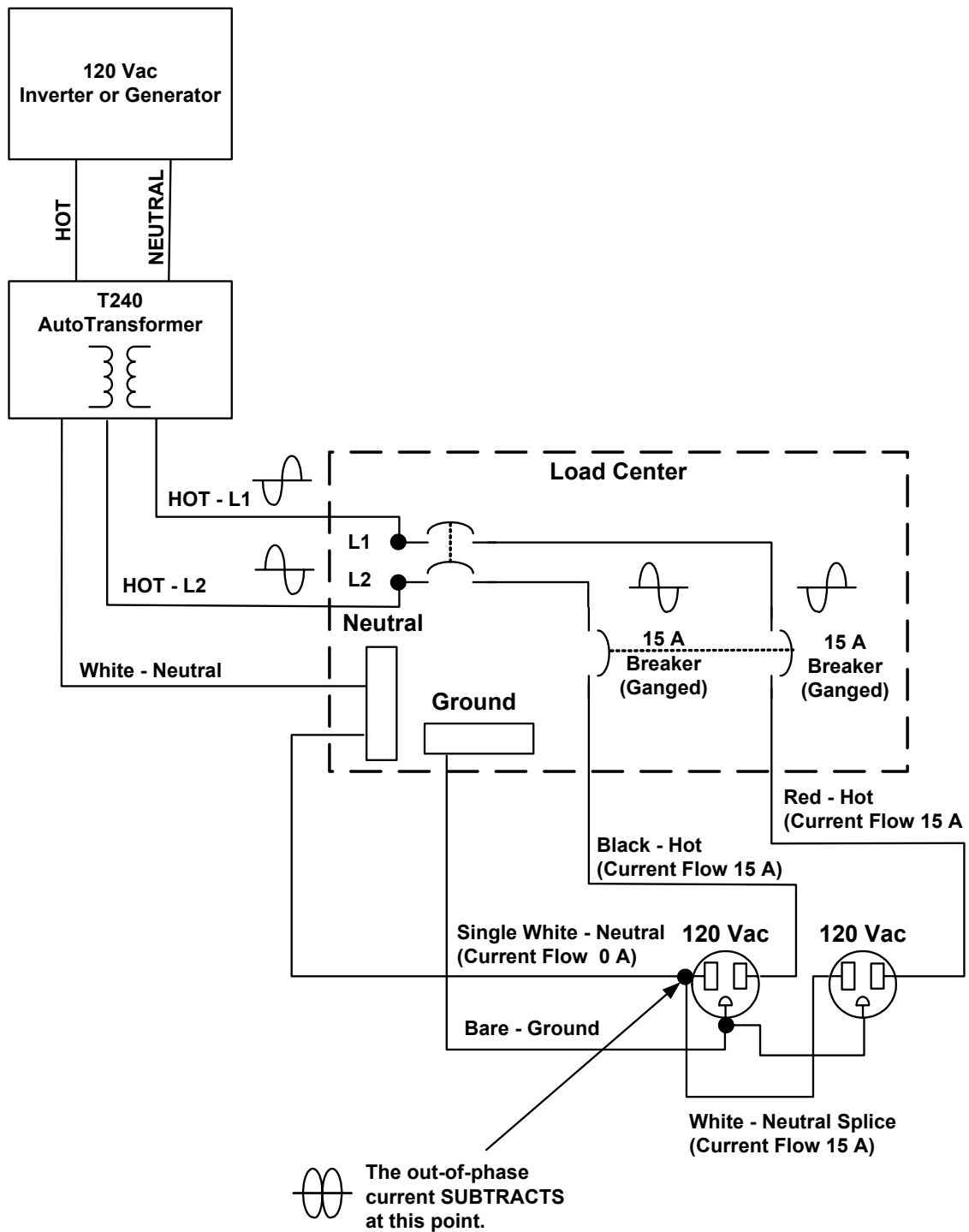


Figure C-5 Using a Step-down Autotransformer in Multi-wire Branch Circuit Wiring

Warranty and Return Information

Warranty

What does this warranty cover? This Limited Warranty is provided by Xantrex Technology, Inc. ("Xantrex") and covers defects in workmanship and materials in your DR Inverter/Charger. This warranty period lasts for Warranty period from the date of purchase at the point of sale to you, the original end user customer. You require proof of purchase to make warranty claims.

This Limited Warranty is transferable to subsequent owners but only for the unexpired portion of the Warranty Period. Subsequent owners also require proof of purchase.

What will Xantrex do?

Xantrex will, at its option, repair or replace the defective product free of charge, provided that you notify Xantrex of the product defect within the Warranty Period, and provided that Xantrex through inspection establishes the existence of such a defect and that it is covered by this Limited Warranty.

Xantrex will, at its option, use new and/or reconditioned parts in performing warranty repair and building replacement products. Xantrex reserves the right to use parts or products of original or improved design in the repair or replacement. If Xantrex repairs or replaces a product, its warranty continues for the remaining portion of the original Warranty Period or 90 days from the date of the return shipment to the customer, whichever is greater. All replaced products and all parts removed from repaired products become the property of Xantrex.

Xantrex covers both parts and labor necessary to repair the product, and return shipment to the customer via a Xantrex-selected non-expedited surface freight within the contiguous United States and Canada. Alaska and Hawaii are excluded. Contact Xantrex Customer Service for details on freight policy for return shipments outside of the contiguous United States and Canada.

How do you get service? If your product requires troubleshooting or warranty service, contact your merchant. If you are unable to contact your merchant, or the merchant is unable to provide service, contact Xantrex directly at:

Telephone: 1 800 670 0707 (toll free North America)
1 360 925 5097 (direct)

Fax: 1 800 994 7828 (toll free North America)
1 360 925 5143 (direct)

Email: customerservice@xantrex.com

Direct returns may be performed according to the Xantrex Return Material Authorization Policy described in your product manual. For some products, Xantrex maintains a network of regional Authorized Service Centers. Call Xantrex or check our website to see if your product can be repaired at one of these facilities.

What proof of purchase is required? In any warranty claim, dated proof of purchase must accompany the product and the product must not have been disassembled or modified without prior written authorization by Xantrex.

Proof of purchase may be in any one of the following forms:

- The dated purchase receipt from the original purchase of the product at point of sale to the end user, or
- The dated dealer invoice or purchase receipt showing original equipment manufacturer (OEM) status, or
- The dated invoice or purchase receipt showing the product exchanged under warranty

Warranty and Return

What does this warranty not cover? This Limited Warranty does not cover normal wear and tear of the product or costs related to the removal, installation, or troubleshooting of the customer's electrical systems. This warranty does not apply to and Xantrex will not be responsible for any defect in or damage to:

- a) the product if it has been misused, neglected, improperly installed, physically damaged or altered, either internally or externally, or damaged from improper use or use in an unsuitable environment;
- b) the product if it has been subjected to fire, water, generalized corrosion, biological infestations, or input voltage that creates operating conditions beyond the maximum or minimum limits listed in the Xantrex product specifications including high input voltage from generators and lightning strikes;
- c) the product if repairs have been done to it other than by Xantrex or its authorized service centers (hereafter "ASCs");
- d) the product if it is used as a component part of a product expressly warranted by another manufacturer;
- e) the product if its original identification (trade-mark, serial number) markings have been defaced, altered, or removed.

Disclaimer

Product

THIS LIMITED WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY XANTREX IN CONNECTION WITH YOUR XANTREX PRODUCT AND IS, WHERE PERMITTED BY LAW, IN LIEU OF ALL OTHER WARRANTIES, CONDITIONS, GUARANTEES, REPRESENTATIONS, OBLIGATIONS AND LIABILITIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE IN CONNECTION WITH THE PRODUCT, HOWEVER ARISING (WHETHER BY CONTRACT, TORT, NEGLIGENCE, PRINCIPLES OF MANUFACTURER'S LIABILITY, OPERATION OF LAW, CONDUCT, STATEMENT OR OTHERWISE), INCLUDING WITHOUT RESTRICTION ANY IMPLIED WARRANTY OR CONDITION OF QUALITY, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE TO THE EXTENT REQUIRED UNDER APPLICABLE LAW TO APPLY TO THE PRODUCT SHALL BE LIMITED IN DURATION TO THE PERIOD STIPULATED UNDER THIS LIMITED WARRANTY.

IN NO EVENT WILL XANTREX BE LIABLE FOR ANY SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, COSTS OR EXPENSES HOWEVER ARISING WHETHER IN CONTRACT OR TORT INCLUDING WITHOUT RESTRICTION ANY ECONOMIC LOSSES OF ANY KIND, ANY LOSS OR DAMAGE TO PROPERTY, ANY PERSONAL INJURY, ANY DAMAGE OR INJURY ARISING FROM OR AS A RESULT OF MISUSE OR ABUSE, OR THE INCORRECT INSTALLATION, INTEGRATION OR OPERATION OF THE PRODUCT.

Exclusions

If this product is a consumer product, federal law does not allow an exclusion of implied warranties. To the extent you are entitled to implied warranties under federal law, to the extent permitted by applicable law they are limited to the duration of this Limited Warranty. Some states and provinces do not allow limitations or exclusions on implied warranties or on the duration of an implied warranty or on the limitation or exclusion of incidental or consequential damages, so the above limitation(s) or exclusion(s) may not apply to you. This Limited Warranty gives you specific legal rights. You may have other rights which may vary from state to state or province to province.

Warning: Limitations On Use

Please refer to your product manual for limitations on uses of the product.

SPECIFICALLY, PLEASE NOTE THAT THE DR INVERTER/CHARGER SHOULD NOT BE USED IN CONNECTION WITH LIFE SUPPORT SYSTEMS OR OTHER MEDICAL EQUIPMENT OR DEVICES. WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, XANTREX MAKES NO REPRESENTATIONS OR WARRANTIES REGARDING THE USE OF THE XANTREX DR INVERTER/CHARGER IN CONNECTION WITH LIFE SUPPORT SYSTEMS OR OTHER MEDICAL EQUIPMENT OR DEVICES.

Please note that the DR Inverter/Charger is not intended for use as an uninterruptible power supply and Xantrex makes no warranty or representation in connection with any use of the product for such purposes.

Return Material Authorization Policy

Before returning a product directly to Xantrex you must obtain a Return Material Authorization (RMA) number and the correct factory "Ship To" address. Products must also be shipped prepaid. Product shipments will be refused and returned at your expense if they are unauthorized, returned without an RMA number clearly marked on the outside of the shipping box, if they are shipped collect, or if they are shipped to the wrong location.

When you contact Xantrex to obtain service, please have your instruction manual ready for reference and be prepared to supply:

- The serial number of your product
- Information about the installation and use of the unit
- Information about the failure and/or reason for the return
- A copy of your dated proof of purchase

Record these details in on page WA-4.

Return Procedure

1. Package the unit safely, preferably using the original box and packing materials. Please ensure that your product is shipped fully insured in the original packaging or equivalent. This warranty will not apply where the product is damaged due to improper packaging.
2. Include the following:
 - The RMA number supplied by Xantrex Technology, Inc. clearly marked on the outside of the box.
 - A return address where the unit can be shipped. Post office boxes are not acceptable.
 - A contact telephone number where you can be reached during work hours.
 - A brief description of the problem.
3. Ship the unit prepaid to the address provided by your Xantrex customer service representative.

If you are returning a product from outside of the USA or Canada In addition to the above, you MUST include return freight funds and are fully responsible for all documents, duties, tariffs, and deposits.

If you are returning a product to a Xantrex Authorized Service Center (ASC) A Xantrex return material authorization (RMA) number is not required. However, you must contact the ASC prior to returning the product or presenting the unit to verify any return procedures that may apply to that particular facility.

Out of Warranty Service

If the warranty period for your DR Inverter/Charger has expired, if the unit was damaged by misuse or incorrect installation, if other conditions of the warranty have not been met, or if no dated proof of purchase is available, your inverter may be serviced or replaced for a flat fee.

To return your DR Inverter/Charger for out of warranty service, contact Xantrex Customer Service for a Return Material Authorization (RMA) number and follow the other steps outlined in "Return Procedure" on page WA-3.

Payment options such as credit card or money order will be explained by the Customer Service Representative. In cases where the minimum flat fee does not apply, as with incomplete units or units with excessive damage, an additional fee will be charged. If applicable, you will be contacted by Customer Service once your unit has been received.

Information About Your System

As soon as you open your DR Inverter/Charger package, record the following information and be sure to keep your proof of purchase.

- Serial Number _____
- Purchased From _____
- Purchase Date _____

If you need to contact Customer Service, please record the following details before calling. This information will help our representatives give you better service.

- Type of installation (e.g. On-Grid, Off-grid) _____
- Length of time inverter has been installed _____
- Battery/battery bank size _____
- Battery type (e.g. flooded, sealed gel cell, AGM) _____
- DC wiring size and length _____
- Alarm sounding? _____
- Description of indicators on front panel _____
- Appliances operating when problem occurred _____
- Description of problem _____

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Xantrex
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