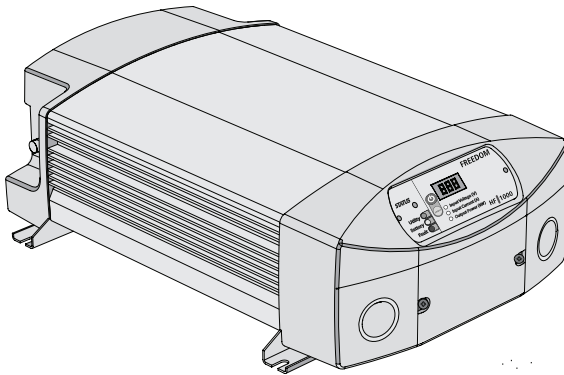


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Installation Guide

Freedom HW 1000 Inverter/Charger

www.xantrex.com

Freedom HW 1000 Inverter/Charger

Installation Guide

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Xantrex Technology Inc. (www.xantrex.com), a subsidiary of Schneider Electric, is a world leader in the development, manufacturing and marketing of advanced power electronic products and systems for the renewable and mobile power markets. The company's products convert and control raw electrical power from any central, distributed, renewable, or backup power source into high-quality power required by electronic equipment and the electricity grid. Xantrex is headquartered in Vancouver, Canada, with facilities in the United States, Germany, Spain, and a joint venture in China.

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As a global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in energy and infrastructure, industrial processes, building automation, and data centres/networks, as well as a broad presence in residential applications. Focused on making energy safe, reliable, and efficient, the company's 120,000 employees achieved sales of more than 17.3 billion euros in 2007, through an active commitment to help individuals and organizations “Make the most of their energy™”.

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Contact Information

Telephone: 1 800 670 0707 (toll free North America)
1 408 987 6030 (direct)

Fax: 1 800 994 7828 (toll free North America)

Email: customerservice@xantrex.com

Web: www.xantrex.com

About This Guide

Purpose

The purpose of this Installation Guide is to provide explanations and procedures for setting up and installing a Freedom HW Installation*.

For complete information on how to operate, maintain, and troubleshoot the Freedom HW unit, see the Freedom HF Inverter/Charger Owner's Guide (Doc. Part Number: 975-0467-01-01)

** Recreational or Fleet Vehicle.*

Scope

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

Audience

The Guide is intended for qualified installers who need to install and configure the Freedom HW Inverter/Charger. The installer should be a qualified technician or electrician with knowledge and experience in installing electrical equipment, knowledge of the applicable installation codes, and awareness of the hazards involved in performing electrical work and how to reduce those hazards.

Organization

This Guide is organized into two chapters.

Chapter 1 provides information to help in installing a Freedom HW Inverter/Charger Installation.

Chapter 2 contains electrical performance information and product specifications.

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.

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

READ AND SAVE THIS INSTALLATION GUIDE FOR FUTURE REFERENCE.

This chapter contains important safety and operating instructions for the Freedom HW Inverter/Charger unit.



WARNING: Limitations on use

The Freedom HW is not intended for use in connection with life support systems or other medical equipment or devices.

-
1. Before installing and using the Freedom HW, read all instructions and cautionary markings on the Freedom HW, the batteries, and all appropriate sections of this guide.



CAUTION: Risk of injury

To reduce the risk of injury, charge only 12 Vdc lead-acid (GEL, AGM, or Flooded) rechargeable batteries. Other battery types may burst, causing personal injury and damage.

-
2. Do not expose the Freedom HW to rain, snow, spray, or bilge water. To reduce risk of fire hazard, do not cover or obstruct the ventilation openings. Do not install the Freedom HW in a zero-clearance compartment. Overheating may result.
 3. 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 Freedom HW with damaged or substandard wiring.
 4. The use of any attachments not recommended or sold by Xantrex, may result in risk of fire, electric shock, or injury to persons.
 5. Do not operate the Freedom HW if it has received a sharp blow, been dropped, or otherwise damaged in any way. If the Freedom HW is damaged, see the Warranty section.

-
6. Do not disassemble the Freedom HW. It contains no user-serviceable parts. See Warranty for instructions on obtaining service. Attempting to service the Freedom HW yourself may result in a risk of electrical shock or fire and will void your warranty. Internal capacitors remain charged after all power is disconnected.
 7. To reduce the risk of electrical shock, disconnect both AC and DC power from the Freedom HW before attempting any maintenance or cleaning or working on any circuits connected to the Freedom HW. Turning off controls will not reduce this risk.
 8. The Freedom HW must be provided with an equipment-grounding conductor connected to the AC input ground.



WARNING: Explosion hazard

1. Working in the vicinity of batteries is dangerous. Batteries generate explosive gases during normal operation. Therefore, it is of utmost importance that each time before servicing the unit in the vicinity of the battery, that you read this manual and follow the instructions exactly.
2. This equipment contains components which tend to produce arcs or sparks. To prevent fire or explosion, do not install the Freedom HW 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.
3. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and the manufacturer of any unit you intend to use in the vicinity of the battery.

Personal Precautions When Working With Batteries



WARNING: BATTERIES PRESENT RISK OF ELECTRICAL SHOCK, BURN FROM HIGH SHORT-CIRCUIT CURRENT, FIRE OR EXPLOSION FROM VENTED GASES. OBSERVE PROPER PRECAUTIONS.

1. Study and follow all of the battery manufacturer's specific precautions, such as removing or not removing cell caps while charging, and recommended rates of charge.
2. Add distilled water in each cell until battery acid reaches the level specified by the battery manufacturer. This helps to purge excessive gas from cells. Do not overfill. For a battery without cell caps, carefully follow manufacturer's recharging instructions.
3. Make sure the area around the battery is well ventilated.
4. Never smoke or allow a spark or flame near the engine or batteries.
5. Use extra 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.
6. Remove all metal items, like rings, bracelets, and watches when working with batteries. Batteries can produce a short circuit current high enough to weld metal to skin, causing a severe burn.
7. Have someone within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
8. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
9. Wear complete eye protection and clothing protection. Avoid touching your eyes while working near batteries.
10. 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.
11. If you need to remove a battery, always remove the ground terminal from the battery first. Make sure all accessories are off so you don't cause an arc.

-
12. Never charge a frozen battery.
 13. Clean battery terminals. Be careful to keep corrosion from coming into contact with your eyes.
 14. Locate the Freedom HW unit away from batteries in a separate, well ventilated compartment.
 15. Never place the Freedom HW unit directly above batteries; gases from a battery will corrode and damage the unit
 16. Never allow battery acid to drip on the unit when reading gravity, or filling battery.
 17. Do not operate the unit in a closed in area, or restrict the ventilation in any way.

DC CONNECTION PRECAUTION

18. Connect and disconnect DC output connections only after setting any recreational vehicle unit switches to off position and opening AC disconnect.
19. Proper disposal of batteries is required. Refer to your local codes for disposal requirements.

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Installation

Chapter 1 provides information to help in installing a Freedom HW Inverter/Charger Installation.

It covers the following:

- Materials list.
- Safety instructions and various installation codes that may be applicable to your installation.
- Sample installation tools and materials.
- High level overview of installation steps.
- Installation procedures starting on page 1–5 including mounting and connecting the equipment ground, AC cabling, DC cabling, and grounding steps.

Materials List

Your Freedom HW Inverter/Charger package includes the items listed below.

- Freedom HW Inverter/Charger unit
- display panel (p/n: 808-9557) with 7-inch (0.17 m) display panel cable (p/n: 053-0049-02)
- display panel mounting plate (p/n: 808-9555)
- display panel mounting template (p/n: 531-0081-01-01)
- display panel compartment cover (p/n: 808-9556)
- AC wiring compartment cover (p/n: 210-0738-01-01)
- two reference materials—an Owner's Guide and an Installation Guide (p/n: 975-0468-01-01 and 975-0467-01-01)
- one set of lock washers and nuts (already connected to the bolts) (p/n: 061-2002 and 062-0030)

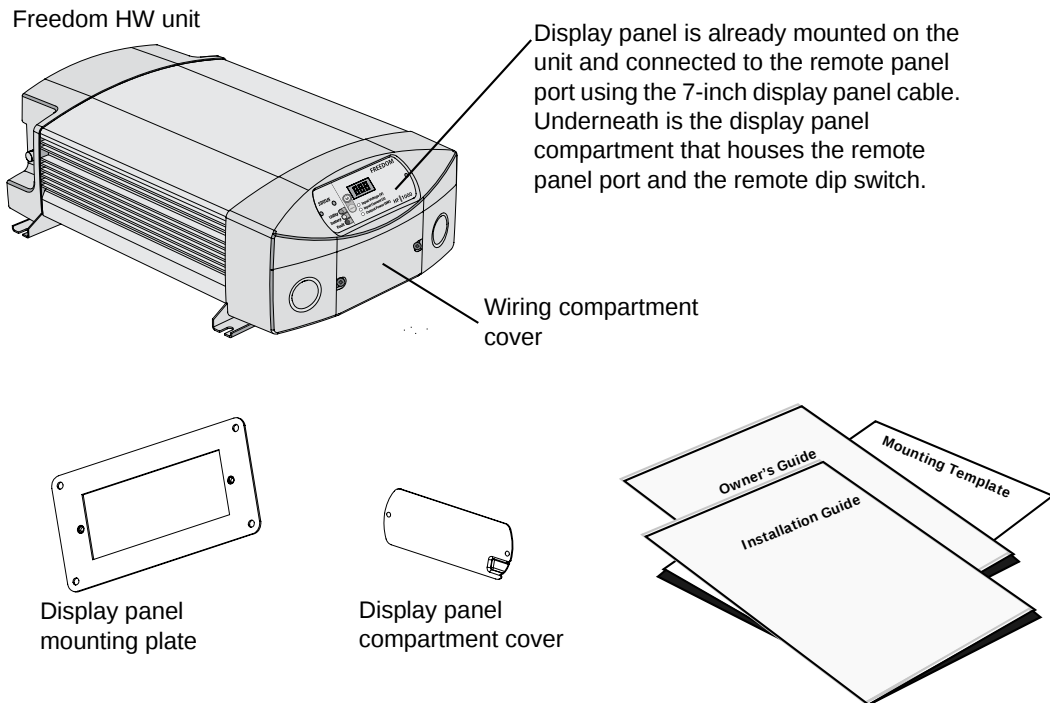


Figure 1-1 What's In The Box

Safety Instructions



WARNING: Shock hazard

Xantrex Technology recommends that all wiring be done by a certified technician or electrician to ensure adherence to the applicable electrical safety wiring regulations.

- Before you begin the installation, review the “Important Safety Instructions” on page v, and read this entire “Installation” section so you can plan your installation from beginning to end.
- Disconnect all AC and DC power sources to prevent accidental shock. Disable and secure all AC and DC disconnect devices and automatic generator starting devices.

Installation Codes

Governing installation codes vary depending on the specific location and application of the installation. Some examples include the following:

- The U.S. National Electrical Code (NEC)
- The Canadian Electrical Code (CEC)
- The U.S. Code of Federal Regulations (CFRs)
- Canadian Standards Association (CSA) and the RV Industry Association (RVIA) for installations in RVs

It is the installer’s responsibility to ensure that all applicable installation requirements are met.

Installation Tools and Materials

You will need the following to install the Freedom HW:

- ☐ Wire stripper
- ☐ Mounting screws or bolts
- ☐ #2 Phillips screwdriver
- ☐ Wrench for DC terminals (1/2 inch or 13mm or adjustable)
- ☐ AC cable (i.e. 2-conductor-plus-ground cable), sized appropriately for load and application
- ☐ Wire nuts or crimp connectors for AC wire and appropriate tools
- ☐ DC cable, sized appropriately for load and application
- ☐ Lugs for DC cables to fit 8 mm (5/16 in.) DC stud terminals) as well as appropriate tools (e.g. crimping tool)
- ☐ AC and DC disconnects and over-current protective devices

High Level Overview of Installation Steps

Installing the Freedom HW includes the following steps.

1. Ensure that AC and DC power are both OFF.
2. Mount the inverter securely and permanently in one of the acceptable orientations.
3. Connect the Equipment Grounding Terminal to the equipment ground bus.
4. Connect the AC input wiring to the AC source panel.
5. Connect the AC output wiring to the AC load panel.
6. Connect one end of the DC negative cable to the negative of the battery, and the other to the negative terminal of the unit.
7. Install an appropriately sized fuse and DC disconnect in the positive cable.
8. Connect the DC positive cable to the positive of the battery, and to the positive terminal of the unit.
9. Close the DC disconnect switch.

Do not proceed with installation until you have read “Safety Instructions” on page 1–3.

Basic Installation Procedures

Xantrex recommends that you have your installation performed by a qualified technician or electrician.

This section provides sample installation information as a guide for your installation. For your convenience, the overall procedure is divided into ten main steps:

- ☐ **Step 1:** Designing an installation. (Start on page 1–6.)
- ☐ **Step 2:** Choosing a location for the Freedom HW.
(Start on page 1–12.)
- ☐ **Step 3:** Mounting the Freedom HW. (Start on page 1–13.)
- ☐ **Step 4:** Connecting the AC input wires. (Start on page 1–15.)
- ☐ **Step 5:** Connecting the AC output wires. (Start on page 1–18.)
- ☐ **Step 6:** Connecting the DC cables. (Start on page 1–23.)
- ☐ **Step 7:** Mounting the display panel. (Start on page 1–27.)
- ☐ **Step 8:** Testing your installation. (Start on page 1–28.)

Step 1: Designing the Installation

Most Freedom HW installations share common components, and some of these are briefly described below. Figure 1-2 shows some components and their relationship to each other in a typical recreational vehicle or fleet vehicle installation.

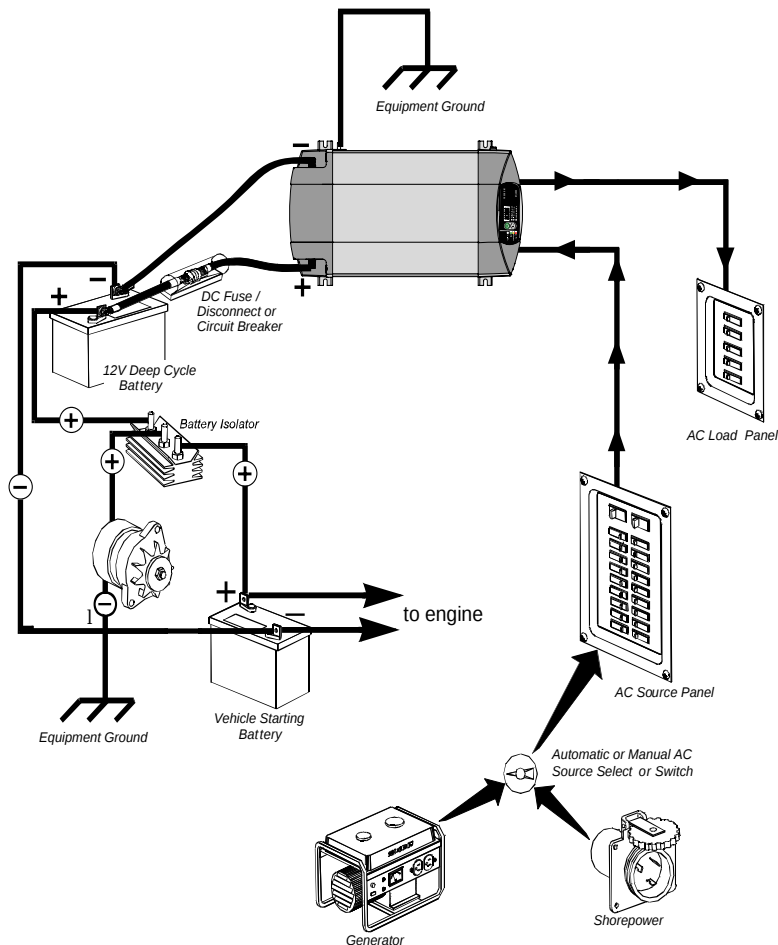


Figure 1-2 Typical Recreational Vehicle and Fleet Vehicle Installation

AC shore power A source of 120 V, 60Hz sine wave alternating current is needed to provide energy to charge batteries and pass power through to AC loads. This source is usually the utility grid (power company) or an AC generator. An automatic or manual AC source selector switch can be used to switch between the multiple sources of shore power to the Freedom HW system.

The AC source feeding the Freedom HW must have the neutral conductor bonded to ground. When the inverter passes shore power through, it will lift the bonding relay on the output and will rely on the input being bonded in order to ensure that the power delivered to a sub panel is properly bonded. See “AC Output Neutral Bonding” on page 1–9 for more information on bonding relay operation.

Important: Throughout this manual, the term “shore power” refers to AC input power from a utility grid, generator, or other AC source.

Generator The Freedom HW is compatible with most generators which produce nominal 120 Vac 60Hz sine wave AC power.

Since the DC charging current limit of the Freedom HW may be configured to provide as little as 7 A it is possible to use very small generators with the Freedom HW to charge batteries. The Freedom HW has been tested with generators of various sizes, including some as small as 700W.

AC Disconnect and Over-Current Protection Device Most safety requirements and electrical codes require the Freedom HW’s AC and DC inputs and outputs to be provided with over-current protection (such as circuit breakers or fuses) and disconnect devices.

AC Input: The circuit breaker or fuse (connected through hard wiring) that is used to supply the Freedom HW must be rated at no more than 30A and must be approved for use on 120 Vac branch circuits. The wire used between the breaker and the Freedom HW input must be sized adequately to carry current up to the rating of the input breaker and in accordance with the electrical codes or regulations applicable to your installation.

AC Output: The circuit breaker or fuse must be rated at no more than the rating of the input breaker in the installation and must be approved for use on 120 Vac branch circuits. The wire used between the Freedom HW and the AC output breaker must be of adequate size to match the AC input circuit breaker's rating. The wiring from each AC output breaker to each of the loads must be adequately sized to carry the current rating of the individual AC output breaker.

Disconnect Devices: Each system requires a method of disconnecting the AC circuits. If the over-current protection devices are circuit breakers, they will also serve as the disconnects. If fuses are used, separate AC disconnect switches will be needed ahead of the fuses. These will have to be a branch circuit rated for 120 Vac and have an appropriate current rating.

AC Distribution Panels

Most systems incorporate distribution centers both ahead of the Freedom HW (the AC source panel) and between the Freedom HW and the loads (the AC load panel). An AC source panel includes a main circuit breaker, which serves as over-current protection and as a disconnect for the AC shore power supply line. Additional circuit breakers serve individual circuits, one of which serves the Freedom HW. The AC load panel can incorporate an AC output circuit breaker and breakers for individual load circuits.



CAUTION: Equipment damage

Do not connect the output of the Freedom HW to what is known as a “multi-wire branch circuit”. These are four-wire circuits consisting of a ground, neutral, and two lines that are 180 degrees out of phase with each other (from a standard 120/240V “split phase” circuit). These circuits are commonly used in kitchens to power “split receptacles” where the top and bottom halves of a duplex receptacle are connected to different lines.

AC Cabling

AC cabling includes all the wires and connectors between the AC source and the Freedom HW, as well as all cabling between the Freedom HW and the AC output panels, circuit breakers, and loads. The type and size of the wiring varies with the installation and load. For example, in high vibration environments, such as RV applications, wire nuts may not be acceptable, so crimp splices would be required. In other applications, flexible multiple-strand wire may be required. Installation codes usually specify solid or stranded, overall size of the conductors, and type and temperature rating of the insulation around the wire.

AC breakers and fuses must be sized to adequately protect the wiring that is installed on the input and output AC circuits of the Freedom HW. All breakers and wiring must be sized and connected in accordance with the electrical codes or regulations applicable to your installation. Table 1-1 gives some examples of wiring sizes based on the U.S. National Electrical Code and the Canadian Electrical Code. These examples are based on using a 2-conductor-plus-ground cable rated at 75 °C, and assuming an ambient temperature of up to 30 °C. Ensure that your breakers, and fuses have suitable temperature ratings for your wiring. Other codes and regulations may also be applicable to your installation.

Table 1-1 Required AC Wire Size vs Breaker Rating

Breaker Size	15A	20A	30A
Minimum Wire Size	14AWG	12AWG	10AWG

AC Output
Neutral
Bonding

The neutral conductor of the Freedom HW’s AC output circuit (i.e., AC Output Neutral) is automatically connected to the safety ground during inverter operation. When the Freedom HW is using AC shore power, this connection is not present, so that the utility neutral (i.e., AC Input Neutral) is only connected to utility ground at your source. This conforms to National Electrical Code, which requires that separately derived AC sources (such as inverters and generators) to have their neutral conductors tied to ground in the same way that the neutral conductor from the utility is tied to ground in only one place. Check the regulations for your specific application to ensure that the installation will comply with the necessary requirements. In other words, the AC Input Neutral and Output Neutral must be isolated from each other.

DC Cabling

This includes all the cables and connectors between the batteries, the DC disconnect and over-current protection device, and the Freedom HW. Most mobile installations require multi-strand insulated cables for flexibility and durability in high vibration environments and require disconnects and over-current devices. Electrical wiring sizes are indicated by AWG notation. Under the AWG standard, a larger gauge number indicates a smaller wire diameter. Wire size is usually marked on the larger sized cables. Table 1-2 specifies the minimum recommended DC cable size and maximum fuse size for the Freedom HW. **The DC cables must be copper and must be rated 75 °C minimum.** The cables should be terminated with lugs that fit the DC stud terminals snugly (8 mm or 5/16 in. hole size).

Table 1-2 Recommended Cable Sizes

Inverter/Charger	Cable Length: Battery to Inverter (one way)	Minimum Cable Size	Maximum battery Fuse Size
Freedom HW	Less than 5 feet (1.5 meters)	No. 2 AWG	150 Adc

Note: Xantrex recommends not using a cable longer than 5 feet (1.5 meters) in each direction. Cable sizes above are based on the US National Electrical Code Table 310.17 - 75C cables, assuming an ambient temperature of 30 °C cables.

Important: Using the correct cable size is critical to achieving the rated performance of the Freedom HW unit. When starting a heavy load the Freedom HW can draw current surges from the battery of up to 400A. If the DC wiring is too small the voltage drop from this surge will result in a voltage at the Freedom HW terminals that is too low for the Freedom HW to operate correctly. The Freedom HW may appear to operate correctly with smaller cables until a heavy load such as a microwave or refrigerator attempts to start - then the unit may work correctly sometimes and not work correctly other times.

DC Disconnects
and Over-
Current Devices

The DC circuit from the battery to the Freedom HW must be equipped with a disconnect and over-current device. This usually consists of a circuit breaker, a “fused-disconnect,” or a separate fuse and DC disconnect. Do not confuse AC circuit breakers with DC circuit breakers. They are not interchangeable. The rating of the fuse or breaker must be matched to the size of cables used in accordance with the applicable installation codes. The breaker or disconnect and fuse should be located as close as possible to the battery, in the positive cable. Applicable codes may limit how far the protection can be from the battery.

Batteries

The Freedom HW uses 12-volt battery banks. Every Freedom HW system requires a deep-cycle battery or group of batteries that provide the DC current that the Freedom HW converts to AC.

Ground Fault
Circuit
Interrupters
(GFCIs)

A GFCI is a device that de-energizes a circuit when a current to ground exceeds a specified value that is less than that required to blow the circuit breaker. GFCIs are intended to protect people from electric shocks and are usually required in wet or damp locations.

Installations in recreational vehicles require GFCI protection of branch circuits connected to the AC output of the Freedom HW.

The modified sine wave output of the Freedom HW is not equivalent to the waveform provided by electric utilities, and compliance with UL and CSA standards requires that Xantrex test and recommend specific GFCIs that will work correctly with the Freedom HW.

For more information about GFCIs, see the application note "Using GFCI Receptacles on Xantrex Inverters and Inverter/Chargers" in the Document Library at www.xantrex.com/support.

Step 2: Choosing a Location for the Freedom HW



WARNING: Fire and explosion hazard

This equipment contains components that tend to produce arcs or sparks. To prevent fire or explosion, do not install the Freedom HW 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, or joints, fittings, or other connections between components of the fuel system.



WARNING: Fire hazard

To reduce the risk of fire, do not cover or obstruct the ventilation openings. Do not install the Freedom HW in a zero-clearance compartment. Overheating may result.

The Freedom HW should only be installed in locations that meet the following requirements:

- ☐ **Dry.** Do not allow water or other fluids to drip or splash on the Freedom HW. **Do not mount the Freedom HW in an area subject to splashing water or bilge water.**
- ☐ **Cool.** Normal air temperature should be between 21 °F and 165 °F (–20 °C and 60 °C)—the cooler the better.
- ☐ **Ventilated.** Allow at least 5 in. (13cm) of clearance at the DC end of the Freedom HW for air flow, 1 in. (2.5cm) on each side, and 2 in. (5cm) at the AC end. The more clearance for ventilation around the unit, the better the performance. Do not allow the ventilation openings on the ends of the unit to become obstructed.
- ☐ **Safe.** Do not install the Freedom HW in the same compartment as batteries or in any compartment capable of storing flammable liquids like gasoline.
- ☐ **Close to the battery compartment and the AC source and load panels.** Avoid excessive cable lengths (which reduce input and output power due to wire resistance). Use the recommended cable lengths and sizes, especially between the battery banks and the Freedom HW.
- ☐ **Protected from battery acid and gases.** Never allow battery acid to drip on the Freedom HW or its wiring when reading specific gravity or filling the battery. Also do not mount the unit where it will be exposed to gases produced by the batteries. These gases are very corrosive, and prolonged exposure will damage the Freedom HW.

Step 3: Mounting the Freedom HW

To mount the Freedom HW:

1. Remove the Freedom HW from its shipping container, verify that all components are present, and record relevant product information on Freedom HF Inverter/Charger Owner's Guide (Doc. Part Number: 975-0467-01-01) Warranty section.
2. Select an appropriate mounting location and orientation. (See Figure 1-3 below.) To meet regulatory requirements, for use in on-land applications, the Freedom HW must be mounted in one of the following orientations:
 - Under a horizontal surface (see 1)
 - In a horizontal position on a vertical surface (see 2)
 - On a horizontal surface (see 3)

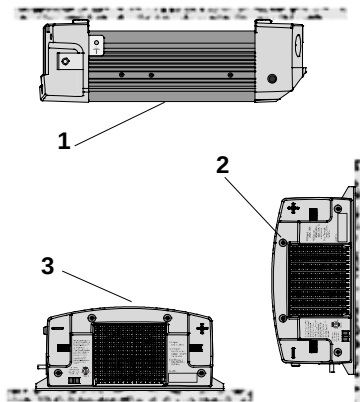


Figure 1-3 Approved Mounting Orientations

3. Look for the mounting template and unfold. Tape it to the mounting surface and pilot-drill the desired number of mounting holes. Remove the template.
4. Fasten the Freedom HW to the mounting surface. If you are mounting the unit on a wall or bulkhead, use #12 or #14 pan-head wood or sheet metal screws to secure it to the framing behind the wall or bulkhead. Alternatively, use nut inserts and 1/4-20 machine screws.

Connecting the Equipment Ground



WARNING: Fire hazard

Never operate the Freedom HW without properly connecting the equipment ground. A fire hazard could result from improper grounding.

The Freedom HW has a ground stud on the side of the unit as shown in Figure 1-4. Follow the guidelines in “Grounding Locations” to connect the inverter’s chassis to the ground.

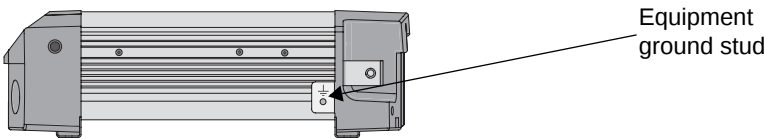


Figure 1-4 DC Panel Connections

Grounding Locations

You must connect the equipment ground stud to a grounding point—usually the vehicle’s chassis or DC negative bus ground—using recommended copper wire (if insulated then green insulation with or without one or more yellow stripes) or larger.

For recommended equipment ground cable size, see below.

Table 1-3 Recommended Equipment Ground Cable size

Application	Minimum equipment ground cable size (Stranded cable is recommended)
Recreational Vehicle ^a	No. 8 AWG

Note: There are no restrictions on length for the equipment ground cable.

a.Based on US National Electrical Code NFPA70, Article 551, par. 551-20c 2005 version.

In general, the equipment ground cable size must not be smaller than one AWG size than the supply cable.

Step 4: Connecting the AC Input Wires



WARNING: Fire, Shock and Energy hazards

Make sure wiring is disconnected from all electrical sources before handling. All wiring must be done in accordance with local and national electrical wiring codes. Do not connect the output terminals of the Freedom HW to any incoming AC source.

General AC Wiring Considerations

AC cable size	The AC input cable may be either solid or stranded (as required), but must have three conductors and be sized as in Table 1-4 on page 1-16.
AC Wiring Connectors	Connect AC wires with crimp-on splice connectors. The amount of insulation you strip off individual wires will be specified by the connector manufacturer and is different for different types of connectors.
AC and DC Wiring Separation	Do not mix AC and DC wiring in the same conduit or panel. Where DC and AC wires must cross, make sure they do so at 90° to one another. Consult applicable codes for details about DC and AC wiring in close proximity to each other.
AC Wiring Compartment	For your reference, the AC Wiring Compartment is shown in Figure 1-5.
AC Wiring	To hard wire the Freedom HW AC input and output to an existing AC installation, read this section. AC wiring includes all the wires and connectors between the AC source and the Freedom HW and all wiring between the inverter, the AC panels, circuit breakers, and the GFCIs. The type and size of the wiring varies with the installation and load. For some RV applications, flexible multiple-strand wire is required. AC wiring must be sized appropriately to carry full load current on the input and output AC circuits in accordance with the electrical codes or regulations applicable to your installation. Table 1-4 is based on the U.S. National Electrical Code, 2003 Ed. and the Canadian Electrical Code, assuming 2-conductor-plus-ground cable, using 75 °C wiring, at an ambient temperature of 30 °C. Other codes and regulations may be applicable to your installation.

Table 1-4 Required AC wire size vs. required breaker rating

	Required Breaker Size	Required Wire Size
Freedom HW	30 A maximum	10 AWG

There are two knockouts on the front panel for AC input and output wiring.



CAUTION: Equipment damage

The AC wiring terminal block is split into input and output sections. Damage to the inverter will occur if the unit is wired incorrectly.

When making the AC input and AC output connections, observe the correct color code for the appropriate AC wire, as described in Table 1-5.

Table 1-5 Color codes for typical AC wiring

Color	AC Wire
Black or Brown	Line
White or Blue	Neutral
Green, Green/Yellow, or bare copper	Ground

AC Input Connections

1. Ensure that AC and DC power are both OFF.
2. Install the required circuit breaker in the AC output panel supplying the unit (See Figure 1-6 on page 1–21).
3. Remove the AC wiring compartment cover.
4. Remove the left-hand side AC wiring knockout from the front panel of the unit (see Figure 1-5 on page 1–17).
5. Locate the terminal block.

The two input terminals are labeled as follows:

- AC Input (L)
- AC Input (N)

A separate screw is provided to connect the AC input ground (see Figure 1-5 on page 1–17).

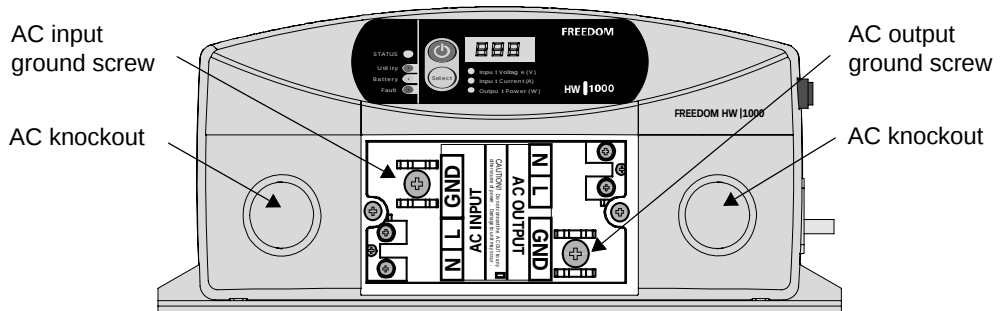


Figure 1-5 Freedom HW AC Wiring Compartment

6. Strip about 2 inches (50 mm) from the jacket of the AC input cable.
The AC input cable may be either solid or stranded (as required), but must have three conductors and be sized as in Table 1-4 on page 1–16. (The AC terminal block accepts wire sizes up to No. 10 AWG.)
7. Strip approximately 3/8 inch (10 mm) from the insulation of each conductor.
8. Run the AC cable through the right-hand side knockout and into the wiring compartment.
9. Fasten the Ground wire to the grounding screw.
10. Using the 1/8 inch slot screwdriver, loosen the wire attachment screws on the terminals.



CAUTION: Reverse polarity

Improper connections (connecting a line conductor to a neutral conductor, for example) will cause the Freedom HW to malfunction and may permanently damage the inverter. Damage caused by a reverse polarity connection is not covered by your warranty.

11. Insert the Line and Neutral wires into the corresponding terminals.
12. Tighten the wire attachment screws to a torque of 15.6–21.6 in-lbf (1.76–2.44 N-m). Leave some wiring slack inside the wiring compartment.
13. Reinstall the AC wiring compartment cover.

Step 5: Connecting AC Output to an Existing AC Circuit



WARNING: Shock, fire, and energy hazards

Make sure wiring is disconnected from all electrical sources before handling. All wiring must be done in accordance with applicable local and national electrical wiring codes.



WARNING: Shock hazard and equipment damage

Do not connect any AC source (such as a generator or utility power) to the AC wiring output of the Freedom HW.

The Freedom HW will not operate if its output is connected to AC voltage from another source, and potentially hazardous or damaging conditions may occur. These conditions can occur even if the inverter is off.

Do not connect the Freedom HW to an AC branch circuit that has high-power consumption loads.

The Freedom HW will not operate electric heaters, air conditioners, stoves, and other electrical appliances that consume more than 1000 watts.

A Xantrex-tested and approved GFCI must be connected to the Freedom HW AC output, and on every receptacle connected to the AC hard wired installation. Other types may fail to operate properly when connected to the Freedom HW. Although you can reuse the factory-installed GFCI, Xantrex has also tested and approved the following GFCIs for use with the Freedom HW.

Make	Model
Hubbell	GFR5252
Leviton	6598, 8598

For more information about GFCIs, see the application note “Using GFCI Receptacles on Xantrex Inverters and Inverter/Chargers” in the Document Library at www.xantrex.com.

**WARNING: Shock, fire, and energy hazards**

Make sure wiring is disconnected from all electrical sources before handling. All wiring must be done in accordance with applicable local and national electrical wiring codes. Do not connect the output leads of the inverter to any incoming AC source.

To make a permanent connection to existing AC wiring (continuing from # 13 of “Step 4: Connecting the AC Input Wires” on page 1–15):

1. Ensure that AC and DC power are both OFF.
2. Install the required value of circuit breaker in the AC load panel (see Figure 1-6 on page 1–21 and Figure 1-7 on page 1–22).
3. Remove the left-hand side AC wiring knockout from the front of the unit.

Important: The applicable installation code may not allow you to run the AC IN and AC OUT wiring through the same AC knockout.

4. Locate the terminal block.

The two output terminals are labeled as follows:

- AC Output (L)
- AC Output (N)

A separate screw is provided to connect the AC output ground.

5. Strip about 2 inches (50 mm) from the jacket of the AC output cable.
The AC output cable may be either solid or stranded (as required), but must have three conductors and sized as in Table 1-4 on page 1–16. (The AC terminal block accepts wire sizes up to No. 10 AWG.)
6. Strip approximately 3/8 inch (10 mm) off the insulation of each conductor.
7. Remove the AC wiring compartment cover.
8. Run the AC cable through the left-hand side knockout and into the wiring compartment.
9. Fasten the Ground wire to the grounding screw.
10. Using the 1/8 inch slot screwdriver, loosen the wire attachment screws on the terminals.



CAUTION: Reverse polarity

Improper connections (connecting a line conductor to a neutral conductor, for example) will cause the Freedom HW to malfunction and may permanently damage the inverter. Damage caused by a reverse polarity connection is not covered by your warranty.

11. Insert the Line and Neutral wires into the corresponding terminals.
12. Tighten the wire attachment screws to a torque of 15.6–21.6 in-lbf (1.76–2.44 N-m). Leave some wiring slack inside the wiring compartment.

Ensure you have maintained correct polarity and that there are no loose strands of wire.

13. Reinstall the AC wiring compartment cover.
14. Connect the outgoing AC wires to the AC load panel.

**CAUTION: Equipment damage**

Do NOT connect the AC OUT Neutral and Line to the AC IN Neutral and Line.

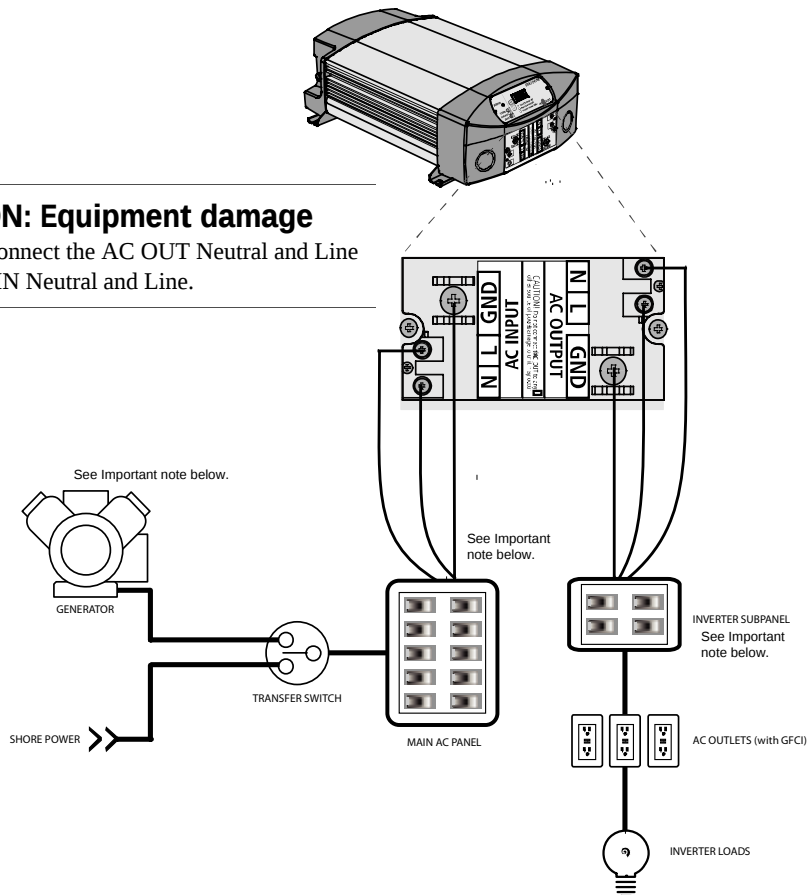


Figure 1-6 AC Wiring Diagram with an Inverter Subpanel

In this wiring diagram, the AC input to the Freedom HW comes from the main AC panel which contains the input circuit breaker. The AC output wiring is routed to a separate inverter subpanel with a dedicated circuit breaker.

Important: The generator must have its neutral bonded to ground. If it is not bonded, a bonding jumper must be installed between the neutral and ground at the generator's output or at the generator side of the transfer switch. Also, both the main AC panel and the inverter subpanel must not have a permanent neutral to ground bonds installed.



CAUTION: Equipment damage

Do NOT connect the AC OUT Neutral and Line to the AC IN Neutral and Line.

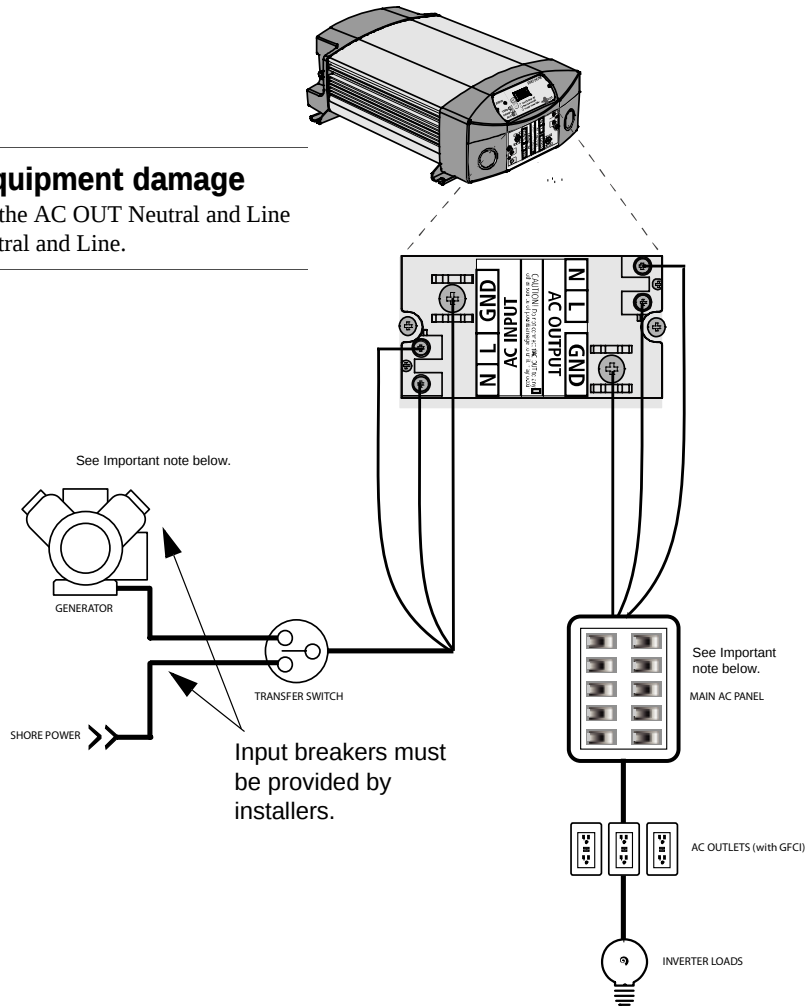


Figure 1-7 AC Wiring Diagram without an Inverter Subpanel

In this wiring diagram, the AC input to the Freedom HW comes directly from an AC source. The AC source input wiring must be protected by an AC breaker of 30 A max. The output wiring is routed to the main AC panel which is also protected by AC breakers or circuit breakers.

Important: The generator must have its neutral bonded to ground. If it is not bonded, a bonding jumper must be installed between the neutral and ground at the generator's output or at the generator side of the transfer switch. Also, the main AC panel must not have a permanent neutral to ground bond installed.

Step 6: Connecting the DC Cables



CAUTION

Before making the final DC connection, check cable polarity at both the battery and the Freedom HW. Positive must be connected to positive; negative must be connected to negative.

Reversing the positive and negative battery cables will damage the Freedom HW and void your warranty. This type of damage is easily detected.



WARNING: Fire hazard

Use only copper wire rated 75 °C minimum. Make sure all DC connections are tight to a torque of 108–120 in-lbf (12.2–13.6 N-m). Loose connections will overheat.

Follow the procedure given below to connect the battery leads to the terminals on the DC end. The cables should be as short as possible and large enough to handle the required current, in accordance with the electrical codes or regulations applicable to your installation. Table 1-2 on page 1–10 specifies the minimum DC cable size and maximum fuse size for the Freedom HW.

Do not route your DC cables through an electrical distribution panel, battery isolator, or other device that will cause additional voltage drops.

Figure 1-8 shows the DC end for your reference.

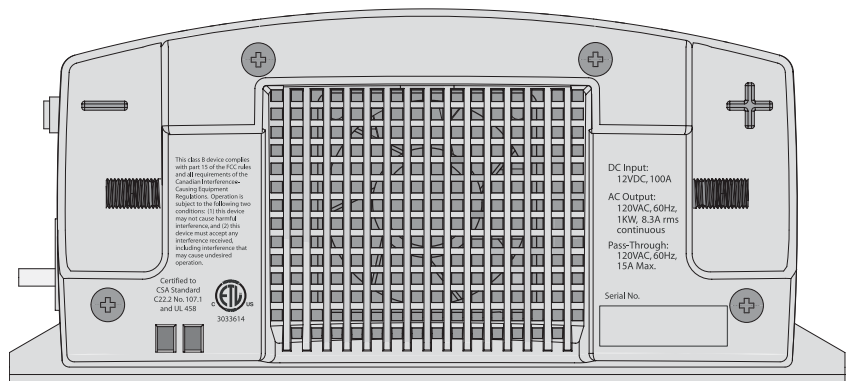


Figure 1-8 DC End

To make the DC connections

Refer to Figure 1-9.

1. Make sure the inverter is off and no AC or DC is connected to the unit.
2. Remove the nuts and washers from the Freedom HW positive and negative DC terminals.
3. Strip 1/2 inch (13 mm) to 3/4 inch (19 mm) insulation from one end of each cable. The amount stripped off will depend on the terminals chosen.
4. Attach the connectors that will secure the cables to the battery, to the disconnect/battery selector switch, and the fuse block. The connectors you use must create a permanent, low-resistance connection. If crimp connectors are required, Xantrex recommends using approved and certified connectors, and to use the tool recommended by the terminal manufacturer. Make sure no stray wires protrude from the connector or terminal.
(You may find it more convenient to have the crimp connectors attached by the company that sells you the cable and/or connectors.)
5. For each cable end that will be connected to the inverter, strip 1/2 inch (13 mm) to 3/4 inch (19 mm) of insulation from the cable. The amount stripped off will depend on the terminals chosen.
6. Attach the connector that will join the cable to the inverter DC terminal.
7. Install a fuse and fuse holder in the cable that will be used for the positive side of the DC circuit.
The fuse must:
 - be as close to the battery positive terminal as possible,
 - be rated for DC circuits,
 - have an Ampere Interrupting Capacity (AIC) that exceeds the short-circuit current available from the battery (i.e., Class T fuse).
8. To prevent sparking when making the connection, ensure the disconnect/battery selector switch is off.
9. Attach the connector on the positive cable to the positive DC terminal on the inverter.

10. Install the lock washer and nut that are supplied with the inverter.
Tighten the nut to a torque of 108–120 in-lbf (12.2–13.6 N-m). Make the connection snug enough so the ring terminal does not move around on the DC terminal, but do not overtighten. See Figure 1-9, “DC Cable Connections” on page 1–26.

**CAUTION**

Loose connections cause excessive voltage drop and may cause overheated wires and melted insulation.

**CAUTION**

Do not over-tighten the nut on the DC input terminals. Damage to the DC input terminals may result.

The maximum torque setting is **120 in-lbf (13.6 N-m)**.

**CAUTION: Reverse polarity**

DC power connections to the Freedom HW must be positive to positive and negative to negative.

A reverse polarity connection (positive to negative) will blow a fuse in the inverter and may permanently damage the inverter. The fuse is not user replaceable and the inverter may need to be returned for servicing.

Damage caused by a reverse polarity connection is not covered by your warranty.

-
11. Before proceeding, double check that the cable you have just installed connects the positive DC terminal of the inverter to the disconnect/battery selector switch, fuse holder, and that the other end of the fuse holder is connected to the positive terminal of the battery.

**WARNING: Explosion or fire**

Do not complete the next step if flammable fumes are present. Explosion or fire may result if the disconnect/battery selector switch is not in the off position.

Thoroughly ventilate the battery compartment before making this connection.

-
12. Connect the cable from the negative post of the battery to the negative DC terminal of the inverter.

-
13. Install the lock washer and nut that are supplied. Tighten the nut to a torque of 108–120 in-lbf (12.2–13.6 N-m). Make the connection snug enough so the ring terminal does not move around on the DC terminal, but do not overtighten.

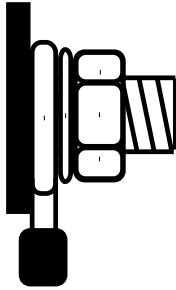


Figure 1-9 DC Cable Connections

DC Grounding

To connect the DC ground:

The equipment grounding lug on the DC end of the Freedom HW is used to connect the chassis of the Freedom HW to your system's DC negative connection or grounding bus point as required by electrical regulations. Use copper wire that is either bare or provided with green insulation. Do not use the DC Ground Lug for your AC grounding. (See the AC wiring instructions in this section.)

Follow the guidelines below that correspond to the specific type of installation. These guidelines assume you are using the DC supply cable and fuse sizes recommended in this manual. If you are using different sizes, refer to the applicable installation code for DC grounding details.

Use 8AWG copper wire and connect it between the Chassis Ground lug and the vehicle's DC grounding point (usually the vehicle chassis or a dedicated DC ground bus).

Recreational
Vehicle

Step 7: Mounting the Display Panel

Xantrex has three communications cables of different lengths available for purchase. Choose a 25-foot cable (p/n: 31-6257-00), 50-foot cable (p/n: 31-6262-00), or a 70-foot cable (p/n: 31-6275-00).

Flush mounting the panel on a wall or bulkhead requires an opening specified in the display panel mounting template. About 1.5 inches (3.8 cm) of free space is required within the wall to accommodate the depth of the panel. Be sure there is no wiring or other obstructions within the wall before you make an opening.

To mount the display panel:

1. Choose a location that is dry, out of direct sunlight, free from corrosive or explosive fumes, and otherwise appropriate for mounting an electronic device.
2. Remove the display panel from Freedom HW.
3. Pilot-drill the corner holes using the display panel mounting template and cut out the hole in which the display panel will be inserted.
4. Position the display panel mounting plate over the hole and fasten it to the wall using all four screws in all the corners of the mounting plate.
5. Route the communications cable(s) inside the wall and through the mounting plate opening.
6. Insert the cable's connector (the one through the opening) in the jack on the backside of the display panel.
7. Place the display panel through the opening of the mounting plate and secure it with two screws – one for each side.
8. Route the communications cable to the Freedom HW's display panel compartment and insert the other connector in the jack located near the battery select dip switch.
9. Install the display panel compartment cover over the compartment and secure it with two screws – one for each side.

Important: Do not route the communications cable in parallel and in conduit with the AC and DC wires. In situations where the cable must cross with the AC and DC wires, make sure they cross at a 90° angle to each other.

Step 8: Testing Your Installation



WARNING: Shock hazard

Pressing the Inverter button to turn OFF the Freedom HW inverter function on display panel does not disconnect DC or AC input power to the Freedom HW. If shore power is present at AC input terminals, it will pass through to the AC output.

There are two tests to be performed. The first test verifies that the Freedom HW is inverting DC battery power and delivering AC power to its output.

The second test is intended for installations where AC input and output is hard wired to the Freedom HW. This test verifies that the Freedom HW transfers from inverter power to shore power when shore power is present.

Note: Shore power (pass-through) refers to the AC input power from a utility grid, generator or external AC source.

When you are ready to test your installation and operate the Freedom HW, close the DC fuse and Disconnect or the DC circuit breaker to supply DC power to the Freedom HW.

Testing in Invert Mode

To test the Freedom HW in invert mode:

1. For hard wired installations, ensure shore power is not present.
2. Press the Inverter button to turn the inverter on.
The status LED on the display panel glows yellow and the LED display illuminates.
3. Plug an appliance within the power rating of the inverter into the AC outlet hard wired to the Freedom HW.
4. Turn the appliance on to verify that it operates.

If the appliance operates, your installation is successful. If your installation has AC input hard wired to the Freedom HW, proceed to “Testing in Shore Power Mode”.

If the status LED on the display panel glows red, see the Troubleshooting chapter.

Testing in Shore Power Mode

To test the Freedom HW in shore power mode:

- ◆ With the appliance from the previous test still connected and operating, connect the shore power source.

The Freedom HW transfers the appliances to shore power. The status LED on the display panel will change from yellow to a ten-second flashing yellow and then green.

If the appliance operates, your installation is successful.

Note: If the Inverter button on the Freedom HW is set to Standby, the Freedom HW will automatically supply the appliances with inverter power if the shore power source fails or becomes disconnected or the shore power voltage is too low (less than 95 volts AC).



WARNING: Shock hazard

Whether or not the Inverter button is turned ON, shore power will pass through the Freedom HW to the output when shore power is within normal operating range.

2

Specifications

Chapter 2 contains electrical performance information and product specifications.

Note: Specifications are subject to change without notice.

Electrical Specifications: Inverter Mode

DC Input	
Low operating voltage range “ SdL ” setting	10.5–15.5 V
High operating voltage range “ SdH ” setting	11.8–15.5 V
Under voltage alarm/shutdown Under voltage recovery “ SdL ” setting	10.5/11.0 V 12.0 V
Under voltage alarm/shutdown Under voltage recovery “ SdH ” setting	11.8/12.3 V 12.6 V
Safe non-operating voltage range	0–16 Vdc
Normal voltage	12.5V
Nominal current at full load	100A
AC Output	
Output voltage	120 Vac
Continuous power	1.0kW @ 25 °C
Surge power	17A (2kW for 200 ms)
Max short-circuit current	55A peak
Frequency	60 Hz
Wave shape	Modified Sinewave
Power derating above 40 °C ambient temp	See “Invert Power Derating vs. Ambient Temperature” on page 2–6.
Peak efficiency	≥88%
Full load efficiency	≥85%
Other	
No load input power (producing output voltage)	≤10W
Off mode current draw	≤3mA

Electrical Specifications: Charge Mode

AC Input	
Operating voltage range	95–135 Vac
Nominal current	12Aac at 55A charge, 120 Vac in
Nominal frequency	60 Hz
DC Output	
Nominal voltage	12.0 Vdc
Min battery voltage for charging	0.0 Vdc
Max output voltage	14.4 Vdc
Nominal output current	User selectable: 5 A, 15 A, 35 A, 55 A
Charger current derating	Automatically reduce charger current as internal temperature exceeds 80 °C, and input Vac approaches low transfer.
Efficiency at nominal output	≥78%
Other	
Battery type settings	Flooded (default), Gel, AGM, or Fixed (13.5V)
Charge algorithms	Three stages (Bulk, Absorption, and Float)
Independent battery banks	1

Environmental Specifications

Operating Temperature Range	32–104 °F (0–40 °C), with output derated above 77 °F (25 °C)
Storage Temperature Range	-40–158 °F (-40–70 °C)
Humidity: Operation/Storage	5–95% RH, non-condensing

System Specifications

Pass-through	120 Vac, 60 Hz, 30 A, 3-hr Max, 24 A continuous
Transfer relay rating	30A, 2.0hp
Transfer time	<30ms (milliseconds)
Transfer on bad voltage	90–100V for low AC and 130–140 for high AC
Cooling	Fan, activated by any of the following: • High internal temperature • High AC output power

Physical Specifications

Unit Dimensions and Weight	
Length	15.5" (39.3cm)
Width	9.5" (24.1cm)
Height	4.2" (10.6cm)
Weight	10.3 lbs (4.7 kg)

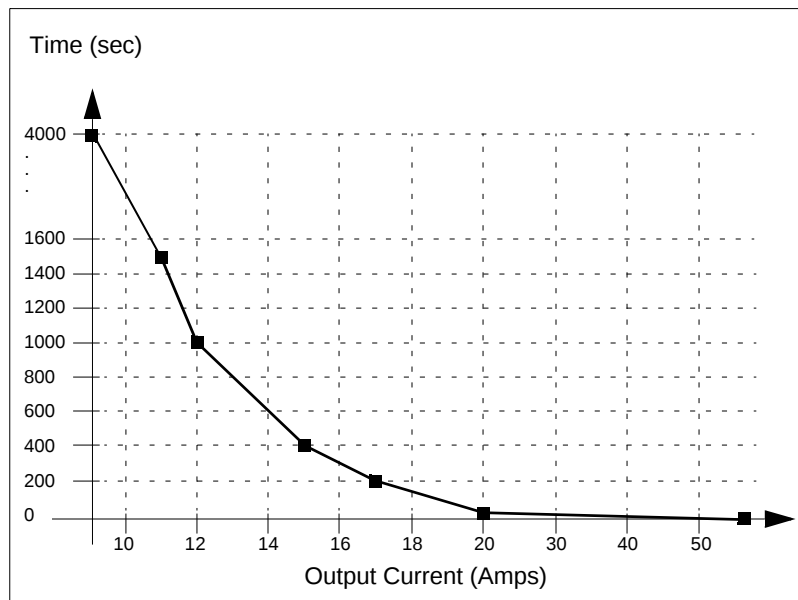
Regulatory Approvals

ETL approved to CSA 107.1, UL458

Inverter Overload Operation

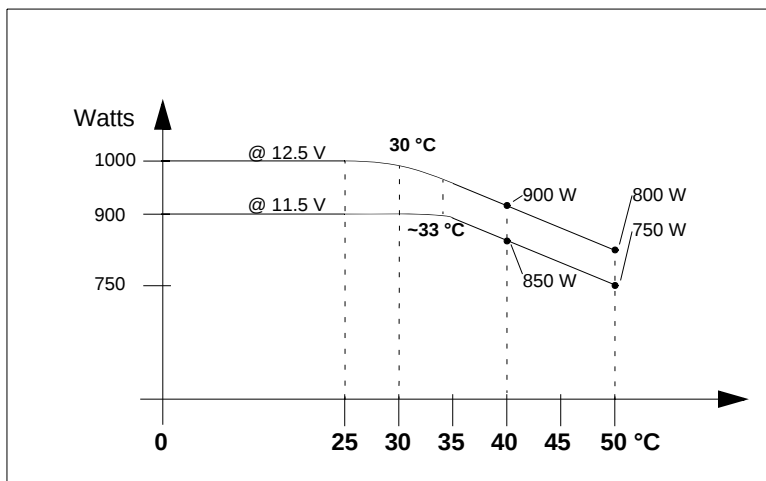
This graph shows how long (measured in seconds) the Freedom HW will operate for a given output current (measured in Amps).

The graph illustrates inverter operation at 25 °C.



Invert Power Derating vs. Ambient Temperature

If the unit is in inverter mode and in elevated ambient temperature above 25 °C, you will have to reduce power draw according to the following chart to avoid over-temperature shutdown.



Charger Output Current vs. AC Input Voltage

When the Freedom HW is charging batteries from a weak shore power source the AC voltage may fall as the Freedom HW draws current. To reduce the chance of the shore power voltage collapsing below the configured transfer level the Freedom HW will reduce the charging current at low shore power voltage according to the following graph:

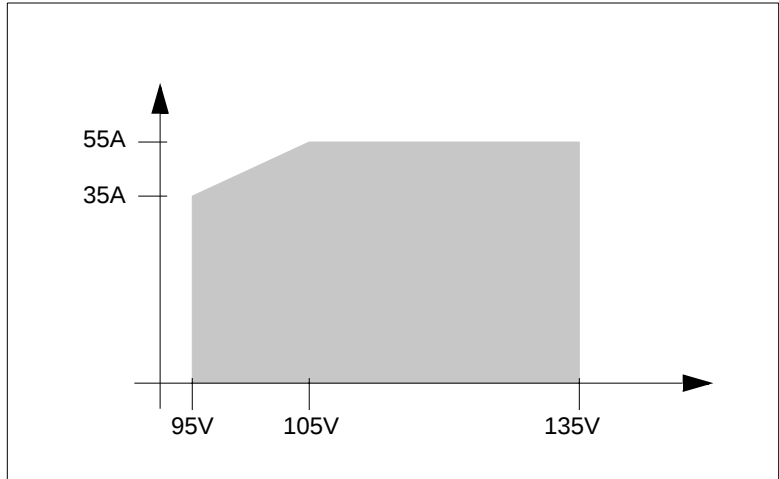


Table 2-1 Charging Voltage

Battery Type	Bulk/Absorption (Volts)	Float (Volts)
Flooded	14.4	13.5
GEL	14.2	13.8
AGM	14.3	13.4
Fixed	13.5	13.5

Xantrex Technology Inc.	

1 800 670 0707 Tel toll free NA

1 408 987 6030 Tel direct

1 800 994 7828 Fax toll free NA

customerservice@xantrex.com

www.xantrex.com



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