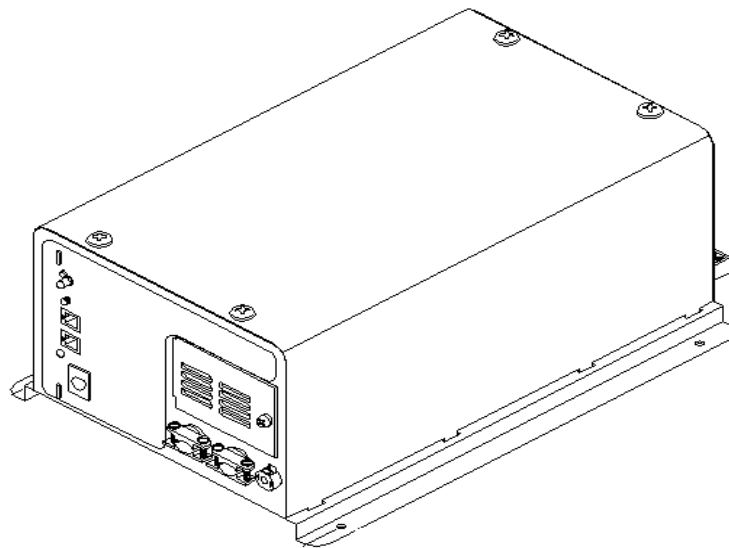




V 1.0

**UX, TRUCK AND LEGEND SERIES
INVERTER/CHARGERS**



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Arlington, WA 98223
Phone (360) 435-8826
Fax (360) 435-2229

**Effective 8/27/97
PN: 3178**

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IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS!

This manual contains important safety and operating instructions as prescribed by Underwriters Laboratories (UL) specifications for inverters used in residential, commercial, and land vehicle applications.

All 120 V_{AC} 60Hz versions of the Legend and Truck models are UL listed to UL 458 covering power inverters for land vehicles. The Export models meet the same requirements (although the UL specifications may not be recognized in countries other than the U.S.). All 120VAC 60Hz versions of the UX model are listed to the proposed UL1741 draft specification for residential and commercial photovoltaic applications.

General Precautions

1. **Before using the inverter/charger, read all instructions and cautionary markings on (a) the inverter/charger, (b) the batteries and (c) all appropriate sections of this instruction manual.**
2. **CAUTION** - To reduce risk of injury, charge only deep-cycle lead acid, lead antimony, lead calcium, gel cell, or absorbed mat type rechargeable batteries. Other types of batteries may burst, causing personal injury and damage.
3. Do not expose inverter/charger to rain, snow or liquids of any type. The inverter is designed for indoor mounting only. Protect the inverter from splashing when used in vehicle applications. Do not mount the inverter in unventilated enclosures or in an engine compartment.
4. Do not disassemble the inverter/charger — take it to a qualified Trace Service Center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire. Before using the inverter/charger, read all instructions and cautionary markings in this manual and on the equipment.
5. To reduce risk of electric shock, disconnect all wiring before attempting any maintenance or cleaning. Turning off the inverter may not reduce this risk. As long as AC input power is present, the charger section will be operable (if installed) regardless of the on/off switch position. Solar modules produce power when exposed to light - disable or disconnect before servicing any connected equipment.
6. **WARNING - WORKING IN VICINITY OF A LEAD ACID BATTERY IS DANGEROUS. BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL OPERATION.** Provide ventilation to the outdoors from the battery compartment. Design the battery enclosure to prevent accumulation and in "pockets" concentration of hydrogen gas at the top of the compartment. Vent the battery compartment from the highest point.
7. **NEVER** attempt to charge a frozen battery.
8. No terminals or lugs are required for hook-up of the AC wiring. AC wiring must be no less than 14 AWG (2.082 mm²) copper wire and rated for 75°C or higher. Battery cables must be rated for 75°C or higher and must be no less than #2 AWG. Crimped and sealed copper-ring terminal lugs with a 5/16 (8mm) hole must be used to connect the battery cables to the DC terminals of the inverter/charger. Soldered cable lugs are also acceptable.

9. Torque all AC wiring connections to 20 inch-pounds (2.3 N-m). Torque all DC cable connections to 12 foot- pounds (144 inch-pounds) (4.5 N-m).
10. **CAUTION:** To reduce the risk of fire, use only input circuits provided with 40-ampere branch circuit protection in accordance with the National Electric Code, ANSI/NFPA70.

Personal Precautions

- i. Someone should be within range of your voice to come to your aid when you work near batteries.
- ii. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
- iii. Wear complete eye protection and clothing protection. Avoid touching eyes while working near batteries. Wash your hands when done.
- iv. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 15 minutes and get medical attention immediately.
- v. Baking soda neutralizes lead acid battery electrolyte. Keep a supply on hand in the area of the batteries.
- vi. **NEVER** smoke or allow a spark or flame in vicinity of a battery or generator.
- vii. Be extra cautious to reduce the risk of dropping a metal tool onto batteries. It could short-circuit the batteries or other electrical parts producing a spark that could cause an explosion.
- viii. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a battery. A battery can produce a short-circuit current high enough to weld a ring or the like to metal, causing severe burns.
- ix. If a remote or automatic generator-start system is used, disable the automatic starting circuit, and/or disconnect the generator from its starting battery while servicing to prevent accidental starting during servicing.

Symbols

Symbols used in this manual and on the inverter/charger are shown below:

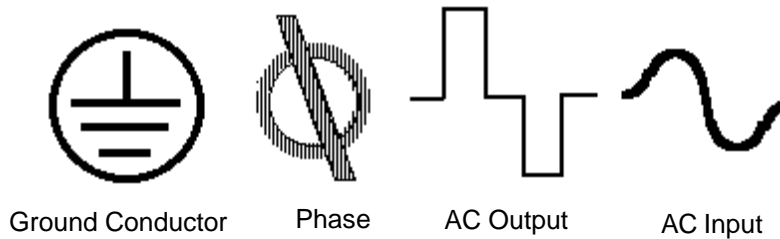


Figure 1, Common Electrical Symbols

Special Notices

- 1) Tools required to make AC wiring connections: Wire strippers, ½" (13MM) open-end wrench or socket, Phillips screw driver #2, slotted screw driver ¼" (6MM) blade, and a torque wrench.
- 2) This inverter/charger is for use with a nominal battery-supply voltage of 12 VDC.
- 3) Instructions for shelf mounting: see the mounting instruction section of this manual. For battery installation and maintenance: read the battery manufacturer's installation and maintenance instructions prior to operating. Do not mount on or near flammable materials (Plywood, Chemicals, Gasoline, etc.)
- 4) No AC or DC disconnects are provided as an integral part of this inverter. Both AC and DC disconnects must be provided as part of the system installation.
- 5) No over-current protection for the battery supply is provided as an integral part of this inverter. Over-current protection of the battery cables must be provided as part of the system installation..
- 6) No over-current protection for the AC output wiring is provided as an integral part of this inverter. Over-current protection of the AC output wiring must be provided as part of the system installation.
- 7) **Caution:** To reduce the risk of fire, use only input circuits provided with 40-ampere branch circuit protection in accordance with the National Electrical Code, ANSI/NFPA70.
- 8) **DC GROUNDING INSTRUCTIONS** - This inverter/charger must be connected to a grounded, permanent wiring system. For most installations, the negative battery conductor must be bonded to the grounding system at one (and only one) point in the system. All installations must comply with national and local codes and ordinances.

- 9) **AC GROUNDING INSTRUCTIONS** – The T and the L versions of this inverter/charger includes neutral ground switching for the AC electrical system. The AC system in mobile installations must have the neutral isolated from the grounding throughout the load distribution circuits. The UX version must have a ground to neutral bond.

Product Materials Package

Thank you for choosing Trace Engineering products to meet your alternative-energy power needs. We make every effort to ensure that your inverter/charger is properly packaged for shipping and includes all the materials requested. Every Trace inverter/charger is packaged with the following materials:

- ☐ Owner's Manual;
- ☐ Red and black battery terminal covers with attaching hardware;
- ☐ Hardware package for hardwire covers;
- ☐ Quick Setup Sheet;
- ☐ Declaration of Conformity (for export models only);
- ☐ Trace bumper sticker;

If any of the above listed materials are missing from your package, or if it is unsatisfactory in any manner, please call Customer Service at 360-435-8826 or fax this page with your comments to 360-435-2229.

Model Number: _____

Serial Number: _____

Packaged by: _____

Package Date: _____

Comments: _____

Check out our web site at www.traceengineering.com for more information and answers to your FAQ's.

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How an Inverter Works

In its most basic form, an inverter transforms Direct Current (DC) to Alternating Current (AC). This section introduces some basic underlying concepts associated with inverters; describes the theory of transformer operation; and compares wave-forms such as square waves, modified sine waves, and sine waves.

Inductance: When a current flows through an electrical conductor, it can induce a similar, sympathetic current in any conductor adjacent to it; this is called "mutual inductance." The conductor inducing the current is the primary; the sympathetic conductor is the secondary. The most common conductor used for this purpose is wound copper wire.

Transformer: The principal component of nearly every inverter is one or more transformers. A transformer consists of a number of windings of wire around a non-conductive bobbin surrounded by a number of laminated sheet-iron plates called a "core."

In a typical inverter transformer, one end of the primary coil is momentarily connected to the positive (+) pole of a DC current source while the other end is connected to the negative (-) pole of the same DC current source. This causes a DC current to flow from positive to negative. The secondary winding has many more turns. When a DC current is passed through the primary winding, a much weaker DC current is induced in the secondary winding, but the voltage is increased. When the ratio of the number of turns between primary and secondary winding is correct, 12 volts in the primary winding become 120 volts in the secondary winding.

Polarity: In order to transform DC current to AC current, the flow of the current through the primary winding must stop and change directions to induce a similar change in the secondary winding. This is accomplished by alternating the polarity of the primary winding. The end of the primary winding connected to the positive pole is switched to the negative pole, and vice-versa. The secondary winding reflects the change in direction while stepping-up the voltage, thus producing alternating current from direct current.

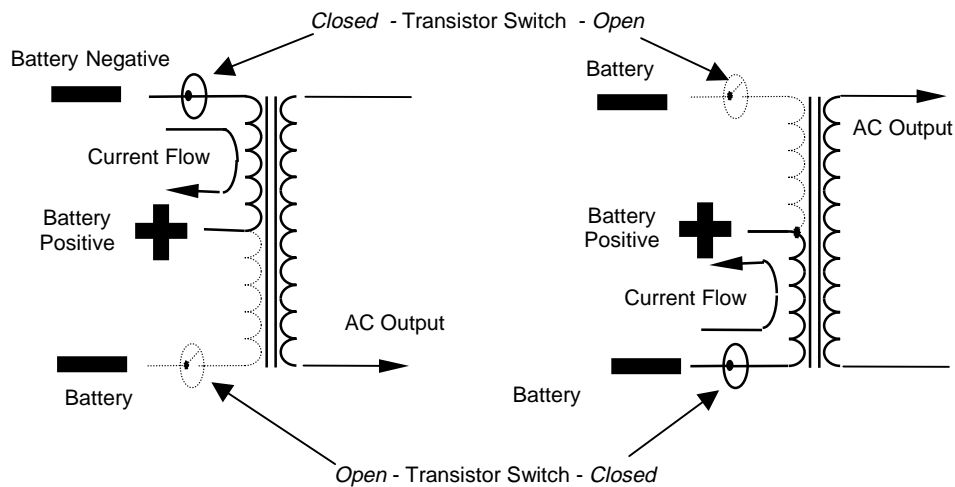


Figure 2, Simplified Inverter Design

Wave Forms

Direct current flows from positive to negative and remains relatively constant in voltage; therefore a graphic representation of such a current would be a flat horizontal line. The polarity of alternating current changes with regularity, usually 120 times per second (a cycle is defined as two changes in polarity; therefore $120 \div 2 = 60$ cycles) while the voltage remains constant. A waveform is a graphic representation of this alternating polarity and voltage. A typical AC waveform (sine wave) shows the proportionately increasing and then decreasing voltage of one polarity (from zero to 120 volts, for example) and then a similar voltage change of the opposite polarity. See *Figure 3, Comparison of Output Waveforms*.

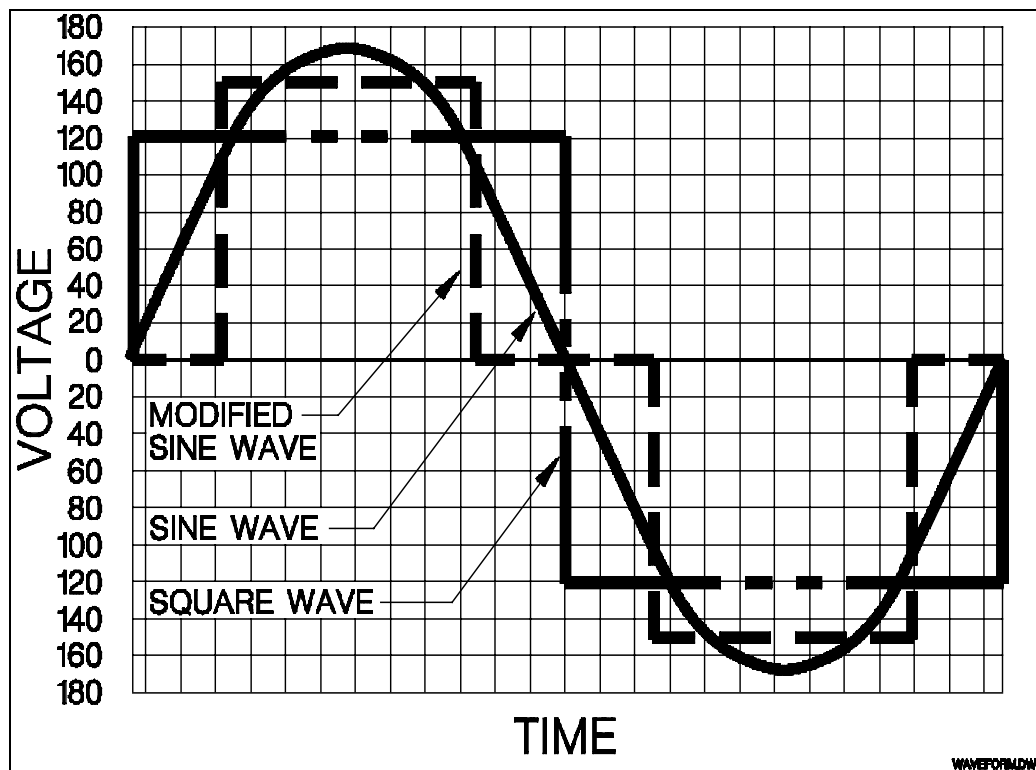


Figure 3, Comparison of Output Waveforms

There are three principal waveforms to consider: square wave, modified square wave (also known as modified sine wave), and sine wave.

Square Wave: produced by instantly switching the polarity of a current while attempting to maintain the voltage, theoretically resulting in a wave form as illustrated in *Figure 3, Comparison of Output Waveforms*.

Modified Sine Wave: produced by introducing a non-polar off-time between alternate polarity resulting in a waveform illustrated in Figure One, below. The duration of the polarized voltage and the neutral polarity off time (Pulse Width) can be regulated (modulated) in order to maintain voltage at a constant level (RMS voltage).

Sine Wave: A smooth waveform created by proportionately increasing voltage and polarity as illustrated in *Figure 3, Comparison of Output Waveforms*.

Inverter Waveform

The output waveform of the Trace inverter is a modified sine wave. This waveform is suitable for a variety of applications such as induction motors (i.e. refrigerators, drill presses), resistive loads (i.e. heaters, toasters), universal motors (i.e. hand tools, vacuum cleaners) as well as microwave ovens and computers. The waveform could be more accurately described as a pulse-width-modulated square wave. *Figure 3, "Comparison of Output Waveforms,"* shows the relationships between square wave, sine wave and modified sine wave formats.

Regulation

The inverter is RMS (Root Mean Square) regulated. RMS regulation ensures that resistive loads will always have the same amount of power delivered to them as battery voltage changes. Regulation is achieved by varying the width of each pulse. Peak voltage is the product of the battery voltage times the turns ratio of the inverter's power transformer and is therefore not actively regulated.

The idea behind RMS regulation is to keep the area inside the waveform equal at all times (see *Figure 2, Simplified Inverter Design*). Since the peak voltage, or pulse height, is a product of battery voltage and transformer ratio (as we learned previously), when the peak voltage increases the area inside the pulse will increase if the pulse width remains the same. With a square wave inverter nothing can be done about this RMS voltage increase, but PWM control allows the width of the pulse to be narrowed, thus maintaining a constant area inside the waveform (*Figure 3B*).

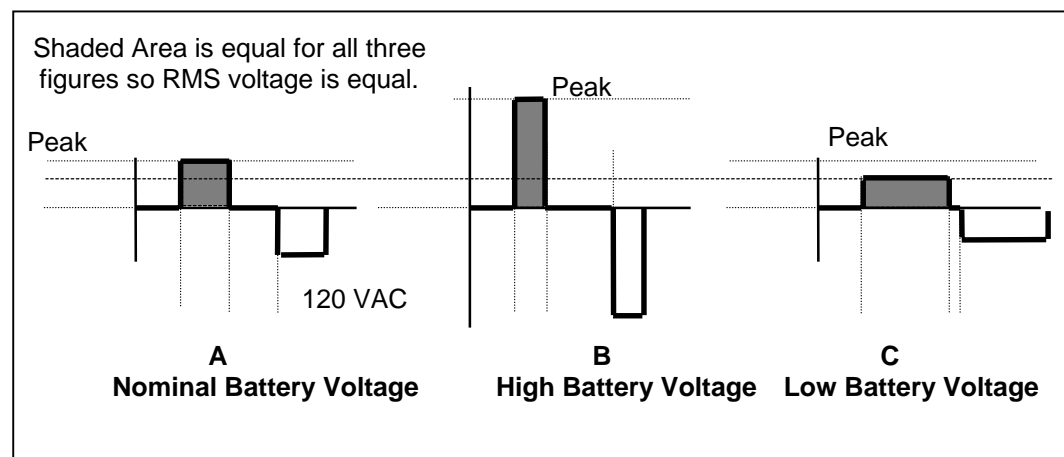


Figure 4, RMS Voltage Regulation Using Pulse Width Modulation

Conversely, if the battery voltage decreases the RMS voltage will also decrease if the pulse width remains the same. In this situation, RMS voltage regulation may be achieved by increasing the pulse width (*Figure 3C*).

Increase and decrease of pulse width is accomplished by controlling the on-and-off time of the transistor switches. Realistically, there is a point where the zero time is no longer present as the pulse width is increased, and essentially a square wave is present. Beyond this point the RMS voltage becomes unregulated.

Modified square wave inverters are a great improvement over square wave types. They offer good voltage regulation, lower total harmonic distortion and better overall efficiency. Electric motors operate much better from a modified square wave and most electronic equipment will operate without problems. To measure the output voltage requires a true RMS reading meter. A standard meter will erroneously read voltages.

What an Inverter Can Power

An inverter can power a wide variety of appliances, motors, and other electrical devices. These have been categorized by the method the device employs to utilize electrical current, known as a *load*. The characteristics of three types of loads are discussed on the following pages: Resistive loads, inductive loads, and problem loads.

Resistive Loads

These are the loads that the inverter finds the simplest and most efficient to drive. Voltage and current are in phase (or, in this case, in step with one another). Resistive loads usually generate heat in order to accomplish their tasks. Toasters, coffee pots and incandescent lights are typical resistive loads. Larger resistive loads—such as electric stoves and water heaters—are usually impractical to run off an inverter. Even if the inverter could accommodate the load, the size of battery bank required would be impractical.

Inductive Loads

Any device that has a coil of wire in it has an inductive load characteristic. Most electronics have transformers (TV's, stereos, etc.) and are therefore inductive. Typically, most inductive loads are motors. The most difficult load for the inverter to drive will be the largest motor you manage to start.

With inductive loads, the rise in voltage applied to the load is not accompanied by a simultaneous rise in current. The current is delayed. The length of the delay is a measure of inductance. The current makes up for its slow start by continuing to flow after the inverter stops delivering a voltage signal. How the inverter handles current that is delivered to it while it is essentially "turned off", effects its efficiency and "friendliness" with inductive loads. The best place for this out-of-phase current is in the load, and Trace's "impulse phase correction" circuitry routes it there.

Inductive loads, by their nature, require more current to operate than a resistive load of the same wattage rating, regardless of whether power is being supplied by an inverter, a generator or a utility power grid. Induction motors (motors without brushes) require two to six times their running current on start-up. The most demanding are those that start under load e.g. compressors and pumps.

Capacitor start motors, typical in drill presses, band saws, etc., require two to four times their rated amperage in order to start the motor. Universal motors are generally easier to start. Since motor characteristics vary, only testing will determine if a specific load can be started and how long it can be run.

If a motor fails to start within a few seconds, or begins to lose power after running for a time, turn it off. When the inverter attempts to start a load that is greater than it can handle, it will turn itself off after about 20 seconds.

Problem Loads

Trace Engineering inverters can drive nearly every type of load. However, loads may behave differently with an inverter than with public power in special situations. Our experience, and the experience of many other inverter users, is provided herein. Due to the variety of load types and internal changes made to these loads by the manufacturer, Trace cannot be responsible for any loads that fail in your specific application.

Very small loads - If the power consumed by a device is less than the threshold of the search mode circuitry, it will not run. See the section on search mode operation for ways to solve this problem.

Fluorescent lights & power supplies - Some devices when scanned by the load sensor cannot be detected. Small fluorescent lights are the most common example. (Try altering the plug polarity-turn the plug over). Some computers and sophisticated electronics have power supplies that do not present a load until line voltage is available. When this occurs, each unit waits for the other to begin. To drive these loads either a small companion load must be used to bring the inverter out of its search mode, or the inverter may be programmed to remain at full output voltage. See the section on search mode operation.

Microwave ovens- Microwave ovens are sensitive to peak output voltage. The higher the voltage, the faster they cook. Inverter peak output voltage is dependent on battery voltage and load size. The high power demanded by a full sized microwave will drop the peak voltage several volts due to internal losses. Therefore, the time needed to cook food will be increased if battery voltage is low. Some microwave models may not operate at all. Try it before you buy it.

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. This may result in periods during which clocks keep time and then mysteriously do not. Most clocks do not draw enough power to trigger the load sensing circuit. In order to operate without other loads present, the load sensing will have to be defeated (see *Search Mode Control*). Clock accuracy is also affected by the accuracy of the generator.

Searching- If the amount of power a load draws decreases after it turns on, and if this "on" load is less than the load sensing threshold, it will be turned alternately on and off by the inverter.

Dimmer Switches- Most dimmer switches lose their ability to dim the lights and operate either fully on or off.

Rechargeable Devices- Sears "First Alert™" flashlights may fail when charged by the inverter. "Skil™" rechargeable products are also questionable. Makita™ products work well. When first using a rechargeable device, monitor its temperature for 10 minutes to ensure that it does not become abnormally hot. That will be your indicator that it must not be used with the inverter.

Laser Printers- While many laser products are presently operating from Trace Engineering inverters, and we have personally run a Texas Instruments Microlaser™ and HP IIP™, we have had reports of an HP III™ and a MacIntosh™ Laser Writer failing under inverter power. We do not recommend the use of laser printers with inverters.

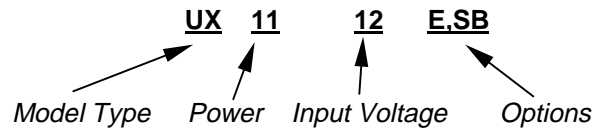
Electronics- AM radios will pick up noise, especially on the lower half of their band. Inexpensive tape recorders are likely to pick up a buzz. Large loads must not be started while a computer is operating off the inverter. If a load is large enough to require "soft starting" it will "crash" the computer, causing it to "reboot".

Low Battery Dropout - The inverter will turn off to protect itself if your battery bank cannot deliver the necessary amperage to drive a particular load without falling below the low voltage protection point for three seconds. With the inverter off, the battery voltage will rise and then it will resume operation.

Model Identification

Trace Engineering inverters are specifically designed to meet the growing demand for high-reliability, high-quality inverters and chargers for alternative energy systems and truck applications. This manual covers the UX, Truck, and Legend inverters with various options and configurations. To determine the model and features of your inverter, check the model number found on the identification placard on the inverter.

Consider the following model number for a unit with a UX1112 Model number:



Model Type: - Designates the use for which the particular unit is intended:

UX = Utility version inverters are designed for fixed residential alternative-energy installations (with or without photovoltaic applications) and are housed in a white enclosure;

T = Truck version inverters employ neutral ground switching and are housed in a gray enclosure;

L = Legend version inverters employ neutral-to-ground switching and are designed for recreational vehicle applications. They also have a white enclosure;

Power: The second and third (if used) positions in the model number indicate the continuous AC power output in hundreds of watts. Five hundred, 600, 1100, and 1400 watts are the currently available power levels. In the example above, 11 would stand for an 1100-watt continuous output inverter.

Input Voltage: The number 12 following the power rating indicates an inverter/charger that is designed to convert 12V_{DC} input to 120V_{AC} output, and charge 12V_{DC} batteries when powered by 120V_{AC}.

Options: The final one to three positions of the model number indicate the installed options, which are listed here:

E = Export model with 230 V_{AC}, 50Hz output .

SB = includes a built-in, three-stage standby battery charger (standard on the Legend version).

UX Model Applications

Models that begin with 'UX' and end with 'SB' are backup power systems in permanent structures such as homes and commercial buildings. These units are listed to UL1741 draft specification for residential and commercial photovoltaic applications.

T and L Models Applications

All models with a 'T' or 'L' designator are for use in mobile applications. They feature 120 volt AC, 60Hz output, and employ neutral ground switching. These units are designed to UL specification 458, for power inverters used in mobile applications. When used in some countries (such as Canada), you may be required to disable the neutral ground switching feature. Local and national electrical codes will govern installation techniques and requirements. See page 39, Disabling Neutral Ground Switching, for instructions on how to disable the neutral ground switching feature.

Serial Number

The unit identification placard on the front panel of the inverter/charger will show the serial number, model number, and options installed. You will find the serial number, model number and warnings on the identification and warning panel on the end plate of each unit.

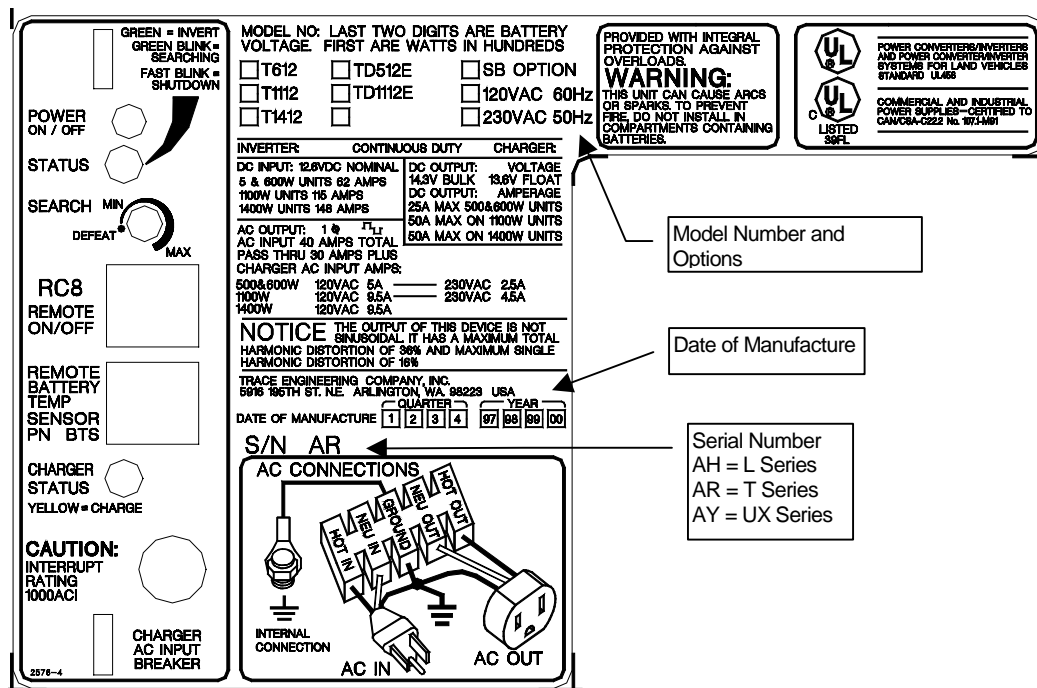


Figure 5, Unit Identification Panel

Features and Options

The UX, T and L series inverters are an advanced design with a combination of features not available on other products regardless of cost.

Extensive Protection Circuitry

The inverter is protected from high-battery, low-battery, over-temperature and over-heating conditions caused by overload or overcurrent. When the inverter senses one of these situations, it will protect itself by disconnecting from the loads, and will signal an error condition with rapid flashing of the green status LED.

The low-battery, high-battery, and over-temperature protection circuitry resets automatically. If an over-heating condition continues for more than 20 seconds, the inverter will shutdown and must be reset with the power button. If the error condition is remedied before the 20-second period has elapsed, the inverter will automatically reset.

Remember that if the inverter shuts down, it is for a reason, usually a result of too many loads. Reduce the loads and allow a cool-down period before attempting a reset. The optional charger will not operate in case of an over-heating condition and will begin the charging process anew.

Search Mode Circuitry

This circuit determines how much power the inverter draws when there are no loads. The inverter's transition from the no load state to full output voltage is fast, eliminating delays when operating devices such as hand tools. Additionally, the threshold sensitivity of the search mode is user adjustable, and it may be disabled.

Impulse Phase Correction

This circuitry improves the shape of the output waveform while the inverter is running reactive loads. It allows the inverter to closely duplicate the characteristics of standard public power. With this design approach, the limitations of the modified sine wave format are largely overcome. Impulse phase correction has many benefits. The primary benefit is realized when the inverter is running induction motors and fluorescent lights. Induction motors are commonly used to run drill presses, fans, bandsaws, and other common loads.

When an inductive load is driven, it tries to return a large portion of the energy that it has received. This returned energy can be thought of as going 'backwards' through the household wiring to the motor, giving the motor an extra push and making it run smoothly. Impulse phase correction provides a similar path for this 'backwards' energy. The UX, T, and L model inverters will run small motors at full speed, start larger ones, and run both efficiently.

True RMS Voltage Regulation

With battery voltages from 11 to 15 VDC and power levels up to the continuous power rating, **the inverter will deliver true RMS regulated power.** This insures that while battery voltages and power levels change, the inverter will deliver the correct output voltage.

Crystal Controlled Time Base

Proper frequency regulation is assured with the use of a crystal. Battery voltage, power, and temperature have no effect on the inverter's operating frequency.

Optional Standby Battery Charger

The Trace inverter features a three-stage Standby Battery Charger (SB) option that automatically recharges and maintains the system's batteries at full charge. This section describes three-stage charging and how to configure the charger for your battery bank.

Three-Stage Charging Process

The UX, L, and T model inverter/chargers feature a three-stage battery charging and maintenance program — Bulk, Absorption, and Float:

Bulk Stage: During the initial "Bulk Charge" stage, the inverter charges at a constant current. This causes the battery voltage to rise over time. When battery-bank voltage reaches the *Bulk Volts DC* setting, the charger starts the second or "Absorption" stage.

Absorption Stage: During this phase, the charge current gradually reduces while the battery voltage is held constant for two hours at the *Bulk Volts* charge voltage ($14.3 V_{DC}$ for sealed batteries, $14.7 V_{DC}$ for vented batteries). If the AC voltage drops below $90 V_{AC}$ during this stage, charging will be interrupted, and the charger will complete the remainder of the absorption charging period when voltage once again exceeds $90 V_{AC}$. This ensures that the battery will be fully charged.

Float Stage: At this point the battery voltage is allowed to fall to the *Float Volts DC* setting, where it is maintained until another bulk-charge cycle is initiated. This reduces gassing of the battery and keeps it fully charged. A new bulk-charge cycle is initiated when AC power is reapplied to the AC input terminals.

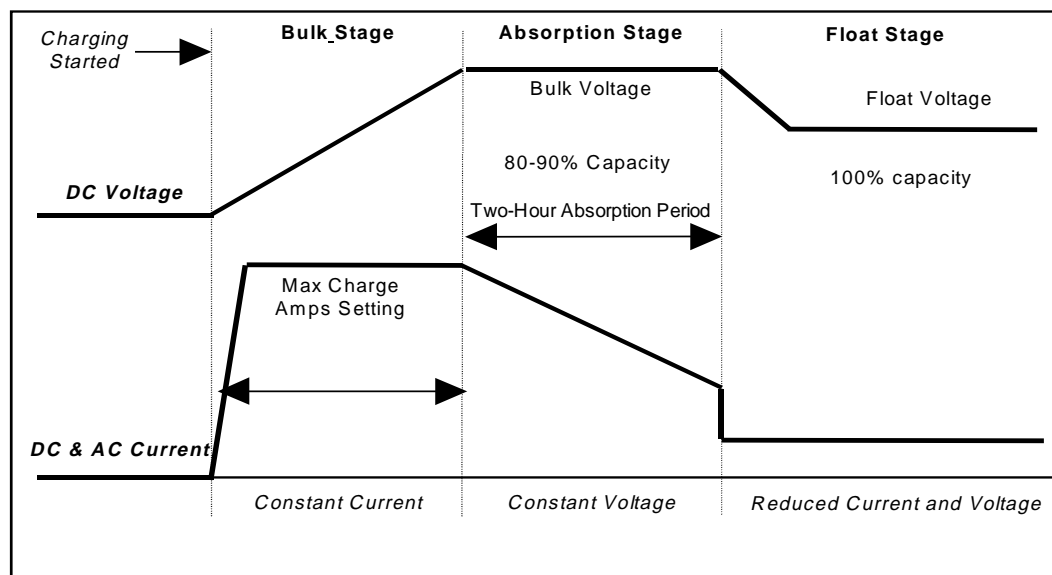


Figure 6, Battery Charging Cycles

Inverter-to-Charger Transition

On inverter models equipped the three-stage internal standby battery charger (Truck and Legend units), the battery charger and an automatic transfer relay allows operation as either a battery charger or an inverter (but not both at the same time). An external source of AC power (e.g., shore power, generator, and/or utility grid) must be supplied to the inverter AC input in order to allow it to operate as a battery charger. As long as AC power is supplied to the charger, it operates regardless of the position of the **on/off** switch. When operating as a charger, the inverter's AC output is provided by the external source (i.e. generator, shore, or public power).

The inverter automatically becomes a battery charger after a 10-second delay whenever AC power is supplied to it. This delay is built-in to provide time for a generator to spin-up to a stable voltage and avoid relay chattering.

The inverter's AC input connects internally to the inverter's AC output while in the battery charger mode. A 30 amp pass-through relay accomplishes this switching, protected by a 30 amp circuit breaker.

Transfer Switching Speed

Trace inverter/chargers are not specifically designed as uninterruptable power supply (UPS) systems, but their transfer time is usually rapid enough to prevent most computers from shutting down. This transfer time is typically 35 milliseconds from inverter to charger. When switching from inverter to charger, the inverter waits a minimum of 10 seconds to ensure the AC source is stable (generator up to speed), and then the transfer occurs in approximately 30 milliseconds. Several PC magazines have run tests indicating a transfer time up to 100 milliseconds will normally hold up the present generation of PC's.

Optional RC8 Remote On/Off

The optional RC8 remote On/Off control unit (illustrated in Figure 2, *RC8 Remote On/Off Front Panel*) duplicates the Power On/Off Switch on the inverter/charger. It connects directly to the port labeled "RC8 Remote" on the front of the inverter, using a standard telephone jack. Always use the remote cable provided with the RC8 because it is tin-plated stranded cable with gold-plated connectors.

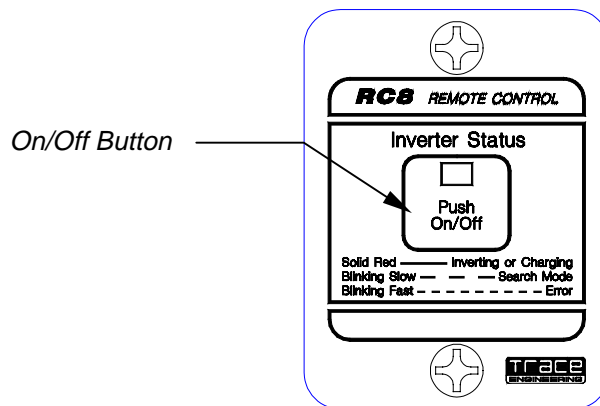


Figure 7, Front Panel of Optional RC8 Remote On/Off

The front panel of the RC8 also shows the status of several different modes of the inverter. The red LED on the front directly mimics the green LED on the inverter/charger. The following indications are shown by the RC8:

- **Steady Red:** Unit is in inverting.
- **Slow blinking Red:** Unit is in search mode
- **Fast Blinking Red:** Indicates error mode. An error condition means an over-heating, over-current, low battery, or high battery condition.

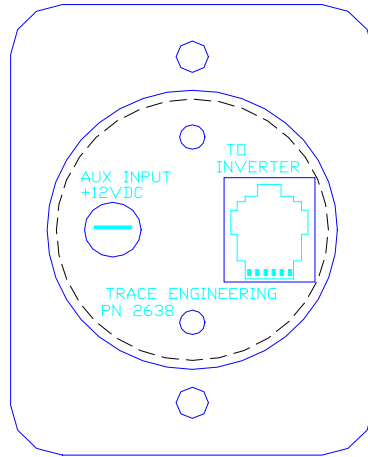


Figure 8, Back Panel of RC8 Remote

RC8 Remote Installation

Using the template provided in the back of this manual as a guide, cut a 1-7/8" diameter hole. At least 1½" of clearance is required behind the hole. Next drill the two holes needed to screw the installation to the wall. The back of the RC8 is shown in *Figure 8, Back Panel of RC8 Remote*. After routing the Trace remote cable, plug it into the phone jack on the back.

In some mobile installations it is desirable to turn the inverter on and off with the ignition switch. An example is a recreational vehicle equipped with a video camera for guidance when backing up. The camera operates from 12 V_{DC}, but the video monitor for the driver is 120 V_{AC}. If the inverter does not come on with the camera switch, the driver can not use the camera for backing up.

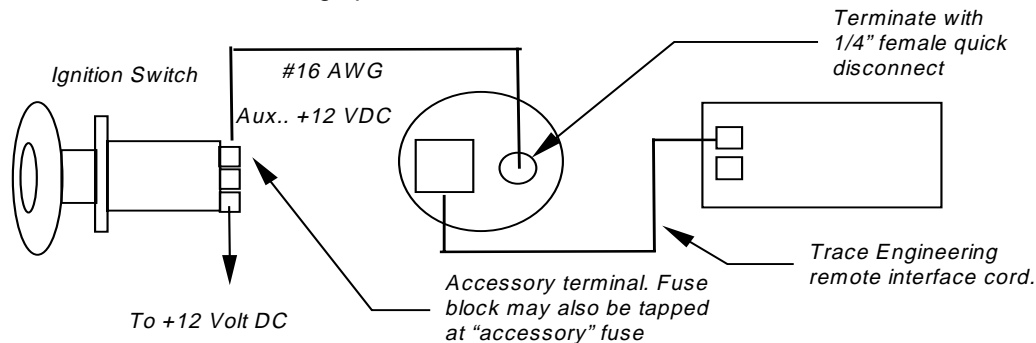


Figure 9, RC8 Installation with Auxiliary Power

In this situation a 12 V_{DC} wire must be run from the ignition switch (or fuse block) through the camera switch to the **Aux. Input +12V_{DC}** on the back of the **RC8**. Run this wire through an appropriately sized fuse. When the RC8 is powered by auxiliary power, the on/off switch on both the RC8 and the inverter will be inoperative. The camera switch becomes the primary power switch for the inverter. All other inverter functions remain unchanged, and the status LED on both the remote and the inverter will operate as before.

Optional External Battery Temperature Sensor

An optional plug-in external battery-temperature sensor (BTS) automatically fine-tunes the charging process of the charger. When the temperature sensor is installed, the inverter/charger adjusts the *BULK* and *FLOAT* charge voltage. A BTS is shown in *Figure 10, Optional Battery Temperature Sensor (BTS)*

If the temperature sensor is **NOT** installed, charger configuration must be manually set. See “*Configuring Your Charger*” section of this manual.

Install the BTS on the side of the battery below the electrolyte level. It is best if the sensor is placed between batteries and if the batteries are placed in an insulated box to reduce the influence of the ambient temperature outside the battery enclosure. Ventilate the battery box at the highest point to prevent hydrogen accumulation.

The optional BTS battery temperature sensor is required by UL Standard 1741(draft) and approval is based on its installation. The BTS provided may be extended an additional 20 feet by using a standard phone cable with RJ-11 plugs.



Figure 10, Optional Battery Temperature Sensor (BTS)

Operating the Inverter

This section describes the operation of the Trace inverter/chargers. The controls on the inverter are very straightforward. They operate exactly as marked on the placard with only a couple of idiosyncrasies.

Control Panel

The figure below shows the control panel, located on the left side of the inverter's front panel.

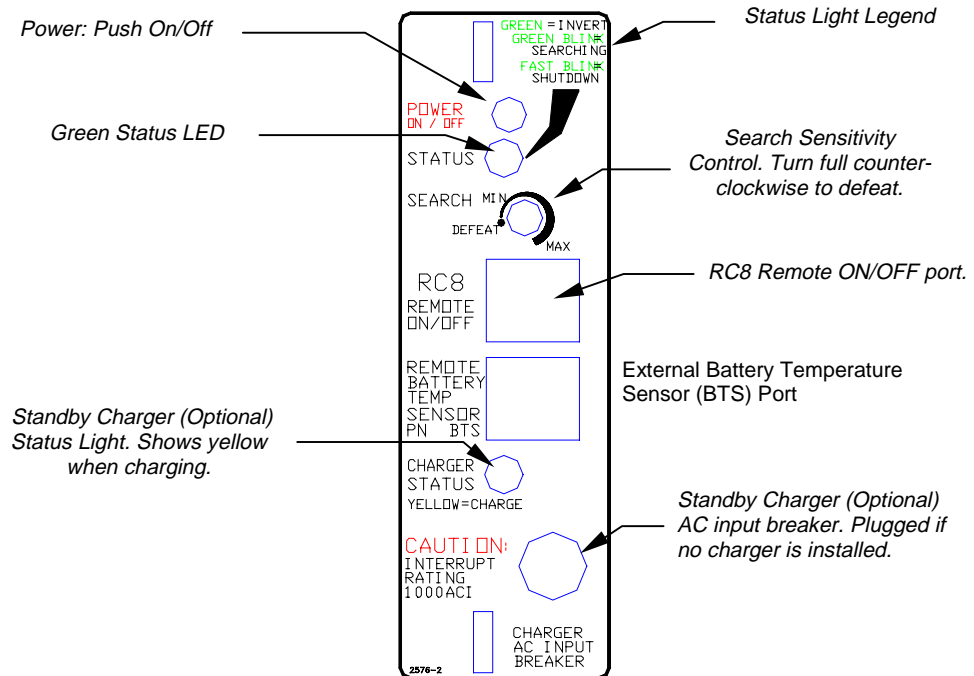


Figure 11, Control Panel

All the information needed to monitor and operate the inverter/charger is listed graphically on the control panel. If the unit does not have the optional standby three-stage battery charger, the charger status light and AC input breaker holes will be plugged.

Power ON/OFF Button

This button turns the inverter on and off: **on initial power up press it twice**. The on/off button also resets the inverter in the event it shuts down completely due to a fault condition. To reset the unit after a fault condition, press the on/off button only one time. The on/off button turns off only the inverter portion of the unit. Anytime AC input power is present, the battery charger section (if installed) will be operable.

Green Status LED

- **Steady Green:** Unit is in inverting.
- **Slow blinking Green:** Unit is in search mode
- **Fast Blinking Green:** Indicates error mode. An error condition means a low-battery, high-battery, over-heating or over-current condition.

Search Sensitivity Control

The knob labeled **Search** sets the threshold (in watts) that will bring the inverter out of search mode. Turning the knob full counter-clockwise to “Defeat” disables the search mode. The adjustment range is 5 to 100 watts (See “*Search Sense Mode*” on this page).

Yellow Status LED

If your unit is equipped with the optional Standby Charger, this yellow LED will be lit when the unit is charging. The greater the charging current, the brighter the LED will shine. When battery voltage is far below full charge, the LED will glow brightest. When the LED is not lighted, battery voltage is higher than both the Absorb and the Float voltage charging threshold or another charger is connected in parallel with the unit.

ON/OFF Control

The Power On/Off button on the control panel of the inverter/charger turns it on and off. **On initial power up it must be pressed twice before the inverter will supply power.** The on/off button also resets the inverter in the event it shuts down completely due to a fault condition. When resetting a fault the on/off button need be pressed only once. The on/off button shuts off only the inverter portion of the unit. Anytime AC input power is present, the battery charger section (if installed) will be operable.

Search Sense Mode

The inverter incorporates a power-saving “Search Sense Mode” that minimizes power drain when there is no load connected by reducing the inverter’s output to brief test pulses. When a load exceeding the threshold you specify on the control panel is detected, the inverter’s output goes to full voltage. The sensitivity threshold is adjustable from about five watts to 100 watts. When the inverter is in search mode, the LED will show a slow flashing green.

Search Control Knob: The control panel knob labeled “Search” sets the sensitivity level in watts that will activate the inverter. Turn the knob full counter-clockwise to “Defeat” to disable the search mode. The adjustment range is from five to 100 watts.

Operation

While idling in the Search Sense mode, the inverter sends out a pulse about six times per second. This electrical pulse travels through the AC wiring “looking” for loads that are connected to the system. When a load is detected, the inverter logic determines the wattage of the load and checks to see if it is greater than the threshold set by the operator. This threshold point is adjustable with the Search Control knob on the control panel. The lowest setting is about five watts and the highest setting is 100 watts.

For example: when the search sensitivity threshold is set at 40 watts, and no loads are present that are 40 watts or greater, the inverter will “ignore” any loads less than 40 watts and remain in idle mode. When a load greater than 40 watts appears, the inverter comes out of idle mode and applies power to the load.

The Search Sense mode may be disabled by turning the Search Control knob counter-clockwise all the way to “Defeat.” The inverter will now remain at full output voltage at all times.

Benefits

Search Sense allows you to selectively operate only loads that draw more than a specified amount of power, which means power savings. An inverter consumes about five watts without-load idle power consumption of five watts. The inverter needs five watts to power itself, even when there is nothing to power.

For example: if a water pump is driven by an inverter for only one hour each day, the other twenty-three hours of the day the inverter is consuming five watts per hour just doing nothing. This power comes from the batteries. By setting the search sensitivity so that the inverter idles until the water pump tries to run, power savings are realized.

Instead of idling at five watts, the inverter consumes only one-half watt while in search mode. This is a savings of $4\frac{1}{2}$ watts every hour, or 108 watt-hours per day. This converts directly to 8.6 amp-hours for a 12 V_{DC} battery system. In systems with small batteries or limited charging capability, this is a substantial savings.

Problem Loads

Some loads can “fool” the Search Sense mode, causing the unit to cycle on-and-off, or not to turn on at all.

Incandescent Lights: Incandescent lights have a higher starting-wattage when the filament is cold than the continuous rating of the bulb. For example: if the inverter is set to sense a 40 watt load, and a 30 watt bulb is turned on, the inverter will initially sense a load because the bulb's cold-starting wattage will exceed the 40-watt threshold. When the bulb warms-up, it will draw less than the threshold wattage, the inverter will revert to idle mode and the light will go off. When the light cools, its load will again exceed the threshold, and the cycle will repeat.

Fluorescent Bulbs: These work the opposite of incandescent light bulbs. If the inverter is set to detect a 30 watt load and a 40 watt fluorescent light is switched on, the inverter will not detect it because fluorescent tubes draw less than 30 watts until the gas in the tube ionizes.

Other loads: Some appliances draw power even when turned off. Examples of this are television sets equipped with instant-on circuits, microwaves equipped with digital clocks, VCR's, and other clocks. If the search sensitivity threshold is set higher than the combined loads, an auxiliary load must be used to bring the inverter out of search mode before the appliances will turn on.

If the sensitivity threshold is set lower than the combination of the loads, the loads will remain on continually, and excess battery drain will occur. Three such 15-watt loads would consume additional 90 amp-hours per 24 hours in a 12V_{DC} system. Some alternatives are: turn the item off at the wall, use an extension cord equipped with an on/off switch, place an on/off switch at the outlet, or install an appropriate circuit breaker.

Confirming Search Mode Operation

A neon-type night light can be used as a test indicator to show whether the inverter is searching for loads. Plug the night light into the wall, if the inverter is in search mode the light will blink, showing the search pulses sent out by the inverter. If the inverter is running a load, the light will be on continuously because continuous power is being delivered to a load. A typical incandescent night light may also work to show the pulses, but it will use more power.

Setting Up Search Mode

The Search Sense feature significantly reduces battery drain only when the inverter spends a fair amount of time “sleeping” each day. Therefore, if Search Sense is to be utilized it must be adjusted properly. The initial adjustment should be made so that the inverter comes on only when needed.

Determine the smallest load that you want to trigger the inverter out of Search mode. Turn the sensitivity control all the way to the lowest setting, turn on the desired load, and turn the sensitivity up until the load just turns on (if loads change significantly, re-tuning of the search sensitivity will be necessary).

Some TV's have a menu or control to disable instant-on circuits. If clocks are a problem load, use battery powered units. A solution might be to place all problem loads on one circuit with one master disconnect.

If problem loads can't be eliminated, disable the Search Sense mode and the inverter will always remain at full output voltage.

Configuring Your Charger

If your inverter includes a Standby Battery Charger, it is equipped with three jumpers used to control charger operation. To locate these jumpers, first remove the inverter cover by removing four Phillips-head screws on the top cover and one on the back cover above the ventilation slots. The jumpers are close to the top of the circuit board near the front of the unit. These jumpers are located on the main circuit board (see photo on following page), and are labeled Sealed, Deep, and UPS.

Sealed: If you are installing sealed batteries, the jumper remains across this pair of pins. This selection sets the charge rate to 14.3 V_{DC} in the Bulk stage and 13.6 V_{DC} in the float stage. For vented batteries, remove the jumper across these pins to set the charge rate to 14.7 V_{DC} and 13.3 V_{DC} respectively.

Deep: This pair of pins controls the amount of allowable battery discharge. When the jumper connects these two pins, the inverter will allow the batteries to discharge until completely drained. When not installed, the inverter will not allow the batteries to be discharged below 11.8 V_{DC} for more than five minutes (in order to ensure starting-battery capacity).

UPS: This pair of pins controls the sensitivity of the charger to variations in voltage from the AC source. When a jumper connects these two pins, the charger will stop charging and the inverter will provide AC power within 35 milliseconds or less of an AC voltage drop to below 85-90 volts. With the jumper removed, the shift from charger to inverter will be delayed at least 200 milliseconds to allow AC voltage to return to normal. If AC voltage does return to normal within this period, the charger will disengage and the inverter (when turned on) will provide AC power from the batteries. This prevents the charger from disengaging unnecessarily due to poor quality voltage. For generator charging, do not connect these pins..

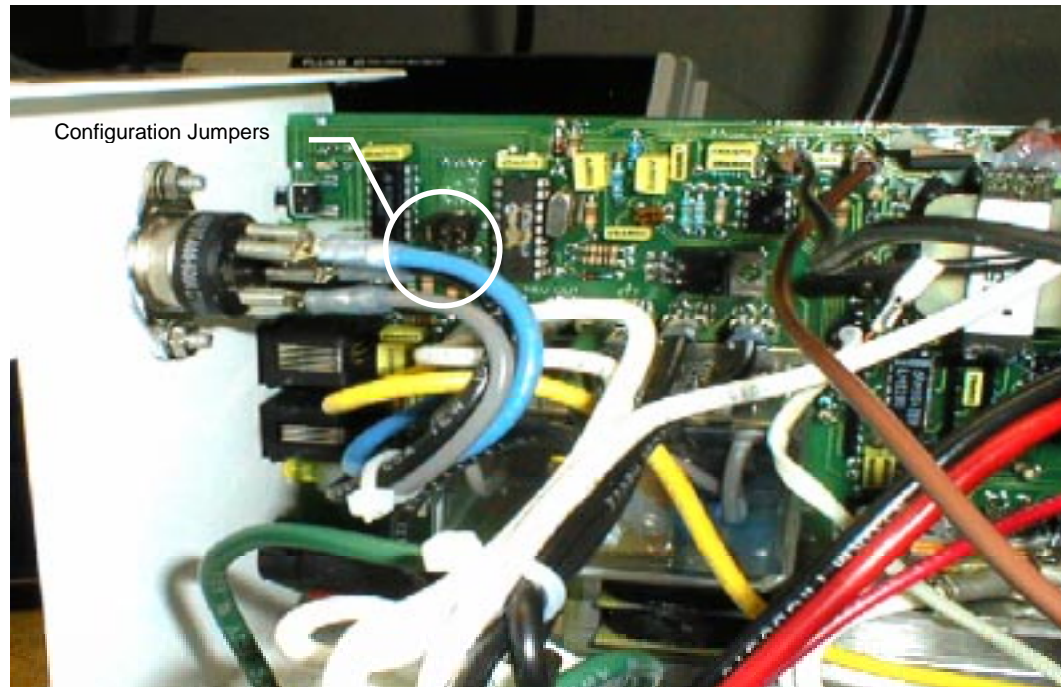


Figure 12, Charger Configuration Jumpers

Battery Charger LED Indicator

A yellow LED located on the lower control panel reports the status of the battery charger.

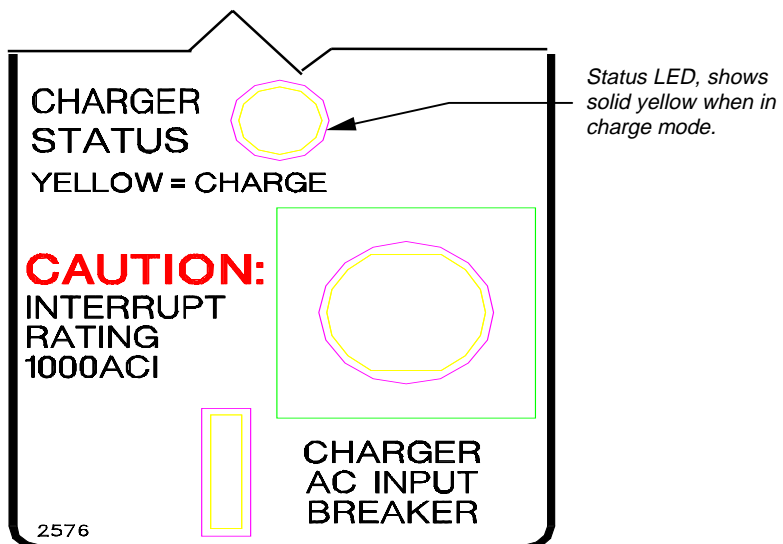


Figure 13, Charger Status LED

Yellow Status LED

This yellow LED will be lighted when the unit is charging. The greater the charging current, the brighter the LED will shine. When battery voltage is far below full charge, the LED will glow brightest.

When the LED is not lighted, battery voltage is higher than both the Absorb and the Float voltage charging threshold, or another charger is connected in parallel with the unit.

Generator Requirements

The maximum charge rate of the battery charger is dependent upon the peak AC voltage available. Because this type of battery charger uses only the peak part of the input sine wave, small variation in peak voltage result in large variations in the amount of energy available to the charger. The charger's output is rated on the basis of typical public power input which has a peak voltage of approximately *164 VAC (116 RMS).

It takes a powerful AC generator set to maintain the full 164 volt peak while delivering the current necessary to operate the charger at its maximum rate. Smaller generators will have the tops of their waveform clipped under such loads. Running at these reduced peak voltages will not harm the charger, but it will limit the maximum charge rate. Large auxiliary AC loads may provoke this problem.

* 325VAC (230 volts RMS) for export models.

All About Batteries

Batteries come in different sizes, types, amp-hour capacity, voltages, and chemistries. There are nearly as many descriptions of exactly how batteries work as there are people willing to offer explanations. Before designing your battery-bank, you need to understand some basic battery concepts and terminology. First, read the battery terminology section to familiarize yourself with important terms and concepts.

Battery Terminology

A description of battery charger operation requires the use of terms with which you may not be familiar. The following terms appear in the description of batteries and battery charger operation.

- **Electrolyte:** Typically a mixture of water and sulfuric acid, it is commonly referred to as battery acid.
- **Plates:** Originally made of lead, now fabricated from lead oxide. Plates connect to the battery terminals and collect current. There are several plates in each cell, each insulated from the other by separators.
- **Sulfating:** As a battery discharges, its plates become covered with lead sulfate. During recharging, the lead sulfate leaves the plates and recombines with the electrolyte. If the lead sulfate remains on the plates for an extended period of time (over two months), it hardens, and recharging will not remove it. This reduces the effective plate area and the battery's capacity.
- **Stratification:** Over time, a battery's electrolyte (liquid) tends to separate. The electrolyte at the top of the battery becomes watery while at the bottom it becomes more acidic. This effect is corrosive to the plates.
- **Deep Cycle:** A deep cycle occurs when a battery is discharged to less than 20% of its capacity (80% depth-of-discharge).
- **Temperature Compensation:** Peak available battery voltage is temperature dependent. As ambient temperatures fall, the proper voltage for each charge stage needs to be increased. An optional temperature-probe (BTS) automatically re-scales charge-voltage settings to compensate for ambient temperatures. The compensation slope based on cell voltage is -2.17mv per degree Fahrenheit per cell (30mv per degree Celsius) for 12 volt systems.

Selecting the Best Battery

There are many types and sizes of batteries available, including starting, deep-cycle, sealed gel, and absorbed glass mat. Which battery is best for your installation depends upon your unique circumstances. In order to help you choose, a discussion of these types of batteries is found in this section.

Starting Batteries

Starting batteries are designed for high cranking power, not deep cycling. Don't use them. No damage to the inverter will occur if you do; they simply will not last long in a deep-cycle application. The way starting batteries are rated gives a good indication of their intended use. The "Cold Cranking Amps" rating is a measure of the amperage output that can be sustained for 30 seconds. Starting batteries use lots of thin plates to maximize the surface area of the battery. This allows very high starting current but lets the plates warp when the battery is cycled.

Deep Cycle Batteries

This type of battery is best suited for use with inverters because they tolerate a greater depth-of-discharge before being recharged. Although they are available in many sizes and types, the most common type is the non-sealed, liquid-electrolyte battery. Non-sealed types have removable cell caps for monitoring the electrolyte level. When a cell is low, add only distilled water. Check the electrolyte level at least monthly. Top-up after recharging.

The most common deep-cycle battery is used in boats and motor homes. Typically called "Group 27" batteries, they are 12 volt batteries rated at 80 to 100 amp-hours and are only a little larger than ordinary "Group 24" car batteries. Often the deep-cycle claim is over-stated. They do work better than the average car battery, but are not recommended for most systems.

Another popular and inexpensive deep-cycle battery is the six-volt "golf cart" battery rated at 220 amp-hours. These can be cycled repeatedly to 80% of their capacity without damage. This is the minimum quality of battery that can be used in normal applications with inverters having the designator after the model number.

Some systems use the L16 type of battery: six-volt batteries rated at 350 amp-hours available from a number of manufacturers. At 17 inches in height and up to 130 pounds each, they may be difficult to place in or marine installations.

Type 8D batteries are available in either starting or deep-cycle construction. Most common are the starting version used to start very large truck engines. Make sure you purchase the deep-cycle version. These deep-cycle versions are 12-volts and are rated at 200 amp hours or so. Type 4D batteries are very similar in construction, but about one-third smaller.

Sealed Gel Cell

The sealed gel cell batteries do not use battery caps because the electrolyte is in the form of a gel. This allows the batteries to be mounted in any position without spilling. Other advantages are: no maintenance, long life (800 cycles claimed), and low self-discharge. The disadvantage is high initial cost and the possibility of damage from overcharging. There are many manufacturers of quality vented batteries, but only a few manufacturers of suitable gel cells.

Don't confuse sealed batteries with maintenance-free batteries - the latter are typically standard liquid electrolyte batteries with no caps for adding water; when the electrolyte gets low you replace the battery.

Absorbed Glass Matt

Absorbed glass mat (AGM) batteries are similar to gel cells and may be used in inverter applications.

Care and Maintenance

If you have read the battery charger section of this manual, you already have a good idea of the three stages of battery charging that promote fast charging and ensure long battery life. To properly care for your batteries, consider these charger parameters:

Battery Charge Rate

- **Charge Rate** - The maximum safe charge-rate is related to the size and type of your batteries. Charge standard vented lead-acid batteries (with battery caps) at a high rate - equal to their capacity. Smaller batteries may require a lower charge rate. Check with the battery manufacturer.

- **Float Voltage** - Batteries produce less gas when maintained at a lower voltage than the voltage at which they are charged. This *float* voltage must be manually selected for the specific battery type using the internal voltage adjustment described in “*Configuring Your Battery Charger*.”

Monthly Maintenance

Check the level of the electrolyte in each battery at least once a month. It must be above the top of the plates, but not completely full. Most batteries have a split plastic cup under the caps, which the electrolyte should just touch when full. Don't overfill the batteries, or the electrolyte will spill out of the batteries when recharging. Refill batteries with distilled water only - “spring” water and regular tap water may have high levels of minerals that can poison the battery chemistry and reduce battery life.

Check the battery cable connectors for tightness and corrosion. To remove corrosion, disconnect the cables and carefully rinse with a mild solution of baking soda and water. **DO NOT ALLOW THE SOLUTION TO ENTER THE BATTERY.** Rinse the top of the battery with clean water when finished.

Remove stubborn corrosion with a wire brush or brass wool. Any automotive parts store will have a wire brush tool specifically designed for cleaning cable lugs and battery terminals.

To prevent corrosion from forming on the battery terminals and cable lugs, coat them (only after installing the cables) with a thin layer of petroleum jelly or anti-corrosion grease available from any auto parts store or battery supplier. Do not apply any material between the terminal and the cable lugs - the connection must be metal-to-metal. Apply the protective coating only after the bolts are tight.

Battery Bank Installation

This section discusses the elements of designing and installing a battery-bank appropriate for your inverter/charger system. Among the considerations are: estimating battery requirements; battery size; cable size, length, and position; enclosures; temperature control; and battery hook-up configuration.

CAUTION: Batteries can produce extremely high currents if they are short-circuited. Be very careful when working around them. Read the important safety instructions at the front of this manual, and the battery suppliers precautions before installing the inverter and batteries.

Location

Batteries must be located in an accessible location with nothing restricting the access to the battery caps and terminals on the tops. At least two feet (6.5m) of clearance above is recommended. They must be located as close as possible to the inverter, but can not limit access to the inverter and the inverter's over-current protection device.

When installed in a vehicle, an over-current protection device (fusible link) must be located per United States National Electric Code (NEC) 551-10(e)(4), within 18"(45.7cm) of the battery installation, and must be covered to prevent possibility of a short circuit. Trace produces several fuses that meet this requirement (see page 33).

If the inverter is located in a residential or commercial building, the batteries must be located where venting to the outside can be easily accomplished, and where spills can be easily contained.

Enclosures

Whether in a vehicle or building, batteries must be protected by a ventilated enclosure. The enclosure must be ventilated from the highest point to the outdoors in order to prevent accumulation of hydrogen gas, which is released in the battery charging process. An air intake must also be provided at a low point in the enclosure in order to allow air to enter the enclosure to promote good ventilation. For most systems, a one-inch (2.5cm) diameter vent pipe from the top of the enclosure is adequate to prevent accumulation of hydrogen. Sealed batteries do not require ventilated enclosures.

Temperature Control

The effective capacity of a battery is reduced when cold. This phenomenon is more significant with lead-acid type batteries than with alkaline types. When the internal temperature of a lead-acid battery is 32°F (0°C), the capacity may be reduced by as much as 50%. If extremely cold temperatures are expected, consider either heating the equipment room or using alkaline batteries.

If the battery-bank is located in an unheated space, an insulated enclosure is highly recommended. Batteries release heat during charging due to the internal resistance of the battery. If the batteries are insulated, this heat can be retained to keep them warmer, substantially increasing performance. Insulated battery enclosures maintain consistent temperatures of the individual battery cells, prevent unequal charging (some cells overcharged – others undercharged) which leads to premature battery failure.

Batteries must also be protected from high ambient temperatures, solar heating of the battery enclosure, or heat released by a generator or other heat-producing device in close proximity. High battery temperatures will result in short battery life. Avoid high temperatures by ventilating the enclosure and reducing the external heat sources with shade and insulation.

Cabling

Connect individual batteries together with large cables to make a battery “bank.” The actual size of the cable depends upon whether the batteries are connected in parallel or in series. Batteries connected in parallel require larger. Generally, battery cables must not be smaller than battery-bank to inverter cables. If the main cables are 0000 AWG (107.2mm²), battery interconnects must also be 0000 AWG (107.2mm²).

When connecting smaller batteries together to create a battery-bank, first connect the batteries in series, then in parallel - a configuration often called “cross-tying” (See the *Hook-up Configuration* section below). Cross tying requires additional cables, but reduces imbalances between the batteries and improves the overall performance. Consult your battery supplier for more information regarding the hook-up configuration required for your system.

Sizing

Batteries are the inverter’s fuel storage devices. The larger the batteries, the longer the inverter can operate before recharging is necessary. An inadequate battery-bank results in reduced battery life and disappointing system performance. Batteries must not be discharged to more than 50% of their capacity on a regular basis. Under extreme conditions, cycling to a discharge level of 80% is acceptable. Totally discharging a battery will result in permanent damage and reduced life. In addition, the built-in charger cannot charge a battery that is under six volts.

Estimating Battery Requirements

To determine the proper battery-bank size, compute the number of amp-hours that will be used between charging cycles. When the required amp-hours are known, size the batteries at approximately twice this amount. Doubling the expected amp-hour usage ensures that the batteries will not be overly discharged and extends battery life. To compute total amp-hours usage, the amp-hour requirements of each appliance that is to be used are determined and then added together.

Compute your battery requirements using the nameplate rating of your appliances. The critical formula is **WATTS = VOLTS X AMPS**. Divide the wattage of your load by the battery voltage to determine the amperage the load will draw from the batteries:

$$\text{load watts} \div \text{battery voltage} = \text{amperage}$$

Example 1: 1000 watts (load) \div 12 V_{DC} = 83 A_{DC}

Multiply the DC amperage (A_{DC}) by the number of hours the load will operate to find amp-hours:

$$(\text{amperage}) \times (\text{hours}) = \text{amp-hours}$$

Example 2: 83A_{DC} X 6 hours = 498 amp-hours

Assuming inverter efficiency is 90%, multiply the load by 110% to determine the actual watts used. Load watts (1000) are multiplied by 110% to arrive at a more accurate true load of 1100 watts. Using this figure to determine load amps, the result will be 92 amps DC (92A_{DC}).

Now use this result to determine the load amp-hours: 92A_{DC} X 6 hours = 552 amp-hours

Electric motors are usually rated by *operating* amperage rather *starting* amperage. Starting amperage may be three to six times the amperage required to run the motor. Manufacturer’s literature may provide more accurate information than the motor nameplate.

If large motors will be started, increase the battery size to allow for the high demand that start-ups require. Follow the procedure described above for each item you want to use with the inverter. Add the resulting amp-hour requirements to arrive at a total. The minimum properly sized battery-bank will be approximately double this amount. This will allow the batteries to be cycled only 50% on a regular basis.

Hook-up Configurations

Large battery banks are created by connecting several batteries together. There are three basic configurations:

Parallel Configuration: In this configuration, all the positive terminals of the batteries are connected together, and all the negative terminals are connected together. This configuration is usually used only with 12 volt systems. Each battery in this installation has 100 amp-hours capacity at 12 V_{DC}. By connecting them in parallel, the battery-bank capacity grows to 400 amp-hours.

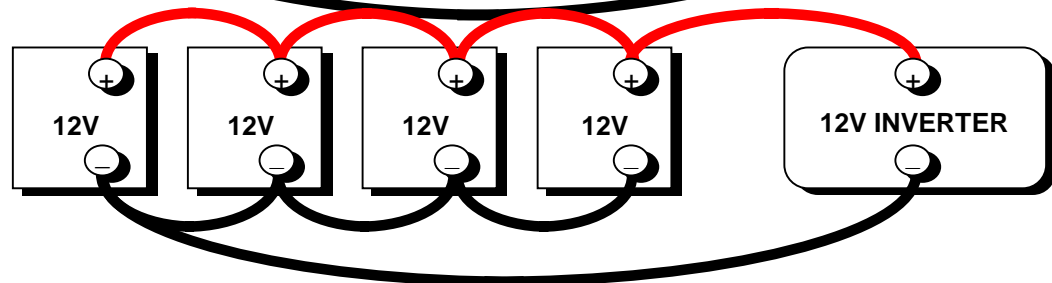


Figure 14, Parallel Hook-up Configuration

Series Connection

When the positive terminal of one battery is connected to the negative terminal of the next, they are connected 'in series.' In this configuration, the battery-bank has the same amp/hour rating of a single battery, but an overall voltage equal to the sum of the individual batteries. This is common with 24 volt or higher battery-inverter systems. By connecting the batteries in series, the voltage increases four-fold, while the amp-hour capacity is constant.

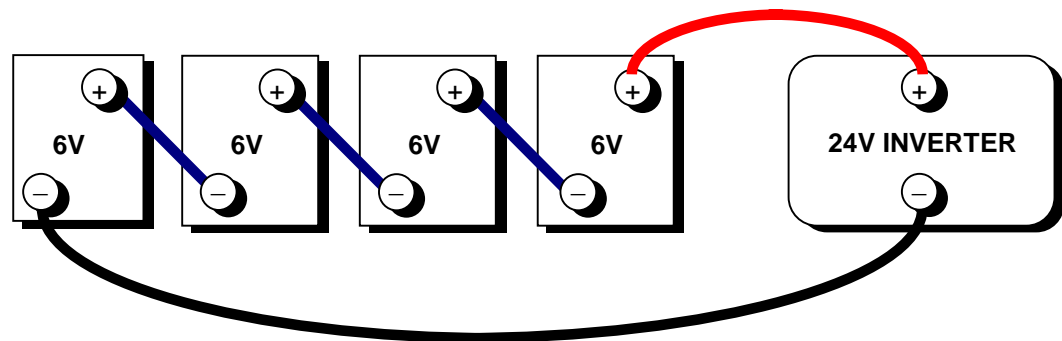


Figure 15, Series Hookup Configuration

Series - Parallel Connection

When pairs of batteries that are connected in series are then connected in parallel, they are connected in series-parallel. The result is an increase in both the voltage and the capacity of the total battery bank. This creates a larger, higher-voltage battery-bank out of several smaller, lower-voltage batteries – a common practice in all battery-inverter systems. In the illustration below, each battery in the bank has 100 amp-hours capacity at 6 V_{DC}, yet the battery-bank will have 400 amp-hours capacity at 12 V_{DC}.

Figure 16, Series-Parallel Hook-up Configuration

Installing the Inverter

This section discusses considerations regarding the mounting, location, environment, and hook-up of your inverter/charger installation. An overview for experienced installers precedes the detailed step-by-step instructions which everyone should read to prevent irreversible damage to the equipment caused by incorrect installation, which is not covered by the warranty.

Environment

Inverters are sophisticated electronic devices and must be treated accordingly. When selecting the operating environment for the inverter, don't think of it in the same terms as other equipment that works with it: e.g. batteries, diesel generators, motor generators, washing machines, etc. An inverter is a highly complex electronic device. Genetically speaking, it is a cousin to stereo equipment, television sets, and computers.

The use of conformal-coated circuit boards, tin-plated copper bus bars, powder-coated metal components, and stainless-steel fasteners improves tolerance to hostile environments. In a condensing environment (one in which humidity and/ or temperature change cause water to form on components) all the ingredients for electrolysis are present: water, electricity and metals. In a condensing environment, the life expectancy of the inverter is indeterminate and the warranty is void.

Location

Caution: It is in your best interests to install the inverter in a dry, protected location away from sources of high temperature 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 cables short. However, **do not** locate the inverter in the same compartment as non-sealed batteries.

Batteries generate hydrogen sulfide gas which is very corrosive to electronics equipment - and everything else. They also generate hydrogen and oxygen. If accumulated, this mixture can be ignited by an arc caused by the connecting of battery cables or the switching of a relay.

Mounting

Mounting the inverter in a ventilated enclosure with sealed batteries is acceptable. Do not mount the inverter in a closed container. To operate at high power for sustained periods of time, unrestricted air flow is required. Without it, the protection circuitry will activate and reduce the maximum power available, or cause complete shutdown of the inverter.

UL standards require the inverter to be mounted on a flat surface (on a shelf), or with the vent holes on the top if the unit is mounted on a wall or bulkhead. The purpose of this requirement is to orient the inverter so that its bottom has no holes that will allow burning material to be ejected in the event of an internal fire. **Do not** mount the inverter on flammable backings (such as plywood), or place flammable objects or materials on or near the inverter.

AC Wiring

Overview

The National Electrical Code (NEC) defines the standards for AC and DC installation wiring, but there are still many installation variables. Most are determined by the level of automatic switching desired and the amount of external AC power to be switched.

AC Connections

Installation must be done by a qualified electrician. Consult local code for the proper wire sizes, connectors, and conduit. The NEC requires that an external disconnect switch be used in the AC input wiring circuit. The AC breakers in a sub panel will meet this requirement.

The AC terminals are located on the same end of the chassis as the control panel. A five-station terminal block is provided to make the AC connections. The terminal block is labeled on the inverter also. Used it to hardwire the AC input and AC output. Some inverters do not utilize all five terminals. On standard models, the terminal block is used only for hardwiring the inverter's AC output. With the standby option, the terminal block is also used to hardwire the AC input.

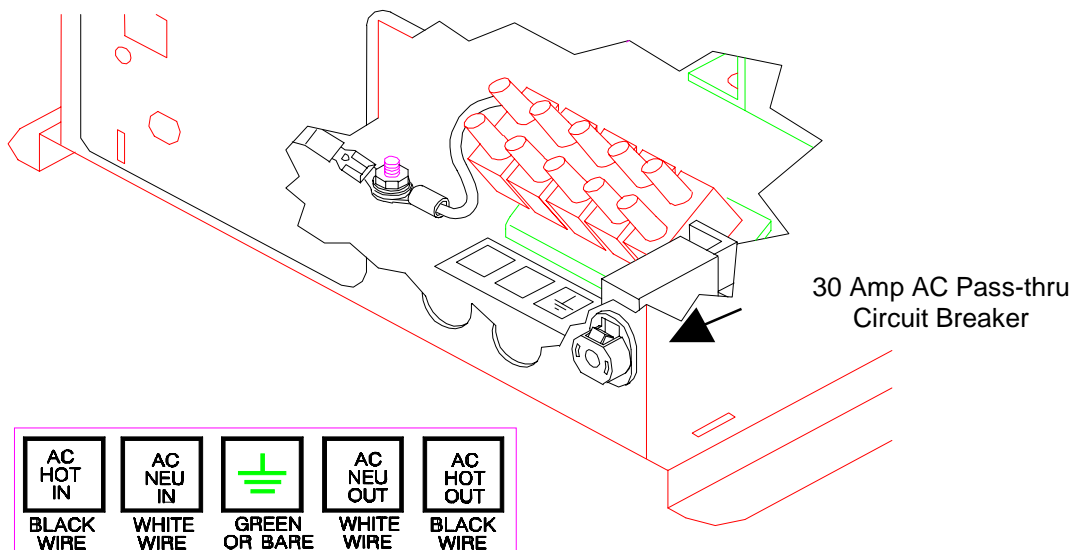


Figure 17, AC Wiring Connections

Procedure

Step 1 - Disconnect the inverter from the battery.

Step 2 - Feed the wires through the connectors on the front panel of the inverter's case. Strain relief's can be replaced with conduit fittings.

Step 3 - Following the wiring guide located immediately to the left of the AC wiring compartment cover plate. Connect the AC sub-panel servicing the AC loads to the AC Hot Out, AC Neutral Out, and Ground with the hot (black) and neutral (white) wires respectively to the terminal block and tighten securely. Models with the T or L before the number have built-in ground switching as required by NEC code. For use in countries such as Canada, the ground switching must be disabled per Canadian Code. This is covered on Page 39.

Step 4 – (Standby Option only) Connect the Safety (green) , Hot (black), and Neutral (white) wires from the AC Input (utility, generator, etc.) to the terminal block and secure tightly.

Step 5 - Replace the cover using the two #12 sheet metal screws to secure the AC front panel.

Table 1 , Minimum Recommended Wire Sizes

MODEL	AC INPUT (with charger)		AC OUTPUT	
	120 VAC	220-240 VAC	120 VAC	220-240 VAC
500 WATT	N/A	14 gauge	N/A	14 gauge
600 WATT	10 gauge	N/A	14 gauge	N/A
1100 WATT	10 gauge	14 gauge	14 gauge	14 gauge
1400 WATT	10 gauge	N/A	10 gauge	N/A

CAUTION: To reduce the risk of fire, use only input circuits provided with 40-ampere branch circuit protection in accordance with the National Electrical Code, ANSI/NFPA 70.

Important Precautions

The output side of the inverter's AC wiring must never be connected to public power or a generator. This condition is far worse than a short circuit. If the unit survives this condition, it will shut down until corrections are made. Installation must also ensure that the inverter's AC output is not connected to its AC input at any time. Review the installation diagrams in Appendix A before you start making connections.

Ground Fault Interrupting Outlets (GFI's)

Trace Engineering has tested the following GFI's and found them to work satisfactorily with our inverters:

LEVITON	6599
PASS & SEYMOR	1591RI 4A957
ACE Hardware	ACE 33238

Check with NEC and/or local codes to determine where or if ground fault interrupting outlets are required.

DC Wiring

Safety Instructions

WARNING: THE INVERTER IS NOT REVERSE POLARITY PROTECTED!

If the positive terminal of the battery is connected to the negative terminal of the inverter, the result will be instant failure of every power transistor. To compound your misfortune, this type of failure is obvious, and *is not covered under the warranty*. **Pay** close attention and double-check when making the battery connections.

The inverter's maximum peak current requirements are high. If battery cables are too small and/or connections are loose, efficiency and maximum output power are degraded. Small cables or loose connections can also cause dangerous overheating of the wire and/or terminals. Make the battery cables as large and as short as possible.

Tape the battery cables together. This reduces the inductance of the wire resulting in a better waveform and less current in the inverter's filter capacitors. Code your battery cables with colored tape or heat shrink tubing. Cable ends must have crimped and/or soldered copper ring lugs, or aluminum mechanical lugs.

Cable Sizing

The bigger the battery cables the better. Undersized cables result in additional stress on the inverter, lower efficiency, reduced surge power, and lower peak output voltage. Don't use cables that are too small in diameter, this will degrade the efficiency that we have worked so hard to achieve and you have paid to own. The following table gives recommended cable and fuse sizes for various run lengths and inverter voltages.

Table 2, Minimum Recommended Battery Cable Size (In Free Air)

Model	Typical Amps	Minimum Fuse Size	Under 5 ft	5 to 10 ft	10 to 20 ft
500 Watt	55	TFB110	#2 AWG	2/0 AWG	2/0 AWG
600 Watt	65	TFB110	#2 AWG	2/0 AWG	2/0 AWG
1100 Watt	120	TFB200	2/0 AWG	2/0 AWG	4/0 AWG
1400 Watt	152	TFB200	2/0 AWG	2/0 AWG	4/0 AWG

The National Electric Code requires that cables be protected by a fuse or breaker rated to match the cables ampacity at 75 degrees Celsius.

Table 3, Recommended Cable and Maximum Disconnect Size

Cable Size	In Conduit		In Free Air	
	Rating	Breaker Amps	Rating	Fuse Amps
2 AWG cable	115 amps Max	N/A	170 amps Max	175
2/0 AWG	175 amps Max	DC175	265 amps Max	300
4/0 AWG	250 amps Max	DC250	360 amps Max	400

WARNING: Very small battery cables will melt if the inverter produces high power.

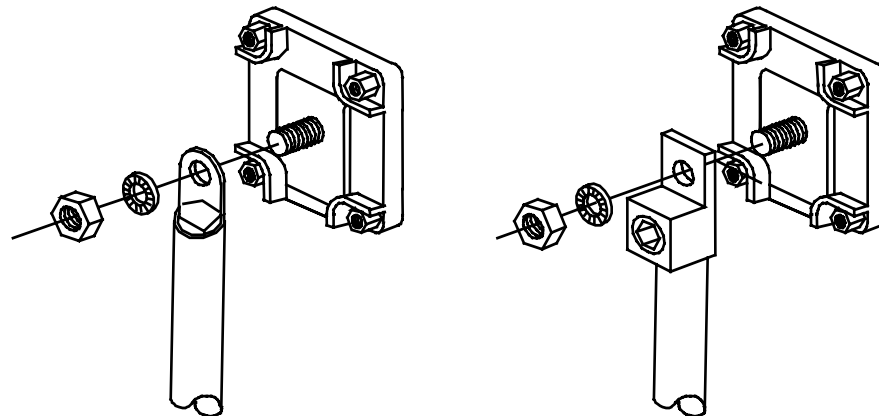
The National Electric Code (NEC) Article 240-6(b) allows rounding up to the next fuse size from the cable rating if a standard size fuse is not available. i.e. 155 amp cable size rounds up to a 175 amp fuse size.

NEC 240-6. Standard Ampere Ratings.

(b) Fuses **and** Fixed Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, and 6000 amperes.

Battery-to-Inverter Connection

Trace inverter/chargers are equipped with two battery terminals on the control-panel end of the inverter. Use either copper compression lugs (ring terminals) or aluminum mechanical-type lugs (as specified below) to connect the cables from the battery-bank to the inverter battery terminals as shown in the illustration below:



2/0 Copper Compression Lug

2/0 Aluminum Mechanical

Figure 18, Battery-to-Inverter Cable Connection

Copper Compression Lugs: Commonly available at hardware, welding, and auto parts retailers, compression lugs must be crimped onto each cable using an appropriate crimping tool. These lugs are not available from Trace Inverters. Suggested sources and part numbers are:

<u>Part #</u>	<u>Description</u>
Hollingsworth, Pompano Beach, FL	305-979-2050
TL3061	2/0 Ring Terminal
TL3062	4/0 Ring Terminal
H40	8 AWG to 250MCM Air-Operated Crimping Tool
Thomas & Betts	
K973	2/0 Ring Terminal
M973	4/0 Ring Terminal
RJ737	2/0 Insulated Ring Terminal
RL737	4/0 Insulated Ring Terminal
TBM6	Hand Operated Crimping Tool (order dies separately)
Dies: #11809	for crimping 2/0 non-insulated lugs
#11811	4/0 non-insulated lugs
#11826	2/0 insulated lugs
#11828	4/0 insulated lugs

Mechanical Lugs: Aluminum mechanical lugs are available from electrical hardware suppliers and do not require crimping. Suggested sources and part numbers are:

<u>Part #</u>	<u>Description</u>
ILSCO	
TA-2/0	2/0 Lug
TA-250 (preferred)	250 MCM Lug
Thomas & Betts	
62205	2/0 Lug
62212	250 MCM Lug
Panduit	
LAMA2/0-14	2/0 Lug
LAMA250-56.	250 MCM Lug

Making the Connection

Connect the positive (+) DC supply cable to the Red terminal; connect the negative (–) DC supply cable to the Black terminal.

WARNING: THE INVERTER IS NOT REVERSE POLARITY PROTECTED! If the positive terminal of the battery is connected to the negative terminal of the inverter, the result will be instant destruction of the inverter/charger and your product warranty.

Place the cable lug over the inverter's battery terminal bolt followed by a lock washer and a nut, then tighten the 5/16 - inch nut to 10-15 ft./lb. (13.5-20 N-m) using a ½ - inch nut driver. Do not place the lock washer under the cable lug.

Note: Connecting the battery cables to the inverter battery terminals will cause arcing - usually accompanied by a "snap". This is normal, don't let it scare you.

Never disconnect the battery cables while the inverter is delivering power or the battery charger is operating. To disconnect the batteries for service follow these steps:

1. Turn the power switch **OFF**,
2. Disconnect all AC inputs, and
3. Disconnect the battery cables.

System Grounding

Even system designers and electricians often misunderstand system grounding. The subject is more easily understood if it is divided into three separate subjects. The grounding requirements vary by country and application. Consult local codes and the NEC for specific requirements.

Equipment or Chassis Grounds

This is the simplest part of grounding. The idea is to connect the metallic chassis of the various enclosures together to have them at the same voltage level. This reduces the potential for electric shock. It also provides a path for fault currents to flow through to blow fuses or trip circuit breakers. The size of the connecting conductors should be coordinated with the size of the overcurrent devices involved. Under some circumstances, the conduit and enclosures themselves will provide the current paths.

Grounding Electrodes / Ground Rods

The purpose of the grounding electrode (often called a ground rod) is to “bleed” off any electrical charge that may accumulate in the electrical system and to provide a path for “induced electromagnetic energy” (lightning) to be dissipated. The size for the conductor to the grounding electrode or grounding system is usually based on the size of the largest conductor in the system. Most systems use a 5/8” (16 mm) copper plated rod 6 feet (2 meters) long driven into the earth as a grounding electrode. It is also common to use copper wire placed in the concrete foundation of the building as a grounding system. Either method may be acceptable, but the local code will prevail. Connect to the ground electrode with special clamps located above ground where they can be periodically inspected.

It is often desirable to use multiple ground rods in a larger system or systems. The most common example is providing a direct path from the solar array to earth near the location of the solar array. Most electrical codes want to see the multiple ground rods connected by a separate wire with its own set of clamps. If this is done, it is a good idea to make the connection with a bare wire located outside of the conduit (if used) in a trench - the run of buried wire may be a better grounding electrode than the ground rods!

Well casings and water pipes can also be used as grounding electrodes. Under no circumstance should a gas pipe or line be used. Consult local codes and the NEC for more information.

Bonding the Grounding System

This is the most confusing part of grounding. The idea is to connect one of the current carrying conductors (usually the AC neutral and DC negative) to the grounding system. This connection is why we call one of the wires “neutral” in the North American type electrical systems. You can touch this wire and the grounding system and not be shocked. When the other ungrounded conductor (the hot or positive) touches the grounding system, current will flow through it to the point of connection to the grounded conductor and back to the source. This will cause the overcurrent protection to stop the flow of current, protecting the system.

The point of connection between the grounding system and the current carrying conductor is called a "bond." This bond is usually located in the over protection devices enclosure. Although it can be done at the inverter, codes do not generally allow it since the inverter is considered a "serviceable" item which may be removed from the system. In residential systems it is located at the service entrance panel, after the power has gone through the kilowatt-hour meter of the utility.

In some countries, the neutral is not bonded to the grounding system. This means you may not know when a fault has occurred since the overcurrent device will not trip unless a "double" fault occurs. In some marine electrical codes this type of system is used.

Bonding must be done at only one point in an electrical system. Our systems inherently have two separate electric systems - a DC system and a AC system. This means that two bonding points will occur in all inverter applications. The bonding point will also be connected to the chassis ground conductors. It is common to have two separate conductors connect the ground electrode and the two bonding points. Each conductor should use a separate clamp.

Neutral to Ground Switching (T & L Series – 120 VAC units only)

Note: Ground Switching is not applicable on the UX model inverter/chargers.

Note: In some countries such as Canada, ground switching is not allowed. If this is the case see the section **Disabling Neutral to Ground Switching** on page 39.

All of the "T" and "L" series units (except those models with "E" after the model number) employ neutral to ground switching as required by the NEC (National Electric Code). The purpose for this requirement is to ensure that the neutral conductor in a three wire system is "bonded" or connected to ground **at only one point**. This prevents a voltage difference from developing between the vehicle's neutral the AC source's neutral wires which may cause an electric shock. When the unit is operating as an inverter, the AC output neutral is connected to the chassis ground by an internal relay, creating the "bond" in the inverter. When operating from an external AC power source the internal relay in the inverter opens and removes the ground from the neutral conductor and allows the "bond" to be provided by the external AC source.

The diagram below graphically describes the ground switching system in the inverter for the first case in question, the unit operating as an inverter and feeding the AC sub-panel.

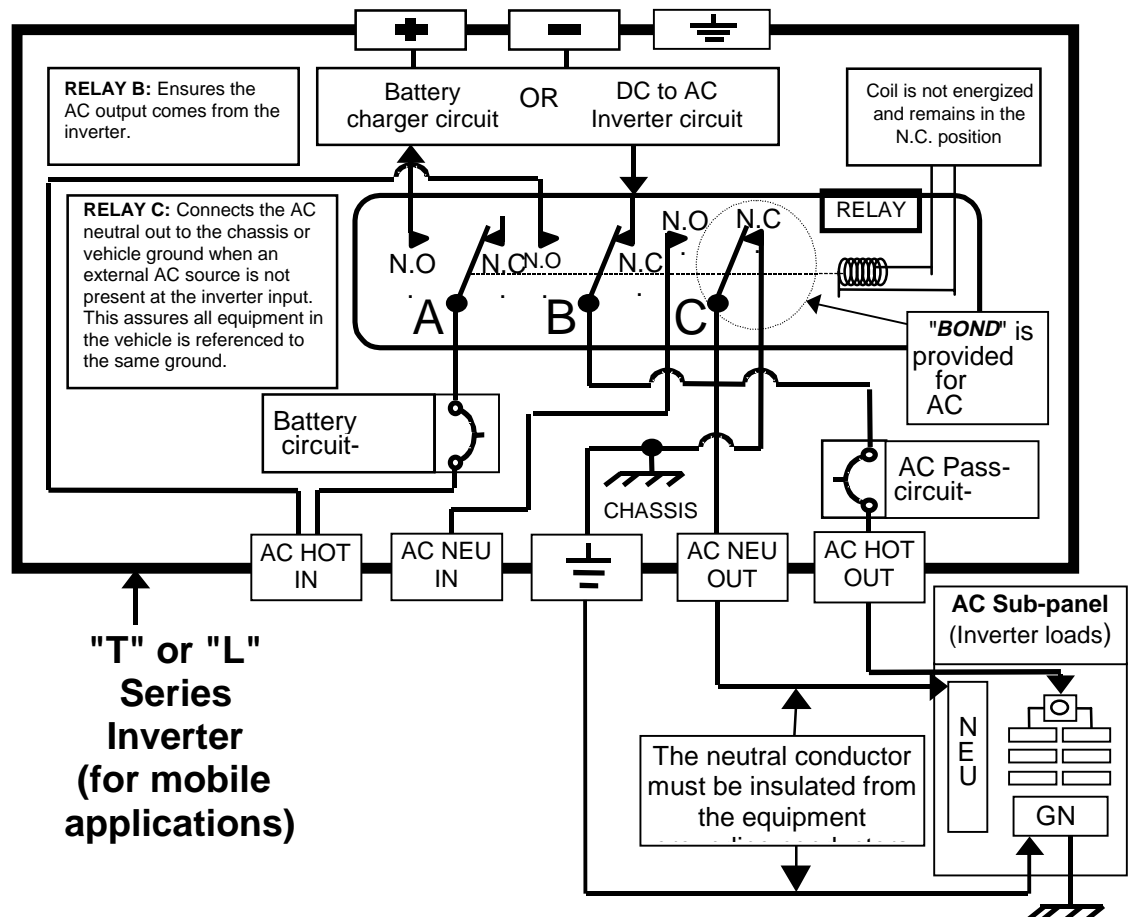


Figure 19, Ground Switching with External AC Source

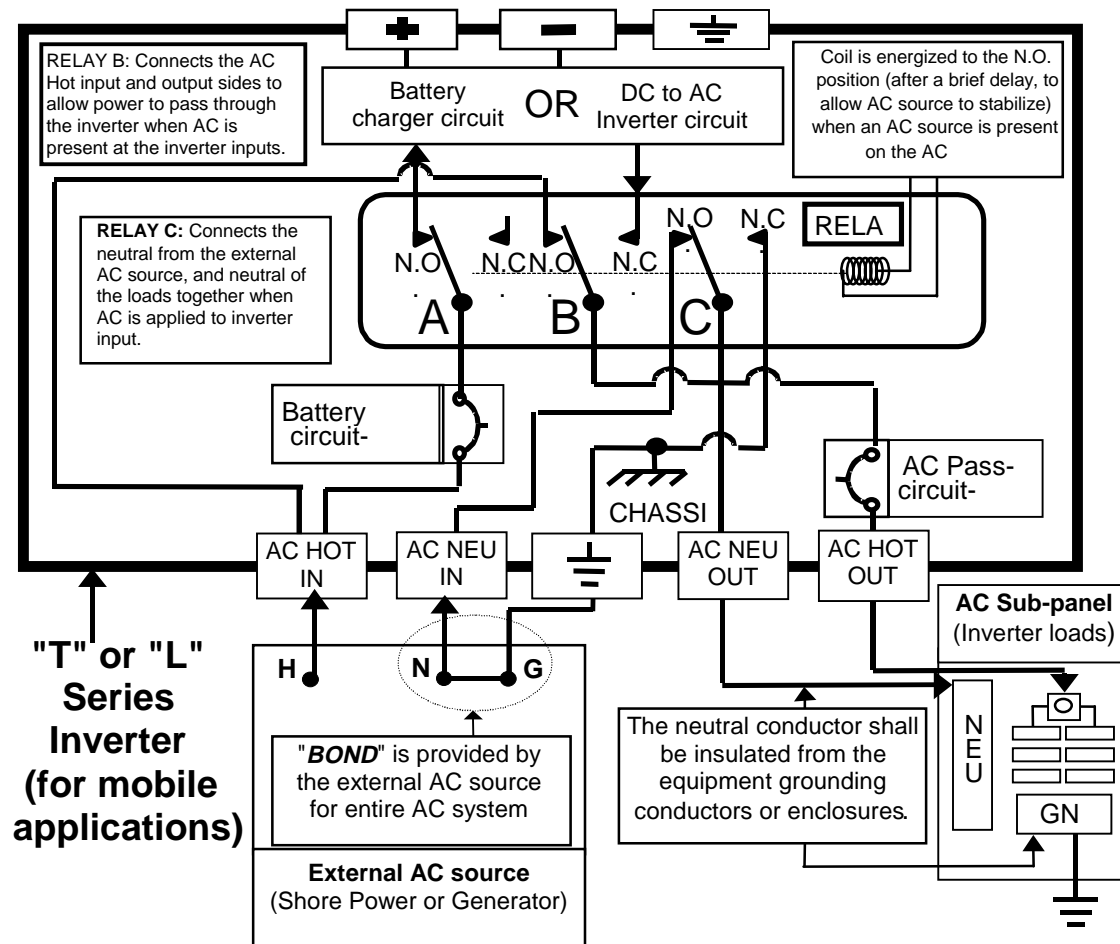


Figure 20, Ground Switching without AC Source

Disabling Neutral Ground Switching

If the inverter you purchased is a gray truck-model inverter, or a white or Legend (L) inverter, it employs neutral ground switching. In countries such as Canada this is not utilized, and therefore may need to be disabled before installation. Check local code if you are not sure whether you must disable the neutral ground switching feature.

Note: Connect the chassis ground to the vehicle chassis even if ground switching has been disabled. Disabling the ground switching is very simple if precautions are taken and these steps followed:

1. If the inverter is already installed, disconnect any AC sources (If any are present)
2. Disconnect the battery(s) from the inverter.
3. Remove the AC terminal block cover on the front of the inverter, or remove the top cover.
4. Locate the **green** wire that runs from the circuit board to the chassis ground bolt as shown in *Figure 21, Disabling Neutral Ground Switching* below. Pull this wire from the circuit board quick-disconnect ground terminal and from the chassis ground bolt.
5. **Do not cut** the green wire that goes from the connector block to the chassis.
6. Replace the AC terminal block cover and reconnect the battery(s) and the AC sources (on units with battery chargers).

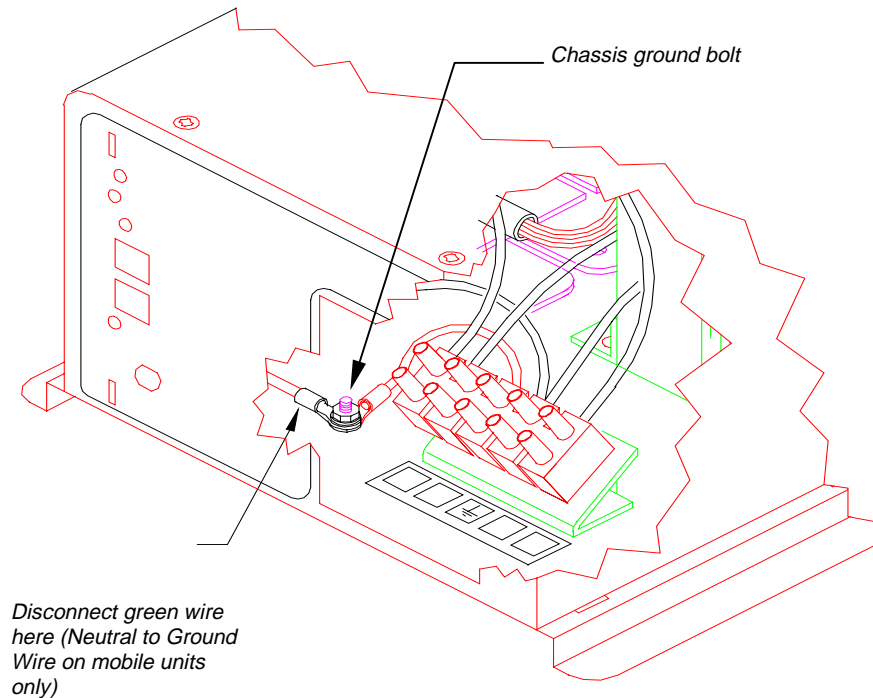


Figure 21, Disabling Neutral Ground Switching

Troubleshooting

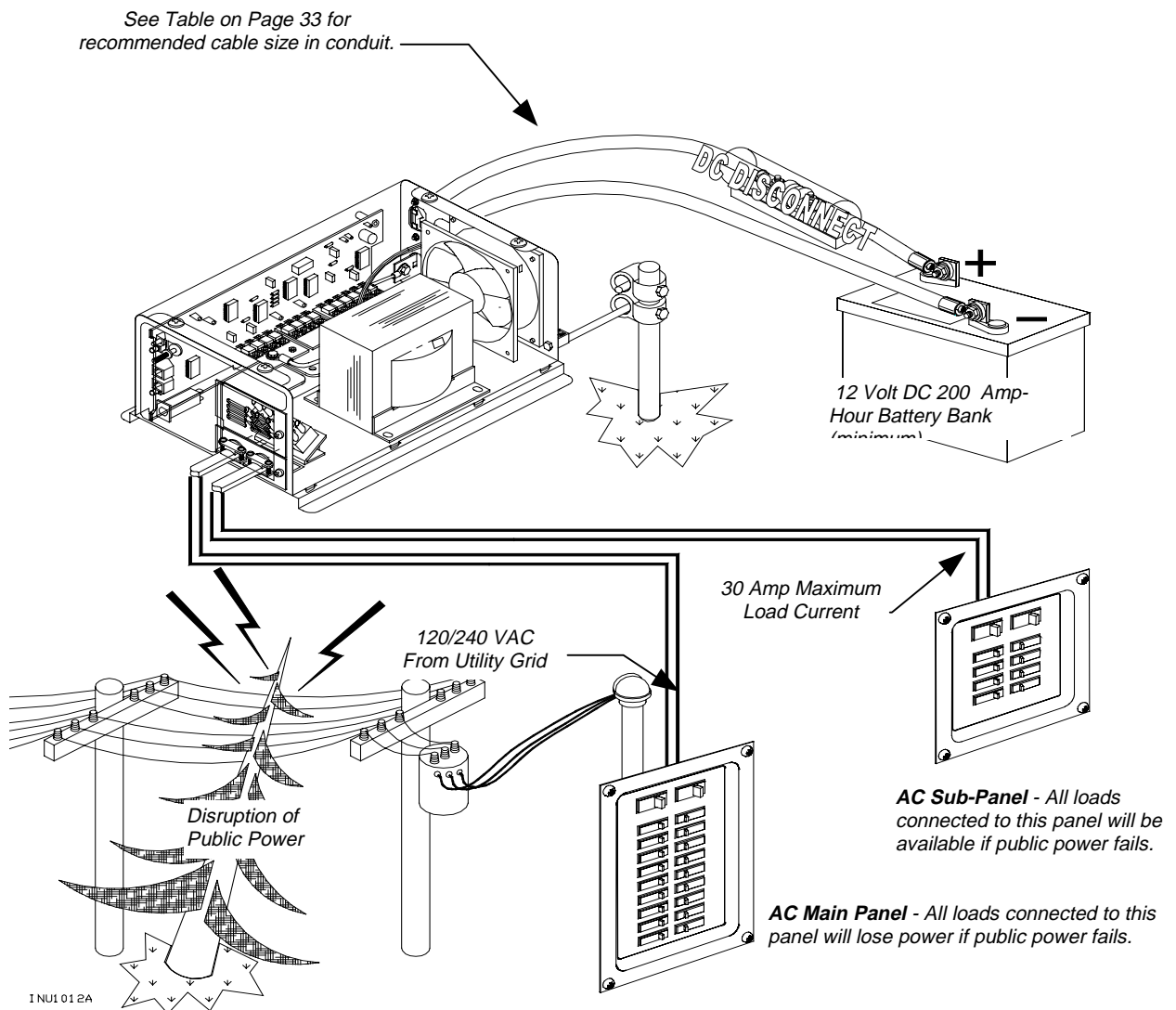
<u>Symptom</u>	<u>Problem</u>	<u>Remedy</u>
No power output and no warning LED's	Battery voltage at the inverter's terminals is too high or low	Check the battery voltage, fuses or breakers, and cable connections
No power output and LED flashing slowly	Load too small for Search circuit to detect	Reduce Search Mode threshold setting or defeat search mode
Power output LED flashing or erratically	Overload LED is "ON"	Remove loads from the rapidly Inverter and restart
Overheat condition		Remove loads and let inverter cool down before restarting
Power output is low and inverter turns loads on and off	Low battery	Check condition of batteries and recharge if possible
	Loose or corroded battery - connections	Check and clean all connections
	Loose AC output connections	Check all AC output connections
Inverter shuts down after 20 seconds No LED at all	Output of inverter is wired back to its own input	Check for proper AC input and output wiring
Charger is inoperative	AC input voltage does not match inverter spec	Check AC input for proper voltage and frequency for your model, 120 VAC models need >90 VAC to operate.
	Charger voltage improperly set	Refer to owner's manual for proper setting
Low charge rate	Low <u>peak</u> AC input voltage (164 volts peak required for full charger output)	Use larger generator, speed up generator, check AC input wiring, cables too small or long
	AC current output of generator too small to handle load	Reduce loads
Low AC output voltage	Measuring with the wrong type voltmeter (displays 80-100 VAC)	Voltmeter must be a true RMS reading meter (most are not).
Low surge power	Weak batteries, battery cables too small or too long	Refer to cable and battery recommendations in this manual
Unit overheats	Unit is Hot	Let unit cool down, reduce load
AC lights flicker while charging	Generator is unstable - charger is losing synchronization	Reduce loads

Appendix A: Installation Diagrams and Templates

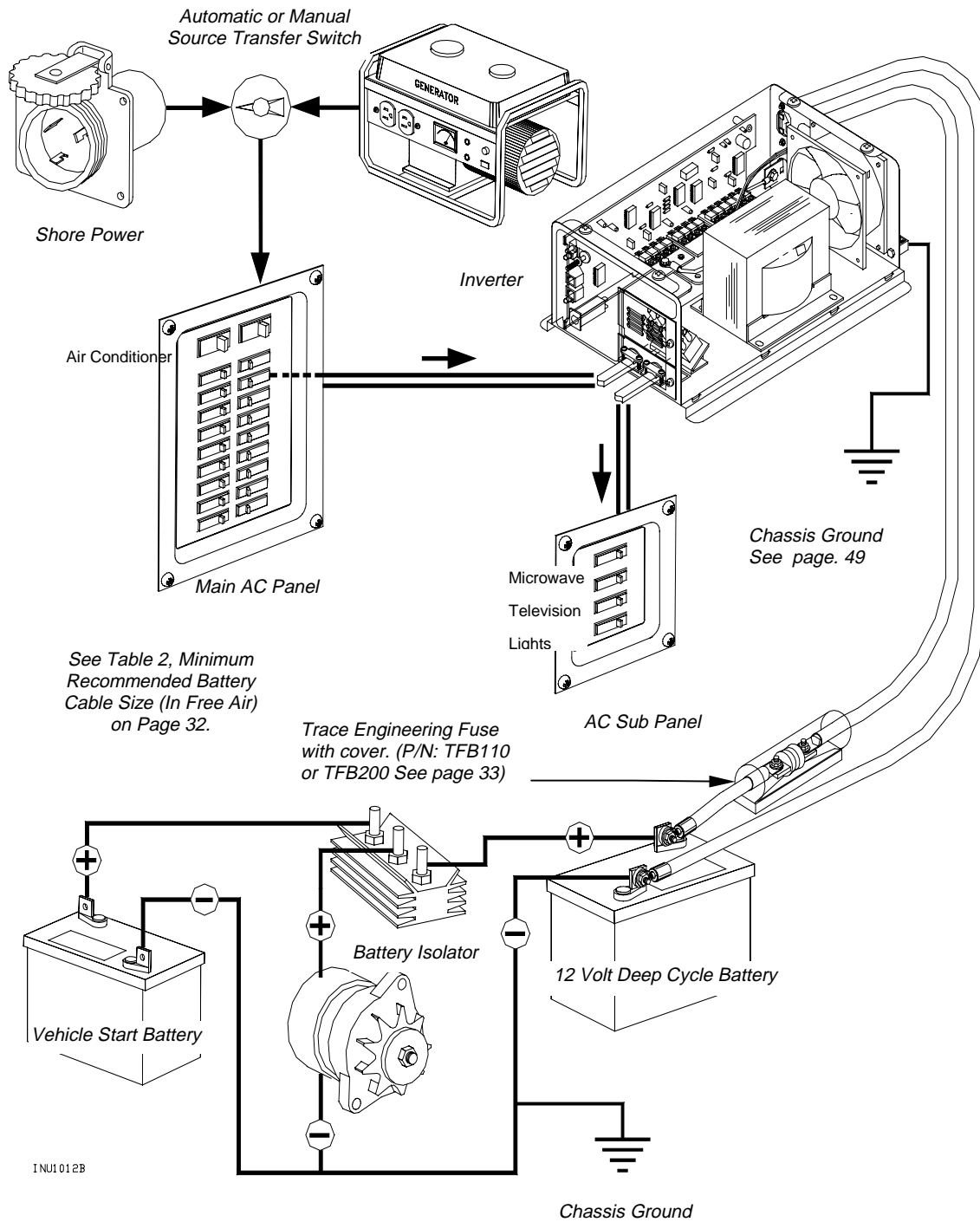
This appendix contains installation diagrams and mounting templates for use and reference during installation of the Trace inverter and its optional RC8 Remote On/Off option. Connection of Battery and Ground systems (Non-Mobile Small Power Backup System)

If the model number of the inverter you purchased has the UX designator, then it is designed for installation in a permanent structure such as a home or commercial building. Connection must be accomplished in the manner shown in the diagram below.

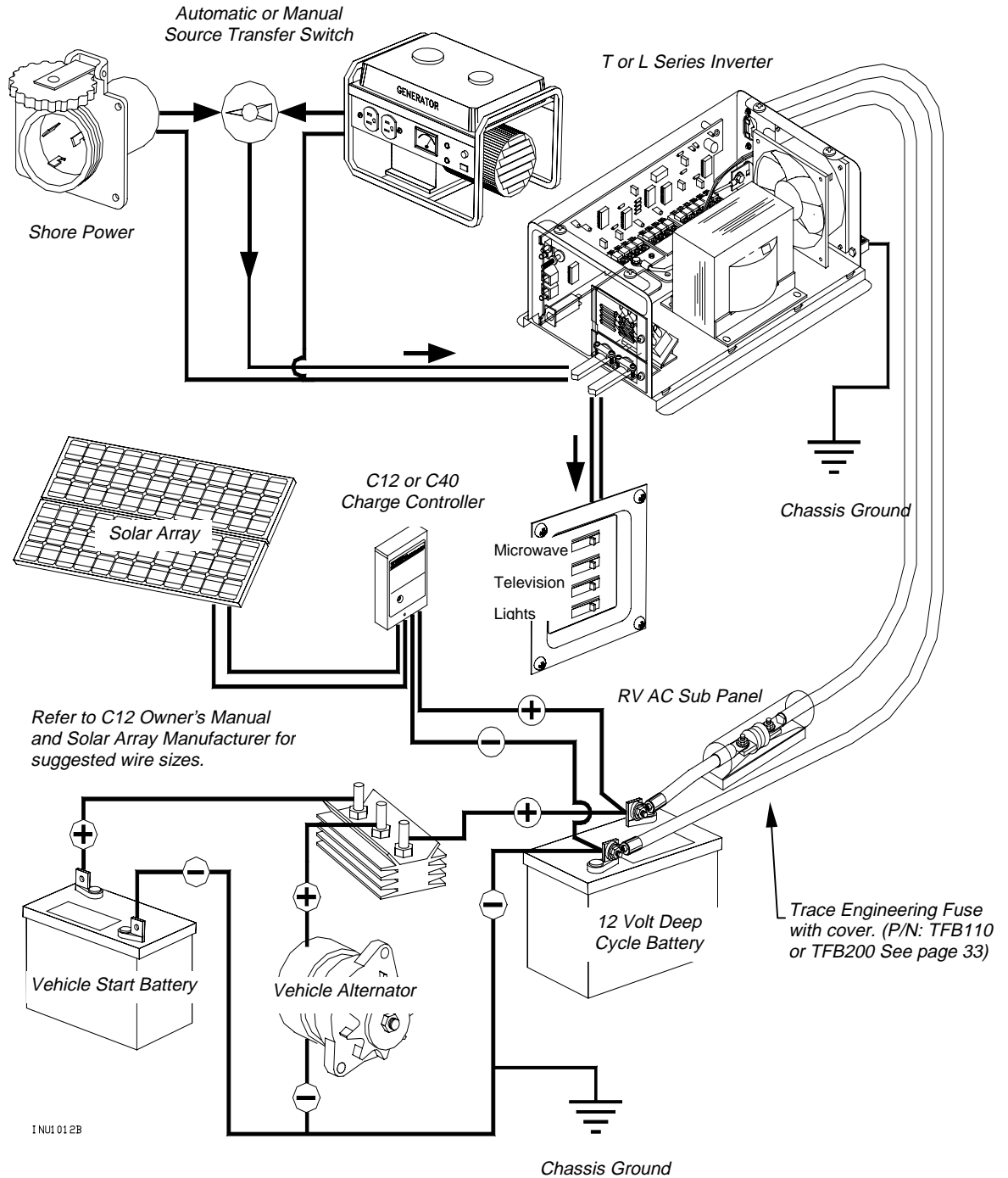
Installation Schematic for Stationary Backup Systems



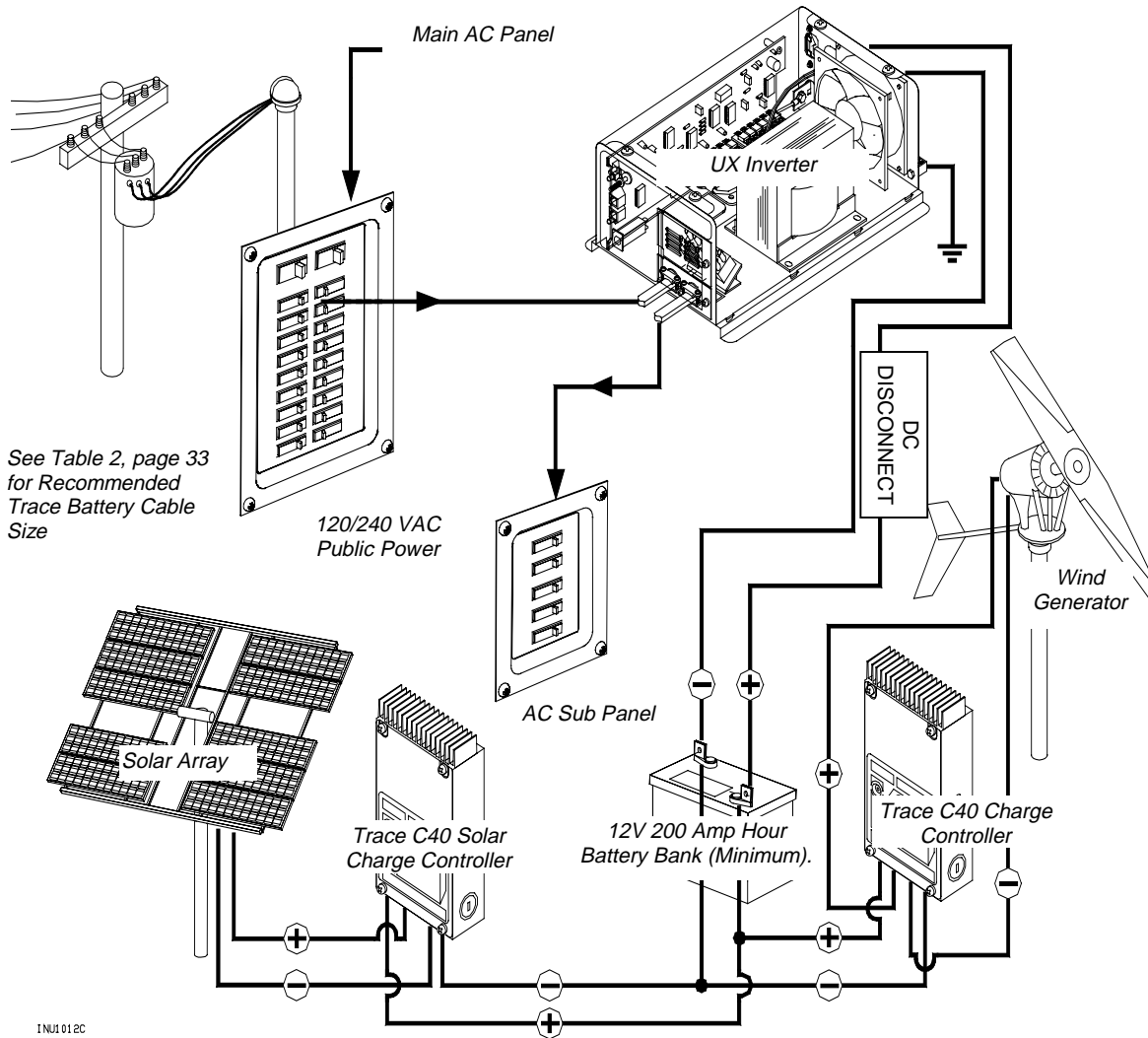
Installation for Mobile Units with AC Sub Panel



Installation Schematic for Mobile Solar System

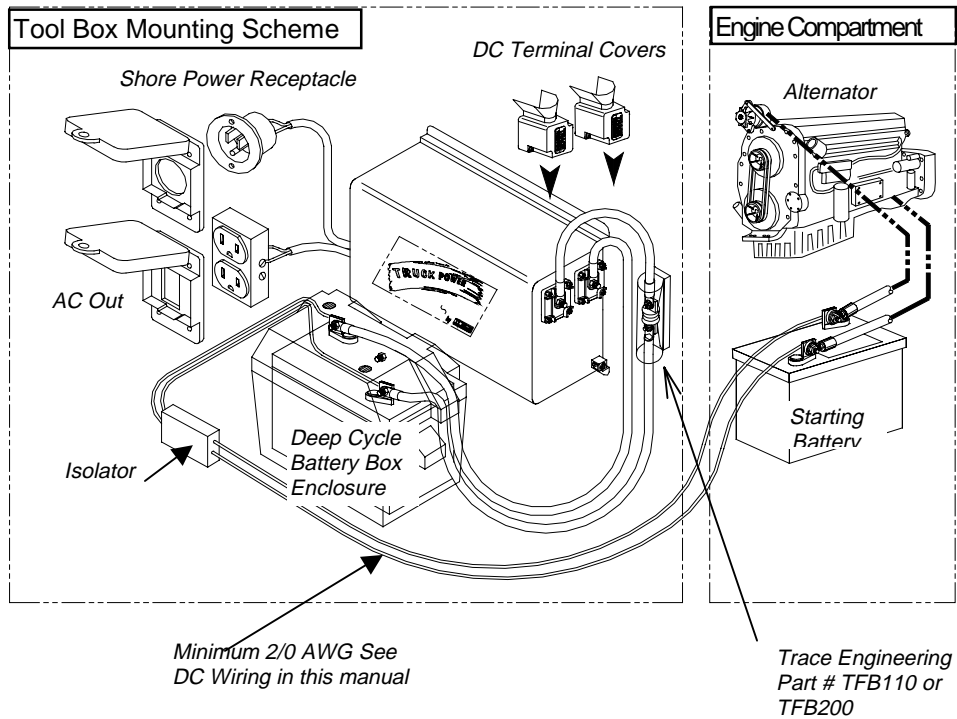


Small Power Backup System with Solar Array

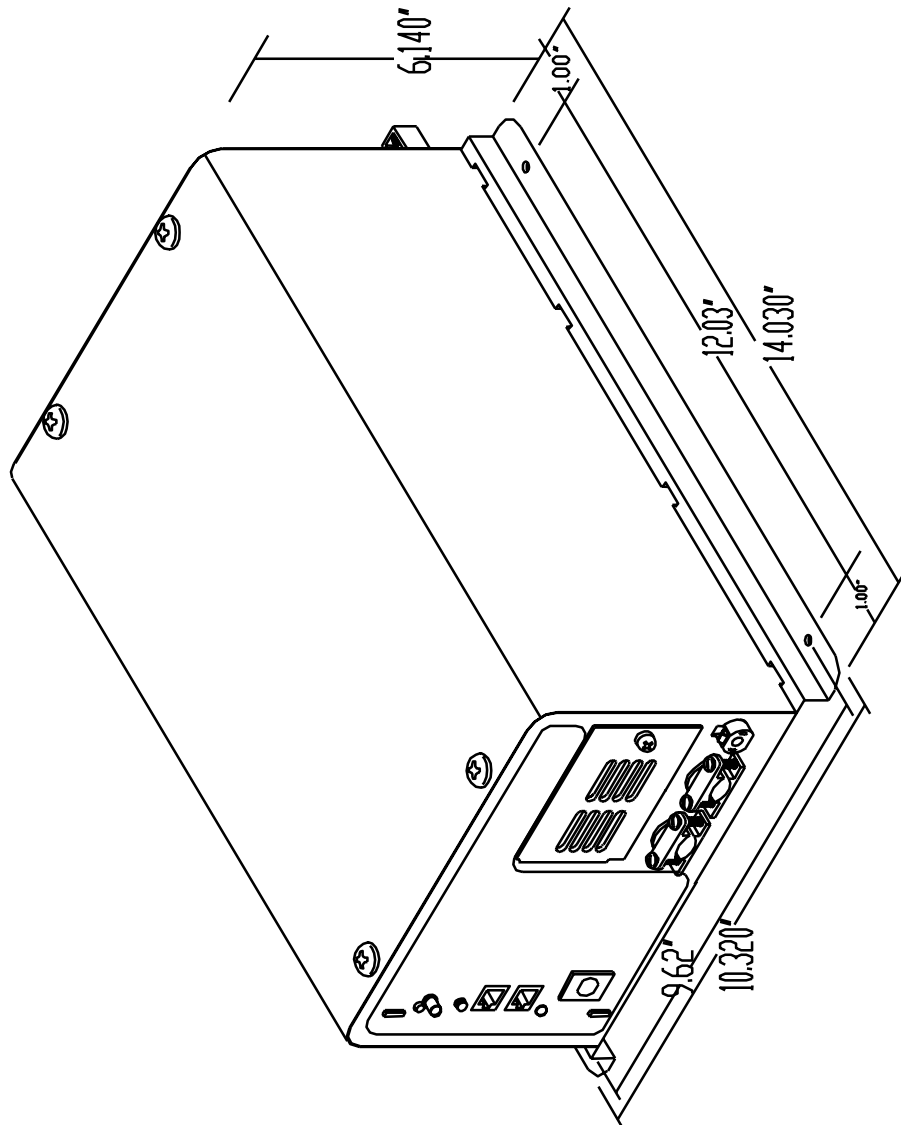


Note: This drawing does not show the required DC disconnect or fuse in the positive battery cable between the inverter and battery, and charge controllers. For appropriate fuse size see page 33. Your Trace dealer can provide you with appropriate Trace fuses, battery cables, and DC disconnects. If a charge controller and solar array or generator are utilized refer to the manufacturer's approved installation and operating manual for information regarding hookup and operation of those units.

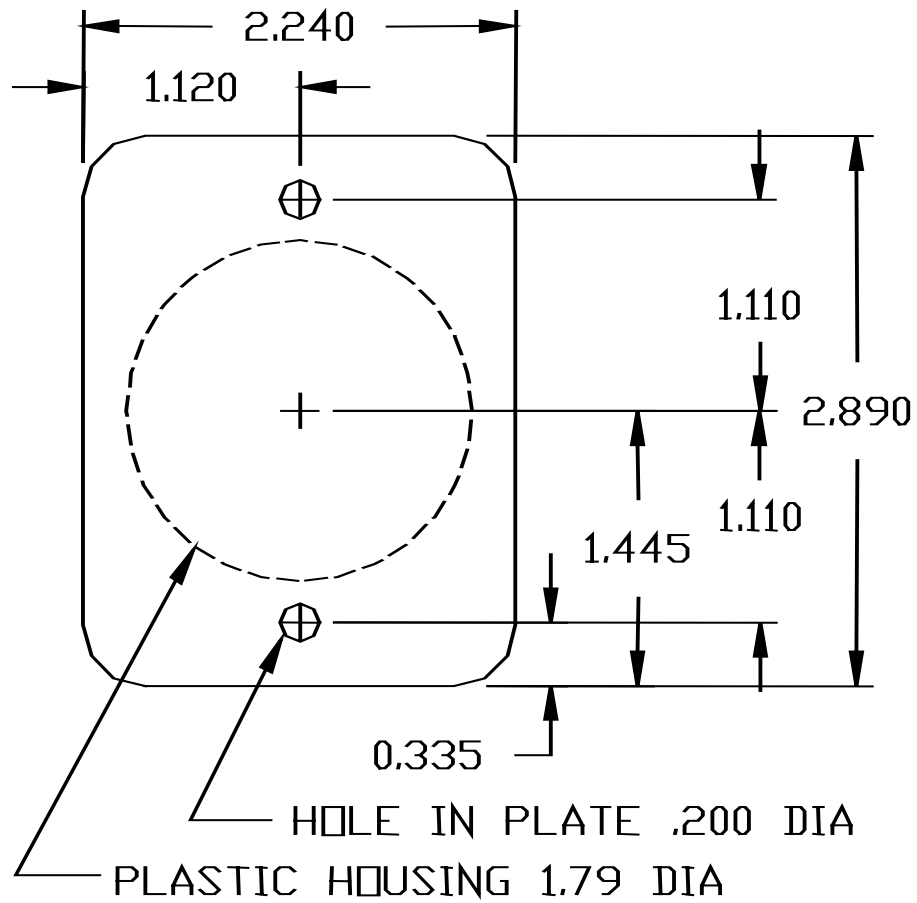
Truck Model Installation Diagram



UX/L/T Inverter Dimensions



Full Size Mounting Template for RC8 Remote Control



Appendix B: Typical Battery Draw of Common Appliances

The table below lists the number of amp-hours consumed by common household appliances over periods ranging from five minutes to four hours. Use this table to calculate minimum battery- bank capacity.

APPLIANCE	Time in Minutes WATTS	5	15	30	60	120	240
		Amp-Hours Consumed					
Single PL Light	10	.1	.3	.7	1.3	2.7	5.3
B & W TV	50	.4	1	2	4	8	17
Computer	100	1	2	4	8	17	34
Color TV	200	2	4	8	17	34	67
Blender	400	3	8	17	34	67	133
Skil Saw	800	6	17	34	67	133	266
Toaster	1000	8	23	46	93	185	370
Microwave	1200	10	28	57	114	227	455
Hot Plate	1800	15	44	88	176	353	706

If the current draw at 120V_{AC} is known, then the battery amperage at 12V_{DC} will be 10 times the AC amperage divided by the efficiency (90% in this table). Motors are normally marked with their running rather than their starting current. Starting current can be five times running current. Refrigerators and ice makers typically run only about one-third of the time. Therefore, their power consumption over 24-hours will be about one-third of what the amp rating would indicate.

Appendix C: Wire Conversion and Ground Wire Sizing Tables

Table 4, Wire Gauge Conversion Chart

AWG	DIAMETER/mm	AREA/mm ²	DC Resistance / 1000 ft at 75°C
14	1.628	2.082	3.14
12	2.052	3.308	1.98
10	2.588	5.261	1.24
8	3.264	8.367	0.778
6	4.115	13.299	0.491
4	5.189	21.147	0.308
2	6.543	33.624	0.194
1	7.348	42.406	0.154
1/0	8.525	53.482	0.122
2/0	9.266	67.433	0.0967
3/0	10.404	85.014	0.0766
4/0	11.684	107.219	0.0608

Table 5, Earth Ground Wire Minimum Size

The ground wire must be sized per NEC 250-95. The following table is derived from this portion of the NEC code

Battery DC Disconnect Size	Minimum Size of Copper Ground Wire
30 Amp or 60 Amp	#10 AWG
100 Amp	#8 AWG
200 Amp	#6 AWG
300+ Amps	#2 AWG or greater

Appendix D: Specifications

<u>MODEL</u>	<u>512E/SB</u>	<u>612/SB</u>	<u>1112/SB</u>	<u>1112E/SB</u>	<u>1412/SB</u>
Continuous Power @ 25°C	500 VA	600 VA	1100 VA	1100 VA	1400 VA
Max AC Current VA					
100 ms Record	10 amps	22 amps	22 amps	11 amps	30 amps
Efficiency	92 % max	92 % max	92 % max	92 % max	92% max
Input Current					
Unit Off	0.020 amps for all units				
Search Mode	0.045 amps	0.045 amps	0.045 amps	0.045 amps	0.060 amps
Full Voltage	0.450 amps	0.450 amps	0.450 amps	0.450 amps	0.600 amps
Rated Power	54 amps	63 amps	120 amps	120 amps	153 amps
Nominal Input Voltage	12.6 V _{DC} for all units				
Input Voltage Range	10.8-15.5 V _{DC}				
Low Battery Cutout	9.5 V _{DC}				
With Optional Charger (SB version)	Shallow setting = 11.8 V _{DC} with 5 minute delay				
High Voltage Cutout	15.7 V _{DC} for all units				
Voltage Regulation – all units					
Maximum	±5%				
Typical	±2.5%				
Waveform	Modified sine				
Power Factor allowed	0 to 1				
Frequency Regulation	50Hz ±0.1%	60Hz ±.01%	60Hz ±.01%	50Hz ±.01%	60Hz ±.01%
Standard Output Voltage	230Vac	120Vac	120Vac	230Vac	120Vac
Adjustable Search Sensing	5 to 100 Watts				
Forced Air Cooling (Fan)					
No	No	Yes	Yes	Yes	Yes
Automatic Transfer Relay	30 amps – all units				
“E” models	30 amps - all units				
Three Stage Standby Battery Charger (Optional)					
	<u>Sealed</u> (default)		<u>Vented</u>		
Selectable Charging Rate	14.3 V _{DC} Bulk		14.7 V _{DC}		
	13.6 V _{DC} Float		13.4 V _{DC}		
Max DC Charging Current					
25 amps	25 amps	50 amps	50 amps	50amps	
Battery Temperature Sensor	BTS (Optional)				
Remote On/Off Control and Status Indicator	RC8 (Optional)				
Environmental Characteristics – all units					
Operating Ambient Temp	0°C to +60°C				
Non-operating Temp	-55°C to +75°C				
Altitude Operating	15,000 feet				
Altitude Non-operating	50,000 feet				
Shipping Weight	25 lb.(11.4kg)	25 lb.(11.4kg)	33 lb. (15kg)	33 lb. (15kg)	33 lb. (15kg)
Dimensions – all units	15.5"L(39.4cm) x 10.25"W(26cm) x 6"H(15.2cm)				
Mounting – all units	Shelf Mount Only				

*Specifications subject to change without notice.

Appendix E: Products by Trace Engineering

DC250/DC175 DC Disconnect/Overcurrent Module

Enclosed 250 amp or 175 amp DC-rated circuit breaker. Can accept up to 4/0 AWG wire and is certified as a “means of disconnect” in compliance with NEC. Rated for interrupting high fault current: 25,000 amps at 65V_{DC}. Knockouts accept ½” through 2” sizes.

SW Series Sine Wave Inverter

High power sine wave inverter/charger. Features low current distortion charger, temperature compensation, series operation, fast transfer time, line tie capability, generator support, generator start and user controlled auxiliary relays.

C40 Charge Controller/Load Controller

A 40 amp solar charge controller, DC load controller or DC diversion regulator. The unit works with 12, 24, or 48 volts systems and is rated at a 40 amp continuous capacity. Other features of the C40 are field adjustable set-points, temperature compensation and protection, electronic overload protection with manual and auto reset ability, optional LCD meter, and optional temperature compensation sensor (BTS) .

C12 Charge Controller

A 12-amp 3-stage solar charge controller, DC load, and automatic lighting control center. The C12 is fully protected against overload, short-circuit, and reverse polarity. It is ideal for controlling lighting systems as it uses a PV array as an electric eye to “see” when it is dark, so it knows when to turn on the lights! Automatic reset, battery over-discharge and overcharge protection, two stage lightning protection and surge suppression, and optional temp compensation sensor are a few of the features of the C12.

Battery Cables

NEC compliant battery cables from Trace in various lengths to ensure maximum power from the inverter and batteries. They are available in two sizes: 2/0 and 4/0 with lengths of 1½, 3, 5, and 10 feet for the 2/0, and 1.5, 3, 5, 10, and 15 feet for the 4/0. All cables are available in red and black color coding.

SW and DR Series Power Panel Systems

Pre-assembled complete power panels featuring the SW or DR series inverters. Each panel is complete and complies with all code. All you do is connect to the battery-bank and hook-up AC loads. Each panel can include single or dual C40 charge controllers with a 60 amp disconnect for use with solar, wind, or hydroelectric DC charging sources. An AC system bypass allows AC loads to operate while the inverter is locked-out for servicing. Battery Cable and flexible conduit is also available for connection of the system to a battery enclosure.

Contact your Trace Engineering dealer for details on any of the above products.

Appendix F: Warranty & Life Support Policy

This section describes Trace Engineering Company's Limited Warranty and Life Support policy.

Limited Warranty

Trace Engineering Company warrants its power products against defects in materials and workmanship for a period of two (2) years from the date of purchase. This warranty is extended to all purchasers or owners of the product during the warranty period. Trace does not warrant its products from any defects:

- arising out of material or workmanship not provided by Trace Engineering;
- resulting from abnormal use of the product, or use in violation of the instructions;
- in products repaired or serviced by other than Trace Engineering repair facilities;
- in components, parts, or products expressly warranted by another manufacturer.

Trace Engineering agrees to supply all parts and labor or repair or replace defects covered by this warranty with parts or products of original or improved design, at its option, if the defective product is returned to any Trace Engineering authorized warranty repair facility or to the Trace Engineering factory *in the original packaging*, with all transportation costs and full insurance paid by the purchaser or owner.

ALL REMEDIES AND THE MEASURE OF DAMAGES ARE LIMITED TO THE ABOVE. TRACE ENGINEERING SHALL IN NO EVENT BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, CONTINGENT OR SPECIAL DAMAGES, EVEN IF TRACE ENGINEERING HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. ALL OTHER WARRANTIES (EXPRESSED OR IMPLIED) ARISING BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE, OR OTHERWISE, (INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), ARE LIMITED IN DURATION TO A PERIOD OF TWO (2) YEARS FROM THE DATE OF PURCHASE. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, OR THE EXCLUSION OF INCIDENTAL OR CONSEQUENTIAL DAMAGE, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS, WHICH VARY, FROM STATE TO STATE.

Life Support Policy

Do not use Trace products where failure or malfunction of the Trace Engineering product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Trace Engineering, Inc. will not knowingly sell its products for use in such applications unless it receives in writing assurances satisfactory to Trace Engineering, Inc. that:

- the risks of injury or damage have been minimized,
- the customer assumes all such risks,
- the liability of Trace Engineering, Inc. is adequately protected under the circumstances

Examples of devices considered to be life support devices are neonatal oxygen analyzers, nerve stimulators (whether used for anesthesia, pain relief, or other purposes), auto-transfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, neonatal ventilator incubators, ventilators for both adults and infants, anesthesia ventilators, and infusion pumps as well as any other devices designated as "critical" by the U.S. FDA.

Warranty Procedure

Complete the warranty card and mailed it to Trace Engineering within ten (10) days from the date of purchase. **KEEP YOUR BILL OF SALE** as proof of purchase, should any difficulties arise concerning the registration of the warranty card.

WARRANTY REGISTRATION is tracked by model and serial numbers only, not by owner's name. Therefore, any correspondence or inquiries made to Trace Engineering must include the model and serial number of the product in question. Be sure to fill in the model and serial numbers in the space provided below. Keep this portion of the warranty card in a safe place for future reference.

WARRANTY SERVICE must be performed **ONLY AT AN AUTHORIZED TRACE SERVICE CENTER, OR AT THE TRACE ENGINEERING FACTORY**. Notify the repair facility before shipping to avoid the possibility of needless shipment. **UNAUTHORIZED SERVICE PERFORMED ON ANY TRACE PRODUCT WILL VOID THE EXISTING FACTORY WARRANTY ON THAT PRODUCT.**

FACTORY SERVICE: If you wish your Trace Engineering product to be serviced at the factory, it must be shipped **FULLY INSURED *IN THE ORIGINAL PACKAGING* OR EQUIVALENT**; this warranty will not cover repairs on products damaged through improper packaging. If possible, avoid sending products through the mail.

Note: Before returning any equipment to Trace Engineering, call our Warranty Coordinator and request an Return Merchandise Authorization (RMA) number. Be sure to have the serial number of the equipment handy.

Ship To:

**Trace Engineering Company, Inc.
Attn: Service Department. RMA #
5916 195th NE
Arlington, WA 98223
Phone: (360) 435-8826
(Warranty Coordinator)**

Be sure to include in the package:

1. Complete return shipping address (PO Box numbers are not acceptable) and telephone number where you can be reached during work hours.
2. A detailed description of any problems experienced, including the make and model numbers of any other equipment in the system, types and sizes of loads, operating environment, time of unit operation and temperature.
3. A copy of your proof of purchase (purchase receipt).

Repaired products will be returned freight C.O.D. unless sufficient return shipment funds are included with the unit.

Products sent to the factory from outside the U.S. **MUST** include return freight funds, and sender is fully responsible for all customs documents, duties, tariffs, and deposits.

Record the model and serial numbers on page one and retain for your files.

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