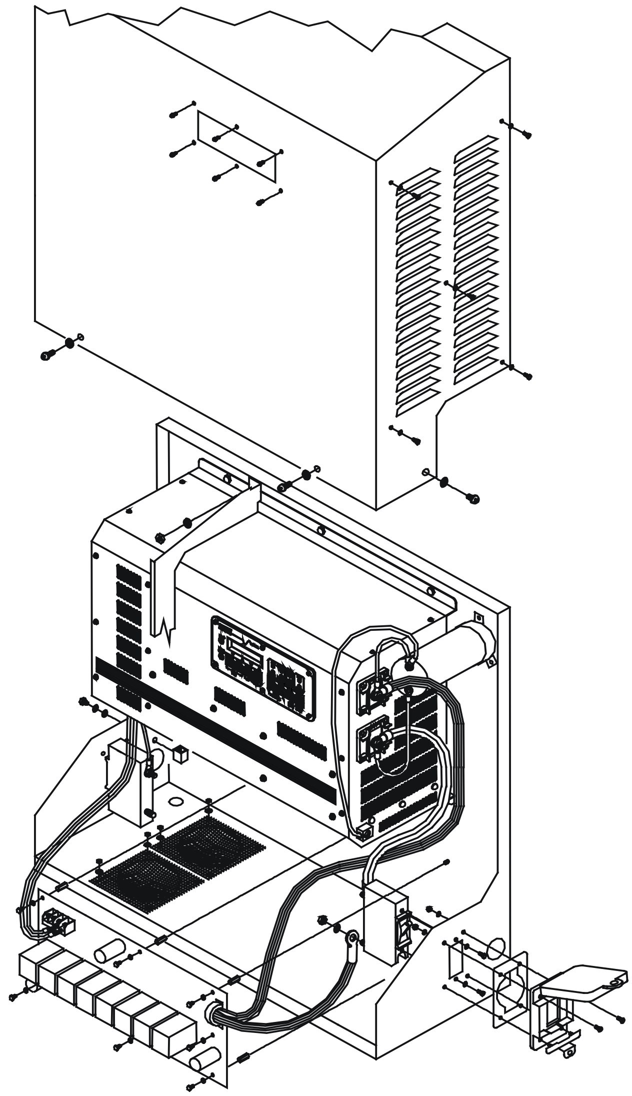
Owner's Manual

Version 1.3

All Utility System Inverter / Chargers



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Quick Start Instructions

For Utility Interactive SW Series Inverters and Utility Systems

These instructions are to assist with the start-up and testing of the SW series inverters designated by the suffix ***PV***, ***EPA*** or ***UPV*** at the end of the inverter's part number. These instructions are intended to supplement the standard inverter manual. The important safety instructions in the SW series manual should be reviewed prior to installing the inverter.

These inverters are specifically designed for connecting a PV array to a utility grid without a battery storage system. They are currently only available with a 48 volt nominal DC input. This requires either 3 solar modules in series or a custom solar module of similar configuration with 108 to 120 silicon type cells in series. The DC input voltage must not exceed 75 volts DC open circuit. Connection to a PV array with a higher DC input voltage may result in permanent damage to the inverter.

The specific installation procedures is as follows:

1. Mount the inverter. Mounting location should take into consideration conduit paths and accessibility. Mounting method depends upon the construction of the wall. The mounting method must be able to support the weight of the inverter, which can reach up to 200 pounds (approximately 100 kg.)
2. Run conduit from the PV array and the utility service entrance. A conduit hole is provided on each side of the enclosure next to the DC and AC disconnects. An interior barrier is provided internally which provides separation of the DC and AC wiring areas. Keep the AC wiring on the AC side (left) and the DC on the DC side (right). Two holes are also provided on the bottom of the enclosure for use if required. Be sure to plug any unused holes.
3. Pull AC and DC wire. The AC wire needs to be sized based on the requirements of the inverters output circuit breaker and the requirements of the utility connection. The DC wiring depends upon if a GFP (ground fault protection) board is provided. If the GFP is being used, then the PV array must be divided into multiple arrays of less than 16 amps each. Each PV subarray must be wired individually.
4. Make AC and DC connections. The AC connections are made at either the AC breaker and/or the internal terminal block of the inverter on its left end. The DC connections are made on the GFP board (if provided) or at the DC terminals of the inverter on the right end.
5. Test the DC input voltage before connecting the PV array to the inverter. It must not exceed 75 volts DC! Be sure to test in case a wiring error has occurred.
6. Apply DC to the inverter's DC terminals by closing the DC disconnect. After a short delay, the inverter should turn on. It is normal to hear some small clicks during this process. If the GFP system is included, it may be necessary to reset the GFP by pressing the green ***RESET*** button. Once the inverter has turned on the display will be illuminated.

Apply AC to the inverter's AC terminals by closing the AC disconnect. Once the AC is present, the green ***AC1 IN GOOD*** indicator should be illuminated. This indicates that the AC has been sensed.

The voltage window is +/- 10% of the nominal output and the frequency window is +/- 2 Hz of the nominal output. The nominal output of the inverters are as follows:

Blank & PV	***120VAC***	***60HZ***
U & UPV	***240VAC***	***60HZ***
E & EPV	***230VAC***	***50HZ***
J & JPV	***105VAC***	***50HZ***
K & KPV	***105VAC***	***60HZ***

After a one minute delay period the inverter will synchronize with the utility and close an internal contactor to connect to the utility grid. This will only occur if the inverter is within the voltage and frequency window and has been stable for the one minute delay period. Once the inverter has connected to the utility grid the yellow ***LINE TIE*** indicator will stop blinking and will remain on. If the utility goes out of the operating window, the contactor will open and the yellow ***LINE TIE*** indicator will return to the blinking state. The AC1 IN GOOD indicator will remain on if AC is applied (except at night). If the inverter can not provide at least 1 amp into the utility grid for a continuous 5 minute period, than the inverter will disconnect from the utility grid and wait for the PV arrays output to increase. If the PV arrays voltage continues to drop, then the inverter will eventually shut off. This typically occurs at the end of the day. Under some conditions the inverter may cycle on and off at the end of the day or during extremely heavy cloud cover. This is to be expected and is normal. The contactor that connects the utility grid to the inverter will remain open during this cycling process.

7. Once the inverter has connected to the utility grid, the display will show the amount of AC current flowing. Negative numbers indicates power into the utility (out of the inverter). Positive AC current readings should not be present. The button labeled as ***GEN MENU*** allows the DC operating voltage to be displayed, and the button labeled ***ON/OFF MENU*** allows the AC current to be displayed.
8. Additional user adjustable menu items are present in the menu system of the inverter. These are provided to allow testing of the inverter. The voltage window can be changed for example. The maximum power tracking system can be disabled and the operating point manually changed to allow performance estimation of the PV array. These changes are only retained until the inverter shuts off, usually at the end of the day. When it restarts the next day, the settings return to the factory default values.
9. If an error occurs, the inverter will stop inverting and will immediately disconnect from the utility grid. The error causes menu heading will show the cause of the error. All of the error conditions will auto reset once the problem has been corrected. The inverter will then resynchronize with the utility grid and close the internal contactor.
10. The display will remain on the position last shown. You may want to reset it to show the ***OUTPUT AMPS AC*** display before replacing the outdoor enclosure (if used).

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS!

This manual contains important safety and operating instructions as prescribed by UL Standards for the Trace Engineering Utility System inverter/chargers for use in residential and commercial applications. This manual covers products for both battery and battery-less applications. This manual is a supplement for the standard SW series manual for the inverter/charger itself.

Some versions of the Utility Systems are ETL listed to UL standards. The standard used varies with the application. Contact Trace Engineering for current listing status for your required version.

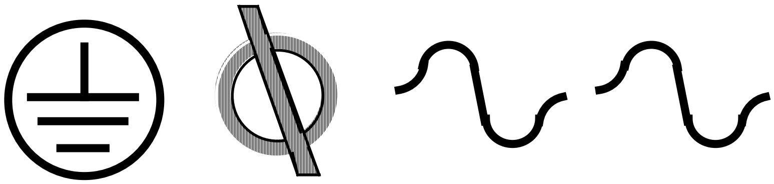
The 120 VAC / 60 Hertz models of the SW series inverter/chargers are ETL listed to **UL Standard 1741 (Draft),** ***Power Conditioning Units for use in Residential Photovoltaic Power Systems.*** Contract Trace Engineering for more information on listing status and models or check the labeling on the AC end (left side) of your inverter for additional information.

The 120 VAC / 60 Hertz models of the SW series inverter/chargers are also ETL listed to Canadian Standard **CSA - C 22.2 No. 107.1 - M1, Commercial *and Industrial Power Supplies***.

General Precautions

1. Before using the inverter/charger, read all instructions and cautionary markings on (1) the inverter/charger, (2) the batteries and (3) 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, absorbed mat, or NiCad/NiFe 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 if used in vehicle applications.
4. Do not disassemble the inverter/charger; take it to a qualified service center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire.
5. To reduce risk of electric shock, disconnect all wiring before attempting any maintenance or cleaning. Turning off the inverter will not reduce this risk. Solar modules produce power when exposed to light - cover them with opaque material 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 outdoors from the battery compartment. The battery enclosure should be designed to prevent accumulation and concentration of hydrogen gas in "pockets" at the top of the compartment. Vent the battery compartment from the highest point. A sloped lid can also be used to direct the flow to the vent opening location.
7. NEVER 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 10 AWG (5.3 mm^2) gauge copper wire and rated for 75°C or higher. Battery cables must be rated for 75°C or higher and should be no less than 2/0 AWG (67.4 mm^2) gauge. Crimped and sealed copper ring terminal lugs with a 5/16 hole should 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. Torque all DC cable connections to 12 foot-pounds. Be extra cautious to reduce the risk of dropping a metal tool onto batteries. It could short-circuit the batteries or other electrical parts resulting in sparks that could cause an explosion.

10. Symbols used in this manual and on the inverter/charger are:



Chassis Phase AC Output AC Input

1. Tools required to make AC wiring connections: Wire strippers, 1/2" (13MM) open-end wrench or socket, Phillips screwdriver #2, Slotted screw driver 1/4" (6MM) blade.
2. This inverter/charger is intended to be used with a battery supply of nominal voltage that matches the last two digits of the model number, e.g.. 24 volt with a SW4024 or 48 volts with a SW4048, etc.
3. Instructions for wall mounting: See mounting instruction section of this manual. **NOTE:** Do not use only the keyhole mounting slots for permanent installations. For battery installation and maintenance: read the battery manufacturer's installation and maintenance instructions prior to operating.
4. AC or DC disconnects may not be provided as an integral part of this inverter. Both AC and DC disconnects must be included as part of the system installation. See **AC and DC WIRING** section of this manual.
5. No overcurrent protection for the battery supply is provided as an integral part of this inverter. Overcurrent protection of the battery cables must be provided as part of the system installation. See **SYSTEM SAFETY WIRING REQUIREMENTS** section of this manual.
6. No over current protection for the AC output wiring is provided as an integral part of this inverter. Overcurrent protection of the AC output wiring must be provided as part of the system installation. See **SYSTEM SAFETY WIRING REQUIREMENTS** section of this manual.
7. **GROUNDING INSTRUCTIONS -** This battery charger should be connected to a grounded, permanent wiring system. For the most installations, the negative battery conductor should be bonded to the grounding system at one (and only one point) in the system. All installations should comply with all national and local codes and ordinances.

Personal Precautions

1. Someone should be within range of your voice to come to your aid when you work near batteries.
2. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
3. Wear complete eye protection and clothing protection. Avoid touching eyes while working near batteries. Wash your hands when done.
4. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cool water for at least 15 minutes and get medical attention immediately.
5. Baking soda neutralizes lead acid battery electrolyte. Vinegar neutralizes spilled NiCad and NiFe battery electrolyte. Keep a supply on hand in the area of the batteries.
6. **NEVER** smoke or allow a spark or flame in vicinity of a battery or generator.
7. Be extra cautious to reduce the risk of dropping a metal tool onto batteries. It could short-circuit the batteries or other electrical parts that may result in a spark which could cause an explosion.
8. 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.
9. 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.

Introduction

Congratulations! You are the proud owner of the finest inverter system on the market today - and one very complex piece of equipment. The Trace Engineering Utility System inverter/charger has many features and capabilities previously either non-existent, or found only in separate products.

The Utility System is a special packaged version of our standard SW series product. It is available for use with a solar array with batteries (the "standard" versions), or without batteries (the "***PV***" versions). See the attached price list for more information at the end of this manual.

With proper installation, the inverter will typically operate satisfactorily for many applications straight out of the box using the factory default settings. To fully utilize the inverter's utility inter-active capabilities, it is necessary to understand the way the inverter operates and then tailor its operation via the control panel and the user and setup menu systems. This manual will provide the necessary information. However, it is recommended that you consult with your authorized dealer to ensure correct installation and maximum utilization of the numerous features of this product. If you do not understand any aspect of installation and your authorized dealer/installer is not available, please contact Trace Engineering for assistance.

If you intend to operate the inverter in a utility inter-active mode in which power will be sold to the utility, you must contact your local utility office and get their approval. The utility may require additional information that may not be included in this manual. Please contact your dealer or Trace Engineering for assistance.

This is a long manual and much of it is fairly technical. If you are an insomniac, properly used, this manual is guaranteed to provide several good nights of sleep.

Battery vs. Battery-less Operation

Two types of Utility Systems are available - ones that are designed to work with batteries and ones that are designed to work without. The battery version of the Utility System use standard SW series inverter/charger. The battery-less versions use a modified version of the 48 volt DC input SW series inverter/chargers that includes different software. The battery-less inverters are designated by the ending of "***PV***" in the model number (for example: ***SW5548PV***).

To allow operation without a battery, an additional filter capacitor is added to the inverter on the DC input of the inverter. This capacitor has to have a very low ESR and be able to handle high ripple current without overheating. The capacitor is custom made for Trace Engineering specifically for the SW series battery-less inverter.

When operating without a battery, the inverter can only "sell" the power of the solar array into the utility grid - it can not provide a utility back-up function or store power to "sell" later.

The operation without a battery is desirable to many customers for three reasons. First, the system is less expensive. Secondly, the system is easier to install and locate without the issues of locating the batteries and enclosing them. Finally, the inverter can operate at the solar array's maximum power point since the operating voltage is not restrict by batteries.

In order to allow the use of the same hardware for the battery and battery-less version, the solar array must be configured to have a maximum power point of approximately 48 volts DC and an open circuit voltage not exceeding 75 volts DC. This typically is achieved by connecting three "12 volt" solar panels in series. This is usually equal to 108 cells in series. The inverter is capable of tracking the solar arrays peak power point from 34 to 68 volts.

The addition of a battery to the system allows it to provide a utility back-up ability for only a small additional cost. This may be attractive to some customers. With the Utility System enclosure, either configuration is possible with much of the same parts and system design. If your Utility System includes the battery version of the SW series inverter, you will also need the standard SW series manual in addition to this manual.

Battery-less System Software Differences

The battery-less system inverter includes a different version of software that controls the operation of the system. There are no user or installer adjustable settings in the menu - all settings are preset or self-adjusting.

The overall operation is similar to that of the standard SW series inverter with Rev 4.01 software. The most noticeable difference is the lack of an ***ON/OFF*** menu and the ***SETUP*** menu. To turn the inverter off, disconnect the AC and DC power sources by turning the disconnects to the ***OFF*** positions. The inverter will shut off after a few second of delay.

All of the menu items and menu headings that are not applicable to battery-less operation have been removed to reduce confusion. All remaining items operate the same as the battery version.

See the Version 4.01 manual for the SW series for more detailed explanation of each menu item and for Utility Systems which include the standard version of the SW series inverter for use with batteries.

Over Voltage Protection for the Battery

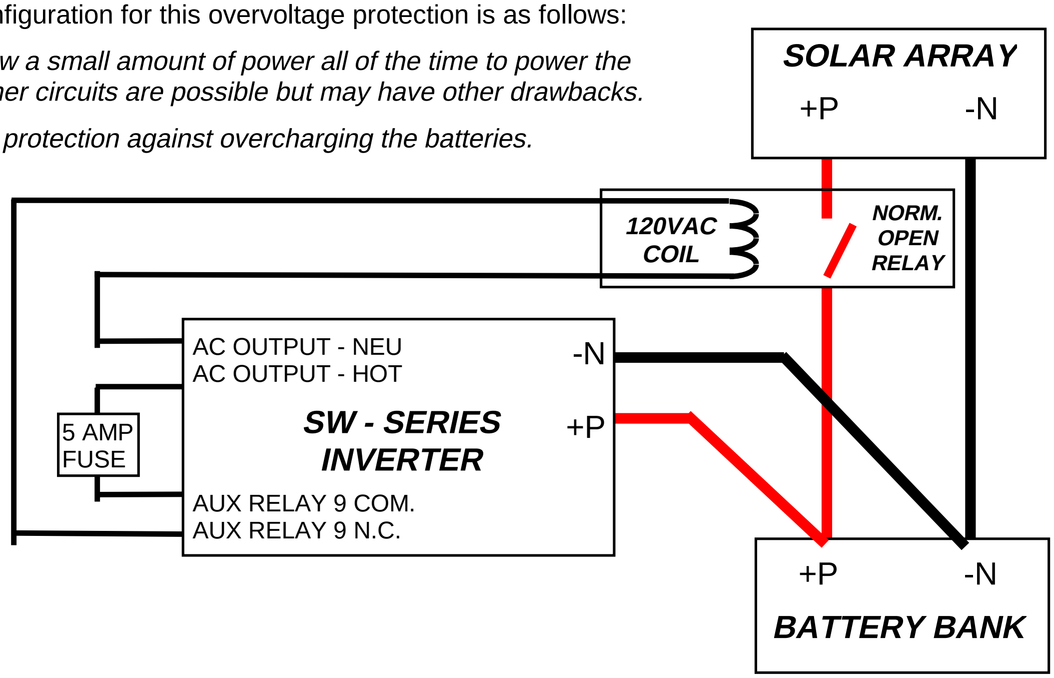
Normally, the inverter will regulate the charging process of the battery by selling excess power into the utility grid. The battery will receive a three-stage charge routine as previously described. If the utility grid is not available (due to an outage or tripped AC input circuit breaker, etc.) or if the inverter shuts off, then the inverter is not able to sell the excess power and the battery voltage will not be regulated, resulting in possible overcharging of the battery.

Therefore, a separate control is required to provide overvoltage protection for the battery when an outage has occurred. The SW series inverters do include three auxiliary relays designed to control an externally connected power relay that would disconnect the solar array and stop the charging process. The voltage and hysteresis are both adjustable. The external relay can be either a standard mechanical type or a mercury displacement type, depending on the voltage and current required. The mercury displacement type relay is usually required when the system voltage is 48 VDC or if the current of the solar array exceeds about 20 amps. Multiple relays can be used if the solar array is divided into several source circuits (do not parallel relays for higher current). Another option is to use a charge controller such as the Trace C40.

A typically wiring configuration for this overvoltage protection is as follows:

This circuit does draw a small amount of power all of the time to power the coil of the relay. Other circuits are possible but may have other drawbacks.

This circuit provides protection against overcharging the batteries.



Operation

The inverter's operation is controlled by three microprocessors operating in a distributed control approach. Each processor controls a different part of the inverter's operation. The software for the microprocessors is different for the battery vs. the battery-less versions.

For information on the battery version's operation, please review the standard SW series owner's manual. It fully explains all the various ways the inverter can be operated with the utility grid.

Battery-less Versions

The battery-less version of the Utility System is fairly simple. There are no user adjustable settings required – the operation of the inverter is fully automatic. Some adjustable parameters are included to allow troubleshooting and verification of the inverter's operation. These adjustments will be reset each day since the inverter turns off each night and reboots each morning, resetting all the settings back to the default values.

Meters

Several meters are available for monitoring the inverter's operation from the front panel of the inverter. The battery-less version includes the following displays.

Output Amps AC

The amount of power flowing into or out of the inverter to the utility grid is displayed. If the current is flowing into the utility grid, the value will be shown as a negative value. If the current is flows into the inverter from the utility, the display will be positive. This should only occur for a short period of time before the inverter shuts off. This can be easily accessed by pressing the red button on the display.

Output Volts AC

The AC output voltage of the inverter is displayed. This is useful to check if the inverter is disconnecting itself from the utility grid.

Input Volts DC

The voltage of the DC source is displayed for reference and monitoring. This can be easily accessed by pressing the green button on the display.

Grid AC1 Volts AC

The voltage of the utility is displayed. This value will be close or the same when the inverter is connected. Before connecting, the value will wander until the inverter has synchronized with the utility grid (this takes a couple of seconds usually). If the inverter has dropped, the utility grid due to voltage being to high or low, the voltage of the grid and the inverter voltage will differ.

Read Frequency HZ

The frequency of the inverter will be displayed here. This will be the frequency that the inverter is operating at itself. If the inverter disconnects itself from the utility, then the frequency shown will be the inverters, not the utility's. This display can be useful for troubleshooting or verifying the correct operation.

LED Indication

Several LED indicators are provided for the monitoring of the inverter. The LED indicators are different for the battery-less version. For the battery version, see the standard SW series inverter owner's manual.

AC 1 IN GOOD

This LED will be solid when the inverter detects AC voltage on its AC1 input terminals. It does not indicate if the inverter is connected to the utility grid. If the LED blinks, it indicates that a poor connection has been made or that the utility is fluctuating on and off.

LINE TIE

This LED indicates that the inverter is in the utility connection mode and that it will send power into the utility grid. It will blink when the inverter is active but not connected. Once connected, it will remain solid. If the utility grid voltage or frequency drifts out of tolerance, the inverter will disconnect and the LED will blink until the utility grid returns to a stable and acceptable condition. It will also disconnect when the utility has an outage. The inverter will delay reconnection for up to 90 seconds once the utility power has returned.

ERROR

This LED indicates that the inverter has shut down due to an error condition. All errors are auto resetting, although a significant delay may occur with some of the shutdowns to prevent cycling. The actual error condition is displayed in the ***ERROR MENU HEADING*** and is indicated by showing a ***YES*** after the error condition.

OVERCURRENT

This LED indicates that the inverter has reached its AC output limit and has shut down. This is typically caused by a short circuit on the output or a utility failure or blackout. The inverter will disconnect itself from the utility grid and should automatically reset.

All other LED indicators present (*BULK, FLOAT, AC2 IN GOOD*) are not used with the battery-less version of the inverter.

Islanding Protection

All of the SW series inverter/charger include the following protective systems. These systems are used to protect the inverter and the installer / operator / utility line-person from hazardous conditions.

The standard protection is as follows:

- **Grid shorted** - Normally, when the utility power fails, the inverter momentarily tries to power the entire neighborhood. This condition looks like a short circuit to the inverter and causes it to reach the overcurrent protection setting and shuts off. It then opens its internal relay and disconnects from the utility grid. This protective system operates instantly.
- **Grid open** - The inverter can tell when there is no current being delivered to the grid and it will disconnect. This is used when a disconnect switch is opened or the power line which feeds the installation is cut. This protective system operates instantly.
- **Islanding** - This occurs when the grid has failed and the "neighborhood" that the inverter is powering requires a power level that the inverter can supply. This condition is often called "islanding". The islanding detection circuit checks grid condition on each cycle. The inverter watches the utility grid and waits for it to rise a couple of volts before it begins to invert again. This is done on each cycle when ***SELL*** mode is activated. Typically, disconnect is achieved in a few cycles after the utility has failed. If a large electric motor is connected, it may provide enough generator capacity that the inverter thinks the grid is still connected. This can fool this protective system. Two additional protective systems are provided to then handle this condition, over / under frequency and over / under voltage detection.
- **Over / Under Frequency -** Since the inverter is locked onto the frequency of the utility grid, the frequency of the islanding system will drift out of regulation in a short amount of time during an islanding condition. This protective system may require a couple of seconds to respond. The settings are 58.5 and 61.5 Hertz for 60 Hertz models (48.5 and 51.5 Hertz for 50 Hertz models) and are not adjustable.
- **Over / Under Voltage -** Since the inverter does not try to regulate the voltage of the utility grid while selling power into it, the AC voltage will drift out of regulation in a short amount of time during an islanding condition. This protective system may require a couple of seconds to respond. The default settings are 108 VAC as the lower limit and 132 as the upper limit. These settings are not adjustable on the "PV" versions but are reset to the factory default values the next day. For systems with batteries, the values are fully adjustable.

AC Wiring and Disconnects

Overview

In the U.S., the National Electrical Code (NEC) defines the standards for both the AC and DC wiring in residential and commercial applications. It will list the requirement for wire sizes, overcurrent protection and installation methods and requirements. Your local utility may also have additional requirements.

All installations should meet all local codes and standards and be completed by qualified personnel such as a licensed electrician. Even though the DC electrical system may be "low voltage", significant hazards may be present, particularly from short circuits of the battery system. Inverter systems by their nature involve power from multiple sources (inverter, generator, utility, batteries, solar arrays etc.) that add hazards and complexity which can make the installation challenging.

Available AC Output Voltages and Disconnect Size & Type

Trace Engineering offers the Utility Systems with a wide variety of AC output voltages and configurations. The model number of the inverter indicates the AC output voltage of the inverter. The output voltage also dictates the type of AC disconnect circuit breaker that is provided or required if not included.

The following table summarizes the possible versions:

Version	Output Voltage / Frequency	AC Disconnect Size	Breaker Model
Standard	120 VAC / 60 HZ	60 amp / Single Pole	Heinemann CD60AC
"J"	105 VAC / 50 HZ	60 amp / Single Pole	Heinemann CD60AC
"K"	105 VAC / 60 HZ	60 amp / Single Pole	Heinemann CD60AC
"U"	240 VAC / 60 HZ	35 amp / Two Pole	Square D - QOU235
"E"	230 VAC / 50 HZ	35 amp / Two Pole	Square D - QOU235

External AC Disconnects

For utility connected systems, many utilities require an externally mounted AC disconnect for the inverter system. This AC disconnect is often required to be located next to the inverter or near the AC service entrance or kWh meter. To simplify the installation, Trace Engineering offers the Utility Systems with a built-in AC and DC disconnect circuit breakers mounted on each side of the outdoor enclosure with lockable, flip-up type outdoor covers. These disconnects may be acceptable to the utility to meet the requirement for external disconnects. If not acceptable, then additional disconnects must be provided. This often occurs if the inverter is in a different area than the service entrance or meter. Some utilities only require that the service entrance be permanently marked with a note showing the presence and location of the inverter system.

AC Connections for 120 VAC Output Models

The ***AC HOT IN 1*** terminal must be connected to the ***AC HOT*** of the utility grid. This is typically the black wire. If the system includes a circuit breaker disconnect for the utility grid, then the ***AC HOT IN 1*** terminal will be prewired to a 60 amp circuit breaker located on the left side of the enclosure under a flip-up type cover. The utility ***AC HOT*** conductor must then be connected to the unused terminal on the bottom of the circuit breaker. If the system does not include the prewired circuit breaker, then the ***AC HOT*** from the utility grid must be terminated on the inverter's AC terminal block. Wiring must be #6 AWG or larger if a 60 amp circuit breaker is used. Wiring must be #10 AWG or larger if a 30 amp circuit breaker is used.

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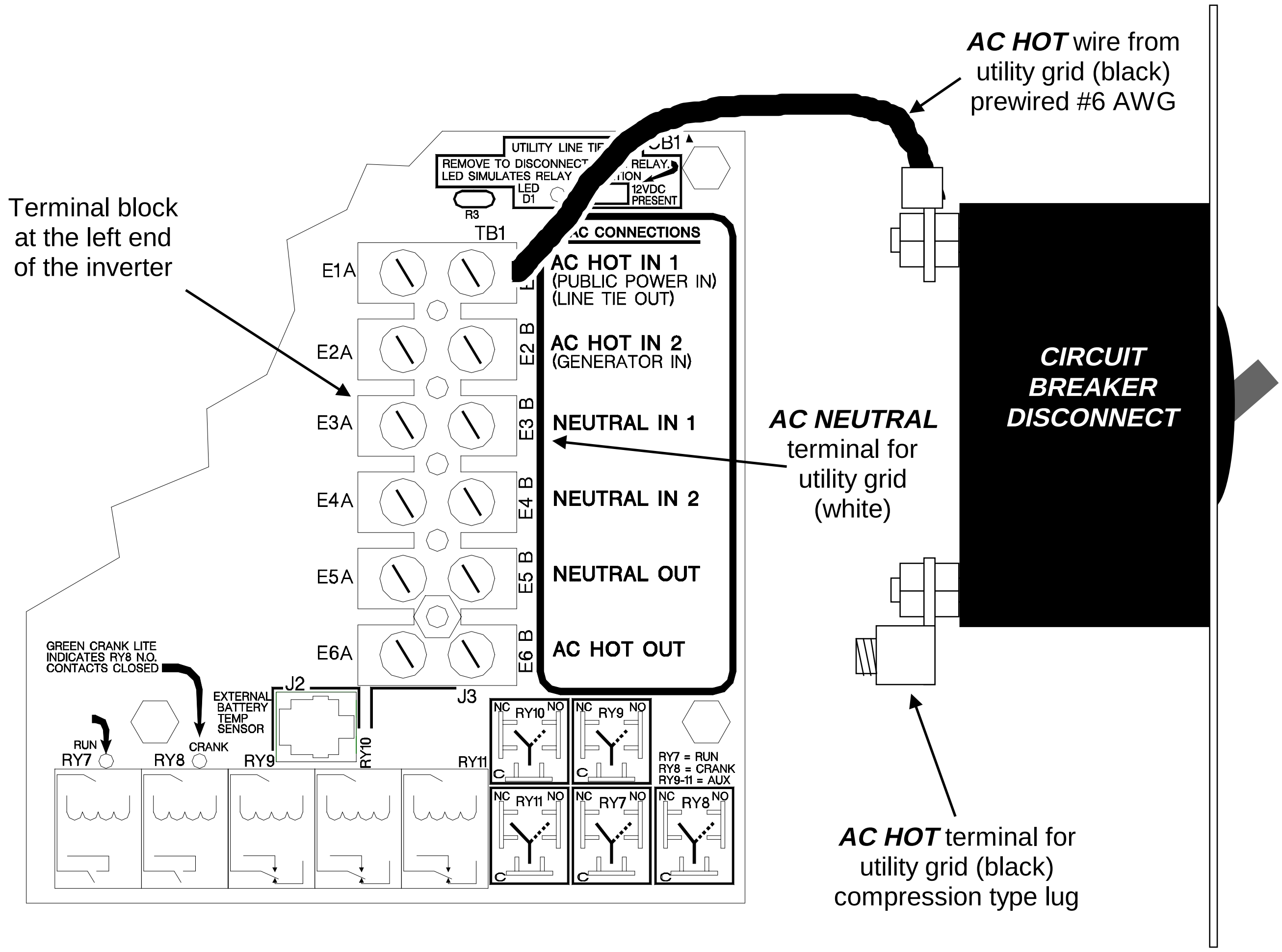
The ***AC NEUTRAL*** of the utility grid must be connected to one of the ***NEUTRAL IN*** terminals of the inverter's terminal block located at the left end of the inverter. This is typically the white wire. Since all of the ***AC NEUTRAL*** wires are common to each other, the actual terminal used does not matter. There is no connection from the ***AC NEUTRAL*** to the chassis or the ground terminal of the inverter - this connection must be made elsewhere in the system, usually at the service entrance or distribution circuit breaker panel.



DO NOT connect the utility grid to the ***AC HOT OUT*** terminals of the inverter. These are only used if a utility back-up function is being provided (which **requires** batteries to be used with the inverter).

AC Connections for 120 VAC Models with Utility Back-Up Ability

If utility back-up is being provided, then the ***AC HOT OUT*** terminal will be wired to the circuits being powered. This will require additional disconnects and/or a separate sub-panel to distribute the AC power provided by the inverter to the AC load circuits. Utility back-up is only possible if batteries are included in the system and requires our standard software version of the inverter, instead of the "***PV***" version provided for battery-less applications. The inverter is limited to "passing through" 60 amps AC for 105/120 VAC versions or 30 amps AC for 230/240 versions.

AC Connections for 240 VAC Output Models - "*U*" and "*UPV*"

The Trace Engineering SW series is also available with 240 VAC output specifically designed for utility connected applications. The 240 VAC output reduces the amount of current flowing in the AC wiring and reduces the possibility of causing an imbalance in the utility distribution step-down transformers. The 240 VAC output models are designated with a "***U***" in the model number, such as "*SW5548**U***" or "*SW5548**U**PV*" for example (other models are available).

Inverters with 240 VAC output are not able to power 120 VAC loads for utility back-up applications unless an additional transformer is included. Contact Trace Engineering for more information. Utility back-up requires a battery storage system and the standard version of the SW series inverter/charger (not the "***PV***" versions).

The ***AC HOT IN 1*** terminal must be connected to the ***AC HOT LEG 1*** conductor of the utility grid. This is typically a black wire. If the inverter system includes a circuit breaker disconnect for the utility grid, then the ***AC HOT IN 1*** terminal will be prewired to one pole of a two pole 35 amp circuit breaker located on the left side of the enclosure under a flip-up type cover. The ***AC HOT LEG 2*** conductor from the utility grid must then be connected to the other unused terminal on the bottom of the circuit breaker. This pole of the two pole 35 amp circuit breaker will be prewired to ***NEUTRAL IN 1*** on the inverter's terminal block located at the left end of the inverter. This can be done with a black or red wire (there is no connection from the ***AC NEUTRAL*** terminals to the chassis or the ground terminal of the inverter).

If the system does not include an AC circuit breaker disconnect, then the ***AC HOT LEG 1*** conductor must be connected directly to the ***AC HOT IN 1*** terminal located at the left end of the inverter's terminal block, then the ***AC HOT IN LEG 2*** conductor should be connected to the ***NEUTRAL IN*** terminal located at the left end of the inverter. External protection of the conductors must be provided separately from the inverter for both overloads and short circuits.

Do not connect any of the conductors from the utility grid to the terminal labeled as ***AC HOT OUT***. This terminal is only used for connecting AC loads if the system provides a utility back-up function. If the inverter is a 240 VAC output version, then only 240 VAC loads can be connected unless an additional step down transformer is included in the electrical system. Contact Trace Engineering for more information.

AC Connections for 230 VAC Output Models - "*E*" and "*EPV*"

The AC wiring directions for the "E" and the "EPV" versions (230 VAC / 50 Hertz output) is the very similar to those for the "U" version. The two current carrying conductors from the utility grid connect either to the 35 amp two pole breaker, if provided, or to the AC HOT IN 1 and the NEUTRAL IN 1 terminals. If no breaker disconnect is provided, an external disconnect will be required, rated at 30 amps or less.

"E" versions (with batteries) are able to provide a utility back-up function, since the AC loads are designed to operate at 230 VAC as well. Connect the AC backed-up circuits to the AC HOT OUT terminal and the NEUTRAL OUT terminals through an external disconnect or sub-panel. Battery-less "EPV" versions can not provide utility back-up.

DC Wiring and Disconnects

Safety Instructions

THIS INVERTER IS NOT REVERSE POLARITY PROTECTED. If the positive terminal of the battery or solar array is connected to the negative terminal of the inverter and vice versa, the result will be instantaneous failure of nearly every power FET in the inverter. To compound your misfortune, this type of failure is very obvious, and is not covered under the warranty. So, pay close attention, color code the cables and double-check the polarity with a voltmeter **before** making the connections.

The inverter's maximum peak current requirements are high. If wiring is too small and/or connections are loose, efficiency and maximum output power are degraded. Small cables or loose connections can cause dangerous overheating and a fire.

Color code the battery cables with colored tape or heat shrink tubing. Cables should have crimped or soldered copper ring terminals for connection to the battery (if included).

DC Disconnect and Overcurrent Protection

The Trace Engineering Utility System is available with and without a DC circuit breaker disconnect connected to the inverter and/or the ground fault protection system. This circuit breaker is located at the right side of the outdoor enclosure and is provided with a flip-up type outdoor lockable cover.

This circuit breaker disconnect is rated at a continuous current of 110 amps DC. You must calculate the maximum current available from the PV array and add at least a 25% safety margin. The total must be less than the 110 amp rating of the circuit breaker.

If a larger disconnect is required, it must be included externally to the inverter.

See your local electrical code or the NEC for more information about DC disconnect and wire sizing.

DC Ground Fault Protection (GFP)

The Trace Engineering Utility System is available with and without a DC ground fault protection circuit board. This option is mounted below the inverter and is pre-wired to the DC terminals of the inverter, filter capacitor and the DC circuit breaker disconnect. This option is provided to meet the NEC requirement for Ground fault protection when the solar array is mounted on a residential dwelling roof. It is not required for commercial buildings or ground mounted solar arrays.

The GFP detects that current is flowing in the grounding system by sensing that the current flowing in the positive and negative conductors is not equal. The threshold for tripping (sensitivity) is adjustable and is factory set at approximately 0.5 amps DC.

The GFP includes a red LED that indicates a tripped condition has occurred. To reset, press the green reset button and then release. After a short delay, the GFP will reset if the problem is not present.

For more information on the GFP, see the attached GFP manual and documentation included with this manual or call Trace Engineering for more information.

DC Disconnect For Battery Storage Systems.

The Trace Engineering Utility System does not include a disconnect for battery storage systems if used. The disconnect must be added externally if required. At the minimum, a DC rated current limiting fuse should be provided for the battery wiring if a disconnect is not included.

The battery wiring and DC fuse can be considerable smaller than used with stand alone inverter applications. This is possible because the amount of AC loads often connected for utility back-up only require a portion of the inverter's ability.

System Grounding

System grounding is often misunderstood even by system designers and electricians. The subject is more easily discussed 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.

With the Utility Systems, the chassis connects all of the internal components together. If external disconnects are used, then additional chassis ground wires will be required.

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" or 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. Connection to the ground electrode should be done with special clamps located above ground where they can be periodically inspected.

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.

The Utility Systems include a terminal for the grounding electrode conductor to connect to the grounding electrode (ground rod). It is located at the right end of the inverter's chassis. An additional grounding terminal is provided in the AC wiring compartment, but is a 1/4" stud type that requires ring terminals for connection.

Bonding the Grounding System to the Neutral and Negative Conductors

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 often called a "bond". It is usually located in the overcurrent 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.

Bonding must be done at only one point in an electrical system. Our systems inherently have two separate electric systems - a DC system and an 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. The Utility Systems are prewired with the DC negative connected to the chassis and the grounding electrode terminal. The AC utility grid input terminals are not connected to the chassis or grounding electrode terminal.

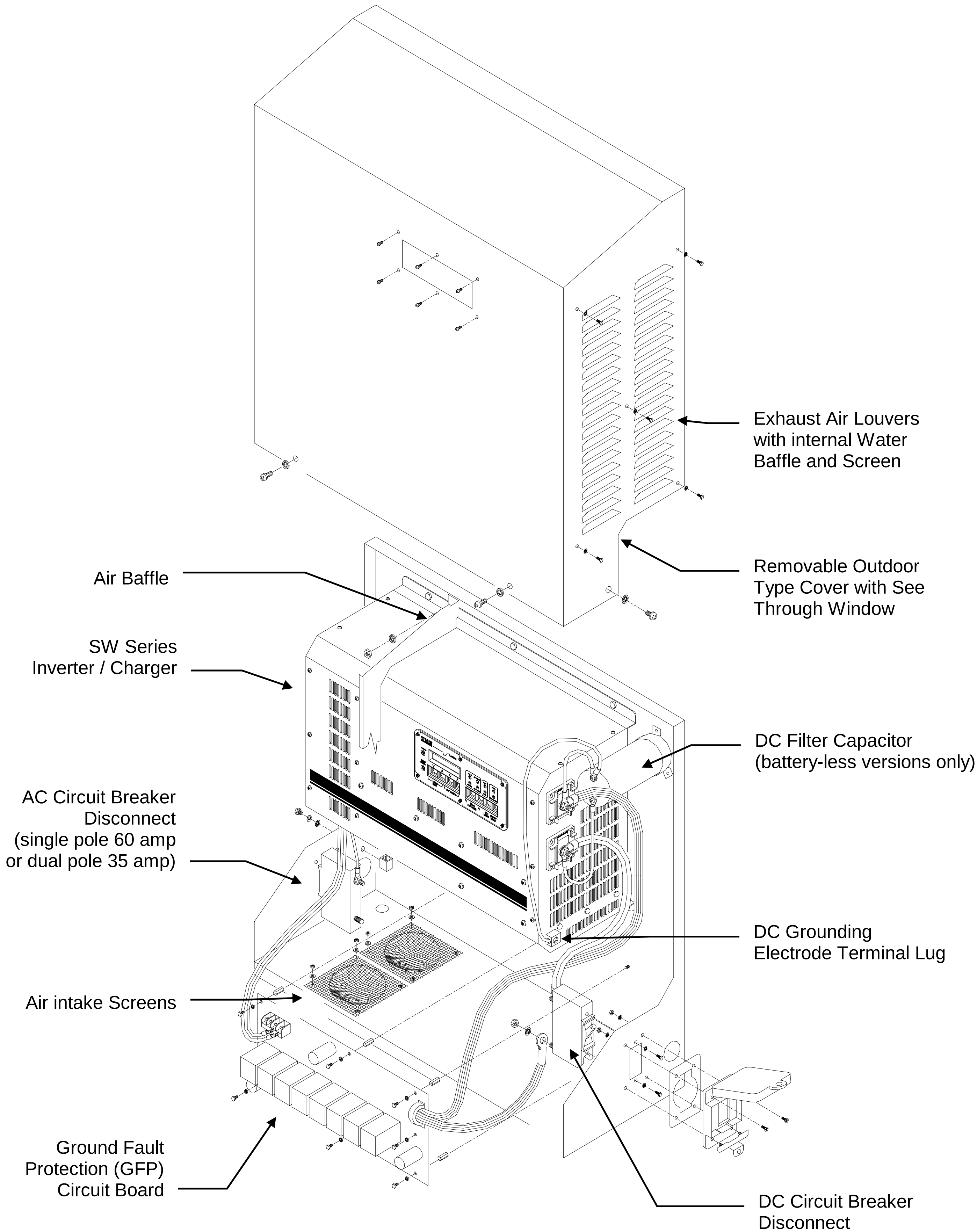
Mounting

The Trace Engineering Utility System is pre-assembled in a steel, powder coated outdoor type ventilated enclosure. The enclosure includes two flanges for mounting which have slotted holes located on 2" centers to allow for easier mounting. The size is approximately 28" wide X 30" tall X 11" deep.

The Utility systems can weigh close to 200 pounds. This requires that the enclosure be mounted with at least four #10 lag bolts into a minimum of two vertical structural members. This applies for both 16" and 24" on center spacing and for 2X4 and 2X6 construction with both load bearing and non-load bearing walls.

The bolts used to mount the enclosure must penetrate the framing members at least 1.375" or more. The actual screw length will vary depending upon the thickness of the walls covering.

To assist with the mounting process, first place a board at the level of the bottom of the enclosure. This board can be bolted to the wall or supported by additional boards. Lift the enclosure up and rest it on the board while the upper bolts are put in place. Once the top is completed, remove the board and put in the lower bolts.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Inverter / Charger
DC Filter Capacitor
(battery-less versions only)
AC Circuit Breaker
Disconnect
(single pole 60 amp
or dual pole 35 amp)
DC Grounding
Electrode Terminal Lug
Air intake Screens
Ground Fault
Protection (GFP)
Circuit Board
DC Circuit Breaker
Disconnect