



# **True Sine Wave Inverter / Charger**

**TSW Series:  
3224 (24VDC)  
4048 (48VDC)**

**User's Manual**





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## Purpose

The purpose of this Installation and Operation Manual is to provide explanations and procedures for installing, operating, maintaining, and troubleshooting TSW series of Inverter/charger.

## Scope

The Manual provides safety guidelines, detailed planning and setup information, procedures for installing the inverter, as well as information for operating and troubleshooting the unit. It does not provide details or suggestions on specific brands of batteries – consult individual battery manufacturers for this information.

## Audience

This manual is intended for anyone who needs to install and operate the TSW inverter/charger. Installers should be certified electricians or technicians.

## Conventions Used

### **WARNING**

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

Les avertissements identifient les conditions ou les pratiques qui pourraient avoir comme conséquence le dommage corporel ou les pertes humaines.

### **CAUTION**

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

Les attentions identifient les conditions ou les pratiques qui pourraient avoir comme conséquence les dommages à l'unité ou à tout autre équipement.

### **IMPORTANT**

These notes describe things that are important to know, but not as serious as a caution or warning.

Ces notes décrivent les choses il est importante savoir que, mais pas aussi sérieux qu'une attention ou un avertissement.

## Abbreviations and Acronyms

<b>AC</b>	<b>Alternating Current</b>	<b>PV</b>	<b>Photovoltaic</b>
<b>ASNET</b>	<b>Apollo Solar Network Interface</b>	<b>GFP</b>	<b>PV Ground Fault Interrupter</b>
<b>COM</b>	<b>COMmunications Port</b>	<b>RE</b>	<b>Renewable Energy</b>
<b>DC</b>	<b>Direct Current</b>	<b>RMA</b>	<b>Return Material Authorization</b>
<b>LED</b>	<b>Light Emitting Diode</b>	<b>TSW Inverter</b>	<b>TSW series Inverter/charger</b>
<b>LCD</b>	<b>Liquid Crystal Display</b>		

# IMPORTANT SAFETY INSTRUCTIONS

*INSTRUCTIONS DE SÉCURITÉS IMPORTANTES*

## SAVE THESE INSTRUCTIONS

## CONSERVER CES INSTRUCTIONS

### General Precautions

1. Before using the TSW inverter, please read all instructions and cautionary marks on (1) the inverter, (2) the batteries, and (3) all appropriate sections of this instruction manual.
2. Do not expose INVERTER 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.
3. Do not disassemble the INVERTER; take it to a qualified service center when service or maintenance is required. Incorrect re-assembly may result in risk of electric shock or fire.
4. To reduce risk of electric shock, disconnect all wiring before making any attempt to maintain or clean. Simply turning off the INVERTER will not reduce this risk.

### WARNING

5. **WORKING IN THE 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 "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 through the vent opening location.

### ATTENTION:

Une batterie peut présenter un risque de choc électrique, de brûlure par transfert d'énergie, d'incendie ou d'explosion des gaz dégagés. Suivre les précautions qui s'imposent.

6. **NEVER charge a frozen battery.**
7. **No terminals or lugs are required for hook-up of the AC wiring. AC wiring must be no less than 10 AWG (5.3mm<sup>2</sup>) gauge copper wire and rated for 90°C or higher.** Crimped and sealed copper ring terminal lugs with a 5/16 inch hole should be used to connect the battery cables to the DC terminals of the INVERTER. Soldered cable lugs are also acceptable. See section on battery cable sizing for more details for your application (see Table 4.1 page 18).
8. Torque all AC wiring connections to 30 in-lbs (3.4 N-m). Torque all DC cable connections to 5 ft-lbs (6.78 N-m). Be extra cautious when working with metal tools on or around batteries. The potential of dropping a tool causing the batteries or other electrical parts resulting in sparks could cause an explosion. Tools required for AC wiring connections: wire strippers, 1/2"(13mm) open-end wrench or socket, Phillips screw driver #2, slotted screw driver 3/16"(4.6 mm) blade.
9. The INVERTER must be used with a battery supply of nominal voltage that matches the last two digits of the model number; e.g., 24 volts with a TSW3224, and 48 volts with a TSW4048.
10. **GROUNDING INSTRUCTIONS.** This battery charger should be connected to a grounded, permanent wiring system. For 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.

## **11. Personal Precautions**

1. Someone should be within voice range when you work near batteries in case of an emergency.
2. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
3. Wear complete eye and clothing protection. Avoid touching eyes while working near batteries.  
Wash your hands when done.
4. If battery acid contacts skin or clothing, immediately wash with soap. If acid enters eyes immediately, flood eyes with cool, running water for at least 15 minutes. Immediately seek medical attention.
5. Never smoke or allow a spark or flame in the vicinity of a battery or generator.
6. Be extra cautious when working with metal tools on and around batteries. The potential of dropping a tool causing the batteries or other electrical parts resulting in sparks could cause an explosion.
7. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a battery. A battery can produce a short -circuit current, which is high enough to weld a ring or the like to metal causing severe burns.
8. If a remote or automatic generator starter system is used to disable the automatic starting circuit and/or disconnect the generator from its starting battery while servicing to prevent accidental starting during servicing.



# 1. Introduction

## 1.1 Introduction to the Inverter

The TSW series inverter is not only an inverter but also contains a powerful intelligent charger. Actually, it contains three modules in a single unit: inverter, charger and switch.

The TSW series inverter is a heavy-duty, continuous working module generating a sinusoidal wave from a 24V (TSW3224), or 48V (TSW4048) battery bank, which can supply energy to various loads such as resistive load (heater), inductive load (air conditioners, refrigerator), motors (vacuum cleaners), and rectifier load (computer). All TSW series are designed to work in heavy load condition. De-rating is not necessary. It provides a rapid and complete charging process.

The TSW series are True Sine wave Inverters, not to be confused with Modified Sine wave models on the market. Unlike the modified sine wave counterpart, a true sine wave inverter provides a pure signal which will not interfere with some of the sensitive electronic equipment currently on the market. The TSW series inverters provide a 120/240 Volt AC Split-Phase input and output. No external transformers are required for step up, step down or balancing, thus saving added costs, installation time, and several points of efficiency. The output provides 240 volts for well pumps, appliances, or shop tools while providing 120 volts for standard circuits. Either side of the output line can supply up to 75% of the total load. The input can accept the line or 240 volt AC generators. The transfer relay is internal.

The smart charger can be set with different charging profiles and battery capacities to match in various battery types and sizes. The switch module automatically diverts the energy transfer path between inverter and utility source. When the utility source is lower than the transfer level, the path switches to the inverter. Otherwise the load is conducted to the utility source. The transfer time is 1/4~1/2 of the total cycle time. The high power charger can charge a 24V/1000 AH battery bank in 10 hours (at 100A maximum for the TSW3224) or a 48V/1000 AH battery bank in 14 hours (at 70A maximum for the TSW 4048). For example, a single unit of Inverter TSW 3224 with a 1000 AH battery bank can supply a 3200W workload for over 6 hours after a charge of 10 hours. The TSW series is an extremely good choice for utility back up power. However, it also can be used as a UPS for computers.

## 1.2 Indicators and Settings

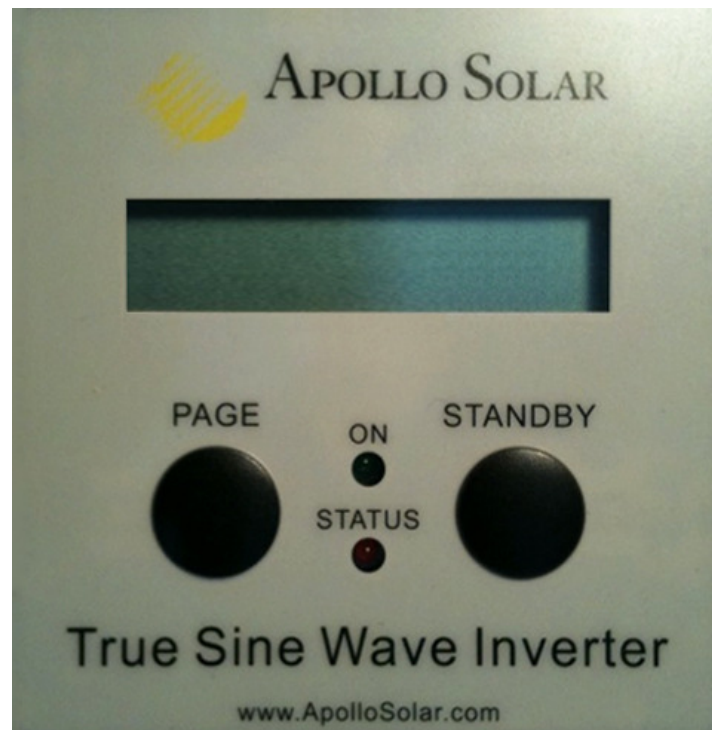


Figure 1.0: TSW Control Panel

**Display:** This is a 16 character by 2 line LCD which provides operational information and setup prompts.

**Note:** For detailed description of the LCD screens, refer to the Operation Section 5.0.

**On LED:** Glows green to indicate that the inverter is powered on (i.e. connected to the battery and receiving power).

**Status LED:** Glows red to indicate error conditions (see section 5.2.6 for descriptions)

**Page Key:** Allows the user to scroll through the various LCD screens (refer to Operation Section for description of individual screen data.

**Standby Key:** Allows the user to enter/exit standby mode.

**Audible Indication:** Provides a loud audio tone to signal mode change or error conditions.

## 2. The Battery Charger

### 2.1 Theory of Operation

The internal battery charger and automatic transfer relay allow the unit to operate as either a battery charger or inverter, but not at the same time. An external source of AC power (e.g. line power or generator) must be supplied to the Inverter's AC input in order to allow it to operate as a battery charger. When the unit is operating as a charger, AC loads are powered by the external source (i.e., generator or public power).

The Battery Charger utilizes a five stage charger algorithm (Bulk, Absorb, Float, Equalize and Standby) similar to the T80 TurboCharger. Figure 2.0 is a chart which illustrates the operation of this unit.

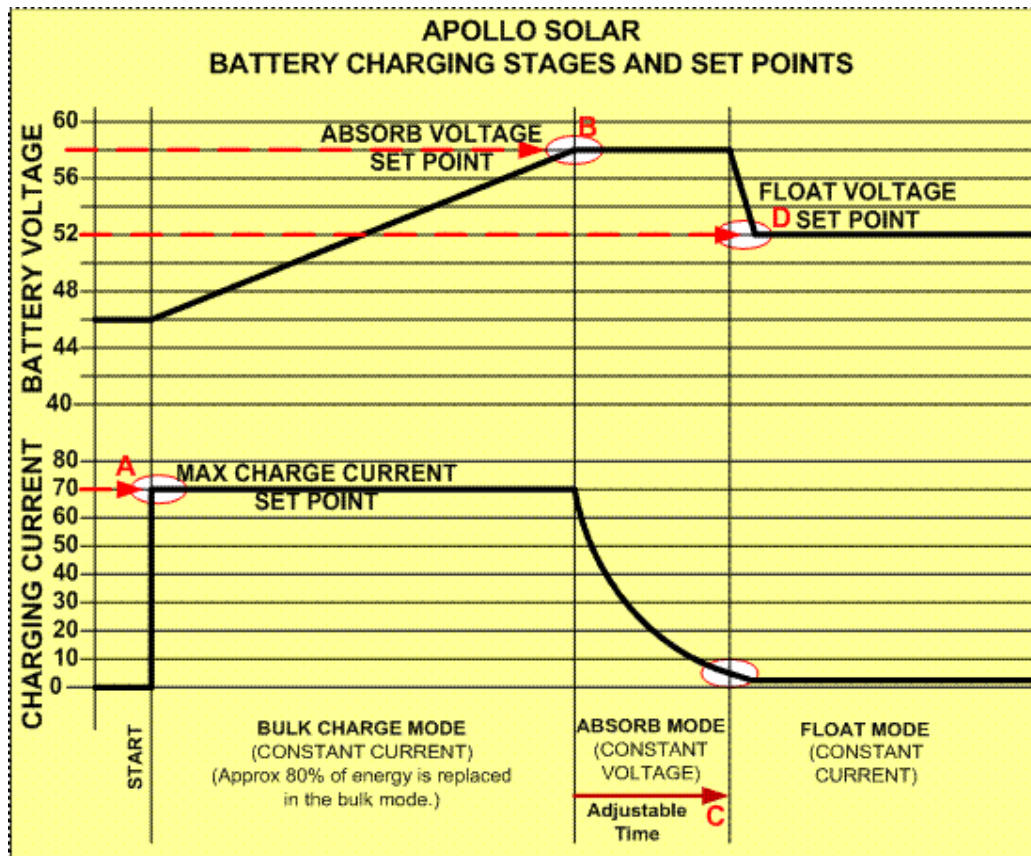


Figure 2.0: Battery Charger operation

**Bulk:** In the Bulk Mode the charger is trying to get the battery voltage up to the Absorb Voltage Setting (B). It will use all the power it can get from the AC input limited only by the Maximum Charge setting (A). When the Absorb Voltage is reached on the batteries, the charger switches into Absorb Mode.

**Absorb:** In this mode the charger will supply just enough current to maintain the Absorb Voltage setting. This current will gradually decrease over time with a constant load but can vary due to outside loads. The charger stays in absorb until the Absorb Timer counts down to 0 or for as long as the batteries were in Bulk

Mode that day which ever time is shorter. When the Timer counts down to 0 the charger goes into Float Mode (D). At this point, the charger will output a minimum current (C).

**Float:** When first switching to this mode the charger may experience a short period of 0 Amps output. This is because the Absorb Voltage is usually set higher than the Float Voltage and the controller waits for the battery voltage to drop. In this mode the Charger will supply just enough current (F) to maintain the Float Voltage setting (E). The current required to maintain the battery at this voltage is usually fairly small but as loads are applied the current will rise to try to maintain the voltage level.

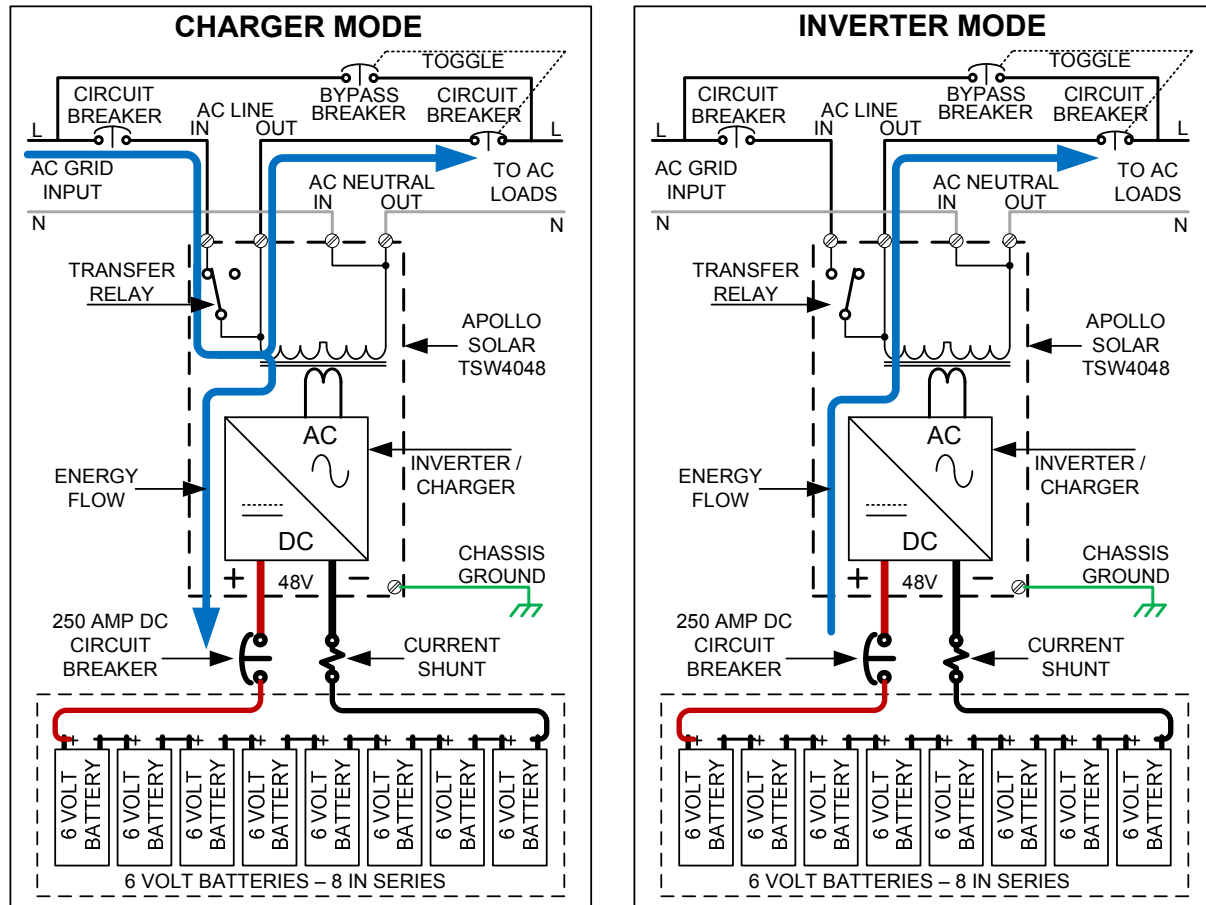
**Standby:** The charger will go into the Standby mode whenever the Standby key is depressed. AC is still provided to the output from the input.

If the ac voltage applied to the input is discontinued the Inverter switches to Invert Mode.

## 2.2 Transfer Relay

When the inverter is in charge mode, the transfer relay switches the input AC current to the output. Figure 2.1 is a simplified illustration of the transfer relay function. It illustrates how the inverter functions in both charge and invert mode.

As seen in Figure 2.1 (and illustrated by the blue arrow pathway); in charge mode, the transfer relay closes to feed input power (whether grid or generator) to the loads, and through the inverter circuit to charge the battery; whereas in invert mode, the relay is open and power is delivered from the battery through the inverter circuit.



**Figure 2.1: Battery Charger operation – Charge mode vs. Invert mode**

The following are specifications associated with the transfer relay.

### 2.2.1 Current Rating

40 Amps per leg - Note: This is an absolute maximum rating. The Default setting for maximum input current is 37.5A. The maximum input current may be adjusted with the Apollo Inverter Manager (AIM) software.

### 2.2.2 Transfer Speed

The transfer time is 1/4~1/2cycle (8ms max).

## 3. Installation

### 3.1 Installation Steps

#### 3.1.1 Selecting appropriate Location

The Inverter is a sophisticated electronic device and should be treated accordingly. When selecting the operating environment for the inverter, do not think of it in the same terms as other equipment that works with it (e.g. Batteries, diesel generators, motor generators, washing machines, etc). It is a highly complex microprocessor controlled device. It should be treated similarly to other electronic devices (e.g. entertainment equipment, computers, etc.) The use of conformal coated circuit boards, plated copper bus bars, powder coated metal components, and stainless steel fasteners allows the unit to function in hostile environments, but high humidity/varying temperature (condensing) environment should be avoided. In a condensing environment the life expectancy of the inverter cannot be determined and the warranty is voided.

#### ⚠ CAUTION

It is in your best interest 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.

#### ATTENTION

Il est dans votre meilleur intérêt d'installer l'inverseur dans un endroit protégé sec à partir des sources de température et d'humidité. L'exposition à l'eau de mer est particulièrement destructive et potentiellement dangereuse.

Locate the Inverter as close as possible to the batteries in order to keep the battery cables short. However, do not locate the inverter in the same compartment as non-sealed batteries. The Inverter may be located in a compartment with other sealed electronic equipment. Batteries generate hydrogen and oxygen. If accumulated, this combination could be ignited by an arc resulting from connection of the battery cables or by switching a relay.

Do not mount the inverter in a closed container. Unrestricted airflow is required to operate at high power for sustained periods of time. Without it, the protection circuitry will activate and reduce the maximum power available.

### 3.1.2 Inverter Mounting (Vertical)



The TSW Series inverter may be mounted vertically or horizontally. The vertical configuration is preferable when using the Apollo Solar Switch Gear. Apollo Switch Gear provides a convenient method for mounting other Balance of System (BOS) components such as circuit breakers, shunts, etc.

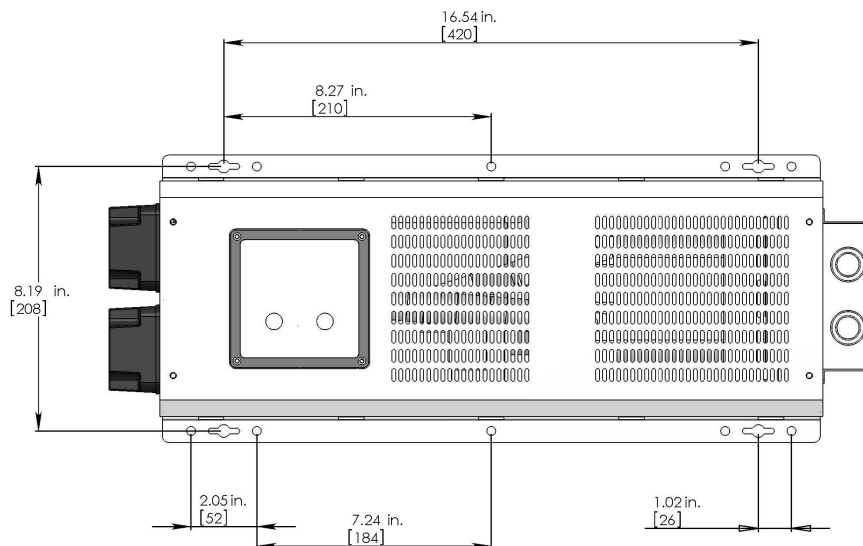
The next section shows dimensions which will aid in mounting the unit. Be sure to mount on a strong stable surface (some suggestions follow). The next section details horizontal mounting of the TSW series Inverter.

**Please Note, the TSW Series inverter is shipped with the Display/Keypad mounted for the vertical mounting configuration. To position it for horizontal mounting, please follow the steps below:**

- Remove the four (4) Display/Keypad mounting screws
- Carefully rotate the Display/Keypad 90 degrees
- Re-install the mounting screws using care not to over tighten.

Horizontal mounting is necessary when using the TSW Series Inverter as a replacement for other inverters with a similar form factor.

### 3.1.3 Inverter Mounting (Horizontal)



It is recommended that the TSW Inverter be mounted on a  $\frac{3}{4}$ " plywood sheet which is nailed or screwed into the wall studs. Ensure that the plywood spans across three wall studs for adequate support. Alternately, when mounting horizontal, two 2x4s may be placed 8" on center to mount the inverter. Again, be sure to span three studs for adequate support. Use no fewer than 6 #10 of  $\frac{1}{4}$ " lag screws to mount the inverter. It is best to locate the Inverter approximately 4 – 5 feet from the floor.

## 4. Wiring

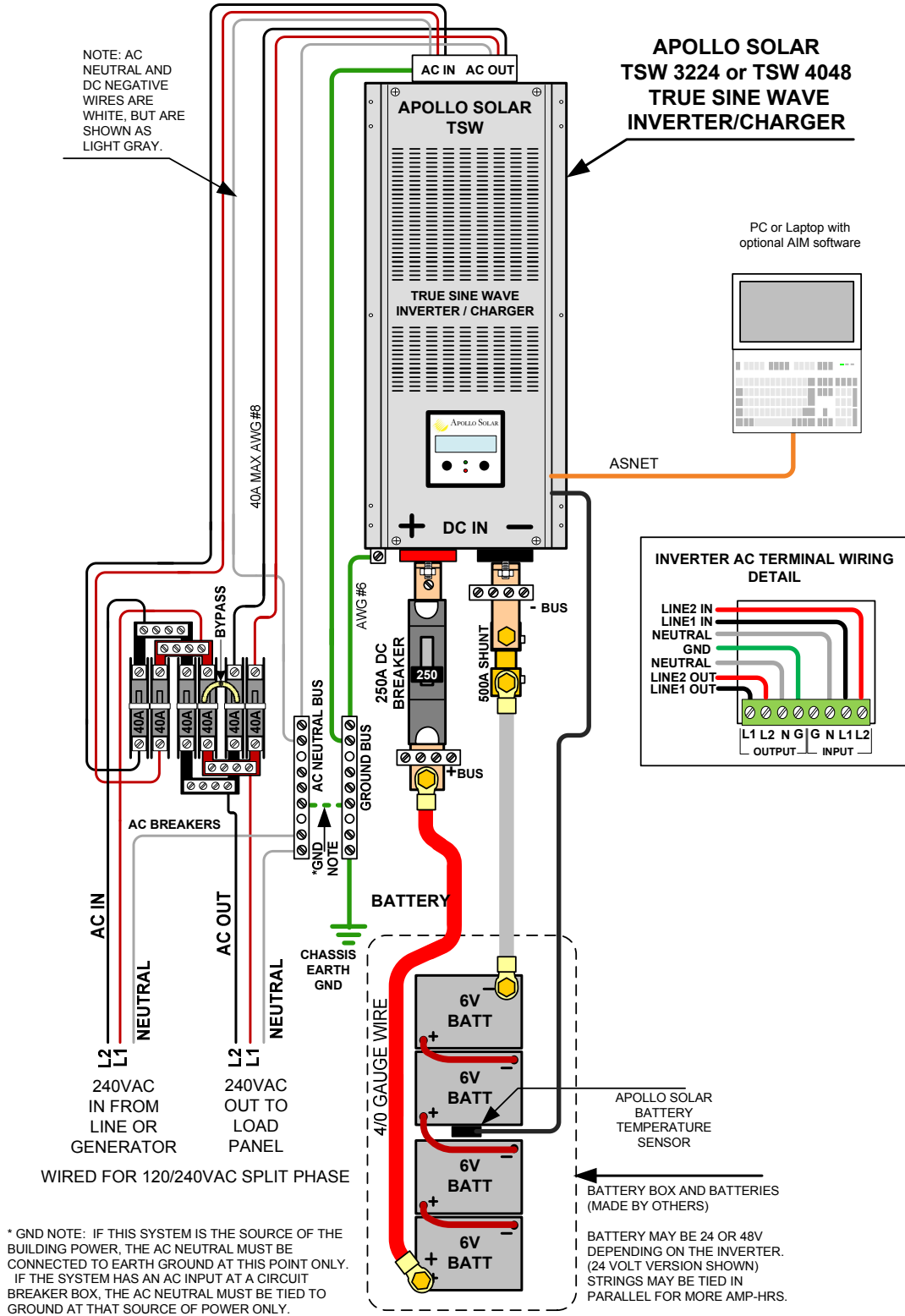


Figure 4.0: Typical system wiring of single inverter (DC ground repositioned for clarity.)





**Wiring and installation may be simplified through the use of the Apollo Inverter Switchgear Module (ISM).**

The Inverter Switchgear Module is designed to provide all the circuit breakers for each inverter and can be stacked.

It is shown here as a sub-system assembled and pre-wired by Apollo Solar, ready for installation.



The ISM also allows for ease of stacking and integration of the T80 or T80HV PV charge controller.

## 4.1 Battery Information

### 4.1.1 Battery Size

Batteries are the Inverter's fuel tank. The larger the batteries the longer the INVERTER can operate before recharging is necessary. An undersized battery bank results in reduced battery life and disappointing system performance.

Avoid discharging batteries to more than 50% of their capacity too often. Under extreme conditions, such as a severe storm or a long utility outage, cycling to a discharge level of 80% is acceptable. Totally discharging a battery may result in permanent damage and reduced life.

For stand-alone applications, battery size should provide between 3 and 5 days of storage before needing to be recharged. The power contribution from other charging sources is not included in this calculation to duplicate the conditions present during a cloudy or windless period. This is often referred to as the "number of days of autonomy." If the system is a hybrid system with daily generator runs periods then the battery size may be smaller. During cloudy periods the generator would be expected to run longer. Utilities back up applications often have very small batteries. The minimum recommended battery capacity is **100 amp-hours@24vdc**, and **50 amp-hours@48vdc**.

### 4.1.2 Battery Bank Sizing

To determine the proper battery bank size, compute the number of amp hours that will be used during charging cycles. 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, determine the amp hour requirements of each load and total them.

You can compute your battery requirements using the nameplate rating of your appliances. The 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.

If the AC current is known, then the battery amperage will be as follows:

**AC Current x AC Voltage / Battery Voltage = DC amps.**

Multiply the amperage by the number of hours that the load will operate, and you have a reasonable estimate of amp hours.

Motors are normally marked with their running current rather than their starting current. Starting current may be three to six times running current. Manufacturer's literature may provide more accurate information than the motor nameplate. For larger motors, increasing the battery size indicates that the high demand for start-ups should be required.

Follow this procedure for each individual load. Add the resulting amp hour requirements for each load to arrive at a total requirement. The minimum properly sized battery bank should be approximately double this amount. This will allow the battery to be cycled only 50% on a regular basis.

### 4.1.3 Monthly Maintenance

The level of the electrolyte of a flooded battery should be checked monthly. It should be about 1/2" above the top of the plates, but not completely full. Don't overfill the batteries or the electrolyte will seep out during charging. Refill the batteries with distilled water. Avoid "spring" water and regular tap water as they may have high mineral levels that can affect the battery chemistry and reduce life.

Check the battery interconnections for tightness and corrosion. If corrosion is found, disconnect the cables; clean them 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 (replace the caps first.)

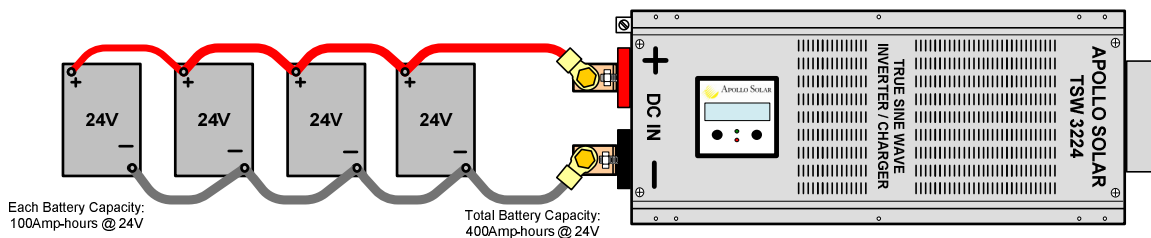
To reduce corrosion on the battery terminals, coat them with a thin layer of petroleum jelly or anti-corrosion grease available from automotive parts stores or battery suppliers. Do not apply any material between the terminal and the cable lugs, the connection should be metal to metal. Apply the protective material after the bolts have been tightened

#### 4.1.4 Battery Hook-up Configurations

Battery banks of substantial size can be configured by connecting several smaller batteries. There are three ways: parallel, series, or series-parallel.

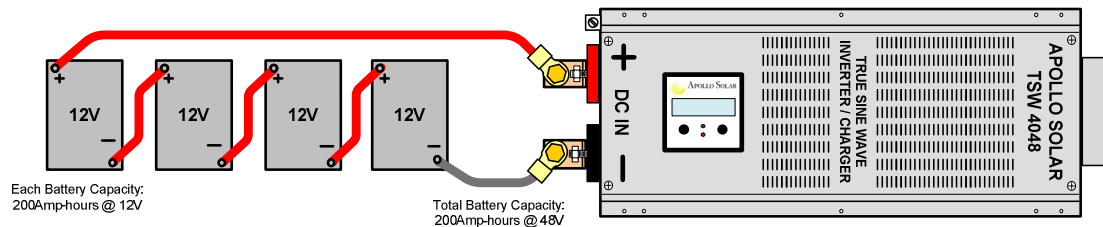
##### 4.1.4.1 Parallel Connection

Batteries are connected in parallel when all of the positive terminals and all of the negative terminals of a group of batteries are connected. In a parallel configuration the battery bank has the same voltage as a single battery and an amp/hour rating equal to the sum of the individual batteries. This is done when the battery voltage matches the inverter voltage.



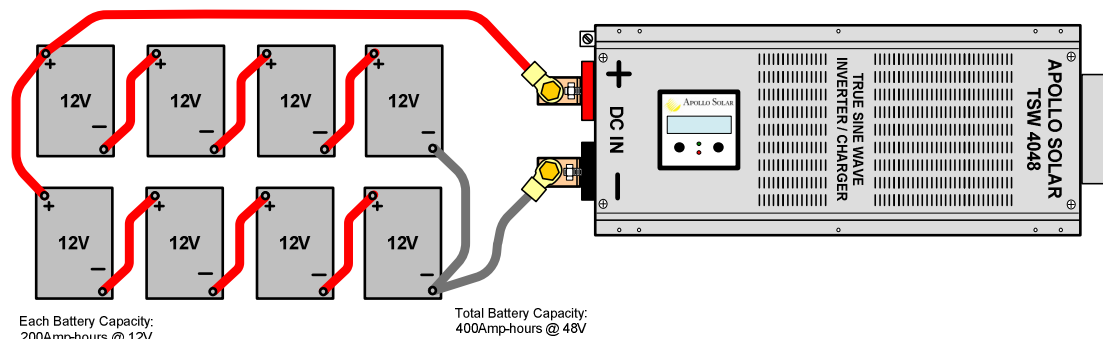
##### 4.1.4.2 Series Connection

When batteries are connected with the positive terminal of one to the negative terminal of the next, they are connected in series. In a series configuration the battery bank has the same amp/hour rating as a single battery and an overall voltage equal to the sum of the individual batteries. This is common with 24 volt or higher battery-inverter systems.



##### 4.1.4.3 Series-Parallel Connection

As the name implies, both of the above techniques are used in combination. The result is an increase in both the voltage and the capacity of the total battery bank. This is done very often to make a larger, higher voltage battery bank out of several smaller, lower voltage batteries. This is common with all battery-inverter system voltages.



#### 4.1.5 Battery Installation



Batteries can produce extremely high currents in short-circuit. Be very careful working around them. Read the important safety instructions at the beginning of this manual and the battery supplier's precautions before installing the Inverter and batteries.

#### **ATTENTION**

Les batteries peuvent produire les courants extrêmement élevés dans le court-circuit. Soyez fonctionnellement très soigneux autour de elles. Lisez les instructions de sûreté importantes au début de ce manuel et de la batterie supplier' ; précautions de s avant d'installer l'inverseur et les batteries.

##### 4.1.5.1 Battery Location

Batteries should be located in an accessible location with nothing restricting access to the battery caps and terminals. At least two feet of clearance above is recommended. Locate as close as possible to the Inverter, but do not limit access to the Inverter and the Inverter's disconnect. Do not locate the inverter in the same compartment with non-sealed batteries (sealed batteries are acceptable) as the gasses produced during charging are very corrosive and will shorten the life of the inverter.

Battery to inverter cabling should be no longer than required. For 24 VDC systems do not exceed 10 feet (one way) if 4/0 AWG cables are used. For 48 VDC systems do not exceed 20 feet (one way) if 4/0 AWG cables are used.

##### 4.1.5.2 Battery Enclosure

Batteries should be protected within a ventilated, locked enclosure or room. The enclosure should be ventilated to the outdoors from the highest point to prevent accumulation of hydrogen gasses that are released from the battery during charging. An air intake should also be provided at a low point in the enclosure to allow air to enter to promote good ventilation. For most systems a one-inch diameter vent pipe from the top of the enclosure is adequate. A sloped top can help direct the hydrogen to the vent location and prevent pockets of hydrogen from occurring. The enclosure should also be capable of containing at least one battery cell worth of electrolyte in the event a spill or leak occurs. The enclosure should be made of acid resistant material or have an acid resistant finish. If the batteries are located outdoors, the enclosure should be rainproof and have mesh screens over any openings to prevent insects and rodents from entering. Before placing the batteries in the enclosure, cover the bottom with a layer of baking soda to neutralize any acid that might be spilled in the future.

##### 4.1.5.3 Battery Cabling

**Heavy cables should be used to connect individual batteries to configure a larger battery bank.** The actual size of the cable depends upon whether the batteries are connected in parallel or series. Generally, the cables should not be smaller than the main battery cables to the inverter. E.g. If the main cables are 4/0 AWG the battery interconnects should be 4/0 AWG.

It is preferable to connect the batteries first in series and then in parallel when connecting smaller batteries. The best option is to connect the batteries both in series and parallel in a configuration often called "cross-tying". This requires additional cables but reduces imbalances in the battery and can improve the overall performance. Consult your battery supplier for more information regarding the hook-up configuration required for your system.

## **4.2 Grounding**

### **4.2.1 System Grounding**

System grounding is often the most misunderstood wiring concept. The subject is more easily discussed if it is divided into three separate subjects. The grounding requirements vary widely by locale and application. Consult local codes and the NEC (ANSI/NFPA 70) for specific requirements.

### **4.2.2 Equipment or Chassis Grounds**

This is the simplest part of grounding. This involves connecting the metallic chassis of the various enclosures 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 resulting in blown fuses or tripped circuit breakers. The size of the connecting conductors should be coordinated with the size of the over current devices involved. Under some circumstances the conduit and enclosures themselves will provide the current paths.

### **4.2.3 Ground Electrodes / Ground Rods**

There are two purposes of the grounding electrode, also known as a ground rod. The first is to "bleed" off any electrical charge that may accumulate in the electrical system. The second is to provide a path for 'induced electromagnetic energy' or lightning to be dissipated. The size of 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" (16mm) copper plated rod 6 feet (2meters) long driven in to 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. While either method may be acceptable, 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 may be used as grounding electrodes. Under no circumstance should a gas pipe or line be used. Consult local codes and the NEC (ANSI/NFPA 70) for more information.

### **4.2.4 Bonding the Grounding System to the Neutral and Negative Conductors**

This is the most confusing part of grounding. The purpose 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 North American electrical systems. You can touch this wire and the grounding system and not receive a shock. 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 over current 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 over current protection devices' enclosure. Although the point of connection 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 the point of connection is located at the service entrance panel. 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 over current device will not trip unless a "double" fault occurs. This type of system is used in some marine electrical codes.

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. Each conductor should use a separate clamp.

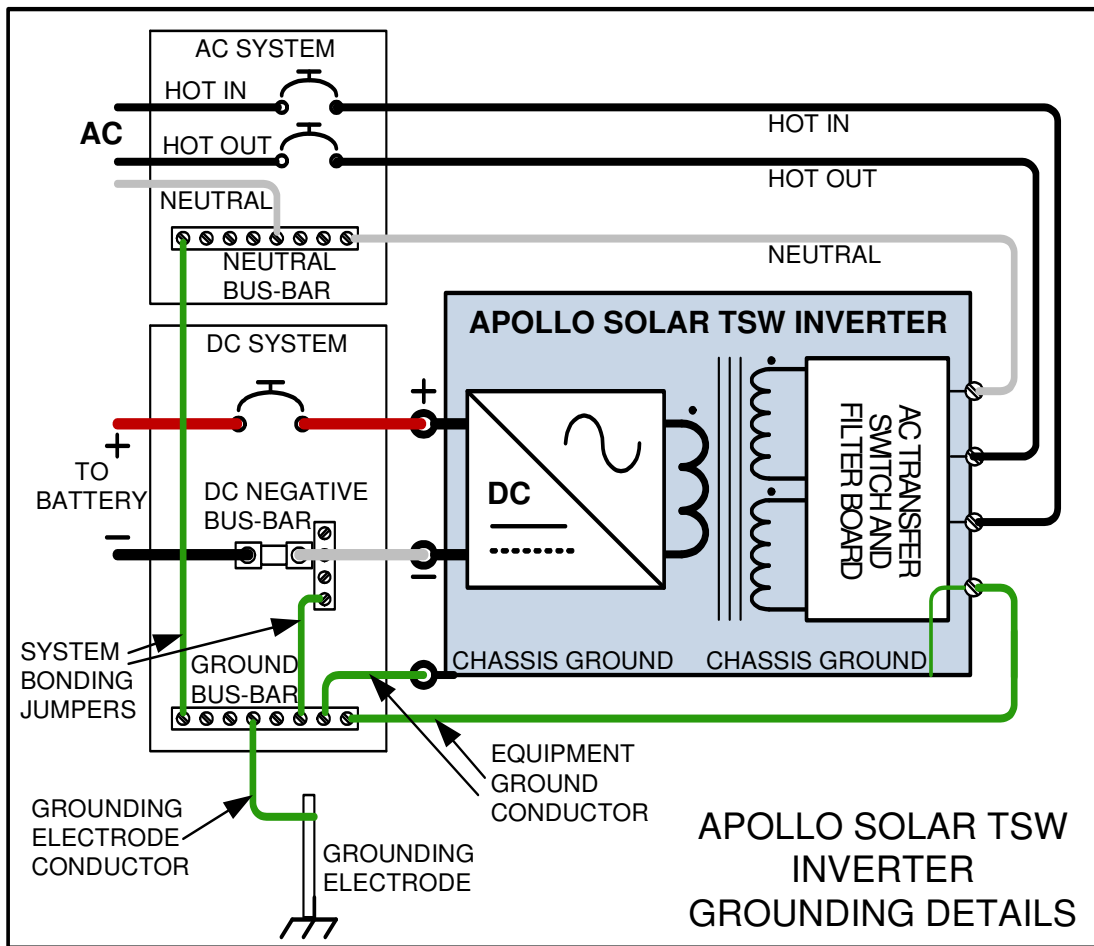


Figure 4.1: Recommended system grounding

APOLLO	DC INPUT			AC INPUT WIRING		AC OUTPUT WIRING	
MODEL	Amps	AWG	mm2	120 VAC	240 VAC	120 VAC	240 VAC
TSW3224	160A	2/0 AWG	67	40A 8 AWG	40A 8 AWG	40A 8 AWG	40A 8 AWG
TSW4048	90A	1/0 AWG	50	40A 8 AWG	40A 8 AWG	40A 8 AWG	40A 8 AWG

Table 4.1 Input/Output Ampacity and Minimum Recommended Wire Gage

### 4.3 AC and DC Wiring

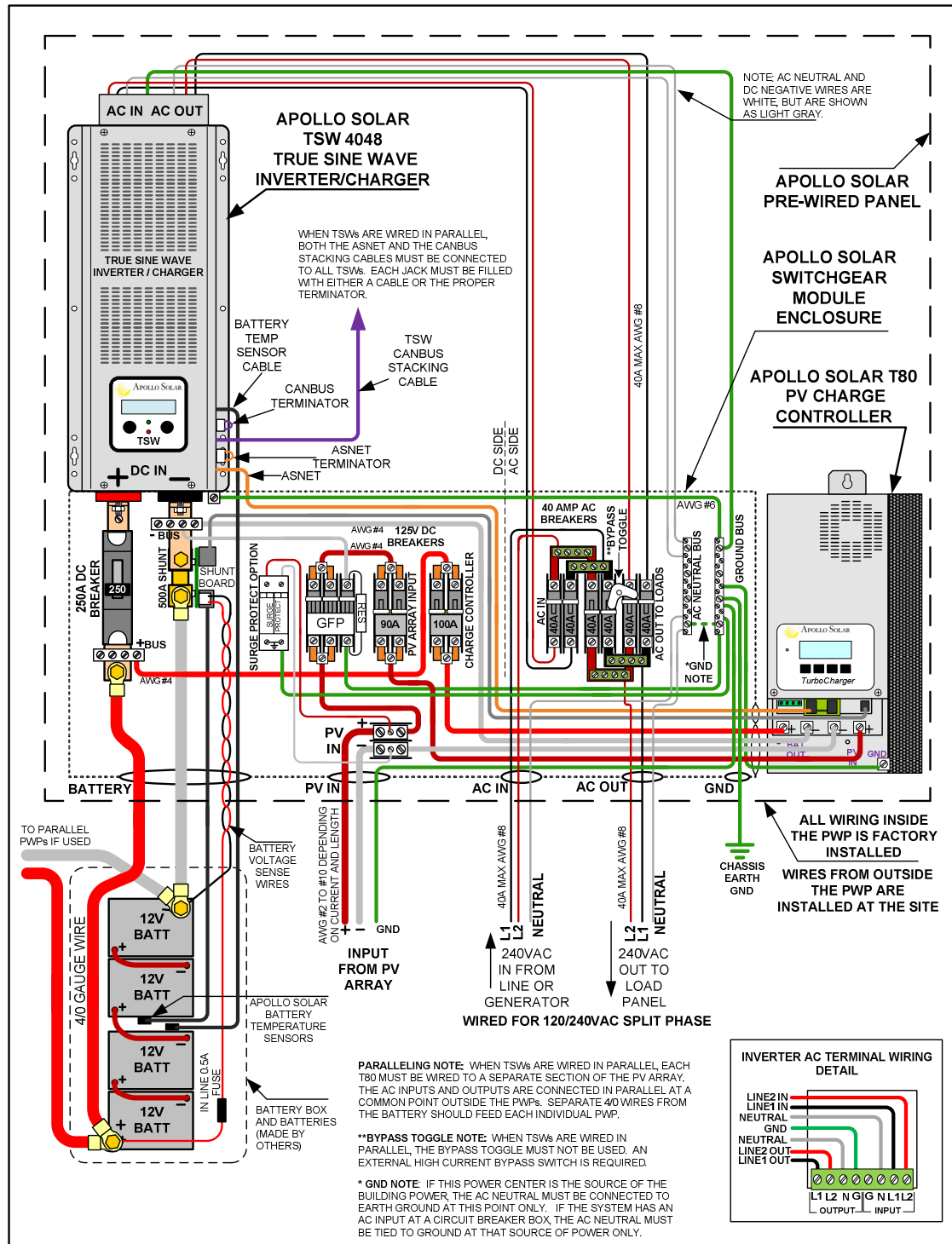


Figure 4.2: TSW Inverter with AC and DC wiring including essential circuit breakers utilizing Apollo Solar Switchgear™ and Pre-Wired Panel. The CHASSIS GND bus bar is the central ground point.

### 4.3.1 DC Wiring

#### **WARNING**

Even though DC Voltage is low voltage, significant hazards may exist, particularly from short circuits of the battery system. A 250A rated circuit breaker must be used on the DC input.

#### **AVERTISSEMENT**

Quoique la tension CC Soit basse tension, les risques significatifs peuvent exister, en particulier des courts-circuits de l'installation de batterie.

#### **CAUTION**

The inverter is NOT reverse polarity protected. Use care not to connect the negative and positive battery voltage backward or damage to the inverter will result. Verify the correct voltage polarity before connecting the DC wires.

#### **ATTENTION**

L'inverseur n'est pas polarité renversée protégée. Prenez soin de ne pas relier le négatif et la tension positive de batterie vers l'arrière ou les dommages à l'inverseur résultera. Vérifiez la polarité correcte de tension avant de relier les fils de C.C.

#### ➤ **IMPORTANT**

DO NOT connect the battery cables to the inverter until all wiring is complete and the correct voltages and polarities are verified.

#### **IMPORTANT**

Ne reliez pas les câbles de batterie à l'inverseur jusqu'à ce que tout le câblage soit complet et les tensions et les polarités correctes sont vérifiées.

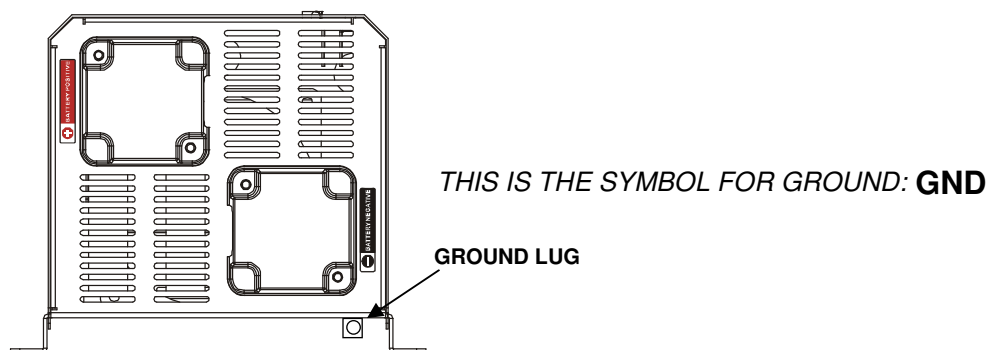


Figure 4.4: Terminals (DC Side) – Positive Top Left, Negative Bottom Right, Ground Lug Bottom Right



- When the inverter is installed in a Photovoltaic system, the NEC (ANSI/NFPA 70) requires that the DC wiring and circuit protection be sized to carry not less than 125% of the inverter's maximum current rating.
- Crimped and sealed copper ring terminal lugs with a 5/16" hole should be used to connect the DC wires to the DC terminals.
- To ensure the maximum performance from the inverter, all connections from the battery bank to the inverter should be minimized.
- All wiring to the battery terminals should be checked periodically (once a month) for proper tightness. The torque requirement is 5 ft-lb (6.78 N-m).
- Refer to Table 4.1 for proper wire sizing.

#### 4.3.1.1 DC Cable Connections

When connecting the DC cable to the battery or inverter input terminals, the cable should be placed directly against the inverter or battery terminals. Incorrectly installed hardware can cause a high resistance connection which could result in poor inverter/charger performance and/or high heat which can melt the cable and terminal connections.

#### CAUTION

Use proper torque when tightening the inverter's DC terminal nuts. Assure that the cable lug is firmly seated against the body of the connector. It is advisable to use an anti-seize lubricant to prevent binding.

#### ATTENTION

Employez le couple approprié en serrant les écrous terminaux du C.C de l'inverseur. Assurez que le crochet de câble est fermement posé contre le corps du connecteur. Il est recommandé d'employer un lubrifiant anti-grippage pour empêcher lier.

#### 4.3.1.2 Wiring the Battery Bank

#### WARNING

Lethal currents will be present if the positive and negative battery cables touch each other.

During the wiring process, ensure the cable ends are insulated or covered to avoid shorting to each other.

#### AVERTISSEMENT

Les courants mortels seront présent si les câbles positifs et négatifs de batterie se touchent.

Pendant le processus de câblage, assurez que les extrémités de câble sont isolées ou couvertes pour éviter de court-circuiter entre eux.

#### ➤ IMPORTANT

Do not connect the cables from the battery bank to the inverter until 1) all DC and AC wiring is complete, 2) the correct DC and AC current protection has been installed and 3) the correct DC voltage and polarity has been verified.

## IMPORTANT

Ne reliez pas les câbles de la banque de batterie à l'inverseur jusque 1) à tout le C.C et le câblage à C.A. est complet, 2) la protection courante correcte de C.C et à C.A. a été installée et 3) la tension CC et la polarité Correcte a été vérifiée.

Place the batteries as close as possible to the inverter, preferably in an insulated and ventilated enclosure. Allow adequate space above the batteries to access the terminals and vent caps (if flooded cells). Allow at least 1 inch of space between batteries too promote air flow. Avoid mounting the batteries directly under the inverter.

When wiring the batteries in either series or parallel (or combination) use a wire size appropriate to the charge/discharge current.

### 4.3.1.3 Battery Temperature Sensor Installation

Remove backing strip from adhesive on Battery Temperature Sensor, and attach to the side of one of the batteries in the bank (toward the center is preferable).

#### ➤ *IMPORTANT*

Do not attach to a battery terminal.

Plug the 4pin modular plug into the jack labeled Battery Temperature Sensor on the left side of the Inverter.

## IMPORTANT

N'attachez pas à une borne de batterie. Branchez la prise 4pin modulaire au cric marqué sonde de température de batterie de l'aile gauche de l'inverseur.

### 4.3.1.4 Wiring the Inverter to the Battery Bank

#### ➤ *IMPORTANT*

The DC overcurrent device (i.e. circuit breaker) must be wired in the positive DC cable line between the inverter's positive DC terminal and the battery positive terminal.

## IMPORTANT

Le dispositif de surintensité de C.C (c.-à-d. disjoncteur) doit être câblé dans la ligne positive de câble de C.C entre la borne positive du C.C de l'inverseur et la borne positive de batterie.

#### ➤ *IMPORTANT*

The shunt must be wired in the negative DC cable line between the inverter's negative DC terminal and the battery negative terminal as close to the inverter as possible.

## IMPORTANT

Le shunt doit être câblé dans la ligne négative de câble de C.C entre la borne négative du C.C de l'inverseur et la borne négative de batterie aussi étroitement à l'inverseur comme possible.

**DC Negative Cable** – Route the appropriately sized cable from the battery negative terminal to the shunt, and from the other side of the shunt to the inverter's negative DC terminal.

## ➤ *IMPORTANT*

The side of the shunt that connects to the inverter should be considered the DC negative bus in order for the State of Charge (SOC) function to operate properly.

## IMPORTANT

Le côté du shunt qui se relie à l'inverseur devrait être considéré l'autobus négatif de C.C afin de l'état de fonction de la charge (SOC) à fonctionner correctement.

**DC Positive Cable** - Route the appropriately sized cable from the battery cable terminal to the circuit breaker.

## *CAUTION*

Observe the proper polarity (line side vs. load side) on DC circuit breakers.

## ATTENTION

Observez la polarité appropriée (ligne côté contre le côté de charge) sur des disjoncteurs de C.C.

## *WARNING*

Assure that the DC circuit breaker is off when connecting the positive battery cable to avoid activating the inverter prematurely.

## AVERTISSEMENT

Assurez que le disjoncteur de C.C est oute de en reliant le câble positif de batterie pour éviter de déclencher l'inverseur prématurément.

Next route the appropriately sized cable from the other side of the circuit breaker to the positive DC terminal on the inverter.

### 4.3.2 AC Wiring

#### **WARNING**

Ensure that the DC input voltage to the inverter is not present prior to making AC connections to the inverter.

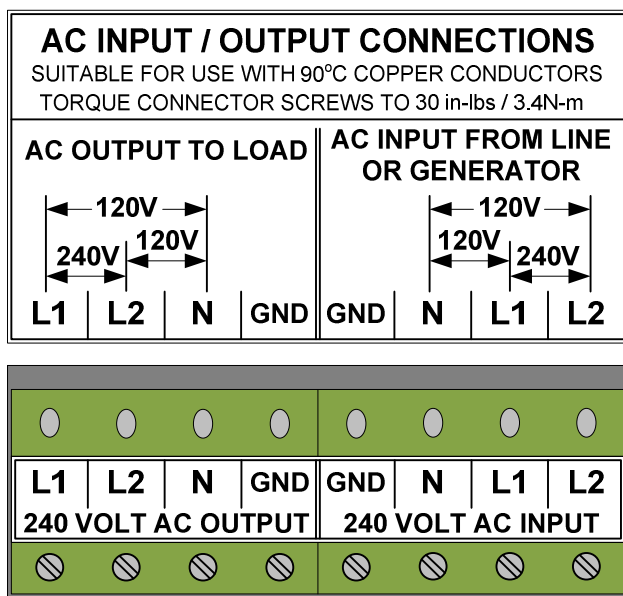


Figure 4.5: Terminal Block (AC Side)

- AC loads powered by the inverter must be installed in an electrical panel.
- Read all instructions and cautionary markings located in the beginning of this manual prior to installing the inverter and batteries.
- Always use 30 Amp rated circuit breakers.
- AC wiring must be no less than #10 AWG copper wire and approved for residential use per the NEC (ANSI/NFPA 70).
- DO NOT connect the inverter's output to an AC power source.
- Listed or labeled equipment must be installed and used in accordance with any instructions included in the listing or labeling.
- Assure that the AC output neutral is bonded to ground per NEC (ANSI/NFPA 70).

#### **CAUTION**

The inverter's internal AC transfer relay is rated at 40 Amps (each leg). The pass-thru current must be no greater than 40 Amps or damage to the relay may occur.

#### **ATTENTION**

Le relais interne de transfert à C.A. de l'inverseur est évalué à 40 ampères (chaque jambe). Passer-à travers le courant ne doit être aucune râpe que 40 ampères ou dommages au relais peuvent se produire.

#### **4.3.2.1 AC Wire Size and Overcurrent Protection**

AC input and output wiring must be sized per NEC (ANSI/NFPA 70) and local electrical safety code requirements to ensure the wires ability to safely handle the inverter's maximum load current.

Overcurrent protection devices are required to protect the inverter's input and output wiring. Since overcurrent protection is not included in the inverter, it must be added at the time of installation.

#### **4.3.2.2 AC Input and Output Wiring Connections**

Refer to Table 4.1 for proper AC input and output wiring gauge. Connect the wires from the AC terminal block (refer to Figure 4.3) to the AC circuit breakers. Please observe the proper torque rating on the terminal block. To avoid confusion (and to conform to code), use white for neutral (N), and black and red for line (L1, L2) connections. Connect Green wires from the ground (GND) terminals to the earth ground bus bar.

#### **WARNING**

Be sure to bond AC neutral to Ground.

## 4.4 Apollo TSW Inverter Stacking

There are three standard wiring configurations for the TSW Inverter:

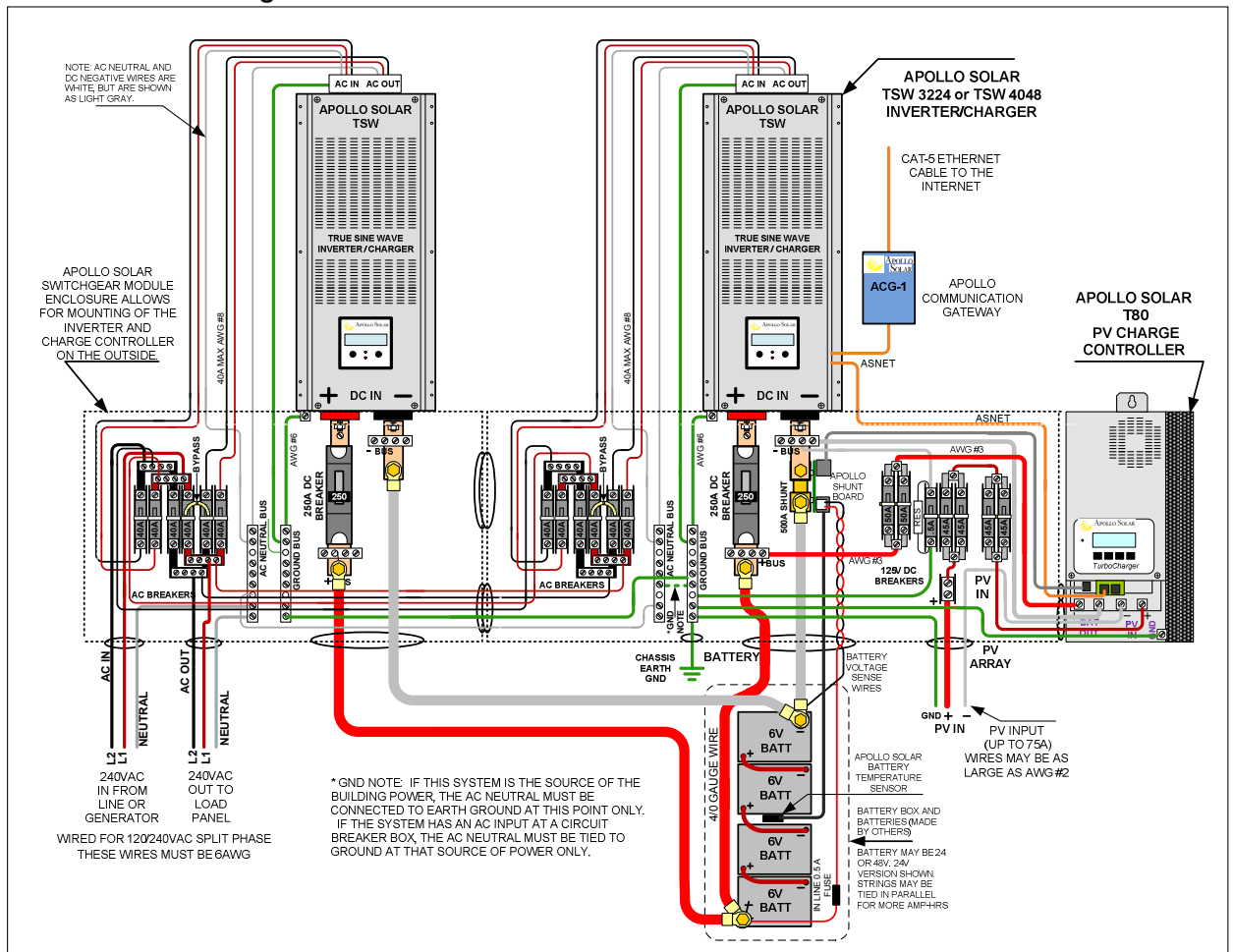
**Standalone (or single)** – This is for an application that only requires the power of a single inverter as illustrated in the previous sections.

**Parallel Stacking** – Using multiple inverters connected in parallel to increase output current. Up to eight (8) inverters may be stacked in parallel. The following sections illustrate this configuration with two inverters.

**Three Phase Stacking** – Where 208V three phase power is required. Two or three inverters can be connected for this requirement. **Note: This application is beyond the scope of this manual; please contact Apollo Solar for the Three Phase application note.**

Follow these directions when connecting multiple inverters in parallel for increased current output.

### 4.4.1 Connection diagram :



1. Use 250A breakers on the DC input and 40A breakers at AC output.
2. 4/0 AWG cable is recommended on the DC side and 8 AWG cable is recommended on the AC side. Beyond the AC combiner point, select a gauge which is appropriate for the total current.
3. Ensure that output L1/L2 connections are correct.
4. Use 6P4C 1.2m line for CAN BUS communication and terminator resistor 120Ω.
5. Be sure that each Inverter voltage and frequency setting is the same.

**Note: The following settings must be performed after the initial functional test (Section 5.1)**

#### 4.4.2 Parameter settings

1. Turn on Inverter 1 and press standby key to enter standby mode.

S	T	A	N	D	B	Y									
B	A	T	:	2	4	.	0	V							

2. Press page key 5 seconds to enter communication ID setting.

S	E	T	T	I	N	G									
C	O	M	M	.	I	D	=		X	X					

3. Press page key to change ID. Please set 32-40 for parallel used.
4. Press page key 5 seconds to enter operation mode setting.

S	E	T	T	I	N	G									
M	O	D	E	=		S	T	A	N	D	A	R	D		

5. Press page key to set PARALLEL.
6. Press page key 5 seconds to enter standby mode.
7. Set other Inverter following steps 1~6.

#### 4.4.3 Parallel Operation:

1. Auto Master setting:

When only one inverter is powered on in a parallel system, it would show 'MASTER' on LCD.

When another inverter turns on, through normal CAN BUS operation, the first inverter powered will be the master and the next becomes the slave. If both inverters power at the same time, then the inverter that initializes first will become the master.

When the master fails or is off-line, one of the slaves will become the master.

2. Average output load:

A Slave will switch from standby to output automatically based on average load on a parallel system. When the total load is over 1760W, the inverter that is in standby mode with the smallest ID will change to output mode. When the average load is under 800W, the inverter that is in output mode with the biggest ID would change to standby mode.

Below is a table of the available addresses (also known as communications IDs) available for parallel inverters.

APOLLO SOLAR TSW INVERTERS				
PARALLEL AND 3 PHASE STACKING				
TABLE FOR CANBUS ID ADDRESS FOR SETUP				
For Version 9.38 and above TSW firmware - update 2010.10.10				
ID	CANbus ID	Group	Function	phase
32	0	Group1	single phase parallel	
33	1			
34	2			
35	3			
36	4			
37	5			
38	6			
39	7			
40	0	Group2		
41	1			
42	2			
43	3			
44	4			
45	5			
46	6			
47	7			
48	0	Group3	3-phase parallel	0
49	1			120
50	2			240
51	3	Group4		0
52	4			120
53	5			240
54	6	Group5		0
55	7			120
56	0			240
57	1	Group6		0
58	2			120
59	3			240
60	4	Group7		0
61	5			120
62	6			240
63	7			

The first sixteen addresses (two groups of eight) are reserved for standard parallel stacking in the single/split phase configuration.

Addresses 48 through 62 are reserved for three phase stacking in five groups. Please note the phase sequence of each address. This is important for proper operation. **Note: Contact Apollo Solar Technical Support for information on using this configuration.**



## 5. Operation

### 5.1 Functional Test and Initial Setup

Commissioning the inverter is a simple four step process.

- **Step 1**

Confirm all wiring is correct and terminals are tight.

- **Step 2**

Check that the battery voltage and polarity is correct. Turn on the DC circuit breaker.

- **Step 3**

The unit will auto start in inverter mode within 6 seconds after power (battery) is applied. At this point, the load may be applied (turn on load circuit breakers).

- **Step 4 (Optional)**

For systems that have grid or generator connection, apply AC input. The unit should switch to charger mode.

**Refer to LCD Screen Descriptions (section 5.2) for operating details.**

#### CAUTION

Excessively high charging rate can overheat a battery. If a small battery capacity is used, set the battery charge rate to the minimum setting.

#### ATTENTION

Excessivement - le taux de remplissage élevé peut surchauffer une batterie. Si une petite capacité de batterie est utilisée comme moyen de placer le taux de charge de batterie à l'arrangement minimum.

## 5.2 LCD Screen Descriptions

### 5.2.1 Startup Screen

A	P	O	L	L	O		S	O	L	A	R		T	S	W
R	E	V	X	.	X	X		S	/	N	X	X	X	X	X

Displayed for 2 seconds when DC power is applied to TSW Inverter. Displays current operating firmware revision and Serial Number.

### 5.2.2 Initial Status Screen

A	C		2	4	0	.	0	V			0	0	.	0	A
B	A	T	:	2	4	.	0	V			X	X	.	X	A

The TSW Inverter powers up in Auto Start mode. The AC voltage, frequency and current battery voltage is displayed.

A	U	T	O	-	S	T	A	R	T						
A	F	T	E	R		5	.	0	S	E	C				

The display counts down the time until startup. After 5 seconds, the TSW enters inverter mode, and displays the Inverter Status Screen.

### 5.2.3 Inverter Mode Main Status Screen

I	N	V	E	R	T	I	N	G			X	X	X	X	V	A
2	4	0	.	0	V						6	0	.	0	H	z

Upon entering Inverter Mode, the TSW displays Main Status Screen #1 which displays total power, line to line voltage and frequency. Pressing the “Page” key switches to screen #2:

I	N	V	E	R	T	I	N	G			X	X	X	X	V	A
L	1	:	X	X	.	X	A				X	X	X	X	V	A

Main Status Screen #2; which reports total power, and AC Line 1 current and power. Pressing the “Page” key switches to screen #3:

I	N	V	E	R	T	I	N	G			X	X	X	X	V	A
L	2	:	X	X	.	X	A				X	X	X	X	V	A

Main Status Screen #3 reports total power, and AC Line 2 current and power. Pressing the “Page” key switches to screen #4:

I	N	V	E	R	T	I	N	G			X	X	X	X	V	A
B	A	T	:	2	4	.	0	V			X	X	X	.	X	A

Main Status screen #3: Battery status. Pressing “Page” cycles to screen #1.

### 5.2.4 Charger Mode Main Status Screen

C	H	A	R	G	I	N	G				6	0	.	0	H	z
A	C	:	2	4	0	.	0	V			X	X	.	X	A	

When an AC input is present, the TSW changes to Charger mode and displays Charger Main Status Screen #1; which reports the AC input status; voltage, frequency, and total current (charge current and load current).

Pressing the “Page” key switches between screens:

C	H	A	R	G	I	N	G					6	0	H	z	
L	1	:	X	X	.	X	A				X	X	X	X	V	A

Main Status Screen #2: Line 1 output (charging current, power, and frequency)

C	H	A	R	G	I	N	G					6	0	H	z	
L	2	:	X	X	.	X	A				X	X	X	X	V	A

Main Status Screen #3: Line 2 output (charging current, power, and frequency)

C	H	A	R	G	I	N	G									
B	A	T	:	2	4	.	0	V			X	X	X	.	X	A

Main Status Screen #4: Battery Status (DC voltage, and DC charge current)

### 5.2.5.1 Equalization

Equalization is entered by pressing and holding the “Page” key when Main Status Screen #4 (battery Status) is displayed.

C	H	A	R	G	I	N	G		E	Q	U	A	L	I	Z
A	C	:	2	4	0	.	0	V			X	X	.	X	A

“EQUALIZ” will be displayed for 4 seconds then change to Main Status Screen #1:

C	H	A	R	G	I	N	G		6	0	.	0	H	z	
A	C	:	2	4	0	.	0	V			X	X	.	X	A

To cancel Equalization; from Main Status Screen #4, press and hold the “Page” key for 5 seconds.

C	H	A	R	G	I	N	G		A	B	S	O	R	B	
A	C	:	2	4	0	.	0	V			X	X	.	X	A

“ABSORB” will be displayed for 4 seconds then change to Main Status Screen #1:

C	H	A	R	G	I	N	G		6	0	.	0	H	z	
A	C	:	2	4	0	.	0	V			X	X	.	X	A

### 5.2.5 Search Mode

S	E	A	R	C	H										
2	4	0	.	0	V		X	X	.	X	A				

This screen is displayed when the inverter is in Search Mode.

### 5.2.6 Error Messages

All error messages are accompanied by an audible tone.

H	E	A	T	S	I	N	K								
O	V	E	R		T	E	M	P	E	R	A	T	U	R	E

Displayed when the Heatsink temperature is too high.

T	R	A	N	S	F	O	R	M	E	R					
O	V	E	R		T	E	M	P	E	R	A	T	U	R	E

Displayed when the Transformer temperature is too high.

O	U	T	P	U	T		E	R	R	O	R	!			

Displayed if a short circuit occurs on the output.

B	A	T	T	E	R	Y									
L	O	W		V	O	L	T	A	G	E	!				

Displays if battery voltage drops below the preset LBCO level.

B	A	T	T	E	R	Y									
O	V	E	R		V	O	L	T	A	G	E	!			

Displays if battery voltage rises above the preset HBCO level.

P	A	R	A	L	L	E	L		F	A	U	L	T	!	
C	A	N		B	U	S			E	R	R	O	R	!	

Displays if a CAN Bus communication error occurs when units are stacked.

### 5.3 System Default Settings

**Battery Low Voltage Cutout (LVCO): 21.0V (TSW3224), 42.0V (TSW4048)**

**Battery High Voltage Cutout (HVCO): 32.2V (TSW3224), 64.4V (TSW4048)**

**Search Watts: 0 VA**

Setting at which the inverter will “wake up” and start inverting.

**Battery AmpHours: 400**

**Battery Type: Flooded**

**Charge Rate: 100%**

**Maximum Charge Current: 20A**

**Absorb Voltage: 28.8V (TSW3224), 57.6V (TSW4048)**

**Absorb Time: 2 hours**

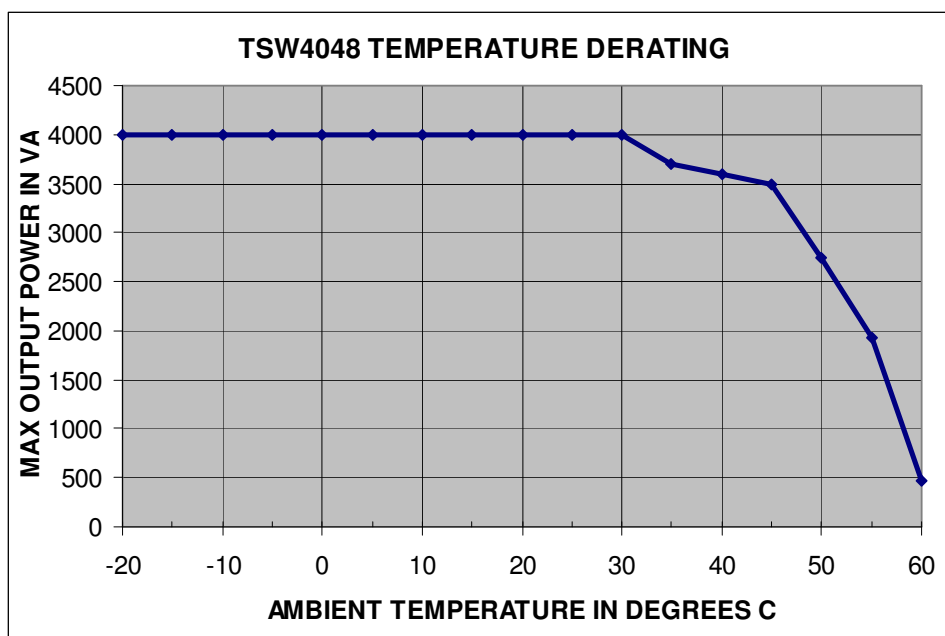
**Float Voltage: 26.5V (TSW3224), 53.0V (TSW4048)**

**VAC Dropout: 160VAC**

Minimum AC voltage that must be present on the input before the unit switches from charge mode to inverter mode.

### 5.4 Power Derating

The TSW inverter will deliver full power to an ambient of 30 degrees C (86 degrees F), then rolls off as shown in the graph below (TSW3224 exhibits similar performance).



## 6. Technical Specifications

True Sine Wave Inverter SPECIFICATIONS	TSW3224	TSW4048
Max. Power Rating 25° C	3200 VA	4000 VA
Nominal DC Battery Input Voltage	24 VDC	48 VDC
Battery input current at rated power	148 Amps	95 Amps
Nominal AC Output Voltage	Selectable 120 / 240 VAC Split Phase, 120VAC single phase or 230VAC single phase	
Surge Power Peak (1ms)	L-N: 80A AC, L-L: 41A AC	L-N: 80A AC, L-L: 41A AC
Surge Power RMS (100ms)	L-N: 52A AC, L-L: 37A AC	L-N: 52A AC, L-L: 37A AC
Overload Capacity from 25°C start		
7Seconds:	6400 VA 200%	8000 VA 200%
30 Seconds:	4800 VA 150%	6000 VA 150%
30 Minutes:	3840 VA 120%	4600 VA 115%
Max. AC RMS Amps Output @ 25°C	L-N: 26A AC, L-L: 13A AC	L-N: 30A AC, L-L: 15A AC
Full on, No load power consumption	~ 27 Watts	~ 39 Watts
Search mode power consumption	~ 4.5 Watts	~ 4.5 Watts
Inverter Efficiency (Peak)	>93%	>95%
Total Harmonic Distortion	Typical: 3.5%, Maximum: 5% (True sine wave)	
Output Voltage Regulation	+/- 3%	
AC Output Frequency	50 or 60Hz +/-1% (Switch Selectable)	
AC Input Frequency Range	46 to 55Hz at 50Hz Nominal, 55 to 65 Hz at 60Hz Nominal, Switch Selectable	
AC Input Voltage Range for Charge Mode	L-N: 80 – 150 VAC for 120VAC mode, L-L: 160 – 270 VAC for 240VAC mode	
DC Output Range	21.0 to 35.0 VDC	42.0 to 64.0 VDC
Maximum Input Short Circuit Current	250A	250A
Continuous Battery Charger Output at 25°C	100 amps DC	70 amps DC
Five Stage Battery Charger Output	Bulk, Absorb, Float, Equalize & Standby	
Battery Charging Power Factor Corrected	>0.92	
Battery Charge temperature compensation	With external temperature sensor	
Transfer relay capability	40 Amps per leg; 8 to 16ms transfer time	
Operating Temperature Range	-20°C to +45°C	
Overtemperature Protection	Sensors on MOSFETs, Transformer and Battery	
Agency Certification	UL 1741	UL 1741 & CSA C22.2 No. 107.1
Warranty	5 Years	
Weight	25.1kg, 55 lbs. (27.5kg, 60.6 lbs shipping weight)	
Size	572x229x184mm, 22.5"x9"x7.25" (686x330x305mm, 27"x13"x12" shipping box)	
Enclosure	Powder coated steel	
Cooling	Variable Speed, Temperature controlled fans	
Data Communication	ASNET (RS-485) and CANBUS	
<b>OPTIONAL ACCESSORIES</b>		
Charge Controllers	Apollo Solar T80 and T100 TurboCharger provide optimum charging from PV arrays.	
Ethernet / Internet Monitoring	Optional Communication Gateway provides full data monitoring from any computer.	
Inverter Switchgear Module	Optional Switchgear Module includes all the DC and AC circuit breakers required.	

\* Technical Specifications subject to change without notification.

## **7. Troubleshooting**

1. A small size battery being charged with a higher charging rate could cause an over voltage shut down or begin charging an already charged battery. Both could cause an over voltage shut down. Please reduce the charge rate or discharge the battery before recharging.
2. If the system does not turn on properly, turn off the Battery Breaker (DC input), disconnecting the system from the battery for 30 seconds, and then repeat the turn on steps. If the system still does not function please contact your Technical Support.

## **8. Service and Support**

If you have any questions or problems with the TSW Series Inverter, call Apollo Solar and ask for a technical support representative.

Please have the following information ready when you call Technical Support:

- Model number
- Serial number
- Date of failure or problem
- Symptoms of failure or problem
- Customer returns address and contact information

If repair is required, you will be given a Returned Material Authorization (RMA) Number. This number must appear on the outside of the package and on the Bill of Lading (if applicable). Use the original packaging (if available) or repack in a secure shipping carton. Units damaged in shipment as a result of improper packaging are not covered under warranty. A replacement or repair unit will be shipped, freight prepaid for all warranted units.

## ***Five Year Limited Warranty Information***

### ***Warranty and Conditions***

Apollo Solar Inc. warrants that the TSW Inverter/Charger it manufacturers will be free from defects in materials and workmanship for a period of five (5) years subject to the conditions set forth below:

- ⇒ This limited warranty is extended to the original user and is non-transferable.
- ⇒ The limited warranty term begins on the date of invoice to the original user of the product. If no invoice is available the warranty term begins on the date of manufacture as recorded by the serial number of the unit.
- ⇒ The limited warranty does NOT apply to any product or part thereof damaged or made inoperable by:  
Operation or installation contrary to the TSW manual, alteration or disassembly, reverse polarity, accident or abuse, corrosion, lightning damage, or repair or service provided by an unauthorized repair facility.

Apollo Solar's liability for any defective TSW Inverter/Charger or any part thereof shall be limited to the repair or replacement of the TSW, at Apollo Solar's discretion. This warranty is limited to the TSW and in no way extends to cover the workmanship of any individual or firm installing the product.

### ***How to Get Warranty Service***

This warranty requires that all equipment suspected of being defective in either materials or workmanship be returned to Apollo Solar or its designated service agents. During the five year warranty period products covered under this warranty will be repaired or replaced with equivalent equipment at the discretion of Apollo Solar.

- ⇒ All products submitted for warranty service must have an RMA number.

To obtain an RMA (return merchandise approval) number, a return shipping address and/or more information about your limited warranty contact Apollo Solar by phone 203 790 6400 or by email at [techsupport@apollosolar.com](mailto:techsupport@apollosolar.com)

- ⇒ Mark all parcels sent for service with RMA number.

Send all equipment approved for warranty service in original or equivalent packaging. All inbound freight must be fully pre-paid, no items will be accepted for service with collect or COD freight charges.

Replaced or repaired equipment will be shipped to the address associated with the RMA number. Freight charges for ground service will be paid by Apollo Solar within the continental United States. Return shipments to other states or US territories or foreign countries will be sent freight collect.

THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE (OR JURISDICTION TO JURISDICTION). APOLLO SOLAR'S

RESPONSIBILITY FOR MALFUNCTIONS AND DEFECTS IN HARDWARE IS LIMITED TO REPAIR AND REPLACEMENT AS SET FORTH IN THIS LIMITED WARRANTY STATEMENT. ALL EXPRESS AND IMPLIED WARRANTIES FOR THE PRODUCT, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF AND CONDITIONS OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE LIMITED WARRANTY PERIOD SET FORTH ABOVE AND NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, WILL APPLY AFTER SUCH PERIOD. SOME STATES (OR JURISDICTIONS) DO NOT ALLOW LIMITATIONS ON HOW LONG IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU. APOLLO SOLAR DOES NOT ACCEPT LIABILITY BEYOND THE REMEDIES SET FORTH IN THIS LIMITED WARRANTY STATEMENT OR LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE. SOME STATES (OR JURISDICTIONS) DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE EXCLUSION OR LIMITATION MAY NOT APPLY TO YOU.

### **Revision History**

<b>Manual Revision</b>	<b>Applies to Firmware Revision</b>	<b>Date</b>	<b>BY</b>
1.0	9.11 (or older)	01/18/10	KMV
2.0	9.38 (and newer)	12/19/11	KMV

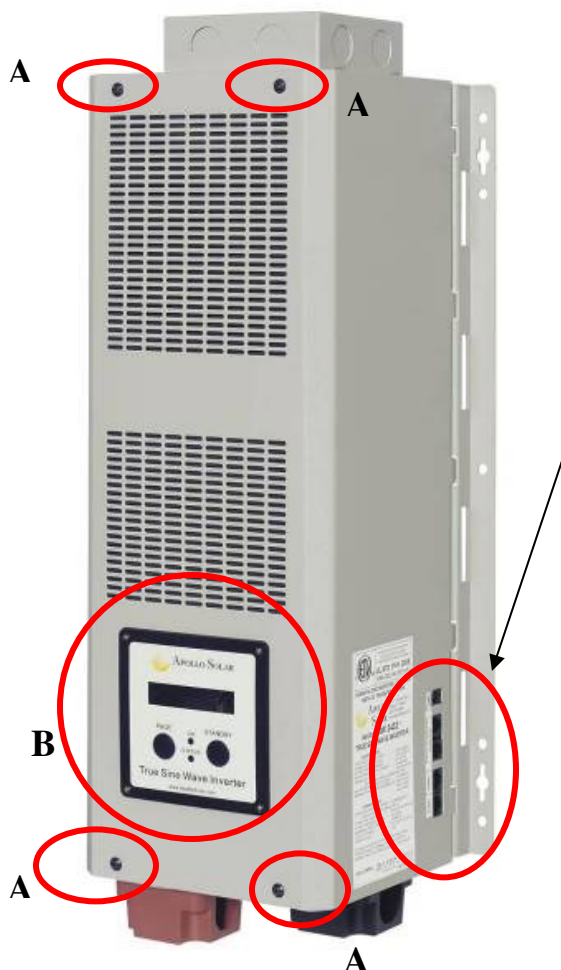




## Appendix A

### Changing Output Settings – 230/240V, 50/60Hz

To change the output settings, the cover must be removed to access DIP switches located on the control board. This must be done carefully to avoid damaging the inverter.



**Step 1:** Remove the four cover screws at location “A”.

**Step 2:** Remove the four screws that secure the control panel at location “B”.

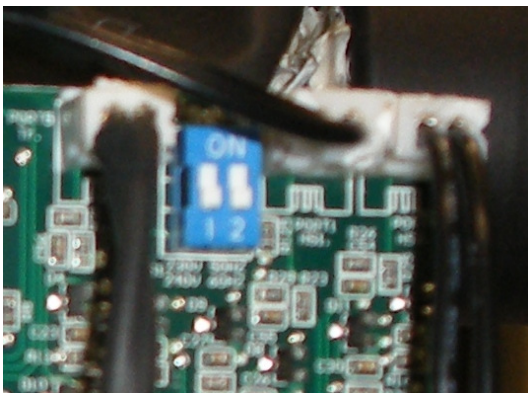
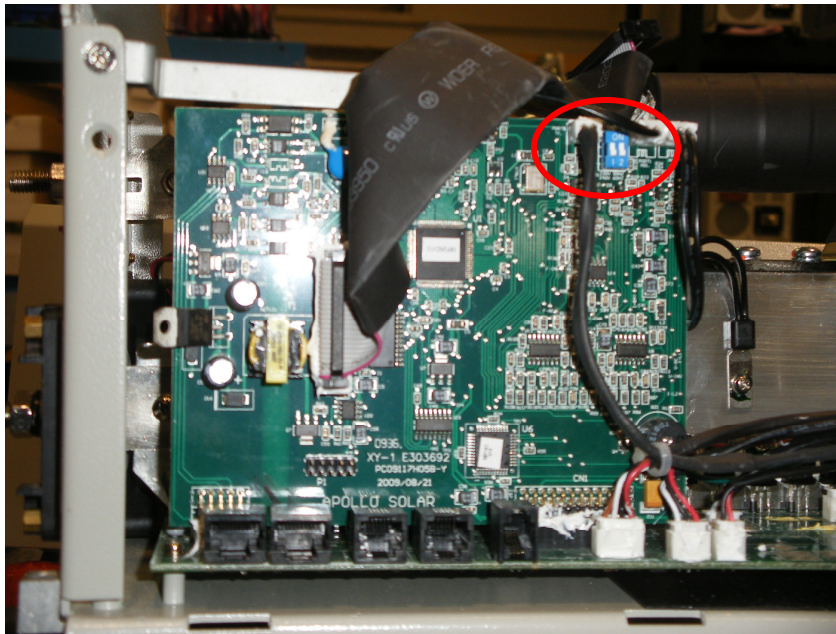
**Step 3:** Disconnect any cables that are connected to the right-side connectors (ASNET, stacking, temperature sensor). **Note, AC and DC power connections do not need to be disconnected, but assure that all circuit breakers / disconnects are turned off.**

In the next steps, the cover must be carefully removed to access the DIP switches on the control board.

A close-up photograph of the internal components of a mobile phone, specifically the logic board and battery. The logic board is green and populated with various electronic components, including a large black integrated circuit (IC) and several smaller components. The battery is a black, rectangular unit with the text "BE 1250" visible on its surface. Two red circles are drawn around the screws that secure the battery to the phone's chassis. The phone's metal casing is visible at the top and bottom edges of the frame.

[illegible]

**Step 6:** The DIP switch is located on the upper right of the control board as shown.



The DIP switch is a two pole switch labeled 1 and 2.

The settings are as follows:

**Switch 1 up: 230V**

**Switch 1 down: 240V**

**Switch 2 up: 50Hz**

**Switch 2 down: 60Hz**

**Step 7:** Reassemble the inverter by replacing the cover, carefully aligning all tabs; reconnecting the control panel making sure the ribbon connector seats fully and the tabs snap in place; and replacing the “A” and “B” screws.

## Appendix B

# Apollo Inverter Manager – Installation and Operation

The Apollo Inverter Manager (AIM) consists of two parts: PC software application and USB to ASNET converter.

### INSTALLATION

The USB to ASNET converter (MN-1) comes with a small CD-ROM containing USB drivers. Install this first as follows:

1. Insert the CD in the computer's CD drive. The CD should start automatically; if not, click "Start", "Run" and type D:/autorun.exe then click "OK".
2. Follow the instructions to install the driver. Accept all recommended settings.
3. Connect the converter to a USB port on the PC and follow the onscreen instructions to complete the installation.
4. **Note: When installing on a Windows 7 system:** Go to C:/Silabs/MCU/CP210X/WIN – Run PreInstaller. A window will pop up titled "Program Compatibility Assistant" – Select "Reinstall using Recommended Settings" – continue following on-screen instructions.

The Apollo Inverter Manager application is on the second included CD, install this next:

1. Your computer must first be connected to the internet as there is an application program that the 'setup' program downloads.
2. Insert the CD in the computer's CD drive.
3. Open the compressed file labeled Apollo Inverter Manager, and click on "setup".
4. Initially, the dialog box as shown in Figure 1 will appear. An Icon will be placed on the desktop as well. This dialog box will appear whenever the AIM software is run.
5. **Please note, the USB to ASNET converter must be connected to the PC whenever the AIM software is started.**

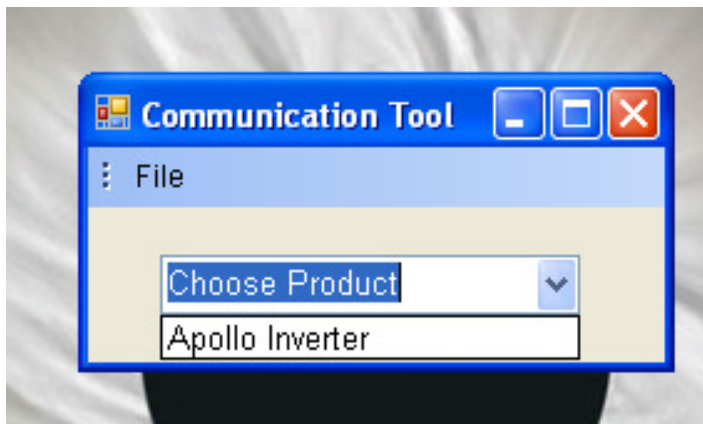


Figure 1



## OPERATION

When the dialog box shown in Figure 1 appears, click the down arrow to show “Apollo Inverter” then click on the text to select. The screen shown in Figure 2 will appear. This is the Inverter Manager Status screen.

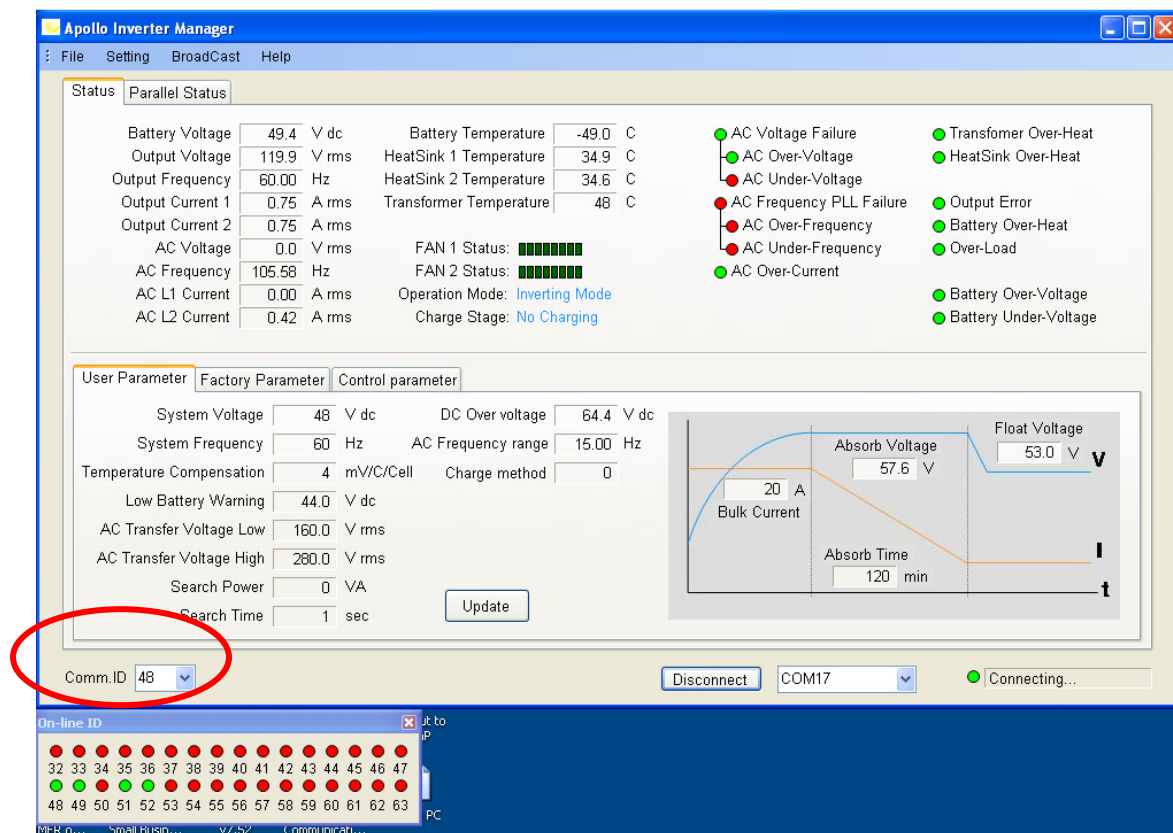
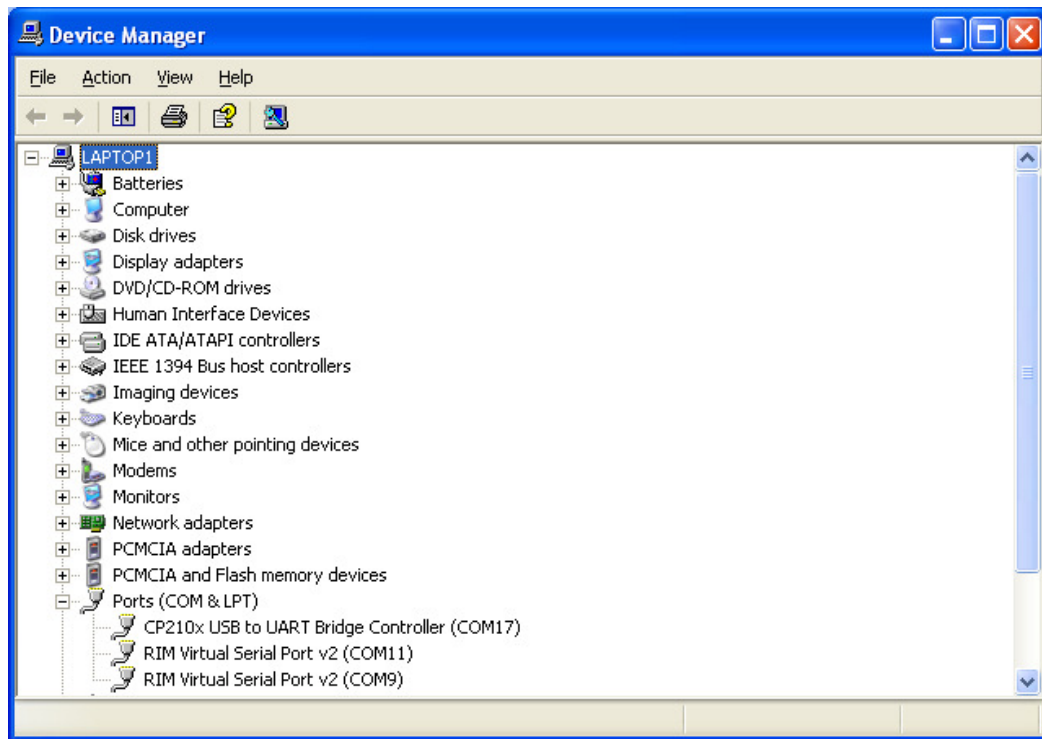
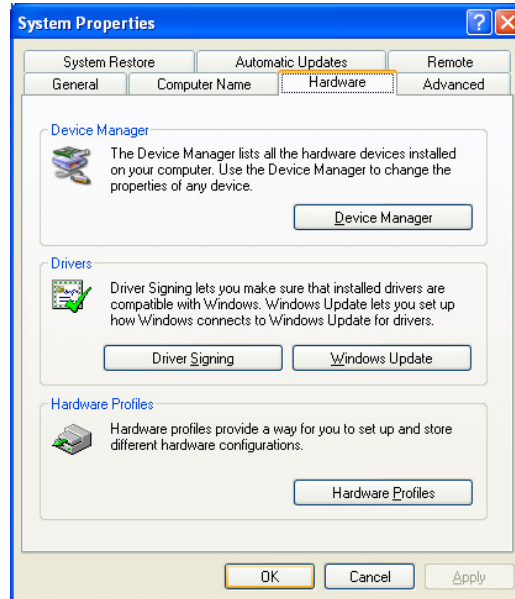


Figure 2

The “Comm.ID” box at the lower left of the display must match the Comm ID of the inverter. The ID can be found on the lower left of the inverter display when battery power is first applied to the inverter (32 is default).

To connect to the inverter, select the USB comm. port from the drop down box at the lower right of the screen (if you don’t know which is the USB comm. port, check under the system hardware “device manager” in the PCs “control panel”).

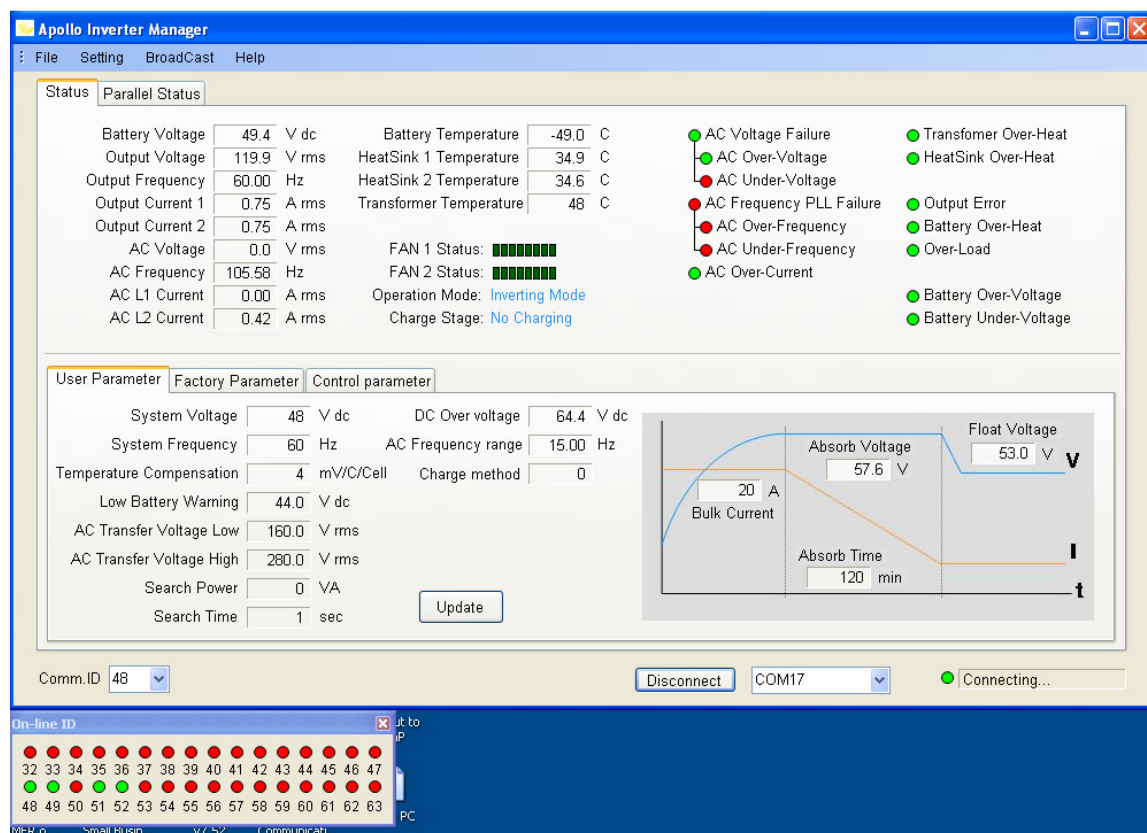


To connect the AIM to the inverter, click the “connect” button (to the left of the pull down box). Then the indicator at the lower right will change from “Disconnect” to “Connecting”. This shows communication between the PC and the inverter.



The screen is divided into two halves: the top half is operating status (these cannot be changed); the bottom half is the changeable parameters.

The “User Parameter” tab on the lower portion of the screen allows access to the user adjustable parameters. **Note: The “Factory Parameter” and “Control Parameter” tabs must not be changed (except where indicated), and should be viewed only.**



The “On-line ID” box at the lower left indicates which inverters when stacked are operational (online) when green. Clicking on an indicator switches to that inverter’s specific readings.

Clicking on changeable parameter field invokes the Input dialog box at the left. **Please note:** If the dialog box does not appear, it may be behind the main screen. Simply move the main screen slightly to see the Input box. Clicking on it will bring it to the top. Enter the new value in the Input field, and click confirm. The value will change on the main screen. **Please Note:** You must click the “Update” button on the main screen to affect the change.

The following is a table of all changeable parameters on the main screen, including their range and defaults.

Parameter	Range	Default	Notes
Temperature Compensation	1 - 8	4	
Low Battery Warning (24V)	21.0 – 24.0	22.0	Shutdown at 2volts below setting
Low Battery Warning (48V)	42.0 – 50.0	44.0	Shutdown at 2volts below setting
AC Transfer Voltage Low	160.0 – 200.0	160	
AC Transfer Voltage High	260.0 – 280.0	280	
Search Power	0 - 200	0	
Search Time	1 - 10	1	
DC Over voltage (24V)	28.6 – 40.0	32.0	
DC Over voltage (48V)	57.2 – 80.0	64.4	
AC Frequency Range	3.00 – 15.00	15.00	Wide range best when generator used
Charge Method	0 - 3	0	See explanation below
Bulk Current	10 - 100	20	TSW4048 limited to 70A
Absorb Voltage (24V)	27.2 – 30.4	28.8	
Absorb Voltage (48V)	54.4 – 60.8	57.6	
Absorb Time	1 - 9999	120	Time in minutes
Float Voltage (24V)	26.4 – 35.0	26.4	
Float Voltage (48V)	52.8 – 70.0	52.8	
Equalize Voltage (24V)	27.2 – 35.0	31.2	Charge Method = 1
Equalize Voltage (48V)	54.4 – 70.0	62.4	Charge Method = 1
Equalize Time	1 - 9999	120	Time in minutes
Comm. ID	32 - 63	32	
Battery Overheat	40 – 60	50	Set on Factory Parameter screen
AC Max Input Current	15 - 40		Set on Factory Parameter screen

**Please Note:** Battery Overheat and AC Max Input Current are the only user changeable parameters on the Factory Parameter screen. **Do not change any others.**

## Charge Method Parameter

There are four (4) Charge Method Parameter settings as follows:

**0 – Absorb setting:** This is the normal operation setting. The battery will bulk charge to the Absorb Voltage, absorb for the preset time, and then enter the float state.

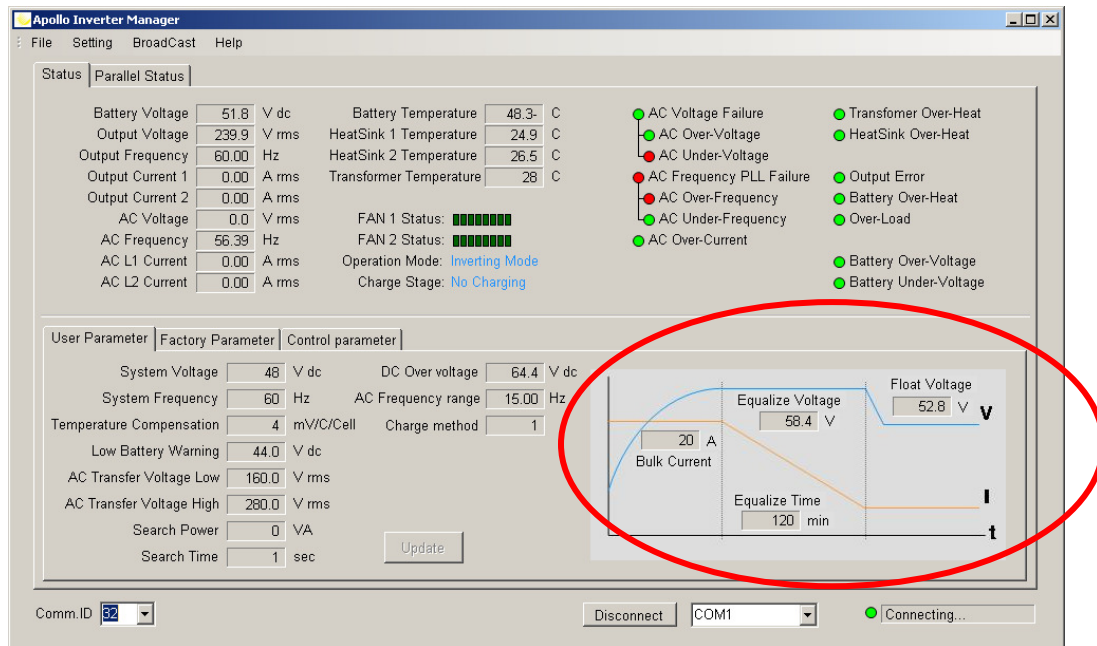
**1 – Equalize setting:** This changes the screen to allow the entry of the equalize parameters. It also enters the equalize mode for the amount of time entered. Equalize may also be run from the front panel as described in the TSW inverter manual.

**2 – Customer specific setting:** This setting was developed for a specific OEM customer and should not be

used under normal circumstances. **Do not use**

**3 – Customer specific setting:** This setting was developed for a specific OEM customer and should not be used under normal circumstances. **Do not use**

Below is an image of the main screen when the equalize setting is entered.



Note: The charge graph changes to allow access to the equalize parameters.

**Parallel Status Screen:** This screen allows the user to view key parameters of all inverters in a parallel (stacked) system.

Apollo Inverter Data Log

File

Setting

Help

Status

Parallel Status

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

Output Volt.

Output Gain

Output Load

AC status

Relay status

Parallel/Standard

Master/Slave

120V/240V

Comm.ID

32

No Response!

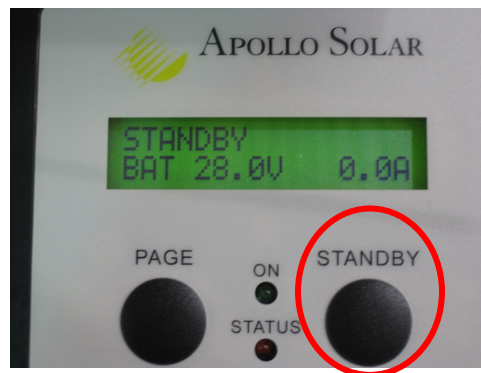
## UPLOADING NEW FIRMWARE – Version 9.40 or greater ONLY

To upgrade earlier versions, call the Apollo Solar factory (203) 790-6400.

There are 5 steps to install a new version of firmware in the TSW using the AIM software as connected in the previous section.

**Note: The inverter must be in Standby mode to upload firmware.**

**Step 1** - Press the right hand “Standby” button to enter the mode.



**Step 2** - To upload new firmware to the TSW Inverter, select “Upgrade Firmware” from the File menu bar in the AIM screen as shown in Figure 3:

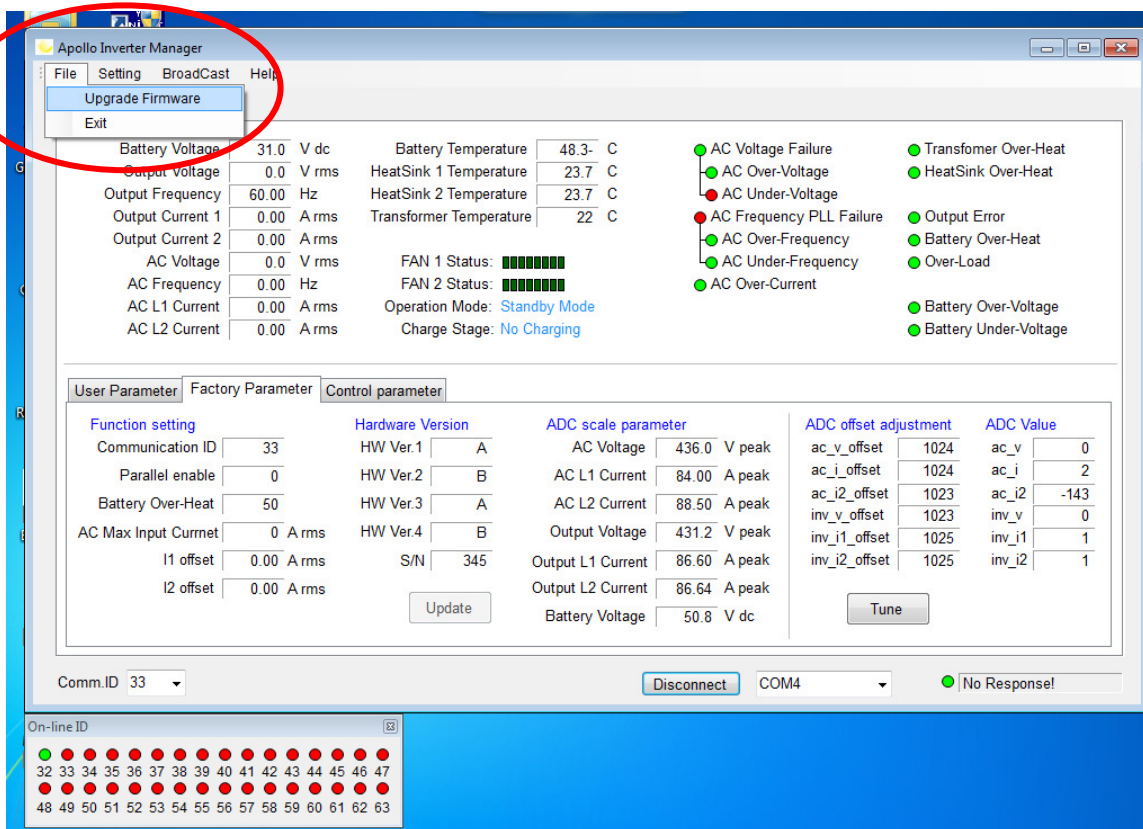


Figure 3

**Step 3** - The “Load File” box will appear as shown in Figure 4. Mouse click on the Load File button. A file select Dialog box will open as shown in Figure 5.

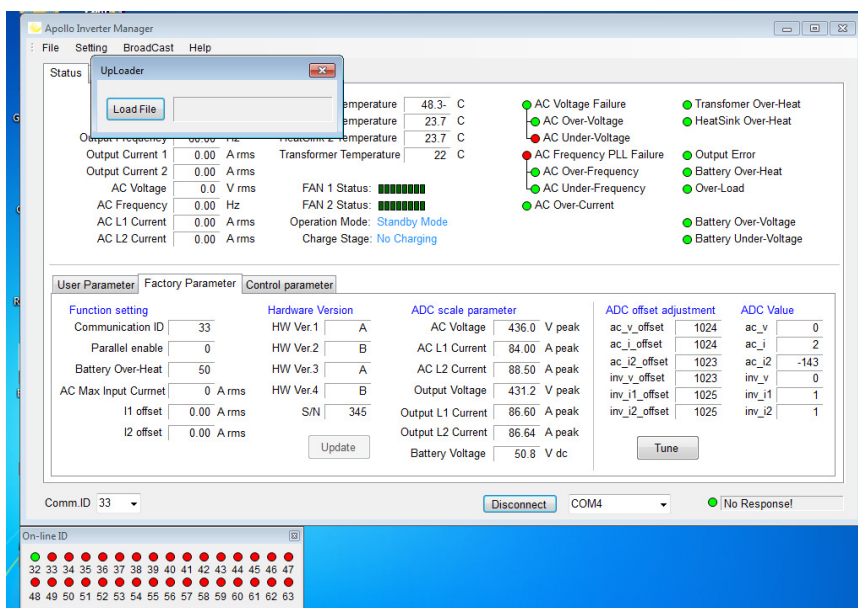


Figure 4

**Step 4** - Select the “.HEX” file from the pull-down menu at the lower right. Locate the file in the appropriate directory, as shown in Figure 6 below and mouse click the open button.

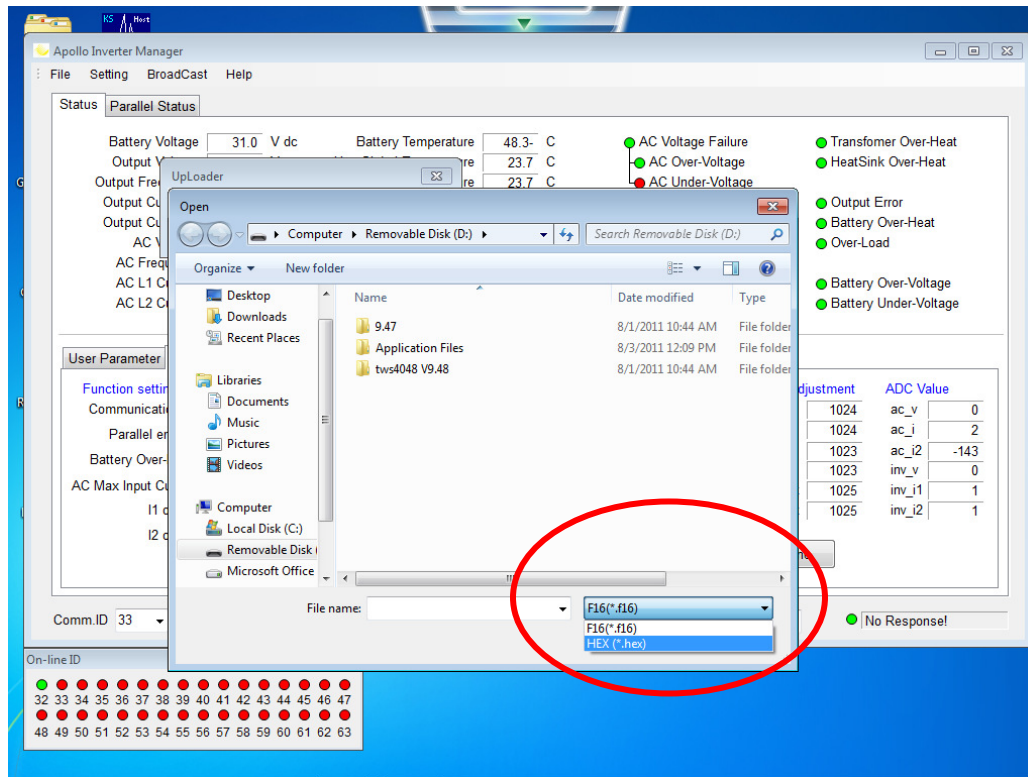


Figure 5

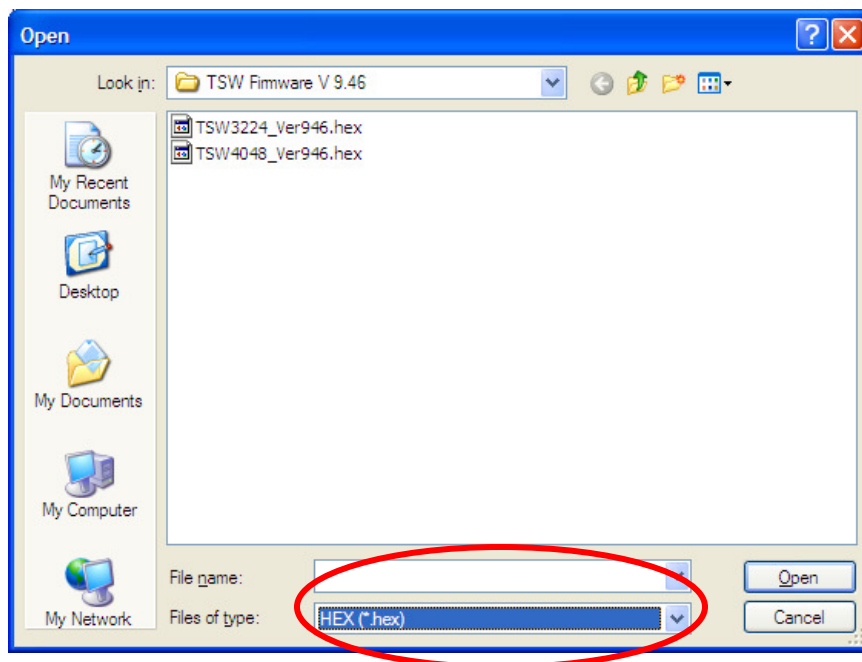


Figure 6



**Step 5** - The uploader process window will appear (figure 7), and the inverter will indicate update in progress on the display (Figure 8). The “% status and bar graph will increase as the upload progresses.  
**Please Note: If the main screen indicates “No Response”, do not be concerned.**

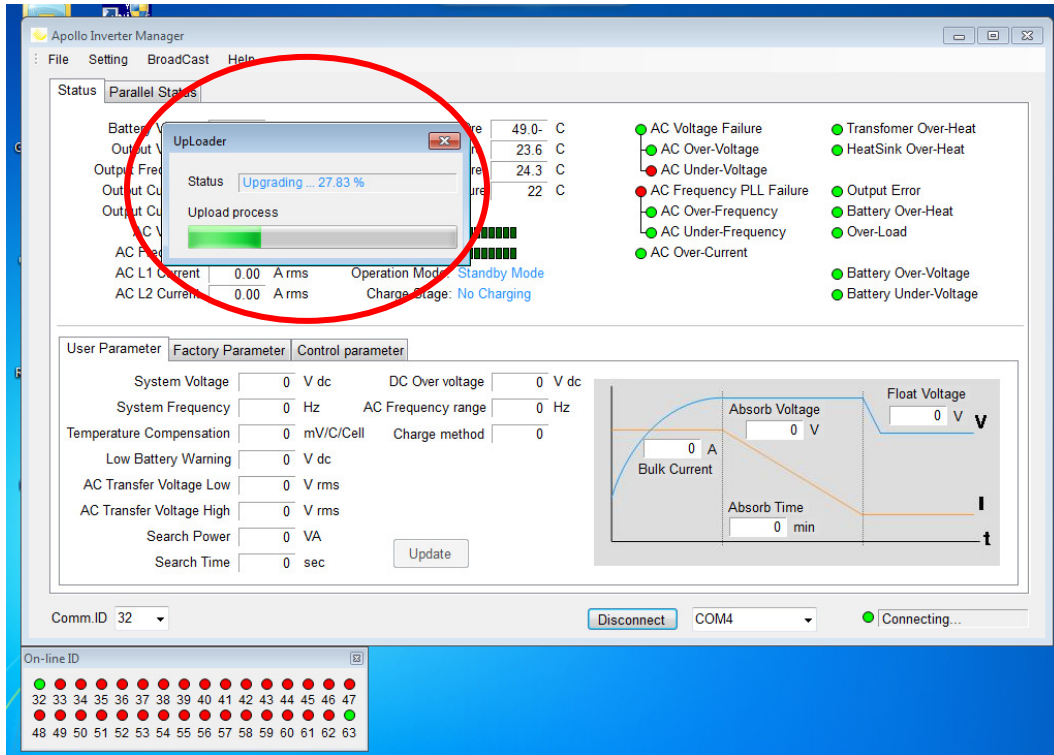


Figure 7



Figure 8



When the firmware is fully uploaded, the AIM will indicate the upgrade is finished as shown in figure 9. This should take approximately 5 to 10 minutes.

**Important:** The upgrade is not complete until the TSW resets (this takes about another minute. **Do not disturb the TSW until the display changes from Figure 8 to figure 10.**

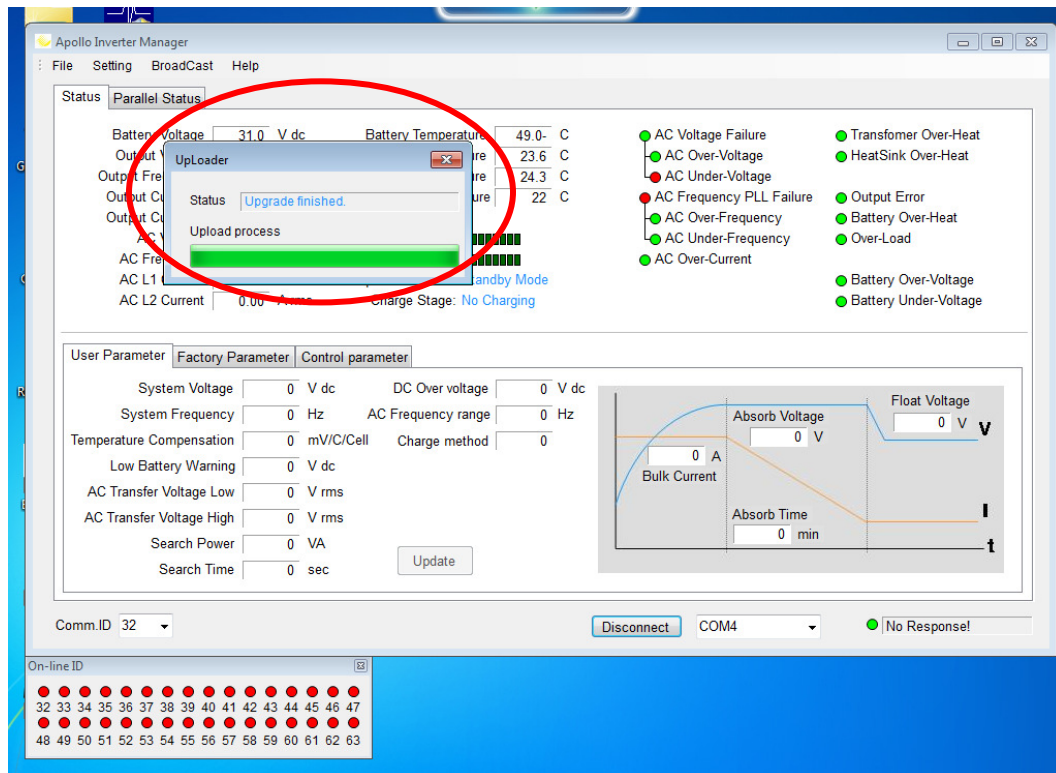


Figure 9

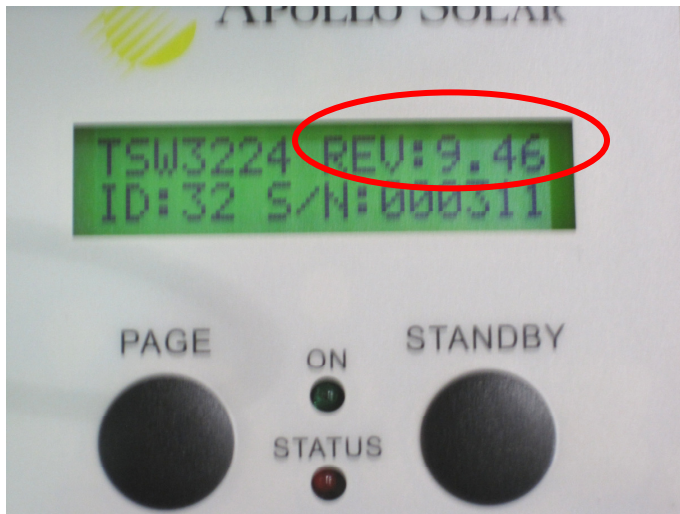


Figure 10

The TSW resets and goes into “Auto-Start” (Figure 11) after which it will enter Invert Mode. **Caution – The TSW is now generating AC voltage.**

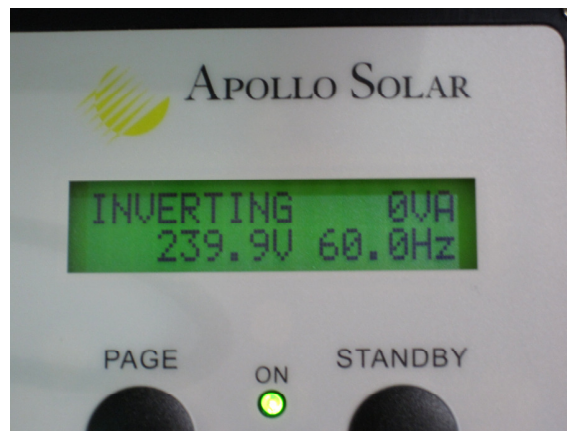


Figure 11

If you do not wish to enter Invert mode

at this time, you may press the “Standby” button to enter Standby Mode.

### FIRMWARE UPLOAD COMPLETE

The TSW is now running with the new version of firmware which you installed as shown in Figure 10 above. There are no more steps. The cable to the computer running the AIM firmware may be disconnected.

**Please Note:** You must restart the AIM program before using it for other purposes.







