



**Continuous Energy**

## **PV FOR TELECOM**



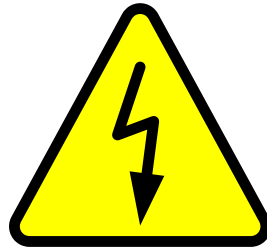
### **Installation Guide**

### **Gen4 PVT Panels and Cabinets**

**For PV Input Power at 5kW, 10kW, 15kW and 20kW sizes  
With 1, 2, 3 or 4 T80HV Charge Controllers**

**Manual Rev 5.5**

## IMPORTANT SAFETY INSTRUCTIONS



### DANGER -- HIGH VOLTAGE

#### WARNINGS:

- During the installation of this product, you will be exposed to wires from the Solar PhotoVoltaic (PV) panel array which are energized with high voltage.
- **The high voltage is present during all daylight hours.**
- If a Combiner Box is wired in the system, turn all the Circuit Breakers in all the Combiner Boxes OFF before opening the Apollo PVT Cabinet doors. If a Combiner Box is NOT wired in series with the PV Array, carefully disconnect the PV Array at the most convenient location and do not re-connect it until the work in the Apollo PVT Cabinet is complete and the doors are closed.
- **This system is energized from multiple sources.** In addition to the PV Array, the Battery also provides dangerous power to the Apollo PVT Cabinet. Disconnect the Battery after the PV Array is de-energized.

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# IMPORTANT SAFETY INSTRUCTIONS

## SAVE THESE INSTRUCTIONS

### 1 General Safety Precautions

1. Before using the PV FOR TELECOM SYSTEM, please read all instructions and cautionary marks on (1) the PV FOR TELECOM SYSTEM, (2) the batteries, and (3) all appropriate sections of this instruction manual.
2. Do not disassemble the PV FOR TELECOM SYSTEM; 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.
3. To reduce risk of electric shock, disconnect sources of power before making any attempt to maintain or clean. Simply turning off the PV FOR TELECOM SYSTEM will not reduce this risk.
4. Proper Disposal of Batteries is required. Refer to your local codes for disposal requirements.
5. NEVER charge a frozen battery.
6. DC battery wiring must be 95mm<sup>2</sup> (4/0 AWG) copper wire and rated for 90°C or higher. Crimped and sealed copper ring terminal lugs should be used to connect the battery cables to the DC terminals of the PV FOR TELECOM SYSTEM. Soldered cable lugs are also acceptable. See section on battery cable sizing for more details for your application.
7. Torque all connections as specified on the panel. Use only insulated 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.
8. The PV FOR TELECOM SYSTEM must be used with a 48 Volt battery supply of nominal voltage.
10. GROUNDING INSTRUCTIONS. This PV FOR TELECOM SYSTEM 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. Do not disassemble the T80HVs. They do not have any user-serviceable parts inside.
12. 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.

### Purpose

The purpose of this Installation and Operation Manual is to provide explanations and procedures for installing, operating, maintaining, and troubleshooting PV FOR TELECOM SYSTEM.

### Scope

The Manual provides safety guidelines, setup information, procedures for installing the PV FOR TELECOM SYSTEM, 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 PV FOR TELECOM SYSTEM. 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.

#### ⚡ **CAUTION**

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

#### ➤ **IMPORTANT**

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

## 2 Warnings to Prevent Damage

- **ALWAYS TURN THE BATTERY POWER TO THE T80HV CHARGE CONTROLLERS ON BEFORE TURNING ON THE PV INPUTS.**
- **ALWAYS TURN THE PV INPUT OFF BEFORE TURNING THE BATTERY POWER OR THE T80HV OUTPUT CIRCUIT BREAKERS OFF.**

The T80HV Charge Controllers in this product operate from the battery power. The microprocessors inside the T80HV must have voltage applied so they can control the FETs which switch power from the PV input. **If the PV input power is allowed into these FETs without the T80HV circuitry running from battery power, the FETs can be damaged.** This damage is NOT covered by the warranty.

### 3 Organization of this Installation Guide

This Installation Guide is designed to include all the essential information to help a trained professional installer complete the installation, wiring, troubleshooting and commissioning of our systems.

The Apollo Solar PV for Telecom (PVT) systems are available with several optional extra features. When such options have been ordered, separate sections of the installation guide will be appended to the main section.

In the Installation Guides, we use the terms “Panel”, “Cabinet” and “System” somewhat interchangeably. This is because Apollo Solar delivers the systems in the form of panels only, or panels in Cabinets, or Panels in Cabinets with Batteries, PV modules, etc as Systems.

Note that the Apollo Solar PVT systems are delivered to meet the requirements of PV input power with 1 to 4 T80HVs per panel or cabinet and up to 4 separate panels for cabinets.

### 4 Introduction to the PV FOR TELECOM SYSTEM

The PV FOR TELECOM SYSTEM contains the Apollo Solar T80HV MPPT Charge Controllers, as well as the appropriate Circuit Breakers on all inputs and outputs, the Apollo System Controller with digital I/O, Latching Relays for controlling Loads, and Connectors for field installation.

#### 4.1 DC Wiring

##### ⚠ WARNING

Even though DC Voltage is low voltage, significant hazards may exist, particularly from short circuits of the battery system. Ensure that the MAIN DC Circuit Breakers are turned OFF.

##### ⚠ CAUTION

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

#### 4.2 Battery Cable Connections

When connecting the DC cable to the battery or PV FOR TELECOM SYSTEM input terminals, the wires must be accurately tightened to the appropriate torque as listed on the back plate for the size wire used. Incorrectly tightened wires can cause a high resistance connection which could result in poor PV FOR TELECOM SYSTEM performance and/or high heat which can melt the cable and terminal connections.

##### ⚠ CAUTION

Use proper torque when tightening the PV FOR TELECOM SYSTEM's DC terminal bolts. 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.

### 4.3 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.

#### ➤ IMPORTANT

Make these connections first and connect to the battery last.

### 4.4 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 below the electrolyte level, in the center of the bank.

#### ➤ IMPORTANT

Do not attach to a battery terminal. Plug the 4pin modular plug into the 4-pin jack on the Apollo Shunt PC Board which is attached to the Shunt adjacent to the Negative Bus Bar.

### 4.5 AC Wiring

#### ⚠ WARNING

Inverters are an option for the PV for Telecom System. Ensure that the DC input voltage to the PV FOR TELECOM SYSTEM is not present prior to making AC connections to the PV FOR TELECOM SYSTEM.

### 4.6 Grounding:

#### System Grounding

The grounding requirements vary widely by locale and application. Consult local codes for specific requirements.

#### Equipment or Chassis Grounds

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.

#### Bonding the Grounding System to the AC Neutral Conductor

The purpose is to connect AC neutral to the grounding 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 PV FOR TELECOM SYSTEM, codes do not generally allow it since the PV FOR TELECOM SYSTEM is considered a "serviceable" item which may be removed from the system. In most systems the point of connection is located at the service entrance panel.

Bonding must be done at only one point in an electrical system. Consult local codes for specific requirements.

### ⚡ CAUTION

**When connecting the battery cables always connect to the PV for Telecom System first, and then to the batteries last.**

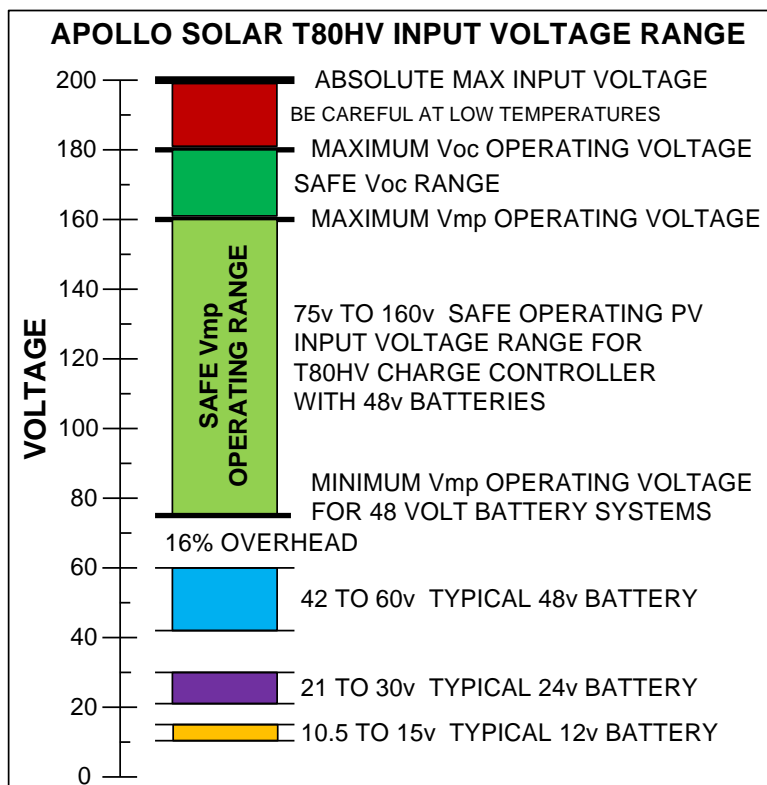
### Safety and Hazard Symbols

This symbol appears beside instructions and warnings that deal with dangerous voltages that can injure people who come in contact with them.



## 5 PV Input Voltage Range Allowed

The Apollo Solar T80V Charge Controller offers a wide range of input voltage from the PV array, but there are limits. **The chart below shows that the minimum input voltage from the PV array to charge 48 volt batteries is 75 volts DC.** This is the  $V_{mp}$  or Maximum Power Point voltage of the PV modules at the highest temperature during operation. The maximum voltage is 180 volts DC which is the  $V_{oc}$  or Open Circuit Voltage during the lowest temperature. If the T80HV is operated in systems outside of these limits, the warranty is no longer valid.





The voltage range of the T80HV was designed to be perfectly compatible with both the popular types of PV modules with either 60 cells or 72 cells. For 60 cell modules, it is recommended that either 3 or 4 PV modules are wired in series in each string. The 72 cell modules fit perfectly by wiring 3 PV modules in series strings.

The Apollo Solar Combiner Boxes are designed to be compatible with the voltage and current ranges as well. Typically 4, 5 or 6 strings are connected in parallel using the Combiner Box so that the total peak power into a T80HV is less than 5000 watts.

## 6 PV System Overview

The Apollo Solar PV for Telecom System may include a number of components inside and outside of the main Cabinet. Extra features are offered as OPTIONS to minimize the costs on sites which do not need the extras. This Installation Guide covers only the options selected for assembly into the Cabinets.

### 6.1 PV Array Sizing

The typical basic system will include a PV array with up to 5 parallel strings of PV Modules, each string will have 3 PV modules wired in series. The Parallel connections will be made inside the Combiner Box.

### 6.2 Combiner Boxes

Apollo Solar offers both a fully weather proof, IP66 Combiner Box with a 70kA Surge Protection Device and an Economy version with a 40kA SPD which is more than adequate to be mounted under the PV Array. The photos below show both versions.

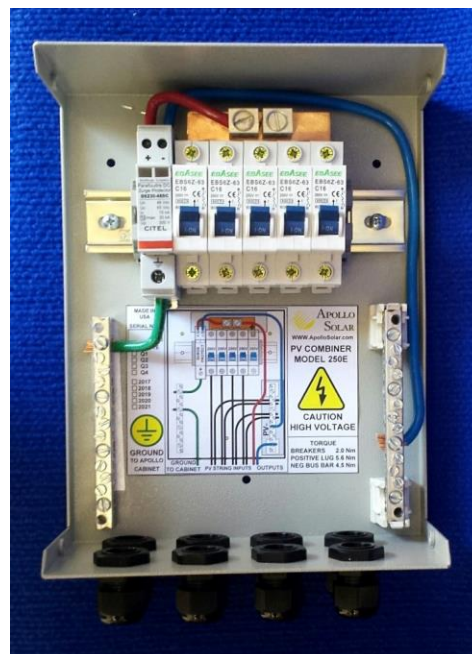


IP66 Weatherproof version





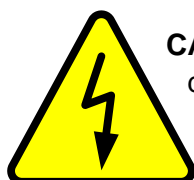
Economy model Combiner Box



Both of the Apollo Solar Combiner Boxes are designed to be compatible with the T80HVs with regard to the voltage levels, the current and the Surge Protection Devices.

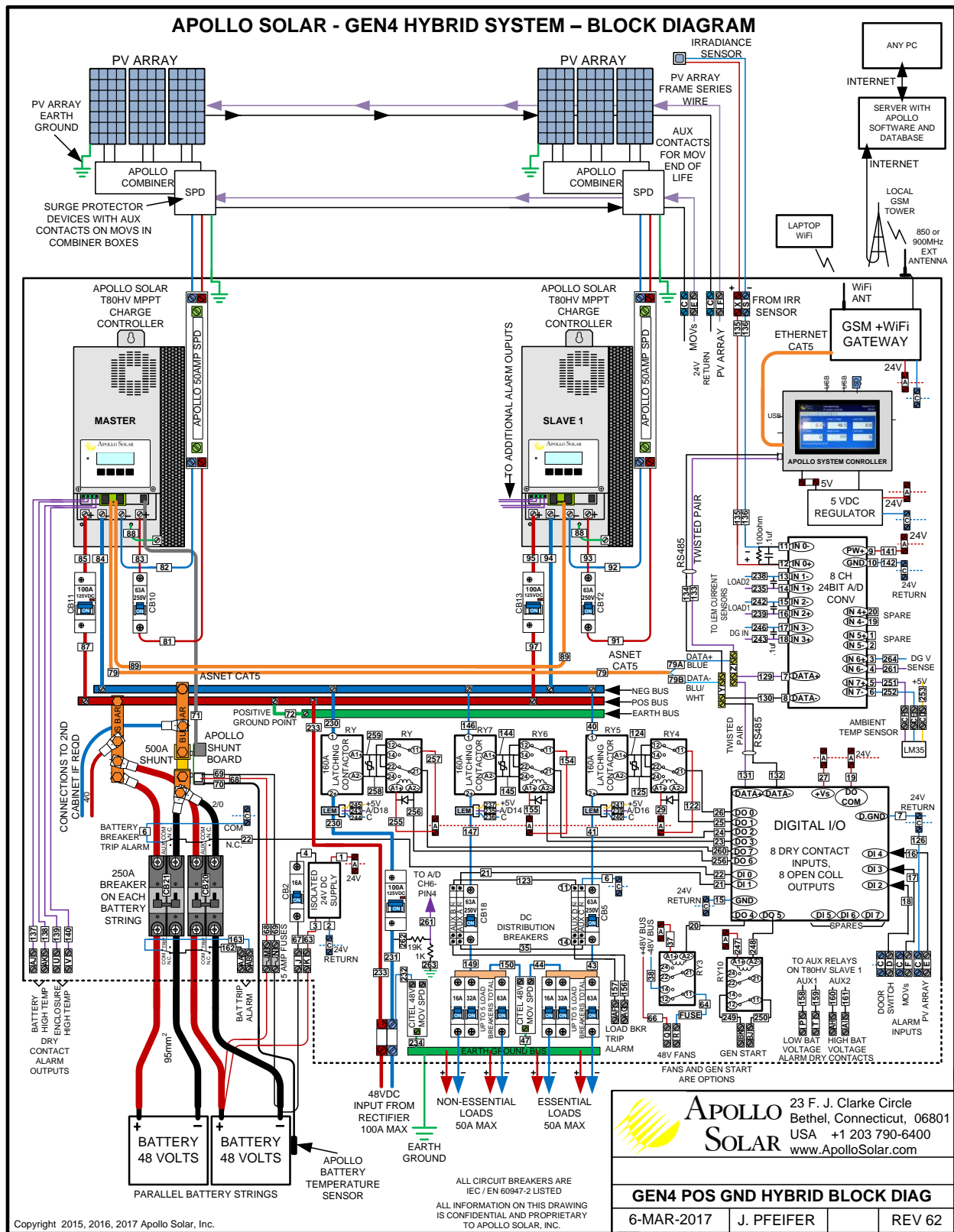
The "Home Run" wires and the Ground Connection from the Combiner Box are connected to the PVT Panel inside the Main Cabinet. All 3 wires (Positive, Negative and Ground) must be run to the Apollo Solar PVT Cabinet. The Earth connection in the Combiner Box is the important connection to the Surge Protection Device. Bring this connection to the central ground bus bar on the PVT panel provides the system with equal potential grounds. Each Combiner Box provides the correct Power for each T80HV Charge Controller. See the Installation Guide which is shipped with the Combiner Box for more details.

The number of T80HVs is dictated by the size of the PV array and the amount of energy harvest required by the loads in the system. Each T80HV will support up to 5000 watts of PV array. Using the newer 72 cell PV modules, a typical system will use 5 strings of 3 modules in each series string, or 15 modules. At 325 watts per module, that is 4,875 watts total.



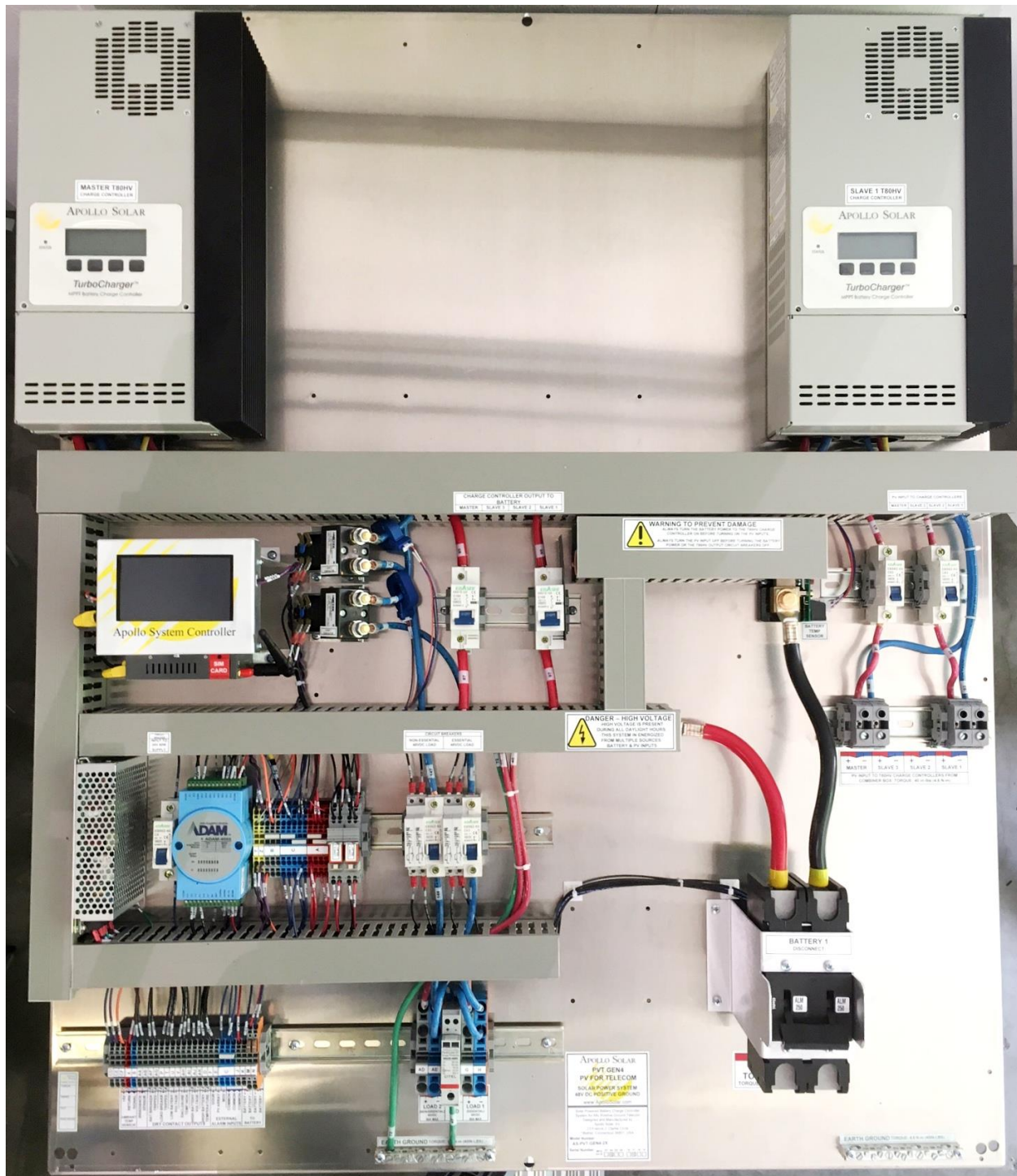
**CAUTION:** Any PV Combiner Box has lethal voltage from the PV Array during all daylight hours. When working on the Apollo Solar PVT Cabinet, turn OFF the circuit breakers in all the Combiner Boxes for all strings. Then ALSO disconnect the Battery since both the PV and the Battery feed power to the Cabinets.

## 7 Detailed Block Diagram





## 8 Photo of 2X Gen4 Panel with 1 Pair of 250Amp Battery Breakers

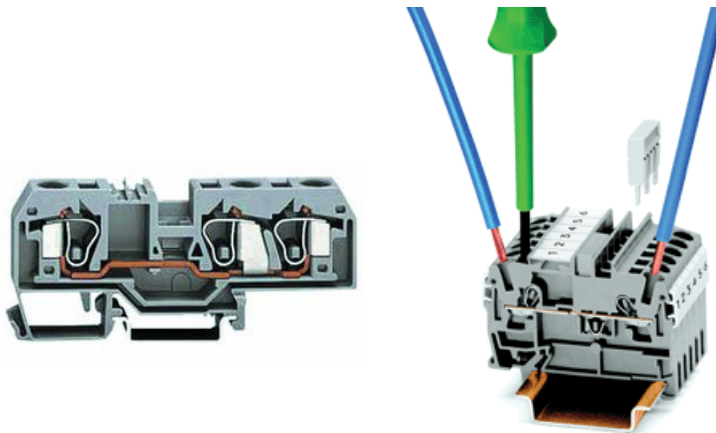


The photo above is a 2X Panel clearly showing the location of each component. There is extra room on this panel for 1 or 2 more T80HVs plus Options such as More Battery Breakers, DC Distribution Breakers, Enhanced Surge Protection and Hybrid Generator Inputs and Controls. Your system may have one or more of these options.

## 9 General Wiring Instructions



Left and Right side Gland Plates with labels at bottom of Cabinet



### **WAGO Cage Clamp Connectors - Insert small screwdriver for easy wire entry**

The Cage Clamp connectors made by the Wago company are used wherever possible. The advantages are that they do not require specific torque to tighten and they never come loose.

The **Wiring Glands** at the bottom of the cabinet provide at least IP66 Ingress Protection.



1. Feed wires from outside up from the bottom.
2. Tighten gland by hand.
3. Connect to proper point inside the cabinet.

Filling the void with Electronics Rated Silicon Sealer completes the IP66 Ingress Protection Process.



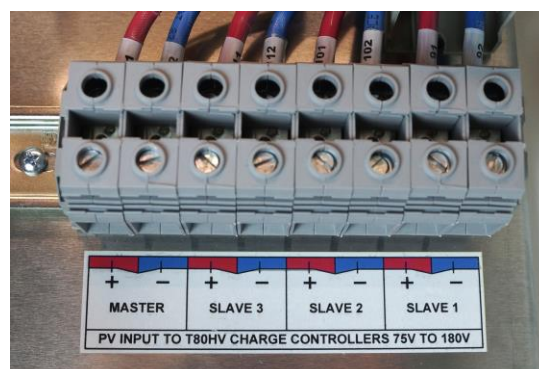
## 10 Connection Points for External Wiring

### PV INPUTS:

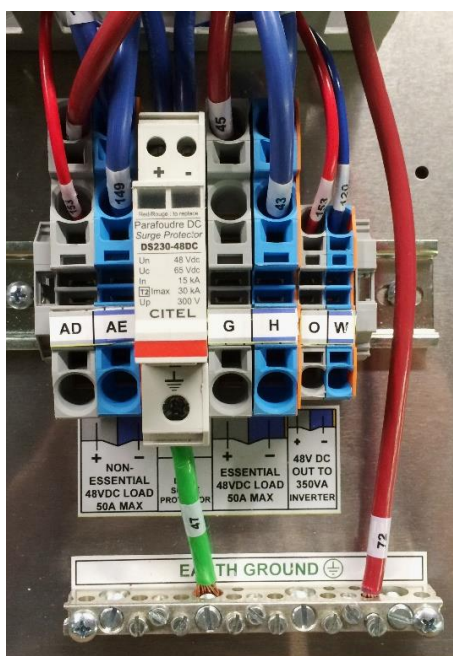
The PV Inputs are on the far right side of the panel. There may be 1 to 4 PV Inputs the same as the number of Charge Controllers on the panel.

The connectors can accept large gauge wire in case the PV Array is far from the Apollo Solar Cabinet.

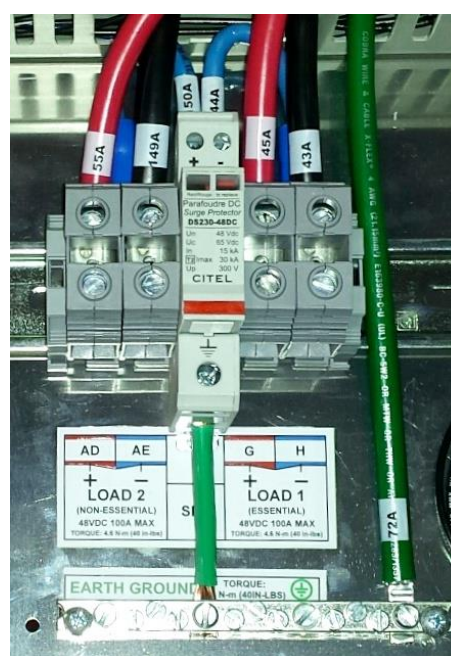
**TORQUE = 2.3 N-m (20 in-lbs)**



### ESSENTIAL and NON-ESSENTIAL LOAD OUTPUTS:



Standard 50 Amp Load Outputs

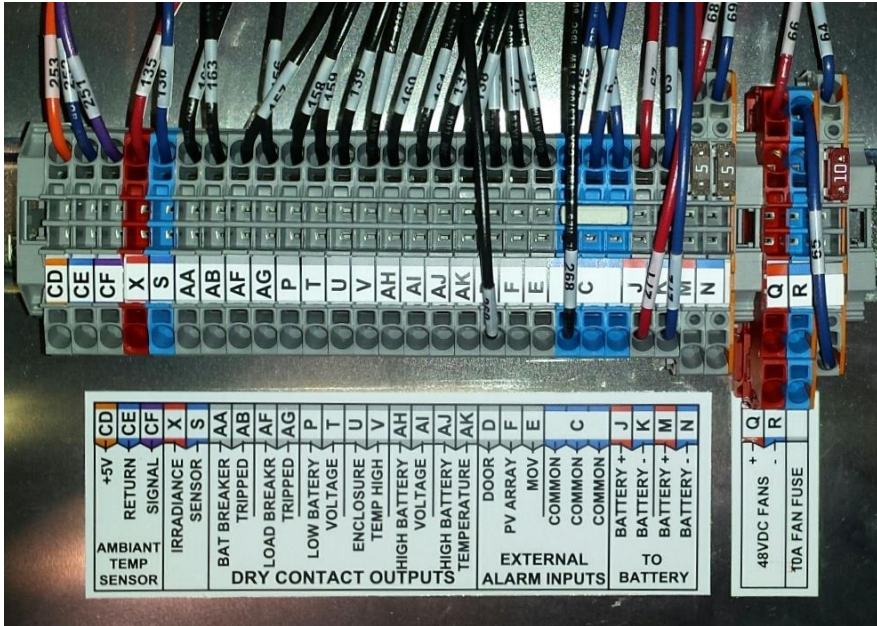


Optional 100 Amp Load Outputs

The Load Outputs are offered at 50Amps and 100Amps. The 50A connectors accept up to 16mm<sup>2</sup> (AWG 6) wires. The 100A connectors will accept up to 50mm<sup>2</sup> (AWG 1). Both versions have a Surge Protection Device on the Negative outputs. The Positive output is already connected to Earth Ground.

### CENTRAL EARTH GROUNDING POINT:

The main central external Earth Ground is connected to the Bus Bar shown in these photos. The Ground Bus Bar **TORQUE = 4.5 N-m (40 in-lbs)**

**ALARM INPUTS AND OUTPUTS:**

The photo at the left shows the left side of the panel with the Alarm Input and Alarm Outputs.

The wires to the battery for Voltage Sense are also in this group.

This cabinet has the optional Fans installed and the 48 VDC connector and 10A fuse is at the right end of this group.

The Ambient Temperature Sensor (included in the cabinet) must be wired through the gland at the bottom of the cabinet and the 3 wires connected as shown above on the far left side.

**FUNCTION OF THE DRY CONTACT OUTPUTS:**

There are 6 pairs of Dry Contact Outputs as shown in the photo above. Their functions are labeled. These are simple switch or relay contacts which open to indicate that an unusual condition has occurred. There is no voltage on these terminals. Some BTS equipment takes these connections and can report the Alarm condition to their supervisory system. This is NOT the same as the Apollo Solar Remote Monitoring system. Our PVT systems provide both functions. The Dry Contact Outputs do NOT need to be wired to the BTS in order for the Apollo Solar Remote Monitoring to report an alarm. They are independent systems.

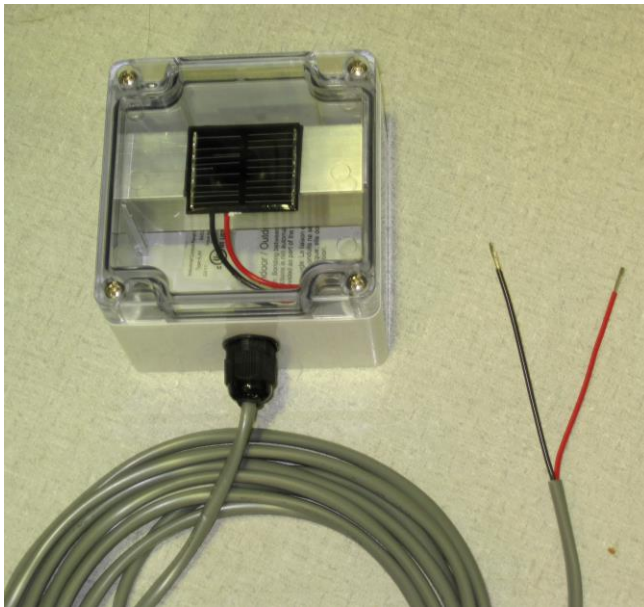
**FUNCTION OF THE EXTERNAL ALARM INPUTS:**

The Apollo Solar Remote Monitoring system reports 3 physical changes on the system. 1) The Cabinet Door has a switch which reports an alarm when opened. 2) The PV Array can be fitted with a wire strung through holes in frames of each PV module. If that wire is broken or cut, the system reports a theft attempt. 3) The Apollo Solar Combiner Boxes include an important Surge Protection Device which is based on a Metal Oxide Varistor (MOV). Every MOV can take a certain number of surges and at some point will reach the end of life. This event trips a switch inside the surge protector which is picked up by the Apollo Solar system using the wires on these terminals.

## 11 Irradiance Sensor – Mounting Instructions

The Apollo Irradiance Sensor is designed to be mounted on the PV Array so the front surface is parallel to the front surface of the PV Modules. The enclosure is 90mm x 90mm x 60mm deep. The enclosure is sealed to meet IP65 (NEMA 4X) ratings.

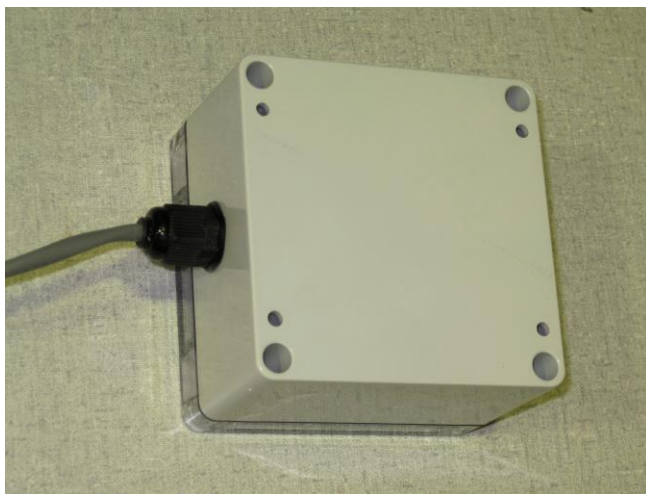
The software in the Apollo System Controller (ASC) reads the Analog to Digital converter and uses a mathematical factor to display the Irradiance in Watts per Square Meter. The accuracy is not specified, but will be within about 5% of actual which meets the requirements.



The photo at the left shows the complete Irradiance Sensor with the 5 meter long cable.

The wires are meant to be inserted into the connector labeled as Irradiance Sensor on the Apollo Solar PV for Telecom panels.

The Red wire goes to the + connector and the Black wire goes to the – connector.



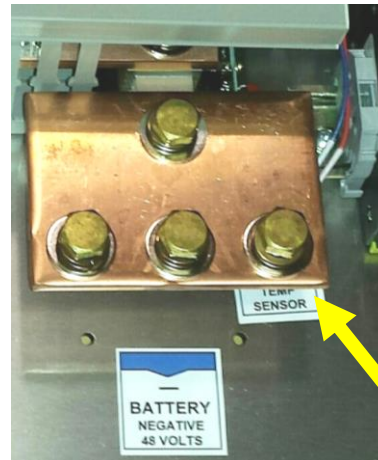
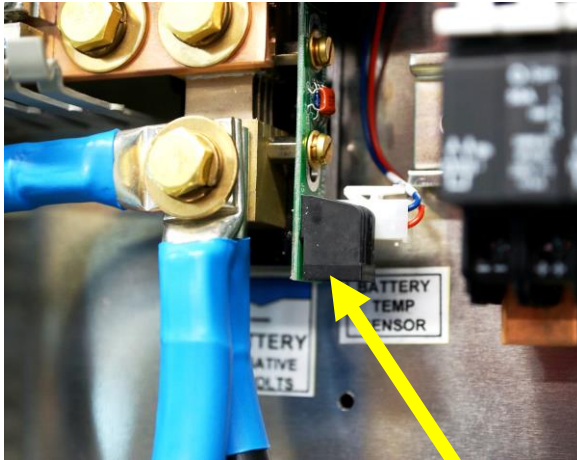
The lower photo shows the mounting holes on the back of the enclosure. The 3.9mm diameter mounting holes are on 57mm x 77mm centers. They are the smaller holes in the photo.

The mounting is done by removing the 4 screws in the front. Then the 4 holes will be used for mounting to the structure. Once attached to the location intended, the clear cover is replaced being careful to secure the gasket to retain the seal.



## 12 Battery Temperature Sensor

The Battery Temperature Sensor should be attached to the battery using the tape provided. The telephone type cable has a 4 pin RJ11 connector. This is meant to be fed through the appropriate gland in the bottom of the cabinet and then plugged into the mating RJ11 connector at the bottom of the Apollo Shunt board as shown in the photo at the left below.



The RJ11 Connector for the Battery Temperature Sensor cable which is plugged in from the bottom. For panels with multiple Battery Breakers, a large Bus Bar is attached to the Shunt. In this case the Temperature Sensor must be plugged in under the bus bar.

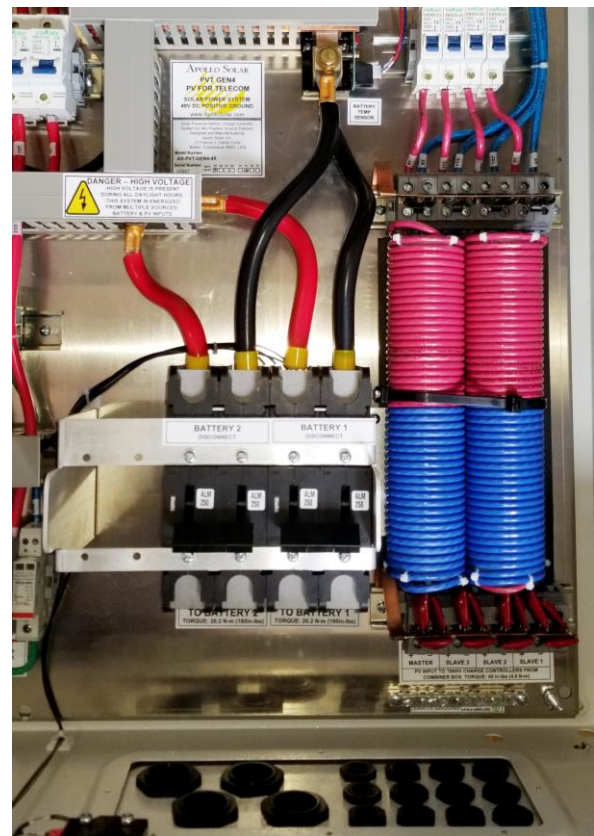
## 13 Battery Connections

Dual Pole, 250Amp Circuit Breakers are supplied for protecting the battery connections. The Battery Breakers are supplied in pairs joined together for protecting both the Positive and the Negative Battery Cables.

Box lugs at the bottom of each breaker will accept up to 95mm<sup>2</sup> (AWG 4/0) cables. **It is important to torque all the battery cable connections to 20.3N-m (180in-lbs).**

The Battery Breakers are offered in pairs for 1, 2 or 3 battery strings. The photo on the right shows 2 breaker pairs installed in the bracket with room for the 3rd breaker pair.

**The connection at the batteries should be the LAST connection.**



## 14 **OPTIONAL** Air Vents, Filters and Fans:

For climates with ambient temperatures over 30°C, it is recommended that the cabinet be fitted with vents to allow convection to exhaust hot air. Above 35°C we recommend that Fans and Filters be added to the lower vents.

The Fans near the bottom of each door behind a vent with louvers and filters pull fresh air into the cabinet through the filters which prevent bugs and dust from entering. The warmer air is exhausted through the vents at the top of each door. There are no fans behind the top vents.

The Filters should be examined on a regular basis and replaced or washed out if they become full of dust. The Filters are easily accessed from the front as shown in the photos below.

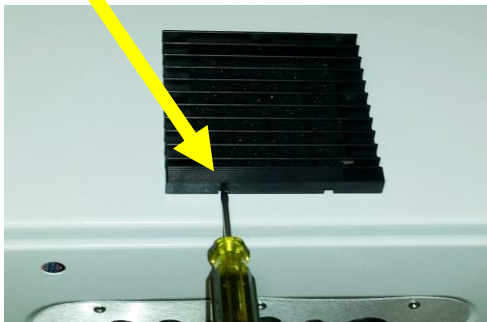


The 48 volt DC fans run from the 48 volt bus with fuse protection. The fans are controlled by a relay from the ASC which turns the fans on only when needed depending on the adjustable temperature thresholds set in the ASC.

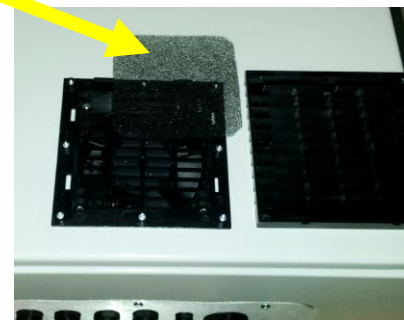
The photo at the right shows a fan installed on the inside of the vent near the bottom of the door. Both fans pull cool air into the bottom of the cabinet.



As shown below, the filters may be removed for cleaning or replacement from the front of the cabinet. The louvered grill comes off with the aid of a screwdriver to release the tabs at the bottom.



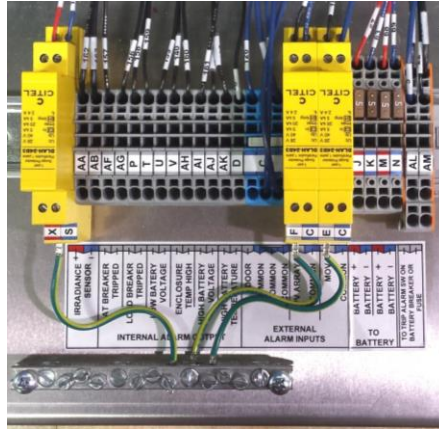
The filter material is captive behind the louvered grill.



## 15 Enhanced Surge Protection Option:

Extra surge is added to all wires coming into the cabinet from the area of the PV Array. The only change to the installation procedure is that the wires from the PV Combiner Boxes are connected at the very bottom right side of the panel, under the large coils which are the key element of the surge protection. There is a set of coils for every PV input. See photo at the right.

In addition, there are 3 Surge Protection Devices in series with the low current inputs. The external wires simply terminate into these devices.





## 16 Power Up Procedure

### WARNING:

- **ALWAYS TURN THE BATTERY POWER TO THE T80HV CHARGE CONTROLLERS ON BEFORE TURNING ON THE PV INPUTS.**
- **ALWAYS TURN THE PV INPUT OFF BEFORE TURNING THE BATTERY POWER OR THE T80HV OUTPUT CIRCUIT BREAKERS OFF.**

The T80HV Charge Controllers in this product operate from the battery power. The microprocessors inside the T80HV must have voltage applied so they can control the FETs which switch power from the PV input. **If the PV input power is allowed into these FETs without the T80HV circuitry running from battery power, the FETs can be damaged.** This damage is NOT covered by the warranty.



### WHEN POWERING UP:

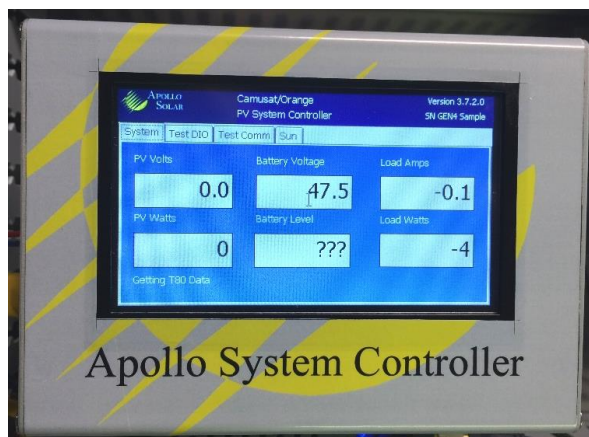
Turn the **Charge Controller Breakers on FIRST**, wait a few seconds, **turn the PV Breakers ON.**

### WHEN POWERING DOWN:

**Turn the PV breakers OFF FIRST, then turn the Charge Controller Breakers OFF.**

This procedure will make sure that the Charge Controllers never have PV power without battery power.

## 17 The Apollo System Controller (ASC)



The Apollo System Controller (ASC) shown here has a System Monitor Screen and 3 Screens which are used to test the system components.

The LCD is a Touch Screen which is activated by a finger. The test screens are selected using the menu bar along the top.

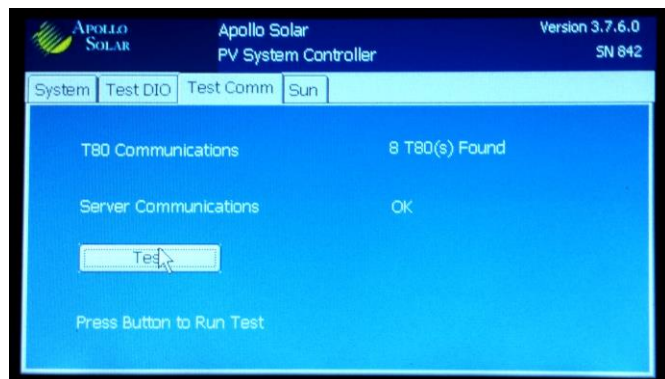
This "System" screen displays PV Volts, PV Watts, Battery Voltage, Battery Level (State of Charge), Load Amps and Load Watts.



The **Test DIO** tab is for testing the Digital Input and Output module. It shows the status of these monitored components:

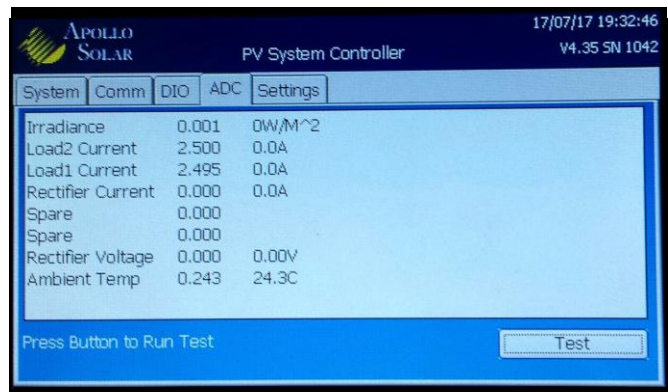
- Battery Breaker
- Load Breaker
- MOV (in Combiner SPD)
- PV Array anti-theft wire
- Door Ajar Switch

It also controls the Fans and the Essential and Non-Essential Load Contactors.



This **Test Comm** screen is used to test the communication between the ASC and each of the T80HV Charge Controllers.

It also tests the entire ASC to Server Communications via the GSM+WiFi Gateway.



Using the **ADC** tab, this screen tests the Analog to Digital inputs as shown on the screen.

The Analog reading is displayed in A/D Converter counts (for troubleshooting) and then converted by the actual reading and displayed in the proper units.

Apollo Solar recommends that on installation or maintenance visits, the full set of tests be run before leaving the site. It only requires selecting each test screen and pushing the Test bottom.

## 18 Parameter Settings for Load Disconnect and Generator Starting

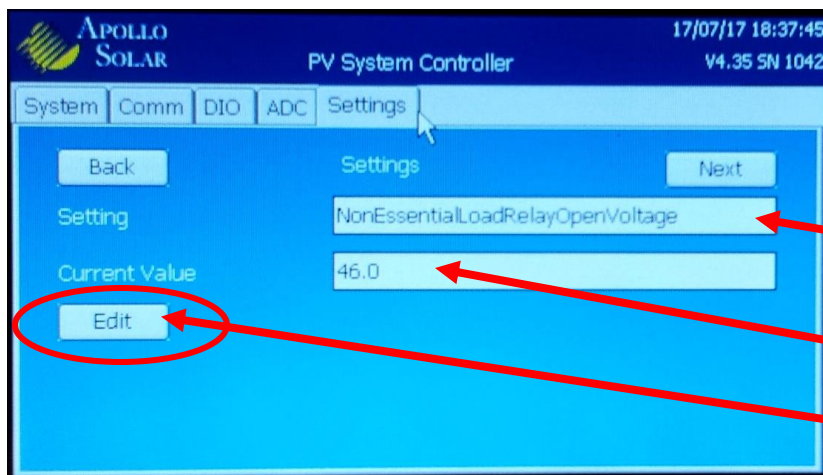
### THE ASC SETTINGS SCREEN:

The Settable Parameters are shown in the table below. The Default Values are highlighted. These values will come control the System when powered up. These values can be adjusted using the Settings Screen shown below. When the any value is changed, it can be saved and used. That is, the new setting will override the default. Using the DEFAULT button on the Settings Screen, the Original Defaults can be recalled. In addition, the Config file on the Micro SC card can be modified to over-write the default values. Note that each has a hard limit on the low end and the high end to prevent accidental adjustment outside the safe range.

APOLLO SOLAR - PV FOR TELECOM GEN4 - SYSTEM SETTINGS ON THE ASC Version 4.34						
NUM	SETTING NAME	UNITS	DEFAULT VALUE	MIN ADJ LIMIT	MAX ADJ LIMIT	NOTES
1	System Serial Number					Factory Setting
2	Local Time Offset (from UTC)	Minutes	UTC	UTC-12	UTC+12	Set at factory
3	Non Essential Load Open Voltage	Volts	46.8	46.0	50.0	Load Contactor
4	Non Essential Load Close Voltage	Volts	51.0	48.0	56.0	Load Contactor
5	Essential Load Open Voltage	Volts	46.4	45.6	50.0	Load Contactor
6	Essential Load Close Voltage	Volts	51.0	46.0	56.0	Load Contactor
7	Enclosure Fan Turn On Temperature	deg C	40.0	39.0	50.0	Master T80 Heatsink
8	Enclosure Fan Turn Off Temperature	deg C	35.0	25.0	36.0	Must be < Turn On
9	Max Number of T80s (Factory Setting)		1	1	16	Not Visable
10	Number of Installed T80s	Number of T80HVs		1	16	Set at factory
11	Low Battery Voltage to Start Generator	Volts	47.5	44.0	50.0	
12	High Battery Voltage to Stop Generator	Volts	57.0	55.0	59.0	
13	High PV Voltage to Stop Generator	Volts	95.0	74.9	160.0	Hysterious
14	Generator Maximum Run Time	Hours	6	2	24	
15	Daily Generator Start Time	ToD Hr	1	0	24	Time of Day
16	Daily Generator Stop Time	ToD Hr	7	0	24	Time of Day



## 19 Changing Parameter Settings:

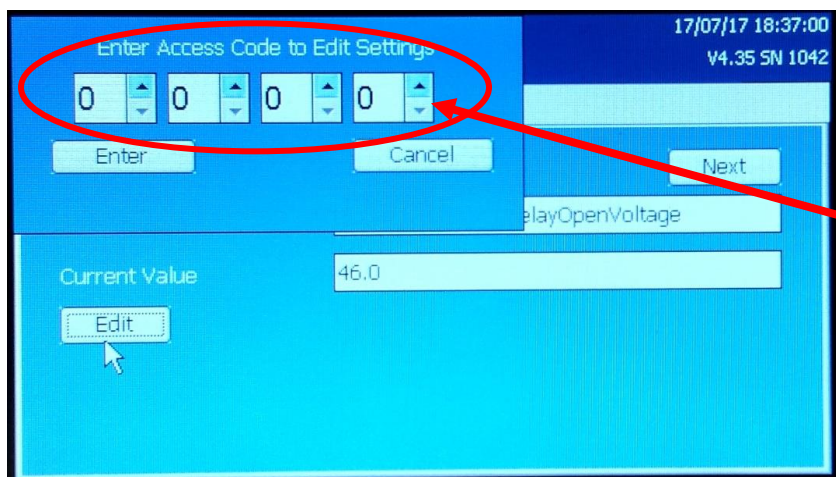


The SETTINGS screen shown at the left is used to modify the DEFAULT settings in the Table above. The Settings listed in the table may be modified.

The NEXT and BACK buttons allow you to scroll through the list.

The Current Value is shown.

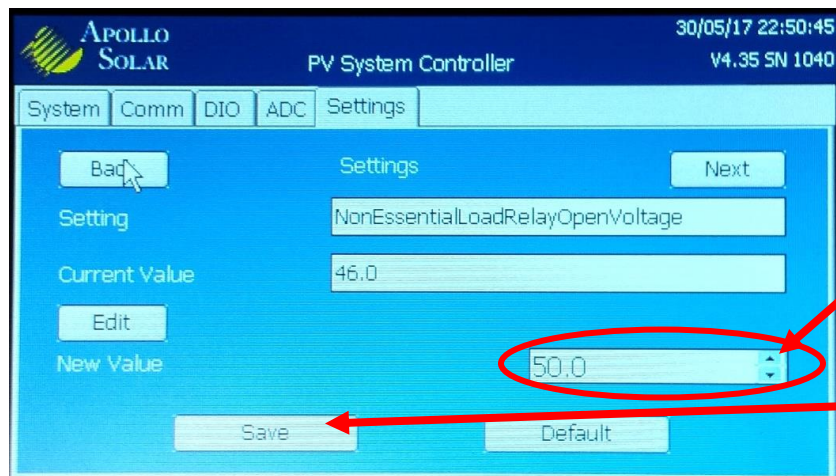
When the desired setting is in the window, hit the EDIT key.



The EDIT button brings up a security screen to prevent unauthorized changes.

A 4 digit Access Code must be entered using the dialog box shown at the left.

The Access Code is provided to all customers via email to the authorized person.



The proper Access Code brings up the window for increasing or decreasing the value of the parameter.

When desired value is reached, hit the SAVE button to use this value instead of the DEFAULT value.

**Visualizing the Load Disconnect and Generator Control based on Battery Voltage:**

APOLLO SOLAR PVT GEN4 - SYSTEM VOLTAGE SET POINTS (AT 25°C)										
Battery Voltage	Approx Open Ckt SoC	T80HV CHARGING PARAMETERS			PVT VOLTAGES SETTABLE ON THE ASC SCREEN					Volts per cell
		Absorb Set Point	Float Voltage Set Point	Equalize Voltage (Flooded)	Essential Load OPEN	Essential Load CLOSE	Non-Ess Load OPEN	Non-Ess Load CLOSE	Generator Start / Stop Voltages	
61.0				The T80HV						2.542
60.8		MAX		Eq Voltage						2.533
60.6				can be set						2.525
60.4				up to 65.6V.						2.517
60.2										2.508
60.0	MOST TELECOM SYSTEMS DO NOT PERMIT ANY VOLTAGE ABOVE 60 VOLTS									2.500
59.8										2.492
59.6										2.483
59.4										2.475
59.2										2.467
59.0				DEFAULT					MAX	2.458
58.8				MIN						2.450
58.6										2.442
58.4										2.433
58.2										2.425
58.0										2.417
57.8										2.408
57.6										2.400
57.4										2.392
57.2										2.383
57.0									STOP	2.375
56.8			MAX							2.367
56.6										2.358
56.4		DEFAULT								2.350
56.2										2.342
56.0						MAX		MAX		2.333
55.8										2.325
55.6		MIN								2.317
55.4										2.308
55.2										2.300
55.0										2.292
54.8										2.283
54.6										2.275
54.4										2.267
54.2										2.258
54.0									MIN	2.250
53.8										2.242
53.6			DEFAULT							2.233
53.4										2.225
53.2										2.217
53.0										2.208
52.8										2.200
52.6										2.192
52.4										2.183
52.2										2.175
52.0										2.167
51.8										2.158
51.6			MIN							2.150
51.4										2.142
51.2										2.133
51.0						DEFAULT		DEFAULT		2.125
50.8	100%									2.117
50.6										2.108
50.4	90%									2.100
50.2										2.092
50.0	80%				MAX		MAX		MAX	2.083
49.8										2.075
49.6	70%									2.067
49.4										2.058
49.2										2.050
49.0	60%									2.042
48.8										2.033
48.6										2.025
48.4	50%									2.017
48.2										2.008
48.0								MIN		2.000
47.8	40%									1.992
47.6										1.983
47.4										1.975
47.2	30%								START	1.967
47.0										1.958
46.8							DEFAULT			1.950
46.6	20%									1.942
46.4					DEFAULT					1.933
46.2										1.925
46.0						MIN	MIN			1.917
45.8	10%									1.908
45.6					MIN					1.900
45.4										1.892
45.2									MIN	1.883
45.0										1.875



## 20 Understanding the Load Disconnects and Generator Control:

The chart on the previous page shows the Battery Voltage Set Points which control Load Contactors and the Starting and Stopping of the external Back-up Generator.

The Battery Voltage is shown on the left in increments of 0.2 volts. The ASC allows settings to a resolution of 0.1 volts, but a chart showing that could not fit in this manual. With this graphic, it is possible to see that if the PV input is not available, and the energy in the battery is being consumed, the voltage will drop.

The priority of the Apollo Solar PVT system is to keep the Essential Loads for Microwave Backhaul service and the Non-Essential Load which includes the BTS transceivers from losing power. It is also a priority of the PVT system to assure a long life for the batteries. Since deep discharges shorten the life of the batteries, the Loads may have to be disconnected in order to save the life of the battery.

Of course measures are taken to avoid this situation. The systems are designed with batteries which are large enough to provide 3 to 5 days of autonomy. That is, the battery can power the loads for 3 to 5 days even if zero solar energy is available. In addition, the systems are designed to have ample solar arrays to keep the batteries charged even with very little sun.

One can see on the right hand side of the Chart on the previous page that the Generator is started if the Battery voltage were to go down to 47.2 volts. This is the DEFAULT START voltage and it can be modified within the range from 50.0 volts down to 45.2 volts. The point is that this is the first line of defense so that once the generator is running, there will no need to disconnect the loads.

However, if the (Optional) Generator is not available, and the battery continues to be discharged, at 46.8 volts, the Non-Essential Loads will be disconnected. This load shedding is done to preserve the Essential Loads and the life of the battery.

The reduced load will extend the time that the energy in the battery will power the Essential Loads, but if the battery voltage should go down to 46.4 volts, even the Essential Loads will be disconnected.

With zero external loads draining energy from the battery, it will be safe from any deeper discharge. When the PV Energy is available, or when the Generator is started, the voltage will increase. Both the Essential Loads and the Non-Essential Loads will be reconnected with the battery voltage reaches 51.0 volts.

All the voltage settings can be adjusted to meet specific requirements. Be advised that the DEFAULT set points were established with input from many telecom and tower operators with many years of combined experience and then field tested on over 1000 systems.

## 21 Local Data Storage on the Micro SC Card:

The Apollo System Controller (ASC) uses a MicroSD memory card to hold the operating program, the Configuration Files and setup parameters as well as months' worth of data.

The MicroSD card is installed or extracted in a slot in the top of the ASC easily accessed as shown here.



In addition to the operating program and the Configuration Files, the MicroSD memory card is also used to store the logged data. The results of the Remote Monitoring system are all stored on a large circular buffer on the card. It can be useful in 2 ways:

- 1) If the system is completely out of range of a BTS tower such that the data cannot be sent back to the server, one can retrieve the data by simply unplugging this card during a site visit. The card will store many month's results.
- 2) The data saved on the MicroSD card is also used to fill in gaps which can occur because of intermittent GSM communications. Each time data is sent to the server, the system looks for gaps in the data. When a gap is present, the missing data is resent until the server and the ASC both confirm that all the data has been received and logged on the server. Large gaps can still occur during times when the Server is performing periodic maintenance of the database.

## 22 The GSM+WiFi Gateway (GSMW)

The Apollo Solar PVT Gen4 Systems include a communication gateway which is multifunctional. The GSMW provides a wireless GSM connection with the local Cellular or Mobile Tower so the PVT can communicate with the Apollo Solar Server for Remote Monitoring and Control. The Modem is a Huawei MU609 module which provides a smooth path to Huawei HSPA+ or LTE high-speed modules. It supports 14.4Mbps downlink data rate, providing data and voice service under global GSM/GPRS/EDGE/WCDMA networks. The frequencies are:

- HSPA+/UMTS quad-band 850/900/1900/2100 MHz
- GSM/GPRS quad-band 850/900/1800/1900 MHz
- Data transfer rates: Downlink:14.4 Mbps, Uplink: 5.76 Mbps

The internal WiFi router provides a simple means for using a laptop computer to setup the parameters of this system. The WiFi Chipset includes Integrated 802.11, MAC, baseband, and 2.4 GHz radio which is 10/100BASE-TX/FX IEEE 802.3u-compliant and has IEEE 802.1X/WPA™/WPA2™ security.

Setting up the GSM+WiFi Gateway requires the proper SIM card from the Mobile Network Operator. Each carrier may have different requirements.



The GSM+WiFi Gateway is located just under the ASC. The SIM CARD for GSM modem operation is located just inside the RED door with easy access from the front of the system.

Note that there are 2 Antennas. The WiFi antenna is mounted to the lower SMA connector.

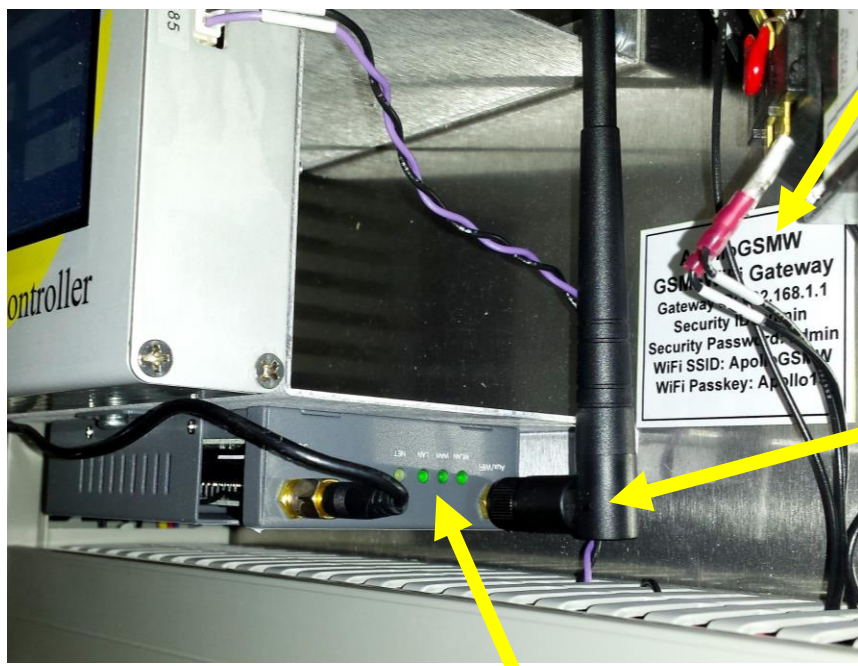
The upper SMA connector is meant for the GSM antenna which must be mounted outside the cabinet.

A SIM CARD is plugged into the socket in the photo below.



This photo shows the GSM Antenna plugged into the SMA connector.

The GSM+WiFi Gateway with the SIM CARD hatch open



The label on the panel states the following:

**Gateway IP: 192.168.1.1**  
**Security ID: admin**  
**Security Password: admin**  
**WiFi SSID: ApolloGSM**  
**WiFi Passkey: Apollo13**

WiFi Antenna comes installed

The GSM+WiFi Gateway showing the LEDs on the side

The diagnostic LEDs on the right side of the GSM+WiFi Gateway are labeled as follows:

Top near GSM antenna jack

- **WLAN** (Green)
- **WAN** (Green)
- **LAN** (Green)
- **NET** (Yellow)

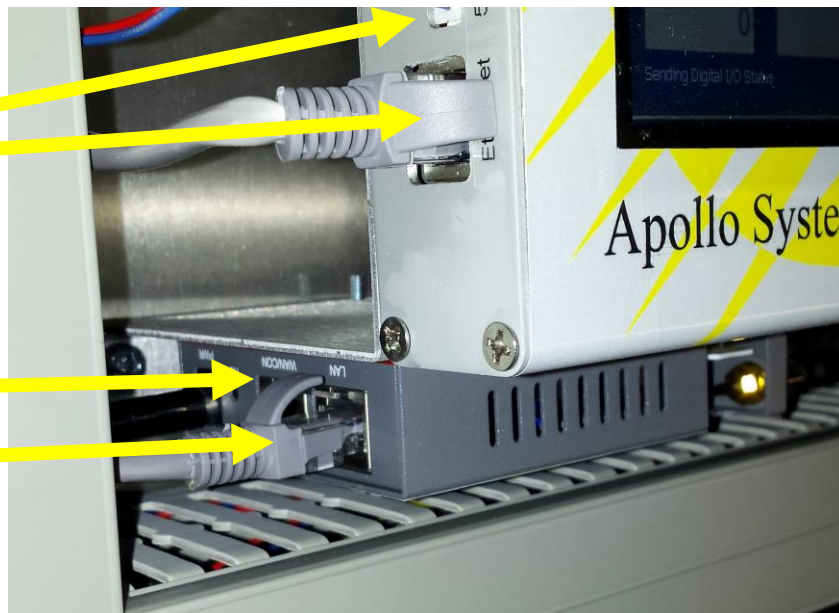
Bottom near the WiFi antenna jack

The left side of the Apollo System Controller has connectors for USB and Ethernet.

The left side of the GSM+WiFi Gateway has RJ45 connectors labeled:

WAN/CON

And LAN.





## 23 T80HV Charge Controller Settings

These parameters are preset at the factory as shown in the table below. They may be modified as needed using the buttons on the face of the T80HV. Except of the maximum output current for each T80HV, all the parameters are set in the Master T80HV.

Master T80HV Settings		
Battery Type	Flooded	
Battery Capacity	750	Ahr
Max Current	80	A
ABS Voltage	56.4	V
ABS Time	2	Hrs
Float Voltage	53.5	V
EQ Voltage	59.0	V
EQ Time	2	Hrs
AUX1 Mode	BATT V	
AUX1 ON	47.4	V
AUX1 OFF	51.0	V
AUX1 MIN ON Time	10	Min
AUX2 Mode	T80 T	
AUX2 ON	70.0	°C
AUX2 OFF	60.0	°C
AUX2 MIN ON Time	10	Min
Slave T80HV Settings		
Max Current	80	A

## 24 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.

## 25 Service and Support

If you have any questions or problems with the PV FOR TELECOM SYSTEM, 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.

## 26 Five Year Limited Warranty Information

### *Warranty and Conditions*

Apollo Solar Inc. warrants that the PV FOR TELECOM SYSTEM 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 PV FOR TELECOM SYSTEM 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 PV FOR TELECOM SYSTEM or any part thereof shall be limited to the repair or replacement of the PV FOR TELECOM SYSTEM, at Apollo Solar's discretion. This warranty is limited to the PV FOR TELECOM SYSTEM 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.