



APOLLO SOLAR

Installation and Wiring of the Apollo Solar Cabinets



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Components of the Apollo Telecom Power System

Step1

Start with enough Solar and Battery to keep the Tower running for 3 days.



Charge
Controllers,
Switchgear
and Remote
Monitoring



The Tower BTS
needs 48V DC at
typically 2kW.



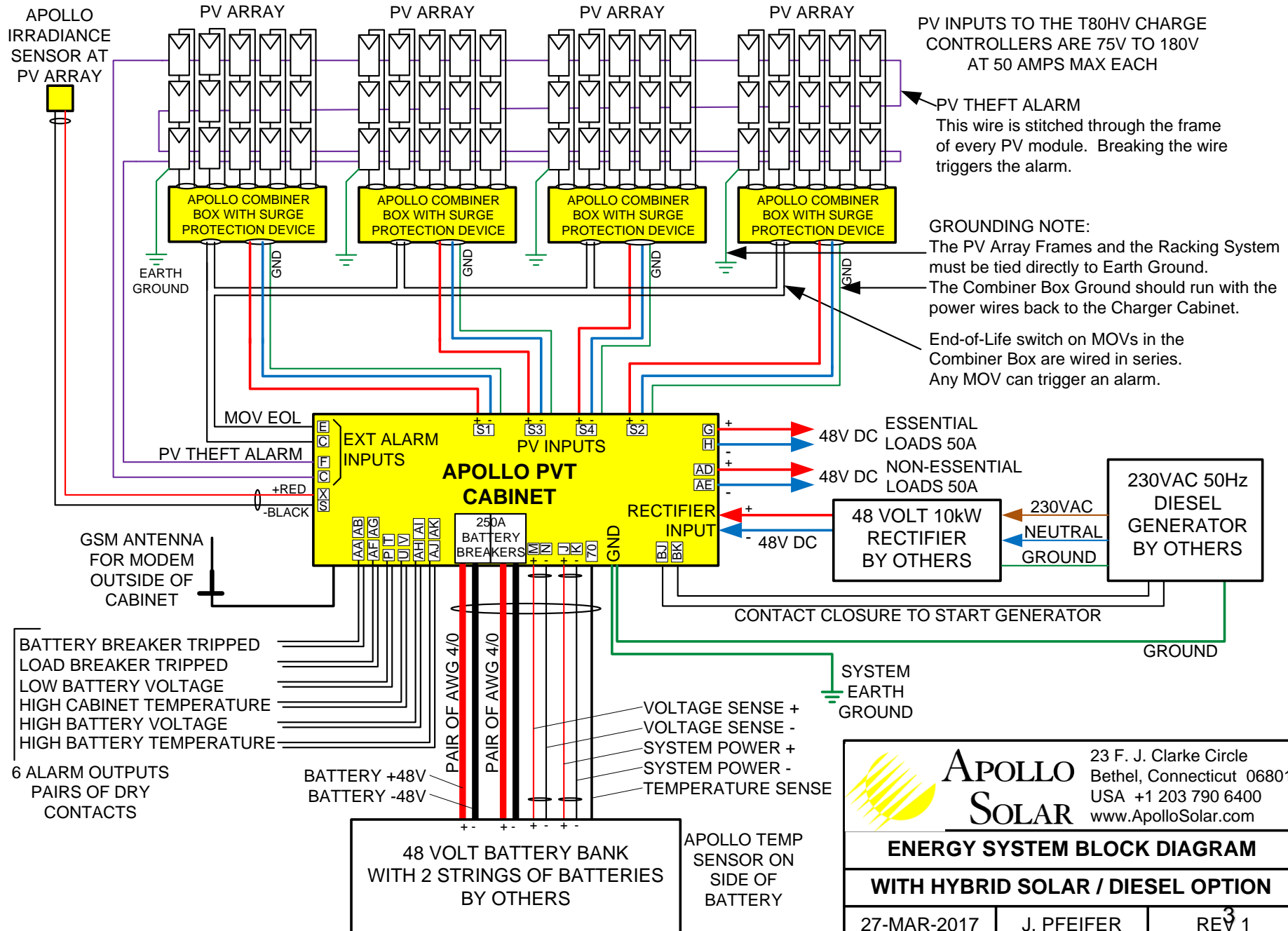
Step 2 – If the space
limits the PV Array, add
a small (6 - 12kW)
Generator for back up to
fill in the difference.



Deep Cycle Batteries provide
continuous DC power.

The losses in the battery are not critical
because the Solar energy is essentially free.

APOLLO SOLAR – REMOTE ENERGY SYSTEM – SYSTEM WIRING DIAGRAM



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ENERGY SYSTEM BLOCK DIAGRAM		
WITH HYBRID SOLAR / DIESEL OPTION		
27-MAR-2017	J. PFEIFER	REV 1

Wiring of the Apollo Solar Cabinet

A good grounding system is essential.

GOOD GROUNDS -- The quality of the connection to earth ground is the single most important issue. The resistance from the ground system to the earth must be very low. You will need many ground rods and if the soil is dry and/or sandy, extreme measures, such as adding carbon dust, will be required to get a reasonably low resistance.

EQUAL POTENTIAL GROUNDS -- Equal Potential Grounding is an important rule. This means a single “star point” ground in your equipment with the best earth connection you have connected to that same star point. Use the Panel in the Apollo Cabinet as the star point ground.

GROUND WIRING -- All ground wires must be short, thick and straight so they are free of resistance and inductance. Any coil in a ground wire makes an inductance which prohibits the fast surge from going to ground.

PREVENT RODENT DAMAGE – We recommend running all the wiring to the Cabinet from the PV Array, the Battery Enclosures and the BTS Equipment Rack in covered metal wiring trays. Rodents like to eat the insulation from wires. It is the largest single cause of field problems.

Apollo Solar - Energy System Cabinet



- The Apollo Gen 4 PVT Systems include all of the electronics in a single cabinet for easy installation.
- The cabinets are powder coated steel and sealed to meet IP66 and are intended to be outdoors, typically in the shade, under the PV array.
- The cabinet is 1000mm wide x 300mm deep x 1200mm tall. It is shown here with 450mm legs. They can also be hung from the ground-mounted PV support system.
- All of the cables exit from the bottom using waterproof glands. The cables should be covered in rodent-proof metallic braided shields and run inside covered metal trays to the PV Combiners, the Battery Enclosures and the BTS Load rack.
- Multiple cabinets can be installed side by side, or back to back as shown here.

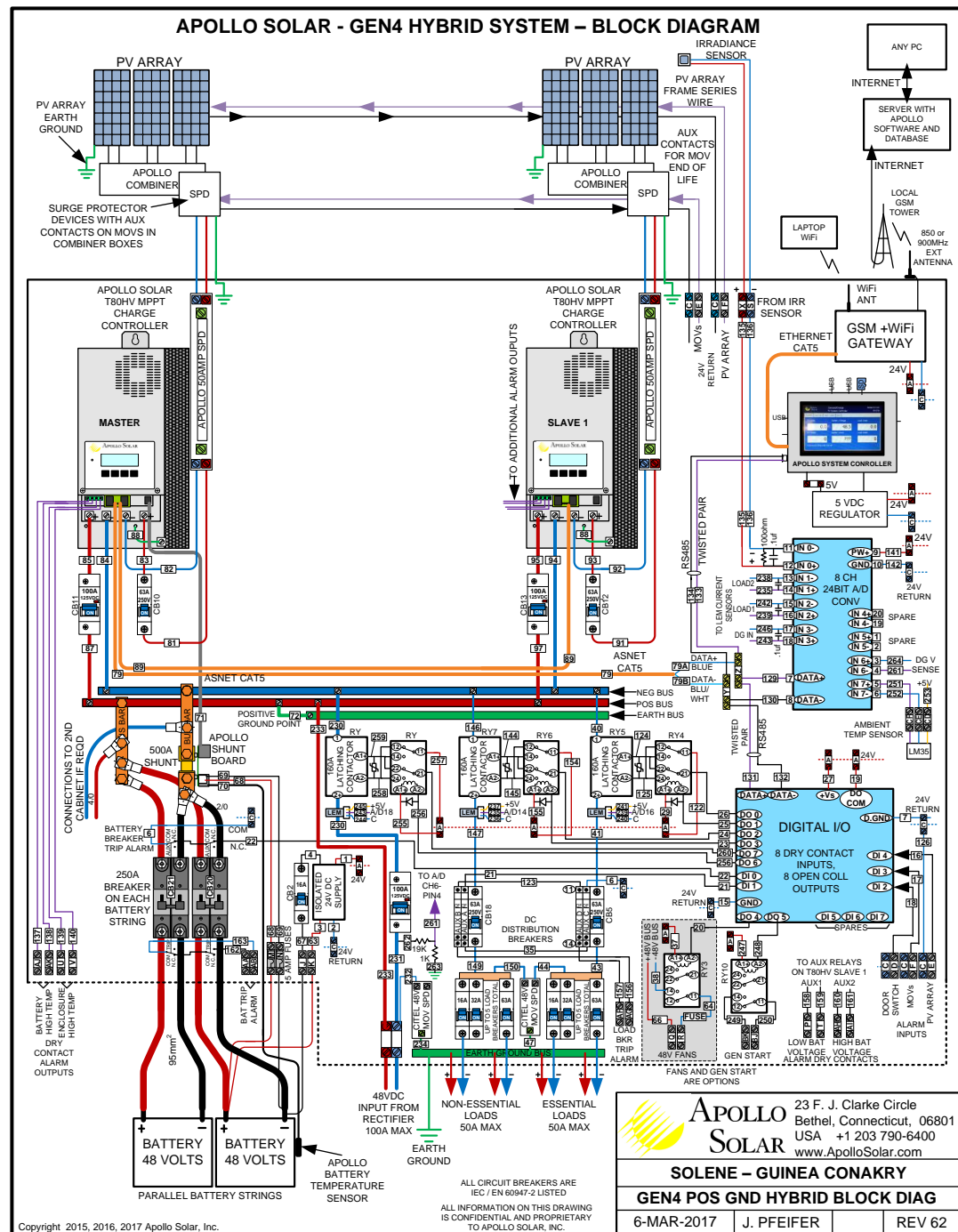
Detailed Block Diagram of Apollo Hybrid Energy System

This is the actual diagram of systems built. It can be expanded to harvest solar energy up to 60kW and support tower loads up to 6kW.

The Apollo system provides all the elements to provide reliable energy for the tower.

Options allow our system to provide all possible features cost effectively.

The input can be Solar and Generator.



APOLLO SOLAR

Assembly Drawing of Apollo Hybrid Energy System

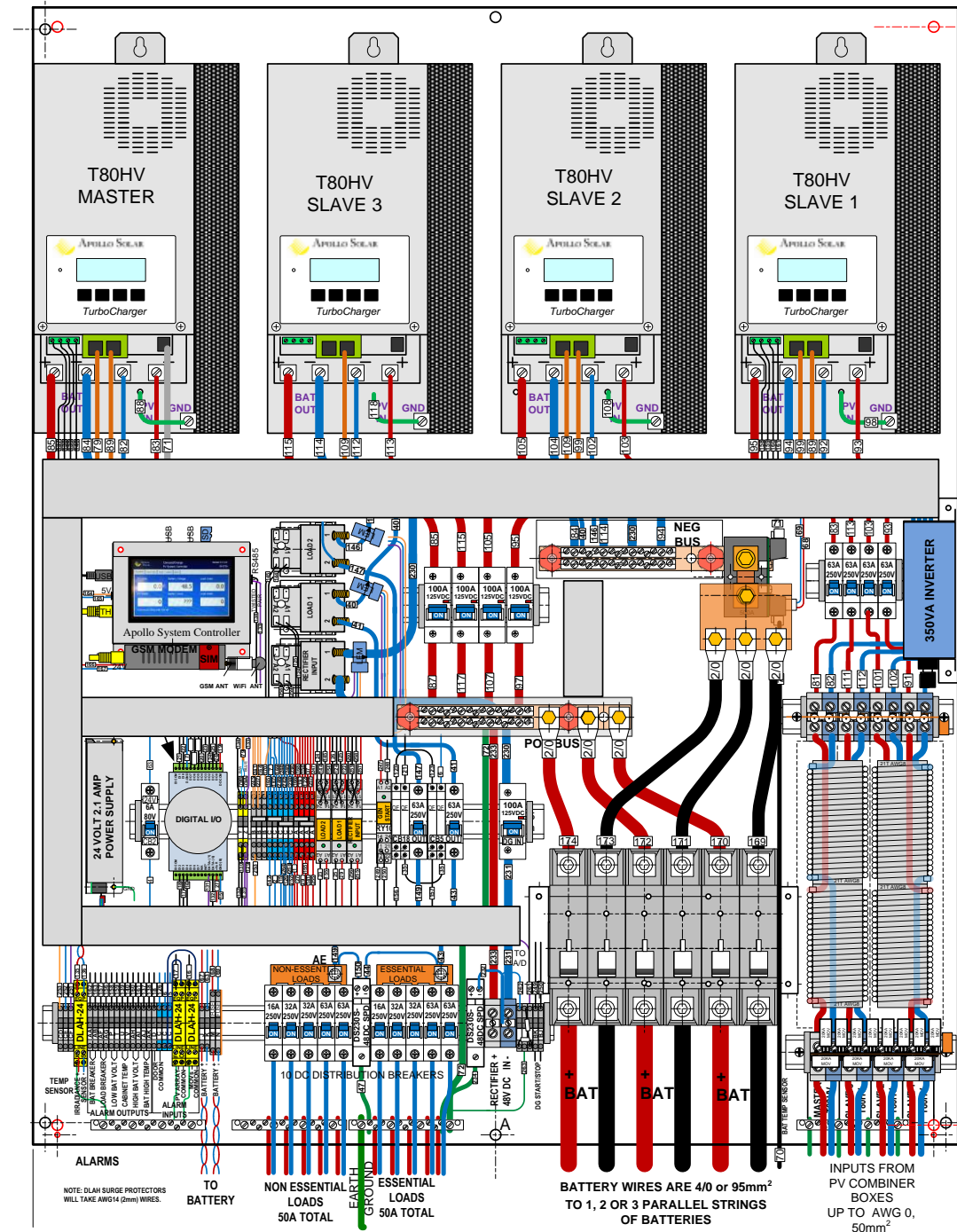
For comparison, many of the popular options are shown on this drawing. If an option is not purchased, the space for it is simply not used.

This drawing is valuable for support since it calls out all the numbers of each wire.

A larger version of this drawing is included in the Installation Manual.

The 10 DC Distribution Breakers are shown at the bottom center. They may not all be used at every site.

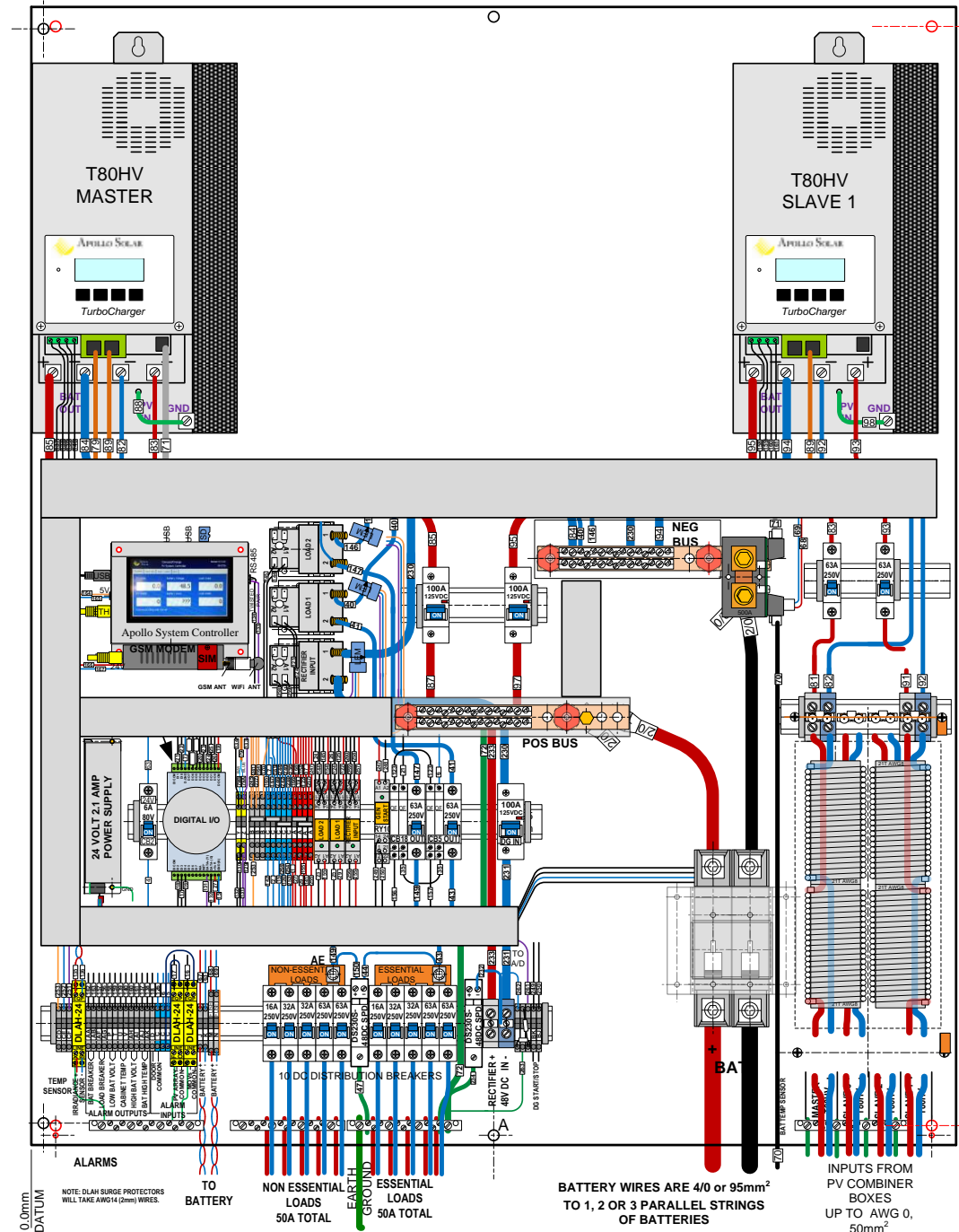
This drawing shows 3 Battery Breakers which is the most that will fit.



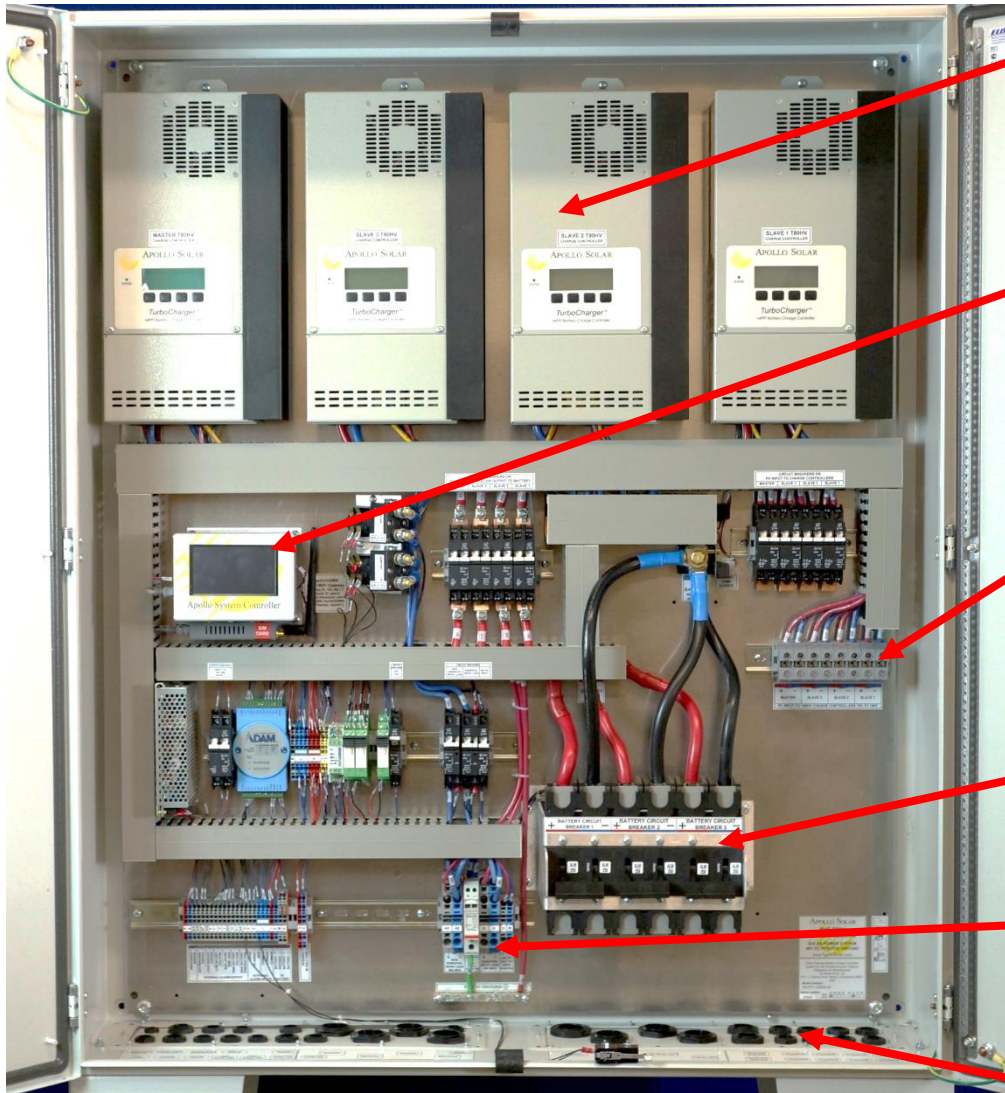
Assembly Drawing of Apollo Hybrid Energy System

This drawing shows the components used for a typical system with 2 charge controllers.

This drawing shows 1 Battery Breaker.



Inside the Apollo Solar Cabinet



➤ SOLAR CHARGE CONTROLLERS

The cabinet will support up to 4 T80HVs at 4 to 5kW of PV each.

➤ APOLLO SYSTEM CONTROLLER –

The ASC provides smart control of all power sources and distribution along with the Remote Monitoring.

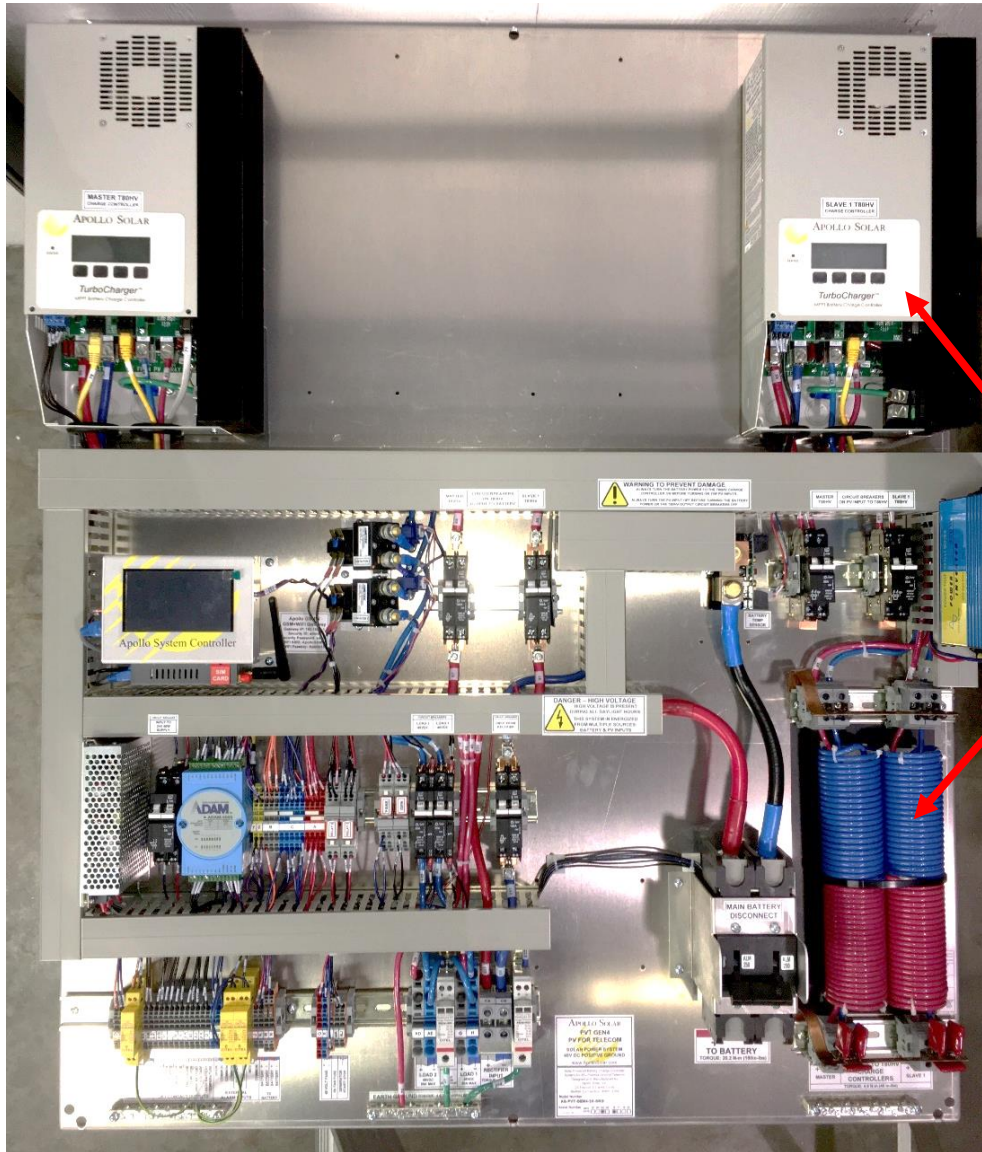
➤ **PV INPUTS** – Wire up to AWG 2 or 35mm² can be used from the Combiner Boxes.

➤ **BATTERY BREAKERS** – Multiple poles are provided for parallel battery stacks.

➤ **EXTERNAL WIRES** – Easy field wiring to well labeled terminals.

➤ **IP67 GLANDS** – All wiring comes in through these proper sized glands.

Inside the Apollo Solar Cabinet



➤ 2X T80HV Charge Controllers

➤ All other features are standard.

➤ Optional Enhanced Surge Protection shown.

The Apollo Panel in Logical Sections

1 to 4 T80HV
Charge Controllers

T80HV Output 100A Circuit Breakers

Positive 48V Bus Bar

Negative Bus Bar and 500A Shunt

PV Input 63A Circuit Breakers

Optional 350VA Pure Sine Wave Inverter

Optional Enhanced Surge Protection on PV Inputs

250A Battery
Breakers, 3 pairs

Optional DG/Rectifier Input & DG Control

Output Contactors

Apollo System Controller and GSM Modem

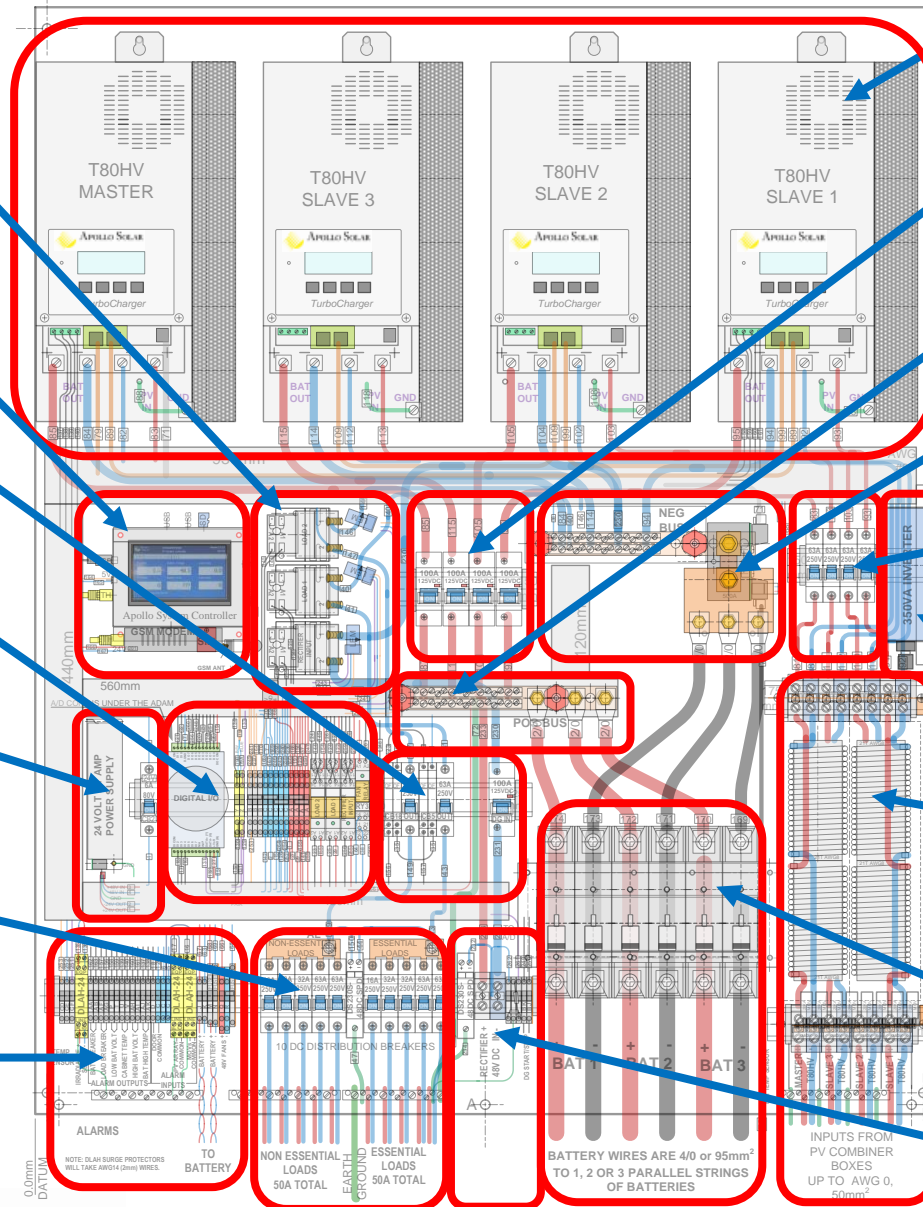
63A Output & 100A DG Input Breakers

Digital Input/Output Circuitry and Relays

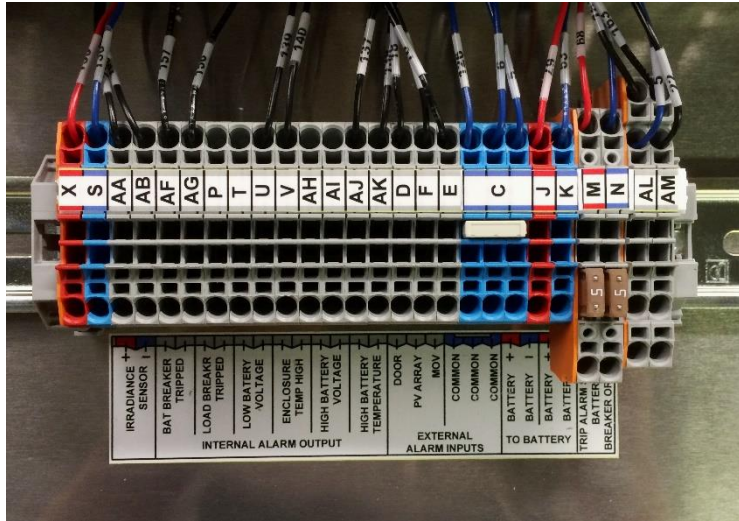
24V Isolated Power Supply & Breaker

Optional DC Distribution Breakers

Alarm Inputs and Outputs

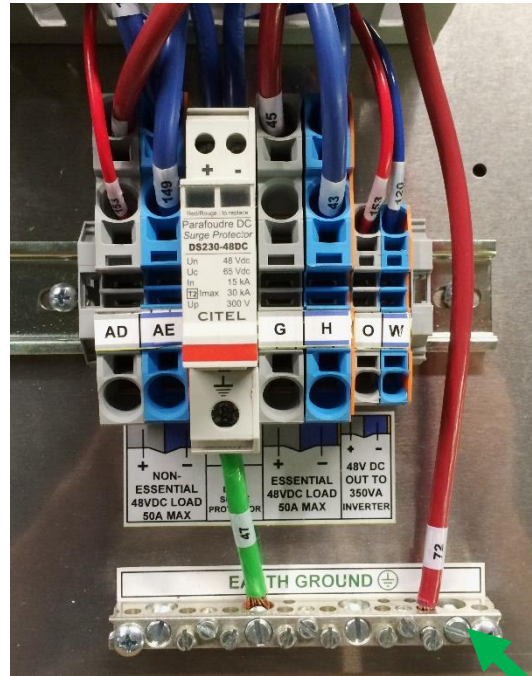


Apollo Solar Gen 4 Wiring Details



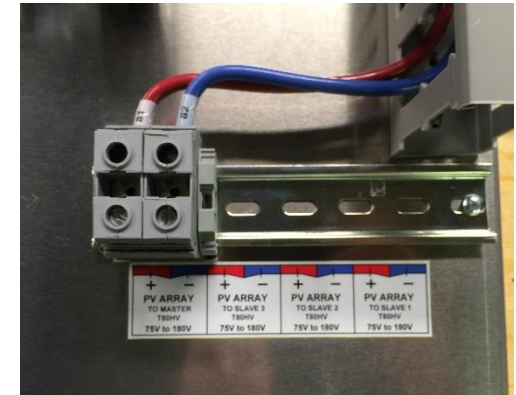
The smaller terminals are used for connecting the Irradiance Sensor, the Alarm signals and the battery voltage sense wires.

Terminals M and N are fitted with 5 Amp automotive type fuses.



The DC Outputs to the Essential Load and the Non-Essential Load are easily connected to terminals G/H and AD/AE.

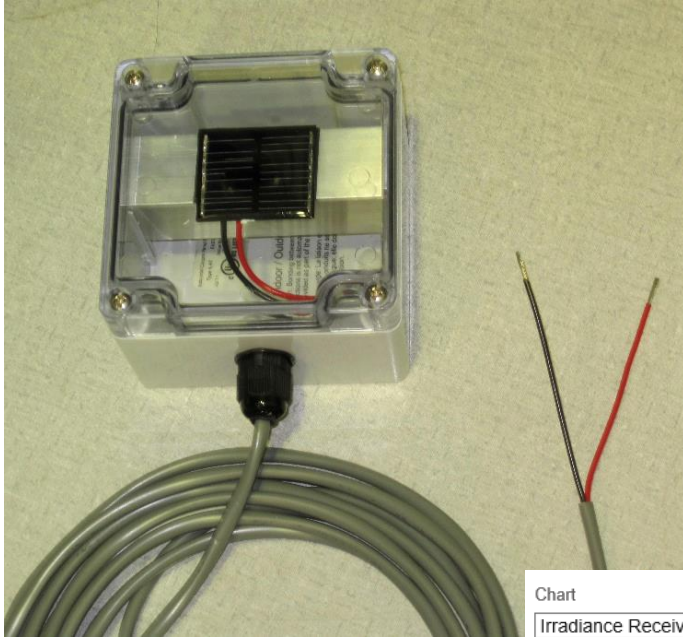
The portable 350VA Inverter is plugged into terminals O and W when used.



The PV inputs have screw type connectors which will accept up to AWG 2 wires from the Combiner Boxes. Torque the screws to 4.6 N-m (40 in-lbs).

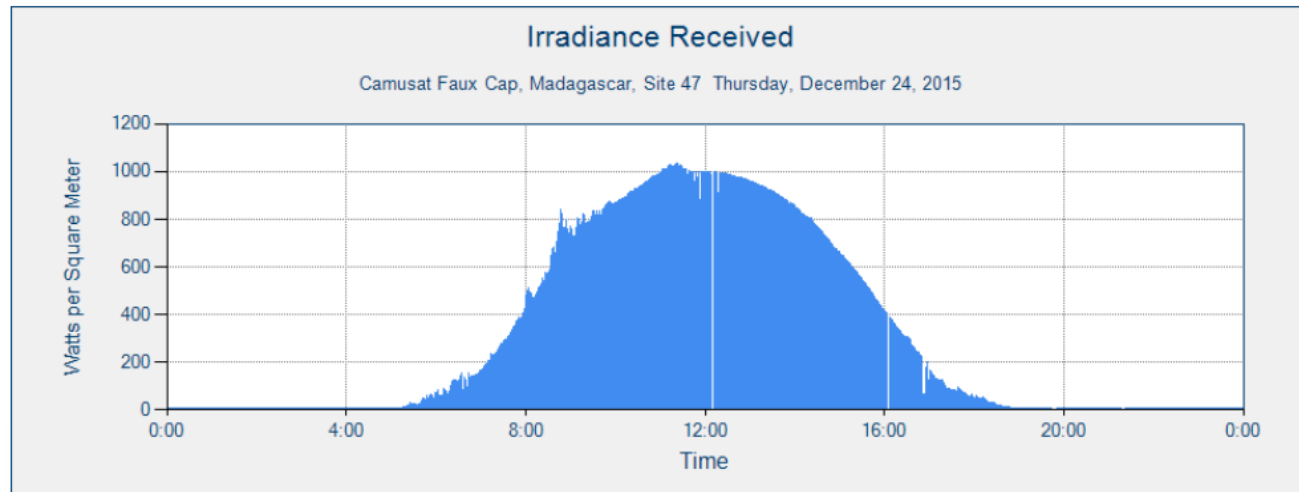
The Earth Ground is a single point with a terminal strip to connect to the external Ground Rod. Torque the screws to 4.6 N-m (40 in-lbs).

Apollo Irradiance Sensor



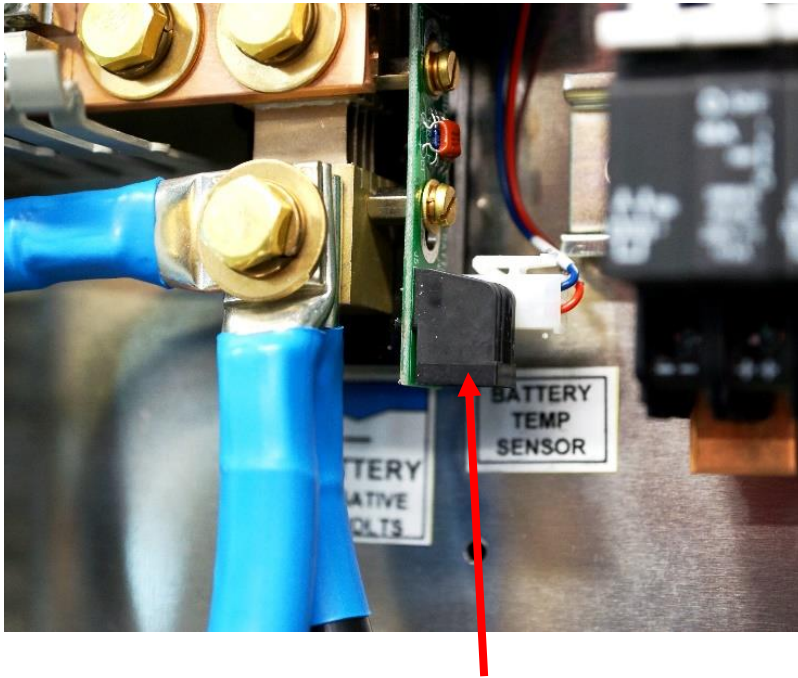
- The Apollo Irradiance Sensor is mounted on top of the PV Array.
- The ASC uses it to calculate the amount of solar energy available each day.
- One of the charts available shows the results.

Chart: Irradiance Received
Period to Show: Show One Day
Frequency: Raw Data
Start Date and Time: 2015 Dec 24 0:00
[Refresh](#)



Friday, January 27, 2017 2:34:22 PM V3.0

Gen 4 Wiring – Battery Temperature Sensor

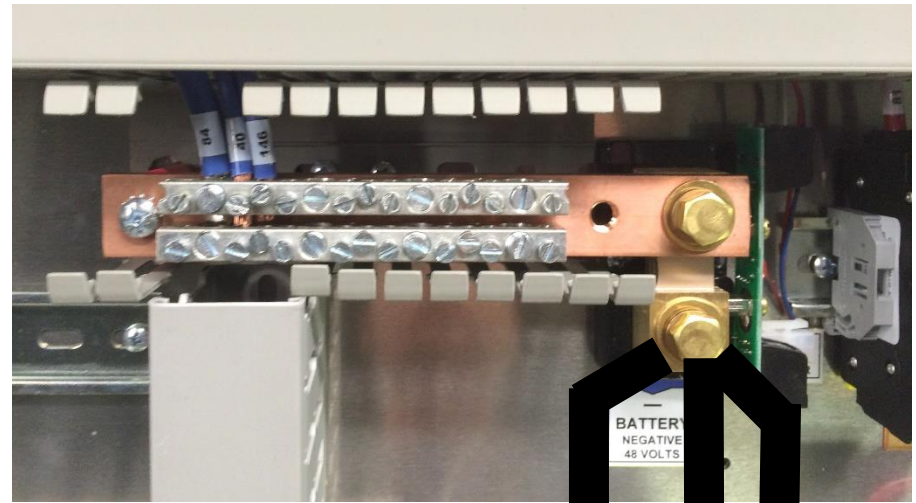


- The T80HV Charge Controllers use the Battery Temperature to compensate the charge voltages.
- The small Square device comes with tape. Stick this unit to the side of a battery near the middle of the battery stack. It should be below the level of the electrolyte.
- Plug the 4 pin connector into the RJ-11 Jack on the Shunt Board as shown in the photo above.

Apollo Solar Gen 4 Installation Details



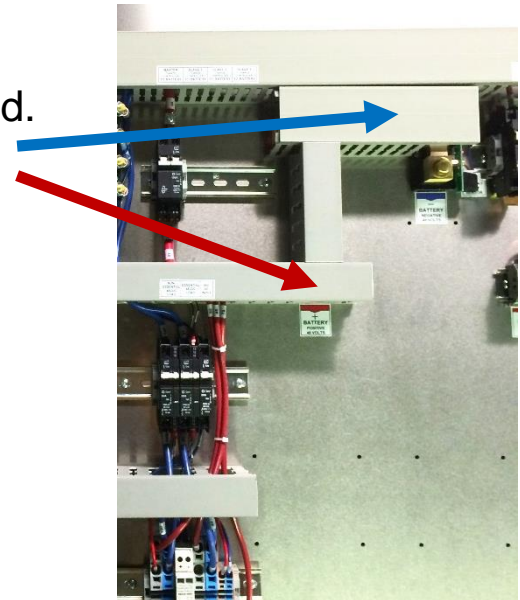
The POSITIVE battery cables are to the POSITIVE BUS BAR.



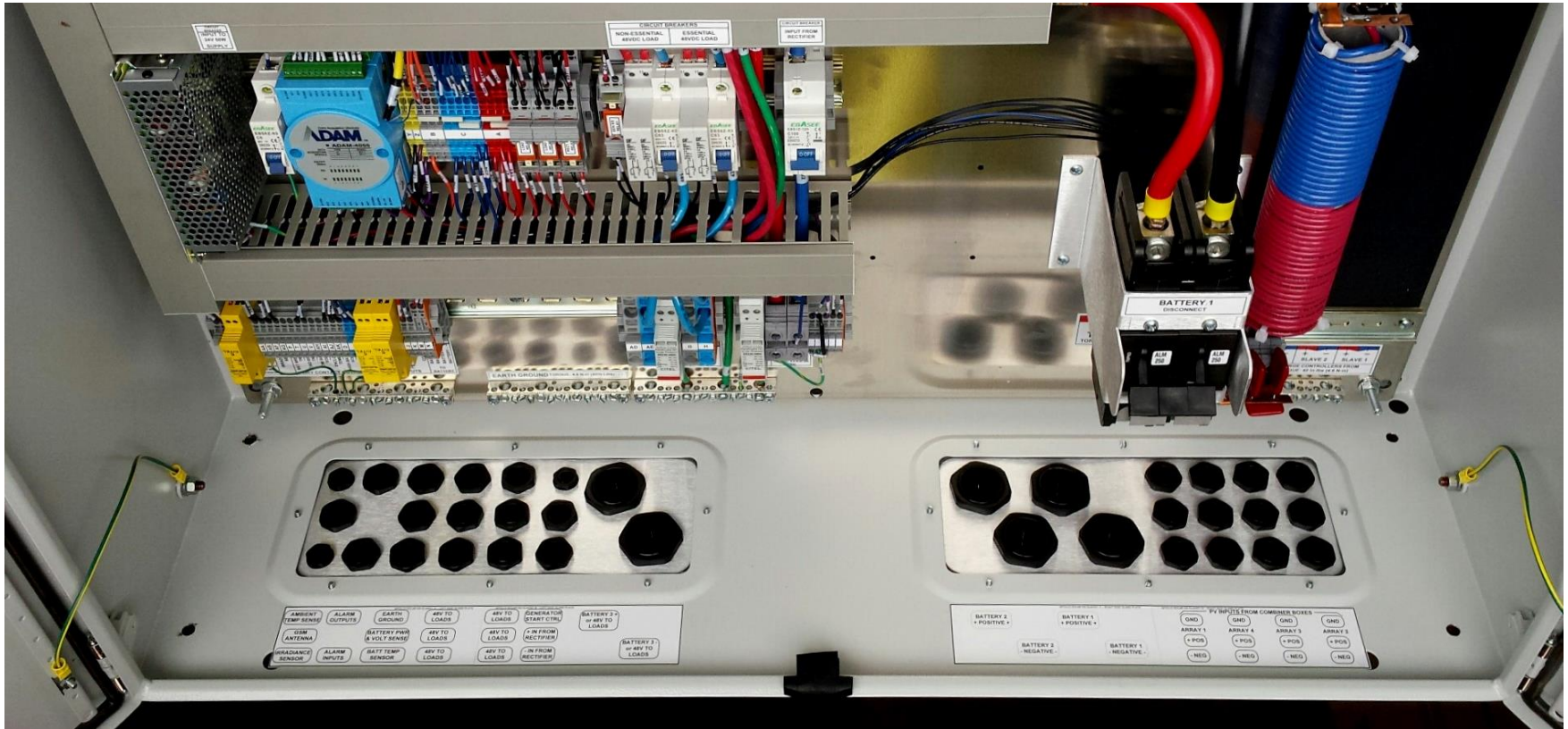
The NEGATIVE battery cables are to the LOWER TERMINAL ON THE SHUNT.

The Bus Bars are shown above with their covers removed. The arrows point to their locations on the Gen 4 Panel.

The battery cables must be AWG 4/0 or 95mm² for minimum voltage drop. The terminals **MUST** be tightened with a calibrated torque wrench 20.2 N-m (180 in-lbs.).

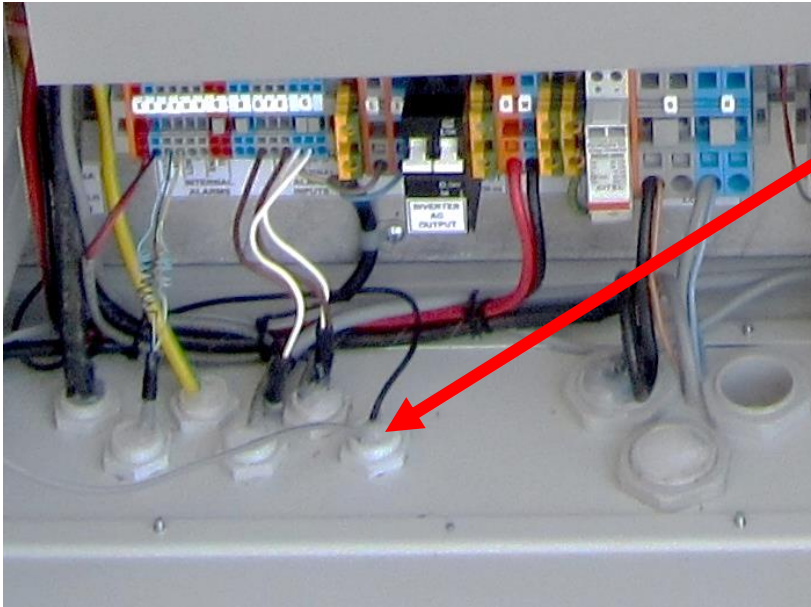


Apollo Solar Gen 4 Wiring Details



- The photo shows the wire entry glands in the bottom of the cabinet.
- Note that each gland is labeled and sized to fit the proper gauge wire for the purpose.
- The connectors for each of the wires are located at the bottom of the panel.

Apollo Solar Gen 4 Wiring Details



- NON-CORROSIVE
Silicone RTV may be used to fill the glands after the wires are secured to ensure IP66 protection.

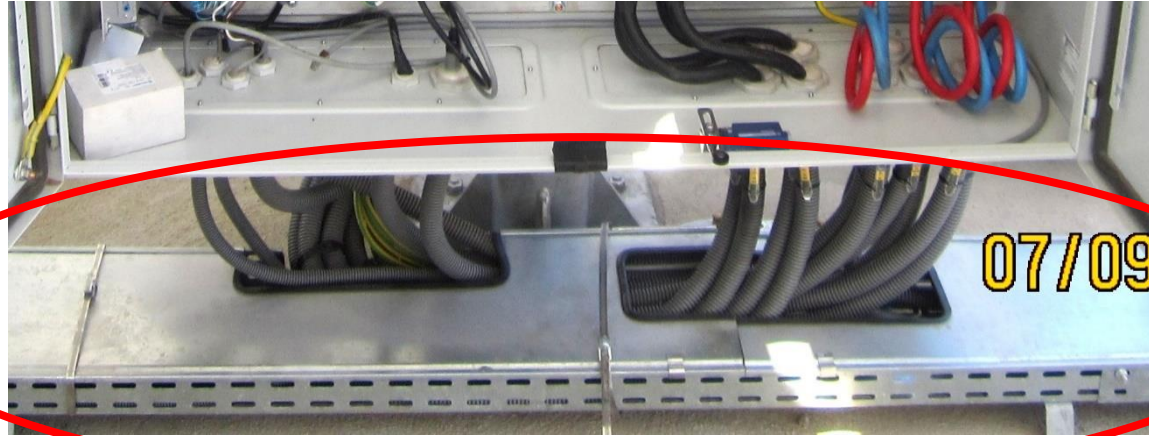
- Make sure the Silicone is NON-CORROSIVE, Electronics Grade.



- NEVER use Household type Silicone Sealant. It gives off acid which will destroy all the copper in the cabinet and the Warranty will be totally void.



Apollo Solar Gen 4 Wiring Details



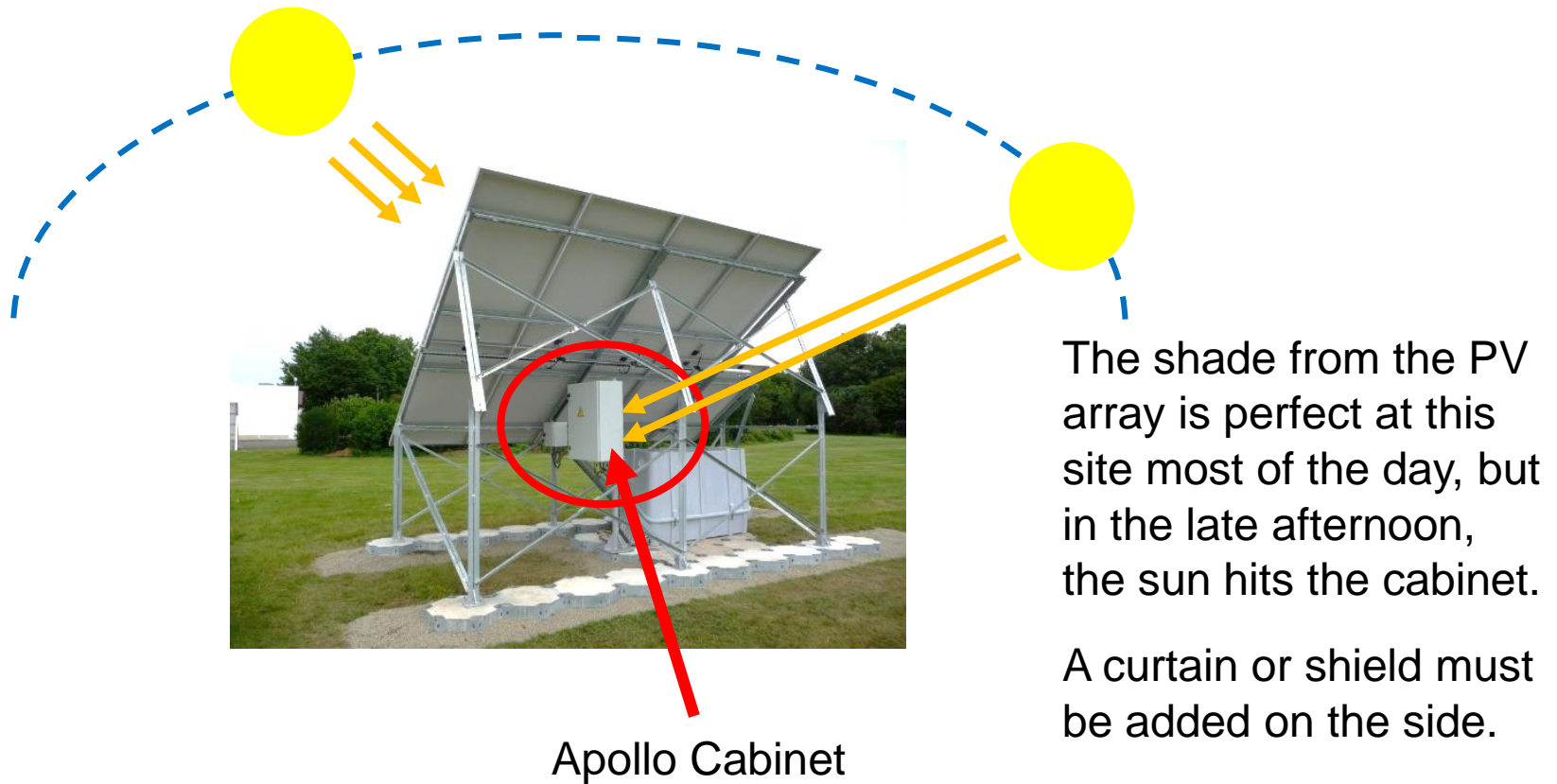
All wires and cables between the Apollo Solar Cabinet, the PV Array, the Battery enclosure and the BTS equipment must be run inside steel conduit.

The conduits must be closed and maintained to prevent damage to wires from abrasion, crushing loads and most commonly, from rats and other creatures.

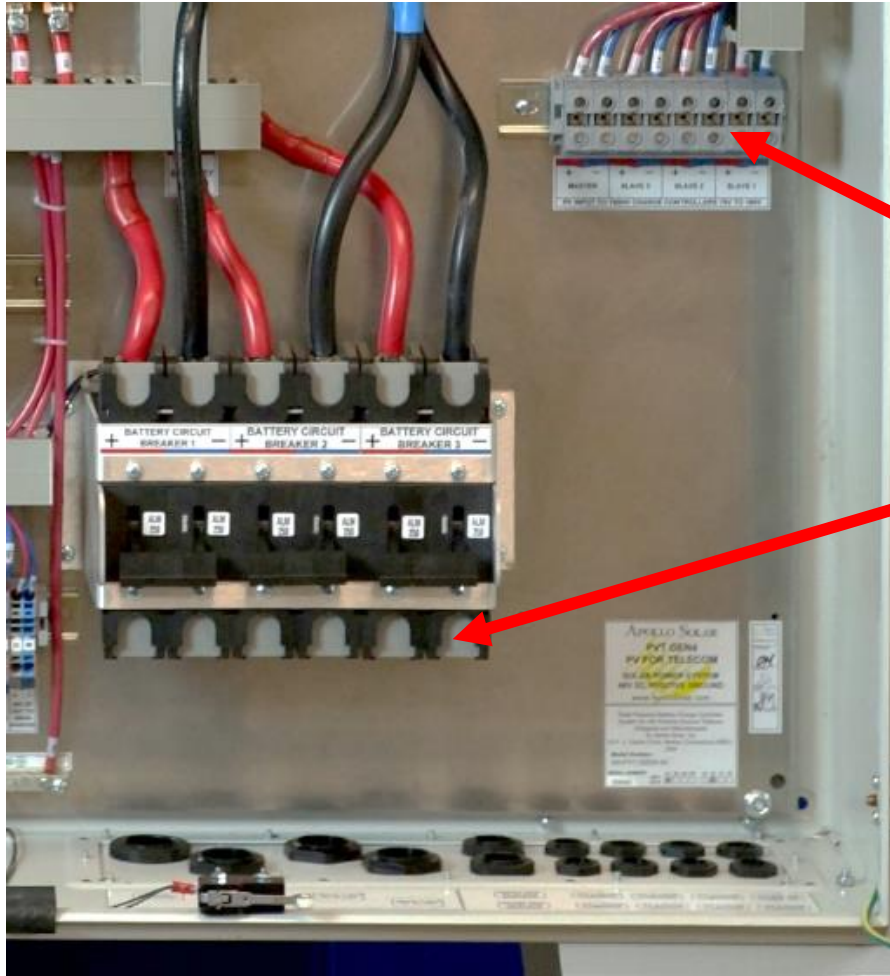


Apollo Solar Cabinet Installation

- It is critical to locate the Apollo Cabinet in the shade.
- Direct sun, even for a short time, can cause overheating inside the cabinet.



Gen 4 Wiring – 4X T80HV, 3 Battery Breakers



- The 4 PV Combiner Boxes are connected through the glands at the lower right to the screw terminals marked for PV Inputs. Torque the screws to **4.6 N-m (40 in-lbs).**
- Cables from the Batteries are connected into the bottom of the Battery Circuit Breakers.
- Double check the Positive + and the Negative – are correct.
- **Torque the Allen head screws to 20.2 N-m (180 in-lbs.).**



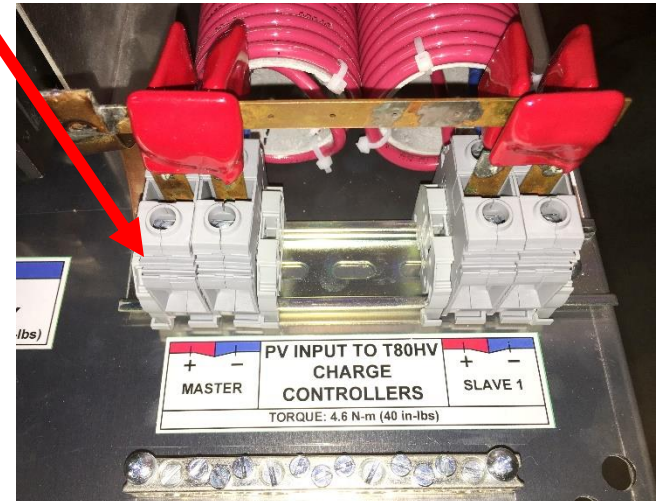
FOR SAFETY, IT IS RECOMMENDED THAT THE BATTERY SHOULD BE THE VERY LAST CONNECTION MADE.

AFTER THE CABLES ARE CONNECTED TO THE BREAKER, THEN THE CABLES CAN BE CONNECTED TO THE BATTERIES THEMSELVES.

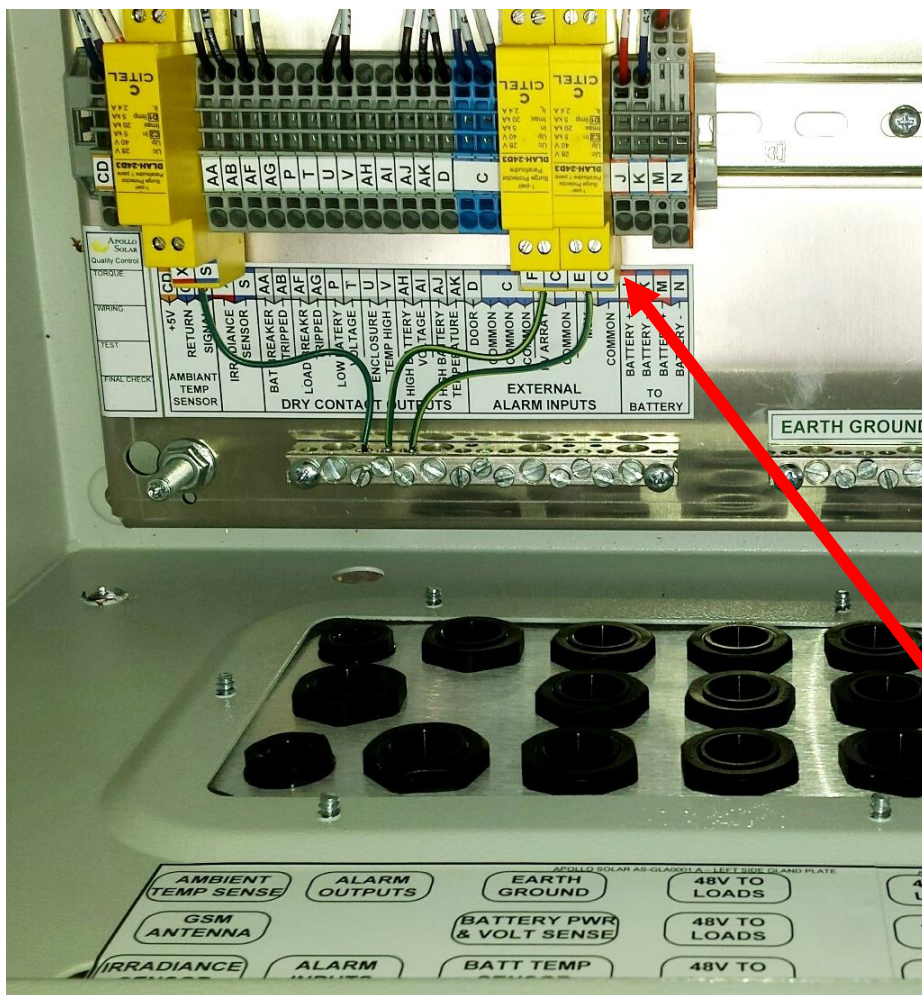
Gen 4 Wiring – 2X T80HVs, 1 Battery Breaker with Enhanced Surge Protection



- The Enhanced Surge Protection option includes a special set of MOVs, High Current Inductors and Transient Voltage Suppressors on each PV input shown in the photo.
- The PV inputs from the Combiner Boxes are attached to the screw terminals at the bottom of the panel. Torque to 4.6 N-m (40 in-lbs.).
- The Ground Wires from the Combiner Boxes are connected to the Ground Bus Bar.

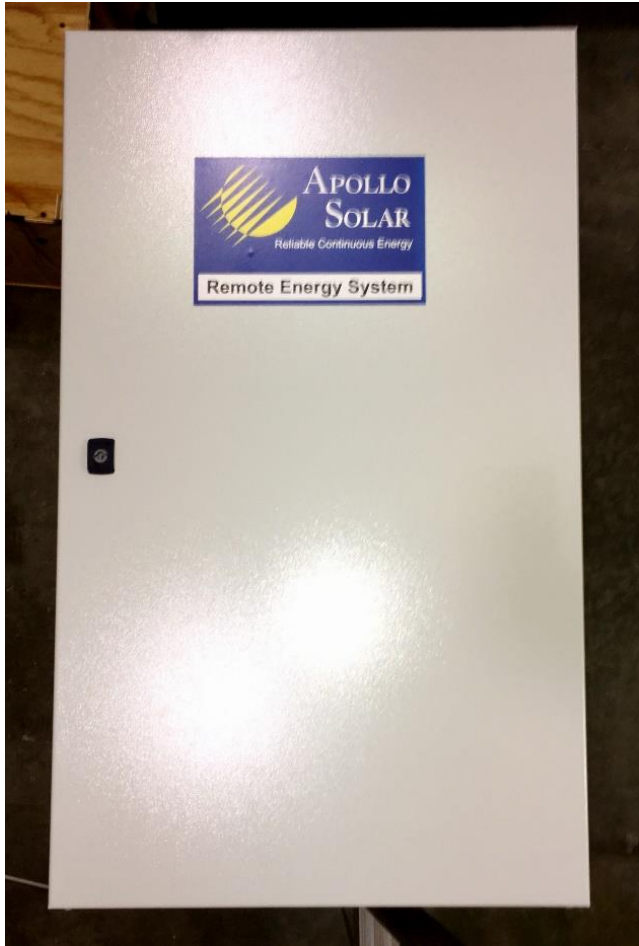


Gen 4 Wiring – 2X T80HVs, 1 Battery Breaker with Enhanced Surge Protection



- The Enhanced Surge Protection option also includes Special Surge Protection modules on the wires that run out to the area of the PV Array.
- These include the wires from the Irradiance Sensor, the PV Array Theft Alarm and the Combiner Box MOV End-of-Life Alarm wires.
- The 3 Yellow devices shown at the left are installed to be wired in series with these 3 sets of wires.
- Simply connect the wires from the outside, through the labeled glands and terminate in the holed provided at the bottom of the Yellow devices.

The Mini Cabinet

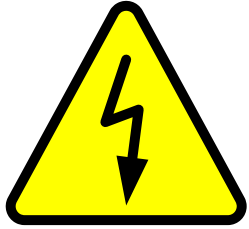


- This 600mm wide x 1000mm tall cabinet is designed for mounting to a wall or the PV support structure.
- The Mini Cabinet supports 1 or 2 T80HVs so it can handle up to 10kW of PV input.
- All the same features from the Standard Cabinet are available in the Mini – Except for the Power Rating.
- When the power required is less than 10kW and expansion or upgrading will never be required, the Mini Cabinet is a cost effective solution.

Inside the Mini Cabinet



- **One T80HV is shown with room for 2.**
- **APOLLO SYSTEM CONTROLER** – The ASC provides smart control of all power sources and distribution along with the Remote Monitoring.
- **CIRCUIT BREAKERS** – Hydraulic-Magnetic Circuit Breakers are immune to ambient temperature.
- **BATTERY BREAKERS** – A single pair of 250A breakers supports a single string of batteries.
- **EXTERNAL WIRES AND GLANDS** – Easy field wiring to well labeled terminals.
- **GEN START RELAY** – This is a HYBRID system with a relay to start an external Diesel Generator.



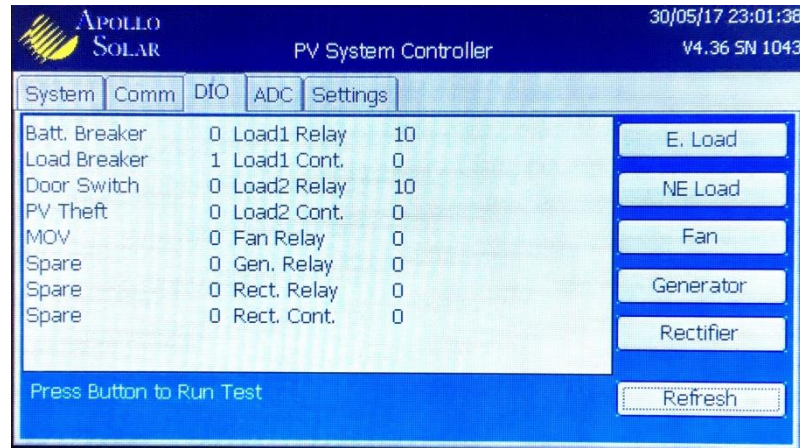
Apollo Solar Gen 4 Wiring Details

Warning 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.

Apollo Solar Gen 4 ASC Details



The Apollo System Controller is responsible for the following functions:

1. Monitoring the Battery Voltage and State of Charge
2. Starting the stopping the external generator to keep the battery charged
3. Disconnecting the Non-Essential or even the Essential Loads if required to prevent the battery from becoming deeply discharged
4. Gathering the data from the T80HV Charge Controllers and the other sensors in the system
5. Storing that data on the SD Card
6. Establishing and maintaining contact with the server via the GSM modem
7. Sending the data to the server and assuring that it arrived

Apollo Solar Gen 4 Installation Details



The Apollo System Controller (ASC) uses a MicroSD memory card to hold the program as well as data from the operation of the system for months.

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



The ASC uses an LCD Touch Screen for user interaction. The screens provide information for the installer to easily test each function and verify the operation of the system.



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 as shown.

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

Apollo Solar Gen 4 ASC Details

The Apollo System Controller is responsible for the following functions:

- Interface for the field technician for setup and test. Some of the test screens are shown at the right.
- Monitoring the Battery Voltage, State of Charge and Temperature.
- Starting the stopping the external generator to keep the battery charged.
- Disconnecting the Non-Essential or even the Essential Loads if required to prevent the battery from becoming deeply discharged.
- Gathering the data from the T80HV Charge Controllers and the other sensors in the system and storing it on the SD memory card.
- Establishing and maintaining contact with the server via the GSM modem.
- Sending the data to the server and assuring that it arrived.

