



**Reliable Continuous Energy**  
**PV FOR TELECOM**



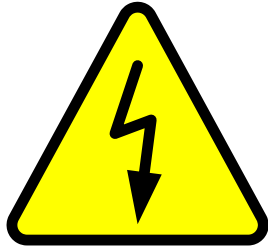
**Installation Guide**  
**Gen 4 PVT Panels**

**ENHANCED SURGE PROTECTION OPTION**

Manual Rev 4.4

## IMPORTANT SAFETY INSTRUCTIONS

ALSO READ THE COMPLETE SAFETY INSTRUCTIONS  
IN THE PVT INSTALLATION GUIDE  
**WARNINGS: DANGER -- HIGH VOLTAGE**

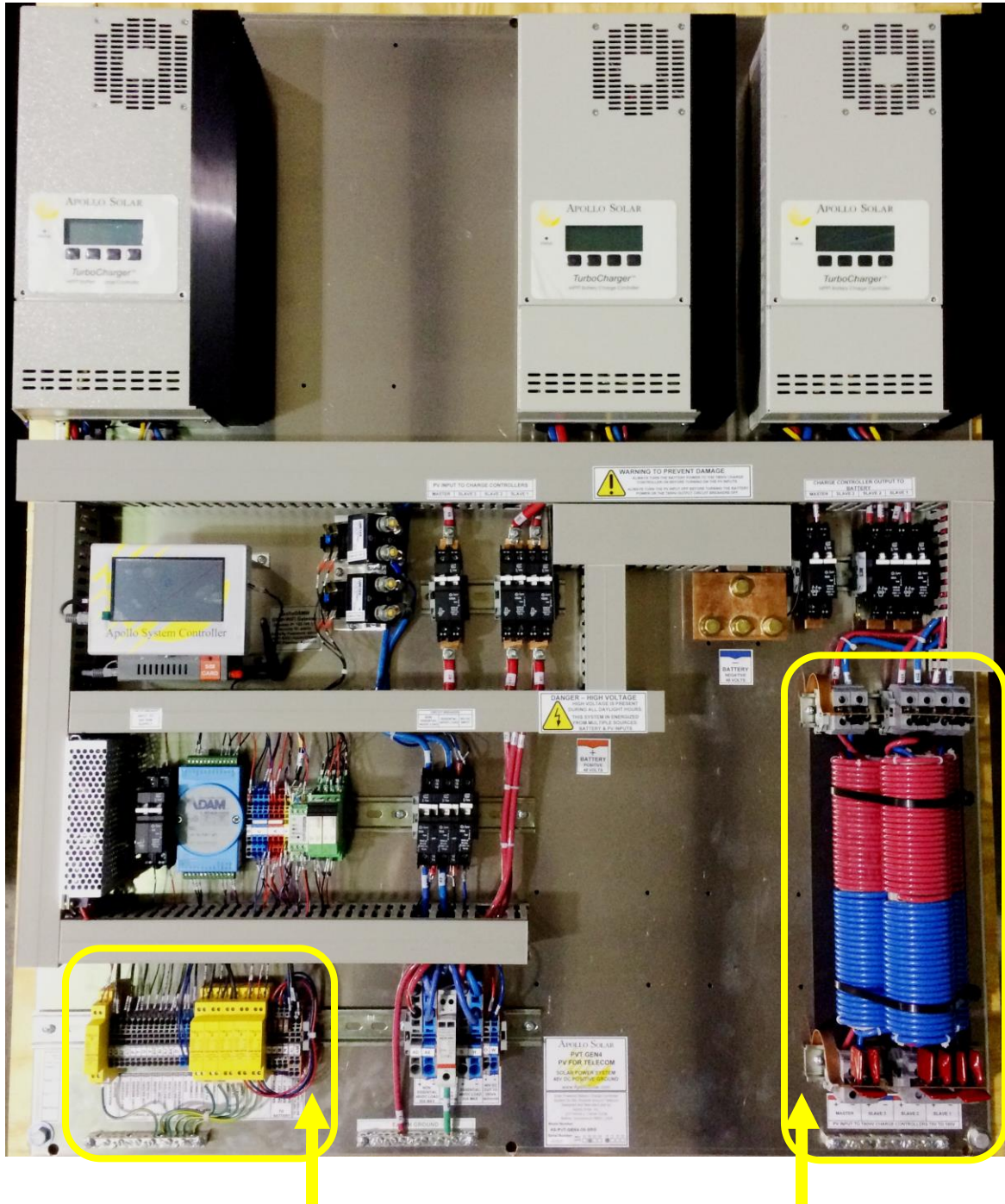


- During the installation of this product, you will be exposed to wires from the Solar PhotoVoltaic (PV) panel array which are energized with high voltage.
- **The high voltage is present during all daylight hours.**
- If a Combiner Box is wired in the system, turn all the Circuit Breakers in all the Combiner Boxes OFF before opening the Apollo PVT Cabinet doors. If a Combiner Box is NOT wiring 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.

### 1 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.**

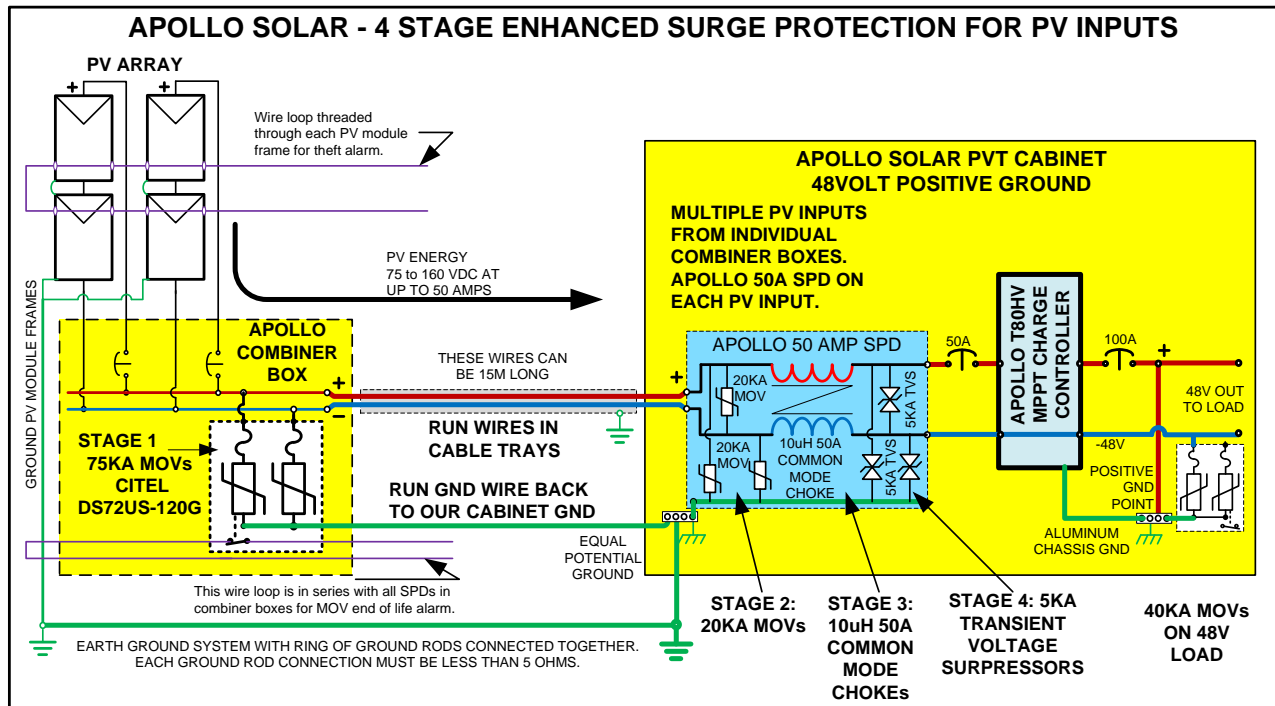
**2 Photo of the Gen4 3X Panel with the Enhanced Surge Protection Option**



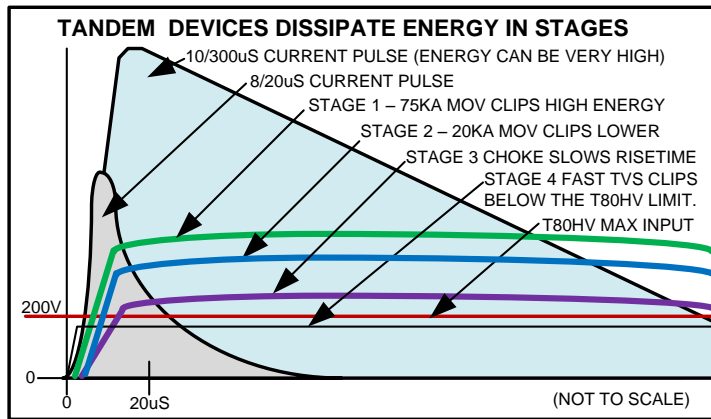
The components of the Enhanced Surge Protection Option are in the lower right and the lower left corners of the standard PVT panel inside the Yellow outline. The balance of the panel is identical to the standard product.

### 3 ENHANCED SURGE PROTECTION – BLOCK DIAGRAM

After a number of years of research, Apollo Solar developed a surge protection scheme which has proven to be effective in both laboratory and field tests. We employ multiple tandem stages of devices to limit the voltage which can reach the vulnerable circuits. The first protection element is a high current MOV in the Combiner Box. These fast acting can dissipate 70 KA and the fact that they are in the Combiner Box, away from the main cabinet, provides a good first line of defense against nearby lightning strikes. The second element is a 20KA MOV just inside the main cabinet. This device is selected to clip any incoming voltage spikes down lower than the heavy duty MOVs in the Combiner Box. The next element is a high current inductor used to slow down the rise time of the offending pulse. Finally, a Transient Voltage Suppressor can accurately clip the voltage to a safe level.







The PV Inputs may be the most vulnerable to surges from nearby lightning strikes because the PV array is a large target and the wires to the electronics cabinet may be relatively long and exposed. Using standard SPDs on these wires is impossible since they carry up to 50 Amps of current from the PV array under normal operation. The inductors must be able to pass 50 Amps continually without saturating or overheating. The

common mode inductors in this option are custom built for this product.

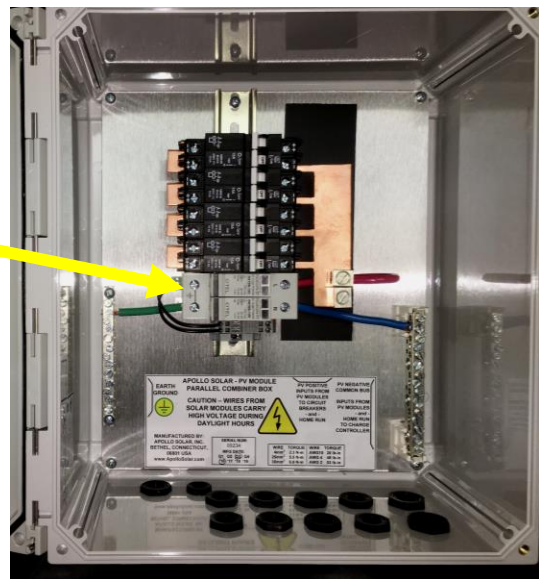
The combination of components work together to clip down the potentially damaging voltage and current pulses as shown in the graph on the left. The grounding of the system is critical. The ground point in each combiner box must be terminated on the Apollo panel in order to have equal potential grounds.

#### 4 COMBINER BOX SPD

The Citel part number DS72R-120, the 70kA Surge Protector located in the Combiner Box (shown at the right) is an integral part of this system. It is the first line of defense.

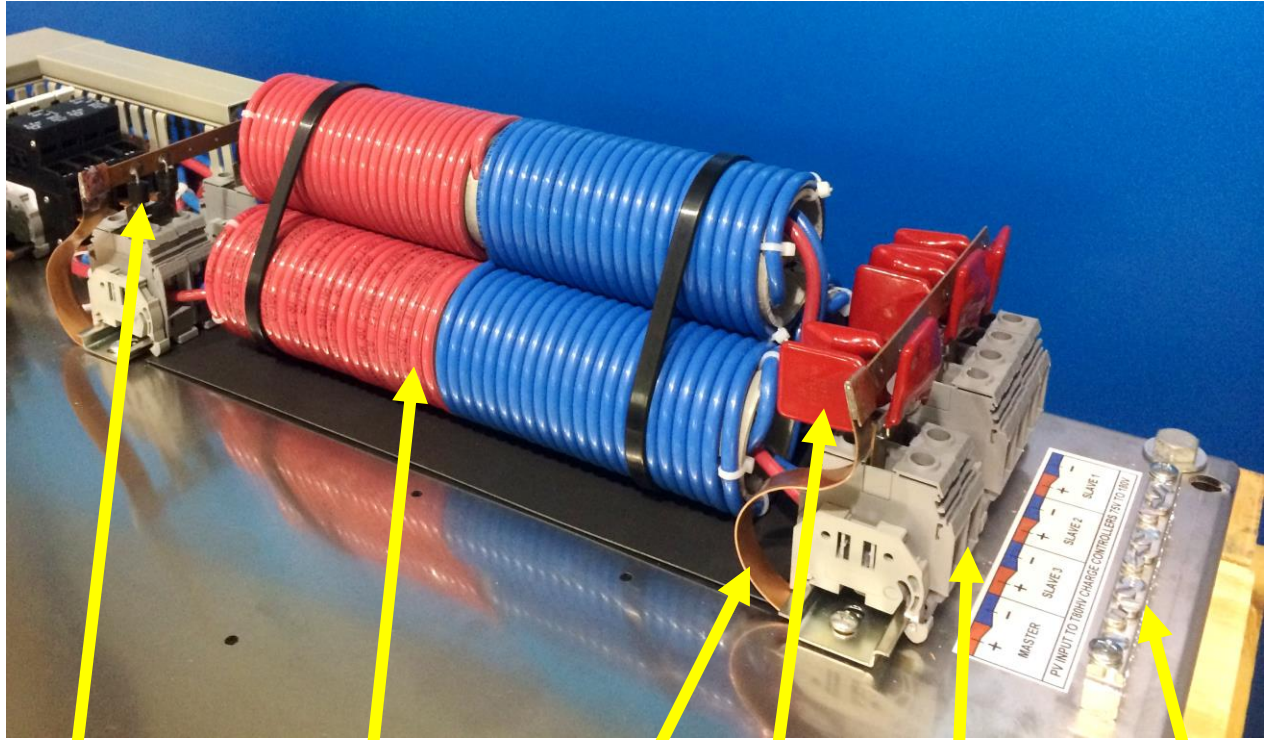
It must be grounded properly with short direct wires of minimum resistance and inductance. The ground terminal on the SPDs in the Combiner Boxes must be wired directly to the ground bus bar on the lower right of the Apollo PVT panel.

This first SPD is considered so important, that we monitor the life of the MOVs inside and report their condition via our Remote Monitoring System.



## 5 WIRING OF PV INPUTS

The special 50 Amp Surge Protection Devices for PV inputs are shown in the photo below. The input wires from the PV Combiner Boxes are connected at the right by the labels. The ground wires from the same combiner boxes should be terminated in the bus bar at the bottom.



5kA TVS with  
Ground Strap

50Amp Common  
Mode Inductors

Ground  
Strap

20kA  
MOVs

PV Inputs from  
Combiner Boxes

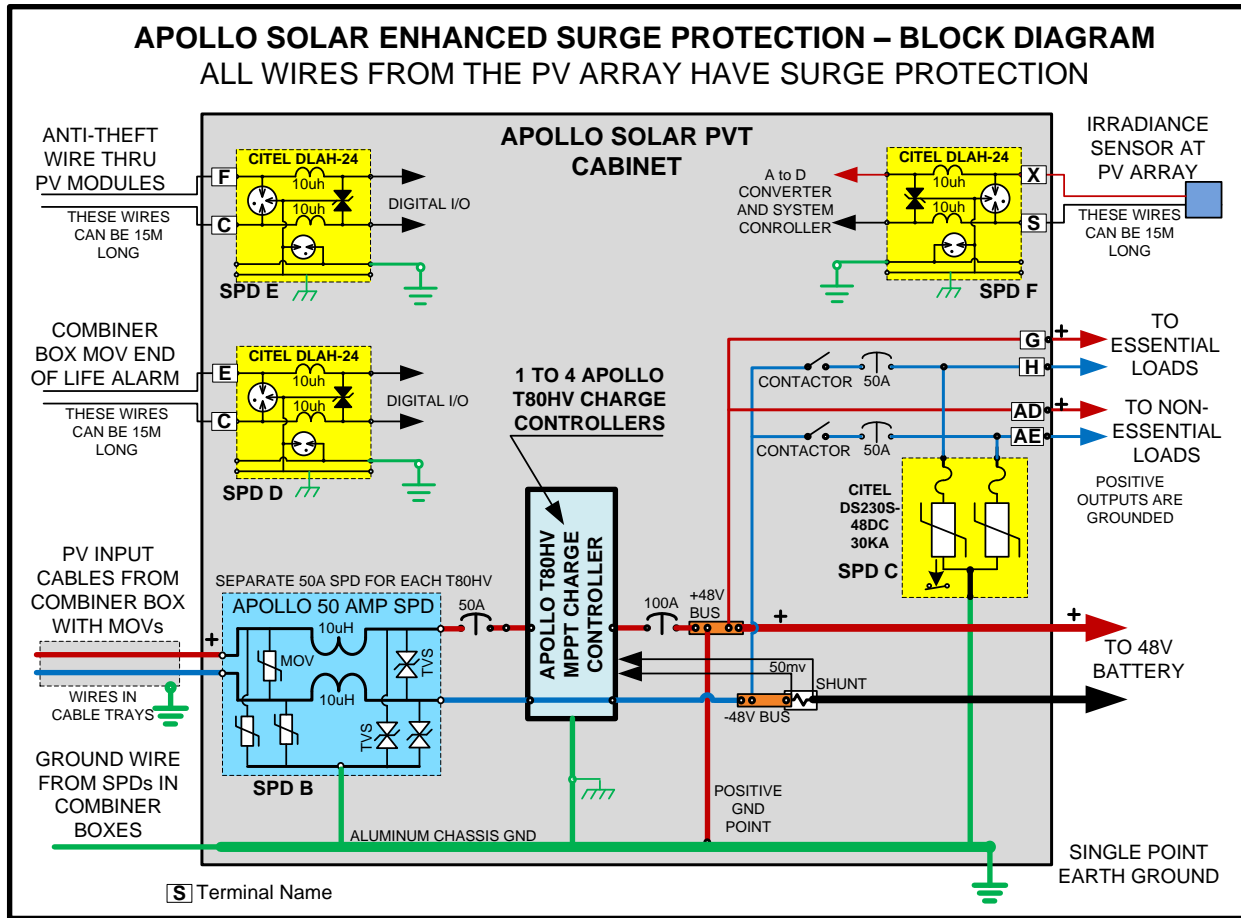
Gnd Bus for  
Combiners

The photo above shows 3 individual 50 Amp SPDs for a PVT panel with 3 T80HVs. The Enhanced Surge Protection Option includes one 50 Amp on the input of each T80HV.

**TORQUE WARNING** – It is critically important to tighten all high current connections to the specified torque with a calibrated, insulated Torque Wrench.

**TORQUE FOR PV INPUT CONNECTORS = 2.3N-m (20 in-lbs)**  
**TORQUE FOR GROUND BUS BAR = 4.5 N-m (40 in-lbs)**

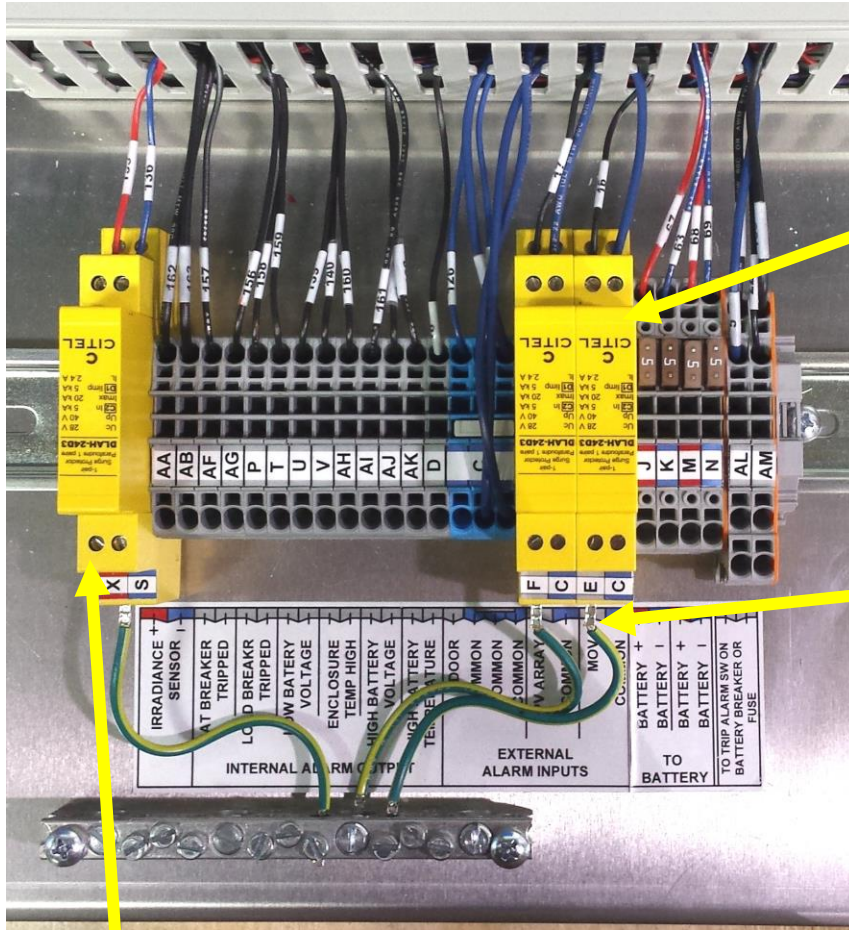
### 6 BLOCK DIAGRAM FOR THE LOW CURRENT WIRING



### 7 WIRING OF LOW CURRENT INPUTS

As shown in the Block Diagram above, all system wiring from the location of the PV array is protected with a Surge Protection Device (shown in Yellow) as soon as it enters the Apollo Solar panel. The external wires are meant to be connected directly into the input terminals on the Citel SPDs. The Terminal labels shown on the Block Diagram should be followed.





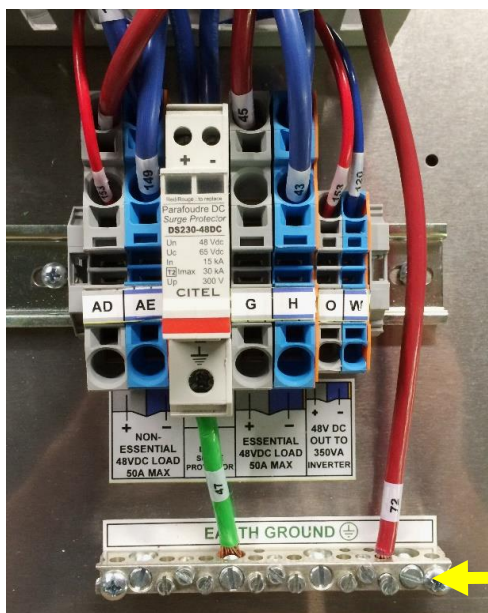
The connection labels for the low current wiring is shown in the photo at the left.

The Citel SPDs are not upside down. The terminals dictate this orientation.

The Ground wires for the SPDs are all in place and must not be removed.

**TORQUE VALUE FOR ALL CITEL DLAH SPD SCREWS = 0.5 N-m (4.4 in-lbs)**

### 8 48 VOLT OUTPUTS FOR LOADS



The Enhanced Surge Protection Option requires no change to the wiring for the Essential and Non-Essential Loads. They are wired to the connectors just like the standard panels since they always included an SPD on the Negative output. The positive output is connected directly to Ground so it does not need any SPD elements.

**GROUND BUS TORQUE = 4.5 N-m (40 in-lbs)**



**9 SURGE PROTECTION DISCLAIMER STATEMENT:**

The Enhanced Surge Protection optional add-on described in this document is intended to provide as much protection as cost effective against damage from near-by lightning strikes. Please note that since a direct lightning strike can discharge an unknown amount of current with a potential difference of unknown voltage, it is impossible to create any device which can provide perfect protection against damage due to lightning. A lightning strike is considered an act of God and as such any damage to the Apollo Solar PVT panels and anything connected it is not covered under the Apollo Solar or any other warrantee.

That being said, this Surge Protection Option uses the best design and system components available to avoid damage from lightning strikes which are close to the equipment.

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