Enhanced Surge Protection option for Apollo Solar Cabinets

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Enhanced Surge Protection Option

- It is not possible to protect against a direct lightning strike, but we can do a great deal to limit the surges caused by nearby strikes and the induced currents they create.
- BTS Towers are a good target for lightning to strike.
- The Mobile Phone industry does a good job of protecting their equipment from damage.
- PV arrays are in the open and also make good targets for lightning.
- In high lightning strike areas, we need to protect the inputs from the PV array from surges.
- A good ground is essential, and the tower can usually provide one.
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The chance of a Lightning Strike damaging the Solar Power equipment is related to the frequency of lightning strikes. The map below shows the number of strikes per square km, per year.
Apollo created an R&D project in lightning protection for remote power systems.

It is not possible to be totally protected against lightning, but we can do many things to minimize the chances of damage from nearby strikes.

Apollo developed and tested surge protection circuits that were tested and proven to reduce the chances of damage from a nearby strike by a factor of at least 16 times.

The Enhanced Surge Protection option uses this advanced technology.

Using Apollo protection circuits, these solar powered products ran perfectly after being actually hit by over 100 lightning strikes ramping up to 25kAmps each in this high voltage lab.
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A good **grounding system is essential** for limiting lightning surge damage.

**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. At 10 ohms a medium size strike of 30kA will lift the wires that you thought were ground up to 300,000 volts. 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. Even if your equipment ground is elevated in voltage during a surge event, we want ALL our equipment grounds to be elevated the same amount. The differential is the killer. 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.
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Every wire from the PV Array area gets a properly rated 3 Stage Tandem Surge Protector.

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**APOLLO SOLAR ENHANCED SURGE PROTECTION – BLOCK DIAGRAM**

**ALL WIRES FROM THE PV ARRAY HAVE SURGE PROTECTION**

**ANTI-THEFT WIRE THRU PV MODULES**

**COMBINER BOX MOV END OF LIFE ALARM**

**PV INPUT CABLES FROM COMBINER BOX WITH MOVs**

**GROUND WIRE FROM SPDs IN COMBINER BOXES**

**FOR EQUAL POTENTIAL GROUND**

**WIRING IN CABLE TRAYS**

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**APOLLO T80HV MPPT CHARGE CONTROLLER**

**APOLLO SOLAR PVT CABINET**

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**1 TO 4 APOLLO T80HV CHARGE CONTROLLERS**

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**TO ESSENTIAL LOADS**

**TO NON-ESSENTIAL LOADS**

**IRRADIANC SENSOR AT PV ARRAY**

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**TO 48V BATTERY**

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**IRRADIANC SENSOR AT PV ARRAY**

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**TOESSENTIAL LOADS**

**TO NON-ESSENTIAL LOADS**

**POSITIVE OUTPUTS ARE AT GROUND SO DO NOT NEED SPD**

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**SINGLE POINT EARTH GROUND**
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Installing the wire to detect an attempt to steal PV modules.

1. The PV Anti-Theft wire is threaded thru the holes in every PV module.

   Small holes must be drilled in the frame of each PV module.

2. A complete circuit is made by passing a single wire thru the holes in every PV module and back to the Apollo cabinet.

3. Inside the Apollo cabinet, this simple wire loop is connected to the input of the Digital I/O module which senses if the wire is cut or disconnected and triggers the alarm.
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The PV Theft Detection Wire is also protect with the Enhanced Surge Protection Option. The wiring is slightly different since there are Surge Protection Devices in the Cabinet.

Both the PV Module Theft Alarm and the MOV End of Life Alarm have long wires coming from the PV Array which are sensitive to nearby lightning strikes. So we protect these wires as they come into the Apollo Cabinet.

Wire loop threaded through each PV module frame for theft alarm.

Up to 15M of wire.

This wire loop is in series with all SPDs in combiner boxes for MOV end of life alarm.

Ground terminal in Combiner Box SPD is connected to the Apollo Cabinet for Equal Potential Grounding.
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Our R&D program resulted in the design of a custom 3 Stage, Tandem surge protector that can withstand the constant 50 Amp current from the PV Array.

We limit the voltage spikes at the input with high current MOVs using heavy copper ground straps. Our secret sauce is our custom high current, differential mode inductors we use to slow down the leading edge of a surge. After the inductors we use Transient Voltage Suppressors to accurately clip off spikes to a safe voltage.

The Ground Wires from the Combiner Boxes should be terminated at the Bus Bar just below the Positive and Negative PV Inputs. This is the equal potential grounding with the SPD in the Combiner.

At installation, the wires from the Combiner Boxes are connected here.

TORQUE = 4.6 N-m
Enhanced Surge Protection Option

This system has 2 T80HV Charge Controllers

SPD protection on the input wires from the DG rectifier

Final protection on the 48V outputs to the BTS load

Multi-stage SPDs in series with all wires from the PV array

Apollo 50A surge protection circuits on each PV input