Application Note: Ginlong Solis US Rapid Shutdown ac Wiring with Multiple Inverters on Site

The ac power conductors for the Solis Rapid Shutdown Device(s) need only be connected to a single inverter

Background

Solis residential inverters are frequently installed in jurisdictions working under the 2014 or 2017 National Electrical Code. Both these versions of the NEC include Article 690.12, Rapid Shutdown. Under these Codes, PV system installers are obligated to install photovoltaic (PV) string rapid shutdown devices into the PV output circuit conductors routed from the PV array to the inverter. Alternatively, the installer can install module-level rapid shutdown PV systems to meet the requirements of the 2014 and 2017 NEC. In either case, the installer will also include a rapid shutdown initiation switch and affix the proper labeling.

Proper labeling of the rapid shutdown initiation switch, or switches is important. Normally, these switches will be used during stressful times. The label(s) should be clear, simple and visible. Fewer is better than many. Additionally, it is reasonable to assume that fire fighters and first responders will expect that cutting power to the "main" will initiate rapid shutdown of the high voltage dc conductors. This is a typical action taken during normal firefighting operations.

The "main" is going to be the utility service entrance disconnect or the main breaker in the main distribution panel (or sub-panels for sub-sections of larger buildings). Commonly, firefighters will find PV system points of connection (POC) and PV system labeling at, and around these electrical panels.

The Solis Rapid Shutdown Device; Connecting the ac power source

The Solis 600Vdc PV String Rapid Shutdown Device (RSD) is UL listed and labeled as "PV rapid shutdown equipment". The RSD is contained in a NEMA 4X enclosure and is typically mounted up on the roof, underneath the PV modules, using a bonding nut and washer. The installer will find a ground lug on the RSD mounting plate.

The RSD is an ac-powered device (240VAC, 0.1A, 2A non-serviceable internal fuse). When ac power is cut to the device, the PV string conductors are rapidly shut down. Using appropriate exterior wiring (e.g. TC-ER 2-conductor cable in free air) and high durability wire management equipment, the installer can daisy-chain the ac power source from one RSD to another, as exterior fixture wire.

Installers will route 2 conductors from the RSD(s) to a disconnect switch (i.e. a rapid shutdown initiation switch, per 2014/2017 NEC) and a 240Vac power source. Per NEC Article 300.3(C)(1), the ac power source conductors may be routed in the same "home run" conduit as PV output circuit conductors. The RSD(s) ac power source could be a dedicated breaker (e.g. DPST 20A on AWG #14 conductors) at the PV system's point of connection. This does not need to be a back-feed breaker. An installer may splice a high-viz E-Switch between the inverter and the RSD's 240Vac power source.

Alternatively, the installer can bring the RSD ac power conductors down to the inverter (via the PV output circuit conduit) and route the RSD ac power conductors to the far side of the Solis residential

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inverter's wiring box. The installer will find two 240Vac non-fusible spring terminals where the RSD ac power conductors can be landed. These smaller terminals are in parallel with the larger Solis inverter ac output terminals. Installers may choose to add an in-line fuse (e.g. 250V Ceramic or 3AG fuses) to one or the other RSD 240Vac power conductors.

At this point, the installer can label the inverter's external ac disconnect switch or the inverter's POC breaker as the Rapid Shutdown Initiation Switch. When the inverter's external ac disconnect switch or the inverter's POC breaker, or the main breaker or the utility disconnect switch is moved the OFF position, the Solis ac output terminals will be de-energized, the Solis RSD will be de-energized and the PV output conductors will be rapidly shutdown.

Case Study

At some residential sites in the US, the PV systems are 10 kW or more and there may be more than one inverter used to handle the large PV array. Solis RSD's are supplied as single or dual PV string devices and there may be a single RSD associated with Inverter #1 and another RSD associated with Inverter #2.

Solis US can recommend two different methods for providing ac power to these multiple RSD's on the roof. Installers can choose either one;

Method #1; Daisy-chain the ac power supply from one RSD to the other RSD using proper conductors and wire management. Bring a single pair of conductors down to a single inverter. The ac power conductors can be landed at the supplemental 240Vac terminals located adjacent to the main Solis inverter ac output terminals. The inverter's external ac disconnect switch or point of connection breaker can be labeled as the site's PV system rapid shutdown initiation switch. Alternatively, this single pair of conductors can be routed through the inverter wire box and be landed at their own dedicated breaker, as described earlier in this paper.

Method #2; Bring a pair of ac conductors to each RSD. Route the ac conductors for RSD #1 to Inverter #1. Route the ac conductors for RSD #2 to Inverter #2. These conductors can be landed at the supplemental ac terminals as described in Method #1, or they can be routed through the inverter wire box(es) and landed at their own dedicated breaker(s).

There are pro's and cons to both methods. Method #1 is the least cost method, the fastest method and there is a single switch to de-energize all the high voltage dc conductors on site. However, this type of wiring, where RSDs from separate inverters are all wired to a single power source may make the system more difficult to work on for the O&M technician. Method #2 is a little more intuitive but it is more expensive to install. In either case, the fireman will be cutting utility power to the site and all high voltage dc conductors will be de-energized rapidly whether the installer uses Method #1 or Method #2.

SAFETY NOTICE

What the installer **CANNOT DO** is daisy-chain the multiple RSD's on the roof, bring down a single pair of ac power conductors, and then split, Y-connect, or splice the conductors and route them to both

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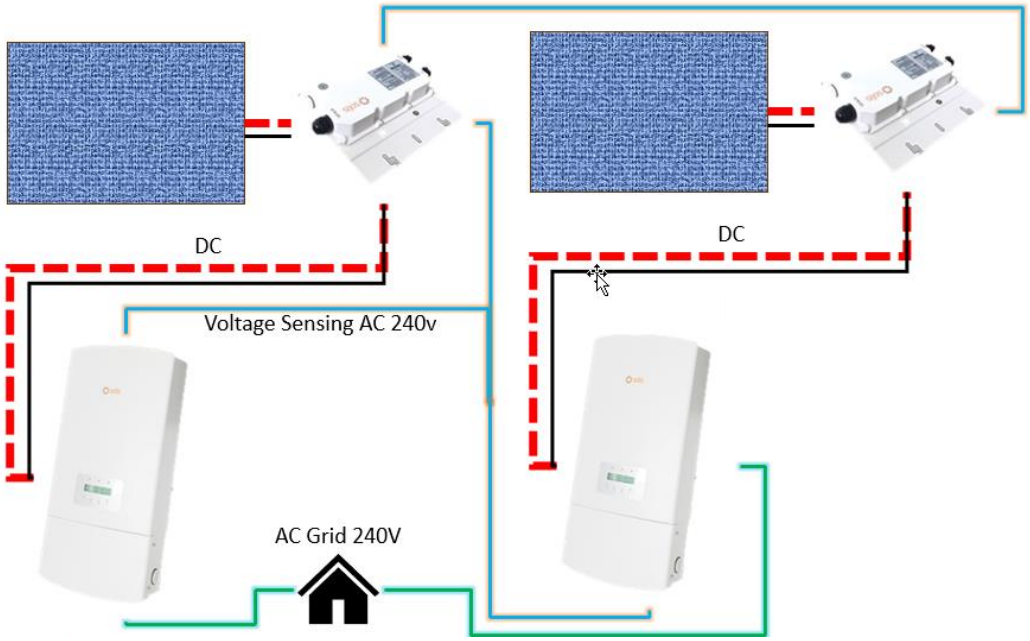
inverters. As one of the engineers at Solis says, "you cannot mix the Kool-Aid and then un-mix the Kool-Aid". This is a dangerous situation. Please see Diagram 1 below.



In Diagram 1, it can be seen that the RSD terminals are in parallel with the ac output terminals at both inverters (factory condition). When the installer splits the single pair of RSD ac power conductors into two pairs and then connects one pair at the RSD terminals at Inverter #1 and the other pair at the RSD terminals of Inverter #2, turning off the AC system disconnect or POC breaker associated with Inverter #2 **WILL NOT** de-energize the ac terminals at Inverter #2. These terminals will still be energized by the ac power conductors being routed from the RSD terminals at Inverter #1. Only when both disconnects from both inverters are moved to the OFF position, will either inverter be safe to work on.

If the installer has wired multiple RSD's together, brought a single pair of conductors down to the inverter, and then has split the RSD ac power between two (or more) inverters, the inverters will detect this wiring scheme and throw an I-Leak Alarm, indicating an abnormal current leak. The inverter is detecting the current flow on the RSD ac conductors between the two inverters. These conductors are in parallel with the bus bars at the inverter's point of connection. The installer must shut the site down and wire the RSDs as described in Method #1 or Method #2.

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