Service Bulletin

Arc Fault Detection and Troubleshooting

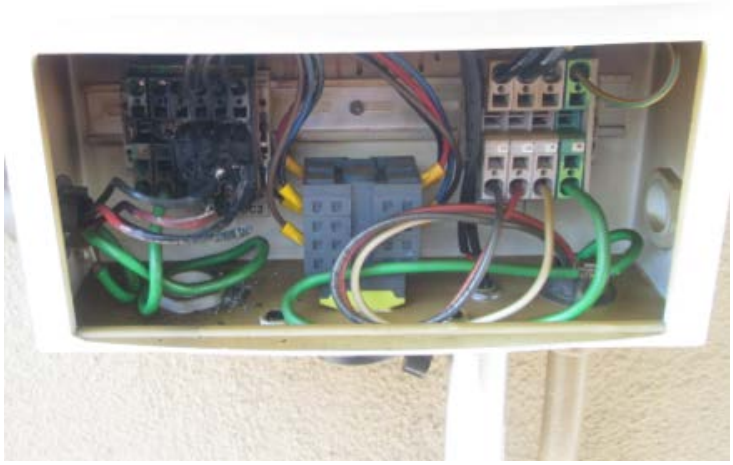
An AFCI or Arc Fault Circuit Interrupter is a device used to detect arcing in an electrical circuit and to interrupt the flow of current. It is installed in many types of electrical circuits to reduce the chances of an electrical fire due to faulty wiring, bad wiring connections or damage sustained during wiring installation.

For PV systems, it is **designed** to detect series arcing in the DC cabling or junction boxes. In the event of an arc, the AFCI circuit will alert the main control CPU in the inverter and interrupt the power conversion process thereby interrupting the DC current flow and reducing the chances of DC wiring related fires.

Before resetting an arc (even if it has been, or seems to be, a nuisance trip) the site MUST be inspected. EVERY TIME AN ARC FAULT OCCURS!

1. **Connections in junction boxes can degrade (oxidize) over time creating hot spots.**
2. **Screw type terminal connections can come loose due to changes in temperature.**
3. **Improper stripping length can result in wire insulation being captured in terminals.**
4. **Improper crimping of DC terminals results loose connections and arcing.**
5. **Improper connector assembly results in connection not being "locked" and arcing.**
6. **DC connectors not fully mated causes arcing.**
7. **Animals chewing through wires or wiring that has come loose and rubbed against the array racking can also lead to serial arcing.**

All of these are common conditions and easily identified with a quick visual inspection. First of all, arcing leaves some evidence. The may be *discoloration of wiring and racking*, *melted connectors and insulation* or even *burned junction boxes* on the *back of panels*. A quick visual inspection can locate such issues very reliably. A *gentle tug on DC cables* whether in the home run connections, *panel to panel connections* or in the combiner/wiring box can locate wires that have loosed or were not terminated properly. The below picture is an example of improperly terminated DC connections in a wire box and blindly resetting an Arc Fault without verifying all DC connections. The DC circuit includes all connections, even those in the inverter.



Bad crimp connections or *connections that are not fully mated* can be found using the same tugging method. Do not just concentrate on field installed connectors. There have been many instances where the factory crimp connection on the PV panel were the cause of arcing issues. The same goes with the PV junction boxes. Damage can happen between the factory and the site or the diodes can fail both which can cause serial arcing and trigger an arc fault. The visual method is very easy, does not require special tools and is effective at pinpointing the failure to a component. An example of connections not mated and causing arc faults is shown below.

This next method is not recommended UNLESS there is prior test data available for comparison.

Another method to locate arc fault issues is somewhat easier to execute but does not pinpoint the issue to a specific connection and the results can be difficult to interpret. For rooftop installations, it may not be easy or even possible to perform the above visual and manual inspection. In these cases, it is recommended to use some sort of high voltage tester to test the cabling to locate a failure. A “Megger” or megohm meter is one example of a simple test set that can help locate arcs to a specific string. For more testing functionality, a string tester is preferred because it can detect not only serial arcs, but also insulation issues and ground faults in the DC cabling. While it is considerably more expensive, it is far more flexible than the simple “megger” and can be useful in troubleshooting other array issues.

Both of these devices usually test at 250V, 500V and 1000V. Neither test at 600V which typical of residential and some small commercial systems are rated at for maximum VOC. If the PV and DC wiring is only rated at 600V, use the 500V setting to test. If the system uses panels and cable rated at 1000V, even if it is residential, it is suggested to test at 1000V. The reasoning is simple; a fault may only occur at voltages higher than 500V on cold bright days in a 600V system. The test may pass at 500V but can fail at 1000V. When using the megger, a failure indication is a resistance that

is higher than "nominal zero". A 'nominal zero' will not be zero ohms, but the baseline resistance that was recorded during the system commissioning tests. Once the faulty string is isolated, then the first method can be used to locate the faulty component.

A final method that can be used is to measure the temperature of the connectors, terminals and junction boxes using an infrared thermometer. These thermometers are quite cheap and effective; they can be purchased from any big box home improvement store. Typically, a connection that has a significantly higher temperature than like connections has a higher resistance and may be causing arc faults. When measuring the temperature of the connections, take into account the location of the connection; a connection that is in direct sunlight may read a higher temperature than one underneath PV panels.

If after all these tests no defect is found, then it is safe to assume that a “false” or nuisance trip has occurred. In this case, reset the fault and observe the inverter to see if it immediately faults again. If so, The AFCI circuit may be faulty and the inverter needs replacement. If not, try to record the exact conditions when the arc fault occurs. It may not be a sensitivity issue, but a weather-related issue. Check local weather to see if there were any special conditions that may have contributed to the suspected “false” trip.

Remember, a simple rain storm can also uncover issues on a system including arc faults that only occurs when the wiring is wet. Finally, report any findings back to the inverter manufacturer. You input is very valuable in the continued refinement of equipment. A manufacturer tests to many conditions to cause a failure, but nothing can completely replicate the conditions on your sites in the real world.