Arc-Fault Detection and Mitigation in PV Systems
Industry Progress and Future Needs

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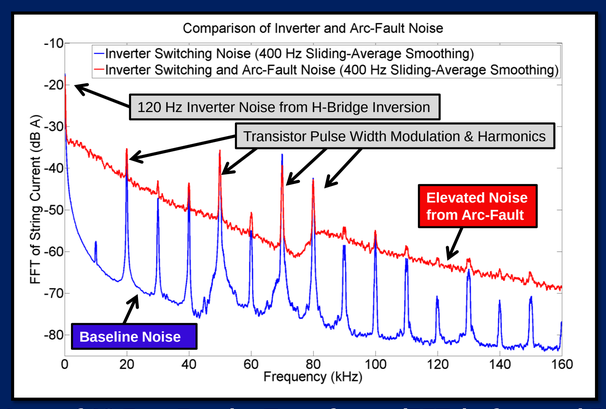
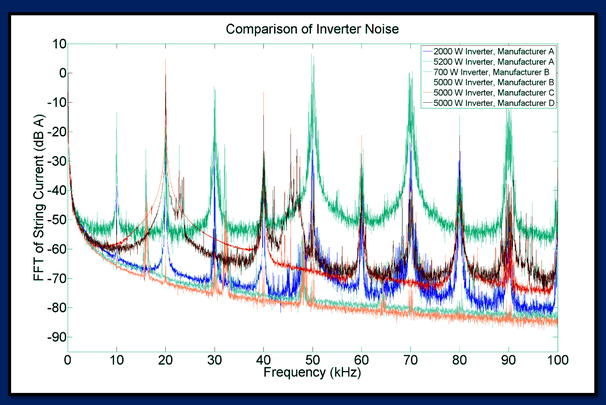
Series arc-fault detectors (AFDs) are being developed to meet National Electrical Code 690.11. These devices de-energize the photo-voltaic system when an arc-fault occurs in order to prevent electrical fires. Many AFDs use AC noise on the DC side of the PV system to detect arcing conditions. This methodology accurately detects arc-faults, but leaves the PV system vulnerable to nuisance tripping from noise sources and fails to differentiate parallel and series arc-faults. A need remains for AFDs which safely handle series and parallel arc-faults, passive and prognostic arc-fault mitigation tools, and instruments for locating arc-faults after the AFD has tripped.

Arc-Fault Detection Basics

Many arc-fault detectors use the AC noise on the DC subsystem to determine when there is an arc. Unfortunately, inverter switching noise varies greatly between manufacturers, so it is difficult to perform arc-fault detection using a single frequency.



Mean of 10 Fast Fourier Transforms (FFTs) of normal PV string operation and AC string noise with an arc-fault.



Mean of 10 Fast Fourier Transforms (FFTs) of different inverter noise signatures normalized to 0 dB at the 120 Hz inversion frequency.

Industry Progress

Many companies have publicly announced they are developing PV arc-fault protection devices. A few companies designing arc-fault detection products include:

SMA inverters SB5000-US-12, SB6000-US-12, SB7000-US-12, and SB8000-US-12 include the first arc-fault detection devices listed to series arc-fault protection standard UL 1699B.

On Sept. 1, 2011, Tigo Energy was awarded $3M in DOE SunShot Incubator funding to produce new, low-cost, arc-fault detectors.

Eaton Corporation has performed extensive arc-fault detection studies for residential and commercial-scale installations and is currently listing their device to UL 1699B.

MidNite Solar's line of Classic MPPT Charge Controllers includes arc-fault detection.

SolarBOS has an Arc-Fault Detection and Interruption combiner box which extinguishes series arc-faults by disconnecting the ungrounded conductor.

In Sept. 2011, Texas Instruments acquired National Semiconductor and their SolarMagic DC Arc Detection Reference Design Package. The evaluation board is currently available for purchase and testing.

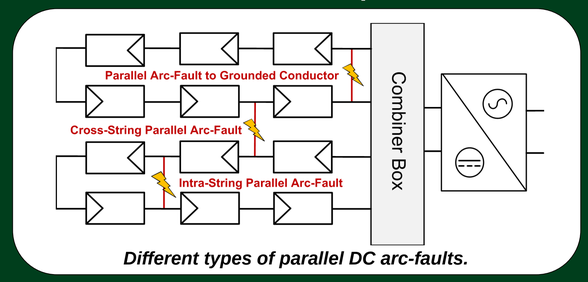
Fronius has developed an arc-detection plug-in card that can be inserted into their inverters. Production is planned for 2012.

SolarEdge power optimizers have module-level arc-fault detection and mitigation algorithms.

Industry Needs for Arc-Fault Safety

Parallel Arc-Fault Detection and Mitigation

In order to insure there are no electrical fires in PV systems, series and parallel arc-faults must be quickly and appropriately de-energized. Therefore, arc-fault detectors need to differentiate series and parallel arcing types because the corrective responses are different.



Different types of parallel DC arc-faults.

Monitoring and Prognostics of PV Systems

The best arc-fault is one that never happens. With known arc-fault failure precursors, PV systems can be monitored for signs of future arc-fault failures and prognostic maintenance could be prescribed.

Arc-Fault Locating Tools

Many series arc-fault interruption approaches detect and de-energize the arc-fault at the inverter or string level. In some PV installations this leaves a large area to search for the faulty component. Further, if the component is not readily identified, the arc-fault indication may incorrectly be assumed to be a false trip.

Acknowledgements

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