Arc-Fault Detector Algorithm Evaluation Method Utilizing Prerecorded Arcing Signatures

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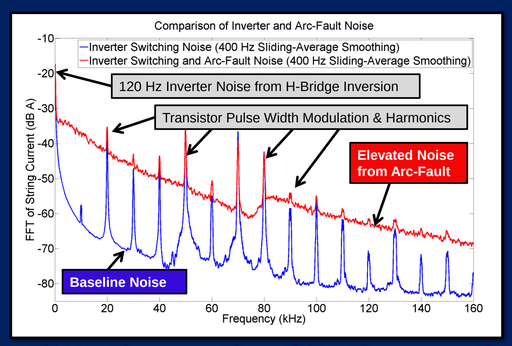
The 2011 *National Electrical Code*® Article 690.11 requires photovoltaic systems on or penetrating a building to include a DC arc-fault protection device. In order to accelerate the development and testing of the Sensata Technologies Arc-Fault Detector (AFD), Sandia National Laboratories provided a number of prerecorded inverter and arc-fault noise data sets to them. Sensata Technologies created a data evaluation method focused on regeneration of the prerecorded arcing and baseline data with an arbitrary function generator. This method helped accelerate PV AFD development by eliminating the need for preliminary field testing, arc-generating hardware, and data acquisition systems. Further, more scenarios were tested without the need to reconfigure the PV system or locate different inverters. As a result, hardware selection and software algorithm tuning time were greatly shortened. Sensata Technologies employed this technique to accelerate the development of their alpha prototype arc-fault detector.

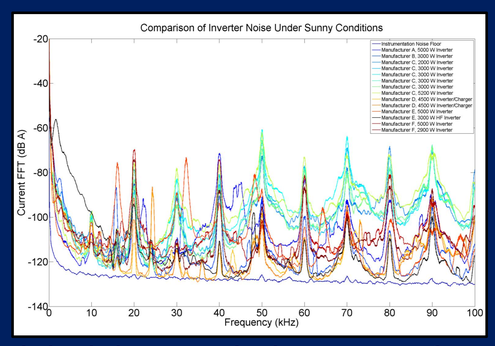
Sandia National Laboratories Arc-Fault Signature Library

Sandia has collected high frequency string current data from various PV systems in different meteorological conditions. The signatures represent a range of arcing and baseline noise conditions, including:

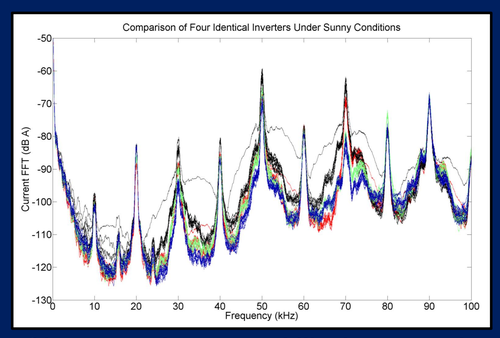
1. **Series and parallel arc-fault noise on a range of systems with different modules and inverters**
2. **Different inverter baseline noise levels (e.g., inverters from different manufacturers and nameplate ratings)**
3. **Inverters at different levels of irradiance (<300 W/m², ~500 W/m², and >900 W/m²)**
4. **DC disconnect noise from switchgear**



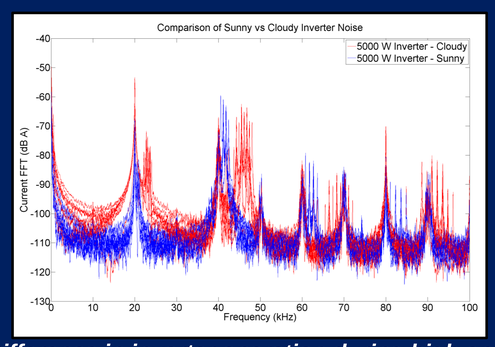
Normal PV string operation with an inverter and arc-fault string noise. These signatures are used to test AFDs for arc-fault detection and nuisance tripping.



Variation in inverter noise between manufacturers and nameplate ratings. AFDs must be tested on many inverters to avoid nuisance trips.



Test of inverter noise repeatability by comparing 10 signatures from four identical 3000 W inverters.

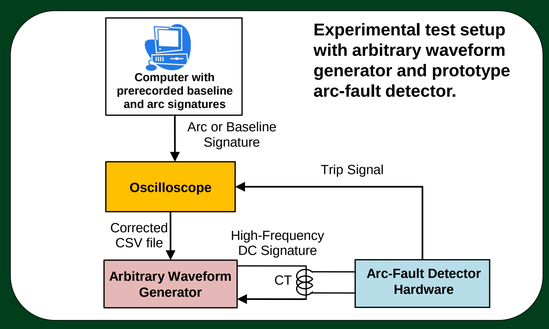


Difference in inverter operation during high and low irradiance levels. It is important to test AFDs on a range of irradiances for each inverter.

SNL signatures provided to Sensata Technologies for AFD development.

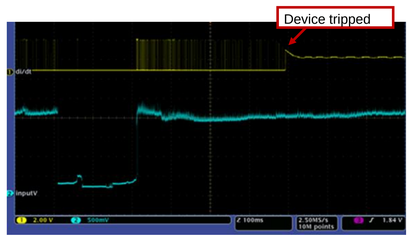
Sensata Technologies AFD Evaluation

Using an arbitrary function generator, prerecorded baseline and arc-fault waveforms were regenerated to adjust the Sensata Technologies arc-fault detector (AFD) hardware and software to robustly detect arc-faults while avoiding nuisance trips.



Experimental test setup with arbitrary waveform generator and prototype arc-fault detector.

Arc-Fault Detector Results



After tuning the AFD detection parameters, arc-fault detection was consistent. For this recorded arc-fault, the device trips in ~400 ms, well within UL 1699B listing requirements.

Acknowledgements

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