Mid-South Synergy Uses DFA Technology to Diagnose Fault-Induced Conductor Slap

Dr. Comfort Manyame
Sr. Mgr., Research and Technical Strategy
Mid-South Synergy Electric Cooperative

Robert E. Taylor
Engineering Specialist
Mid-South Synergy Electric Cooperative

Carl L. Benner
Research Associate Professor
Texas A&M Engineering

Dr. B. Don Russell
Distinguished Professor
Texas A&M Engineering

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Distribution Fault Anticipation (DFA) technology helped Mid-South Synergy Electric Cooperative (MSEC) diagnose a complex fault event that included a difficult-to-diagnose condition known as fault-induced conductor slap (FICS). Absent remediation, FICS tends to recur. Each instance causes sparks that can ignite a fire. Repetitive instances progressively damage conductors, which can cause them to break and fall, endangering the public. Remediation of FICS typically is straightforward, if the utility is aware that it is occurring. DFA provided MSEC's only notice that FICS had occurred.

MSEC is one of seven utility companies participating in the Texas Power Line-Caused Wildfire Mitigation project, a field demonstration supported by the Texas legislature. As part of that effort, MSEC has instrumented ten circuits, primarily long, rural circuits, with DFA technology. Each is fitted with a single, substation-installed DFA device, which detects faults, failures, and other events along the circuit's length and reports them to a central master station server computer for access by personnel. MSEC has used DFA to diagnose multiple types of diverse issues on their circuits.

Fault-induced conductor slap, or FICS, is a complex phenomenon that occurs when an initial fault on a circuit causes line conductors to swing together and create a second fault. The second fault occurs closer to the substation and often results in a more widespread outage. FICS is an onerous problem, both because its complex nature makes it difficult to diagnose, and because, absent proper diagnosis and remediation, it tends to recur. Individual episodes may occur months or even years apart, making it difficult for personnel to recognize that a problem that occurred today is the same as the one that occurred six months ago.

The subject event was even more complex than conventional FICS. On 11 June 2017, a balloon string contacted a 25 kV circuit, causing a fault. An automatic circuit recloser (ACR) upstream of the fault locked out, as would be expected, but a second ACR and even the substation circuit breaker locked out, too.

MSEC's field crew found a burned jumper in the section of line between the first ACR and the second. They concluded that the passage of fault current from the first fault caused the jumper to fail, resulting in the second fault and tripping the second ACR. They also initially concluded that the complexity of the sequence of events had "fooled" the substation protection and caused it to trip.

DFA recorded the current and voltage signals of the full sequence. The DFA On-Line Waveform Classification Engine software analyzed those signals and reported probable FICS. Prompted by the DFA report, MSEC used their circuit model software to determine that the fault currents that caused the substation circuit breaker to trip were too large to have resulted from the balloon fault or from the jumper fault. Using model-based location predictions, they then patrolled a targeted area of the circuit and found conductors with the "bright spots," or arc pitting, typical of slapping conductors. On site, they spoke with a member of the public, who reported seeing the conductors slapping and causing a shower of sparks, further confirming the FICS. Notably the FICS was more than five circuit miles from the initial, balloon-induced fault.

Remediating the subject span was possible only because DFA made MSEC aware of the FICS. Left uncorrected, the span likely would have caused additional outages, in addition to the dangers associated with fire ignition and public safety.

DFA technology enables a utility to manage its power distribution system better, by providing awareness of line conditions and events not detected by conventional technologies. Each substation-installed DFA device monitors circuit currents and voltages continuously, via conventional CTs and PTs. DFA devices use embedded pattern-matching software, known as the On-Line Waveform Classification Engine, to characterize and report electrical events, including events not detected by conventional means. DFA devices report line events to a master station server, which provides access to reports from the system-wide fleet of DFA devices. DFA reports conventional faults and also events that have not yet caused faults or affected customers. Awareness of adverse events and conditions enables preemptive action, directed repairs, and condition-based maintenance. No technology can detect all problems, but DFA provides a quantum step forward in the detection and diagnosis of many failures and incipient failures.

DFA technology was developed by Texas A&M Engineering, in collaboration with the Electric Power Research Institute, Inc. and is offered commercially by Texas-based Power Solutions, LLC.

Headquartered in Navasota, Texas, Mid-South Synergy serves 22,500 members and 30,000 meters in a service territory covering parts of six counties in Central Texas. Mid-South has installed DFA technology on ten distribution circuits as part of its participation in the Texas Power Line-Caused Wildfire Mitigation project.