



Comparative Characterization of Parallel Distribution Sensors Under Field Conditions

Final Project Report

Power Systems Engineering Research Center

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Project Team

Dr. B. Don Russell, Project Leader

Carl L. Benner

Jeffrey Wischkaemper

Texas A&M University

Dr. Ward Jewell

Trevor Hardy

Wichita State University

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Information about this project

For information about this project contact:

Dr. B. Don Russell
3128 TAMU, 238 Wisenbaker
Texas A&M University
College Station, TX 77843-3128
bdrussell@tamu.edu
Phone: 979.845.7912

Power Systems Engineering Research Center

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For additional information, contact:

Power Systems Engineering Research Center
Arizona State University
577 Engineering Research Center
Tempe, Arizona 85287-5706
Phone: 480-965-1643
Fax: 480-965-0745

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Executive Summary

Electric utilities have an increasing number of technology options to enhance the performance and reliability of distribution systems. Electrical current and voltage measurements are foundational to many of these technologies. The type and quality of measurements vary by application. Conservation voltage reduction, for example, requires accurate feeder voltage magnitudes. Power-quality instruments require accurate spectral content of feeder voltages. Applications such as Distribution Fault Anticipation technology require accurate, high-fidelity, steady-state and transient current and voltage signals with substantial bandwidth and dynamic range.

Conventional current and potential transformers (CTs and PTs) are the de facto standards for sensing feeder currents and voltages. Although these conventional instrument transformers have their limitations, use has proven them to be suitable for a wide variety of purposes, including those outlined in the preceding paragraph. However, acquisition and installation costs for conventional CTs and PTs may constitute a limiting factor in the widespread application of technologies.

The accuracy of any measurement or control system is limited by fidelity of the measurement system and by the transfer characteristics of the sensors used to provide inputs to that system. Even a hypothetical monitoring device with perfect fidelity would produce inaccurate results if the signals at its input terminals were inaccurate. This seems obvious when stated, but it would be easy for a utility engineer to simply assume that sensors accurately represent reality, without questioning the validity of that assumption.

Under this PSERC project, researchers consulted with advisor utilities to determine commonly used varieties of alternative sensors. After reaching consensus on sensor selection, researchers installed a three-phase set of each selected model alongside a three-phase set of conventional CTs and PTs on an in-service, 12.47-kV distribution feeder. Over an extended period of time, the outputs of these devices were monitored with high-fidelity data-recording devices. These devices recorded multiple steady-state and transient electrical signals, including several overcurrent faults.

Waveforms recorded simultaneously from the multiple sensors were analyzed in the time and frequency domains. Analysis focused on relative characterization of the sensors, using the conventional CT and PT signals as the benchmark. In general, voltage waveforms from the alternative sensors were similar to those of PTs, but current waveforms from the alternative sensors differed substantially from their CT benchmark.

The generalized conclusion from this project is that utilities should not assume that any particular sensor has performance adequate for any particular function, without first carefully studying the requirements of the function and the performance of the sensors under consideration. In some cases, a sensor's published specifications may be inadequate for making an informed decision. In such cases, the utility would be well served to commission or otherwise obtain the results of tests that truly represent the types of signals to be encountered in the application for which they desire to use the sensor.

The electric utility industry continues to have need for economical current and voltage sensors with transfer characteristics suitable for power-quality measurements, fault-anticipation requirements, and other advanced applications, to enable improvements in service quality and reliability. Various manufacturers are known to be working on new types of sensors, some based on optical principles. As those sensing technologies mature, there will be a need for future work to quantify and validate their true performance in the field, and also to evaluate their survivability, longevity, and life-cycle costs. Specifically, statistically valid evaluation of the characteristics of new sensors, measured against conventional CTs/PTs and against laboratory standards, is a logical next step.