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A COMPUTER-CONTROLLED SYSTEM FOR CALIBRATING HIGH VOLTAGE REVENUE METERING SYSTEMS UNDER ACTUAL OPERATING CONDITIONS OF HIGH VOLTAGE AND SINUSOIDAL/NON-SINUSOIDAL VOLTAGE AND CURRENT WAVEFORMS

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Abstract

The development of a computer-controlled system for the calibration of high voltage revenue metering systems under actual operating conditions of high voltage and sinusoidal/non-sinusoidal voltage and current waveforms will be described. Measurements can be made at any power factor from zero lag through unity, at voltages up to 100 kV line-to-ground voltage and currents up to 2000 A. The magnitude and phase uncertainties ($k=2$) are estimated to be not more than 50 $\mu\text{W}/\text{VA}$ and 50 μrad , and 100 $\mu\text{W}/\text{VA}$ and 100 μrad for sinusoidal and non-sinusoidal conditions, respectively.

Summary

Energy is a commodity product that plays a central role in the economies of all countries. The industrial and commercial sectors are very dependent upon the cost and quality of this resource. Reliable trade measurements, traceable to the primary physical standards, play a key role in facilitating commerce in energy. NMIs are essential components of the energy infrastructure of all industrialized countries.

In a deregulated market of the electrical power industry, traceability for revenue metering is required not only between the distributor and the customer, but also between the electricity producers and the transmission company and between the transmission company and the distributors. For the latter two metering points, revenue metering will be performed at significantly higher voltages than prior to deregulation. Due to the large amount of electricity measured by the high voltage wholesale revenue metering at these latter two metering points, even a

small measurement error will have a large economic impact to the detriment of the power producers, the network operators, the distributors and eventually the consumers of the deregulated system. Therefore, a measurement assurance program should be implemented to include the verification of the accuracy of the high voltage wholesale revenue metering systems by providing traceable power measurements at high voltage under different operating conditions, including non-sinusoidal waveform conditions which better reflect the true operating conditions of the power system.

Due to the large economic impact, utilities and independent power producers are trying to meet the requirements as set forth by regulating bodies to have a revenue metering system based on instrument transformers with an accuracy class of at least 0.2 or 0.1 as per IEC, or class 0.3 or 0.15 as per IEEE/ANSI, and power/energy meters of accuracy class of 0.2. This would ensure that the overall accuracy of the high voltage revenue metering system could meet 0.5% or better, as set forth by many regulating bodies. Therefore, a system to calibrate such high voltage revenue metering system would require an accuracy of at least 0.1%, a test uncertainty ratio (TUR) of at least 4 times, or preferably at least 10 times, that is, 0.05%

At the National Research Council of Canada a computer-controlled system for calibrating high voltage revenue metering systems under actual operating conditions of high voltage and sinusoidal/non-sinusoidal voltage and current waveforms has been developed. It is based on previously developed computer-controlled systems for calibrating high voltage transformer loss

measuring systems [1, 2]. A unique software based feedback loop has been added to ensure that the high voltage and high current test waveforms represent the required test conditions.

The system can be used for calibrating three-phase high voltage revenue metering systems of transmission voltage class of up to a nominal 161 kV (100 kV line-to-ground voltage) and currents up to 2000 A with an estimated uncertainty (k=2) of not more than 50 μ W/VA for magnitude and 50 μ rad for phase, and 100 μ W/VA for magnitude and 100 μ rad for phase, under sinusoidal and non-sinusoidal voltage/current waveform conditions, respectively. The calibration system, including its error sources, will be described and presented.

References

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[2] R. Arseneau, M. Frigault, J.J Zelle, "On-site calibrations of transformer loss measuring systems for distribution class power transformers", *Conference on Precision Electromagnetic Measurements Digest: CPEM 2006*, pp. 572-573, June 2006.