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TECHNICAL ARTICLE

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BIG OPPORTUNITIES FOR METER DATA ANALYTICS

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Introduction

In an industry that is over 100 years old and destined to be running for many more centuries, the smart meter is relatively in it's infancy in terms of deployments and usage. The meter is the front-end cash register for the utility and, as such, its accuracy needs to be without refute. There are plenty of requirements, specifications, and regulations placed on the metering equipment and the utilities that try to ensure accuracy will be delivered. However, in practice, once a meter design is certified, manufactured, and then deployed, the accuracy of most meters is only known at the point when it is initially production tested. How a given meter fares in the field until the point it is decommissioned is only implied through statistical sample testing.

Connectivity is the major change from electronic and mechanical meters to the smart meter, and it's now possible to not only report remotely the amount of electricity used, but also to implement diagnostic features that can report the status, health, and performance of the meter itself. This new possibility provides a way to acquire a range of information while the meter is operating in the field without the need for human intervention, disconnection, or dedicated equipment.

Accuracy and Knowledge of the Full Signal Chain Is Key

Other industries, such as automotive and industrial, with mission critical functions have integrated the concept of functional safety into their diagnostics requirements, which in essence is the requirement to check that the function is performing correctly before, during, and after it is needed. One such function for the utility metering industry is the accuracy of the meter while it is deployed. While the industry currently performs field sample testing and relies on the implied precision of components inside meters remaining in calibration while deployed in the field, this approach comes with risk. A recent *Metering International* article discusses why field accuracy monitoring is needed.[1] Importantly the mechanism for change in accuracy is significantly influenced by the sensor, which is also effectively exposed to high current and voltage events, as well as harsh environmental effects. Therefore, it is important that any diagnostic capability includes monitoring the full signal chain that measures the electricity, such as the sensor and the electronics.

Opportunities for Big Data Analytics

A good question for information system architects is, "What would you do if you could periodically obtain the accuracy of each and every meter deployed in the field?" There could be possibilities to weed out failures and outliers, but there are far greater opportunities to gather information about the whole population of the deployment and conduct some form of big data analytics.

The notion of remotely monitoring the accuracy of your entire deployment of meters does not contravene any regulations, and the large amount of data accumulated could give you an advantage depending on how you manage your meters. The amount of data, gathered hourly or daily, is not huge but the possibilities are endless. Figure 1 shows a scenario where you could monitor the accuracy of the whole population to a fine granularity of accuracy resolution, and the differences in population across their usage lifetime could be extracted. This may lead to insights regarding differences in manufacturing lots, suppliers, regions deployed, or different electrical grid topologies. You could also correlate with other metrics such as seasonality, temperature, humidity, and power usage in order to determine if there are some trends that would allow you to drive the specifications of future meters to deliver more repeatable field measurements.

In addition, knowing how your whole population is performing gives insight into what to expect from the sample testing that will still be required by the regulating agencies. The implementation of big data analytics for the entire population of meters will enable better handling of the liability risk assumed by the utilities.

The Solution: *m*Sure

To date, no test has existed that includes the complete signal chain, operates in situ, and self checks accuracy. Consequently, there has been no mechanism that can identify and report a change in the accuracy of the equipment. However, Analog Devices pioneered the development of integrated metrology circuits for electronic meters more than 15 years ago and has devices in nearly ½ billion deployed meters worldwide, has now developed a new monitoring technology for use in electricity meters called *m*Sure.™ This system can continuously monitor in situ the accuracy of the meter to provide a built-in self-test facility for checking meter performance throughout its life.

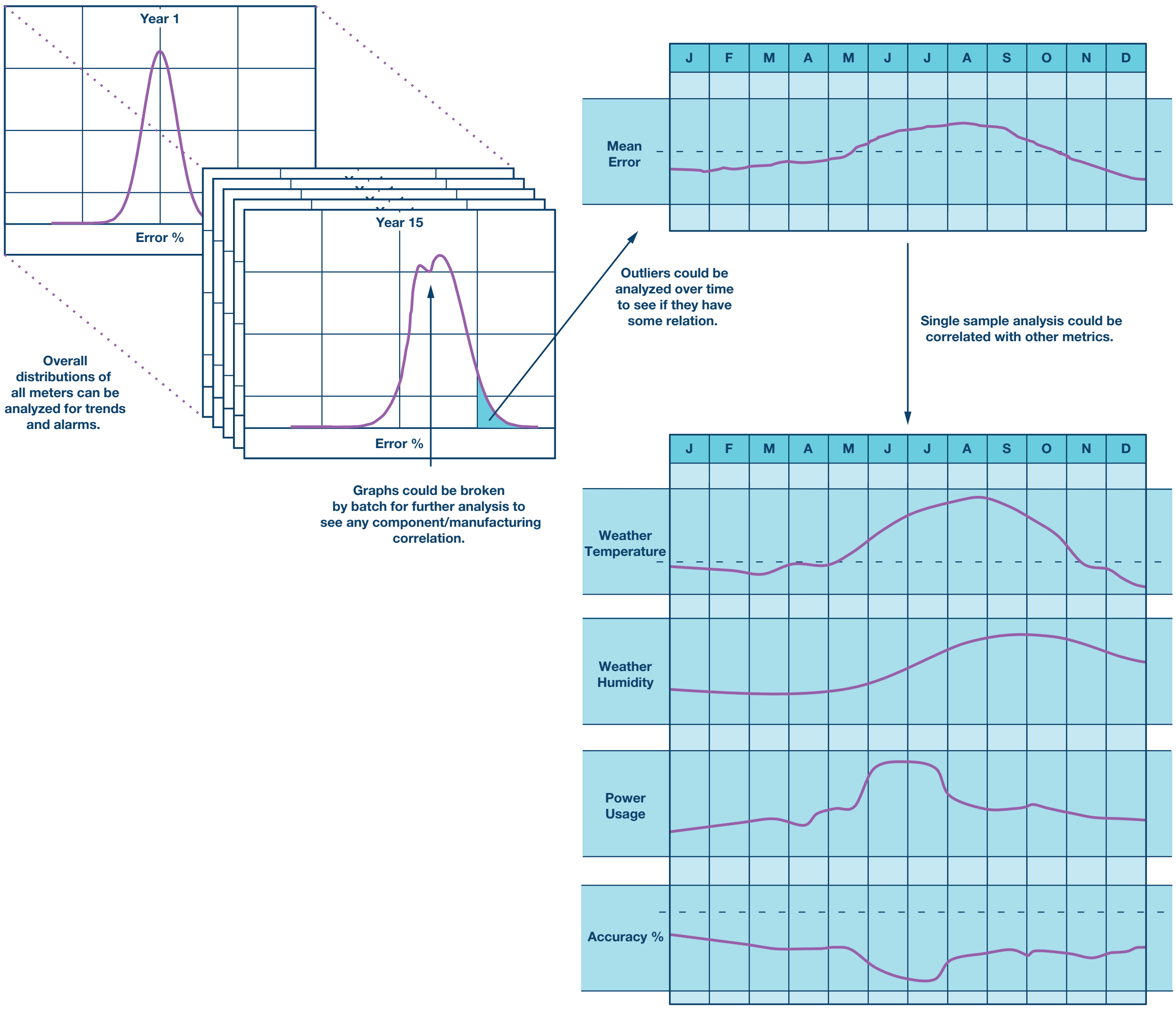

Figure 1. Diagrammatic data analytics on meter accuracy measurements sent to the cloud, showing how populations and correlations with other parameters may lead to added value insight.

*m*Sure measures the accuracy and, most importantly, it operates while the meter is running without impacting the metrology function so there is no need to disconnect. Figure 2 below shows a block diagram of the front end of an *m*Sure enabled meter. Much like a conventional metrology front end, there is a sensor (orange) and some electronics to digitize the voltage or current signal (blue), and there are additional blocks contained within the integrated circuit (in green) that include a reference signal generator, a detector, and a removal circuit to enable the *m*Sure function.

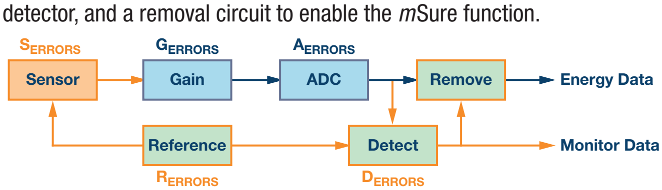

Figure 2. The mSure concept.

During manufacturing, the meter supplier calibrates the accuracy of the sensor and electronics so that the whole meter conforms to specification by measuring a known current or voltage through the sensor. The meter then relies on the precision of these components to maintain meter accuracy for the rest of its deployed lifetime. Any error in lifetime and environment is effectively a function of the subsequent error in the sensor and electronics.

The *m*Sure system continually monitors the response of this signal path by injecting a known reference signal into the same sensor path. By superposition, the sensor now senses both the reference signal and the load signal at the same time. This combined signal is acquired from the same path, so at the end of the electronics there is a digital representation of this combined signal. The detection circuit extracts the unique reference signal component from the load signal and, once it has achieved this, the *m*Sure system uses the transfer function of the complete signal chain from the sensor to the digital representation. By superposition theory, the same transfer function is applicable to the load signal through to the digital representation, so we are able to determine if the accuracy changes. In order to preserve the energy data, the *m*Sure signal is digitally removed from the signal path to the metrology.

To make it universally acceptable, the *m*Sure system was designed to be cost-effective, power efficient, very stable over a long lifetime, and robust for all kinds of loads and interferences. It can be configured to work with the main types of sensors used in the industry, including shunts, current transformers, potential dividers, and Rogowski coils. The monitoring function does not interfere with the metrology certification and does not require any regularity change or certification, as it is not altering the calibration or accuracy settings.

Revenue Protection

Meter tampering is a major source of revenue loss for utilities. Although often associated as a larger problem in developing economies, it is significant and on the rise in many developed regions. A recent report from the UK-based Office of Gas and Electricity Markets estimates that over £200 million worth of electricity is stolen each year and an additional £25 million is spent by utilities investigating theft and also repairing or replacing tampered equipment in the field.[2] While *m*Sure on its own does not prevent every type of tampering approach, its unique capability to monitor the sensor as well as the electronics enables it to detect a number of tampering attempts that the current tamper proof meters fail to identify, such as altering the sensor transfer function. Even if utilities prevent a small percentage of all tampering events, the resulting revenue can have a significant benefit to the bottom line.

Summary

Today's electricity meters are supplied and installed after certification, calibration, and testing in the factory to ensure that they meet a set of accuracy and performance criteria, as laid down in various standards prevailing in different geographies. Then it's mainly a matter of faith (component quality and statistical testing) that they will all remain accurate. A new technology called *m*Sure is suitable for leveraging the connectivity of smart meters and allows noninvasive in situ accuracy testing in the field. It can bring benefits such as big data analytics to understanding the accuracy of your whole deployment and identify any tampering attempts, which should help improve the business revenue generation for the utility.

In the future, the *m*Sure approach will also be used to deliver broader benefits beyond utility metering to monitor electrical grid equipment, particularly in the areas of asset health and fault location isolation and service restoration (FLISR).

References

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2. "Tackling Electricity Theft—Consultation." Ofgem, July 2013.

About the Author

Jed Hurwitz (B. Eng.) pioneered CMOS imagers at Vision Group and cofounded Gigle Semiconductor (acquired by Broadcom, 2010) and Metroic (acquired Analog Devices, 2014). He is now a technologist in the ADI Energy Management Products Group. He has 18 granted and more than 50 pending patents.

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TA13618-0-2/16

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