

A high accuracy standard for electricity meters

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Introduction

INCREASING price of energy and public pressure to reduce carbon emissions has lead utilities to increase energy efficiency efforts. With all the discussion around smart meters and the energy efficiency benefits they can bring, the basic role of the electricity meter seems to be losing focus. Accuracy is perhaps the most important attribute of high-end metering. ANSI C12 metering standards have proven invaluable to the technical buyer at the utility for evaluating new metering technologies as they emerge. However, ANSI C12 will need to be amended to keep pace with technology and remain relevant to the end user.





Accuracy is perhaps the most important attribute of high-end metering

Who makes the standard

Founded in 1918 as a non-profit organization, the American National Standards Institute (ANSI) coordinates the development and use of voluntary consensus standards in the United States and represents the needs and views of U.S. stakeholders in standardization forums around the globe. The Institute is the sole U.S. representative and dues-paying member of the two major non-treaty international standards organizations, the International Organization for Standardization (ISO), and, via the U.S. National Committee (USNC), the International Electrotechnical Commission (IEC)¹. The American National Standards Institute does not develop standards and has no power to enforce the use of approved standards. However, regulators have adopted and enforce these standards as requirements for participation in electricity markets.

The ANSI accredited standards development organization (SDO) for electricity metering includes members from IEEE, NEMA, NIST, UL, and other organizations as well as utility metering experts. ANSI C12.1 covers the acceptable performance criteria for new types of AC

watthour meters, demand meters, demand registers, pulse devices, instrument transformers, and auxiliary devices. Acceptable in-service performance levels for meters and devices used in revenue metering are stated. Information on recommended measurement standards, installation requirements, test methods, and test schedules is included².

ANSI C12.20 establishes the physical aspects and acceptable performance criteria for 0.2 and 0.5 accuracy class electricity meters meeting Blondel's Theorem. This American National Standard establishes acceptable performance criteria for electricity meters. Accuracy class designations, current class designations, voltage and frequency ratings, test current values, service connection arrangements, pertinent dimensions, form designations, and environmental tests are covered³.

These standards give buyers of electricity meters a uniform method of evaluating competing products, eliminating misunderstandings between manufacturer and purchaser, and assisting the purchaser in selecting and obtaining the proper product for his particular need.

¹ «Introduction.» American National Standards Institute - ANSI. American National Standards Institute. Web. 10 Jan. 2007. <<http://ansi>.

² American National Standard for Electric Meters Code for Electricity Metering, ANSI Standard C12.1-2008, Jun. 2008.

³ American National Standard for Electricity Meters – 0.2 and 0.5 Accuracy Classes, ANSI Standard C12.20-2002, Jan. 2003.

The current standard

The current revision of ANSI C12.20 requires a list of 38 separate tests that must be passed before a meter manufacturer can claim compliance. It is important to note that these tests account for a wide range of influencing parameters including changes in load current, power factor, temperature and harmonic distortion.

Each of the tests can have multiple test points to prove the operation of the meter over a dynamic range. Note how misleading a statement of single test point accuracy can be.

The only way to fully describe the accuracy of a meter in a form that will fit on a standard specification sheet is to claim accuracy to the standard.

Market place claims for accuracy outside of the standard

A quick browse of metering vendor websites will show that there are numerous claims to higher accuracy than the current Class 0.2 standard. Table 1 is a summary of a sample of ANSI style meter vendors and their claims.

TABLE 1

Vendor Claims of Accuracy in product Litterature		
Vendor	Accuracy	Disclaimer
Vendor 1	±0.06% revenue metering accuracy	At maximum load and 1.0 PF
Vendor 2	0.07% of Reading	
Vendor 3	0.06% WHr Revenue Meter	Watt-hours at 1.0 PF
Vendor 4	Class 0.1% Accuracy	The XX meter is a +/- 0.1% accuracy device complying with the requirements of IEC 60687 (1992-06) for 0.2S meters and ANSI C12.20:1997 for class 0.2 meters
Vendor 5	Class 0.1%, IEC 62052-11, IEC 62053-22 and ANSI C12.20	
Vendor 6	Exceeds ANSI C12.20 0.2 class accuracy	At 1.0 PF

Note that two vendors (number 4 and 5 in Table 1) even state accuracy to a Class that is not defined in any standard. This shows a level of confusion on the part of the suppliers and hints at the confusion that must exist on the part of buyer. While these claims seem appealing, one has to wonder why the performance is so well qualified at a specific point. The meter should be designed to operate at high accuracy over the entire range of operating currents and influencing phenomena. In this case, we would expect the vendor to provide a report similar to Fig. 1. This graph shows the performance at each test point along with the distribution of a large sample of units to show that the yield of the manufacturing process is high and under control.

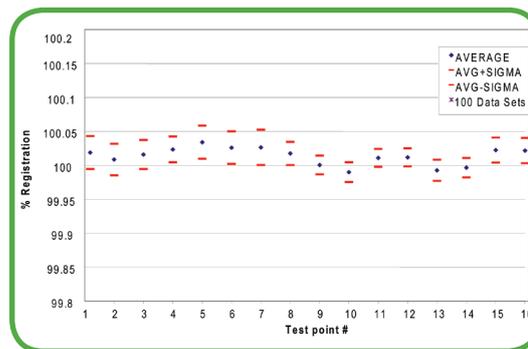


Fig. 1 _ Accuracy range for a sample of devices plotted at multiple testpoints.

Obviously, there must be some perceived benefit for a higher accuracy device if the majority of major ANSI style meter suppliers are positioning their devices as better than the standard.

Benefits of high accuracy metering

Metering accuracy includes the errors of the instrument transformers and the meter. If we assume a Gaussian distribution⁴, the expected error from the instrument transformers can be calculated by:

$$\epsilon IT = \sqrt{\epsilon VT^2 + CT^2} \quad (1)$$

Where:

ϵVT is the expected error of the voltage transformer

ϵCT is the expected error of the current transformer

ϵIT is the expected instrument transformer error (combined measurement error)

Consider the instrument transformer error found on a well designed system to be 0.15%. By (1), the instrument transformer error, ϵIT is:

$$\epsilon IT = \sqrt{0.15\%^2 + 0.15\%^2}$$

$$\epsilon IT = 0.212\%$$

Using the same principle outlined above, the total system error including the meter is:

$$\epsilon TS = \sqrt{\epsilon M^2 + \epsilon IT^2} \quad (2)$$

Where:

ϵTS is the error of the system

ϵM is the measurement error of the meter

Therefore the measurement error for a Class 0.2 meter and 0.15% instrument transformers would be 0.292%.

Assuming a wholesale price of \$0.03/kWh, a 10 MW load, and a system error of 0.292% from the previous example, an equivalent dollar value of the measurement error is \$7,661.87 per year. Likewise, consider a meter with 0.1% error at the same location would yield an equivalent dollar value of \$6163.21 per year or a \$1,498.66 per year difference. Taking the meter error down to 0.05% would result in an additional \$435 over the 0.1% error meter. Fig. 2 shows the benefit of higher accuracy diminishes rapidly below 0.1% as the cost of building and maintaining a very high accuracy meter increases rapidly.

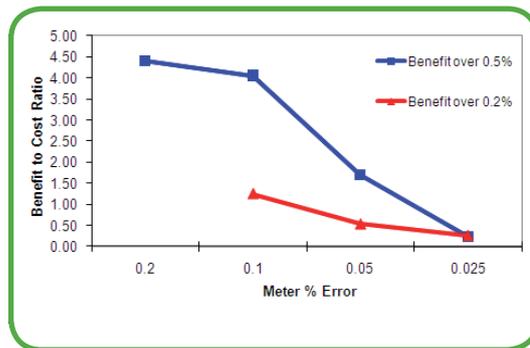


Fig. 2 _ Benefit to cost analysis for improving metering accuracy at a 10MW site with \$0.03/kWh energy cost.

⁴ Travis Mooney, Dick Martin, «Increasing Metering Accuracy by Optimizing the Analog-to-Digital Converter Characteristics», Schweitzer Engineering Laboratories, Inc., Pullman, WA, Tech. Paper TP6235-01, Feb. 2006.

A new standard accuracy class

The author proposes that the utility community take up the discussion of a new standard accuracy class in the C12.20 committee. An initial proposal is to simply take the existing standard and halve all the accuracy values at the test points. This would provide the utility community with a well-defined standard that increases the accuracy performance of compliant meters over the whole range of operating

conditions and influences (load, PF, temperature, etc.), without the ambiguity and disclaimers associated with present vendors' claims. The community should debate the benefits of tightening the constraints of each test to come to a consensus that is acceptable for the parties ultimately responsible for the accuracy of the metering...the utilities.

Issue to resolve

No one would expect the utility to pay for higher accuracy at every point on the electrical system, but there are locations where the need is obvious. Consideration would need to be given to classifying what type of metering should be considered for a higher accuracy class. Also, utility owned laboratory and field test equipment and watt-hour standards would need to be evaluated to ensure they were sufficient to accurately classify a higher accuracy.

Stability of components would need to be understood. Today, some Class 0.2 meters will hold the accuracy over the life of the meter without need to calibrate. Manufacturers may require a more frequent periodic testing or calibration to maintain a higher accuracy. These are just a few of the issues to be discussed and debated in the ANSI C12.20 committee. These issues cannot be resolved by manufacturers alone.

Conclusion

Evidence would suggest the market is ready for an evolution of ANSI C12.20. The evolution of the ANSI C57.13⁵ standard to include a higher accuracy class and the abundance of high accuracy claims by electricity meter manufacturers, are good indicators that utilities need higher accuracy energy measurements at some locations on the electrical network. However, there has been no action to standardize a higher accuracy class. Left to their own designs with no standards guidance, meter manufacturers have been posturing inadequate accuracy claims in an effort to differentiate from one another. The ambiguity leaves the technical buyer at the utility having little faith in the claims, no third-party laboratory back-up, and possible costly testing to justify the use of a particular meter. To avoid this scenario, utility metering professionals should debate the requirements for a new high accuracy Class 0.1 standard and begin drafting a standard in the ANSI C12.20 committee.

⁵ IEEE Standard for High-Accuracy Instrument Transformers, IEEE C57.13.6 – 2005, Dec. 2005

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