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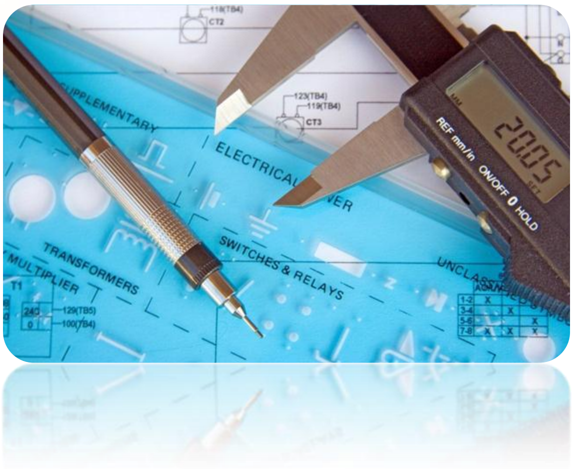
Powerful Solutions

APPLICATION NOTE:

ACCURACY CLASS: A SMALL "S" THAT MAKES A BIG DIFFERENCE



When it comes to energy metering, accurate reading is important since a fraction of percent can end up in thousands of dollars. Due to the fact that the accuracy of an energy meter depends on the loading of the network (full load condition will always be more accurate than partial load) as well as the power factor, standards were put into effect. However, sometimes standards are misleading customers which are not aware of the details and instead of helping customers to get better accuracy, they help manufacturer mislead them. This article explains the difference between various definitions.

The physics of accuracy

The accuracy depends on the design and build quality of the meter's input channels - a higher quality will provide better accuracy but will also increase the price.

There are three major parameters for the accuracy:

1. Fluctuation of the reading value, represented in percents from the actual value ("reading")
2. A fixed error ("noises"), normally represented as percentage from full scale ("FS") as it is constant value
3. For power and energy measurement the phase shift between the voltage and the current also affect the accuracy, since the power equals voltage multiplied by current multiplied by the cosine of the phase angle. This angle accuracy is represented in degrees in current transformers and in additional error in power meters.

Accuracy standards

A statement of a power meter for 0.5% FS accuracy means that its inherited accuracy is half percent of the full scale. For example, if the full scale of the meter is 50A, its error is 0.25A. If the network load is 25A, the error is 1% (0.25/25). Since accuracy depends on loading, IEC placed several standards to check the accuracy under various load conditions. This is known as "Accuracy Class". Class 0.5 means that the accuracy is 0.5% from reading under full load and unity power factor, similar to 0.5% FS above, but also adds levels of accuracy under lower (typical) load and different power factor. Table 1 shows the levels of Class 0.5, according to IEC 62053-11.

Value of current		Power factor	Percentage error limits for meters		
for direct connected meters	for transformer operated meters		0,5	1	2
$0,05\ I_b \leq I < 0,1\ I_b$	$0,02\ I_n \leq I < 0,05\ I_n$	1	±1,0	±1,5	±2,5
$0,1\ I_b \leq I \leq I_{max}$	$0,05\ I_n \leq I \leq I_{max}$	1	±0,5	±1,0	±2,0
$0,1\ I_b \leq I < 0,2\ I_b$	$0,05\ I_n \leq I < 0,1\ I_n$	0,5 inductive 0,8 capacitive	±1,3 ±1,3	±1,5 ±1,5	±2,5 -
$0,2\ I_b \leq I \leq I_{max}$	$0,1\ I_n \leq I \leq I_{max}$	0,5 inductive 0,8 capacitive	±0,8 ±0,8	±1,0 ±1,0	±2,0 –
When specially requested by the user: from $0,2\ I_b \leq I \leq I_b$	$0,1\ I_n \leq I \leq I_n$	0,25 inductive 0,5 capacitive	±2,5 ±1,5	±3,5 ±2,5	– –

Table 1: Class 0.5 Accuracy

As can be seen from the table, when the power factor is unity and the load is above 10% the accuracy is 0.5%. However, when the power factor is less than unity, which is the case in every single site due to harmonics (harmonics reduce the power factor), the accuracy become worse - 0.8%. This means that Class 0.5 meter will be 0.8% accurate under normal conditions.

In order to provide more accurate information, IEC published standard 62053-22 which defines the Class 0.5S accuracy as shown in table 2 below.

Value of current	Power factor	Percentage error limits for meters of class	
		0,2 S	0,5 S
$0,01\ I_n \leq I < 0,05\ I_n$	1	±0,4	±1,0
$0,05\ I_n \leq I \leq I_{max}$	1	±0,2	±0,5
$0,02\ I_n \leq I < 0,1\ I_n$	0,5 inductive 0,8 capacitive	±0,5 ±0,5	±1,0 ±1,0
$0,1\ I_n \leq I \leq I_{max}$	0,5 inductive 0,8 capacitive	±0,3 ±0,3	±0,6 ±0,6
When specially requested by the user: from $0,1\ I_n \leq I \leq I_{max}$	0,25 inductive 0,5 capacitive	±0,5 ±0,5	±1,0 ±1,0

Table 2: Class 0.5S Accuracy

This means that Class 0.5S meter will be 0.6% accurate compared to 0.8% of the Class 0.5 under normal load conditions (the difference is even bigger in lower load).

System accuracy vs. meter accuracy

The accuracy of energy measurement system is the summary of all its components. A typical system would have a power meter and current transformers (CTs). Similarly to power meters, standard IEC 60044-1 defines the accuracy classes of CTs as shown below:

Accuracy class	± Percentage current (ratio) error at percentage of rated current shown below			
	5	20	100	120
0.1	0,4	0,2	0,1	0,1
0.2	0,75	0,35	0,2	0,2
0.5	1,5	0,75	0,5	0,5
1.0	3,0	1,5	1,0	1,0

Accuracy class	± Percentage current (ratio) error at percentage of rated current shown below				
	1	5	20	100	120
0.2 S	0,75	0,35	0,2	0,2	0,2
0.5 S	1,5	0,75	0,5	0,5	0,5

Table 3: Current Transformers Accuracy

As seen from the tables, under full load conditions both Classes have similar accuracy. However, loading must not be 100%, which means Class 0.5 CT is only 0.75% accurate but Class 0.5S is accurate as long as the load is over 20%.

The system accuracy is adding both accuracies:

	Class 0.5	Class 0.5S	Class 0.5S with Direct Connect or Remote CTs
Meter typical accuracy	*0.8*	*0.6*	*0.6*
CT typical accuracy	*0.75*	*0.5*	*Included*
System typical accuracy	*1.55*	*1.1*	*0.6*

As seen from the above table, a class 0.5 system is typically 1.55% accurate, which is not sufficient. A Class 0.5S system is 1.1% accurate and with direct connection (or integral remote current sensors) it is 0.6% accurate - almost three times better!

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SATEC accuracy

SATEC puts significant efforts on the design and manufacturing of accurate meters which includes:

1. Minimal accuracy of Class 0.5**S** for all devices and Class 0.2**S** for mid and high end ones
2. Option for remote sensors for most meters, which provides Class 0.5S accuracy for the whole system - power meter and the remote solid core current sensor
3. 100% testing and calibrating of all products - meters and current sensors

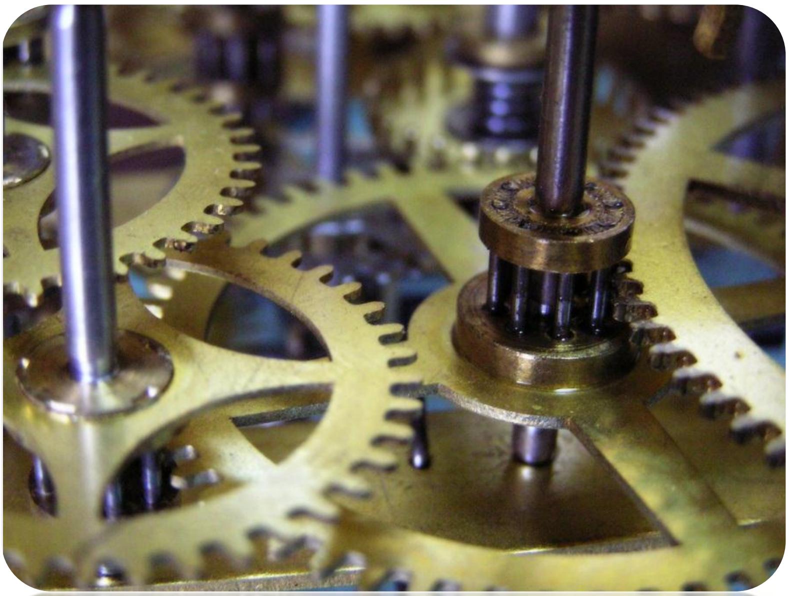
The result of the above is that SATEC meters are very accurate which allows us to guarantee their accuracy for 5 years without the need to calibrate or make periodic testing.

Example

High accuracy meters provide fast Return On Investment (ROI) as can be shown in the following example: the difference between 1.55% and 0.6% accuracy for 1000kVA load, 0.90 power factor and 80% loading at US$ 0.15/kWh, equals to US$ 8,988 per year (1000×0.8×0.9×8760×0.15×(1.55%-0.6%)), which means the investment is returned in single month.

Conclusion

Class 0.5S is a minimal requirement for any energy monitoring application while Class 0.5 (without S) is not good enough and Class 1 is not more than a good estimation. The use of direct measurement or remote current sensors will provide unbeatable accuracy to comply with the challenges of modern energy management and billing applications.



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