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TenneT arteche KEMA Labs VSL

Study Committee B5

Protection and automation

10551

System accuracy evaluation of metering application based on optical current Low Power Instrument Transformers (LPIT) and IEC 61850 SV static energy meters

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Motivation

The application of new techniques for current sensors, using Optical Current Transformer (OCT), requires new standards and guidelines to prove compliance to the Dutch law (metering code).

After having ordered an OCT for a pilot, additional tests have been performed by the supplier and an independent laboratory, to get familiar with the technique and get insight in the accuracy of (1) the OCT and (2) the complete metering installation.

Table 1 – Max allowable error (%) for new metering installations

PF	1.5% *In*	3% *In*	7.5% *In*	15% *In*	120% *In*
1	0.6	0.6	0.4	0.4	0.4
0.5 Ind	--	1.2	1.2	0.95	0.95
0.8 Cap	--	0.85	0.85	0.65	0.65

Approach

The pilot setup consists of an OCT + merging unit, a conventional voltage transformer, a metering device, a switch and a GPS clock. Tests have been performed on the separate OCT and merging unit to test the current and voltage accuracy, and on the complete setup to test the accuracy of the power measurements.

Object of investigation

Low frequency measurements are acquired using the oblique probe method.

Fig. 1 OCT, merging units, metering unit, clock and switch

Results

The ratio and phase error of the OCT, as measured by the supplier, are presented below.

Fig.2 - Accuracy SN 14050 - supplier

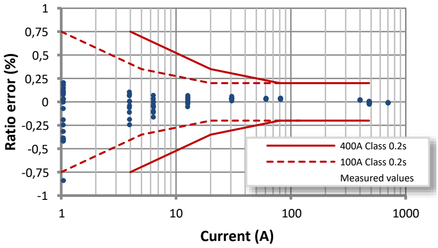
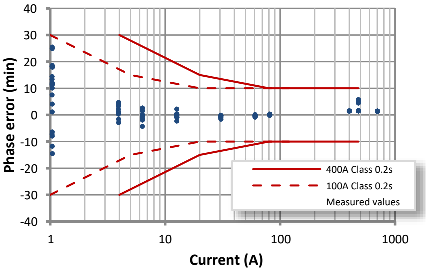
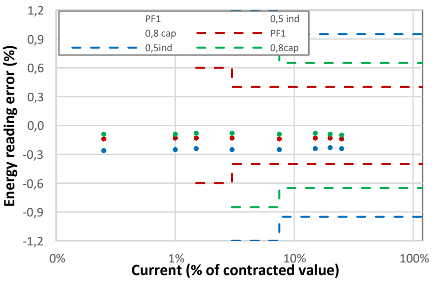


Fig.3 - Accuracy SN 14050 - supplier



The accuracy of the complete measurement chain, as measured by the independent laboratory, is presented in the figure below.

Fig. 4 - Error metering chain with sensor 1 (100% voltage, active energy, 3ph)



Conclusion

- Current standards do not adequately provide in good test routines to prove compliancy.
- Integration time and statistics need to be incorporated in testing.

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Complete pilot setup

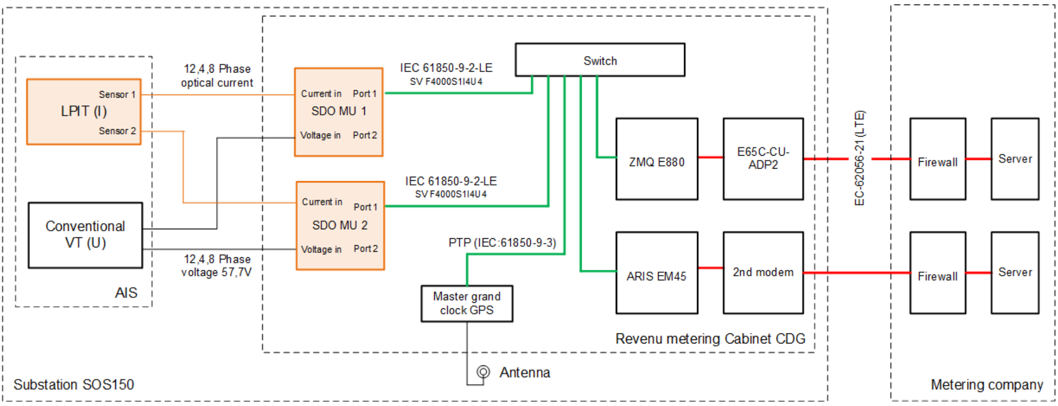


Fig. 5 – metering application - pilot setup

Current accuracy test

The test setup of the supplier and the laboratory are both been presented below.

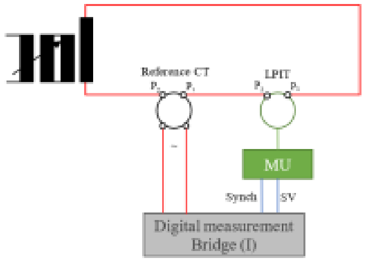


Fig. 6 – Current measurement test setup - supplier

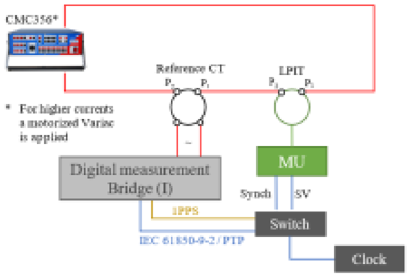


Fig. 7 – Current measurement test setup - laboratory

Measurement results

Multiple measurements have been performed per current value. The ratio error is within limits, however the phase error turns out to be (marginally) out of limits for some test points.

Fig.8 - Accuracy SN 14050 - laboratory

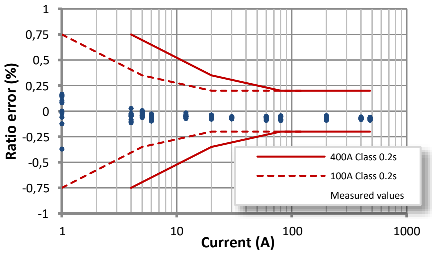
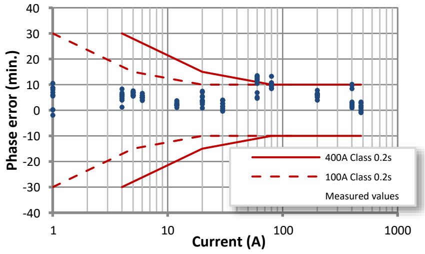


Fig.9 - Accuracy SN 14050 - laboratory



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Energy measurement test - supplier

The setup as below is applied for the tests. A single-phase setup was applied.

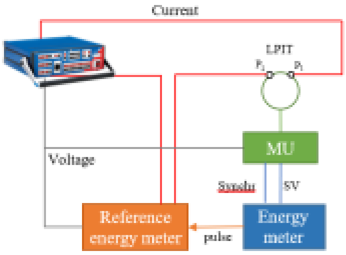
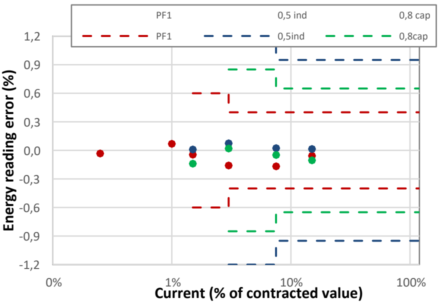


Fig. 10 – Test setup as applied by supplier

Fig. 11 - Error metering chain (100% voltage, active energy, 1ph)



Energy measurement test - laboratory

The setup as below is applied for the tests. A three-phase setup was applied, and single- and three-phase tests have been performed.

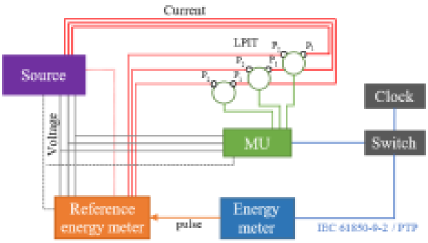
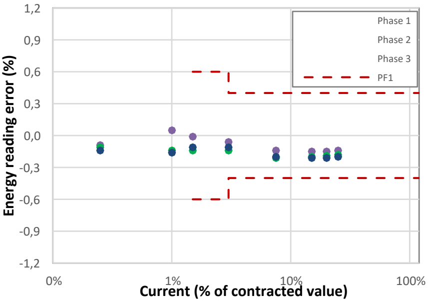


Fig. 12 – Test setup as applied by laboratory

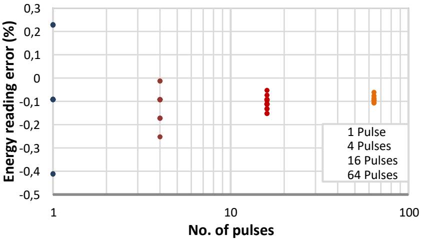
Fig.13 - Error metering chain with sensor 1 (100% voltage, active energy, 1ph, PF1)



Measurement time

If a short measurement time for the measurements is applied, for example 1 pulse, the total error and resolution of the error are relatively large. Measurement over a longer time (more pulses) results in higher accuracy. Present standards do not provide guidance on this.

Fig.14 – Influence of measurement time



Conclusions

- The application of new current sensor technology needs additions in standards, law and guidelines in order to prove compliancy in terms of accuracy.
- Especially the measurement time / integration time needs to be mentioned for testing. Although measurements are taken every 15 minutes in the Netherlands, a specified integration time would be a quality aspect for the design of the equipment.
- Test equipment needs to be calibrated. Currently not many services are offered in the market for this.
- Particular attention needs to be paid to evaluation of the phase error (related to timing delays).
- The pilot setup is within the specified limits for energy metering. Long term evaluation is currently underway.