Calibration systems for Analogue non-conventional Voltage and Current transducers

E. Houtzager, E. Mohns, S. Fricke, B. Ayhan, T. Kefeli, H. Çaycı

VSL
Physikalisch-Technische Bundesanstalt (PTB)
TÜBİTAK UME

Introduction

To make the high-voltage grid more secure and to ensure continues supply of electrical energy, more measurement points are being added to the grid. Especially with the decentralized generation of electrical energy the power flows need to be managed to keep the grid stable. The newly installed sensors for these measurements are adapted from the traditional levels (100 V or 1 / 5 A) to more convenient levels to interface with analogue to digital converters used in electronics. These are called non-conventional instrument transformers (NCIT). Some of these NCITs use new measurement techniques such as optical CTs and VTs. To ensure accurate and traceable measurements with NCITs, calibration methods of those devices are needed which poses a new challenge to the metrology world and especially to calibration laboratories and to test-centers.

Calibration Techniques

Contributions to solving this challenge can be subdivided in to three methods being investigated.

A) Amplifier-based measuring systems

Using active components to scale voltage or current to a level where they can be compared with a reference either using commercial bridges or sampling systems

B) Measuring system with scaling devices

Scaling devices primarily made for use with sampling systems and serve as primary reference.

C) Verification of new commercial test-set

Using commercial test-sets is in many cases more convenient and less labour intensive.

Conclusion

Several devices have been developed to scale current and voltages to levels which can be compared on either traditional test-sets or using new sampling based systems. Also a commercial test-set has been characterized. The methods described in A and C are better suited for calibration labs although they don't have the best uncertainty. Method B is best suited for NMi's due to the added flexibility but at the expense of increased complexity. Further work is needed to compare the different measurement setups and methods.

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

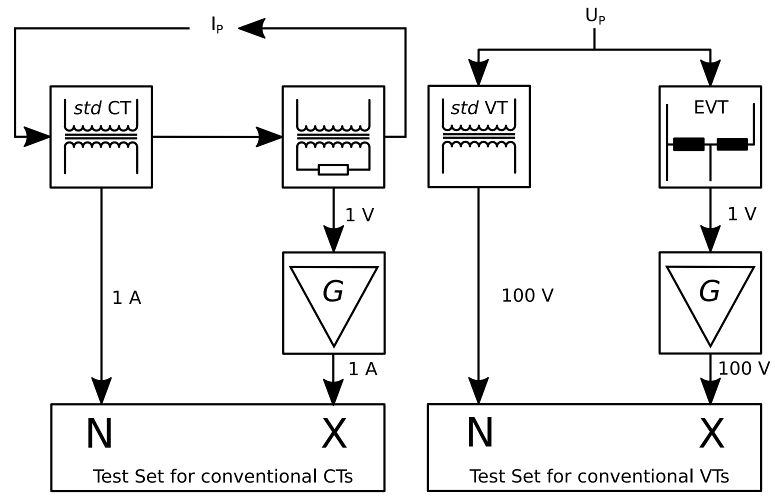
Ministerie van Economische Zaken

This work is funded by the European Union on the basis of Decision No 912/2009/EC, and identified in the EMRP as Joint Research Project (JRP) ENG61 FutureGrid Non-conventional voltage and current sensors for future grids. Additional funding was received from the Dutch Ministry of Economic Affairs.

TÜBİTAK

Amplifier-based

Because the output voltages of NCITs are too low for direct comparison with the secondary output of conventional transformers using traditional bridges, analogue outputs of such transducers must be amplified up to the traditional current or voltage levels. For this purpose a trans-conductance amplifier based on an electronically-compensated two-stage voltage-to-current converter for current sensors and a voltage amplifier with an electronically-compensated two-stage voltage transformer are being developed at UME.



Single Range Voltage Amplifier

Input= 1V@50-60 Hz

Output= 101V@50-60Hz

Accuracy: <10ppm/μrad at 100% of nominal voltage

Single Range Voltage-to-Current Amplifier

Input= 1V@50Hz

Output= 1A@50Hz

Accuracy: <10ppm/μrad at 100% of nominal current

Evaluation of the systems/methods and comparing the Results

Applied Value	Ratio Error				Phase Error			
	WM3000U	Step-up	Step-down	Manufacturer	WM3000U	Step-up	Step-down	Manufacturer
	%	%	%	%	min	min	min	min
190%	0,011	0,010	0,010	0,02	-2,0	-2,1	-1,9	-3,2
120%	-0,008	-0,009	-0,009		-2,0	-2,1	-1,9	-3,2
100%	-0,013	-0,014	-0,013	0,00	-2,0	-2,1	-1,9	-3,2
80%	-0,016	-0,017	-0,016	-0,01	-2,1	-2,2	-1,9	-3,2

Evaluation of the systems/methods and comparing the Results

Applied Value	Ratio Error			Phase Error		
	WM3000I	Step-up	Step-down	WM3000I	Step-up	Step-down
A	%	%	%	min	min	min
500	0,015	0,013	0,013	-0,3	-0,2	-0,4
400	0,015	0,014	0,013	-0,3	-0,1	-0,4
300	0,015	0,014	0,013	-0,3	-0,1	-0,4
250	0,018	0,012	0,013	-0,3	-0,1	-0,4
200	0,018	0,013	0,013	-0,3	-0,1	-0,4
150	0,015	0,012	0,013	-0,3	-0,1	-0,4
100	0,015	0,012	0,013	-0,3	-0,1	-0,4
50	0,015	0,012	0,013	-0,3	-0,2	-0,4