ENG61 FutureGrid Non-conventional

voltage and current sensors for future grids

Mo-PS 1129748

Scaling devices for sampling bridges

Scaling devices are developed at VSL for voltage and current. Sampling bridges typically have input signals at the level of 1 V.

Current scaling is done using a pair of identical two-stage electronically enhanced current transformers which are binary divided giving a maximum ratio of 512 to 1.

Voltage scaling will be done using automated self-calibrating resistive dividers. Based on a R2R network.

Both scaling devices are used to reduce voltage and current of traditional transformers to lower levels which can be directly compared with the outputs of NCITs using sampling bridges.

Experimental R2R divider

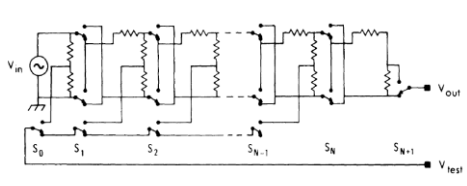
10 Stages, Ratio's ranging from 1024:1 to 1:1

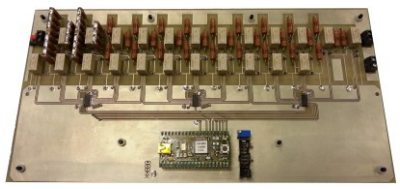
Input: 1 – 1000 V_{rms}

Output: 1 V_{rms}

Accuracy: TBD.

Determining the corrections for each stage is problematic due to the high common-mode rejection needed. Also the paracitic capacitance changes when switching from calibration to measuring mode.





Binary divided enhanced core CT's

Input: 0 – 5 A

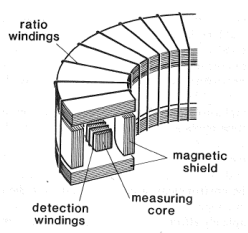
Output: 10 mA

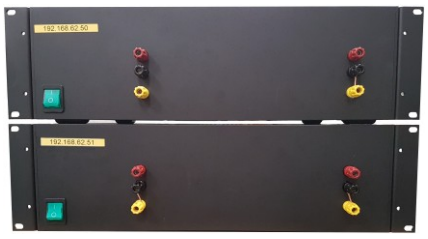
Accuracy: < 3 µA/A / µrad

Primary winding: 1;1;2;4;8;16;32;64;128;256 selectable through Ethernet.

Secondary: 512 Windings. Keeping secondary current and flux in the core constant and minimizing the effect of linearity of the digitizer.

Using two of these devices ratio build-ups can be made from 1:1 to 512:1.





Ratio CT1:CT2	Magnitude [ppm] mean	Stdev	Phase [µrad] mean	Stdev		Magnitude [ppm] mean	Stdev	Phase [µrad] mean	Stdev
512:512	-8.5	± 0.3	-4.7	± 0.4					
512:256	-10.0	± 0.4	-1.9	± 0.5					
256:256	-9.7	± 0.4	2.2	± 0.5		-0.3	± 0.5	0.3	± 0.7
256:256	-9.0	± 0.3	2.6	± 0.4					
256:128	-10.9	± 0.3	1.6	± 0.5					
128:128	-9.7	± 0.4	3.2	± 0.5		-1.2	± 0.5	-1.5	± 0.7
128:128	-8.6	± 0.3	3.1	± 0.4					
128:64	-10.8	± 0.3	3.7	± 0.4					
64:64	-9.9	± 0.4	3.5	± 0.5		-0.9	± 0.5	0.2	± 0.7
64:64	-8.2	± 0.3	3.7	± 0.5					
64:32	-10.4	± 0.3	4.6	± 0.6					
32:32	-9.9	± 0.3	4.4	± 0.6		-0.4	± 0.4	0.2	± 0.8
32:32	-8.4	± 0.3	4.3	± 0.6					
32:16	-10.9	± 0.3	5.8	± 0.5					
16:16	-10.4	± 0.4	5.4	± 0.5		-0.5	± 0.5	0.4	± 0.7
16:16	-8.9	± 0.3	5.6	± 0.5					
16:8	-10.2	± 0.4	6.5	± 0.5					
8:8	-9.6	± 0.4	6.3	± 0.4		-0.6	± 0.6	0.2	± 0.7

A calibration system based on commercial test-sets

Commercial test-set offers a simple and versatile measuring method, capable of calibrating NCITs. Only one calibrated standard voltage or current transformer, connected to the conventional input of the test-set is necessary as a reference. The voltage and current ranges of this input are from 3.75 V to 480 V, or from 5 mA to 15 A, respectively. The ranges of the EVT / ECT input of the test-set are from 25 mV to 15 V. Software for controlling the test-set, reading out the measuring data and correcting the errors of the standard transformer has been developed by PTB.

Commercial Test Set

calibration facilities for:

- conventional current and voltage transformers
- non-conventional analogue current (ECT) and voltage (EVT) transformers
- non-conventional digital current and voltage transformers

Hardware consists of:

- ZERA WM3000U
- ZERA WM3000I
- PC with readout and control software

The accuracy for calibrating ECTs is below 0.010 % or crad

The accuracy for calibrating EVTs is below 0.015 % or crad

Sampling-based calibration system

PTB self-made Two-Channel Sampling System

Input: 1V; 10V

Accuracy: < 10^{-5} V/V / or rad

Automatic cancellation of the channel mismatches of U_1 and U_2.

Automatic frequency synchronization

High measuring rates up to 3 meas. / s

Current-to-Voltage-Converter

Input: 0.1A - 5A

Output: 3V (nominal)

Accuracy: <10 µA/A or µrad

Two-Stage-Voltage-Transformer

Input: 30V; 60V; 120V; 240V

Output: 3V (nominal)

Accuracy: <10 µV/V or µrad