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Progress in the development of low-frequency quantum-based AC Power Standard at NRC Canada

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Publisher's version / Version de l'éditeur:

<https://doi.org/10.1109/CPEM.2010.5545095>

*2010 Conference on Precision Electromagnetic Measurements (CPEM 2010), pp.
233-234, 2010*

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voltage and the low-level voltage and current replicas.

Performance

The IVDs are expected to have in-phase and quadrature errors lower than 0.2 $\mu\text{V/V}$ and 0.5 $\mu\text{V/V}$, respectively. Achieving, at power frequencies, IVD calibration uncertainties about ten times lower is demanding. Preliminary testing with AC calibrators and precision voltmeters indicated IVD ratio errors lower than a few $\mu\text{V/V}$. A calibration of the 132 V IVD was performed with the current comparator-based capacitance bridge and low loss gas-dielectric capacitors. It indicated in-phase and quadrature errors lower than 10^{-6} . For lower uncertainty calibrations at power frequencies, using Thompson's method [9]-[11], a 10:-1:1 calibrating transformer, voltage comparator, and special sockets were built.

Calibration of IVDs with low-uncertainties is the basis for verification that in-phase and quadrature errors of the composite voltage amplifier operating together with two IVDs are better than 0.5 $\mu\text{V/V}$ and 1.0 $\mu\text{V/V}$, respectively.

Calibrations of the current transformers in the I/V converter were performed using current-comparator-based techniques. The errors of the current transformer CT2, 5 A (1 A)/20 mA, are not critical for the output power as CT2 plays an auxiliary role in the I/V converter.

The performance of the current transformer CT1, 5 A (1 A)/10 mA, is critical for the I/V converter. At a burden R_b as large as 120 Ω , the CT1 two-stage design is ineffective. However, when CT2 and RC network provide optimum operating conditions, CT1 errors drop to only a fraction of 1 $\mu\text{A/A}$, as shown in Table I.

Table I Current Transformer CT1 Errors

CT1: 5A (1A)/10mA			Errors	
R_b [Ω]	f [Hz]	I [%In]	In-Phs. [$\mu\text{A/A}$]	Quad. [$\mu\text{A/A}$]
120 CT1	57	100	-570	3620
		10	-200	4440
	63	100	-860	3320
		10	-610	4010
120 CT1 & CT2	57	100	0.1	0.1
		10	0.1	0.1
	63	100	0.0	0.1
		10	0.1	0.1

A specially compensated 120 Ω foil-resistor with the temperature coefficient below 1 $\mu\Omega/(\Omega\cdot\text{K})$ is used as the reference resistor.

Additional results regarding the performance of the system will be available at the conference.

Acknowledgment

The continuing collaboration of the NIST labs in Boulder and Gaithersburg on this NRC project is gratefully acknowledged. The assistance of the Electrical Standards Group of INMS/NRC is also acknowledged.

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