Digital impedance bridge at CMI

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Coaxial impedance bridges for ratio measurements in the audiofrequency range

Calibration of electrical impedance standards on the highest metrological level is performed by means of coaxial impedance bridges. With increasing accuracy of today digital programmable voltage sources, an advanced automation of calibration process and any-ratio measurements are introduced.

Manual bridges:
- manual operation
- coverage of only predefined ratios
- rel. uncertainty in the range 10^{-7} up to 10^{-9}

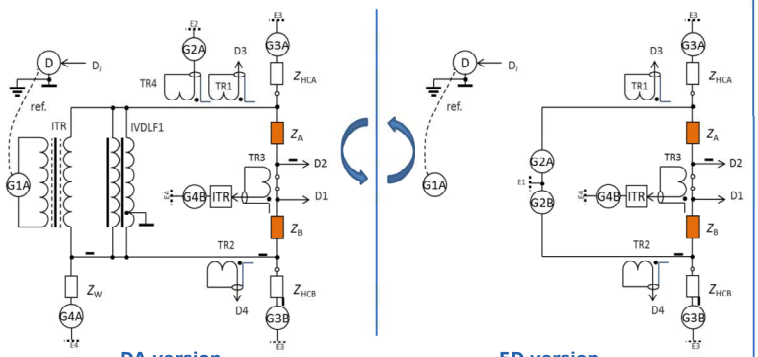
Digitally assisted bridges (DA):
- partial/full automation
- coverage of only predefined ratios
- rel. uncertainty in the range 10^{-6} up to 10^{-8}

Fully digital bridges (FD):
- full automation
- coverage of the whole complex impedance plane
- rel. uncertainty in the range 10^{-5} up to 10^{-7}

Building reconfigurable **FD-DA bridges** ables to perform both high accurate calibrations at predefined ratios and calibrations in the whole complex plane with same equipment and full automation.

FD-DA impedance bridges

- 4-TP version, operation range 10 Ω – 10 MΩ in audiofrequencies
- Calibration of reference ratio arms for FD bridge by means of modified DA bridge or a precision DMM



DA version FD version

FD-DA bridge (left), reference standards (middle), DUT (right)

MEASUREMENTS WITH FD VERSION

- 10:1 ratio measurement @1 kHz, voltage set at G2A and G2B between 2 % and 100 % of full scale.

Ratio *N*	Bridge voltage (V_{rms})	$N_{ref}/N_{nom}-1$ $\times 10^6$	$N_{FD}/N_{nom}-1$ $\times 10^6$
QFR 1kΩ/QFR 100Ω	1.1	251.5	260.9
AH11 100 pF/AH11 10 pF	7.7	0.3	-4.1
	3.8	0.3	-2.2

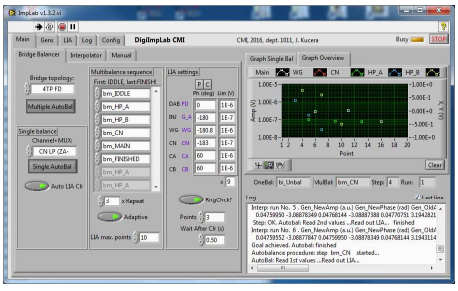
REFERENCE RATIO ARM AND AUXILIARY ENERGIZING SOURCES

- Main ratio arms and auxiliary sources formed by set of fully isolated DDS based 2-ch generators CMI SWG03 [1]:

- output voltage up to 7 Vrms
- resolution up to 0.01 ppm
- phase resolution 2x10^{-7} rad
- ratio stability up to 0.05 ppm/30 min.
- SFDR < -95 dB @ 100 Hz, < -85 dB @ 1 kHz
- crosstalk < -150 dB @ 1 kHz
- Int/Ext reference clock 10 MHz and voltage reference up to 10 V
- internal battery/external power supply

BRIDGE BALANCE

- Overal bridge equilibrium is achievable within few minutes by sequential balancing of each equilibrium condition [2].

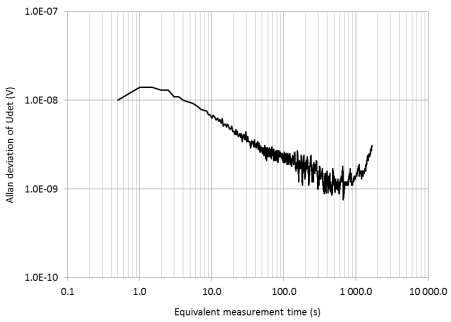


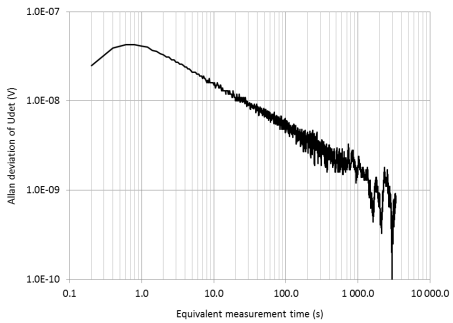
STABILITY PERFORMANCE

Allan deviation of main balance voltage @1 kHz, DUT ratio 1 kΩ/100 Ω, DA version:

Allan deviation of main balance voltage @1 kHz, DUT ratio 30 kΩ/10 kΩ, DA version:

Voltage 10^{-9} V ~ rel. change of ratio about 10^{-8}





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AIM QuTE

CONCLUSION

- Two bridges with easy reconfiguration were built.
- Both bridges are based on same equipment and ables calibration of FD bridge by means of DA bridge reference measurements.
- Achieved rel. uncertainty for FD version 10^{-5} up to 10^{-6}.

REFERENCES

[1] J. Kováč, "Precision low-frequency multichannel generator", *Diploma thesis*, CTU in Prague, FEE, 2014

[2] J. Kováč, J. Kučera, "A modular coaxial multiplexer with high isolation between channels", XXI IMEKO, 2015

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