Modular Universal Divider System for Calibration of UHVDC, Composite and Combined waves

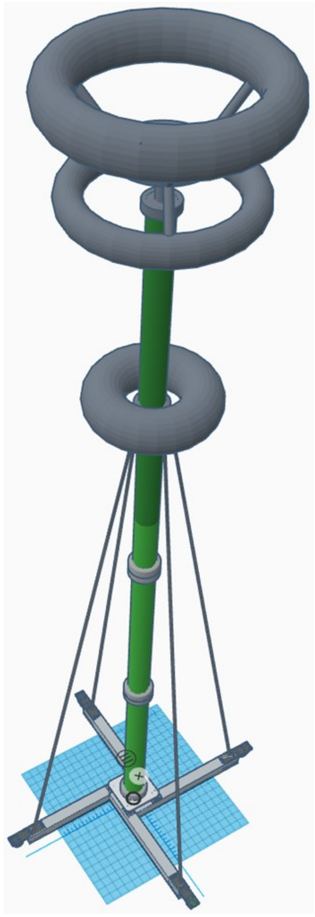
Metrology for Future Energy Transmission

HV-com²

Modular universal divider

- Two 500/330/600/700 kV (DC/AC_{rms}/SI/LI) divider modules were financed and built by RISE in response to two EU funded projects *Metrology for future energy transmission* and *Support for standardisation of high voltage testing with composite and combined wave shapes* in 2010–2013.
- The 500 kV modules were designed to be used for precision HVDC and composite/combined wave calibration.
- The height of each divider is < 2.4 m for easy loading into the RISE truck which is used for on-site calibrations. In 2022 this divider was used for more than 30 different calibrations.
- The system to be expanded up to 2000/1280/1450/2800 kV.

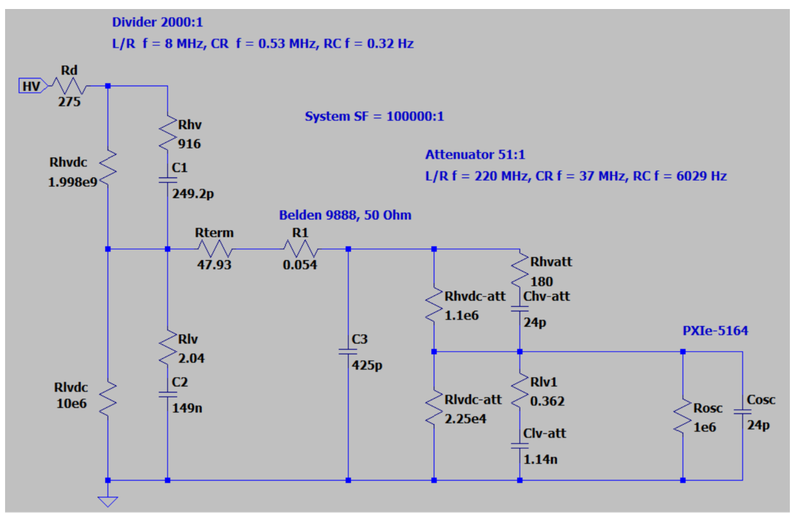
The two RCR 500 dividers at RISE.



Future divider (9.5m tall) 2000/1280/1450/2800 kV

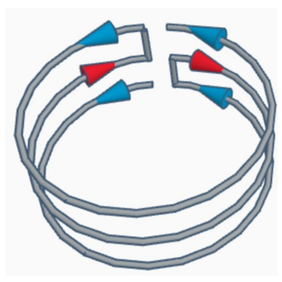
HV Components and properties

- Total capacitance - 250 pF, 600 pc - WIMA FKP1
- Total damping R 1200 kΩ, 300 pc - Ohmite OX + OY
- Total Bleeder R – 2 GΩ, 600 pc - Caddock TF050R 3.33 MΩ
- The current flow, component mounting and field strengths is shown in the figures on the left side



Calibration - DC stability

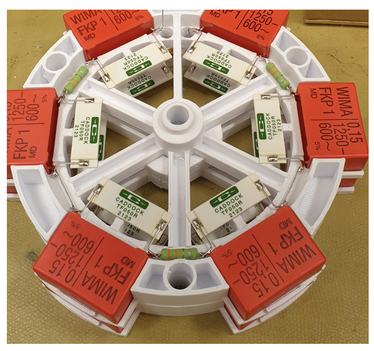
- Scale factor of a stacked 1000 kV configuration in UHVDC comparison at PTB in June 2022, 35 µV/V.
- 500 kV divider TC_{DC} = 2 µV/V/K, TC_{AC} = 7 µV/V/K
- The scale factor for UHDVC was calibrated at RISE in April 2023, and is stable within 10 µV/V.



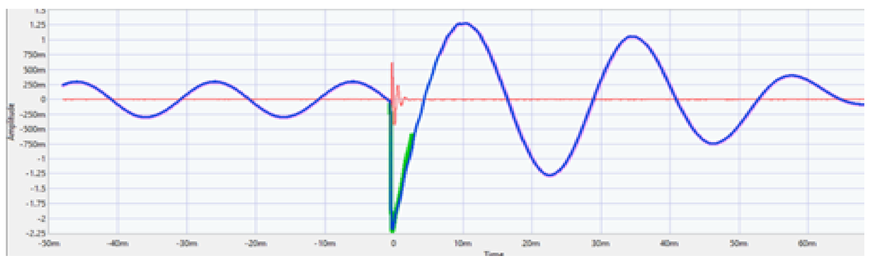
Current flow in the HV stack

Composite and combined waves

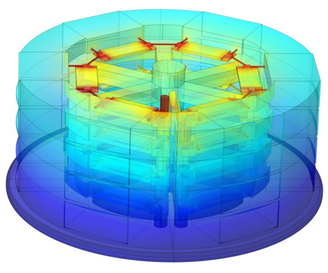
- A intercomparison took place at PTB in July 2022 between four measurements systems of three different divider designs.
- Composite DC+LI, DC+SI, AC+LI and AC+SI, and combined wave LI+AC were measured.
- The expanded uncertainty for the RISE measurement system is 0.7%/1.0%/1.0% for .Ut/T1 and T2 and 0.1% for DC and AC



Divider HV construction



Example of measured composite wave: -200 kV SI on 30 kV AC.



Field strength FEM modeling

Conclusions

- The target for 19ENG02 was to design a UHVDC divider for calibration up to 1600 kV. In this project we have designed two dividers.
- The target for 19NRM07 was to design a measurement system for calibration of composite and combined waves to 400 kV. With this divider we have produced three systems.

Intercomparison at PTB in June 2022. The universal divider stacked to 1000 kV to the right, two modular HVDC 1200 kV to the left, followed by a new 2000 kV DC generator and the modular UHVDC 2000 kV divider.

References

[1] A-P Elg, T. Nieminen, J. Klüss, S. Passon, F. Gerdinand and J. Meisner, "A Modular Universal Divider for Calibration of UHVDC, and Composite/ Combined Waves up to 1400 kV", Submitted to ISH2023

[2] A-P Elg, Andreas Nilsson and Tatu Nieminen "Reference Measurement System for Traceability of Composite and Combined waves", Submitted to ISH2023

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EMPIR EURAMET

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