Supplementary Comparison EURAMET.EM-S46 and EURAMET.EM-S47

**High voltage comparison of DC ratio and high resistance**

**TECHNICAL PROTOCOL**

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# Introduction

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| --- | --- |
| **Metrology area, branch** | Electricity and Magnetism, High Voltage and Current  |
| **Description** | High DC voltage ratio up to 200 kV  |
| **Time of measurement** | 2022-03-07 – 2022-03-25  |
| **Measurand(s)** | DC voltage ratioDC resistance |
| **Parameter(s)** | Nominal ratio: 20000Nominal resistance: 2 GΩVoltage: up to 200 kV |
| **Transfer device(s)** | Star comparison, all references in one lab at the same time. |
| **Comparison type** | Supplementary comparison  |
| **Consultative Committee** | CCEM (Consultative Committee for Electricity and Magnetism) |
| **Related regional metrology organizations** | EURAMET  |

The 200 kV reference dividers were built in 2014 for RISE, VTT, PTB, VSL and TUBITAK as part of EMRP project HVDC. These dividers will be transported to RISE in February/March 2022 to compare their ratios and high voltage arm resistances.

# Standards

The standards to be compared are identical 200 kV divider modules shown in Figure 1.



Figure 1 The five high voltage dividers to be compared (coloured).

The outer diameter of a module is 480 mm, it is 1500 mm high, and it weighs about 150 kg. The internal structure of the module is shown in Figure 2. The components are enclosed in an SF6 filled fiberglass tube. The top endplate houses a gas valve, pressure gauge and a feed-through for the reference divider signal. The bottom plate has a mating feed-through, so that the modules can be directly stacked and mounted on top of each other.



Figure 2 Internal structure of the dividers. The adjustments are
used to optimise the AC behaviour, when needed.

# Measurement methods

## General

Participants shall define the scale factor (ratio) and the resistance of the reference branch high voltage resistor of their divider using existing home laboratory procedures before sending the divider for comparison measurements at RISE. Each participant shall repeat their home calibration after the divider has returned after comparison.

# Quantities to be measured

1. The DC ratio of the divider, with nominal value of 20000; and
2. The resistance of the high voltage reference branch resistor, with nominal value of 2 GΩ.

## Ambient conditions

Ambient conditions shall be reported for each home calibration (before and after measurements at RISE), and for measurements at RISE. Recorded temperature values will be used for correcting the final report results to reflect performance at e.g. 22.0 °C. Humidity does not have to be controlled, but shall be reported.

The dividers must be acclimatized for a suitable duration (not less than 7 days) in the laboratory before the measurements in order to reach stable temperature.

## HVDC ratio

The scale factor (ratio) of the dividers will be compared at RISE on the voltage levels shown in Table 1.

Table 1 Voltages for ratio comparison

|  |
| --- |
| Nominal voltage [kV] |
| 1 |
| 10 |
| 100 |
| 200 |
| -200 |

The comparison at RISE will be performed by connecting two or several dividers in parallel to measure the high voltage. The output of each divider will be measured using calibrated 3458A multimeter(s).

## High voltage arm resistance

The high voltage arm resistance of each divider will be separately measured at RISE at 1 kV using voltage bridge method.

# Measurement reporting

## Before RISE comparison measurements

Each participant shall calibrate their divider before the comparison session. The calibration certificate shall be signed before the start of the RISE session and, at minimum, it shall contain the following:

* description of the measuring set-up(s) including the electrical circuit configuration;
* traceability scheme; if the traceability to the SI is provided by another NMI, the name of the NMI has to be stated (needed to identify possible sources of correlation);
* value and uncertainty of the scale factor, and respective voltage level(s);
* value and uncertainty of the reference branch high voltage resistor, and respective voltage level(s);
* description of the measurement procedure(s);
* the ambient conditions of the measurement: the temperature and humidity with limits of variation.

## RISE comparison measurements

The pilot (RISE) prepares a report summarising the results of the measurements described in chapters 4.2 and 4.3. RISE will not disclose this report to other participants until all calibration certificates described in clauses 5.1 and 5.3 are submitted.

## After RISE comparison measurements

Each participant shall repeat the calibration described in chapter 5.1 within 2 months after return of the divider to their laboratory and send both calibration certificates to the coordinator.

# Final report of the comparison

Within 3 months after completion of all measurements, the VTT will prepare the first draft report and send it to the participants for comments.

This final report will summarise the results from the calibration certificates and comparison report described in chapter 5.

# Organization

## Coordinator

Dr. Alf-Peter Elg

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## Support group

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##  Participants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Acronym** | **Institute** | **Country** | **Status** | **Contact** |
| RISE | Research Institutes of Sweden AB | Sweden | NMI | Dr. Alf-Peter Elgalf.elg@ri.se |
| VTT MIKES | Technical Research Centre of Finland Ltd  | Finland | NMI | Dr. Jari Hällströmjari.hallstrom@vtt.fi  |
| PTB | Physikalisch-Technische Bundesanstalt | Germany | NMI | Dr. Johann Meisnerjohann.meisner@ptb.de  |
| TUBITAK | TÜBITAK Ulusal Metroloji Enstitüsü | Turkey | NMI | Dr. Ahmet Merev ahmet.merev@tubitak.gov.tr |
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## Time schedule

Comparison measurement will be performed in February/March 2022 at RISE according to the schedule shown below.

Timetable

|  |  |  |
| --- | --- | --- |
| **Action** | **Start** | **Finish** |
| Arrival of dividers to RISE | 20.01.2022 | 22.02.2022 |
| Temperature stabilization (7 days) | 14.01.2022 | 01.03.2022 |
| 2 GΩ measurements | 21.01.2022 | 01.03.2022 |
| 200 kV scale factor measurements | 7.03.2022 | 11.03.2022 |
| Divider departure from RISE | 21.03.2022 | 06.04.2022 |

## Transportation

Participants will be responsible for arranging transportation for their own divider to and from RISE.

## Financial aspects, insurance

Each participating laboratory covers the costs of its own labor and transportation cost, as well as of any possible damage to their own equipment.

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