TÜBİTAK
ULUSAL METROLOJİ ENSTİTÜSÜ

TECHNICAL PROTOCOL FOR KEY COMPARISON EURAMET.AUV.V-K3.1

ISSUE 1
NOVEMBER 2021

Eyüp Bilgiç, Enver Sadıkoğlu
TÜBİTAK Ulusal Metroloji Enstitüsü(UME)
Gebze - Kocaeli
Turkey

Tel +90 262 679 50 00
E-mail: eyup.bilgic@tubitak.gov.tr
enver.sadikoglu@tubitak.gov.tr

Contents

TECHNICAL PROTOCOL FOR KEY COMPARISON EURAMET.AUV.V-K3.1

BACKGROUND

According to the rules set up by the CIPM MRA the consultative committees of the CIPM have the responsibility to establish "degrees of equivalence" (DoE) between the different measurement standards operated by the NMIs. This is done by conducting key comparisons (KC) on different levels of the international metrological infrastructure.

The specific task of this EURAMET Key Comparison (KC) is to measure the complex voltage sensitivity of capacitive accelerometer at specified frequencies with primary means i.e. according to [1] and [2].

The reported sensitivities and associated uncertainties are then supposed to be used for the calculation of the DoE between the participating NMI and the key comparison reference value (through a linking procedure based on the results of the linking laboratories).

The Technical Protocol was drawn up in accordance with EURAMET Guide on Comparisons (Guide 4, ver.2.0, 2021) [3] that is based on provisions of CIPM MRA-G-11 document [4]. The aim of this document is to describe the requirements for the comparison in detail.

PARTICIPANTS

The following laboratories will participate in the comparison.

- TÜBİTAK UME, Turkey
- METAS, Switzerland

PILOT LABORATORY

Pilot laboratory for this EURAMET Key Comparison is TÜBİTAK UME (Turkey).

The delivery address for the transfer standards and communication with pilot laboratory is

TÜBİTAK Ulusal Metroloji Enstitüsü (UME)
TÜBİTAK Gebze Yerleşkesi
P.O. Box 54 41470 GEBZE-KOCAELİ / TURKEY
Phone: +90 (262) 679 50 00
Fax: +90 (262) 679 50 01
Contact persons:
Eyüp Bilgiç (E-mail: eyup.bilgic@tubitak.gov.tr)
Enver Sadıkoğlu (E-mail: enver.sadikoglu@tubitak.gov.tr)

DEVICES UNDER TEST AND MEASUREMENT CONDITIONS

For the calibration task within the key comparison, two same type capacitive accelerometers and their cables will be circulated among the participating laboratories. The individual transducers being:

• Silicon Designs 2240-005 (SN: 27957)
• Silicon Designs 2240-005 (SN: 27958),

will be supplied by TÜBİTAK UME.

A special adapter (Figure 1) was developed by TÜBİTAK UME and will be used during this comparison. The adapter is made of stainless steel and its mass is 95 g. Its top surface is polished in order to provide mirror-like reflectivity for the laser beam. Thread size of the stud used for mounting the adapter to exciter is 1/4" – 28 UNF.

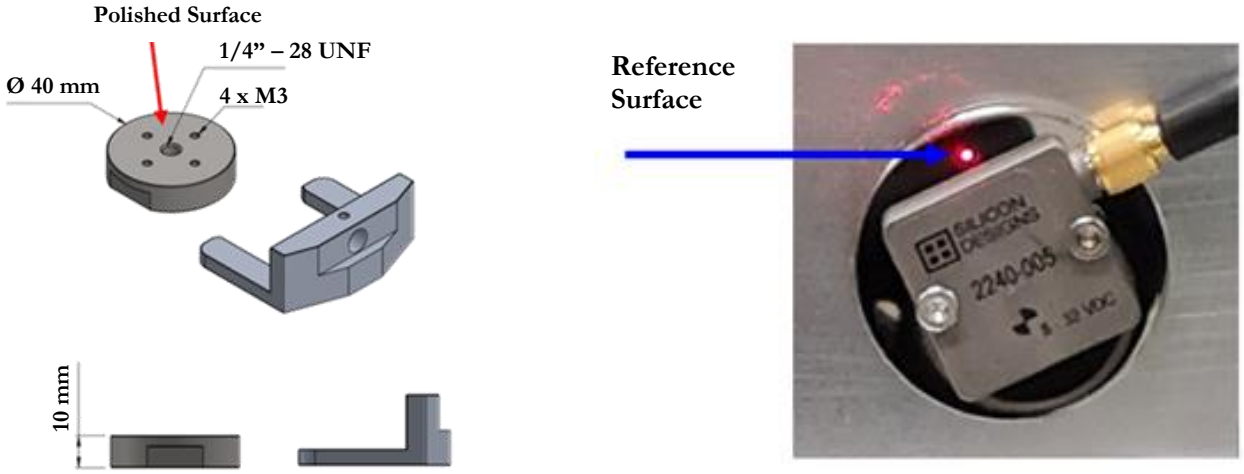

Figure 1. Adapter to be used with accelerometers during calibrations

The accelerometers are to be calibrated for magnitude and phase of their complex voltage sensitivity according to those procedures and conditions implemented by the NMI in conformance with ISO 16063-11 standard, which provide magnitude and phase information of the artefact.

The sensitivities reported shall be for the accelerometers alone, excluding effects from any auxiliary devices used during calibrations.

The frequency range of the measurements was agreed to be from 0.2 Hz to 40 Hz. Specifically, the participants shall perform calibrations at the following frequencies (all values in Hz).

0.2, 0.25, 0.315, 0.4, 0.5, 0.63, 0.8, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3, 8.0, 10, 12.5, 16, 20, 25, 31.5, 40.

The participating laboratories will measure and report magnitude of the voltage sensitivity and phase results at all frequencies stated above. Laboratories with CMCs published in the BIPM KCDB within the frame of the CIPM MRA shall provide results covering their CMCs in the scope of this comparison.

The measurement condition should be kept according to the laboratory's standard conditions for calibration of customer accelerometers for claiming their calibration and measurement capability. This presumes that these conditions comply with those defined by the applicable ISO standard [5].

Specific conditions for the measurements of this comparison are:

- Acceleration amplitudes: preferably 0.05 m/s² to 30 m/s²,
- Ambient temperature and accelerometer temperature during the calibration: (23 ± 3) ºC (actual values to be stated within tolerances of ±0.3 ºC). The accelerometer temperature should be measured and reported.
- Relative humidity: maximum 75 %
- Mounting torque of the adapter: (1.5 ± 0.1) N·m

CIRCULATION TYPE, SCHEDULE AND TRANSPORTATION

The transducers are circulated by the pilot laboratory and a measurement period of two weeks is allocated for each participant. The planned schedule for the comparison is as follows:

Participant	ISO country code	Duration in weeks	Week number
TÜBİTAK UME (Monitoring measurements)	TR	10	35 – 44 / 2021
TÜBİTAK UME	TR	2	45 – 46 / 2021
Transportation to METAS			47 / 2021
METAS	CH	2	48 – 49 / 2021
Transportation to TÜBİTAK UME			50 / 2021
TÜBİTAK UME (Monitoring measurements)	TR	2	51 – 52 / 2021
Draft A Report			01 – 04 / 2022
Draft B Report			06 – 08 / 2022

The transportation of transducers will be made by international courier company. The cost of transportation of the transducers, including insurance are covered by TÜBİTAK UME. The full delivery address for each participant is presented in Annex 1.

HANDLING, MEASUREMENTS AND ANALYSIS INSTRUCTIONS

The participating laboratories must observe the following instructions:

- The motion should be measured with the laser directly on the polished surface of the supplied adapter.
- In order to reduce the influence of non-rectilinear motion, the measurements on the polished surface of the adapter should be performed for at least four different laser positions which are symmetrically distributed over the respective measurement surface.
- Sensor provides AC voltage signal with response to vibration excitation. All required cables and connectors will be supplied by TÜBİTAK UME. However, DC power supply for capacitive transducers will not be provided by pilot laboratory and should be arranged by each participant.

- The mounting or dismounting torque between the adapter and the shaker shall be applied only to the mounting adapter. An appropriate crowfoot wrench with suitable square drive adaptation will be provided by pilot laboratory.
- The mounting surface of the adapter and the moving part of the exciter must be slightly lubricated before mounting.
- It is advised that the measurement results should be compiled from complete measurement series carried out at different days under nominally the same conditions, except adapter is remounted and the cable reattached. The standard deviation of the subsequent measurements should be included in the report.

COMMUNICATION OF THE RESULTS TO THE PILOT LABORATORY

Participating laboratory will submit one printed and signed calibration report (sent by e-mail to Eyüp Bilgiç) for each accelerometer including the following:

- The magnitude (mandatory) and the phase (optionally) of the complex voltage sensitivity of accelerometer for at least each mandatory point,
- The description of the calibration systems used and the mounting techniques for the accelerometer,
- The position of the shaker (vertical or horizontal),
- The description of the calibration methods used,
- The record of the ambient conditions during measurements,
- The calibration results, including the relative expanded measurement uncertainty, and the applied coverage factor for each value,
- The detailed uncertainty budget for the calibration covering all components of measurement uncertainty (calculated according to GUM [6]). Including among others information on the type of evaluation of uncertainty (A or B), assumed distribution function and repeatability component

In addition, each participating laboratory will receive two electronic spreadsheets prepared by the pilot laboratory, where the calibration results have to be filled in following the structure given in the files. The use of the electronic spreadsheets for reporting is mandatory. The consistency between the results in electronic form and the printed and signed calibration report is the responsibility of the participating laboratory. The data submitted in the electronic spreadsheet shall be deemed the official results submitted for the comparison.

Considering that the impartiality may be a delicate issue, particularly with bilateral comparisons, the participants will submit their respective measurement results to an independent third party, which in the present case will be the CCAUV Executive Secretary, before exchanging them. They will only be shared with the pilot laboratory for further analysis, once all the measurements are completed. Results have to be submitted to the CCAUV Executive Secretary within three weeks after completion of measurements.

REMARKS ON THE POST PROCESSING

The results of the participants will be scaled to the level of Key Comparison Reference Value (KCRV) of CCAUV.V-K3 comparison. The scaling factor will be determined via the results of the METAS.

The report will include the results of the participants and their degrees of equivalence respectively to the KCRV of the CCAUV.V-K3.

In case of damage or loss of any of the artefacts the comparison will be evaluated as far in the schedule as possible, all further action concerning continuation will be decided in coordination with the participants.

FINANCE

All costs associated with transportation and insurance of accelerometers for the purpose of their circulation within the comparison will be paid by the pilot laboratory. However, participants are responsible for cost of any damage to the accelerometers while they are in their possession.

REFERENCES

1. ISO 16063-1:1998 "Methods for the calibration of vibration and shock transducers. Part 1: Basic concepts", International Organization for Standardization, Geneva
2. ISO 16063-11:1999 "Methods for the calibration of vibration and shock transducers. Part 11: Primary vibration calibration by laser interferometry", International Organization for Standardization, Geneva
3. EURAMET Guide on Comparisons, EURAMET Guide No.4, ver.4.0, April 2021, www.euramet.org
4. Measurement comparisons in the CIPM MRA, Guidelines for organizing, participating and reporting CIPM MRA-G-11, version 1.1, 18.01.2021, www.bipm.org
5. ISO/IEC 17025:2005/2017 "General requirements for the competence of testing and calibration laboratories", International Organization for Standardization, Geneva
6. ISO/IEC Guide 98-3:2008 "Uncertainty of measurement. Part 3: Guide to the expression of uncertainty in measurement" (GUM:1995), International Organization for Standardization, Geneva

ANNEX 1. CONTACT DETAILS

Eyüp Bilgiç TÜBİTAK Ulusal Metroloji Enstitüsü (UME) Barış Mahallesi Dr. Zeki Acar Caddesi No:1, 41470 Gebze – Kocaeli, Turkey Phone: +90 262 679 50 00 ext. 3100 Fax: +90 262 679 50 01 e-mail: eyup.bilgic@tubitak.gov.tr Enver Sadıkoğlu Phone: +90 262 679 50 00 ext. 2044 Fax: +90 262 679 50 01 e-mail: enver.sadikoglu@tubitak.gov.tr	Christian Hof Federal Institute of Metrology (METAS) Lindenweg 50 3003 Bern-Wabern Switzerland Phone: +41 58 387 07 50 Fax: +41 58 387 0210 e-mail: christian.hof@metas.ch