Technical protocol of the Comparison in the field of vibration EURAMET.AUV.V-S1

Primary calibration of accelerometers at low frequencies

1. PARTICIPANTS

The following laboratories are participant in the proposed comparison:

- LNE / France
- PTB / Germany
- CMI / Czech Republic
- DPLA / Denmark
- METAS / Switzerland
- SP / Sweden
- GUM / Poland
- CEM / Spain
- MIKES / Finland
- INRIM / Italy

2. AIM AND TASK OF THE COMPARISON

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 national NMIs. This is done by conducting key comparisons (KC) on different levels of the international metrological infrastructure.
The results of this comparison will, after approval for equivalence, form the new basis for DoE derived in subsequent RMO key comparisons, and therefore be the foundation for the registration of “calibration and measurement capabilities” (CMC) in the framework of the CIPM MRA.

The specific task of this comparison is the measurement of the magnitude and phase of the complex voltage sensitivity of one servo accelerometer at frequencies and amplitudes specified in clause 4 in low frequency domain as no comparison has ever been performed in this domain. The voltage sensitivity shall be calculated as the ratio of the amplitude of the output of the accelerometer to the amplitude of the acceleration at its reference surface with primary means in accordance with ISO 16063-11 : 1999 “Methods for the calibration of vibration and shock transducers - Part 11: Primary vibration calibration by laser interferometry”.
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.

3. PILOT LABORATORY

The pilot laboratory for this comparison is LNE (France). The pilot will report its results to the CCAUV-Executive Secretary before the first measurement of the participants.

The delivery address for the set of artifacts and the written and signed reports is:

Laboratoire national de métrologie et d’essais (LNE)
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4. DEVICE UNDER TEST AND MEASUREMENT CONDITIONS

For the calibration task of this comparison, the device is a servo accelerometer QA700 SN 39477 fixed on the WB 3519 conditioning module coupled to a supply junction box WB 3479. The accelerometer is fixed on a plate of size 65 mm * 42 mm. The distance between the holes are 25.2 mm (≈ 1 inch) and 50.4 mm (≈ 2 inches) which permits mounting on platforms with both 25 mm and 0.5 inch patterns. The supplied screws are M5 and 10-32 UNF types. The cable is fixed to the accelerometer and is a LEMO 7 pin connection on the other side. The junction box has an input in LEMO 7 pin and a BNC output. The junction box WB 3479 has to be connected to a +15 / 0 / -15V power supply unit (3 banana plugs) and from chassis/shield connection WB 3479 to ground or 0 (1 banana plug) on measurement instrument. The voltage shall be within +/- 0.2 V.

The nominal sensitivity of the accelerometer is 500 mV/(m/s²).

The mass of the accelerometer (QA700+WB3519) is 280g.

The reference surface will be a small mirror fixed on a face of the accelerometer (fixed with a 10-32 UNF screw). The size of the tool for applying the torque on the mirror is M11. The calibration has to be performed in the horizontal axis of the plate.

The following pictures present the standard accelerometer with its mirror and the junction box.

The schema of the WB3519 and of the junction box WB 3479 are given in annex A.

The frequency range of the measurement is **mandatory** from 1 to 80 Hz.
The participating laboratories could give results for the frequency range DC to 200 Hz.
The laboratories are supposed to measure at the exact frequencies corresponding to these nominal frequencies (all values are in Hz) :
0.1, 0.125, 0.16, 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, 10, 12.5, 16, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200.

The value of the exact frequencies can be calculated from fn=fr*10^(n/10) with fr the reference frequency 1 000 Hz; n will takes values between –40 and –7 (cf. ISO 266 standard).

Optionally, the laboratories can specify some frequencies of the list as experiments. The results at these frequencies will not be included in the report and will not be usable to claim CMCs.

The DC_{gn} response (± 90°) of the accelerometer could be included as exp eriments.

Specific conditions for the measurement 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)°C.
- Relative humidity: max 75%.
- Mounting torque of the mirror on the accelerometer: 2 N.m.
- Screw coupling of the box on the table.

5. CIRCULATION TYPE AND TRANSPORTATION

The transducer is circulated in a star type fashion with a measurement period of two weeks for each participant. Between two subsequent measurements, the transducer is measured by the pilot lab in order to monitor the long term stability.

The transducer will be transported in a specific box by an international transportation agency (eg UPS, TNT ,…). The participating laboratories will support the costs of the transportation to and from the pilot laboratory. The transportation has to include an insurance covering a value of 5 000 € in case of damage or lost during the transportation.

The schedule is planned as follows :
For information W6 is from 6 to 10 of February 2012. W1 /13 is from 1 to 4th of january 2013.

Participant	Transportation to participant	Measurement	Transportation to pilot	Monitoring measurement
CMI	W 6	W 7 - 8	W 9	W 10 - 11
SP	W 12	W 13 - 14	W 15	W 16 - 17
METAS	W 18	W 19 - 20	W 21- 25	W 26 - 27
INRIM	W 28	W 29 - 30	W 31	W 32 - 33
CEM	W 37	W 38 - 39	W 40	W 41 - 42
GUM	W 43	W 44 - 45	W 46	W 47 - 48
PTB	W 49	W 50 – 51	W 1 / 13	W 2 - 3 / 13
DPLA	W 4	W 5 - 6	W 7	W 8 - 9
MIKES	W 10	W 11 - 12	W 13	W 14 - 15

6. MEASUREMENT AND ANALYSIS INSTRUCTIONS

The participants have to observe the following rules :

- The motion should be measured with the laser directly on the supplied mirror.
- The participating laboratories should supply the power supply unit (+ and - 15 ± 0.2V).
- The motion will be measured on the center of the mirror taking care to avoid scratch on the surface of the mirror.
- The mounting surface of the mirror should be slightly lubricated before mounting.
- The calibration is to be carried out in accordance with the usual procedure of the participating laboratory.

- It is advised that the measurement results should be compiled from complete series carried out on different days under nominally the same conditions except that the transducer and the mirror are remounted. The standard deviation of the subsequent measurements should be included in the report.

7. COMMUNICATION OF THE RESULTS TO THE PILOT LAB

Each participating laboratory will submit one printed and signed calibration report for the accelerometer to the pilot laboratory including the following:

- The magnitude (mandatory) and the phase (not mandatory) of the complex voltage sensitivity of the servo accelerometer for at least each mandatory point
- A description of the calibration system used for the comparison and the mounting techniques and configuration of the accelerometer on the exciter plate.
- A description of the calibration method used.
- The position of the shaker (vertical or horizontal)
- A documented record of the ambient conditions during measurements.
- The calibration results including the relative expanded measurement uncertainty and the applied coverage factor.
- A detailed uncertainty budget for the system covering all components of measurement uncertainty calculated according to GUM:1995 and ISO 16063-11 Annex A . Including among other information on the type of uncertainty (A or B), assumed distribution function and repeatability component.

In addition each laboratory will receive one electronic spreadsheet prepared by the pilot laboratory where the calibration results have to be filled in following the structure given in the file. The use of the electronic spreadsheet for reporting is **mandatory**. The consistency between the results in the electronic form and in the printed and signed calibration report is the responsibility of the participating laboratory. The data submitted in the electronic spreadsheet will be taken as the official results submitted for the comparison.
The results have to be submitted to the pilot laboratory within 6 weeks after the measurements.

8. REMARK ON THE POST PROCESSING

Presuming consistency of the results, the comparison reference value and the degrees of equivalence will be calculated according to the established methods as a weighted mean as agreed upon already for CCAUV.V-K1.
In case of damage or loss of the artefact, the comparison will be evaluated as far in the schedule as possible, and any further action concerning continuation will be decided in coordination with the participants.

9. REFERENCES

[1] ISO 16063-1:1998 “Methods for the calibration of vibration and shock transducers – Part 1: Basic concepts”

[2] ISO 16063-11:1999 “Methods for the calibration of vibration and shock transducers – Part 11: Primary vibration calibration by laser interferometry”

[3] ISO/IEC 17025:2005 “General requirements for the competence of testing and calibration laboratories”

[4] ISO/IEC Guide 98-3:2008 “Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)”

[5] ISO/IEC Guide 98-3:2008/Suppl 1:2008 “Propagation of distributions using a Monte Carlo method”

ANNEXE A

Product Data

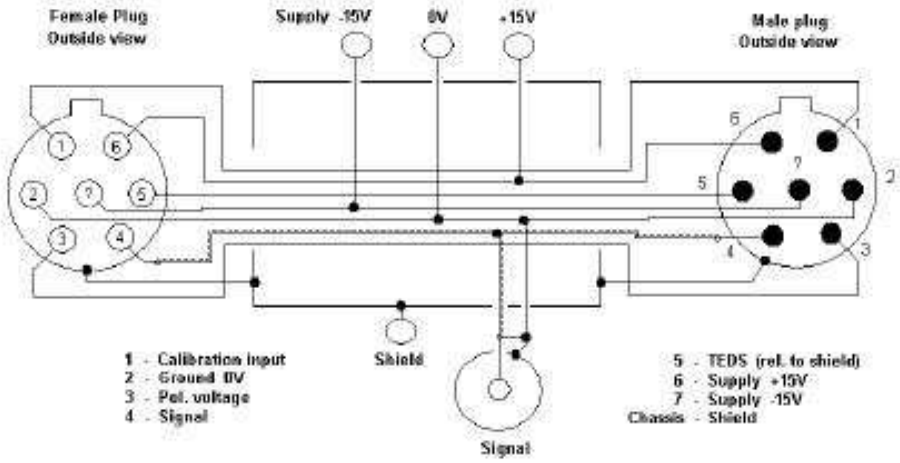
Customised Product

WB-3479 7 pin LEMO Junction Box

Description

The Type WB-3479 7 pin LEMO Junction Box is suitable to insert between a unit fitted with the 7-pin LEMO microphone connector and a PULSE or a NEXUS.
It is then possible to measure directly on the signal and the power supply pins in the LEMO plug or use an external ± 15 V Power supply for calibration of a preamplifier unit alone.

Diagram



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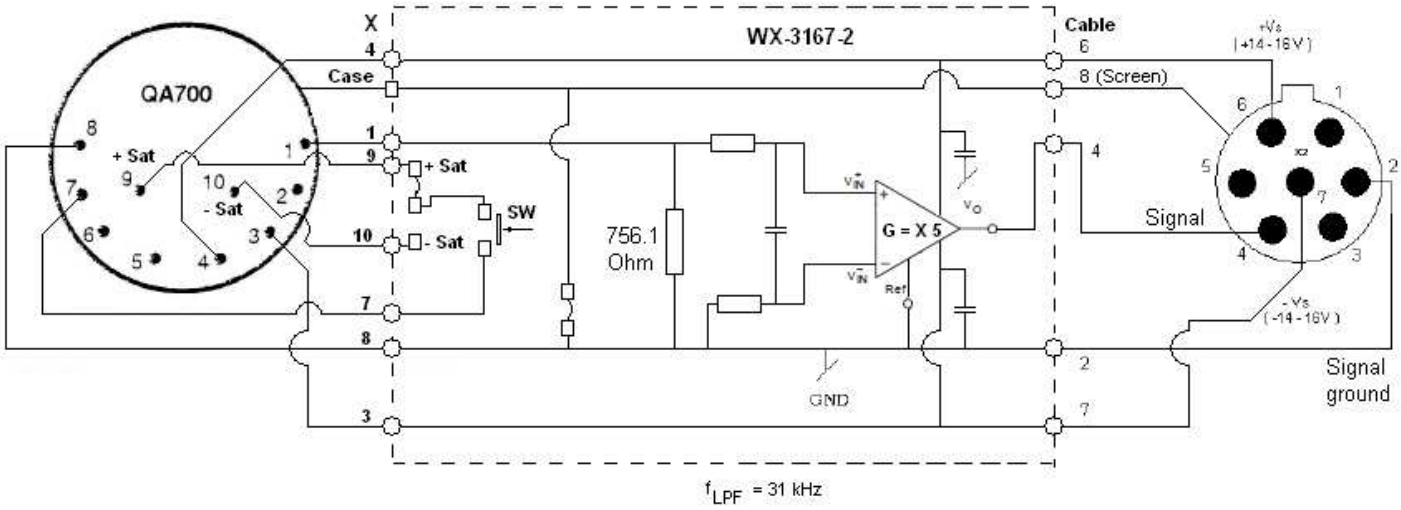
SCHEMA of the QA 700 / WB 3519



PIN FUNCTION **QA700**

1 SIGNAL OUTPUT (SIG OUT)
2 CURRENT SELF-TEST
3 -V SUPPLY INPUT
4 +V SUPPLY INPUT
5 NOT ASSIGNED
6 TEMPERATURE SENSOR (NOT ASSIGNED, QA-T150)
7 VOLTAGE SELF-TEST
8 POWER/SIGNAL RETURN (GND)
9 -REGULATOR OUTPUT (-REG OUT)
10 +REGULATOR OUTPUT (+REG OUT)