Brief report to the 7th CCAUV meeting
Recent research activities in
Acoustics, Ultrasound and Vibration at INMETRO

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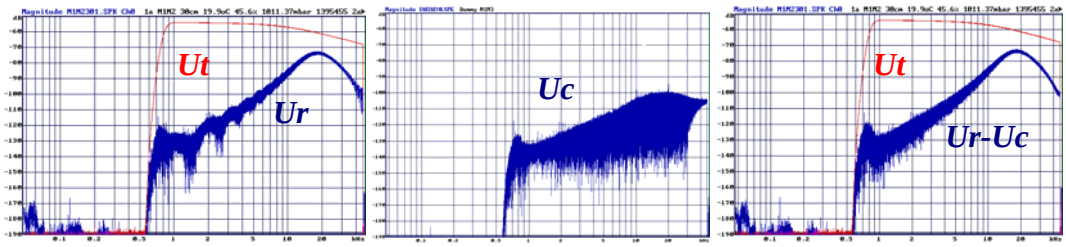
ACOUSTICS

1) Improvements in microphone calibration by reciprocity in free-field

Electrical crosstalk occurs between the transmitter and receiver measuring channels during free-field reciprocity calibrations. Its effect is suppressed by INMETRO using the subtraction technique. A correction file with magnitude and phase information of the crosstalk is obtained through direct measurement of the transfer function of the microphone under calibration in an unpolarized (0 V supply) condition. In the past, a dummy microphone was used, what required additional and time consuming mounting and unmounting steps. The correction file is subtracted from transfer function of the receiver microphone to suppress the effect of electrical crosstalk, which is a major interference component in the results.



(a) (b) (c)

Fig.1 – Subtraction of the crosstalk effect: (a) *Ur* is the transfer function of the receiver microphone with crosstalk; (b) *Uc* is the correction transfer function; (c) *Ur-Uc* is the transfer function of the receiver microphone after correction is applied.

The elimination of crosstalk allows the measurement of the electrical impedance at a single relative distance between transmitter and receiver microphones (e.g. 300 mm). This represents a considerable reduction in calibration time.

The software used to control the measurement was improved and now allows the user to choose from saving registers at nominal, or using base 2 or base 10 system calculated 1/n-octave centre frequencies.

2) Improvements in microphone calibration by reciprocity in pressure field using the impulse response technique

A research project is currently being developed to implement calibrations of magnitude and phase shift of microphones in pressure field, in order to comply with the

requirements of the future comparison CCAUV.A-K5. INMETRO will use for this purpose a two-channel, 24-bit simultaneous sampling measuring system CMF22 and the software MONKEY FOREST. This system has already shown its capability to furnish accurate and reliable results using the impulse response technique and several signal processing tools applied to free field measurements.

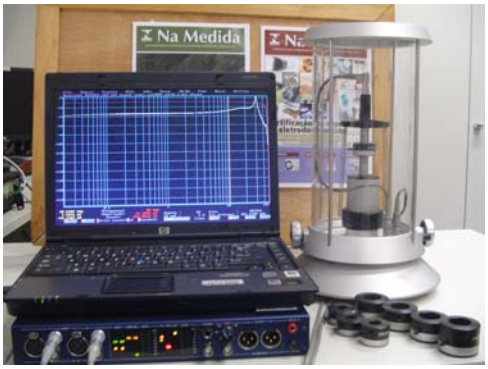


Fig.2 – Setup for reciprocity calibration of microphones in pressure field

Additionally, the same measuring techniques and hardware are being used in several comparison calibrations in pressure field. These calibrations include: sequential and simultaneous comparison in pressure field (IEC 61094-5), calibration of electrostatic actuators (IEC 61094-6) and calibration of ear simulators (IEC 60318-1).

[1] SOARES, Z.M.D.; **"Use of swept sine in calibration services of the acoustical metrology area".** In: Proc. 39th International Congress and Exposition on Noise Control Engineering, Lisboa, Portugal, June 13 – 16, 2010.

3) Improvements in the measurement of sound absorption coefficients

A novel method was developed for measurement of sound absorption coefficients in impedance tubes, with the possibility of its application to in-situ measurements. This technique uses a single microphone at two different positions in an impedance tube. The analysis of impulse responses in the time domain allows windowing and phase shifting for separation and synchronization of the arrival times of the incident and reflected waves to then apply the subtraction technique. The excitation signal used is a band limited swept sine. This technique allows the minimization of bias errors caused by multiple reflections and provides a substantial measurement time reduction.

$$R = \frac{\left(P_2 - P_1 e^{iks}\right)}{\left(P_1 e^{-iks} - P_2\right)} e^{-k2l}$$

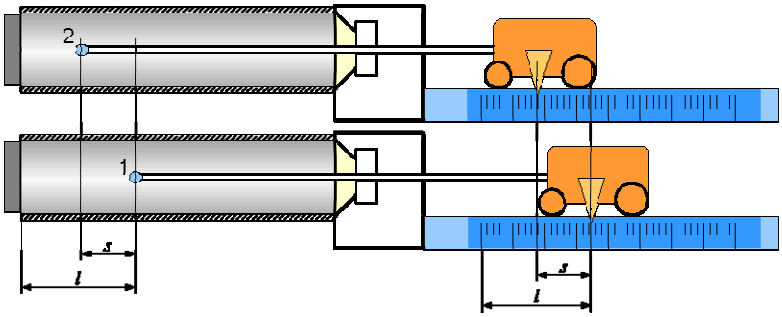


Fig. 3 – Measurement setup for measurement of sound absorption coefficients

[2] MASSARANI, P.M.; "The Two-Microphone Method in the Impulse Response Domain". In: Proc. 39th International Congress and Exposition on Noise Control Engineering, Lisboa, Portugal. June 13 – 16, 2010.

VIBRATION

1) New system for low-frequency calibration of vibration transducers:

A new system has been developed for low-frequency calibrations of vibration transducers. It can be configured for carrying out both comparison or primary interferometric calibration of accelerometers in the frequency range from 0,4 Hz to 160 Hz using a common measuring platform.
This new system complies with the requirements of the standards ISO 16063 parts 11 and 21. For primary calibrations, the fringe counting method is used and expanded uncertainties of 0,35 % are estimated for accelerometers with high sensitivity and low internal noise.

Fig. 4 – Measurement setup for measurement of sound absorption coefficients

[3] RIPPER, G.P., FERREIRA C.D., TEIXEIRA, D.B., DIAS, R.S., MICHELI G.B.; "A new system for primary calibration of vibration transducers at low frequencies". In: Proc. IMEKO 2010 TC3, TC5 and TC22 Conferences, November 22−25, 2010, Pattaya, Chonburi, Thailand.

[4] RIPPER, G.P., TEIXEIRA, D.B., FERREIRA C.D., DIAS, R.S; "A new system for comparison calibration of vibration transducers at low frequencies". In: Proc. IMEKO World Conference 2009, paper: FP_294.pdf, Lisbon, Portugal, September 6-11, 2009.

2) Primary acceleration shock calibration system:

A primary shock calibration system based on a pneumatically driven shock exciter is currently being manufactured. A prototype of a Mach Zender heterodyne interferometer was built and is being tested.

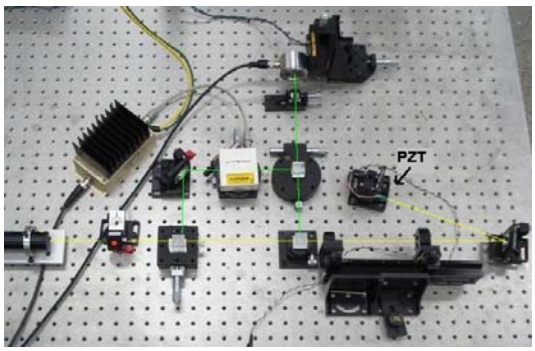


Fig. 5 – Mach Zender heterodyne interferometer

[5] MICHELI, G.B., GARCIA, G.A., RIPPER, G.P.; "Implementation of a primary shock calibration system in Lavib - Inmetro". In: Proc. Simpósio de Metrologia 2010, Querétaro, Mexico, October 27-29, 2010.

In support to this project, technical exchange and an informal comparison in shock was carried out between INMETRO and NMIJ in 2010. Results of shock sensitivities, obtained using the comparison shock calibration system of INMETRO, were compared with primary shock results obtained by NMIJ. This comparison has shown an agreement between the results within the limits of the reported measurement uncertainties.

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20 / September / 2010