Brief report from the INMETRO

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Brief report on recent activities in Acoustics, Ultrasound and Vibration at INMETRO

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ACOUSTICS

1) Microphone calibration by free-field reciprocity

The Electroacoustics Laboratory of INMETRO has participated in the free-field primary microphone interlaboratory key comparison CCAUV.A-K4. The measurements were carried out in January 2008 and the capability to perform reciprocity calibrations in free-field was developed during 2007.

A new small anechoic chamber with a volume of 2.5 m^3 was built and a calibration system was developed to perform calibrations in accordance with the requirements of the standard IEC 61094-3.

The measurement system is based on a two-channel, 24-bit simultaneous sampling measuring system CMF22, which runs under the MONKEY FOREST software. It allows the use of different excitation signals, including sine sweeps with amplitude and group delay adjustments in order to obtain improved signal-to-noise ratios. Several digital signal processing techniques including FFT, IFFT, windowing and filtering can be applied to the acquired data. Disturbing components that usually interfere in the determination of the sensitivity of the microphones in free-field can then be minimized, if not completely suppressed. This includes crosstalk, multiple backscattering and anechoic chamber internal sound reflections.

Crosstalk was suppressed using the subtraction technique. A correction file with magnitude and phase information of the crosstalk is obtained through direct measurement of a dummy microphone with a capacitance similar to the one of the microphone under calibration. This correction file is then subtracted from the receiver microphone output voltage to suppress the effect of electrical crosstalk, which is a major interference component in free field reciprocity measurements.

Multiple backscattering and other sound reflections present in the impulse response of the receiver microphone were suppressed using a time-selective technique. A hybrid time-window function (not symmetrical) formed by the combination of hanning-rectangular-hanning windows was applied for selection of the direct sound.

The measurements of electrical impedance were obtained for four relative distances between response and receiver microphones (170 mm, 200 mm, 240 mm and 300 mm). Measurements were carried out with a frequency resolution of 1.47 Hz and arithmetic mean interpolation was used to obtain the results at the required nominal frequencies.

Figure 1 presents the measuring system used to determine the electrical transfer impedance of the acoustical system.

Figure 1 – Anechoic chamber (2.5 m^3) and the measuring system (Aurélio CMF22 + Monkey Forest software).

VIBRATION

1) <u>Key Comparison CCAUV.V-K1.1:</u>

The vibration laboratory of INMETRO has participated in the interlaboratory comparison CCAUV.V-K1.1, which was coordinated by the PTB and also included NIM and NPLI. The calibrations performed by INMETRO were carried out in August 2007 with its homodyne quadrature interferometric system. The calibrations were performed in compliance with method 3 (sine-approximation method) of the international standard ISO 16063-11:1999. This calibration system employs a special synchronization scheme, which allows the setting of a flexible sampling rate for data acquisition. This flexible sampling rate is matched to each driving frequency and its use eliminates the need of time windows to suppress leakage problems during digital signal processing. Lack of quadrature between the interferometric signals is corrected by a least squares ellipse fit technique and the effect of low-frequency noise is minimized by a digital high-pass moving average filter. Results of magnitude and phase shift of the complex sensitivity were reported by INMETRO for a SE and a BTB accelerometer from 10 Hz up to 20 kHz.

2) <u>Primary acceleration shock calibration system:</u>

A primary mid-amplitude primary shock calibration system is currently under development. A pneumatically driven shock exciter is being built and the system is expected to be operational by the end of 2009.

ULTRASOUND

The Ultrasound Laboratory have implemented the following measurement setups.

1) Hydrophone calibration

a. Secondary calibration method (comparison): This system employs a reference standard, which is traceable to the National Physical Laboratory from 1 MHz to 20 MHz. Typical expanded uncertainties are about 7 %.

b. Absolute calibration method (self-reciprocity): For ultrasonic transducers, Inmetro settled the self-reciprocity calibration method for the frequency range 1 MHz to 3 MHz, with typical expanded uncertainties about 15 %. Future work will be carried out to decrease uncertainties and extend frequency range up to 10 MHz.

2) Power measurement

An ultrasonic power measurement setup comprising a radiation force balance with 2 mW resolution was implemented. This system is capable of performing power measurements from 100 mW to 15 W for the frequency range 0.5 MHz to 20 MHz. Typical expanded uncertainties of about 8% are estimated. Currently, the setup is being improved in order to decrease uncertainty figures.

3) Field mapping

Field mapping of therapeutic ultrasound devices has been implemented in accordance with the requirements of both IEC 61689 1996 and 2007 editions. Effective radiation area is assessed with a typical expanded uncertainty lower than 4%, and non-uniformity ratio lower than 4%, as well.

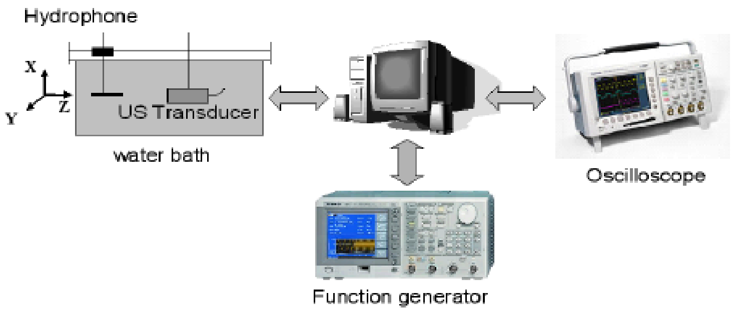

Figure 2 – Ultrasonic pressure field mapping setup

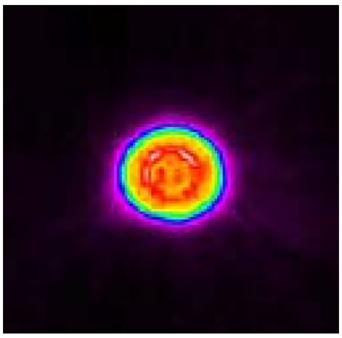

Figure 3 - 1 MHz transducer mapping

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