

Joint Report of Activities from DFM and BKSVDPLA

Joint Report of Activities, November 2015

1. Introduction

The Danish Primary Laboratory of Acoustics (DPLA) is an entity co-operated by Brüel & Kjær S&V A/S (BKSVDPLA) and Danish Fundamental Metrology Ltd. (DFM). DPLA has been nominated as Danish Primary Laboratory in the field of Acoustics in gases and solids by the Danish Safety Technology Authority (Sikkerhedsstyrelsen). In order to comply with the new structure required to participate in EURAMET, DPLA is represented by DFM as the Danish National Metrology Institute, and BKSVDPLA as Designated Institute.

Further cooperation on research in acoustic metrology is maintained between DPLA and the Acoustic Technology group of the Institute of Electrical Engineering, Technical University of Denmark.

DFM and BKSVDPLA are members of Daniamet. This is an umbrella organization that covers and coordinates multiple aspects of the decentralised Danish metrological infrastructure such as: fundamental metrology, legal metrology, and the network of primary and reference laboratories.

Acoustics is one of the four priority subject fields for Danish Metrology. This implies that acoustic Metrology is undergoing a special effort for marketing and dissemination among the Danish acoustical community.

Responsibilities

It is the responsibility of DPLA to maintain and disseminate the basic units in the field of Acoustics in gasses and solids and through research in the field to develop and improve methods for primary as well as secondary calibration. This responsibility is partially undertaken by offering services of microphone and accelerometer calibration at primary and secondary level. DPLA's services are accredited by DANAK (accr. 255 and 277). Secondary calibrations by comparison methods, performance testing and verification of acoustical measuring instruments are also performed by other accredited calibration laboratories in Denmark.

2. Activities in 2014-2015

Calibration activities

The combined annual number of certificates issued to external customers by DFM and BKSVDPLA in 2014-2015 on primary pressure reciprocity calibration of microphones is over 100 and over 85 on laser-calibration of accelerometers. In addition to the calibrations for customers a large number of internal microphone calibrations are performed to maintain the unit of sound pressure and for research and development activities. For this

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purpose DPLA holds a combined number of 19 B&K Type 4160 and 30 B&K Type 4180 microphones, which generally are calibrated each year. DPLAs partners holds four sets of reference accelerometers, including the associated preamplifiers, which are maintained and used as transfer standards. The four sets are calibrated every month.

Research activities

The major research activities on Acoustics in air are related to calibration of microphones by improving the calibration methods, extending the frequency range and the dynamic range of calibrations. New measurement techniques are also investigated, for instance opto-acoustic methods for characterising sound fields.

The activities on Acceleration have mainly been focused on refining the ISO16063-11 method 3 using off the shelf FFT analysers and extending the frequency range. Furthermore an effort has been made to include calibration at DC using the earth's gravitation.

Microphone calibration at DFM

Low-frequency calibration

Calibration of LS1 microphones to frequencies down to 2 Hz has been tested in the past, and DPLA participated in a Key Comparison (CCAUV-A.K2), and pressure calibration in this frequency range became a typical service of DFM. Additionally, calibration of LS2 microphones down to 2 Hz was also implemented. Efforts on testing the calibration of working standard microphones type WS2 have yielded stable and repeatable results, though with an increased uncertainty without major changes to measurement and calculation procedures. This means that WS2 microphones can also be primary calibrated using the reciprocity technique, and a new service offered.

Other lines of research for the validation of low-frequency calibration are also under consideration. These methods include the use of electrostatic actuators, optical measurements of the velocity of the membrane of the diaphragm, and use of acousto-optical methods to reconstruct the sound field within a cavity.

High-Frequency calibration

Following the development and implementation of a system for free-field calibration of working standard microphones up to 150 kHz, investigation of alternative methods for the realisation of the acoustic pascal have been carried out. These methods are based on the estimation of the sound pressure at a point from measurements of the acousto-optic effect and assumptions of wave propagation. Preliminary results show a reasonable agreement with free-field sensitivity obtained by free-field reciprocity.

Optical techniques for sound measurement

Following up the results obtained during a PhD project awarded to DFM for the investigation of the application of the acousto-optic effect in acoustic measurements, research on the application of such methods in realistic cases has been conducted. These situations include visualisation of sound fields close to a dynamic loudspeaker, and the characterisation of impulsive sound sources.

Microphone calibration at BKSVDPLA

Very low frequency calibration

Research continues with the aim of establishing well documented and reliable references at frequencies below 1 Hz. Focus is on extending the frequency range of pressure sensitivity reciprocity calibrations and sustaining the results with other, independent methods. The aim is to refine the method in order to establish a calibration service for very low frequency references. The work is in continuation of the effort to resolve the ambiguities in the international standard governing these measurements (IEC 61094-2). The work is close to a conclusion.

Vibration transducer calibration at BKSVDPLA

Extended frequency range for vibration transducer calibration

ISO16063-11 method 3 has been implemented using quadrature output laser interferometers to cover low frequency vibration transducer calibration down to 0.1 Hz and high frequency calibration up to 100 kHz but limited by the mechanical properties of the exciters and transducers. During 2007 funding has been found to establish such a system at DPLA. This system has now been accredited in the range 10 Hz to 10 kHz and is expected to be extended down to 0.1 Hz dynamically and also at DC using Earth's gravity later this year. Focus has been on getting the systems to operate smoothly and precisely.

International cooperation

The two Institutes of DPLA are active players in the global cooperation in CCAUV and in the regional cooperation within EURAMET. A member of DFM held the Chair of EURAMET's TCAUV until May 2013.

Staff members of DPLA are active members of IEC TC29 and ISO 108/SC3 in which they act as specialists and project leaders for specific standards. A member of BKSVDPLA staff is chairman of ISO 108/SC3.

BKSVDPLA has participated in the Key Comparison CCAUV.A-K5, dealing with calibration of LS1 microphones in both Modulus and Phase at frequencies down to 2 Hz.

DFM is participating in the Regional Supplementary Comparison AFRI-METS.AUV.A-S1 concerned with pressure calibration of LS2 microphones. Additionally, DFM is participating in the regional supplementary comparison EURAMET.AUV.A-S2 concerned with free-field secondary calibration of WS microphones.

BKSV-DPLA has also participated in the Key Comparison CCAUV.V-K2 (10 Hz to 10 kHz) in EURAMET.AUV.V-S1 (0 Hz to 200 Hz) and in CCAUV.V-K3 (0.1 Hz to 40 Hz).