

APPLICATION NOTE

Dynamic Calibration of Pressure Sensors using Brüel & Kjær High Pressure Microphone Calibration System Type 9719

Dynamic sensitivity calibration of pressure sensors using steady sine wave excitation is very rare. Pressure sensors are typically calibrated with static pressure only or, in addition to this, with a single pulse using a dynamic or hydraulic impulse calibrator. Until now no system has been available for dynamic calibration using steady sine excitation.

Experiments have been made using the Brüel&Kjær High Pressure Microphone Calibration System Type 9719 for this purpose. This system was originally designed to measure the dynamic linearity and the harmonic distortion of measurement microphones in the dynamic range of 94 to 171 dB_{RMS} re 20 µPa at a single frequency, 500 Hz. The distortion of the applied pressure is less than 0.5% up to the maximum SPL of 171 dB_{RMS}.



Introduction

Since pressure sensors usually are specified to a maximum pressure in psi or bar and the unit of the sensitivity as mV/psi (mV/bar) or pC/psi (pC/bar) some conversion figures are supplied below:

dB re 20 µPa	Pascal	psi	bar
94	1.00	0.000145	0.00001
124	31.7	0.0046	0.000317
171	7096	1.03	0.07096

According to the figures in the table the system can generate pressure levels up to

1 psi_{RMS} (equal to 1.4 psi_{Peak}) or 0.07 bar_{RMS} (equal to 0.1 bar_{Peak}).

Most pressure sensors have a dynamic range of more than 60 dB and some can exceed 110 dB, depending on type of sensor element and built-in electronics. The system will be able to calibrate the dynamic sensitivity of pressure sensors having

maximum pressure specifications of more than 1000 psi (more than 70 bar) depending on the dynamic range of the pressure sensor.

The system will accept pressure sensors with a diameter up to 23.7 mm. Pressure sensors with smaller diameters can be coupled to the system by using an appropriate acoustic adaptor.

The electrical interface of the system is a voltage input. For pressure sensors having differential output or charge output a differential amplifier or charge to voltage converter can be delivered as part of the system.

Information about the sensor, customer data, the procedures and the results of the calibrations are stored in a database.

Data can be retrieved from the database for further investigation or a calibration report can be printed out. The system uses Word templates for the reports and inserts the result of the calibration where the associated bookmarks are placed in the report template. A standard template is delivered with the system. This can easily be modified by the user to get a customized report.

Results

Table 1

The result of a calibration of a 10 psi pressure sensor is shown.

The sensitivity can be shown as mV/Pa or as mV/psi.

As can be seen in the results table this sensor has been calibrated in level steps of 10 dB from 121 dB to 171 dB.

The procedure can be defined in steps of 1 dB in the range from 94 dB to 171 dB

Calibration Level [dB]	RMS Level Deviation [dB]	Peak + Level Deviation [dB]	Peak – Level Deviation [dB]	Total Harmonic Distortion [%]	Second Harmonic Distortion [%]	Third Harmonic Distortion [%]
121.0	0.00	-	-	<0.1	<0.1	<0.1
131.0	0.00	0.04	-0.01	<0.1	<0.1	<0.1
141.0	0.01	0.02	0.03	<0.1	<0.1	<0.1
150.9	0.03	0.04	0.04	0.12	<0.1	0.10
161.0	0.05	0.06	0.08	0.46	0.27	0.36
170.9	0.01	0.00	0.11	1.13	0.60	0.94

This calibration was performed at 500 Hz

Sensitivity: 0.0130 mV/Pa @ 124 dB – including the gain of the applied conditioner

Phase of electrical output signal relative to applied pressure: ☒ Positive ☐ Negative

Comments

Gain of 2697 conditioner = 20 dB

Fig. 1

RMS sensitivity deviation shown as a function of the excitation level.

The reference level is 124 dB.

If 124 dB is outside the range of the procedure, the procedure step closest to 124 dB will be used as reference level

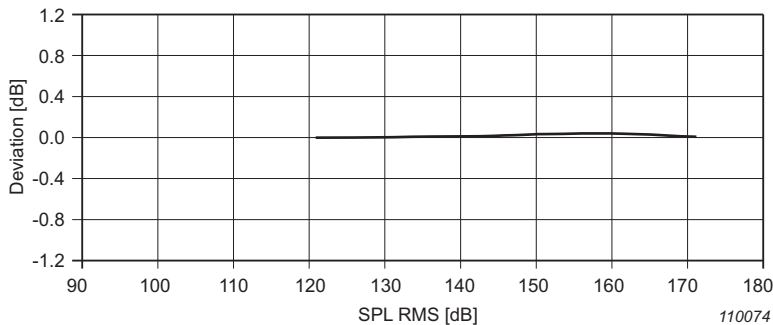


Fig. 2

Peak sensitivity deviation shown as a function of the excitation level.

Both positive peak (solid curve) and negative peak (dotted curve) values are shown

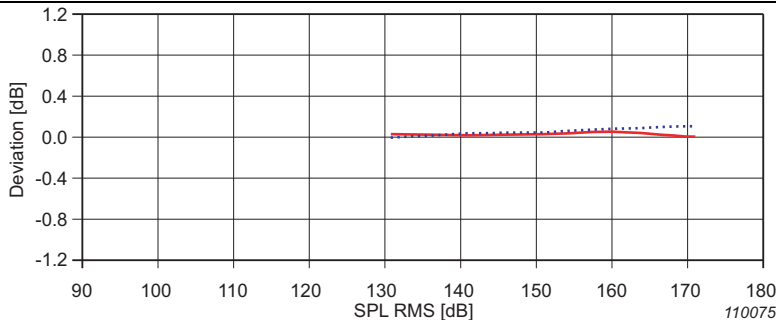


Fig. 3

Harmonic distortion shown as a function of the excitation level.

Total Harmonic Distortion (solid curve), 2nd Harmonic (dotted curve) and 3rd Harmonic (dashed curve) values are shown

