PRODUCT DATA

Sound Intensity Calibrator Type 4297

Sound Intensity Calibrator Type 4297 is used for on-site sound-pressure calibration and pressure-residual intensity-index verification.

Its most important and unique feature is that there is no need to dismantle the sound-intensity probe for calibration.

The calibrator is optimised for use with Sound Intensity System Type 2270-G for phase enhancement, but it can also be used with sound intensity analysis systems based on PULSE™.

Type 4297 is a complete sound-intensity calibrator in one compact, portable unit with built-in sound sources. The acoustic feedback system automatically adjusts for variations in atmospheric pressure and fulfils the IEC 61043 standard.

Uses

- Measurement and verification of pressure-residual intensity index
- Sound-pressure calibration at 251.2 Hz (Type 1 IEC 60942)

Features

- No need to dismantle the probe when calibrating
- Optimised for use with Sound Intensity System Type 2270-G for phase enhancement
- A complete sound-intensity calibrator in one unit
- Built-in sound source for sound-pressure calibrations with acoustic-feedback system to automatically adjust for variations in atmospheric pressure
- Built-in broad-band sound source for pressure-residual intensity-index measurements

Introduction

Sound Intensity Calibrator Type 4297 enables instruments which measure sound intensity to be accurately calibrated. It is intended for use with Brüel & Kjær Sound Intensity Probes Types 3583, 3584, 3595 and 3654 with Sound Intensity Microphone Pair Type 4197 (or earlier Type 4181). The microphones must be used with ¼″ preamplifiers.

The Sound Intensity Calibrator can be used for calibration of sound-pressure sensitivity. To do this, the microphones are both positioned in the calibration chamber. There is no need to dismantle the probe, and both microphones are exposed to exactly the same sound pressure (amplitude and phase). A barometer is not needed because an accurate feedback system holds the sound-pressure level at a constant value.

The broad-band sound source is provided for measurement of the pressure residual-intensity index spectrum. This is used to assess the accuracy of sound-intensity measurements.

A calibration chart is supplied which states the levels that should be detected during calibration.

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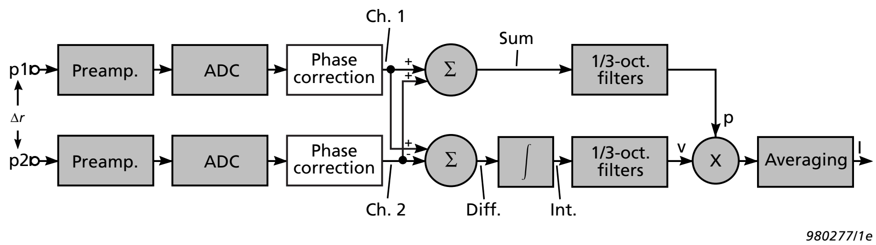
Fig. 1 shows a simplified block diagram of an intensity measuring instrument. The signals from two pressure microphones, *p1* and *p2*, are used to determine the pressure midpoint of the probe axis, *p*, and the particle velocity along the probe axis, *V*. Multiplying *p* and *V* gives the intensity reading, *I*. Δr is the microphone spacing and *r* is the density of the air.

Fig. 1
Simplified block diagram of an intensity measuring instrument



Calibration of an intensity measuring instrument includes:
- sound-pressure calibration of the individual microphone channels
- measurement of the pressure residual-intensity index spectrum of the system

Fig. 2
Type 4297 Sound Intensity Calibrator with a sound-intensity probe in place for calibration

Sound-pressure Calibration
With the probe in the calibrator as shown in Fig. 2, the sound source produces the same sound-pressure level at each microphone. The microphone channels are calibrated against this known sound-pressure level.

Pressure Residual-intensity Index Measurement
Small differences in the phase responses of the microphones and input channels result in the detection of “residual intensity”. Residual intensity is a parameter that should be taken into account when interpreting measured intensity data. The pressure residual-intensity spectrum is not fixed; it is “tied” to, and rises and falls with, the measured sound-pressure level.

Fig. 2 shows an arrangement for measuring the pressure residual-intensity index. The probe is placed in Type 4297. Both microphones are exposed to the same sound pressure and same phase, and therefore any intensity detected is residual intensity.

It can be shown that, for a given measurement system and frequency, the difference between measured sound-pressure level and detected residual-intensity level is a constant. This constant difference is called the pressure residual-intensity index.

The pressure residual-intensity index spectrum can be measured in the frequency range 40 Hz to 3 kHz with the probe used with the spacer by subtracting the detected intensity spectrum from the sound-pressure spectrum; an example is shown in curve A of Fig. 3.

In order to measure the pressure residual-intensity index spectrum in the frequency range 40 Hz to 6.3 kHz, remove the spacer from the probe, replace the probe in the calibrator, maintaining the 12 mm distance between the microphones, and measure again; an example is shown in curve B of Fig. 3.

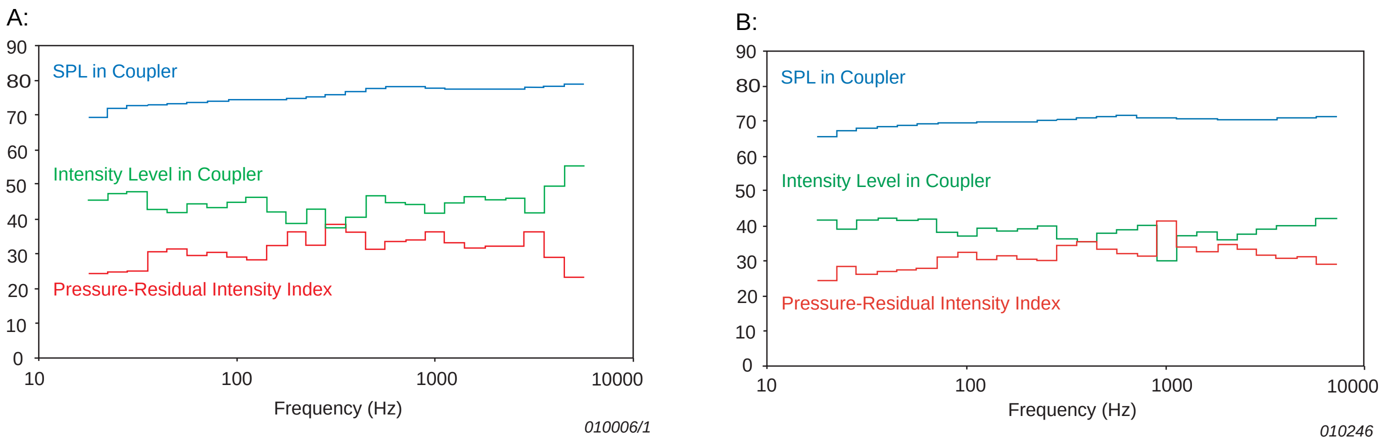
Residual-intensity Level
If a pressure residual-intensity index spectrum is to be used to assess the accuracy of sound-intensity measurements, then the mean sound-pressure spectrum in the field must also be measured. The residual-intensity level is then quickly established by subtracting the pressure residual-intensity index spectrum from the measured, mean sound-pressure spectrum.

The residual intensity level is then compared to the measured sound-intensity level. It can be shown that, for a certain frequency, the residual-intensity level must be at least 7 dB lower to ensure a measurement error of less than 1 dB.

Microphones and Vent Sensitivity
Type 4297 has been designed to work with Microphone Pair Types 4197 and 4181, which have an extremely low sensitivity to sound pressure at the equalisation vents due to their patented acoustical filters. When microphones are inserted into the coupler, their diaphragms are exposed to the sound pressure in the

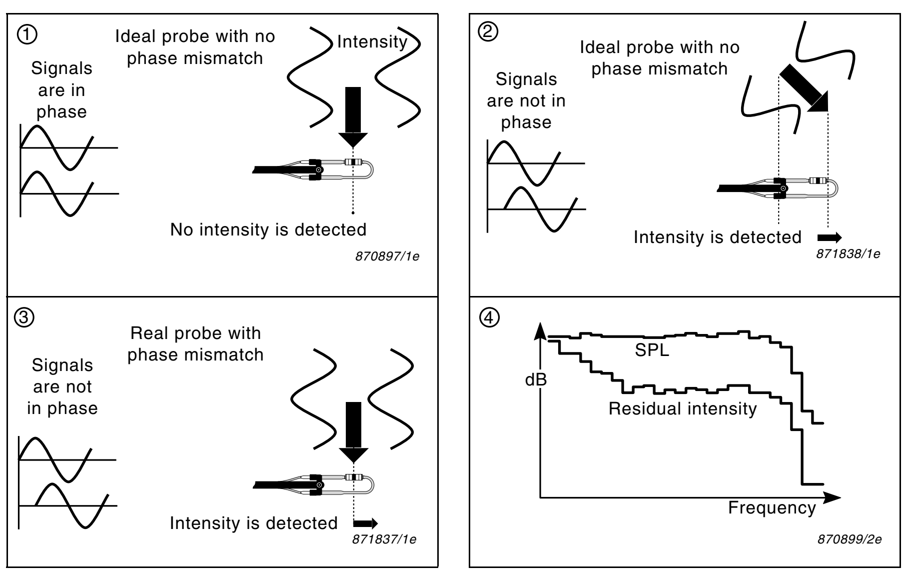
coupler but their pressure-equalisation vents are not. Type 4297 cannot be used to measure the pressure-residual intensity index with conventional microphone pairs as they have vent sensitivities several orders of magnitude higher than that of Type 4197.

Fig. 3
A: *Typical intensity and sound-pressure levels measured with spacers using the arrangement shown in Fig. 2. The pressure residual-intensity index spectrum is characteristic of the measurement system and is obtained by subtracting the intensity spectrum from the pressure spectrum*
B: *Typical intensity and sound-pressure levels measured without spacer. Notice that the Pressure-Residual Intensity Index above 3 kHz has now increased*



Residual Intensity

Even under controlled laboratory conditions, it is very difficult to create a free-field situation where the angle between the propagation of the sound wave and the probe axis is exactly 90 degrees – as shown in the following scenarios. However, for practical applictions, this situation can easily be simulated using the set-up shown in Fig. 2.



1. A sound wave is incident on a probe axis at 90°. There is no flow of acoustic energy along the probe axis. The signals from the microphones are in phase and no intensity is detected.
2. If a sound wave is incident at an angle other than 90°, then acoustic energy flows along the probe axis. The microphone signals are out of phase and intensity is detected.
3. In practice, if a sound wave is incident at 90°, then small differences between the phase responses of the microphones cause a small phase difference between the microphone signals. There now appears to be a flow of acoustic energy along the probe axis.
4. It is this apparent flow of acoustic energy that is detected and called “residual intensity”.

Compliance with Standards

Safety: EN 61010–1 and IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use.
UL 3111–1: Standard for Safety – Electrical measuring and test equipment
EMC Emission: EN/IEC 61000–6–3: Generic standards. Emission for residential, commercial and light-industrial environments
EN/IEC 61000–6–4: Generic standards. Emission for industrial environments
CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits
FCC Rules, Part 15: Complies with the limits for a Class B digital device

EMC Immunity: EN/IEC 61000–6–1: Generic standards. Immunity for residential, commercial and light-industrial environments
EN/IEC 61000–6–4: Generic standards. Immunity for industrial environments
EN/IEC 61326–1: Electrical equipment for measurment, control and laboratory use – EMC requirements
EN/IEC 60942: Sound Calibrators – Amendment 1
Temperature: IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat.
Operating Temp.: – 10 to + 50°C (14 to 122°F)
Storage Temp.: –25 to +70°C (–13 to 158°F)
IEC 60068–2–14: Change of Temp.: – 10 to + 50°C (2 cycles, 1°C/min)
Humidity: IEC 60068–2–78: Damp Heat: 90% RH (non-condensing at 40°C (104°F))

Specifications – Sound Intensity Calibrator Type 4297*

Note: All specifications are for a probe with a spacer unless otherwise stated

POWER SUPPLY
2 × 1.5 V Alkaline Battery, type LR6 (QB-0013)
Lifetime: 8 hours continuous
External DC Power Supply Voltage: Regulated or smoothed 10–14 V, max. 100 mV ripple
Power: 3.5 W
Current: 300 mA
Inrush Current: 1000 mA
Socket: 5.5 mm diameter, 2 mm Pin (Positive)

SIGNAL LEVELS OBTAINED IN INTENSITY CALIBRATOR
Reference conditions according to IEC 60942
Ambient Static Pressure: 101.3 kPa
Ambient Temperature: 23°C
Relative Humidity: 50%

INDIVIDUAL CALIBRATION ACCURACY
Sound Pressure Level for Sine Output 251.2 Hz ± 0.1%at Reference Conditions: 94 ± 0.08 dB re 20 µPa
Nominal Sound Pressure Level: 94 ± 0.2 dB re 20 µPa
Stabilisation Time: 5 s
Temperature Coefficient: < ± 0.002 dB/°C
Humidity Coefficient: Negligible
Total Harmonic Distortion: <2%

SOUND PRESSURE LEVELS MEASURED WITH SPACER
(Pink noise: all levels measured in 1/3-octaves):
251.2 Hz: 75 dB ± 2.0 dB SPL
20 Hz to 3.15 kHz: ± 3.0 dB re level at 251.2 Hz
Linear: Typical 89 dB
Fulfils IEC 60942, 1997 Class 1

SOUND PRESSURE LEVEL MEASURED WITHOUT SPACER
20 Hz to 6.3 kHz: ± 3 dB re level at 251.2 Hz

PRESSURE-RESIDUAL INTENSITY INDEX OF SOUND FIELD
(Pink noise: all levels measured in 1/3-octaves):
Measured with 12 mm Spacer: >24 dB from 40 Hz to 3 kHz
Fulfils IEC 61043, 1993 Class 1
Measured without Spacer: >24 dB from 40 Hz to 6.3 kHz

DIMENSIONS AND WEIGHT (CASE)
Height: 6 cm (2.4″)
Width: 5.5 cm (2.17″)
Depth: 17 cm (6.7″)
Weight: 730 g (1 lb. 10 oz.)

ELECTRICAL SPECIFICATIONS
AC Input Sensitivity: 15.4 Pa/V with spacer
Max Input Voltage: 70 mV RMS
Input Impedance: >18 kΩ (f <10 kHz)

Ordering Information

Type 4297 Sound Intensity Calibrator
Includes the following accessories:
- 2 × QB-0013: 1.5V Alkaline Battery, type LR6
- BC-0276: Calibration Chart
- KE-1003: Etui
- DH-0732: Wrist Strap

OPTIONAL ACCESSORIES

AO-0440	BNC to LEMO Cable
ZG-0386	EU Power Supply
ZG-0387	UK Power Supply
ZG-0388	US Power Supply
DH-0713	Harness
4297-CAI	Accredited Initial Calibration
4297-CAF	Accredited Calibration
4297-TCF	Conformance Test of Type 4297 with Certification

* All values are typical at 23° C, unless measurement uncertainty or tolerance field is specified. All uncertainty values are specified at 2σ (that is expanded uncertainty using a coverage factor of 2).

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