

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 the 2260 E Investigator™ sound intensity system 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 Type 2260 E Investigator sound-intensity system 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.

Type 4297 is intended for use with Brüel & Kjær Sound Intensity Probes Types 3583, 3584 and 3595 (or earlier Types 3545 or 3548) 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).

Fig. 1
 Type 4297 Sound Intensity Calibrator with a sound-intensity probe in place for calibration



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.

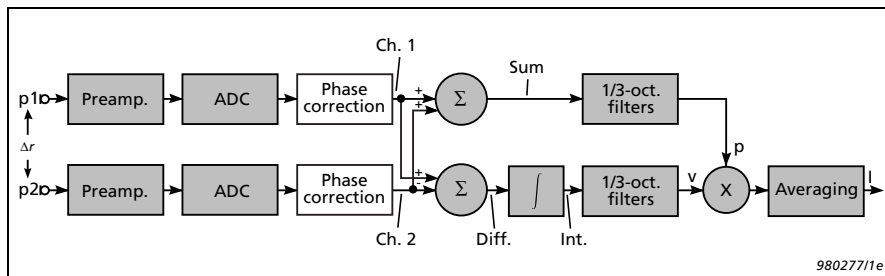
A barometer is not needed because an accurate feedback system holds the sound-pressure level at a constant value.

Calibration Procedure

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 Simplified block diagram of an intensity measuring instrument. The signals from two pressure microphones, p_1 and p_2 , 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 ρ is the density of the air



Sound-pressure Calibration

With the probe in the calibrator as shown in Fig. 1, 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. 1 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 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 Fig. 4.

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.

Fig. 3
Typical intensity and sound-pressure levels measured with spacers using the arrangement shown in Fig. 1. The pressure residual-intensity index spectrum is characteristic of the measurement system and is obtained by subtracting the intensity spectrum from the pressure spectrum

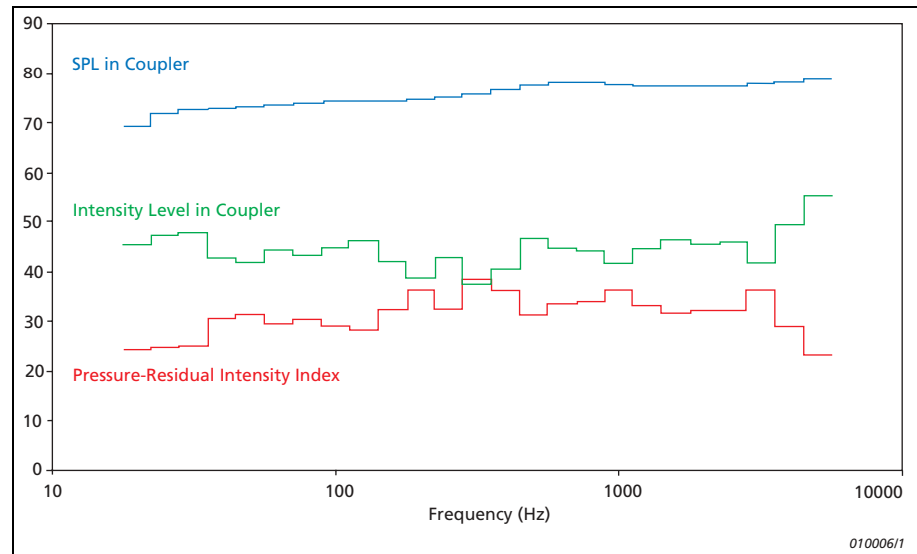
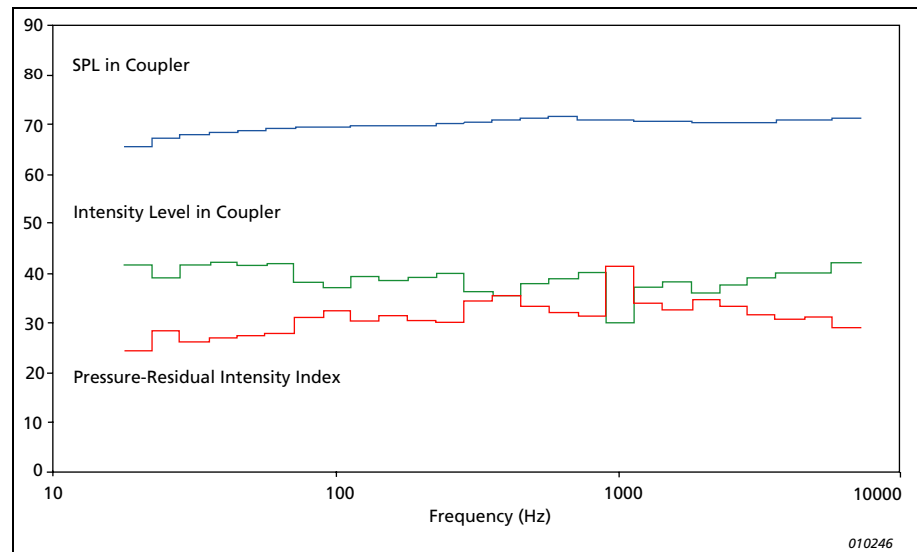


Fig. 4
Typical intensity and sound-pressure levels measured without spacer. Notice that the Pressure-Residual Intensity Index above 3 kHz has now increased



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.

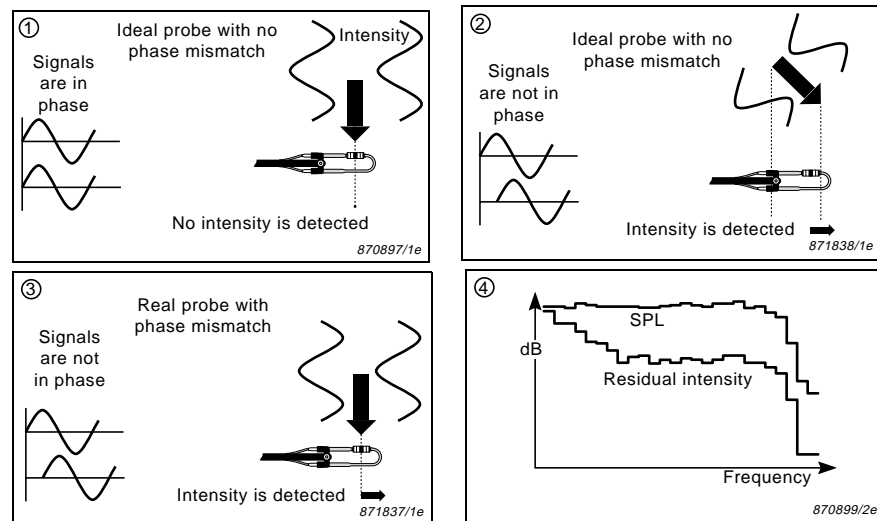
Microphones and Vent Sensitivity

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.

Residual Intensity


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.

Fig. 5
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 ① and ③). However, for practical applications, this situation can easily be simulated using the set-up shown in Fig. 1



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

	<p>CE-mark indicates compliance with: EMC Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand</p>
<p>Safety</p>	<p>EN 61010-1 and IEC 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use. UL3111-1: Standard for Safety – Electrical measuring and test equipment</p>
<p>EMC Emission</p>	<p>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</p>
<p>EMC Immunity</p>	<p>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 measurement, control and laboratory use – EMC requirements EN/IEC 60942: Sound Calibrators – Amendment 1</p>
<p>Temperature</p>	<p>IEC 60068-2-1 & IEC 60068-2-2: Environmental Testing. Cold and Dry Heat. Operating Temperature: -10 to +50°C (14 to 122°F) Storage Temperature: -25 to +70°C (-13 to 158°F) IEC 60068-2-14: Change of Temperature: -10 to +50°C (2 cycles, 1°C/min.)</p>
<p>Humidity</p>	<p>IEC 60068-2-78: Damp Heat: 90% RH (non-condensing at 40°C (104°F))</p>

Specifications – Sound Intensity Calibrator Type 4297

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

POWER SUPPLY

2 × 1.5V Alkaline Battery, type LR6 (QB 0013)

Lifetime: 8 hours continuous

External DC Power Supply Voltage: Regulated or smoothed 10–14V, max. 100mV ripple

Power: 3.5W

Current: 300mA

Inrush Current: 1000mA

Socket: 5.5mm diameter, 2mm Pin (Positive)

SIGNAL LEVELS OBTAINED IN INTENSITY CALIBRATOR

Reference conditions according to IEC 60942

Ambient Static Pressure: 101.3kPa

Ambient Temperature: 23°C

Relative Humidity: 50%

INDIVIDUAL CALIBRATION ACCURACY

Sound Pressure Level for Sine Output 251.2Hz ±0.1%

At Reference Conditions

94 ± 0.08dB re 20mPa

NOMINAL SOUND PRESSURE LEVEL

94 ± 0.2dB re 20mPa

Stabilisation Time: 5s

Temperature Coefficient: < ±0.002dB/°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: 75dB ±2.0dB SPL

20 Hz to 3.15 kHz: ±3.0dB re level at 251.2Hz

Linear: 94dB ±3dB

Fulfils IEC 60942, 1997 Class 1

SOUND PRESSURE LEVEL MEASURED WITHOUT SPACER

20 Hz to 6.3 kHz: ±3dB re level at 251.2Hz

PRESSURE-RESIDUAL INTENSITY INDEX OF SOUND FIELD

(Pink noise: all levels measured in 1/3-octaves):

Measured with 12 mm spacer: >24dB from 40Hz to 3kHz

Fulfils IEC 61043, 1993 Class 1

Measured without spacer: >24dB from 40Hz to 6.3kHz

DIMENSIONS AND WEIGHT (CASE)

Height: 6 cm (2.4")

Width: 5.5 cm (2.17")

Depth: 17 cm (6.7")

Weight: 730g (1 lb. 10 oz.)

ELECTRICAL SPECIFICATIONS

AC Input Sensitivity: 15.4Pa/V with spacer

Max Input Voltage: 70mV RMS

Input Impedance: >18kΩ (f <10kHz)

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

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

AO0440 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
Pressure-Residual Intensity Index Verification of
Types 2260, 3595 and 4297

4297 CAF Accredited Calibration
Pressure-Residual Intensity Index Verification of
Types 2260, 3595 and 4297

4297 TCF Conformance Test of Type 4297

TRADEMARKS

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Brüel & Kjær reserves the right to change specifications and accessories without notice.

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