Product Data

Ear Simulator for Telephonometry — Type 4185

USES:

- ❍ Measurements on telephone handsets
- ❍ Earphone calibration

FEATURES:

- ❍ Performance according to ITU–T P.57 Type 1 recommendation and the IEC 318 standard
- ❍ Fits Telephone Test Head Type 4602 B
- ❍ Incorporates a miniature sound source for automatic seal check
- ❍ Includes $^1/_2$″ microphone and microphone preamplifier
- ❍ Soft Seal included
- ❍ Supplied with individual calibration data according to ITU–T P.57

Ear Simulator for Telephonometry Type 4185 is designed for telephone measurements requiring an IEC 318 coupler. Type 4185 converts the acoustic signal from an earphone into an electrical equivalent which takes into account the response of the human ear. It enables electroacoustic measurements on telephone handsets to be carried out under well-defined acoustical conditions. Type 4185 fulfils all relevant ITU–T, IEEE and BS recommendations.

Ear Simulator for Telephonometry Type 4185 consists of an acoustic coupler with built-in miniature sound source for seal checking, a microphone and a preamplifier. It fits directly into the Telephone Test Head Type 4602 B and can be used with a wide range of Brüel & Kjær telephone test systems.

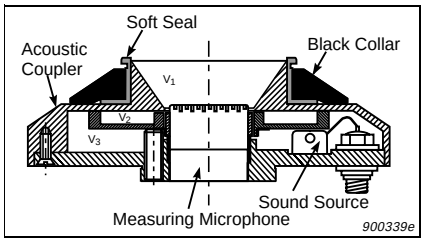
Brüel & Kjær

Description

Fig. 1 Type 4185 fully assembled

Ear Simulator for Telephonometry Type 4185 fulfils the requirements of the ITU–T P.57 Type 1 recommendation and the IEC 318 standard. Type 4185 simulates the acoustical impedance of the average human ear (under sealed conditions).

Fig. 2 Sectional view of the acoustic coupler used in the 4185



Acoustic Coupler UA 1110 (Fig. 2) contains three volumes (V_1 = 2.5 cm^3, V_2 = 1.8 cm^3 and V_3 = 7.5 cm^3) acoustically connected in parallel by means of a narrow annular slit and four parallel holes. The acoustic resistances and inductances of the slit and parallel holes are given in the section “Equivalent Diagrams”.

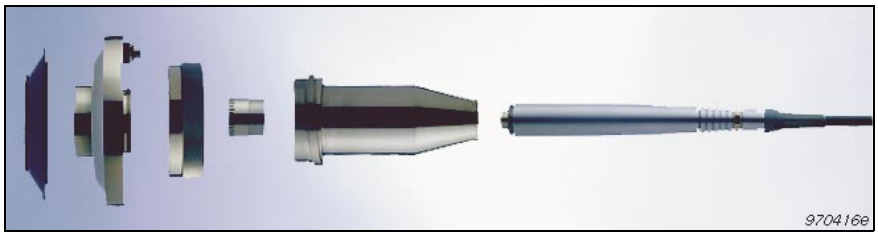
Type 4185 is an IEC 318 coupler for measurements on high impedance earphones requiring sealed conditions.

The seal between the 4185 and the handset must be completely tight. The quality of the seal can be verified by using the miniature sound source located inside the Acoustic Coupler UA 1110. This sound source is a small transducer which can be excited with an external signal to produce a sound pressure inside the main cavity. If the seal between the coupler and handset is poor, the sound pressure measured by the microphone will be considerably lower at low frequencies than if the seal is tight.

Each Type 4185 ear simulator is supplied with individually measured calibration data, as specified in the ITU–T P.57 recommendation. All relevant calibration data are stated on the calibration chart and is also available on the enclosed calibration data disk. The data is stored both in a text file format (ASCII-format) suitable for import to a common spreadsheet and in the binary data format of Brüel & Kjær Audio Analyzer Type 2012.

Assembly

Fig. 3 Left to right: Black Collar with Soft Seal, Acoustic Coupler, Ring for Acoustic Coupler, $^1/_2$″ Microphone Type 4134, Adaptor Sleeve and Microphone Preamplifier Type 2669



The Ring for Acoustic Coupler DB 1160 is supplied already screwed to the Acoustic Coupler UA 1110. Black Collar YJ 0430 and a Soft Seal YJ 0431 are also connected to the coupler. Microphone Preamplifier

Type 2669 is inserted into Adaptor Sleeve DB 1164 at the opposite end to the coarse thread and Microphone Type 4134 screwed onto the preamplifier body so that the adaptor face is clamped between the microphone and the preamplifier (see Fig. 3). This complete assembly can then be screwed onto the acoustic coupler using the coarse thread in its Adaptor DB 1160.

Calibration

During manufacture at Brüel & Kjær the ear simulator is calibrated according to the ITU–T P.57 recommendation. The acoustic impedance and the frequency sensitivity response are individually measured, both as a function of frequency.

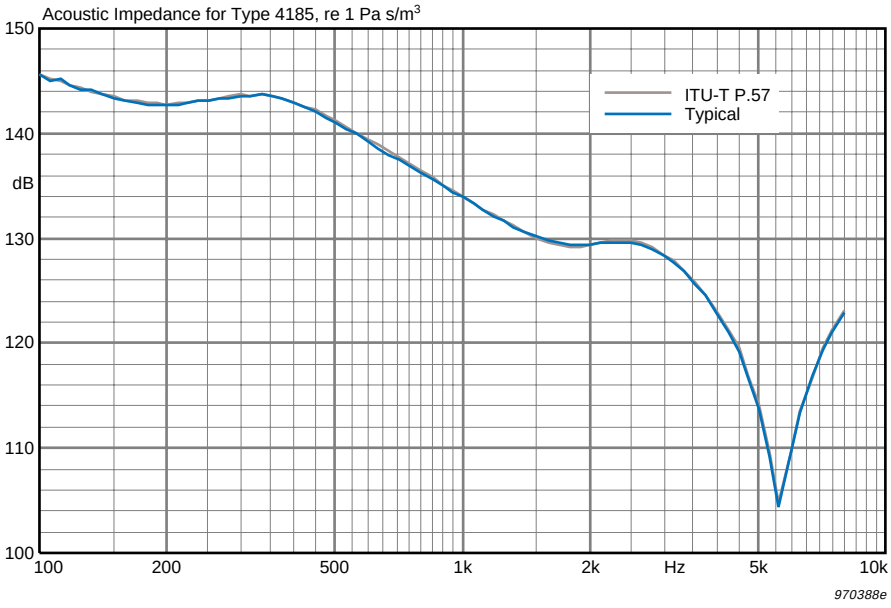


Fig. 4 Typical acoustic impedance for ear simulator Type 4185 and the standardized ITU–T P.57 Type 1 curve to which Type 4185 complies

Acoustic Impedance

The acoustic impedance is defined as the acoustic input impedance of the ear simulator, seen from the Ear Reference Point. It is measured using a specially designed impedance probe containing a built-in high acoustic impedance sound source and a calibrated probe microphone. When the impedance probe is mounted on the ear simulator, the tip of the probe microphone will be positioned exactly at the ERP. By measuring the sound pressure at the ERP from the high acoustic impedance sound source, the acoustic input impedance of the ear simulator can be calculated. The impedance is displayed in dB relative to 1 acoustic ohm. See Fig. 4.

Frequency Sensitivity Response

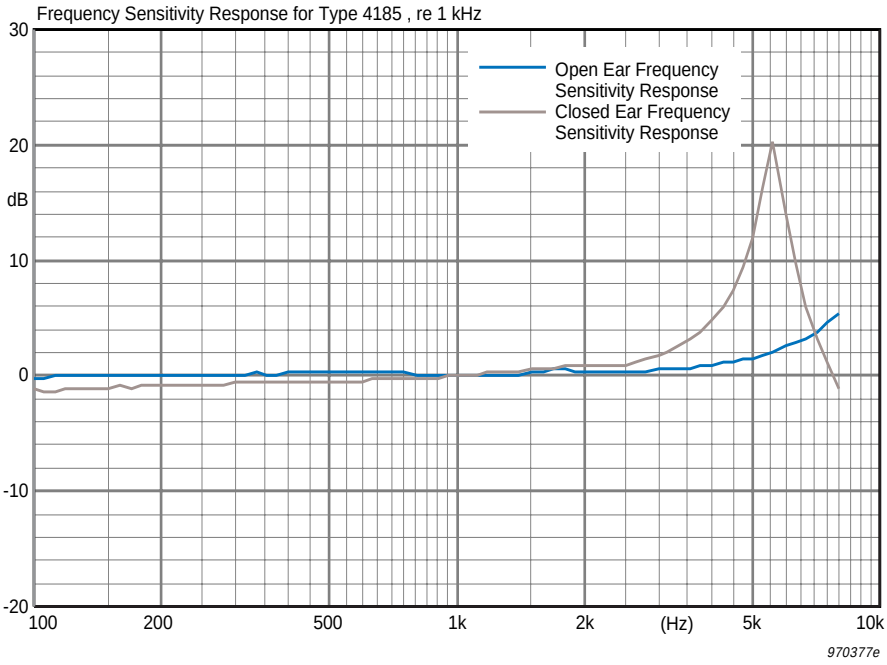
The frequency sensitivity response is defined as the modulus of the ratio of output voltage of the ear simulator to input sound pressure at the ERP. The frequency sensitivity response, which is also referred to as the DRP to the ERP transfer function, is normalized to 0 dB at 1 kHz. The response is measured under “open ear conditions” by mounting the artificial ear in a large plane baffle exposing it to a plane incident wave perpendicular to the baffle. The sound pressure at the

ERP is then measured using a calibrated probe microphone together with the output voltage of the ear simulator, both as a function of frequency. The frequency sensitivity response can then be calculated as the ratio of the measured output voltage of the ear simulator to the measured input sound pressure at the ERP. For practical reasons the frequency sensitivity response also is measured under “closed ear conditions”. The frequency sensitivity response is used as a correction function. Normally the open ear response is used. The closed ear frequency sensitivity response is only used for diagnostic purposes, for example, to interpret differences between measurements made on a handset with Type 4195 with measurements made with other ear simulators.

Using the open ear frequency sensitivity response as a correction function, measurements made on any telephone handset are (by division with the frequency sensitivity response) referred to the equivalent sound pressure at ERP required to calculate loudness rating or to check results against specifications, based on measurements referred to ERP. The Ear Reference Point is the reference point for telephone measurements in most telephone standards.

However, for the Type 4185, the frequency sensitivity response under open ear conditions is practically independent of frequency up to 3 kHz and the correction is less than 1 dB up to 4 kHz. See Fig. 5. Hence, the frequency dependency is often ignored for the Type 4185, i.e., the ear simulator is considered as measuring at the ERP and the measurements can be used directly without need for further correction.

Fig. 5 Open and closed ear frequency sensitivity responses for the ear simulator



Absolute Sensitivity

The absolute sensitivity at 1 kHz in [V/Pa] is defined as the modulus of the ratio of the absolute output voltage of the ear simulator to input sound pressure at the ERP. The absolute sensitivity is specified on the calibration chart for both open and closed ear conditions. The sensitivities can be verified using Sound Level Calibrator Type 4231.

Normally the calibration level, P_{4231} produced by Type 4231 mounted on a $^1/_2$″ microphone is 94 dB SPL. But if an extra volume is added, caused for instance by the presence of a coupler unit, the sound pressure produced by the calibrator will be affected.

Also, the required measurement conditions influence the calibration. When using the calibrator, the ear simulator is exposed to closed ear conditions. Therefore, when calibrating, it is the sensitivity according to closed ear conditions that is measured. As it is the open ear sensitivity that is of interest, the calibration data must be transformed to refer to this situation.

The required sensitivities can therefore be found if the calibration level of the sound level calibrator is corrected. The calibration level must be corrected by a factor $P_{\Delta V}$ caused by any added volume and, furthermore, to obtain the open ear sensitivity by a factor $P_{\Delta(\text{open-closed})}$ to take into account the change in sensitivity when going from closed ear to open ear conditions.

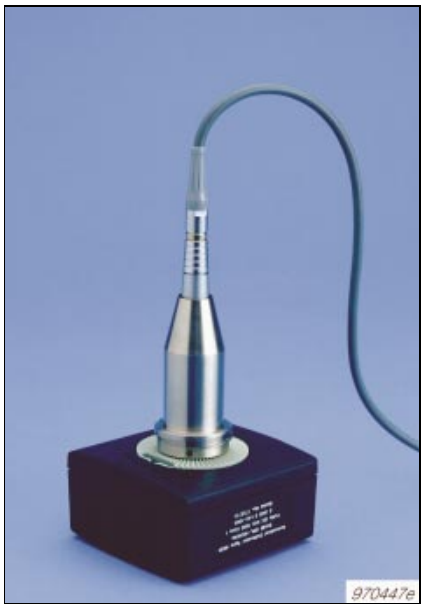
The corrected calibration level to obtain the open ear sensitivity is then given by:

$$P_{4231,\,\text{corrected}}(\text{open ear}) = P_{4231} + P_{\Delta V} + P_{\Delta(\text{open}-\text{closed})}$$

and the corrected level to obtain the closed ear sensitivity by:

$$P_{4232,\ \text{corrected}}(\text{closed ear}) = P_{4231} + P_{\Delta V}$$

Fig. 6 Sensitivity calibration at 1 kHz using Sound Level Calibrator Type 4231



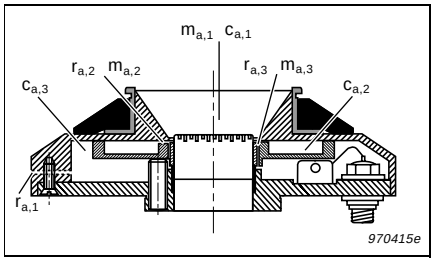
Note that the microphone and preamplifier can be calibrated as an assembly without removing the Adaptor Sleeve, see Fig. 6. By using the corrected calibration levels as given in Table 1 the open or closed ear sensitiviy of the complete ear simulator is obtained.

Table 1 Corrected calibration levels for Sound Level Calibrator Type 4231

	$P_{4231,\,\text{corrected}}$(open ear)	$P_{4231,\,\text{corrected}}$(closed ear)
Type 4185	93.8 dB	(93.3 dB)

Equivalent Diagrams

Fig. 7 Cross-section of Acoustic Coupler UA 1110. The electrical component names refer to the electrical equivalent diagram below



An electrical equivalent diagram can be set up based on the mechanical properties of the ear simulator. This concept makes it possible to perform computer simulations to show the effect of the acoustic loading presented by the ear simulator. The cross-section in Fig. 7 shows the physical construction of Acoustic Coupler UA 1110 and the associated electrical component names.

Fig. 8 shows the equivalent diagram and associated component values for the ear simulator.

Fig. 8 Electrical equivalent diagram of Ear Simulator Type 4185 using an impedance type analogy. The circuit is seen from the acoustical side with associated component values in acoustic units

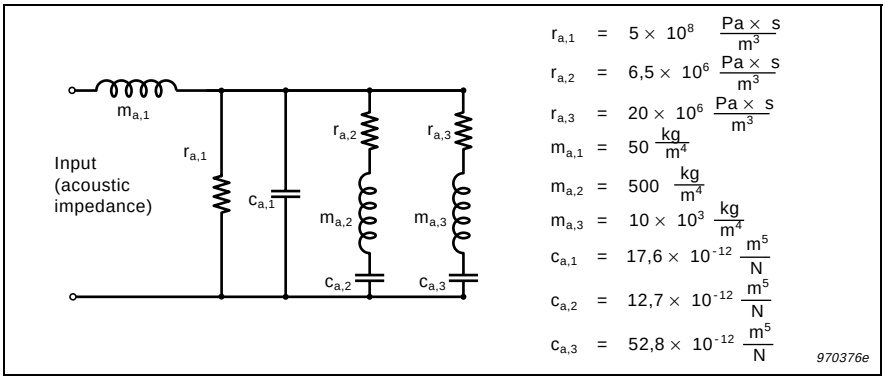


Fig. 9 Simulated acoustic impedance for Type 4185 compared to a typical measured impedance curve

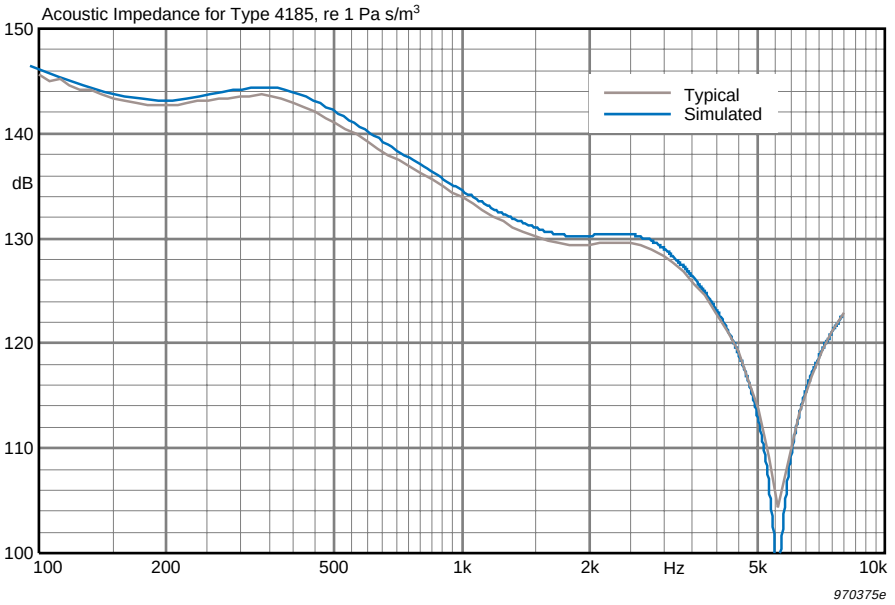


Fig. 9 shows the simulated acoustic impedance based on the electrical equivalent diagram. Although the equivalent diagram is based on the mechanical properties of the ear simulator, it constitutes a compromise between complexity (good simulation of reality) and simplicity (poorer simulation of reality). As a consequence, some of the component values

have been adapted to give the best simulation of the acoustic impedance. In the frequency range from 100 Hz to 4 kHz, the deviation of the simulated curve compared to the typical measured curve is less than 1 dB.

Compliance with Standards

CE	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
Safety	EN 61010–1 and IEC 1010–1: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN 50081–1: Generic emission standard. Part 1: Residential, commercial and light industry. 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 50082–1: Generic immunity standard. Part 1: Residential, commercial and light industry. **Note 1:** The above is guaranteed using accessories listed in this Product Data sheet only.
Temperature	IEC 68–2–1 & IEC 68–2–2: Environmental Testing. Cold and Dry Heat. Operating Temperature: 5 to 40°C (41 to 104°F) Storage Temperature: –25 to +70°C (–13 to 158°F)
Humidity	IEC 68–2–3: Damp Heat: 90% RH (non-condensing at 40°C (104°F))
Mechanical	Non-operating: IEC 68–2–6: Vibration: 0.3 mm, 20 m/s^2, 10–500 Hz IEC 68–2–27: Shock: 1000 m/s^2 IEC 68–2–29: Bump: 1000 bumps at 250 m/s^2

Specifications 4185

General

STANDARDS:
Acoustic performance according to ITU–T P.57 sec. 4.1 Type 1 recommendation and IEC 318

FREQUENCY RANGE:
100 Hz to 4 kHz

DIMENSIONS (of coupler and preamplifier):
Height: 103 mm (4.06″)
Max. diameter: 60 mm (2.6″)

WEIGHT (of coupler):
332 g (11.7 oz)

Miniature Sound Source:

Typical Sensitivity: –7 dB re 1 Pa/V (at 250 Hz, with flat surface termination)
Min. Sensitivity: –11 dB re 1 Pa/V (at 250 Hz)
Max. input Voltage: 10 V
Electrical Impedance: Approx. 1.6 kΩ
Recommended Frequency Range: 100 to 400 Hz

Environmental Calibration Conditions

Static Pressure: 101.3 ±3.0 kPa
Temperature: 23 ±3°C (73,4 ±5,4°F)
Relative Humidity: 60 ±20%

Ordering Information

Type 4185 Ear Simulator for Telephonometry

Includes the following accessories:
Type 4134: 1/2″ Condenser Microphone
Type 2669: 1/2″ Microphone Preamplifier
UA 1110: Acoustic Coupler (with built-in miniature sound source)
DB 1160: Ring for Acoustic Coupler
DB 1164: Adaptor Sleeve for Acoustic Coupler
YJ 0430: Black Collar for Acoustic Coupler
5 x YJ 0431: Soft Seal
AO 0419: Microphone Cable, 3 m (10 ft) LEMO to LEMO
AO 0122: Reinforced Accelerometer Cable
JP 0145: BNC Input Adaptor
ZG 0350: LEMO to 7-pin Brüel & Kjær adaptor
Calibration Chart
Calibration Data Disk

Optional Accessories

Type 4231: Sound Level Calibrator

Services Available

4185–CFF: Factory Standard Calibration

Brüel & Kjær

WORLD HEADQUARTERS:
DK-2850 Nærum · Denmark · Telephone: +45 45 80 05 00 · Fax: +45 45 80 14 05 · Internet: http://www.bk.dk · e-mail: info@bk.dk
Australia (02) 9450-2066 · Austria 00 43-1-865 74 00 · Belgium 016/44 92 25 · Brazil (011) 246-8166 · Canada: (514) 695-8225 · China 10 68419 625 / 10 6843 7426
Czech Republic 02-67 021100 · Finland (0)9-229 3021 · France (01) 69 90 69 00 · Germany 06103/908-5 · Hong Kong 2548 7486 · Hungary (1) 215 83 05
Italy (02) 57 60 4141 · Japan 03-3779-8671 · Republic of Korea (02) 3473-0605 · Nederland (0)30 6039994 · Norway 66 90 4410 · Poland (0-22) 40 93 92
Portugal (1) 471 14 53 Singapore (65) 275-8816 · Slovak Republic 07 378 9520 · Spain (91) 368 10 00 · Sweden (08) 711 27 30 · Switzerland 01/940 09 09
Taiwan (02) 713 9303 · United Kingdom and Ireland (0181) 954-2366 · USA 1 800 332 2040
Local representatives and service organisations worldwide

BP 0974 – 14

97/10