Product Data

Wideband Ear Simulator for Telephonometry — Type 4195

USES:

- ❍ Development and conformance testing of all types of telephone handsets using Telephone Test Head Type 4602 B
- ❍ Realistic measurement of telephone receive response

FEATURES:

- ❍ Design based on ITU – T Rec. P.57, Type 3.2 low-leak and high-leak simplified pinna simulators
- ❍ Includes IEC 711 coupler with $^1/_2$″ microphone and preamplifier
- ❍ Individual calibration according to ITU – T P.57. Supplied with acoustic impedance and frequency sensitivity response measurements

Wideband Ear Simulator for Telephonometry Type 4195 is designed for realistic telephone receive response measurements. The design is based on the specifications in the standard ITU – T Recommendation P.57, Artificial Ear Type 3.2 low- and high-leak.

The two grades of well-defined leakage make it possible to simulate the average real ear loss for telephone handsets which are held either comfortably tight (low-leak pinna) or loosely (high-leak pinna) against the human ear.

The ear simulator is recommended for measurements on supra-aural and supra-concha earphones, both sealed and unsealed, practically covering all kinds of earphone design. The ear simulator can be used for wideband telephonometry in the frequency range 100 Hz to 8 kHz.

Type 4195 has been developed for use in combination with Brüel & Kjær Telephone Test Head Type 4602 B and Mouth Simulator Type 4227.

Description

Fig. 1 Type 4195 fully assembled

Brüel & Kjær Wideband Ear Simulator for Telephonometry Type 4195 supplements the current Ear Simulator for Telephonometry Type 4185, which conforms to the IEC 318 standard.

Type 4195 offers improved performance, both in the low and the high ends of the frequency range (up to 8.0 kHz), making it suitable for measurement on wideband telephones. This performance is obtained using a Simplified Pinna Simulator, which adds an ear canal extension and a cavity to the IEC 711 Coupler. The cavity has a carefully controlled leakage (opening that can be selected in two grades) to the exterior.

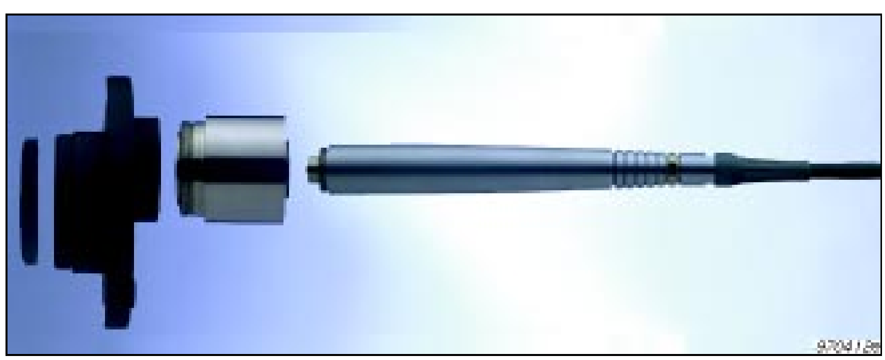
This design has been adopted as an option to the European CTR8 Standard for ISDN handset telephones, and is being proposed for the new wideband applications within ETSI and ITU – T.

The ear simulator is equipped with Soft Seal (YJ 0892) to ensure a good seal between the coupler and handset surfaces, and to protect the latter from being scratched when mounting the handset for testing.

All relevant calibration data are stated on the supplied calibration chart, and are also available on the enclosed calibration data disk. The data are 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. 2 Left to right: Soft Seal, Simplified Pinna Simulator (low- or high-leak pinna, DB 3429 and DB 3598 respectively), IEC 711 Coupler and Microphone Preamplifier Type 2669



Soft Seal YJ 0892 is attached to the Simplified Pinna Simulator. The IEC 711 Coupler is screwed into the Simplified Pinna Simulator, and Microphone Preamplifier Type 2669 is screwed into the IEC 711 Coupler which contains a $^1/_2$″ microphone. This assembly is shown in Fig. 2.

Low- and High-leak Pinna Simulators

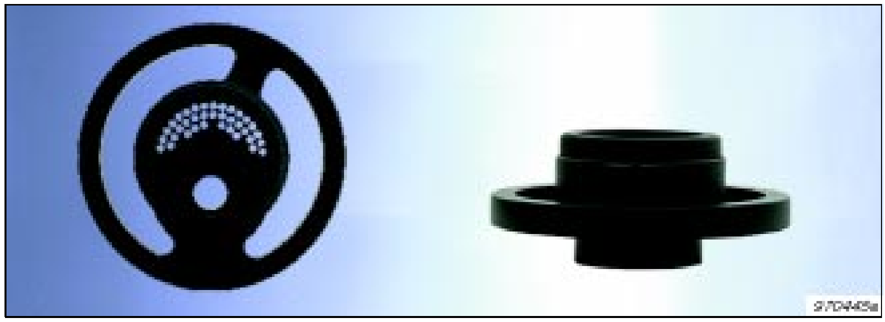


Fig. 3 The two grades of leakage are obtained by using two different pinna simulators. The high-leak pinna DB 3598 (to the left) has a controlled opening consisting of a number of holes. The low-leak pinna DB 3429 (to the right) has two very thin precision slits

Wideband Ear Simulator for Telephonometry Type 4195 is a Type 3.2 ear simulator which consists of the ITU – T Type 2/IEC 711 occluded-ear simulator, to which an ear canal extension terminated with a pinna simulation device is added.

Type 4195 provides a realistic acoustic load to telephone handsets under test and reveals acoustic differences between telephone handsets as they appear in real use

The Simplified Pinna Simulator has a well-defined leak (available in two grades) from the cavity to the exterior to simulate the average real ear loss for telephone handsets which are held either comfortably tight (low-leak pinna) or loosely (high-leak pinna) against the human ear. Type 4195 is recommended for measurements on supra-aural and supra-concha earphones, sealed and unsealed and of both high and low impedance (covering practically all kinds of earphone design). It can be used in the wide frequency range from 100 Hz to 8 kHz.

The Type 4195 ear simulator was made with the anatomically shaped Type 3.3 ear simulator as a reference. The acoustic behaviour of the Type 4195 ear simulator is therefore very close to that of the anatomically shaped pinna simulator. Type 4195 ear simulator measures at the Drum Reference Point (DRP). By using the individually measured frequency sensitivity responses supplied with the ear simulator the measurements can be referred to the ERP (Ear Reference Point).

Calibration

During manufacture the ear simulator is calibrated according to ITU – T P.57. The acoustic input impedance and the frequency sensitivity response are individually measured.

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 and Fig. 5.

Fig. 4 Typical acoustic impedance for Type 4195 low-leak ear simulator and the standardized ITU – T P.57 Type 3.2 low-leak curve which Type 4195 complies to

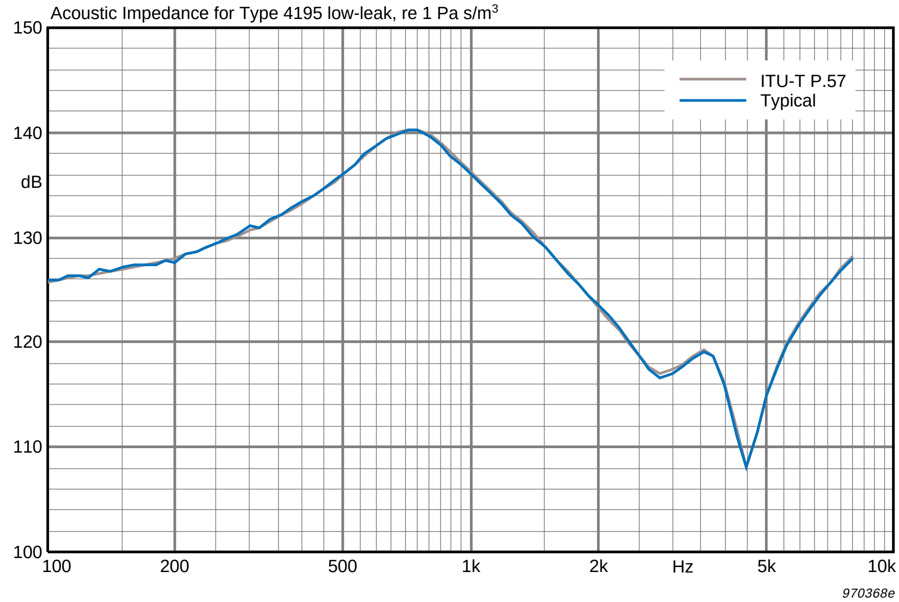
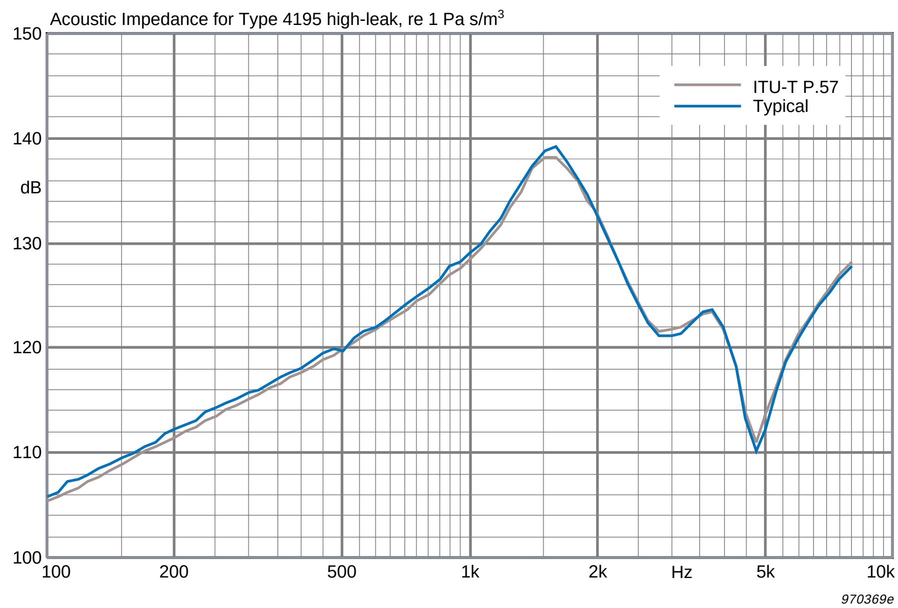


Fig. 5 Same as Fig. 4, but for Type 3.2, high-leak pinna



Frequency Sensitivity Response

The frequency sensitivity response (also referred to as the DRP to the ERP transfer function) is defined as the modulus of the ratio of output voltage of the ear simulator to input sound pressure at the ERP normalised to 0 dB at 1 kHz. The frequency sensitivity 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 is also 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 primarily used for diagnostic purposes, for example, to interpret differences between measurements made on a handset with Type 4195 with measurements made with the ITU–T Type 1 Ear Simulator (Type 4185).

Using the open ear frequency sensitivity response as a correction function, measurements made on any telephone handset can be 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. When calculating loudness rating (RLR) no LE correction is required, since the leakage is already provided by the artificial ear.

Fig. 6 Open and closed ear frequency sensitivity responses for Type 4195, low-leak pinna

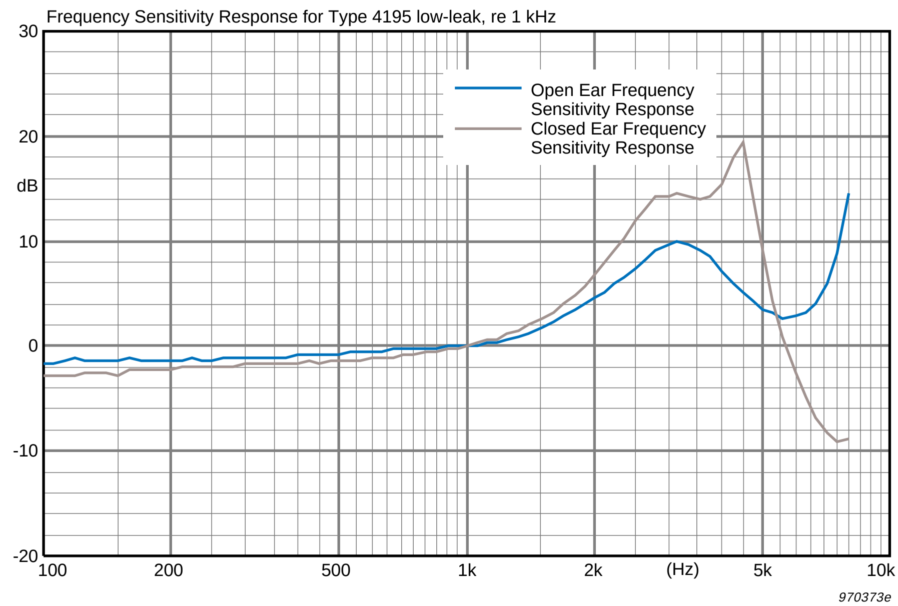
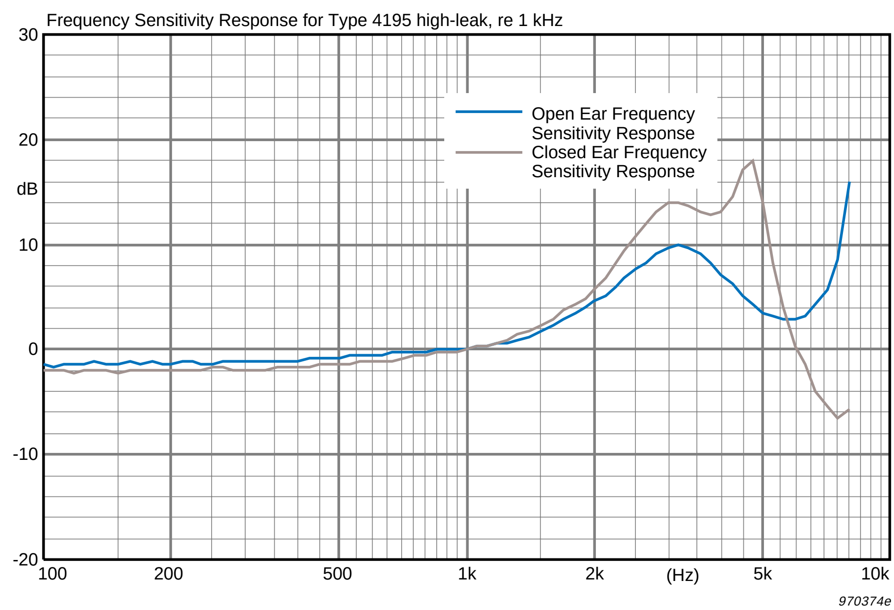


Fig. 7 Open and closed ear frequency sensitivity responses for Type 4195, high-leak pinna



The frequency sensitivity responses for Type 4195 are shown in Fig. 6 and Fig. 7. The correction is obtained by dividing the measured data by the frequency sensitivity response (as a post-processing operation on the measurement data).

Absolute Sensitivity

The absolute sensitivity at 1 kHz in [V/Pa] is defined as 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 and the supplied Calibration Adaptor DP 0939.

Fig. 8 Absolute sensitivity calibration at 1 kHz of Type 4195 using Sound Level Calibrator Type 4231 and Calibration Adaptor DP 0939

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 or the adapter used for the calibration, 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 therefore can 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:

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

The absolute sensitivities at 1 kHz in [V/Pa] of Type 4195 as specified on the calibration charts are verified by means of Calibration Adaptor DP 0939 which is mounted in the calibrator and applied to the ear simulator, see Fig. 8. The calibration levels to obtain the open and closed ear sensitivities are given in Table 1.

Table 1 Actual calibration levels using Sound Level Calibrator Type 4231 to find the absolute open and closed ear sensitivities at 1 kHz for Type 4195 low- and high-leak pinnae

	$P_{4231,\,\text{corrected}}$(open ear)	$P_{4231,\,\text{corrected}}$(closed ear)
Type 4195 low-leak	98.2 dB	(98.0 dB)
Type 4195 high-leak	84.7 dB	(85.4 dB)

Electrical equivalent diagrams can be set up based on the mechanical properties of the IEC 711 Coupler and the low- and high-leak pinna simulators. This concept makes it possible to perform computer simulations to show the effect of the acoustic loading presented by the ear simulator. The electrical equivalent diagrams for the IEC 711 Coupler and the low- or high-leak Simplified Pinna Simulators can be combined to give an equivalent diagram for the complete Type 4195 ear simulator. The cross-sections in Fig. 9 show the physical construction of the IEC 711 Coupler and the low- and high-leak pinna simulators with the associated acoustical component names. Fig. 10, Fig. 11 and Fig. 12 show the equivalent diagrams and associated component values for the IEC 711 Coupler and the low- and high-leak Simplified Pinna Simulators respectively. The equivalent diagrams are obtained using an impedance type analogy. The circuits are seen from the acoustic side with associated component values in acoustic units.

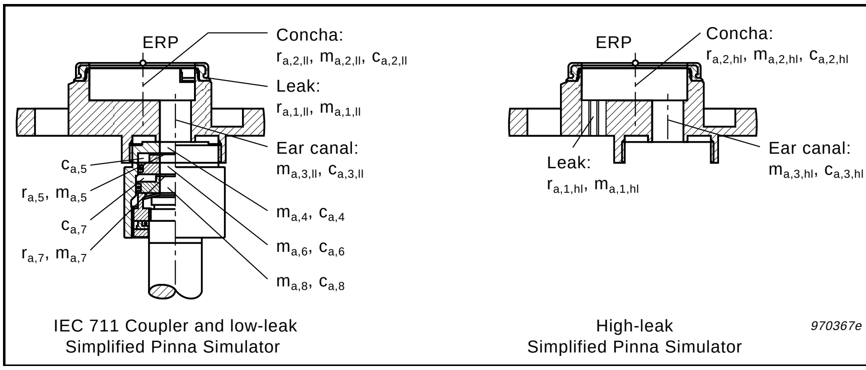
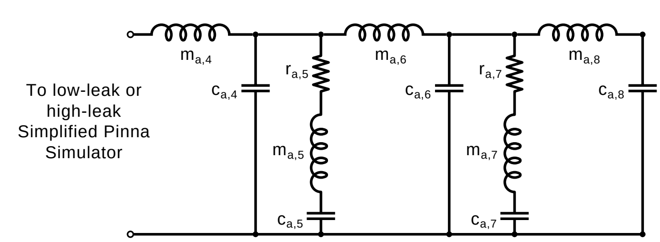


Fig. 9 Cross-section of IEC 711 Coupler fitted with low-leak Simplified Pinna Simulator and separate high-leak Simplified Pinna Simulator. The electrical component names refer to the separate electrical equivalent diagrams



IEC 711 Coupler:

$r_{a,5} = 50.6 \times 10^{6} \frac{Pa \times s}{m^3}$

$r_{a,7} = 31.1 \times 10^{6} \frac{Pa \times s}{m^3}$

$m_{a,4} = 78.8 \frac{kg}{m^4}$

$m_{a,5} = 9.4 \times 10^{3} \frac{kg}{m^4}$

$m_{a,6} = 132.3 \frac{kg}{m^4}$

$m_{a,7} = 983.8 \frac{kg}{m^4}$

$m_{a,8} = 153.5 \frac{kg}{m^4}$

$c_{a,4} = 0.9 \times 10^{-12} \frac{m^5}{N}$

$c_{a,5} = 1.9 \times 10^{-12} \frac{m^5}{N}$

$c_{a,6} = 1.5 \times 10^{-12} \frac{m^5}{N}$

$c_{a,7} = 2.1 \times 10^{-12} \frac{m^5}{N}$

$c_{a,8} = 2.1 \times 10^{-12} \frac{m^5}{N}$

970370e

Fig. 10 Electrical equivalent diagram and associated component values for the IEC 711 Coupler

Fig. 11 Electrical equivalent diagram and associated component values for the low-leak Simplified Pinna Simulator

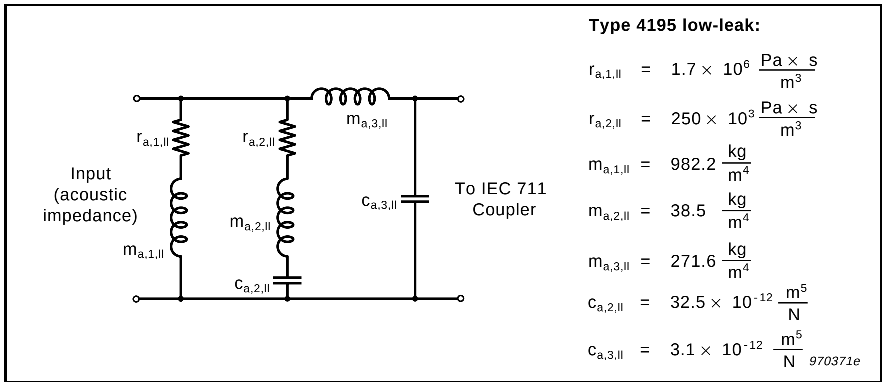


Fig. 12 Electrical equivalent diagram and associated component values for the high-leak Simplified Pinna Simulator

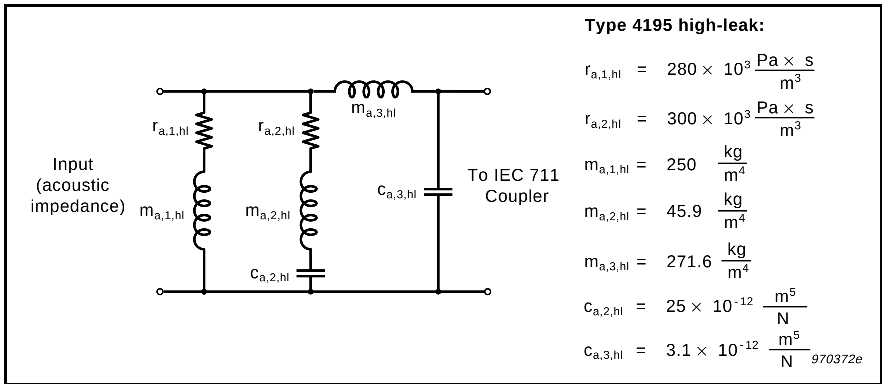


Fig. 13 and Fig. 14 show the simulated acoustic impedances of the Type 4195 with low- and high-leak simulators respectively, based on the electrical models. Although the equivalent diagrams are based on the mechanical properties of the ear simulator, they constitute a compromise between complexity (good 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.

Fig. 13 Simulated acoustic impedance for Type 4195 low-leak ear simulator compared to typical measured impedance curve

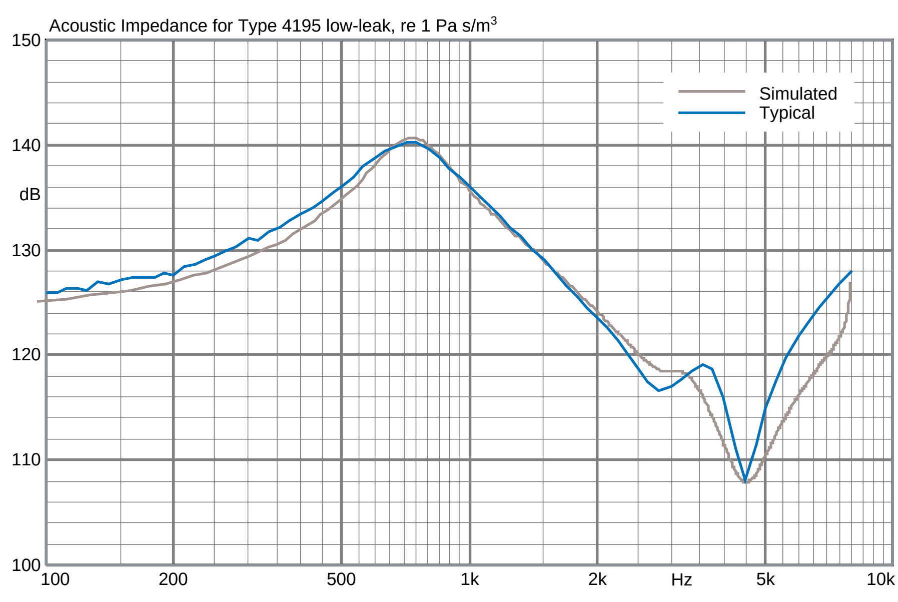
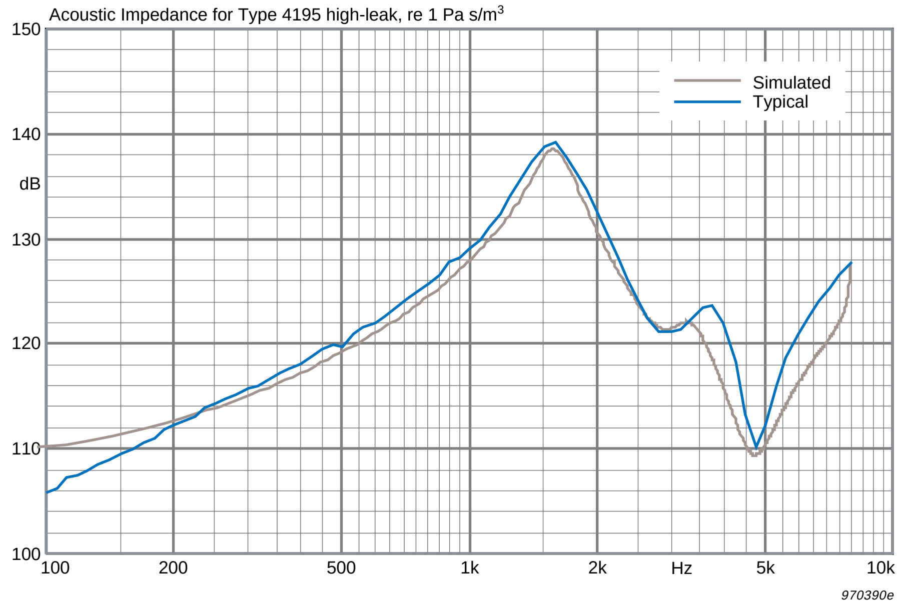


Fig. 14 Same as Fig. 13, but for high-leak pinna



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 4195

General

STANDARDS:
Acoustic performance according to ITU–T Recommendation P.57 sec. 4.3.2 Type 3.2

DIMENSIONS:
Height: 126 mm (5″)
Max. Diameter: 60 mm (2.4″)

WEIGHT:
(without Preamplifier Type 2669): 107 g (3.8 oz)

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 4195 **Wideband Ear Simulator for Telephonometry**

Includes the following accessories:
UA 1304: Simplified Pinna Simulator, low-leak
UA 1448: Simplified Pinna Simulator, high-leak
UA 1305: IEC 711 Coupler
YJ 0892: Soft Seal
ZG 0350: LEMO to 7-pin Brüel & Kjær adaptor
Type 2669: 1/2″ Microphone Preamplifier
AO 0419: Microphone Cable, 3 m (10 ft) LEMO to LEMO

Calibration Charts for low- and high-leak simulators

Calibration Data Disk

Optional Accessories

Type 4231: Sound Level Calibrator

Services Available

4195–CFF: Factory Standard Calibration
4195–MUF: Upgrade to high-leakage (includes 4195–CFF)

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

Brüel & Kjær
WORLD HEADQUARTERS: DK-2850 Nærum • Denmark • Telephone: +4545800500 •Telex: 37316 bruka dk • Fax: +4545801405
e-mail: info@bk.dk Internet: http://www.bk.dk

BP 1423 – 13

97/10