

# Product Data

## Artificial Ears — Types 4152 and 4153

### USES:

- Frequency response and sensitivity measurements on insert earphones and headphones
- Calibration of audiometers

### FEATURES:

- Conform to IEC and ANSI standards
- Complete reproducibility of results
- Well defined measuring conditions
- 2 cm<sup>3</sup> and 6 cm<sup>3</sup> couplers
- Adjustable clamping force

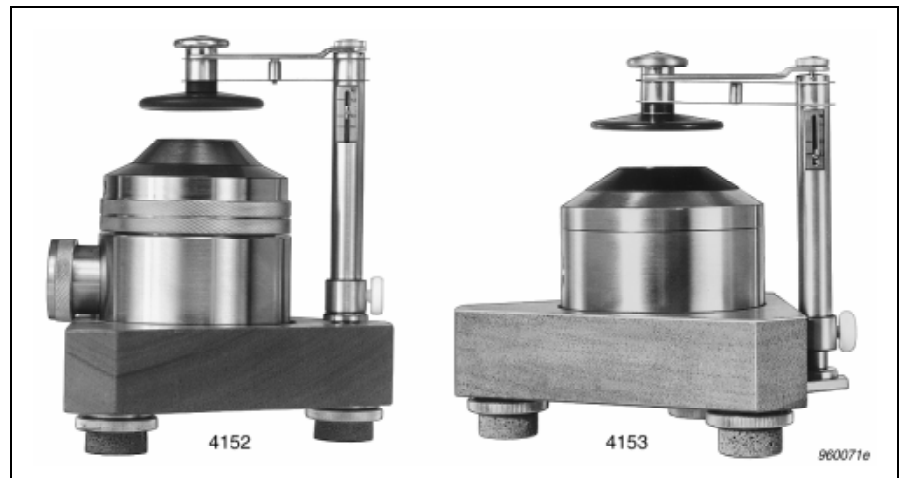
The Artificial Ears Types 4152 and 4153 have been designed for measurements in the audiometric and related fields. They enable electroacoustical measurements on either insert earphones or headphones to be carried out under well defined acoustical conditions, which are of great importance for the comparability of different designs and the reproducibility of measurements.

The Artificial Ears Types 4152 and 4153 consist of an acoustic coupler, a main housing containing the sockets for the connection of a Brüel & Kjær condenser microphone and a base plate with a mechanism for clamping the object being tested.

The clamping mechanism is spring loaded and provides a force which can be adjusted from 2 N (approx. 0.2 kg) to 10 N (approx. 1 kg) as recommended by the relevant ANSI Standards, the actual force value being set on a scale engraved on the clamp holder. To minimise the effect of vibration during the measurements, each Artificial Ear is isolated from shock and vibration by means of three soft rubber feet.

### Artificial Ear Type 4152

In the Artificial Ear Type 4152 the socket for mounting the measuring microphone permits use of a Brüel & Kjær 1" Condenser Microphone Cartridge Type 4144 with associated Preamplifi-



er Type 2669 (Adaptor DB 0962 required). The couplers (see Fig. 1) supplied with the Artificial Ear consist of a 2 cm<sup>3</sup> Coupler DB 0138 in accordance with IEC 126 and ANSI S3.7-1973 for measurements on hearing aid earphones, and a 6 cm<sup>3</sup>

Coupler DB 0913 which fulfils the requirements of the NBS 9A Coupler (United States National Institute of Standards and Technology, formerly the National Bureau of Standards) and the ANSI S3.6-1969 and IEC 303 Coupler for measurements on



Fig. 1 Left to right: couplers DB 0138, DB 0909 and DB 0161 with their respective adaptors and stop collars

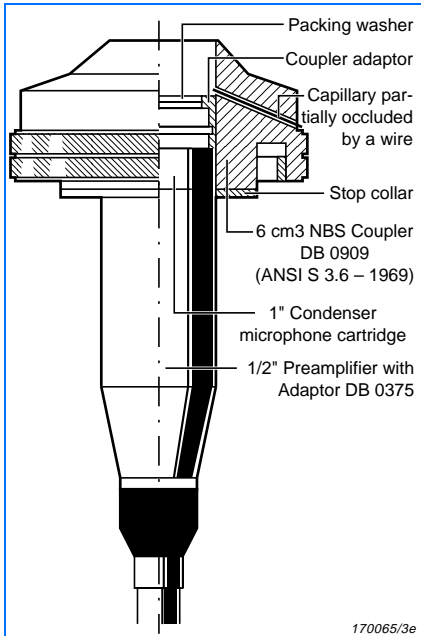


Fig. 2 Sketch showing how a 6 cm<sup>3</sup> Coupler is mounted directly on a 1 inch Condenser Microphone

headphones. If required, a special 6 cm<sup>3</sup> Coupler DB 0161 designed according to the requirements of ANSI S3.7-1973 Type 1 Coupler is available.

The 2 cm<sup>3</sup> Coupler may be used directly on the microphone with preamplifier without use of the main housing. In this manner an artificial ear is obtained which is very small and useful for measurements on, for example, spectacle type hearing aids, the arrangement still being in agreement with the IEC publication. A typical example of this type of application is the testing of hearing aids in the Anechoic Test Chamber Type 4222 or Anechoic Test Box Type 4232. The 6 cm<sup>3</sup> couplers may also be mounted directly on the microphone with the aid of a Stop Collar YO 2340 delivered with the 6 cm<sup>3</sup> couplers when they are ordered separately as DB 0161 or DB 0909.

## Artificial Ear Type 4153

The Artificial Ear Type 4153 fulfils the requirements of IEC 318 and has an acoustical impedance basically similar to that of the human ear. The acoustic coupler (Fig. 3) contains three volumes ( $V_1 = 2.5 \text{ cm}^3$ ,  $V_2 = 1.8 \text{ cm}^3$  and  $V_3 = 7.5 \text{ cm}^3$ ) acoustically connected in parallel by means of a narrow annular slit and four parallel holes. The slit and the four holes

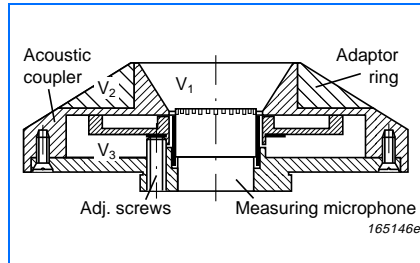


Fig. 3 Sectional view of the Acoustic Coupler used in the 4153

act as an acoustic resistance of  $6.5 \times 10^6 \text{ Ns/m}^5$  and  $20 \times 10^6 \text{ Ns/m}^5$  respectively, while their acoustic inductances are  $5 \times 10^2 \text{ Ns}^2/\text{m}^5$  for the slit and  $10^4 \text{ Ns}^2/\text{m}^5$  for the holes. An electrical equivalent of the acoustic circuit is shown in Fig. 4.

The coupler fits the Brüel & Kjær 1/2 inch Condenser Microphone Type 4134, and may be used with a Preamplifier Type 2669 mounted in the housing. The coupler also mounts directly on the preamplifiers by means of the Adaptor Ring DB 0742 supplied. The coupler is shaped to fit the headphone under test, and a spe-

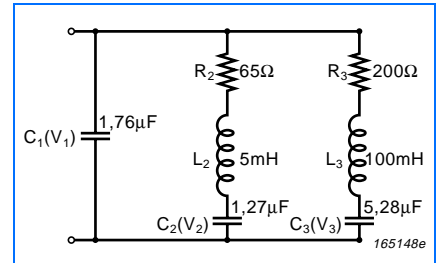


Fig. 4 The electrical equivalent circuit of the Type 4153

cial Adaptor DB 0843 is supplied for testing circumaural headphones.

For calibration purposes a well defined high acoustic impedance sound source is supplied with the Ear (Fig. 5). It consists of an Earcap YJ 0305 and an Adaptor AQ 0015 for a 1/2 inch condenser microphone cartridge, which is used as sound transmitter.

Fig. 6 shows the pressure frequency response of the Artificial Ear Type 4153 measured with a 1/2 inch Condenser Microphone Type 4134. The sound pressure is produced by the high impedance sound source, described



Fig. 5 Left to right: Adaptor DB 0843, Adaptor Ring DB 0742, Adaptor YJ 0304 and Earcap YJ 0305 with Adaptor AQ 0015 mounted

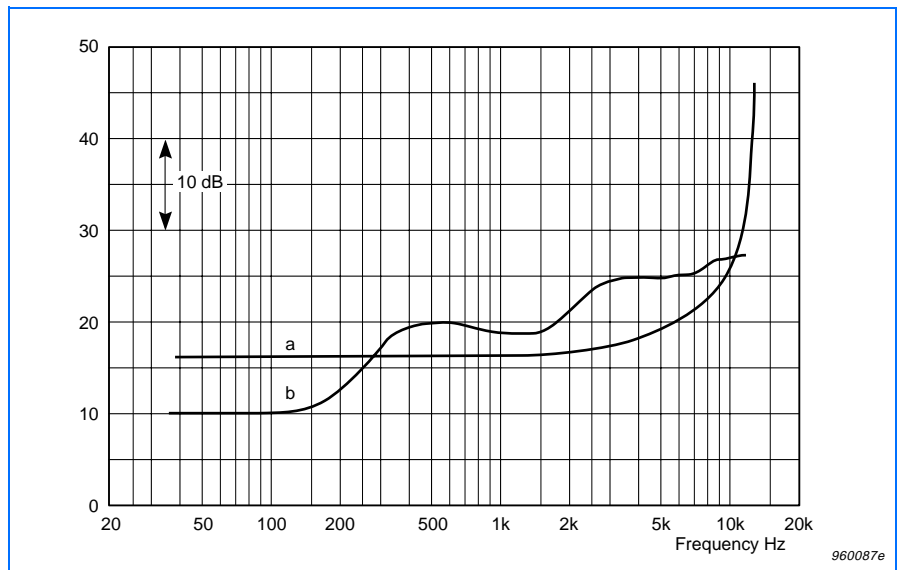


Fig. 6 Frequency response curves for the Artificial Ears  
a) pressure response of Type 4152  
b) pressure response of Type 4153

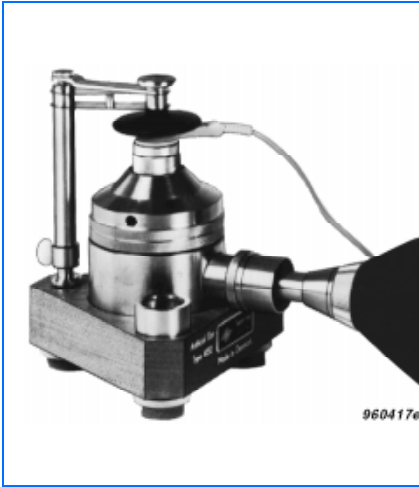


Fig.7 Artificial Ear Type 4152 and Sound Level Meter in combination

above, which is fed from a constant ac voltage generator. The acoustical coupling between the transmitting microphone and the Artificial Ear is established by pressing the Earcap against the Ear.

Fig. 6 also shows the pressure frequency response of the Artificial Ear Type 4152 with the 6 cm<sup>3</sup> Coupler DB 0913 measured with a 1" Condenser Microphone Type 4144. The sound source is the same as above.

### Measuring Instruments

Measuring Amplifier Type 2610 or 2636 can be used as the indicating instrument for the Artificial Ears. If frequency analysis, distortion measurements or measurements at very low levels are required Brüel & Kjær Frequency Analyzer Type 2012 can be used. For a more portable system a Sound Level Meter for instance Type 2260 can be employed as the indicating instrument with the Artificial Ear Type 4152. An Adaptor DB 0962 is provided for connecting the 4152 to the input of the Sound Level Meter.

### Sensitivity Calibration

A measuring set-up with one of the Artificial Ears Type 4152 or 4153 can easily be calibrated with a Pistonphone Type 4228 to an accuracy of within  $\pm 0.2$  dB at 250 Hz or with a Sound Level Calibrator Type 4231, to an accuracy of within  $\pm 0.3$  dB at 1000 Hz.

## Examples of Use

### Frequency Response Recording

Fig. 8 shows a measuring set-up that allows the frequency response and distortion of a headphone to be measured automatically using Audio Analyzer Type 2012. The amplifier WQ 1105 provides the necessary ac current for the headphone. if required, the current delivered to the headphone may be kept constant by weighting the generator output of the Audio Analyzer. The output from the microphone in the Artificial Ear Type 4153 is fed to the Preamplifier input of Audio Analyzer Type 2012.

### Audiometer Calibration

Accurate audiometers are vital instruments in hospitals and schools as well as in industry because they allow full checks to be made of a person's hearing, and possible hearing loss. The accuracy of such measurements, however, depends to a great extent on the accuracy with which the audiometer is calibrated. Litigation concerning hearing loss claims calls for audiometric tests supported by calibration data which will withstand expert critical examination.

Only a complete acoustical calibration on the audiometer at all hearing levels, with the calibration referenced to an incontestable acous-

tic source, can fulfil such stringent requirements. Movement of an audiometer may also upset its calibration, hence the calibration equipment itself must be made portable.

A suitable calibration arrangement which would meet these demands could consist of a Sound Level Meter Type 2260, a Pistonphone Type 4228 and an Artificial Ear Type 4152. To minimise the effects of ambient noise and structure-borne vibrations on low level acoustic calibration of audiometers, the octave or 1/3-octave filters in the Sound Level Meter Type 2260 should be used. Sound Level Meter Type 2260 has 9 octave filters with centre frequencies from 31.5 Hz to 8 kHz, and 30 third-octave filters with centre frequencies from 16 Hz to 12.5 kHz. By first calibrating the Sound Level Meter by means of the Pistonphone and then using the Sound Level Meter together with the Artificial Ear for the actual Audiometer calibration, an accurate, easy to operate and fully portable audiometer calibrator is obtained.

For measurements on bone vibrators, the Product Data sheet for the Artificial Mastoid Type 4930 should be consulted.

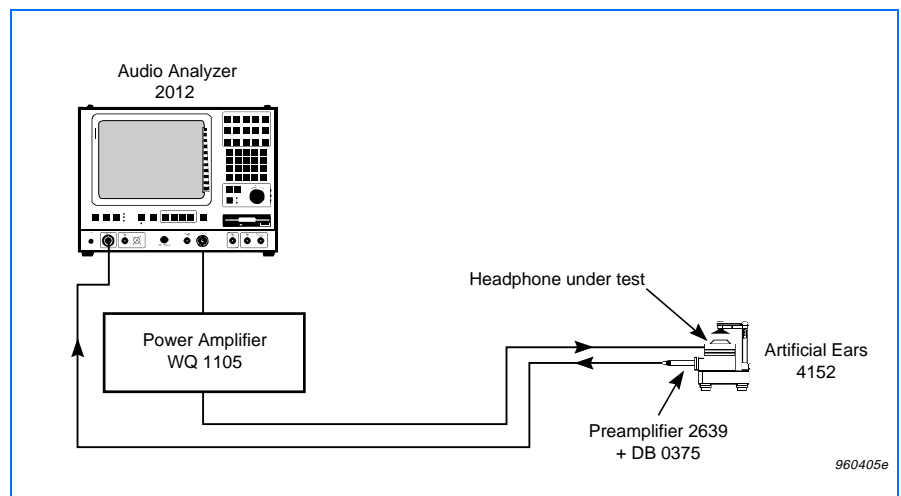


Fig.8 Set-up for measuring the frequency response and distortion of a headphone

# Specifications 4152 and 4153

## TYPE 4152

### COUPLERS AVAILABLE:

**DB 0138:** 2 cm<sup>3</sup> (supplied)  
**DB 0909:** 6 cm<sup>3</sup> (supplied)  
**DB 0161:** 6 cm<sup>3</sup>

### MAX. FORCE APPLIED TO THE TOP OF ACOUSTIC COUPLER:

10 N (1 kg)

### DIMENSIONS:

**Height:** 104 mm (4.1 in)  
**Max. diameter:** 123 mm (4.85 in)

### WEIGHT:

1.5 kg (3.3 lb)

## TYPE 4153

### DIMENSIONS:

**Height:** 104 mm (4.1 in)  
**Max. diameter:** 123 mm (4.85 in)

### COUPLER VOLUMES:

	Volume	Acoustic Capacitance
V <sub>1</sub>	2.5 cm <sup>3</sup> = 1%	17.6 x 10 <sup>-12</sup> m <sup>5</sup> /N
V <sub>2</sub>	1.8 cm <sup>3</sup> = 1%	12.7 x 10 <sup>-12</sup> m <sup>5</sup> /N
V <sub>3</sub>	7.5 cm <sup>3</sup> = 1%	52.8 x 10 <sup>-12</sup> m <sup>5</sup> /N

### CONNECTIONS BETWEEN CAVITIES:

	Acoustic Resistance	Acoustic Inductance
Annular slit:	6.5 x 10 <sup>6</sup> Ns/m <sup>5</sup>	5 x 10 <sup>2</sup> Ns <sup>2</sup> /m <sup>5</sup>
Four parallel holes	20 x 10 <sup>6</sup> Ns/m <sup>5</sup>	10 <sup>4</sup> Ns <sup>2</sup> /m <sup>5</sup>

## COMPLIANCE WITH STANDARDS:

<b>CE</b>	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
<b>Safety</b>	EN 61010-1 (1993) and IEC 1010-1 (1990): Safety requirements for electrical equipment for measurement, control and laboratory use.
<b>EMC Emission</b>	EN 50081-1 (1992): Generic emission standard. Part 1: Residential, commercial and light industry. CISPR 22 (1993): Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
<b>EMC Immunity</b>	EN 50082-1 (1992): Generic immunity standard. Part 1: Residential, commercial and light industry. <b>Note:</b> The above is guaranteed using accessories listed in this Product Data sheet only.
<b>Temperature</b>	IEC 68-2-1 & IEC 68-2-2: Environmental Testing. Cold and Dry Heat. Operating Temperature: 5 to +40°C Storage Temperature: -25 to +70°C
<b>Humidity</b>	IEC 68-2-3: Damp Heat: XX% RH (non-condensing at 40 °C (104 °F))
<b>Mechanical</b>	Non-operating: IEC 68-2-6: Vibration: 0.3 mm, 20 m/s <sup>2</sup> , 10-500 Hz IEC 68-2-27: Shock: 1000 m/s <sup>2</sup> IEC 68-2-29: Bump: 1000 bumps at 250 m/s <sup>2</sup>

## Ordering Information

Type 4152 Artificial Ear

### MEASURING MICROPHONE:\*

Type 4144: 1" Condenser Microphone

### PREAMPLIFIER:\*

Microphone Preamplifier Type 2669

### Accessories Included

**DB 0138:** 2 cm<sup>3</sup> Coupler  
**DB 0913:** 6 cm<sup>3</sup> coupler (equal to DB 0909 but without base ring YO 2340)  
**DB 0111:** Coupler adaptor ring

\* to be ordered separately

**DB 1021:** Guard ring adaptor

**DB 0962:** Adaptor for Sound Level Meter

### Optional Accessories

**DB 0161:** 6 cm<sup>3</sup> Coupler (with base ring YO 2340)  
**DB 0909:** 6 cm<sup>3</sup> Coupler (with base ring YO 2340)  
**DB 0375:** Adaptor for Preamplifier

Type 4153 Artificial Ear

### MEASURING MICROPHONE:\*

Type 4134: 1/2" Condenser Microphone

### PREAMPLIFIER:\*

Microphone Preamplifier Type 2669

### Accessories Included

**DB 0742:** Adaptor  
**DB 0843:** Adaptor  
**AQ 0015:** Adaptor  
**YJ 0305:** Earcap

\* to be ordered separately

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

# Brüel & Kjær

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