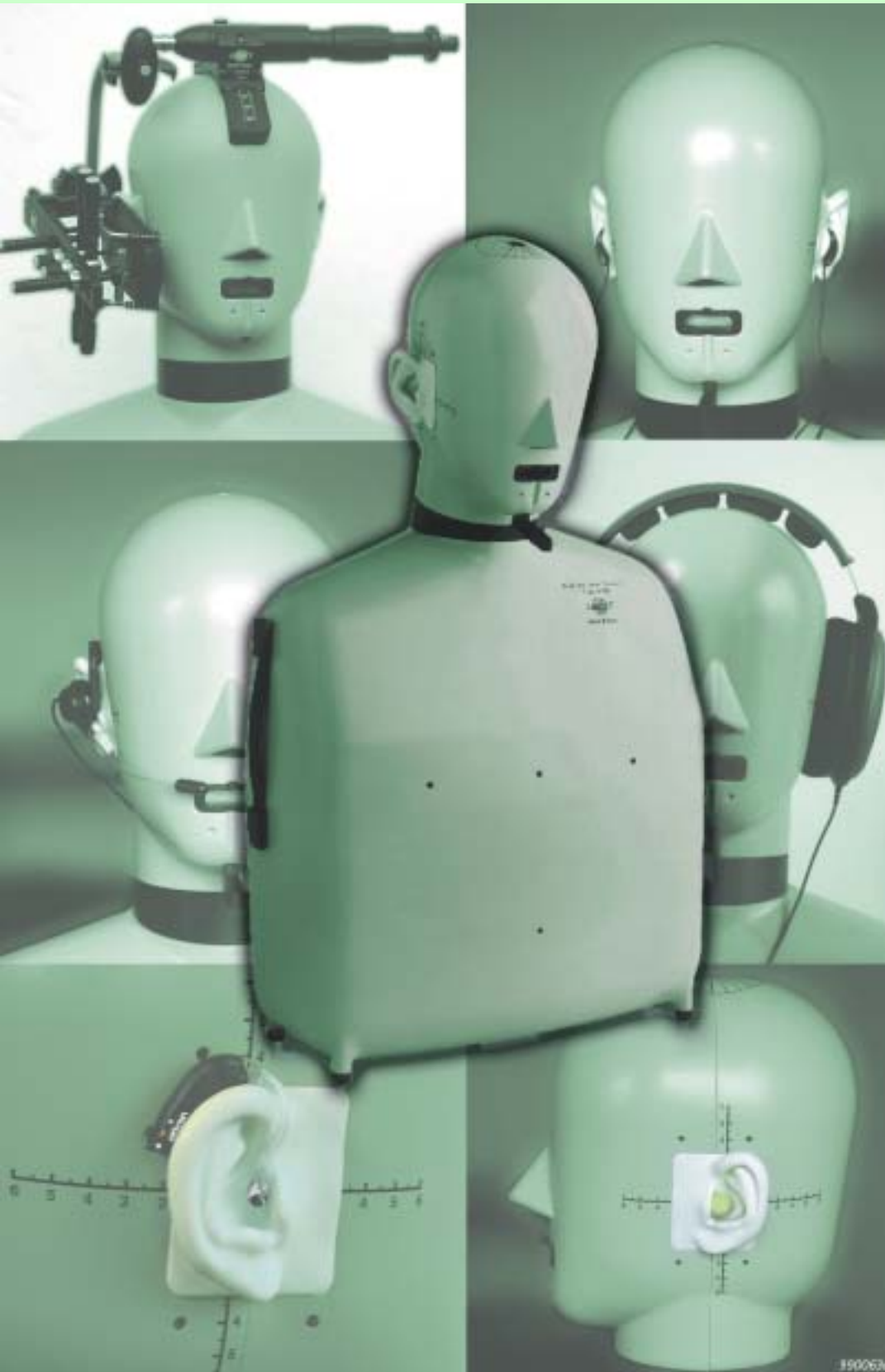


# PRODUCT DATA

Head and Torso Simulator — Type 4128C  
Handset Positioner for HATS— Type 4606



## ***Head and Torso Simulator (HATS)***

Head and Torso Simulator Type 4128C is a mannequin with built-in ear and mouth simulators that provides a realistic reproduction of the acoustic properties of an average adult human head and torso. It is ideal for performing in-situ electroacoustic tests on, for example, telephone handsets (including mobile and cordless), headsets, audio conference devices, microphones, headphones, hearing aids and hearing protectors.

## ***Handset Positioner for HATS***

Type 4606 allows accurate and repeatable mounting of telephone handsets on HATS in both standardised and user-defined positions. This makes HATS into a state-of-art telephone test rig providing both an artificial mouth and ear with pinna for measurement according to the ITU-T recommendations.

**4128 C, 4606**

## *USES* Type 4128 C

- Measurements on telephone handsets and headsets, and hands-free telephones
- Measurements on mobile and domestic telephones
- In-situ/insertion measurements on hearing aids
- Testing of headphones
- Testing of hearing protectors
- Evaluation of close-talking/noise-cancelling microphones

## **Type 4128 C with Type 4606**

- Accurate and repeatable positioning of telephone handsets on HATS for electroacoustic measurements
- Testing of almost all telephone handset designs, including handsets with antennas or with asymmetrically mounted transducers
- Measurements in standardized positions according to the ITU-T Rec. P.64
- Investigation of handsets with asymmetrically mounted transducers

## *FEATURES* Type 4128 C

- Mannequin provides accurate acoustic representation of the average human adult
- Complies with the acoustic requirements of ITU-T Rec. P.58, IEC 60959, and ANSI S3.36-1985
- Highly representative mouth simulator with overload protection
- Highly representative IEC 711/ITU-T Type 3.3 based calibrated ear simulator (Type 4158 C) with built in ½" condenser microphone and microphone preamplifier
- Soft pinnas included in addition to the standard pinnas for realistic headphone measurements
- Adjustable neck angle to permit realistic measurement of hands-free telephones
- Individual calibration data supplied

## **Type 4128 C with Type 4606**

- Adaptable for a wide variety of telephone handset types including normal, cordless and mobile
- Simple to configure for standardised or user-defined mounting positions
- Table-top alignment jig for aligning ear-cap plane and Ear Reference Point (ERP) of handset
- Graduated adjustment in 3 planes about the Ear Reference Point
- Spring-loaded mounting of the handset against the ear with adjustable pressure force
- Positioning on both ears simulating left- and right-handed users

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## **Introduction**

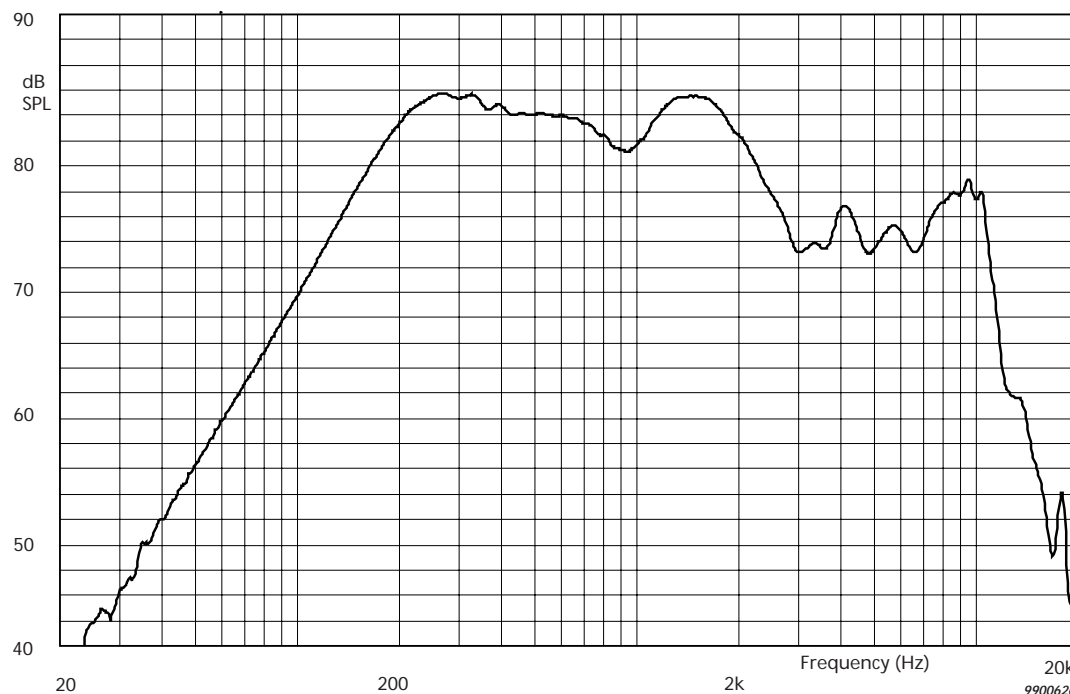
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Head and Torso Simulator (HATS) Type 4128 C consists of a head mounted on a torso, both of which represent the international average dimensions of a human adult. In airborne acoustic measurements it provides the correct simulation of the acoustic field around a human head and torso. You can use HATS free standing, fitted on a tripod, or on a turntable using the tripod mounting adaptor.

## The Mouth Simulator

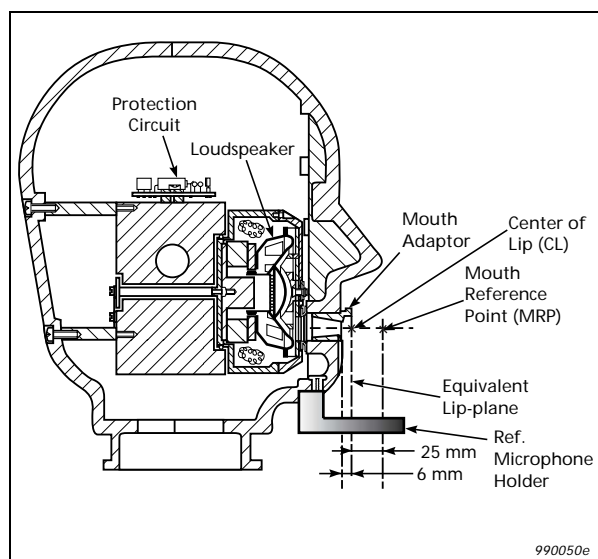
The mouth simulator in the Head and Torso Simulator has a high-compliance loudspeaker which gives powerful low-frequency response and low distortion. The acoustic transmission path from the loudspeaker to the mouth opening ensures an easily equalizable frequency response of the sound pressure level in front of the mouth. The equivalent lip plane containing the ITU-T Center of Lip (CL) is 6 mm in front of the mouth opening. The usual calibration position is at the ITU-T Mouth Reference Point (MRP), 25 mm in front of this plane. A holder is supplied with Type 4128 C which will hold a ¼" reference microphone at precisely the correct distance for calibration at the MRP.

**Fig. 1**  
Typical Talker free-field frequency response of Type 4128 C



This holder can also hold a microphone right at the opening of the mouth if you want to monitor or equalize the sound pressure at this point.

**Fig. 2**  
The mouth simulator of Type 4128 C



The mouth simulator produces a sound-pressure distribution around the opening of the mouth which simulates that of a median adult human mouth, correlating to the figures given in ITU-T Rec. P.51.

The position of the acoustic centre of the mouth simulator also follows that of human subjects over the speech frequency range.

A typical Talker frequency response is shown in Fig. 1.

## Ear Simulator Type 4158 C

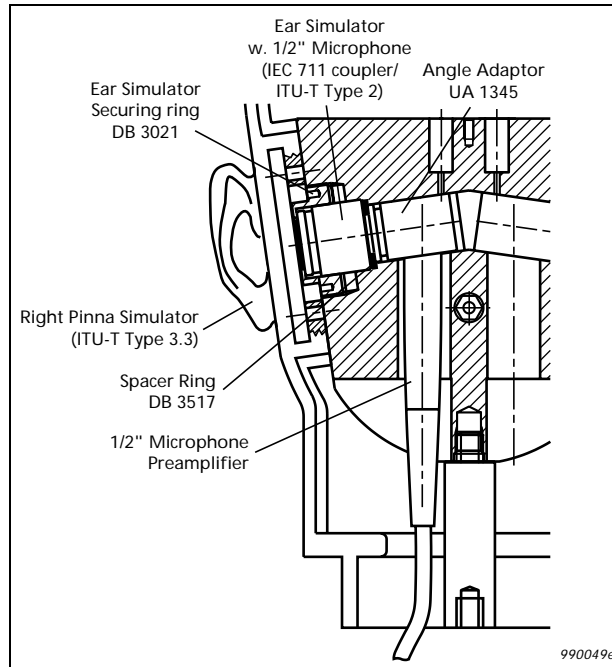
Ear Simulator Type 4158 C is shown in Fig. 3. It consists of a removable silicon-rubber pinna joined to an

ear canal. The ear canal ends in an occluded ear simulator which simulates the inner part of the ear canal according to the IEC 60711 standard. The occluded ear simulator

contains a 1/2" microphone and is connected to a microphone preamplifier with an adaptor. The ear simulator complies with ITU-T Rec. P.57.

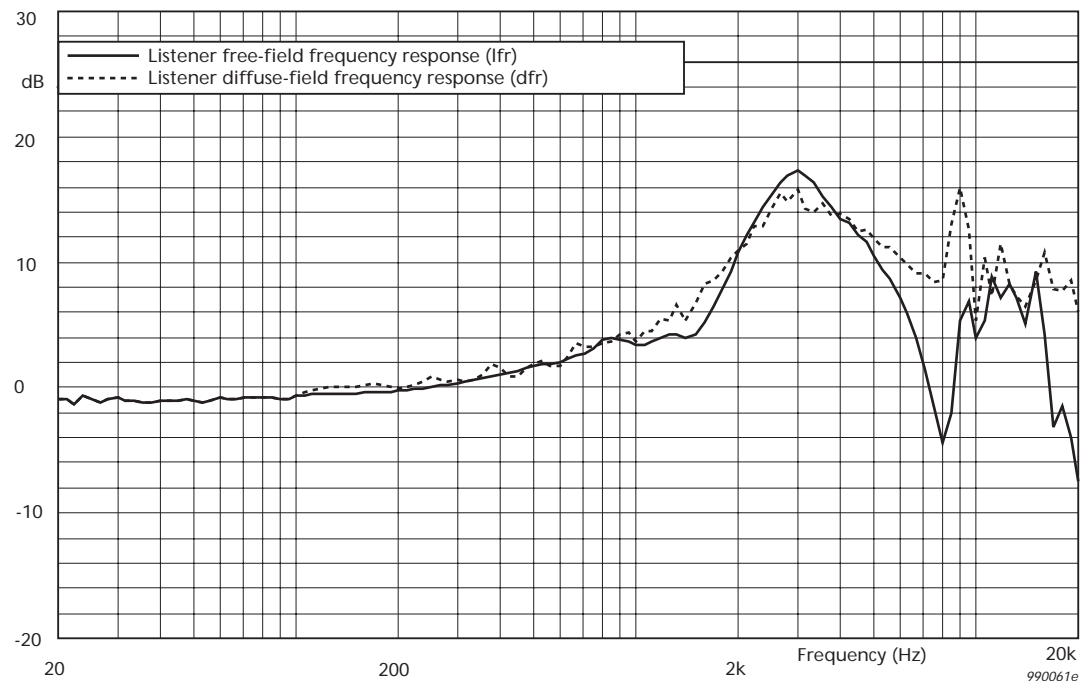
Type 4158 C is the right ear of Type 4128 C. A left ear, Type 4159 C, is also available for binaural measurements. For headphone measurements, soft pinnas are also available. Both Type 4158 C and Type 4159 C are delivered with a calibration chart specific to their ear simulator and pinna. Pistonphone Type 4228 and Sound Level Calibrator Type 4231 are both suitable calibrators for these ear simulators.

**Fig. 3**  
Cross-section of the right ear with the ear simulator fitted



The combined influence of the torso, head, pinna and ear-canal on airborne sound signals can be quantified by the acoustic free-field transfer function (the frequency response from free-field to the eardrum). This is called the Listener free-field frequency response (lfr) in telecommunications work and the Mannequin frequency response in technical audiology. A typical response of Type 4128 C for sound incident at 0° (that is, coming from the front) is shown in Fig. 4 (lfr). The Listener diffuse-field frequency response (dfr) is also shown.

**Fig. 4**  
Typical Listener free-field and diffuse-field frequency responses of Type 4128 C



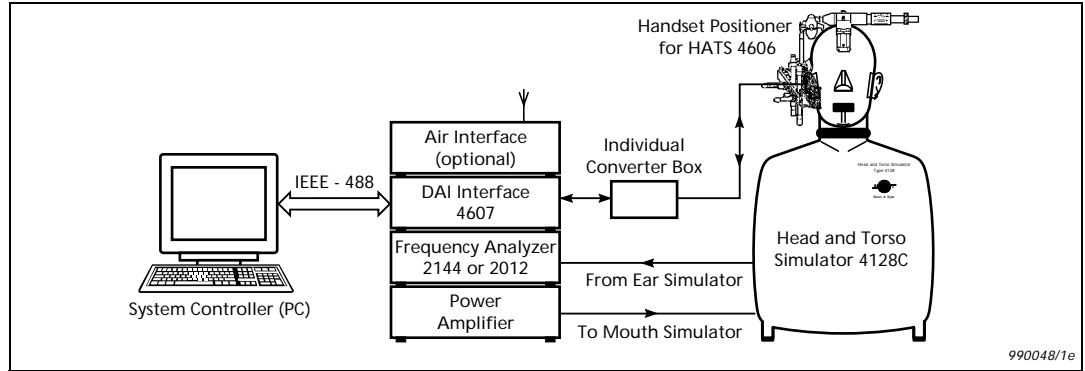
### Adjustable Neck

Type 4128 C has an adjustable neck that allows you to position the head in a realistic posture for different positions of the torso. This is useful in real-life simulations, for

example measurements in car seats. To update earlier versions of Type 4128 C with no neck ring, a Torso with neck-ring (UC 5345) is available as an accessory.

## Telephone Measurements

**Fig. 5**  
Handset Positioner For HATS combined with the GSM Voice Testing System Type 6712 and the DAI Air Interface Type 4607 is well suited to acoustic R&D work on mobile handsets



Head and Torso Simulator Type 4128 C can be used as a representative mannequin for the in-situ evaluation of telephone equipment (see Fig. 5), including handset telephones, hands-free telephones, group audio terminals and group audio headsets. With both an ear and a mouth simulator you can investigate receive, transmit, acoustic sidetone and background noise characteristics for the full range of audio terminal devices. Full duplex operation is possible.

## Type 4606 Handset Positioner for HATS

**Fig. 6**  
The Handset Positioner for HATS Type 4606



Brüel & Kjær has developed a handset positioner specifically for use with HATS. Handset Positioner for HATS Type 4606 (see Fig. 6), accurately and repeatably positions telephone handsets on the HATS for electroacoustic measurements. The device screws directly into the top of the HATS and securely holds and positions virtually any handset, i.e., mobile, cordless or conventional. The handset mounts in the handset cradle which is a multi-adjustable fixture capable of holding practically any type of handset firmly.

**Fig. 7**  
Alignment jig with handset cradle



An alignment jig is supplied (see Fig. 7) that allows you to position the handset within the cradle setting up the handset ERP and the ear-cap plane. When the handset and cradle are mounted on the handset positioner, the ERP of the handset then corresponds to the nominal ERP of the HATS pinna.

All the important fixing and positioning adjustments are accomplished via precision mechanisms equipped with graduated markings so that any position or adjustment is repeatable by simply setting all of the positioning parameters to the appropriate values. To this end Brüel & Kjær supply a table (available from our website or in the Type 4606/4128 C manual) for noting down these parameters. Once the cradle is mounted on the handset positioner, it can be adjusted in 3 different planes, about the ERP and the corresponding angles can be read off graduated markings. Additional cradles are available as accessories.

The handset can be pressed against the HATS pinna with adjustable force (0–25 N) by the handset positioner. This is done with a screw adjustment that allows you to set the

force via a graduated scale in Newtons. The resulting deflection of the pinna and the movement of the handset ERP occur along the axis formed by the nominal ERPs of the left and right HATS' pinna. The deflection can be read off the handset positioner graduations in millimetres.

Type 4606 is also easy to set up to do standardised measurements. A standardised position, the "HATS position" as defined in ITU-T Rec. P.64 is clearly marked on the handset positioner. This standardised position takes into account the anatomy of the average human head.

For exploring the effect of asymmetric transducers and simulating left- and right-handed users, it is possible to perform measurements on both ears. This is simply done by turning the transverse part of the handset alignment tool by 180°, with all graduations of the adjustment screws being repeated for the left-hand position. A built-in quick release mechanism makes the cradle quickly dismountable, making it easy to change handset or to change between measurement on the left and right ear.

**Fig. 8**  
Table top  
Telephone Test  
Head Type 4602 B



For users of the table top Telephone Test Head Type 4602 B, when it is fitted with the HATS positioning jig, it corresponds directly to the HATS position of the Type 4606.

### GSM Voice Testing System Type 6712

The Handset Positioner for HATS together with the GSM Voice Testing System Type 6712 and the DAI Interface Type 4607 turns HATS into a formidable telephone test system designed specifically for electroacoustic tests on mobile phones.

For bench test measurements the DAI interface along with HATS and Type 4606 can be used with the Audio Analyzer Type 2012 and an amplifier.

### Audio Analyzer Type 2012

Brüel & Kjær Audio Analyzer Type 2012 is ideal for telephone measurements because it has post-processing facilities which allow for the calculation of quantities such as Loudness Rating in the analyzer itself (with Calculation Software Type 7661). You can also make simulated free-field measurements in ordinary rooms.

Type 4128 C is especially useful for developing new designs of telephone equipment. Realistic simulation of the acoustic leakage between a handset and the human pinna enables you to perform measurements on low impedance devices. In addition, Type 4128 C accurately simulates the "obstacle effect" of the head, which allows realistic measurements on loud-speaking or hands-free telephones.

### Headphone Characteristics

You can use Type 4128 C to determine a variety of headphone characteristics in-situ. The influence of the pinna is taken into account and the ear simulator provides the correct acoustic loading, so realistic evaluation of open, closed and insert headphones can be made. In addition to the standard calibrated pinnas, Type 4128 C is delivered with a set of soft, non-calibrated pinnas (left and right) with a hardness very close to that of a real human pinna. This enables easy and realistic mounting of headphones. Simulated *insertion* responses are measured referring to either the equivalent free-field or diffuse-field response. Type 4128 C can also be used to determine the left/right tracking of headphones and their background noise insertion-loss.

## Hearing Protector Evaluation

Evaluating hearing protectors is straightforward and much more reliable using the Head and Torso Simulator instead of human subjects. The most important characteristic for hearing protectors is airborne insertion loss. This is found by measuring the free-field response of the 4128C with and without the hearing protectors in place and comparing the results. Diffuse-field measurements can be used instead of free-field if they are more relevant to the environment in which the hearing protectors are going to be used. Audio Analyzer Type 2012 is able to perform the measurements and post-processing required.

The Type 4128C can be placed in-situ so the actual noise sources for which the hearing protector is designed can be used in test. The effectiveness of hearing protectors on noise incident at different angles is also easy to investigate.

## Hearing Aid Characteristics



Both in-the-ear and behind-the-ear hearing aids can be evaluated with Type 4128C. Two ear-mould simulators are supplied with the 4128C for testing hearing aids where individually made ear-moulds are normally used. The mouth simulator in Type 4128C is useful for developing multi-microphone noise-cancelling hearing aids. Simulated insertion gain, simulated directional responses and in-situ maximum output can be measured using the Head and Torso Simulator, as describe in IEC Publication 60118-8 *Methods of Measurement of Performance Characteristics of Hearing Aids under Simulated In-situ Working Conditions*.

## Microphone Measurement

When making measurements on microphones, Type 4128C can closely simulate the interaction between the mouth, head, body and microphone. Its mouth simulator is an ideal sound source for applications in research, development and evaluation of a variety of microphones. In particular, you should use the 4128C with close-talking, noise-cancelling and Lavalier types in which the characteristics of the human voice must be reproduced accurately and the acoustic influence of the head and body is very important.

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## Compliance with Standards – Type 4128C

 	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand
Safety	EN 61010-1 & 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 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 Class B Limits.
EMC Immunity	EN 50082-1: Generic immunity standard. Part 1: Residential, commercial and light industry. <b>Note: The above is guaranteed using accessories listed in this Product Data sheet only.</b>
Temperature	IEC 60068-2-1 & IEC 60068-2-2: Environmental Testing. Cold and Dry Heat. Operating Temperature: -5°C to +40°C Storage Temperature: -25°C to +70°C
Humidity	IEC 60068-2-3: 90% RH (non-condensing at 40°C)
Mechanical	IEC 60068-2-6: Vibration: 0.3 mm, 20 m/s <sup>2</sup> , 10-500 Hz IEC 60068-2-27: Shock: 1000 m/s <sup>2</sup> IEC 60068-2-29: Bump: 1000 bumps at 250 m/s <sup>2</sup>

# Specifications – Head and Torso Simulator Type 4128C

## LISTENER FREQUENCY RESPONSE

Conforms to ITU-T Rec. P.58 for measurements on telecommunications devices and to IEC 60959 and ANSI S3.36-1985 for measurements on air conducting hearing aids

## EAR SIMULATOR

The ear simulator complies with ITU-T Rec. P.57, IEC 60711 and ANSI S3.25 standards. The output from the ear simulator is via a 7-core 3 m cable (2.3 m from the bottom of the torso) terminated with a Lemo (1B) plug. For connection to a preamplifier input socket of Brüel & Kjær Power Supplies, Analyzers, etc., a Lemo-to-Brüel & Kjær adaptor is supplied  
**Typical Sensitivity:** 12.6 mV/Pa (-38 dB re 1 V/Pa) at 250 Hz  
**3% distortion level:** 162 dB re 20 µPa at eardrum position

## LEFT EAR TO RIGHT EAR TRACKING

±1 dB up to 5 kHz, ±3 dB up to 8 kHz (measured using the same ear simulator)

## PINNA SIMULATORS

Dimensions similar to those specified in ITU-T Rec. P.58, IEC 60959 and ANSI S3.36. Minor adjustments in the dimensional details have been made which enable the 4128C to conform with the acoustic specifications of these documents in the frequency range 100 Hz to 8 kHz. Types 4158C and 4159C are supplied with calibrated pinna simulators. An additional pair of uncalibrated soft pinna simulators are supplied with the 4128C

## MOUTH SIMULATOR

Input to mouth simulator via 0.75 m cables (0.2 m from the bottom of the torso) terminated with banana-sockets  
**Sound Pressure Distribution:** conforms to ITU-T Rec. P.51

**Mouth Opening:** W×H: 30×11 mm

(42×16 mm with mouth adaptor removed)

**Equivalent Lip Plane Position, CL:** 6 mm in front of the sound radiation opening

**Mouth Reference Point, MRP:** 25 mm in front of mouth CL

**Continuous Output Level at MRP:**

Min. 110 dB SPL, 200 Hz to 2 kHz

Min. 100 dB SPL, 100 Hz to 8 kHz

**Typical Sensitivity at 1 kHz:** 80 dB SPL 2V/500 mm

**Distortion (harmonic components up to 8 kHz) at 94 dB SPL:**

<2%, 200 Hz to 250 Hz

<1% >250 Hz

**Max. Average Input Power:** 10 W max. continuous average power (at 20°C (68°F))

**Max. Pulsed Input Power:** 50 W for 2 seconds (limited by protection circuit)

**Loudspeaker Impedance:** 4 Ω

**Loudspeaker Diameter:** 80 mm (3.1 in)

## DIMENSIONS AND WEIGHT

The main dimensions comply with the dimensional requirements of ITU-T Rec. P.58 and the reports from IEC 60959 and ANSI S3.36-1985

**Total height, Head and Torso:** 695 mm (27.4 in)

**Torso:** Height: 460 mm (18 in)

Width: 410 mm (16 in)

Depth: 183 mm (7.2 in)

External neck diameter: 112 mm (4.4 in)

**Head Angles:** Vertical or 17°

**Weight:** 9 kg (19.8 lb.)

## Ordering Information

<b>Type 4128D</b>	Head and Torso simulator with 4128C and 4606
<b>Type 4128C</b>	Head and Torso Simulator
<b>Including:</b>	
<b>Type 4158C</b>	Right Ear Simulator (including Right Pinna – hard) Mouth Simulator
<b>and the following accessories:</b>	
BC 5000	Calibration Disk
BC 0183	Calibration Chart – Listener Frequency
BC 0181	Calibration Chart – Talker Frequency
BC 0168	Calibration Chart – Type 4158C
DZ 9751	Left Pinna – soft
DZ 9752	Right Pinna – soft
DB 2902	Ear Mould Simulator
UC 0199	Ear Mould Simulator – long
UA 1546	Adaptor for Calibration
QA 0167	Ear Mounting Tool
QA 0223	Preamplifier Mounting Tool
UA 1043	Pair of Feet
ZG 0350	Lemo-to-Brüel & Kjær Adaptor
UC 5290	Adaptor for Tripod

## Optional Accessories

Type 4606	Handset Positioner for HATS
Type 4159C	Left Ear Simulator
Type 4231	Sound Level Calibrator
Type 4938	Pressure-field ¼-inch Microphone
Type 2670	Falcon Range® ¼-inch Microphone Preamplifier
UA 1541	Cradle (For Type 4606)
UC 5345	Torso with adjustable neck ring – Upgrade
DZ 9626	Left Pinna – hard
DZ 9627	Right Pinna – hard
AO0419	Microphone Extension Cable 3 m
EL 4006/xx	Microphone Extension Cable xx m
UA 0587	Tripod

## Services

4128 – CFF	Factory Standard Calibration
4606 – TCF	Conformance Test (Mounting and Testing of Type 4606 on Types 4128/4128C)

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