Product Data

Head and Torso Simulator — Type 4128

USES:

- ❍ Measurements on handset and headset telephones
- ❍ Measurements on loudspeaking and hands-free telephones for mobile and domestic use
- ❍ In-situ/insertion measurements of hearing aids
- ❍ Evaluation of headphones
- ❍ Evaluation of hearing protectors
- ❍ Evaluation of close-talking/noise-cancelling microphones

FEATURES:

- ❍ Manikin with surfaces replicating the shape of a median adult human head and torso
- ❍ Highly-representative mouth simulator with overload protection
- ❍ Highly-representative IEC 711/ITU-T Type 3.3 based calibrated ear simulator (Type 4158) with built-in 1/2" condenser microphone and microphone preamplifier
- ❍ Compliance with the acoustic requirements of ITU-T Rec. P.58, IEC 959, and ANSI S3, 36–1985
- ❍ Soft Pinnas included for realistic headphone measurements

Head and Torso Simulator Type 4128 has been developed for objective in-situ research and evaluation of:

- ❍ telephones and headsets
- ❍ audioconference devices
- ❍ microphones
- ❍ headphones
- ❍ hearing aids and hearing protectors

The design of Type 4128 is based on an efficient minimum-parameter description of the median human adult. It provides a correct representation of the acoustic field around a human head and torso.

The acoustic performance and the main physical dimensions of Head and Torso Simulator Type 4128 conform to the requirements of ITU-T Rec. P.58, IEC 959, and ANSI S 3.36–1985.

The built-in mouth simulator closely replicates the sound field generated by the human mouth, including the frequency-dependent motion of the acoustic centre in the frequency range which is important for noise-cancelling microphones.

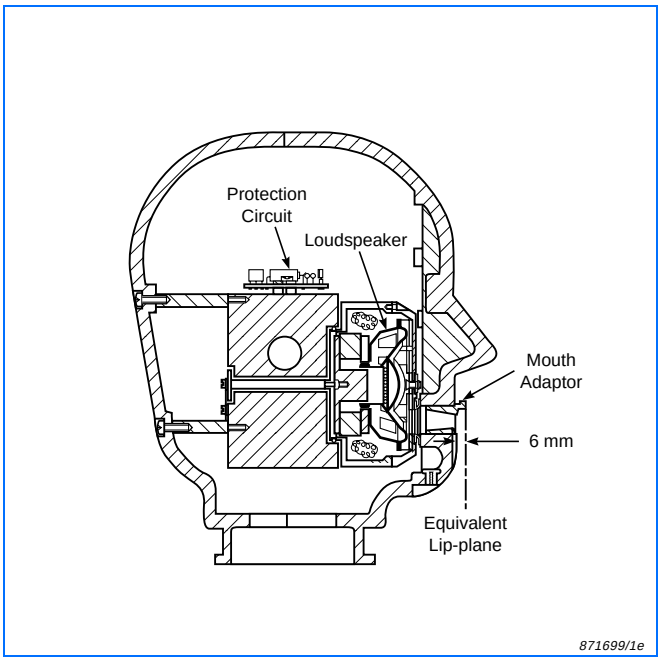

Fig. 1 The mouth simulator of Type 4128

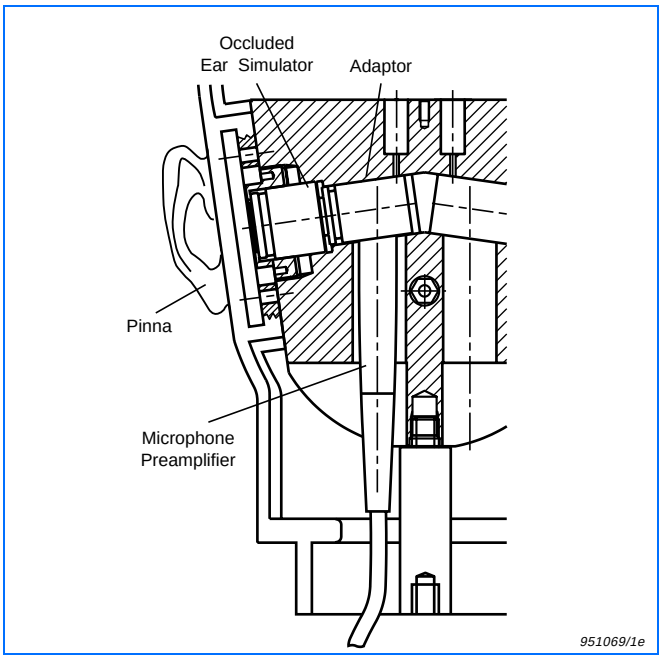

Fig. 2 Cross-section of the pinna of the right ear with the ear simulator fitted

Introduction

Head and Torso Simulator Type 4128 consists of a head mounted on a torso which extends to the waist. You can use it free-standing, or fitted on a tripod or rotating table using the tripod mounting-adaptor supplied.

With its simplified shape, Type 4128 has 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.

The Mouth Simulator

The mouth simulator in the Head and Torso Simulator (see Fig. 1) 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 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 the 4128 which will hold a reference microphone (Brüel&Kjær Type 4135 with Preamplifier Type 2633) at precisely the correct distance for calibration at the MRP. This holder can also hold a microphone right at the opening of the mouth if you want to monitor the sound pressure at this point.

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 Recommendation P.51. The position of the acoustic-centre of the mouth simulator also follows that of human subjects over the speech frequency range.

Ear Simulator Type 4158

Ear Simulator Type 4158, is shown in Fig. 2. It consists of a removable silicone-rubber pinna joined to an ear canal. The pinna complies with ITU-T Rec. P57. The ear canal ends in an occluded ear-simulator which simulates the inner part of the ear canal according to the ICE711 standard The occluded ear-simulator contains a 1/2” microphone and is through an adaptor connected to a microphone preamplifier.

Type 4158 is the right ear of Type 4128. A left ear, Type 4159, is also available for measurements requiring two ears. For headphone measurements soft pinnas are also available (refer to the section about this subject). Both Type 4158 and Type 4159 are delivered with a calibration chart specific to their ear simulator and pinna.

Suitable calibration reference levels can be generated by Pistonphone Type 4228 or Sound Level Calibrator Type 4231.

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 frequency response in telecommunications work and the manikin frequency response in technical audiology. The response of Type 4128 for sound incident at 0° (that is, coming from the front) is shown in Fig. 3. The listener diffuse-field frequency response is also shown.

Type 4128 has an adjustable neck allowing 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 with no neck ring, a Torso with neckring (UC 5345) is available as an accessory.

Applications

Telephone Measurement

The Head and Torso Simulator Type 4128 can be used as a representative manikin for the in-situ evaluation of telephone equipment (see Fig. 4), 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.

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 Special Calculation Software Type 7661). You can also make simulated free-field measurements in ordinary rooms.

Type 4128 is especially useful for developing new designs of telephone equipment. Realistic simulation of the acoustic leakage between a handset and the human pinna enables measurements of low impedance devices to be performed. In addition, Type 4128 accurately simulates the "obstacle effect" of the head, allowing realistic measurements on loudspeaking or hands-free telephones to be made.

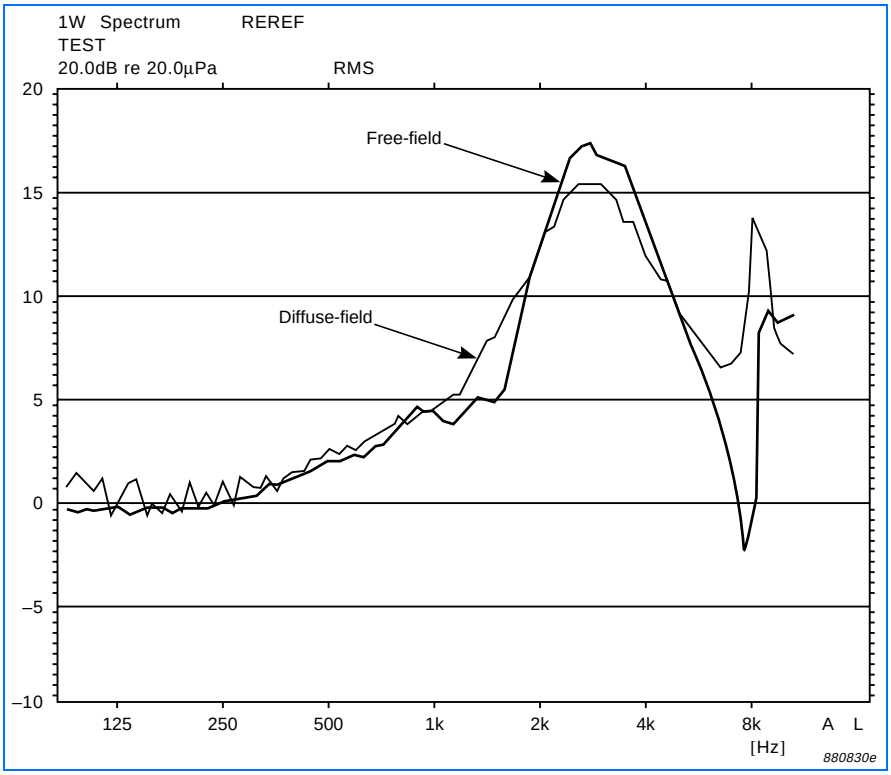

Fig.3 The listener free-field frequency response and the diffuse-field frequency response of Type 4128

Headphone Characteristics

You can use Type 4128 to determine a variety of headphone characteristics in-situ. Any type of headphone can be investigated; 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. For insert headphone or earphone measurements an additional set of non-calibrated pinnas (left and right) with a hardness very close to that of a real human pinna are supplied with the 4128. These soft pinnas feature a Shore A hardness of more than 4 times less the standard Type 3.3 pinna. This enables an easy and realistic mounting of any type of headphone. Simulated *insertion* responses are measured referring to either the equivalent free-field, or diffuse-field response. Moreover, when used with Audio Analyzer Type 2012, frequency response measurements are made simply and rapidly.

Type 4128 can also be used to determine the left/right tracking of headphones and their background noise insertion-loss.

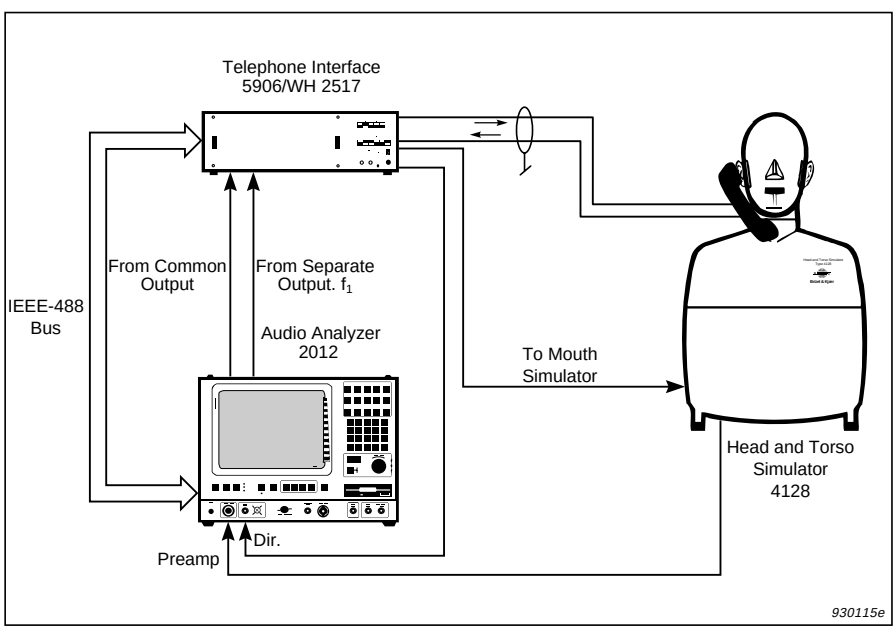

Fig.4 Measurement of telephone headset using Type 4128, Audio Analyzer Type 2012 and Telephone Interface Type 5906/WH2517

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 transfer function of the Type 4128 fitted with a hearing protector and then giving this result relative to the free-field response of the 4128. 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 necessary without the need for an external computer.

The Type 4128 can be placed in-situ so the actual noise sources for which the hearing protector is designed can be used in tests. The ef-

fectiveness 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 4128. Two ear-mould simulators are supplied with the 4128 for testing hearing aids where individually-made ear-moulds are normally used. The mouth simulator in Type 4128 is very 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 described in IEC Publication 118–8 (1983) *Methods of Measurement of Performance Characteristics of Hearing Aids under Simulated In-situ Working Conditions.*

Microphone Measurement

When making measurements on microphones, Type 4128 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 4128 with close-talking, noise-cancelling and lavalier types, where the characteristics of the human voice must be reproduced accurately and the influence of the head and body is very important.

Speech Intelligibility Investigation

You can investigate the quality of speech intelligibility in a room using the Head and Torso Simulator, together with the Brüel & Kjær Speech Transmission Meter Type 3361. This quantifies speech intelligibility based on the RASTI (RApid Speech Transmission Index) method. Type 4128 is incorporated in the system as transmitter, simulating the speaker, and can be driven from the transmitter part of the system. The RASTI calculation is performed by the receiving part of the 3361.

Specifications 4128

LISTENER FREQUENCY RESPONSE:
Conforms to ITU-T Rec. P.58 for measurements on telecommunications devices and to IEC 959 and ANSI S3.36-1985 for measurements on air conduction hearing aids

EAR SIMULATOR:
The output from the ear simulator is via a built-in 7-core 3 m cable (2.3 m from the bottom of the torso) terminated with a standard plug for connection to a preamplifier input socket of Brüel & Kjær Power Supplies, Analyzers, etc. The Ear Simulator complies with IEC 711 and ANSI S3.25 standards
Sensitivity: 9 mV/Pa (–41 dB re 1 V/Pa) at 250 Hz
3% distortion level: 160 dB re 20 µPa at ear-drum 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 959 and ANSI S3.36-1985. Minor adjustments in the dimensional details have been made which enable the 4128 to conform with the acoustic specifications of these documents in the frequency range 100 Hz to 8 kHz. Types 4158 and 4159 are supplied with calibrated pinna simulators. An additional pair of uncalibrated soft pinna simulators are supplied with the 4128

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

Mouth opening: W × H: 30 × 11 mm
(42 × 16 mm with mouth adaptor removed)
Equivalent lip plane position: 6 mm in front of the sound radiation opening
Continuous output level at MRP:
Min. 110 dB SPL, 200 Hz to 2 kHz
Min. 100 dB SPL, 100 Hz to 8 kHz

Distortion (harmonic components up to 8 kHz) at 94 dB SPL:
<2%, 200 Hz to 250
<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)
(all mouth-simulator performance parameters are measured at 25 mm from the equivalent lip plane (ITU-T MRP))

DIMENSIONS:
The main dimensions comply with the dimensional requirements of ITU-T Rec. P.58 and the reports from IEC 959 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 (20 lb)

COMPLIANCE WITH STANDARDS:

CE	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
Safety	EN 61010–1 (1993): Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN 50081–1 (1992): Generic emission standard. Part 1: Residential, commercial and light industry. CISPR 22 (1993): Limits and methods of radio disturbance characteristics of information technology equipment. Class B Limits. FCC Class B limits.
EMC Immunity	EN 50082–1 (1992): Generic immunity standard. Part 1: Residential, commercial and light industry. **Note:** 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°C to +40°C Storage Temperature: –25°C to +70°C
Humidity	IEC 68–2–3: 90% RH (non-condensing at 40°C)
Mechanical	IEC 68–2–6: Vibration: 0.3 mm, 20 m/s², 10–500 Hz IEC 68–2–27: Shock: 1000 m/s² IEC 68–2–29: Bump: 1000 bumps at 250 m/s²

Ordering Information

Type 4128	Head and Torso Simulator
Including:	
Type 4158	Right Ear Simulator Mouth Simulator
and the following accessories:	
BC 5000	Calibration Disk
BC 0183	Calibration Chart – Listener Frequency
BC 0181	Calibration Chart – Talker Fequency
BC 0188	Calibration Chart – Type 4158
DZ 9751	Left Pinna – soft
DZ 9752	Right Pinna – soft
DB 2902	Ear Mould Simulator
UC 0199	Ear Mould Simulator – long
UA 1034	Adaptor for Calibration
QA 0167	Ear Mounting Tool
UC 5290	Adaptor for Tripod
QA 0038	Allen Key
UA 1052	Handle
UA1043	Pair of Feet

Optional Accessories

Type 4159	Left Ear Simulator
UC 5345	Torso with adjustable neck ring
DZ 9626	Left Pinna
DZ 9627	Right Pinna
AO 0027	Microphone Extension Cable 3 m
AO 0028	Microphone Extension Cable 10 m
AO 0029	Microphone Extension Cable 30 m
UA 0587	Tripod

Brüel & Kjær

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