PRODUCT DATA

High-frequency Head and Torso Simulator Type 5128-C and Handset Positioner Type 4606 for HATS

High-frequency Head and Torso Simulator (HATS)

By utilizing a new generation of high-frequency ear and mouth simulators, the High-frequency Head and Torso Simulator Type 5128-C now offers unprecedented realism in audio testing, covering the full audible frequency range of 20 Hz to 20 kHz.

By adding a geometrically correct ear canal to the pinna, small devices designed for in-ear placement can now be positioned as they will be used. A new, state-of-the-art coupler design simulates the inner-ear and concludes the simulation of the ear of an average human adult.

High-frequency HATS is ideal for performing in situ electroacoustic tests on, for example, headphones, smartphones, headsets, conference phones and hearing aids.

Handset Positioner for HATS

Handset Positioner Type 4606, with pressure, force and position read-outs, allows accurate, repeatable mounting of smartphones on HATS in both standardized and user-defined positions. This makes HATS into a unique test rig for measurements of handset telecommunication equipment.

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Uses and Features

Uses

Type 5128-C

- Research and development of headphones
- Research and development of communication handsets and smartphones
- Development of headsets and hands-free communication devices
- Evaluation of hearing aids

Type 5128-C with Optional Type 4606

- Accurate, repeatable positioning of handsets on HATS for electroacoustic measurements
- Measurements in standardized positions according to ITU-T Rec. P.64

Features

- Ear simulator with human-like pinna and ear canal as well as high-frequency coupler
- Individual calibration data for ear simulator
- Pinnae complying with ITU-T Rec. P.57
- High-frequency mouth simulator complying with ITU-T Rec. P.58
- Full-range acoustic simulation of the average human ear
- Head and torso geometry complying with ITU-T Rec. P.58, IEC 60318-7* and ANSI S3.36-1985
- Internally powered mouth for simplified test configuration
- Side connector panel for easy set up
- Extended soft area around pinnae for better sealing of over-ear devices
- Adjustable neck angle to provide realistic posture
- Simple to configure for both standardized and user-defined mounting position†
- Graduated adjustment in three planes around the ear reference point†
- Spring-loaded mounting of the handset against the ear with adjustable pressure force†

* IEC 60318-7, formerly IEC 60959

† Only when Type 4606 is mounted on High-frequency HATS Type 5128-C

Brüel & Kjær

Introduction

High-frequency Head and Torso Simulator (HATS) Type 5128-C addresses an increasing need for realistic, accurate and repeatable acoustic measurements across the full range of human hearing. This enables more precise correlation between subjective evaluation and objective characterization of the acoustic performance of smart devices and associated accessories like headphones.

High-frequency HATS provides realistic acoustic loading of smart devices and headphones over the full audible frequency range, more than doubling the current maximum frequency range from 8 kHz to 20 kHz. Equipped with a more realistic ear canal, in-ear devices can now be positioned as they would be by the consumer.

The product consists of a head mounted on a torso, representing 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. High-frequency HATS can be used free standing, fitted on a tripod, or on a turntable using a tripod mounting adapter. High-frequency HATS is configurable, but typically includes a mouth simulator and one or two ear simulators. However, other configurations are available on request. High-frequency HATS has an adjustable neck that allows the head to be placed in a realistic posture for different positions of the torso. This is useful in real-life simulations, for example, when making measurements in car seats.

Description of Type 5128-C

The Artificial Ear

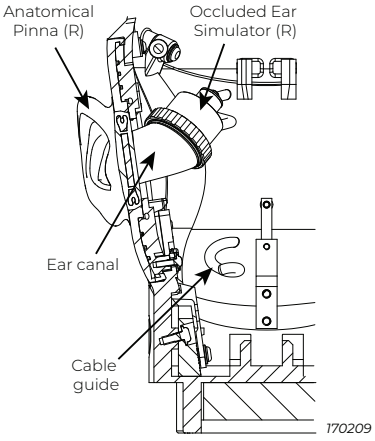


Fig. 1
Cross-section of the right artificial ear fitted in High-frequency HATS. It consists of a pinna, an ear canal and an occluded ear simulator

Each artificial ear (referred to as the Ear Simulator throughout this document) consists of a removable silicon-rubber pinna joined to a human-like ear canal. The ear canal ends in an occluded ear simulator that simulates the inner part of the ear, that is, from the ear drum and inwards. The occluded ear simulator (which contains patented technology) includes a prepolarized measurement microphone and preamplifier.

Each ear simulator is delivered with a pinna corresponding to ITU-T Rec. P.57 (hardness 35 on the Shore-OO scale). This allows measurements on, for example, handsets using a realistic application force and obtaining a close simulation of an average human acoustic impedance to the handset. The pinna enables realistic deformation levels for measuring in open, semi-sealed, or sealed conditions due to its specially designed human-like shape and stiffness.

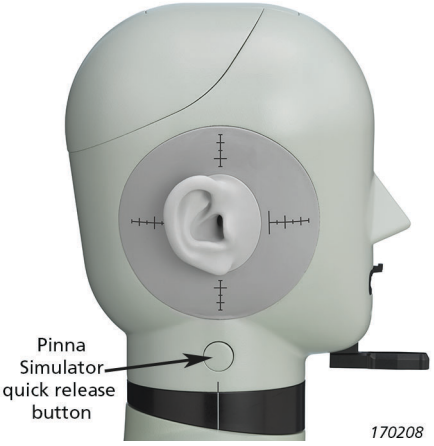
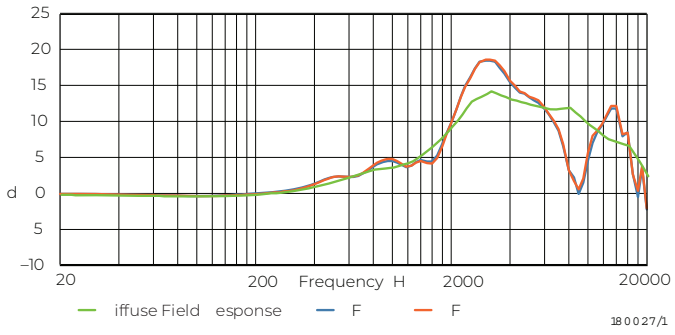


Fig. 2
Pinna simulator quick release button

Each pinna simulator has a quick release button directly below the pinna (see Fig. 2). This allows you to remove the pinna (and surrounding soft area) for servicing and cleaning.

Fig. 3
Typical listener free-field and diffuse-field frequency responses of Type 5128-C.



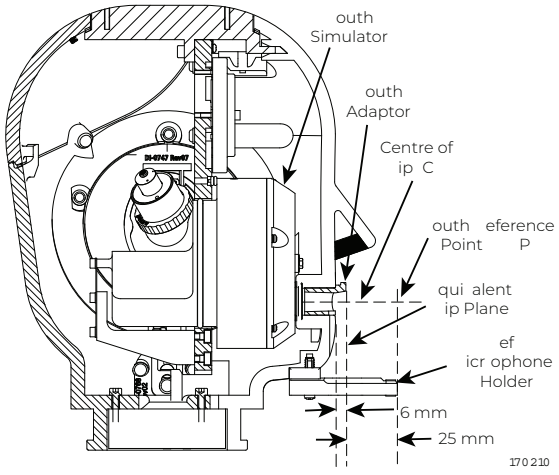
Each ear simulator is delivered with a calibration chart specific to that ear simulator and pinna. The calibration information is also stored electronically in a chip inside the microphone preamplifier and can be utilized by measurement instrumentation that supports TEDS. Sound Calibrator Type 4231 and Pistonphone Type 4228 are suitable calibrators for these ear simulators.

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 the free field to the eardrum). This is called the listener free-field frequency response, or head-related transfer function (HRTF) in telecommunications, and the mannequin frequency response in technical audiology.

The typical listener free-field response of Type 5128-C for sound incidence at 0° (that is, coming from the front) is shown in Fig. 3. The frequency response data is provided with High-frequency HATS.

The Mouth Simulator

Fig. 4
Reference points and main features of the High-frequency HATS mouth simulator



High-frequency HATS mouth simulator has a high-compliance loudspeaker that gives powerful low-frequency response and low distortion. The acoustic transmission path from the loudspeaker to the mouth opening ensures an easily equalized frequency response of the sound pressure level in front of the mouth.

The mouth simulator produces a sound-pressure distribution around the opening of the mouth simulating that of an average adult human mouth, corresponding to the figures given in ITU-T Rec. P.58. An individual equalization procedure ensures a flat frequency response, enabling the mouth simulator to reproduce the frequency range of human subjects.

The loudspeaker in the mouth simulator is powered by an integrated amplifier, and the signal for the mouth simulator is directly wired to the connector panel on the side of High-frequency HATS.

A holder is supplied with High-frequency HATS that will hold a ¼" reference microphone at precisely the correct distance for calibration at the mouth reference point (MRP). 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. 5
Top:
Handset Positioner Type 4606 for HATS

Bottom:
Alignment of receiver of mobile phone in cradle

Handset Positioner Type 4606 for HATS (see Fig. 5, top) is well suited for repeatedly accurate positioning of telephone handsets on HATS when performing electroacoustic measurements.

The device can be mounted directly on the top of HATS and securely holds and positions any type of handset, that is, smartphones, cordless or conventional handsets.

The supplied alignment jig (see Fig. 5, bottom) allows the handset to be positioned within the cradle, setting the handset's ear reference point (ERP) and the ear cap plane. Once the cradle is mounted on the handset positioner, it can be adjusted in three different planes around the ERP, and the corresponding angles can be read off graduated markings. The ERP of the handset then corresponds to the nominal ERP of the HATS pinna. Precision positioning mechanisms with graduated markings enable exact positioning that is easily repeatable. A table for noting down these parameters is available for download from Brüel & Kjær's web page. Additional cradles are available as accessories.

The handset can be pressed against the HATS pinna with adjustable force (0 – 18 N) by the handset positioner. This is done using a screw adjustment that allows you to set the force via a scale graduated 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 pinnae. The deflection can be read off the handset positioner that is graduated in millimetres.

Type 4606 is also easy to set up for standardized measurements. A standardized position, the 'HATS position' as defined in ITU-T Rec. P.64, is clearly marked on the handset positioner. This position takes into account the anatomy of the average human head. For exploring the effect of asymmetric transducers and simulating right- and left-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°, and repeating all graduations of the adjustment screws for the left-hand position. A built-in quick release mechanism for the cradle makes it easy to change the handset, or to change between measurements on the right and left ear.

Compliance with Standards

	The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives RCM mark indicates compliance with applicable ACMA technical standards – that is, for telecommunications, radio communications, EMC and EME China RoHS mark indicates compliance with administrative measures on the control of pollution caused by electronic information products according to the Ministry of Information Industries of the People's Republic of China WEEE mark indicates compliance with the EU WEEE Directive
Safety	EN/IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use. ANSI/UL 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN/IEC 61000–6–3: Generic emission standard for residential, commercial and light industrial environments. 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/IEC 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments. EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements. **Note:** The above is only guaranteed using accessories listed in this document.
Temperature	IEC 60068–2–1 and IEC 60068–2–2: Environmental Testing. Cold and Dry Heat. Operating Temperature: –5°C to +40°C (+23°F to +104°F) Storage Temperature: –25°C to +70°C (–13°F to +158°F)
Humidity	IEC 60068–2–78: Damp Heat: 93% RH (non-condensing at 40 °C (104 °F))
Mechanical	Non-operating: IEC 60068–2–6: Vibration: 0.3 mm, 20 m/s^2, 10–500 Hz IEC 60068–2–29: Bump: 1000 bumps at 250 m/s^2

Specifications – High-frequency Head and Torso Simulator Type 5128-C

LISTENER FREQUENCY RESPONSE
Based on specifications in ITU-T Rec. P.58, IEC 60318–7 and ANSI S3.36–1985

EAR SIMULATOR
Output BNC (Connector Panel)
Sensitivity: 15.8 mV/Pa = –37.7 dB (±2.2 dB) re 1 V/Pa @ 250 Hz
Sound Pressure Level at 3% Harmonic distortion: 160 dB re 20 µPa at eardrum position
Typical Noise Level: 27.5 dB SPL(A) re 20 µPa at eardrum position

TYPICAL LEFT EAR TO RIGHT EAR TRACKING
Better than ±1 dB up to 5 kHz, better than ±3 dB up to 20 kHz

PINNA SIMULATORS
Dimensions comply with ITU-T Rec. P.58, IEC 60318 – 7 and ANSI S3.36. Type 5128-C is supplied with calibrated pinnae and ear simulators

MOUTH SIMULATOR
Input BNC (Connector Panel)
Sound Pressure Distribution: conforms to ITU-T Rec. P.58
Mouth Opening (W × H): 30 × 11 mm (1.18 × 0.43″)
Equivalent Lip Plane Position, CL: 6 mm (0.24″) in front of the mouth opening
Mouth Reference Point, MRP: 25 mm (0.98″) in front of mouth CL
Continuous Output Level at MRP with sine tones:
- Min. 110 dB SPL, 200 Hz to 3 kHz
- Min. 100 dB SPL, 100 Hz to 11.8 kHz
- Min. 95 dB SPL, 100 Hz to 12.5 kHz

Continuous Output Level at MRP with 1/3-octave pink noise*:
- Min. 106 dB SPL, 50 Hz to 16 kHz
- Min. 100 dB SPL, 20 Hz to 20 kHz

Typical Sensitivity at 1 kHz at MRP:
- 94 dB SPL @ 35 mV_{rms}
- 110 dB SPL @ 0.2 V_{rms}
- 120 dB SPL @ 0.7 V_{rms}

Harmonic Distortion at 94 dB SPL: Less than 14% at 100 Hz; less than 1% from 300 Hz to 11.8 kHz
Max. Input Voltage: 0.7 V_{rms} continuous input voltage (at 20 °C (68 °F))
Input Impedance: greater than 30 kΩ
Typical Amplifier Gain: 19 dB ±0.3 dB
Protection Circuit:
- Threshold voltage: 1 V
- Detection time: 12 s
- Recovery time: 2 s (loudspeaker muted)

DIMENSIONS AND WEIGHT
The main dimensions comply with the dimensional requirements of ITU-T Rec. P.58 and the reports from IEC 60318–7 and ANSI S3.36–1985
Total Height, Head and Torso: 695 mm (27.4″)
Torso: Height: 460 mm (18″), Width: 410 mm (16″), Depth: 183 mm (7.2″)
External Neck Diameter: 112 mm (4.4″)
Head Angles: Vertical or tilted 17° forwards
Weight: 9 kg (19.8 lb)

* For example when using ITU-T P.50 artificial speech and real speech signals according to ITU-T P.501.

SPEAKING POSITION
Standardized Position: HATS position as defined in ITU-T Rec. P.64
∠A = 21.2°, ∠B = 12.9°, ∠C = 2.3°
Variable Positions: ∠A adjustable from +15° to +35°, ∠B adjustable from +30° to –10°, ∠C adjustable from +20° to –20°
Angle Resolution: 0.5°
Precision: Once mounted, the handset ERP can be set within 1 mm relative to the nominal ERP of the HATS pinna

CENTERING FORK UA-1587
Min. Width: 26 mm (1.02″)
Max. Width: 92 mm (3.62″)
Min. Thickness: ≥0 mm (≥0″)
Max. Thickness: 44 mm (1.73″)

CENTERING FORK UA-1537
Min. Width: 26 mm (1.02″)
Max. Width: 66 mm (2.6″)
Min. Thickness: ≥0 mm (≥0″)
Max. Thickness: 44 mm (1.73″)

OFFSET ADJUSTMENT
For asymmetrical handsets, the offset perpendicular to the handset can be adjusted in the range ± half the handset width minus 8 mm (0.31″)

END STOP ADJUSTMENT
The end stop can be adjusted from 8 to 36 mm (0.31″ to 1.42″).
0 mm is located at the ERP of the handset

APPLIED EAR FORCE
The force that a handset exerts against the HATS pinna can be adjusted from 0 to 18 N

WEIGHT
Handset Positioner (incl. cradle, excl. handset): 1.4 kg (3.09 lb)
Alignment Jig (excl. cradle): 2.4 kg (5.29 lb)

Ordering Information

Overview of included parts:

Included:	Handset Positioner*	Right Ear Simulator†	Left Ear Simulator†	Mouth Simulator‡	Right Ear**	Left Ear**
Type 5128-C-110 Head and Torso Simulator with Right Ear Simulator, Left Ear Simulator and without Mouth Simulator		•	•			
Type 5128-C-111 Head and Torso Simulator with Right Ear Simulator, Left Ear Simulator and Mouth Simulator		•	•	•		
Type 5128-C-771 Head and Torso Simulator with Right Ear, Left Ear and Mouth Simulator				•	•	•
Type 5128-D-111 Head and Torso Simulator with Right Ear Simulator, Left Ear Simulator, Mouth Simulator and Handset Positioner	•	•	•	•		

* Handset Positioner Type 4606.
† Consists of a Type 3.3 pinna with an average human ear canal attached to an ear drum simulator. The ear drum simulator has an average human acoustical impedance. A pre-polarized microphone (with pre-amplifier) is incorporated.
‡ The mouth simulator complies with ITU-T P.58 (2013) and incorporates an integrated audio amplifier.
** Consists of a Type 3.3 pinna with an average human ear canal terminated with a plastic cap.

Included Accessories

All configurations of Type 5128 include the following accessories:
- DI-0658: Calibrator Adapter
- UI-0209: Microphone Holder (for 7 mm wide ¼″ microphone)
- DI-1057: Adapter for UI-0209 (to hold 6.25 mm wide ¼″ microphone)
- BC-5009: Data Disk for High-frequency HATS
- ZG-0426: Power Supply, Mains Cable
- KE-4364: Flight Case

Optional Accessories

Type 4606	Handset Positioner for HATS* with 2 × UA-1587
UA-1537	Centering Fork for Type 4606 (for handsets with width between 26 mm and 66 mm)
UA-1587	Centering Fork for Type 4606 (for handsets with width between 26 mm and 99 mm)
UA-1642	Deep Cradle (for Type 4606)
UA-4132	Four alignment pins for Mounting Bracket (for Type 4606)
Type 4231	Sound Calibrator
Type 4938	¼″ Pressure-field Microphone, 200 V polarization voltage
Type 4944-A	Prepolarized ¼″ Pressure-field Microphone
Type 2670	¼″ Microphone Preamplifier
UC-5345	Torso, with adjustable neck ring (for repair)
AO-0087-x-yyy†	Cable, coaxial single screen, BNC (M) to BNC (M)
AO-0090-x-yyy†	Cable, floating ground, BNC (M) to LEMO 1B 7-pin (M)
AO-0479-x-yyy†	Cable, floating ground, BNC (M) to LEMO 1B 7-pin (M)
WQ-2701	Heavy-duty Tripod
WA-1647	HATS Car Seat Fixture
KE-4347	Flight Case for Two Heads
KE-4364	Flight Case
UA-1043	Support Feet‡
UC-5290	Adapter for Tripod

* It is recommended that Type 4606 is checked on a regular basis. Specifically, if any part of the handset positioning system has been mishandled in any way, a physical check is recommended. If you want Brüel & Kjær to perform such a check for you, order Conformance Test 4606-TCF

Services

5128-CFF	Factory Standard Calibration
5128-EW1	Extended Warranty for Head and Torso Simulator Type 5128-C, one year extension
4606-TCF	Conformance Test (mounting and testing of Type 4606 on Type 5128-C)
4938-CAF	Accredited Calibration of ¼″ Pressure-field Microphone

† x = D (decimetres) or M (metres)
yyy = length in decimetres or metres
Please specify cable length when ordering

‡ It is recommended to use support feet when Handset Positioner Type 4606 is mounted on High-frequency HATS

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