

Brüel & Kjær

Electroacoustic Solutions

Audio testing solutions to optimise product performance in development and maintain quality in production.

ABK





The Audio Quality Challenge

Audio performance has become increasingly important to our everyday lives – both in entertainment but also, crucially, in communication, where real-time global meetings between multiple people are often held in challenging environments with high background noise levels.

To address these issues requires complex acoustic designs and accurate measurements to ensure customer satisfaction with the audio quality.

Most of these products are used on, in or over the ear and that scenario requires evaluation with an ear simulator rather than a microphone, and a mouth simulator rather than a loudspeaker. This is because the proximity to the ear and mouth alters the audio characteristics of the products requiring compensation and equalisation to obtain a good sound quality.

HBK produces the widest range of ear and mouth simulators in the industry, optimised for use over the full range of wearable audio devices.

Measurement condenser microphones remain the most accurate way of characterising the audio performance of products used in free- or diffuse-field situations. HBK can provide microphones optimised for accurate evaluation of open sound sources or loudspeakers embedded in sound ports with measurement ranges for high-level impulsive sounds down to below the threshold of human hearing.

To optimise the measurement and analysis process, we have high-quality but economic solutions for both signal conditioning and data acquisition solutions, including an agile software solution designed to solve the headaches of fast, accurate measurements and simplify custom software solutions.

Whatever your audio challenge, HBK has the products and solutions to meet your needs to refine your design and ensure that the achieved audio quality is maintained in production to deliver to customers the experience they expect.





Ear and Mouth Simulators

Ear Simulators reproduce key features of an average adult human ear, such as the geometry and acoustic impedance. This is important for products that are used in positions on, in or near the ear. There are several variants of ear simulator targeted at different markets and conforming to relevant standards for those industries.



An ear simulator consists of an acoustic coupler, which serves to reproduce the correct acoustic impedance and resonances of the human ear, a simulated ear canal and, optionally, a pinna. For hearing-aid testing, the most common form of ear simulator used includes the 2cc click-on coupler defined in ANSI S3.7

(2008) and IEC 60318-5 (2006) standards. HBK's version is Type 4946, which includes a wide range of adaptors for different hearing aid designs.



Perhaps the most ubiquitous ear simulator is the wideband version defined in ITU-T Rec. P.57, Type 3.2, which is based on the coupler commonly called the '711' after the original IEC standard that defines it. It provides a more realistic representation of the human ear acoustic impedance up to 8 kHz. HBK produces a wide range of

'711-based' wideband ear simulators containing both ¼-inch and ½-inch microphones and a range of both simplified and real pinnae to suit applications in both product design and manufacture. The Type 3.2 standard also includes definitions of high and low-leak coupling of the ear simulator to the device under test. The Wideband Ear Simulator Type 4987 family represents the culmination of more than 30 years' experience in designing '711' couplers with unparalleled accuracy and stability. Type 4987 is available as a stand-alone coupler or with integrated, simplified pinna to suit various applications such as the testing of earbuds or speaker ports on mobile devices with integrated high and low-leak specifications.

The ever-increasing audio fidelity and frequency range of portable devices drove the requirement for a new standard of ear simulator that accurately represented the human

ear beyond 8 kHz. Extensive research by HBK resulted in the release of Ear Simulator Type 4620, which extended the range to 20 kHz and, for the first time, modelled the average geometry of a human ear canal.



Mouth simulators seek to simulate the acoustic dispersion pattern of the human mouth, which is particularly useful when testing communication devices or evaluating speech

recognition systems. HBK's Mouth Simulator Type 4227 complies with ITU-T Rec. P.51 and provides high stability and reliability. It's available in two versions, with a built-in amplifier or externally powered.



Type Number	Description
4152/4153	Ear Simulator 6cc coupler/IEC 60318 coupler without microphone and preamplifier
4195	Wideband Ear Simulator for Telephonometry (Type 3.2 coupler with microphone and preamplifier)
4227/4227-A	Mouth Simulator/Mouth Simulator with built-in amplifier
4620-L/R-001	Left/Right Ear Simulator for High-frequency HATS Type 5128
4946	2cc Click-on Coupler
4987	Wideband Ear Simulator (½-inch microphone + CCLD preamplifier)
4987-A-001	Wideband Ear Simulator (½-inch microphone + CCLD preamplifier) with O-shaped pinna and high leak adaptor
4987-A-002	Wideband Ear Simulator with semi-circular shaped pinna and high leak adaptor
4987-B-005	Wideband Ear Simulator with Ø11 adaptor

Head and Torso Simulators (HATS)



Individual ear and mouth simulators can provide an accurate evaluation of audio devices where the response is unaffected by the presence of the human body, most commonly for in-ear or far-field measurements. For devices such as mobile phones and headsets, the influence of the human pinna, head and torso becomes significant to the reproduction and evaluation of audio performance.

To accurately measure acoustic performance under these conditions requires the use of Head and Torso Simulator (HATS) where the ear and mouth simulators are integrated into the average geometric form of an adult human head and torso. A HATS is also more efficient when evaluating full duplex communication as well as evaluating the speech recognition of smart devices and virtual assistants.

In this new generation of HATS, the acoustic measurement range has been extended to the entire audio bandwidth of 20 Hz to 20 kHz. A new ear simulator family, holding a patented acoustic coupler design and a representative human-like ear canal, is the foundation for High-frequency HATS Type 5128 that conforms to the latest ITU-T P58 type 4.3 ear simulator standard.

The ear simulators include prepolarized microphones equipped with TEDS and that can be directly powered from most data acquisition systems. The mouth simulator has a built-in power amplifier requiring only a voltage input to produce the test signal required for audio performance evaluation.

Type 5128 can be ordered in different configurations depending on the application. The full HATS, Type 5128-C-111, includes the torso, two ear simulators and a mouth simulator. For compact applications, such as measurements in a small anechoic chamber or making headphone measurements on a desktop, the torso can be replaced by a small stand as model Type 5128-B-111. Configurations that will accomodate applications where the mouth, or either one of ear simulators, are not required are also available.

For mobile phone applications, a special version of the HATS, including Handset Positioner Type 4606 is

available, allowing accurate and repeatable positioning of a mobile phone and ordered as Type 5128-D-111. In addition to providing accurate positioning of the device, it also allows investigations into the variation of acoustic performance with increasing pressure, and ear canal sealing, on the ear.



Type Number	Description
5128-B-110	Tabletop HATS with left and right ear simulator (20 kHz, CCLD, 4.3 pinna)
5128-B-111	Tabletop HATS with left and right ear simulator (20 kHz, CCLD, 4.3 pinna), with active mouth simulator
5128-C-110	Head and Torso Simulator with left and right ear simulator (20 kHz, CCLD, 4.3 pinna)
5128-C-111	Head and Torso Simulator with left and right ear simulator (20 kHz, CCLD, 4.3 pinna), with active mouth simulator
5128-C-771-	Head and Torso Simulator with left and right pinna, with active mouth simulator
5128-D-111	Head and Torso Simulator with left and right ear simulator (20 kHz, CCLD, 4.3 pinna), with active mouth simulator and handset positioner
4606	Handset Positioner with Wide Centering Forks UA-1587 for HATS Type 4128
UA-2180	Support Foot for Tabletop HATS

Microphones

HBK manufactures a wide range of precision measurement microphones optimised for the various challenges facing our customers in evaluating the performance of their products. The microphones listed below represent a small subset of the most popular transducers used for electroacoustic testing. For a full list of the microphones available from HBK visit our website at: https://www.bksv.com/en/transducers/ acoustic/microphones



Туре 4989-А

A ¼-inch CCLD powered, pressure-field microphone optimised for production line test applications. Well suited

for cost effective and precise measurements close to sound ports and in production testing where the DUT's acoustic performance is a key differentiator. The microphone is designed to ensure maximum resistance to corrosion and minimum sensitivity to magnetic fields, with the microphone capsule and preamplifier housing made of titanium. It is fitted with a gold-plated brass SMB connector.



Туре 4944-А

A ¼-inch high-frequency, prepolarized pressure-field microphone designed to be used in small enclosures,

close to hard reflective surfaces or flush mounted. It has a measurement range of 16 Hz to 70 kHz, allowing evaluation of an extended audio range as required by, for example, Hi-Res audio standards. The preamplifier supports IEEE P1451.4 V0.9 TEDS (Transducer Electronic Data Sheet).



Type 4955

A ½-inch low-noise, free-field TEDS microphone with a 5.5 dB(A) noise floor, capable of measuring near

the threshold of human hearing. It can be used to detect low-level noise problems such as keyboard rattles, hinge creaks and electrical component noise. With an all-titanium construction and a frequency range covering the full audio band to 20 kHz, it is the ultimate choice for precision audio measurements.



Туре 4966-А-041

A ¹/₂-inch CCLD powered, free-field microphone with a flat response from 12.5 Hz to 20 kHz. It can be delivered in several versions including this one that is fitted with the

shortened Type 2695 preamplifier, allowing it to be used in situations where space is at a premium, such as building an array with a low noise floor. The preamplifier is terminated in a 10-32 UNF connector and supports IEEE 1451.4 V1.0 TEDS (Transducer Electronic Data Sheet)



Туре 4971-Н-041

A ½-inch CCLD powered, pressure-field corrected version of Type 4966 microphone, allowing it to

be used for precision coupler measurements or close to sound ports and where low-noise measurements are required. The preamplifier is terminated in a BNC connector and supports IEEE 1451.4 V1.0 TEDS (Transducer Electronic Data Sheet).

Type Number	Description
4944-A	¼-inch Pressure-field Microphone with CCLD amplifier, 4 Hz to 70 kHz, 1.0 mV/Pa
4954-A	¹ / ₄ -inch Free-field TEDS Microphone with SMB connector
4955	¹ / ₄ -inch Low-noise Microphone, 5 Hz to 20 kHz, externally polarized
4958	20 kHz Precision Array Microphone
4966-A-041	¹ / ₂ -inch Free-field Microphone, 12.5 Hz to 20 kHz, prepolarized, including preamplifier Type 2695 with TEDS
4971	½-inch Pressure-field Microphone, 3.5 Hz to 20 kHz, prepolarized, 12.5 mV/Pa
4989-A	¹ / ₄ -inch Pressure-field TEDS microphone with SMB connectors, all titanium, 5 to 20 kHz

Data Acquisition and Signal Conditioning

HBK's data acquisition and signal conditioning systems are highly scalable and modular, providing you with ample power and flexibility for even the most demanding applications. Our product portfolio ranges from small, ready-to-go systems with low channel-count analogue-to -analogue signal conditioning through combined signal conditioning and USB DAQ (data acquisition system) up to large LAN-XI data acquisition systems with more than 1000 channels. Signal Conditioning Amplifiers Types 1704 and 1708 are designed for easy use in test systems and are well suited for both R&D and production use. Type 1704 provides signal conditioning and power for one or two CCLD (Constant Current Line Drive) transducers such as microphones, accelerometers, and tachometer probes. The single-channel Type 1708 provides signal conditioning and power for HBK classical microphones (requiring 200 V excitation) as well as CCLD transducers.



The NEXUS[™] Range of Conditioning Amplifiers Types 2690, 2692 and 2693 provide up to four conditioning channels in a single mainframe with market-leading performance. Each CCLD, charge or

classic microphone module is highly customisable for a variety of filter options, allowing you to configure your conditioning amplifier to suit your needs. Automated TEDS detection is supported for



Production Test USB DAQ Type 3670 is specifically designed to be used with CCLD measurement transducers, streaming data through a USB interface to the HBK Electroacoustic Engine analysis software BZ-7852 or the customer's own analysis software. The system is designed for production QA applications being completely tamper-free, sealed and fanless.



www.bksv.com/3670

LAN-XI is a modular data acquisition system and analyzer platform providing you with a wide range of input/output modules that can be combined in a single DAQ system with more than 1000 channels. Both LAN-XI and LAN-XI Light are designed to deliver unrivalled dynamic input range for capturing sound and vibration data in a wide range of demanding measurement applications and interfaces with BK Connect® analysis software or the customer's own software through an Open API.

www.bksv.com/LANXI



Special Systems and Applications

Understanding the source of poor acoustic performance sometimes requires specialised equipment or analysis to pinpoint the root cause and the path to resolution. For example, identifying the exact location of an acoustic leak or the component responsible for a rattle excited by a speaker can best be achieved using our noise source identification systems. Commonly referred to as acoustic arrays these systems use near-field holography and acoustic beamforming techniques to accurately locate and evaluate acoustic artifacts mapped directly onto an image of the product.

HBK produces the widest range of arrays in the market, including a family of semi-circular arrays, specifically designed to evaluate acoustic emissions from small devices. It can also be used to evaluate leakage from wearable items mounted on our HATS Type 5128 and, when used in conjunction with Turntable Type 9640-A-001, can provide a full 360 view of the product performance or total leakage.

Acoustically absorbent materials are widely used in products to filter, attenuate or control acoustic resonances or limit impulsive sounds. Assessing the acoustic performance of a material and the impact it will have on audio quality can be measured using one of HBK's material testing tubes. Versions are available to measure both acoustic impedance and transmission and to cover frequency ranges from 50 Hz up to 20 kHz, providing input to numerical models for performance prediction.

Accurate assessment of the free-field performance of a product requires the use of an anechoic chamber, which are expensive facilities to use. For small products, an alternative is HBK's tabletop anechoic test box, which combines >40 dB attenuation in an anechoic environment and a built-in speaker providing a uniform sound field with equalisation from 50 Hz to 20 kHz.

Artificial Mastoid Type 4930

Impedance Tube Kit Type 4206

An increasingly common alternative to the use of loudspeakers in headphones and hearing aids is the use of vibration transducers to excite the bones in the skull surrounding the ear. Most commonly the mastoid bone behind the ear. The type 4930 Artificial Mastoid can accurately reproduce the impedance of the human mastoid to evaluate the hearing equivalent performance of bone-conducting devices.

> Anechoic Test Box Type 4232

> > Turntable System Type 9640-A-001



HBK partners with engineers across a wide variety of industries including automotive, aerospace, industrial, and telecom/audio to drive competitiveness across their business, and quality across their products. Our offering brings everything from sensors and data acquisition to data preparation, evaluation and engineering services together, with software-driven solutions designed to facilitate digital transformation and industry-leading excellence in hardware systems.

HBK provides a complete portfolio of technologies that cover the entire test and measurement life cycle across every domain. While sensor hardware and DAQs remain at the heart of our offering, we also provide state-of-the-art data management and analysis software, as well as simulation software and hardware. So whether you are a developer or a manufacturer, we are ready to support you at every stage of the product development and optimization process, including:

- Physical and virtual testing for more innovative Research & Development
- In-line measurement and end-of-line testing for manufacturing control and efficiency
- In-product sensing and in-service monitoring to maximize product quality for OEMs

On one hand, this means engineers have the tools they need to accelerate development cycles while maintaining production efficiency and quality. On the other, OEMs can continuously and reliably optimize performance through sophisticated in-product measurement and monitoring.