HMS II.3

HEAD Measurement System, Basic Version with Right Ear Simulator, 3.3 Pinna & Artificial Mouth
OVERVIEW

HMS II.3

Code 1703

HEAD Measurement System, Basic Version with Right Ear Simulator, 3.3 Pinna & Artificial Mouth

HMS II.3 is an artificial head measurement system with an artificial mouth and an IEC 60318-4-compliant right ear simulator. The system is ideally suited for measuring close-to-the-ear transducers in handsets, headsets, headphones, earphones, hearing protectors and hearing aids. By realistically replicating the acoustically relevant structures of the human anatomy, HMS II.3 also allows measurements of far-to-the-ear transducers such as hands-free equipment.

The ear simulator and the anatomically shaped pinnae are compliant with the type 3.3 ear simulator laid out in Recommendation ITU-T P.57 (06/2021). The low self-noise level (23 dB SPL(A)) allows conclusive measurements close to the hearing threshold. Combined with the very high upper limit of 165 dB SPL, this HMS system is ideally suited for all measurements in telecommunication and beyond.

Interchangeable ear simulator components allow flexible adaption and extension of the system, e.g. with a second ear simulator for binaural measurements or for standards that require type 3.4 or 4.4 ear simulators.

The P.58-compliant artificial mouth of HMS II.3 is a two-way loudspeaker design. It is capable of reproducing the full spectrum of human voice with lowest distortion, allowing high-quality measurements in super-wideband and fullband applications.

KEY FEATURES

Geometric and acoustic characteristics according to ITU-T P.58.

Modular design for easy retrofitting with compatible HMS components.

Ear simulator:
› Anatomically shaped pinnae for comprehensive measurements in near- and far-field
› Fully compliant with type 3.3 ear simulator laid out in ITU-T P.57 (06/2021)
› High quality condenser microphone with low inherent noise floor & very high SPL limit

Artificial mouth:
› Low-distortion two-way design with very wide frequency range for super-wideband & fullband applications
› Acoustic characteristics according to ITU-T P.58
› Digital equalization is supported by ACQUA
› Noise-free operation with coreOUT-Amp2

APPLICATIONS

Measurements in send & receive direction of:
› Telephone terminal equipment
› Hands-free devices

High precision measurements of arbitrary:
› Handsets
› Headsets and headphones (over-/on-ear)
› Hands-free devices
› Voice-operated equipment
› Active & passive hearing protectors
HMS II.3 is an artificial head measurement system ideally suited for all measurements in the field of telecommunications under realistic conditions. It comprises an artificial ear as well as an artificial mouth and thus supports measurements in sending and receiving direction. Complying with the geometric and acoustic characteristics of Recommendation ITU-T P.58, HMS II.3 is appropriate for close-to-the-ear, but also arbitrary far-field measurement scenarios. It can be used to test all kinds of transducers in e.g. handsets, headsets, headphones, hands-free devices, voice-operated equipment, hearing protectors and more.

**Ear simulator & pinnae**

The pinna and ear simulator of HMS II.3 accurately replicate the anatomy of the human outer ear. The microphone capsule in the ear simulator of HMS II.3 provides a low inherent noise floor of 23 dB SPL(A). As such, it is qualified for any measurement scenario with signal levels close to the human hearing threshold. The very high sound pressure level limit of 165 dB SPL ensures full usability of HMS II.3 for measurements up to high levels, too.

HMS II.3 is delivered with two anatomically shaped pinnae compliant with the type 3.3 ear simulator laid out in Recommendation ITU-T P.57 (06/2021).

**Artificial mouth**

The artificial mouth of HMS II.3 is compliant with Recommendation ITU-T P.58 in its free-field emission characteristics. Combined with diffraction and reflection at shoulders and torso, it realistically reproduces the acoustic behavior of a talking person. The two-way loudspeaker design of the mouth provides an excellent frequency response even without software equalization. The wide frequency range is superior to existing one-way designs in the market, making it ideally suited for measurements in super-wideband and fullband applications. The mouth is optimized for use with the labCORE hardware extension board coreOUT-Amp2. The board provides two class-D-amplified channels for one or two artificial mouths. In this constellation, the artificial mouth of HMS II.3 offers high performance without any notable self-noise.
Modularity

The modular design of the artificial ear allows to quickly add or change ear simulator(s) and pinnae. This can be used to equip HMS II.3 with a left-side ear simulator for binaural measurements. Alternatively, the ear simulator of the low-noise variant HMS II.3 LN (with pinnae type 3.3) or the low-noise ear simulator(s) with a human-like ear canal of HMS II.3 LN HEC (with pinnae type 4.4) can be installed. Replacing a pinna or ear simulator requires only the 2.5 mm Allen key that is included in the delivery.

HMS II.3 includes TEDS (Transducer Electronic Data Sheet) technology that allows ACQUA to determine the type and serial number of the HEAD Impedance Simulator(s) (HIS) as well as the HATS itself.

Playback and recording

For measurements, HMS II.3 connects to the communication analysis system ACQUA via the hardware platform labCORE equipped with the optional hardware board coreIN-Mic4. In combination with the necessary hardware modules including coreBEQ, equalization of binaural acoustical signals using various equalization variants is possible.

The artificial mouth of HMS II.3 is powered by the labCORE’s optional coreOUT-Amp2 hardware board. ACQUA allows comfortable and precise equalization of the mouth.

All connections are established at the bottom panel of HMS II.3. It offers the same connectors as an appropriately equipped labCORE: a 4-pin speakON socket for the artificial mouth and two 7-pin LEMO sockets for the artificial ear(s).

The delivered microphone fixture is designed for ease of use. It can be inserted into a dedicated flange at the throat of HMS II.3. Flexible rubber bands allow fixing of arbitrary measurement microphones in front of the mouth for quick and convenient equalization.

Accessories

For measurements of telephony handsets, HMS II.3 can be equipped with the optional handset positioners HHP IV or HHP III.1. The required neck bolts are part of the standard equipment and come pre-installed. HHP IV is fully motorized and remotely controllable and thus fully automatable via ACQUA. HHP III.1 offers manual positioning. Both allow precise positioning of any handset as well as precise adjustment of application forces to the pinna, ensuring meaningful and repeatable measurement results.

Another accessory for HMS II.3 is the artificial nose AN HMS. It makes measurements of nose-supported devices, e.g. AR / VR glasses and headsets, more reproducible and convenient to set up.

For own background noise recordings and to perform equalization of a background noise simulation system (e.g. 3PASS lab/flex), the microphone surround arrays MSA I or MSA II can be mounted on top of the artificial head. For precise alignment of HMS, the triaxial laser pointer TLP can be mounted here alternatively.

The supplied Torso Box HTB VI acoustically simulates a human torso. Its compact design allows easy handling and transportation of the complete system, e.g. for mobile applications. The bottom plate of HMS II.3 offers a quick-clamping mechanism for convenient mounting on HTB VI. For a more permanent connection, a screw thread allows fixation of HMS on the torso box.

In conjunction with the optional power box labPWR 1.2 for labCORE, mobile application (e.g. in vehicles) is also possible with HMS II.3.
**TECHNICAL DATA**

### Artificial Ear

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>3 Hz – 20 000 Hz</td>
</tr>
<tr>
<td>Frequency responses (FF/DF)</td>
<td>Compliant with ITU-T P.58</td>
</tr>
<tr>
<td>Directivity characteristics</td>
<td>Compliant with ITU-T P.58</td>
</tr>
<tr>
<td>Transfer impedance</td>
<td>Compliant with IEC 60318-4 and ITU-T P.57</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>23 dB$<em>{re}$(A) – 164 dB$</em>{re}$</td>
</tr>
<tr>
<td>Self-noise</td>
<td>Compliant with ITU-T P.57</td>
</tr>
<tr>
<td>Microphone sensitivity</td>
<td>12.5 mV / Pa</td>
</tr>
<tr>
<td>Polarization voltage</td>
<td>200 V</td>
</tr>
<tr>
<td>Supply voltages</td>
<td></td>
</tr>
<tr>
<td>› U (recommended)</td>
<td>± 60 V</td>
</tr>
<tr>
<td>› U (possible)</td>
<td>+ 120 V</td>
</tr>
</tbody>
</table>

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**Typical self-noise of HMS ear simulators (—) vs. average human hearing threshold (—)**

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**Typical transfer impedance of HMS II.3 ear simulator (—) vs. IEC 60318-4 tolerance scheme (—)**

1. All curves diffuse-field equalized, HMS II.3 measured with 4096 FFT, average hearing threshold according to ISO 389-7
2. Curve and tolerance scheme normalized to 500 Hz

### Artificial Mouth

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loudspeaker configuration</td>
<td>2-way</td>
</tr>
<tr>
<td>Impedance</td>
<td>4 Ω</td>
</tr>
<tr>
<td>Frequency range</td>
<td></td>
</tr>
<tr>
<td>› Unequalized</td>
<td>100 Hz – 20 000 Hz (± 4 dB)</td>
</tr>
<tr>
<td>› Equalized</td>
<td>50 Hz – 20 000 Hz (± 1 dB), exceeds ETSI TS 102 924</td>
</tr>
<tr>
<td>Total Harmonic Distortion (THD)</td>
<td>(at MRP, equalized, with coreOUT-Amp2)</td>
</tr>
<tr>
<td>› @ 0 dBPA (94 dB$_{re}$)</td>
<td>&lt; 4 % (100 Hz), &lt; 0,5 % (200 Hz – 20 000 Hz), exceeds ITU-T P.58</td>
</tr>
<tr>
<td>› @ +6 dBPA (100 dB$_{re}$)</td>
<td>&lt; 6 % (100 Hz), &lt; 1 % (200 Hz – 20 000 Hz)</td>
</tr>
<tr>
<td>› @ +12 dBPA (106 dB$_{re}$)</td>
<td>&lt; 10 % (100 Hz), &lt; 2 % (200 Hz – 20 000 Hz)</td>
</tr>
<tr>
<td>› @ +18 dBPA (112 dB$_{re}$)</td>
<td>&lt; 3 % (200 Hz – 20 000 Hz)</td>
</tr>
</tbody>
</table>
### Dimensions and Weight

<table>
<thead>
<tr>
<th>Max. continuous output level</th>
<th>(at MRP, equalized, with coreOUT-Amp2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink noise</td>
<td>min. 112 dB$<em>{spl}$ (50 Hz – 16 000 Hz), min. 106 dB$</em>{spl}$ (20 Hz – 20 000 Hz)</td>
</tr>
<tr>
<td>Sine</td>
<td>min. 112 dB$<em>{spl}$ (200 Hz – 6 000 Hz) @ THD &lt; 3 %, min. 106 dB$</em>{spl}$ (100 Hz – 10 000 Hz) @ THD &lt; 10 %</td>
</tr>
<tr>
<td>Real speech acc. ITU-T P.501</td>
<td>No audible distortion up to approx. 110 dB$_{spl}$</td>
</tr>
</tbody>
</table>

#### Other

<table>
<thead>
<tr>
<th>Power handling</th>
<th>20 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>P (continuous)</td>
<td></td>
</tr>
<tr>
<td>P (short-term)</td>
<td>50 W (max. power is electrically limited &gt; 6 kHz)</td>
</tr>
</tbody>
</table>

#### Environmental Conditions

- **Operating temperature range**: 0°C – 50°C (32°F – 122°F)
- **Storage temperature range**: -20°C – 70°C (-4°F – 158°F)
- **Humidity**: 20% – 80% relative humidity (non-condensing environment)
FEATURES & OPTIONS

**MSA II**

A centrally embedded thread at the top of HMS holds top-mounted accessories such as the Microphone Arrays MSA I, MSA II (shown) or the Triaxial Laser Pointer TLP.

Two additional threads towards the back of the head protect against accidental skew when using rotatable top-mounted accessories.

**IMPEDEANCE SIMULATOR AND PINNA**

The anatomically shaped pinna of HMS II.3 replicates the geometry of a human auricle. Beyond, the accompanying impedance simulator HIS R (shown) precisely recreates the ear’s acoustic properties.

The modular design of HMS II.3 allows to retrofit compatible ear simulators and pinnae (see next page).

**HHP IV**

Four neck bolts provide sturdy mounting points for an optional handset positioner. Available models are the manual HHP III.1 or the motorized HHP IV (shown).

**ARTIFICIAL NOSE & ARTIFICIAL MOUTH**

The artificial mouth’s two-way loudspeaker design provides excellent frequency coverage, a high maximum SPL and very low distortion.

The optional Artificial Nose AN-HMS can be fixed at the facial crosshair of HMS II.3.

**BOTTOM PLATE**

The bottom plate offers a speakON connector for the artificial mouth and two 7-pin LEMO connectors for left and right ear simulator.

A quick-clamping mechanism allows easy and fast attaching of HMS to the supplied torso box HTB VI. The thread below allows to fasten HMS on e.g. the optional tripod HMT III.1.

**MICROPHONE MOUNT**

A flange at the throat can accommodate the delivered microphone mount for calibration of the mouth. Durable rubber rings can accommodate optional microphones of different sizes.
EAR SIMULATOR & PINNA OPTIONS

Every HMS II.3 variant comes with a left & right pinna and a right ear impedance simulator for monaural measurements. For binaural testing, a left ear impedance simulator can be added. The modular nature of HMS systems of the latest generation allows users to build numerous different configurations optimized for specific purposes. HMS II.3 is delivered with two anatomically shaped pinnae type 3.3 as well as a right ear impedance simulator, both according to ITU-T P.57. This basic equipment as well as all further options for this HMS model are shown below for the right ear. The left ear can be equipped likewise.

HMS II.3

› Impedance simulator with straight ear canal
› Anatomically shaped pinna type 3.3 with straight ear canal

HMS II.3 LN

› Low-noise impedance simulator with straight ear canal
› Anatomically shaped pinna type 3.3 with straight ear canal

HMS II.3 LN HEC

› Low-noise impedance simulator with human-like ear canal
› Anatomically shaped pinna type 4.4 with human-like ear canal
OTHER HMS MODELS

In addition to HMS II.3 and its two variants LN and LN HEC, four additional models of the HEAD Measurement System are available.

HMS II.4
› Anatomically shaped pinnae type 3.3
› Right ear impedance simulator
› Ear retrofitting options like HMS II.3
› No artificial mouth (not retrofittable)
› Can serve as e.g. a (second) listener

HMS II.5
› Anatomically shaped pinnae type 3.3
› No impedance simulators
› Ear retrofitting options like HMS II.3
› Artificial mouth like HMS II.3
› Can serve as e.g. a (second) talker

HMS II.6/7
› Binaural free-field microphones in solid pinnae with simplified geometry
› HMS II.6 with high quality condenser microphones
› HMS II.7 with high quality ICP® microphones
› Not retrofittable with any other pinna or impedance simulator
› Artificial mouth like HMS II.3
› Can serve as e.g. a talker and/or listener in free-field applications

SCOPE OF DELIVERY

HMS II.3 (Code 1703)
› HEAD measurement system, basic version with right ear simulator, 3.3 pinna & artificial mouth

HIS R (Code 1702)
› HEAD impedance simulator, right, for HMS II.3/4/5

HEL 3.3 (Code 1711)
› Flexible pinna for HMS II.3/4/5, left ear, according to ITU-T P.57 Type 3.3

HER 3.3 (Code 1712)
› Flexible pinna for HMS II.3/4/5, right ear, according to ITU-T P.57 Type 3.3

CLL-R I.3 (Code 1722-3)
› Cable LEMO I 7-pin male ↔ LEMO I 7-pin male, red, 2.95 m

CSS V.3 (Code 1723-3)
› Cable speakON plug ↔ speakON plug, 2.95 m

CSB II (Code 9849)
› Adapter speakON male ↔ Banana plug

HTB VI (Code 1574)
› HEAD Torso Box for HMS II/III/IV & HSU

HCC-HMS (Code 1741)
› Carrying case for accessory parts HMS II.x containing:
  › Microphone holder
  › Lip ring & MRP pointer
  › Calibration adapter
  › 2.5 mm Allen key
  › 3 × Allen screw for HIS (spare parts)
  › 2 × Throat blind cap (spare parts)
  › Manual
OPTIONAL ACCESSORIES

General
HIS L (Code 1701)
 › HEAD impedance simulator, left, for HMS II.3/4/5
   (is delivered with cable LEMO I 7-pin male ↔ LEMO I 7-pin male, black, 2.95 m (Code 1721-3))
coreBEQ (Code 7740)
 › labCORE binaural equalization, incl. filter set for one artificial head (delivered with labCORE)
coreBEQ-Add (Code 7741)
 › labCORE binaural equalization, additional set of filters for one artificial head (coreBEQ required)
 › AN HMS (Code 1418)
   Extension for HEAD measurement system HMS: Artificial nose
HSM V (Code 1520)
 › HEAD Seat Mount adapter for artificial head measurement systems or a head-shoulder unit
HSC V-V2 (Code 1525-V2)
 › Carrying case for HMS II.x
HMT III (Code 1961)
 › Height-adjustable tripod for HMS
TLP (Code 1967)
 › Triaxial laser pointer for HMS/HSU positioning incl. two batteries and carrying case
MSA I (Code 6487)
 › 8 channel microphone surround array, Asymmetrical, according to ETSI TS 103 224
MSA II (Code 6487.2)
 › 8 channel microphone surround array, Symmetrical, according to ETSI TS 103 224

Ear Simulator retrofitting
All ear simulators are delivered with a cable LEMO I 7-pin male ↔ LEMO I 7-pin male, black, 2.95 m (Code 1721-3)

HIS L LN (Code 1701.1)
 › HEAD impedance simulator, left, low-noise version, for HMS II.3/4/5

GENERAL REQUIREMENTS

Hardware
labCORE (Code 7700)
 › Modular multi-channel hardware platform
coreBUS (Code 7710)
 › I/O bus mainboard
coreOUT-Amp2 (Code 7720)
 › Power amplifier board, for sending direction
coreIN-Mic4 (Code 7730)
 › Microphone input board, for receiving direction

Software
One of the following HEAD acoustics Software:
ACQUA (Code 6810)
 › Advanced Communication Quality Analysis Software, Full-license Version
   (Version 4.3.100 or newer)
ACQUA Compact (Code 6860)
 › (Version 4.3.100 or newer)
RC-labCORE (Code 6984)
 › (Version 1.1.100 or newer)
VoCAS (Code 6985)
 › Voice Control Analysis System
   (Version 1.2.150 or newer)
HIS L LN HEC (Code 1701.2)
› HEAD impedance simulator, right, low-noise version, for HMS II.3/4/5, human-like ear canal version

HIS R LN (Code 1702.1)
› HEAD impedance simulator, right, low-noise version, for HMS II.3/4/5

HIS R LN HEC (Code 1702.2)
› HEAD impedance simulator, right, low-noise version, for HMS II.3/4/5, human-like ear canal version

Pinna retrofitting

HEL 3.4 (Code 1713)
› Flexible pinna for HMS II.3/4, left ear, according to ITU-T P.57 type 3.4

HER 3.4 (Code 1714)
› Flexible pinna for HMS II.3/4, right ear, according to ITU-T P.57 type 3.4

HEL 4.4 (Code 1715)
› Flexible pinna for HMS II.3/4/5, left ear, according to ITU-T P.57 Type 4.4

HER 4.4-V1 (Code 1715-V1)
› Flexible pinna for HMS II.3/4/5, right ear, according to ITU-T P.57 Type 4.4, gray color

HER 4.4-V1 (Code 1716-V1)
› Flexible pinna for HMS II.3/4/5, right ear, according to ITU-T P.57 Type 4.4, gray color
IN PRACTICE

APPLICATION EXAMPLES

Measurement of a Voice-Controlled Smart Speaker with HMS II.3

This exemplary test scenario depicts testing a voice-controlled smart speaker with HMS II.3. labCORE connects to the artificial mouth and ear simulators of HMS II.3 via coreOUT-Amp2 and coreIN-Mic4 respectively. Background noise is simulated with 3PASS flex. For full repeatability of measurements, background noise playback is synchronized by labCORE through a pulse connection to the hardware platform labBGN. Another pulse connection controls motion of the motorized reflector HRR I to vary the echo path for the smart speaker. ACQUA operates in conjunction with labCORE to generate, receive and analyze signals.
Measurement of a Vehicle’s Hands-Free Communication System with HMS II.3

This exemplary test scenario depicts testing the hands-free communication system of a vehicle according to Recommendation ITU-T P.1100.

HMS II.3 is connected to an appropriately equipped labCORE. Together with ACQUA, labCORE acts as a central element by providing and receiving test signals and triggering background noise simulation via 3PASS flex. To assess echo attenuation, HRR I varies the acoustic echo path during measurements.

The hands-free system of this vehicle uses Bluetooth® for communication. The head unit is wirelessly connected to a mobile phone. The phone accesses the simulated mobile network of a radio tester.
Measurement of a Mobile Handset with HMS II.3

This exemplary test scenario depicts testing mobile handset - typically a smartphone - according to 3GPP TS 26.131 / 32. The handset is mounted in and positioned by the motorized handset positioner HHP IV. For testing, the smartphone accesses the simulated mobile network of a radio tester.

labCORE and ACQUA operate as the central software and hardware elements. Together they provide, receive and analyze test signals and control playback of background noise simulation via 3PASS lab. Connection to HMS II.3 - the "user" conducting a phone call - is established with the labCORE hardware extension boards coreOUT-Amp2 and coreIN-Mic4.

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Contact Information

Ebertstraße 30a
52134 Herzogenrath, Germany
Phone: +49 (0) 2407 577-0
E-Mail: sales@head-acoustics.com
Website: www.head-acoustics.com