DATA SHEET

APPLICATION EXAMPLES INCLUDED

Code 1703

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

DETILS

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 *lab*CORE hardware extension board *core*OUT-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.

HMS II.3 mounted on the supplied torso box HTB VI

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 *lab*CORE equipped with the optional hardware board *core*IN-Mic4. In combination with the necessary hardware modules including *core*BEQ, equalization of binaural acoustical signals using various equalization variants is possible.

The artificial mouth of HMS II.3 is powered by the *lab*CORE's optional *core*OUT-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 *lab*CORE: 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.
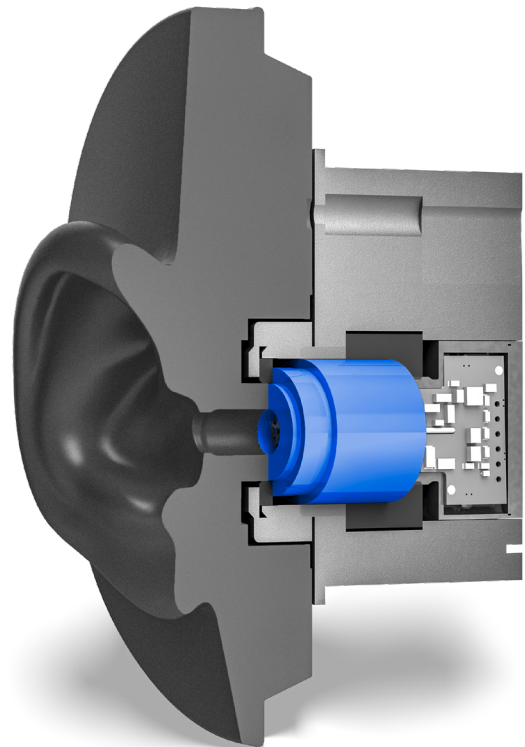
A cut through the P.57-compliant right ear simulator of HMS II.3 shows its inner construction. The straight ear canal is followed by the acoustic coupler (highlighted in blue) that contains a high-quality condenser microphone. The microphone covers a very wide dynamic range from close to the human hearing threshold to 165 dB$_{SPL}$.

The anatomically shaped pinna according to type 3.3 described in Recommendation ITU-T P.57 accurately simulates the properties of the human outer ear. This makes HMS II.3 ideally suited for precision measurements in various close-to-the-ear scenarios, e.g. testing the transfer characteristics of handsets. By being suitable also for arbitrary far-from-the-ear scenarios, HMS II.3 is a multi-purpose HATS.

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 *lab*PWR I.2 for *lab*CORE, mobile application (e.g. in vehicles) is also possible with HMS II.3.

TECHNICAL DATA

Artificial Ear

Frequency range	3 Hz – 20 000 Hz
Frequency responses (FF/DF)	Compliant with ITU-T P.58
Directivity characteristics	Compliant with ITU-T P.58
Transfer impedance	Compliant with IEC 60318-4 and ITU-T P.57
Dynamic range	23 dB_{SPL}(A) – 164 dB_{SPL}
Self-noise	Compliant with ITU-T P.57
Microphone sensitivity	12.5 mV / Pa
Polarization voltage	200 V
Supply voltages	
› U (recommended)	± 60 V
› U (possible)	+ 120 V
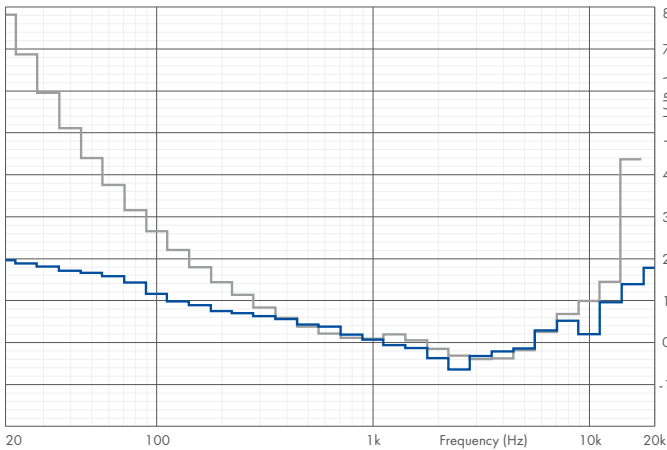
Typical self-noise of HMS ear simulators (—) vs. average human hearing threshold (—)[1]
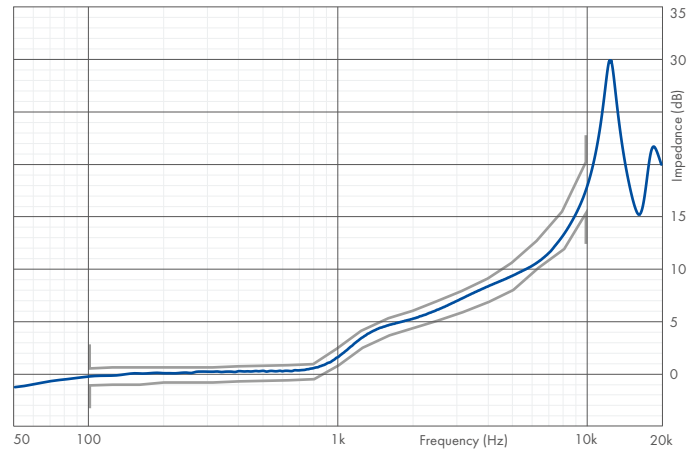
Typical transfer impedance of HMS II.3 ear simulator (—) vs. IEC 60318-4 tolerance scheme (—)[2]

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

|	
Loudspeaker configuration	2-way
Impedance	4 Ω
Frequency range	
› Unequalized	100 Hz – 20 000 Hz (± 4 dB)
› Equalized	50 Hz – 20 000 Hz (± 1 dB), exceeds ETSI TS 102 924
Total Harmonic Distortion (THD)	(at MRP, equalized, with coreOUT-Amp2)
› @ 0 dBPA (94 dB_{SPL})	< 4 % (100 Hz), < 0,5 % (200 Hz – 20 000 Hz), exceeds ITU-T P.58
› @ +6 dBPA (100 dB_{SPL})	< 6 % (100 Hz), < 1 % (200 Hz – 20 000 Hz)
› @ +12 dBPA (106 dB_{SPL})	< 10 % (100 Hz), < 2 % (200 Hz – 20 000 Hz)
› @ +18 dBPA (112 dB_{SPL})	< 3 % (200 Hz – 20 000 Hz)

Max. continuous output level	(at MRP, equalized, with *coreOUT-Amp2*)
› Pink noise	min. 112 dB$_{SPL}$ (50 Hz – 16 000 Hz), min. 106 dB$_{SPL}$ (20 Hz – 20 000 Hz)
› Sine	min. 112 dB$_{SPL}$ (200 Hz – 6 000 Hz) @ THD < 3 %, min. 106 dB$_{SPL}$ (100 Hz – 10 000 Hz) @ THD < 10 %
› Real speech acc. ITU-T P.501	No audible distortion up to approx. 110 dB$_{SPL}$
Power handling	
› P (continuous)	20 W
› P (short-term)	50 W (max. power is electrically limited > 6 kHz)
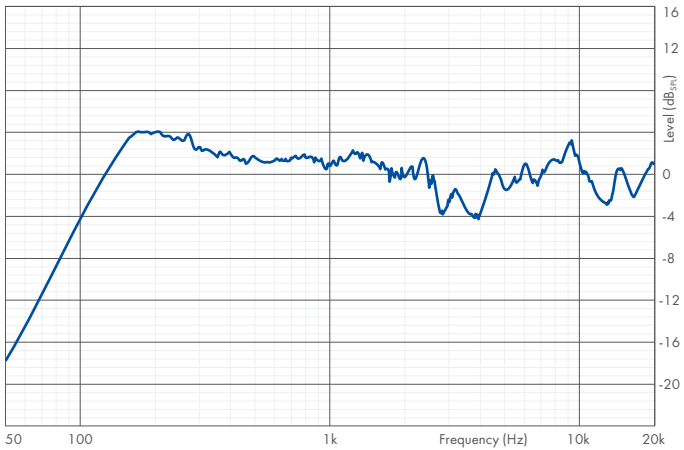
Typical frequency response of unequalized two-way mouth (—)
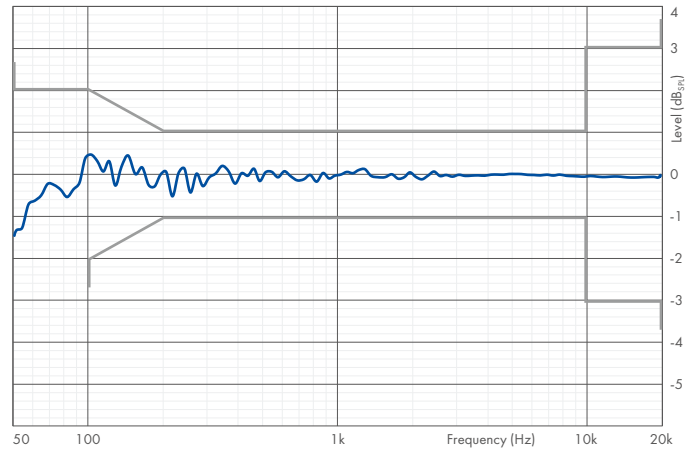
Typical frequency response of equalized two-way mouth (—) vs. ETSI TS 102 924 tolerance scheme (—)
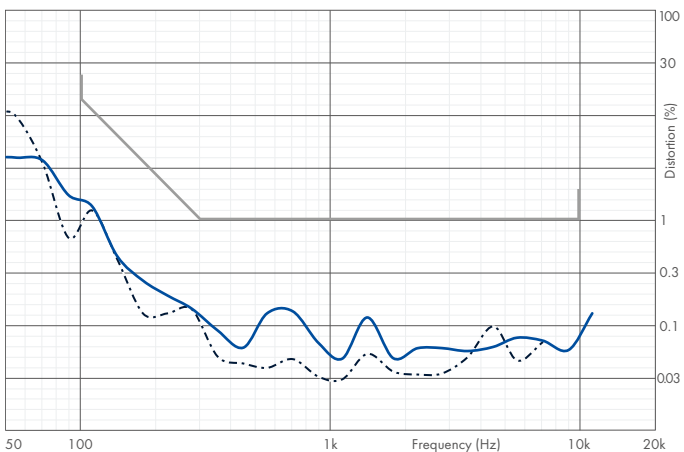
2nd (—) and 3rd (– -) order harmonic distortion of equalized two-way mouth at 0 dB$_{Pa}$ vs. Recommendation ITU-T P.58 tolerance scheme (—)

Other

| **Dimensions and Weight**	
Overall dimensions (Width × Height × Depth)	460 × 400 × 210 mm
	460 × 790 × 400 mm on Torso Box
Weight	Approx. 5.9 kg (standard options)
	Approx. 13.9 kg with Torso Box (standard options)
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.
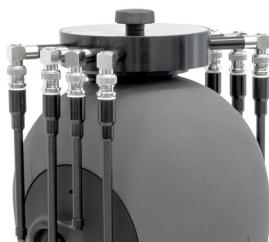
Two additional threads towards the back of the head protect against accidental skew when using rotatable top-mounted accessories.

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).
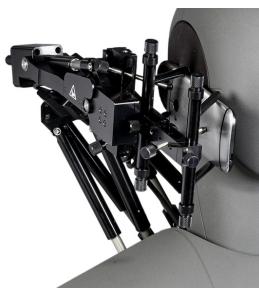
BOTTOM PLATE

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.

IMPEDANCE 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).


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.

MICROPHONE MOUNT

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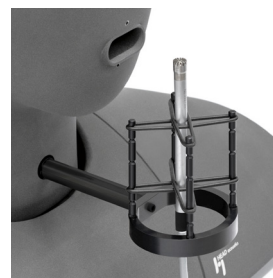
EAR SIMULATOR & PINNA OPTIONS

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

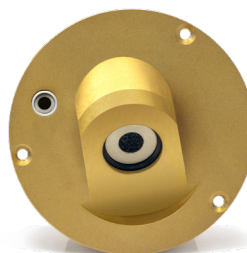› Anatomically shaped pinna type 3.3 with straight ear canal
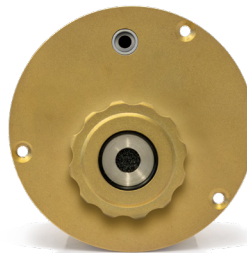
HMS II.3 LN

› 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
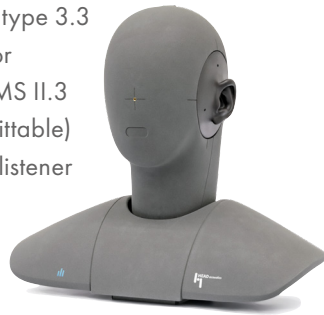
HMS II.5

› 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
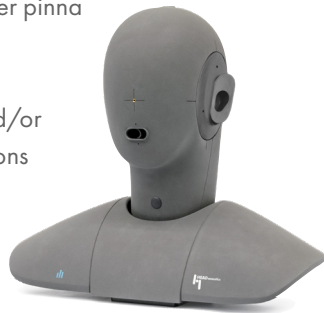
SCOPE OF DELIVERY

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

HEL 4.4-V1 (Code 1715-V1)
› Flexible pinna for HMS II.3/4/5, left 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. *lab*CORE connects to the artificial mouth and ear simulators of HMS II.3 via *core*OUT-Amp2 and *core*IN-Mic4 respectively. Background noise is simulated with 3PASS *flex*. For full repeatability of measurements, background noise playback is synchronized by *lab*CORE through a pulse connection to the hardware platform *lab*BGN. 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 *lab*CORE to generate, receive and analyze signals.
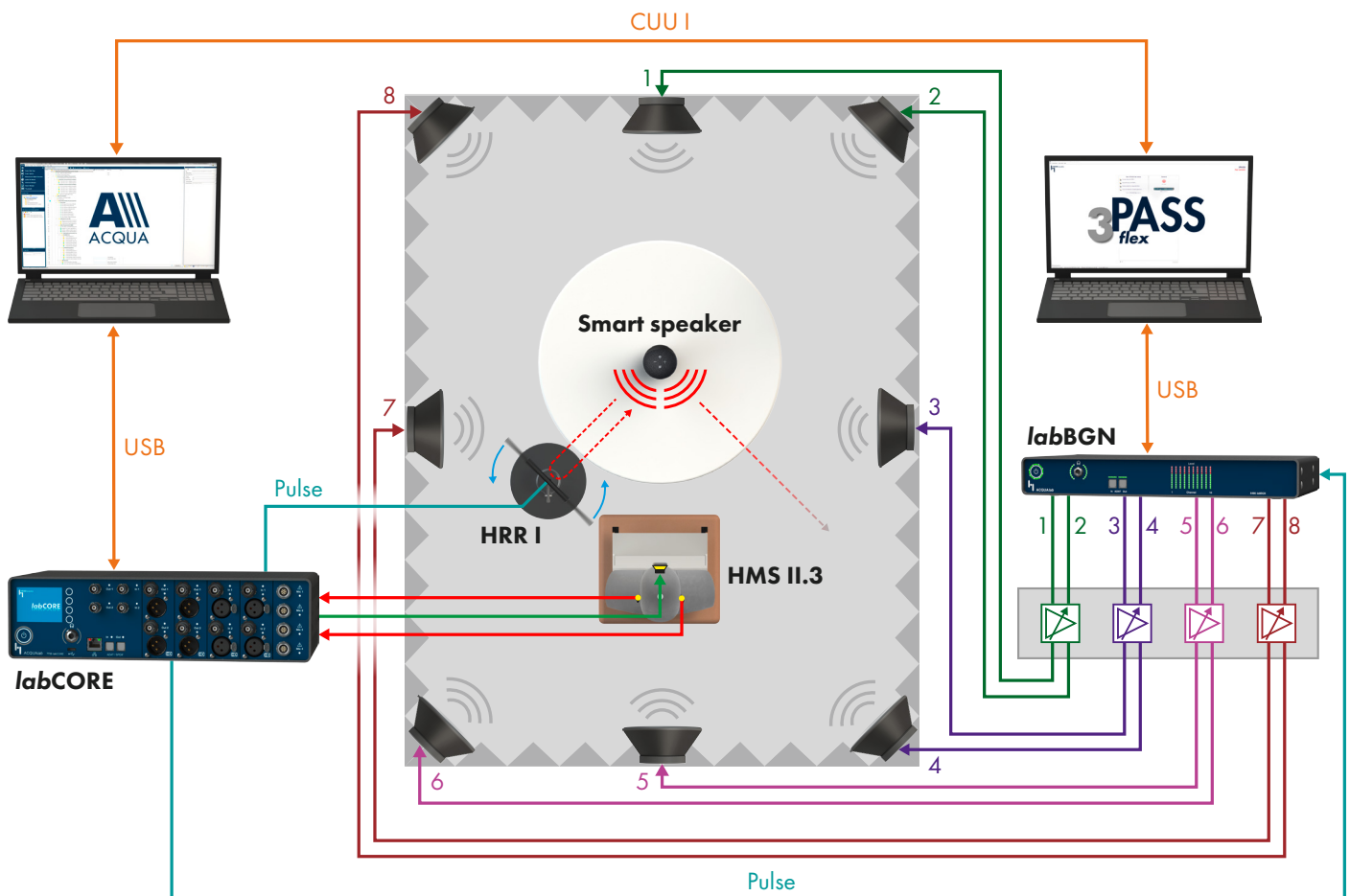
Measurement of a Vehicle's Hands-Free Communication System with HMS II.3

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 *lab*CORE. Together with ACQUA, *lab*CORE 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.
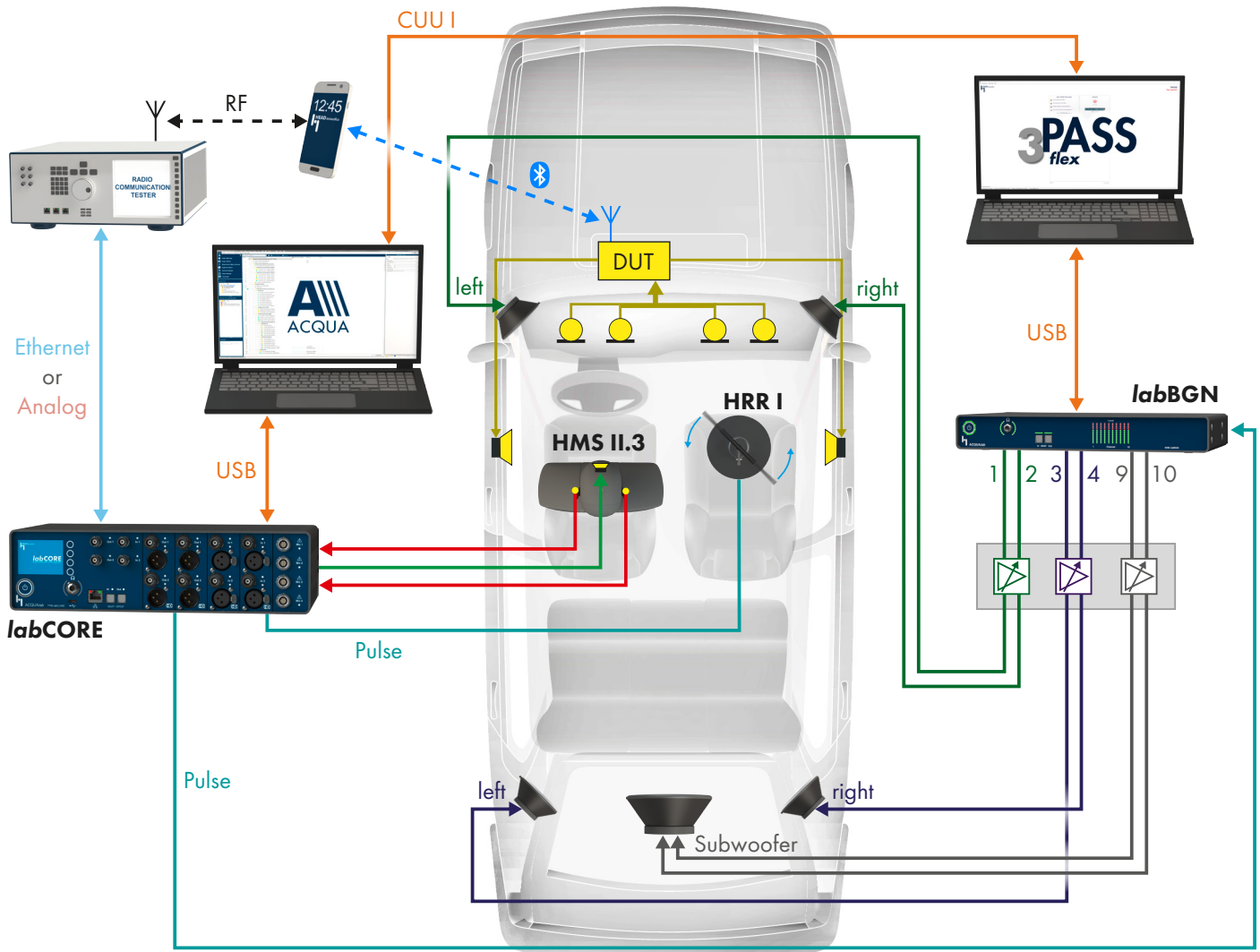
Measurement of a Mobile Handset with HMS II.3

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.

*lab*CORE 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 *lab*CORE hardware extension boards *core*OUT-Amp2 and *core*IN-Mic4..
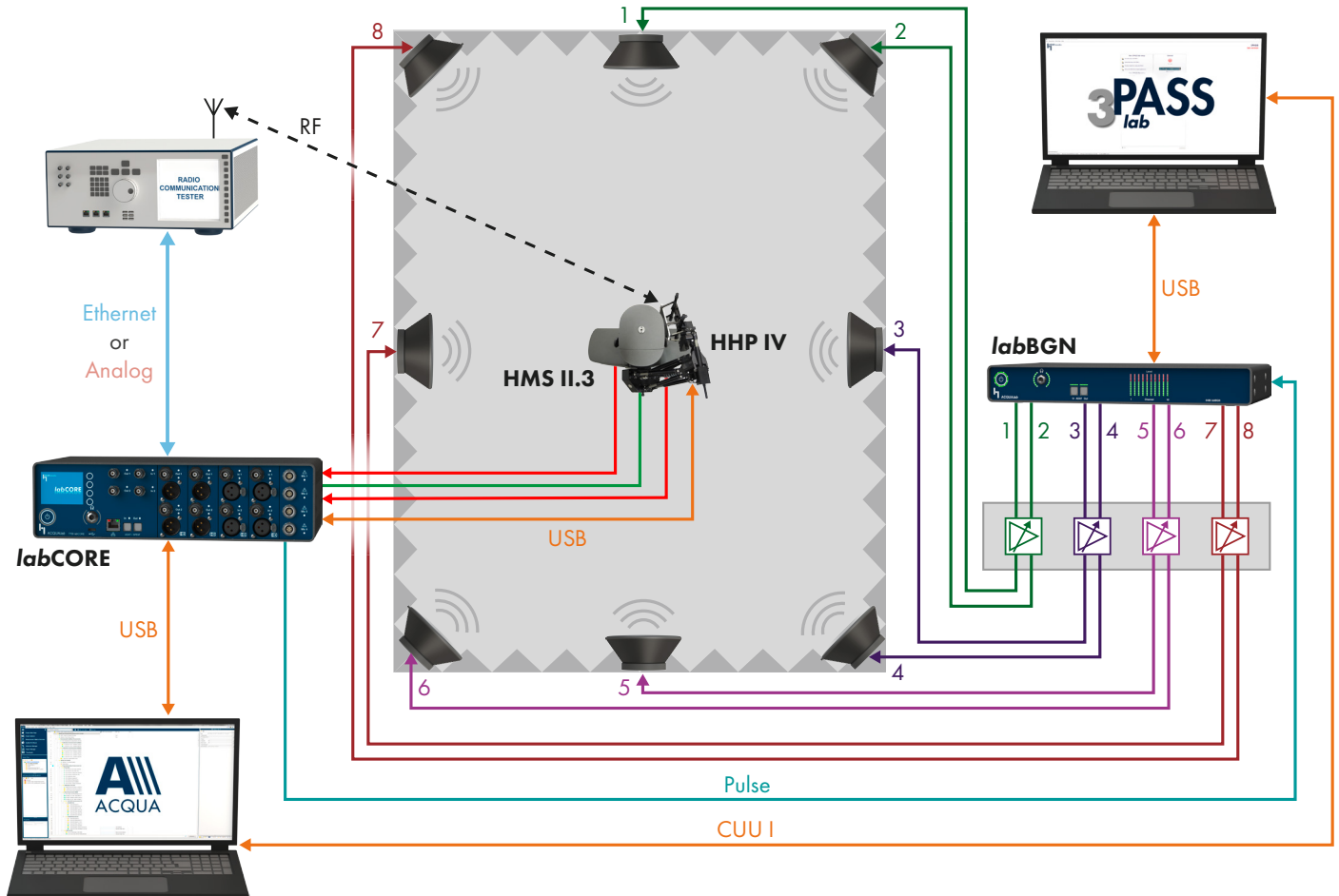
HEAD acoustics

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