HEAD acoustics

DATA SHEET



Code 6798

P.1110

ACQUA Standard ITU-T P.1110, Wideband Car Hands-Free Terminals

OVERVIEW

P.1110

Code 6798

ACQUA Standard ITU-T P.1110, Wideband Car Hands-Free Terminals

Achieving a reasonable speech quality with hands-free telephony in vehicles is a challenging task due to the difficult acoustic environment. For ensuring good communication quality, ITU-T published Recommendation ITU-T P.1110 for tests and requirements for wideband hands-free communication in vehicles. The test methods focus on the different criteria for audio signal analysis, e.g., frequency response, loudness rating; echo performance and level variation between single talk and double talk situations; and speech quality performance with interfering background noise.

The ACQUA standard P.1110 applies to manufacturers and suppliers of the automotive industry to qualify and optimize their built-in / aftermarket hands-free systems and microphones for compliance with Recommendation ITU-T P.1110.

KEY FEATURES

Automated ACQUA standard database to assess wide-band speech quality of hands-free in communication systems and devices in vehicles

Testing of built-in and aftermarket hands-free systems used in vehicles

State-of-the-art measurement methods for analysis of speech quality

Supports A²B® for recording and digital insertion of background noise

APPLICATIONS

Assessing parameters and requirements of car hands-free terminals with wideband signals according to Recommendation ITU-T P.1110

Assessing parameters and requirements of hands-free microphones (anechoic / car cabin conditions) with wideband signals according to Recommendation ITU-T P.1110

Assessing transmission performance of short-range wireless (SRW) enabled phones with wideband signals according to Recommendation ITU-T P.1110

Experimental development and optimization of vehicle hands-free terminals with objective evaluation of sound quality

Optimizing positioning of hands-free microphones and loudspeakers in vehicles

DETAILS

Hands-free telephony in vehicles faces a number of acoustic peculiarities – a low signal-to-noise ratio, echo, double-talk, impairments in RF transmission and more. Therefore, achieving a good communication quality is a challenge. The International Telecommunication Union (ITU) published Recommendation ITU-T P.1110 including tests and requirements for speech quality of wideband hands-free communication in vehicles.

Recommendation ITU-T P.1110 provides test scenarios, methods, and requirements for elementary factors of communication quality. It contains tests for built-in hands-free systems, aftermarket hands-free car kits in vehicles, and microphones.

DESCRIPTION

Compliance

Recommendation ITU-T P.1110 provides assessment tools (test methods and requirements) by applying wideband signals for

- built-in hands-free systems
- after-market hands-free car kits

used in motor vehicles for communication purposes. Clause 11 of Recommendation ITU-T P.1110 is mandatory for compliance of above mentioned devices with Recommendation ITU-T P.1110.

Other clauses of Recommendation ITU-T P.1110 include complementary measurements for approving/improving single microphones (Clause 10) or verifying the transmission performance of short-range wireless enabled phones (Clause 12).

These three clauses from Recommendation ITU-T P.1110 have been implemented in the P.1110 ACQUA standard database. Thus, the ACQUA standard database enables users to verify full compliance of appropriate devices with Recommendation ITU-T P.1110.

Test Signals

Recommendation ITU-T P.1110 specifies numerous tests which use different test signals to capture a comprehensive analysis of system performance. Test signals include real speech, composite source signals (CSS), AM/FM modulated sine signals, and activation sequences according to ITU-T P.501.

Background noise signals have to be recorded inside the vehicle beforehand. The required scenarios are described in

GENERAL REQUIREMENTS

Hardware Platform

*lab*CORE (Code 7700)
- Modular multi-channel hardware platform

*core*BUS (Code 7710)
- *lab*CORE I/O bus mainboard

*core*OUT-Amp2 (Code 7720)
- *lab*CORE power amplifier board

*core*IN-Mic4 (Code 7730)
- *lab*CORE microphone input board

*core*IN-ICP4[1] (Code 7735)
- *lab*CORE IEPE/ICP® sensor input board, instead of *core*IN-Mic4

*core*BEQ (Code 7740)
- *lab*CORE binaural equalization, incl. filter set for one artificial head (delivered with *lab*CORE)

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1 Only for use with HMS II.7

Recommendation ITU-T P.1110. The recorded scenarios can be played back with an appropriate background simulation software, such as 3PASS *flex*, or digitally inserted by applying *core*A2B-Basic and *core*A2B-Proxy.

Equipment for Test Set-Up

Almost all necessary equipment for conducting compliant measurements according to Recommendation ITU-T P.1110 is available in our product portfolio. That includes key equipment:

- Head and torso simulator (HMS II Series)
- Test system (*lab*CORE hardware platform + ACQUA measurement and analysis software)

Further, there is special equipment for particular test methods, measurements, and analyses:

- Sophisticated analysis algorithms (e.g., 3QUEST)
- Hardware for creating a variable echo path (HRR I)
- Hardware and software for recording and playback of background noises (SQuadriga III, 3PASS *flex*)

The entire required equipment for conducting all measurements of the P.1110 ACQUA standard database is listed in the section General Requirements on this data sheet.



GENERAL REQUIREMENTS

Head and Torso Simulator

One or multiple of the following HEAD Measurement Systems:

HMS II.3

- HMS II.3 (Code 1703)
  - HEAD Measurement System, basic version with right ear simulator, 3.3 pinna, and artificial mouth
- HIS L (Code 1701)
  - HEAD Impedance Simulator, left

HMS II.3 LN

- HMS II.3 LN (Code 1703.1)
  - HEAD Measurement System, low-noise version with right ear simulator, 3.3 pinna, and artificial mouth
- HIS L LN (Code 1701.1)
  - HEAD Impedance Simulator, left, low-noise version

HMS II.3 LN HEC

- HMS II.3 LN HEC (Code 1703.2)
  - HEAD Measurement System, low-noise version with human-like ear canal simulator right and artificial mouth
- HIS L LN HEC (Code 1701.2)
  - HEAD Impedance Simulator, left, low noise, human-like ear canal version

HMS II.6[2]

- HMS II.6 (Code 1706)
  - HEAD Measurement System, with artificial mouth and free-field microphones (left and right)

HMS II.7[2]

- HMS II.7 (Code 1707)
  - HEAD Measurement System, with artificial mouth and free-field IEPE/ICP microphones (left and right)

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2 Recommendation ITU-T P.1110 specifies the usage of a head-and-torso simulator (HATS) according to Recommendation ITU-T P.58, which needs to be equipped with artificial ears according to Recommendation ITU-T P.57. However, for measurements of far-field scenarios, only the corresponding equalization (e.g., FF or DF) according to Recommendation ITU-T P.58 is relevant for comparable test results and HMS II.6 / HMS II.7 can be considered as compliant for testing of Recommendation ITU-T P.1110.

DATABASE CONTENTS

Preparation Measurements

› NC40, NC30, and NC20 evaluation

Measurements for Hands-Free Terminals

› Delay
› Loudness rating
› Sensitivity
› Speech quality during single talk
› Listening speech quality stability
› Idle channel noise
› Out-of-band signals
› Distortion send/receive
› Echo performance
› Switching characteristics
› Double Talk performance
› Background noise transmission

Performance of Short-Range Wireless Enabled Phones

› Delay
› Loudness rating
› Sensitivity
› Noise cancellation test
› Speech quality

Measurement Parameters and Requirements for Microphones of Hands-Free Speakerphones

› Anechoic conditions
  » Microphone sensitivity
  » Microphone frequency response
  » Microphone directional characteristics
  » Microphone distortion
  » Maximum sound pressure level
  » Self-noise
  » Linearity range
› In-Car Conditions
  » Microphone sensitivity
  » Microphone frequency response
  » Self-noise
  » Signal-to-noise (SNR) improvement

GENERAL REQUIREMENTS

Background Noise Simulation

General

ACOPT 21 (Code 6844)
› Option 3QUEST – 3fold Quality Evaluation of Speech in Telecommunication (Narrowband/ Wideband)
ACOPT 17 (Code 6839)
› Option Relative Approach
BHS II (Code 3322)
› Binaural Headset for SQuadriga II, III or SQobold

One of the following methods for adding background noise:

Acoustic Playback and BGN Recording

3PASS *flex* (Code 6995)
› Advanced background noise simulation system with automated equalization – *flex* version
SQuadriga III (Code 3324)
› Handheld 8-channel frontend
SQ3 TP 05 (Code 3324-05)
› SQuadriga III tool pack controller mode
RC X.1 (9850)
› Remote control for starting and stopping of recording and activating real-time filters, USB
RC X.2 (Code 9851)
› Wireless handheld transmitter

Digital Insertion

*core*A2B-Basic (Code 7791)
› *lab*CORE I/O Module, A²B Interface (32 channels), Hardware + Main-/Sub-node mode
*core*A2B-Proxy (Code 7793)
› *lab*CORE Proxy Mode for A²B
*lab*PWR I.2 (Code 3712)
› HEAD*lab* supply module (max. 100 W)
CLB I.2 (Code 9847)
› Adapter cable (passive), BHS II > Line/ICP input, requires *core*IN-ICP4
CBB-L I.3 (Code 1724-3)
› Cable BNC <> BNC, black, 3 m
CBB-R I.3 (Code 1725-3)
› Cable BNC <> BNC, red, 3 m

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OPTIONS

Hardware

*core*BT2-HFP-LC3 (Code 7785)

› *lab*CORE Bluetooth® LC3 Option for HFP (*core*BT2 module required)

Software

ACOPT 20 (Code 6843)

› Option Quality pie

RELEASE NOTES

Database Revision and Specification Version			
Database revision	**Based on specification**	**ACQUA**	***lab*CORE firmware version**
Revision 08	Recommendation ITU-T P.1110 (10/2025)	at least 6.3.100	at least 3.16

GENERAL REQUIREMENTS

Measurement and Analysis Software

ACQUA (Code 6810)

› Advanced Communication Quality Analysis Software, Full-license Version

ACQUA Compact (Code 6860)

› Compact test system

Speech Quality

ACOPT 10 (Code 6820)

› Option TOSQA

Only for measurements with short-range wireless transmission enabled phones. Signal transmission is solely electrical:

ACOPT 30-SL (Code 6876)

› Option POLQA – Perceptual Objective Listening Quality Analysis (Soft License)

Idle Channel Noise

ACOPT 43 (Code 6877)

› Option Psychoacoustics - Advanced Analysis

Echo During Double Talk

ACOPT 32 (Code 6859)

› Option Speech-based Double Talk analysis

Variable Echo Path

HRR I (Code 6597)

› HEAD acoustics rotating reflector

Connection to Hands-Free Terminal

The connection between the hands-free terminal and *lab*CORE can be established via a network simulator or Bluetooth®.

Network Simulator

Radio communication tester (third-party equipment)

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GENERAL REQUIREMENTS

labCORE Extensions for Using VoLTE/VoNR

The selection of the audio codec depends on the characteristics of the device under test:

- coreIP (Code 7770)
  - labCORE I/O module, Voice over IP reference gateway

AMR codec or EVS codec require extra extensions:

- coreIP-AMR (Code 7772)
  - labCORE VoIP AMR codec option (coreIP module required)
- coreIP-EVS (Code 7773)
  - labCORE VoIP EVS codec option (coreIP module required)

Bluetooth

coreBT2 (Code 7782)

- labCORE I/O Module, Bluetooth Reference Access Point, Version 2

Environmental Conditions

One of the following microphone types depending on the microphone input board of labCORE:

Measurement microphone (third-party equipment)

- 200 V polarization, LEMO 7-pin (1B), pressure field

IEPE/ICP microphone (third-party equipment)

- Power supply 4mA, BNC connector, pressure field

SCOPE OF DELIVERY

P.1110 (Code 6798)

- delivered as ACQUA database backup

V2C File

- License file for ACQUA dongle

Revision history

- PDF file

IN PRACTICE

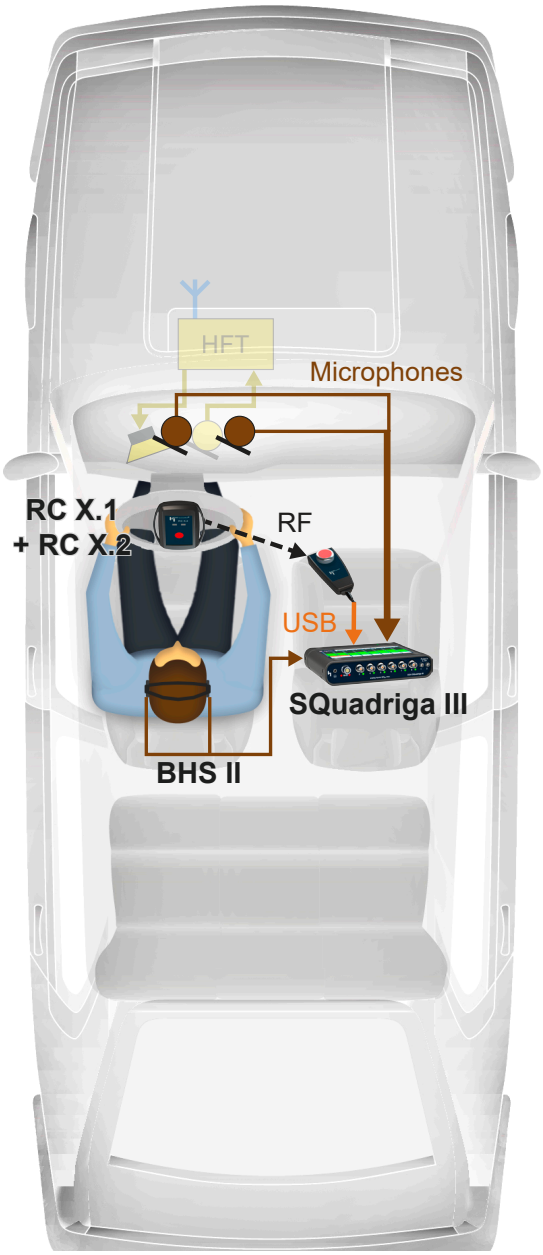
APPLICATION EXAMPLES

Configuration Example 1:
Measurement with Acoustical Background Noise

Step 1 of 3: Recording of Background Noise

In this scenario, a basic hands-free system with one microphone is the device under test. Driving noise is recorded with two IEPE/ICP microphones which are positioned next to the integrated microphone. The IEPE/ICP microphones connect to the mobile hardware platform SQuadriga III.

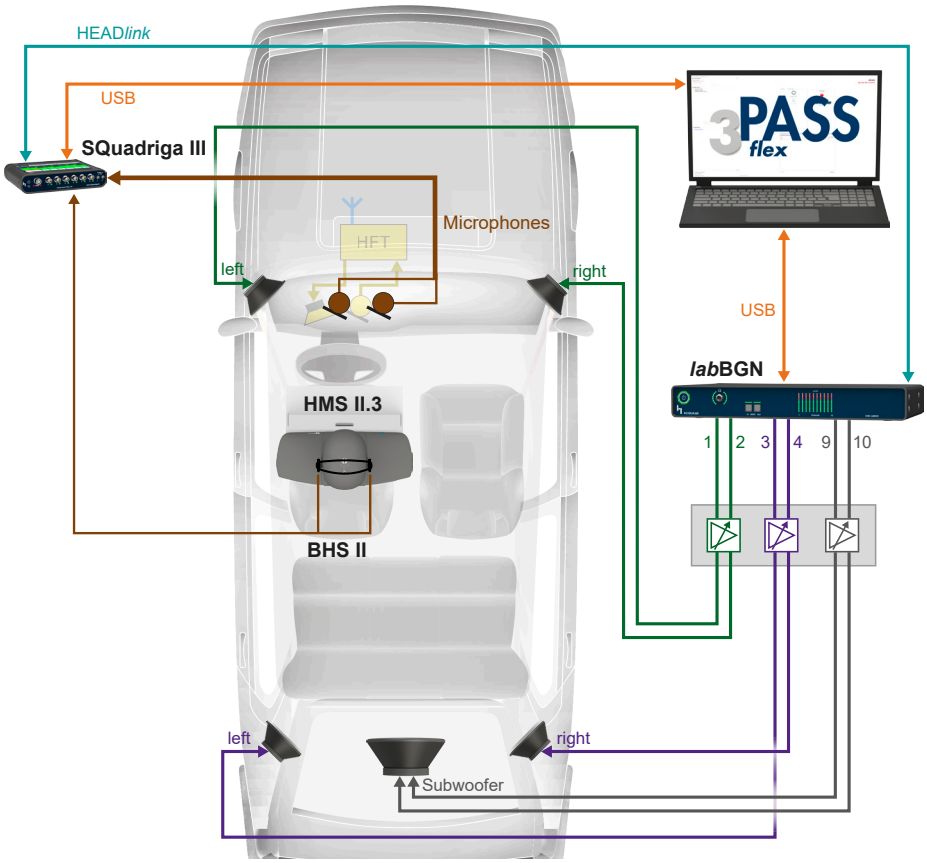
SQuadriga III records and stores the signals from the IEPE/ICP microphones. The recording is started conveniently by the RC X.2 wireless handheld transmitter. The remote control is fixed to the steering wheel to allow operation of SQuadriga III without diverting the driver from traffic

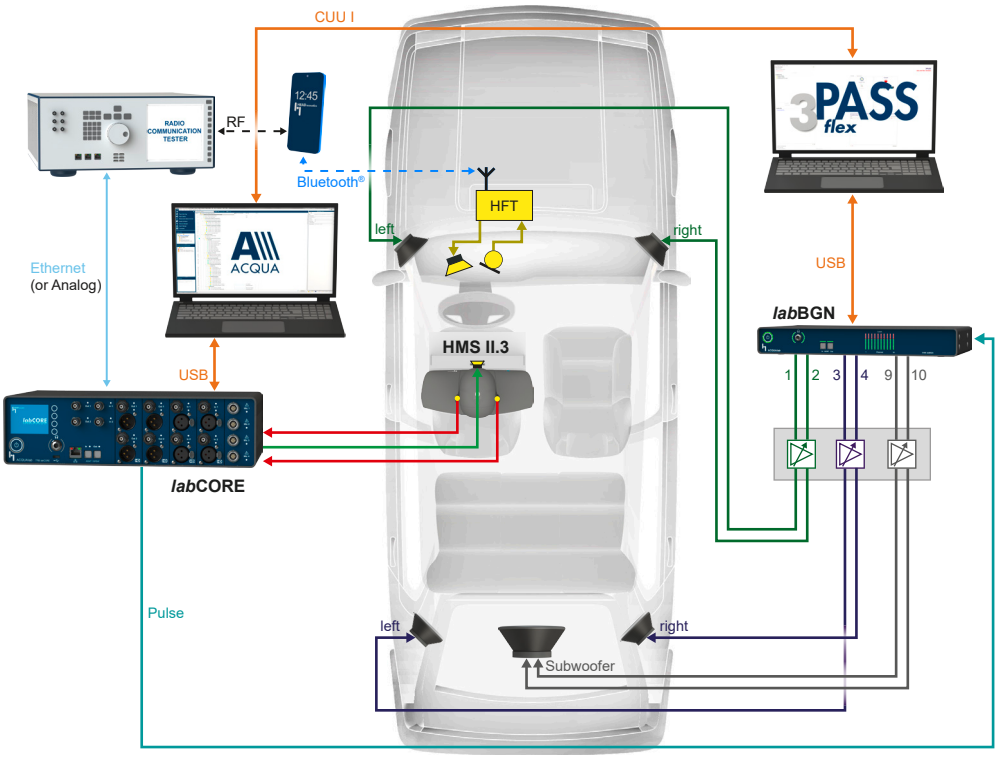


Step 2 of 3: Equalization

After the mobile recording session, the configuration changes to stationary. Four loudspeakers and a subwoofer are set up in the vehicle for background noise playback with 3PASS *flex*.

HMS II.3 replaces the driver – not yet interconnected, just as a physical stand-in for the driver. It recreates the acoustic situation that was present during the recording. The equalization of 3PASS *flex* includes SQuadriga III, the two IEPE/ICP microphones, and BHS II.





Step 3 of 3: Measurements

Once 3PASS *flex* has been equalized, HMS II.3 is connected to *lab*CORE for operation of artificial ears and artificial mouth. A second computer runs ACQUA and is connected to *lab*CORE. ACQUA controls *lab*CORE, provides and analyzes incoming signals. *lab*CORE distributes the signals via its interfaces. The playback of background noises is synchronized with playback from HMS II.3.

The hands-free terminal (HFT) of this vehicle uses Bluetooth for communication. An SRW enabled phone connects to the HFT via Bluetooth. The phone also connects to the network of a radio tester which is connected to *lab*CORE.

Configuration Example 2:
Measurement with Digitally Inserted Background Noise via A²B®

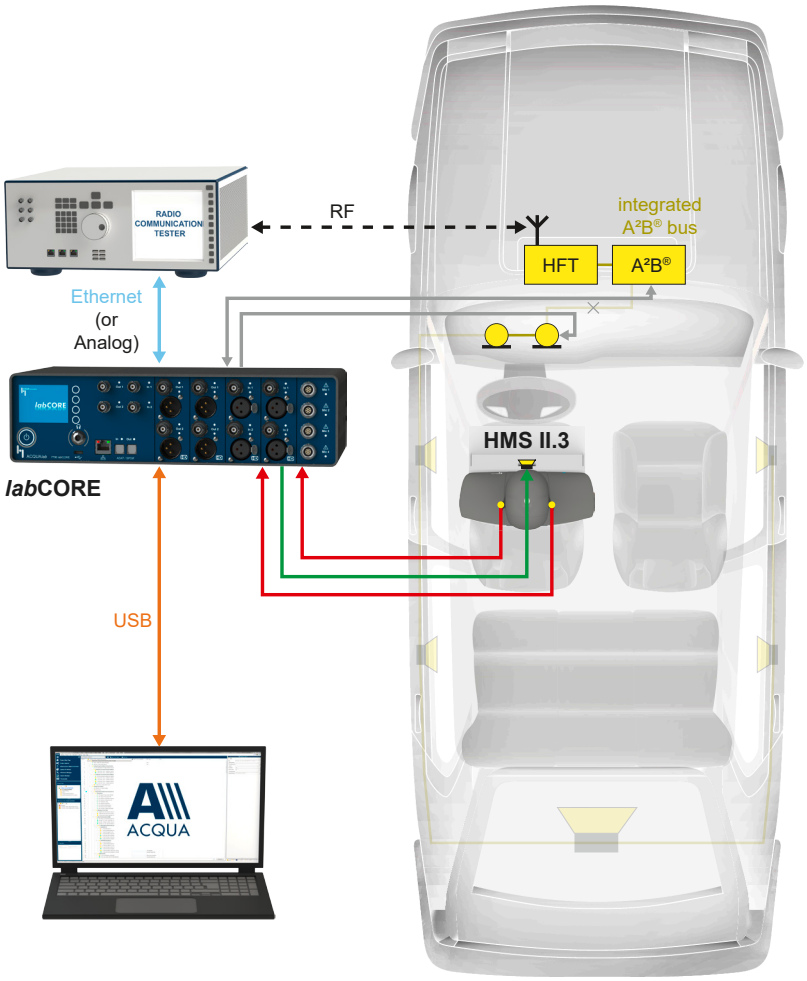


Step 1 of 2: Recording of Background Noise

The first step for testing hands-free communication systems with interfering background noise is recording real driving noises. In case a vehicle distributes audio signals – including the hands-free communication system – through an A²B® bus system, the background noise can be recorded with the built-in microphones.

*lab*CORE accesses the A²B® bus via its extension board *core*A2B-Basic. Running in proxy mode, *lab*CORE enters the A²B® bus between the main node and the first sub-node to gain full access to all bus signals. For this mobile application, *lab*PWR I.2 powers *lab*CORE.

*lab*CORE receives the audio signal from the microphones of the hands-free system and passes them on to a computer running ACQUA. Additionally, BHS II records binaural signals at the driver's ears.



Step 2 of 2: Measurement

The configuration for measurements is stationary and also convenient for vehicles with an A²B® bus system. A background noise simulation system is not required.

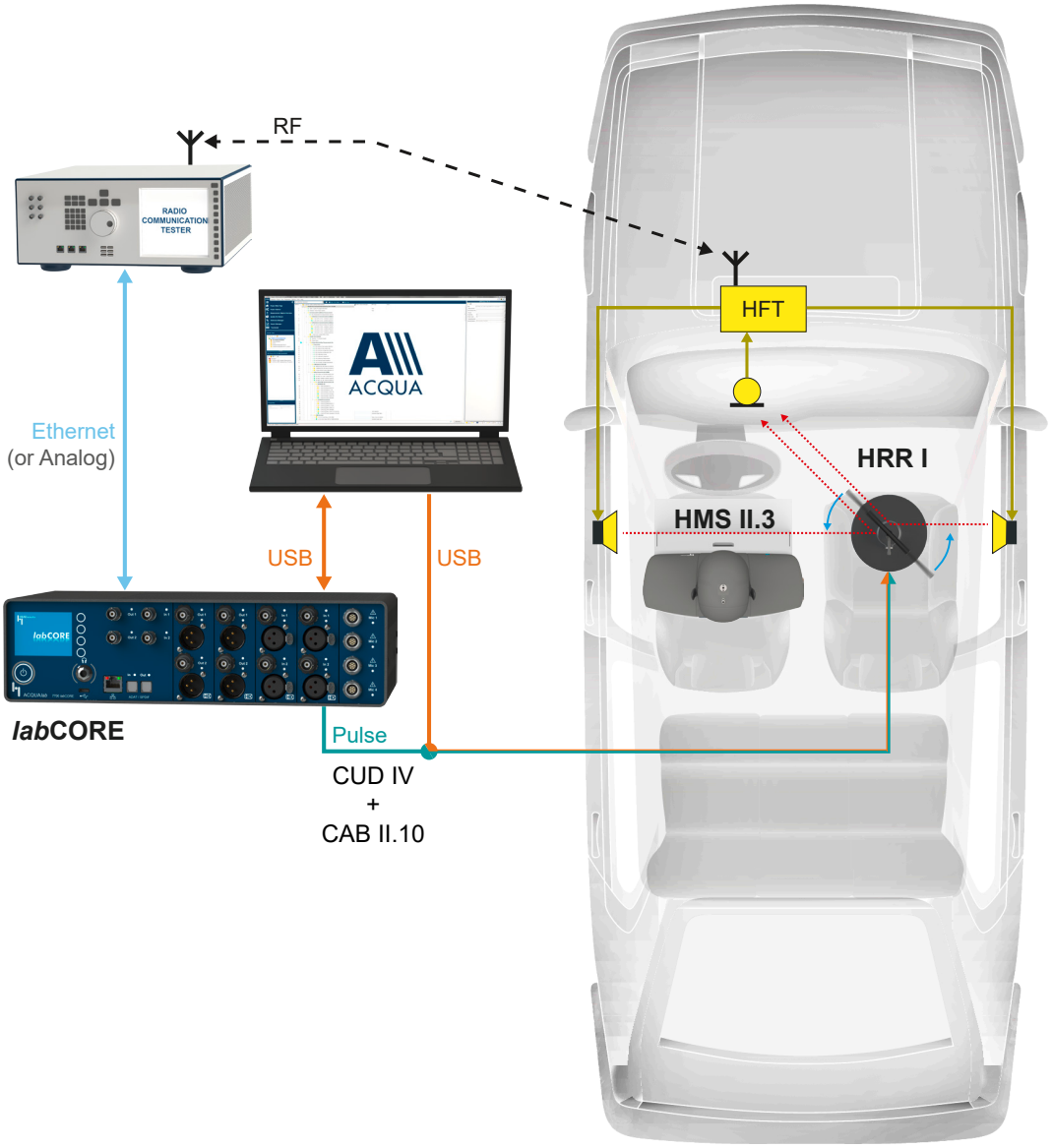
Direct access to the A²B® bus via *lab*CORE allows to insert previously recorded background noise signals digitally in real time during measurements. Therefore, acoustic playback in the vehicle cabin and equalization of the system are not necessary.

*lab*CORE and the laptop running ACQUA shall be placed outside of the car for easier operation. HMS II.3 simulates a driver conducting a phone call via the hands-free system of the vehicle.

Configuration Example 3: Echo Performance with Variable Echo Path

HMS II.3 just represents the physical appearance of the driver in this configuration. A computer runs ACQUA and is connected to *lab*CORE. ACQUA controls *lab*CORE, and provides/analyzes incoming signals. *lab*CORE distributes the signals via its interfaces. The HFT is directly connected to the network simulated by a radio tester. The radio tester is connected to *lab*CORE via Ethernet.

HRR I provides a rotating reflecting surface during the playback of the speech signal from the loudspeakers of the hands-free terminal. Thus, the echo path is variable which affects the echo attenuation of the echo canceler. The requirement for this test demands that the echo level stays below a specified value for a certain amount of time. The echo level is recorded with the microphone of the hands-free terminal. The signal is transmitted via the radio tester and *lab*CORE to ACQUA. Then, ACQUA analyzes and evaluates this signal according to the requirement.



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