HEAD acoustics

Smart Home Testing

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Content

The test solution comprises:

3PASS *flex* and 3PASS *lab* are two high-performance background noise simulation systems. These systems enable the evaluation of the performance under true-to-reality conditions; an essential attribute when testing smart speakers and other smart home devices. 3PASS *reverb* is the new option for accurate simulation of reverberation in rooms.

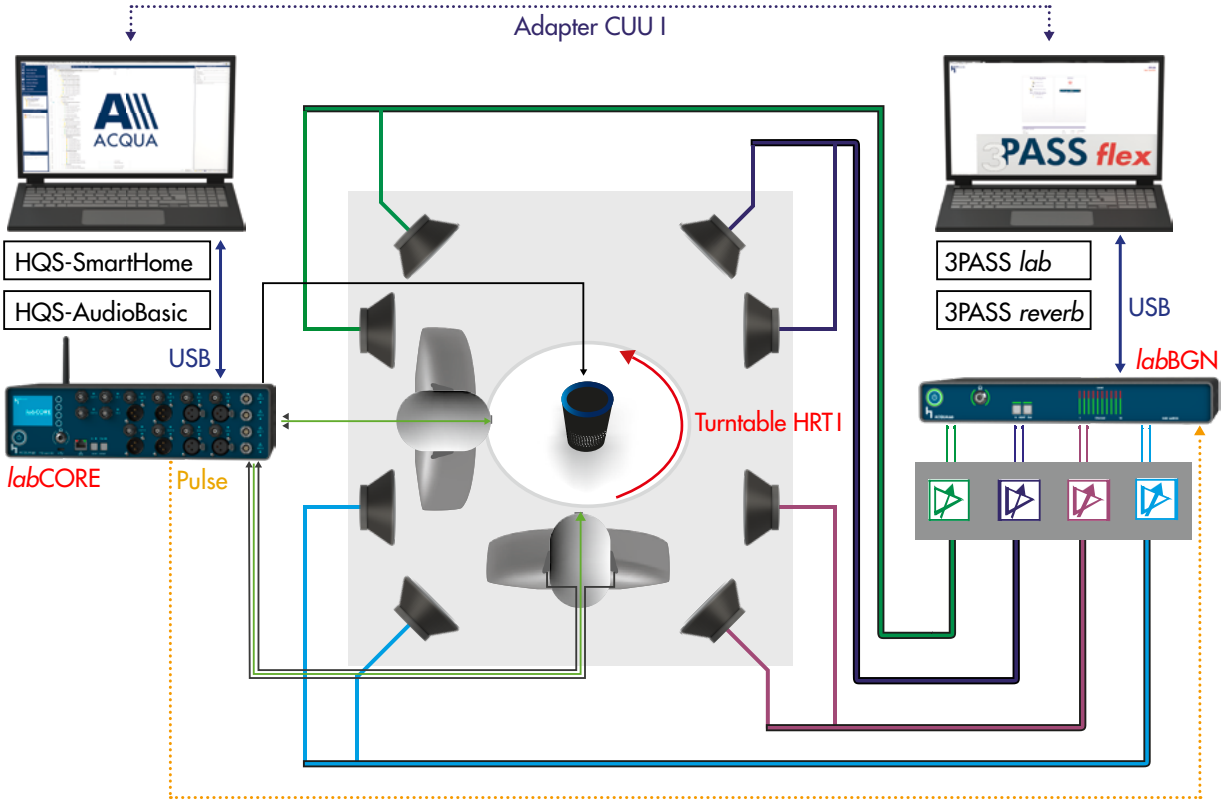
VoCAS (Voice Control Analysis System) is the turnkey solution for objective and fast quality assessment of voice control systems like smart speakers and other smart home devices under realistic and reproducible test conditions.

ACQUA is the analysis software and offers advanced methods for all essential voice and audio quality testing and optimization. For testing speech communication of smart home devices like smart speakers, ACQUA provides measurements of e.g. frequency response, loudness rating and distortion. Extension modules like 3QUEST for speech quality in the presence of background noise and EQUEST for testing the echo performance of smart home devices are available.

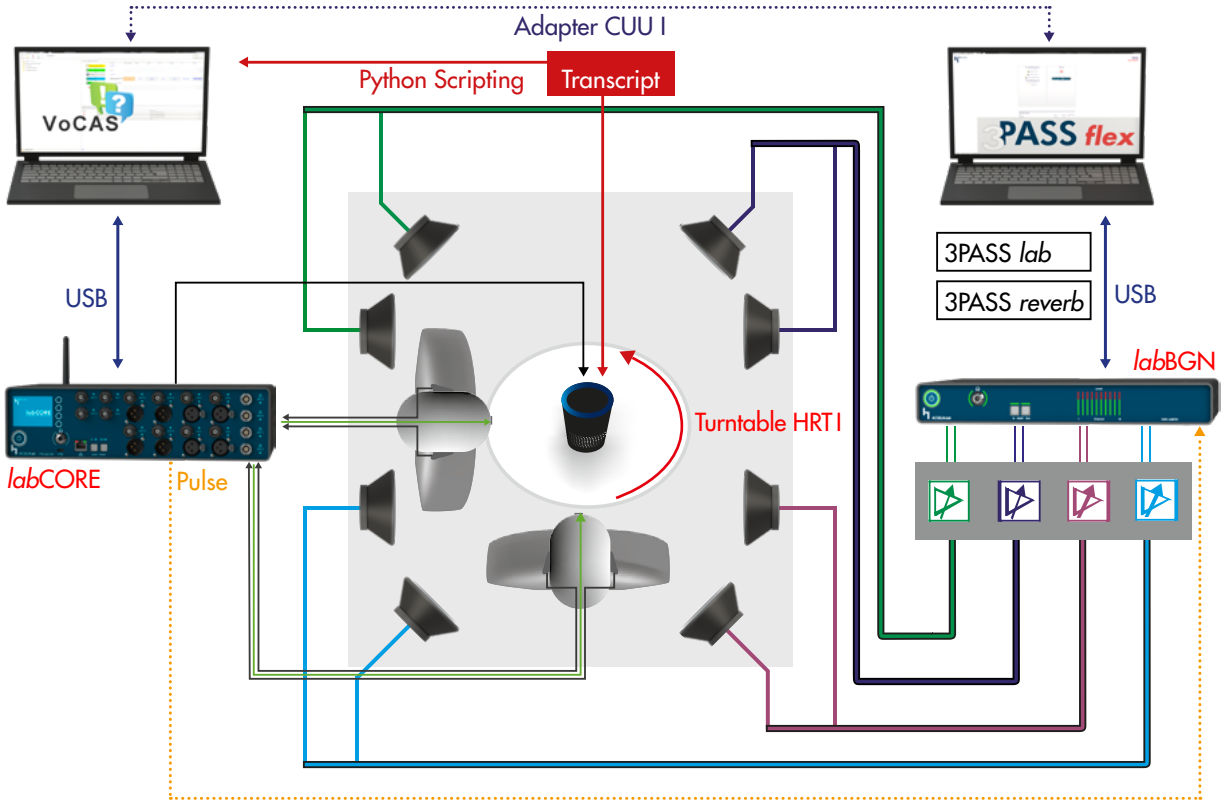
HQS-SmartHome is especially tailored for testing communication quality of voice-operated smart speakers and other smart home devices. The database is implemented for the use with the analysis software ACQUA.
Key features:
- Directivity measurements
- Performance tests of echo cancelling
- Performance tests during double talk

HQS-AudioBasic is a database for the analysis software ACQUA for testing and analyzing electroacoustical parameters of loudspeakers like smart speakers.
Key features:
- Tests of directivity characteristics
- Calculation of Thiele/Small parameters
- Relative Approach analysis

Configuration example ACQUA



Configuration example VoCAS



The smart way of testing smart home devices: Automated tests and true-to-reality simulations that take crucial factors into account

Smart Home and Internet of Things (IoT) devices operated and controlled by voice may offer a huge variety of functionalities. These may be speech-controlled operation of various functions, all types of audio and video playback but conference functionality as well. The devices may be placed at various locations in the home environment at varying distances between talker and the device. Furthermore, talkers may move in the room and interfering talkers may be present. Background noise of various sources may degrade the system performance as well as reverberation. In speech recognition mode the system should be able to focus on the talker who initiated the recognition process and not react on interfering talkers. In voice communication mode the signals of all talkers should be transmitted. The smart home device must be capable of adjusting its signal processing capabilities according to the application and the local environment. In consequence, tests have to take into account:

- Different operational modes (applications)
- Different environmental conditions
- Different user expectations

Laboratory setup

The large number of different scenarios, rooms and situations requires realistic but reproducible test setups. The most efficient way chosen by HEAD acoustics is to simulate the user environment realistically in a lab. This requires:

- Realistic background noise simulation, ideally with pre-recorded background noise scenarios
- Realistic simulation of room reverberation and reflection patterns measured in different rooms at various locations
- Excellent reproducibility of the setups in different labs

The HEAD acoustic test solution provides background noise simulation software 3PASS *lab* and 3PASS *flex* according to ETSI standard TS 103 224 (page 6).

For reverberation simulation 3PASS *reverb* is available according to ESTI TS 103 557 which basically is using the identical hardware setup as 3PASS *lab* and 3PASS *flex*.

Smart home test suite

The room and background noise simulation forms the basic setup, which is used for testing all speech and audio applications relevant in the smart home and IoT environment:

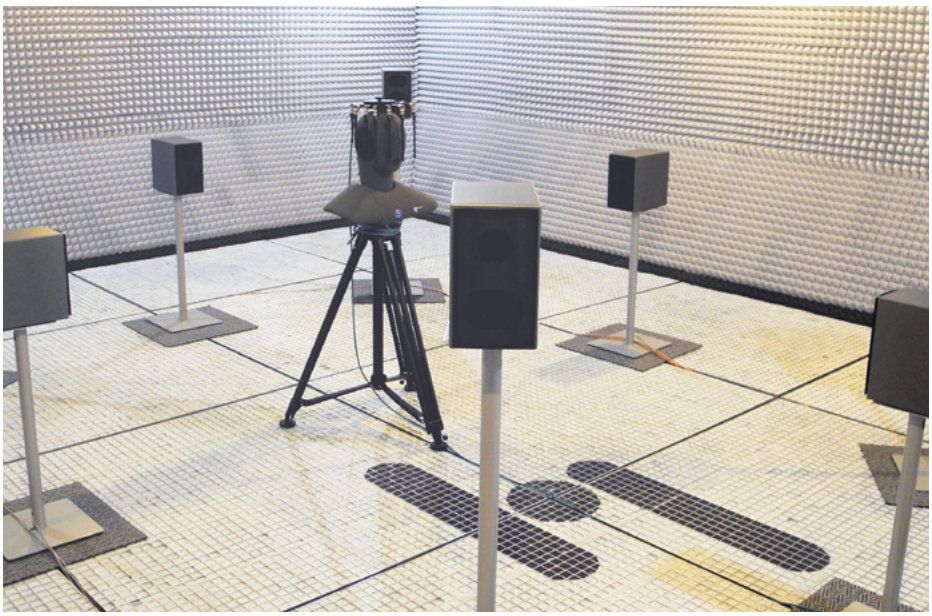
- Speech recognition testing
- Speech communication testing
- Audio quality testing

Moving talkers, moving listeners, interfering talkers and multiple talker scenarios can be simulated for all applications. Using setups including one or more HATS (head and torso simulator), the turntable HRT I with table simulation and the appropriate test suites enable simulating the various operational conditions in the lab:

- ACQUA for all communication and audio testing with the test standards (page 10):
- HQS-SmartHome (page 14)
- HQS-AudioBasic (page 17)
- VoCAS for all types of speech recognition testing (page 8)

3PASS *lab* (Code 6990)
3PASS *flex* (Code 6995)

3-dimensional Playback of Acoustic Sound Scenarios



3PASS lab test setup in anechoic room with HMS II.3, MSA I and 8 loudspeakers

Overview

3PASS *lab* and 3PASS*flex* are playback and recording systems capable of preserving and reproducing real-life background noise scenarios in different test rooms or in vehicle cabins.

3PASS *lab* is especially suited for the evaluation of complex noise reduction algorithms, e.g. as often found in modern smartphones. 3PASS *lab* complies with the ETSI standard TS 103 224 and includes a noise database as specified by the standard.

3PASS *flex* is particularly suited for multi-point noise simulation (MPNS), e.g. as required for testing multi-microphone car hands-free systems. 3PASS *flex* complies with the ITU-T standards P.1100/P.1110/P.1120 (Annex F) and P.1140 (Annex B).

3PASS *lab and* 3PASS*flex* are Windows® software that are used in conjunction with the front end *lab*BGN as well as other HEAD acoustics components.

Description

3PASS *lab* serves to preserve and reproduce the essential spatial characteristics of background noise which makes the system valuable for the development of complex background noise reduction algorithms. This is of particular importance for assessing the real life performance of modern smartphones, especially those with multiple microphones.

3PASS *flex* is particularly suited for testing multi-microphone systems, microphone arrays or beamforming microphones in real world conditions where multi-point noise simulation (MPNS) with flexible microphone and loudspeaker arrays is required. As more and more applications from car hands-free systems and In-Car Communication (ICC) systems to televisions, conference systems and even Internet of Things (IoT) devices as well as home automation systems offer multi-microphone solutions, 3PASS *flex* is the ideal solution for testing such systems. Both 3PASS *lab* and 3PASS *flex* allow the automated digital system equalization (cf. below and section "Features"). Owners of the legacy systems HAE-BGN/HAE-car using *lab*BGN can easily upgrade to 3PASS *lab*/ 3PASS *flex* without requiring a new front end (cf. section "Options").

Major components of the system are:

- Software 3PASS *lab* (for use in laboratories) or 3PASS *flex* (for car cabins and other use cases)
- Measurement front end *lab*BGN (for background noise playback and microphone connection)
- Microphone array MSA I and artificial head HMS II.3 (for sound recordings and system equalization with 3PASS *lab*)
- Flexible microphone array and SQuadriga II (for sound recordings and system equalization with 3PASS *flex*)

An 8-loudspeaker setup (for 3PASS *lab*) or a flexible loudspeaker setup (for 3PASS *flex*) including amplifiers and cables complements the system setup.

Applications

- 3PASS *lab*: Sound field reproduction for device testing at one location in space according to ETSI TS 103 224
- 3PASS *flex*: Sound field reproduction for device testing at multiple locations in space (MPNS according to ITU-T P.1100/P.1110/P.1120 Annex F and P.1140 Annex B)

Features

- 3PASS *lab*: Optimized for three use cases (Handset, Hands-free, Desktop hands-free), especially for use case with HMS and HHP
- 3PASS *flex*: Full flexibility of number and location of microphones and loudspeakers
- Automated digital system equalization via *lab*BGN in conjunction with
- HMS II.3 and MSA I (3PASS *lab*) or in conjunction with a flexible microphone array and SQuadriga II (3PASS *flex*)
- Including noise database as specified by ETSI TS 103 224 for three use cases (cf. above)
- User-friendly software control

Delivery Items

3PASS *lab* (Code 6990) /
3PASS *flex* (Code 6995)
comprises the following components:
– Setup DVD 3PASS *lab* / 3PASS *flex*
– Including noise database as specified by ETSI TS 103 224
- Dongle (USB)

System Requirements
Required for both 3PASS *lab* and 3PASS *flex*:

- PC with multi-core processor, 1.6 GHz or faster, 4 GB RAM, 40 GB free disk space, 4 USB Ports (for connecting dongle, CUU I, *lab*BGN, SQuadriga II), Microsoft® Windows® 7 Professional, Windows® 8/8.1 Pro or Windows® 10 Pro (English or German version, includingall current service packs).
- *lab*BGN (Code 6486): ACQUA*lab* (8+2 channel) background noise front end

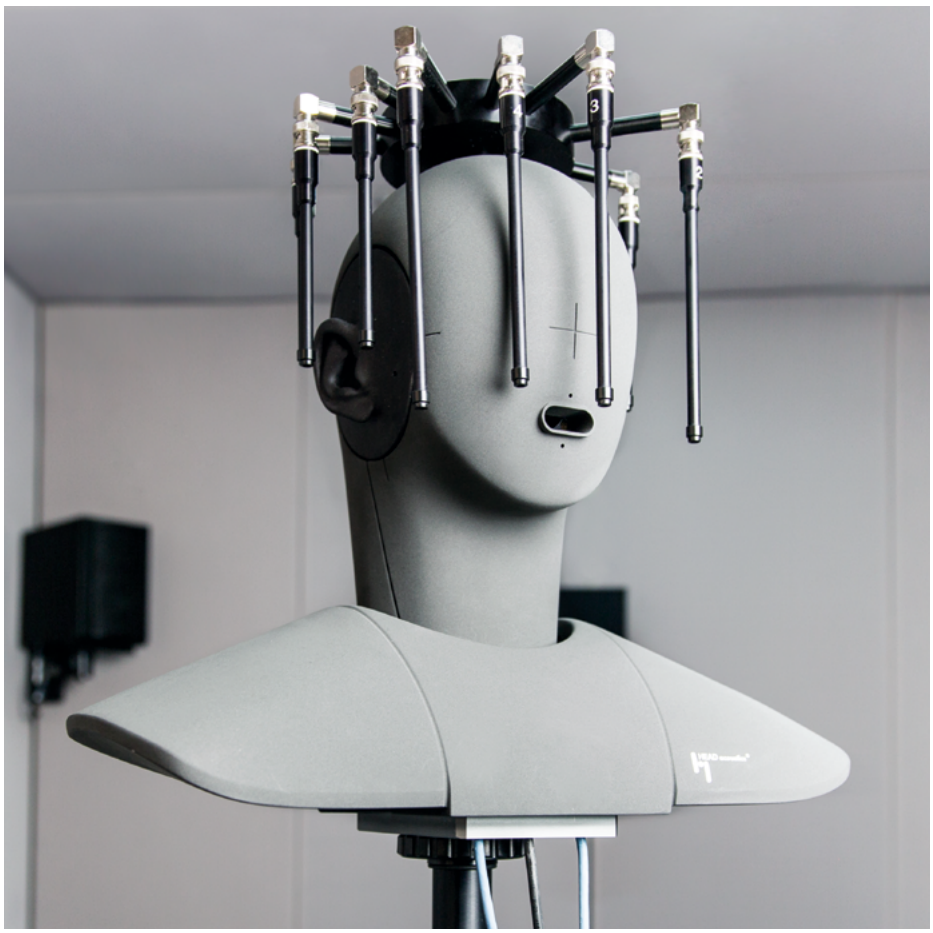
Background noise front end *lab*BGN

Additionally required for 3PASS *lab*:

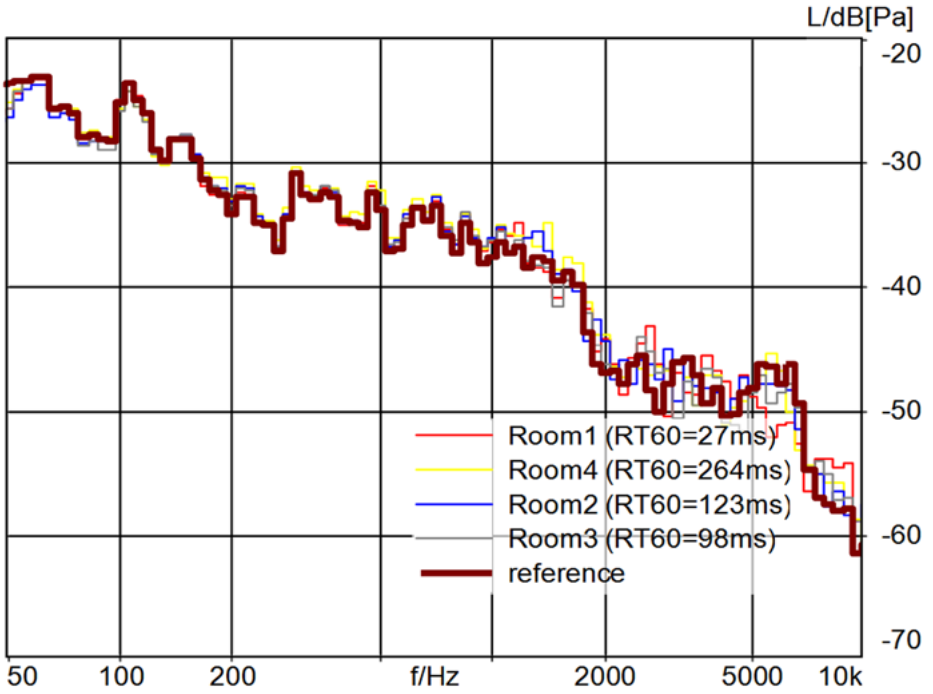
- HMS II.3-33 (Code 1230.1): HEAD Measurement System, basic version with ear canal coupler, pinna type 3.3 & artificial mouth. Note: Only required for use case "Handset". Alternatively: B&K HATS (requires mounting adapter MA MSA I)
- MSA I (Code 6487): 8 channel microphone surround array according to ETSI TS 103 224
- 2x 4-channel power amplifiers
- 8 loudspeakers
- 2x CSO I.0 (Code 9822): loudspeaker cable set

Additionally recommended for 3PASS *flex*:

- SQuadriga II (Code 3320): Mobile recording & playback system with car adapter SCA II.2 (Code 3345), HEAD*lab* adapter CLD VII.6 (Code 3356), HEAD*link* cable CLL X.xx (Code 3780-xx). *Note: Alternatively, MSA I can be used (for details, please contact us)*
- Flexible array of loudspeakers and microphones (including power amplifiers and cables)

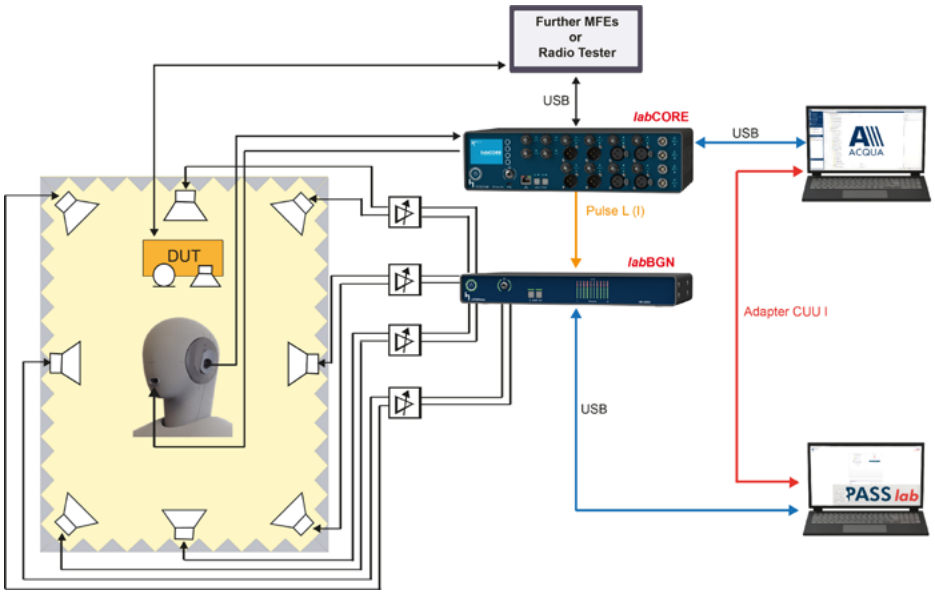


Microphone surround array MSA I mounted on HMS II.3



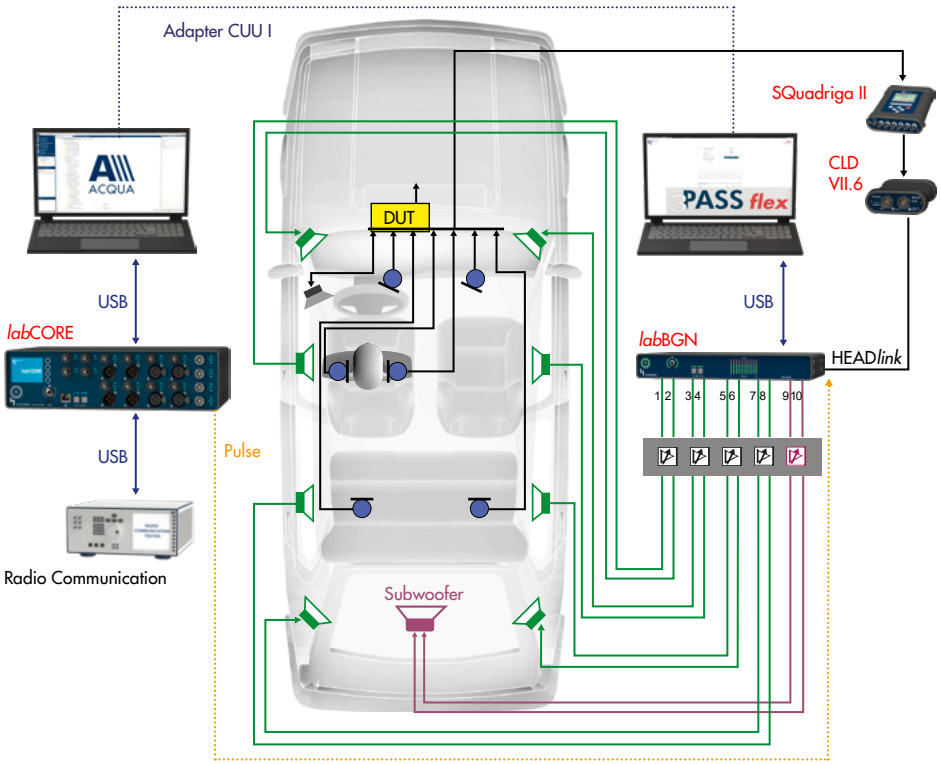
Reproduction accuracy of a background noise recorded at microphone entry point of DUT (Dark red: Original signal - Car noise played back over several loudspeakers in a reference room; Other colors: Result curves after automatic equalization in four rooms with different reverberation times)

Configuration example 3PASS *lab*



Setup for hands-free phone with ACQUA, 3PASS *lab*, HMS II.3, *lab*CORE, *lab*BGN, 8 loudspeakers, power amplifiers

Configuration example 3PASS *flex*



Setup for measurement operation in a car cabin with ACQUA, 3PASS *flex*, HMS II.3, *lab*CORE, *lab*BGN, SQuadriga II, 6 microphones, 8 loudspeakers, 1 subwoofer, power amplifiers

Related Products

- ACQUA Communication Analysis System as one of the following variants (version 4.0.62 or later):
  - Full-license (Code 6810)
  - Compact Systems (Code 6860.xx)
  - Note: ACQUA requires a separate PC!
- *lab*CORE (Code 7700):
  - *core*BUS (Code 7710)
  - *core*OUT-Amp2 (Code 7720)
  - *core*IN-MIC4 (Code 7730)
  - *core*BEQ (Code 7740)
- HHP IV (Code1406): Motorized handset positioner for HMS II, *MotoMount* (Hexapod) Version. *Alternatively:* HHP III.1 (Code1403): handset positioner for HMS II, VariMount Version

Accessories

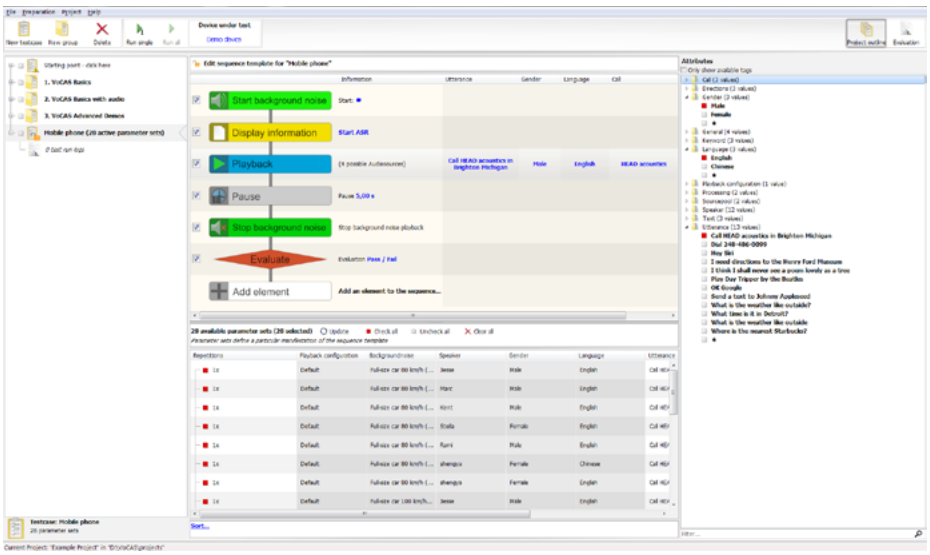
- MA MSA I (Code 6488): MSA I mounting adapter for Brüel & Kjaer HATS
- HD IV.1 (Code 2380): Dynamic headphones
- HMT III (Code 1961): Height-adjustable tripod for HMS (for use case "Hands-free")
- SB MSA I (Code 6489): MSA I Stand Base (for desktop hands-free equalization)
- CUU I (Code 6085): Adapter USB <> USB for remote control 3PASS (Connection ACQUA PC < > 3PASS PC)
- RMB IV.3 (Code 9852): 19" rack Mount Bracket for *lab*BGN (2 pcs.)
- RC X.1-V2 (Code 9850-V2): Remote Control for SQuadriga II
- RC X.2 (Code 9851): Wireless module for Radio Control of RC X.1-V2

Options

- UG HAE-BGN -> 3PASS *lab* (Code 6991): Upgrade HAE-BGN -> 3PASS *lab* (as of HAE-BGN Version 2.1)
- UG HAE-car -> 3PASS *flex* (Code 6992): Upgrade HAE-car -> 3PASS *flex* (as of HAE-car Version 2.1)
- UG 3PASS *lab* -> 3PASS *flex* (Code 6993): Upgrade 3PASS *lab* -> 3PASS *flex* (as of 3PASS Version 2.0)
- UG 3PASS *flex* -> 3PASS *lab* (Code 6994): Upgrade 3PASS *flex* -> 3PASS *lab* (as of 3PASS Version 2.0)

VoCAS (Code 6985)

Voice Control Analysis System



Defined test sequence in VoCAS. The efficient and flexible software enables an objective and fast quality assessment of voice control systems under realistic and reproducible test conditions.

Overview

Automatic Speech Recognition (ASR) systems find widespread application, such as automatic call processing in telephone networks, multimedia systems in cars or device control e.g. of mobile phones, tablets, laptops, televisions or IoT devices such as smart speaker.

The performance of ASR systems depends mainly on:

- Background noise
- Variety of speakers
- Variety of languages

By consequence, testing with a lot of variations is needed while the testing conditions have to be reproducible.

In order to provide a very flexible and efficient way to evaluate the quality of ASR systems under realistic and reproducible conditions, HEAD acoustics has developed the Voice Control Analysis System VoCAS.

Short Description

VoCAS allows the quality evaluation of Automatic Speech Recognition (ASR) systems in reproducible conditions. It offers the following functions:

- Reproducible execution of test sequences
- Preparation of audio file databases:
  - Record files with integrated recorder
  - Easy import of existing files with import wizard
  - Add meta-data to audio sources by setting values for different attributes
- Flexible definition of test sequences:
  - Template definition
  - Variations via parameter sets (e.g. different background noise)

Test sequence parameter sets can determine the following values:

- Playback settings:
  - Level at mouth reference point
  - Lombard effect (e.g. ITU-T P.1100)
- Background noise settings:
  - Noise signals (e.g. from 3PASS *flex*, 3PASS *lab*)
  - Noise levels
- Different audio sources by changing meta data values:
  - e.g. “Eiffel Tower, Paris” or “Airport Cologne” for the attribute “Address”
- Result acquisition, presentation and export
- Integration into HEAD acoustics product ecosystem:
  - *lab*CORE or MFE VI.1 incl. mouth equalization, playback, monitoring
  - Remote control of 3PASS *lab*, 3PASS *flex*, HAE-BGN or HAE-car

Applications

- Flexible, objective and reproducible evaluation of the performance of Automatic Speech Recognition (ASR) systems
- Benchmarking of different ASR systems or ASR software versions

Features

Audio source databases:

- Assisted import of audio files (e.g. as *.dat, *.wav, *.raw or *.mp3) with automatic tagging using filename/folder structure, information in HDF header or by script
- Manual tagging also possible
- Table overview of tagged audio files with attribute columns and values
- Assisted recording of audio files for individual tests with immediate viewing of time data and assignment of tags
- Processing of imported or recorded audio files (Level adjustment RMS or ASL, trimming, splitting, FIR/IIR filtering)
- File storage in SQLite databases

Hardware features:

- Control of *lab*CORE or MFE VI.1 incl. mouth equalization, playback, monitoring
- Remote control of 3PASS *lab*, 3PASS *flex*, HAE-BGN or HAE-car

Test sequence features:

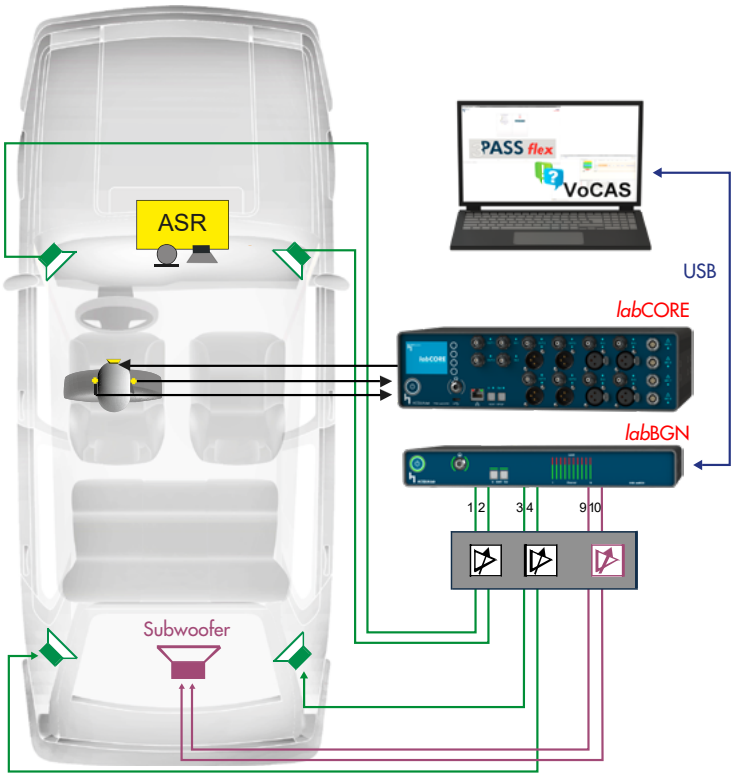
- Define playback configurations for different levels and Lombard effect
- Background noise configurations for different types and/or levels
- Automated modification of test sequence by means of parameter sets with placeholders
- Python scripts with simple API for further automation of testing process
- Reproducible playback of sequences
- Result acquisition, presentation and export to Microsoft® Excel

Delivery Items

VoCAS (Code 6985) comprises the following components:

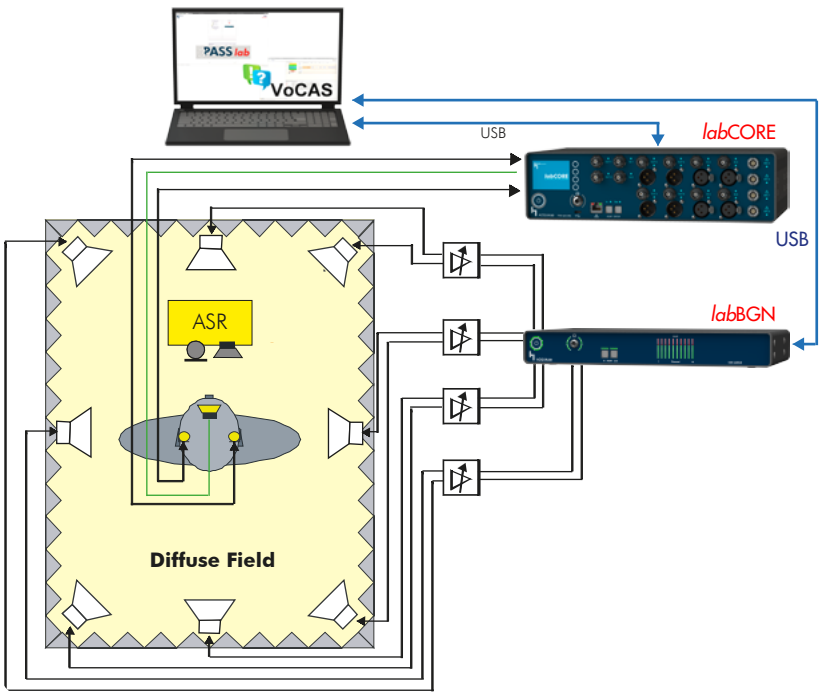
- Setup DVD, including demo project and demo audio database
- Dongle (USB)

Configuration example VoCAS



Setup for voice recognition systems in vehicles with VoCAS, 3PASS *flex*, *lab*CORE, *lab*BGN

Configuration example VoCAS



Setup for voice recognition systems in e.g. mobile phones, IoT devices such as smart speakers with VoCAS, 3PASS *flex*, *lab*CORE, *lab*BGN

System Requirements

The PC (not included in the delivery) on which VoCAS is installed should meet the specifications required by Microsoft® for the operating systems Windows® 7 Professional, Windows® 8/8.1 Pro or Windows® 10 Pro (English or German version, including all current service packs).

Hardware

For playback via artificial mouth of head measurement system (HMS) and binaural feedback from device under test using ear microphones of HMS:

- *lab*CORE (Code 7700), modular multi-channel hardware platform with *lab*CORE modules:
  - *core*BUS (Code 7710), I/O bus mainboard
  - *core*OUT-Amp2 (Code 7720), output module, power amplifier (2 channels)
  - *core*IN-Mic4 (Code 7730), input module, microphone (4 channels)
- Alternatively: MFE VI.1 (Code 6462), analog USB measurement front end
- HMS II.3-33/-34 (Code 1230.1/2) or HMS II.6 (Code 1389), artificial head measurement system with pinna simulator

For level measurement and mouth equalization:

- Reference microphone

For simulation of realistic background noise scenarios one of the following background noise simulation systems depending on the device under test:

- One of the following background noise simulation systems:
  - 3PASS *lab* (Code 6990), for testing at fixed microphone positions (e.g. mobile phones), including necessary system components (cf. separate data sheet)
  - 3PASS *flex* (Code 6995), for testing multi-microphone systems, microphone arrays, beamforming microphones, including necessary system components (cf. separate data sheet)
  - HAE-BGN (Code 6970), automated equalization for background noise simulation in labs, including necessary system components (cf. separate data sheet)
  - HAE-car (Code 6971), automated equalization for background noise simulation in car cabins, including necessary system components (cf. separate data sheet)
  - control over TCP/IP or USB adapter for remote control CUU I

For a simultaneous execution of 3PASS *lab*, 3PASS *flex* and ACQUA or VoCAS on the same PC the minimum requirements are:

- Processor: Modern Quad-Core Processor (2017 or newer) min. 3 GHz (eg. Intel Xeon E5, Intel i5 or Intel i7)
- RAM: 8 GB or more
- Drives: SSD drives recommended for optimal performance
- Disk Space: 40 GB or more

ACQUA (Code 6810)

Advanced Communication Quality Analysis

In combination with the *lab*CORE hardware platform, ACQUA is capable of analyzing a wide range of single components, complete terminals and transmission networks.

Overview

ACQUA is a voice and audio quality test and measurement system. The software includes a multi-channel analysis system for diagnosis of acoustic and/or electric transmission paths up to 192 kHz. Predefined but modifiable measurement descriptors, which are embedded in a database structure, allow gathering and evaluating measurement data in a simple and quick manner. All telecom specific analyses comply with the international standards of e.g. ETSI, ITU, TIA, 3GPP, GCF, PTCRB, GSMA, or CTIA.

ACQUA includes a multi-channel signal generator and a multi-channel analyzer. In combination with for example e.g. the multi-channel hardware platform *lab*CORE a wide range of single components, complete terminals and transmission networks can be analyzed via fully synchronized digital in- and outputs.

A variety of ACQUA options (ACOPT) allows the individual tailoring of the software to specific fields of application which may range from the evaluation of frequency responses to psychoacoustic models and voice quality analysis systems.

Short description

ACQUA is an expandable system solution for testing and analyzing acoustics and network access for different scenarios such as VoLTE, UMTS, DECT, Bluetooth®, hands-free (mobile, office, car), headsets, emergency call and in-car communication. It allows the generation, modification and conduction of measurement sequences as well as the analysis, documentation and archiving of measurement data in the time and frequency domain.

ACQUA makes use of user-definable standards or standards based on national and international telecommunication bodies. These standards are implemented in ACQUA databases and consist of various single measurement descriptors (SMDs) which are combined to measurement sequences and which determine how the measurement data are captured and analyzed in the time and frequency domain.

The settings of the measurement descriptors are shown in a clearly structured and comprehensible form. Users are able to modify the measurement descriptors or protect them against modification.

The clearly arranged hardware configuration provides a complete overview of the measurement chain from ACQUA over front ends (e.g. *lab*CORE) to artificial head measurement system, third party equipment, and the device under test.

ACQUA includes comfortable and useful report and documentation functions such as A/B comparison of multiple measurement objects, benchmarking or Quality Pie report. It is possible to edit reports with Microsoft® Office (alternatively: Open Office, Libre Office).

The databases can be installed on a local SQL server or a network SQL server and allow the automatic archiving of all measurement sequences, results and reports.
The high degree of automization and the ease of use of ACQUA allow the fast conduction of complex test suites with minimal requirements on user interaction.

Delivery items

The ACQUA version "Full-license" (Code 6810) includes the following delivery items:

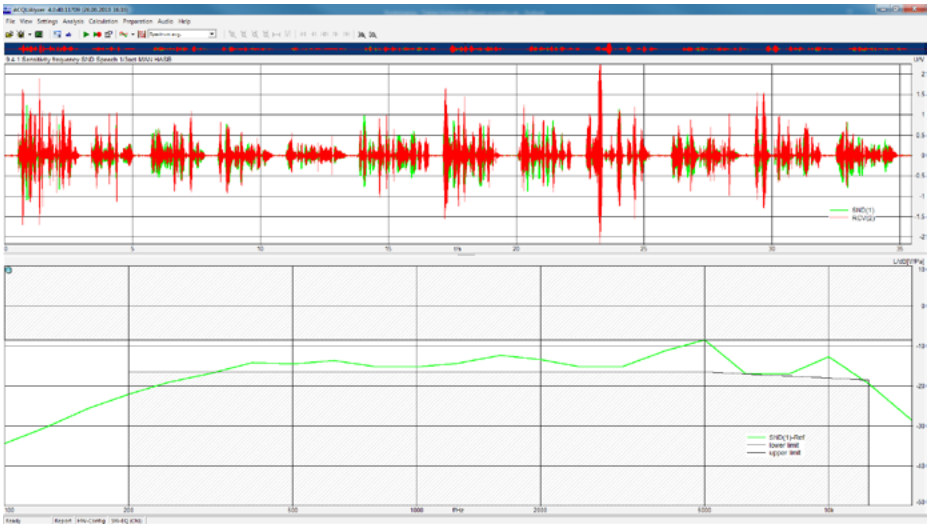
- ACQUA setup medium as download or DVD
- Local dongle (for USB port)
- One year software maintenance and update contract (optionally renewable on a yearly basis)

The ACQUA version "Workplace" (Code 6830) additionally includes the ACQUA option ACOPT 02, option signal analysis. Optionally, a network dongle is available instead of the local dongle (upon request, at an extra charge).

The ACQUA Compact system (Code 6860) is a bundle consisting of compact software and the *lab*CORE main hardware platform (Code 7700).

Features

- Analyses in the time domain, determination of level, level vs. time, delay etc.
- Analyses in the frequency domain, determination of transmission functions, loudness ratings, echo loss, distortions, background noise, out-of-band signals etc.
- Database controlled configuration and control of test procedures and front ends
- Predefined test cases for fast, automated and guided measurements according to various – partly mandatory – international standards
- Digital real-time equalization of any artificial mouth
- Individual default settings definable
- Modifiable measurement descriptors
- Automated measurement sequences
- Creation and automatic verification of tolerance schemes
- Recording of any signals via digital interfaces (only with full-license version and compact systems)
- Auditory evaluation of measurement objects, especially important for non-linear time-variant systems
- Acoustic real-time playback for analysis support (e.g. via headphones)
- Data integrity and reproducibility due to archiving of measurement sequences and results in an SQL database
- Calibration of measurement system in e.g. dBV, dBPa
- All telecom specific measurement methods available; implemented calculation methods according to e.g.:
  - ITU-T G.122 / P.64 / P.79 / P.340 / P.502 (Appendix III) / O.131 / O.132
  - IEEE 269
- Optionally, further methods are available, e.g.:
  - 3QUEST (ETSI EG 202 396-3, TS 103 106, TS 103 281 (Model A))
  - EQUEST
  - TOSQA
  - PESQ (ITU-T P.862)
  - POLQA (ITU-T P.863)
  - Relative Approach
  - GCF / PTCRB
  - SNRi & TNLR (ITU-T G.160)
  - 3GPP TS 26.132 (ANR-Tests, Speech-based Double Talk)
  - STITEL, STIPA, RASTI (variants of Speech Transmission Indices)
  - SII (Speech Intelligibility Index)



ACQUAlyzer window

Applications

- Voice quality and audio quality testing and optimization (algorithms, devices and systems)
- Conformance tests
- Quality control
- Research & development

Measurement signals

The following measurement signals are used by the measurement descriptors (depending on the corresponding standard):

- Sine
- Sine Stepped Sweep
- Multisine
- Pseudo Noise
- Artificial Voice (P.50)
- Pink, White and Hoth Noise
- Program simulating noise
- Maximum Length Sequence (MLS)
- Speech
- Test signals according to ITU-T Rec. P.501, e.g. Composite Source Signal (CSS)
- Define and edit any test signal
- Import of any test signal

Product versions

ACQUA Full-license (Code 6810)

Full version with maximum range of features (cf. feature list).

ACQUA Workplace (Code 6830)

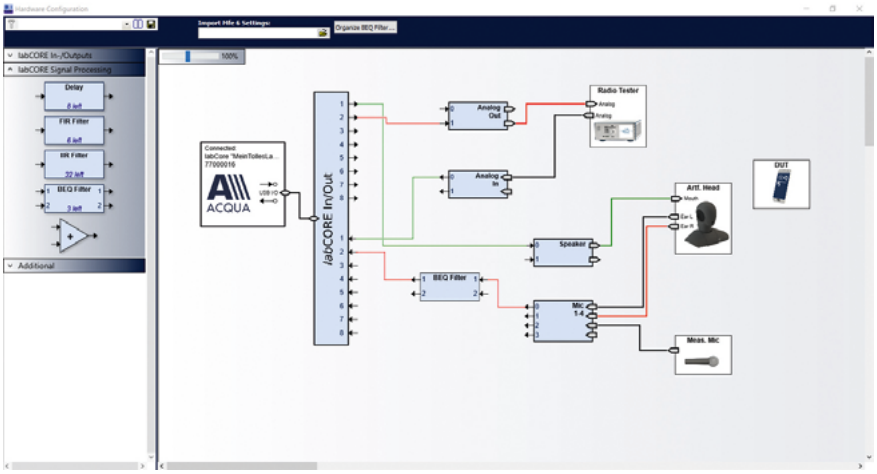
For post-analyses, measurement preparation and documentation, i.e. without the possibility to start measurements. All SMD types can be created/opened/edited, even those which normally require an additional ACOPT.

Optionally, ACQUA Workplace can be upgraded to the full-license version with "UG ACQUA Workplace" (Code 6862).

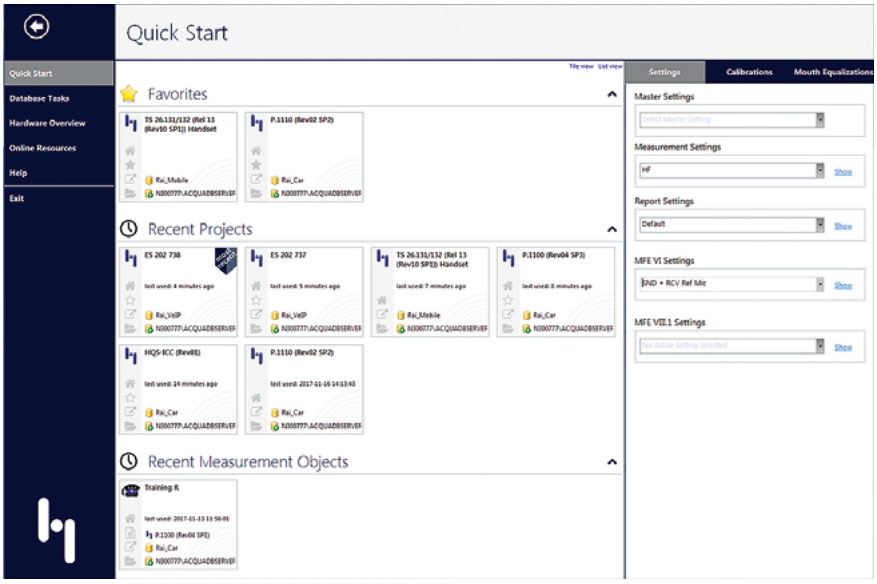
- Main application areas:
  - Expert system, for building measurement descriptors
  - User system for post-analysis, report generating and measurement data reappraisal (thus "relieving" the measurement room)
  - Verification system for customers and suppliers, especially for customers who do not want to measure themselves, but want to verify tests in detail

ACQUA Compact (Code 6860)

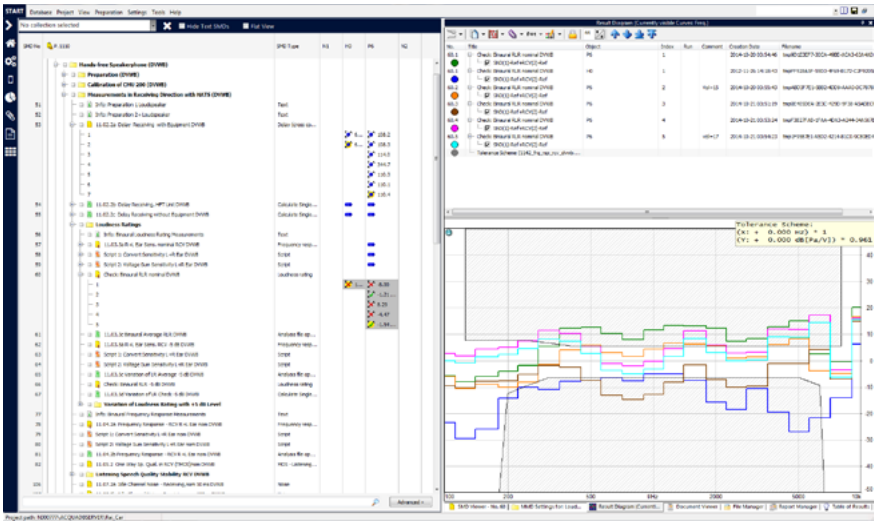
This version includes the ACQUA Compact software and the *lab*CORE main hardware platform. Further *lab*CORE hardware modules and ACQUA databases can be added as needed for the given application.



Window for hardware configuration and front end control in ACQUA



Interface of the Quick Start menu in ACQUA



Measurement database in ACQUA

Network licensing

ACQUA Workplace and most ACQUA options (ACOPT) are available as network license. Pre-existing local licenses can be upgraded to corresponding network licenses. ACQUA Full-license, ACQUA Compact, all ACQUA databases, and some ACOPTs are only available as local licenses.

System requirements

The PC which ACQUA is installed on has to fulfill the following minimum specifications:

- Core i5
- Min. 4 GB RAM
- NTFS file system required
- Free hard disk capacity required for installation of all components: 1,5 GB
- Free hard disk capacity required for ACQUA databases: depending on the number and size of your databases
- Min. 2 unused USB ports (3 ore more recommended)
- Microsoft® Windows® 7 Professional/ Ultimate, Windows® 8/8.1 Pro, Windows® 10 Pro,
  English or German version, including all current service packs
- Microsoft® Office (2007 or later), English or German version, including all current service packs. Note: the OEM version "Microsoft® Office Starter" is not suitable for ACQUA due to a lacking COM interface support

  – Alternatively: Open Office or Libre Office

Options

A variety of ACOPTs allows the individual tailoring of the software to specific fields of application. The currently available options are described in detail in a separate data sheet.

Accessories

Depending on the measurement task, one or several *lab*CORE modules or measurement front ends (MFEs) are required for data acquisition and measurement control. Moreover, measurements standards, artificial head with handset positioner and other components may be required.

Feature list

The following table gives an overview of the differences regarding the support of various features in the three versions Full-license (Code 6810), Workplace (Code 6830 and 6830N) and Compact (Code 6860), as well as showing the ACOPTs available as network license:

Data and results	Full	Workplace	Compact
Database archiving			
• Report	•	n. a.	•
• Analysis data	•	n. a.	•
• Time data	•	n. a.	n. a. **1)**
Import/export data with conversion **2)**	•	•	•
MP3 import and export	•	•	n. a.
Signal recording	•	n. a.	•
Create report **3)**	•	•	•
Edit results with ACQUA-lyzer	•	•	n. a.
Open additional projects in separate viewers (r/o)	•	•	n. a.
Project merge and compare	•	•	n. a.
Access ACOPTs from network dongle	•	•	n. a.

Single measurement descriptors	Full	Workplace	Compact
Create and edit SMDs	•	•	•
Basic SMD types **4)**	•	•	•
Special SMD types			
• 3QUEST (ETSI EG 202 396-3, TS 103 106)	◆21	◆21	◆21
• Active Speech Level (ITU-T P.56)	◆09	◆09	◆09
• CLIP	◆11	n. a.	n. a.
• DTMF	◆12	◆12	n. a.
• EQUEST	◆29	◆29	◆29
MOS — Listening Speech Quality			
• PESQ (ITU-T P.862)	◆16	◆16	◆16
• POLQA (ITU-T P.863)	◆30	◆30	◆30
• TOSQA	◆10	◆10	◆10
Psychoacoustics (ISO 532 A/B, DIN 45631)	◆25	◆25	◆25
Relative Approach	◆17	◆17	◆17
Room Acoustics (ISO 3382, ITU-T P.340)	◆26	◆26	◆26
Speech Intelligibility Index	◆34	◆34	◆34
SNR Improvement (ITU-T G.160)	◆28	◆28	◆28

ACQUA Option		Network	Full	Workplace	Compact
01	Signal Generator and Editor	☐	◆	◆	n. a.
02	Signal Analysis	☐	◆	•	n. a.
09	SLVM P.56	☐	◆	◆	◆
10	TOSQA	n. a.	◆	◆	◆
11	CLIP (ETSI ETS 300 778-1)	☐	◆	n. a.	n. a.
12	DTMF	☐	◆	◆	n. a.
16	PESQ (ITU-T P.862)	n. a.	◆	◆	◆
17	Relative Approach	☐	◆	◆	◆
18	ACQUA COM Remote Control	☐	◆	◆	◆
19	Online Analysis	☐	◆	◆	n. a.
20	Quality Pie (ITU-T P.505)	☐	◆	◆	◆
21	3QUEST (ETSI EG 202 396-3, TS 103 106)	n. a.	◆	◆	◆
22	ETSI ES 203 021	n. a.	◆	n. a.	◆
23	GCF	n. a.	◆	n. a.	◆
24	PTCRB	n. a.	◆	n. a.	◆
25	Psychoacoustics (ISO 532 A/B, DIN 45631)	☐	◆	◆	◆
26	Room Acoustics (ISO 3382, ITU-T P.340)	☐	◆	◆	◆
27	Speech Transmission Index (RASTI, STIPA, STITEL)	☐	◆	◆	◆
28	SNRI & TNLR Calculation (ITU-T G.160)	☐	◆	◆	◆
29	EQUEST	n. a.	◆	◆	◆
30	POLQA (ITU-T P.863)	n. a.	◆	◆	◆
31	ACQUA Batch Processing (PESQ, TOSQA, 3QUEST, POLQA)	n. a.	◆	◆	n. a.
32	Speech-based Double Talk Analysis	☐	◆	◆	◆
33	LinearX Turntable Support	n. a.	◆	◆	◆
34	Speech Intelligibility Index (ANSI S3.5-1997)	☐	◆	◆	◆
35	3QUEST-SWB/FB (ETSI TS 103 281, Model A)	n. a.	◆	◆	◆

•	Included
◆	Optional
◆ xx	Optional, requires ACOPT XX
☐	Available
n. a.	Not available

1) Time data can be archived for the following SMD types: Time response, 3QUEST, EQUEST, MOS (TOSQA , PESQ, POLQA)

2) Conversion to and from the following formats: ASCII, Wave, MS Excel (*.xls), Matlab, PCM

3) Requires Microsoft Word, Open Office or Libre Office

4) Analysis file operations, Automated double talk (ITU-T P.502 Appendix III), Calculate single value, Correlation and transfer function, Delay (Two-frequency method, Cross correlation), Distortion (Noise [ITU-T O.131, IEEE 269-2010], Sinusoidal, Fast sinusoidal), Echo loss, Frequency response, Level, Level vs Time, Loudness rating , Noise, Out of band, Play file, Return loss and longitudal conversion loss, Script, Sidetone masking rating, Text (info), Time distance, Time response, Variation of level, Variation of loudness rating

5) For 3QUEST, EQUEST, PESQ, POLQA, SNRI, Speech-based Double Talk and TOSQA, the respective ACOPTs (21, 29, 16, 30, 28, 32 and 10) are needed in addition. For automated double talk, no ACOPT is needed in addition.

HQS-SmartHome (Code 60054)

HEAD acoustics Quality Standard, Smart Home Devices

Measurement configuration with multiple talkers

Overview

HEAD acoustics introduces the quality standard HQS-SmartHome. The standard is especially tailored for testing the communication quality of voice-operated smart home devices.

Key features of HQS-SmartHome:

- Performance tests of echo canceling
- Performance tests during double talk
- Directivity measurements
- Speech and transmission quality with background noise scenarios
- Speech and transmission quality with reverberant simulations

There are measurements available for single and multi talker scenarios. The analysis software ACQUA processes recorded audio signals, analyzes them and generates result reports. HEAD acoustics provides the complete package of hardware and software to execute measurements.

Description

HQS-SmartHome helps improving the communication quality of voice-operated smart home devices. It contains tailored measurements for this purpose. Among others, there are directivity measurements with HEAD acoustics' turntable HRT I, background noise and environmental simulations for various everyday situations. The analysis software ACQUA automatically processes, calculates and analyzes the measurement results. It presents the results convenient and clear.

Applications

Testing communication performance of:

- Smart home devices
- Speakerphones
- Conferencing devices

Measurement projects

Single talker

Single talker measurements involve one HATS. The measurements apply artificial signals as well as real-speech signals in sending and receiving directions. Speech quality is also tested with background noise and with reverberant simulations. The scope is extended with measurements concerning echo canceling, double talk and directivity.

Multi talker

Multi talker measurements involve two HATS. There are preparatory measurements and settings to simplify the measurement procedure afterwards. The main measurements meet the ITU-T recommendation P.340 Annex B including real-speech signal testing. Furthermore, there are speech quality measurements including background noise scenarios and disturbing noise from concurrent talker.

General requirements

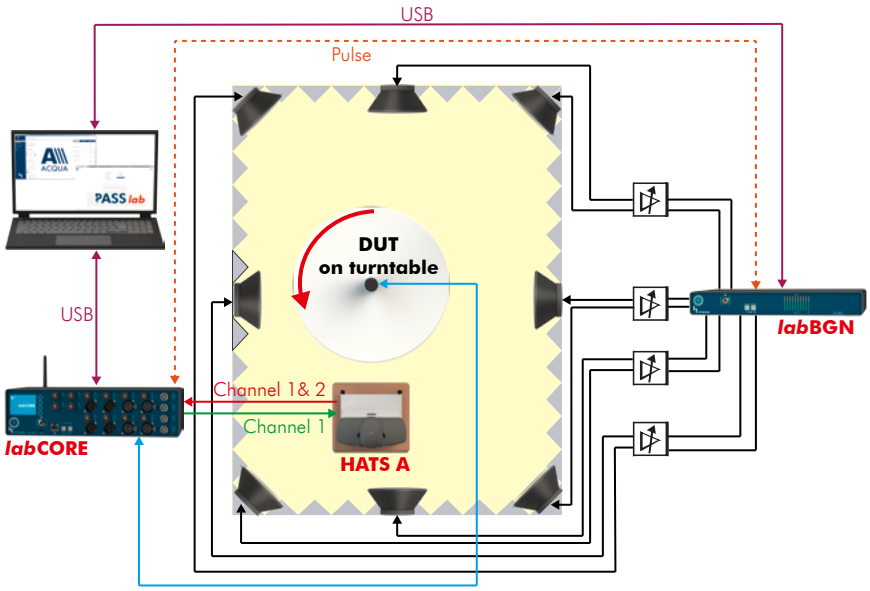
Software

- ACQUA (Code 6810), Advanced Communication Quality Analysis, Version 4.0.60 or later
- 3PASS *lab* (Code 6990), background noise simulation system or 3PASS *flex* (Code 6995), background noise simulation system
- ACOPT 09 (Code 6819), option Speech Level Voltmeter
- ACOPT 20 (Code 6843), option Quality Pie
- ACOPT 21 (Code 6844), option 3QUEST
- ACOPT 35 (Code 6866), option 3QUEST-SWB/FB

Delivery Items

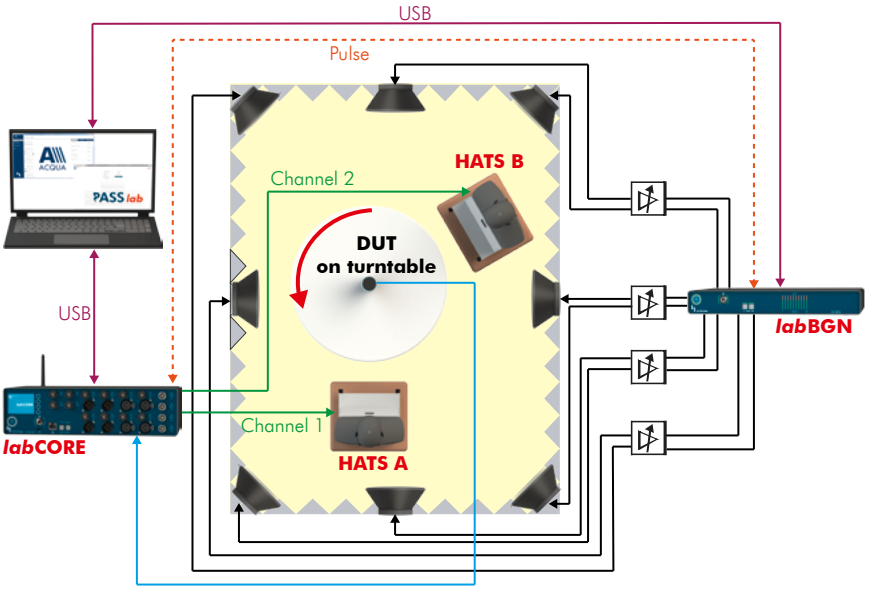
- HQS-SmartHome (Code 60054), delivered as ACQUA database
- V2C file
- Manual as PDF

Configuration example HQS-SmartHome



Setup with one HATS, ACQUA, 3PASS *flex*, *lab*CORE, *lab*BGN, turntable HRT I

Configuration example HQS-SmartHome



Setup with two HATS, ACQUA, 3PASS *flex*, *lab*CORE, *lab*BGN, turntable HRT I

Hardware

- *lab*CORE (Code 7700), modular multi-channel hardware platform
- *core*BUS (Code 7710), I/O bus mainboard
- *core*OUT-Amp2 (Code 7720), power amplifier output module (two channels) analog output module
- *core*IN-Mic4 (Code 7730), microphone input module (four channels)
- HMS II.3 (Code 1230), HEAD measurement system with ear simulator, pinna type 3.3 or 3.4
- HRT I (Code 6498), HEAD acoustics remote-operated turntable

Project requirements

Single talker

- 3PASS *reverb* (Code 6996), option, simulation of reverberation scenarios
- ACOPT 25 (Code 6852), option Psychoacoustics
- ACOPT 26 (Code 6853), option Room Acoustics
- ACOPT 29 (Code 6856), option EQUEST
- ACOPT 30 (Code 6857), option POLQA
- ACOPT 32 (Code 6859), option Speech-based Double Talk
- *core*BEQ (Code 7740), binaural equalization
- HIS L (Code 1231), HEAD impedance simulator, left ear

Multi talker

- HMS II.5 (Code 1388), HEAD measurement system without ear simulator

Options

- *core*IP (Code 7770), *lab*CORE I/O module, Voice over IP reference gateway
- *core*IP-IMP (Code 7771), *lab*CORE VoIP impairment option
- *core*BT (Code 7780), *lab*CORE I/O module, Bluetooth reference access point
- *core*BT-EXT (Code 7781), *lab*CORE Bluetooth extended codec option

Measurements
The list gives an overview of the measurements included in HQS-SmartHome.

Measurements in receiving direction (single talker)
- Delay
- Loudness rating
- Variation of loudness rating
- Active speech level (ASL)
- Frequency response
- Listening speech quality (POLQA)
- Distortion
- Idle channel noise
- Out-of-band signals
- Activation performance
- Directivity measurements
- Network impairment measurements

Measurements in sending direction (single talker)
- Delay
- Loudness rating
- Active speech level (ASL)
- Frequency response
- Listening speech quality (POLQA)
- Distortion
- Idle channel noise
- Out-of-band signals
- Activation sensitivity
- Muted microphone tests
- Directivity measurements
- Transmission performance with background noise
- Reverberant speech performance

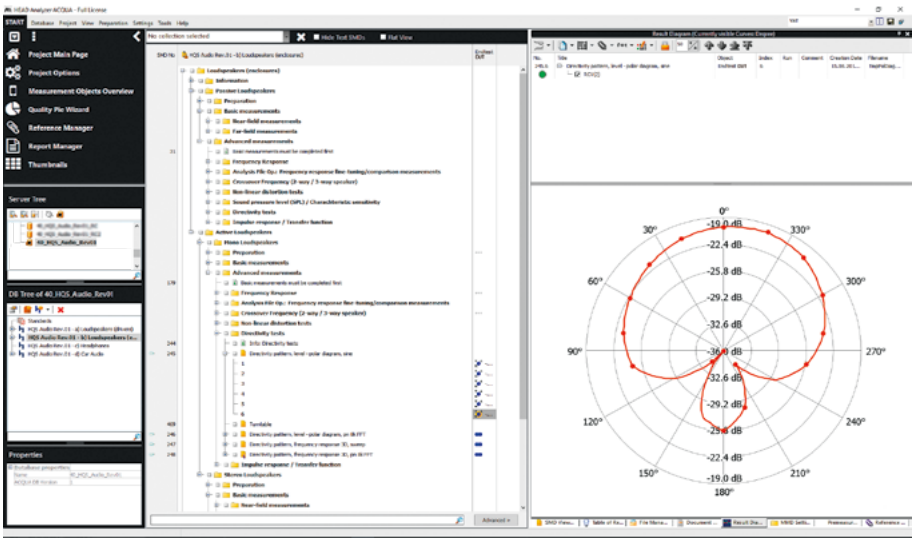
Echo measurements (single talker)
- Terminal coupling loss
- Echo level vs. time
- Spectral echo attenuation
- Echo performance with time variant echo path
- Perceptual echo assessment
- Stability loss

Double talk measurements (single talker)
- Attenuation range (SND, RCV)
- Detection of echo components

Measurements in sending direction (multi talker)
- Attenuation range (SND, RCV)
- Detection of echo components
  Measurements in sending direction (multi talker)
- Adaption time in talker alternation (composite source signals)
- Adaption time in talker alternation (real speech signals)
- Level of completely overlapping bursts (CSS)
- Level of completely overlapping bursts (real speech signals)
- Dynamic turn taking, switching characteristics (CSS)
- Dynamic turn taking, switching characteristics (real speech signals)
- Concurrent talk with AM-FM signals (Composite source activation signal)
- Concurrent talk with AM-FM signals (real speech activation signal)
- Speech quality measurements with background noise
- Robustness against disturbing noise from concurrent talker

HQS-AudioBasic (Code 60052)

HEAD acoustics Quality Standard, Basic electroacoustic tests of loudspeakers



Directivity pattern in ACQUA (polar diagram, exemplary)

Overview

HEAD acoustics developed the quality standard HQS-AudioBasic for the analysis of electroacoustical parameters of loudspeakers. The key features within the included measurements are:

- Automated measurement sequences for loudspeaker enclosures as well as loudspeaker drivers
- Tests of directivity characteristics for enclosed loudspeakers
- Calculation of Thiele/Small parameters of loudspeaker drivers
- Relative Approach analysis for all applications

The database of HQS-AudioBasic is implemented in the advanced communication quality analysis software ACQUA.

Description

HQS-AudioBasic is a measurement standard that has been developed exclusively by HEAD acoustics to test and analyze electroacoustical parameters of loudspeakers. It contains two projects for different applications (loudspeaker drivers, loudspeaker enclosures). The projects are subdivided into basic and advanced measurements. Convenient and informative instructions guide the user through the measurement sequence. Implemented scripts with graphical user interfaces simplify the definition of customized variables and documentation.

Execute, control and set up the measurements via the analysis software ACQUA. The hardware platform *lab*CORE is equipped with various interfaces for signal transmission. HEAD acoustics provides all necessary measurement equipment for the different applications.

Applications

- Testing of speaker drivers
- Testing of enclosed speaker drivers
- Testing of smart speakers

Measurement projects

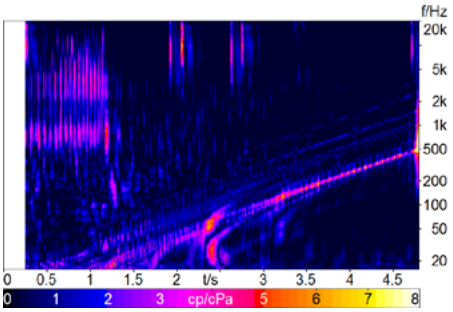
There are two measurement projects following the same pattern. Both projects contain preparatory, basic and advanced measurements. Some of the basic measurements are necessary prerequisites for the advanced measurements.

Loudspeaker drivers

The project provides measurements for single speaker drivers without enclosure. Hence, it is suited for tests in an early development stadium of single speaker drivers (woofer, mid-range driver, tweeter, full-range speaker). Standard loudspeaker driver measurements like Thiele/Small parameters are included.

Loudspeaker enclosures

This project contains measurement sequences to assess loudspeaker drivers within enclosures. Measurements address passive loudspeakers, active mono loudspeakers and active stereo loudspeakers. Especially directivity measurements of loudspeakers are fast and convenient due to the automated interaction of ACQUA and the turntable HRT I. Wireless measurements via Bluetooth® are easily performed with the suitable *lab*CORE module.

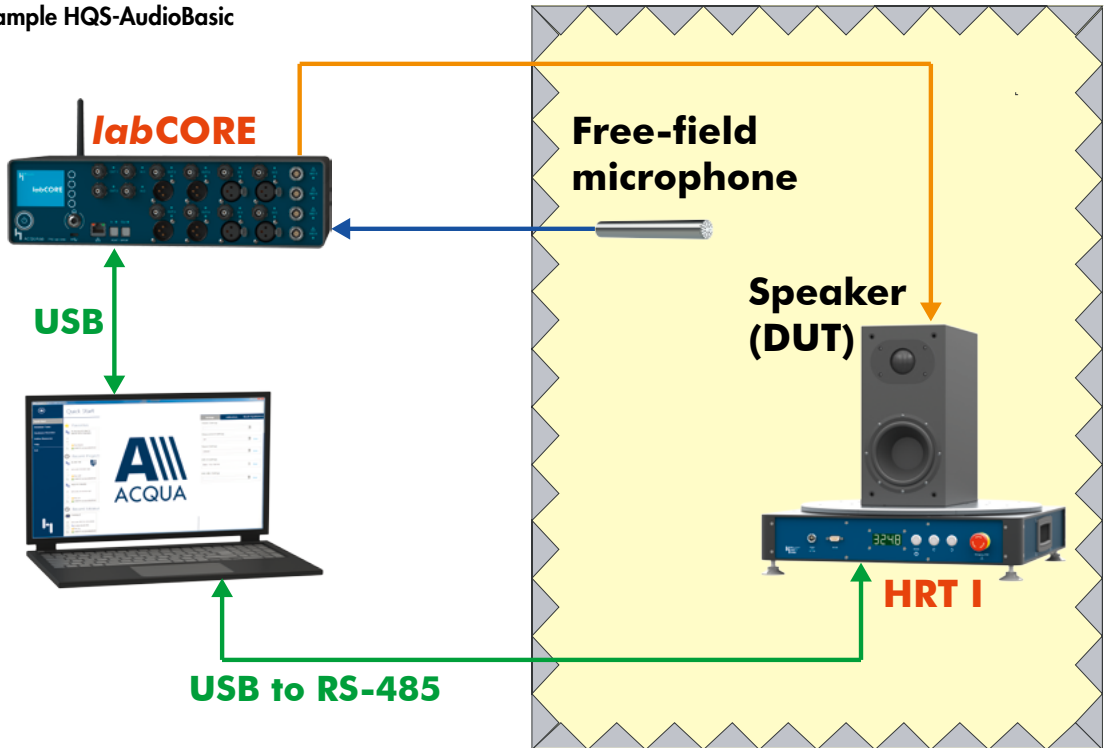


Relative Approach spectrogram - Rub & Buzz (exemplary)

Delivery Items

- HQS-AudioBasic (Code 60052), delivered as ACQUA database
- V2C file
- Manual as PDF

Configuration example HQS-AudioBasic



Setup for enclosured loudspeaker ith *lab*CORE, ACQUA, turntable HRT I

General requirements

Software

- ACQUA (Code 6810), Advanced Communication Quality Analysis, Version 4.0.62 or later
- ACOPT 17 (Code 6839), option Relative Approach
- ACOPT 26 (Code 6853), option Roomacoustics

Hardware

- *lab*CORE (Code 7700), modular multi-channel hardware platform
- *core*BUS (Code 7710), I/O bus mainboard
- *core*IN-Mic4 (Code 7730), microphone input module (four channels)
- *core*IN-A2 (Code 7760), analog input module
- Audio output:
  - *core*OUT-Amp2 (Code 7720), power amplifier output module (two channels) or
  - *core*OUT-A2 (Code 7750), analog output module
- Free-field microphone

Project requirements

Loudspeaker drivers

No further equipment required.

Loudspeaker enclosures

- HRT I (Code 6498), HEAD acoustics remote-operated turntable

Options

- *core*BT (Code 7780), *lab*CORE I/O module, Bluetooth reference access point
- *core*BT-EXT (Code 7781), *lab*CORE Bluetooth extended codec option

Measurements
The table gives an overview of the measurements included in HQS-AudioBasic.

SMD \ Project	Loudspeaker (drivers)	Loudspeaker (enclosures)		
		Passive LS	Active mono LS	Active stereo LS
Frequency response	•	•	•	•
Signal/Noise Ratio (SNR) at level of max desired dist.	•	•	•	•
Sound Pressure Level, sine, user defined parameter	•	•	•	•
Sound Pressure Level, broadband noise (acc. to EN standards)	•	•	•	•
Sound Pressure Level max desired distortion (sine, broadband noise)	•	•	•	•
Sound Pressure Level max. (rated power), sine, broadband noise	•	•	•	•
Visualize crossover frequency (2-way, 3-way loudspeakers)	n/a	•	•	•
Directivity pattern, level-polar plot (sine/broadband noise), frequency response 3D (broadband noise)	n/a	•	•	•
Impulse response, sweep, 262k FFT	•	•	•	•
Transfer function, H1, sweep, 262k FFT	•	•	•	•
Phase response, H1, sweep, 262k FFT	•	•	•	•
Group delay, sweep, 262k FFT	•	•	•	•
Coherence, sweep, 262k FFT	•	•	•	•
Impulse response time windowing	•	•	•	•
Cumulative spectral decay	•	•	•	•
Total harmonic distortion (THD)	•	•	•	•
Total harmonic distortion & Noise (THD+N)	n/a	n/a	•	•
Intermodulation distortion, two-tone, 2nd & 3rd order	•	•	•	•
Distortion - Rub & Buzz	•	•	•	•
Relative approach, Impulsive distortion	•	•	•	•
Electrical polarity of EUT connection	•	•	n/a	n/a
Electrical impedance, resonance frequency of EUT	•	n/a	n/a	n/a
Calculate Thiele/Small parameters	•	n/a	n/a	n/a

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