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MDAQS

DATA SHEET

ACOPT 36 (Code 6867)

MDAQS – MultiDimensional Audio Quality Score

Overview

MDAQS is an AI-based method for instrumental evaluation of audio quality. It merges the key criteria for perceived audio playback quality – timbre, distortion and immersiveness – into one single MOS value for quick assessment and good comparability.

HEAD acoustics developed MDAQS – the MultiDimensional Audio Quality Score – based on a tailor-made auditory test design. An algorithm trained with test results calculates a MOS value that reflects the audio quality of arbitrary playback systems or devices, e.g. loudspeakers, headphones & headsets, in-vehicle audio systems, mobile & smart speakers and more. It allows quick and convenient assessment of playback quality during and after development.

MDAQS is available for ACQUA as the optional extension ACOPT 36.

Key Features

- Comprehensive automated test suite
- First algorithm for professional assessment of perceived audio playback quality
- Supports all types of audio systems and devices with audible playback

Applications

- Automated testing for evaluation and experimental optimization of audio quality in systems & devices with audible playback

Description

Customer expectations to audio playback quality are increasing continuously. Manufacturers of audio equipment meet these demands by different measures, e.g. increasing the number of amplifier channels and loudspeakers, active sound optimization (e.g. digital equalization), active noise cancellation and other measures. This rising complexity is prevalent in virtually every modern application with audible playback:

- Multi-channel loudspeaker systems in vehicles & at home
- Earphones, headphones & headsets
- Smart speakers
- Mobile loudspeakers
- One-piece multiroom loudspeakers
- Stereo audio systems

Developing and tuning such complex systems and devices towards a desired sound signature becomes increasingly difficult. Basic measurements (e.g. frequency response) do not represent the system in its entirety and thus do not suffice to predict human perception. This can be met by conducting auditory tests. However, getting statistically meaningful results entail high personnel expenses and significant expenditure of time.
To meet the demand for a quick and cost-effective solution to assess audio playback quality, HEAD acoustics developed MDAQS – the MultiDimensional Audio Quality Score. MDAQS is the first algorithm for instrumental assessment of audio quality of arbitrary systems and devices with audible playback.

Mean Opinion Score (MOS)

The MDAQS algorithm calculates a Mean Opinion Score (MOS), a numerical ranking system defined by ITU-T in Recommendation P.800.
The Mean Opinion Score ranges from 1 (worst value) to 5 (best value). Intermediate values (including decimals) allow benchmarking of similarly performing devices.

MOS	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

The basis for MDAQS is to describe human perception of sound quality with three main categories: timbre, distortions and immersion. Trials with naïve listeners have proven test designs based on these criteria to be a very adequate method for assessing perceived audio quality. HEAD acoustics developed a sophisticated algorithm based on this method. Trained with the results of numerous sessions of auditory testing, the algorithm is able to accurately predict the audio quality of the system / device under test as perceived by naïve listeners. Tasks usually performed by trained listeners may not yield representative results.

Analysis with MDAQS is straightforward. The MDAQS database contains two-channel test signals as well as music excerpts representing a cross-section of genres. The test sequence is played back by the device under test (DUT). Feedback is recorded with a suitable HMS system and subsequently analyzed in ACQUA.
Based on these recordings, the MDAQS algorithm calculates four MOS values for the DUT:

- MOS_T for Timbre
- MOS_D for Distortion
- MOS_I for Immersiveness
- A combined MOS for overall quality

These values allow to determine audio quality, to verify the success of fine-tuning and benchmarking against similar devices. Additionally, they show strong suits as well as weaknesses in single categories, allowing to target specific areas to improve a device's performance.
The environment for testing with MDAQS depends on the type of DUT. For example, testing a closed headphone only requires a reasonably quiet environment, not necessarily a (semi-)anechoic room. A high signal-to-noise ratio (SNR) is the deciding factor. If the SNR falls too low, the predictive accuracy of MDAQS naturally decreases. DUTs providing only low sound pressure levels at the ear despite an ideal environment, e.g. small mobile loudspeakers, can benefit from choosing a low-noise HMS system to increase SNR. The MDAQS test suite can be used by manufacturers and suppliers of audio systems and devices fast and convenient testing, comparison and experimental optimization of audio playback quality.

General Requirements

Hardware

- **labCORE (Code 7700)**
  modular multi-channel hardware platform **with**
  - **coreBUS (Code 7710)**
    I/O bus mainboard
  - **coreBEQ (Code 7740)**
    binaural equalization incl. filter set for one artificial head
  - One of the following
    ***lab*CORE Input Modules**
    - **coreIN-Mic4 (Code 7730)**
      labCORE input module, microphone (4 Channels)
      only for HMS II.3/LN/HEC, 4, 6

    or

    - **coreIN-ICP4 (Code 7730)**
      labCORE input module, ICP (BNC connector, 4 Channels),
      only for HMS II.7

- One of the following
  HEAD Measurement Systems[1]
  - **HMS II.3 (Code 1703)**
    HEAD Measurement System, basic version with right ear simulator, 3.3 pinna & artificial mouth **with**
  - **HIS L (Code 1701)**
    HEAD Impedance Simulator, left, for HMS II.3/4/5, version 2021

  or

  - **HMS II.3 LN (Code 1703.1)**
    HEAD Measurement System, low-noise version with right ear simulator, 3.3 pinna & artificial mouth (based on IEC 60318-4, low-noise, high dynamics) **with**
  - **HIS L LN (Code 1701.1)**
    HEAD Impedance Simulator, left, low-noise version, for HMS II.3/4/5, version 2021

  or

  - **HMS II.3 LN HEC (Code 1703.2)**
    HEAD Measurement System, low-noise version with human-like ear canal simulator right, 4.4 pinna & artificial mouth **with**
  - **HIS L LN HEC (Code 1701.2)**
    HEAD Impedance Simulator, left, low-noise version, for HMS II.3/4/5, human-like ear canal version

  or

  - **HMS II.4 (Code 1704)**
    HEAD Measurement System, with right ear simulator and 3.3 pinna (w/o artificial mouth) **with**
  - **HIS L (Code 1701)**
    HEAD Impedance Simulator, left, for HMS II.3/4/5, version 2021

  or

  - **HMS II.6**[2] **(Code 1706),**
    HEAD Measurement System, with artificial mouth and free-field microphones (left & right)

  or

  - **HMS II.7**[2] **(Code 1707),**
    HEAD Measurement System, with artificial mouth and free-field ICP® microphones (left & right)

Software

- **ACQUA (Code 6810 etc.)**
  Advanced Communication Analysis System

Delivery Items

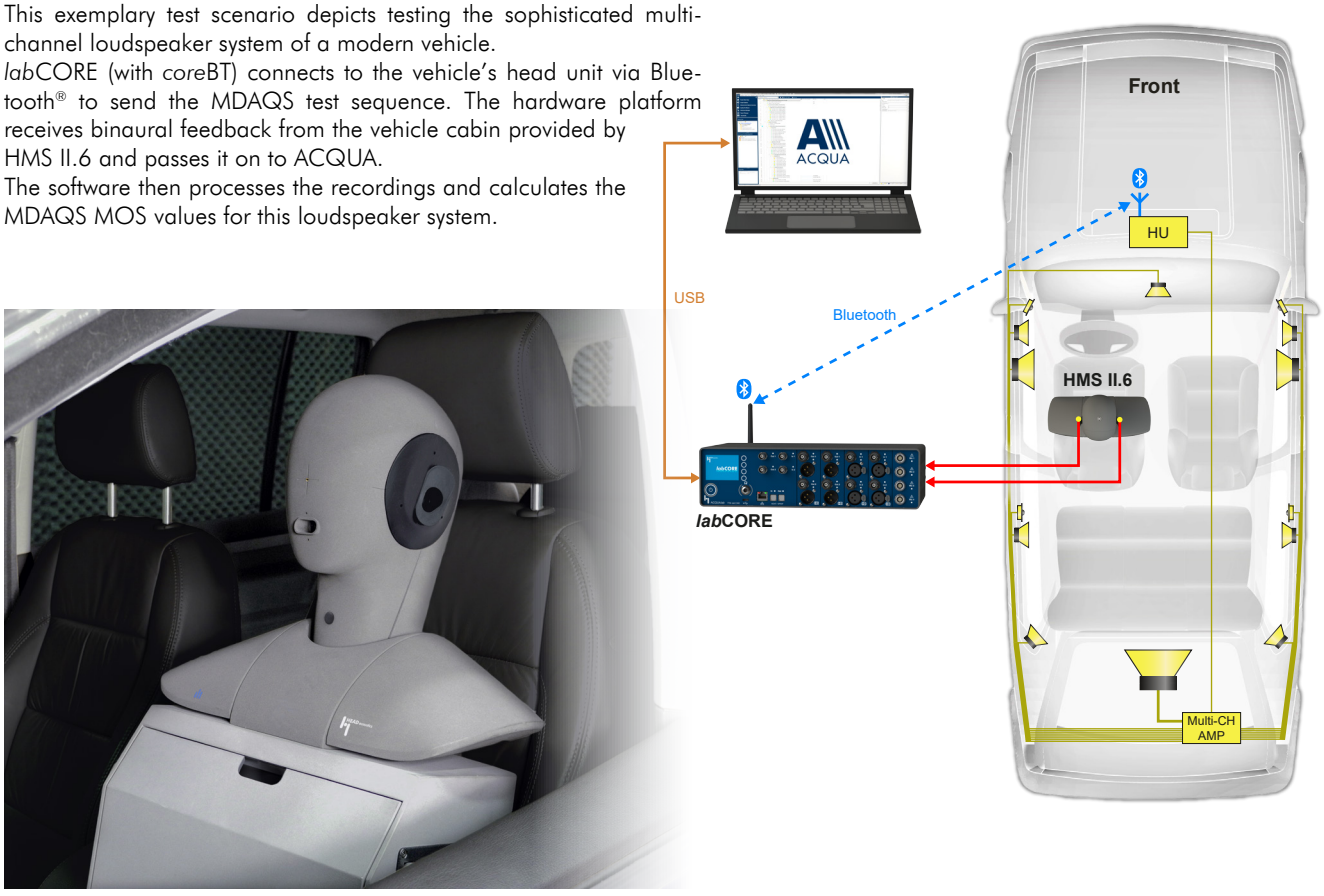
- **ACOPT 36 (Code 6867)**,
  MDAQS - Multi-Dimensional Audio-Quality Score
  delivered as ACQUA database
- **Documentation**

Configuration example 1: Measurement Setup for a High Quality Headphone

This exemplary test scenario depicts testing a high quality hi-fi headphone.
*lab*CORE sends the MDAQS test sequence via its headphone output to the DUT worn by HMS II.3 LN HEC. The hardware platform receives binaural feedback from the HATS via *core*IN-Mic4 and passes it on to ACQUA. The software then processes the recordings and calculates the MDAQS MOS values for the headphone.

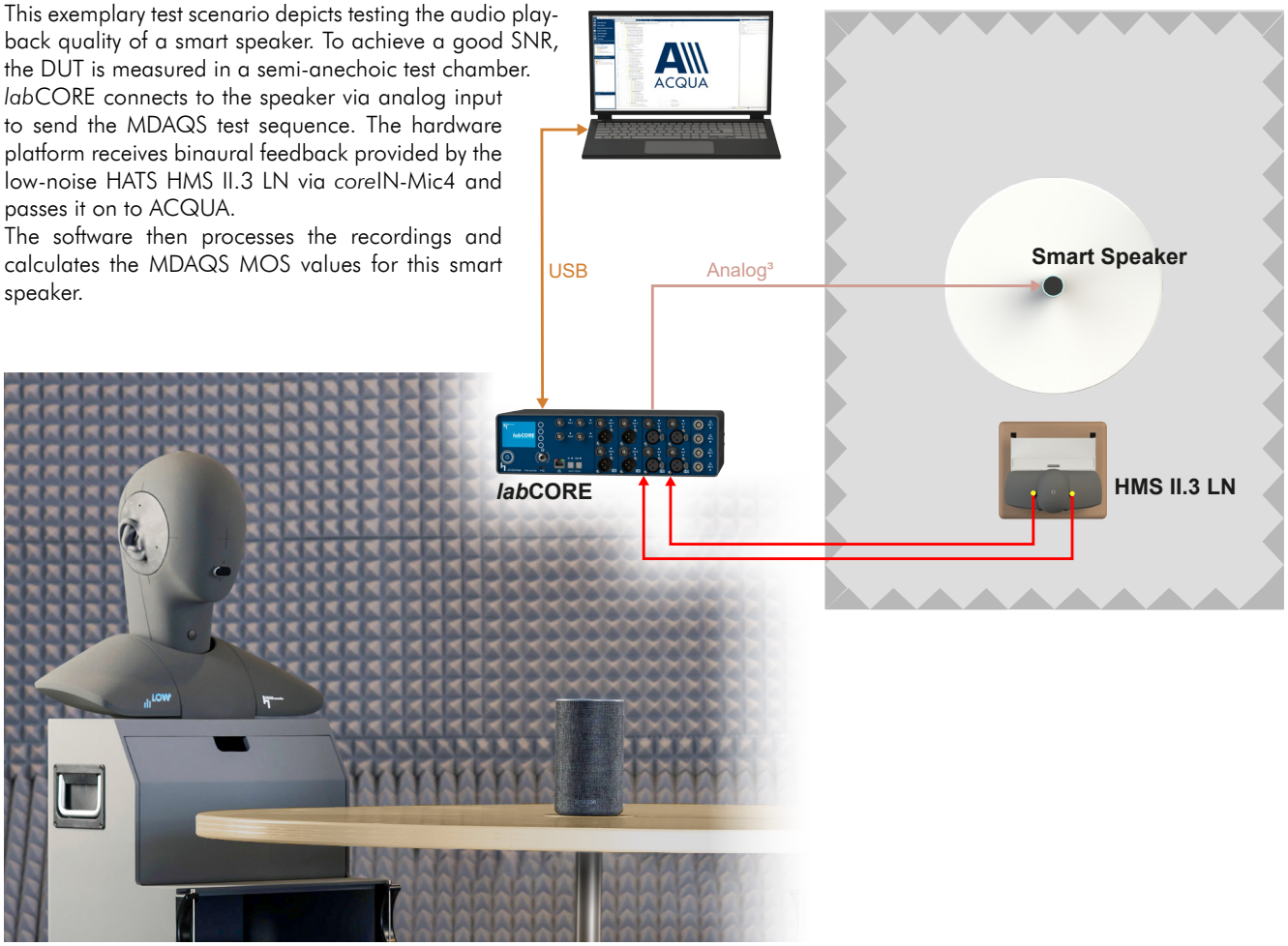
Configuration example 2: Measurement Setup for a Multichannel Loudspeaker System in a Vehicle

This exemplary test scenario depicts testing the sophisticated multichannel loudspeaker system of a modern vehicle.
*lab*CORE (with *core*BT) connects to the vehicle's head unit via Bluetooth® to send the MDAQS test sequence. The hardware platform receives binaural feedback from the vehicle cabin provided by HMS II.6 and passes it on to ACQUA.
The software then processes the recordings and calculates the MDAQS MOS values for this loudspeaker system.



Configuration example 3: Measurement Setup for a Smart Speaker

This exemplary test scenario depicts testing the audio playback quality of a smart speaker. To achieve a good SNR, the DUT is measured in a semi-anechoic test chamber. *lab*CORE connects to the speaker via analog input to send the MDAQS test sequence. The hardware platform receives binaural feedback provided by the low-noise HATS HMS II.3 LN via *core*IN-Mic4 and passes it on to ACQUA.
The software then processes the recordings and calculates the MDAQS MOS values for this smart speaker.



1) If available, respective HMS systems and HMS accessories of the previous generation can be used alternatively.

2) HMS II.6/7 can only be used in far-from-the-ear measurement scenarios.

3) Devices under test that do not have an analog input must be accessed in other ways, which may require additional hardware and/or software.