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Left: HQS-ICC measurement tree. Right: Example of result diagram showing spectrogram of speech transmitted by ICC system with BGN removed via TNC

OVERVIEW

In-Car Communication (ICC) systems are becoming more and more important, as they are no longer an accessory reserved for upper class vehicles only. Testing these systems under realistic conditions is a challenging task due to the nature of ICC devices, which are designed to work with background noise present and the general situation with "near end" and "far end" talkers being close to each other with a direct acoustical coupling between them.

HQS-ICC provides comprehensive tests for the analysis of ICC systems, e.g.:

- Noise Transmission Spectrum
- Speech Transmission Spectrum
- Speech Level / SNR
- Speech Intelligibility Index
- Delay

HEAD acoustics HQS-ICC database is a powerful tool for developers of such systems wanting to tune their devices, as well as car manufacturers desiring to assess the overall quality of the built-in system.

DESCRIPTION

The tests implemented in the HQS-ICC test suite cover various important quality aspects of ICC systems such as

- Noise Transmission Spectrum (residual noise transmitted by ICC)
- Speech Transmission Spectrum (speech transmitted by ICC)
- Estimation of ICC time constants
- Speech Levels and Signal-to-Noise ratios of speech
- Speech Intelligibility Index (SII)
- Delay of ICC system

As all tests have to be conducted with background noise (BGN) present and "near end" (driver) and "far end" (passenger) situated in the same acoustical environment, these tests cannot be performed in a conventional manner. The HQS-ICC test suite therefore employs a technique called "Time-synchronous Noise Compensation" (TNC). It allows compensating background noise in the time domain and is used to extract the audio signal actually transmitted by the ICC system itself. This approach allows ICC testing via purely acoustic interfacing (black box approach).

Furthermore, HQS-ICC employs real Lombard speech as test signals, consisting of recordings of ITU-T P.501 sentences spoken by native speakers with BGN at five different levels. Thus, the tests take into account the frequency shifting effect as well as the level adjustment of a person talking in the presence of BGN.

The HQS-ICC test suite comes with tests for three different BGN scenarios: 80, 120 and 160 km/h (50, 75 and 100 mph) driving speed. The user is required to provide these driving noise recordings, as they strongly depend on the actual vehicle. However, for testing purposes, sample recordings for each scenario are delivered by HEAD acoustics. The user can easily add measurements for different BGN scenarios and conversation directions other than driver to passenger to the database.

In addition to measurements of the ICC, an FIR filter can be gained from the speech transmission spectrum, allowing to simulate the ICC system as a linear, time-invariant system, thus making the nonlinearity of the system visible. Furthermore, the database contains several Impulse Response measurements, which can provide useful information to developers of ICC systems.

APPLICATIONS

- Experimental development and optimization of ICC systems
- Testing of ICC systems under realistic conditions

SYSTEM REQUIREMENTS

HQS-ICC (Code 60015) requires the following system components:

- **ACQUA** Advanced Communication Quality Analysis System, **Full-license (Code 6810)**, Version 3.3.200 or later

  Note: existing customers need a valid software maintenance agreement (SMA)

- **ACOPT 09 SLVM P.56 (Code 6819)**
- **ACOPT 26 Room Acoustics (Code 6853)**
- **ACOPT 34 Speech Intelligibility Index (Code 6865)**
- **MFE VI.1 (Code 6462)**, measurement front end with integrated mouth amplifier as well as option
  MFE VI-BEQ (Code 6461)
- **2 × HMS II.3-33/34 (Code 1230.1/2)**, artificial HEAD Measurement System with pinna simulator type 3.3/3.4 **with**
  HIS L (Code 1231), HEAD Impedance Simulator, Left
  Alternatively:
  2 × HMS II.6 (Code 1389), artificial HEAD Measurement System with artificial mouth and free-field microphones
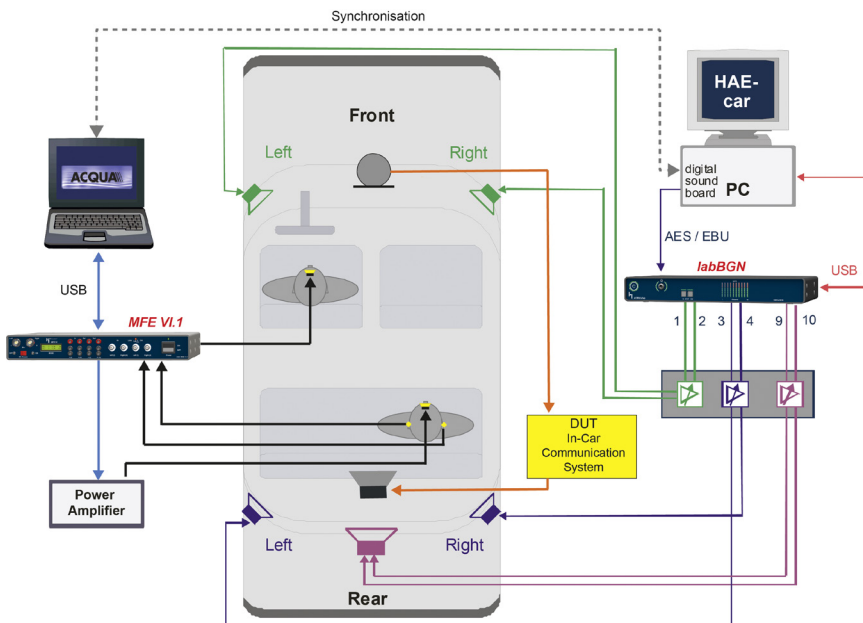
MEASUREMENTS

The following list gives an overview of the measurements included in the HQS-ICC test suite:

Measurement Title	Results	Improvements	Informative
Noise Transmission Spectrum	●	n/a	n/a
Noise Transmission Spectrum Time Characteristics	●	n/a	n/a
Speech Transmission Spectrum	●	n/a	n/a
Speech Intelligibility Index	●	●	n/a
Speech Level	●	●	n/a
Speech Level +/- 6dB	●	●	n/a
Signal to Noise Ratio	●	●	n/a
Speech Level Variation +/- 6dB	●	n/a	n/a
Speech FFT	●	n/a	n/a
FIR-simulated Speech	n/a	n/a	●
Speech Spectrum vs. Time	n/a	n/a	●
FIR-simulated Speech Spectrum vs. Time	n/a	n/a	●
ICC Delay	●	n/a	n/a
Double Talk Attenuation	●	n/a	n/a
Impulse Responses (various Directions and Equalizations)	n/a	n/a	●

- **Additional Power Amplifier** for second HMS II.3
- **HAE-car**, Background Noise Simulation including required accessories, cf. separate data sheet for Code 6970
- **Pulse Splitter Box PSB III (Code 6001)** for synchronization
- **2 x Cable CXX II.3 (Code 5177-3)** AES/EBU XLR male 3-pin <> XLR female 3-pin, 2.95 m
- Additional components are required for recording background noise signals

DELIVERY ITEMS
- **HQS-ICC (Code 60015)**, as ACQUA database
- **V2C File** (for ACQUA, Version 3.3.200 or later)
- **Documentation** as PDF

Measurement setup in real car cabin

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