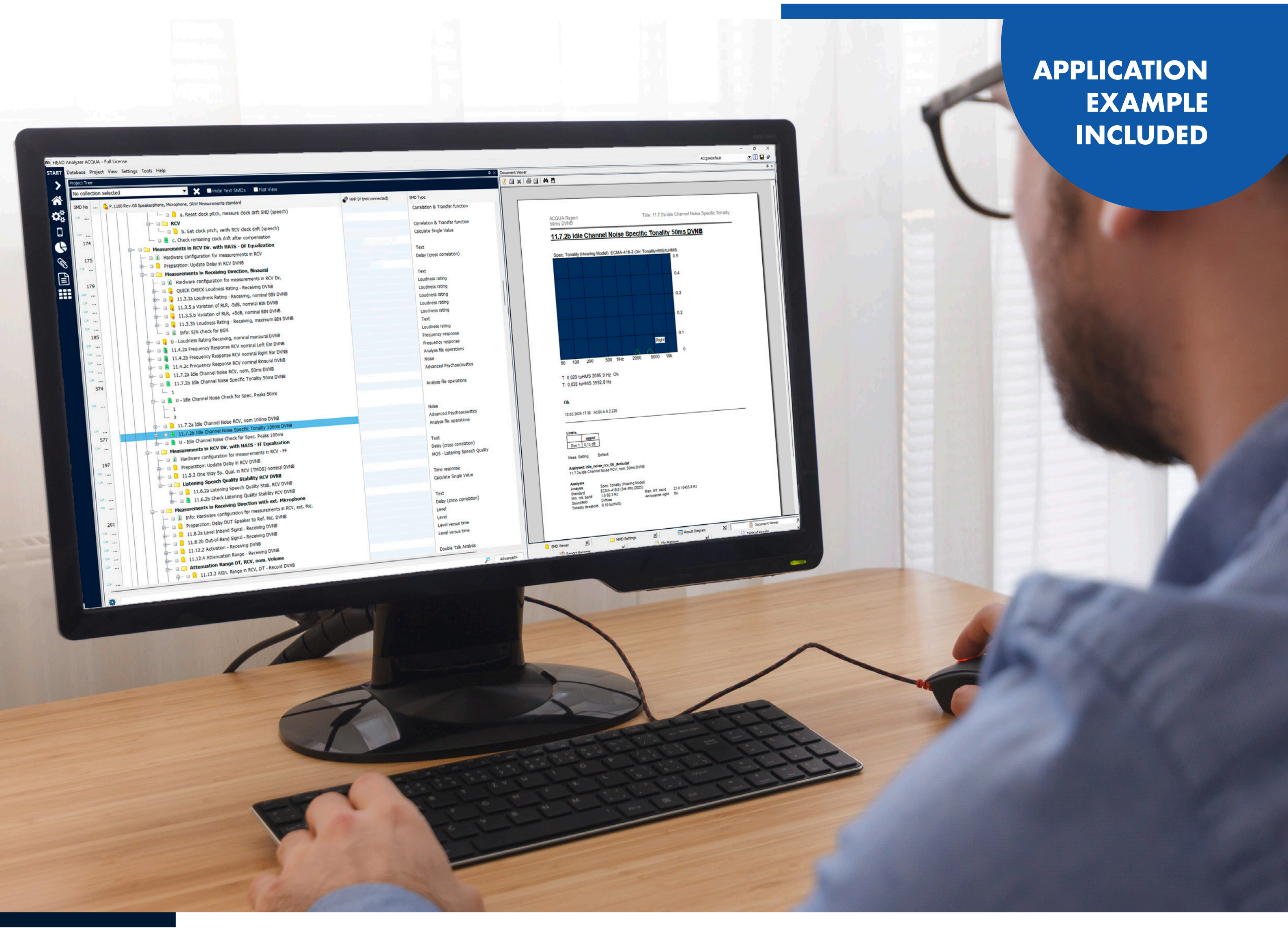
HEAD acoustics

DATA SHEET

APPLICATION EXAMPLE INCLUDED



Code 6877

ACOPT 43

Option Psychoacoustics – Advanced Analysis

OVERVIEW

ACOPT 43

Option Psychoacoustics – Advanced Analysis

The standardized analyses based upon the Sottek Hearing Model show that the psychoacoustic methods, for example, in comparison with an FFT analysis, may display the characteristics of human noise perception much better.

As the human hearing does not work like a linear measurement device, a simple representation of the level, e.g., dB(A), of a signal cannot capture the impression perceived by a listener. Just like humans, psychoacoustic analyses concentrate on the pattern level differences, modulations, tonal components, roughness components, etc., which are present in a sound. This corresponds to cognitive signal processing during listening.

Listening tests are the basis for the development of psychoacoustic analyses. As a pioneer in the development and application of psychoacoustic methods, we have continuously performed extensive listening tests for several decades, the evaluations of which are permanently incorporated into the further development of the analyses. The results of the listening tests confirm the high validity of all psychoacoustic analyses.

KEY FEATURES

ACOPT 43 includes Sottek Hearing Model analyses:

- Tonality vs. Time (Hearing Model)
- Specific Tonality (Hearing Model)
- Specific Tonality vs. Time (Hearing Model)
- Tonality Frequency vs. Time (Hearing Model)
- Loudness vs. Time (Hearing Model)
- Specific Loudness (Hearing Model)
- Specific Loudness vs. Time (Hearing Model)
- Impulsiveness vs. Time (Hearing Model)
- Specific Impulsiveness (Hearing Model)
- Specific Impulsiveness vs. Time (Hearing Model)
- Roughness vs. Time (Hearing Model)
- Specific Roughness (Hearing Model)
- Specific Roughness vs. Time (Hearing Model)

Analyses according to

- ECMA 418-2 (1st Ed., 2020)
- ECMA 418-2 (2nd Ed., 2022)
- ECMA 418-2 (3rd Ed., 2025)
- ECMA 418-2 (4th Ed., 2025)
- DIN 38455 (2024)
- ECMA 74 (15th Ed., 2015)
- ECMA 74 (17th Ed., 2019)

APPLICATIONS

- Hands-free communication in vehicles: Assessing the specific tonality of the idle channel noise according to Recommendation ITU-T P.1100, Recommendation ITU-T P.1110, and Recommendation ITU-T P.1120
- Simulating human perception with suitable analyses
- Improving sound quality
- Evaluation of environmental noise

DETAILS

DESCRIPTION

Sottek Hearing Model

The human hearing outclasses every available technical system in terms of performance and flexibility when it comes to sound analysis. To cover as many psychoacoustic phenomena in principle as possible, the Sottek Hearing Model based upon the physiology of the human ear was developed by HEAD acoustics to explain and describe psychoacoustic effects and basic auditory sensations.

The Sottek Hearing Model mainly consists of an ear-related time-frequency representation and is characterized in particular by its high correlation to the results of many psychoacoustic experiments. For example, just-perceptible amplitude and frequency variations can be predicted whereas the nonlinear processing has a fundamental meaning.

Analyzing According to Standards

Evaluating and ensuring sound quality has become a very important function for today's product design. As the human hearing does not work like a linear measurement device, a simple representation of the level, e.g. dB(A), of a signal cannot capture the sound volume perceived by a listener. Therefore, the DIN 38455 and ECMA-418-2 (1st, 2nd, 3rd, and 4th Edition) standards have been developed based upon the Sottek Hearing Model. The standards describe methods for the automatic quantification of spectro-temporal noise patterns, such as tonal sounds or modulated signals.

Calculations in ACOPT 43 comply with the standards as per the following table:

Loudness / Specific Loudness	› ECMA 418-2 (2nd Ed.) › ECMA-418-2 (3rd Ed.) / ECMA-418-2 (4th Ed.)
Roughness / Specific Roughness	› ECMA 418-2 (1st Ed.) › ECMA 418-2 (2nd Ed.) / DIN 38455 › ECMA-418-2 (3rd Ed.) / ECMA-418-2 (4th Ed.)
Tonality / Specific Tonality	› ECMA 418-2 (1st Ed.) / ECMA 74 (17th Ed.) › ECMA 418-2 (2nd Ed.) › ECMA-418-2 (3rd Ed.) / ECMA-418-2 (4th Ed.) › ECMA 74 (15th Ed.)

These analyses take the standard procedures into account and reproduce human perception accurately.

Loudness

Loudness is the sensation value for the human perception of loudness. Since the loudness perception of the human auditory system is dependent on frequency, sound events with the same level but different frequency do not always evoke the same loudness perception in humans. Therefore, the loudness scale is characterized by the fact that a sound that is perceived as twice as loud also has a value that is twice as high on the loudness scale.

Loudness (Hearing Model) vs. Time

The ECMA-418-2 Loudness (Hearing Model) vs. Time analysis takes the different perception of loudness of tonal and non-tonal noise components into account and features a significant improvement of the prediction quality for synthetic and technical sounds, for example.

Specific Loudness (Hearing Model), Specific Loudness (Hearing Model) vs. Time

The Specific Loudness (Hearing Model) and Specific Loudness (Hearing Model) vs. Time analyses exhibit the distribution of loudness across the critical bands. Both analyses are based upon the ECMA-418-2 standard.

Roughness

The impression of roughness occurs whenever a time-variant envelope exists within a critical band; for example, when tones exhibit a temporal structure due to a variation of their amplitude or frequency. The roughness depends on the center frequency, the modulation frequency, and the modulation depth. With increasing modulation depth, the impression of roughness becomes stronger. The signal level only has a small influence on the roughness impression.

Roughness (Hearing Model) vs. Time

The analysis Roughness (Hearing Model) vs. Time calculates the roughness of the input signal versus time. The analysis is ideally suitable for evaluating technical products, such as electric and combustion engines as well as ITT (Information Technology and Telecommunications) products.

ECMA-418-2 (1st Ed.) represents the enhanced version of HEAD acoustics' original procedure from 1993, developed through ongoing research and objective listening tests. As a result, different technical sounds are more comparable with each other and with synthetic sounds. DIN 38455 / ECMA-418-2 (2nd Ed., 3rd Ed., 4th Ed.) additionally provide an optional entropy weighting. This reduces a possible overestimation of the roughness caused by stochastic signal components that are detected and mitigated. The weighting is determined by the analysis of the entropy of the estimated modulation frequencies.

Specific Roughness (Hearing Model), Specific Roughness (Hearing Model) vs. Time

The Specific Roughness (Hearing Model) and Specific Roughness (Hearing Model) vs. Time analyses calculate the specific roughness of an input signal (versus time). The standards correspond to the Roughness (Hearing Model) vs. Time analysis.

GENERAL REQUIREMENTS

Software

One of the following software applications:

ACQUA (Code 6810)
- Advanced Communication Quality Analysis Software, full license version

ACQUA Compact (Code 6860)
- Compact test system

SCOPE OF DELIVERY

ACOPT 43 (Code 6877)
- Delivered as V2C file for ACQUA dongle

Tonality

Sounds are perceived as tonal if they contain distinct individual tones or narrow-band noise. Undesired tonal noise is perceived as more annoying than comparable noise without tonal components. If a product or machine causes tonal noise components, this will have a negative effect on the perceived overall quality.

Tonality (Hearing Model) vs. Time

The Tonality (Hearing Model) vs. Time analysis according to the Sottek Hearing Model is characterized by a linear representation of human tonality perception, a good correlation with the results of jury tests, and a correct detection in case of sounds with quickly changing tonality.

The analysis detects disturbing components, even in sounds with rapidly changing tonalities, such as electric motors or information technology. Furthermore, the analysis is ideal for detecting tonal sound components using a metric.

ECMA-74 (15th, Ed.) includes a perceptual based method developed by HEAD acoustics for automatic detection and classification of tonal components and their characteristics in noise emissions. With ECMA-74 (17th, Ed.), the outer and middle ear filtering was revised, which improves the calculation of the tonality especially for lower frequencies. In 2020, the method was finally transferred to the ECMA-418-2 standard.

Specific Tonality (Hearing Model), Specific Tonality (Hearing Model) vs. Time, Tonality (Hearing Model) Frequency vs. Time

The Specific Tonality (Hearing Model) analysis calculates the specific tonality of an input signal (versus time).

The Tonality (Hearing Model) Frequency vs. Time analysis calculates the frequency of the highest tonality of an input signal versus time. The analysis only provides useful results for airborne sound signals that represent the human perception in a linear way.

The standards correspond to the Tonality (Hearing Model) vs. Time analysis.

Impulsiveness

The impulsiveness sensation is generated by fast and huge signal level fluctuations. The impulsiveness analyses take this into account by mapping the human perception of fast and at the same time huge noise level changes to a linear scale.

Impulsiveness (Hearing Model) vs. Time

The Impulsiveness (Hearing Model) vs. Time analysis calculates the impulsiveness of an input signal versus time.

Specific Impulsiveness (Hearing Model), Specific Impulsiveness (Hearing Model) vs. Time

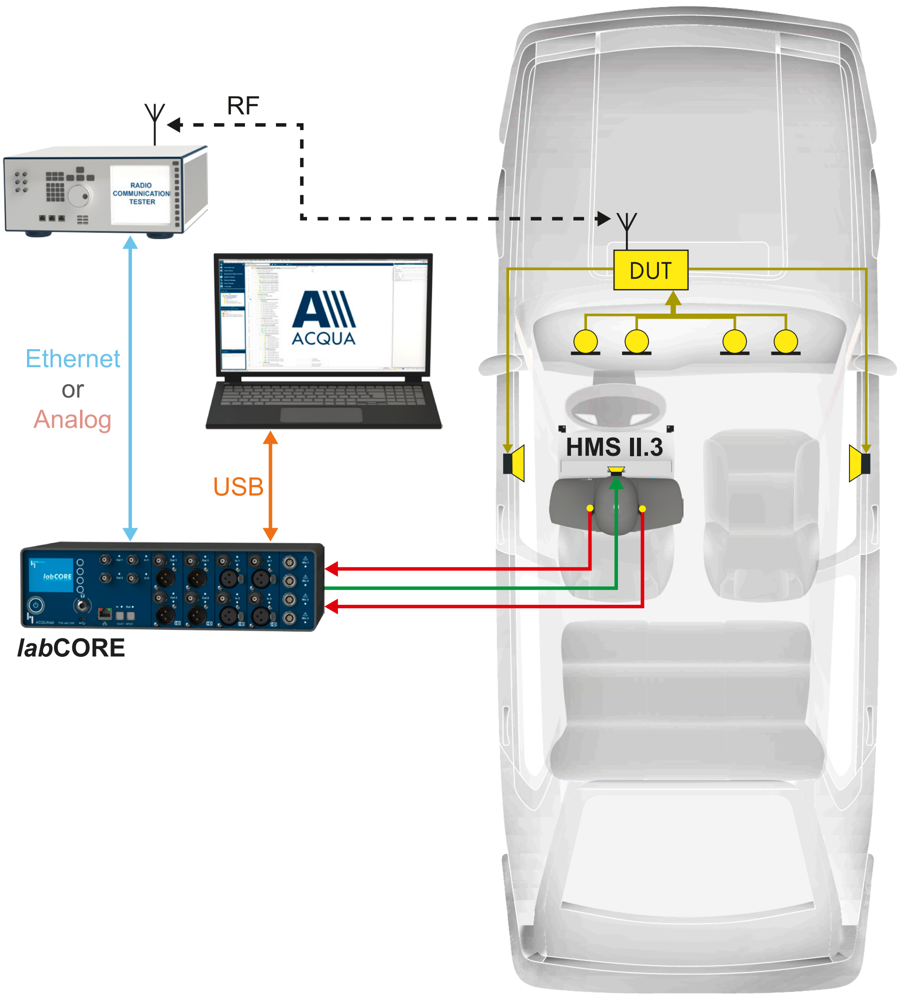
The Specific Impulsiveness (Hearing Model) and Specific Impulsiveness (Hearing Model) vs. Time analyses calculate the specific impulsiveness of an input signal (versus time).

IN PRACTICE

APPLICATION EXAMPLES

Specific Tonality Measurement of Idle Channel Noise in a Vehicle

The hands-free system of the vehicle is connected to the simulated mobile network of a radio tester that is connected to *lab*CORE. HMS II.3 is connected to *lab*CORE for operation of the artificial ear and the artificial mouth. *lab*CORE distributes the incoming and outgoing signals via its interfaces. A computer running ACQUA is connected to *lab*CORE. ACQUA controls *lab*CORE, provides source signals, and analyzes incoming signals. ACOPT 43 calculates the specific tonality from the recording with HMS II.3 (receive direction) as well as from the recording with the vehicles head unit (sending direction). In each case the idle channel noise of the signal is analyzed and presented in the magnitude tu_{HMS} (tonality units according to the Hearing Model of Sottek). The calculated value in tu_{HMS} shall not exceed the threshold provided by Recommendation ITU-T P.1100/1110/1120.



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