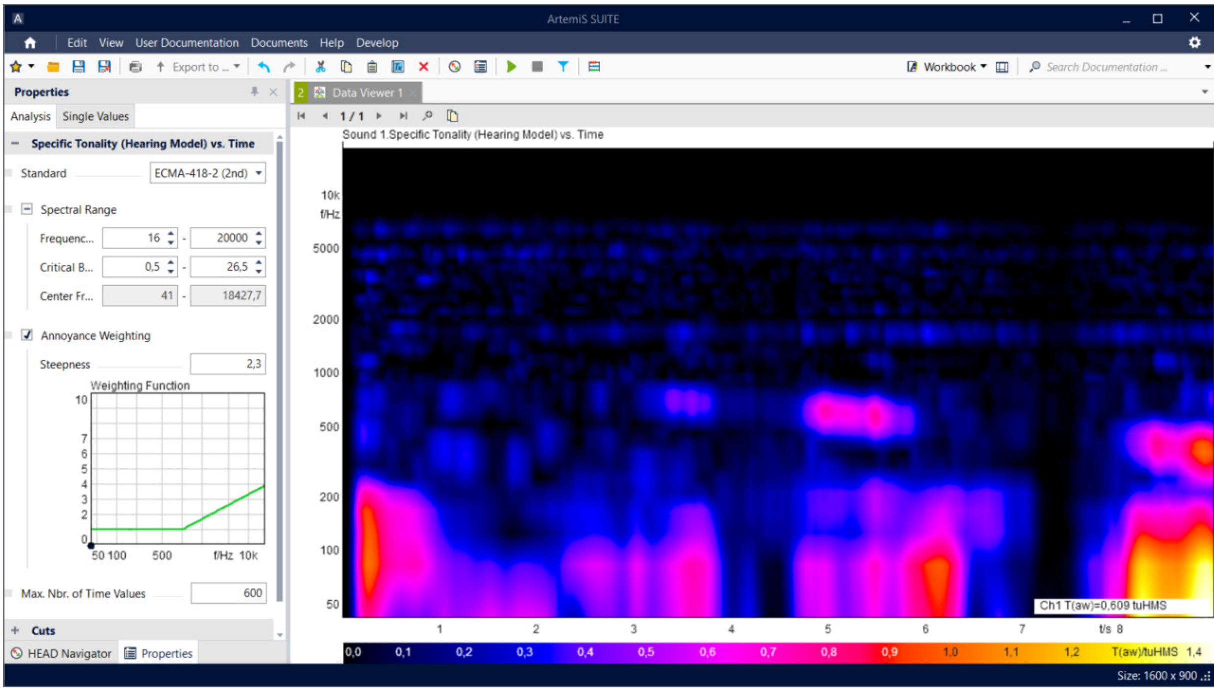
HEAD acoustics

DATA SHEET



ArtemiS SUITE
Signal Processing

Code 51103

ASP 103 Psychoacoustics - Advanced Analysis

Psychoacoustics - Advanced Analysis of ArtemiS SUITE provides sophisticated analyses based upon the Sottek Hearing Model, such as loudness, roughness, and tonality.

OVERVIEW

ASP 103 Psychoacoustics - Advanced Analysis

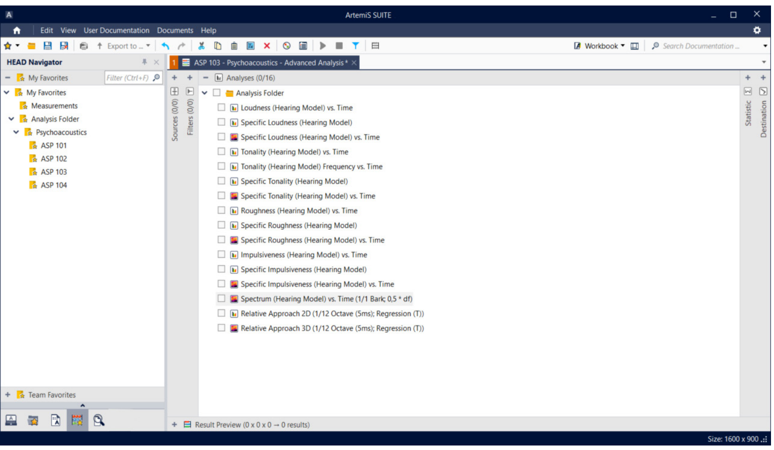
Code 51103

Psychoacoustics - Advanced Analysis provides analyses, which simulates the signal processing of the human auditory system and describes basic auditory impressions.

ArtemiS SUITE offers further psychoacoustic analysis options:

ASP 104 (Psychoacoustics - Advanced Analysis vs. Control Channel),
ASP 101 (Psychoacoustics - Basic Analysis),
ASP 102 (Psychoacoustics - Basic Analysis vs. Control Channel)

- ASP 103 and 104 provide the standards:
  DIN 38455, ECMA 418-2 (1st Edition) / (2nd Edition),
  ECMA 74 (15th Edition) / (17th Edition)
- ASP 101 and 102 provide the standards standards and methods:
  DIN 45631/A1, ISO 532-1, 532-3, ANSI S3.4-2007,
  DIN 45681, Aures, von Bismarck, DIN 45692



KEY FEATURES

ASP 103 includes several Sottek Hearing Model analyses:

- Loudness (Hearing Model) vs. Time
- Specific Loudness (Hearing Model)
- Specific Loudness (Hearing Model) vs. Time
- Roughness (Hearing Model) vs. Time
- Specific Roughness (Hearing Model)
- Specific Roughness (Hearing Model) vs. Time
- Tonality (Hearing Model) vs. Time
- Specific Tonality (Hearing Model)
- Specific Tonality (Hearing Model) vs. Time
- Tonality (Hearing Model) Frequency vs. Time
- Impulsiveness (Hearing Model) vs. Time
- Specific Impulsiveness (Hearing Model)
- Specific Impulsiveness (Hearing Model) vs. Time
- Spectrum (Hearing Model) vs. Time
- Relative Approach 2D
- Relative Approach 3D

Available standards:

- DIN 38455
- ECMA 418-2 (1st Edition) / (2nd Edition)
- ECMA 74 (15th Edition) / (17th Edition)

ASP 103 can be used in Pool Projects (require APR 010), Automation Projects (require APR 050), Standardized Test Projects (require APR 220), and Metric Projects (require APR 570)

APPLICATIONS

- Simulating human perception with suitable analyses
- Improving the sound quality of products
- Evaluation of environmental noise

OVERVIEW ASP 101 – ASP 104

PSYCHOACOUSTICS – BASIC ANALYSIS (ASP 101)

- Loudness vs. Time
- Specific Loudness
- Specific Loudness vs. Time
- Sharpness vs. Time
- Tonality DIN 45681
- Tonality DIN 45681 vs. Time
- Tone to Noise Ratio
- Tone to Noise Ratio vs. Time
- Specific Prominence Ratio
- Specific Prominence Ratio vs. Time
- Fluctuation Strength vs. Time
- Specific Fluctuation Strength
- Specific Fluctuation Strength vs. Time

PSYCHOACOUSTICS – ADVANCED ANALYSIS (ASP 103)

- Loudness (Hearing Model) vs. Time
- Specific Loudness (Hearing Model)
- Specific Loudness (Hearing Model) vs. Time
- Tonality (Hearing Model) vs. Time
- Specific Tonality (Hearing Model)
- Specific Tonality (Hearing Model) vs. Time
- Tonality (Hearing Model) Frequency vs. Time
- Roughness (Hearing Model) vs. Time
- Specific Roughness (Hearing Model)
- Specific Roughness (Hearing Model) vs. Time
- Impulsiveness (Hearing Model) vs. Time
- Specific Impulsiveness (Hearing Model)
- Specific Impulsiveness (Hearing Model) vs. Time
- Spectrum (Hearing Model) vs. Time
- Relative Approach 2D
- Relative Approach 3D

PSYCHOACOUSTICS – BASIC ANALYSIS VS. CONTROL CHANNEL (ASP 102)

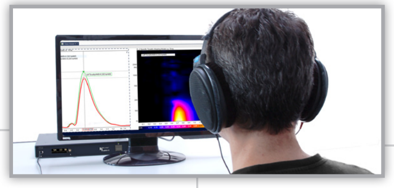
- Loudness vs. RPM
- Specific Loudness vs. RPM
- Sharpness vs. RPM
- Tonality DIN 45681 vs. RPM
- Tone to Noise Ratio vs. RPM
- Specific Prominence Ratio vs. RPM
- Fluctuation Strength vs. RPM
- Specific Fluctuation Strength vs. RPM

PSYCHOACOUSTICS – ADVANCED ANALYSIS VS. CONTROL CHANNEL (ASP 104)

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

STANDARDS

- Loudness
  - DIN 45631/A1
  - ISO 532-1, ISO 532-3
  - ANSI S3.4-2007 (FFT) / (FFT/3rd Oct)
- Sharpness
  - Aures
  - Von Bismarck
  - DIN 45692
  - DIN 45631/A1
  - ISO 532-1, ISO 532-3
  - ANSI S3.4-2007 (FFT) / (FFT/3rd Oct)
- Tonality
  - DIN 45681
- Loudness (Hearing Model)
  - ECMA 418-2 (2nd)
- Roughness (Hearing Model)
  - DIN 38455
  - ECMA 418-2 (1st) / (2nd)
- Tonality (Hearing Model)
  - ECMA 74 (15th) / (17th)
  - ECMA 418-2 (1st) / (2nd)



ARTEMIS SUITE PROJECTS

- Pool Project (APR 010)
- Automation Project (APR 050)
- Standardized Test Project (APR 220)
- Metric Project (APR 570)

Additional solutions from HEAD acoustics

JURY TESTING SOFTWARE SQALA

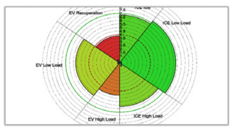
- Jury Testing - SQala Basic (APR 500)
- Jury Testing - SQala Net (APR 501)
- Jury Testing - SQala Server (APR 501)

BINAURAL MEASUREMENT AND PLAYBACK

- Artificial heads HMS V, HSU
- HEAD*lab* systems
- Mobile frontend SQuadriga III, ...
- ...

SOUND QUALITY INDEX

- Metric Project (APR 570)



DETAILS

Sottek Hearing Model

The human hearing outclasses every available technical systems 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 whereat the nonlinear processing has a fundamental meaning.

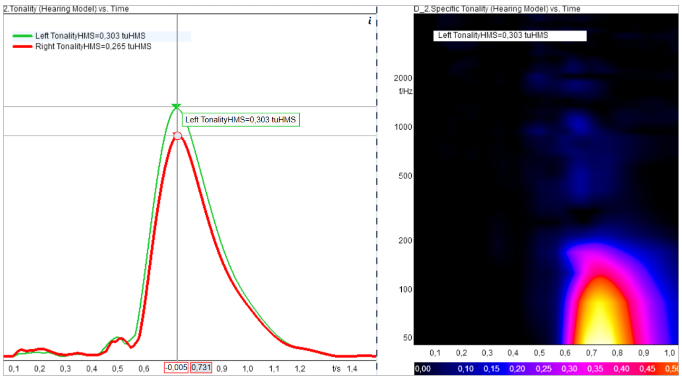
Analyzing according to standards

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, DIN 38455 and ECMA-418-2 (1st and 2nd Edition) 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.

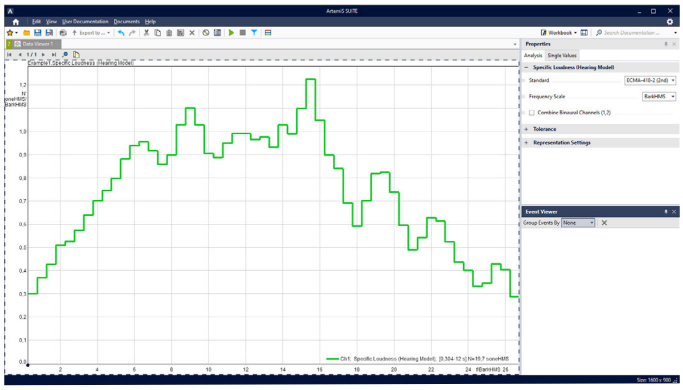
To comply with the standards, ASP 103 provides:

› Loudness	ECMA 418-2 (2nd)
› Roughness	DIN 38455, ECMA 418-2 (1st) / (2nd)
› Tonality	ECMA 418-2 (1st) / (2nd), ECMA 74 (15th) / (17th)

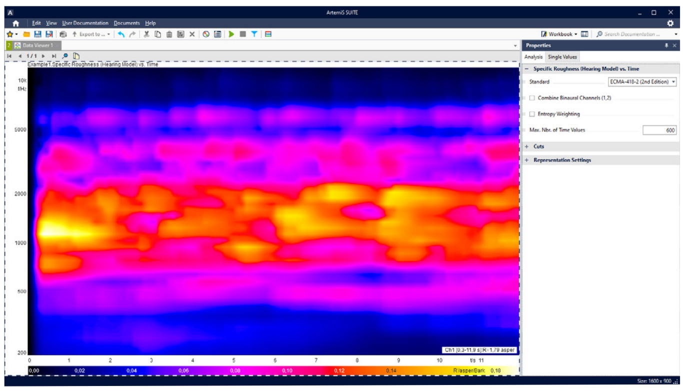
These analyses take the standard procedures into account and reproduce human perception accurately.



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



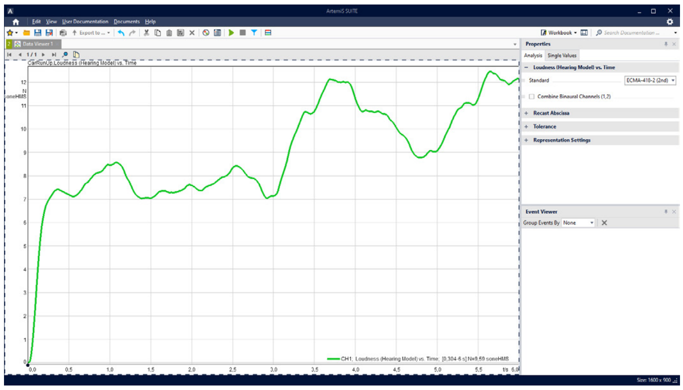
Specific Loudness (Hearing Model) vs. Time



Specific Roughness (Hearing Model) vs. Time

Loudness

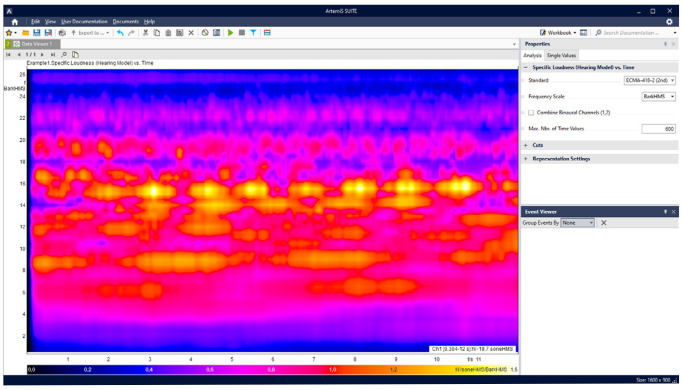
Loudness is the sensation value for the human perception of loudness. Since the loudness perception of the human auditory system is dependent on frequency, sound events with the same level but different frequency do not always evoke the same loudness perception in humans. Therefore, the loudness scale 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

LOUDNESS (HEARING MODEL) VS. TIME

The ECMA-418-2 (2nd) analysis 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.



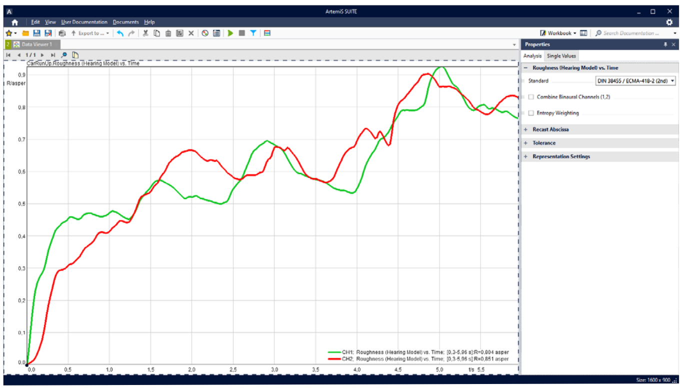
Specific Loudness (Hearing Model) vs. Time

SPECIFIC LOUDNESS (HEARING MODEL), SPECIFIC LOUDNESS (HEARING MODEL) VS. TIME

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

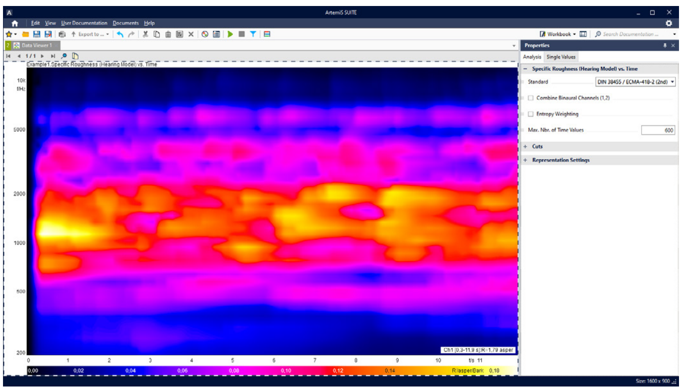


Roughness (Hearing Model) vs. Time

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) 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) 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) vs. Time

SPECIFIC ROUGHNESS (HEARING MODEL), SPECIFIC ROUGHNESS (HEARING MODEL) VS. TIME

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

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 analysis Tonality (Hearing Model) vs. Time 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 analyses detect disturbing components, even in sounds with rapidly changing tonalities, such as electric motors or information technology. Furthermore, the analyses are ideal for detecting tonal sound components using a metric – for this the Metric Project (APR 570) is available.

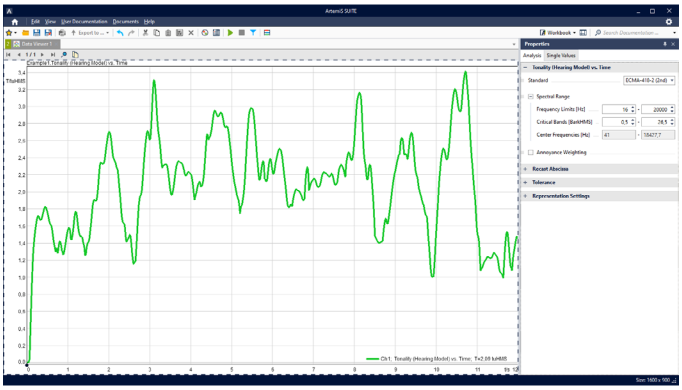
ECMA-74 (15th Edition) includes a perceptual based method developed by HEAD acoustics for automatic detection and classification of tonal components and their characteristics in noise emissions. With ECMA-74 (17th Edition), the outer and middle ear filtering was revised, which improves the calculation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

SPECIFIC TONALITY (HEARING MODEL), SPECIFIC TONALITY (HEARING MODEL) FREQUENCY VS. TIME

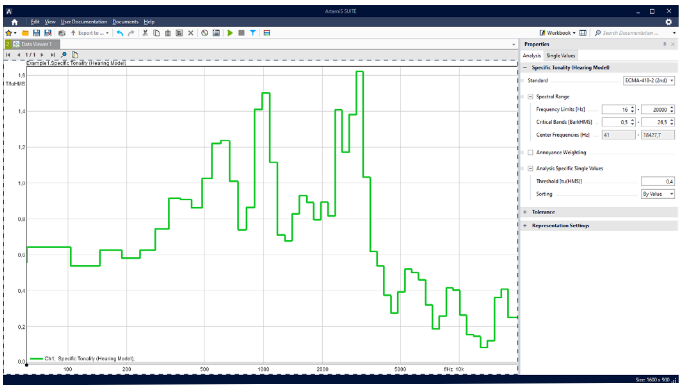
The analysis Specific Tonality (Hearing Model) calculates the specific tonality of an input signal (versus time).

The analysis Specific Tonality (Hearing Model) Frequency vs. Time 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.

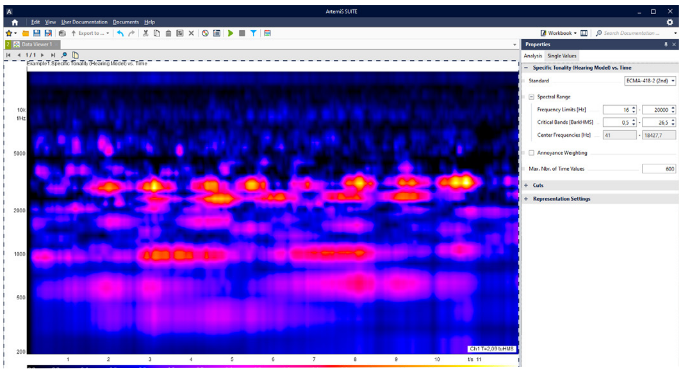
The standards correspond to the analysis Tonality (Hearing Model) vs. Time.



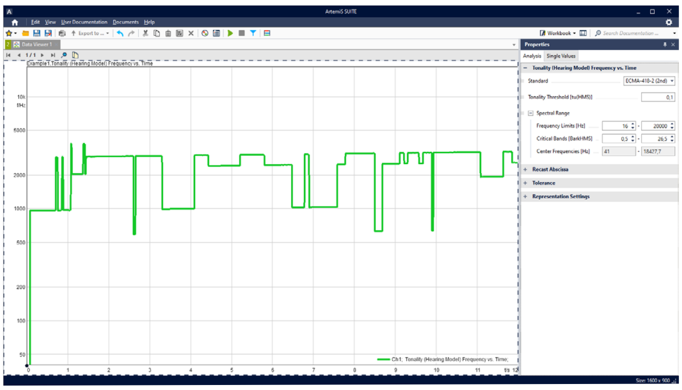
Tonality (Hearing Model) vs. Time



Specific Tonality (Hearing Model)



Specific Tonality (Hearing Model) vs. Time



Tonality (Hearing Model) Frequency vs. Time

Impulsiveness

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

SPECIFIC IMPULSIVENESS (HEARING MODEL), SPECIFIC IMPULSIVENESS (HEARING MODEL) VS. TIME

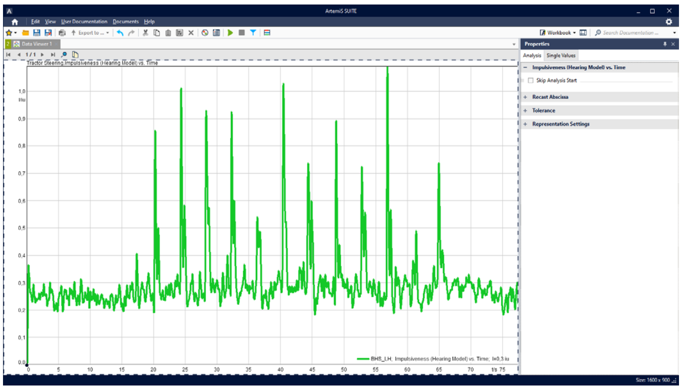
The analyses Specific Impulsiveness (Hearing Model) and Specific Impulsiveness (Hearing Model) vs. Time calculate the specific impulsiveness of an input signal (versus time).

Spectrum (Hearing Model) vs. Time

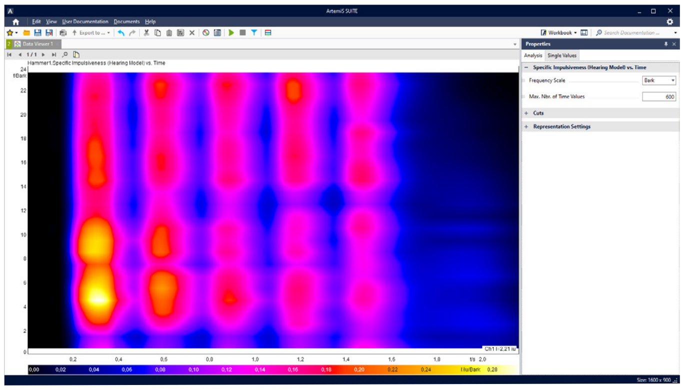
The analysis Spectrum (Hearing Model) vs. Time calculates the spectrum of an input signal versus time.

Relative Approach 2D, Relative Approach 3D

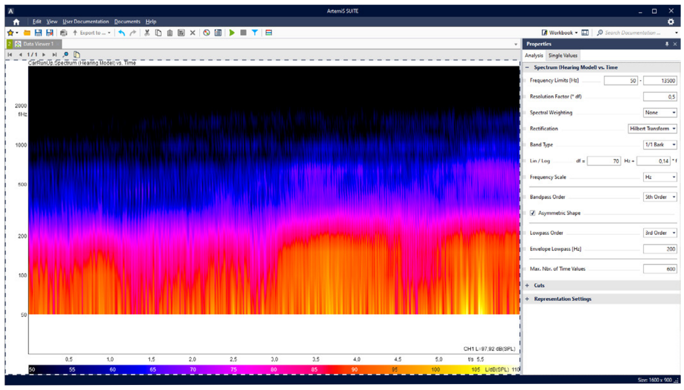
The Relative Approach analyses developed by HEAD acoustics model the adaptive behavior of human perception and are therefore very suitable for detecting patterns. The analyses perform a time-frequency analysis of signal level curves, detect rapidly changing temporal and spectral structures in signals, and correlate excellently with the pattern detection capabilities of human hearing



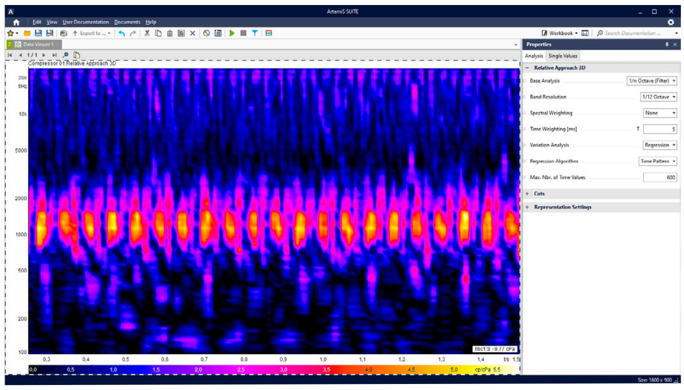
Impulsiveness (Hearing Model) vs. Time



Specific Impulsiveness (Hearing Model) vs. Time



Spectrum (Hearing Model) vs. Time



Relative Approach 3D

Advantages of psychoacoustic analyses

The standardized analyses based upon the Sottek Hearing Model as well as the Relative Approach analyses 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., found 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, HEAD acoustics has 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 provided by HEAD acoustics.

Required: APR Framework (Code 50000)

and/or: HEAD System Integration and Extension (ASX) programming interfaces

HEAD acoustics

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