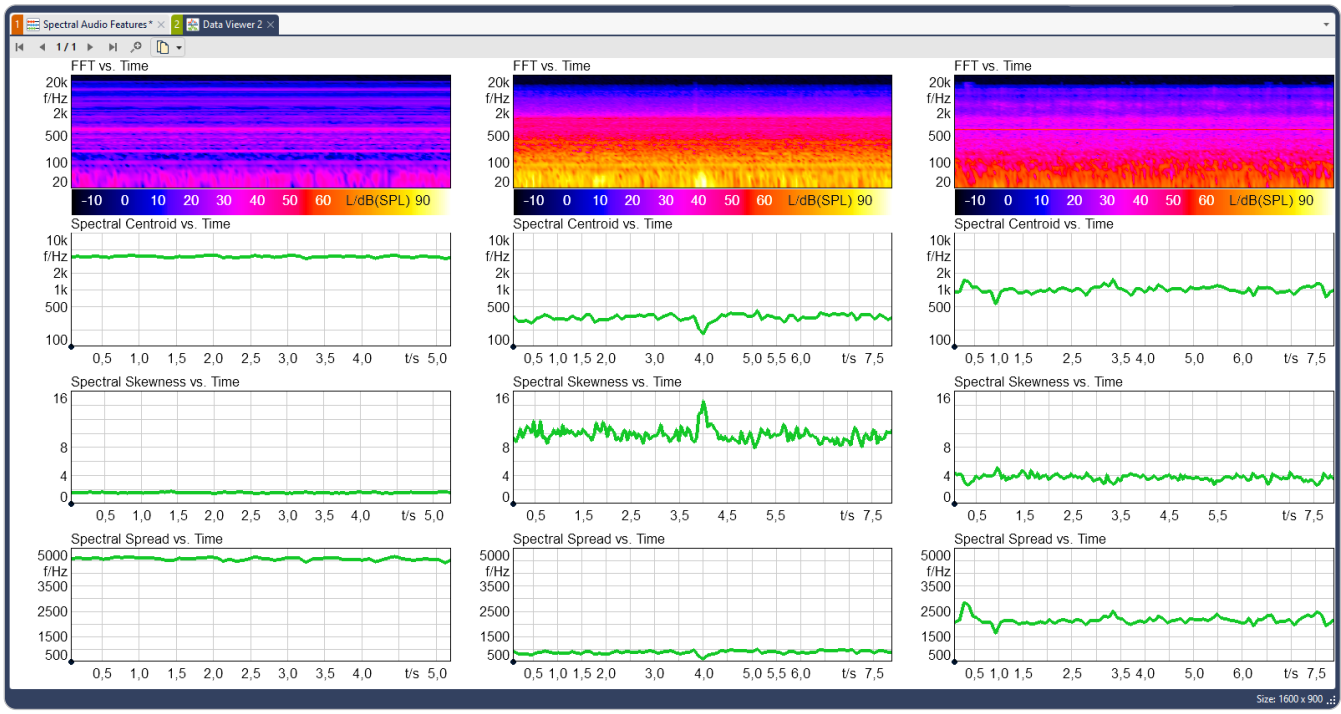
HEAD acoustics

DATA SHEET



ArtemiS SUITE
Signal Processing

Codes 51107, 51108

ASP 107 Spectral Audio Feature Analysis
ASP 108 Spectral Audio Feature Analysis vs. Control Channel

The analyses included in ASP 107 and ASP 108 of ArtemiS SUITE characterize the distribution of signal energy across the frequency spectrum and its variation over time.

OVERVIEW

ASP 107 Spectral Audio Feature Analysis

Code 51107

ASP 108 Spectral Audio Feature Analysis vs. Control Channel

Code 51108

Individual spectral feature analyses, as well as a combination of multiple analyses, enable comprehensive examination of the acoustic or noise characteristics of signals and facilitate a more accurate interpretation of auditory impressions. The analyses can be performed as a function over time (included in ASP 107) and as a function over control channels such as RPM, velocity, force, temperature, etc. (included in ASP 108).

Spectral feature analyses can be used in Pool Projects (APR 010 is required), Automation Projects (APR 050 is required), Standardized Test Projects (APR 220 is required), and Metric Projects (APR 570 is required).

KEY FEATURES

Analyses included in ASP 107:

- Spectral Centroid
- Spectral Spread
- Spectral Skewness
- Spectral Kurtosis
- Spectral Slope
- Spectral Decrease
- Spectral Rolloff Point
- Spectral Crest
- Spectral Flatness
- Spectral Entropy
- Spectral Flux

Analyses included in ASP 108:

- Spectral Centroid vs. RPM
- Spectral Spread vs. RPM
- Spectral Skewness vs. RPM
- Spectral Kurtosis vs. RPM
- Spectral Slope vs. RPM
- Spectral Decrease vs. RPM
- Spectral Rolloff Point vs. RPM
- Spectral Crest vs. RPM
- Spectral Flatness vs. RPM
- Spectral Entropy vs. RPM
- Spectral Flux vs. RPM

APPLICATIONS

- Audio and sound analysis and classification
- Machine diagnostics and condition monitoring
- Speech recognition, segmentation, and speech analysis
- Development of application-specific sound metrics and AI-based evaluation models

DETAILS

Combining Spectral Feature Analyses

Individual spectral feature analyses examine specific aspects of a signal, such as spectral spread, shape, and temporal variability. Multiple analyses can be combined to provide a more comprehensive characterization of a signal and improve the reliability of the results.

Combinations

Analysis of energy distribution and spectral spread

- Spectral Centroid
- Spectral Spread

Analysis of the shape of the spectral distribution

- Spectral Skewness
- Spectral Kurtosis

Analysis of the spectral slope and energy decrease

- Spectral Slope
- Spectral Decrease

Analysis of cutoff frequencies and threshold frequencies

- Spectral Rolloff Point

Analysis of uniformity and tonality

- Spectral Crest
- Spectral Flatness
- Spectral Entropy

Analysis of changes over time

- Spectral Flux

Note: Alternative combinations may be possible and appropriate depending on the application.

Spectral Feature Analyses and Psychoacoustic Analyses

Combining spectral feature analyses with psychoacoustic analyses provides particularly meaningful insights, enabling objective signal processing and the characterization of subjective human perception. While spectral feature analyses reveal the frequencies and energy distribution in a signal, psychoacoustic analyses characterize the perceived sound characteristics of the signal (e.g., loudness, sharpness, tonality, or roughness) and explain why signals of identical level may be perceived differently.

As a pioneer in the development and application of psychoacoustic methods, we have provided corresponding analyses for several decades:

ASP 101 (Psychoacoustics - Basic Analysis) and
ASP 102 (Psychoacoustics - Basic Analysis vs. Control Channel)

- Loudness
- Sharpness
- Tonality
- Tone-to-Noise Ratio
- Specific Prominence Ratio

- Supported methods: ISO, ANSI, DIN, ECMA, Aures, and von Bismarck

ASP 103 (Psychoacoustics – Advanced Analysis) and
ASP 104 (Psychoacoustics – Advanced Analysis vs. Control Channel)

- Loudness (Hearing Model)
- Tonality (Hearing Model)
- Roughness (Hearing Model)
- Impulsiveness (Hearing Model)
- Spectrum (Hearing Model)
- Fluctuation Strength (Hearing Model)
- Relative Approach

- Supported methods: DIN, ECMA, Sottek Hearing Model

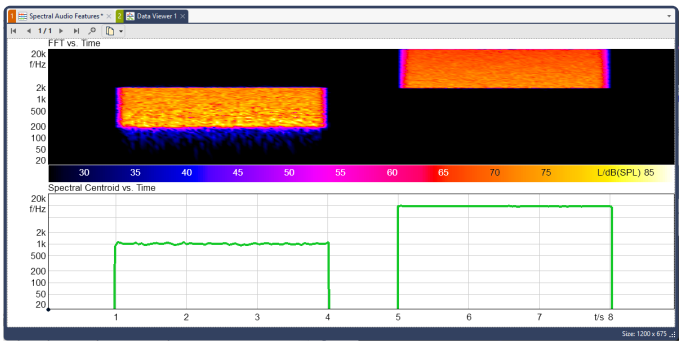
Spectral Feature Analyses in Detail

Spectral Centroid

The analysis characterizes the weighted mean value of the frequencies of a spectrum and is comparable to the center of mass in physics.

› Low spectral centroid:
Energy is concentrated in the low-frequency range (dull, low-frequency sounds, e.g., bass, engine noise)

› High spectral centroid:
Energy is concentrated in the high-frequency range (bright, sharp sounds, e.g., hissing, squeaking)



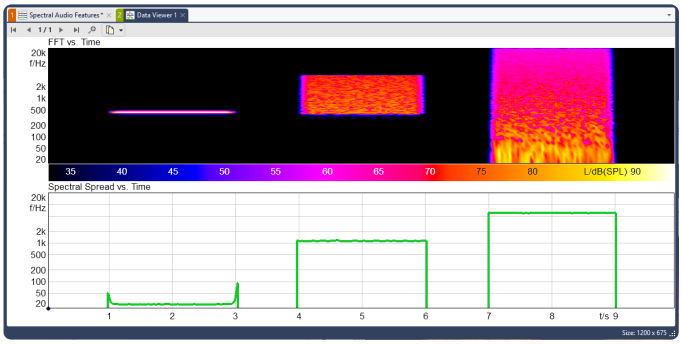
Spectral Centroid

Spectral Spread

The analysis characterizes the extent to which spectral energy is spread around the centroid, indicating the width of the spectrum.

› Low spectral spread:
Energy is concentrated near the centroid (narrowband, tonal signals)

› High spectral spread:
Energy is distributed over a wide frequency range →
(broadband signals, e.g., noise)



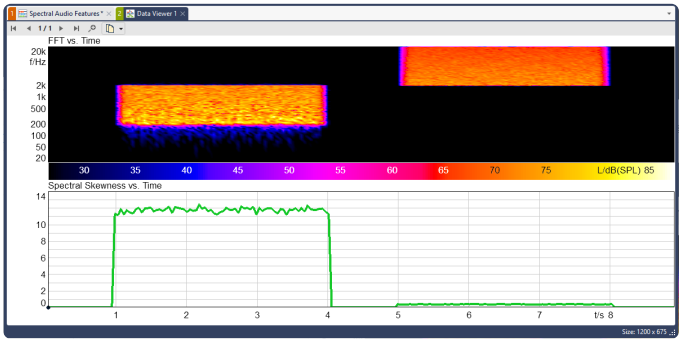
Spectral Spread

Spectral Skewness

The analysis characterizes the skewness of the energy distribution around the spectral centroid.

› Positive spectral skewness (right-skewed):
Energy is concentrated primarily at lower frequencies, with a long tail toward higher frequencies.

› Negative spectral skewness (left-skewed):
Energy is concentrated primarily at higher frequencies, with a long tail toward lower frequencies



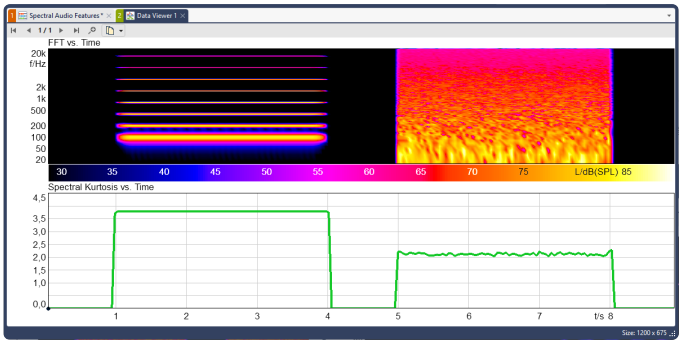
Spectral Skewness

Spectral Kurtosis

The analysis characterizes the degree to which energy is concentrated in pronounced peaks.

› Low spectral kurtosis:
Flat or uniform distribution of energy without pronounced peaks

› High spectral kurtosis:
Strongly pronounced, sharp spectral peaks (i.e., a limited number of dominant frequencies)



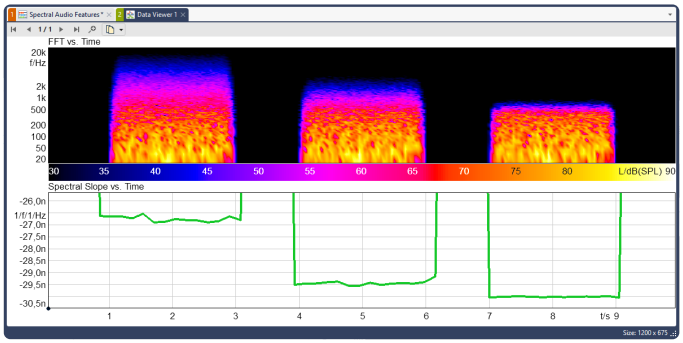
Spectral Kurtosis

Spectral Slope

The analysis characterizes the general trend in energy distribution over frequency.

› Low (less negative) spectral slope:
Energy decreases only gradually with increasing frequency (typically associated with brighter or broadband sounds)

› High (negative) spectral slope:
Energy decreases rapidly with increasing frequency (dull or low-pass-filtered sounds)



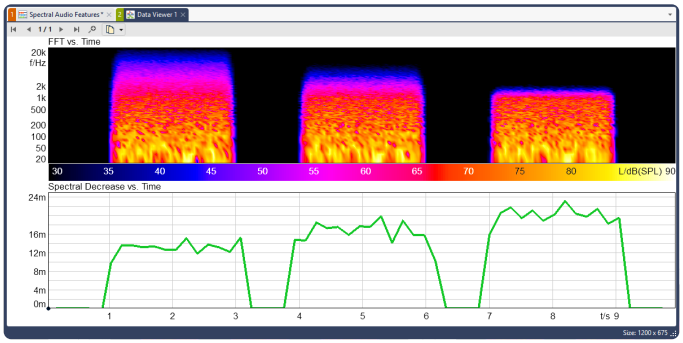
Spectral Slope

Spectral Decrease

This analysis characterizes the extent to which energy decreases relative to a reference point (typically in the lower-frequency range).

› Low spectral decrease:
Energy is retained across most of the frequency range (bright signals)

› High spectral decrease:
Energy is concentrated in the low-frequency range (dull signals)



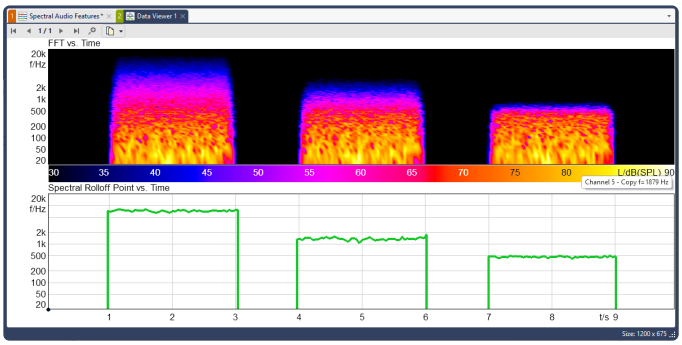
Spectral Decrease

Spectral Rolloff Point

The analysis identifies the frequency below which a defined percentage (e.g., 85% or 95%) of the total energy is contained.

› Low spectral rolloff point:
Energy is predominantly concentrated in the low-frequency range (dull signals)

› High spectral rolloff point:
Energy extends into the high-frequency range (bright, brilliant signals)



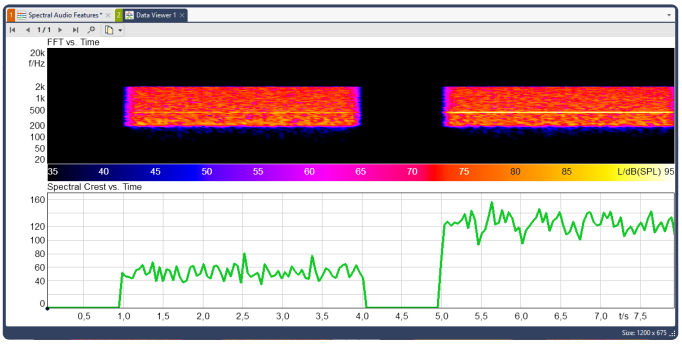
Spectral Rolloff Point

Spectral Crest

This analysis characterizes the extent to which individual peaks dominate the spectrum

› Low spectral crest:
Energy is distributed uniformly (e.g., noise)

› High spectral crest:
Dominant individual peaks (e.g., tonal whistles)



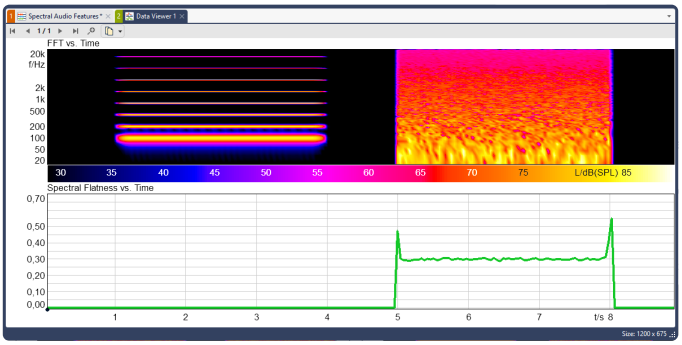
Spectral Crest

Spectral Flatness

The analysis characterizes the degree to which energy is distributed uniformly across the spectrum.

› Low spectral flatness:
Energy is concentrated at a limited number of frequencies (tonal signals)

› High spectral flatness:
Uniform distribution (noise-like signals)



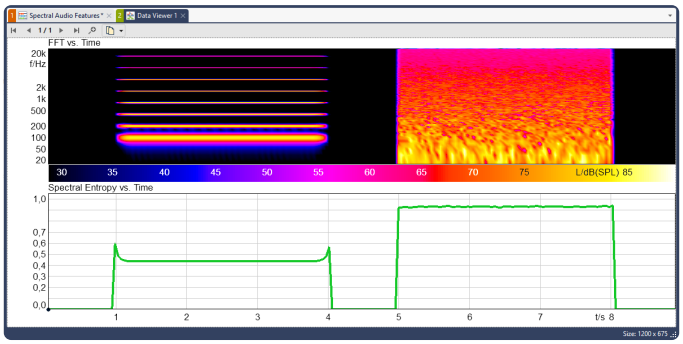
Spectral Flatness

Spectral Entropy

The analysis characterizes the degree to which the energy distribution is random or ordered.

› Low spectral entropy:
Energy is distributed in an orderly manner (a limited number of dominant frequencies, e.g., a sinusoidal signal)

› High spectral entropy:
Energy is distributed uniformly and randomly (noise)



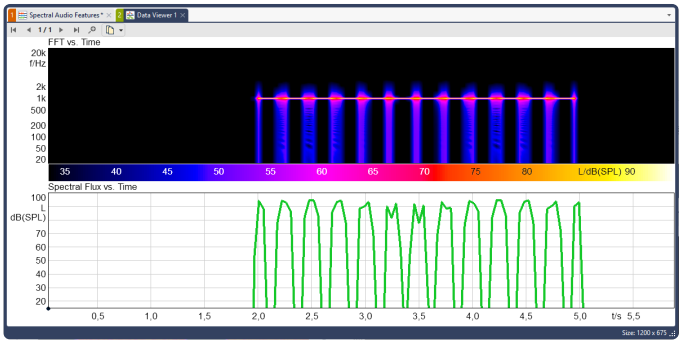
Spectral Entropy

Spectral Flux

The analysis characterizes the degree to which the spectrum changes over time.

› Low spectral flux:
The spectrum exhibits minimal variation (stationary signals, e.g., a constant tone)

› High spectral flux:
The spectrum exhibits significant variation (transient or dynamic signals, e.g., percussion instruments)



Spectral Flux

LICENSES AND OPTIONAL FEATURES

Requirements

Code	Product Name	Description
50000	APR 000 APR Framework	Basis of ArtemiS SUITE
51107	ASP 107 Spectral Audio Feature Analysis	Analyses for the detailed characterization of spectral features and the quantitative description of sound characteristics
or		
51108	ASP 108 Spectral Audio Feature Analysis vs. Control Channel	Analyses based on various control channels (RPM, force, ...) for the detailed characterization of spectral features and the quantitative characterization of sound characteristics
At least one of the central projects of ArtemiS SUITE—Pool Project, Automation Project, Standardized Test Project—or a Metric Project is required and must be licensed.		

Optional Features

Code	Product Name	Description
50010	APR 010 Pool Project	Central project of ArtemiS SUITE: Interactive operation, ease of use, data processing based on cross-product logic
50050	APR 050 Automation Project	Central project of ArtemiS SUITE: One-time definition of processing steps, automatic execution and reuse for all subsequent data
50220	APR 220 Standardized Test Project	Central project of ArtemiS SUITE: Measurement of multiple operating conditions of objects using the Recorder, and analysis of the measurements using various methods
50570	APR 570 Metric Project	Project of ArtemiS SUITE: Creation of quality metrics by correlating listening test results with acoustic signal analyses

51101	ASP 101 Psychoacoustics - Basic Analysis	Psychoacoustic analyses, standards, and methods for the analytical characterization of perceived sound quality
51102	ASP 102 Psychoacoustics - Basic Analysis vs. Control Channel	Analyses from ASP 101 vs. control channels
51103	ASP 103 Psychoacoustics - Advanced Analysis	Advanced psychoacoustic analyses, standards, and methods based on the Sottek Hearing Model for the characterization of psychoacoustic effects and fundamental auditory perceptions of the human auditory system
51104	ASP 104 Psychoacoustics - Advanced Analysis vs. Control Channel	Analyses from ASP 103 vs. control channels

5097	ASX 07 Local Processing Service (API)	ASX programming interface: Execution of Automation Projects, e.g., in End-of-Line processes, on the basis of automation specifications (calculation jobs); installation of ArtemiS SUITE is not required
5092	ASX 02 Data Processing and Representation API	ASX programming interface: Automated or interactive control of Pool Projects and Automation Projects, execution of Reports, exports, etc. using third-party software; ArtemiS SUITE must be installed

Further modules of ArtemiS SUITE (see ArtemiS SUITE Overview data sheet)

HEAD acoustics

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