

Experimental Solutions for Noise and Vibration (N&V) Design

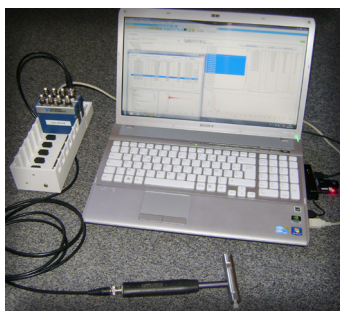
SEA-XP Software allows engineers to more effectively apply laboratory testing to the N&V design process. It offers highly optimized data acquisition, signal processing and data reduction capabilities to extract parameters used in the Energy Flow N&V design process based on the method of Statistical Energy Analysis (SEA).

Wide-ranging applications include:

- Automobile interior acoustic design
- Air- & rotor-craft interior noise control
- Rocket & spacecraft vibro-acoustics
- Railcar interior & railway structure noise
- Shipboard and underwater noise
- Architectural acoustics
- Consumer appliance noise control

Data Acquisition

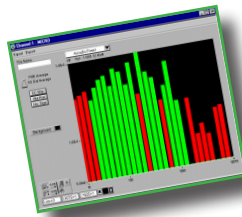
SEA-XP offers sophisticated software control for a range of National Instruments™ data acquisition (DAQ) cards for low cost PCs - even highly portable laptops. Its signal processing includes time history and frequency analysis functions which are highly optimized for vibro-acoustics applications. The Quality Signal Detection (QSD) function indicates overload, under-level and double hit rejection of signals in measurement averages with voice warning messages to eliminate the need for two people to conduct a test. It also includes efficient real time data streaming to disk.



- An engineer can test without a technician
- Highly portable PC and laptop system
- Low cost, industry standard hardware

Vibro-acoustic Signal Processing

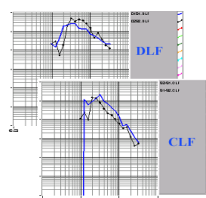
SEA-XP signal processing is specifically developed, optimized and validated for vibro-acoustics applications. For data acquired in SEA-XP - or data imported from an external source- you can conduct times history analysis, frequency analysis or time-frequency analysis. Vibro-acoustic outputs include decay rate in 1/N th octave, Frequency Response Function (FRF) in narrow band and 1/3 octave, sound intensity, transmission loss, waterfall analysis and direct data streaming to disk. Vitrally useful utilities include signal generation, synthesis of time data and spectrum records and conversion of different test data file formats.



- Correct processing for acoustics
- Time-saving, automated processing
- No custom coding required for processing

Extract N&V Parameters

Multiple noise and vibration measurements can be grouped for different structural and acoustic regions-corresponding to the 'subsystems' of the SEA design method. SEA-XP reduces the subsystem FRF data and time decay data to a set of SEA parameters that completely describe how N&V energy will distribute itself in the test specimen.



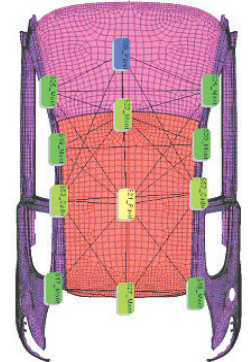
These parameters are effective mass (or acoustic volume), Damping Loss Factor (DLF),

Coupling Loss Factor (CLF), modal density and power level of applied excitation.

- Avoid errors in reducing large datasets
- No custom coding required for processing
- FAST, automatic processing

Experimental SEA Modeling

The reduced data set defines a mathematically complete SEA model of a test specimen - or even just a part of the specimen. With this 'experimental SEA' (ESEA) model you can predict subsystem N&V levels due to synthesized load cases, conduct 'noise path analysis' diagnostics and determine optimum damping for noise control. Other applications include the identification of a load or environment as an SEA power source - directly from operating N&V (energy) level measurements. ESEA models are also an excellent way to conduct quantitative assessment of competitors' products.



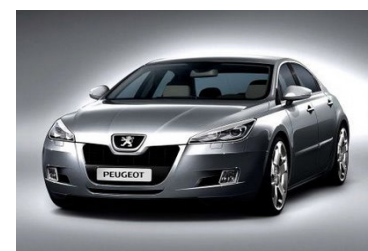
- Better understanding of physics
- Answer N&V design questions

Interface to SEA+ software

Your ESEA data can also be imported in SEA+ analytical SEA design code by InterAC or in other theoretical SEA software.

The data can be used in three powerful ways:

- 3D fully-ESEA modeling
- HYBRID SEA modeling-where selected SEA parameters can be used to enhance the analytical SEA estimates
- MODEL REFINEMENT-where comparison with ESEA parameters is used as a rational basis for refining assumptions made in SEA analytical modeling parameters



Peugeot Citroën has successfully applied SEA-XP to the experimental SEA modeling of white and fully-trimmed passenger car and proven that the model can predict the effectiveness of noise control



Data Acquisition

Controls PCI, PXI and CompactRIO
National Instruments multichannel DAQ cards for N&V

Software controls for DAQ cards

- Nb of channels (1 to hardware max)
- Selectable sampling frequency
- Record size (128 to 32768 points in buffered acquisition and unlimited in stream mode)
- Triggered capture of transients
- Quality Signal Detection (QSD):
 - Overload indicator by channel
 - Low level alarm
 - 'Bounce' detection for impact
 - Audio alerts
 - Auto-rejection from averaging
- Transducer manager
- Auto-calibration
- Microphone phase compensation

Signal Frequency Analysis

Fourier transform (FFT) windowing

- Rectangular, Hanning, Hamming, Flat top, Blackman-Harris, Exponential and Force windows
- Selectable on each channel

Real time Narrow Band analysis

- Auto spectrum
- FRF frequency response function
- Q-FRF quadratic FRF (energy)
- QF/Mobility, Q-FRF normalized by real part of input mobility
- Coherence

Real time 1/3rd octave analysis

- Band-limited RMS level
- Band-average Mag & Real FRF
- Band-limited acoustic power

Averaging

- Manual and no average
- Auto-average with QSD
- Auto-average & Store time data
- Interactive, stop & continue
- Mean & Standard deviation

Data storage

- Manual & Standard deviation with QSD
- Overwrite & delete stored data

Direct (Stream) Acquisition

- Acquire/record functions:
 - Auto-range
 - Storage in binary .stream files
- Processing of .stream files:
 - Re-calibration function
 - Animated plots, 3D waterfall

- User definable filtering fns.
- Local RMS integration fn.
- Auto-Analyze multi-streams
- Audio listening of stream
- Statistics & FFT analysis:
 - Probability density, histogram, Min max, % over threshold
 - Real, absolute and RMS data
 - dBA, linear & exp. averaging
- Test signal generation:
 - White, pink, windowed noise (with Gaussian or Uniform probability density), sine burst
- Export facilities:
 - WAV file export
 - Play signal within SEA-XP

Data Visualization

- Time histories for all channels
- Zoom to process channel data
- Oscilloscope mode
- Time data and FFT spectrum plots:
 - Resizable 2D plot window
 - Plot zoom in/out
 - User-defined x, y scale; log/lin.
 - Auto-scale (on/off)
 - Cursor (snap, free & lock fns.)
 - Signal label(s)
 - Store & export zoom window
 - Print plot from zoom window
- Print plot from main window
- Export graph to UNV, TXT, Excel, Word, Picture

Experimental SEA - Test

- Test Project Manager defines:
 - Test name, location, date, specimen, # subsystems, Subsystem names & comments
 - Progress panel
- Auto-configuration, including:
 - Reverberation time history
 - Power injected
 - FRF, Q-FRF or QF/Mobility for transfer energy quantities
 - Matrix visualization
 - Automatic record naming

Experimental SEA - Data Reduction

- Input power:
 - From force & acceln. time history or input point complex FRF
 - Sign change & neg. value filtering - 1/3 oct. & narrow band power
 - Mean & standard deviation Quadratic (energy) response from FRF, Q-FRF, QF/ Mobility
 - Subsystem-averaged, 1/3 octave quadratic (energy) response
 - Auto compacting per subsystem
 - Mean & standard deviation
- Decay rate parameter estimation:
 - From multiple FRFs, time histories
 - Selectable Butterworth filtering
 - Hilbert envelope & Schroder

- smoothing options
 - Selectable 1/Nth octave bands
 - Mean & standard deviation
 - Automatic & interactive modes
 - Calculates reverberation time (T60), apparent damping loss factor and absorption coefficient
 - Subsystem Equivalent mass, volume-Subsystem modal density & modal overlap

Experimental SEA - Modeling

- Build SEA model as 2D network:
 - Graphical icons define subsystems
 - Coupling via network or matrix
 - Subsystem suppression, union, auto renumbering & connect-all fns.
 - Store/Open SEA model & results file
- Coupling and damping loss factors (CLF, DLF):
 - Equivalent or user-defined mass
 - Lalor's simplified CLF method
 - Matrix estimation of CLF, DLF with random Monte Carlo inverse or SVD pseudo- inversion methods
 - Mean and standard deviation
 - Auto detection of connections between subsystems
 - SEA model optimizer for best fitted solution
- SEA model solution & diagnostics:
 - Apply multiple power inputs
 - Solve for subsystem energy, velocity or Sound Pressure Level (SPL)
 - Subsystem power inputs, outputs
 - Network energy flow diagram
 - Model performance index for data reconstruction
- Source power identification

Utilities

- 1/3rd octave power spectral density
- Transmission loss
- Vigner-Ville time-frequency analysis
- User's defined processing using Math style equations

External Interfaces

- Read data in Universal #58 and tab-delimited ASCII text file formats
- Export 1/3rd octave files in SEA+ or in other theoretical SEA software

Minimum hardware Requirements

- PC with Windows 7 to 10
- XGA monitor resolution (1024x748)
- 2 Gb memory



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