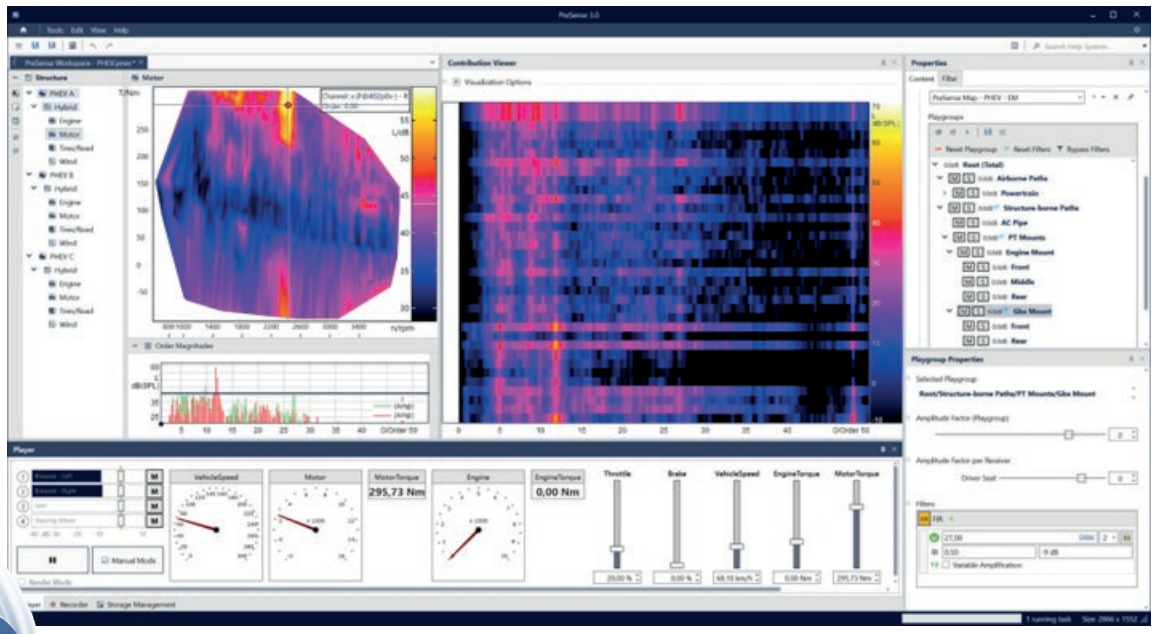
HEAD acoustics

DATA SHEET



NVH SIMULATOR PRESENSE

Code 7600ff

# PreSense

**Interactive simulator for NVH assessment**

# OVERVIEW

## PreSense

### Code 7600ff

Interactive simulator for NVH assessment of virtual prototypes and virtual test drives.

PreSense facilitates analyses of NVH performance during early stages of development and prototyping. It is an invaluable tool to speed up development, reduce costs, save prototypes, and real testing time. Vehicle, component noise, and vibration likewise can be validated extensively in early development stages, not having to physically assemble components, provide a prototype, or access a test vehicle.

The interactive vehicle simulation lets you experience sound and vibration and gives you a better insight than charts and numbers. The simulation uses sound data measured under real-life conditions as well as data generated by binaural transfer path analyses. Additionally, simulation data (CAE) can be integrated and made perceptible.

In addition, as an Advanced Active Sound Design Studio, PreSense enables you to create EV sound in a vehicle context. Thus, you can not only listen to a specific EV sound within the simulated vehicle sound but you can also change characteristics of the EV sound within the simulation.

The simulated vehicle responds to interaction such as gear selection, acceleration, and braking in real-time. Operating state variables such as vehicle speed, engine speed, and load are calculated based on a driving dynamics model. The NVH simulator then auralizes the corresponding sounds accordingly.

During simulation, you can quickly replace, add, and modify sound sources like engines, tires, or other components, and easily switch between them. Such changes are immediately audible and perceptible, enabling the driver of the virtual vehicle to make valid acoustic assessments and quick decisions without in-depth special knowledge.

## KEY FEATURES

Scalable, modular driving sound simulator with multiple configuration options

Interactive true-to-life re-synthesis of powertrain, tire/road, and wind noise in real-time using advanced algorithms

Powertrain CAE data auralization

Additional audio sources such as Order Generator, HDF Player, ImPulser

Blackberry QNX ASD integration

Software-in-the-Loop and hardware-in-the-Loop interfaces for externally generated sounds

Interactive level adjustment, mute, and solo function for Audio Sources

Basic driving dynamics model to calculate RPM, load, and speed from acceleration and brake pedal

IPG CarMaker® interface for complex driving dynamics models, e.g., hybrid and electric vehicles

Operating state values from multiple sources for different applications or system configurations: USB pedals, CAN bus, HDF file, network interface, manual mode

Multichannel playback, e.g., sound at driver's ears, seat vibration, and steering wheel vibration simultaneously

Configurable IIR and FIR online filter

Seamless TPA data import from an ArtemiS SUITE TPA Project for path contributions of powertrain or tire/road noise

Road-visualization to enhance speed perception

Integrated recorder saves re-synthesized audio and operating states into a file (Drive-to-file) for later analysis with ArtemiS SUITE

# DETAILS

## Simplify decision-making during development

- Make what-if analyses audible by switching between components, for example, different tires, engines, exhaust systems, and immediately experience the changes in sound and vibration.
- Hear and feel the difference. Personal experience is more convincing than numbers and charts.
- Assess weaknesses and problems by evaluating counter-measures without the need of a costly prototype or expert NVH knowledge.
- Let colleagues and decision-makers experience the effects of different measures and find convincing solutions.


## Make TPA results easily perceptible

- Identify the problem by determining transfer paths of sound phenomena to locate the source of a complaint.
- Attain deeper insight by listening to sounds individually and trace them back to their originating components.
- Work on a solution and derive corrective measures and optimization potential.
- Simplify in-situ assessment for decision-makers by providing perceptible and comprehensible solutions.

## Acoustic assessment of control strategies for hybrid vehicles

- Evaluate energy management and corresponding control strategies early in the development process.
- Find the best compromise between energy consumption, driveability, and acoustic performance through an interdisciplinary approach.
- Coordinate your work with other departments by using the same 3D vehicle model from 3rd party software such as IPG CarMaker®.

## Global collaboration

- Experience NVH performance anywhere. Perform Transfer Path Analyses somewhere in the world and let your colleagues in another part experience the simulation.

## Virtual NVH prototype

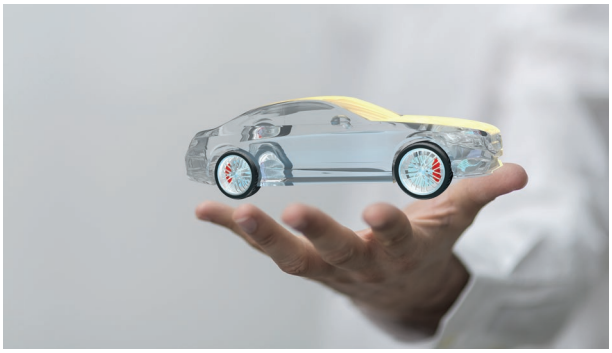
- Perform a Transfer Path Analysis with ArtemiS SUITE TPA Project based on test bench data to drive a newly developed engine on a test rig.
- Hear the acoustic performance of the new engine and experience its effect during a virtual test drive.
- Use TPA software and PreSense to build a virtual NVH prototype by combining CAE data with test data that uses Frequency Response Functions (FRF) or source strengths from CAE.
- Auralize full vehicle powertrain CAE data and evaluate it in the context of test-based road and wind noise.

## Advanced Active Sound Design (ASD)

- Tuning the sound generating device considering the actual driving sound in a software-in-the-loop (SiL) or hardware-in-the-loop (HiL) approach
- The proposed approach speeds up the process because the sound is perceived according to the driving dynamics and the masking of the actual driving sound (powertrain, tire/road, wind) is already considered in the concept phase.
- Virtual prototypes enable designing and tuning ASD even if physical prototypes or (pre-)production vehicles are not available.

## Troubleshooting and target sound setting

- Involve customers, colleagues, and decision-makers to assess various measures or sound manipulations.



## Sophisticated tools for office work

- Virtual test drive at your desk, in your lab, or using a host vehicle to evaluate NVH performance.
- Replay a real driving scenario from a test track in the NVH PreSense Simulator.
- Listen to and analyze data at a defined operating state with the Manual Mode.
- Use the integrated Recorder to save audio data and operating states of any virtual test drive to a file for later analysis, e.g., in ArtemiS SUITE.
- Apply different sounds or filters to a virtual test drive based on recorded operating states.

# CONFIGURATIONS

The NVH simulator PreSense as a scalable solution for many different applications is available in various configurations and configuration levels.

## Desktop simulator

The desktop simulator offers calibrated and aurally accurate sound reproduction via binaural headsets. The driving situation is simulated by a steering wheel, pedals, and a monitor.

## SoundSeat

Combined with SoundSeat (code 7040) from HEAD acoustics, PreSense can be operated similar to a real vehicle. The user accelerates, changes gears, and brakes while the simulation adapts sound and vibration according to the current driving situation in real-time. Shakers provide an even more realistic driving feeling through vibration of the steering wheel and the seat while a large screen offers a visual impression of the driving situation.

## SoundCar

Integrated into a real vehicle converted for this purpose, the NVH simulator Presense facilitates playback in a real vehicle environment. Both the acoustic and vibration-specific aspects of sound perception are considered. The system produces sound scenarios recorded in the vehicle by simultaneously generating airborne sound and vibration stimulus, e.g., from the steering column and the driver's seat.

## Complete vehicle simulator

PreSense can be integrated as a subsystem into a full-fledged vehicle simulator with a movable platform. The NVH simulator PreSense receives operating state variables such as engine speed, vehicle speed, and load from the simulator via a software interface and adapts the sound accordingly.

## Mobile NVH simulator

As a mobile version with ANC headphones, PreSense can be used in a vehicle without having to invest in a costly conversion. In such a real driving situation, PreSense receives all relevant operating state variables via the CAN bus of the vehicle and calculates the sound accordingly. The virtual sounds are than played back via headphones.

## PreSense Software Modules (PSM) overview for typical configurations

| **PSM** / **Configuration type** | 00 | 10 | 11 | 12 | 19 | 20 | 21 | 22 | 30 | 31 | 32 | 33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Desktop Simulator | ● | ● | ● | | | ● | ● | ● | ● | | | |
| SoundSeat | ● | ● | ● | | | ● | ● | ● | ● | | | |
| SoundCar | ● | ● | ● | ● | | ● | ● | ● | ● | | | |
| Subsystem for complete vehicle simulator | ● | ● | ● | ● | | ● | ● | ● | | ● | | |
| Mobile NVH simulator | ● | ● | ● | | | ● | ● | ● | | | | |
| NVH expert | ● | ● | ● | | | ● | ● | | ● | | | |
| Advanced Sound Design Studio | ● | ● | | | | | | | | | ● | ● |
| Light Version/Listen only | ● | | | | ● | ● | ● | ● | | | | |

● *mandatory* / ● *advanced configuration*

# PRESENSE SOFTWARE MODULE FEATURES

## PSM 00 (code 7600) PreSense Basic Framework

- Scalable and modular configurations (see table above)
- Define vehicles and scenarios within you workspace. Each scenario is a combination of audio sources.
- Available Audio Sources are HDF Player, ImPulser, and Order Generator.
- Change the level of an Audio Source, mute or solo channels or Audio Sources.
- Import and export your workspace to transfer data and/or settings between systems.
- Flexible configuration of operating states (RPMs, loads, speeds, acceleration pedal, brake pedal, ...)
- Operating state values from various sources for different applications or system configurations:
  - USB pedals, gear shifters, or simulated UI pedals
  - Connect to a car via CAN bus to receive pedal positions, speed, load(s), and rpm(s) in a mobile simulator.
  - Use operating states from an HDF file or constant values to replay a recorded NVH simulator drive or even a test track session.
  - Calculate speed, RPM, and load from an included basic driving dynamics model based on acceleration, brake pedal, and gear:
  - Use sliders to freely adjust any desired operating state value in Manual Mode.
- Basic driving dynamics model for powertrains with one RPM. Parametrization for various included vehicle classes, import of user-defined parametrization based on an Excel file
- Save re-synthesized audio and operating state data to an HDF file using the integrated Recorder.
- Road visualization
- Flexible configuration of tachometers and operating state sliders
- Performance Mode with low latency
- ASIO support
- Support for up to two audio output channels

## PSM 10 (code 7610) PreSense Audio Sources Automotive Standard

- Requirement: PSM 00
- Multiple Audio Sources such as Powertrain (2-D), Powertrain (n-D), Wind, Tires/Road, Wind and Tires/Road
- Data preparation algorithms
  - Source Separator Tool separates sound components (orders) from different sound sources, for example, to separate the sound shares of different engines in recordings of a hybrid powertrain.
  - Annotation Tool to exclude invalid time segments from data set generation
  - Test Data Map document as a guide through data preparation steps
  - TPA-based maps require PSM 21
- Powertrain maps vs. load via throttle position or map vs. load via torque
- Wind, tire, tire/road, wind/tires vs. speed
- Support for recuperation (negative torque)
- Authentic, realistic, artifact-free re-synthesizing algorithms
- Reusable acoustic maps for Audio Sources
- Data presentation as heat maps, e.g., load vs. RPM vs. order level

## PSM 11 (code 7611) PreSense Audio Sources CAE

- Requirements: PSM 00, PSM 21
- Auralization of powertrain CAE data
- RPM-based or order-based data of an entire vehicle simulation with loads and transfer functions
- Support for PCH file format
- Simulation Data Map document as a guide through the data preparation steps
- Powertrain (2-D) Map Audio Source

## PSM 12 (code 7612) PreSense Audio Sources Driving Simulator

- Requirements: PSM 00
- Special Events Audio Source: Triggered playback of sound samples, for example, turning signal, warning sounds, instructions, background noise, transient noise phenomena.
  - Every Special Event Audio Source consists of one or more events each of which consists of one or more sound files.
  - Different event playback modes: serial, random sound, loop n-times, loop indefinitely
  - Triggered events form third party software via the gRPC (Remote Procedure Call) interface (requires PSM 30)

## PSM 19 (code 7619) PreSense PreSenter Mode

- Requirements: PSM 00
- All Audio Sources from PSM 10, PSM 11, and PSM 12 can be used for playback only.
- Workspaces can be created and modified using existing data sets.
- Existing maps or events cannot be created or modified. PSM 10, PSM 11, or PSM 12 is necessary for full functionality.

## PSM 20 (code 7620) PreSense Online Filter

- Requirements: PSM 00
- Individual filter configuration for each Audio Source
- Playgroup filter or TPA path contributions (requires PSM 21)
- Serial or parallel IIR filters (lowpass, highpass, parametric lowpass/highpass, parametric bandpass, bandstop)
- IIR filter with variable amplification vs. load and vs. rpm or vs. speed.
- Enable/disable filters while driving.
- Adjust filter parameters while driving.
- FIR filter including Filter Editor

## PSM 21 (code 7621) PreSense TPA Support

- Requirements: PSM 00, PSM 10, PSM 11 or PSM 19
- Make path contributions from TPA audible for powertrain and tire/road noise.
- Level adjustments of path contributions
- Mute or solo path contributions.
- Contribution Viewers display actual path combinations as color bands or lines diagram in real-time.
- Seamless TPA data import from an ArtemiS SUITE TPA Project and Prognoise
- Import of path contributions from other software possible (via ATFX-to-HDF conversion in ASM 00)

## PSM 22 (code 7622) PreSense Multichannel Playback

- Requirements: PSM 00
- Support of more than two audio output channels, for example, additional shaker playback or driver's and passenger's ears at the same time

## PSM 30 (code 7630) PreSense Driving Dynamics Model Interface

- Requirements: PSM 00
- Interface to IPG CarMaker® to read/write Operating State values
- Use Complex driving dynamics models from IPG CarMaker® to simulate hybrid and electric vehicles.
- Support for CVT transmissions

## PSM 31 (code 7631) PreSense Vehicle Simulator Interface

- Requirements: PSM 00
- gRPC interface to integrate PreSense into a vehicle simulator.
- Receive Operating State values (speed, rpm, load, ...) from a third-party vehicle simulator.
- Send Operating State values (speed, rpm, load, ...) to third-party software.
- Remote Controlling PreSense:
  - Start, stop, and request PreSense Player and PreSense Recorder status.
  - Select the active Workspace/Vehicle/Scenario.
  - Select maps in Audio Sources (requires PSM 10, PSM 11, or PSM 19).
- Trigger Event Audio Source (requires PSM 12)
  - Start and stop event playback.
  - Start and stop sound playback within an event.

## PSM 32 (code 7632) PreSense Active Sound Design QNX

- Requirements: PSM 00
- Blackberry QNX ASD integrated into Active Sound Design QNX audio source
- Connect the Blackberry QNX LiveAmp tuning software to the audio source for interactive sound design during test drives.
- Load QCF files from Blackberry QNX LiveAmp.

## PSM 33 (code 7633) PreSense Interfaces for SW/HW in the Loop

- Requirements: PSM 00
- Integrate third-party sound generating software or hardware in PreSense.
- Interfaces to send operating state values:
  - OSC (Open Sound Control) network protocol is used to send vehicle operating state values to a third-party software. Configurable OSC addresses for operating state, update rate, IP address, and port.
  - CAN Output: Operating state is sent via CAN bus simulation to a third-party hardware. Supported devices: HXB PreSense, PCAN-USB (FD) from PEAK System.
- Frontend Audio Source integrates external sound in PreSense via analog input or loopback of a (virtual) sound card:
  - Channel routing and gain from each input channel to each output channel
  - Filter matrix with an optional FIR filter for each input channel to each output channel
  - Supported devices:
    - HEAD*lab*
    - *lab*COMPACT HEAD*lab* modules
    - SQuadriga III
    - SQuadriga II
    - HMS V, HMS IV, HMS III
    - ASIO and Windows audio devices

## PreSense Software Modules

PreSense 3.0 (code 7600ff) contains

- PSM 00 (code 7600) PreSense Basic Framework
- PSM 10 (code 7610) PreSense Audio Sources Automotive Standard
- PSM 11 (code 7611) PreSense Audio Sources CAE
- PSM 12 (code 7612) PreSense Audio Sources Driving Simulator
- PSM 19 (code 7619) PreSense PreSenter Mode
- PSM 20 (code 7620) PreSense Online Filter
- PSM 21 (code 7621) PreSense TPA Support
- PSM 22 (code 7622) PreSense Multichannel Playback
- PSM 30 (code 7630) PreSense Driving Dynamics Model Interface
- PSM 31 (code 7631) PreSense Vehicle Simulator Interface
- PSM 32 (code 7632) PreSense Active Sound Design QNX
- PSM 33 (code 7633) PreSense Interfaces for SW/HW in the Loop

## Related software

- Prognoise (code 4914) Binaural Transfer Path Synthesis

## Compatible playback devices

- Recommended: HXB PreSense (code 7661)
- RME Audio Interface with optical output connected to *lab*O2/*lab*P2 (codes 3731/3732) via *lab*ADAT (code 3794)
- *lab*P2 (higher latency compared to HXB PreSense or an RME Audio Interface
- Integrated sound card (uncalibrated playback and higher latency)

## System Requirements

- Windows 11 x64
  - Pro, Enterprise, Education; version 21H2 or newer
  - Languages: US/Western Europe
- Windows 10 x64
  - Pro, Enterprise, Education; version 1809 or newer
  - Branch SAC
  - Languages: US/Western Europe
- Processor
  - Minimum: Core™2 Duo with 2 GHz
  - Recommended: Core™2 Quad with 3 GHz
- RAM
  - Minimum: 16 GB
  - Recommended: 64 GB (Laptop), 128 GB (Desktop PC)
- Solid State Drive (SSD) for the data
- Graphics card
  - Minimum: NVIDIA card with 640 CUDA® cores and 2 GB of dedicated RAM, e.g. Quadro® K2200
  - Recommended: NVIDIA card with 1024 CUDA® cores (or more) and 4 GB dedicated RAM (or more), e.g., Quadro® P2000, P2200, P3200, P5000
- Display with WXGA resolution (1366x768), full HD with 1920x1080 recommended
- .NET framework 4.8
- Internet Explorer 11
- HASP dongle driver
- Optional HEAD USB driver