

PULSE Reflex Base Type 8700, PULSE Reflex Data Viewer Type 8701 PULSE Reflex Core Types 8702, 8703, 8704, 8705, 8706 and 8710

PULSE Reflex™ adds dedicated post-processing applications to the PULSE software environment. It brings together a range of generic post-processing tools for offline analysis and processing of time data, and experimental modal analysis. The innovative user interface delivers genuine ease-of-use through a workflow that is easy to learn and consistent across applications.

Data viewing, storage and reporting are built into the workflow and include tools and features for immediate traceability via an SQL database, for quick data overviews and for automatic report creation – all based on user-definable templates. The aim is to make the task of data processing and reporting as simple and straightforward as possible, giving testers and engineers more time to focus on result interpretation.

PULSE Reflex Core is a general purpose sound and vibration signal analysis and reporting application enabling engineers to perform a range of signal analysis types with high productivity. The tools are built into a framework that provides for fully automated operation, including batch processing and the ability to create project templates to standardize and simplify repetitive processes.

PULSE Reflex also includes an interface to the PULSE LabShop real-time environment.

Uses and Features

Uses

- Offline analysis of recorded time data
- General vibration and acoustic analysis
- Rotating machinery analysis
- Stationary and non-stationary FFT, CPB (1/n-octave) and Overall (broadband) analysis
- Sound quality analysis
- Simultaneous parallel analysis with different filter settings, FFT bandwidths, and 1/n-octave setups
- Visualization, editing and audio playback of time data in preparation for analysis
- Display of frequency, RPM and order content of time signals during audio playback
- Batch processing of multiple sets of time recordings
- Human vibration analysis
- Simple and efficient reporting of results with user-definable layouts and user-selectable metadata

Features: PULSE Reflex Base and Data Viewer

- Support of a wide range of file formats for import from, and export to, native and third party systems
- Project database based on Microsoft® SQL Server®
- Powerful Data Viewer for reviewing and automated reporting

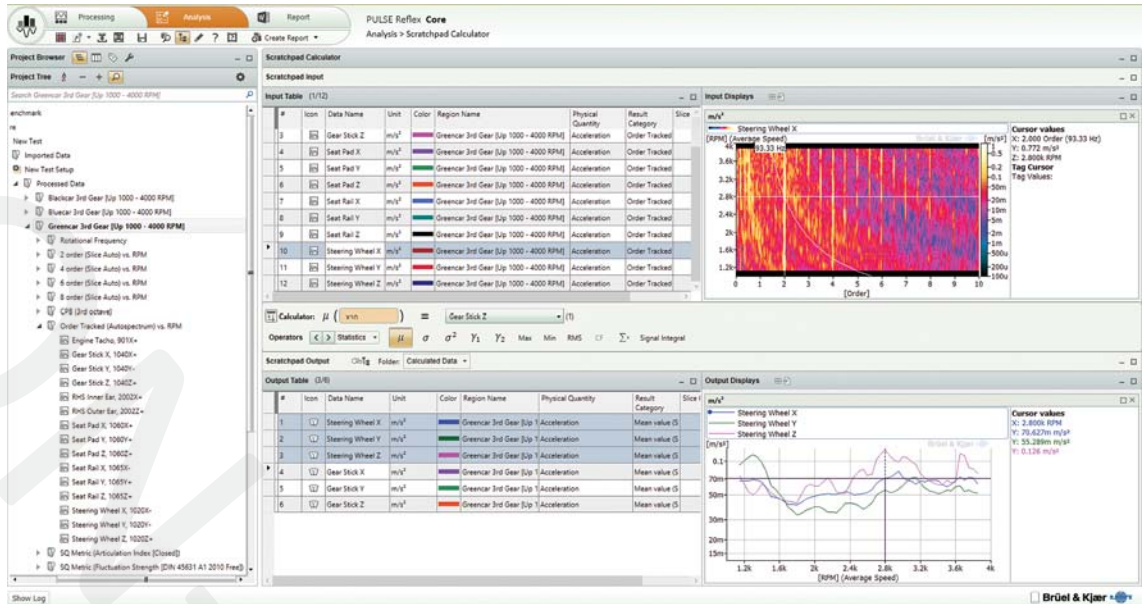


- Scratchpad Calculator for mathematical and statistical analysis of project data
- Embedded reporting in all display components
- Multiple export and import options for transport of project data and setups, including:
 - Interface to PULSE LabShop for import of function data from a PULSE project (*.pls)
 - Interface to PULSE Data Manager for import of data from a PDM database

Additional Features: PULSE Reflex Core

- Graphical Time Editor capable of dealing with multiple input files simultaneously
- Analysis based on graphical process chain concept with ability to store and re-use analysis setups
- Fully automated processing – auto-import data from a folder on disk directly to your project
- Signal filtering for automatic processing of signals
- Batch mode operation of process chain for sequenced or parallel analysis of multiple sets of imported data
- Processing of streamed auxiliary data (temperature, oil pressure, wind speed, etc.)
- Spectrogram display for quick visualization of frequency and order content of time signals

Fig. 1
PULSE Reflex Base provides the fundamental framework and data management components of PULSE Reflex, together with a function calculator



PULSE Reflex Base Type 8700, is the prerequisite for all PULSE Reflex applications. It provides project file and data import, metadata and general test data management, offline calculations on stored data, graphical displays, and integrated reporting tools.

Key features and components of PULSE Reflex Base include:

- **File Import:** Import of data files from a variety of formats including:
 - from PULSE Reflex: *.bkc (time and function data)
 - from PULSE Time Data Recorder and PULSE Reflex Measurements: *.pti (time data)
 - from PULSE LabShop: *.dat (time data, must also have the ancillary *.rec file), PULSE ASCII *.txt (time and function data)
 - from Test for I-deas: *.ati (time data), *.afu (function data)
 - from ASAM-ODS: *.atfx (time data)
 - from DSPCon: *.DATX (time data)
 - from Head Acoustics: *.hdf, *.dat (time data)
 - from HBM Somat: *.sie (time data)
 - universal files: *.unv, *.uff (time and function data)
 - wave files: *.wav (time data)
- **Import from LabShop and Import from PDM:** Interfaces that allow you to import your saved data directly from PULSE LabShop or PULSE Data Manager. You can also open a PULSE project (*.pls) from within PULSE Reflex
- **Export to Excel:** In addition to exporting data to file or exporting entire projects, you can also export data to a Microsoft® Excel® workbook
- **My Data:** Organize your data any way you wish. Data can be copied from any application in the current project, or dragged in from other projects in the database via the Search tool
- **Metadata Editor:** Set up metadata for storage to a PULSE Reflex database, including identifying legacy data from Test for I-deas
- **Project Browser:** Essential data management tool, including data search, filter, selection and editing of data descriptors
- **Scratchpad Calculator:** Standard mathematical and statistical operations can be performed on 2D and 3D functions
- **Reporting:** The Report Organizer gives a complete overview of available templates and generated reports. You can create reports from the supplied templates or use an existing report to create a new, customized template. The graphical displays in the Scratchpad provide basic reporting capabilities. For more advanced, batch-style, reporting, PULSE Reflex Data Viewer Type 8701 is required

PULSE Reflex Data Viewer Type 8701 can be added to PULSE Reflex Base Type 8700 to provide a powerful stand-alone viewing and reporting tool. It incorporates tabular and graphical views for display of data values, annotations and metadata as well as quick reporting. Its tools provide easy overview and management of data for both large and small projects no matter the application.

Key features include:

- Fast, template-based reporting to Microsoft® Word and PowerPoint®
- User-controllable use of metadata for sorting and filtering displayed data
- Graphical, user-interactive template setup for automatic generation of customized reports
- Result Matrix for automatically sorting results from a large number of tests
- Full use of metadata to automatically annotate graph legends, display titles and page titles
- Reportable metadata table for displaying a user-defined selection of metadata values
- Reportable scalar table for displaying single-value data such as statistics
- Graph presets, separately definable based on physical unit type, for graphical axis limits, ranges, dB references and weighting

Note:

Type 8701 is included with the PULSE Reflex Core module, Basic Processing Type 8702.

Fig. 2
The Result Matrix in Data Viewer presents a compact overview of results from different tests. In this example, five sets of results are compared by selecting individual cells in the matrix. The resulting graphical displays are automatically overlaid and the overall metric results are presented in tabular form

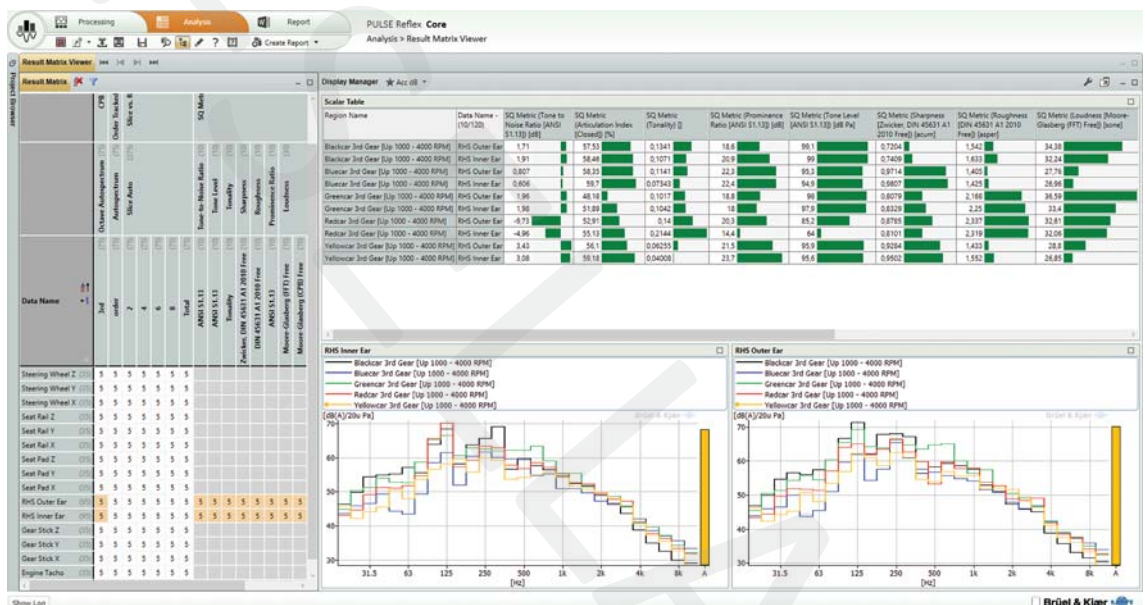
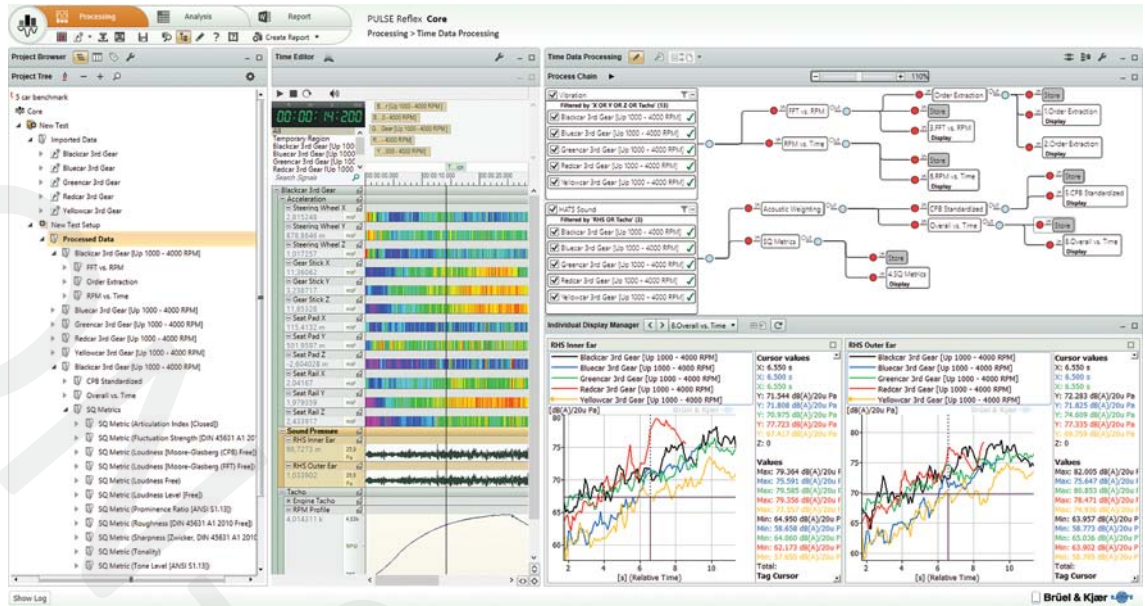


Fig. 3
The three basic components of PULSE Reflex Core: Time Editor, Process Chain, and Display Manager. Batch processing is included as standard and is very easy to set up using graphical elements to represent both data and analysis components



Central to PULSE Reflex Core are:

- **Time Editor:** Fast, efficient display and audio playback of imported time data enable intelligent selection of signal groups and time ranges (regions) for later analysis
- **Process Chain:** A graphical means for setting up the analysis process including individual, separately configurable, elements for filtering, analysis, display and storage of results. A chain is made up of these elements connected together to form the analysis process, which can be stored for later re-use. A chain can also be exported to a file and, for example, e-mailed to others to repeat a defined process

Analysis capabilities depend on which parts of PULSE Reflex Core are licensed. With Type 8702, the process chain elements include the following analyses:

- **Pre-analysis:** Acoustic Weighting, Human Vibration Weighting, Integration/Differentiation, time Filters, HATS Equalizer, Resampling of time data and Gate elements
- **Analysis:** FFT Signal and FFT System processing, Overall Level and Correlation Analysis elements
- **Analysis versus time:** FFT Signal and FFT System processing, Overall Level and RPM vs time
- **Post-analysis:** CPB Synthesis, Frequency Band Extraction, Peak Finder and Playback to listen to the output at any part of the Process Chain
- **General elements:** Individual Display, Live Display and Result Matrix for result data monitoring, evaluation and reporting, Store for automatic data storage to database and Collect to collect results in one data set from individual function data

To Type 8702 you can add following options:

- **Type 8703:** Spectrogram and process-chain calculations
- **Type 8704:** RPM-based processing and Order analysis using fixed bandwidth FFT
- **Type 8705:** Tracked FFT and Order analysis
- **Type 8706:** CPB (1/n-octave) analysis according to IEC, DIN and ANSI standards
- **Type 8710:** Calculation of sound quality metrics

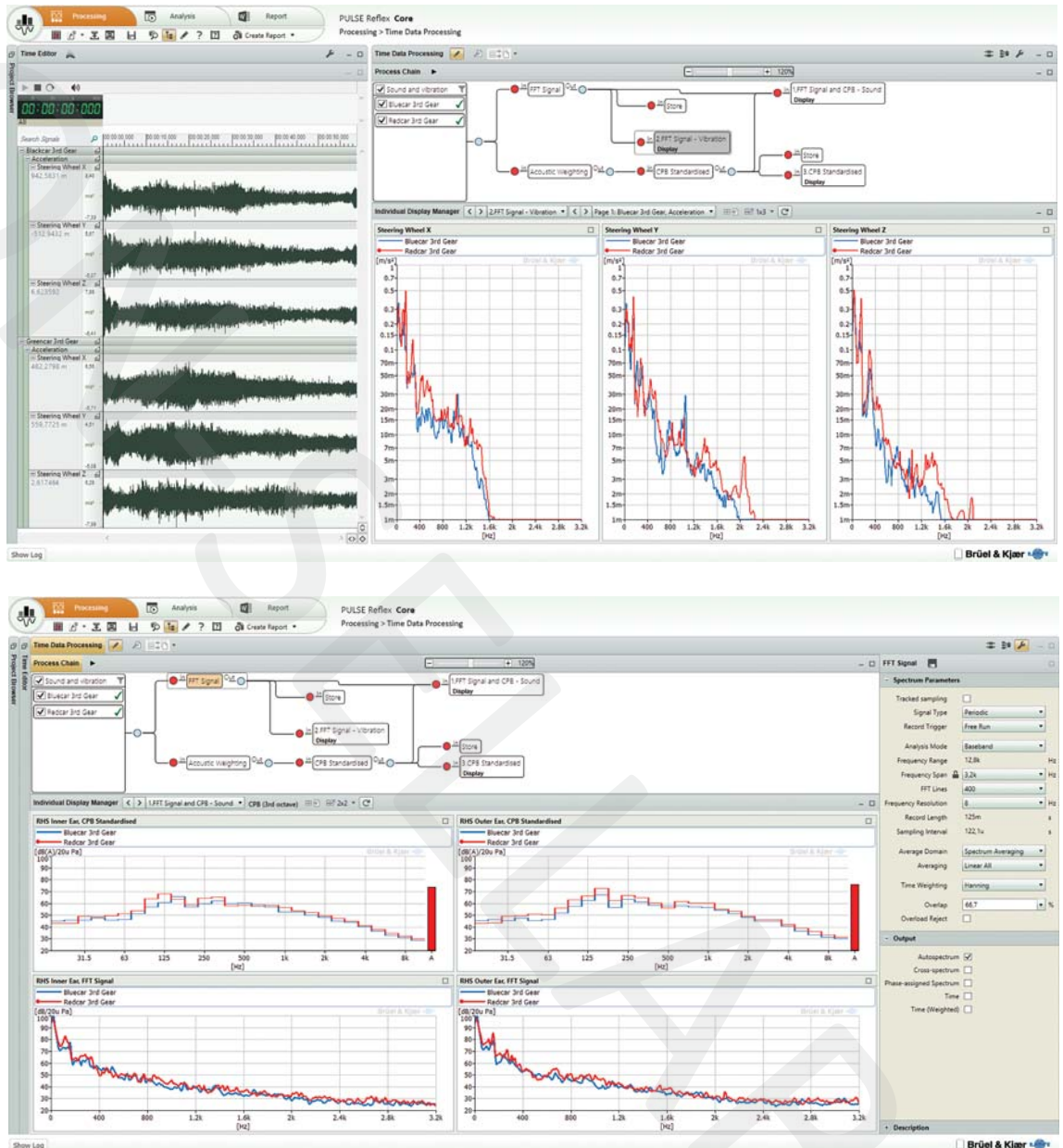
Results are displayed directly from the analysis process using a display strategy defined in the display element. This functionality provides a highly efficient and repeatable means to set up multiple pages of displays, allowing great flexibility in defining where and how the results are displayed. All display pages can then be sent to a report in a single operation making generation of customized reports quick and simple.

In cases where there are many input files from a sequence of related tests, for example repeated runs on a single test item, or an identical test on a number of different test items, there are automation tools allowing all input data to be analysed in one go. Batch Statistics (requiring Type 8703) enables run averaging, and calculation of extrema (min. and max.) on any chosen set of results.

A highly interactive dimension is added by the spectrogram display (requiring Type 8703), which provides instant feedback on the frequency and order content of raw time data simultaneously with audio playback. This helps the engineer to make better decisions on the parameters to be used for later analysis, as well as giving early insights into the fundamental characteristics of the raw data.

PULSE Reflex Basic Processing Type 8702

Fig. 4
Type 8702 provides a comprehensive set of data processing, display and reporting tools. The core of the process is the graphical Process Chain that allows setup of multiple analyses and batch running of multiple input files. The bottom figure shows a close-up of the Process Chain with configurable analysis properties. Results can be easily customized and made ready for automatic reporting



Type 8702 is the basic prerequisite for Types 8703, 8704, 8705, 8706, 8710 and is the engine room of PULSE Reflex Core, containing a comprehensive set of analysis tools for processing prerecorded time data.

Supported time data files are:

- *.ati (Test for I-deas)
- *.atfx (ASAM-ODS)
- *.bkc (PULSE Reflex native format)
- *.dat with *.rec (PULSE LabShop)
- *.dat (Head Acoustics)
- *.DATX (DSPCon)
- *.hdf (Head Acoustics)
- *.pti (PULSE Time Data Recorder and PULSE Reflex Measurements)

- *.sie (HBM Somat file format)
- *.txt (PULSE ASCII)
- *.uff and *.unv (universal files)
- *.wav (wave files)

The Time Editor provides swift and efficient viewing, audio playback, and selection of time data in preparation for analysis in the Process Chain. Regions of time data can be appended to one another and combined into a single region for analysis.

Input data for analysis can be dragged-and-dropped into the Process Chain, either from the Time Editor, or directly from the Project Browser if no editing is required. Spectra can, for example, be dragged directly from the Project Browser to the Process Chain, using the Function Data Processing task.

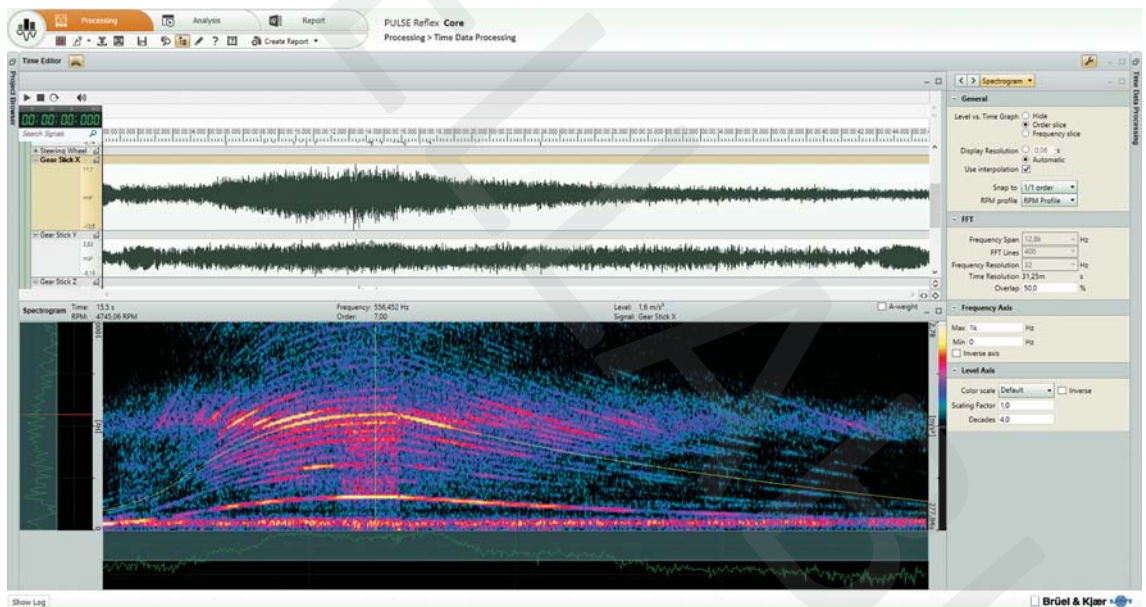
In the Process Chain, setup can be made easier by applying signal filtering. In this way different imported signals can be processed in different ways – for example, separating sound power calculations from sound quality metric calculations in one dataset. You can then select from a library of functional elements, including re-sampling, acoustic weighting, filtering (low-, high- and band-pass filters), overall level analysis, and FFT analysis. Even data from a [Sonoscout System](#) can be quickly processed with sound field correction filters for Binaural Recording Headphones Type 4965 built into the HATS Equalizer pre-analysis element.

Process chains are highly versatile as they allow for multiple parallel analyses in one run, for example, analysing vibration data at a different bandwidth to acoustic data. Individual process chains can be stored for later use, which means that there is no need to repeat the setup after the first time – simply drag-and-drop a previously stored chain into the Data Processing pane. It is also possible to attach a number of regions to a chain and run the analysis in batch mode, thus analysing multiple input regions in one operation.

PULSE Reflex Data Viewer Type 8701 is included in Type 8702.

PULSE Reflex Advanced Processing Type 8703

Fig. 5
Cursors in the time and spectrogram displays are synchronized during audio playback to give instant feedback on frequency, order, RPM and amplitude. 2D graphs, projected to the left and bottom of the spectrogram show the instantaneous spectrum and frequency slice



Type 8703 adds advanced functionality to Type 8702, including:

- Fast spectrogram display and interactive filters in the Time Editor that is synchronized with audio playback
- Calculation elements in the Process Chain like frequency weighting and scaling, function calculation and complex math operations and function smoother to apply smoothing to spectral data by averaging over a selected bandwidth with a selected weighting
- Batch Statistics element in the Process Chain allowing function statistics – min., max. and mean – to be calculated on results from different time input regions and can be based on selected metadata, enabling more recordings, from different tests, to be processed simultaneously in one process chain

Fig. 6

Calculation sequences can be included in the Process Chain with Type 8703. In this example, a vibration dose value (VDV) calculation, including human vibration weighting, is performed on acceleration time data

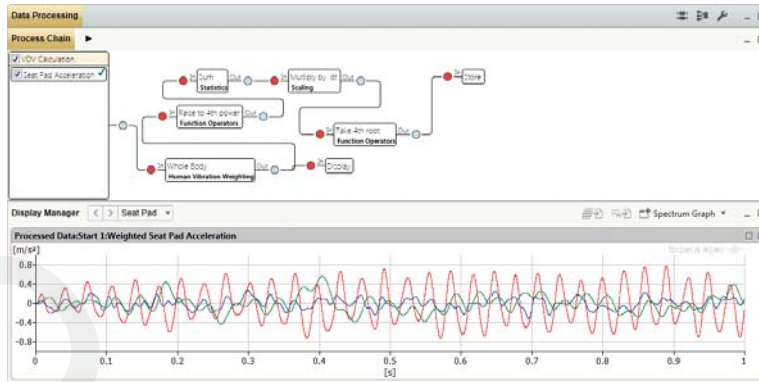
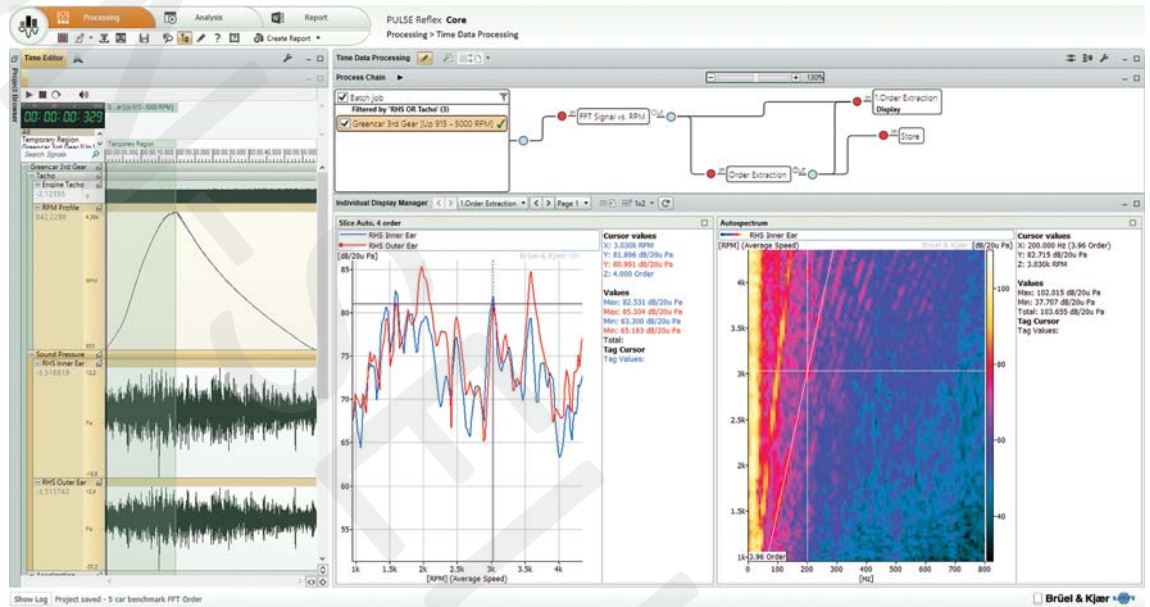


Fig. 7

In this run-up example, the focus is on the fourth order level, in each ear, of the recorded binaural sound

PULSE Reflex Order Analysis Type 8704



Type 8704 adds fixed bandwidth FFT-based order analysis to Type 8702. When a tachometer pulse train is available in the time data file, the analysis can be set up to include RPM as a time-varying tag to 3D spectral maps. As an alternative to RPM, the tachometer conditions and profile can be defined with position (unit: m), speed (m/s) or vehicle speed (km/h) (ft, ft/s or mph for imperial units).

With Type 8704, these additional elements are available in the Process Chain:

- FFT Signal vs RPM and FFT System vs RPM
- Order extraction (order slices extracted from spectra)
- CPB vs RPM (requires PULSE Reflex Standardized CPB Option Type 8706)
- Overall vs RPM

Additional Time Editor features include:

- Tachometer pulse train synthesis from speed profiles, for example from CAN data, voltage-proportional-to-speed conditioning equipment, or the graphical auto-tracker
- Tachometer repair: Smoothing and pulse drop-out, or multiple pulse, correction

Additional analysis tasks are available for graphical (interactive) order slice extraction and auto-tracking to generate an RPM profile from FFT vs Time outputs. An auto-tracked speed profile can then be converted to a tachometer pulse train using the synthesis utility.

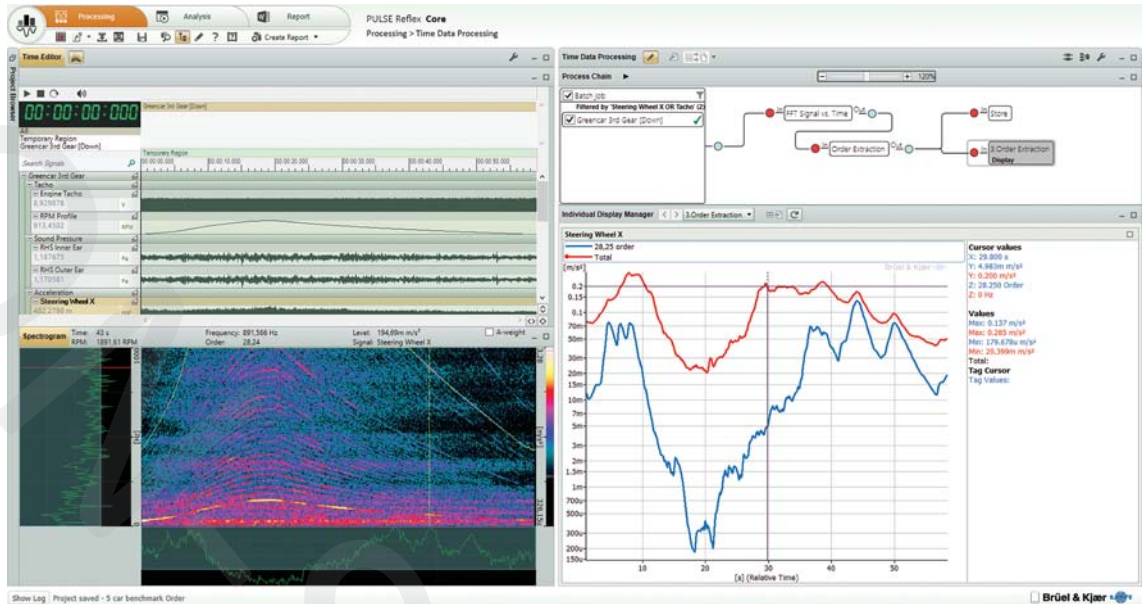
Typical applications include rotating machinery analysis and processing vehicle or engine speed sweeps (run-up/down) with respect to RPM or other time-varying quantities. Fixed bandwidth FFT order analysis is best suited to situations where sweep rates are relatively small or, for faster speed sweeps, where the

lower order numbers are of interest. Tracked order analysis (see Type 8705) is recommended for high accuracy analyses of higher orders and fast speed sweeps.

PULSE Reflex Advanced Order Analysis Type 8705

Fig. 8

In this example, a distinct tone/whine is heard during the run down and is picked up in one of the acceleration signals. The spectrogram focuses on the order of interest, a zoom order analysis is performed, and the tracked order is displayed against total level. The entire workflow is visible in a single view



Type 8705 adds tracked resampling to basic Type 8702 and 8704 elements: FFT Signal, FFT Signal vs Time, and FFT Signal vs RPM. The time data is resampled according to the instantaneous RPM value from a given tachometer signal.

When used in conjunction with the Order Extraction element (Type 8704), the individual order functions can be extracted from the order spectra.

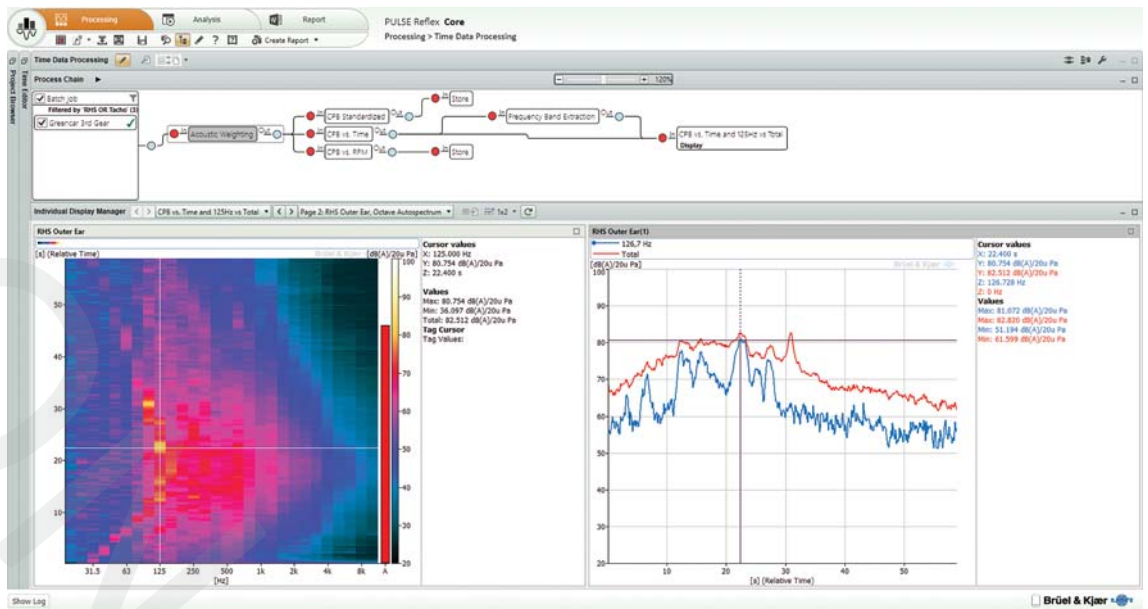
Tracked order analysis is recommended for high accuracy analyses of high order numbers occurring in rotating machinery equipment such as gearboxes, transfer boxes, differentials, power trains, turbines and aircraft engines.

PULSE Reflex Standardized CPB Option Type 8706

Conforming to IEC, DIN and ANSI standards, Type 8706 provides 1/1-, 1/3-, 1/6-, 1/12- and 1/24-octave analysis with digital filters and simultaneous calculation of overall level, both weighted and unweighted. Acoustic weighting can be applied to the spectrum itself and min./max. holds on individual, single, overall, or overall weighted bands.

Fig. 9

CPB (here 1/3-octave) analysis follows the same simple workflow as FFT, order and overall analysis. The displays show A-weighted 1/3-octave vs time (left) and the 125 Hz band level vs time overlaid on total level. The cursors are synchronized between the displays



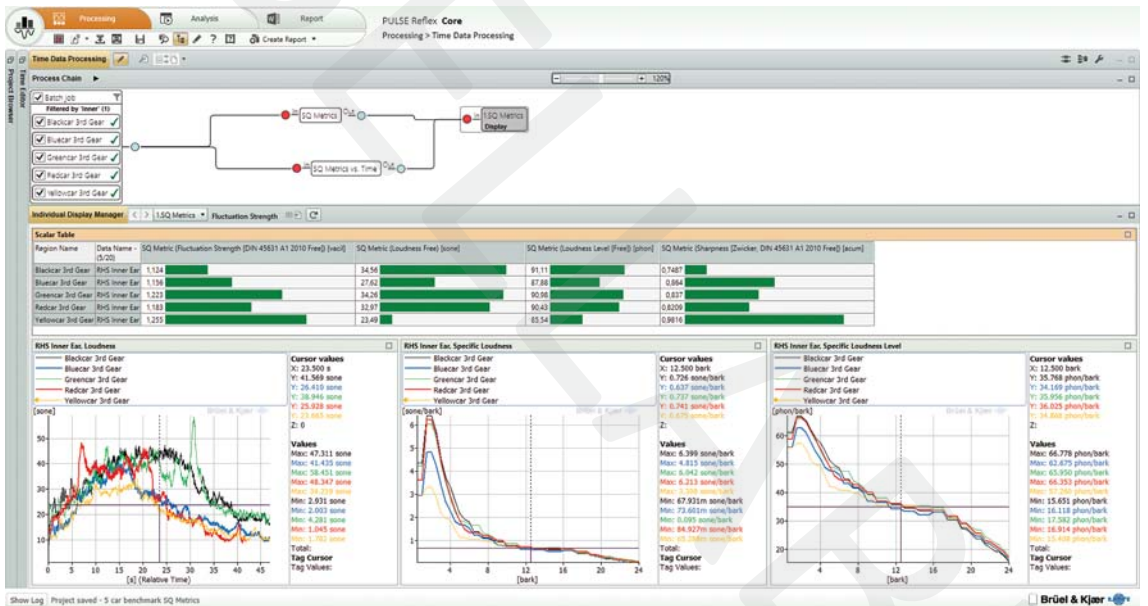
The CPB option adds three Process Chain elements:

- CPB
- CPB vs Time
- CPB vs RPM (requires PULSE Reflex Core Basic Order Analysis Type 8704)

PULSE Reflex Sound Quality Metrics Type 8710

Fig. 10

Sound quality metrics are integrated into the same processing framework as all other analysis types in PULSE Reflex Core

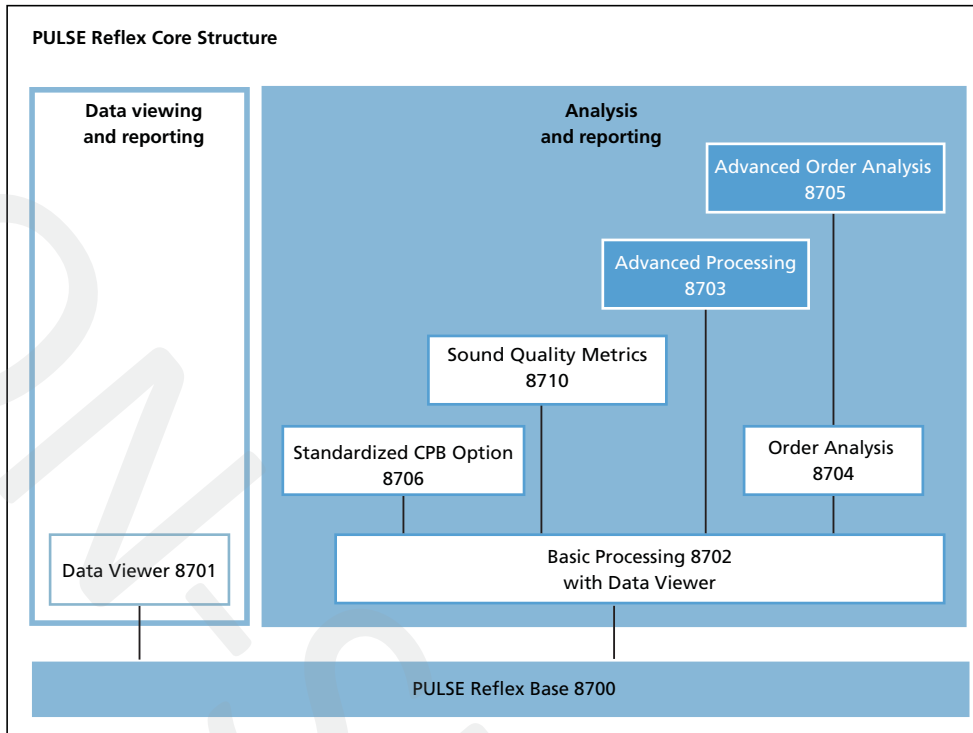


Type 8710 adds sound quality metric calculations to Type 8702. Two specialized process chain elements enable the calculation of metrics as either overall values/spectra or as values/spectra versus time.

The following sound quality metrics are included:

- Articulation Index (AI)
- Stationary Loudness
- Time-varying Loudness
- Statistical Loudness
- Loudness Level
- Binaural Loudness
- Sharpness
- Fluctuation Strength
- Roughness
- Tone-to-Noise Ratio
- Prominence Ratio
- Tonality

Fig. 11
Product structure for
PULSE Reflex Core
modules



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Specifications – PULSE Reflex Base Type 8700

This Windows®-based analysis software is delivered via installation media (DVD or USB). As many signal groups as desired can be created from measured signals. The license is either: node-locked to a PC host ID or dongle; or floating, locked to a network server

System

SYSTEM REQUIREMENTS

Microsoft® Windows® 10 Pro or Enterprise (x64), Windows® 8.1 Pro or Enterprise (x64), or Windows® 7 Pro, Enterprise or Ultimate (SP1) (x64) operating system

RECOMMENDED PC

- Intel® Core™ i7, 3 GHz processor or better
- 32 GB RAM
- 480 GB Solid State Drive (SSD) with 20 GB free space, or better
- DVD-RW drive
- 1 Gbit Ethernet network
- Microsoft® Windows® 10 Pro or Enterprise (x64)
- Microsoft® Office 2016 (x32)
- Adobe® Reader® 11
- Microsoft® SQL Server® 2014 Express (SP1) (included in installation)

Import/Export

Import and export in Project Browser or connect to PULSE LabShop via built-in tool for direct import from LabShop Measurement and Function Organisers. PULSE ASCII files can be exported from both PULSE LabShop and PULSE Data Manager (PDM)

FUNCTION DATA IMPORT/EXPORT

The following function data file formats are supported:

- *.bkc (PULSE Reflex native format)
- *.txt (PULSE ASCII) – Import only
- *.unv, *.uff (binary and ASCII universal files)
- *.afu (Test for I-deas)

TIME DATA IMPORT/EXPORT

The following time data file formats are supported:

- *.bkc (PULSE Reflex native format)
- *.pti (PULSE Time Data Recorder Type 7708 and PULSE Reflex Measurements Type 8729-A/B)
- *.wav – 16-, 24- and 32-bit (wave files)
- *.dat + *.rec (PULSE LabShop) – Import only. The ancillary *.rec file must be in same folder to import *.dat file
- *.txt (PULSE ASCII) – Import only
- *.ati (Test for I-deas)
- *.atfx (ASAM-ODS)
- *.unv, *.uff (binary and ASCII universal files)
- *.hdf (Head Acoustics)
- *.dat (Head Acoustics) – Import only
- *.DATX (DSPCon)
- *.sie (HBM Somat) – Import only

EXPORT DATA TO EXCEL

Results can be exported to a Microsoft® Excel® workbook

PROJECT FILE EXPORT AND IMPORT

Export a project to an external “transport” file (*.ReflexExport), with or without imported or processed data, for archiving outside the database, sharing with other PULSE Reflex users, capturing a snapshot of a particular state, or creating a project template

Data Display

Displays enable viewing and comparison of measurements and results. Data is dragged-and-dropped to/from the Project Browser. The Display Manager is the container for displaying graphical results

GRAPH TYPES

Display of functions in a range of graph types including:

- Waterfall

- Waterfall (step)
- Colour contour (3 variants)
- Campbell diagram
- Bar
- Line
- Curve
- Curve (step)
- Overlay
- Overlay (all)
- Multi-value

Superimposed Graphs: A number of functions can be superimposed on the same curve graph

AXES

- X-axis Scale: Linear, logarithmic and CPB
- Y-axis Scale: Linear, logarithmic and dB
- Z-axis Scale: Linear and logarithmic

COMPLEX DISPLAYS

- Real
- Imaginary
- Magnitude
- Phase
- Nyquist
- Bode

SPECTRAL UNITS

- Root mean square (RMS)
- Power (PWR)
- Power spectral density (PSD)
- Root mean square spectral density (RMSSD)
- Energy spectral density (ESD)
- Peak (Peak)
- Peak-to-Peak (PkPk)

ACOUSTIC POST-WEIGHTING

A-, B-, C-, D-, L-weighting

j ω WEIGHTING

$1/j\omega^2$, $1/j\omega$, 1, $j\omega$, $j\omega^2$ (single and double integration and differentiation)

CURSOR TYPES

Depending on the display type, the following are available:

- Main
- Delta
- Order
- Reference
- Harmonic
- Sideband

Alignment: Cursors in different displays can be synchronized to allow the changes to one display to be reflected in other displays showing the same or different functions

CURSOR READINGS

The cursor values that can be read:

- Acoustic levels
- Corrected frequency
- Cursor indices and values
- Delta
- Delta/total
- Max. and min. values
- Nearest harmonic
- Nearest sideband
- Reference
- Resonance
- Reverberation
- Slice definition
- Status
- Total

Calculator

FUNCTION MATH

Operates on a function selection using another single selected function

- Add
- Subtract
- Multiply
- Divide
- Addition in dB
- Subtraction in dB

FUNCTION OPERATORS

Operates on a function selection

- Natural logarithm: Ln
- Inverse Ln: e to the power of the function amplitude
- Logarithm to the base 10: Log10
- Inverse Log10: 10 to the power of the function amplitude
- Reciprocal
- Square Root
- Square
- Raise to power, x^y
- Absolute Value
- To dB: Convert amplitude of a function to dB values with a user-defined reference
- To Real: Result is a function containing real values from selected complex function
- To Imaginary: Result is a function containing imaginary values from selected complex function
- To Magnitude: Result is a function containing magnitude values from selected complex function
- To Phase: Result is a function containing phase values from selected complex function
- Conjugate: Result is complex conjugate of selected complex function

SCALING

Operates on a function selection

- Scale by Real: multiply selected functions by real-valued scalar
- Scale by Complex: multiply selected functions by complex-valued scalar
- Scale by Averaging Time: Multiply selected functions by the averaging time, for example. to get sound exposure levels (SEL, ASEL, ...)

STATISTICS

Operates on a function selection, single value output

- Mean Value
- Standard Deviation
- Variance
- Skewness
- Kurtosis
- Max Value
- Min Value
- RMS Value
- Crest Factor
- Sum Value

FUNCTION STATISTICS

Operates on a function selection, single function output

- Mean
- Standard Deviation
- Mean minus Standard Deviation
- Mean plus Standard Deviation
- Min
- Max
- Sum

FREQUENCY WEIGHTING

Operates on a function selection

- Linear Weighting: Remove weighting from spectrum
- A-Weighting: Apply A-weighting (removing existing weighting first)
- B-Weighting: Apply B-weighting (removing existing weighting first)
- C-Weighting: Apply C-weighting (removing existing weighting first)
- D-Weighting: Apply D-weighting (removing existing weighting first)
- Single Integration
- Double Integration
- Single Differentiation
- Double Differentiation

INTERPOLATION

Operates on a function selection

- Linear vs Frequency: Interpolate frequency values according to min, max and interval
- Linear vs RPM: Interpolate RPM values according to min, max and interval
- Linear vs Time: Interpolate time values according to min, max and interval

Reporting

A separate reporting task enables templates to be created in Microsoft® Word, Excel® or PowerPoint®. Templates contain links (bindings) to data, metadata and displays in the PULSE Reflex project, making it easy to create additional reports with new data as data, metadata and displays are automatically updated. This is particularly useful for standardized reporting

Data Management

Data management is based on a data model that interacts with a Microsoft® SQL Server® 2012 Express (SP2) or SQL Server® 2014 database. Connection to the last used database is automatic upon starting PULSE Reflex. However, the user can connect to a different database at any time during a session. Only one database can be connected at a time.

Local database with each PULSE Reflex installation; optionally accessible via a Reflex service, one user at a time, over a company network

DATABASE HANDLING

Databases can be created, deleted, backed up and restored

Database Migration Tool: Tool that allows users to start application using an SQLite database and at a later point migrate data to an SQL Server solution

DATA STORAGE (of data files, report templates, pictures)

Uses a filefarm (on disk) referenced by the database. File sizes limited by disk only.

Files linked either to a project in their original format (at their original location) and worked on without converting to native PULSE Reflex format, or copied and converted to PULSE Reflex format, bringing them under control of the PULSE Reflex database

METADATA

Defined by the user. Enables customized searching for input data and results. Includes support of Test for I-deas IDs (for use with UNV, AFU and ATI file types)

DATA SHARING

Via external BK Common file enables one file to contain all results from a common source, including their metadata

Specifications – PULSE Reflex Data Viewer Type 8701

Type 8701 adds to the functionality and specifications of PULSE Reflex Base Type 8700, as follows:

Data Viewer

The Data Viewer enables review and display of project data:

- Data table with user-configurable columns. Can contain a wide range of data descriptors, including user-defined metadata
- Advanced filtering and sorting capabilities using a combination of columns, providing a powerful way to focus on any data of interest
- Automatic data presentation in graphical displays. Auto-filled based on data selection in the table
- Controls in header bar enables table selections to be automatically incremented for quick and easy scanning through the entire data set
- Automatic report generation based on the data selection in the table

Result Matrix

The Result Matrix provides a structured overview of results from a large number of tests, making selection and comparison very easy:

- Result layout as a matrix of signals versus analyses
- Smart results grouping – each individual cell in the matrix represents a group of similar results for which comparison is valid
- Automatic result data presentation – selecting a cell presents the results, either in a table view for scalars, or graphical display for function data
- Automatic report generation – reports can be generated in either Microsoft® Word or PowerPoint®, either from blank documents, or from templates prepared in advance. Template creation is controlled directly from the Data Viewer and is both flexible and easy to perform

Integration in PULSE Reflex Core

PULSE Reflex Data Viewer Type 8701 is included in PULSE Reflex Base Processing Type 8702

Specifications – PULSE Reflex Basic Processing Type 8702

Type 8702 includes the same functionality and specifications as PULSE Reflex Base plus the following:

Time Editor

Display, audio playback and pre-processing of time data in preparation for analysis:

- Automatic calculation of RPM profile from a tachometer pulse train
- Fast navigation by scrolling through channels, panning and zooming in time axis
- Region selection by group of channels and time range
- Saving regions to project
- Appending of regions to other regions (concatenation)
- Manual grouping of regions – for batch processing
- Automated generation of regions from multiple files having similar channel configurations – in preparation for batch processing

Data Processing

All functionality is contained in the Process Chain, which consists of graphical elements connected together to form an analysis process

INPUT

An input area is provided into which data is dragged-and-dropped

Time Data: Using Time Data Processing, drag either from the Time Editor or Project Browser (if no editing required)

Function Data: Using Function Data Processing, drag directly from the Project Browser

Auxiliary Data: Using Time Data Processing, drag either from the Time Editor or Project Browser. Overall analysis is recommended

STORAGE AND EXPORT

A process chain can be stored in the project for later use. It can also be exported to an external file for transfer to other computers

AUTOMATION

- Auto Import: Definition of folder on disk to which the system checks for data files for automated import and processing
- Signal Filter: Filter by data name or physical quantity for processing
- Batch Job: Automated batch processing

PROCESSING TYPES

Four basic types of process chain elements – Pre-analysis, Analysis, Post-analysis and General

Pre-analysis Elements:

- Acoustic Weighting: A-, B-, C-, D and G-weighting. Meets the requirements of IEC 61672–1, ANSI S1.42–2001, and ISO 7196: 1995

- Human Vibration Weighting: Linear, Wb, Wc, Wd, We, Wf, Wh, Wj, Wk, Wm (ISO 2631)
- Integration/Differentiation:
- Filters: FIR low pass, high pass, band pass and band stop. Filter lengths: 512, 1024, 2048, 4096, 16384 and 32768 samples
- HATS Equalizer: Apply known sound field correction filters for Head and Torso Simulators and binaural recording headsets
- Resample: To range of 20 user-selectable freq., 512 Hz to 524.288 kHz
- Gate: Open and close data flow based on signal triggers, different signals can be used for opening and closing

Analysis Elements:

- FFT Signal
- FFT System
- Overall Level
- Correlation
- FFT Signal vs time
- FFT System vs time
- Overall Level vs time
- RPM vs time

Post-analysis Elements:

- CPB Synthesis (1/n-octave, n = all integers from 1 to 24)
- Playback: Playback of selected signals with gain, pan and mute controls
- Frequency Band Extraction
- Peak Finder: Peak/valley extraction from FFT spectra

General Elements:

- Individual Display: Display strategy setup for creation of multiple display pages in the Display Manager
- Live Display: Fast displays, 2D and Colour Contour, which update in real time during processing. Normal processing speed is much faster than real time; to force 1:1 real-time processing use a Playback element
- Result Matrix: Review results before storing them using same functionality as PULSE Reflex Data Viewer's Result Matrix
- Store: Setup of folder structure and names for results output from a standard process or batch process
- Collect: Setup of folder structure and names for results output from a collection batch process

Measurement Control

AVERAGING

Averaging can be performed either in the frequency or time domains. Averaging types available for the measured signals are:

- Linear (fixed number of blocks)

- Linear All (full time range)
 - Exponential
 - Maximum hold
- Overlap:** User selectable values of 0%, 50%, 66.67%, and 75%, user editable from 0% to 99%

GATING

Data flow in the Process Chain can be controlled by signals, independently for on and off, using the Gate element

Measurement

ANALYZERS

FFT and Overall Level analysis

FFT ANALYSIS

The following specifications apply to all FFT elements: FFT Signal, FFT System, FFT Signal vs Time and FFT System vs Time

Frequency Range:

- Baseband and Zoom: 50 – 102400 lines
- Frequency Span: 1 Hz – 204.8 kHz in 1, 2, 5 ... or 2^n (1, 2, 4, 8 ...) sequence (depending on hardware)

Signal Type: Random; Periodic; Transient

Properties are automatically set up to a logical default; for example, when transient type is selected, Signal Trigger is selected as the triggering mode

Triggering Modes:

- Free run
- Signal Trigger: Trigger attributes include level, hysteresis, slope, hold-off, delay and divider

Time Weighting: The following are available:

- Exponential
- Uniform
- Transient

- Hanning
- Flat-top
- Kaiser-Bessel

Output:

- FFT Signal: Autospectrum, Cross-spectrum, Phase-assigned Spectrum, Time, Weighted Time
- FFT System: Autospectrum, H1, H2, H3 and Hv FRFs, Coherence, Principal Component, Cross-spectrum, Phase-assigned Spectrum, Signal-to-Noise, Coherent Power Spectrum, Non-coherent Power Spectrum, Time, Weighted Time. MIMO computation for H1, Hv, Coherence and Principal Component
- FFT Signal vs Time and FFT Signal vs RPM: Autospectrum Phase-assigned Spectrum, Time, Weighted Time
- FFT System vs Time: Autospectrum, H1, H2, H3 and Hv FRFs, Coherence, Principal Component, Cross-spectrum, Phase-assigned Spectrum, Signal-to-Noise, Coherent Power Spectrum, Non-coherent Power Spectrum, Time, Weighted Time. MIMO computation for H1, Hv, Coherence and Principal Component
- Correlation: Auto-correlation, Cross-correlation, Time

OVERALL ANALYSIS

Applies to all Overall Level analyzer elements: Overall, Overall vs Time, and Overall vs RPM (with Type 8704).

Meets the requirements for a class 1 instrument in IEC 61672-1, ANSI S1.43-1997 Type 1, ANSI S1.4-1983 Type 1, IEC 804-1985 Type 1 and IEC 651 Type 1

Averaging: Exponential, Impulse, Linear (L_{eq}), Linear All, True Peak, True Peak All

Trigger Method: Free run; Fixed time interval

An auxiliary signal may be used as a trigger signal

Frequency Span: 1 Hz – 204.8 kHz in 1, 2, 5 ... or $2n$ (1, 2, 4, 8 ...) sequence

Acoustic Weighting: As signals, A, B, C, D, G

Specifications – PULSE Reflex Advanced Processing Type 8703

Type 8703 adds to the functionality and specifications of PULSE Reflex Basic Processing Type 8702, as follows:

Time Editor

- Fast spectrogram display – synchronized with time data display & playback
- Interactive order slice and frequency spectrum display synchronized with spectrogram cross-hair cursor

Specifications – PULSE Reflex Order Analysis Type 8704

Type 8704 adds to the functionality and specifications of PULSE Reflex Basic Processing Type 8702, as follows:

Time Editor

- Synthesis of tachometer pulse train from a given RPM profile
- Tacho repair: Profile smoothing and dropout/spurious pulse correction

Data Processing

ANALYSIS ELEMENTS

- FFT Signal vs RPM and FFT System vs RPM
- Order Extraction: Order slices, relative or absolute bandwidth, from FFT vs RPM 3D spectra. Optional smoothing for cleaner order slices
- CPB vs RPM (requires both Types 8704 and 8706)

OUTPUT

FFT Signal vs RPM: Auto Spectrum, Phase Assigned Spectrum, Time, Weighted Time

FFT System vs RPM: Autospectrum, H1, H2, H3 and Hv FRFs, Coherence, Principal Component, Cross-spectrum, Phase-assigned

Data Processing

ANALYSIS ELEMENTS

- Batch Statistics
- Calculation elements: Statistics, Function Statistics, Function Operators, Scaling, Frequency Weighting (frequency domain), Complex Math (toReal, toImaginary, toMagnitude, toPhase, toConjugate)

Spectrum, Signal-to-Noise, Coherent Power Spectrum, Non-coherent Power, Spectrum, Time, Weighted Time. MIMO computation for H1, Hv, Coherence and Principal Component

Graphical Order Extractor

An additional analysis task for quickly visualising and storing sets of order slices one signal at a time.

Displays update automatically when moving order cursors and selecting different data sets

- Order slice extraction
- Overall RMS level computed from input spectra
- Frequency band RMS level extraction, band defined by delta cursor
- Optional selection of modulation frequency
- Store to project

Input: RPM-tagged 3D spectra

Auto-tracker

An additional task for extraction of RPM profile from FFT vs Time results. When combined with tachometer pulse train synthesis, RPM-related analysis of data without a tachometer measurement is enabled

Specifications – PULSE Reflex Advanced Order Analysis Type 8705

Type 8705 adds to the functionality and specifications of PULSE Reflex Order Analysis Type 8704, as follows:

Measurement Control

- Order tracking included as option in FFT Signal, FFT Signal vs Time and FFT Signal vs RPM – same output options as ordinary FFT analysis except with evenly spaced order axis instead of frequency

- Individual order functions can be extracted from order spectra when tracked FFT Signal vs RPM element is combined with Order Extraction element

Specifications – PULSE Reflex Standardized CPB Option Analyzer Type 8706

Type 8706 adds to the functionality and specifications of PULSE Reflex Basic Processing Type 8702, as follows:

Data Processing

ANALYSIS ELEMENTS

- CPB Standardized
- CPB vs Time
- CPB vs RPM (requires Types 8704 and 8706)

The CPB elements operate with 1/n-octave bands, where $n = 1, 3, 6, 12$ and 24. Multiple CPB analyzers can be used simultaneously

Measurement

1/1-OCTAVE FILTERS

14-pole filters with centre frequencies given by $10^{3n/10}$, where $-3 \leq n \leq 17$ (21 filters)

Filters with centre frequencies from 250 mHz to 125 kHz that meet the requirements of:

- IEC 61260-1 Class 1
- IEC 1260-1995 Class 1
- IEC 225-1966
- ANSI S1.11-2004 Class 1
- ANSI S1.11-1986 Order 7 Type 1-D, optional range
- ANSI S1.11-1966 Class 1 Type E
- DIN 45651 (1964-01)

1/3-OCTAVE FILTERS

6-pole filters with centre frequencies given by $10^{n/10}$, where $-10 \leq n \leq 52$ (63 filters)

Filters with centre frequencies from 266 mHz to 160 kHz that meet the requirements of:

- IEC 61260-1 Class 1
- IEC 1260-1995 Class 1
- IEC 225-1966
- ANSI S1.11-2004 Class 1
- ANSI S1.11-1986 Order 7 Type 1-D
- ANSI S1.11-1966 Class 1 Type E
- DIN 45651 (1964-01)

1/6-OCTAVE FILTERS

6-pole filters with centre frequencies given by $10^{(n+0.5)/20}$, where $-21 \leq n \leq 104$ (126 filters)

Filters with centre frequencies from 270 mHz to 168 kHz that meet the requirements of:

- IEC 61260-1 Class 1
- IEC 1260-1995 Class 1
- ANSI S1.11-2004 Class 1

1/12-OCTAVE FILTERS

6-pole filters with centre frequencies given by $10^{(n+0.5)/40}$, where $-42 \leq n \leq 209$ (252 filters)

Filters with centre frequencies from 345 mHz to 173 kHz that meet the requirements of:

- IEC 61260-1 Class 1
- IEC 1260-1995 Class 1
- ANSI S1.11-2004 Class 1

1/24-OCTAVE FILTERS

6-pole filters with centre frequencies given by $10^{(n+0.5)/80}$, where $-84 \leq n \leq 419$ (504 filters)

Filters with centre frequencies from 208 mHz to 175 kHz that meet the requirements of:

- IEC 61260-1 Class 1
- IEC 1260-1995 Class 1
- ANSI S1.11-2004 Class 1

CPB SPECTRUM AVERAGING

- Linear (fixed time range)
- Linear All (full time range)
- Exponential

MAX./MIN. SPECTRUM HOLD

Max./Min. Hold of spectrum for exponential averaging mode.

ACOUSTIC WEIGHTING

Perform acoustic weighting on sound pressure signals before CPB analyses. Select between A, B, C, D and G-weighting

OVERALL BANDS

Process overall bands in parallel with the CPB spectra
The overall bands can be acoustic weighted

Specifications – PULSE Reflex Sound Quality Metrics Type 8710

Type 8710 adds sound quality metric calculations to Type 8702

Data Processing

ANALYSIS ELEMENTS

- SQ Metrics and SQ Metrics vs Time

SOUND QUALITY METRICS

- Stationary Loudness – ISO 532B, Moore-Glasberg model (ISO 532–1 proposal) based on FFT or CPB
- Time-varying Loudness – DIN 45631 and Zwicker (1989), DIN 45631/A1 (2010)
- Statistical Loudness with user-definable percentile

- Loudness Level – ISO 532B
- Binaural loudness – Robinson and Whittle (1960), Moore-Glasberg model and mean loudness between the two ears
- Sharpness – with methods Aures, DIN 45692 (2009), Zwicker, Bismarck
- Articulation Index (AI) – Beranek
- Roughness – Zwicker et al.
- Fluctuation Strength – Zwicker et al.
- Tonality – Terhardt
- Tone-to-Noise Ratio – ANSI S1.13 (2005)
- Prominence Ratio – ANSI S1.13 (2005)

BASE AND REPORTING

8700-X	PULSE Reflex Base
8701-X	PULSE Reflex Data Viewer

CORE APPLICATIONS

8702-X	PULSE Reflex Basic Post-processing
8703-X	PULSE Reflex Advanced Processing
8704-X	PULSE Reflex Order Analysis
8705-X	PULSE Reflex Advanced Order Analysis
8706-X	PULSE Reflex Standardized CPB Option
8710-X	PULSE Reflex Sound Quality Metrics

SERVICE AND SUPPORT PRODUCTS

M1-8700-X	Software Maintenance and Support Agreement for Type 8700
M1-8701-X	Software Maintenance and Support Agreement for Type 8701
M1-8702-X	Software Maintenance and Support Agreement for Type 8702
M1-8703-X	Software Maintenance and Support Agreement for Type 8703
M1-8704-X	Software Maintenance and Support Agreement for Type 8704
M1-8705-X	Software Maintenance and Support Agreement for Type 8705
M1-8706-X	Software Maintenance and Support Agreement for Type 8706
M1-8710-X	Software Maintenance and Support Agreement for Type 8710

PULSE Reflex Software Overview

Applications and Upgrades	Prerequisites	More Info
PULSE Reflex Base Type 8700	see Specs	–
PULSE Reflex Data Viewer Type 8701	8700	–
PULSE Reflex Basic Processing Type 8702	8700	–
PULSE Reflex Advanced Processing Type 8703	8700 + 8702	–
PULSE Reflex Order Analysis Type 8704	8700 + 8702	–
PULSE Reflex Advanced Order Analysis Type 8705	8700, 8702 + 8704	–
PULSE Reflex Standardized CPB Option Type 8706	8700 + 8702	–
PULSE Reflex Sound Quality Metrics Type 8710	8700 + 8702	–
PULSE Reflex Finite Element Interfaces Type 8718	8700	BP 2395
PULSE Reflex Geometry Type 8719	8700	BP 2257
PULSE Reflex Modal Analysis Type 8720	8700 + 8719	BP 2257
PULSE Reflex Modal Analysis Pack Type 8720-A	8700	BP 2257
PULSE Reflex Modal Acquisition & Analysis Pack Type 8720-B	–	BP 2257
PULSE Reflex Advanced Modal Analysis Type 8721	8700, 8719 + 8720	BP 2257
PULSE Reflex Advanced Modal Analysis Pack Type 8721-A	8700	BP 2257
PULSE Reflex Advanced Modal Acquisition & Analysis Pack Type 8721-B	–	BP 2257
PULSE Reflex Correlation Type 8722	8700, 8719 + 8720	BP 2395
PULSE Reflex Spectral Analysis Type 8729-A	8700 + 3099-A	BP 2518
PULSE Reflex Structural Measurements – Hammer and Shaker Type 8729-B	8700, 3099-A + 8729-A	BP 2518
PULSE Reflex Structural Measurements – Stepped Sine Type 8729-C	8700, 3099-A + 8729-A	BP 2518
PULSE Reflex Shock Response Analysis Type 8730	8700	BP 2339

* “X” indicates the license model, either N: Node locked or F: Floating

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Brüel & Kjær Sound & Vibration Measurement A/S
 DK-2850 Nærum · Denmark · Telephone: +45 77 41 20 00 · Fax: +45 45 80 14 05
 www.bksv.com · info@bksv.com
 Local representatives and service organizations worldwide

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Applications and Upgrades	Prerequisites	More Info
PULSE Reflex Angle Domain Analysis Type 8740	8700 + 8702	BP 2433
PULSE Reflex Telephone Test Type 8770	8700	BP 2428
PULSE Reflex Telephone Test Pack Type 8770-A-XS	8700	BP 2428
PULSE Reflex Telephone Test for ITU-P.862 PESQ Type 8771-X01	8700+8770	BP 2428
PULSE Reflex Telephone Test for ITU-P.863 POLQA Type 8771-X02	8700+8770	BP 2428
PULSE Reflex Telephone Test, Test Suite for 3GPP2.C.S5600-0, Type 8772-X01	8700 + 8770	BP 2429
PULSE Reflex Telephone Test, Test Suite for 3GPP2.26.132 Handset, Type 8772-X02	8700 + 8770	BP 2522
PULSE Reflex Telephone Test, Test Suite for 3GPP2.26.132 Hands-free, Type 8772-X04	8700 + 8770	BP 2522
PULSE Reflex Telephone Test, Test Suite for CES-Q003-2, Type 8772-X05	8700 + 8770	BP 2528
PULSE Reflex Telephone Test, Test Suite for YD/T-1538 Handset, Type 8772-X06	8700 + 8770	BP 2532
PULSE Reflex Telephone Test, Test Suite for CMCC, Type 8772-X07	8700 + 8770	BP 2542
PULSE Reflex Telephone Test, Test Suite for YD/T-1538 Hands-free, Type 8772-X08	8700 + 8770	BP 2532
PULSE Reflex Array Analysis Type 8781 (for PULSE Reflex Acoustic Camera)	8700	BP 2534

