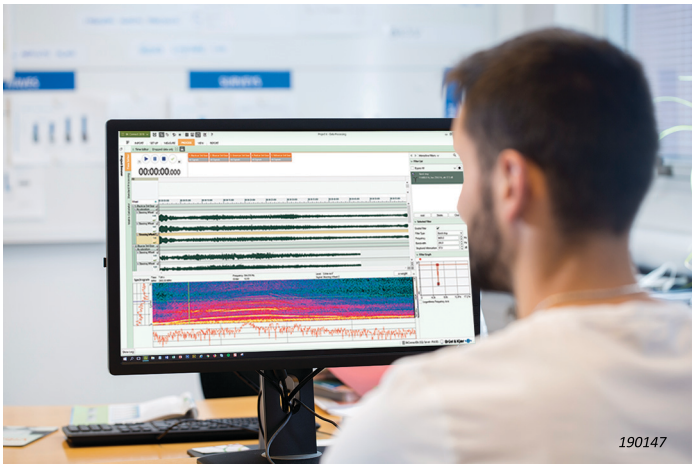
BRÜEL & KJÆR® Data Analysis Software

BK Connect Data Processing

BK Connect® is a fully integrated solution for multi-channel data acquisition (using our industry-leading LAN-XI hardware), data processing, data management and reporting. The innovative user interface is easily customized so you can adapt it to the needs of different users within your organization enabling expert users and operator technicians to work together with maximum efficiency and high productivity.

The core applications of BK Connect are designed for general-purpose sound and vibration engineering. Together they provide a comprehensive set of tools for real-time measurements and data processing with the flexibility to deal with a wide range of engineering scenarios – from repetitive, standardized testing to complex troubleshooting investigations.



Uses and features

Uses

- General vibration and acoustic analysis
- Data acquisition, analysis and reporting (with a Type 8401 and 8402 licence)
- Off-line analysis (post-processing) of recorded time data
- Batch processing of multiple sets of time recordings
- Stationary and non-stationary FFT, CPB (1/n-octave), overall (broadband) analysis, order analysis and envelope analysis
- Simultaneous parallel analysis with different filter settings, FFT bandwidths, and 1/n-octave setups
- Simple and efficient reporting of results with user-definable layouts and user-selectable metadata
- Rotating machinery analysis
- Sound quality metrics analysis
- Human vibration analysis

Features

- Modular application:
  - With a Data Processing Type 8403 licence: Powerful batch post-processing, data management and reporting capabilities
  - With BK Connect Hardware Setup and Time Data Recorder licences: A single integrated application with data acquisition, measurement, recording, data processing, data management and reporting
  - Specialized data analysis with one or more Data Processing Type 8405 options
- Immediate display and storage of analysis results
- Automated processing and run averaging based on user-defined metadata
- Standard FFT-based measurements with trigger setting for background recording
- Visualization, editing and audio playback of time data after recording and in preparation for analysis
- Graphical setup of data analysis flow through interactive process chains
- Display of frequency, rpm and order content of time signals during audio playback
- User interface and data organization optimized to fit your workflows, allowing multiple tests, setups and applications inside a single project
- Tools that provide a flexible yet structured overview of results from a number of tests, making selection comparison and reporting very easy
- Embedded reporting using Microsoft® Office products to integrate report writing into the test process
- Easy to learn and use, reducing training and test time

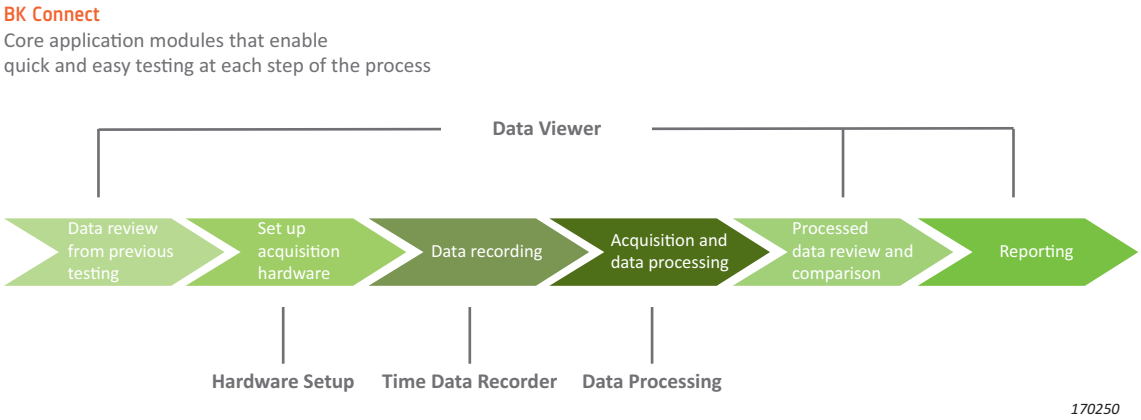
The BK Connect core suite

The core applications of BK Connect are:

- **BK Connect Data Viewer** for data management, viewing and reporting
- **BK Connect Hardware Setup** for setting up transducers and front-end hardware
- **BK Connect Time Data Recorder** for dedicated time data recording and review
- **BK Connect Data Processing** for real-time measurements and time or function data processing

Each of these applications is designed as a self-contained solution for a typical task or set of tasks within test and analysis. Select the module or modules that will help you perform the task, or combine applications to increase functionality and create super-efficient workflows for quick and easy completion of multiple steps in a sound and vibration test process.

Fig. 1
BK Connect core applications

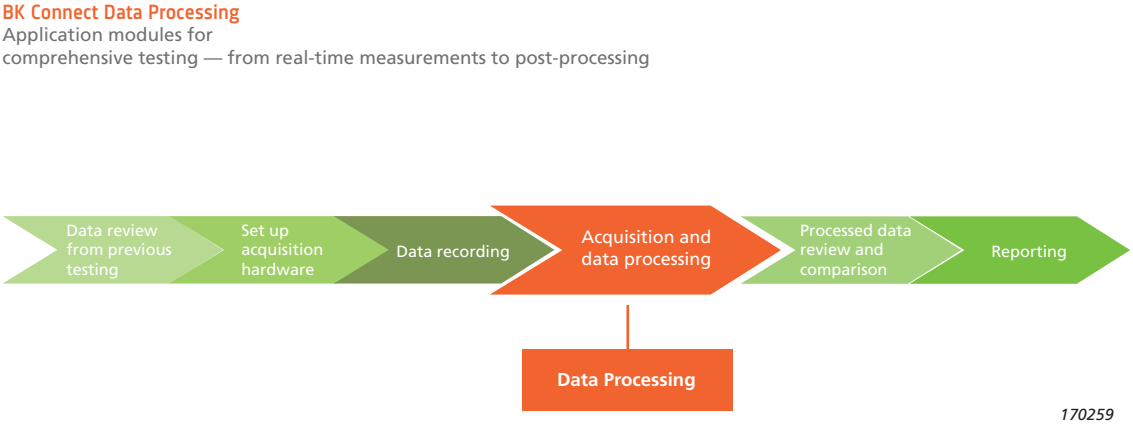


Licencing that fits your needs

BK Connect Data Viewer Type 8400, a free licence, is the prerequisite for all applications except BK Connect Hardware Setup.

The four core applications can all be used stand-alone or incorporated into the main application, BK Connect Data Processing. On its own, Data Processing is purely for time or frequency data post-processing, however when the Hardware Setup licence is present, you can also measure in real time. When the Time Data Recorder licence is present, you can simultaneously record and post-process test data to quickly produce your final results and/or reports.

BK Connect Data Processing as stand-alone solutions



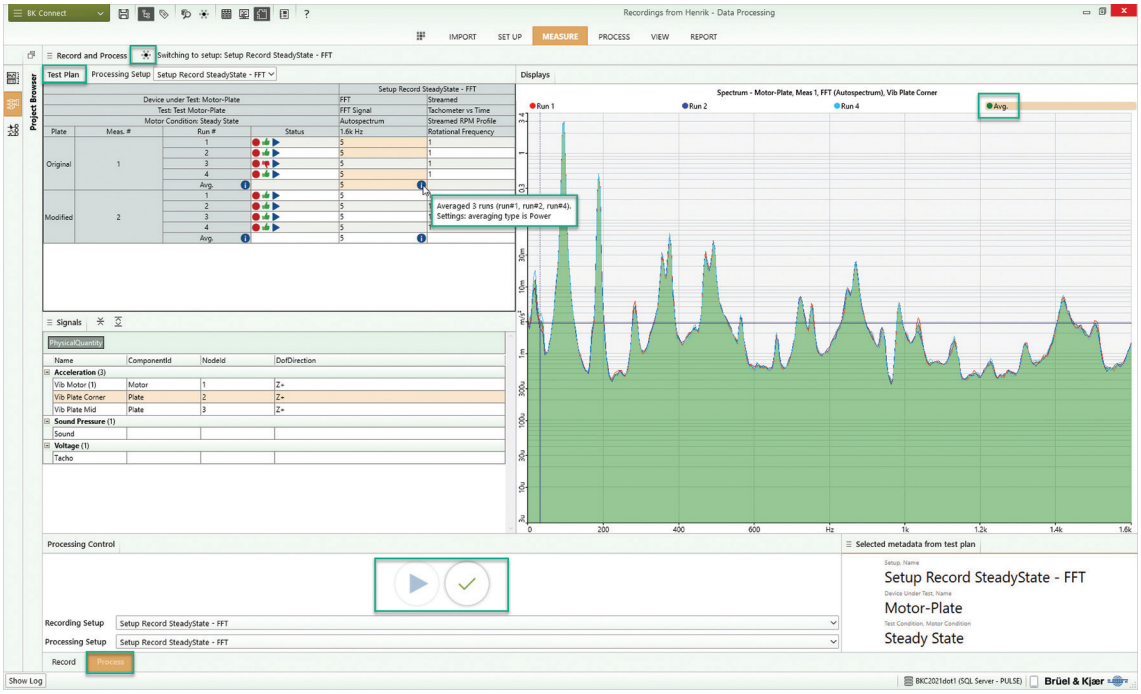
BK Connect Data Processing brings together a comprehensive set of signal analysis tools for post-processing sound and vibration data. Central to data processing is the process chain – a graphical tool for setting up the analysis process using individual, separately configurable elements for filtering, analysis, display and storage of results. A chain is made up of selected elements to form a complete analysis process. You can run analysis on one or multiple data sets or save the chain for later re-use.

Base and advanced licences

- **Data Processing Type 8403** provides a simplified, template-driven mode of operation. It is a basic application intended for those who need standard time data processing and/or measurement with a simple click-and-go interface
- **Data Processing (advanced) Type 8403-A** provides a fully customizable, expert mode of operation. It is intended for advanced users who need the flexibility of determining all the functions and parameters of their test setup

Types 8403 and 8403-A contain the same basic set of signal processing functions, including time domain filters, FFT analysis and overall analysis, which means the analysis functionality is identical. You can also add the same analysis options (Types 8405-B, C, E, F and G) to the base licences.

Fig. 2
The basic components in the Record and Process task

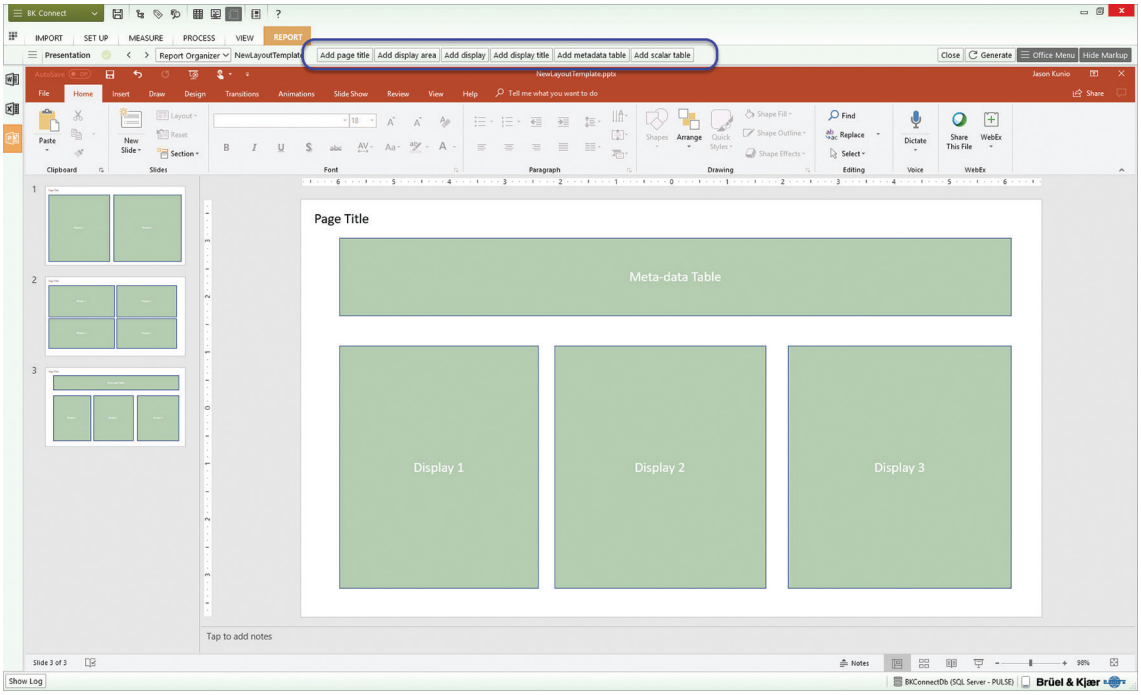


BK Connect Data Processing Type 8403

Type 8403 contains the following features:

- **Processing Parameter Editor** sub-task (in the Standard Processing Setup task) to view the predefined process chains and adjust available parameters
- **Record and Process** task is based on a test plan created from a matrix of device(s) under test and test conditions to automate run averaging based on common metadata
- **Standard Processing** task to perform automated, batch processing of data: Any data in the active setup is run through one or more predefined process chains in different setups, including accept/reject criteria
  - **Time data analysis:** FFT, FFT vs time, overall, overall vs time, and tachometer (rpm or speed) vs time
  - **Pre-processing elements:** Weighting, filtering, integration, etc.
  - **Calculation elements:** Function statistics, function operators, scaling with unit conversion, frequency weighting, complex math, statistics and function smoothing – can all be included in time data processing and function data processing
- **Standard Measurements** task to perform real-time spectral measurements (with the appropriate Hardware Setup licence for front-end connection). Set up triggering, bandwidth, resolution, number of averages, selection of reference signals, and output function types. You can validate the setup using the real-time monitors. Results are automatically sent to the Standard Processing task
- **Data Table Viewer** task which provides a highly flexible tabular presentation of large amounts of data with powerful filtering and sorting tools and automated reporting
- **Result Matrix Viewer** task that gives a structured overview of results from a number of tests, making selection, comparison and reporting very easy
- **Immediate display and storage** of analysis results
- **Automated reporting**

Fig. 3
The Microsoft® PowerPoint® layout templates available in the Reporting task



With Type 8403 you can run a predefined template, then import data, adjust the analysis parameters as necessary and process with a single click – perfect for repetitive testing.

BK Connect Data Processing (advanced) Type 8403-A

Type 8403-A has the following features:

- **Standard Processing Setup** task which provides the same pre-processing and analysis elements that are available in Type 8403, but allows you to create process chains in the Process Chain Configuration sub-task. You can also save process chains for reuse. Validate the process chain in the Processing Parameter Editor sub-task
- **Calculation Setup** task to create function calculation chains that will be executed in the Matrix Calculator (requires Data Viewer (advanced) Type 8400-A licence)
- **Time Editor** task for fast, efficient display and audio playback of time data, intelligent selection of signal groups and time ranges (regions), spectrogram display and interactive filters
- **Automatic display and storage** of analysis results
- **Automated reporting**

Process chains are highly versatile as they allow for multiple parallel analyses in one run, for example, analysing vibration data at a different bandwidth than your 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.

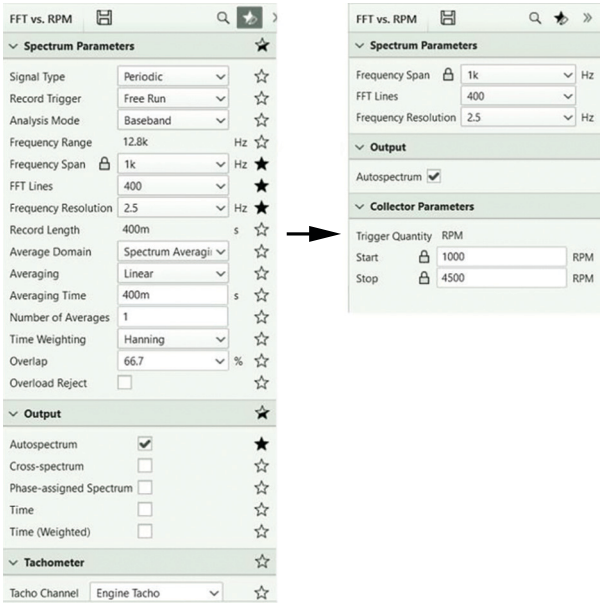
Unlike Type 8403, Type 8403-A gives you the freedom to adapt the analysis to the test scenario by interactively selecting the process elements in your process chain. You can preview the time data in the Time Editor and select regions of interest to post-process.

Fig. 4
The Time Editor task

Using BK Connect's 'favourites' concept, you can decide which features are visible in a saved template. This includes the properties of each process chain element. For example, you can predefine a set of properties then hide them so that the template user need only define specific parameters, while others are set beforehand. You can define the workflow, setting where the template navigates to once a task is completed, and include notes to guide and inform the user about each task.

Like Type 8403, you can view results and generate reports quickly and easily.

Fig. 5
Type 8403-A using 'favourites' to hide parameters in a template for use in Type 8403



The Data Processing application is specially designed as a completely integrated solution for teams providing targeted usability for each standard profile in an acoustic and/or vibration test team: for example, the test manager, specialist, test engineer and operator.

For test engineers and operators: BK Connect Data Processing Type 8403

Types 8403 and 8403-A have similar tools for measurement, data processing, display and reporting, however, Type 8403 is designed for use with templates containing ready-made setups and workflow. This is perfect if your only task is to run a simple process: a predefined measurement or recording, data processing with fixed analysis settings, or repetitive recording and analysis.

Type 8403 users cannot create templates or process chains, therefore they must run with a configured template containing at least one setup for hardware and analysis.

The template and predefined setup is made using Type 8403-A and, depending on the intentions of the template designer, you may be allowed the flexibility to adjust many processing parameters, or restricted to a few or no editable parameters. In the most extreme operator scenario, the channel settings and analysis parameters may be completely locked and invisible leaving you to concentrate solely on controlling the physical test setup, operating parameters and measurements.

For specialists: BK Connect Data Processing (advanced) Type 8403-A

To edit and configure a Type 8403 interface, you will need to use a Type 8403-A licence. With Type 8403-A, you can determine which tasks are included and which, if any, analysis parameters can be seen and edited.

A template can contain a number of different tests and setups, each with its own step-by-step workflow, so it can encompass an entire test programme if needed. You can customize the workflow, for example, by:

- Defining the task in which to start
- Defining which task comes next when the current task has been completed using Done Management ✔
- Defining which features are visible to the operator based on the 'favourites' concept ★
- Defining which of the setup parameters can be edited
- Including notes, diagrams and photographs to guide the operator through each step of the workflow
- Defining the displays to be viewed for result validation and the displays to be populated to the report using the Results Selector. These two distinct tasks may contain different displays

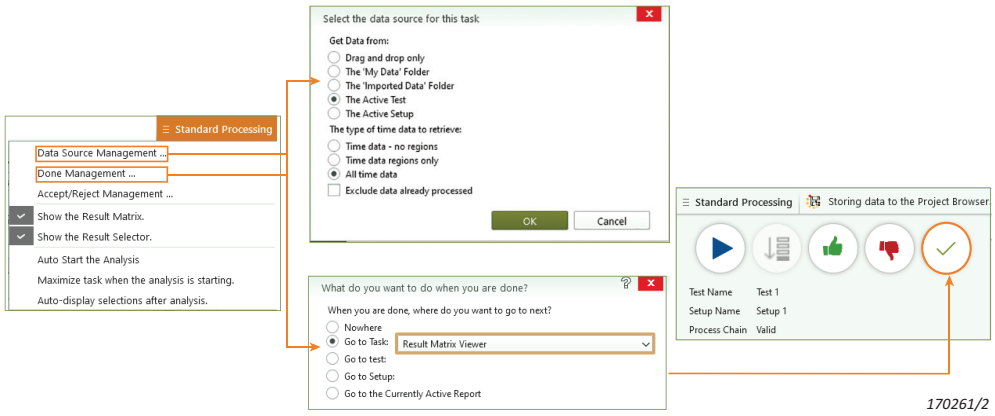


Fig. 6
Data Source Management and Done Management tools allow you to automate your workflow. If Done Management has been defined in a task, you can simply click the check mark to go directly to the next step in the workflow

In a multi-user test scenario, typically only one Type 8403-A licence (installed on the specialist or test designer's PC) is needed for a group of Type 8403 users (the operators or technicians).

To Types 8403 and 8403-A you can add the following options:

- **Type 8405-B:** Advanced frequency analysis including envelope and demodulation analysis, time correlation analysis and IIR filtering
- **Type 8405-C:** CPB (1/n-octave) analysis according to IEC, DIN and ANSI standards
- **Type 8405-E:** RPM-based processing and order analysis using fixed bandwidth FFT
- **Type 8405-F:** Tracked order analysis
- **Type 8405-G:** Calculation of sound quality metrics

Advanced frequency analysis with Type 8405-B

Type 8405-B adds Envelope, Demodulation and Time Correlation Analysis to the list of available process chain elements.

Envelope analysis is a means for understanding the amplitude modulation of machine vibration, most often used to diagnose fault modes in bearings and gear trains. Time correlation analysis enables you to find repeated patterns between signals in the time domain, for example when a sound takes more than one path to reach the receiver.

The Demodulator element is for amplitude or phase demodulation of signals based on a given reference (modulation) frequency. Amplitude demodulation is part of the process for envelope analysis and separating it from the FFT analysis enables greater flexibility of analysis when deciding how to process the output demodulated signal. Phase demodulation enables you to study frequency perturbations of a given reference frequency; for example, the fundamental frequency of a rotating shaft where the perturbations represent angular (or torsional) vibration superimposed on the carrier rotating frequency.

Also included is a pre-analysis element for time domain-based Infinite Impulse Response (IIR) filtering, including low-pass, high-pass and combined low- and high-pass filters with control of filter order and filter design options of Butterworth, Bessel or Chebyshev.

Standardized CPB option with Type 8405-C

Conforming to IEC, DIN and ANSI standards, Type 8405-C 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.

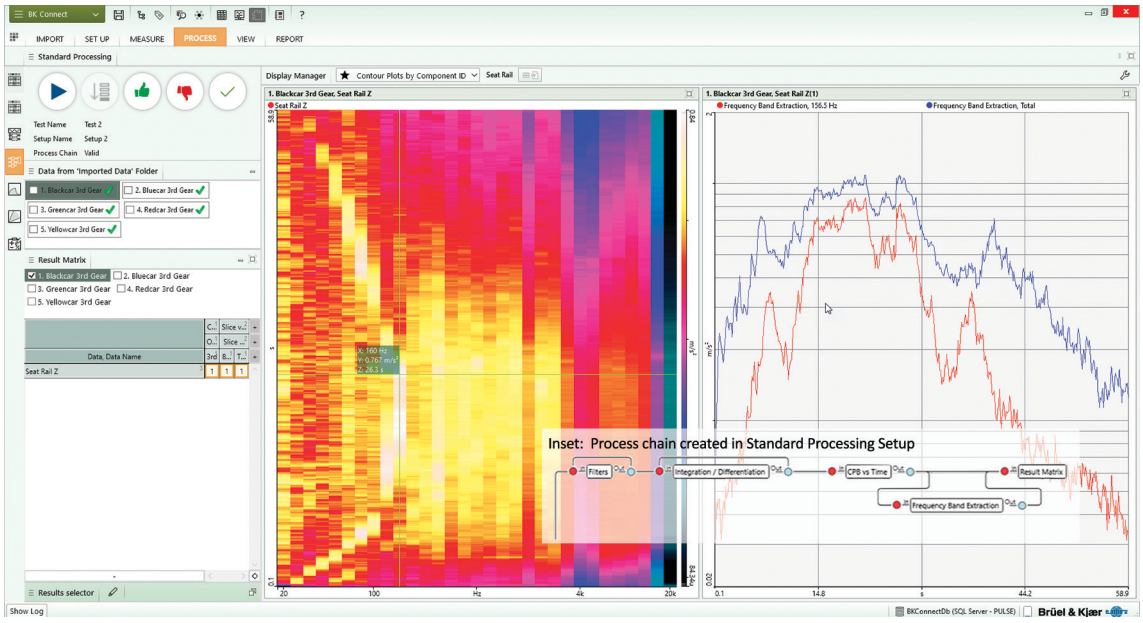


Fig. 7
*CPB (here 1/3-octave) analysis follows the same simple workflow as FFT, order and overall analysis. The displays in the Standard Processing task show A-weighted 1/3-octave vs time (**left**) and the 125 Hz band level vs time overlaid on total level. The cursors are synchronized between the displays*

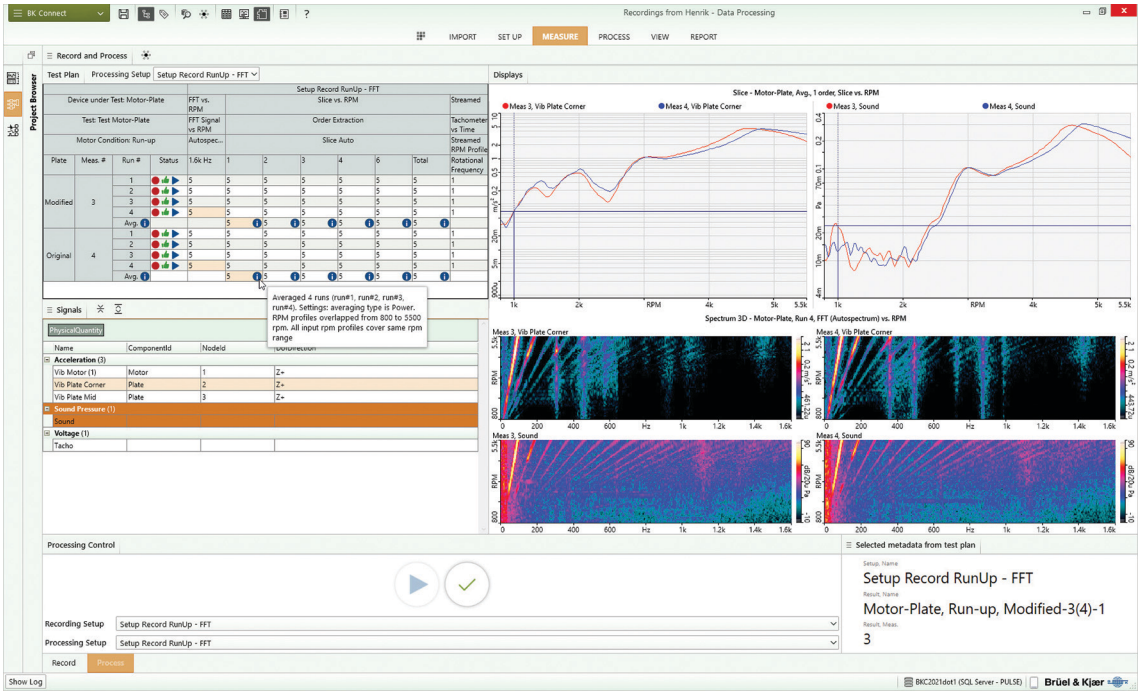
The CPB option adds two process chain elements:

- CPB
- CPB vs time

Order analysis with Type 8405-E

Type 8405-E adds fixed bandwidth FFT-based order analysis to Type 8403/8403-A. When a tachometer pulse train is available, 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).

Fig. 8
In this run-up example, the focus is on the first order for an acoustic and vibration signal using the FFT v RPM processing in the Record and Process task



With Type 8405-E, 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 (also requires Standardized CPB Analysis Type 8405-C licence)
- Overall vs rpm

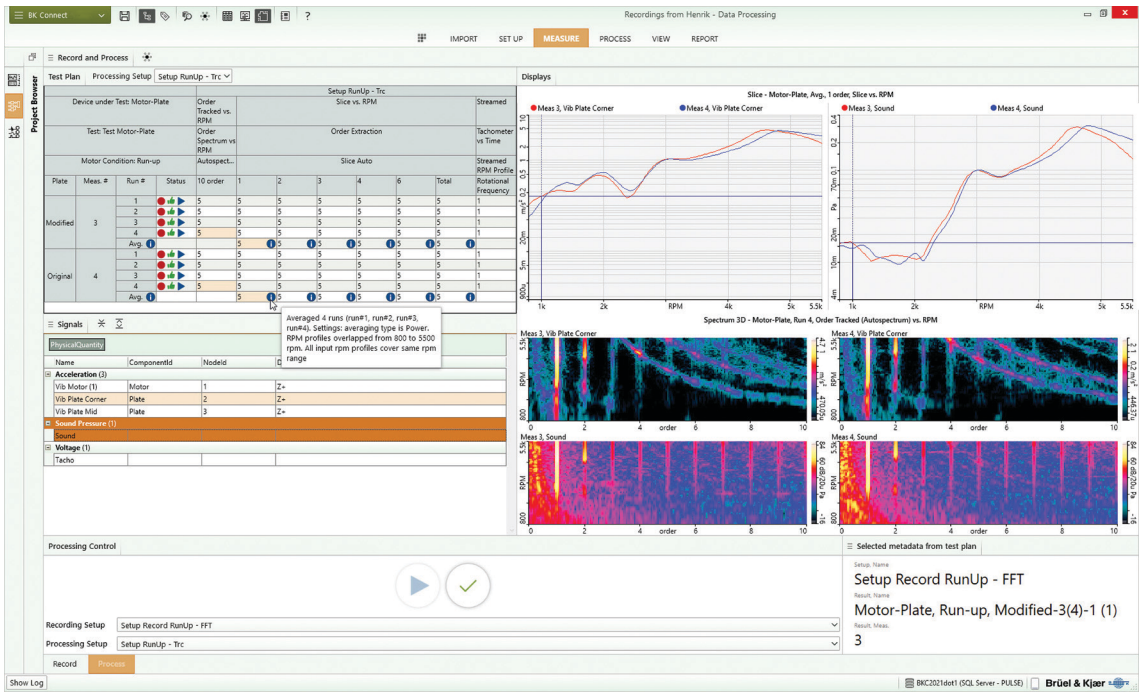
Additional Time Editor features include:

- 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 correction for pulse drop-out or multiple pulses

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.

Order tracking with Type 8405-F

Fig. 9
In this example, we focus on the first order for an acoustic and vibration signal using the digital resampling Order v RPM processing in the Record and Process task



Type 8405-F adds tracked resampling to basic Type 8403/8403-A: Streamed data is resampled according to the instantaneous rpm value from a given tachometer signal.

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.

With Type 8405-F, these additional elements are available in the process chain:

- Order spectrum
- Order spectrum vs time
- Order spectrum vs rpm
- Order extraction (order slices extracted from order spectra)

Additional Time Editor features include (same as Type 8405-E):

- 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 correction for pulse drop-out or multiple pulses

Sound quality (SQ) metrics with Type 8405-G

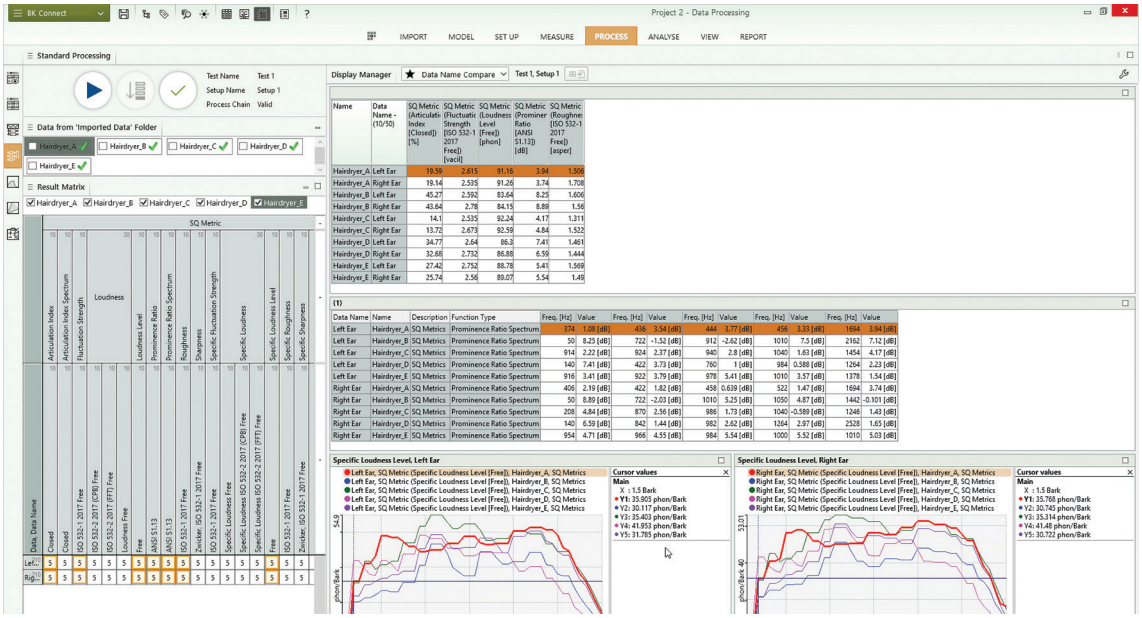


Fig. 10
Sound quality metrics are integrated into the same processing framework as all other analysis types in BK Connect Data Processing

Type 8405-G adds sound quality metric calculations. 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

The latest ISO 532 2017 loudness standard, parts 1 and 2, is supported in addition to past standards. Through TEDS detection, Brüel & Kjær binaural microphone pairs can easily be configured to include the appropriate head-related transfer function, allowing the SQ Metrics to be more easily calculated.

Integrated single application for data acquisition, recording and processing

On its own, the Data Processing application is only for post-processing time or function data. With the addition of Hardware Setup and Time Recorder licences, the application expands to include real-time spectral measurements and recording.

The Data Processing application's unique capability to integrate with the other core applications as well as BK Connect Geometry Type 8410 (for geometry-guided measurements) and BK Connect Structural Measurements – Hammer and Shaker Type 8411, makes it a complete yet flexible solution. You can configure the user interface, properties and tasks to suit your needs or mode of working, then save the workflow as a template. The addition of Types 8410 and 8410-B, with the proper analysis results, will allow you to animate the spectral calculations and measured time producing operational deflection shape (ODS) results.

Specifications – BK Connect Data Processing modules

This Windows®-based analysis software is delivered via download options or USB installation media. The licence is either: node-locked to a PC host ID or dongle; or floating, locked to a network server

System

PC SYSTEM REQUIREMENTS

- Windows® 10 Pro or Enterprise (x64) with either Current Branch (CB), Current Branch for Business (CBB), Semi-annual Channel (Targeted) or Semi-annual Channel servicing model
- Windows® 11 Pro or Enterprise (x64) with either Current Branch (CB), Current Branch for Business (CBB), Semi-annual Channel (Targeted) or Semi-annual Channel servicing model
- Microsoft® Office 2019 (x32 or x64) or Office 2021 (x32 or x64)
- Microsoft® SQL Server® 2019 (SQL Server 2019 Express included with software)
- When using with Type 8402: Windows®-compatible sound card in order to play back signals

RECOMMENDED PC SYSTEM

- Intel® Core™ i9, 3 GHz processor or better
- 32 GB RAM
- 1 TB Solid State Drive (SSD) with 100 GB free space, or better
- 1 Gbit Ethernet network*
- Microsoft® Windows® 10 Pro or Enterprise (x64) with CB
- Microsoft® Office 2021 (x32)
- Microsoft® SQL Server® 2019
- Screen resolution of 1920 × 1080 pixels (full HD)
- When using with Type 8402: PC optimized for CPU and hard disk intensive operations

FRONT-END SUPPORT

One or more LAN-XI data acquisition modules (stand-alone or in frame). Required for real-time measurements and recording

* A dedicated data acquisition network (LAN or WAN) is recommended. A network that only handles data from the front end improves the stability of the data

Specifications – BK Connect Data Processing Type 8403

Software prerequisites

- BK Connect Data Viewer Type 8400 or 8400-NT

Included licences

- For PULSE LabShop software owners with a valid M1 agreement: PULSE LabShop FFT & CPB Analysis Type 7700 licence (measurement and analysis with unlimited channel count)
- Tasks and functionality previously provided with Types 8404-F/N and 8404-A-F/N licences are now integrated in Types 8403 and 8403-A

Data Processing

Automated processing that requires a project template (created by a Type 8403-A specialist) with a predefined process chain using the Record and Process or Standard Processing task. A process chain consists of graphical elements connected together to form an analysis process

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. Meeting 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 and ISO 5349) • 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 • 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) • Peak Finder: Peak/valley extraction from FFT spectra • Playback: Playback of selected signals with gain, pan and mute controls • Frequency Band Extraction
CALCULATION ELEMENTS	Statistics, Function Statistics, Function Operators, Scaling, Frequency Weighting (frequency domain), Complex Math (toReal, toImaginary, toMagnitude, toPhase, toConjugate)
GENERAL ELEMENTS	• Fast 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: Results are presented using the same functionality as the Result Matrix Viewer, with the addition of the Result Selector to make predefined selections in the matrix, simplifying the process of displaying data

Measurement

Only available with BK Connect Hardware Setup Type 8401 licence

MEASUREMENT CONTROL	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
ANALYZERS	FFT and overall level

FFT analysis

Applies to measurements and all FFT process chain 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	• Exponential • Uniform • Transient	• Hanning • Flat-top • Kaiser-Bessel
OVERLAP	User selectable values of 0%, 50%, 66.67%, and 75%, user editable from 0% to 95%	
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 measurements and process chain elements: Overall, Overall vs Time, and Overall vs RPM (with Type 8405-E)

STANDARD	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 and IEC 651
AVERAGING	Exponential, Impulse, Linear (L_{eq}), Linear All, True Peak, True Peak All
TRIGGER METHOD	Free run, Fixed time interval 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

Data Table Viewer

DATA SOURCE	• Drag and drop from Project Browser
DATA OVERVIEW	• 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
DATA SELECTION	• Controls in header bar enables table selections to be automatically incremented for quick and easy scanning through the entire data set • Automatic data presentation in graphical displays. Auto-filled based on data selection in the table
DATA HANDLING	• Automatic report generation based on the data selection in the table

Result Matrix Viewer

RESULT SOURCE	• Drag and drop from Project Browser
RESULT OVERVIEW	• 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
RESULT SELECTION	• Automatic result data presentation – selecting a cell presents the results, either in a table view for scalars, or graphical display for function data
RESULT HANDLING	• 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

Software prerequisites

- BK Connect Data Processing Type 8403

Included licence

- For PULSE LabShop software owners with a valid M1 agreement:
  - PULSE LabShop FFT & CPB Analysis Type 7700 licence (measurement and analysis with unlimited channel count)
  - PULSE LabShop Time Capture Type 7705 licence
- Tasks and functionality previously provided with Types 8404-F/N and 8404-A-F/N licences are now integrated in Types 8403 and 8403-A

Added functionality to Type 8403

- Time Editor for time data editing before analysis with interactive filters and spectrogram
- Template creation for use with Type 8403 licences
- Process chain configuration
- Calculation chain setup

Calculation setup

Build and save calculation chains for later post-processing in the Matrix Calculator. The Matrix Calculator, for processing the created chain, is available with a BK Connect Data Viewer Type 8400-A licence

CALCULATION ELEMENTS	Statistics, Function Statistics, Function Operators, Scaling, Frequency Weighting (frequency domain), Complex Math (toReal, toImaginary, toMagnitude, toPhase, toConjugate)

Time Editor

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

DATA SELECTION	• Automated generation of regions from multiple files having similar channel configurations – in preparation for batch processing • Manual grouping of regions – for batch processing • Region selection by group of channels and time range • Append regions to other regions (concatenation) • Save regions to project
DISPLAY	• Fast navigation by scrolling through channels, panning and zooming in time axis • Fast spectrogram display – synchronized with time data display & playback • Interactive order slice and frequency spectrum display synchronized with spectrogram cross-hair cursor
PRE-ANALYSIS	• Automatic calculation of rpm profile from a tachometer pulse train

Data Processing

Added processing functionality to Type 8403:

ANALYZERS	FFT and overall level
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 calculation chains in the Matrix Calculator • **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
GENERAL ELEMENTS	• Individual Display: Display strategy setup for creation of multiple display pages in the Display Manager • Fast 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 Data Viewer's Result Matrix Viewer • 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 from a collection batch process

Software prerequisites

- BK Connect Data Processing Type 8403

Advanced Frequency Analysis Option Type 8405-B

INCLUDED LICENCES

For PULSE LabShop software owners with a valid M1 agreement:

- PULSE LabShop Envelope Analysis Type 7773
- PULSE LabShop Multiple-input Multiple-output Analysis Type 7764 (MIMO) licences

ADDED FUNCTIONALITY TO TYPE 8403/8403-A:

Analysis Elements	• Demodulator – Amplitude or phase demodulation as a pre-analysis element • Envelope – Combination of a demodulator and a classic FFT with user-definable analysis bandwidth and a tuning frequency • Time correlation • Infinite Impulse Response (IIR) Filter – Butterworth and Chebyshev with a user definable filter order • Smoothing – Time domain moving average filter

CPB Option Type 8405-C

INCLUDED LICENCES

For PULSE LabShop software owners with a valid M1 agreement:

- PULSE LabShop CPB Analysis Type 7771 licence (with unlimited channel count)

ADDED FUNCTIONALITY TO TYPE 8403/8403-A

DATA PROCESSING	
Analysis Elements	• CPB Standardized • CPB vs Time • CPB vs RPM (also requires Type 8405-E) 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 Type 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

Order Analysis Option Type 8405-E

INCLUDED LICENCES

For PULSE LabShop software owners with a valid M1 agreement:

- PULSE LabShop Order Analysis Type 7702 licence (with unlimited channel count)
- PULSE LabShop Sound Quality Order Analysis BZ-5277 licence

ADDED FUNCTIONALITY TO TYPE 8403/8403-A

Time Editor	• Synthesis of tachometer pulse train from a given rpm profile • Tacho repair: Profile smoothing and drop-out/ spurious pulse correction
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 (also requires Type 8405-C) • Overall vs RPM
Output	• FFT Signal vs RPM: Auto-spectrum, Phase-assigned Spectrum, Time, Weighted Time • FFT System vs RPM: Auto-spectrum, 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
Graphical Order Extractor	An additional analysis task for quickly visualizing 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

Order Tracking Option Type 8405-F

INCLUDED LICENCES

For PULSE LabShop software owners with a valid M1 agreement:

- PULSE LabShop Order Analysis Type 7702 licence (with unlimited channel count)
- PULSE LabShop Sound Quality Order Analysis BZ-5277 licence

ADDED FUNCTIONALITY TO TYPE 8403/8403-A

Time Editor	• Synthesis of tachometer pulse train from a given rpm profile • Tacho repair: Profile smoothing and drop-out/ spurious pulse correction
Analysis Elements	• Order Spectrum, Order Spectrum vs Time and Order Spectrum vs RPM • Order Extraction: Order slices, relative or absolute bandwidth, from Order vs RPM 3D spectra. Optional smoothing for cleaner order slices
Output	• Order spectrum • Auto-spectrum • Phase-assigned Spectrum • Time • Weighted Time
Graphical Order Extractor	An additional analysis task for quickly visualizing 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

Sound Quality Metrics Option Type 8405-G

INCLUDED LICENCES

For PULSE LabShop software owners with a valid M1 agreement:

- PULSE LabShop Sound Quality Type 7698 licence
- PULSE LabShop Sound Quality Zwicker Loudness BZ-5265 licence

ADDED FUNCTIONALITY TO TYPE 8403/8403-A:

Analysis Elements	• SQ Metrics and SQ Metrics vs Time
Sound Quality Metrics	• Stationary Loudness: ISO 532B, Moore-Glasberg (ISO 532-1 proposal) based on FFT or CPB • Time-varying Loudness: DIN 45631, Zwicker (1989) • DIN 45631/A1 (2010) • Statistical Loudness with user-defined percentile • Loudness Level: ISO 532B • Binaural Loudness: Robinson & Whittle (1960), Moore-Glasberg, Mean loudness between 2 ears • Sharpness: 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)

Type 8403-X	**BK Connect Data Processing**
Type 8403-A-X	**BK Connect Data Processing (advanced)**
Type 8405-B-X	**BK Connect Advanced Frequency Analysis Option**
Type 8405-C-X	**BK Connect CPB Option**
Type 8405-E-X	**BK Connect Order Analysis Option**
Type 8405-F-X	**BK Connect Order Tracking Option**
Type 8405-G-X	**BK Connect Sound Quality Metrics Option**

Team data sharing

Type 8400-T-FY	BK Connect Team Server, Single User, Annual Floating Lease Licence and Support

Software Maintenance and Support Agreements†

M1-8400-X	Agreement for Type 8400
M1-8400-A-X	Agreement for Type 8400-A
M1-8400-B-X	Agreement for Type 8400-B
M1-8400-C-X	Agreement for Type 8400-C
M1-8400-D-X	Agreement for Type 8400-D
M1-8400-E-X	Agreement for Type 8400-E
M1-8400-F-X	Agreement for Type 8400-F
M1-8401-X	Agreement for Type 8401
M1-8401-A-X	Agreement for Type 8401-A
M1-8401-V-X	Agreement for Type 8401-V
M1-8402-X	Agreement for Type 8402
M1-8403-X	Agreement for Type 8403
M1-8403-A-X	Agreement for Type 8403-A
M1-8405-B-X	Agreement for Type 8405-B
M1-8405-C-X	Agreement for Type 8405-C
M1-8405-E-X	Agreement for Type 8405-E
M1-8405-F-X	Agreement for Type 8405-F
M1-8405-G-X	Agreement for Type 8405-G
M1-8402-NS	Agreement for Type 8402-NS Pack
M1-8402-A-NS	Agreement for Type 8402-A-NS Pack
M1-8403-NS	Agreement for Type 8403-NS Pack
M1-8404-A-NS	Agreement for Type 8404-A-NS Pack
M1-8402-NS	Agreement for Type 8402-NS Pack

Other BK Connect software modules and packs

BASIC APPLICATION AND IMPORT OPTION MODULES

Type 8400-NT	BK Connect Data Viewer (free viewer)
Type 8400-X	BK Connect Data Viewer
Type 8400-A-X	BK Connect Data Viewer (advanced)
Type 8400-B-X	BK Connect Native File Importers
Type 8400-C-X	BK Connect External File Importers
Type 8400-D-X	BK Connect Nastran Interface
Type 8400-E-X	BK Connect Ansys Interface
Type 8400-F-X	BK Connect Abaqus Interface

DATA ACQUISITION APPLICATION MODULES

Type 8401-X	BK Connect Hardware Setup
Type 8401-A-X	BK Connect Hardware Setup (advanced)
Type 8401-V-X	BK Connect Virtual Hardware Setup

DATA RECORDING APPLICATION MODULES

Type 8402-X	BK Connect Time Data Recorder

DATA RECORDING PACKS

Type 8402-NS	BK Connect Time Data Recorder Pack – node-locked licence that includes Types 8400, 8401 and 8402
Type 8402-A-NS	BK Connect Time Data Recorder Pack (advanced) – node-locked licence that includes Types 8400, 8400-C, 8401, 8401-A and 8402

DATA PROCESSING PACKS

Type 8403-NS	BK Connect Data Processing Pack – node-locked licence that includes Types 8400, 8401 and 8403

DATA RECORDING AND PROCESSING PACKS

Type 8404-NS	BK Connect Data Processing and Time Data Recorder Pack – node-locked licence that includes Types 8400, 8401, 8402, 8403 and 8403-A
Type 8404-A-NS	BK Connect Data Processing and Time Data Recorder Pack (advanced) – node-locked licence that includes Types 8400, 8400-A, 8400-B, 8401, 8401-A, 8402, 8403 and 8403-A

* "X" indicates the licence model can be either N: Node-locked or F: Floating
† Agreement expiration date to be agreed at time of contract

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