

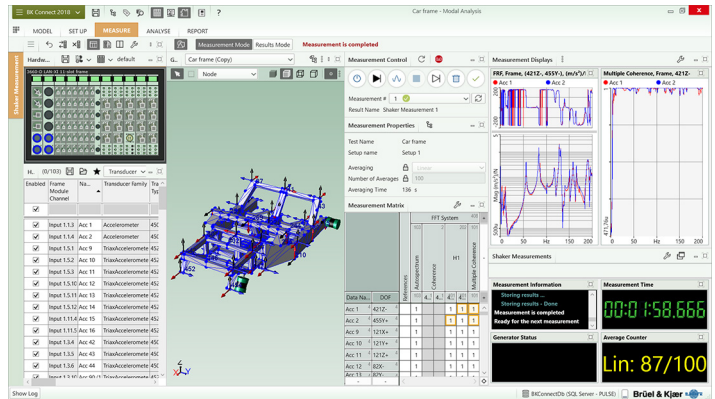
BRÜEL & KJÆR® Structural Dynamics Solutions

BK Connect Structural Dynamics Structural Measurements – Hammer and Shaker Type 8411, Advanced Sine Measurements Type 8412 and Geometry Type 8410

BK Connect® real-time measurements are designed to take advantage of the unique coverage of the complete measurement chain by Brüel & Kjær products: from transducers and front-end hardware to data acquisition, analysis and reporting. The emphasis is on scalability, from small (single-module) systems to large (multi-module) systems, and high productivity in the traditionally most time-consuming aspects of data measurement:

- Setting up transducers, channel tables, excitation and analysis parameters
- Post-processing, displaying and reporting results

All measurements are directly accessible by the BK Connect post-processing applications: Data Processing for general-purpose post-processing, Modal Analysis for modal parameter estimation and Correlation Analysis for test-FEA model correlation.



Uses and Features

Uses

- Modal data acquisition and validation
- Impact hammer FRF measurements
- Single- or multi-shaker FRF measurements
- Mechanical impedance or mobility measurements
- Linearity checks and analysis
- Time data recording during measurements
- Integrated solution from structural measurements to FEM correlation with BK Connect Modal Analysis Types 8420 and 8420-A and Correlation Analysis Type 8421

Features

- Live Monitor showing levels and spectra for all active channels once the system is activated
- Geometry-guided modal data acquisition using BK Connect Modal Analysis or Data Processing applications
- Interactive graphical representation of the front-end hardware using the Hardware Matrix, with coloured light rings to indicate channel status, for example, overloads, just as on the actual LAN-XI hardware
- Easy management and overview of large channel counts

- Automatic detection of TEDS-enabled transducers as well as auto-import of TEDS data
- Integrated transducer manager and database
- Quick assignment of non-TEDS transducers by simple drag and drop (singly or in groups) from database to specific channels
- Transducer verification/calibration with automatic detection of calibration signals and optional automatic application of gain adjustment
- Powerful test geometry creation tools
- Decimation of FE models to test geometries
- Intuitive hammer and shaker setup and measurement tasks
- Wide range of excitation signals including random (continuous, burst, periodic and pseudo), periodic chirp, fixed sine and stepped sine
- Voice feedback during hammer setup and measurement
- Tear-off of panels such as Hardware Browser, Monitor and Measurement Controls and view in other PC monitors
- Result Matrix tool (as in BK Connect post-processing) for easy display, comparison and reporting of results
- Support of SI and imperial units and acceleration in 'g'
- Support of accelerometers, displacement and velocity transducers for response measurements

Prerequisite Software

To measure in BK Connect, you must have a BK Connect Hardware Setup Type 8401 licence installed in order to connect to and set up your LAN-XI data acquisition hardware.

With the BK Connect Hardware Setup licence, you get the following tools and setup tasks:

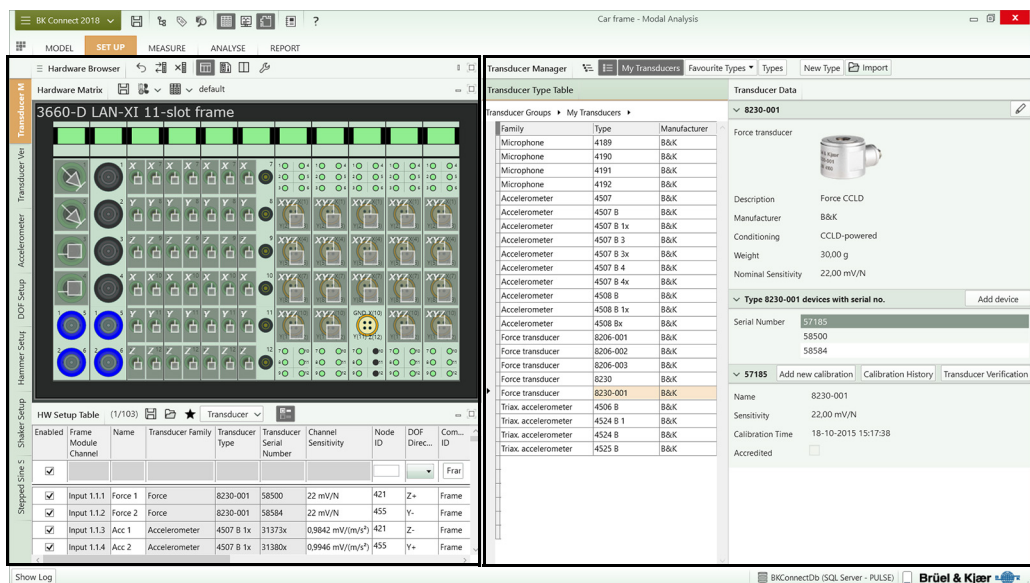
- Hardware Browser
- Monitor
- Transducer Manager
- Transducer Verification
- Accelerometer Mounting Check (with Type 8401-A)

Data Acquisition Setup

The Hardware Browser displays your data acquisition hardware (Fig. 1, blue frame), graphically using the Hardware Matrix and as a list using the Hardware (HW) Setup Table.

The Hardware Matrix is an interactive graphical representation of the physical hardware that functions both as a channel selector, for choosing channels of interest, and as a status indicator for the measurement system. It can provide useful information for troubleshooting error states such as overloads and cable breaks. The LED rings on the physical LAN-XI front end are reproduced in the Hardware Matrix to provide insight into the physical state of the system. Transient overloads are latched to enable the root cause to be investigated.

Fig. 1
Setup of data acquisition hardware using the Hardware Browser and Transducer Manager. TEDS transducers are recognized automatically, while non-TEDS are easily handled using drag and drop



The Transducer Manager (Fig. 1, red frame) comes with an established database of Brüel & Kjær transducer types. You can easily create new transducer types and new devices of specific types, and add them to the database, making it simple to register your equipment for later use. Triaxial accelerometers are explicitly recognized as a transducer type so that sensitivity data for the three axes is kept together in one device. Images of each transducer type make identification and selection much easier. A calibration history is stored with each transducer making it easy for you to check when the next calibration is due.

When TEDS transducers are present, they are automatically detected. The HW Setup Table automatically updates the hardware list with the TEDS information and the Hardware Matrix indicates, per channel, each transducer with a type-specific symbol. Non-TEDS transducers are not auto-detected, but can easily be assigned to individual channels by dragging and dropping them from the Transducer Manager to the Hardware Matrix. This can be done one-by-one or collectively for a group of channels. If desired, you can instrument a system of 1000 channels or more in one go using transducers of nominal sensitivity.

Simplifying Large System Setup

We know that setting up large systems can be cumbersome, so we have enabled both single or multiple channel selection in the Hardware Matrix for setup, management and editing. You can even select one or more front-end modules. Channels can be displayed in an abstract, non-physical view, sorted according to channel state, transducer type, or error state. This enables, for example, grouping of overloaded channels for easy troubleshooting.

You can store HW Setup tables and reload them later to restore a known setup. The default file format is XML, but import and copy/paste from Microsoft® Excel® is also supported as well as Universal Dataset number 1808 (Channel Table), enabling offline setup outside BK Connect if desired.

Smart Setup of Transducers via App

BK Connect interfaces to the Brüel & Kjær Transducer Smart Setup app, making transducer setup as simple, safe and automated as possible. Using the camera on your iOS 8.0 device (or later), you can scan any Brüel & Kjær transducer with a laser-engraved data matrix code for quick and easy reading of transducer data and orientation. If needed, the data matrix code can also give you instant access to specifications, documentation and calibration data. With the transducer information, you can start building a transducer setup project that can be seamlessly exported to the HW Setup table using a cloud service, an email account or iTunes® (via wired transfer).

Fig. 2
Using the Transducer Smart Setup app to scan the data matrix code on the transducer and the label next to the transducer ensures fast and correct DOF information for the measurement



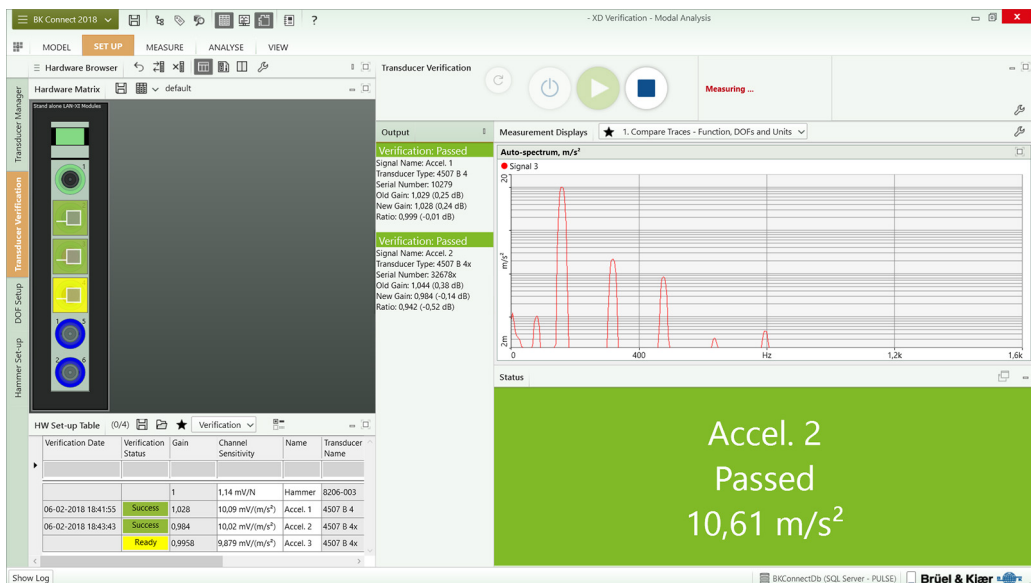
The app can also scan non-Brüel & Kjær 2D matrix codes. This allows you to attach your own customized labels with transducer position (Component ID) and node ID that the app will read and add to a setup project.

If you do not have a transducer with a Brüel & Kjær data matrix code, you can still use the app to build a transducer setup project and transfer it to BK Connect. You can either select the transducer from a list or type in the transducer data. You get the transducer orientation by aligning the drawing of the transducer in the app with the camera's view.

Verification of Transducers

The Transducer Verification task can be used, together with a hand-held calibrator, for checking the operation of transducers and, optionally, to apply gain adjustment factors for transducers that deviate from their last calibrated sensitivities. More than one calibrator can be used at a time. The software automatically detects the calibration signals and shows the result using a simple green-yellow-red colour coding to indicate pass, in progress, or fail. The colours are latched in the HW Setup Table and the Hardware Matrix to provide an overview of verification/calibration status.

Fig. 3
The Transducer Verification task



BK Connect Geometry Type 8410 provides you with a number of tools to view, create, edit and animate geometries for structural measurements including: geometry import, creation and editing, transducer and DOF assignment, DOF sequencing, geometry-guided measurements and measurement validation using a geometry.

With the BK Connect Geometry licence, you get the following tools and tasks:

- **Model:**
 - Geometry Editor where you can create a geometry from scratch
 - Geometry Decimation where you can import and decimate a large model, such as a finite element model (FEM) to simpler/coarser model with the same main physical features as the original model. Nastran, Ansys, Abaqus and UFF finite element models are supported*
- **DOF Setup:** Lets you create a measurement sequence for both hammer and shaker testing. Using a geometry as guidance is generally recommended, but not mandatory.
- **Measurement Validation**

Setting Up DOFs

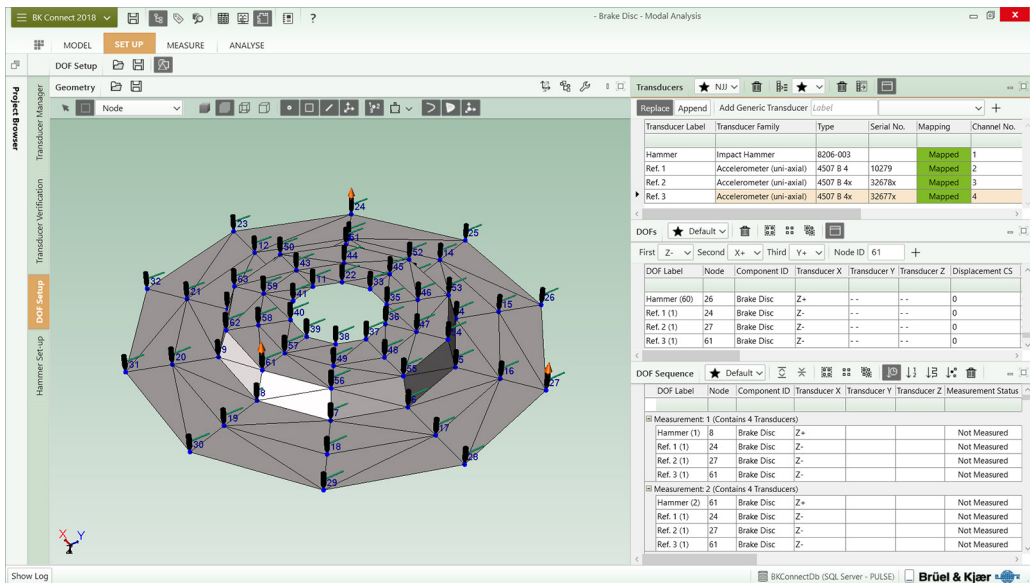
When a geometry is used, transducers in the DOF Setup task's Transducer Table can be dragged and clicked onto the geometry's nodes. If a geometry is not present, the DOFs can be defined manually.

You can work with the transducers shown in the HW Setup Table, transducers you have defined as favourites in the Transducer Manager or generic descriptions that are later mapped to the specific transducers used.

The DOF sequence can be generated based on:

- The chronological order the DOFs have been defined
- Increasing node number
- The path through the closest nodes (requires use of geometry)
- Manual selection of DOFs

Fig. 4
DOF Setup:
Creation of a
measurement sequence is
flexible and easily
performed in the DOF
Setup task

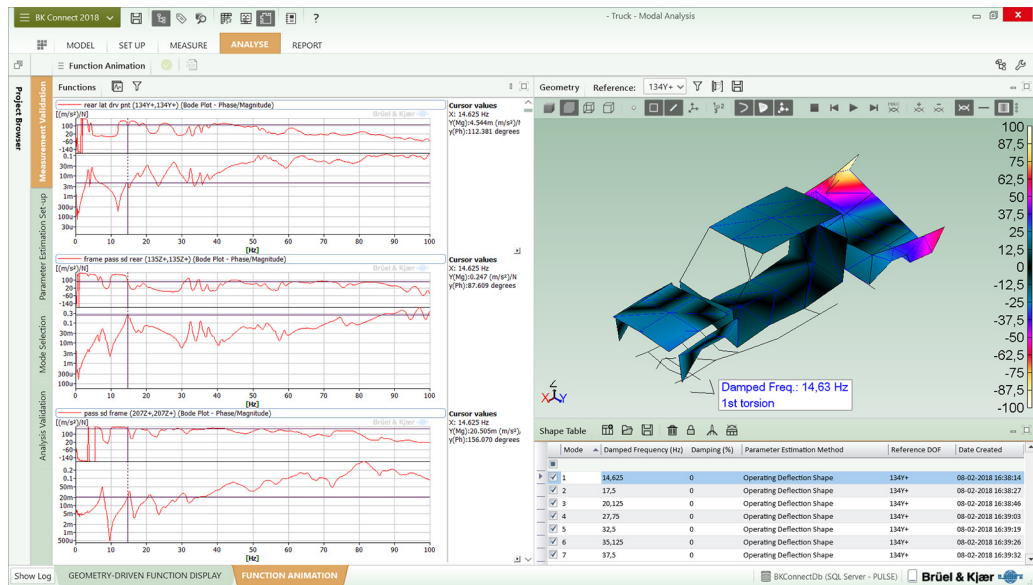


Validating with a Geometry

BK Connect measurement applications also provide you with the tools to quality-check your measurement results. With the Measurement Validation task (Fig. 5) you can animate the measured FRFs to validate the setup and troubleshoot errors in DOF assignment or transducer sensitivity. Often an error is immediately visible and you can quickly correct it before performing the analysis. You can also select on the geometry the DOFs that you want to use for the functions to be displayed. Data can be sorted and filtered to easily select individual functions.

* Nastran (MSC, NX and NEi), Ansys and Abaqus finite element models are supported with BK Connect FE Interface Types 8400-D, -E and -F, respectively.

Fig. 5
Measurement Validation:
 Animation of the
 amplitude and phase of
 measured FRFs at a
 cursor-selected frequency



BK Connect Structural Measurements – Hammer and Shaker Type 8411

Type 8411 adds the following tasks:

- Hammer Setup
- Hammer Measurement
- Shaker Setup
- Shaker Measurement

These tasks are dedicated for measurements of FRFs and related functions using either hammer or shaker excitation. The setup and measurements can be performed either in BK Connect Modal Analysis or in Data Processing applications.

Geometry-guided Measurements

Measurements can be performed based on:

- DOF entries in the HW Setup Table and Auto Increment features in the measurement tasks
- A DOF Sequence table created in the DOF Setup task

When a DOF sequence is defined in the DOF Setup task, geometry-guided measurements can be performed with indication on the geometry which DOFs should be included in the next measurement, which DOFs are currently being measured, which are already measured, and so on. Geometry-guided measurement is, in particular, beneficial when roving excitation and/or response DOFs are used, for example, due to the limited number of available transducers.

Structural Measurements Using an Impact Hammer

Single impact as well as random impact testing is supported. With single impact testing, the structure is hit once in a given DOF per FFT time record. With random impact testing, the structure is hit randomly in time multiple times for a given DOF per FFT time record. Random impact testing allows for injecting more energy into the structure per time record. This is useful for large structures (long time records) giving a better signal-to-noise ratio.

The Hammer Setup task helps you to set up hammer triggering and response weighting windows for optimal measurements, when doing single impact testing. For random impact testing, predefined values are used.

To perform the trigger setup, you record a series of typical hammer impacts and with them, interactively set the signal trigger parameters using special cursors (Fig. 6) for best possible conditioning of the trigger signal.

Response weighting windows help minimize noise and improve the accuracy of the measurement. Dedicated data displays enable you to fine-tune the windows for both the force and the response by typing in the parameters or using graphical grippers (Fig. 7).

Fig. 6
Hammer Setup:
 The trigger level and hysteresis are set up using a series of trial impacts (upper graph) and the effects of varying trigger settings, like pre-delay, are observed interactively (lower graphs). The Auto Adjust functionality automatically sets the trigger level and hysteresis

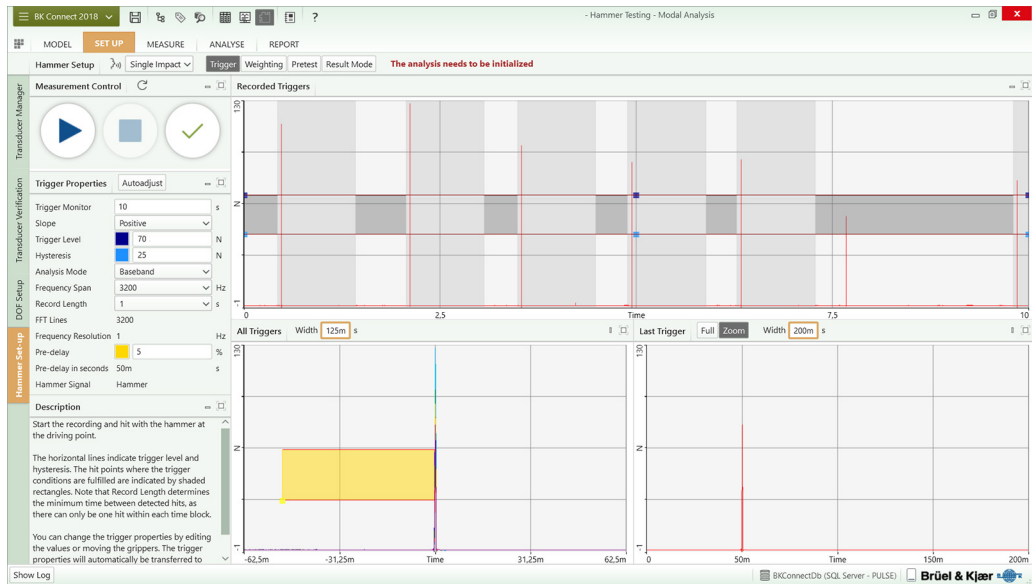
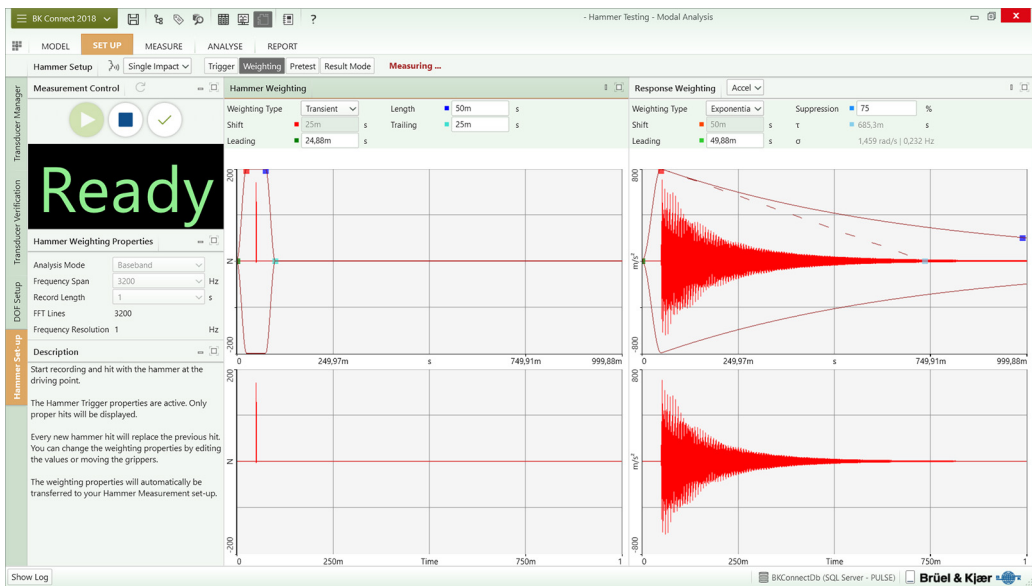


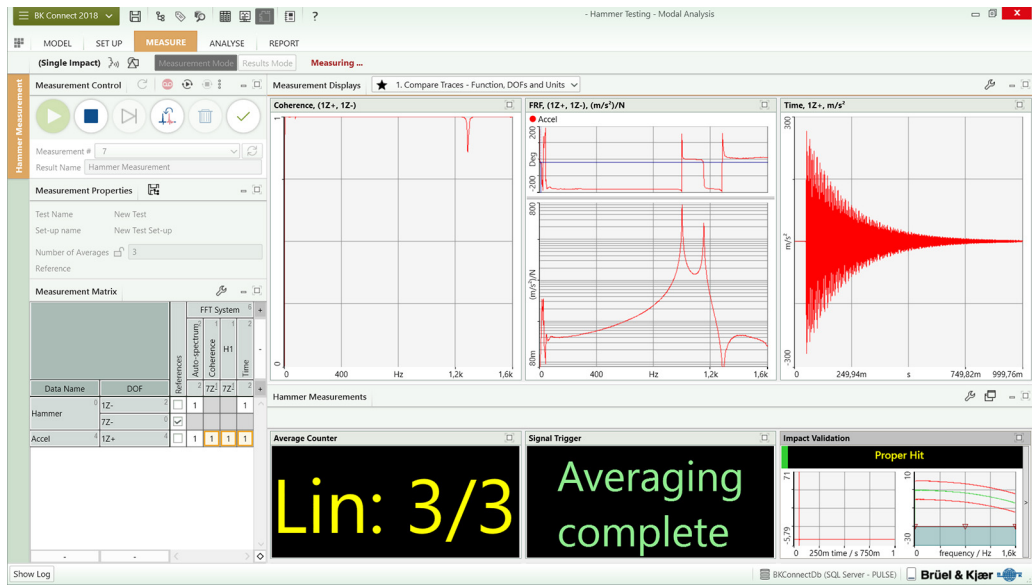
Fig. 7
Hammer Setup:
 Time weighting can be set up interactively. Raw input force and acceleration response (upper graphs) are compared with weighted data (lower graphs)



Once the trigger parameters and weighting windows are set up, there is a pretest mode for verifying that the overall measurement setup is correct. You can store these measurements if desired.

The Hammer Measurement task inherits the settings from the Hammer Setup task and lets you make repeated measurements. It includes a feature for undoing the last average, which can be very helpful when measurement conditions are difficult. Using the Impact Validation monitor, you can easily detect potential double hits, soft hits and unacceptable force level roll-offs, so any unwanted measurements can be avoided. Voice feedback during setup and measurement is also supported with audible alerts such as “ready”, “triggered”, “double-hit” and “overload”, that you keep you aware of measurement events even if you cannot see the screen.

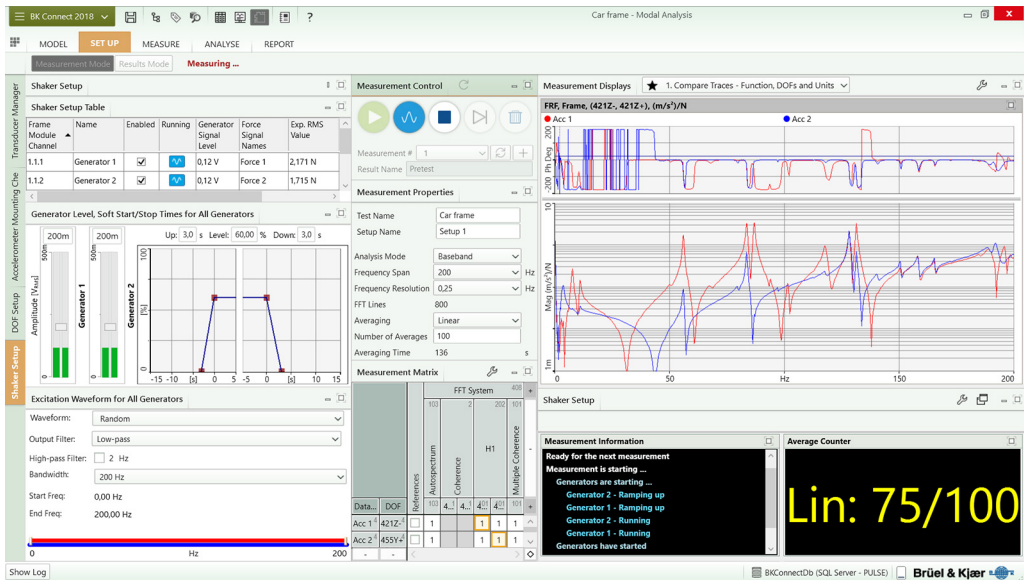
Fig. 8
Hammer Measurement
 task showing Coherence, FRF and the time signal of the response accelerometer



Structural Measurements Using One or More Shakers

The Shaker Setup task lets you prepare for shaker measurements by setting up one or more generators for fixed sine, continuous random, burst random, periodic random, pseudo-random or periodic chirp excitation. For random excitation, the signals are automatically uncorrelated with one another. Key parameters for the generator signals are set using interactive graphical tools for easy adjustment and visualization.

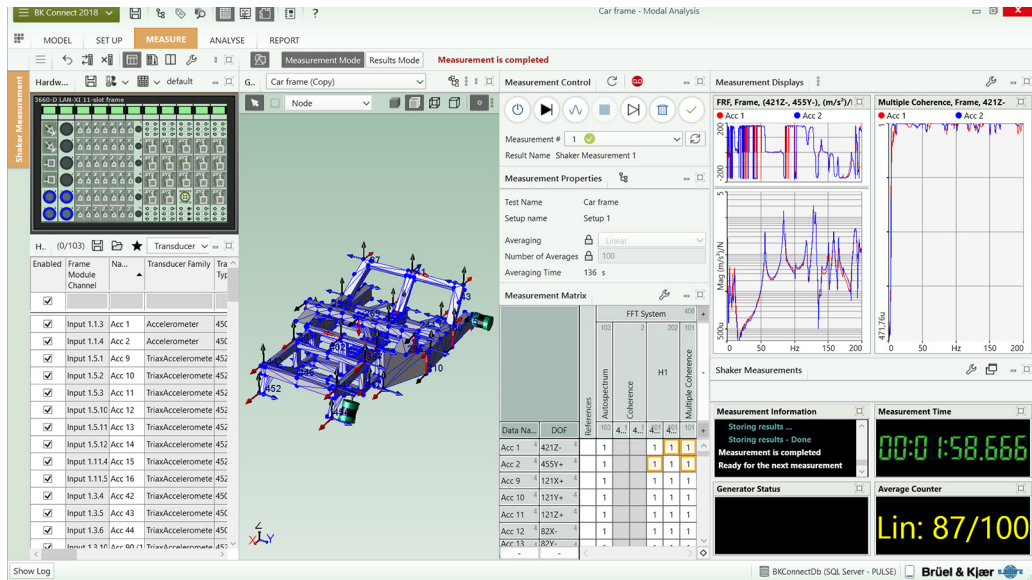
Fig. 9
 The Shaker Setup on the right provides interactive controls for the generator signals, in this case two-channel, uncorrelated, continuous random excitation



Once the generator and analysis parameters are set up, there is a pretest mode for verifying that the overall measurement setup is correct. You can store these measurements if desired.

The Shaker Measurement task inherits the settings from the Shaker Setup task and lets you make repeated measurements. The generators are automatically ramped up before averaging starts and automatically ramped down on completion of the last average. This minimizes exposure of the test item to unwanted excitation input.

Fig. 10
Shaker Measurement task
 for easy setup and
 monitoring of time and
 frequency functions



BK Connect Advanced Sine Measurements Type 8412

Type 8412 adds the following tasks:

- Stepped Sine Setup
- Stepped Sine Measurement

These tasks are dedicated for measurements of FRFs and related functions using stepped sine excitation. **Geometry-guided** measurements can be performed as seen with Hammer and Shaker Type 8411 measurements. The setup and measurements can be performed either in BK Connect Modal Analysis or in Data Processing applications.

Stepped Sine Measurements

Stepped sine measurement is a technique where sine excitation and corresponding measurements are made at predefined fixed frequencies (step frequencies). After the measurement at each step frequency, the frequency is swept to the next step frequency. The step type, the step frequency interval and the step direction(s) are user-defined.

Advantages of stepped sine testing includes:

- High signal-to-noise ratio
- Low crest factor of the excitation signal
- Possibility to control excitation and response amplitude
- Concentration of energy allowing smaller shakers to be used compared to broadband testing

Applications of stepped sine measurements include:

- Leakage-free FRF measurements as input to very accurate modal analysis
- Resonance surveys
- Forced response ODS analysis
- Control and study of non-linearities

Performing Stepped Sine Measurements

With Type 8412, stepped sine measurements can be performed with single-shaker excitation (single-input multiple-output (SIMO)) and multi-shaker excitation (multiple-input multiple-output (MIMO)). For multi-shaker excitation, the calculation of the MIMO FRFs requires more stepped sine sweeps, where the phases between the excitation forces are changed for each sweep.

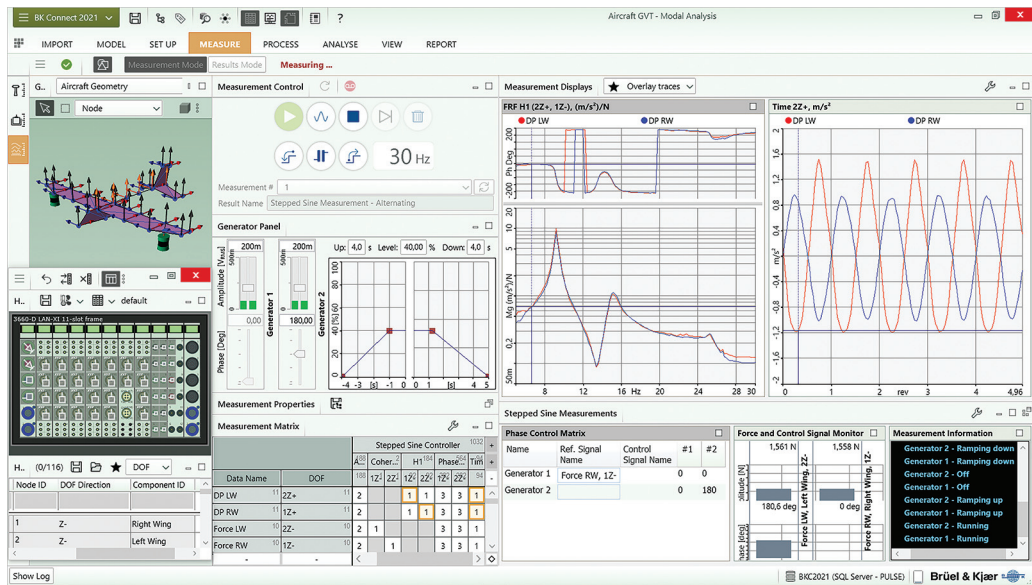
Type 8412 can be set up to perform a classical full MIMO sweep series with N shakers consisting of $2(N-1)$ independent sweeps, where the excitation phases are either in-phase or out-of-phase. In addition, a more time efficient optimal MIMO sweep series of only N sweeps can be performed using a more efficient phase distribution scheme.

Type 8412 supports software closed-loop control. Each generator, with corresponding shaker, can be set up to attempt control of the amplitude and/or the phase of a selected control signal. The control signal can be a force signal or a response signal. A target rms and/or phase with corresponding tolerance is specified. The phase to be controlled is the relative phase between the control signal and a selected reference force signal. This allows for measurements where an excitation force or a response signal is controlled and attempted to be kept constant at a target rms and/or phase at all frequencies during the stepped sine sweep (or sweeps in cases of multiple shakers).

In order to protect the test item and avoid high response levels during the measurements, alarm and abort levels for each signal can be specified in the HW Setup table. The levels are taken directly from your LAN-XI front-end hardware to avoid any software delays.

If alarm levels are exceeded, a warning is given in the Level Meter and, if an abort level is exceeded, the measurement will stop and the generators will shut down.

Fig. 11
The Stepped Sine Measurement task contains various tools for controlling the measurements and generators, monitoring status information and viewing data



Product Structure

Fig. 12
BK Connect structural dynamics product structure – from setup and measurements to analysis and test-FEA integration

Core Applications

BK Connect Data Viewer Type 8400
BK Connect Data Viewer provides the framework, including BK Connect database, Project Browser, reporting, Notes and help system. This module must be installed to run most BK Connect applications.

BK Connect Data Viewer (advanced) Type 8400-A
Adds a Data Table Viewer, Result Matrix Viewer and Scratchpad Calculator sub-tasks.

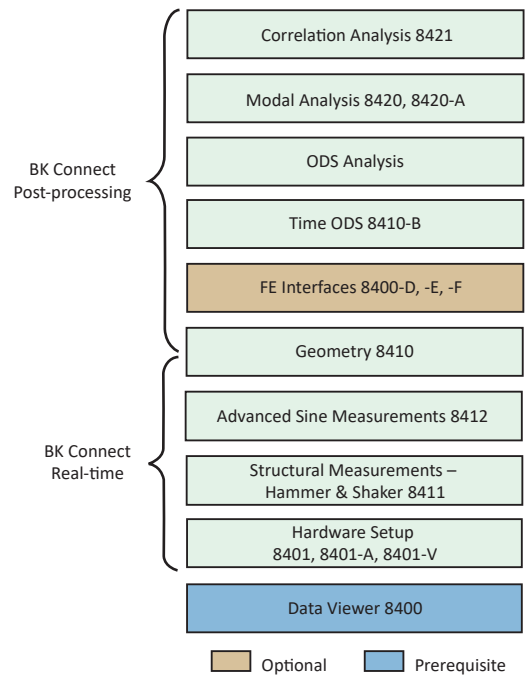
For more information on BK Connect Data Viewer Type 8400/8400-A see product data [BP 0005](#).

BK Connect Hardware Setup Type 8401
This is a prerequisite for measurements in BK Connect. It provides the Hardware Matrix, the HW Setup Table and Monitor including a built-in monitor recorder as well as the Transducer Manager and Transducer Verification tasks. Up to two LAN-XI data acquisition modules are supported.

BK Connect Hardware Setup (advanced) Type 8401-A
Adds support of more than two LAN-XI data acquisition modules and Accelerometer Mounting Check, Brüel & Kjær's patented method of validating the mounting of your accelerometers and thus the integrity of the measurement chain.

BK Connect Virtual Hardware Setup Type 8401-V
This free software makes it possible to set up your hardware without having it connected thereby freeing it up for other purposes.

For more information on Hardware Setup Type 8401/8401-A and Virtual Hardware Setup Type 8401-V, see product data [BP 2602](#).



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Measurement and Modelling Applications

BK Connect Structural Measurements – Hammer and Shaker Type 8411

Adds dedicated setup and measurements tasks for hammer and shaker testing, including measurements for MIMO analysis. Geometry-guided measurement setup, execution and validation is supported.

BK Connect Advanced Sine Measurements Type 8412

Type 8412 adds dedicated setup and measurement tasks for single and multi-shaker stepped sine testing. Geometry-guided measurement setup, execution and validation is supported.

Geometry Type 8410

Geometry allows the importation and creation of geometries and is used across the various BK Connect Structural Dynamics solutions. FE models can be imported using UFF, and decimated to test models.

A variety of animation types are supported including wire frame, surface contour, point and arrow animation as well as overlaid, difference, top-bottom and side-by-side animation in single, dual or quad view format. The animations can be recorded as AVIs and included in Word and PowerPoint® reports.

Post-processing in BK Connect

All measurements are directly accessible by the BK Connect post-processing applications.

The BK Connect post-processing platform brings together a range of generic post-processing tools for immediate and offline analysis and processing of measurement data. Data viewing, storage and reporting are built into the workflow with immediate traceability via an SQL database. Special tools and features allow for quick data overviews and automatic report creation 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.

BK Connect Data Processing Types 8403 and 8403-A

BK Connect Data Processing 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.

For more information on BK Connect Data Processing, see product data [BP 2604](#).

BK Connect Modal Analysis Type 8420

An application designed for single-reference modal analysis with a basic, yet comprehensive, set of mode indicator functions (MIFs), curve-fitters and analysis validation tools. For use with single shaker FRF data and single-reference hammer testing data.

BK Connect Modal Analysis (advanced) Type 8420-A

Adds polyreference modal analysis capabilities and advanced MIFs, curve-fitters and analysis validation tools to the Modal Analysis application. For use with shaker MIMO (multiple-input multiple-output) FRF data, polyreference hammer testing data or for advanced analysis and validation of both single and polyreference data.

Type 8411 and Type 8412 tasks can be executed inside BK Connect Modal Analysis. There is no switching between applications when going from setup, measurement and on to analysis – simply progress to the next task.

For more information on BK Connect Modal Analysis, see product data [BP 1523](#).

BK Connect ODS Analysis

With Type 8400 and Type 8410 licences installed, a BK Connect ODS Analysis application is available for frequency-based spectral ODS post-processing analysis or for viewing modal analysis results.

BK Connect Time ODS Option Type 8410-B adds a dedicated task for Time ODS analysis. Results can be converted between acceleration, velocity and displacement and shown as peak, peak-peak or rms using SI or imperial units.

For more information on BK Connect ODS Analysis including Time ODS Option Type 8410-B, see product data [BP 0018](#).

BK Connect Test-FEA Integration

FE Interfaces Types 8400-D, -E and -F enable you to import FE models from Nastran, Ansys and Abaqus. Correlation Analysis Type 8421 adds the ability to correlate two modal models: FEM vs Test, Test vs Test or FEM vs FEM.

For more information on BK Connect Correlation Analysis, see product data [BP 2577](#).

Specifications – BK Connect Structural Measurement Applications

SYSTEM REQUIREMENTS

- Microsoft® Windows® 10 Pro or Enterprise (x64) with either Current Branch (CB) or Current Branch for Business (CBB) servicing model
- Microsoft® Office 2016 (x32 or x64) or Office 2019 (x32 or x64)
- Microsoft® SQL Server® 2019

SOFTWARE REQUIREMENTS

- BK Connect 2021.1 or later
- The following BK Connect applications are required to perform structural measurements:
 - Data Viewer Type 8400
 - Hardware Setup Type 8401
 - Geometry Type 8410 (for geometry-guided measurements and measurement validation)

RECOMMENDED PC SYSTEM

For configurations with up to three generator output channels and 200 input channels:

- 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 2019 (x32)
- Microsoft® SQL Server® 2019
- Screen resolution of 1920 × 1080 pixels (full HD)

For bigger configurations, a more powerful PC may be required and measurement and analysis capabilities will depend on the parameter settings. Please contact your local HBK Global Care Centre for additional information.

For more information on setup specifications, please see product data [BP 0005](#) and [BP 2602](#).

* 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 Structural Measurements – Hammer and Shaker Type 8411

Setup and measurement of FRFs (and related functions) using either hammer or shaker excitation

Hammer Setup

For single impact and random impact test setups

TRIGGER

Record a set of experimental hammer impacts and display as time history. Using graphical tools, adjust the trigger parameters directly on the data display, or by direct parameter entry, until the desired trigger behaviour is achieved. An Auto Adjust functionality sets the Trigger Level and Hysteresis automatically. The aim is to condition the trigger parameters for maximum success in the actual measurement

WEIGHTING

The hammer signal and a response signal are displayed in graphs with graphical tools for adjusting the type and amount of time weighting to be applied to each. The aim is to use as much of the measured signals as possible whilst minimizing noise

PRETEST

Experiment with different FFT settings (bandwidth, number of spectral lines) and perform trial measurements for display and (optional) storage to the database

RESULT MODE

Pretest measurement results can be viewed and overlaid previous measurements before storing to the database

Hammer Measurement

The Hammer Measurements user interface is streamlined for typical hammer test scenarios in which the hammer excitation location is roved from point to point or performed at a fixed location. All measurement parameters are inherited from the Hammer Setup.

Key features include:

- Last hit undo
- Double-hit detection
- Frequency content warning (soft hit)
- Auto-increment of the reference DOF after a measurement

MEASUREMENT MODE

Includes a measurement control panel that is detachable and scalable

Control Buttons:

- Initialize analysis system
- Measurement start/stop
- Undo last hit
- Delete last measurement

RESULT MODE

Measurement results can be viewed and overlaid previous measurements

VOICE FEEDBACK

Audible status/error warnings during hammer test setup and measurement

Shaker Setup

Set up the generator(s) and FFT properties before measurement

GENERATOR CONTROL

Graphical tools can be used for setting up excitation type, frequency parameters, output level, level ramp up/down times, and whether burst excitation is to be used

Generator Signal Types:

- Sine (fixed frequency)
- Continuous and Burst Random
- Periodic and Pseudo-random
- Periodic chirp

ANALYSIS SETTING

FFT properties are adjusted to match generator settings, but can be independently adjusted if desired. Interface tools are highly interactive, enabling engineers to quickly assess when the settings are appropriate for the structure under test

PRETEST

Experiment with different FFT settings (bandwidth, number of spectral lines) and perform trial measurements for display and (optional) storage to the database

RESULT MODE

Pretest measurement results can be viewed and overlaid with previous measurements before storing to the database

Shaker Measurement

Classical Modal Analysis (with single/multiple references):

Auto-spectra, Cross-spectra, FRF, Impulse response, Coherence and Correlation functions

MEASUREMENT MODE

Includes a measurement control panel that is detachable and resizable

Control Buttons:

- Initialize analysis system
- Generator start/stop
- Measurement start/stop

The averaging setup can be adjusted from within this mode

RESULT MODE

Measurement results can be viewed and overlaid previous measurements

Specifications – BK Connect Advanced Sine Measurements Type 8412

Setup and measurement of FRFs (and related functions) using single- or multiple-shaker stepped sine excitation

Stepped Sine Setup

Set up the closed-loop control, the generator(s) and the analysis parameters before measurement

CLOSED-LOOP CONTROL

Software-based

Type: None, Amplitude, Phase, Both

Parameters: Amplitude Tolerance, Phase Tolerance, Control Strength (Strong, Balanced, Gentle), Max. Control (Time, Periods), Control Fail Action (Stop, Continue)

Analysis Parameters: Settling Type (Time, Periods), Settling Time, Record Periods, Tracking Source

Phase Control matrix for manually or automatic specification of phase control and showing the phase relations between the excitation signals. Force and control signal monitor with amplitude and phase readout including tolerance bands

SWEEP MODES

- Optimal Sweep Series: Phases uniformly distributed; Maximum number of shakers is 9
- Full MIMO Sweep Series: Phases either 0 or 180 degrees; Maximum number of shakers is 7
- Manual: User-defined phases; Maximum number of shakers is 9
- Specific Sweep Series: User-defined subset of sweeps; Maximum number of shakers is 9

GENERATOR

Frequency Range: 0.1 – 3200 Hz

Parameters: Step Type (Linear, Log (Octaves), Log (Decades)), Step Size, Lower Frequency, Upper Frequency, Step Direction (Up, Down, Alternating), Start Frequency (Lower, Upper), Transition Mode (Fixed Time, Automatic)

GENERATOR CONTROL

Graphical tools for setting up master control and individual generators with respect to ramp up/down, amplitude and phase

Stepped Sine Measurements

MEASUREMENT MODE

Includes a measurement control panel that is detachable and resizable
Control Buttons:

- Initialize analysis system
- Generator start/stop
- Measurement start/stop
- Dwell/sweep mode
- Step sine frequency – adjustable when dwelling
- Frequency step upwards/downwards while dwelling

ALARM AND ABORT LEVELS

- Alarm and abort levels for each signal can be specified in the HW Setup Table
- If alarm level is exceeded, a warning is given in the Level Meter
- If abort level is exceeded, the measurement will be stopped and the generators will be shut down
- Detection of alarm and abort levels are detected in the LAN-XI input

Specifications – BK Connect Geometry Type 8410

Geometry-guided Measurements

Supported for both hammer and shaker measurements

DOF SETUP

For defining the DOFs to be measured and a DOF sequence

- Using transducers from the HW Setup Table, favourites transducers defined in the Transducer Manager or generic transducers
- DOFs are defined by dragging transducers to the geometry nodes or by manual definition
- Creation of DOF sequence based on:
 - Chronological order the DOFs have been defined
 - Increasing node number
 - Path through the closest nodes (requires use of geometry)
 - Manual selection of DOFs

Geometry Creation, Import and Decimation

GEOMETRY CREATION AND EDITING

- Basic geometries using nodes, trace lines, triangle and quad elements
- Geometries based on built-in CAD models:
 - Curves: Circle, Circular Arc, Ellipse, Elliptical Arc, Hyperbolic, Parabolic, Line, Polyline, Interpolation Spline and Control Points Spline
 - Surfaces: Circular, Circular Arc, Ellipse, Elliptical Arc, Hyperbolic, Parabolic, Triangular, Rectangular, Polygon, Interpolation Spline and Control Points Spline
 - Solids: Cylinder, Hemisphere, Sphere, Box, Cone and Conical Frustum
- CAD models with selectable colour and transparency
- Move (translate, rotate) and copy (linear, radial) operators for CAD models and meshes using interactive handles or manual entry
- Definition of locations with three directions on a CAD model (Sites)
- Definition of locations with three directions on a CAD model (Sites)
- Meshing of built-in CAD models
- Extrusion of CAD models: Curves can be extruded to surfaces. Plane surfaces can be extruded to solids. Preselection of colour is available
- Hierarchical geometry tree view with subfolders for Coordinate Systems, Nodes, Elements, Trace Lines and Equations
- Tables for Coordinate Systems, Nodes, Elements, Trace Lines and Equations with sorting, filtering, multiple selection and editing

- Support of Cartesian, Cylindrical and Spherical coordinate systems. Local and Global coordinate systems
- Automated point numbering. Partial or complete semi-automated point renumbering

VISUAL LINK BETWEEN SELECTIONS IN GEOMETRY 3D VIEW AND GEOMETRY TREE

Geometry Import Formats:

- UFF data set types 15, 18, 82, 2411 or 2412 and Microsoft® Excel® (*.csv)
- UFF FE models
- Nastran (MSC, NX, NEi), Ansys and Abaqus FE models (requires [BK Connect FE Interface Type 8400-D/E/F](#), respectively)

Geometry Export Formats:

UFF data set types 15, 18, 2412 or 82 and Microsoft Excel (*.csv)

Decimation:

Imported FE models can be decimated to test models by manually selecting nodes on the FE model or by entering the nodes directly in a table

Dynamic Point Numbering:

Show more point numbers (IDs) when zooming in on parts of the geometry (user-definable) – also during animation

Geometry Views:

- Single, Side-by-Side, Top-Bottom and various Quad views
- Definition of front, back, left, right, top and bottom view axis
- Isometric view
- Perspective, orthographic and stretched projections of geometry
- Hidden lines and transparency
- Pan, zoom and rotate options for viewing geometries
- Symbols for shaker, impact hammer, force transducer, accelerometer, velocity transducer and displacement transducer positions shown on geometry with customized colours and sizes

Cutting Planes:

Cut through a geometry in three user-definable 2D planes to view the interior or exclude viewing parts of the geometry – also during animation

Animation:

- Deformed and undeformed animation with Max. Deformation
- Single, overlaid and difference animation

- Wireframe, contour (solid/solid edge) points and arrow animation
- Animation of non-measured DOFs using interpolation equations
- Geometry legends showing information about the shapes being animated such as shape number, frequency and complexity
- GIF and AVI video file generation with selectable codec and geometry legends

Measurement Validation

GEOMETRY DRIVEN FUNCTION DISPLAYS

Show FRFs based on selected excitation and response DOFs on the geometry

FUNCTION-BASED ANIMATION

Animate geometry using, for example, FRFs or phase-assigned spectra (PAS) for ODS analysis. Saving of shapes in Shape Table

Ordering Information*

Type 8411-X	BK Connect Structural Measurements – Hammer and Shaker	Software Maintenance and Support Agreements	
Type 8412-X	BK Connect Advanced Sine Measurements	M1-8400-X	Software Maintenance & Support for Type 8400
PREREQUISITE SOFTWARE		M1-8400-A-X	Software Maintenance & Support for Type 8400-A
Type 8400-X	BK Connect Data Viewer	M1-8400-D-X	Software Maintenance & Support for Type 8400-D
Type 8401-X	BK Connect Hardware Setup	M1-8400-E-X	Software Maintenance & Support for Type 8400-E
Type 8410-X	BK Connect Geometry – for geometry-guided measurements and measurement validation	M1-8400-F-X	Software Maintenance & Support for Type 8400-F
SOFTWARE FOR PRETEST ANALYSIS, EXPANDED MEASUREMENT FUNCTIONALITY AND MODAL FUNCTIONALITY		M1-8401-X	Software Maintenance & Support for Type 8401
Type 8400-D-X	BK Connect Nastran Interface – for Nastran finite element model support	M1-8401-A-X	Software Maintenance & Support for Type 8401-A
Type 8400-E-X	BK Connect Ansys Interface – for Ansys finite element model support	M1-8410-X	Software Maintenance & Support for Type 8410
Type 8400-F-X	BK Connect Abaqus Interface – for Abaqus finite element model support	M1-8410-B-X	Software Maintenance & Support for Type 8410-B
Type 8401-A-X	BK Connect Hardware Setup (advanced)	M1-8410-C-XS	Agreement for Type 8410-C-XS
Type 8410-B-X	BK Connect Time ODS Option	M1-8410-D-XS	Agreement for Type 8410-D-XS
Type 8420-X	BK Connect Modal Analysis – for integrated measurement to modal analysis	M1-8411-X	Software Maintenance & Support for Type 8411
Type 8420-A-X	BK Connect Modal Analysis (advanced)	M1-8411-XS	Software Maintenance & Support for Type 8411-S
		M1-8411-A-XS	Software Maintenance & Support for Type 8411-A-S
		M1-8412-X	Software Maintenance & Support for Type 8412
		M1-8420-X	Software Maintenance & Support for Type 8420
		M1-8420-A-X	Software Maintenance & Support for Type 8420-A
		M1-8420-XS	Software Maintenance & Support for Type 8420-S
		M1-8420-A-XS	Software Maintenance & Support for Type 8420-A-S
		M1-8421-X	Software Maintenance & Support for Type 8421
		M1-8491-A-N-SYS	Software Maintenance & Support for Type 8491-A-N-SYS

* "X" indicates the licence model, either N: Node-locked or F: Floating

Other BK Connect Products

For an overview of all Brüel & Kjær Structural Dynamics applications, visit the [Structural Dynamics](#) software page. For an overview of BK Connect data acquisition software, visit the [BK Connect](#) page.

APPLICATIONS, APPLETS AND PACKS IN THE BK CONNECT STRUCTURAL DYNAMICS SUITE

Application Software

Type 8421-X BK Connect Correlation Analysis

Applets

Type 8491-A-N-SYS BK Connect Hammer Impact Applet

Packs

Type 8410-C-XS	BK Connect Time and Frequency ODS Measurement and Analysis Pack
Type 8410-D-XS	BK Connect Time, Frequency and Run-up/down ODS Measurement and Analysis Pack
Type 8411-XS	BK Connect Structural Measurements and Analysis Pack
Type 8411-A-XS	BK Connect Structural Measurements and Analysis Pack (advanced)
Type 8420-XS	BK Connect Modal Analysis Pack
Type 8420-A-XS	BK Connect Modal Analysis Pack (advanced)

Table 1 Overview of BK Connect structural dynamics packs

Comprises:	PACKS					
	TIME AND FREQUENCY ODS MEASUREMENT AND ANALYSIS TYPE 8410-C-S	TIME, FREQUENCY AND RUN-UP/DOWN ODS MEASUREMENT AND ANALYSIS TYPE 8410-D-S	STRUCTURAL MEASUREMENTS AND ANALYSIS TYPE 8411-S	STRUCTURAL MEASUREMENTS AND ANALYSIS (ADVANCED) TYPE 8411-A-S	MODAL ANALYSIS TYPE 8420-S	MODAL ANALYSIS (ADVANCED) TYPE 8420-A-S
Data Viewer Type 8400	•	•	•	•	•	•
Hardware Setup Type 8401	•	•	•	•		
Hardware Setup (advanced) Type 8401-A		•		•		
Time Data Recorder Type 8402		•				
Data processing Type 8403	•	•				
Order Analysis Option Type 8405-E		•				
Geometry Type 8410	•	•	•	•	•	•
Time ODS Option Type 8410-B	•	•				
Structural Measurements – Hammer and Shaker Type 8411			•	•		
Modal Analysis Type 8420			•	•	•	•
Modal Analysis (advanced) Type 8420-A				•		•

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