Modal Test Solutions

Brüel & Kjær, Ometron and ENDEVCO have formed an alliance that covers every level of modal testing and creates a one-stop shop that aims to become the preferred choice for all modal needs. The alliance draws upon its members' vast reserves of experience built up over decades to provide modal test solutions comprising everything from impact hammers, transducers and non-contact vibrometers, to data acquisition/analysis platforms and modal analysis software.

One-stop Shop

ENDEVCO

Brüel & Kjær

Introduction to Modal Testing

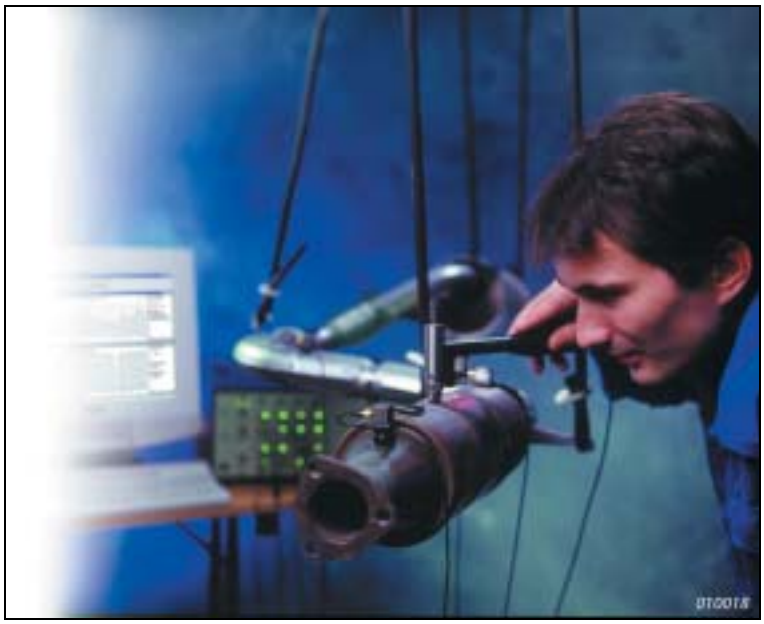


Fig. 1
Modal testing is a powerful tool for investigating the root-cause of many vibration related problems. Armed with the right equipment, the experimentalist can gain unique insight into the inherent dynamic properties of the test specimen

All machines, vehicles and buildings are subject to dynamic forces that cause vibration. Very often, the vibrations and their underlying causes have to be investigated because they cause an immediate problem, or because the structure has to be "cleared" to a "standard" or test specification. Any vibration problem is governed by the trinity "Source–Path–Receiver", and experimental modal analysis, or modal testing, can be regarded as path analysis in the sense that it describes how time-varying forces are being mapped into vibrations by inherent structural dynamic properties. To construct a mathematical model of these dynamic properties by experimental means is the ultimate aim of a modal test.

Several powerful applications are possible once the mathematical model of the structure under test has been constructed and verified:

- Refinement of an analytical Finite Element Model (FEM)
- Structural dynamics modifications
- Dynamic load scenarios that allow for structural response predictions
- Structural assembly analysis
- Troubleshooting

Most practical noise and vibration problems are related to resonance phenomena where the operational forces excite one or more modes of vibration. Modes of vibration that lie within the frequency range of the operational dynamic forces always represent potential problems. An important property of modes is that any forced or free dynamic response of a structure can be reduced to a discrete set of modes.

The modal parameters that make up a mode of vibration are:

- Modal frequency
- Modal damping
- Mode shape

The modal parameters of all the modes, within the frequency range of interest, constitute a complete dynamic description of the structure. Hence, the modes of vibration represent the inherent dynamic properties of a structure.

Modal testing is the process of determining all the modal parameters that are sufficient for formulating a mathematical dynamic model.

One-stop Shop

The Brüel & Kjær, Ometron and ENDEVCO alliance covers every level of modal testing and every link in the measurement chain. With the aim of becoming your preferred One-stop Shop for all your modal test needs, from a single transducer to a complete turnkey system, you can rely on us to deliver superior technology, unsurpassed product quality and careful attention to every detail in the measurement chain.

Fig. 2
High-quality, reliable test results depend completely on the quality and integrity of the measurement chain

In order to ensure that you always have the opportunity to update your modal test system with the latest developments, all our transducers, cables, conditioners, and analysis and calibration systems have been meticulously designed to ensure the highest possible level of integration.

With our expert knowledge based on more than 50 years of modal test experience, we constantly focus on innovation to maintain our technological lead within the sound and vibration market. It is because of this that we are capable of making complete customised modal solutions to serve your specific needs...

... no matter what your modal test application may require:

- Piezoelectric (PE), DeltaTron®, ISOTRON®, Integrated Electronics Piezoelectric (IEPE), Piezoresistive (PR), Variable Capacitance (VC) or non-contact vibration transducer technologies
- Smart transducers compatible with IEEE P1451.4 standards
- Mounting, positioning and orientation accessories
- Excitation equipment
- Data acquisition and analysis systems
- A range of software for workflow, measurement and analysis

... or whatever the size of your system:

- Small, typically 2- to 7-channel systems for troubleshooting
- Medium-sized, typically 8- to 64-channel systems for lightweight and intricate structures, and for structural dynamic component testing
- Large systems, typically above 64 channels for large, complex and bisymmetrical structures

Fig. 3
With attention to all the details of a modal test application, we have developed a complete range of equipment needed for a successful test result

Pick of the Crop

Fig. 4
The Brüel & Kjær, Endevco and Ometron alliance offers our customers the world's most comprehensive range of transducer technologies

Brüel & Kjær, Ometron and ENDEVCO offer the sound and vibration industry's most comprehensive line of high-performance, economical, rugged and lightweight uniaxial and triaxial sensors. These include piezoelectric, ISOTRON®, DeltaTron®, piezoresistive, variable capacitance, servo force balance accelerometers and Laser Doppler Vibrometers. A wide variety of quality connectors, cables and mounting options ensure optimum measurement integrity, ease of setup and data reliability.

A unique commitment to quality has led to all-inclusive, in-house manufacturing that includes piezoelectric material production, the building of cables and harnesses, and the micromachining of piezoresistive accelerometers. Unlike most manufacturers, Brüel & Kjær and ENDEVCO modal accelerometers are based on many different types of piezoelectric materials and sensing-element design to secure the best performance in every type of modal application.

Non-contact Single-point and Scanning Laser Doppler Vibrometers

Fig. 5
LDVs provide fast and accurate vibration measurements without mass loading in severe environments. The ability to scan large areas with extremely high spatial resolution is a unique feature

Laser Doppler Vibrometers (LDVs) are optical instruments primarily designed for accurate, efficient and fast non-contact measurement of surface vibration. They are widely used in applications where traditional contact vibration transducers are impractical or prohibited. Accurate and reliable "point and shoot" operation eliminates mass loading of the measurement target, tedious mounting procedures and wiring of contact vibration transducers.

Based on eye-safe and visible Class II HeNe lasers, the systems avoid the need for special, expensive facilities or protective equipment.

Fig. 6
Laser Doppler Vibrometer Type 8333

Laser Doppler Vibrometers Types 8329, 8333 and 8334 are single-point LDVs ideal for a variety of applications, including measurements at very high or very low temperatures, in nuclear or chemically polluted environments, and in high magnetic fields. Excellent optical sensitivity allows you to make measurements at working distances from 0.05 m to 200 m (Types 8333 and 8334) – with a spot size down to 0.2 mm – without the use of retro-reflective tape or paint.

Scanning Laser Doppler Vibrometer Type 8330 is an intelligent, full-field system that quickly produces vibration maps depicting structural response at multiple measurement points. The unrivalled compactness, together with the superior optical sensitivity, zero

hysteresis, digitally controlled stepper motors and standard 6400 line FFT, make Type 8330 an ideal choice for demanding laboratory and field work.

Meticulous attention to detail during development has resulted in an ultra-precise, 16-bit, digital mirror control that allows angular mirror steps of 0.6102 millidegrees and a built-in FFT analyzer based on a high-end, 4-channel, 20 kHz DSP board. The board is standard equipment and has two built-in generators for the choice of single input or multiple input test configurations.

Especially important for smaller test objects and repeated measurements is the ability to provide a true one-to-one relationship between reality and what is seen on the screen. Scanning Laser Doppler Vibrometer Type 8330 achieves this as the built-in full colour CCD camera is in perfect co-linear alignment with the laser beam. The system is controlled either by a personal computer running dedicated software, with the option of advanced, integral modal analysis software, or directly via MTS® I-DEAS® Master Series.

Clip, Click, Done!

Correct mounting of accelerometers for experimental modal analysis applications is crucial. The mounting method and care taken are usually the limiting factors for the maximum frequency that can be measured. Mounting misalignment with respect to the defined coordinate system can seriously impair the quality of the modal model. With this in mind, we have developed a range of mounting clips for our dedicated modal accelerometers. Made of glass reinforced polycarbonate, the clips can be mounted using hot glue or double-sided adhesive tape. There are four different types available in various sizes:

- **Normal** – for relatively flat surfaces where little or no removal of material is needed to ensure optimal surface contact.
- **Thick base** – for curved or irregular surfaces. These can easily be filed down to suit your mounting surface.
- **Swivel base** – Ensures unsurpassed ease of mounting on curved surfaces compared to traditional mounting methods. Independent of the geometry of the structure under test, this clip provides consistent alignment and orientation of each and every transducer mounted on the test specimen without using the traditional method of cutting wooden blocks into shape. Perfect alignment with a defined global coordinate system has never been easier!
- **High-temperature** – for temperature range –55 to +175°C (–67 to +347°F), or, if discolouring can be accepted, –55 to +250°C (–67 to +482°F).

Fig. 7 *Easy mounting and alignment of vibration transducers provides not only fast mounting and dismounting but also helps ensure the highest data quality*

Work Smarter not Harder

Fig. 8
TEDS-equipped transducers hosts all pertinent specifications inside the transducer itself, in a special format defined by IEEE P1451.4

Imagine that all the transducers used in a modal analysis can automatically download their transfer characteristics and installation information to the system software at a click of the mouse. A number of Brüel & Kjær and ENDEVCO transducers available with Transducer Electronic Data Sheet (TEDS) offers the test engineer just that. Our IEEE P1451.4 TEDS-based measurement system makes it possible for automatic adjustment of channel sensitivity, for data acquisition systems to obtain calibration data regarding sensitivity and date, and check of valid calibration intervals.

TEDS also includes transducer specific data that, together with a general formula, best fit the measured frequency response. Using the ENDEVCO Handheld Programmer, installation specific data, such as position ID, orientation, and polarity, can be entered into the TEDS transducer on location. The benefits gained from this automatic identification of accelerometers are immense. The use of built-in digital memory chips in the sensors and electronics virtually do away with human errors such as mistakes in data entry and wrong cable connections. You can also swap transducers "on the fly" without having to make any setup changes – true Plug and Play technology. Best of all, these features reduce hardware and software setup time dramatically.

Modal Excitation

Impact Hammers: Fast, Precise and Perfect for Field Work

Fig. 9
Impact hammers are ideal for field modal testing: excitation is fast, portability is inherent and no elaborate fixtures or set up of exciters are needed

Scaled modal models require a precise force measurement. This can be achieved by a hammer fitted with a high-quality piezoelectric force transducer or exciters controlled by a signal generator via a power amplifier.

In applications where a high crest factor and a limited ability to shape the input force spectrum is of no concern, impact hammer testing is an ideal source of excitation. Impact hammer testing is quick, doesn't require elaborate modal exciter fixtures and cumbersome stinger attachment. It is also portable and highly suitable for field work. Moreover, impact hammers are relatively inexpensive, and provide no unwanted mass loading of the structure under test.

The Impact Hammer Palette – All with Top-class Specifications
Years of experience with structural dynamic measurements using impact hammer testing has resulted in one of the industry's finest and broadest range of impact hammers. Whatever structure you need to test, from larger civil engineering structures to the smallest disk drives, you can rely on our expertise to bring you first class, proven technology for optimum measurement quality, durability and reliability. DeltaTron®/

ISOTRON® outputs are provided on all hammers except on the miniature Force Transducer/Impact Hammer Type 8203. The hammers are practical and they all come with ergonomic rubber grips. All are fitted with a high quality piezoelectric force transducer.

A unique design principle known as Acceleration Compensation is found on most of our impact hammers. This allows the true force pulse to be accurately measured while minimising any potential error due to the deceleration of the front part of the impact hammer.

Rugged Construction Ensures Superior Performance in all Environments
Impact hammer measurements are often conducted in harsh industrial environments where dust, temperature fluctuations and high humidity often pose severe demands on the electrical and mechanical quality of the instrumentation. All of our impact hammers have been meticulously designed to meet demanding expectations for maintained reliability even in such types of environments.

Modal Exciters

Fig. 10
A full range of dedicated high-quality modal exciters and a complete line of power amplifiers and accessories, accommodate even the most demanding modal test application

Obtaining accurate and reliable force measurements is of paramount importance for a successful modal test session. When a scaled, high-precision, experimental modal model is sought, the natural choice of excitation is one or several exciters, and many issues have to be dealt with prior to the FRF measurements, for example:

- Choosing the best exciter location
- Minimising exciter/test structure interaction
- Distributing and minimising dynamic force levels
- Ensuring sufficient low frequency energy input

As the result of years of practical experience with structural dynamic measurements, all Brüel & Kjær modal exciters exhibit high force-to-weight ratio, have been specifically developed to address these issues and help ensure the best possible modal test performance with minimum setup time.

With force ratings (sine) from 100 N to 1000 N, low weight armatures, up to 2″ stroke capability, special “hole-through” armature for tension wire stinger technology and rare earth magnet technology (some types), this line of robust modal exciters is ready to handle even the most demanding modal test application. Most types feature an optional, built-in, electrical stinger pre-tensioning system maintaining complete freedom of exciter positioning and orientation. This allows the use of tension wire stinger technology without traditional external mechanical wire pre-tensioning.

A complete range of power amplifiers and dedicated accessories is available, to help users obtain the highest degree of measurement precision and ease of setup. This program includes force transducers, impedance heads, exciter stands for easy horizontal positioning as well as a family of stingers. Push/pull and various tension wire types are available with different attachment methods, including a “snap on” accessory for fast mounting and dismounting of push/pull type stingers.

The ultimate aim in modal analysis is to obtain an accurate, reliable and consistent mathematical model of the structure under test. In order to obtain the highest quality modal model, test engineers are often confronted with the need for a large-scale modal test setup. This can often involve a large number of vibration response channels that can provide for time invariant, accurate and consistent FRF data. For these applications, Brüel & Kjær and ENDEVCO have developed instrumentation that provides consistent, high-quality, multichannel measurements and experimental data.

PULSE™, the Multi-analyzer System

Fig. 11
The PULSE™ analyzer family provides an unsurpassed degree of versatility, scalability and modularity. All this, combined with a commitment to user-friendly, fully feature analysis software, provides for an optimum platform for structural dynamic testing

PULSE™ is a versatile, task-oriented, multi-analysis system. A wide range of system configurations is available, ranging from 2 to more than 100 channels. The noise and vibration analysis software in PULSE™ can basically be used for any type of noise and vibration analysis including single-input multiple-output (SIMO) or multiple-input multiple-output (MIMO) frequency response calculations for traditional modal analysis, or time data acquisition for operational modal analysis.

Adding the dedicated Modal Test Consultant™ software turns PULSE™ into a very powerful structural dynamics measurement platform, focusing on reducing the very time-consuming data acquisition aspects of preparing, performing and validating such measurements. Geometry-driven measurements allow you to set up your measurement points on the geometry, just as they are in real life. This provides almost foolproof guidance during the measurement procedure and also during the transfer of geometry and measurement data to the modal software package, e.g., ME'scopeVES™ and Operational Modal Analysis.

IDA – Intelligent Data Acquisition

Intelligent Data Acquisition (IDA) is a fully featured front-end specifically developed for demanding, large-scale multichannel sound and vibration data acquisition. Features include performance that is independent of the channel count (6 channels to 3000 channels, frequency range DC to 25.6 kHz), scalable, gap-free recording using on-board memory, or real-time throughput-to-disk. IDA uses a LAN-based connection between separate frames and has a full range of transducer input possibilities. Other features that makes IDA a unique front-end system include the continuous channel monitoring that gives immediate notification of cable breaks and shorting.

OASIS – Optimal Architecture Sensor Interface System

Fig. 12
For large-scale multichannel modal testing with hundreds of vibration transducers, the OASIS system provides power supply and signal conditioning to all types of accelerometer technologies in a compact and convenient manner

The Optimal Architecture Sensor Interface System (OASIS) is a low-cost, high-density signal conditioning system that provides the interface for multiple transducer types (PE, IEPE, PR as well as VC-based transducers) by using the 400 series modular family of signal conditioning cards, all housed in a 16-slot, 19-inch rack. The 400 series signal-conditioning cards can be freely mixed in any configuration, providing maximum flexibility to customise the desired system configuration. In addition to IEEE P1451.4 TEDS transducer support, the OASIS system provides numerous convenient features that help to minimise human errors and reduce test setup time. Its Import/Export functions also make communicating the TEDS information to the analysis software easy.

New Conditioning Units for Multichannel Applications

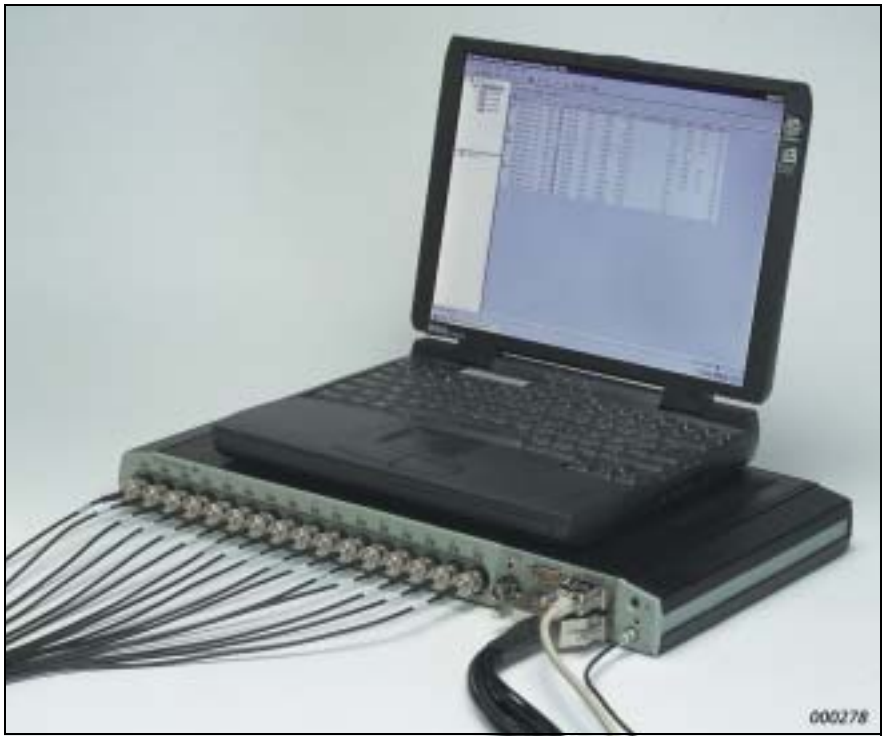


Fig. 13
16-channel DeltaTron® Conditioning Amplifier Type 2694 is the optimum choice for flexible power supply of DeltaTron®/ ISOTRON® transducers. Several units can be used in a multiple configuration for large channel counts

A new range of Brüel & Kjær 16-channel conditioning amplifiers offers a range of unique facilities, which allows you to reduce setup time and increase measurement reliability considerably.

The four versions of the 16-channel amplifiers are controlled via a PC RS−232 interface by a Windows®-based software program. This means that setups can be defined "off-line" then loaded into the units. Providing maximum measurement flexibility, up to 16 units can be daisy-chained and controlled by each COM port on the PC. When not in use, superfluous channels can be disabled which means that the control and the transfer of commands become quicker.

The amplifiers do not only offer full IEEE P1451.4 (TEDS) support. They also support IEPE transducers such as DeltaTron®/ISOTRON® accelerometers and microphone preamplifiers, voltage output transducers and tachometers as well.

The new amplifiers can be used as stand-alone units or in a multiple configuration for large channel counts. Either way, a multichannel test setup based upon these amplifiers provides for a superior combination of test reliability, efficiency, integrity and cost-effectiveness.

Multichannel measurements are often conducted in difficult environments where vibrations, temperature fluctuations, high humidity and electromagnetic interference (EMI) conditions often impose severe demands on the electrical and mechanical quality of the instrumentation. The Brüel&Kjær conditioning amplifier range has been meticulously designed to meet demanding requirements for maintained data reliability even in such types of environments.

Software

Reduce Setup Time

The Modal Test Consultant™ software has been developed with the express aim of simplifying and reducing the time taken to perform structural dynamic measurements such as Modal Testing.

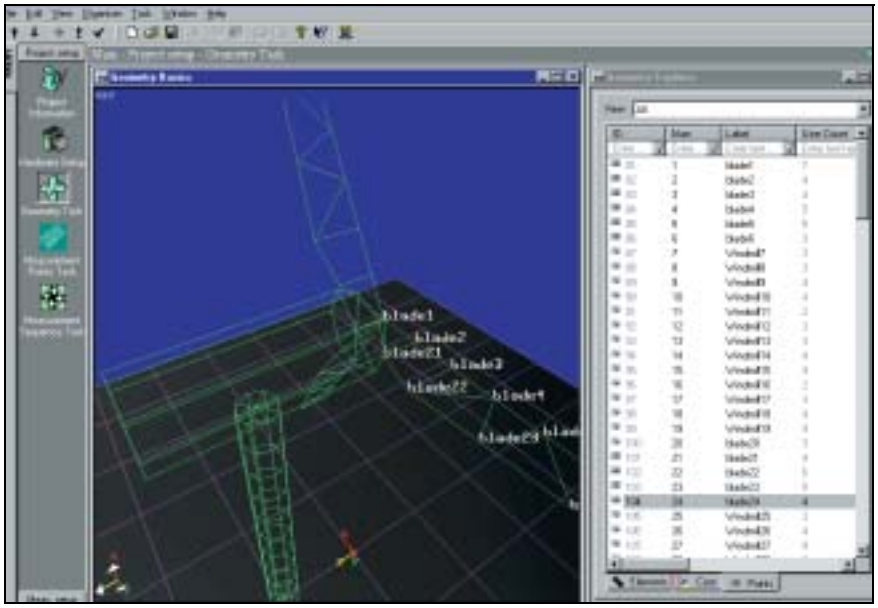


Fig. 14
Easy geometry definition is just one of the many benefits of Modal Test Consultant™

It bases its concept on the experience that in modal testing, setting up the measurement takes a majority of the time for the complete modal test compared to, say, the modal post-processing. Accordingly, Modal Test Consultant™ focuses on reducing setup and data acquisition time. Modal Test Consultant™ exports the test object geometry with Degree-of-Freedom (DOF) information and the measured spectra or functions, to the

modal post-processing package of your choice in an open data format. Modal Test Consultant™ also connects directly with the ME'scopeVES™ family of structural dynamic applications and operational Modal Analysis, to provide a complete structural dynamic test solution.

Modal Test Consultant™ software runs within PULSE™ to provide a unique and dedicated environment for modal testing. All measurement stages are geometry driven and important information is held in tabular form to give an immediate overview. This means that you can concentrate on the test itself rather than the secondary issues such as cable connections and correct test object DOF labelling.

Modal Parameter Extraction Software

ME'scopeVES™ is a user-friendly, post-test modal and structural analysis tool with many features. It allows you to observe, analyse and document the dynamic behaviour of machines and mechanical structures. ME'scopeVES™ is Microsoft® Windows®-based and includes options for performing operating deflection shape analysis, modal analysis, multiple input/output (MIMO) analysis and structural modifications.

ME'scopeVES™ is capable of both time domain and frequency domain animations. By animating the measured responses (operational deflection and mode shapes) of a structure in slow motion, you receive a unique perspective of the structure's dynamic behaviour. Operating deflection shapes or mode shapes can be stored in a Shape table.

Analytical mode shapes from a finite element model can be imported into a Shape table and compared with experimental results.

Shapes can be compared analytically using the Modal Assurance Criterion (MAC) or by displaying them together in animation. ME'scopeVES™ provides more realistic animated pictures of a structure's deformations from relatively few measurements using measurement point interpolation. The motions for all unmeasured points on the model are interpolated from motions at neighbouring measured points.

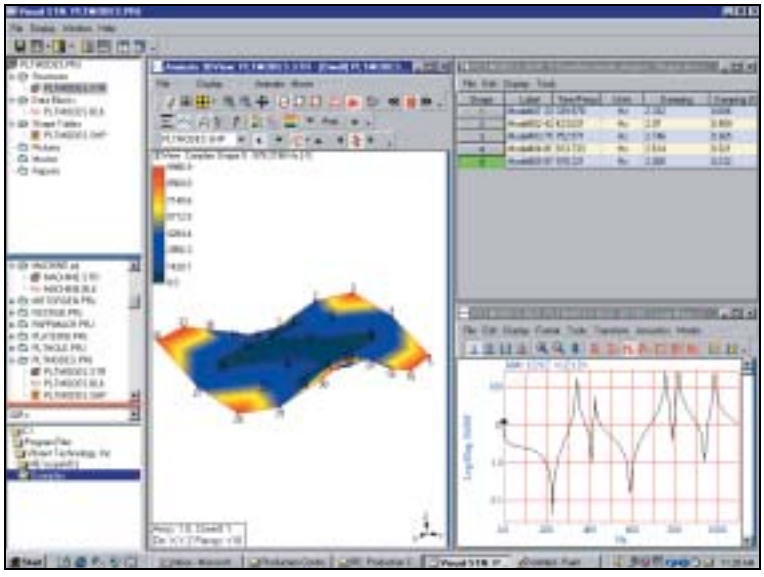


Fig. 15 *ME'ScopeVES™ provides high-tech modal parameter extraction algorithms in a user-friendly format for easy and reliable curve fitting of measured data*

Using ME'scopeVES™ Visual MODAL™, an experimental modal model is obtained by curve fitting a set of FRF measurements. ME'scopeVES™ contains four built-in curve-fitting methods:

- Quadrature fit
- Peak fit
- Rational Fraction Polynomial
- Least Squares Complex Exponential – single as well as multi-degree-of-freedom.

The curve fitters can be used to fit single or multiple reference FRF data sets. Model building in 3D, display, and interactive animation together with Digital Movies™ are unique features that are standard in all ME'scopeVES™ solutions.

New Development within Modal Analysis

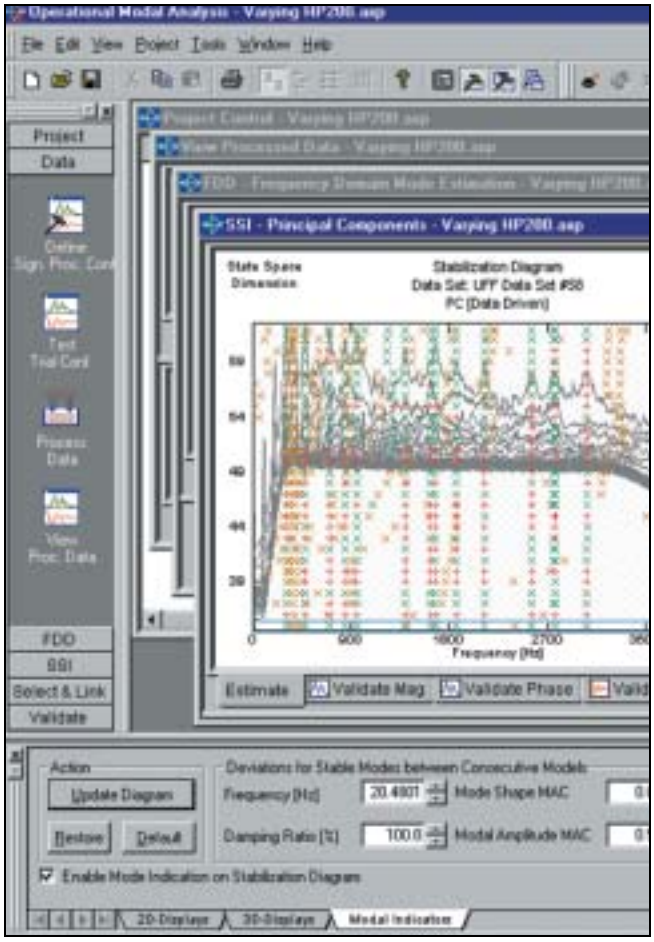


Fig. 16
Operational Modal Analysis software runs on the PULSE™ analyzer platform providing an intuitive and user-friendly interface to the operation of the software

In traditional modal analysis, the modal parameters are found by fitting a model to Frequency Response Functions, thus relating excitation forces to vibration responses. In Operational Modal Analysis, there is no input force and therefore the modal identification is based solely on the vibration responses. By using a completely different identification strategy it is therefore possible to make modal testing on structures which are normally difficult or impossible to excite.

Some mechanical structures are difficult to excite artificially due to their size, shape or simply because the location means that the excitation force may be mixed with noise. Operational Modal Analysis can be used in these cases, but it also gives you an opportunity to know the modal parameters of the structure in a real life situation. This is often of importance when testing on vehicles, operating machinery in general or machine parts where the modal parameters depend on the actual operating conditions.

Whenever the technique of output-only modal identification is used instead of traditional modal identification, the basic idea is the same. However, instead of exciting the structure artificially and dealing with the force signal as an input noise source, the natural excitation is used as input. The main advantages of this kind of testing are:

- Test setup time is reduced, as elaborate fixtures for exciting the structure are not needed
- Testing does not interrupt or interfere with the normal operation of the structure
- The measured response is representative of the real operating conditions of the structure

In principle, discarding the information about the input will add some uncertainty to the modal estimates. However, with the advanced algorithms included, the added uncertainty is very small. In practice, the only major difference between modal parameters estimated from traditional modal testing and those from operational modal analysis is that the operational modal analysis yields unscaled (i.e., not calibrated) mode shapes. Scaled mode shapes are needed when simulations (such as Forced Responses and Structural Modifications) are applied to modal data.

Examples of Modal Test Solutions

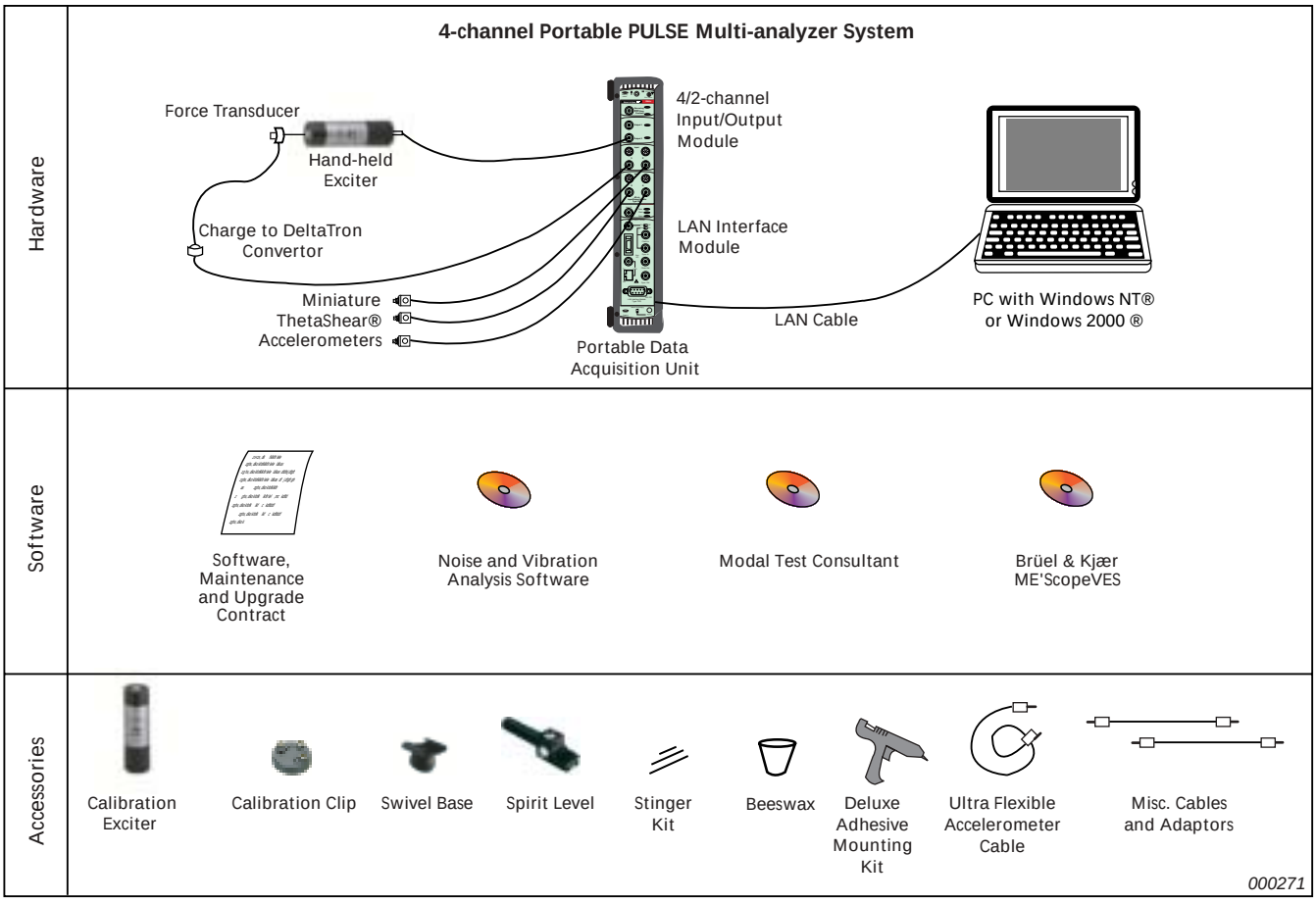
Modal Test Troubleshooting and Testing in the Field

For troubleshooting and testing in the field, it is important to have a small – yet accurate and powerful – analysis system which is easily transported and set up. Brüel&Kjær has developed a portable version of the PULSE™ System with 2 to 7 channels. This gives you modular and scalable multi-analysing capabilities, with reduced measurement and documentation time in a compact and convenient design. Combined with accelerometers and accessories from the Brüel&Kjær/Endevco alliance, a formidable portable modal test system is the result.

Features

- Portable PC-based Multi-analyzer using Native Windows® 2000/NT®
- FFT, CPB and Overall level analyzers, capable of running in parallel on several channels simultaneously (multi-analysis)
- Four DeltaTron®/ISOTRON® conditioned input channels and two generator outputs for driving modal or vibration exciters
- Predefined projects and project style data architecture lets you set up system in advance
- Spectra, cross-spectra and functions can be viewed on-site as well as modal parameter estimates made using the various cursor facilities in PULSE™
- Data output in UFF, SDF, and BUNV
- IEEE P1451.4 TEDS (Transducer Electronic Data Sheet) compatible
- Available with PULSE™ Modal Test Consultant™ software, ME'scopeVES® and Operational Modal Analysis
- Wide range of instrumented impact hammers

Fig. 17 *Example of a 4-channel Portable PULSE™, Multi-analyzer System*



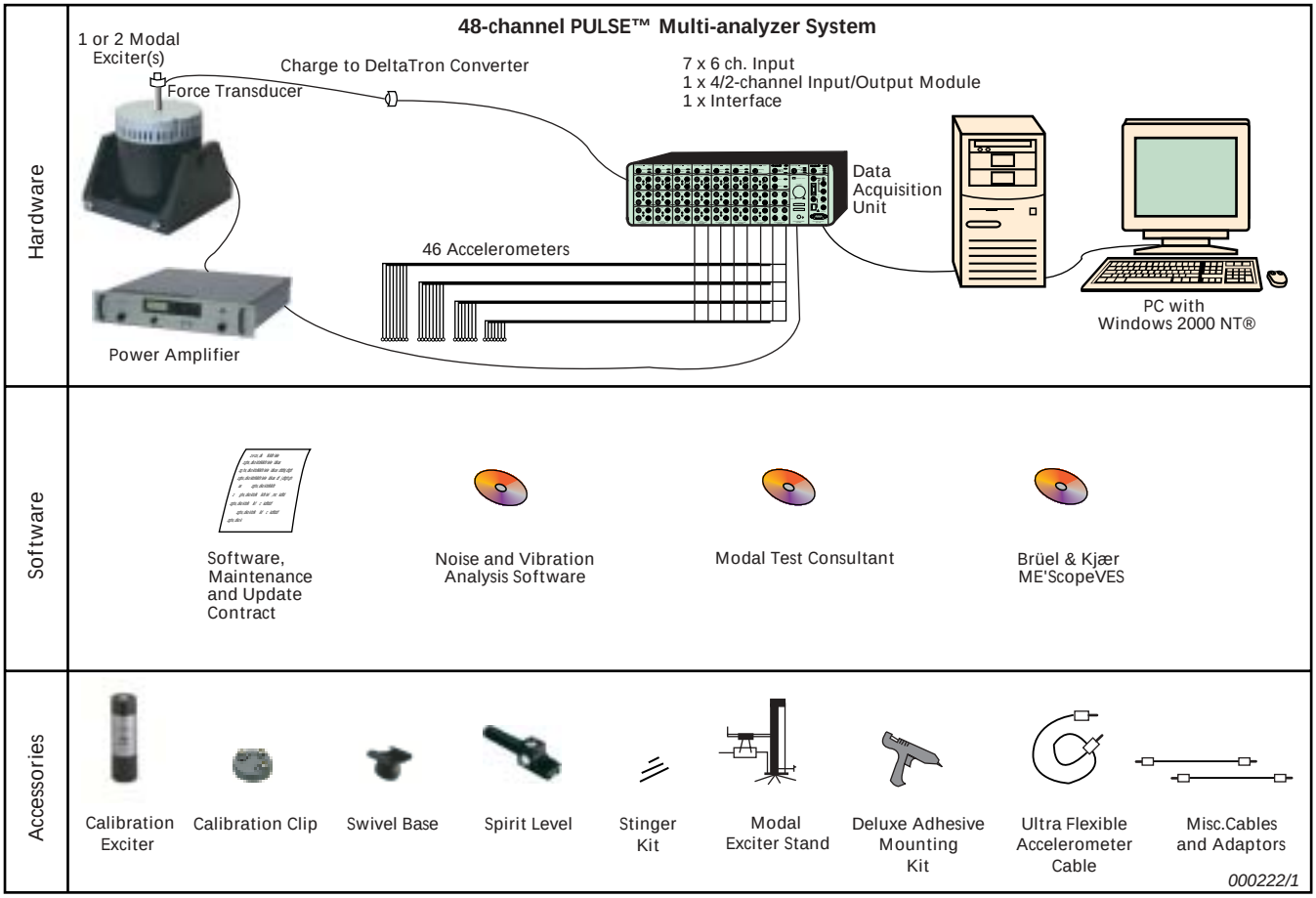
Modal Testing of Medium to Large Structures

Faster test results and the ability to test larger structures often require more channels and dedicated modal exciters with accessories. The PULSE™ Multi-analyzer platform lets you measure and analyse up to 48 channels. Unique modal exciters, a broad palette of force transducers, impedance heads and vibration transducers and industry-leading post-processing tools ensure superior test accuracy, precision and reliability.

Features

- PULSE™ Multi-analyzer platform using Native Windows® 2000/NT®
- FFT, CPB and Overall level analyzers, capable of being run in parallel on several channels at once (multi-analysis)
- Full range of impact hammers, vibration exciters, power amplifiers and accessories
- A range of conditioning and data acquisition systems
- Available with PULSE™ Modal Test Consultant software, ME'scopeVES and Operational Modal Analysis
- Available with microminiature (0.2 gram) ISOTRON accelerometer that fits almost anywhere

Fig. 18 *Example of a 48-channel PULSE™, Multi-analyzer System*



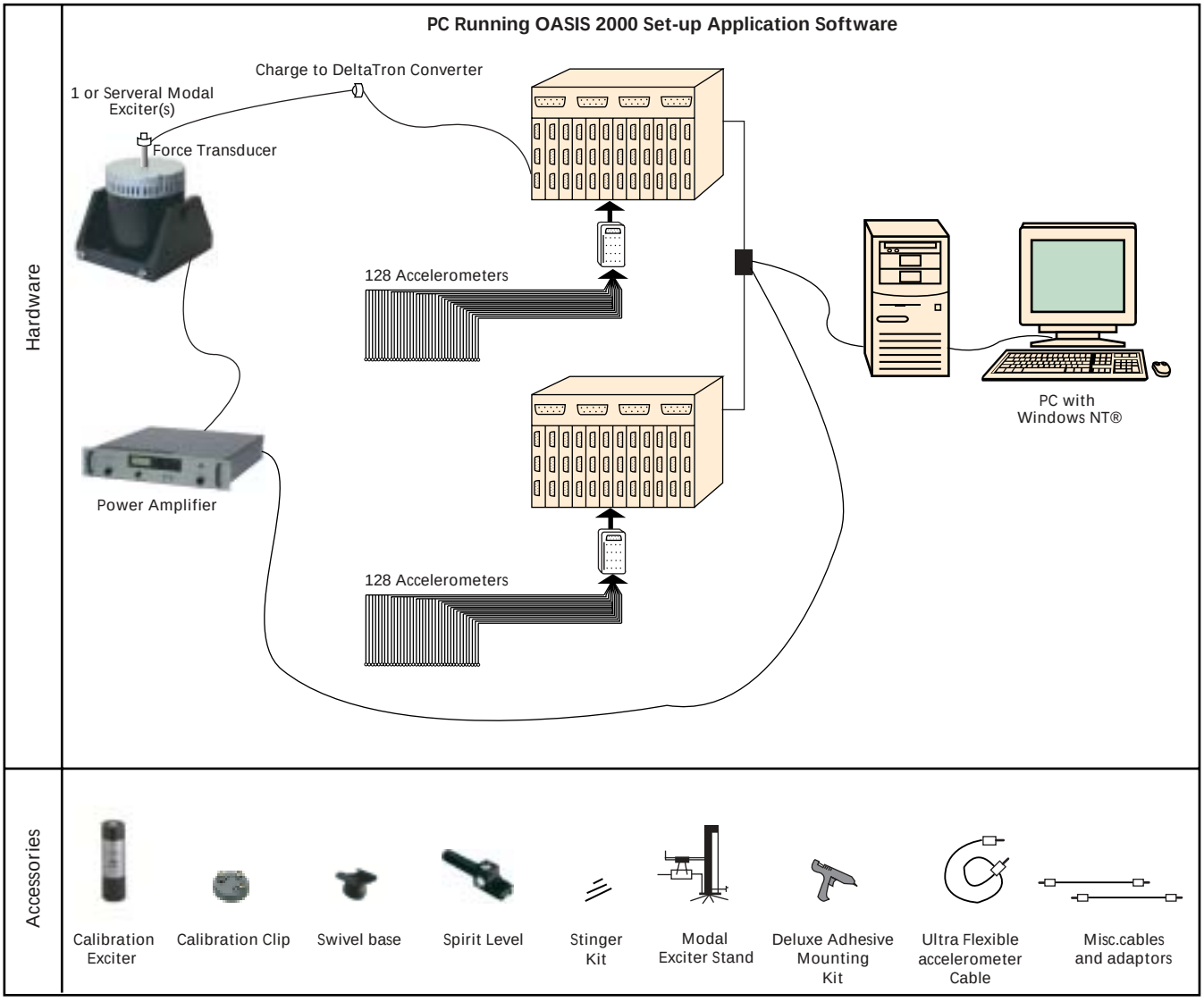
Transducers and Conditioning for Very Large and Dynamically Complex Structures

For modal testing of very large and complex structures where hundreds of channels are needed, it is possible to use the OASIS 2000 – Optimal Architecture Sensor Interface System. Equipped with the appropriate module, the high-density OASIS 2000 system provides signal conditioning for every Brüel&Kjær/Endevco alliance transducer technology. Data acquisition and analysis is not provided by the Brüel&Kjær/Endevco alliance.

Features

- ❍ OASIS sensor interface unit
- ❍ Transducer patch panels
- ❍ TEDS read/write, intelligent transducers and systems
- ❍ Geometry digitisation technology
- ❍ Cabling/connection solutions
- ❍ Wide range of dedicated modal exciters and accessories
- ❍ Hand-held TEDS programmer allows in-situ writing of measurement position

Fig. 19 *Example of a 256-channel conditioning system with OASIS 2000*



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Brüel & Kjær and ENDEVCO – Partners and Suppliers of High Standards

Brüel & Kjær

ENDEVCO

The sound and vibration measurement market is a very specialised industry niche. It requires an in-depth understanding of the nature of sound and vibration combined with a very good understanding of customers' needs and applications. Having been in this market for more than 55 years, Brüel & Kjær has been the leading player in the sound and vibration market. Brüel & Kjær has over 900 employees, offices in 55 countries and 7 accredited calibration centres worldwide. Brüel & Kjær has a wide product range in excess of 450 products, including transducers, a full range of hand-held sound level meters, analyzers, systems, service products and customised solutions. The products and solutions are sold to a wide range of industries including automotive sub-suppliers, aerospace, consumer goods, rotating machinery, telecommunication and national government agencies.

Founded in 1947, ENDEVCO is the world's leading supplier of dynamic instrumentation for vibration, shock, inertial motion and dynamic pressure measurements. Always at the cutting edge of technology and quality, the company designs and manufactures its own materials, including piezoelectric crystals, electronics, and cables. ENDEVCO also has its own MEMS research and silicon foundry in Sunnyvale, California. Both ENDEVCO and Brüel & Kjær are ISO 9001 certified – the international benchmark for Quality Assurance. In addition, ENDEVCO is AS9000 (Aerospace Basic Quality Standard) certified and Boeing D1-9000 (Boeing's own supplement to ISO 9002) approved.

Together we make a formidable team.

Where Do I Go From Here?

We offer a comprehensive range of **literature** including Product Data, Bulletins, Application Notes, Reference Books, Case Studies and Brochures for those interested in our products and services.

We also offer a **Master Catalogue CD-ROM** with its collection of product information, the **Brüel & Kjær Magazine** or the **Transducers & Conditioning Selection Guide CD-ROM**. Alternatively, visit our website **www.bksv.com** or **www.endevco.com**, where you can peruse and download most of our literature.

We invite you to meet us at many of the major international sound and vibration exhibitions and conferences, or on one of our training courses held on-site or at our own facilities. Our website will keep you up to date with coming events.

Remember, we're as close as your local Brüel & Kjær and ENDEVCO sales representative, the Internet, a phone, a fax or an e-mail.

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