

# VIBRATION TEST SYSTEMS



BRÜEL & KJÆR

# THE PERFECT MATCH



**Brüel & Kjær** is a world-leading manufacturer and supplier of sound and vibration solutions. We help our customers solve their sound and vibration measurement problems, whether measuring traffic noise, car engine vibration, evaluating building acoustics or performing quality control.

We are unique in the industry in producing all of the elements for complete sound and vibration systems.

In 2008, Brüel & Kjær acquired LDS Test and Measurement, making us the market leader in vibration test solutions. Brüel & Kjær's product range of transducers and data acquisition systems is perfectly complemented by the addition of the LDS product portfolio, which covers electro-dynamic shakers, vibration slip tables, fixtures, amplifiers and vibration controllers.



# VIBRATION TEST SYSTEMS



# COMPLETE VIBRATION TEST SOLUTIONS – WITHOUT COMPROMISE

Brüel & Kjær can help you perform the most complex vibration tests to ensure the integrity and reliability of your products. Our comprehensive range of LDS electrodynamic shakers are designed for vibration testing of devices of practically any size – from a semiconductor component to a complete satellite system.

# ONLY ONE PC AND ONE SOFTWARE PACKAGE NEEDED

With an LDS vibration test system, your shaker, power amplifier, vibration controller and even environmental chamber are not only controlled from one PC, they run under one software package. Combined with world-class data acquisition systems and analysis software suites, Brüel & Kjær offers the complete vibration testing solution. We also provide vital service and staff training to maximise the operation of your vibration test system.



# AEROSPACE & DEFENCE

For any aircraft, helicopter, space vehicle or ballistic device, reliability is the number one priority. By using our vibration test systems and dynamic signal analyzers alongside our transducers and high-speed data acquisition systems, a product's reliability and integrity can be proven.



ESA's VEGA launcher upper-stage being tested on the LDS QUAD Shaker System, at the European Space Research and Technology Centre (ESTEC), in The Netherlands.

(Image courtesy of ESA, 2009)

## Satellite testing

When launching a satellite or vehicle to explore a neighbouring planet, ensuring its survival after launch is fundamental. As a leader in satellite vibration testing, whether testing small components or launch-ready payloads, Our experience makes us the obvious choice.

## Aircraft testing

From the latest unmanned combat drone through to the newest commercial airliner, Our products have tested almost every part from the smallest component to finished jet engines. Field test applications include in-vehicle, structural, modal and rotating machinery diagnosis. Brüel & Kjær offers complete solutions, from transducers and data acquisition systems to shakers and controllers, for field and lab testing.

## Ballistics & missile testing

Military personnel have to be confident that highly dangerous material is stored safely. In order to achieve this they often need to carry out a series of tests including shock and vibration, temperature, altitude and humidity testing. The LDS line of electrodynamic shakers and controllers ensures that everything from the smallest of triggers to the largest of missiles are properly designed for safe storage and transport.

## Marine testing

Proving the integrity of onboard components and systems to ensure they hold up against the most extreme ocean conditions is essential.

# GROUND TRANSPORTATION

Manufacturers of cars, motorcycles, trucks, buses and rail vehicles all face similar requirements for improving performance durability, comfort and safety. Here at Brüel & Kjær, we provide a range of solutions to meet your needs.



## **Squeak & Rattle**

Our quiet electrodynamic shakers support industry standard QA practices for Squeak & Rattle vibration testing, ensuring automotive components and interiors remain durable and free from noise, for greater passenger comfort. As hybrid and electrical vehicles become more common, battery durability testing is key to the next generation of transport. We have developed a custom vibration test system for hybrid battery testing in conjunction with Highly Accelerated Life Testing (HALT) of multi-cell computer managed batteries.

## **NVH structural & modal testing**

Brüel & Kjær products provide solutions for a wide variety of noise, vibration and harshness test requirements. Field test applications include in-vehicle, structural, modal and rotating machinery diagnosis. Brüel & Kjær also offers complete solutions, from transducers and data acquisition hardware to shakers and controllers, for both field and lab testing such as road test simulation.

## **Rotating machinery testing**

Brüel & Kjær analyzers provide all the tools you need to rapidly isolate and diagnose vibration and noise problems in rotating machinery. Order tracking analysis, real-time waterfalls and spectrograms, octave band analysis, orbit plots and cepstrum analysis are all available.

# TRANSPORT SIMULATION

The Quad V9 (4 x 105 kN) Vibration Test System has been specially designed for transport simulation, testing structures at frequencies from DC and payloads exceeding 6 tonnes. With a cross-section of over 6 m x 3 m it is much larger in size than the individual payload interface plates. Having the capability to independently control the vibration acceleration at multiple positions on a single payload of this size is revolutionary.

The payload interfaces for each of the four V9 shakers are not connected to each other, so to control their relative positioning, a new position indicator control stand has been developed.

A special version of the LDS Combo has been designed to incorporate a solid-trunnion vibrator body mounting, with the slip table combo frame being attached directly to steel plates on top of a seismic mass. The base fabrication is designed to accept a Load Bearing Platform (LBP) used for vertical vibration.

An air-isolated seismic block has been designed so that all forces are transmitted to it. Testing is controlled using an LDS Multiple Amplifier Control (MAC) system together with a Multi-Input Multi-Output (MIMO) vibration controller, to simultaneously control each independent V9 system in order to achieve the required combined effect. Using Airglides, the four units can be readily repositioned into multiple orientations, to enable both vertical and horizontal testing of various-sized payloads.





# PACKAGE TESTING

Most consumer products undergo vibration testing, the most common form being package testing. Package testing is designed to simulate a product's journey from when it's boxed at the factory until it is transported to the customer's home.

One such package testing system was designed to enable the customer to simultaneously test two plasma screen television sets weighing 85 kg each in their transport boxes. The tests were designed to reproduce the effects of transport on the televisions and allowed for the optimisation of the packaging design, and savings on materials like polystyrene packaging. The customer used a combination of sine tests, typically <5 mm peak-to-peak in the 5 - 20 Hz range, and Random tests <1.5 g up to 200 Hz.

The system combines a rigidly mounted standard LDS V875-640 shaker with specially designed steel trunnions and a magnesium head expander measuring 1.8 m x 2.2 m and supported by a load-bearing platform. The basic over-turning capability of the load-bearing platform is 5 kNm, and it is restrained by guide shafts which are part of the steel work. Airbags located underneath the trunnions isolate the vibration. Pneumatic isolation is incorporated to prevent unwanted vibration being transmitted into the building.

Once on site, the head expander is positioned at floor level, allowing the loading and unloading of payloads by pallet truck for the quick turnaround of large test articles. A remotely operated safety mechanism to lock and unlock the LBP had to be designed to allow access to the shaker.



V875-640 mounted in trunnions with load-bearing platform and 1.8 m x 2.2 m head expander

# DEFENCE TESTING

Designed to test payloads for a defence customer, the Dual LDS V850-440 SPA24/56K Special Vibration Test System has been engineered for coupled operation.

Each shaker is fitted with a guided head expander that allows interfacing to the customer's specialised payload. A steel truss rigidly connects the shakers together.

To ensure the dual system is mobile, each shaker base is integrated with Airglides allowing the full shaker assembly to be moved effectively on a cushion of air.

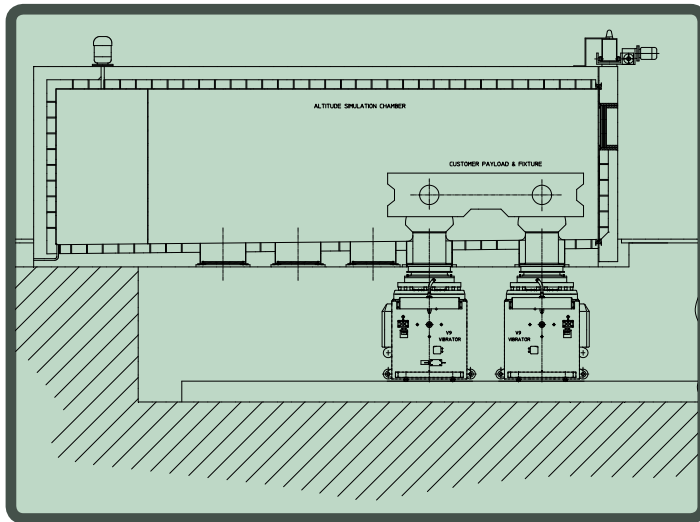
The special pneumatic control stands provide the operator with shaker body and armature position display and control. Shaker armature and body position are automatically controlled to ensure that the whole system remains balanced.

Both shakers can be used either individually or in the standard dual configuration, thanks to LDS Multiple Amplifier Control (MAC) system. Each shaker is driven at a tight amplitude and phase tolerance of the other to ensure consistent application of vibration, minimise cross-coupling and ensure system and payload safety.



# ALTITUDE SIMULATION

The Dual V9 (2 x 105 kN) Vibration Test System has been specially adapted to operate in conjunction with an altitude simulation chamber, to enable testing of large payloads under near-vacuum conditions.



To prevent the vacuum pulling the shaker armature up into the environmental chamber, the shaker is fitted with a special vacuum compensation extender system that provides an opposing force to hold the armature down to its mid-position. In both static and dynamic testing, the shaker armature and body positions are controlled by a special balancing control system.

To ensure the consistency of any vacuum effect, the shaker is sealed to the floor of the altitude simulation chamber, allowing full armature movement within its velocity, displacement and acceleration capabilities.

To allow testing of large payloads, the V9 vibrators are operated in a dual configuration using LDS Multiple Amplifier Control (MAC).



# LOW FORCE RANGE

### Industry applications

- ✓ Modal and structural analysis
- ✓ Electronic assembly testing
- ✓ Laboratory experiments

## Solutions for vibration testing of components, small assemblies, or modal and structural analysis

- Wide frequency range (5 Hz to 13 kHz) combined with high peak forces (8.9 N - 489 N peak sine force)
- Low-mass, high-performance armature construction
- Robust, lightweight suspension system provides excellent torsional and transverse stiffness with minimal impact on acceleration
- Base or trunnion mounted
- Powered by compact, quiet, energy-efficient amplifiers
- Compatible with *COMET<sub>USB</sub>* and *LASER<sub>USB</sub>* vibration controllers

V406 shaker testing camcorder to ensure product reliability during operation



## V101, V201, V406/8, V450 AND V455 SHAKERS

This range of permanent magnetic shakers is ideal for modal analysis. Their efficient armature design enables them to deliver impressive peak forces and accelerations over a wide frequency range.

The shakers are controlled using either the *COMET<sub>USB</sub>*™ or *LASER<sub>USB</sub>*™ system controllers, and are compatible with third-party controllers and amplifiers.

Shaker model	V101 -PA 25E	V201 -PA 25E	V406/8 -PA 100E	V406 -PA 500L	V450 -PA 500L	V455 -PA 1000L
System sine force peak (N)	8.9	17.8	98	196	311	489
Shaker max random force rms (N)	-	-	38	89	214	290
Max acceleration sine peak (g <sub>r</sub> )	140	91	50	100	74.5	117
System velocity sine peak (m/s)	1.31	1.49	1.52	1.78	1.78	2.5
System displacement continuous pk-pk (mm)	2.5	5	14	17.6	19	19
Moving element mass (kg)	0.0065	0.02	0.200	0.200	0.426	0.426
Usable frequency range (Hz)	5-12,000	5-13,000	5-9,000	5-9,000	5-7,500	5-7,500

# LOW-MEDIUM FORCE RANGE

## Vibration testing solutions for modal, structural and component testing

- Wide frequency range from DC up to 6,300 Hz\*
- Peak force ratings from 667 N to 5,115 N
- Lightweight, high-performance armature design (110 mm to 180 mm in diameter) delivers excellent acceleration and velocity performance
- Vertical or horizontal operation
- Optional software allows system tests to be controlled remotely using a PC
- Compatible with *COMET<sub>USB</sub>* and *LASER<sub>USB</sub>* vibration controllers
- Ease of use and power saving features reduce operating costs
- Proven reliability maximises system availability, combined with global servicing and support

\*Control strategy and isolation dependant



### Industry applications

- ✓ Automotive component testing
- ✓ Aerospace component testing
- ✓ Electronic assembly testing
- ✓ Structural testing
- ✓ Modal investigation
- ✓ Vibration stress testing under varied environmental conditions
- ✓ In-house test and calibration facilities



## V555, V650, V721, AND V780 SHAKERS

### Total system solutions

Combining a wide frequency range, high force and high acceleration, this range of air-cooled shaker solutions delivers excellent all-round testing capabilities.

A number of optional extras enable the system to be tailored to suit most applications. Trunnion mounting and slip tables enable both

vertical and horizontal testing, and the addition of a thermal barrier allows for improved product testing under diverse environmental conditions.

The shakers can be controlled using either the *COMET<sub>USB</sub>* or *LASER<sub>USB</sub>* system controllers, and are compatible with third-party controllers and amplifiers.

Shaker model	V555 -PA 1000L	V650 -PA 1000L	V650 -HPA-K	V721 -PA 1000L	V780 -HPA-K
System sine force peak (N)	940	1,620	2,200	2,900	5,120
System max random force rms (N)	640	1,090	1,540	1,900	4,230
Max acceleration sine peak (g <sub>r</sub> )	100	73.7	100	66.3	111
System velocity sine peak (m/s)	1.5	1.4	1.5	0.7	1.9
Displacement pk-pk (mm)	25.4	25.4	25.4	25.4	25.4
Moving element mass (kg)	0.94	2,24	2.24	4.46	4.7



# MEDIUM FORCE RANGE

## Industry applications

- ✓ Automotive parts and systems – qualification testing
- ✓ Electronic assembly – computer equipment testing
- ✓ Avionics and military hardware testing
- ✓ Satellite component testing
- ✓ Product and package testing
- ✓ General stress screening



## Medium and large air-cooled electrodynamic shakers

- V800 - V8 series shaker systems are ideal for sine, random and high-acceleration shock tests, and many more control profiles
- Lightweight yet robust interchangeable armatures give the highest performance with reduced capital cost
- Advanced switching power amplifiers offer high reliability, reduced space requirements, and simple installation and operation
- Systems can be tailored for special applications
- State-of-the-art vibration control system enables remote monitoring and control
- Compatible with *COMET<sub>USB</sub>* and *LASER<sub>USB</sub>* vibration controllers
- Vertical or horizontal operation with optional slip table

Brüel & Kjær offers a full range of accelerometers to complement your vibration test system



## V800-V8 SERIES SHAKERS

### Industry standard for automotive, military and electronic testing

Providing the versatility and capability demanded by research and development, product qualification and stress screening, the V800 - V8 series shaker systems combine superior performance with low capital and running costs.

Shaker model	V830-185	V830-335	V850-240	V850-440	V875-240	V875LS-440	V875LS-640	V875-640EF	V8-440	V8-640
System sine force peak (kN)	8.9	9.8	17.8	22.2	35.6	35.6	35.6	37.8	60	57.8
System max random force rms (kN)	5.78	9.81	13.3	22.2	31.1	35.6	32.5	37.8	66.0	55.6
Max acceleration sine peak (g <sub>r</sub> )	120	75	125	60	163	112	90.9	57.3	140	40
System velocity sine peak (m/s)	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8	1.8	1.8
Displacement pk-pk (mm)	50.8	50.8	50.8	50.8	50.8	76.2	76.2	50.8	63.5	63.5
Moving element mass (kg)	6.98	12.05	14.0	23.8	22.3	32.4	39.9	63.2	42.0	47.0

## High-force long-duration electrodynamic shaker

- Full water cooling, including body cooling, enables prolonged testing at maximum force levels
- Long 76.2 mm stroke allows greater acceleration at low frequencies, combined with higher maximum velocity
- Advanced switching power amplifier offers high reliability, simple installation and easy operation
- Powerful LDS vibration control system enables remote monitoring and control
- Payloads up to 1,800 kg
- Systems can be tailored for special applications such as load-bearing platforms
- Vertical or horizontal operation with optional slip table



# HIGH FORCE RANGE

## V9 SHAKER

### The standard for high-force, long-duration vibration testing

Providing the versatility and capability demanded by production testing and research and development, the V9 shaker system offers exceptional performance combined with low capital and running costs. The V9 shaker offers the highest achievable envelope of testing parameters.

Shaker model	V9
System sine force peak (kN)	105
System max random force rms (kN)	105
Max acceleration sine peak ( $g_r$ )	150
System velocity sine peak (m/s)	3.0
Displacement continuous pk-pk (mm)	76.2
Moving element mass (kg)	49.8
Usable frequency range (Hz)	DC - 2,700*

\*Control strategy and isolation dependant

### Industry applications

- ✓ High-force, long-duration automotive testing
- ✓ Avionics and military hardware testing
- ✓ Low-frequency and shock pulse testing
- ✓ Product and package testing



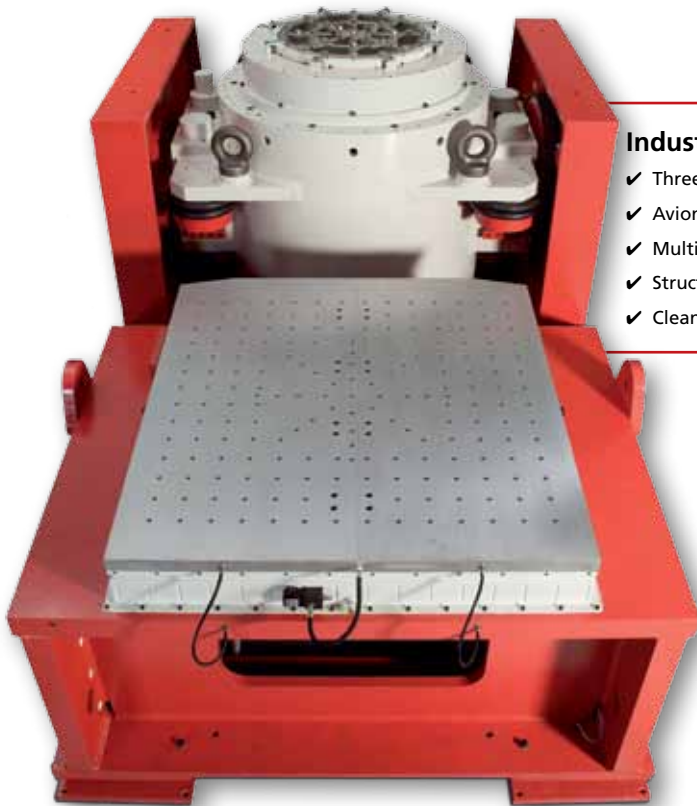
# HIGH FORCE RANGE

## V964, V984, AND V994 SHAKERS

### High force, high reliability

Ideal where large payloads need high performance vibration or shock testing, LDS V900 series shakers give engineers the confidence they need to develop highly reliable products. These systems have been used in single and multi-shaker configurations, and are suited to test products such as satellites and missiles.

The Lin-E-Air shaker suspension system gives excellent isolation, reducing the the shaker's affect on the surrounding environment. An optional guided head expander ensures that loads with off-centre centres of gravity can be tested effectively and safely. The addition of a slip table enables products to be tested in both vertical and horizontal axes. The slip table is also available with a thermal barrier for use in environmental tests.



### Industry applications

- ✓ Three-axis testing of complete satellite systems
- ✓ Avionics and military hardware testing
- ✓ Multi-shaker, multi-axis applications
- ✓ Structural dynamics testing
- ✓ Clean room environments

## High-force electrodynamic shaker

- Peak force ratings from 89 kN to 289 kN – the highest available force of any shaker available today!
- Wide frequency range up to 2,500 Hz
- Combination of high-performance armature design and water-cooled coils delivers excellent acceleration and velocity performance
- Automatic armature and body position load compensation system ensures larger loads can be comfortably accommodated
- Trunnions feature Lin-E-Air suspension system as standard, resulting in improved low-frequency performance and providing air isolation from test vibration
- Rolling strut armature suspension system provides up to 50.8 mm displacement for sine operation and 63.5 mm for transient pulses
- Vertical or horizontal operation, with optional slip table
- Thermal barriers available for all systems for improved environmental test capability
- Compatible with *COMET* *USB* and *LASER* *USB* vibration controllers



Mars Mission satellite testing.  
(Photo courtesy of NASA/JPL-Caltech)

Shaker model	V964 - DPA-K	V984 - DPA-K	V994 - DPA-K
System sine force peak (kN)	89	160.1	289.1
System max random force rms (kN)	89	160.1	266.9
Max acceleration sine peak (g <sub>r</sub> )	100	100	75
System velocity sine peak (m/s)	2.0	2.0	2.0
Displacement continuous pk-pk (mm)	38.1	38.1	50.8
Moving element mass (kg)	59.0	130.2	254.9
Usable frequency range (Hz)	DC-2,500*	DC-2,000*	DC-1,700*

\*Control strategy and isolation dependant

# AMPLIFIERS/REPLACEMENT AMPS

The LDS line of linear and digital switching amplifiers offers energy-efficient and robust operation for power requirements up to 280 kVA.

The standard SPA-K range of amplifiers can be used to power legacy LDS and third-party shakers, and include a unique remote control capability that allows the user to control the amplifier remotely via a PC.

#### **SPA-K & HPA-K switching power amplifiers**

These amplifiers power air-cooled electrodynamic shakers and come with integral field power and blower power supplies, and range from 8kVA to 176kVA.

The HPA-K amplifier is designed for use with V650 and V780 electrodynamic shakers.

#### **DPA-K switching power amplifiers**

Designed for use with water-cooled electrodynamic shakers, DPA-K amplifiers offer a maximum power output of 280kVA, providing optimum performance for your vibration test system.

#### **PA 100L - PA 1000L linear power amplifiers**

Compact standalone amplifiers designed to support LDS vibration test systems power both permanent magnet shakers and small electrodynamic shakers. Both are used with a separate field power supply when required.





# VIBRATION CONTROLLERS

## COMET<sub>USB</sub> VIBRATION CONTROL SYSTEM

### Economical for production testing with the performance for R&D testing

Offering high performance at a very affordable price, the COMET<sub>USB</sub> Vibration Controller is an ideal solution to the everyday demands of your shock and vibration testing. COMET<sub>USB</sub> provides the flexibility to perform random, swept sine and shock testing on electrodynamic shakers. Easy-to-use software together with extensive automation features make it a perfect fit for vibration stress screening and production testing applications.

## Powerful, flexible and economical vibration controllers

LASER<sub>USB</sub> and COMET<sub>USB</sub> bring vibration testing into the new era of USB connectivity

### LASER<sub>USB</sub>

- Full capability for vibration control, data analysis and signal/modal analysis
- Kurtosis control and fatigue monitoring reduce test time and improve product reliability
- Multi-channel with 2 to 16 channels for multi-point control, limiting and analysis
- 24-bit resolution with programmable voltage ranges provides wide dynamic range to control highly dynamic structures
- Processing independent of the host PC with fast loop times for the ultimate in performance and safety
- Amplifier and thermal chamber interfaces for seamless lab integration

### COMET<sub>USB</sub>

- Very economical yet suitable for random, sine and shock tests
- Simplified or advanced user interfaces are suitable for different operators and tests
- Setup wizard for error free test setup



COMET<sub>USB</sub> offers the convenience of USB 2.0 connectivity and is an economical controller for random, sine and shock testing.



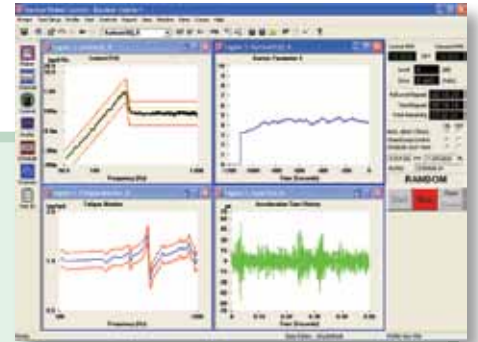


*LASER<sub>USB</sub>* has a USB 2.0 interface for easy PC connectivity, while its multiple DSP processors handle the control loop independently of the PC host.

## LASER<sub>USB</sub> VIBRATION CONTROL SYSTEM

**Delivering what test engineers demand: Convenience, performance, flexibility and safety**

*LASER<sub>USB</sub>* is the ideal controller for your test lab as it combines convenience, performance, flexibility and safety. It offers 24-bit precision with wide control dynamic range, and fast loop times to provide superb control for your most challenging tests. *LASER<sub>USB</sub>* is also a highly flexible answer to your test needs with full capability control and analysis software applications for random, swept sine, resonance dwell, classical shock, random on random, sine on random, shock SRS, and field data replication. Advanced technologies such as kurtosis control and fatigue monitoring reduce test time and increase the reliability of your product. One-click reporting makes it quick and easy to create comprehensive reports for your design group or customer, and special active reports allow you to re-scale, zoom, or cursor any data plots within a Microsoft® Word® report document.



### Lab integration

*LASER<sub>USB</sub>* can make your lab more efficient with capabilities that integrate and coordinate all of your test equipment. The Amplifier Controller software option allows control of an LDS SPA-K amplifier from the same PC used to run the vibration control software. A seamless connection with the control software of many popular chamber makers is provided by the Chamber Interface option.

NET-Integrator provides ActiveX commands that interface vibration control applications with user programs. This capability makes it possible to develop simple user interfaces and automate complex test procedures.

### Advanced technologies

***Kurtosis control for better real world simulation*** – The capability to specify kurtosis, the ‘peakedness’ of a random signal, provides for better simulation of real-world environments. Tailoring kurtosis is also important to accelerate fatigue tests.

***Fatigue Monitor protects test article & shaker*** - Offering an unprecedented level of protection, the Fatigue Monitor detects looseness or fatigue in the product, fixture or shaker system.

# PULSE – YOUR SOUND & VIBRATION ANALYZER PLATFORM



Developed as an advanced solution for sound and vibration measurement, Brüel & Kjær's PULSE™ is the analyzer platform of the future. With its vast range of software applications and hardware configurations, PULSE is the most popular analyzer solution in the world today with more than 10,000 systems delivered.

### Data acquisition

With PULSE LAN-XI front-ends, your data acquisition setup is scalable from 2 channels to more than 1000 – with an analysis measurement bandwidth of up to 100 kHz. PULSE LAN-XI front-ends support one-cable operation where both synchronisation (PTP), power (POE) and data transfer, is achieved using a standard ethernet cable. PULSE LAN-XI front-ends can even synchronise with your existing PULSE IDAe front-ends, allowing modular expansion of existing systems.

### Real-time

The real-time capability of PULSE means there is the closest possible link between cause and effect. You see your analysis results instantaneously on-screen as they are measured, enabling you to validate your data immediately.

### Multi-analysis

PULSE allows you to perform FFT, 1/n-octave (CPB), order, and overall analyses simultaneously on the same or different channels/signals while displaying real-time results on screen – and even storing the acquired time data.

### Post-processing

With Brüel & Kjær's range of post-processing products – PULSE Reflex™ – you get powerful, workflow-orientated post-processing tools with integrated time data editing and an extremely flexible display function.

### Reporting

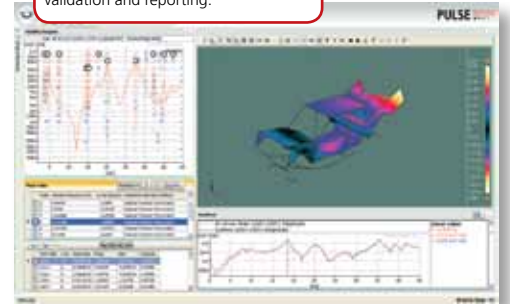
PULSE Reflex with built-in support for Microsoft® Word®, Microsoft® Excel® and Microsoft® PowerPoint® makes reporting easy whether it is for a meeting or a report.

### Solid foundation

The flexibility of PULSE combined with industry-specific solutions has made PULSE the best-selling analyzer platform in a wide range of industries, including:

- Automotive
- Electroacoustics and telecommunications
- Aerospace and defence
- Consumer products

PULSE Reflex Modal Analysis guides you efficiently through measurement validation, parameter estimation setup, mode selection, analysis validation and reporting.



Type 4524: a lightweight triaxial piezoelectric accelerometer.

Images courtesy of CTAG



# SERVICE

Your choice of a service partner is as critical as your choice of system. Effective maintenance and adequate training are vital if you are to get the most out of your investment.

To make sure all our customers worldwide have access to professional services and training resources, Brüel & Kjær has developed a market-leading support network.

Whether installing a system for the first time or maintaining existing equipment, reliability, efficiency and investment protection will naturally be high priorities. Brüel & Kjær understands the cost implications of downtime and appreciates that no two users' needs are identical. We can provide a portfolio of support services which can be carefully tailored to complement your own resources, meeting your needs and budget and ensuring compliance with all necessary safety directives.

### Your needs, our commitment

The prime goal of Brüel & Kjær's support services is to ensure that your system is fine tuned to your needs, and that any problems are resolved quickly.

## Consider the benefits

- Complete range of high quality support services
- Site surveys, installation, commissioning and decommissioning warranty plans
- Personalised maintenance contracts from simple factory repairs to a complete on-site system strip-down
- System modifications and upgrades
- Spares service





# UNIVERSITY



Brüel & Kjær University offers both standard and custom training courses for established or new vibration test engineers. Regular scheduled courses are held globally, while custom on-site courses can also be arranged explaining how to interpret specific vibration test specifications and apply them to customers' vibration test systems.

Brüel & Kjær provides you with complete solutions that are ready to run. Even though they are designed for ease-of-use, we offer specialised training for your people to become real experts in less time.



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