



Brüel & Kjær Vibration Test Systems (VTS)

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Abstract

A comparative information about vibration test systems by Brüel & Kjær is presented in the article.

Keywords: vibrations, systems, shaker

1. Introduction

Founded in 1942, Brüel & Kjær Sound & Vibration Measurement A/S has grown to become the world’s leading supplier of advanced technology for measuring and managing the quality of sound and vibration. Brüel & Kjær uses core competences and comprehensive range of products and solutions to help customers solve sound and vibration challenges. Since the 1950s, their products have set the standard to which others are compared.

From high-force LDS electrodynamic shakers to palm-sized modal and measurement exciters, Brüel & Kjær offers a wide range of vibration test solutions. Brüel & Kjær also have a large selection of dedicated power amplifiers and vibration controllers, as well as matching slip tables, head expanders and thermal barriers, to meet all vibration testing needs – whether it’s testing electronic components for mobile phones to complete satellite systems.

Brüel & Kjær’s world-renowned experts provide comprehensive staff training onsite and online. And it’s all backed up with dedicated service personnel trained at Royston LDS shaker factory in the UK.



Figure 1. LDS shaker factory Royston (UK)

2. Vibration test

Vibration testing is done so it can be introduced a forcing function, usually with the use of vibration test shaker or vibration testing machine. These induced vibrations, vibration tests, or shaker tests are used in the laboratory or production floor for a variety of things, including qualifying products during design, quality assurance, life test, transport test, prototype evaluation, reduce time-to-market, meeting standards, regulatory qualifications, fatigue testing, screening products, and evaluating performance.

Vibration test helps by answering a lot of critical questions like:

- Can 100kg stellite take the excessive vibration level of being launched into space?
- Can HEV battery sustain 250,000 km of road life?
- What is the operational service time for a jet engine turbine blade?
- Can we choose the cheapest mounting principle for this printed circuit card?
- Will this type of package material ensure that a flat – screen TV arrives safely at its destination?

Dynamic measurements and vibration testing are necessary, because static measurements of stress/strain properties are not sufficient for the demands of high speed operation and the use of light structures in modern machinery. By doing this we ensure that the products we are using are going to survive real – life conditions. [1]

3. Vibration test systems

Brüel & Kjær helps performing the most complex vibration tests to ensure the integrity and reliability of products. The company comprehensive range of LDS electro – dynamic shakers are designed for vibration testing of devices of practically any size – from a semiconductor component to a complete satellite system. Combined with world – class data acquisition systems and analysis software suites, Brüel & Kjær offers the complete vibration testing solution and also provides vital service and staff training to maximize the operation of your vibration test system.

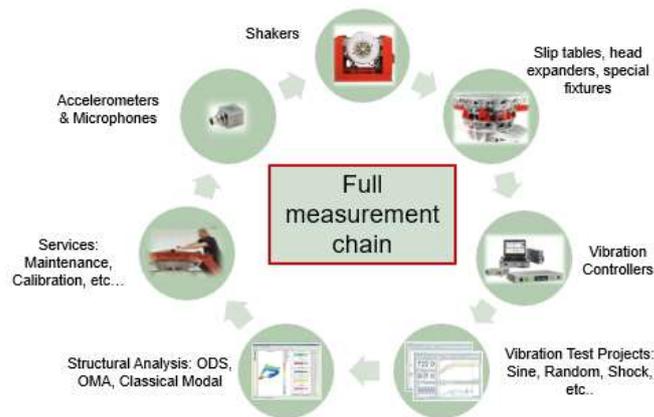


Figure 2. Full measurement chain of vibration test system

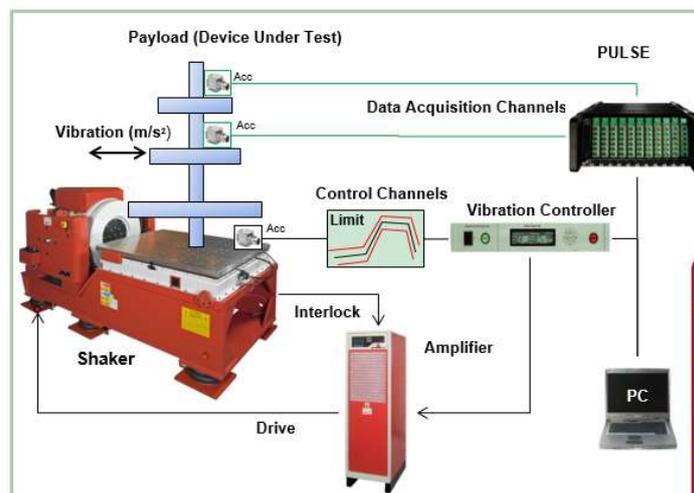


Figure 3. Vibration test system

Durability and fatigue testing:

- Sine, Random, Shock and SoRRoR;
- Resonance searches;
- Transportation testing;
- HALT testing;
- IEC 60068-2-64.

Brüel & Kjær comprehensive array of exciters and LDS shakers covers applications throughout the entire spectrum of vibration testing and modal and structural analyses. The product range of vibration test systems is split in four sections: small, medium, large and very large vibration test systems.

Small systems characteristics:

Type: Permanent magnet vibration test system:

- Permanent magnet construction;
- Low mass, high performance armature construction;
- Well-proven armature suspension system;
- 9 N to 489 N force;
- V101 to V455;
- Modal and structural analysis;
- Electronics assembly test;
- Calibration systems.



Figure 4. Permanent magnet – small vibration test system

Medium systems characteristics:

Type: Air – cooled vibration test systems:

- Air – cooled vibration test system;
- V555 – V780;
- 940 N to 5.1 kN force;
- Lightweight, high – performance armature design;
- Choice of amplifiers – linear or switching;
- Easy self – installation design;
- Automotive component testing;
- Aerospace component testing;
- Electronic assembly testing;
- Vibration stress testing under varied environmental conditions.



Figure 5. Air-cooled vibration test system – medium

Large systems characteristics:

Type: Air – cooled vibration test systems:

- High strength, low mass armature, Up to 76mm continuous displacement;
- High force, long duration testing;
- 8.9kN to 60kN force;
- V830 – V8;
- Automotive parts and systems – qualification testing;
- Avionics and military hardware testing;



Figure 5. Type: Air-cooled vibration test system – large

- Satellite components testing;
- Electronic assembly computer;
- Product and package testing.

Very large system characteristics:

Type: Water – cooled vibration test systems:

- High force, long duration testing;
- Space, avionics and military hardware testing;
- Product and package testing;
- 3 – axis testing of complete satellite systems;
- Multi – shaker, multi – axis application;
- Suitable for clean room environments;
- V9 – V994;
- 89kN to 289kN force.

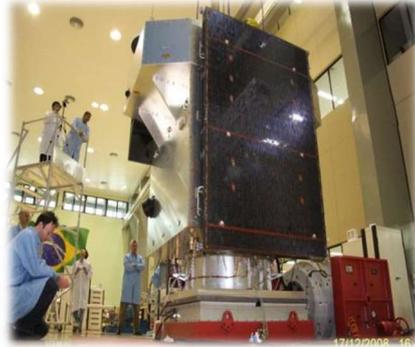


Figure 7. Water – cooled vibration test system – very large

Testing with respect to gravity

Typically a fixture will support the product for all 3 axes and thus a test can be applied using a vertical shaker only. However if the UUT has a requirement to be tested with respect to gravity (e.g. filled water tank), a slip table shall be used. A slip table can be designed in many sizes and their overturning moment specifications are depending of the used bearing technology and number. There are two main slip bearing technologies:

- Low Pressure Table

Low pressure table (LPT) uses standard low pressure journal bearing, magnesium alloy plate floating on an oil film above a granite block.

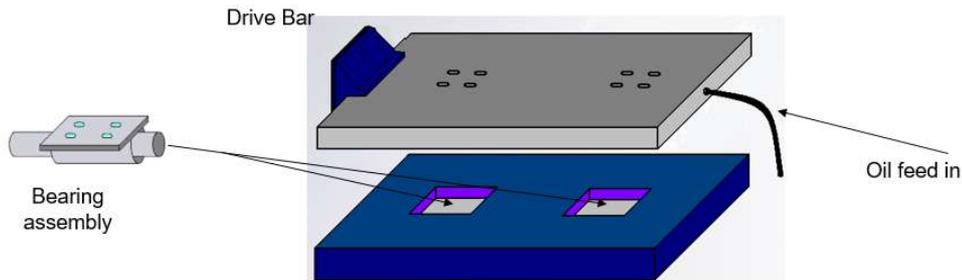


Figure 8. Low Pressure Table (LPT)

- Hydrostatic Bearing Tables

Hydrostatic bearing tables (HBT) uses special high pressure journal bearing, magnesium alloy plate floating on an oil film above a granite block. Using high pressure oil (172bar) through the bearing, and a clever multi – bearing arrangement on an HBT slip plate, the all specifications are improved.

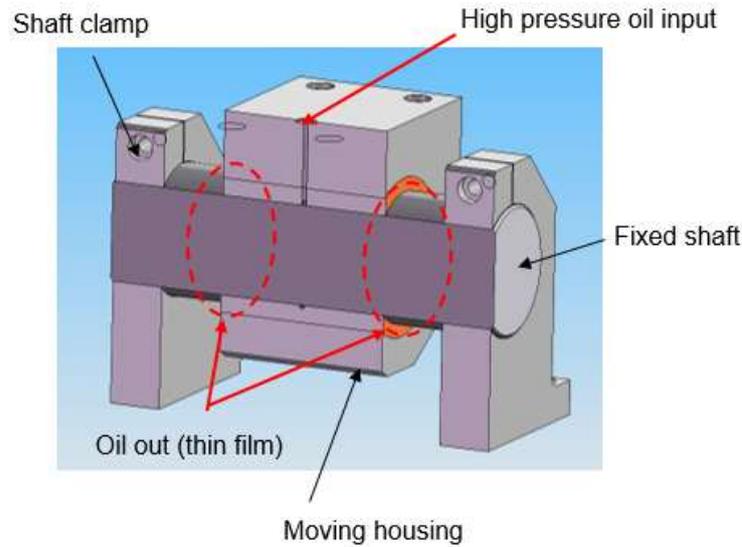


Figure 9. Hydrostatic Bearing Tables (HBT)

	LPT600	HBT600
Slip plate working area, mm	600 x 660	600 x 660
Slip plate thickness, mm (nominal)	37	37
Slip plate mass, kg (nominal)	29.7	28.9
Number of bearings	2	2
Moving mass of each bearing, kg	1.0	4.5
Maximum stroke (metal to metal), mm	91	91
Table pitch moment, kN m	6.1	23.7
Table roll moment, kN m	5.1	21.3
Table yaw moment, kN m	0.46	19.0
Maximum table load, kg	500	4250

Figure 10. Comparison of overturning moment restrains (V875LS)

4. Vibration test systems isolation, support, barrier

Lin – E – Air isolation:

The Lin-E-Air air isolation system by Brüel & Kær VTS provides excellent isolation between the shaker and the mounting platform (and hence the building floor), allowing tests to be conducted at frequencies as low as 5 Hz. The additional air isolation between the platform and the building floor further reduces the requirements and costs of seismic bases for simple tests. However, systems used for high-force shock testing and low frequency applications requiring maximum displacement can be isolated from the building by removing the Lin-E-Air suspension, and rigidly fixing the trunnion-mounted shaker to a seismic mass which itself is isolated from the building. This allows tests to be conducted below the 5 Hz limit imposed by the air suspension.

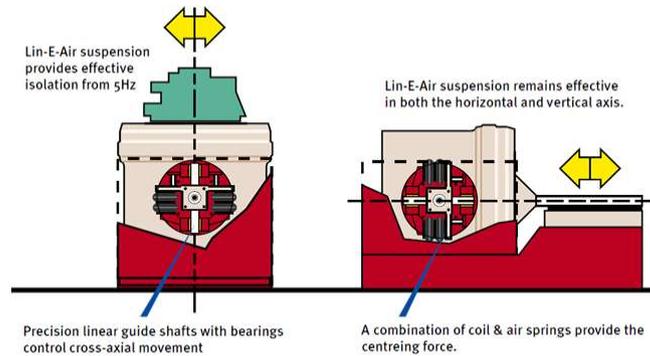


Figure 11. Lin-E-Air body isolation

Air isolation mounts:

To isolate the combo from the floor, the base assembly is supported as standard on air isolation mounts. Two manual regulators control the air supply to the isolation mounts. One regulator supplies the mounts located under the vibrator while the other supplies the mounts located under the slip table.

The two regulators should be adjusted to raise the combo by approximately 12 mm (½ in) at each mount. Before operating the slip table, an engineer’s level should be used to check that the table is perfectly level; minor adjustment of the regulators may be required. Each isolation mount here above incorporates a safety stop which prevents the base fabrication being lowered when the air isolation mounts are deflated to such an extent that a human foot could be crushed between the combo and the floor.

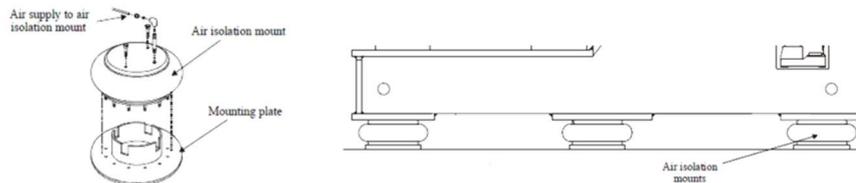


Figure 12. Air isolation mounts

Internal load support:

Available displacement is a major limitation on what shock pulses can be achieved, and therefore long stroke exciters have a clear performance edge. The exciters have an Internal Load Support System (ILS) which adds no unnecessary mass, and does not limit maximum acceleration levels or frequency range. Apart from supporting heavy test loads without external aid, these ILS systems allow the armature datum to be positioned at one extreme of the available travel, to get maximum performance with controllers that use pre- and post-pulse conditioning.

Thermal barrier:

When operating a slip table in conjunction with a climatic chamber it is normal practice to fit a thermal barrier to the slip plate in order to reduce thermal transfer from the chamber to the slip plate. This reduction, combined with the heat sink effect of the slip table granite block, allows short duration tests (up to approximately 90 minutes) to be performed without any control of oil temperature. At higher temperature, or if the test time is to exceed 90 minutes, it will be necessary to maintain the temperature of the slip plate within acceptable limits. This is achieved by the use of a special hot/cold oil supply combined with special ‘gundrilled’ holes in the slip plate as described further.

5. Vibration test controllers

Brüel & Kær has wide range portfolio of controllers and some of them are:

a) *COMET USB*

- 2 channels;
- Sine, Random and Shock.

b) *LASER USB*

- 4 – 16 channels;
- Mixed mode, kurtosis, SRS and Resonance search;
- Amplifier control and chamber interface.

c) *VC – LAN*

- Scalable (64-ch.): combine smaller controllers to one large one;
- Waveform recording and replication;
- Built – in charge support.

6. Case studies

Case study number: 1

- For satellite production testing – vibration sine testing, shock response and modal analysis.
- For company INPER – a research unit of the Brazilian Ministry of Science and Technology and the civilian research center for aerospace activities.
- Case studying a 160kN shaker combined with a very large PULSE system (320 – channels).

Case study number: 2

- Doing it for pre – production qualification and functional test for electric and hybrid vehicles, also heavy – duty, durability, testing and simulating the whole lifetime of the car which means continuous testing for several days at very high vibration levels and extreme temperature conditions.
- For company named General Motors – one of the world’s largest automakers, with roots going back to 1908.
- Case studying a LDS V8 – based system, test capacity 60kN Random and Sine and Payload ~ 250 kg.

Case study number: 3

- For electronics transportation testing by simulating the journey of products from manufacture to a customer’s home.
- Doing the case study for the company Foxconn – one of the world’s principal contract manufacturers of electronic products and equipment.
- Case studying a load bearing platform and V8 shakers.

7. Conclusions

Brüel & Kær’s mission is to find long – term solutions for their customers sound and vibration challenges. The company also provides vibration test systems solutions that are ready to run. They are designed to be ease – of – use and they come with specialized training for the customers that are going to use the system, so they can become real experts in less time.

References

1. Brüel & Kær, <https://www.bksv.com/media/doc/br0227.pdf>
2. Brüel & Kær, <https://www.bksv.com/media/doc/bf0223.pdf>