

A decorative graphic consisting of multiple thin, white, wavy lines that flow horizontally across the middle of the page, creating a sense of motion and complexity.

ENVIRONMENTAL SIMULATION AND CONFORMITY EVALUATION

Vibration tests for an easier market access

VIBRATION TESTS FOR AN EASIER MARKET ACCESS

Vibration tests as a part of environmental simulations, are common and crucial part of quality management and product safety monitoring during the early stages of development.

Products on their way to the market must pass various tests before they may be sold. These tests can be regulatory on the one hand but they also can be important for the internal quality assurance. Examples for such measurements might be EMC (Electromagnetic Compatibility), Electrical Safety, Radio measurements or environmental simulations. Examples for environmental simulations are temperature, corrosion or humidity and so on. Vibration tests are an important part of the environmental simulation. Many settings can be simulated in the area of vibration tests. What is needed for every scenario is a Vibration Test system, colloquially called a "Shaker". Different Shakers are used for different standards.

IEC 60068-2-6	Oscillation, sinusoidal
IEC 60068-2-64	Broad band noise, Random
IEC 60945	Maritime Navigation / Radio
UN 38.3	Vibration, Shock for Li-Ion Batteries
MIL-STD-810	Environmental Measurements / DEPARTMENT OF DEFENSE

In particular Transportation type products are especially important candidates to vibration testing. Standards which simulate transport situations are often low frequency excitations. The shaker generates sinusoidal vibrations for transport tests. Depending on the demands, the product is tested in its packaging or on a palette. Besides the standards which are developed by the logistic industry, there are a few laws and regulations in Germany which rule the area of transport of dangerous goods, such as the dangerous goods regulation for transport on street, railway and inland water transportation (GGVSEB), the dangerous goods regulation for maritime transport (GGV-See) or the regulations for air transport (LuftVZO).



The main focus of vibration tests is the safety aspect as it provides assurances to the quality of the product.

Depending on the application, transportation of the product is the easiest challenge. The practical use of every product should be safe and reliable. For the very different applications of a product (for example maritime transport, air transportation or mechanical engineering) there are appropriate standards available. If no standard is available, a manufacturer may benefit from their Know How and create their own test specifications which reflect the application of their product perfectly.

To save costs, weight, and to reduce noise emission, the automobile industry is interested in keeping its components as light as possible. To verify these special components, OEMs differ 15 locations in a car where the product might be installed. As different as the location are the excitation profiles (Which acceleration at what frequency?) which are applied.

- engine compartment
- engine
- gearbox
- door
- cargo bay, trunk
- trunk lid, tailgate
- interior, cabin

Often climatical conditions are part of the simulations in the automotive industry. Therefore the temperature is lowered down to -40°C , the test sample stays several hours at this temperature and then temperature is raised up to $+70^{\circ}\text{C}$. If wished or required according to the applicable standard, the humidity is controlled in the climatic chamber. The excitation profile of the shaker is rather a broad band noise than a sinusoidal signal. For this signal many sinusoidal signals are overlaid to generate one broad band noise signal. Measurements on real objects are recorded in a wide frequency range (from 5 to 2000 Hz) to be simulated by the shaker. To investigate potential material fatigue, resonance analysis is made before and after the measurement. By means of this analysis conclusions on the quality and the toughness of a material can be drawn. The ISO 16750 standard is a good reference for components with application in road vehicles.

A resonance analysis is also useful for the inspection of products with their application in the maritime area. Mostly low frequencies are used for endurance tests of these products to simulate the slow turning motors or propellers. If a product under test shows resonances in a particular frequency range, these are examined for longer terms. With this long time examination it is ensured that there is no failure caused by material fatigue even in the worst-case scenario.

Mechanical shock has a special attention in products used for air traffic. Vibration tests as we know them today are used for many industries beginning in the 40's and 50's of the last century in the air traffic industry. Planes have to be rigid and flexible to the same degree. Their lifetime should be more than 25 years and they should withstand every kind of turbulences. When the change from classical piston engines came to turbine engines, there was the need for a set of new test profiles for shaker. In order to reproduce realistic effects, combinations of sinusoidal and broad band noise signals were applied. This gave the chance to simulate strains

of broad band noise together with the special strains of the gear which is simulated by the sinusoidal signal. Accidents, such as the failure of a turbine blade or crack of the propellers, can be simulated with special profiles. Especially when there is a damage at the gear, the whole system can become out of balance and this scenario can be simulated by such tests.



Electrodynamic vs. Induct-A-Ring

Conventional shakers work with electrodynamic engine. On principle, the setup is the same than the structure of a loudspeaker. The moving coil in the magnetic field is activated with the help of an audio amplifier. When there is a signal on the moving coil, it moves by the electrical interdependency inside the static magnet field to the outside. Depending on the working area, the outer magnet field can be generated by a solid body or by a coil. The coil itself can be cooled by air or water. The disadvantage of this conventional gear is that all components of the product are stressed under the test profile used for the test case. This constant excitation causes material fatigue, limitation of amplitude and the limitation of the overall performance.

Shaker tests are of importance for several product types and do not only have a regulatory background. Internal quality management and the inspection of house standards are reasons to perform vibration tests.

A US company developed a new technology in the 70's. This new development eliminates the disadvantages of the conventional moving coils by using a new invention. The moving coil is now made out of a single solid aluminum winding. From the outside, alternating current is inducted through the coils. This current causes the movement of the moving element. Manufacturing of this new technology is more expensive on one hand but the advantages dominate. The gears have a lower weight so that a higher weight of the product under test is possible. A shaker with Induct-A-Ring technology has less moving parts which might deteriorate. This new shaker can be operated at very high temperatures up to 250°C. Conventional Shakers reach their temperature limit at about 120°C. Last but not least, shakers with this new technology provide a much higher shock performance than classic ones.

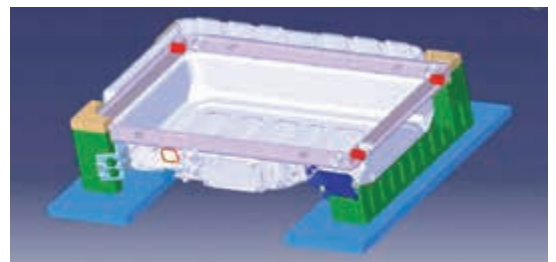
Profiles according current standards or on customer request

When there is no standard applicable, a specification by the customer describes the excitation profile a product is exposed by transport or the intended use.

With these tests, it is ensured that there is no danger or early blackout caused by the product.

Possible profiles for a scope of inspection are:

- Sine wave
- Multi sine wave
- Broad band noise
- Sine wave with broad band noise
- Broad band noise with broad band noise
- Shock
- Shock response spectrum

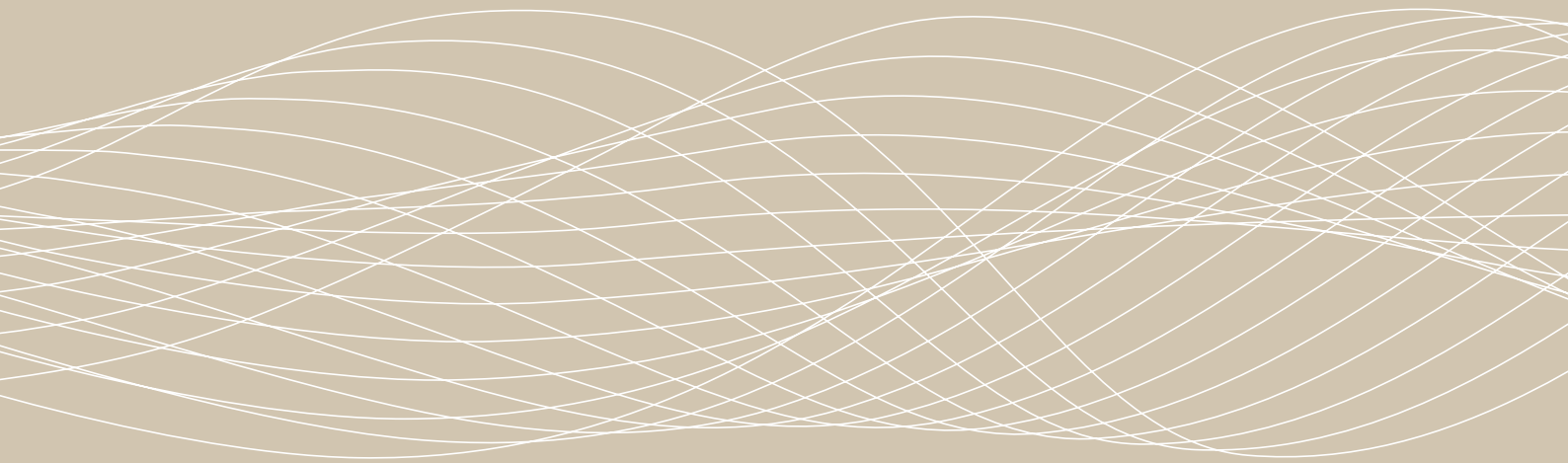


It is very important to have a fixture to mount the product under test on the shaker available, which fits perfectly. When there is no suitable fixture available, it is possible to design and engineer one. With the help of CAD-pictures form-fit fixtures can be designed which work resonance free and which offer a perfect force transmission. The size of the mounting table plays a major role here. With a large mounting table, it is possible to have plenty of products run through the test. With the additional expense of the construction of a fixture a customer can save test times and effort, so that this additional expense is profitable.

Shaker measurements for all kind of products

The field of application for Shaker measurements is manifold and not only limited for the before-mentioned transport industries. Several products from nearly any industry can be tested by a suitable excitation profile. Examples for other industries are batteries (cells, modules, battery systems) as well as consumer products such as power tools or multimedia products or means of transport like pedelecs e-bikes.

Further products which can benefit from shaker tests to make them safer and better are radar systems, devices for medical use, optical or laser systems, products with valve technology, storage technology or control units. All these products can be used under more difficult conditions by transport or intended use. To pass the vibration tests, even outside of regulatory frameworks, increases the quality of a product regardless of which industry the product is used.



ABOUT CETECOM

Besides testing familiar standards like GSM, WCDMA, LTE, CDMA, Bluetooth, Wi-Fi and NFC, CETECOM also performs a wide range of consulting and testing of mobile software applications, OTA antenna, SAR, EMC, acoustics and batteries. In addition, CETECOM supports new developments in the markets of "Internet of Things", especially for the domains of connected car and smart energy. CETECOM also participates in the development of global standards and test specifications.

CETECOM is also member of the German Energy Storage Association (BVES) and offers diverse services in the area of battery and environmental testing. Our battery and environmental laboratory is equipped with three Shaker (one LDS Shaker, two Unholtz-Dickie Shaker) and copes with the miscellaneous test profiles due to the additional use of a conditioning cabinet with its movable cover to perform temperature tests. If necessary, we can also access our in-house crash course.