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measure. analyze. innovate.

Extremely robust miniature sensors for lunar missions

Space travel places extreme demands on technical equipment – sensors uncover vulnerabilities

Temperatures above boiling point in the sunlight and in the shock-freezing range in the shade – these are normal, everyday conditions on the moon. Space is the environment that presents the most challenging possible conditions for technical equipment. In order for spacecraft to withstand these extremes and safely transport their crews, simulation tests are performed to guarantee reliability before the launch. And Kistler sensors, which are just a few millimeters in size and can brave even the harshest conditions, are the main focus of these tests.

Aerospace engineers are constantly walking a tightrope: extreme temperature ranges, major pressure fluctuations and high levels of vibration require durable materials that can make it through missions lasting several months without maintenance. Astronauts need enough room to live and carry out their research. At the same time, every additional gram of weight means more fuel is needed. Designing rockets is challenging – particularly because it is impossible to test them under real conditions: once the first engine ignites, there's no turning back. This is why realistic simulations are used to guarantee safety on board. Testing equipment plays a decisive role in these simulations and must meet the strictest requirements both in terms of accuracy and reliability.

Crucial tests under extreme conditions

The main sources of stress on the materials are constant micro-vibrations and temperatures of up to 1,000°C around the engines. To sound out the limits, numerous aerospace research centers around the world rely on measurement technology from Kistler. Kistler sensors provide highly accurate measurements despite challenging conditions. They contain a quartz crystal that releases an electrical charge when a force is applied – and the charge is proportional to the force. Charge amplifiers make it possible to measure the pressure.

Let's take, for example, a lunar mission: in this case, the European Space Agency (ESA) has been contracted by NASA to construct a propulsion module. When it comes to the most critical components, even minor deviations could result in major catastrophe. The focus is on the fuel valves in particular: the faster they open or close, the stronger the pressure surges will be. If the pressure rises above a specific limit, it could damage the fuel lines or relevant components – or, in the worst-case scenario, result in a fatal explosion.

The ESA's test model for the simulations is equipped with numerous sensors from Kistler that measure the pressure in the fuel lines. This makes it possible to determine the optimal closing speed

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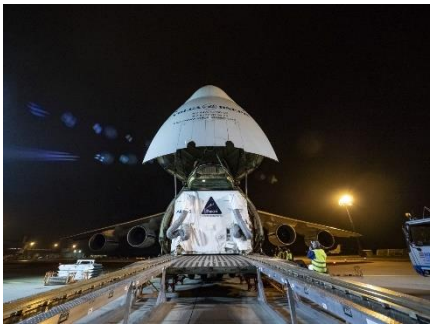
for the valves. So that these highly accurate sensors fit into the limited space inside the engines, they measure only five-and-a-half millimeters – and yet, despite their minuscule size, they guarantee the survival of the astronauts on board.

Razor-sharp images

Challenges in spacecraft design are not always immediately life-threatening, but even seemingly mundane issues can jeopardize the success of a mission. For example: unlike photos intended for personal use, blurred images on space expeditions can put the entire research project at risk. In the early years of space exploration, constant vibrations repeatedly caused cartographic imaging instruments to fail.

Given the long exposure times required for these images, even minimal vibrations can result in blurry photographs. These kinds of vibrations are barely perceptible by humans. They only become evident when photos are of low quality or cannot be used at all. In order to discover which instruments are permanently vibrating before the start of a mission, force sensors from Kistler are used to detect these types of micro-vibrations. This allows engineers to cushion the components in a targeted manner – so razor-sharp images are guaranteed despite challenging external conditions.

Image material (please name the Kistler Group as the picture source)



Ready for countdown: the engine module built by ESA and Airbus arrives at the Kennedy Space Center. (Source: NASA)

The piezoelectric pressure sensor Type 601C from Kistler delivers high-precision measurements, even at temperatures in the high-triple-digit range.

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NASA is installing additional components (such as the main engine) in the test module and is conducting acceptance and hot-fire tests. Sensors from Kistler also provide essential information for these tests.

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About the Kistler Group

Kistler is the global market leader for dynamic pressure, force, torque and acceleration measurement technology. Cutting-edge technologies provide the basis for Kistler's modular solutions. Customers in industry and scientific research benefit from Kistler's experience as a development partner, enabling them to optimize their products and processes so as to secure sustainable competitive edge. Unique sensor technology from this owner-managed Swiss corporation helps to shape future innovations not only in automotive development and industrial automation but also in many newly emerging sectors. Drawing on our extensive application expertise, and always with an absolute commitment to quality, Kistler plays a key part in the ongoing development of the latest megatrends. The focus is on issues such as electrified drive technology, autonomous driving, emission reduction and Industry 4.0. Some 2,200 employees at more than 60 facilities across the globe are dedicated to the development of new solutions, and they offer application-specific services at the local level. Ever since it was founded in 1959, the Kistler Group has grown hand-in-hand with its customers and posted sales of CHF 466 million in 2019. About 7% of this figure is reinvested in research and technology – with the aim of delivering better results for every customer.