maxon motor Australia Pty Ltd
Unit 1, 12-14 Beaumont Rd.
Mount Kuring-Gai NSW 2080

Tel. +61 2 9457 7477
sales.au@maxongroup.com
www.maxongroup.net.au

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Press Release

The challenges a DC motor faces on Mars.

The atmosphere and environment in outer space is unforgiving, hence the need for precision DC motors to meet extremely high quality standards when embarking on a trip to other planets.

Every Mars DC motor from maxon is based on a catalogue product and is modified for the specific mission. This is because the DC motors, gearheads, and encoders face brutal conditions during liftoff, the long journey through space, and the mission on the Red Planet. Robin Phillips, Head of maxon's Space-Lab, explains the properties a drive needs to have to qualify for a journey to Mars.

Vibration and shock

The first challenge is to survive the rocket launch. During this time the motor must be resistant to shock and vibration. The vibration is not as strong as people might think: A little more than on a passenger plane, but not much more, and only for a few minutes. Shocks, on the other hand, are something that we need to deal with on a regular basis when working with standard products. These occur mainly during staging, which is when the first stage separates from the rest of the rocket. The resulting forces would destroy normal motors because the rotor would become separated from the stator. That's why we need to reinforce our drives, for example by encapsulating the rotor and using special welds, special retaining rings, and optimised materials.

Vacuum and radiation

The trip to Mars takes about six months. During this time, the DC motors need to survive the vacuum and radiation. The most damaging radiation doesn't come from the Sun, but from high-energy particles from outside the solar system, which can damage the electronics. That's why we need specially hardened electronics for the Hall sensors on the motors. To be extra safe, we install them in pairs for redundancy. In a vacuum, the durability of components is important. You can't use a glue that undergoes changes in its chemical properties and loses its adhesiveness after a few days in a vacuum.

Weight reduction

Rockets can carry only a limited mass to other planets. To be as light as possible, we also resort to unusual shapes and use thinner housings, or titanium instead of steel. We also often use the smallest possible DC motor sizes, because we know that the operating time required is usually shorter than for industrial applications. Higher wear is therefore acceptable.

Atmosphere of Mars

After arriving, the DC motor must work faultlessly for the entire duration of the mission: Due to the thin atmosphere, the lubricants need to be resistant to outgassing and need to retain their properties. Especially for brushed DC motors, it is also necessary to use the right brush mixture. No patina forms on Mars, which

is why we developed special brushes impregnated with a lubricant (silver graphite with 15% MoS2). That's one of the most important modifications, because regular brushed motors fail after only a few hours in a vacuum.

Quality tests

While DC motors used on Earth are also tested, there are limits to those tests due to financial considerations. This is different with a Mars mission, where any kind of risk is unacceptable. Here it pays to test every single component. We also test every assembly, and the tests are comprehensively documented. This is how we prove to our customer that the motor is exactly as we promised. The models used on mission must be identical to the units that were qualified, because these were exposed to the same strains in tests as in real life. They were put on a shaker, exposed to temperature cycles, and subjected to durability tests. If the DC motors pass all these tests, then we can be confident that the design is good. The only remaining step is to build all the other drives in the exact same way—hence our detailed and voluminous documentation. The process takes a lot of effort, but it's worth it: The history of space missions shows that anything that's overlooked will cause problems—and outer space is unforgiving.

Learn more about maxon's contribution to the current NASA Perseverance mission here.

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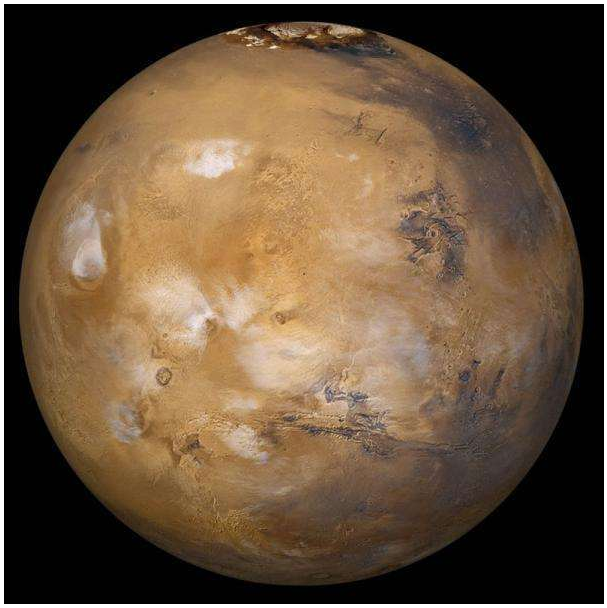
The press release is available on the internet at: www.maxongroup.net.au



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sales.au@maxongroup.com
www.maxongroup.net.au
Twitter @maxongroupAus

The Swiss specialist for quality drives

maxon is a developer and manufacturer of brushed and brushless DC motors. as well as gearheads, encoders, controllers, and entire mechatronic systems. maxon drives are used wherever the requirements are particularly high: in NASA's Mars rovers, in surgical power tools, in humanoid robots and in precision industrial applications, for example. To maintain its leadership in this demanding market, the company invests a considerable share of its annual revenue in research and development. Worldwide, maxon has more than 3000 employees at nine production sites and is represented by sales companies in more than 30 countries.