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Press Release

The challenge of operating DC motors in Space.

We take a look at the various impacts upon DC motors in Space, how do the motors withstand the harsh environment created during spaceflights?

The standard properties of maxon DC motors makes them well suited for spaceflight applications. The DC motors are exposed to extreme temperature fluctuations, shock, vibration and ultra-high vacuum environments. The motor's characteristic hi-power density and miniature size makes them space and weight efficient while still yielding high power. Their carefully designed operation and low losses aid the efficient use of energy, a very valuable resource on a spacecraft. The negligible electromagnetic interference increases the reliability of the entire system and simplifies the design of space vehicles. With spaceflight there are several issues that need addressing to ensure the operation of the DC motors endure take-off, orbit and landing. maxon have addressed these issues and developed a solution with special customised DC motors.

Addressing the issues associated with spaceflights

Operating in a vacuum environment

During spaceflight, different classes of vacuum climates can be encountered. Space conditions usually present an average of one particle per cubic centimetre. This can increase dramatically during take-off or when approximating celestial bodies.

There are several issues associated with operations under vacuum. There is usually not enough gas density to dissipate heat by convection methods. In addition, radiation has a minor effect given the typical temperature differences. The only dissipating method is conduction and DC motors rely on convective heat dissipation at atmospheric pressure. Overheating in vacuum conditions is usually avoided by operating at custom measured ranges, usually about 30% below the standard values.

Another issue to address while operating in a vacuum environment is the outgassing of lubricants. This affects bearings, gears and commutation. The outgassing of other materials that are part of the motor such as plastics, surface coatings and adhesives, can also serve to contaminate the vacuum atmosphere.

Depending on the actual application, several customised solutions are suggested. Common examples include the coupling of the motor to metallic structures, low vaporisation rate lubricants and the preference for DC motors to avoid brush lubricant evaporation.

Extreme temperature variations

Space travel encounters very wide-ranging temperature amplitudes. Special lubricants are used for these extreme conditions. Different materials in the DC motor assembly can have different rates of thermal expansion, leading to mechanical stress. In load bearing elements, titanium is usually used instead of aluminium. The bonding of electronic components in circuit boards can also be irreversibly damaged by mechanical stress.

Ionisation and UV radiation

High energy particles are common in space where the magnetic field of earth is not present. Their ionising effects and UV radiation can create short circuits and potentially destroy electronic components. maxon have attended to this issue by using radiation resistant, or larger width components. UV radiation can also affect cable insulation or other plastics. maxon's common solution to this issue is the use of Teflon instead of PVC.

Service life and reliability

The use of DC motors in space means there are very specific manufacturing requirements to be met, to ensure their operation remains reliable, energy efficient and retains levels of continuous high-power. In some cases the motors must remain operationally dormant with start-up months or years after being situated in space, and then work perfectly, even if for just for a few seconds. In addition, they must survive environmental conditions during lift-off and space flight.

For more than 20 years, maxon DC motor technology has driven the Mars rovers on the Red Planet. The missions maxon have been involved in include the Mars Rovers: Opportunity, InSight, Curiosity, Sojourner and ExoMars; as well as expeditions to the Moon and the Sun. This longevity proves the DC motors efficiency, reliability and capacity to withstand the harsh environmental conditions found in Space. maxon's dedicated Aerospace team are certified ISO EN 9100 which follows commonly accepted aerospace standards.

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



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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.