IKO
Innovation, Know-how & Originality

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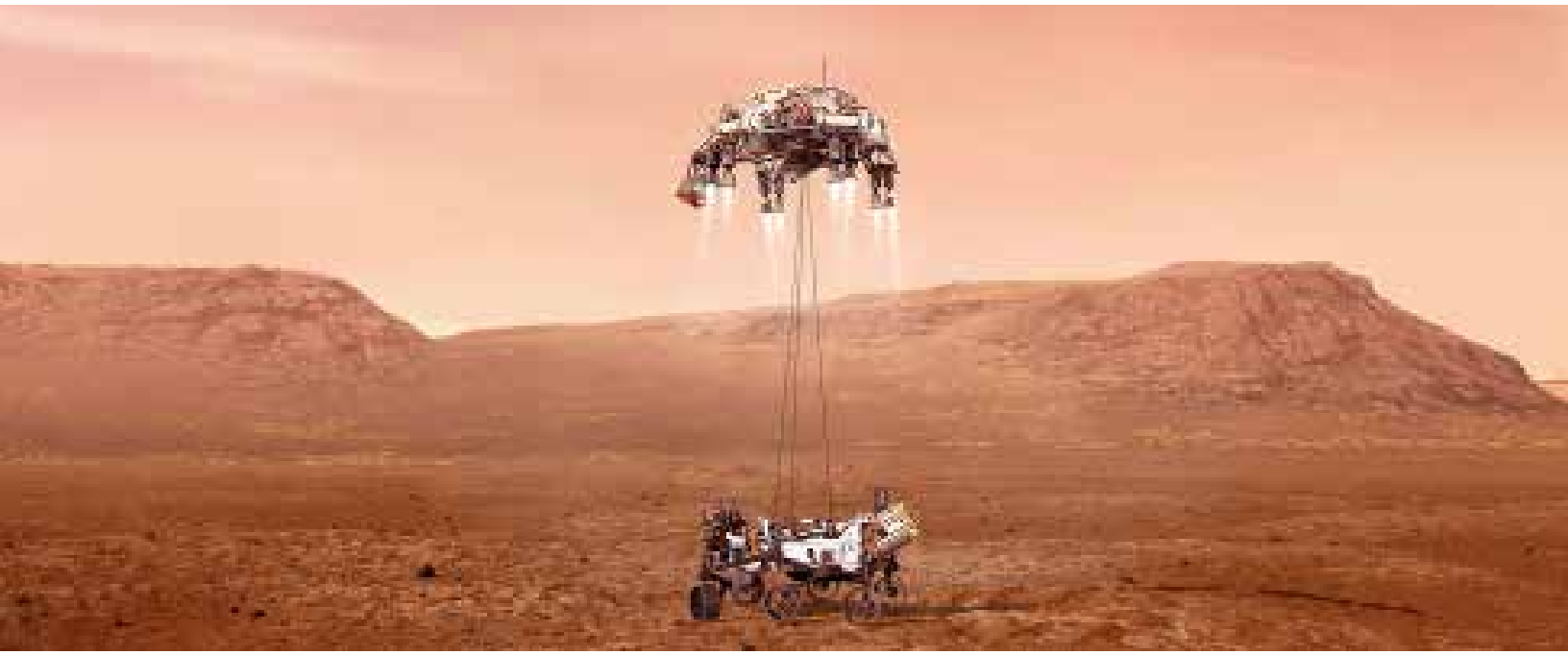
Motion Components Rise To Space Flight Challenges

Linear guides, cam followers and crossed roller bearing can meet space flight hardware requirements



As space activity shifts from governmental agencies to a growing industry driven by commercial entities and even startups, the types of spacecraft and the missions they support are also expanding. This diversifying industry is delivering innovative concepts such as autonomous exploration vehicles, solar sails, internet satellite constellations, space junk removal and reusable spacecraft, to name a few. Like many other innovative technologies, they depend on precision motion components that must reliably work as planned once in space. Because failure is not an option in space applications, it's important to choose a motion device supplier known for its innovation, know-how and originality.

High-quality Products Get Designs off the Ground

Although mechanical systems typically behave differently in space than on earth, it still makes sense to review standard products as a starting point for your design before going all-in on a customized motion component. After all, reliability is paramount in space applications, and a motion product specialist will have years of experience and application data gleaned from that standard component. This will help determine the product elements that will perform reliably in space and those that will need modification or replacement. Here is an overview of some points to consider as you begin specifying a motion product for space applications.

- **Linear guides.** IKO's linear guides and rails have proven reliable in space aboard autonomous exploration vehicles, for example. They offer exceptional metallurgical properties that deliver smooth, accurate motion with good rigidity, and a long lifetime. Many linear guides have interchangeable parts, allowing designers to modify their guides for conditions in space.
- **Crossed roller bearings (CRB).** With modifications to withstand vacuums and low-temperatures, CRBs can operate reliably aboard spacecraft such as in radar dishes on miniature WiFi satellites that send signals to ground-based systems. Their small size also makes them ideal for swivel mechanisms in military surveillance cameras.
- **Cam followers.** Widely used to convert rotary motion to linear motion for twisting, turning or pulling, cam followers are well-suited for opening or closing antennae or solar panels such as aboard space stations and satellites. IKO cam followers feature a small coefficient of friction, excellent rotational performance designed for outer ring revolution and high load capacities.

Figure 1. With modifications to withstand vacuums or temperature variations, crossed roller bearings can operate reliably aboard spacecraft.

Starting with a standard product is not only practical, it can also be the most economically viable option. With a few modifications for the space environment, the standard part can be significantly less expensive than creating an exotic part that may ultimately prove to be cost-prohibitive to the mission.

Figure 2. The LWL miniature linear motion rolling guide incorporates two rows of steel balls arranged in four-point contact with the raceways to provide stable accuracy and rigidity.

Getting Your Motion Component Space-Ready

The following considerations are just some of the typical factors to investigate when specifying a motion component for space deployment. Some of these considerations include modifications we made to our LWL miniature linear motion rolling guide in conjunction with NASA's Jet Propulsion Laboratory (JPL) when integrating it into the Mastcams of the Mars Curiosity and Perseverance rovers. This onboard camera system creates panoramic images for navigation which are also sent back to Earth for analysis.

Operating in a vacuum. The LWL linear guide used aboard the Curiosity rover was given specialized vacuum and cleanroom-style packaging, free of dust, lint, oil and rust. Keep in mind that contamination caused by outgassing will present many opportunities for component failure. While some standard linear guides are made for controlled vacuum environments on Earth, they will need some customizations in order to perform as intended in space. In addition, traditional lubricating greases cannot be used, so your supplier will recommend the most appropriate grease or dry film lubricant.

Surface coatings. Like lubricating greases, traditional surface protection methods such as chrome plating may not perform in space. Your motion component specialist can suggest an alternative such as precision thin dense chromium deposition. If your device interacts with lasers or other light sources, certain coatings may reflect the light. In these cases, IKO often recommends a dark-color coating.

Extreme temperatures. Excessive heat can cause critical parts within a linear guide or bearing to expand or contract and hinder its reliability. Be sure to consult your motion product specialist about the thermodynamics of the component's materials. Different materials may expand and shrink at different rates. You will need to know, for example, if a potential problem may occur, if clearances are required and how the temperatures affect preloading.

For the Mars Curiosity rover, IKO's LWL guide was customized in order to provide continuously smooth motion at -130°C, and it underwent rigorous low-temperature bench tests to ensure it operated with proper clearances prior to launch. The guide's ball recirculation and ball retaining features were also optimized to ensure consistent motion at fluctuating temperatures.

Corrosion. Space applications face a significant threat of corrosion and its impacts, making stainless steel a sensible choice of material for motion devices. IKO's ML Series is an example of a standard stainless steel linear motion rolling guide suitable for applications in which corrosion-prevention oils cannot be used. IKO can recommend a non-standard rust-prevention lubricant for this compact, lightweight guide.

Weight. Sometimes saving a few ounces can make the difference between a part moving properly or even getting off the ground. It could also mean savings of thousands of dollars. IKO works with designers to achieve ideal space performance-to-weight ratios and can suggest "lightening" strategies such as choosing smaller size product, lightweight rolling elements in linear guides or adding extra holes to rails in addition to the mounting holes.

Preventing contamination. One of the lessons learned when designing the lens systems for Curiosity's cameras is that small mechanisms tend to jam easily. To prevent contaminants from impeding a device's accuracy or causing it to fail prematurely, consider accessories like seals, wipers or cover sheets and end plates that are specially engineered for hostile or corrosive environments.

Note that the JPL requires systems and components to be able to operate on their own via remote control for the entire mission. After launching in 2011, Curiosity's two-year mission was extended indefinitely, and it is still operational today. The LWL linear guide's continued reliable operation underscores the value of choosing a motion component supplier that will partner with you to plan, test and tailor the device to address the eventualities of your space application. In fact, the LWL miniature linear motion rolling guide is also hard at work aboard Curiosity's successor, Perseverance.

Figure 3. NASA Jet Propulsion Laboratory's Mars Curiosity rover. The IKO LWL Series bearings used aboard JPL's Mars Curiosity and Perseverance rovers were outfitted with special reliability features to allow them to operate for years in space.

Choose The Right Partner for Space Applications

When selecting a motion component for your space application, there are many things to look for in a supplier. As mentioned earlier, it should have a deep understanding of your motion goals, a large portfolio of products and the capability to accomplish those goals. While many companies focus on one particular specialty such as rotary or linear motion, they may not have the full range of standard products that form your starting point or the flexibility to develop and hone your ultimate solution. And once you understand the design options to achieve your objective, be sure to engage with a company with extensive motion expertise and engineering capabilities early in the process. Not only can they deliver the final product, they can be your design partner along the way.

Time and again, the aerospace industry presents motion challenges to IKO. We're well-known in many critical industries for our innovation, knowledge and originality. And, we have a long history of delivering quality, reliable products.

From the time you engage with our technical sales staff, we'll work with you every step of the way. Using our extensive range of standard linear guides, crossed roller bearings and cam followers as a foundation, we'll take your motion concept and offer proposals that encompass all the conditions and scenarios you can devise, along with their pros and cons. We'll also work with your test engineers to create and carry out a test plan, helping to interpret the results and lend our expertise to analyze failures and solve any issues.

Through extensive collaboration, IKO will modify and custom-engineer your component so it will function and meet your expectations in its operating environment. Whether the motion component is intended for flying craft, exploration vehicles, robotic mechanisms or ground support equipment, designers of space systems can be confident that their motion product will be designed to operate reliably for the life of its mission and beyond.

For more information, visit www.ikont.com.