Diamond Roll-Ring®

Applications Brief

With maintenance-free operation and lower cost of ownership, Diamond Roll-Rings can solve slip-ring related performance issues for a wide variety of mission critical applications.

Roll-Rings were invented over forty years ago to solve slip-ring related performance issues for F-14 fighter aircraft mission critical gyroscopes.

The long-life and performance capabilities of Roll-Rings led to their use on the International Space Station (ISS) in Solar Array Drive Mechanisms and in Power and Data Transfer Devices to connect power from the solar arrays to the rest of the Station. Roll-Rings continue to serve aboard the ISS today.

Today, Roll-Rings are found operating in mission critical applications such as the SPS-48E radar system aboard aircraft carriers and the AN/APX-134 Big Look airborne radar aboard EP-3E aircraft for the US Navy, in the Patriot Missile System, in military helicopters, in military and civilian Air Traffic Control radar systems globally, in weather radar systems and in spacecraft mechanisms such as the European Space Agency's MetOp2 weather satellite.

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Maintenance-Free

The driving force behind a majority of Roll-Ring programs is to significantly extend or in some cases eliminate maintenance cycles. As military, government and commercial operating budgets continue to come under pressure to do more with less, incorporating hardware that requires frequent maintenance is no longer an option.

Roll-Rings eliminate field maintenance by employing a proven design that produces extremely little wear over a very long operating life. The maintenance-free benefit enables cost reductions in parts, personnel, training and technical support while improving operational readiness. The Roll-Ring design delivers the additional unique benefit of reducing the potential for sabotage as no maintenance access port is provided.

Long Life

A standard Air Traffic Control Roll-Ring unit was placed on test at 200 rpm for over two and a half years to simulate 30 years of continuous duty. The unit logged 240 million revolutions before the test was concluded. All circuits were found to be within specification at the end of the test. The vast majority of Roll-Rings supplied for mission critical applications today will survive long past the anticipated service life of the system in which they are installed. The long operating life of a Roll-Ring has the potential to reduce the total cost of ownership for the system they are designed into.

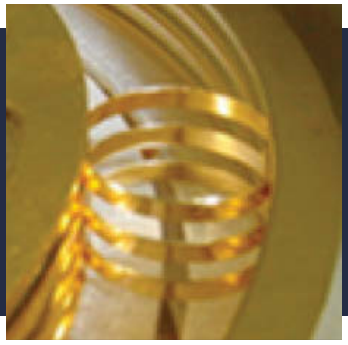
Low Resistance

A 600 Amp test circuit using 3 inch (76.2 mm) diameter Roll-Rings measured 0.81 mΩ under rotation. The International Space Station Utility Transfer Assembly (UTA) tested at 1.9 milliohms at ambient conditions with two circuits in series including the loop-back connector at the rotating end. The gold on gold rolling interface

Capabilities

Current	Standard flexures available up to 35 amperes, higher current custom flexures available
Voltage	Per customer request
Dynamic Noise	2-5 milliohms (typical)
Channel Count	Unlimited
Rotational Speed	0 - 3,000 rpm
Shock	Tested at 300g, all three axes
Vibration	Excellent
Temperature	-60 °C to 115 °C (-76 °F to 239 °F)
Space Qualified	Heritage: International Space Station
Data Rate	1 Gb/s
Coax Signal	64 MHz @ 1.15 VSWR
Environment	IP 65
Diameter	2.0” (50.8mm) over clear bore is the smallest standard size
Axial	0.180” (4.6mm) per channel plus mechanicals (RF and Data circuits are larger)
Connectors	Flying Leads, Mil Spec or Space Grade connectors





allows for very low resistance for all Roll-Ring devices. This has the benefit of reducing power loss for power, signal and data circuits which reduces heat transfer management requirements.

Surge Capacity

The Beta Gimbal Roll-Ring Sub-System (BGRRS) module for the International Space Station, with each crossing designed for a nominal 113A, was required to survive a 1 millisecond in-rush fault current pulse of 4500A. With the unit stationary at ambient temperature and pressure, an in-rush current of 5000A was applied across two crossings in parallel peaking at approximately 0.27 ms with a 1.0 ms period. The BGRRS modules measured no increase in resistance between pre and post test measurements and disassembly showed no detectable damage by the application of the fault current. Roll-Rings have the proven capability for high current handling.

Static Operation

Wind turbines on Black Island in Antarctica operate for months at gale force winds with no change in direction. This is a problem for slip-rings. Once the wind finally shifts, the balance of the ring surface is not clean and thus creates overheating and other issues requiring maintenance in an expensive-to-access location. Roll-Rings are capable of indefinite operation in a fixed position without reducing the capability of the unit for low resistance electrical transfer once azimuth rotation has resumed. This benefit is available to Roll-Ring units designed to handle 10 amps per circuit as well as units designed for 1,200 amps per circuit and beyond.

Data Rates

15 Mb/s 30 MHz on an IntelliBus network was successfully demonstrated with a six channel Roll-Ring unit running 900+ hours at 1,200 rpm with a 0.006 inch (0.152 mm) displacement. The application requirement was to transfer on-blade performance and operating measurements for a rotary wing aircraft during flight tests. The incumbent slip ring caused expensive delays in the flight test schedule due to its relatively short lifespan, about 100-150 hours, before wear debris increased data error rates to unacceptable levels. The 15 Mb/s data rate was the upper limit for IntelliBus network for this application but was not the upper bit rate for the Roll-Ring.

Using a Bit Error Rate Tester the same helicopter tail rotor design was later tested at 100 Mb/s and experienced zero drops. For a significantly larger clear bore a design was developed for a satellite application to allow for LVDS signal transfer at 10 Mb/s at 20 MHz. This design later passed at 100 Mb/s.

Temperature Range

Roll-Rings operating now on the International Space Station successfully tested at temperatures ranging from -55°C to 80°C at sea level atmospheric conditions as well as under the perfect vacuum of outer space. Roll-Rings are in service today as part of the Patriot Missile System, the US Navy's shipboard SPS-48E long range threat detection air search radar system and the AN/APX-134 Big Look airborne radar aboard the US Navy's EP-3E aircraft proving suitability for land, sea, air and space applications.

Shock

A twelve channel Roll-Ring assembly installed around a Diamond Antenna & Microwave rotary joint successfully survived a three axis 180g shock load as part of marine qualification testing. The Roll-Ring devices passed a 300g shock load test for a space application. The comparative light weight of a flexure, the concentric conductive grooves that it rolls between and the compressive load the flexure is under while installed between the grooves enables a Roll-Ring device to survive extreme shock loads.

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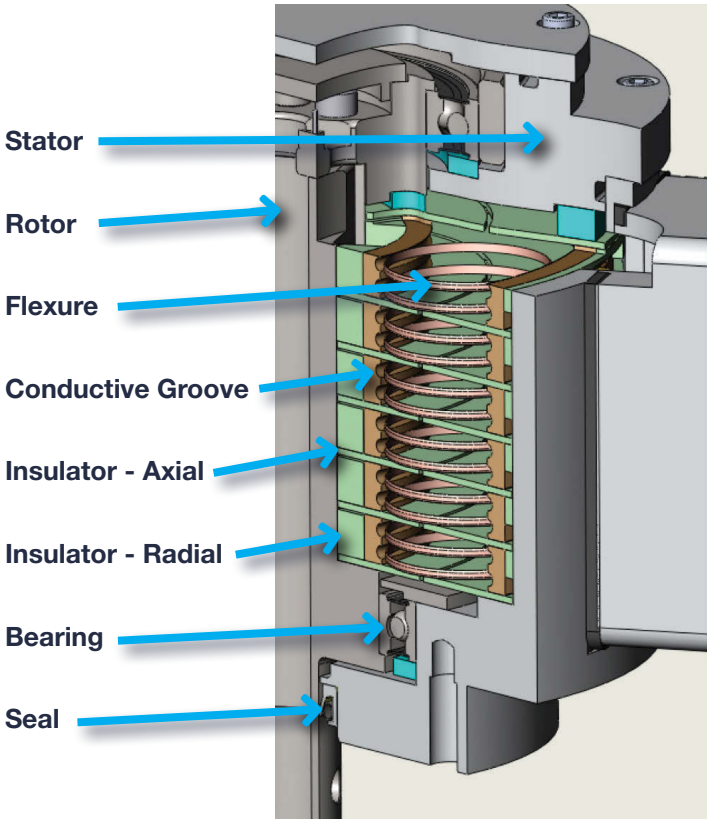
Design

The benefits of the Roll-Ring solution are a direct result of its simple yet rugged design. Flexures, rings of spring copper plated with gold, roll between two gold plated concentric coplanar grooves. In the design pictured at the right two flexures are used per circuit and there are six circuits total. Each circuit is separated by insulators in the axial and radial directions. Rotor and stator are precisely aligned with bearings to ensure proper rotation for long life. The rolling electrical interface is made shock and vibration tolerant due to the compression otherwise known as pre-load of the flexure between the rotor and stator grooves. Seals are added as necessary for the specific application environment.



Conclusion

A number of significant military, government, defense prime, commercial and space mechanism customers have chosen Roll-Rings for their mission critical applications. The same customers, including NASA, the US Navy, and Airbus, have subjected Roll-Rings to full qualification testing. Each one of these clients cited long-life performance as compared to slip rings as their reason for selecting Roll-Rings.

To discover how Roll-Rings can enable your mission critical application please utilize the RFQ section at **www.diamondroll-ring.com** or call +1 978-679-3135 to start a conversation with a Roll-Ring Engineer.

Call +1 978-679-3135

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