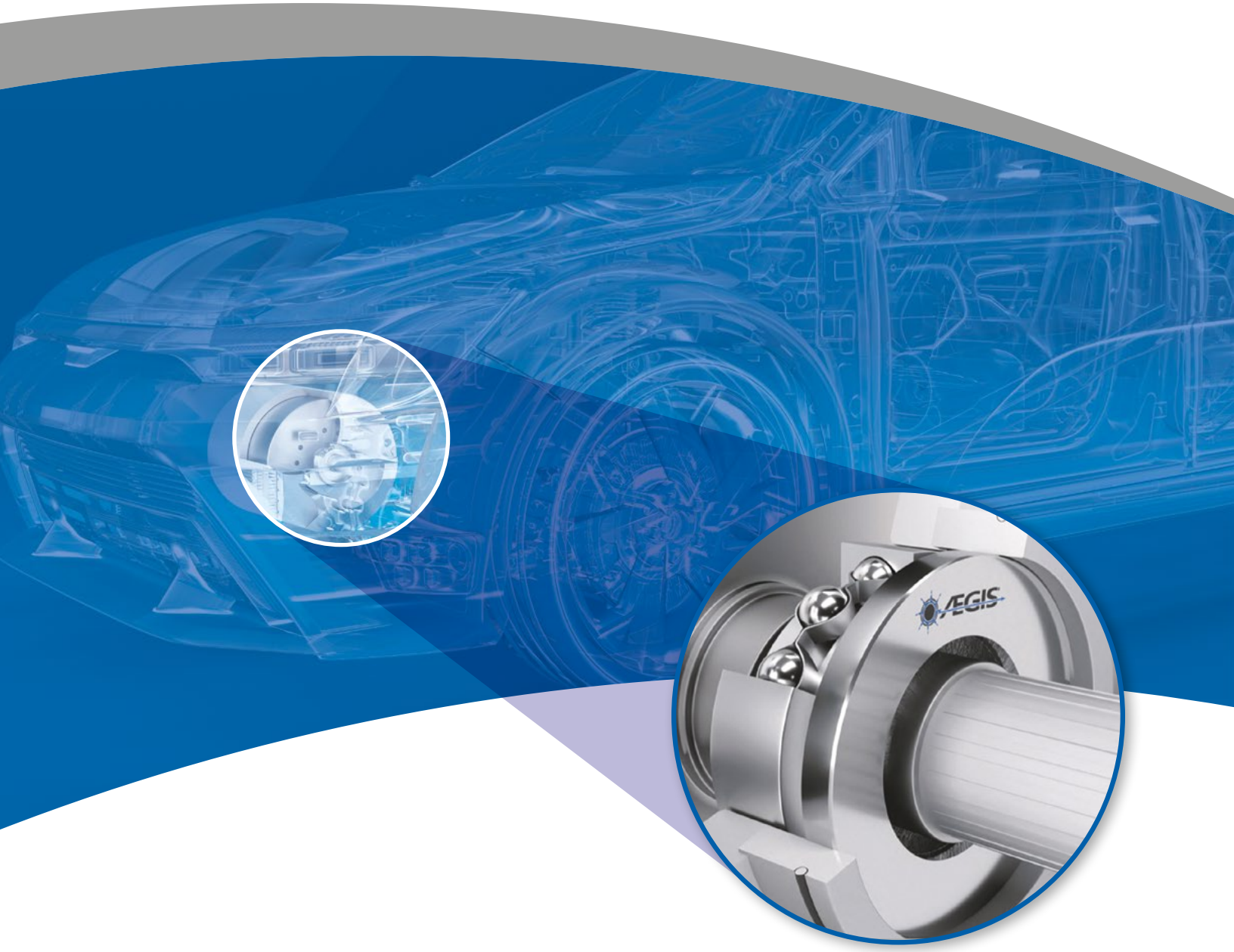
PROTECTING MOTOR BEARINGS AND IMPROVING ELECTROMAGNETIC COMPATIBILITY IN ELECTRIC VEHICLES **WITH AEGIS® EV SHAFT GROUNDING RINGS**



Electro Static Technology™
An ITW Company

COMPANY INFORMATION

Electro Static Technology, an ITW company, is the inventor and manufacturer of AEGIS® Shaft Grounding Rings, which are used in electric motors and other rotating equipment to safely dissipate stray voltage to ground.

Electro Static Technology is ISO9001.2015 and IATF-16949 certified.

AEGIS® Shaft Grounding Ring technology has been installed for decades in countless types of motors, from fractional to hundreds of horsepower/kW, used in virtually all industrial and electric vehicle applications. Our customers around the world rely on the outstanding function and quality of our products, which has been confirmed by many years of practical experience and proven functionality in numerous tests.

THE IMPORTANCE OF ELECTRICAL PROTECTION FOR DRIVETRAINS

Inverters are required to convert direct current from the battery to alternating current. They do this by generating series of high-frequency DC voltage pulses to approximate an AC waveform.

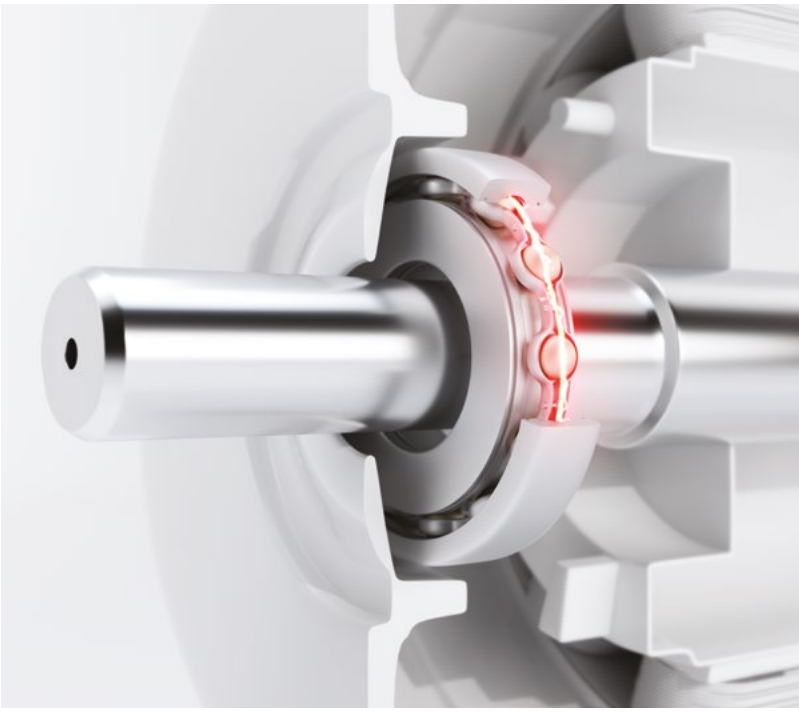
Modern inverters come with side-effects that present automotive engineers with complex challenges, including:

- Parasitic voltage on the motor shaft
- Undesirable electromagnetic interference

Over time, parasitic voltage discharge causes microscopic electrical discharge machining (EDM) resulting in damage to bearings, gears, and other metallic drivetrain interfaces.

Without effective, long-term protection, the EDM damage accumulates and can lead to noise, vibration, and eventual failure.

Because the parasitic voltage discharge current follows the path of least resistance, solutions like insulating motor bearings can move the damage to the transmission bearings, gears, or other components. Even the combustion engine components in a hybrid vehicle are not immune to such damage.



ELECTRICAL BEARING DAMAGE

The primary cause of electrical damage to motor bearings is the inherently imbalanced phase voltage from the inverter. This results in a non-zero common mode voltage. Inverters in EVs use either fast-switching silicon IGBTs or wide band gap MOSFETs (SiC, GaN) with higher output voltage and even faster switching speeds. The extremely short voltage rise times (i.e. large dv/dt) produce a capacitively coupled voltage on the shaft. Without mitigation, this voltage discharges through the bearings.

The consequence of this is electrical bearing damage. EDM causes micro-pitting on the rolling elements and the bearing race [Fig. 1]. Within a short time, the entire bearing race can be covered with EDM pits due to frequent discharges – something known as frosting. The vibrations generated as the rolling element travels over these EDM pits can cause the phenomenon known as fluting. This is when the races develop grooves in a 'picket fence' or slatted pattern. These frosting and fluting damages lead to a significant development of noise and increased vibration and eventually bearing failure [Fig. 2].

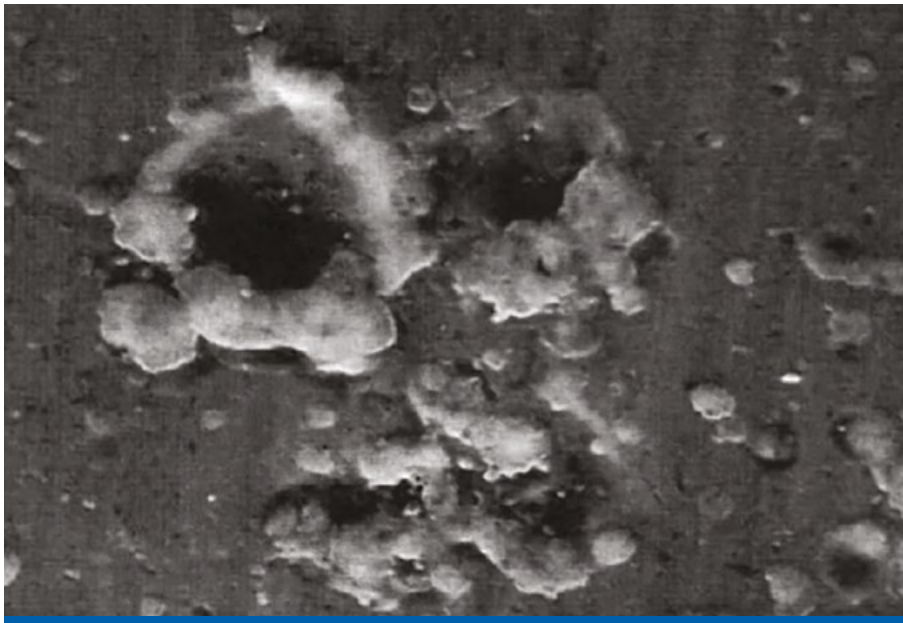
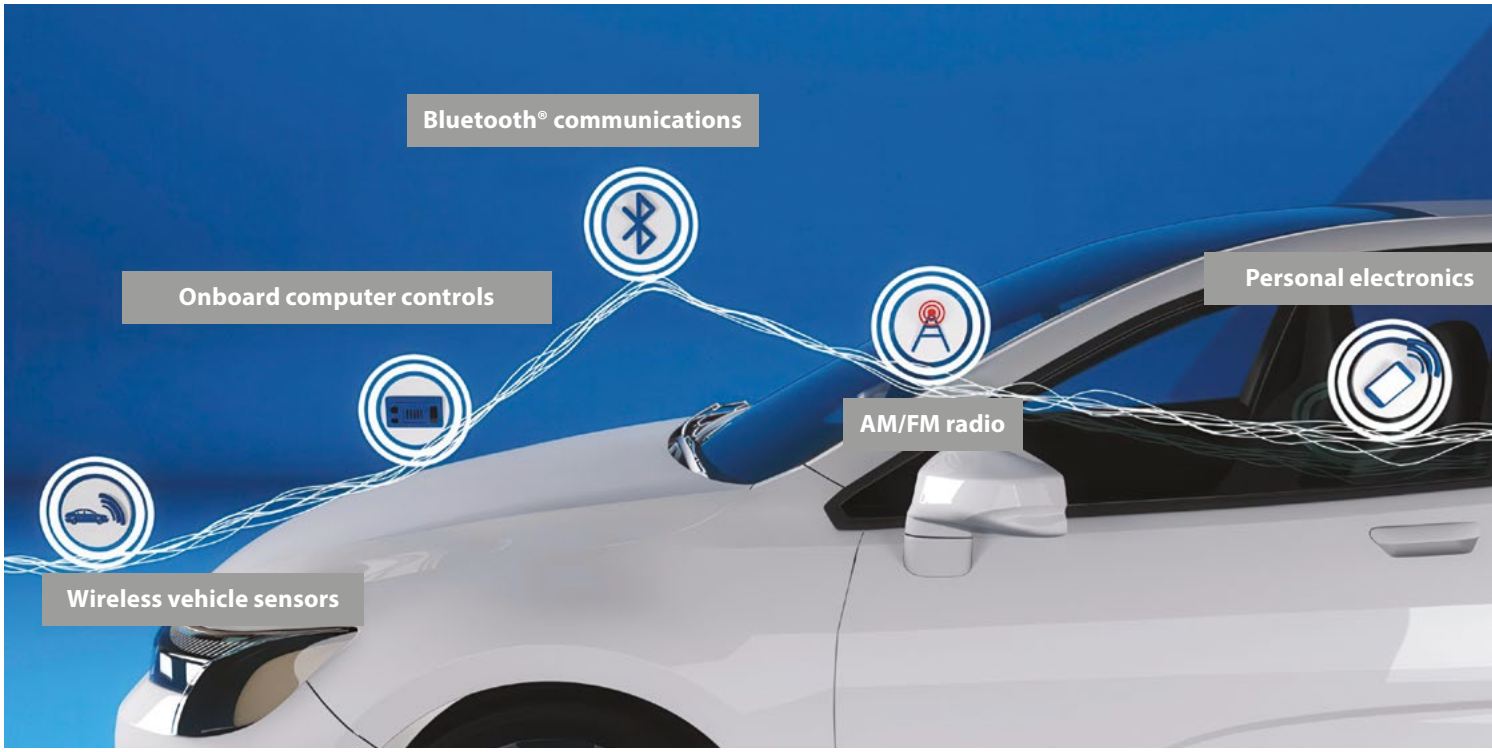


Figure 1: EDM pitting on a bearing race (enlarged) – the result of electrical discharges in the bearing

Figure 2: The "fluted" bearing race on of an electrically damaged bearing.

ELECTROMAGNETIC COMPATIBILITY (EMC)



EMC is a concern in all electronic products, and electric vehicles are no exception. Indeed, their complexity and number of subsystems make EMC even more important. Some of those systems are shown in the figure above.

Along with EDM damage, the parasitic voltage produced by the inverter can also cause electromagnetic interference (EMI) and radio frequency interference (RFI) when it arcs through the bearings. Reducing EMI/RFI by eliminating or reducing this arcing can help manufacturers ensure their vehicles comply with regulatory requirements.

AEGIS® SHAFT GROUNDING RING TECHNOLOGY

AEGIS® Shaft Grounding Rings mitigate discharge through the bearings by reducing parasitic voltage levels. They provide a lower-impedance path compared to the bearings. So rather than arcing through the bearings, stray voltage is safely bled off by the AEGIS® ring.

The key attribute of the AEGIS® ring is the **high density** of highly conductive microfibers [Fig. 3]. These are arranged to contact 360° of the motor shaft. This dissipates voltage effectively while minimizing electrical wear for extended operational life.

Measurements of shaft voltage using an oscilloscope demonstrate the effectiveness of the AEGIS® ring [Fig. 4]. Without shaft grounding, the parasitic voltage has a high peak value. Viewed at the same scale, the voltage is practically flat after installation of an AEGIS® ring.

Tests of the rings show minimal mechanical wear to the conductive microfiber after 10,000 hours of continuous rotation.

Figure 3: Highly conductive microfibers.

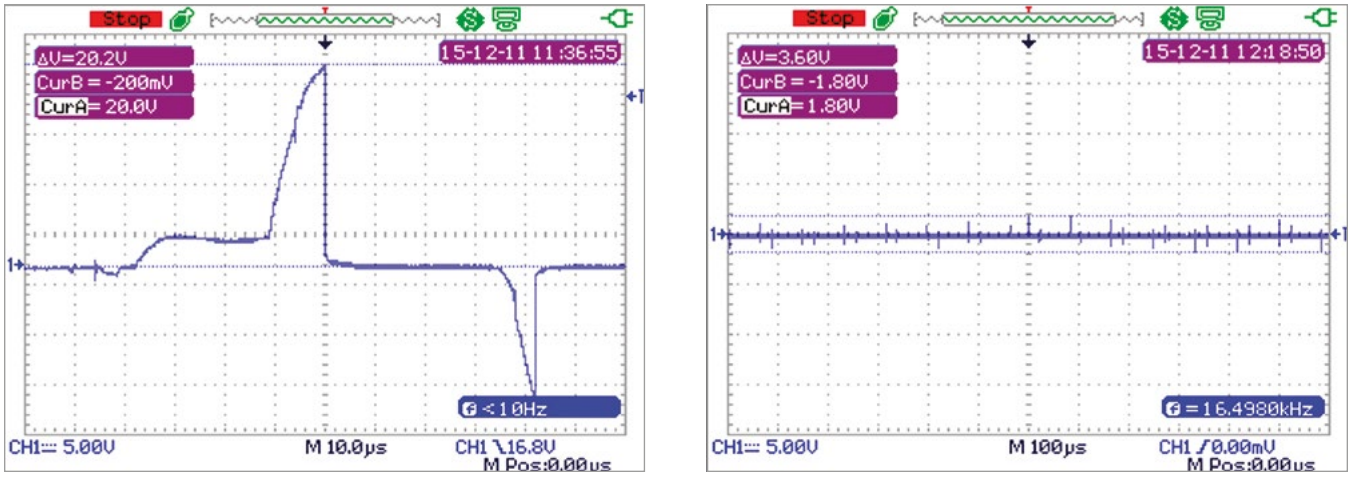


Figure 4: Voltage on the motor shaft before (left) and after (right) installing an AEGIS® Shaft Grounding Ring. Two discharges (bearing pitting events), from 10 to 15V peak, are visible before installation of the AEGIS® ring. After installation, shaft voltage levels are greatly decreased, to levels too low to cause destructive bearing discharge.

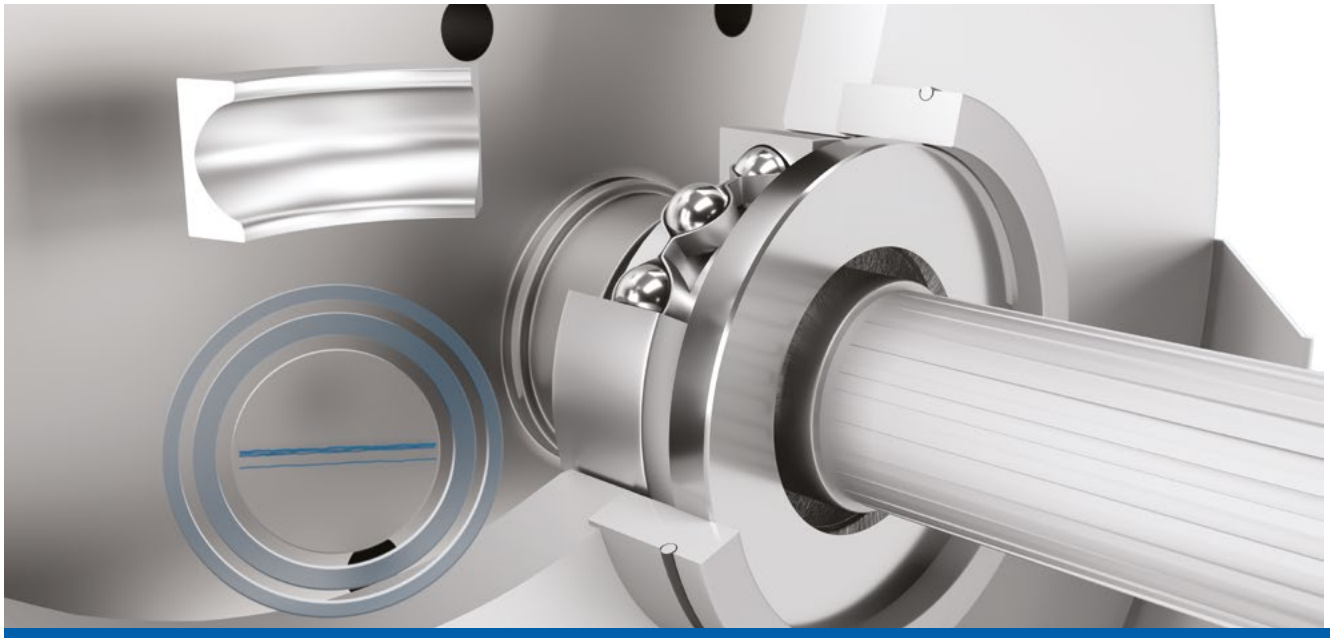
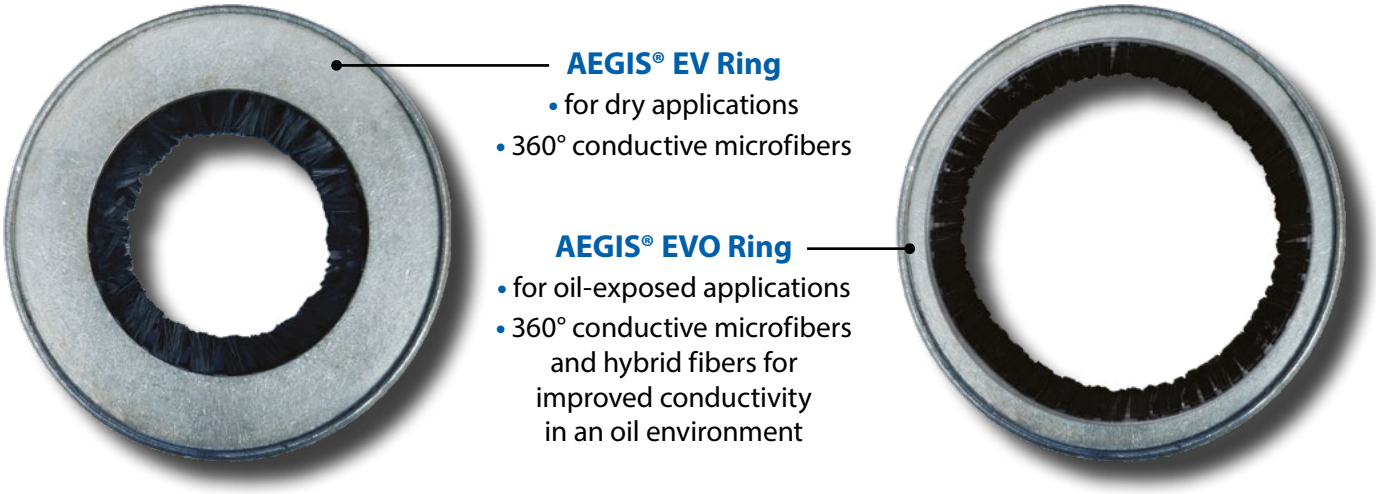


Figure 5: Typical position of the AEGIS® Shaft Grounding Ring press fit next to the bearing. The ring can be installed inside or outside of the motor. A representative shaft voltage reading and a section of AEGIS-protected bearing race are also shown.

AEGIS® Shaft Grounding Rings provide 360° protection

BENEFITS OF AEGIS® SHAFT GROUNDING RING TECHNOLOGY:

1. Protects bearings with low impedance for excellent stray voltage mitigation
2. Protects driveline components (e.g. transmission gear teeth)
3. Outstanding low-friction contact for high mechanical efficiency
4. Low wear rate and excellent long-term reliability
5. Compatible with peak shaft surface speed of at least 80 m/s
6. Optimized and standardized design for automated manufacturing
7. Customizable to the application
8. Low space requirements
9. Light weight construction
10. Pressfit assembly



AEGIS® EV Ring
- for dry applications
- 360° conductive microfibers

AEGIS® EVO Ring
- for oil-exposed applications
- 360° conductive microfibers and hybrid fibers for improved conductivity in an oil environment

Best practice:

AEGIS® Ring on drive end in addition to isolated bearing on non-drive end.

Electro Static Technology™
An ITW Company

31 Winterbrook Road
Mechanic Falls ME 04256 USA

Toll Free: +1 866 738 1857
Ph: +1 207 998 5140

Email: info@est-aegis.com
www.est-aegis.com

© 2026 Electro Static Technology

Form 931-1 EN 03/26