



Protecting VFD-Driven Motors In: Rail Traction Motors

The Growing Reliance on Light Rail Systems

Population density in many metropolitan cities and the issues it creates — congestion, snarled traffic, lack of parking, and air pollution — have led many cities and their surrounding suburbs to turn to light rail systems and mass transit. And recent advances in light rail vehicle (LRV) traction systems have made it possible for vehicle designers to replace cumbersome and heavy DC traction systems with VFD-controlled AC motors that provide equal or greater pulling power, weight and energy savings, and reduced maintenance.

A Lurking Problem... Bearing Damage

Despite the many impressive advantages of these AC traction systems, their use of variable frequency drives (VFDs) to control motor speed creates a high potential for bearing and motor damage in the not-so-distant future. VFDs induce currents on motor shafts that discharge through the bearings, causing pitting, fluting, and catastrophic motor failure. Without bearing protection, any savings from the use of VFDs can be quickly cancelled out by the cost of replacing motors and by system downtime.

The Need for Proven Long-Term Bearing Protection

By diverting bearing currents safely to ground, AEGIS® SGR Shaft Grounding Rings ensure the reliable, long-term operation of VFD-driven motor systems, reducing downtime, increasing reliability, and making LRV systems truly sustainable and green!



Applications:

- ☐ Light rail vehicles
- ☐ Subway trains
- ☐ Street cars
- ☐ Trolleys
- ☐ Trams
- ☐ Monorails
- ☐ Locomotives
- ☐ Electric buses
- ☐ Electric vans



Protecting Bearings in LRV Traction Motors

Because electrical bearing damage is a lurking problem in any VFD driven motor, rail system design engineers face a new set of challenges. Inverter-induced shaft voltages jump to the path of least resistance wherever it leads, so partial mitigation measures such as insulated motor bearings can just shift the damage to other components, such as gear box bearings, transmission gears, or wheel bearings.

To nip the problem of electrical bearing damage in the bud, traction motor engineers need only look to other industries that have sought solutions to this problem. For years, design and maintenance engineers and contractors in manufacturing, processing, HVAC, and materials handling have turned to inverters as a way of controlling the speed of AC motors and thereby saving energy. These engineers found that — without an effective method of channeling inverter-induced shaft voltages safely to ground — any savings due to reduced energy consumption could quickly be wiped out by the high maintenance costs of replacing damaged motor bearings.

In short, an effective, long-term method of grounding motor shafts is needed to make inverter-driven systems reliable. Industrial engineers learned that a shaft-grounding device installed on a motor can divert harmful currents before they can cause bearing damage. Applied to the traction motor in light-rail vehicles or freight locomotives, such a device should prevent bearing damage and guarantee overall vehicle reliability improvements and decrease expensive motor repairs.

Proven Effective

One of the most reliable and cost-effective grounding devices is a ring that fits over the motor's shaft. Engineered with specially designed conductive microfibers, the AEGIS® SGR Bearing Protection Ring safely channels damaging currents to ground, bypassing the bearings entirely. Scalable to any NEMA or IEC motor regardless of shaft size or horsepower, the ring has been installed successfully on motors powering pumps, fans, turbines, conveyors, and in hundreds of thousands of industrial and commercial applications worldwide. More recently, the AEGIS® ring has proven itself effective in the inverter-controlled traction motors of electric light rail vehicles, trains, trolleys, trucks, and in construction equipment. In fact, it is currently being used extensively by companies such as EVAG-Essener and HAVAG-Hallesche in Europe [Figure 1].

Key to the ring's success are the patented conductive microfibers arranged along the entire inner circumference of the ring that completely surround the motor shaft. Secured in the patented FiberLock™ channel, these fibers can flex without breaking. The deep channel also protects the fibers from dust, liquids, and other debris. Tests of the ring on



Figure 1: This all-electric tram in Halle (Saale), Germany, suffered bearing damage from inverter-induced voltages until the problem was solved in 2007 with the installation of an AEGIS® SGR Bearing Protection Ring (inset) on the shaft of every traction motor in the fleet. The city has had an electric tram system since 1891.

multiple motors show surface wear of less than 0.001" per 10,000 hours of continuous operation and no fiber breakage after 2 million direction reversals.

The AEGIS® SGR's effectiveness can be seen on an oscilloscope [Figure 2]. Without shaft grounding, damaging shaft voltages show up as peaks and valleys. After the installation of an SGR, the nearly straight line demonstrates how the ring diverts these voltages, channeling them safely to ground.

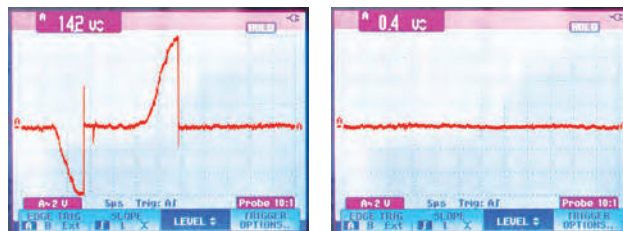


Figure 2: Motor-shaft voltage discharges before (left) and after (right) installation of the AEGIS® SGR Bearing Protection Ring.

Conclusion

With the continuing need for reliable mass transportation systems in the United States and around the world, light-rail vehicles will expand both in urban, suburban settings while inter-city rail transportation will grow in importance. As the advantages of VFD driven AC traction motors are embraced in electric vehicle design, the potential for bearing failure in these vehicles also grows. The AEGIS® SGR Bearing Protection Ring offers traction vehicle designers a way to improve the reliability of AC traction motors now and in the future. Not only will it protect electric motors from bearing damage and thus extend their lives, but it will also protect other components from the same inverter-induced voltages. In short, it offers the promise of high reliability that buyers want before they invest in a new rail projects.