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Ingress Protection in Slip Ring Assemblies

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If you've seen an Ingress Protection Rating (IP) you probably know that it relates to the protection classification of a product or enclosure. Have you ever wondered what those numbers specifically mean? What testing is required to classify a product with an IP classification? What does that mean for slip ring performance? Fortunately, the engineering team at UEA is knowledgeable about the IP standards and classifications. Many of UEA's slip ring assemblies come with an enclosure, though if the customer is supplying an enclosure check out our "O" style and "X" style slip ring assemblies. When an enclosure is present it will technically have some type of IP rating, whether documented or not. An IP code will start with the "IP" identifier and be followed by two numbers. The first, between 0 and 6, will relate to the solid object protection classification. The second, between 0 and 9, will relate to liquid protection classification. In certain circumstances another character exists at the end with a special meaning. In general a lower number represents a lower level of protection with the exception being liquid protection going from 6 to 7. The following classifications are described below.

The X's and O's

In either solid object or liquid protection, a "0" classification exists meaning no protection - the product is not being protected at any other classification. An "X" used as a place holder simply means the product hasn't been tested or designed to meet either the object or liquid protection. For example, a slip ring with an IP4X code is protected against objects greater than 1mm in size but hasn't been tested or certified to any liquid protection level. An IP40 product is also protected against objects less than 1mm in size but isn't protected against even dripping vertical water, the lowest level of liquid protection. In most cases when products are tested it's done separately for solid object protection and liquid protection. Thus, if the known environment doesn't call for object or liquid protection, testing may be avoided and replaced with the "X" placeholder.

Basic Protection for a Slip Ring Assembly

UEA slip rings are mounted in various types of applications where falling liquids or foreign objects may try to enter the enclosure. A very common assembly for construction applications places a slip ring underneath a hydraulic swivel or next to a gear box. In either case it is realistic to think that either hydraulic fluid or oil may fall onto the slip ring assembly during typical operation. For this type of protection, Engineering will need to know the mounting orientation of the slip ring assembly in order to seal against falling fluids and to allow any penetration to drain underneath. On an IP scale, this covers up to IP43 based on intrinsic design. In order to certify to this level, the product will undergo a foreign object intrusion test. At IP1X nothing larger than 50mm should be able to penetrate the enclosure. While at IP2X that size drops to 12.5mm, then at 2.5mm for IP3X and finally at 1mm for IP4X. Low level liquid protection involves testing the product in operation position against falling water at IPX1. Then the water angle covers a 15 degree tilt, 30 degrees total, for IPX2, a 60 degree tilt for IPX3. Each test has a specified water flow rate and duration of testing. The test apparatus for the falling water test is shown in figure 1.1.

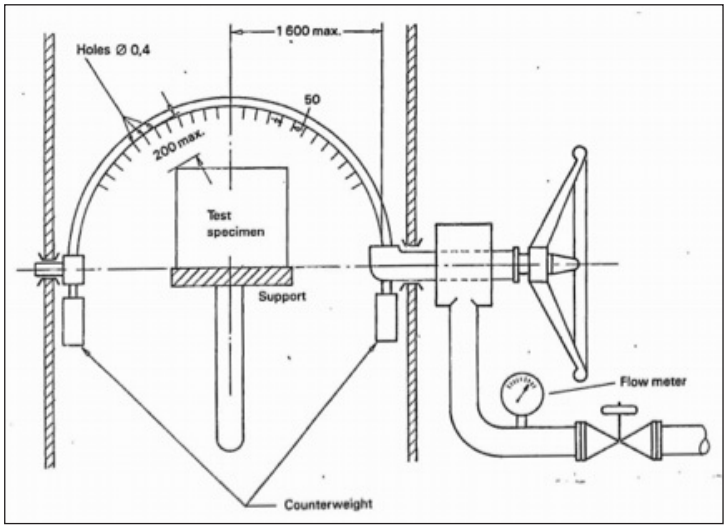

Figure 1.1

IP 54

One of the most common protection ratings for slip rings is IP54. This fits for almost every application that uses slip rings including wind turbines, construction equipment and irrigation equipment. The “5” stands for dust protection. In order to ensure the design is properly sealed, the product is placed within a dust chamber while talcum powder is agitated airborne. The test is run for 8 hours according to IEC 60529 standards. Upon completion of the testing the product is covered in fine dust as shown in Figure 1.2. The “4” relates to water being sprayed from all angles, shown in figure 1.3. IEC 60529 has standards on the flow rate, pressure, nozzle size and duration of the spray that apply to testing. The product is sprayed from all angles to simulate a worst case scenario of splashing water on the product. Upon separate completion of each test, the product is opened and tested for performance to ensure there were no harmful effects.

Figure 1.2

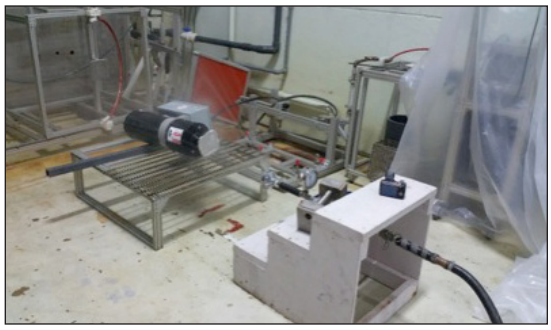

Figure 1.3

IP65 & IP66

The next step for sealing is IP65 testing. In many ways the dust protection testing is similar to IP54 except the dust is forced into the product by spraying at sealing points or by applying a vacuum to the internal slip ring assembly. The jetting process is similar except for higher pressure jets with an increased flow rate and reduced nozzle size. Stepping up to IP66 requires the same dust protection techniques with even more powerful water jets. The biggest challenge with IP65 or IP66 testing for slip ring applications is the balance of keeping water and dust out while still allowing air in. For metal graphite and other slip ring contacts humidity above 20% is suggested in order to help lubricate the sliding contacts.

Our tests have shown that when a slip ring contact is completely sealed during rotation, a noticeable increase in wear can be observed. For construction applications, where the slip ring never sees more than a few million rotations, this isn’t an issue. However, when a product is expected to last 200 million-plus revolutions, engineering needs to pay special attention to the sealing methods. In many cases we will use a product called a breather that prevents foreign bodies from entering the enclosure but allows ventilation, which in turn, allows proper lubrication for the sliding contacts.

Immersion Protection

IP6X is the highest classification for dust testing, but liquid protection also includes IPX7 and IPX8. These include the product being fully immersed in a liquid. Testing for IPX7 includes a 30 minute immersion of the DUT in water up to 1m, with the highest point being at least 150mm below the surface. IPX8 doesn’t have a specific depth of immersion or a set amount of time as this is defined by the product specification. As noted before, having an immersion protection rating doesn’t mean the product will pass jetting protection IPX5 or IPX6. Certain sealing enclosures will allow for fully water immersed designs but when having powerful jets applied it may damage the seals. If both jetting and immersion are required, the designation will be denoted by a “/” such as IPX6/IPX7.

IP69K

There is one last IP code that is used for slip ring protection classification: IP69K. At first glance this will seem like a water submersible, fully dust tight enclosure but the special character “K” throws out all the rules. An IP69K rating requires protection against powerful water jets (1,000 kPa) from all angles with water temperatures at 80° C. This code was developed by DIN 40050-9 for road vehicles and other applications that need to be cleaned regularly, typically by pressure washers. Not only does the slip ring need to be properly sealed from every angle, but special potting, seals and materials need to be used to withstand both the pressure and heat from the water jets.

Overall, a better sealed up slip ring isn’t always a better option and sealing should be done to properly represent the actual operating environment to maximize performance. If any of these applications fit your demand, please contact UEA for your slip ring ingress protection needs.