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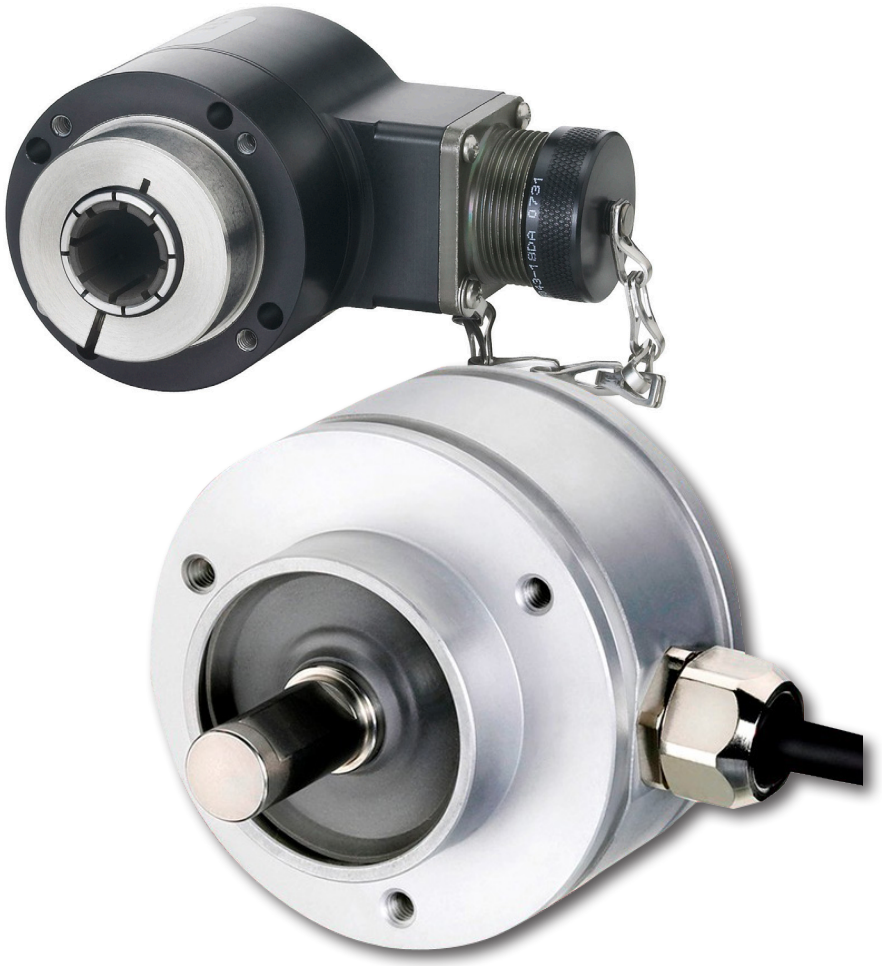
Understanding IP Encoder Ratings

What is the Right IP Rating for Your Application?

To specify an encoder that will last, you have to pay close attention to IEC 60529 details like duration and pressure of exposure to solid objects and liquids...How do you choose the correct IP rating for your application?



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Automation is a workhorse technology across a wide range of industries, and feedback plays an essential role in ensuring that systems perform as expected. In a perfect world, devices would operate on anti-vibration tables in temperature-controlled cleanrooms. Unfortunately, the industrial environment is rarely so kind. Instead, components must endure punishing conditions like drifts of sawdust in paper mills or high pressure washdowns in food-processing facilities. As a result, for many applications, the effectiveness of an encoder housing is just as important to the overall success of an application as the performance of the feedback device itself.

The Ingress Protection (IP) rating system established by the International Electrotechnical Commission's IEC 60529 provides a useful tool for specifying electrical enclosures—but only when used properly. Choosing a product with an IP rating that's too low may lead to early failure, while choosing one that's too high can add unnecessary cost. To make the appropriate selection, OEMs need to understand IEC 60529 and what it means for their application.

IP ratings

Encoder housings provide protection for devices by preventing the entry of solids and liquids that might damage the electronics. Although most countries and regions have their own enclosure standards, such as DIN 40050 from the German Institute for Standardization or NEMA 250 from the U. S. National Electrical Manufacturers Association, IEC 60529 is the primary international standard governing electrical enclosures. IEC 60529 defines enclosure performance based on a two-digit code of the form IPxy, where x refers to the enclosure's ability to keep out solid materials (see table 1) and y describes protection from liquids (see table 2). An IP54 rating, for example, means the device is protected against dust and against water splashed from all directions. In general, the higher the number, the greater the degree of protection provided.

Table 1. Protection against solid objects (meaning of first digit in code)

x	Protection Provided
0	No protection
1	Protected against solid objects > 50-mm (2-in.) diameter
2	Protected against solid objects > 12.5-mm (0.5-in.) diameter
3	Protected against solid objects > 2.5-mm (0.1-in.) diameter
4	Protected against solid objects > 1.0-mm (0.04-in.) diameter
5	Limited protection against dust (no harmful deposit)
6	Fully protected against dust (dust tight)

Table 2. Protection against liquids (meaning of second digit in code)

y	Protection Provided
0	No protection
1	Protected against vertically dripping water for 10 min.
2	Protected against vertically dripping water for 10 min. when tilted 15° from vertical
3	Protected against spraying water for 5 min. when tilted up to 60° from vertical
4	Protected against water splashed from any direction for 5 min.
5	Protected against low pressure water sprayed from all directions for 3 min.
6	Protected against high volume jets of water from all directions for 3 min.
7	Protected against 30 min. of immersion in water to a depth of 1 m (3.3 ft.)
8	Protected against immersion in water to manufacturer-specified pressure
9K*	Protected against high-pressure and high-temperature water jets

** Per German standard DIN 40050-9*

The IP rating system provides a useful tool to help OEMs find the components they need, but it requires understanding to get the best results. The different levels of IEC 60529 are quite detailed. All too often, however, manufacturer websites display incomplete versions of the tables shown above. An IP54 encoder can be considered dirt tight and splash proof, but a close look at the descriptions will reveal that it is not resistant to fine dust or exposure to liquid for durations of more than five minutes.

Similarly, at a quick glance, an IP66 encoder might appear to be a good fit for an application requiring daily high-pressure, high-temperature washdown, but that's not necessarily the case. The standard specifies that an IP66 encoder be able to survive exposure to a jet of water delivered from a 12.5-mm nozzle located 3 m away—but only for three minutes. More important, those jets deliver water at 100 L/min, for conditions corresponding to an effective pressure of 0.1 MPa. To sum it up, an IP66 encoder can tolerate a large volume of water but not one delivered at particularly high pressure.

What to know before you choose an IP-rated encoder

1. *Does your application involve dirt and dust or do you simply need to prevent the incursion of foreign bodies like screwdrivers, wires, or fingers?*
2. *Does it involve exposure to liquids? If so, what kind of liquids?*
3. *Will the encoder need to survive only occasional exposure or will it be ongoing? Will the exposure take place at high pressure and/or high volumes?*
4. *What is the operating temperature for the application?*

Unfortunately, there are plenty of applications that do involve high pressures, such as pharmaceutical packaging lines. In 1993, the German Institute for Standardization released DIN 40050, which augments IEC 60529 with an additional liquid ingress protection level 9K. This level specifies protection against multiple nozzles delivering 14 to 16 L/min of 80°C water to the target from a distance of no more than 15 cm away, for an effective pressure of 8 to 10 MPa. A device that can pass this test can easily survive high-temperature washdowns. Although the IEC has not added this level to IEC 60529, the 9K specification has been broadly adopted, leading to the availability of IP69K devices such as Dynapar's Series AR62/AR63 in the marketplace.

As these examples show, when choosing an encoder, it is essential to both know the exact conditions presented by the application and to understand the performance delivered by each of the IP levels. A food processing line that bakes and packages meat pies would probably require daily washdown with bleach solution, but a packaging line designed to put bottles of cognac into cartons might only need periodic cleaning in the event of breakage. Using an IP69K encoder for the cartoner would add unnecessary cost, while putting an IP66 encoder into the meat pie line would risk early failure and costly downtime.

Ingress protection

Protecting components from ingress by dust or liquid requires a solid housing, appropriate coatings, and most of all, careful attention to the seals. For washdown applications, the basic protection consists of a static seal, which is usually an O-ring located between the cover and the base, and a dynamic seal for the shaft. Dynamic seals

often simply consist of a radial oil seal. Encoders with higher ratings may use V-ring seals or multi-lip seals, or combine the seals with protective flanges.

Hollow shaft encoders, which allow the shaft being monitored to pass right through the component, present a bigger challenge. In these cases, the shaft must be sealed on both sides of the product—the base side and the cover side.

When it comes to the seal material, once again the application drives the decision. A splashdown environment involving water might only need standard nitrile rubber seals. A washdown environment involving caustic liquid would typically use a fluoropolymer elastomer such as Viton that would better tolerate those chemical environments.

Nearly all industrial applications present some sort of challenging environmental conditions, making the choice of housing and IP rating an essential part of encoder specification. Producing an optimal product or system requires a clear understanding of the IP rating system and a thorough knowledge of the application (see sidebar). Only then can OEMs make an informed trade-off among factors like lifetime, performance, and cost to get the most competitive product to market as rapidly as possible.

Table 3. Encoder enclosure rating examples

Application	Dynapar Encoder	Enclosure Rating	Protection
Light Duty	Series E14	IP54	Limited protection against dust and splashing water
Light Industrial Duty	Series H20 without shaft seals	IP54	Limited protection against dust and splashing water
Industrial Duty	Series H20 with shaft seals	IP66	Fully protected against dust and large volumes of water from all directions
Heavy Duty	Series HSD37	IP67	Fully protected against dust and 30 min. of immersion in water to a depth of 1 m (3.3 ft.)
Heavy Duty	Series AR62/AR63	IP69K	Fully protected against dust and high temperature, high-pressure jets of water from all directions

Additional Resources:

- Learn how to specify an encoder for high shock and vibration environments
- See how temperature and humidity affect encoder performance
- What a video to learn more about Dynapar's non-contact encoders

About Dynapar

Dynapar is an industry leading supplier of encoders, resolvers and condition monitoring solutions. From small kit encoders to large mill-duty tachometers, Dynapar has a strong market presence in a wide range of industries including steel, paper, elevator, oil and gas, aerospace & defense, medical, material handling and industrial servo manufacturing. Dynapar offers a broad array of encoders and resolvers through our well established Dynapar™, Hengstler™, NorthStar™ and Harowe™ brands. Dynapar also provides 24/7 remote condition monitoring systems with built-in cloud-based analytics. Dynapar supports global customers with local sales and production locations in Germany, Japan, China, and Brazil.