Your Global Automation Partner

TURCK

Ingress Protection
A Guide to IP and NEMA Type Ratings

Ingress protection ratings are self-declared and can be tested either internally or by 3rd party laboratories. Similar test results from IP testing can be assumed to have passing results on portions of NEMA testing. Ingress protection ratings always assume a mated connection tightened to the proper torque value or hand tight. Ingress protection on receptacles applies to the connection point only. Additional usage of gaskets/ O-rings and proper cutout dimensions are required to achieve NEMA protection to the face of an enclosure.

What is an IP rating?

IP (Ingress Protection) ratings are defined in international standard IEC 60529, which classify the degree of protection against the intrusion of solid foreign objects and moisture. The IP rating is intended to help determine the suitability of product for a particular environment. The rating consists of the letters IP followed by two numerical digits and an optional letter.

In the IP designation, the first number is used to indicate the degree of protection against solid foreign objects such as hands, tools, wire, and dust. It will range from 0 (no protection at all) to 6 (total protection against solids).

The second number indicates the degree of protection against water. It determines if the product can handle water projected by powerful jets, like a sprayer, dripping water or complete submersion. The number will range from 0 (no protection) to 8 (can withstand total immersion in water more than 1m deep) or 9 (can withstand high pressure spray down).

What IP rating do I need?

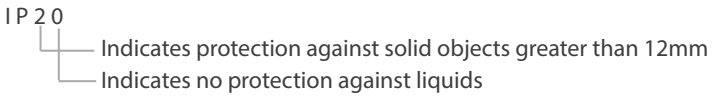
Industrial and harsh environments require high IP ratings and adequate water resistance. Below are commonly found IP ratings for connectors and their intended usage. IP ratings on product assume proper mating and mounting techniques.

First number - Protection against solids		Second number - Protection against liquids	
0	No protection	0	No protection.
1	Protected against solid objects greater than 50 mm.	1	Protected against vertically dripping water.
2	Protected against solid objects greater than 12 mm diameter.	2	Protected against dripping water when tilted up to 15°.
3	Protected against solid objects greater than 2.5mm diameter.	3	Protected against spraying water at an angle of up to 60° from vertical.
4	Protected against solid objects greater than 1.0mm diameter.	4	Protected against splashing water when the enclosure is titled at any angle up to 15°.
5	Dust protected.	5	Protected against water jets from any direction.
6	Dust tight. No Ingress of dust.	6	Protected against heavy seas or poerful jets of water.
		7	Protected against the effects of short-term immersion (under defined conditions of pressure and time.).
		8	Protected against submersion (under conditions specified by the manufacturer).
		9K	Protected against against close-range high pressure, high temperature spray downs.

**Note that a higher number in the second position of the IP code does not necessarily mean that the product can pass all the lower number tests. For example, a product could pass an IP67 test (protection against temporary immersion in water), but it could fail an IP66 (protection against powerful waterjets) test. If the product passes both tests, it will need to carry the IP66 and IP67 rating to indicate that it complies with both sets of test requirements.*

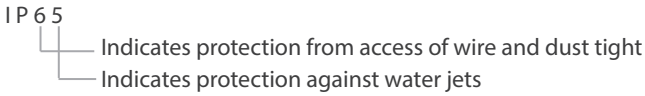
We reserve the right to make technical alterations without prior notice.

IP20



IP20 rated products are a good choice for dry indoor environments when used inside a NEMA rated enclosure. A rating of IP20 would offer protection against the touch of fingers or hand, but no protection against dust or water. Indoor applications containing humidity will require a higher IP rated solution.

IP65

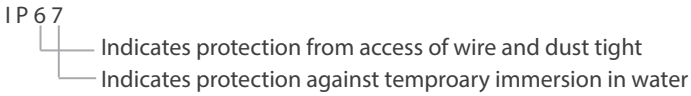


These products can be safely used in indoor industrial applications with dust or debris and infrequent light water exposure. They can be used outdoors but should be protected from extended moisture exposure.

How testing is conducted:

The 6 in the first character position of the IP code indicates protection from access of wire. To test this, a probe with a 1.0 mm diameter shall not be able enter the enclosure. The 6 also indicates that the product is dust tight. No ingress of dust is permitted upon inspection after testing is complete. This test requires that the enclosure is placed in a dust chamber that circulates talcum powder. If the enclosure is expected to have a lower air pressure than the surrounding environment (could be caused by temperature cycling), the enclosure must be tested with a vacuum applied to it. See section 13.4 of IEC 60529 for full details.

IP67



The 5 in the second character position of the IP Code indicates protection against water jets. This test involves spraying the enclosure from all angles with a nozzle that has an internal diameter of 6.3mm. The delivery rate of water is 12.5 l/min, and the nozzle must be positioned 2.5 to 3 meters from the enclosure. The minimum test duration is 3 minutes. See section 14.2.5 of IEC 60529 for full details.

IP67 rating offers complete protection against foreign objects as well as water exposure and limited water submersion. These products are suitable for most industrial indoor and outdoor applications. They are not intended for permanent submersion installations or high spray/washdown environments.

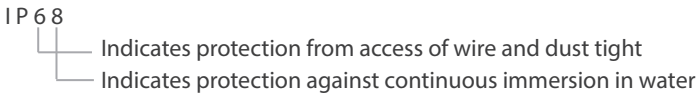
How testing is conducted:

(See IEC IP65 above for first character requirements.)

The 7 in the second position of the IP Code indicates protection against temporary immersion in water. For this test, the enclosure is completely submerged in water. The lowest point of the enclosure is placed 1m below the surface of the water and remains there for 30 minutes. The water temperature and test sample must be within 5 K of each other. See section 14.2.7 of IEC 60529 for full details.

We reserve the right to make technical alterations without prior notice.

IP68



IP68 rated products meet the requirements of IP67 and extend the submersion depth and time. The test specifications for IP68 are unique in that they are manufacture defined. It can be expected that the testing parameters may be different between different manufacturers.

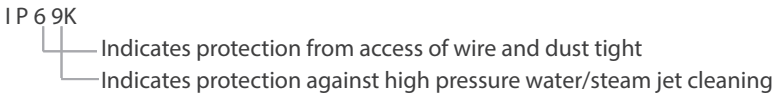
How testing is conducted:

(See IEC IP65 above for first character requirements.)

The 8 in the second position of the IP Code indicates protection against continuous immersion in water. For this test, the enclosure is completely submerged in water. The test conditions are subject to agreement between the manufacturer and user. The conditions must be more severe than the conditions of IP67 and take account for the enclosure to be continuously immersed in actual use. See section 14.2.8 of IEC 60529 for full details.

Turck's internal IP68/NEMA 6P test procedure matches the External Pressurization Test described in the NEMA 6P section. Products are placed in a water tank with a depth of 6 ft for 24 hours.

IP69 & IP69K



IP69(K) rated products provide high pressure, high temperature ingress protection where cleanliness and hygiene are essential. Products carrying this rating are suitable for food and beverage processing where equipment must be thoroughly cleaned and sanitized or mobile equipment and vehicles which require regular high-pressure cleaning. IP69K is the highest rated protection available and high-grade materials such as passivated 316 Stainless Steel are preferred.

How testing is conducted for IP69:

(See IEC IP65 above for first character requirements.)

The 9 in the second position of the IP Code indicates protection against high pressure water/steam jet cleaning. This test involves spraying the enclosure from angles of 0^0, 30^0, 60^0, and 90^0 for 30 seconds each, at a distance of 150 to 200mm from the nozzle while the sample is rotating 4 to 6 times a minute. The fan jet nozzle must deliver 75^0 to 85^0C water at a rate of 14 to 16 l/min. The fan jet nozzle's opening is an oval shape with dimensions of 2.34x1.33mm. A distributed impact force of 0.9 – 1.2N must be achieved and verified at the upper and lower limits of the distance tolerance range using a 2x30mm impact plate and a force sensor. This results in a 15 to 20 kPa (2.2 to 2.9 psi) impact pressure assuming the water impact is evenly distributed across the whole plate. The stream pressure at the outlet of the nozzle was calculated to be about 5,400 kPa (780 psi). See section 14.2.9 of IEC 60529 for full details.

How testing is conducted for IP69K:

(See IEC IP65 above for first character requirements.)

Note that IP69K is not defined by IEC 60529. Instead, it is defined by ISO 20653. This standard was developed specifically for IP ratings of enclosures that are used on road vehicles. The 9K in the second position of the IP Code indicates protection against high pressure water/steam jet cleaning. This test involves spraying the enclosure from angles of 0^0, 30^0, 60^0, and 90^0 for 30 seconds each, at a distance of 100 to 150mm from the nozzle while the sample is rotating 4 to 6 times a minute. The fan jet nozzle must deliver 75^0 to 85^0C water at a rate of 14 to 16 l/min resulting in a stream pressure of about 8,000 to 10,000 kPa (1,160 to 1450 psi) at the outlet of the nozzle according to DIN 40050 Part 9. The fan nozzle must be 8mm to 10mm wide nominally depending on distance from the test specimen and project water in a 30^0 arc. See DIN 40050 Part 9 for full details.

We reserve the right to make technical alterations without prior notice.

What is a NEMA Type rating?

NEMA (National Electrical Manufacturer Association) is a protection rating that applies to an enclosure to define the type of environment where it can be used. Turck's use of NEMA Type ratings on products indicate that when used with the proper rated enclosure, the product can achieve and maintain that enclosure rating. NEMA Type ratings have more stringent testing requirements than IP ratings to verify protection from external ice, corrosive materials, oil immersion, dust, water, etc. This document focuses on the NEMA Type ratings most applicable to electrical connectors.

What NEMA Type rating do I need?

NEMA Type ratings are predominately used in the United States with IP ratings being preferred by many international manufacturers. Many Turck products carry dual ratings indicating compliance to both standards. Users should choose a Type rating equal to or better than the enclosure's Type rating to avoid additional testing requirements. NEMA Type ratings on products assume proper mating and mounting techniques.

NEMA Type	Definition*
1	General-purpose. Protects against dust, light, and indirect splashing but is not dust-tight; primarily prevents contact with live parts; used indoors and under normal atmospheric conditions.
2	Drip-tight. Similar to Type 1 but with addition of drip shields; used where condensation may be severe (as in cooling and laundry rooms).
3	Weather-resistant. Protects against falling dirt and windblown dust, against weather hazards such as rain, sleet, and snow, and is undamaged by the formation of ice. Used outdoors on ship docks, in construction work, and in tunnels and subways.
3R	The same as 3 but omits protection against windblown dust.
3S	The same as 3 but also operable when laden with ice.
3X, 3RX, 3SX	X indicates additional corrosion protection; commonly used near salt water.
4 and 4X	Watertight. Must exclude at least 65 Gallons per minute of water from a 1 in nozzle delivered from a distance not less than 10 ft for 5 min. Used outdoors on ship docks, in dairies, in wastewater treatment plants and breweries. X (as 4X) indicates additional corrosion resistance.
5	Dust-tight. Provided with gaskets or equivalent to exclude dust; used in steel mills and cement plants.
6 and 6P	Submersible. Design depends on specified conditions of pressure and time; submersible in water or oil; used in quarries, mines, and manholes. 6 is temporarily submersible, 6P withstands occasional prolonged submersion. Neither are intended for continuous submersion.
12	General-purpose. Intended for indoor use, provides some protection against dust, falling dirt, and dripping non-corrosive liquids. Meets drip, dust, and rust resistance tests.

**Reference: NEMA Enclosure Types (from NEMA 250) & NEMA/IEC enclosure ratings (Cole-Parmer)*

NEMA Type 1

Type 1 enclosures require the least amount of protection and are commonly used in indoor commercial applications.

How testing is conducted:

1. Rod Entry Test: A rod of 0.125-inch diameter may not enter nonventilated enclosures. A rod of 0.5-inch diameter may not enter ventilated enclosures. See section 5.2 of NEMA 250 for full details.

2. Rust-Resistance Test: Nonferrous enclosures with no external ferrous parts need not be tested. The test is a 24-hour salt spray test. The enclosure passes the test if there is not rust except at points where protection is impractical, such as machined and mating surfaces of cast enclosures and sliding surfaces of hinges, shafts, etc. See section 5.8 of NEMA 250 for full details.

We reserve the right to make technical alterations without prior notice.

NEMA Type 3

Type 3 enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, and windblown dust and to be undamaged by the formation of ice on the enclosure. They are not intended to provide protection against conditions such as internal condensation or internal icing. Turck uses IP67 testing to verify passing of the Rain and Outdoor Dust tests.

How testing is conducted:

1. Rain Test: Shall not allow water to enter the enclosure when a continuous water spray is applied to the entire top and all exposed sides of the enclosure. The test is run for 1 hour at a rate of 18 inches per hour and an operating pressure of 5 psi. See section 5.5.1 of NEMA 250 for full details.

2. Outdoor Dust Test: See section 5.5.1 of NEMA 250 for full details.

a. Dust-Blast Method: A blast of compressed air mixed with dry Type 1 cement is directed at the enclosure with a pressure of 90 to 100 psi. The nozzle is held 12 to 15 inches from the enclosure and is directed at all points of potential dust entry. No dust may enter the enclosure.

b. Hose Method: Enclosure is subjected to a stream of water from a hose with a 1-inch diameter nozzle that delivers at least 45 gallons per minute. The water is directed at all joints, from all angles, from 10 to 12 feet for a minimum of 5 minutes. No water may enter the enclosure.

3. External Icing Test: Entire enclosure is sprayed with slightly above freezing water at a rate of 1 to 2 gallons of water per hour per square foot of spray area. The test will run for at least 1 hour, maintaining a room temperature slightly above freezing. After 1 hour, the room temperature is lowered to between 20°F and 27°F while continuing water spray. Water spray shall be controlled to cause an ice buildup of ¼ inch per hour and continue until ¾ of an inch is built up. The spray is then stopped, and the enclosure remains in the freezing room for 3 hours to assure all parts have been equalized to constant temperature. The enclosure passes the test if it is undamaged after the ice has melted. Enclosures with no external cavities to trap water when mounted in the normal position shall be considered acceptable and need not be tested. See section 5.6 of NEMA 250 for full details.

4. Corrosion Protection Test (5.10 of NEMA 250): This is a 200-hour salt spray test where results are compared to galvanized steel. Enclosure is evaluated in accordance with UL50 part 13: Protection Against Corrosion. According to section 7.2.1.1 of UL 50E, parts made of copper, aluminum, stainless steel, or of bronze or brass containing at least 80 percent copper, can be considered to comply with indoor and outdoor corrosion resistance.

NEMA Type 4

Type 4 enclosures are intended for indoor and outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water, and to be undamaged by the formation of ice on the enclosure. They are not intended to provide protection against conditions such as internal condensation or internal icing. If no significant cavities where water can be trapped exist or the materials are expected to withstand expansion of ice, it can be assumed that the product passes the External Icing Test. Internal IP67 testing can be used to verify passing of the Hose Down Test.

How testing is conducted:

1. External Icing Test: See NEMA 3 above for details.

2. Hose Down Test: Enclosure is subjected to a stream of water from a hose with a 1-inch diameter nozzle that delivers at least 65 gallons per minute. The water is directed at all joints, from all angles, from 10 to 12 feet for a minimum of 5 minutes. No water may enter the enclosure. See section 5.7 of NEMA 250 for full details.

3. Corrosion Protection Test: See NEMA 3 above for details.

NEMA Type 4X

Type 4X offers the same protection as Type 4 and adds corrosion resistance. Enclosures with this rating are often found in industrial areas such as marine, food processing, oil and gas and treatment facilities. Passivated stainless steel and various types of plastic are common materials that can provide corrosion resistance. Products installed in corrosive environments should receive regular cleaning with a mild, neutral solution to help remove salt, chemicals, and other materials.

We reserve the right to make technical alterations without prior notice.

NEMA Type 6P

Type 6P enclosures are intended for indoor and outdoor use primarily to provide a degree of protection against hose-directed water and the entry of water during prolonged submersion at a limited depth and to be undamaged by the formation of ice on the enclosure. They are not intended to provide protection against conditions such as internal condensation or internal icing. Internal IP67 testing can be used to verify passing of the Hose Down Test.

How testing is conducted:

1. Air Pressure Test: See section 5.12.1 of NEMA 250 for full details.

a. Internal Pressurization Test: The complete enclosure shall be pressurized to 6 psig for a 24-hour period without permeant deformation. The enclosure has met requirements if the pressure drop does not exceed 2 psig.

b. External Pressurization Test: When the enclosure does not have connections for pressurizing the interior, it may be submersed in water so that the highest point is 6 feet below the surface for a period of 24 hours. The enclosure need not be submersed to 6 feet if the equivalent pressure differential is maintained for the required period by pressurizing the water around the enclosure. The enclosure has met requirements if no water has entered the enclosure.

2. External Icing Test: See NEMA 3 above for details.

3. Hose Down Test: See NEMA 4 above for details.

4. Corrosion Protection Test: See NEMA 3 above for details. Additionally, section 7.2.4.1 of UL 50E states that for Type 4X and 6P enclosures, and external parts attached to these enclosures, shall be manufactured of American Iron and Steel Institute (AISI) Type 304 or Type 316 stainless steel, polymerics, or other materials that have been determined to comply with sections 7.2.3 and 8.9.

We reserve the right to make technical alterations without prior notice.

NEMA Type 12

Type 12 enclosures are intended for indoor automated applications such as packaging, material handling and non-corrosive process control and manufacturing. They provide protection against light drips and splashing but are not intended to be weatherproof. Outdoor and corrosive applications require NEMA 4X or 6P Type protection. Turck's Internal IP68/NEMA 6P or IP67 testing can be used to verify the External Pressurization Test and the Hose Down Test

How testing is conducted:

1. Air Pressure Test: See section 5.12.1 of NEMA 250 for full details.

a. Internal Pressurization Test: The complete enclosure shall be pressurized to 6 psig for a 24-hour period without permeant deformation. The enclosure has met requirements if the pressure drop does not exceed 2 psig.

b. External Pressurization Test: When the enclosure does not have connections for pressurizing the interior, it may be submersed in water so that the highest point is 6 feet below the surface for a period of 24 hours. The enclosure need not be submersed to 6 feet if the equivalent pressure differential is maintained for the required period by pressurizing the water around the enclosure. The enclosure has met requirements if no water has entered the enclosure.

2. External Icing Test: See NEMA 3 above for details.

3. Hose Down Test: See NEMA 4 above for details.

4. Corrosion Protection Test: See NEMA 3 above for details. Additionally, section 7.2.4.1 of UL 50E states that for Type 4X and 6P enclosures, and external parts attached to these enclosures, shall be manufactured of American Iron and Steel Institute (AISI) Type 304 or Type 316 stainless steel, polymerics, or other materials that have been determined to comply with sections 7.2.3 and 8.9.

References:

- IEC 60529
- ISO 20653
- NEMA 250

TURCK



30 subsidiaries and over
60 representations worldwide!

Printed in USA

©2021 by Turck Inc. All rights reserved. No part of the
publication may be reproduced without written permission.

B2009 A 05/21

www.turck.com