



enlighten



## Design Considerations for IP-Rated Telecom Products and Enclosures

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## Abstract

In the telecom field, increased IP protection is a major requirement. The protection of enclosures against the ingress of dirt or against the ingress of water is defined in the IEC standard code. An enclosure which protects equipment against ingress of particles will also protect a person from potential hazards within that enclosure, and this degree of protection is also defined as a standard.

Principally, these requirements are detailed in the IEC 60529:1989 second edition. This paper provides a simplified understanding of the standard, accompanied by some typical examples as foreseen for the general telecom products available. As IEC-60529 is a document covering a wide range of equipment, this paper will try to cover relevant information applicable to telecom products.

These measures protect both the enclosure and the equipment inside the enclosure against external influences or conditions. Those influences and conditions include:

- mechanical impacts
- corrosion
- corrosive solvents (for example, cutting liquids)
- fungus
- vermin
- solar radiation
- icing
- moisture
- explosive atmospheres

...and the protection against contact with hazardous moving parts external to the enclosure (such as fans), are matters for the relevant product standard to be protected.

## Abbreviations

Sl. No.	Acronyms	Full form
1	NEMA	National Electrical Manufacturers Association
2	IEC	International Electro-technical Commission
3	IP	Ingress Protection

“The IP rating of an enclosure is dictated not only by the enclosure itself, but also by its fixing method, lid sealing and cable entries, etc.”

## Introduction

The IEC standard describes a system for classifying the degrees of protection provided by the enclosures of electrical equipment. While this system is suitable for use with most types of electrical equipment, it should not be assumed that all the listed degrees of protection are applicable to a particular type of equipment. The International Protection is applicable to electrical equipment enclosures having rated voltage up to 72.5kV.

The equipment manufacturer should be consulted to determine the degrees of protection available and the parts of equipment to which the stated degree of protection applies. It is particularly important where products and enclosures need to be adapted or modified by the user for the attachment of other equipment or for installation and cabling, that any instructions provided by the enclosure manufacturer should be strictly observed to ensure the required degree of protection is maintained.

IP Code classifies and rates the degrees of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact, and water in mechanical casings and with electrical enclosures. The IP rating of an enclosure is dictated not only by the enclosure itself, but also by its fixing method, lid sealing and cable entries, etc.

This paper aims to provide users more detailed information to help them understand the IP rating and its testing methods. NEMA ratings can be approximately compared to those of the IP system. But other factors such as corrosion protection are involved in the NEMA system as well, so please refer to official documentation for details.

“In general the higher the IP code, the more expensive the enclosure.”

## Problem Definition

In Telecom field the devices should be designed by considering the degree of protection rating & also the factors like daily use in harsh environments with dust and splash water, or cleaning should be considered. Designing a corresponding Telecom device components such as power plug connections, switches, operation elements or display elements, which have increased impermeability will be a challenge for Engineers to design the IP rating housings. This applies to components on the front side as well as those on the back side of the devices.

The manufacturers must meet a goal of higher IP ratings for more and more products in order to meet tougher device standards and increased client demands. Today, most of modern industrial plants typically work with IP54 and IP20 in electrical enclosures. Complete protection against contact is given upwards of IP 5x, and with this level of protection, accidental entry with a wire ( $\varnothing > 1$  mm) is prevented.

In general, the higher the IP code, the more expensive the enclosure, but specifying a higher degree of protection does not necessarily ensure it is the most suitable for a particular application. The harmful effects of both dust and moisture on sensitive equipment and circuitry can cause electrical shorting, component corrosion and greatly reduced reliability, hence proper sealing is crucial.

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“The IP protection factor thus states if a device is suitable for use in the corresponding environmental conditions.”

## Scope of IP Protection

The IP protection factor indicates the ability of electrical equipment in various environmental conditions. The relevant standard IEC 60529 specifies:

- 1) Terms for the protection factor of electrical equipment housing relating to:
  - Protection of people from coming into contact with dangerous parts inside the device
  - Protection of the device inside the housing from entry of solid foreign objects such as wire or dust
  - Protection of the device inside the housing from harmful effects caused by water entry
- 2) Identification of protection factor
- 3) Requirements for every identification
- 4) Inspections that are required to be performed in order to confirm compliance to the standard

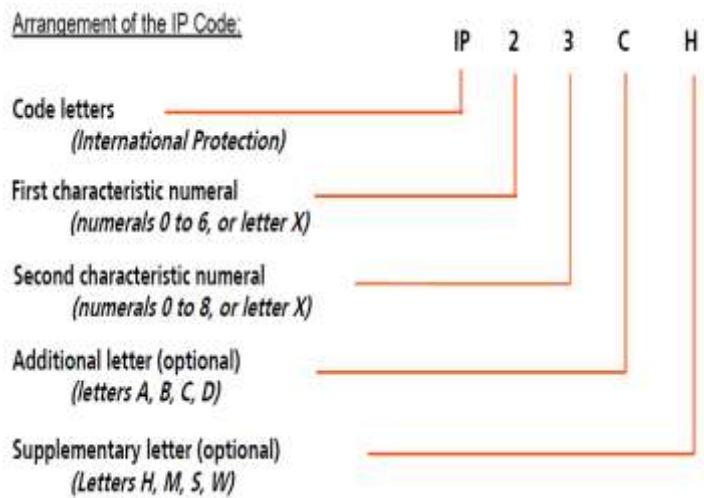
The first number following IP indicates the protection provided from entry of solid foreign objects, the second is the protection from water entry. The IP protection factor thus states whether or not a device is suitable for use in the corresponding environmental conditions.

“The degrees of protection are most commonly expressed as "IP" followed by two numbers, e.g. IP65. “

### Designation

The degrees of protection are most commonly expressed as "IP" followed by two numbers, e.g. IP65, where the numbers define the degree of protection. The first digit (Foreign Bodies Protection) shows the extent to which the equipment is protected against particles, or to which persons are protected from enclosed hazards. The second digit (Water Protection) indicates the extent of protection against water.

The degree of protection provided by an enclosure is

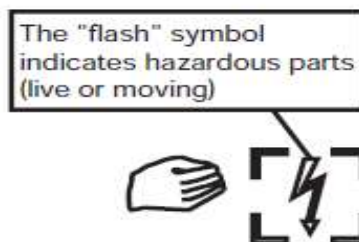


indicated by the IP Code in the following way:

Where a characteristic numeral is not required to be specified, it shall be replaced by the letter "X," e.g. IP4X specifies that protection against the 1.0mm probe is required and there is no requirement for protection from the ingress of water.

- Additional letters and/or supplementary letters may be omitted without replacement
- Where more than one supplementary letter is used, the alphabetic sequence shall apply

**Note:**





“The first numeral identifies the degree of protection against access to hazardous parts.”

### First Numeral:

The first numeral identifies the degree of protection against access to hazardous parts – IPXX. There are seven numbers (including zero ‘0’) and the whole numbers also represent the protection against entry of solid foreign objects. “0” indicates there is no protection, e.g. IP00.

Protection against ingress of solid foreign objects		Meaning protection of persons against access to hazardous parts with:	
IP	Requirements	Example	
0	no protection		no protection provided
1	full penetration of 50.0mm diameter sphere not allowed and shall have adequate clearance from hazardous parts. Contact with hazardous parts not permitted		back of hand
2	full penetration of 12.5mm diameter sphere not allowed. The jointed test finger shall have adequate clearance from hazardous parts		finger
3	the access probe of 2.5mm diameter shall not penetrate		tool
4	the access probe of 1.0mm diameter shall not penetrate		wire
5	limited ingress of dust permitted (no harmful deposit, refer to standard)		wire
6	totally protected against ingress of dust		wire

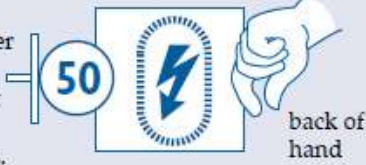
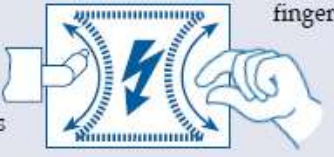


“The second numeral identifies the degree of protection against ingress of water.”

**Second Numeral:**

The second numeral identifies the degree of protection against ingress of water IP-X. There are up to eight whole numbers covering the water characteristics and zero “0” also means “non-protected.”

Protection against harmful ingress of water			Meaning for protection from ingress of water:
IP	Requirements	Example	
0	no protection		no protection provided
1	protected against vertically falling drops of water.		vertically dripping
2	protected against vertically falling drops of water with enclosure tilted 15° from the vertical.		Enclosure tilted 15° from the vertical
3	protected against sprays to 60° from the vertical.		limited spraying
4	protected against water splashed from all directions.		splashing from all directions
5	protected against low pressure jets of water from all directions.		hosing jets from all directions
6	protected against strong jets of water		strong hosing jets from all directions
7	protected against the effects of immersion between 15.0 cm and 1.0 m		temporary immersion
8	protected against longer periods of immersion under pressure		immersion

**Additional Letter**

<b>ADDITIONAL LETTER</b> <i>(Optional)</i>		Meaning protection of persons against access to hazardous parts with:
IP	Requirements	
	<b>Example</b>	
<b>A</b>		
	<p>For use with first numerals 0</p> <p>penetration of 50.0mm diameter sphere up to guard face must not contact hazardous parts.</p>	 <p>back of hand</p>
<b>B</b>		
	<p>For use with first numerals 0 &amp; 1</p> <p>test finger penetration to a maximum of 80.0mm must not contact hazardous parts</p>	 <p>finger</p>
<b>C</b>		
	<p>For use with first numerals 0, 1 &amp; 2</p> <p>wire of 2.5mm diameter x 100.0mm long must not contact hazardous parts when spherical stop face is partially entered</p>	 <p>tool</p>
<b>D</b>		
	<p>For use with first numerals 0, 1, 2 &amp; 3</p> <p>wire of 1.0mm diameter x 100.0mm long must not contact hazardous parts when spherical stop face is partially entered</p>	 <p>wire</p>
<p>Limited penetration allowed with X1, X2, X3, X4, X5 and all four additional letters. Refer to standard.</p>		

**SUPPLEMENTARY LETTER (Optional)**

For specific applications.

H: High voltage equipment

M: Moving or rotating equipment  
*(Tested whilst in motion)*

S: Moving or rotating equipment  
*(Tested whilst at rest)*

W: Weather conditions  
*(Agreed between Manufacturer and User)*

**Examples for the Use of Letters in the IP Code****IP Code not using optional letters:****IP 34**

An enclosure with this designation (IP Code):

- protects persons, handling tools having a diameter of 2.5 mm and greater, and against access to hazardous parts
- protects the equipment inside the enclosure against the ingress of solid foreign objects having a diameter of 2.5 mm and greater
- protects the equipment inside the enclosure against the harmful effects of water splashed against the enclosure from any direction

**IP Code using optional letters:****IP 23 C S**

- Protects persons against access to hazardous parts with fingers
- Protects the equipment inside the enclosure against the ingress of solid foreign objects having a diameter of 12.5 mm and greater
- Protects the equipment inside the enclosure against the harmful effects of water sprayed against the enclosure
- Protects persons handling tools having a diameter of 2.5 mm and greater and a length not exceeding 100 mm against access to hazardous parts

## Test Conditions

A designation with characteristic numerals implies that all test conditions are met for this numeral:

- Test means for the tests for protection against solid foreign objects

First numeral	Test means (object probes and dust chamber)	Test force
0	No test required	-
1	Rigid sphere without handle or guard (50mm diameter)	50N ± 10%
2	Rigid sphere without handle or guard (12,5mm diameter)	30N ± 10%
3	Rigid steel rod 2,5mm diameter with edges free from burrs	3N ± 10%
4	Rigid steel wire 1mm diameter with edges free from burrs	1N ± 10%
5	Dust chamber, with or without underpressure	-
6	Dust chamber, with underpressure	-

- Test means and main test conditions for the tests for protection against water

Second numeral	Test means	Water flow rate	Duration of test
0	No test required	-	-
1	Drip box	1 mm/min.	10 min.
2	Drip Box (Enclosure 15° tilted)	3 mm/min.	10 min.
3	Oscillating tube: distance max. 200mm / Spray nozzle; Spray ±60° from vert.	10 l/min.	1 min/m <sup>2</sup> (≥ 5 min)
4	As for 3; Spray ±180° from vert.	-	*
5	Water jet hoze nozzle 6,3mm; distance 2,5 to 3m	12,5 l/min.	1 min/m <sup>2</sup> (≥ 3 min)
6	Water jet hoze nozzle 12,5mm; distance 2,5 to 3m	100 l/min.	*
7	Immersion tank; water-level on enclosure 0,15m above top, 1m above bottom	-	30 min.
8	Immersion tank; water-level by agreement	-	by agreement



"An IP65 rated box is not IP65 when the cable entries do not offer the same protection. "

## Useful Information and Guidelines

### Plastic and Metal Enclosures

Most often, it offers a first digit rating of 4, 5 or 6:

- for a basic wiring junction protected by a wall, ceiling, cabinet or similar in a dry environment, 4 is suitable
- for most industrial applications where the box can be seen or is accessible as part of routine operation or maintenance, 5 or 6 is the preferred option
- cast and most polystyrene and virtually all polycarbonate enclosures fall into the 5 or 6 categories

### Pressed Metal Enclosures

It offers the poorest protection and are generally a 4 series

### Mounting an Enclosure inside a Cabinet:

When fixing to a machine wall, a building wall or a post, the method of attachment can either maintain or instantly downgrade the IP rating of the enclosure assembly.

For example, in an industrial environment that may include water sprays, wash downs or atmospheric moisture, a screw fixed 'IP65' enclosure with 'IP68' cable glands can come down to 'IP64' or lower simply by not employing grommets between the screw or bolt heads and the enclosure wall when fixing the enclosure in place.

### Fixing to Posts or Uneven Surfaces

- This is more problematic, and an external fixing of some sort, such as cable-tie brackets, can be very useful
- Gluing or gun applied sealant is preferable

### General above Ground Outdoor Applications

Recent developments in push-fit seals have seen both the grommet type and the molded-in versions offering high ratings – up to IP65 in some instances – providing protection from drips to low power water sprays.

### Underground Use

Temporary immersion, wash downs in the food and processing industries, or exposure to the sea requires IP65 and above. This generally requires cable glands fixed to the enclosure wall and high quality compression seals. An IP65 rated box is not IP65 when the cable entries do not offer the same protection.

## Conclusion:

The effects of continuous exposure to weather and the environment are difficult to evaluate, and therefore the choice of material for the enclosure is important. This paper does not include any guidance for the selection of enclosure materials.

It should be noted that IP ratings are for ingress only, and that tests are comparative and are conducted with fresh water. Therefore, they in no way indicate the enclosure's ability to withstand the effects of corrosion from salt water, chemicals, acid rain and other special environments as well as the normal expected weather conditions. Thus, we need to consider both the material and the finish as important factors.

The adoption of this IP classification system, wherever possible, will promote uniformity in methods of describing the protection provided by the enclosure and in the tests to prove the various degrees of protection. It should also reduce the number of types of test devices necessary to test a wide range of products.

## Reference

1. IEC60529 Second edition 1989 - Am. 1 1999, "Degrees of protection provided by enclosures (IP Code)"
2. Guide to the 'IP' Codes for Enclosures EIEMA Third Edition "Degrees of Protection"
3. "Enclosure Design Tips Hand Book," Bud Industries, Inc.
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## Author Info

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