

Appendix L. Degrees of protection provided by enclosures

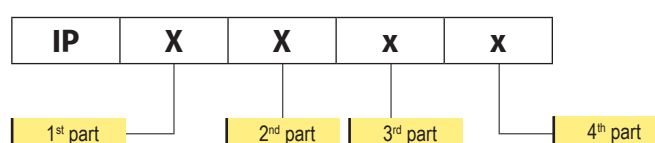
Herewith will be analysed all the reference standards specifying the degrees of protection provided by enclosures for electrical equipment and materials both for the European and for the North American markets, with the aim of clarifying the definition of the degrees of protection and a correlation, if possible, between the European and the American requirements.

L.1 Degree of protection IP

The European EN 60529 standard and the German DIN 40050 standard, part 9, are, combined, an exhaustive document as concerns the degrees of protection provided by enclosures. The object of this standard is to give:

- 1) Definitions for the degrees of protection provided by enclosures for electrical equipment as regards:
 - a) Protection of persons against contact with hazardous parts inside the enclosures;
 - b) Protection of the equipment inside the enclosures against ingress of solid foreign objects;
 - c) Protection of the equipment inside the enclosures against the harmful effects due to the ingress of water.
- 2) Designations and classification for the degrees of protection
- 3) Requirements for each designation
- 4) Tests to be performed

These Standards classify the degree of protection of the enclosures with the IP code. The IP code (International Protection or Ingress Protection) is made by 4 parts which identify and characterize the degree of protection provided by the enclosure.



First part indicates the protection of the equipment against the ingress of solid foreign objects and the protection against access to hazardous parts also by means of tools in the hands of a person.

Table L.1. Definition of the first part of the IP code

Level	Definition	Effects
IP0_	Non-protected.	Non- protected.
IP1_	Protected against solid foreign objects ≥ 50 mm in diameter.	Protected against access with the back of hand.
IP2_	Protected against solid foreign objects $\geq 12,5$ mm in diameter.	Protected against access with a finger.
IP3_	Protected against solid foreign objects $\geq 2,5$ mm in diameter.	Protected against access with a tool, for instance with a screwdriver.
IP4_	Protected against solid foreign objects ≥ 1 mm in diameter.	Protected against access with a wire.
IP5_	Partially dust-protected. Ingress of dust is not totally prevented, but the dust must not enter in sufficient quantity to interface with satisfactory operation of the equipment or compromise its safety.	Ingress of dust is not totally prevented, protected against access with a thin wire.
IP6_	Protection against ingress of dust.	No ingress of dust, complete protection against contact (dust tight).

Second part indicates the degree of protection against the harmful effects due to the ingress of water inside the enclosure. If a protection against the ingress of water is not foreseen, the characteristic numeral must be replaced by letter X. This part may consist of additional levels contained in the DIN 40050-9 standard.

Table L.2. Definition of the second part of the IP code

Level	Definition	Standard
IP_0	Non-protected.	EN 60529, DIN 40050-9
IP_1	Protected against the vertical water dripping.	EN 60529, DIN 40050-9
IP_2	Protected against the water dripping when the enclosure is tilted at an angle up to 15° .	EN 60529, DIN 40050-9
IP_3	Protected against rain (enclosure tilted up to 60°).	EN 60529, DIN 40050-9
IP_4	Protected against spraying (water sprayed from any direction).	EN 60529, DIN 40050-9
IP_4K	Protected against high-pressure water spray (from any direction).	DIN 40050-9
IP_5	Protected against water jets (from any direction).	EN 60529, DIN 40050-9
IP_6	Protected against powerful water jets (from any direction).	EN 60529, DIN 40050-9
IP_6K	Protected against powerful high-pressure jetting (from any direction).	DIN 40050-9
IP_7	Protected against the effects of temporary immersion (up to 1 m).	EN 60529, DIN 40050-9
IP_8	Protected against the effects of continuous immersion (beyond 1 m).	EN 60529, DIN 40050-9
IP_9K	Protected against high-pressure jets or steam (from any direction).	DIN 40050-9

The integration with DIN standard allows additional designations which permit to identify the products with high qualitative standards, such as the corrugated plastic conduits for the protection of cables and pertinent fittings. The test with high-pressure jets (about 80 bar) permits to define the product as IP 69K degree of protection (6 = total protection against dust and access with a wire, 9K = Protection against the harmful effects due to the high-pressure jets).

Third part is the first additional letter and indicates the degree of protection for persons against the access to hazardous parts. It is used when the protection for persons against access to hazardous parts is higher than the one indicated by the first part, usually when there is no coincidence between the degree of protection for persons and the degree of protection against the ingress of solid foreign objects; when the degree of protection against solid foreign objects is not indicated (the first part is replaced by a X), but only the degree of protection for persons.

Table L.3. Definition of the third part of the IP code

Level	Definition
a	Protected against access with the back of hand.
b	Protected against access with a finger.
c	Protected against access with a tool, for instance with a screwdriver.
d	Protected against access with a wire.

Fourth part, after the second part or after the supplementary letter, an additional letter can be appended to provide further information related to the protection of the device.

Table L.4. Definition of the fourth part of the IP code

Level	Definition
f	Oil resistant.
H	High-voltage equipment.
M	Tested against the harmful effects due to the ingress of water when its movable parts are in motion.
S	Tested against the harmful effects due to the ingress of water when its movable parts are not in motion.
W	Suitable for use under specific atmospheric conditions and provided with additional protective measures or proceedings.

L.2 Degree of protection NEMA

On the USA market the enclosures' degrees of protection is defined by the "Type" (type of enclosure) according to NEMA (National Electrical Manufacturers Association) classification. NEMA, unlike the European standards, includes specific conditions such as corrosion, rust, ice, oils and coolants; the NEMA classification takes also into consideration uses for indoor, outdoor and hazardous locations. In the following tables are indicated the Types of Enclosure and the conditions under which they provide protection in nonhazardous and hazardous locations.

Table L.5. Type of enclosure for use in nonhazardous locations

Provides protection against the following conditions	Type of Enclosure															
	1 ^(a)	2 ^(a)	3	3X	3R ^(a)	3RX ^(a)	3S	3SX	4	4X	5	6	6P	12	12K	13
Indoor	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Outdoor			•	•	•	•	•	•	•	•	•	•	•			
Access to hazardous parts	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Ingress of solid foreign objects (falling dirt)	•	•							•	•	•	•	•	•	•	•
Ingress of solid foreign objects (settling airborne dust, lint, fibers, and flyings ^(b))									•	•	•	•	•	•	•	•
Ingress of solid foreign objects (circulating dust, lint, fibers, and flyings ^(b))									•	•	•	•	•	•	•	•
Ingress of solid foreign objects (windblown dust, lint, fibers, and flyings ^(b))			•	•			•	•	•	•		•	•			
Ingress of water (dripping and light splashing)		•							•	•	•	•	•	•	•	•
Ingress of water (rain, snow, and sleet ^(c))			•	•	•	•	•	•	•	•		•	•			
Ingress of water (hosedown and splashing water)									•	•		•	•			
Sleet ^(d)							•	•								
Ingress of water (occasional temporary submersion)												•	•			
Ingress of water (occasional prolonged submersion)													•			
Oil and coolant seepage														•	•	•
Oil or coolant spraying and splashing																•
Corrosive agents				•		•		•		•			•			

(a) These enclosures may be ventilated.

(b) These fibers and flyings are nonhazardous materials and are not considered Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code, Article 500.

(c) External operating mechanisms are not required to be operable when the enclosure is ice covered.

(d) External operating mechanisms are operable when the enclosure is ice covered.

Table L6. Type of enclosure for use in hazardous locations

Provides protection against the following typical chemicals contained in atmosphere and for the specified ambient type ^(a)	Related hazardous locations	Type of Enclosure ^(b)			
		7	8	9	10
Indoor	-	•	•	•	cfr. ^(d)
Outdoor	-		•		cfr. ^(d)
Acetylene	Class I Group A	•	•		
Hydrogen, manufactured gas	Class I Group B	•	•		
Diethyl ether, ethylene, cyclopropane	Class I Group C	•	•		
Gasoline, hexane, butane, naphtha, propane, acetone, toluene, isoprene	Class I Group D	•	•		
Metal dust	Class I Group E			•	
Carbon black, coal dust, coke dust	Class II Group F			•	
Flour, starch, grain dust	Class II Group G			•	
Fibers, flyings ^(c)	Class III Group G			•	
Methane with or without coal dust	MSHA ^(d)				•

(a) If the installation of Type 7, 8, 9 and 10 is outdoors and/or additional protection is required by Table K.5, a combination-type enclosure is required.

(b) Due to the characteristics of the gas, vapor, or dust, a product suitable for one Class or Group may not be suitable for another Class or Group unless marked on the product.

(c) For Class III type ignitable fibers or combustible flyings see the National Electrical Code, Article 500.

(d) Mine Safety and Health Administration, 30 CFR, Part 18.

L.3 Conversion between degrees of protection

The NEMA standard n.250 (Appendix A) gives a correlation among the recognized enclosures and the degrees of protection of the enclosures according to IP classification. As the European standard does not specify degrees of protection against the mechanical damage of equipment, risk of explosion or particular conditions such as moisture, corrosive vapors, etc., the correlation with the IP degrees of protection is not univocal and binding. The IEC designation consists of the letters IP followed by two numerals. The first characteristic numeral indicates the degree of protection provided by the enclosure with respect to persons and solid foreign objects entering the enclosure. The second characteristic numeral indicates the degree of protection provided by the enclosure with respect to the harmful ingress of water.

The following tables provide an equivalent conversion from the enclosure NEMA Type numbers to the IEC enclosure classification designations IP. The enclosure type numbers meet or exceed the test requirements for the associated IEC classification; for this reason the tables cannot be used to convert from IEC classifications to enclosure NEMA Type numbers.

Table L.7. Conversion of NEMA enclosures with the first part of the IP code.

First part of the IP code	NEMA Type of Enclosure															
	1	2	3	3X	3R	3RX	3S	3SX	4	4X	5	6	6P	12	12K	13
IP0_	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP1_	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP2_	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP3_			•	•			•	•	•	•	•	•	•	•	•	•
IP4_			•	•			•	•	•	•	•	•	•	•	•	•
IP5_			•	•			•	•	•	•	•	•	•	•	•	•
IP6_									•	•		•	•			

Table L.8. Conversion of NEMA enclosures with the second part of the IP code.

Second part of the IP code	NEMA Type of Enclosure															
	1	2	3	3X	3R	3RX	3S	3SX	4	4X	5	6	6P	12	12K	13
IP_0	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP_1		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP_2		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP_3			•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP_4			•	•	•	•	•	•	•	•	•	•	•	•	•	•
IP_5			•	•			•	•	•	•	•	•	•			
IP_6									•	•		•	•			
IP_7												•	•			
IP_8												•	•			

For convenience, the table below sets the NEMA Types of enclosures and the correspondent maximum degree of protection IP.

Table L.9. Conversion of NEMA enclosures with the correspondent maximum degree of protection IP.

NEMA Type of Enclosure	1	2	3	3X	3R	3RX	3S	3SX	4	4X	5	6	6P	12	12K	13
IP Degree of protection	IP20	IP22	IP55	IP55	IP24	IP24	IP55	IP55	IP66	IP66	IP53	IP67	IP68	IP54	IP54	IP54

Example

A IP65 degree of protection is defined, what are the types (Type) of NEMA enclosures that meet or exceed the requirements for this degree of protection?

Using table K.7 identifies the NEMA types of enclosures that satisfy the first part of the IP code, with table K.8 those which satisfy the second part of the IP code.

Conversion	1	2	3	3X	3R	3RX	3S	3SX	4	4X	5	6	6P	12	12K	13
IP6_									•	•		•	•			
IP_5			•	•			•	•	•	•		•	•			
On the row below only the common type of enclosures are listed																
IP65									•	•		•	•			

Finally the NEMA types 4, 4X, 6 and 6P meet or exceed the requirements for the degree of protection IP65.