
**Road vehicles — Degrees of protection
(IP code) — Protection of electrical
equipment against foreign objects,
water and access**

*Véhicules routiers — Degrés de protection (codes IP) — Protection
des équipements électriques contre les corps étrangers, l'eau et les
contacts*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

This third edition cancels and replaces the second edition (ISO 20653:2013), which has been technically revised.

The main changes are as follows:

- test conditions for IPX9K test were extended, the method for measuring of the impact forced was described and tolerances were added, the visualization method for impact force with foam was added;
- details to test setup for degrees of protection against water 3, 4 and 4K were added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The IP codes used in this document are in accordance with IEC 60529, except in the case of codes “K”, which describe special requirements for road vehicles that are not covered by IEC 60529.

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Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access

1 Scope

This document applies to degrees of protection (IP code) provided by enclosures of the electrical equipment of road vehicles. It specifies the following:

- a) designations and definitions of types and degrees of protection provided by enclosures of electrical equipment (IP codes) for the:
 - protection of electrical equipment within the enclosure against ingress of foreign objects, including dust (protection against foreign objects);
 - protection of persons against access to hazardous parts inside the enclosure (protection against access);
 - protection of electrical equipment inside the enclosure against effects due to ingress of water (protection against water);
- b) requirements for each degree of protection;
- c) tests carried out in order to confirm that the enclosure complies with requirements of the relevant degree of protection.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12103-1, *Road vehicles — Test contaminants for filter evaluation — Part 1: Arizona test dust*

IEC 60068-2-68, *Environmental testing — Part 2: Tests — Test L: Dust and sand*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

enclosure

part providing protection of equipment against certain external influences and in any direction against access

3.2

degree of protection

protection provided by an *enclosure* (3.1) against access, foreign objects and/or water and verified by standardized test methods

3.3

IP code

international protection code

coding system used to indicate the *degree of protection* (3.2) provided by an *enclosure* (3.1) against access, foreign objects and/or water and to give additional information in connection with such parts

3.4

hazardous part

part that is hazardous to approach or touch

3.5

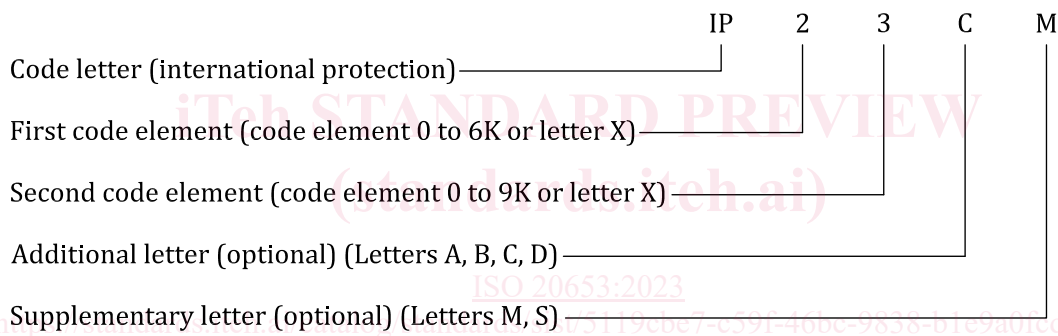
opening

gap or aperture in an *enclosure* (3.1) which exists or may be formed by the application of a test probe at the specified force

4 Structure and meaning of the IP code

4.1 Structure of the IP code

The structure of the IP code is as follows.



Where no code element is given, the letter “X” shall be substituted (or “XX”, if none of the two code elements have been indicated).

Additional and/or supplementary letters may be omitted without substitute.

Additional letters following each other directly shall be in alphabetical order.

Wherever the degree of protection of a part of the enclosure or the electrical equipment deviates from the degree of protection of the remaining part, both degrees of protection shall be indicated.

4.2 Meaning of IP code

Table 1 contains an overview of the IP code elements.

Table 1 — Overview of all IP code elements and meaning

Element	IP	Meaning for the protection of electrical equipment	Meaning for the protection of persons
First code element		Against foreign objects (including dust):	Against access:
	0	— not protected	— not protected
	1	— with diameter ≥ 50 mm	— with back of hand
	2	— with diameter $\geq 12,5$ mm	— with finger
	3	— with diameter $\geq 2,5$ mm	— with tool
	4	— with diameter $\geq 1,0$ mm	— with wire
	5K	— dust-protected	— with wire
	6K	— dust-tight	— with wire
Second code element		Against water:	Not applicable
	0	— not protected	
	1	— vertical water drips	
	2	— water drips (15° inclination)	
	3	— water spray	
	4	— splash water	
	4K	— splash water with increased pressure	
	5	— high-velocity water	
	6	— strong high-velocity water	
	6K	— strong high-velocity water with increased pressure	
	7	— temporary immersion	
8	— continuous submersion		
9K	— high-pressure/steam-jet cleaning		
Additional letter (optional)		Not applicable	Against access (unless described by first letter)
	A		— with back of hand
	B		— with finger
	C		— with tool
	D		— with wire
Supplementary letter (optional)	M	Movement of moveable parts during water test	Not applicable
	S	Standstill of moveable parts during water test	

4.3 Examples for the use of letters in the IP code

The following examples explain the use and arrangements of letters in the IP code. For more comprehensive examples, see [Clause 7](#).

IP44	no letters, no options;
IPX5	omitting first code element;
IP2X	omitting second code element;
IP20C	using additional letter;
IPXXC	omitting both code elements, using additional letter;
IPX1C	omitting first code element, using additional letter;

IP3XD	omitting second code element, using additional letter;
IP23S	using supplementary letter;
IP21CM	using additional letter and supplementary letter;
IPX5/IPX7	giving two different degrees of protection by an enclosure against both water jets and temporary immersion for “versatile” application.

5 Degrees of protection against foreign objects and against access

Tables 2 and 3 contain short descriptions of the degrees of protection with the relevant requirements.

If the same degree of protection (identical code element) for protection against foreign objects and access is required, then both requirements are indicated by the first code element.

If different degrees of protection for both protection types are required, then an additional letter shall be used. In this case the first code element only defines the protection against foreign objects and the additional letter indicates the protection against access.

Additional letters may only be used if:

- the degree of protection against access is higher than indicated by the first code element, or
- only the degree of protection against access is to be indicated (first code element substituted by X).

The indication of a degree of protection against access and foreign objects always includes the preceding degrees of protection.

Table 2 — Degrees of protection against foreign objects

First code element	Degree of protection	
	Brief description	Requirements
0	Not protected	None
1	Foreign objects diameter \geq 50 mm	Test probe with a diameter of 50 mm shall not penetrate completely ^a .
2	Foreign objects diameter \geq 12,5 mm	Test probe with a diameter of 12,5 mm shall not penetrate completely ^a .
3	Foreign objects diameter \geq 2,5 mm	Test probe with a diameter of 2,5 mm shall not penetrate completely ^a .
4	Foreign objects diameter \geq 1,0 mm	Test probe with a diameter of 1,0 mm shall not penetrate completely ^a .
5K	Dust	Dust shall only penetrate in quantities which do not impair performance and safety.
6K	Dust	Dust shall not penetrate.

^a “Shall not penetrate completely” indicates that the full diameter shall not pass through an opening of the enclosure.

Table 3 — Degrees of protection against access

First code element	Additional letter	Degree of protection	
		Brief description	Requirements
0	–	Not protected	None
1	A	Back of hand (no protection against intentional contact)	Test probe with a diameter of 50 mm shall not penetrate completely ^a and maintain sufficient distance from hazardous parts.

^a “Shall not penetrate completely” indicates that the full diameter shall not pass through an opening of the enclosure.

Table 3 (continued)

First code element	Additional letter	Degree of protection	
		Brief description	Requirements
2	B	Finger	Jointed test finger with a diameter of 12 mm may penetrate completely, but shall maintain a sufficient distance from hazardous parts.
3	C	Tool (e.g. screwdriver)	Test probe with a diameter of 2,5 mm, 100 mm long, may penetrate completely, but shall maintain a sufficient distance from hazardous parts.
4	D	Wire	Test probe with a diameter of 1,0 mm, 100 mm long, may penetrate completely, but shall maintain a sufficient distance from hazardous parts.
5K	D	Wire	
6K	D	Wire	
^a "Shall not penetrate completely" indicates that the full diameter shall not pass through an opening of the enclosure.			

6 Degrees of protection against water

Table 4 contains short descriptions of the degrees of protection with the relevant requirements.

Up to and including degree of protection 6K for the protection against water, the designation implies compliance also with the requirements for all lower degrees of protection.

For degrees of protection against water 7, 8 and 9K, lower degrees of protection up to and including 6K are not covered by the designation. In such cases where a lower degree of protection up to and including 6K is required in addition to protection against water 7, 8 or 9K, it shall be indicated separately, e.g. IPX4K/IPX7, IPX5/IPX7, IPX6K/IPX8, IPX6K/IPX9K and IPX8/IPX9K.

Table 4 — Degrees of protection against water

Second code element	Degree of protection	
	Brief description	Requirements
0	Not protected	None
1	Water drips vertically	Vertical drips shall not have any harmful effects or impair performance.
2	Water drips with enclosure inclined by 15°	Vertical drips shall not have any harmful effects or impair performance when the enclosure is tilted at any angle up to 15° on either side of the vertical.
3	Water spray	Water spray at an angle up to 60° on either side of the vertical shall have no harmful effects or impair performance.
4	Splash water	Water which splashes against the enclosure from any direction shall not have any harmful effects or impair performance.
4K	Splash water with increased pressure	Water which splashes against the enclosure from any direction with increased pressure shall not have any harmful effects or impair performance.
5	High-velocity water	Water which is directed against the enclosure from any direction as a jet shall not have any harmful effects or impair performance.
6	Strong high-velocity water	Water which is directed against the enclosure from any direction as a strong jet shall not have any harmful effects or impair performance.
6K	Strong high-velocity water with increased pressure	Water which is directed against the enclosure from any direction as a strong jet with increased pressure shall not have any harmful effects or impair performance.

Table 4 (continued)

Second code element	Degree of protection	
	Brief description	Requirements
7	Temporary immersion in water	Water shall not penetrate in a quantity causing harmful effects or impairing performance if the enclosure is immersed in water temporarily under specified pressure and time conditions.
8	Continuous immersion in water	Water shall not penetrate in a quantity causing harmful effects if the enclosure is continuously immersed in water under conditions which shall be agreed between supplier and car manufacturer, but which are more severe than code 7.
9K	Water during high-pressure/steam-jet cleaning	Water which is directed against the enclosure from any direction shall not have any harmful effects or impair performance.

7 Designation examples

7.1 General

The degree of protection shall be indicated using the IP code.

7.2 Example IP34K

The marking of an enclosure with the IP code IP34K means:

- (3) protection of the electrical equipment access to the enclosure against foreign objects with a diameter of $\geq 2,5$ mm (protection against foreign objects), and protection of persons handling rods of 2,5 mm diameter or more against access within the enclosure (protection against access);
- (4K) protection of electrical equipment within the enclosure against harmful effects resulting from water splashing against the enclosure with increased pressure from any direction (protection against water).

7.3 Example IP16KB

The marking of an enclosure with the IP code IP16KB means:

- (1) protection of the electrical equipment within the enclosure against foreign objects with a diameter of ≥ 50 mm (protection against foreign objects);
- (6K) protection of electrical equipment within the enclosure against harmful effects resulting from water directed against the enclosure from any direction as a strong jet with increased pressure (protection against water);
- (B) protection of persons against finger contact with hazardous parts within the enclosure (protection against access).

7.4 Example IP2X/IP5KX

The designation

- IP2X for the complete enclosure, and
- IP5KX for the cover of a part inside the complete enclosure

mean: