



inventronics

Technical application guide

IP codes in accordance
with IEC 60529 and external
environment impacts

What are IP codes?

Depending on their potential exposure to foreign objects, electrical devices (e.g. luminaires, LED modules and operational equipment) must, according to IEC 60529, belong to a specific type of protection. The types of protection are also called IP codes. The abbreviation IP stands for “ingress protection”.

The IP codes refer only to protection against contact and the penetration of solid foreign objects and dust (marked by the first characteristic numeral of the IP code) and against the damaging ingress of water (marked by the second characteristic numeral of the IP code).

The IP codes make no reference to the effect of external influences. In addition, the types of protection must not be confused with the electrical protection classes that refer to safety measures aimed at the prevention of electric shock.

The lowest type of protection is IP00, i.e. the electrical equipment is neither protected against solid foreign objects nor against the damaging penetration of water. The IP code IPXX means that the type of protection is not defined because the electrical equipment has not been subjected to testing. If the IP code is not stated, then the electrical equipment is protected in accordance with IP20.

Important note:

In addition to the type of protection, you always need to take into account external influences and conditions (see page 7 ff.)!

The IP codes refer only to:



Solid foreign objects, sand and dust



Water and moisture

Arrangement of the IP code



If one or both numerals are stated as "X", the product was not subjected to the relevant test. The statement "X" cannot, however, be used to signify any random IP rating.

First characteristic numeral

The first characteristic numeral of the IP code has two meanings. On the one hand, it determines how the electrical equipment is protected against the ingress of solid foreign objects (including dust). On the other hand, it also states the level of protection of persons against access to hazardous parts.

Degrees of protection against solid foreign objects indicated by the first characteristic numeral

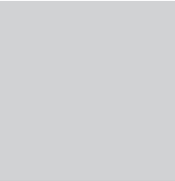

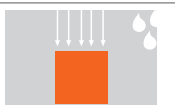
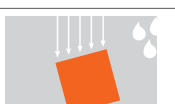







First characteristic numeral	Image	Degree of protection	
		Brief description	Definition
0		Non-protected	No special protection
1		Protected against solid foreign objects of 50mm diameter and greater	The object probe, sphere of 50mm diameter, shall not fully penetrate ¹⁾
2		Protected against solid foreign objects of 12.5mm diameter and greater	The object probe, sphere of 12.5mm diameter, shall not fully penetrate ¹⁾
3		Protected against solid foreign objects of 2.5mm diameter and greater	The object probe of 2.5mm diameter shall not penetrate at all ¹⁾
4		Protected against solid foreign objects of 1mm diameter and greater	The object probe of 1mm diameter shall not penetrate at all ¹⁾
5		Dust-protected	Ingress of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the apparatus or to impair safety
6		Dust-tight	No ingress of dust

¹⁾ The full diameter of the object probe shall not pass through an opening of the enclosure.

Second characteristic numeral

The second characteristic numeral of the IP code determines the protection of the electrical equipment against damaging effects caused by the ingress of water.

Degrees of protection against water indicated by the second characteristic numeral

Second characteristic numeral		Degree of protection	
		Brief description	Definition
0		Non-protected	No special protection
1		Protected against vertically falling water drops	Vertically falling drops shall have no harmful effects
2		Protected against vertically falling water drops when enclosure tilted up to 15°	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angle up to 15° on either side of the vertical
3		Protected against spraying water	Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects
4		Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects
5		Protected against water jets	Water projected in jets against the enclosure from any direction shall have no harmful effects
6		Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects
7		Protected against the effects of temporary immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under standardized conditions of pressure and time
8		Protected against the effects of continuous immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but which are more severe than for numeral 7
9		Protected against high pressure and temperature water jets	Water projected at high pressure and high temperature against the enclosure from any direction shall not have harmful effects

Cleaning processes carried out by professionals are not covered by the IP rating data. If necessary, manufacturers are advised to provide relevant cleaning process information. This is in accordance with the recommendations on professionally executed cleaning processes as stated in IEC 60529.

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An enclosure designated with the second characteristic numeral 7 or 8 is only considered unsuitable for exposure to water jets (designated by the second characteristic numeral 5 or 6) and doesn't need to comply with the requirements for numeral 5 or 6 unless it is dual-coded as follows:

Enclosure passes test for:

Water jets, second characteristic numeral	Temporary/continuous immersion, second characteristic numeral	Designation and marking	Range of application
5	7	IPX5/IPX7	Versatile*
6	7	IPX6/IPX7	Versatile*
5	8	IPX5/IPX8	Versatile*
6	8	IPX6/IPX8	Versatile*
-	7	IPX7	Restricted**
-	8	IPX8	Restricted**

* Enclosures for "versatile" application indicated in the last column shall meet the requirements for exposure to both water jets and temporary or continuous immersion.

** Enclosures for "restricted" application indicated in the last column are considered suitable only for temporary or continuous immersion and unsuitable for exposure to water jets.

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Additional letter (optional)

An additional letter can stipulate the protection of persons against access to hazardous parts of the electrical equipment (contact protection). Quoting of the additional letter is voluntary.

Supplementary letter (optional)

A supplementary letter after the second characteristic numeral or the additional letter can provide supplementary information. Thus far, the letters listed below have been defined. If more than one supplementary letter is used, they must be quoted alphabetically. Quoting of the supplementary letter is voluntary.

Additional letter	Degree of protection	Supplementary letter	Significance
A	Protected against access with the back of the hand	H	High-voltage apparatus
B	Protected against access with a finger	M	Tested for harmful effects due to the ingress of water when the movable parts of the equipment (e.g. the rotor of a rotating machine) are in motion
C	Protected against access with a tool	S	Tested for harmful effects due to the ingress of water when the movable parts of the equipment (e.g. the rotor of a rotating machine) are stationary
D	Protected against access with a wire	W	Suitable for use under specified weather conditions and provided with additional protective features or processes

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What are external influences?

When planning and implementing electrical installations, the external influences, to which the electrical equipment is exposed during operation, must be taken into account. This involves individual consideration of each application before realization in order to define and implement corresponding safety measures.

We differentiate between various types of external influences:

- Environmental influences
- Influences resulting from use
- Influences resulting from construction
- Influences resulting from cleaning and maintenance

We differentiate between three negative influences:

- Incorrect usage during design/construction/production
- Influence of not suitable (improper) construction (installation and/or usage in the wrong environment)
- Incorrect usage/handling during installation

Important note:

Our products must never be directly exposed to external influences. Always provide adequate protection for relevant applications (covers, housings etc.), otherwise the warranty claim will be invalid.

Incorrect usage during design/construction/production, e.g.:

- Negative chemical impacts from potting materials and protection lacquers
- Electrostatic discharge (ESD)
- Electrical overload
- Incorrect tightening torque
- Inadmissible overvoltage or reverse voltage

Influence of not suitable (improper) construction (installation and/or usage in the wrong environment), e.g.:

- Mechanical stress (e.g. vibrations, impacts)
- Installation of non-vibration-resistant devices on ships etc.
- Installation of non-dust/non-UV-resistant devices in environments exposed to dust or direct UV radiation
- Devices for indoor applications installed outdoors
- Thermal overstress

Typical environmental influences:

- Corrosion through sulfur, chlorine, volatile organic compounds (VOCs) etc.
- Corrosion through water or air humidity (e.g. from condensation)
- Salt mist
- Direct exposure to sunlight/UV radiation
- Pollution by excrements of animals (e.g. bird excrement)
- Microorganisms (e.g. mold, moss, fungi)
- Dust, dirt, insects and other foreign objects
- High ambient temperatures
- Chemical influences (e.g. acids)
- Flammable or explosive atmospheres
- Formation of ice
- Aggressive constituents of rainwater (e.g. heavy metals)
- Air pollution

Incorrect usage/handling during installation, e.g.:

- Electrostatic discharge (ESD)
- Electrical overload

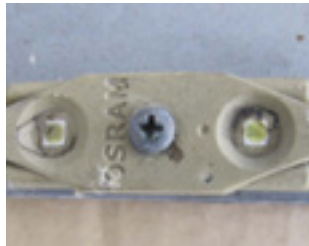
Examples for environmental influences

Combined impact of several influences

The images below show the combined impact of rainwater, dirt, salt mist and contamination from birds, insects etc. The LED modules were mounted directly on a facade without proper protection.



Exposure to sunlight (UV radiation)



Dirt in the LED cavity and corrosion of the mounting screws



Dirt on top of the LED surfaces



Bird excrement and salt mist residues

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Water ingress leads to corrosion of components

The ingress of humidity (e.g. rainwater, condensation water) into an electrical device can cause corrosion on the components within. Once that happens, device failure is almost inevitable. The images below show several examples of LED drivers that failed due to water ingress and subsequent corrosion.

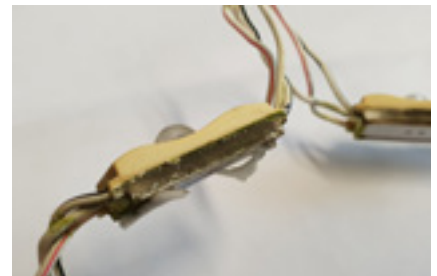


Important note:

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Humidity ingress leads to growth of microorganisms

The ingress of humidity into an LED module can also support the growth of microorganisms (e.g. moss and fungi) within the housing. The LED modules in the example below were continuously exposed to rainwater and condensation. This caused the growth of microorganisms on the LED optics, which led to a reduction in light output.

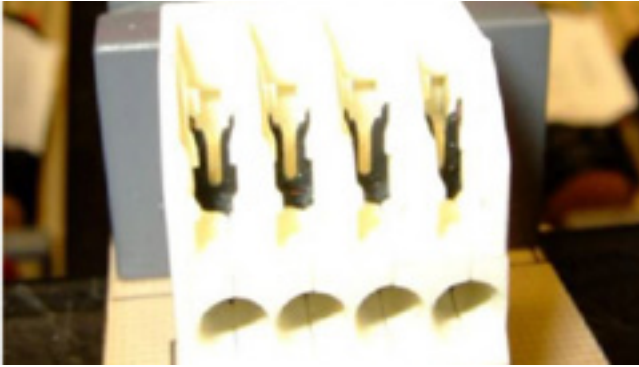


Important note:

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LED driver failure due to corrosion through gases

Apart from water or humidity, corrosion can also be caused by aggressive gases. In the example below, the damage of the contacts was caused by ammonia gas, which is highly corrosive to the copper of the contacts.



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Malfunction of products exposed to dust or sand

If LED drivers with an ingress protection rating of IP20 are used in industrial facilities where there is dust or sand circulation in the environment, the housing of the device must have at least IP54. Otherwise, dust or sand may accumulate on the electrical components, which will damage them and prevent the electronic circuit from cooling.



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Damage due to insects

If, as shown in this example, small animals such as insects or spiders succeed in penetrating an LED driver or any other circuit-containing electronic component, there is a high risk that this will cause a short circuit, which can damage the device irreparably.



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Damage due to vibrations

Mechanical stress, such as vibrations, can also cause the early failure of electronic devices. In the example shown here, the electrolytic capacitor within an LED driver was first loosened and then gradually ground down by vibrations. This ultimately caused a rupture in the housing of the capacitor and damage to the coil inside.



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Useful notes on the electrical connections

General information

Connection terminals are manufactured in many different versions, including screw-type terminals, plug connectors and joining terminals (connectors).

Terminals should be selected on the basis of the following parameters:

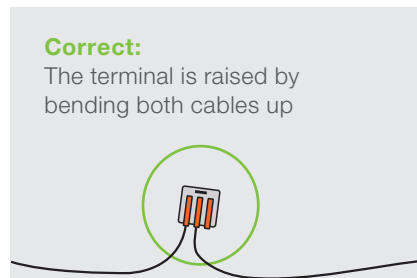
- Type of mounting
- Location
- Cables used (single or multi-wire)
- Ambient conditions
- Maximum permitted voltage and voltage drop during operation
- Maximum permitted current

Further useful notes:

- Use only appropriate cables and connectors to connect the LED modules to the OPTOTRONIC® LED drivers.
- Plug connectors must not be used where they may be directly exposed to the weather without adequate protection. For outdoor applications, plug connectors (without moisture protection) must therefore be protected by suitable junction boxes, light boxes or channel letters (IP casing).
- The equipment must not be used under water.
- Cables must not be soldered to one another.

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If you are using plug connectors that do not have ingress protection (moisture protection), make sure that the openings are always pointing downwards.

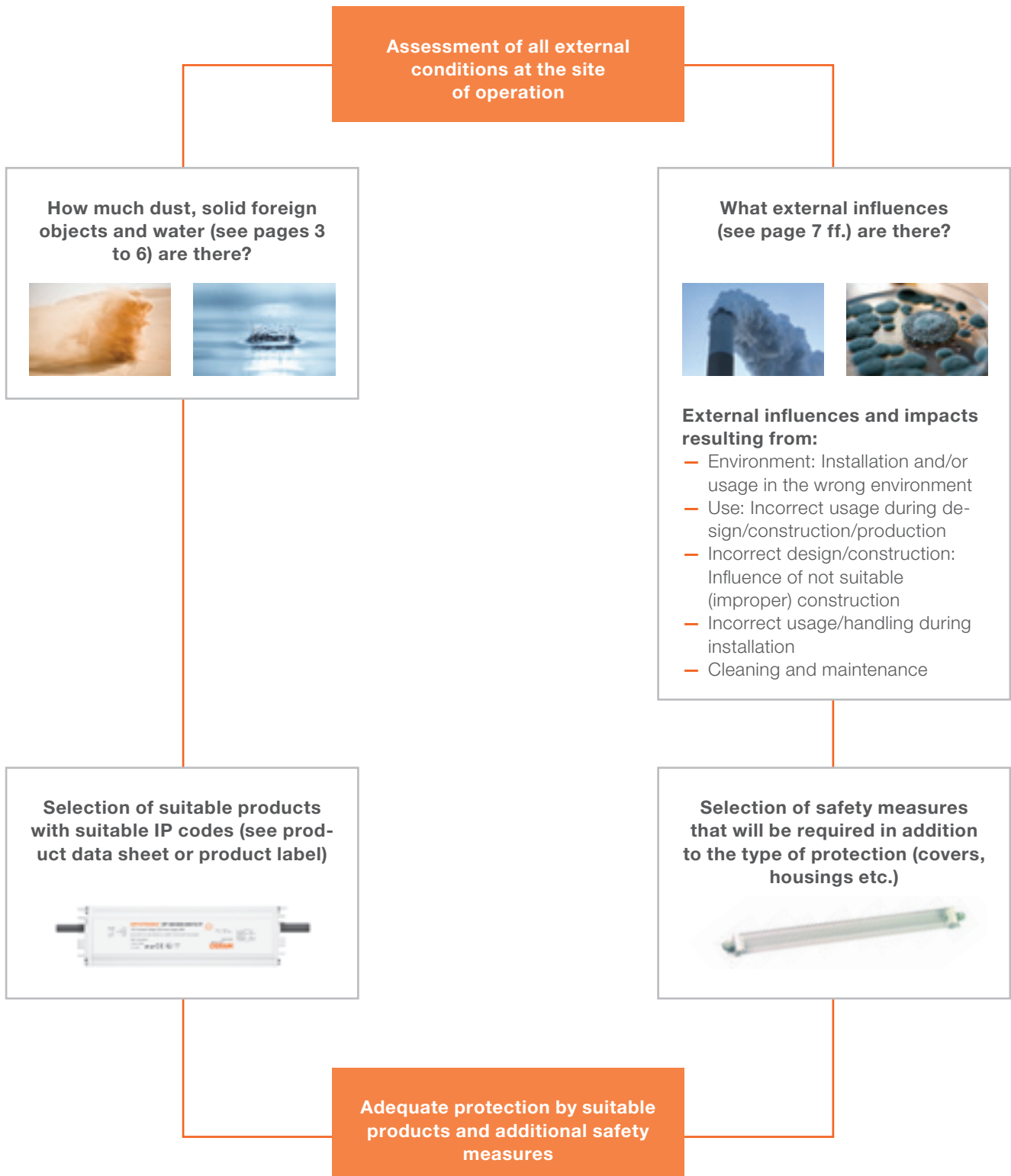
Electrical terminals with moisture-resistant seal can prevent the ingress of humidity and therefore avoid corrosion

Manufacturer	Reference	Type of cable*	Maximum outer diameter	AWG cable cross-section	Operating temperature	Special properties
3M	316IR	Single-wire/ multi-wire	0.160" (4.064 mm)	AWG22-16 (0.34-2.5 mm ²)	Max. 105 °C (221 °F)	UL-listed, standard 486C, UL file E23438
3M	314	Single-wire/ multi-wire	0.0082" (2.08 mm)	AWG22-16 (0.34-2.5 mm ²)	Max. 105 °C (221 °F)	Sealed against moisture

Provide the necessary protection!

The selection of suitable products and potentially necessary additional safety measures requires careful and detailed assessment of all external conditions that apply at the site of operation.

We recommend proceeding as follows:



Use our contact form

www.inventronics-light.com/contact-us



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