

IP protection of power plug connections in devices in accordance with IEC 60529

Increasing requirements for higher dust or splash water impermeability require components with equal properties.

In order to meet the requirements of device standards, the demands of daily use in harsh environments with dust and splash water, or cleaning, devices must in many cases offer a protection rating higher than IP 40. Components such as power plug connections in accordance with IEC 60320, switches, operation elements or display elements, which have increased impermeability and allow the same with the device housing, facilitate the engineer while designing a corresponding device. This applies to components on the front as well as those on the back of the device.

Increasing client demands

Tougher device standards and the increasing demands of clients require of device manufacturers more and more products with an IP rating matching a set goal. Today modern industrial plants typically work with IP 54, and IP 20 in electrical enclosures. Complete protection against contact is given upwards of IP 5x, as with this level of protection accidental entry with a wire ($\varnothing > 1$ mm) is prevented (Fig. 2, p. 2).

In the medical field increased IP protection is a big requirement. On one hand for uses involving fluids, for example with ultrasonic cleaning devices, suction devices, analysis devices or infusion pumps. On the other hand, the devices must be able to withstand cleaning, disinfection, and as needed, sterilization, without becoming damaged. In such situations a protection rating of IP 54, IP 65, or higher, is often required. In addition to the medical field, reliable IP protection is also an important factor for devices used in food production. For all these uses SCHURTER offers various components such as device power plugs, fuse holders, input elements, line filters or circuit breakers to fill customer needs accordingly.

With power supply lines there is a need to secure the plugged connections from accidentally

being pulled out. This can be very disruptive during a measurement analysis, or lead to critical situations at times when patients are being monitored. The danger is most present in mobile devices, especially device superstructures built on top of a cart, as are often found in the medical field or industrial measuring systems, or wherever many people are moving in the proximity of a device. A locking device is also recommended to secure the tightness of the connection between the connector plug and the power cord.

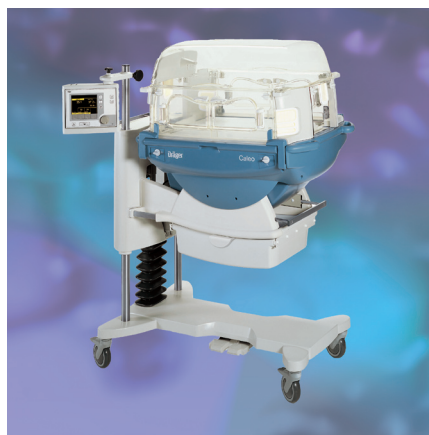


Fig. 1: Mobile station for newborns

IEC 60529 – protection factor for device housings

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

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

The first number following IP indicates the protection provided from entry of solid foreign objects, the second the protection from the entry of water. IP stands for Ingress Protection. The IP protection factor thus states if a device is suitable for use in the corresponding environmental conditions.

IP code components and their meanings

A short description of IP code components is given in the following table.

Code letter	First number (protection from foreign objects)	Second number (protection from water)
IP	6	5
IP xy	Meaning for the protection of equipment	Meaning for the protection of persons
	Against ingress of solid foreign objectif	Against access to hazardous parts with
x = 0	(non protected)	(non protected)
x = 1	50 mm diameter	back of hand
x = 2	12.5 mm diameter	finger
x = 3	2.5 mm diameter	tool
x = 4	1.0 mm diameter	wire
x = 5	dust protected	wire
x = 6	dust tight	wire
		Against ingress of water with harmful effects
y = 0		(non protected)
y = 1		vertically dripping
y = 2		dripping (15° tilted)
y = 3		spraying
y = 4		splashing
y = 5		jetting
y = 6		powerful jetting
y = 7		temporary immersion
y = 8		continuous immersion
y = 9K		high pressure, i.e. steam jet cleaning

Fig. 2: IP code overview

Products with increased IP protection

SCHURTER offers various components which not only offer an increased protection factor within them, that is to say throughout the device, but also offer the possibility of installing the components to the housing wall without leaks. These are the components in the area of power supply, such as device connector plugs, device connector plugs with line filter or fuse holder, but also operational elements such as switches, buttons or device circuit breakers.

Considering the device-sealing concept of the pluggable power supply according to IEC 60320, we have differentiated two fundamental levels of function in regards to IP protection:

1. IP protection to the device
2. IP protection to the device including protection of the pluggable power supply

1. IP protection to the device

Depending on the functionality of the device, the seal of the device plug combination element can be shaped manifold. For a device plug with a fuse holder and filter the seal concept is composed of various measures. The seal concepts that follow are demonstrated using SCHURTER product type 5707 as an example. The 5707 is a sealed device plug combination element with a safety switch and EMC filter with a protection factor of 65. This also applies to the insert molded plug pins of the power supply in the device as well as for the fuseholder. The gasket ring placed into the flange mount seals in between the combination element and the flange mount up to this protection factor.



Fig. 3: Power entry module 5707 with IP 65

For products that in their basic configuration are not equipped with an integrated flange mount, a seal kit must be ordered as an accessory. For instance, a device plug type 6100 would require a flat seal with screw set as shown in fig. 4 and possibly a safety clip set to fasten the device socket (fig. 5). This accessory allows a protection factor up to IP 54.



Fig. 4: Device plug type 6100 with flat seal and screw set obtains IP 54

Usage examples for those seeking to seal a device:

- devices that must be sealed for cleanliness purposes (medical devices, commercial kitchen appliances, food preparation)
- battery-powered outdoor devices
- devices with sensitive electronics/mechanics in dusty environments
- devices whose internals are under vacuum

Along with the IP protection of the device exterior, protection of the device interior is also possible. In this case protecting the device from the entry of liquids and dust has a much lower priority than sealing the components themselves. On one hand is defined to what extent protection from accidental contact (for example: during service) is guaranteed. On the other hand manufacturing can also call for the sealing of a device. If, for example, parts of a device are cast, an appropriate level of imperviousness on the rear side is desired.

2. IP protection to the device including power supply protection

Based on the description above of the seal between the combination element and the device, the seal can now be extended to the protection of plug connections. This additional safeguard assures a certain protection against the unwanted entry of moisture and dust when working with power cables that are plugged in. The power supply seal is produced with an inlet gasket around the plug pin. When plugged into a cable socket, the seal prevents liquids and dust on the plug pins from reaching live parts, as well as from ending up in the socket. With this concept a protection factor of IP 54 is achieved.

It should be verified, that the socket face is as planar as possible, for example with no approval symbols in the bellow area, and that parts are free of grime and dirt. The device plug with inlet gasket is approved by IEC and UL. To be sure that the cord connector really is properly and completely plugged in, and to additionally protect the connection from accidentally being unplugged, device plugs should be equipped with a pullout preventer. Only in this way can an IP-protected connection be secured, regardless of operating conditions.

Power supply protection is not to be used by itself, but rather in combination with IP protection to the device. At the same time the protection to the device should have a protection factor at least as good as that of the power supply. In this sense the described requirement is also valid here.

Examples where **sealing of a device including protection of the power supply** is desired:

- medical devices (endoscopy, general OP equipment, laboratory equipment), mobile physical and electrical measuring devices
- ultrasonic cleaning devices
- commercial kitchen appliances, food preparation

Pullout prevention on pluggable power supplies

With mobile devices, for example analytical apparatuses, diagnostic devices or laboratory devices in medical technology, mobile measuring apparatuses or devices in the food industry, exists the danger of accidentally unplugging a power cable from the device. In order to avoid this, several various types of pullout preventers are offered. The most prevalent types are retaining clips, which are mounted to the device plug and are pressed over the cord connector. Regardless of device plug type and the multitude of electrical sockets shapes, the correct selection of retaining clip must be made. With this retaining clip system, it must first be verified that the socket is inserted adequately deep, and second that any possible IP protection (for example IP 54) is secured in the middle of an inlaid flat seal. **The safety of an IP-protected power supply always assumes a careful selection of device plug, seal kit, power cable and pullout preventer.**

These pullout preventers may at times be employed without the combination of a seal in the power supply.

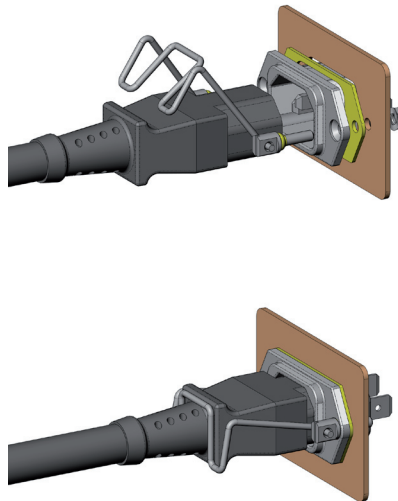


Fig. 5: Plug connection with retaining clip and additional sealing kit

In cases where solely a retaining clip, without increased IP protection of the plug connection, is desired, use of an appliance inlet and power cable using the V-Lock system is also possible. With this system the cord connector latches with a notch in the appliance inlet thereby preventing the cable socket from accidentally being pulled out. The catch mechanism is released by pressing the sliding lever. This is easily recognized thanks to its bright yellow color and differentiates this system from conventional connection assemblies. The advantage of this system is due to the fact that no connector-specific retaining clip system needs to be adapted.

SCHURTER makes various device plugs, combination elements and power cables using the V-Lock latching system, available for most countries.



Fig. 6: The V-Lock pullout prevention system prevents accidentally pulling out power cables in a simple and elegant manner

Overview of SCHURTER products with increased IP protection

SCHURTER offers you a large selection of products with increased IP protection, which are tailored to their respective needs and functions.

Fuseholders	IP 54	IP 65	IP 67	IP 68
Connectors	IP 54	IP 65		
Circuit Breakers	IP 54	IP 65		
Input Systems	IP 64	IP 65	IP 66	IP 67
	IP 68	IP 69K		
EMC-Products	IP 65			

A detailed product overview can be found on our website:

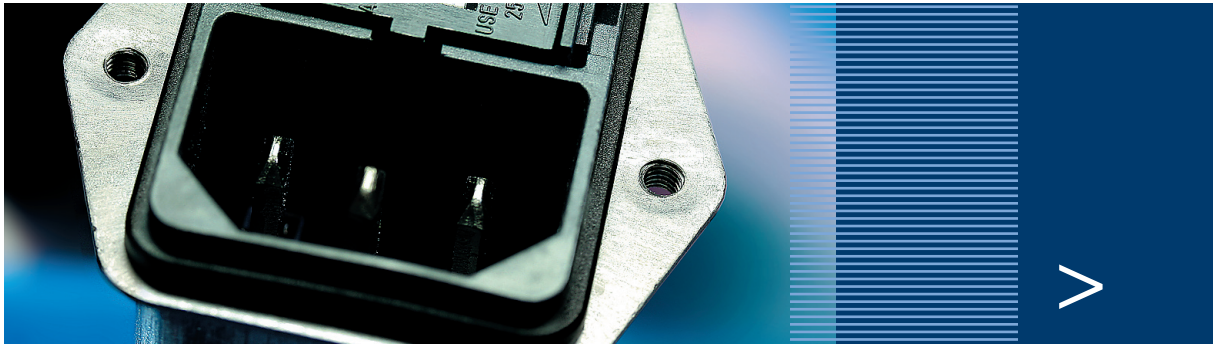
- www.schurter.com/en/Products/Fuses-Varistors
- www.schurter.com/en/Products/Connectors
- www.schurter.com/en/Products/Circuit-Breakers
- www.schurter.com/en/Products/Input-Systems
- www.schurter.com/en/Products/EMC-Products

Product Management
SCHURTER AG
Werkhofstrasse 8–12
6002 Lucerne
Switzerland
contact@schurter.ch
www.schurter.com

About SCHURTER

SCHURTER is an internationally leading innovator and manufacturer of fuses, connectors, circuit breakers, input systems and EMC products as well as a PCB-assembly service provider for the electronics industry.

Customers are manufacturers of computers and peripheral equipment, appliances/instruments, telecommunication equipment, operator panels, medical technology, industry automations, renewable energy, aerospace, hobby, household and gardening equipment.



Power Entry Module with IP 65 for Medical Applications

The Product 5707 with its 2 screw cap fuseholders is IP 65 sealed and can be mounted from the front or the rear side.

The Flange seals to the chassis by observing the required mounting instruction. The product is ideally suited for use in medical applications according IEC 60601-1.



Circuit Breaker for Equipment with Protection Cover

The circuit breaker for equipment TA45 can be configured in millions of variants. An important version is the rocker switch type with cover to be used in rough environment.

The cover meets the requirements according IP 54 and improves the use of the circuit breaker to be used for over current protection in rough environments.