

IEC Appliance Couplers Safe, Simple and Flexible

Power Supply System Selection made easy

Detachable power systems (Appliance couplers) according to IEC 60320 provide a great deal of flexibility and efficiency. Products must comply with the strictest safety agency requirements to ensure user safety, while responding to the increasing need for user-friendliness. In SCHURTER's portfolio, this product line plays a central role [1]. Our website's "Mating Connectors" [2] service provides support in selecting the right detachable power configuration by simplifying product selection.

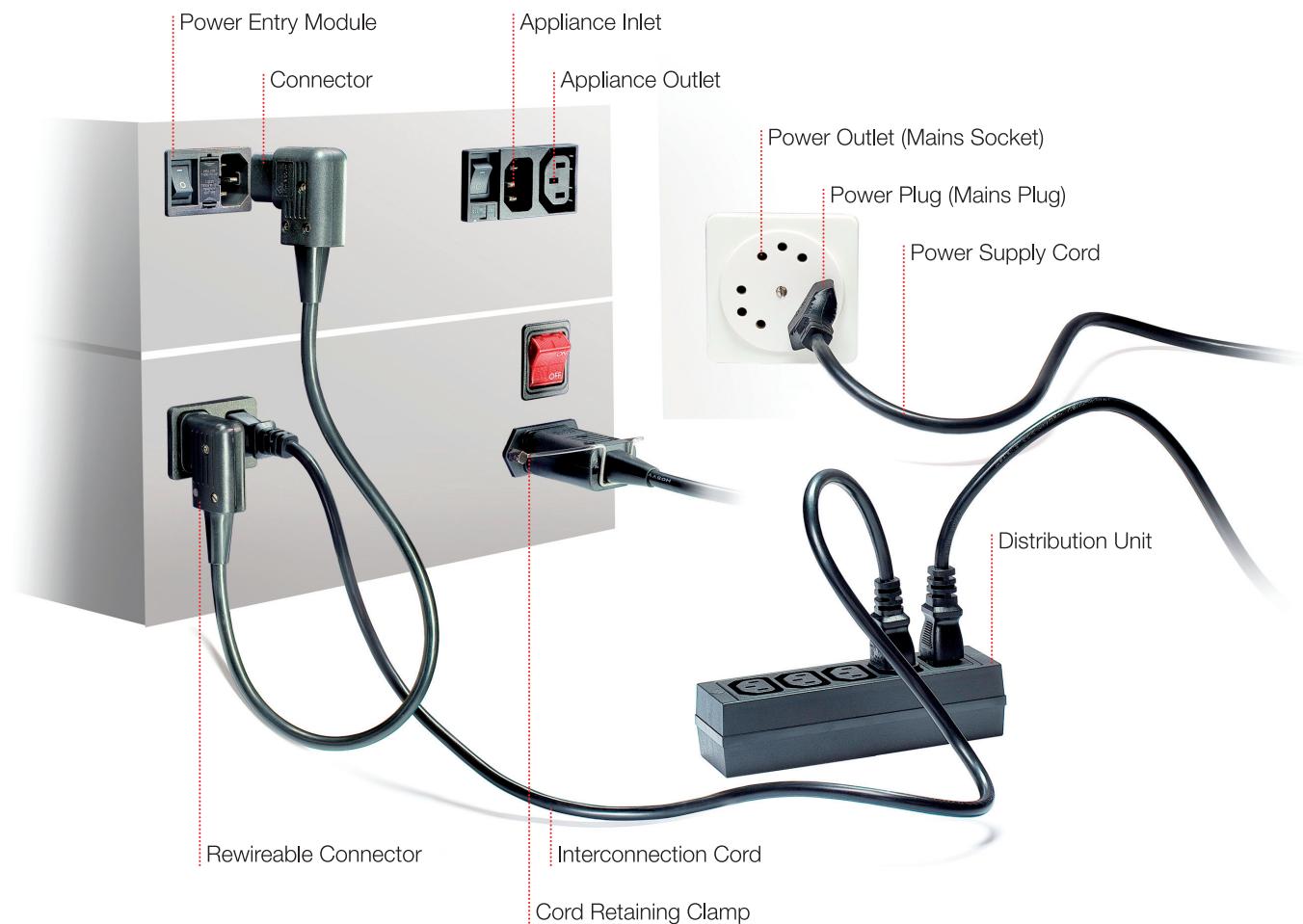


Figure 1: Application example including standard terms

Detachable power connectors are used in office equipment, in measurement instruments, in IT environments and in medical devices, among many other types of equipment for worldwide distribution. Therefore, each appliance's power system must be adapted to country-specific

conditions (e.g. different power plugs in the US, Germany, the UK, etc.). This, in turn, entails differences in the requirements placed on the appliances from the beginning of the life cycle to assembly and testing to logistics and field maintenance. In contrast to hard-wired power components, detachable power systems make it easier to comply with these diverse requirements, thereby minimizing cost and

expenses in each phase of the product's life. These trends toward power harmonization are reasons why the need for appliance couplers continues to grow.

Figure 1 illustrates the great variety of detachable power systems (appliance couplers) and the different components.

The individual terms shown in figure 1 are explained below:

Appliance coupler means a device for connecting a flexible power supply cord to an appliance or another type of installation. An appliance coupler consists of an appliance inlet and a connector.

Power supply cord means a flexible cord fitted with a power (mains) plug and a connector,



Appliance Inlet



Connector



Plug



Appliance outlet

used for connecting an electrical appliance to the power supply (mains).

Interconnection cord means a structural unit consisting of a flexible cord fitted with a plug and a connector built for interconnecting or disconnecting any appliance or installation with/ from any other appliance or installation using a power supply cord.

The figures below show the fundamental differences between the various plug and socket components as defined by the standards on appliance couplers (IEC 60320-1) and interconnection couplers (IEC 60320-2-2), using components rated for 10 A, Protection Class I, pin temperature.

Figure 2: Component differences between the two standards IEC 60320-1 and IEC 60320-2-2

PEM (short for 'Power Entry Module') means a component that integrates other functional components with the actual appliance coupler such as:

- a switch including integrated or remote bowden cable actuation
- a circuit breaker for equipment including overload and overcurrent protection, undervoltage protection and remote triggering
- an appliance fuseholder
- a voltage selector
- an EMC filter for standard and medical applications

Schurter distinguishes between Power Entry Modules with and without filters

Advantages of PEM over Individual Components:

- Compact dimensions
- Only one product with pre-wired individual components
- Efficient mounting
- Alternative designs with similar dimensions
- Protected, pre-wired and tested power components

Distribution unit means a housing fitted with multiple appliance outlets to form a component designed to distribute power. A typical application area could be a mobile measurement station, where several devices can be supplied with power from a single distribution unit.

Cord retaining clamp means a mechanical device preventing an appliance coupler from inadvertently being pulled or shaken loose. Typical application areas with stricter safety requirements include medical technology, stage and lighting technology as well as IT.

Advantages of Appliance Couplers over the entire Life Cycle

An appliance becomes universally compatible with country-specific power requirements when using appliance couplers. A country-specific power supply cord is simply included in the packaging. Model variations are thus minimized. Mounting and hardwiring a power supply cord is labor-intensive and subject to errors. On the other hand, when using appliance couplers all that needs to be mounted is the appliance inlet. In many cases, there is no need for internal wiring, as the appliance's PCB already comes fitted with an appliance inlet. There are no connection wires dangling from the housing exterior. Assembly and handling become easier as a result. Detachable power solutions help eliminate errors while increasing process security; hence enhancing the quality of the finished product.

Further economies of scale can be realized during systems testing. No country-specific test setups are required. The appliances can be connected to slot-in test ports which test appliance functionality and safety in one go using the predefined testing procedures.

Parts procurement, manufacturing and inventory costs are reduced, as appliance manufacturers need only keep a small number of appliances in their inventory. When ready to ship, the appliance is packaged according to its destination country, and includes a country-specific power supply cord as well as operating instructions in the respective language.

Evidence of the consistent and steadfast implementation of this optimized production principle can be seen in the fact that in many instances the software's country-specific basic settings, too, are determined by the end users themselves instead of being set at the factory.

After initial use, appliances can be easily transferred to and used in another country, with a simple change of the power supply cord including an IEC 60320 connector and a country-specific power plug. Even when the power supply cord is damaged, it can be replaced easily, because it is a standardized part that can simply be unplugged and reinserted.

Safety hazards, maintenance expenditure and repairs are thus minimized.

Below is a summary of the advantages of power supply systems fitted with IEC appliance couplers in each phase of an appliance's lifecycle (Figure 3):

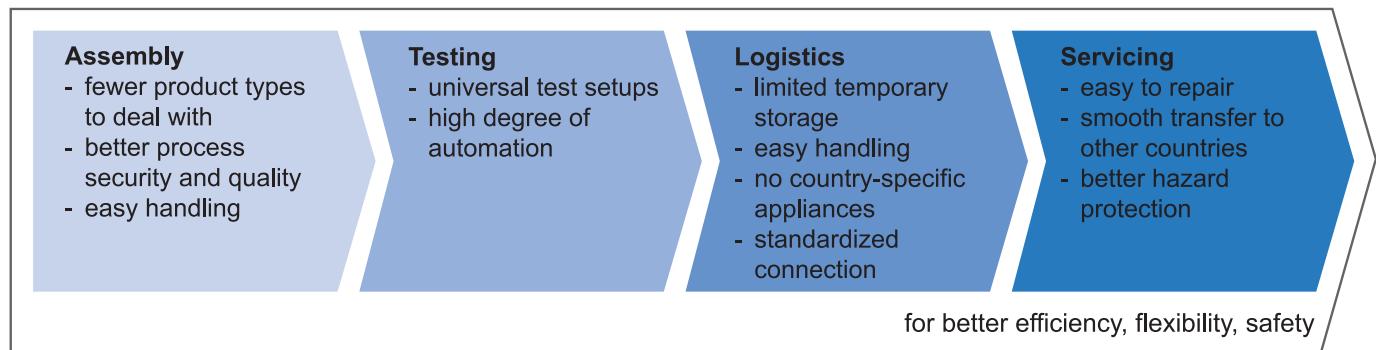


Figure 3: Advantages of appliance couplers

Standards Overview

Power supply safety is crucial from the users' perspective. The IEC 60320 standards as well as its sub-standards create a binding agreement, defining the mechanical, electrical

and thermal requirements and safety goals of a detachable power system (appliance couplers) and by establishing a common base for combining components with different origins, thus eliminating the potential safety hazards involved when adding an additional, separate

component, i.e. power supply cord. The standard scope is limited to appliance couplers rated at 250 VAC, up to 16A (20A 125/250 VAC UL respectively). Figure 4 shows an overview of the standardized appliance couplers with their relevant names as described in IEC 60320.

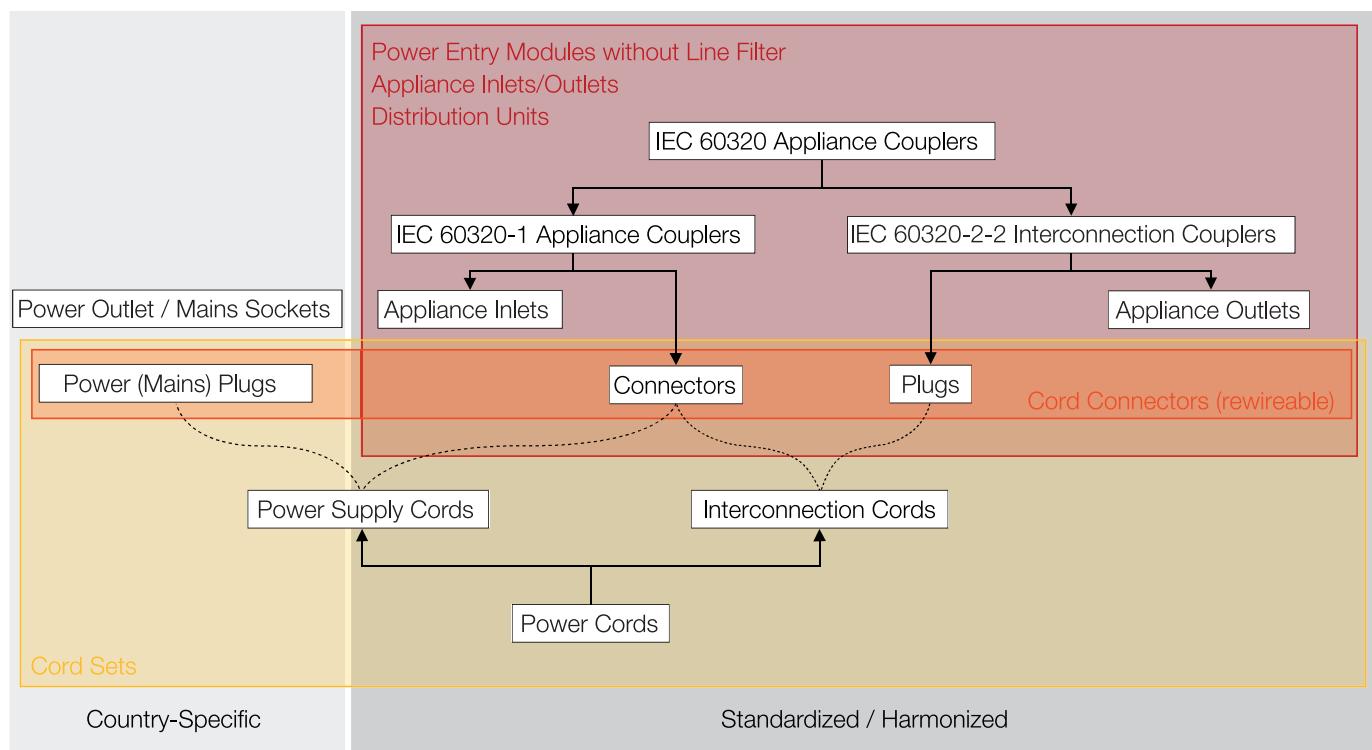


Figure 4: Overview of the couplings and their designation

IEC 60320-1 deals with appliance couplers including appliance inlets and appliance outlets. IEC 60320-2-2 describes interconnection couplers including connectors and plugs. Power supply cords are fitted with these appliance couplers (dotted lines). In addition to these two central standards, there are further sub-standards of IEC 60320 that focus on special topics such as IP protection and appliance specific requirements.

Safety through Coding

The standards establish the fundamental criteria governing protection class, nominal current and pin temperature as well as define various plug outlines. The purpose of plug outlines is to code the appropriate connections in a manner that: the part of an appliance coupler or interconnection coupler to be supplied with power defines the relevant safety limits. In other words, an appliance inlet can be fed only by a connector of identical or higher valency. It is impossible, for instance, to connect a

protection class II connector to a Protection Class I appliance inlet, while the opposite, i.e. connecting a protection class I connector to a Protection Class II appliance inlet, is very well possible. The same applies to the nominal current and the pin temperature. This coding plays a significant role in the safe operation of appliances and the protection against improper use.

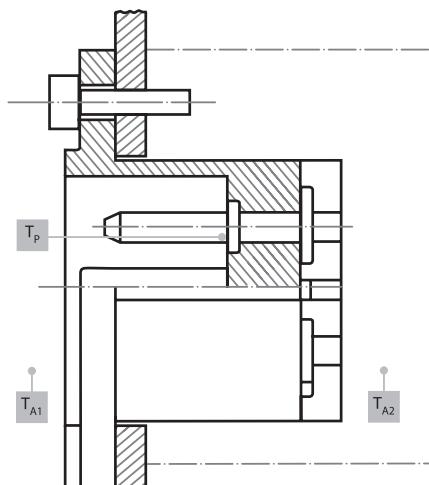
Parameter	Example				Distinguishing Features
Protection Class	C14  Protection Class I		C18  Protection Class II		with / without earth conductor contact
Rated Current	C8 A  2.5A	C9  6A	C14  10A	C20  16A	varying plug outlines
Pin Temperature	C14  70°C for cold applications	C16  120°C for hot applications	C16 A  155°C for very hot applications		plug outlines feature additional notches

Table 1: Standard's definition

Table 1 shows the various main criteria and their specific values according to the standard's definition

Nominal current: The standard, instead of 'nominal current', uses the term 'rated current'. It defines the current for which the manufacturer has designed the appliance coupler.

Pin temperature T_P is measured where the pin projects from the engagement surface (Figure 5). The maximum permitted pin temperatures, according to the standard, are 70°C, 120°C and 155°C, respectively. The appliance's normal ambient temperature T_{A1} during operation, according to IEC 60320, is 25°C and may occasionally reach 35°C. In other words, the pin temperature is determined essentially by the design of the respective appliance, i.e. its interior temperature T_{A2} , rather than by its ambient temperature. Typical applications with increased pin temperatures include appliances with heating coils such as ovens or electric grills.

**Figure 5: Lateral section view of an appliance inlet and its relevant temperatures**

Protection classes are defined in IEC 61140. The IEC 60320 standard defines, for appliance couplers, protection class 1 and 2 types, i.e. types for appliances equipped with a protective conductor and special insulation.

In addition to the limiting values described, the standards define further general criteria such as withdrawal forces, testing procedures, the minimum number of insertion cycles and the number of flexions in flexible cords. IEC 60320-1 codes the various plug outlines using a combination of letters and numbers (e.g. 'C14'), while IEC 60320-2-2 uses a single letter (e.g. 'F').

Tables 2, 3 and 4 describe the individual plug outlines in detail, i.e. their relevant nominal/rated current, pin temperature and protection class parameters. They also show which combination the standard defines. Each possible combination in the matrix is denoted with a dot. The columns list the components with the pins, while the lines show the sockets.

Normally the parameter of inlet and outlet are similar (e.g. protection class 1-> 1). It is generally possible to match a connector with a higher rated temperature to a lower rated inlet.

Mating Appliance Coupler IEC60320-1					Appliance Inlets											
					Gender Male											
					Symbol											
					Type	C6	C8	C8p	C10	C14	C16	C16A	C18	C20	C22	C24
					Current [A]	2.5	2.5	2.5	6	10	10	10	10	16	16	16
IEC60320 Connectors	Gender Female	Temperature [°C]	70	70	70	70	70	120	155	70	70	155	70	70	155	70
		Protection classe	1	2	2	2	1	1	1	2	1	1	2	1	1	2
			C5	2.5	70	1	•									
			C7	2.5	70	2		•								
			C7p	2.5	70	2			•							
			C9	6	70	2				•						
			C13	10	70	1					•			□		
			C15	10	120	1					□	•		□		
			C15A	10	155	1				□	□	•		□		
			C17	10	70	2							•			
IEC 60320 Appliance Outlets	Gender Female		C19	16	70	1								•		□
			C21	16	155	1							•	•	•	•
			C23	16	70	2										•

Table 2: Combinations according to IEC 60320-1: • Intended □ Possible

Mating Interconnection Coupler IEC 60320-2-2					Plugs											
					Gender Male											
					Symbol											
					Type	A	C	E	G	I	K					
					Current [A]	2.5	2.5	10	10	16	16					
IEC 60320 Appliance Outlets	Gender Female	Temperature [°C]	70	70	70	70	70	70	70	70	70	70				
		Protection class	1	2	1	2	1	2	1	2	1	2				
			B	2.5	70	1	•									
			D	2.5	70	2			•							
			F	10	70	1				•			□			
			H	10	70	2					•					
IEC 60320 Appliance Outlets	Gender Female		J	16	70	1							•		□	
			L	16	70	2										•

Table 3: Combinations according to IEC 60320-2-2: • Intended □ Possible

Mating Appliance Coupler IEC60320-1					Plugs							
					Gender Male							
					Symbol							
IEC60320 Connectors	Gender Female	Symbol	Type	Current [A]	Temperature [°C]	Protection class	1	2	1	2	1	2
			C5	2.5	70	1	•					
			C7	2.5	70	2		•				
			C13	10	70	1			•	□		
			C15	10	120	1			□	□		
			C15A	10	155	1			□	□		
			C17	10	70	2				•		
			C19	16	70	1					•	
			C21	16	155	1					•	•
			C23	16	70	2						•

Table 4: Combinations according to IEC 60320-1: • Intended □ Possible

In addition to the connections within the standards, as mentioned, there are possible combinations between IEC 60320-1 and IEC 60320-2-2. Fitted with a flexible cord, the components become interconnection cords to be used for connecting appliances or for extending other interconnection cords or power supply cords.

Finding the right Connection

Knowing which counterpart to choose for a given component is one thing; finding it is another. SCHURTER has therefore created on its Web site the 'Mating Connectors' service reflecting the relationships shown in tables 2, 3 and 4 above. This tool makes it easy for the

user to find the right power supply system fast, instead of having to flip through several pages to of individual components. There are two approaches to finding a solution.

- The user already knows a product from the SCHURTER catalog and is looking for the matching counterpart. One click shows all suitable counterparts.
- The user knows the desired parameters according to IEC 60320 (current, pin temperature, protection class). All combinations of matching appliance couplers with the corresponding characteristics are shown.

In both cases, the selection range is narrowed down step by step and iteratively by additional parameters and thus gradually adapted to the user's needs.

Figure 6 (on the next page) shows the access via a specific SCHURTER product leading to a mating coupler or below the entry of a specific IEC connector parameter to gain an overview of the specific SCHURTER inlets and their mating couplers.

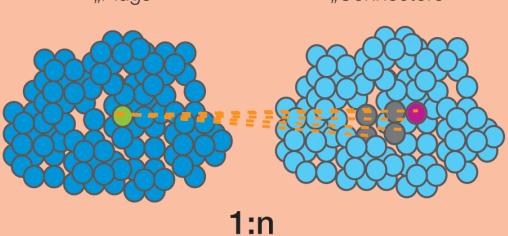
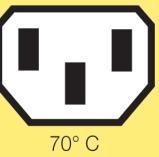
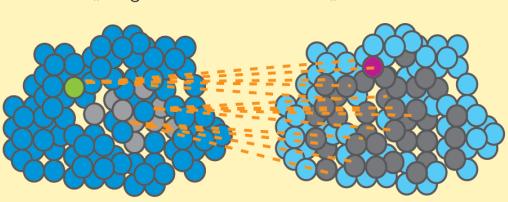
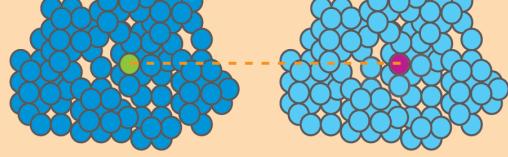
	Start	Relationships	Appliance Coupler
SCHURTER Type	 Bsp. DC11	 1:n	 
IEC 60320 Parameter		 n:n	 1:1
Explanation	Starting with an actual connector type or via IEC 60320 parameters, the selection process begins.	Comparing relationships „Mating Connectors“ identifies the matching components from among over 20.000 possible combinations of „Plugs“ and „Connectors“.	Incrementally parametrizing the possible „Plugs“ and „Connectors“, the user selects his Connector System (Appliance Coupler) of choice (selecting, on the basis of a n:n relationship, a 1:1 relationship).

Figure 6: Selection of a power supply system

The advantage of SCHURTER's 'Mating Connectors' tool [2] is that the user is shown every possible combination, ensuring that he finds the optimal solution from among the vast variety of over 20,000 possible connections available from SCHURTER.)

Selection Criteria for Appliance Inlets and Appliance Outlets:

Detailed product descriptions can be found in the associated datasheet or by referring to the product comparisons in the selector chart. The selector charts [2] also lead you to the mating products as well as the necessary accessories [4].

- Nominal/rated current / nominal/rated voltage / pin temperature / protection class
- Mounting side (front / rear)
- Mounting method (screw-on / rivet or snap-in mounting)
- Terminals (push-on, rivet, solder tabs, PCB mounting, pre-fitted with stranded wires)
- Additional features such as line switch / fuseholder / voltage selector / circuit breaker for equipment / cord retaining clamp

Selection Criteria for Connectors / Plugs and Cords:

- Nominal/rated current / nominal/rated voltage / pin temperature / protection class
- Non-rewireable / rewireable components
- Color / cross-sectional area/gauge / cord length and material
- Accessory

SCHURTER's 'Mating Connectors' tool increases the efficiency of detachable power supply systems by simplifying the selection process and making it possible to find the best combination possible. It helps users keep track of the vast variety of power supply systems.

Introducing this tool, SCHURTER sets a new standard in IEC appliance coupler product selection. Providing an extremely broad range of individual components backed by proven consulting services and a high quality standard, SCHURTER is your expert partner for complete IEC-compliant appliance couplers worldwide.

Further explanations and description of terms can be looked up under general information for connectors [3].

Please do not hesitate to contact us if you have any questions or comments to improve the information we have provided.

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Links:

- [1] www.schurter.com/connectors
- [2] www.schurter.com/iec_connectors
- [3] www.schurter.com/connector_info
- [4] www.schurter.com/accessories

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.