

# White Paper

## Environmentally sealed connectors

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## ■ 1. Introduction : sealing categories and scope of document

Sealed connectors are used in many applications where leakage into or out of an equipment must be avoided. Sealing is a very complex science by itself as it involves many physical aspects including mechanical design, materials science, surface science and fluid behaviour.

Practically three major application groups exist which require different sealing levels and therefore different solutions.

### ■ Environmental sealing

Typically for outdoor application, one side of the connector might be exposed to rain, dust and other aggressive environments. The exposure is in general limited in time and pressure.

Fischer Connectors product range for these applications include receptacles sealed in mated or unmated state, for example styles DEU, DBEU, DBPU etc. as well as plugs in association with sealed clamp sets.

These products are designed to offer sealing up to IP68.

### ■ Hermetic sealing

Hermeticity is required for gas tightness. Such connectors are used for example in vacuum applications or pressurized vessels. This requires a high level of sealing to prevent gas leaks over longer periods of time.

These products ranges, for example styles DEE, DBEE, DBPE etc, are designed specifically and undergo a 100% leak test. Such connectors can be used also in other severe conditions like immersion for longer periods of time or exposed to strong jets. They achieve IP69K rating.

### ■ High pressure sealing

For applications requiring exposure for extended period of time towards liquids under high pressure (for example deep submarine applications) special designs can be proposed combining hermeticity with adequate high strength mechanical design. Fischer Connectors design center can assist customers for such special requests.

***This document focuses on the environmental sealing as encountered in many application areas***

## ■ 2. Typical operating conditions for sealed connectors

When selecting the appropriate connector, all influences and conditions under which the connector will operate must be taken into account. The most frequent conditions encountered in environmental sealing are :

Substances to be blocked by sealing	Water (rain, soft)
	Water (sea)
	Dust
Temperature range	Normal -20°C to +60°C
	Military, extreme -50°C to +150°C <sup>1)</sup>
Pressure differential	Typ < 0.2 bar
Type of exposure	Most common is splash, but jets or immersion are possible
Duration of exposure	Typ < 1 day

<sup>1)</sup> Although water or dust ingress may be less common at very low or very high temperatures, it is essential that connector design may allow correct operation in such extreme conditions. This of course affects also design of sealing elements.

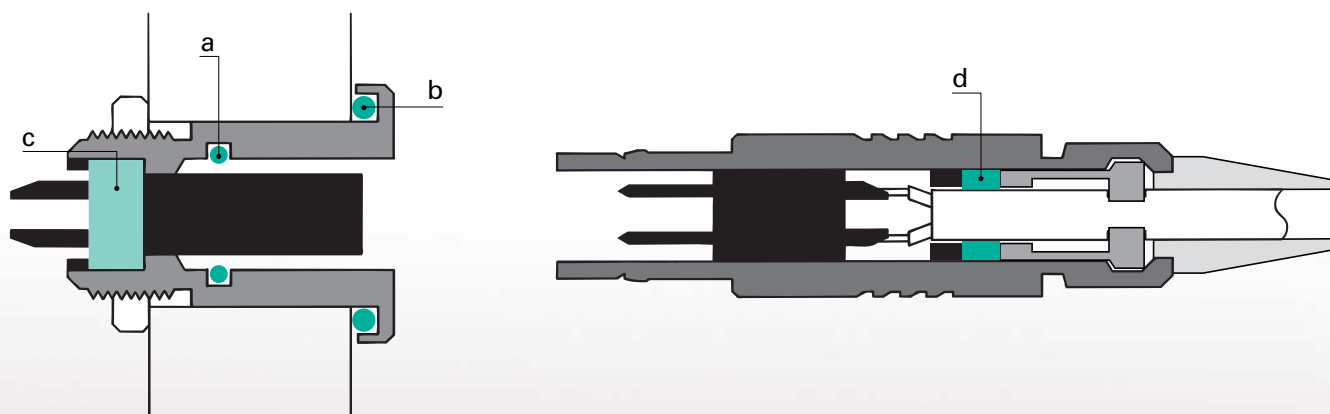
These conditions are typical, and offer a first filter for the selection of an appropriate connector range. Depending on risk analysis, a worst case evaluation might be necessary in some critical cases.

## ■ 3. Connector sealing

### 3.1 Fischer Connectors sealing techniques

A typical sealed connector offers several sealing barriers. Fischer Connectors products, unlike other lower grade connectors, have clearly independent sealing functions designed to exactly control the connector's performance for every requirements.

Following sealing functions can be found on typical Fischer Connectors environmentally sealed products.



### **a. Interface seal**

Per definition, this seal protects the connector interface, i.e. the junction between two connectors, preventing ingress of water or harmful particles into the connection area where male and female contacts mate. This seal has an essential function for the long term product reliability, especially if the connector is frequently unmated.

Because the interface seal works dynamically when mating and can be exposed to the environment, it is essential that the quality of seal is chosen according to operating temperature, environment and fluids.

A range of standard solutions is available, material selection is detailed below.

Usually all standard sealed Fischer Connectors products come with an interface seal.

### **b. Panel seal**

This sealing elements joins the connector housing with the panel or equipment housing. The seal works in a static way, in most application its exposure to the environment is very limited due to recessed O-ring position. Usually all standard sealed Fischer Connectors products come with a panel seal.

### **c. Sealing of block**

Normally, when disconnected, an open connector shall be protected against environmental influences by using an adequate protective cap. Fischer Connectors offer a wide range of accessories for all kinds of situations. However in some cases it is required that the connector remains sealed even without protective accessories, in such a case the inner contact block of the receptacle must also be sealed to prevent ingress into the equipment.

High quality sealing compound are used for factory sealing of the block. Although this is a standard process on environmentally sealed products, it is not compatible with designs where contacts are put in place by the customer (crimp contacts). In such cases the use of protective caps is mandatory.

### **d. Cable seal**

This grommet type seal is designed to prevent ingress of liquids into the connector along the cable. Cable material and quality strongly affect reliability of this seal, careful selection of diameter is essential to properly match cable. Separate environmentally sealed clamp sets are available for all common Fischer Connectors plugs.

## **3.2 Sealing materials**

Fischer Connectors materials selection is based on solutions that have proven high reliability in many difficult operating conditions.

Standard sealing materials are :

**Viton®** is a fluoropolymer often designated FKM. Its low permeation and excellent broad chemical resistance are interesting for many applications. Fischer Connectors uses Viton® as first choice for most receptacle seals.

**EPDM** (ethylene propylene rubber) is another elastomer characterized by wide range of applications. Commonly used as weather seals on vehicles it combines good water resistances with low glass temperature. EPDM is the preferred choice for interface o-rings in connectors designed to be mated and unmated at low temperatures.

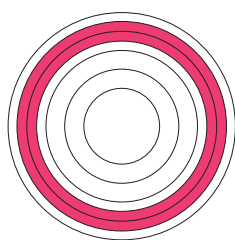
Fischer Connectors further offers a wide range of custom solutions for applications where special sealing requirements are essential.

## ■ 4. Connector installation

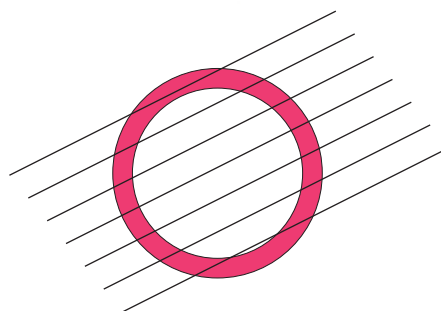
### 4.1 Panel mounted connectors

Correct panel sealing can only be achieved if the contact surface for seal “b” is correctly prepared. Special care must be taken depending on manufacturing techniques. Following aspect are most commonly encountered in seal designs :

- The surface flatness shall be designed in such a way that sealing can be achieved without excessive torque required to mount the connector. Typical recommended flatness is  $< 0.05\text{mm}$ , usually not problematic for modern machining techniques. However plastic mouldings may be more critical and must be carefully designed.
- Machining grooves shall be circular and not perpendicular to the O-ring.



**YES**



**NO**

If however circular machining is not possible, reasonable sealing performance can be obtained if surface roughness is  $< \text{Ra } 0.8 \mu\text{m}$ .

- Edges and burrs of panel cut-out shall be carefully cleaned.

### 4.2 Cable mounted connectors

Several factors impact the long term behaviour and reliability of the plug seal. When selecting cable, following aspects are particularly important :

- Cable sheath material  
The grommet type seal acts through compression by tightening connector backnut. Soft cable materials may relax over time resulting in a potential loss of sealing efficiency and/or loosening of backnut. Trials are always recommended to determine the right grommet size.
- Cable diameter and shape  
Some cable qualities show poor cross-sectional circularity, this can also have negative impact on short and long term sealing reliability. Sometimes selection of a smaller seal size can help to overcome this problem.

Through an adequate match of cable and seal, IP rating up to IP68 or even IP69K for limited period of time, can be achieved.

For the highest reliability of long term sealing in demanding applications, Fischer Connectors recommends overmolding the plug back-end. This offers strong hermetic link between cable and connector even in applications subjected to intense mechanical load. Fischer Connectors can offer customer specific solutions for overmolding.

## ■ 5. Sealing standards

The protection level offered by a typical envelope (IP rating) is described in IEC 60529 .

Environmental tests performed during design and qualification of Fischer Connectors environmentally sealed products are standardized to IP68 at a depth of 2 m and duration of 24 hours.

IP69K is an additional sealing level defined to protect an envelope from intense water jets for short duration (typically for high pressure cleaning). IP69K is a definition from German DIN 40050-9.

### Limitations

**The recommendations provided in this present White Paper are given only with the intention of assisting with the choice of a connector with respect to its particular application. It remains always the responsibility of the equipment manufacturer, and not the connector supplier, to determine the appropriate technical standards, as well as the necessary safety factors for a given application.**