Telegärtner

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Telegramm

Sealing concepts for coaxial connectors

The electrical connecting points in coaxial connectors must be protected against ambient influences. Dust and water or moisture are a constant hazard especially in outdoor applications, e.g. mobile radio masts. Moisture, particularly, which penetrates a coaxial system, changes the HF transmission enormously and leads to impedances or poor return loss values. Seals must be fitted at all connecting points to protect the sensitive and expensive electronics. This two-part newsletter presents the requirements for correct sealing design and different sealing concepts.

Requirements for seals

Seals are a class of construction elements which differ widely and which are used in almost every technical object. The task of a seal is to separate two functionally different spaces so that no transfer of substances can take place between them. Seals can be classified in many different ways. The first classification distinguishes moving seals (dynamic sealing points) and seals at rest (static sealing points). Only the static sealing points are relevant for coaxial connectors. A distinction is made here between contacting seals (O-rings, profile seal, flat seal) and non-contact seals (venting). Static seals can also be subdivided into sealing compounds, irremovable, removable and diaphragms. The removable seals are what we colloquially refer to as gaskets. The frequently used O-rings are therefore static, contacting and removable seals. The influences on the static, contacting sealing function in coaxial connectors can be divided into liquid and sealing body influence. Pressure, density, temperature, viscosity and the pH value play a role on the fluid side. The sealing function is additionally determined by elasticity, surface roughness, chemical resistance, wear resistance and porosity of the sealing body. There is no such thing as absolute tightness in the physical sense. It has to be clearly defined what is to be understood as "tight" (atoms, molecules, moisture, drips...). This tightness is known as technical tightness. In coaxial connectors a technical tightness on the level of the molecules is defined. This means that tightness against molecules, i.e. multi-atom particles, such as water is guaranteed but not against single atoms.

IP protection classes

In order to classify the tightness of coaxial connectors clearly, their degree of protection must always be specified. Degrees of protection are identified in accordance with IEC 60529. The used identification system is the IP-Code or International Protection Code, e.g. IP-67. Here, the first figure indicates the degree of protection against solids, the second figure the degree of protection against water. The meanings of the individual degrees of protection are shown in figure 1 below.

Protection against solid foreign bodies*
Schutzgrade gegen feste Fremdkörper*

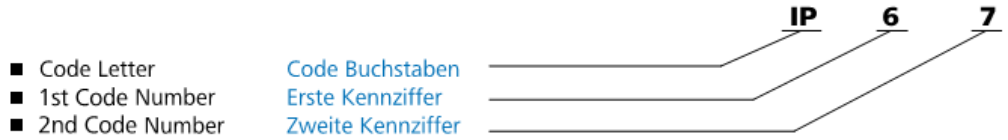
1st Code Number Erste Kennziffer	Description Kurzbeschreibung
0	No particular protection Nicht geschützt
1	Protection against ingress of solid foreign bodies with a diameter of 50 mm or more Geschützt gegen feste Fremdkörper 50 mm Durchmesser oder größer
2	Protection against ingress of solid foreign bodies with a diameter of 12.5 mm or more Geschützt gegen feste Fremdkörper 12,5 mm Durchmesser oder größer
3	Protection against ingress of solid foreign bodies with a diameter of 2.5 mm or more Geschützt gegen feste Fremdkörper 2,5 mm Durchmesser oder größer
4	Protection against ingress of solid foreign bodies with a diameter of 1.0 mm or more Geschützt gegen feste Fremdkörper 1,0 mm Durchmesser oder größer
5	Dust protected Staubgeschützt
6	Dust-proof Staubdicht

Protection against water*
Schutzgrade gegen Wasser*

2nd Code Number Zweite Kennziffer	Description Kurzbeschreibung
0	No particular protection Nicht geschützt
1	Protection against dripping water Geschützt gegen Tropfwasser
2	Protection against vertically dripping water. There must be no harmful effect on materials tipped (in a container) up to 15° from it is normal position. Geschützt gegen Tropfwasser, wenn das Gehäuse bis zu 15° geneigt ist
3	Protection against fine water spray Geschützt gegen Sprühwasser
4	Protection against water spray Geschützt gegen Spritzwasser
5	Protection against water jet Geschützt gegen Strahlwasser
6	Protection against strong water jet Geschützt gegen starkes Strahlwasser
7	Protection against water, when the material is immersed in water Geschützt gegen die Wirkungen beim zeitweiligen Untertauchen in Wasser
8	The material is suitable for continuous submersion in water. Must be agreed between customer and supplier. Geschützt gegen die Wirkungen beim dauernden Untertauchen in Wasser. Wird zwischen Kunden und Lieferanten vereinbart.

* Definitions see IEC 60529 * Definitionen siehe IEC 60529

Example of Classification in Accordance with the IP Code
Bezeichnungsbeispiel mit dem IP-Code



Seal shapes

The shape of a seal depends on its respective function and application. The best known seal shape is the O-ring seal. However, there are countless other shapes and types.

The most important seal shapes for connectors are so-called soft profile seals. These are only pre-pressed externally and get their sealing pressing from the system pressure. The pressing is therefore always higher than the system pressure by the pre-pressing in operation. The typical representative of these soft profile seals is the elastomer O-ring. This is installed with oversize in a housing groove which produces the pre-pressing. Seals such as the O-ring are used frequently in technology because of their good sealing effect and their easy replacement. Various rules of construction must be observed for a perfect function:

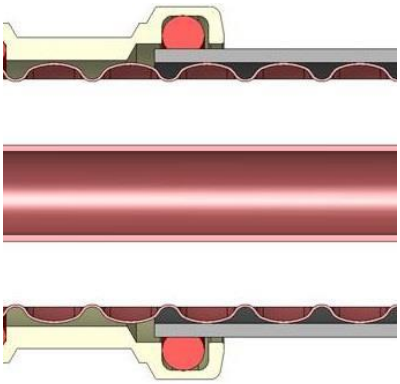
- Pre-press the O-ring sufficiently, 10 - 20%.
- A groove width of 130 – 140% of the ring diameter should be selected.
- A certain surface roughness of the adjacent surfaces for sufficient sealing.

- The ring may not be pulled over sharp edges to avoid installation damage. An installation bevel of about 15 to 20% must be incorporated in the design for this.
- A suitable elastomer must be used for the application.

The special feature of O-rings is that they have an automatic sealing effect. The sealing face of an O-ring has an almost parabolic pressing curve in the installation state without excess pressure. Due to the superposition of the pressure p to be sealed, a maximum pressure pmax exists at approximately the centre of the sealing face which is always greater than the pressure of the liquid.
Flat seals are thin seals which are suitable for level surfaces and which are pressed on by external forces. They are used in many areas, mainly for fluids and gases, at high and low temperature. In coaxial connectors, for example, seals in the dielectric are flat seals. There is a wide variety of shapes and materials accordingly. They can be used both as soft seals and hard seals.

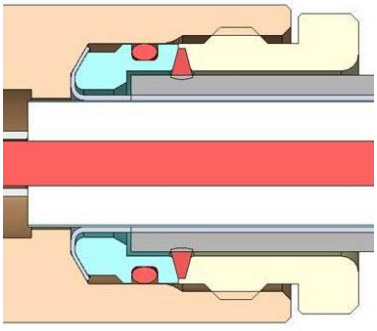
Design of a seal and pressure build-up

Before using a seal, a preselection must be made with regard to the chemical and thermal resistance.



The pressure of the sealed fluid supports the pressing of the sealing body. This support and thus an automatic sealing effect is largely absent in coaxial connectors. Therefore it is particularly important that application forces are already active (pre-pressing) in the state without excess pressure. In axial sealing, this pre-pressing is achieved by pulling the O-ring apart in assembly. However, two cases can be distinguished here: a seal under inherent pressure as well as a seal under forced pressure. Figure 2 shows a seal under inherent pressure as it is mainly used as a seal between a cable sheath and a connector.

Figure 2: Inherent pressure seal



Inherent pressure seals usually achieve a much lower tightness than forced pressure seals, see figure 3. In a forced pressure seal a sealing element, here on the left an O-ring, is compressed until the pressure screw (yellow) hits the cone ring (blue). There is therefore a mechanical stop in this place which prevents the pressure screw from being screwed in further. The pressure of the sealing element can therefore not increase further and damage it.

Figure 3: Forced pressure seal

Forced pressure seals only have low or no pre-pressing because they do not seal until a counterpart, here the pressure screw, acts on them. In addition to the classic O-rings, there are many different application forms such as V-tubes, which are split by a wedge when connecting (MIL seal).