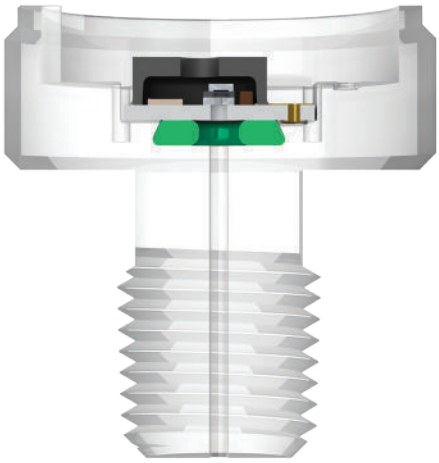
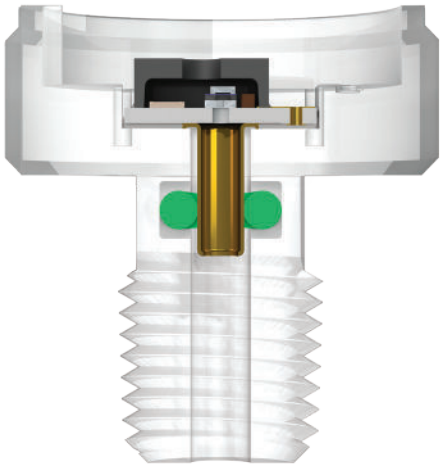
CREATING A SEAL TO A TR SERIES PRESSURE SENSOR USING AN O-RING

To isolate the media to the wetted materials, i.e. glass, solder, ceramic, and silicon, you need to create a good seal. This will be best accomplished with an O-ring. The type of O-ring seal depends on the type of TR Series pressure sensor, specifically whether or not it has a ferrule/pressure port. This application note will discuss the face seal and radial seal. The images below with the O-rings in green show examples of both types of O-ring seal.

Face Seal



Radial Seal



There are many technical aspects, such as package stress, material compatibility, and O-ring geometry, that need to be evaluated when a seal is created with an O-ring. If you want to ensure that a good design is achieved during the first round of development, you must consider these aspects. This application note will help you know what should be considered.

Application Considerations

First and foremost, you should know the pressure, temperature, and media to which the pressure sensor and O-ring will be exposed.

Pressure

In regards to pressure, consider the following questions:

What is the pressure range?

Will pressure be positive at all times, negative at all times, or fluctuating between positive and negative pressure?

Will pressure be constant or intermittent?

Temperature

In regards to temperature, consider the following questions:

What is the storage-temperature range?

What is the operating-temperature range?

Is the operating temperature constant or fluctuating?

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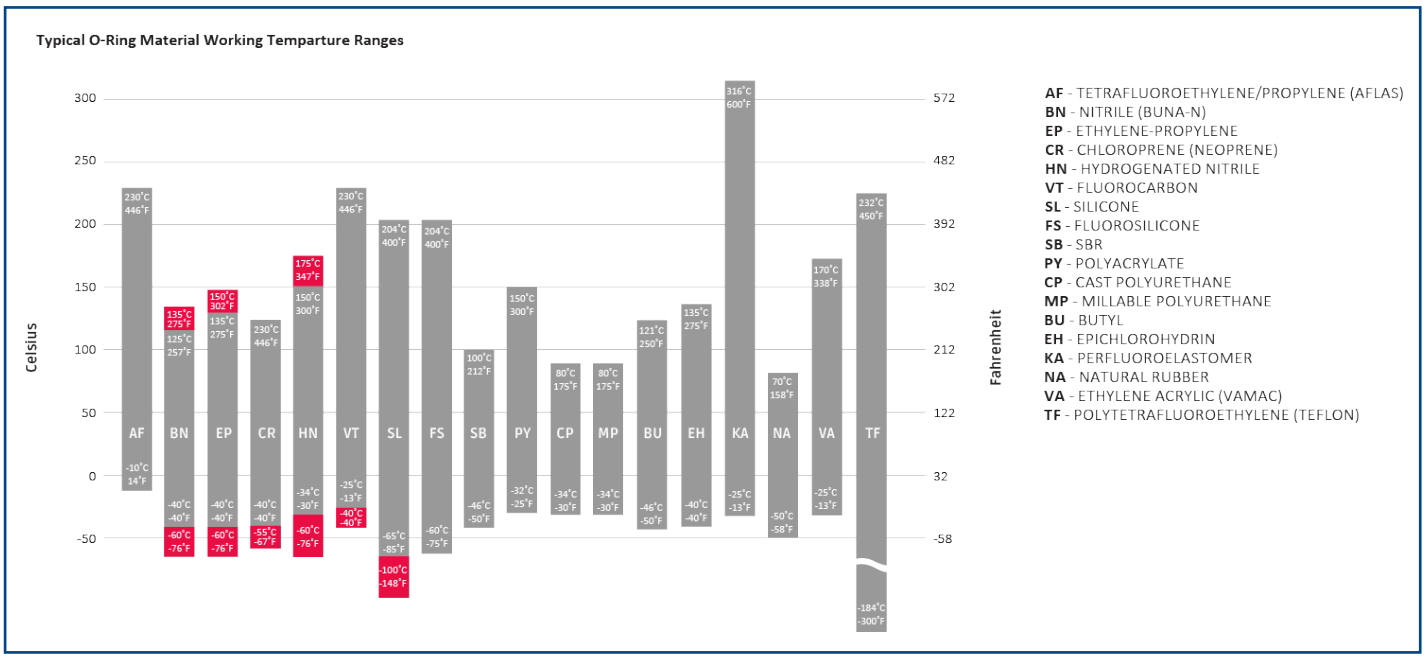
The chart below will help you select an O-ring material based on the operating temperature. Keep in mind that the chart is for general guidance. Testing should always be performed to ensure that the O-ring will function well in the end application.



Media

In regards to media, i.e. the environment to which the sensor and O-ring are exposed, consider the following questions:

What are the chemistries of the media?

Will the pressure sensor and O-ring be exposed to the media continuously or intermittently?

How long will the exposure periods last?

How exposed will the pressure sensor and O-ring be to the media?

Refer to https://www.applerubber.com/chemical-compatibility-guide/ for more information regarding media compatibility of O-rings.

O-Ring Considerations

Material

The pressure, temperature, and media of the application will all have an impact on the O-ring. Therefore, you should consider different O-ring materials. Some common materials are nitrile, silicone, and polyurethane. The following website will help you make your selection: https://www.applerubber.com/material-selection-guide/.

The media to which the O-ring will be exposed will help you determine the O-ring's material. An O-ring's swell and longevity, for example, will differ depending on the material's compatibility with the media.

Knowing the maximum pressure will also help you select the O-ring material. One thing to be considered is the softness of the material. A soft O-ring provides a very compliant seal, resulting in very low packaging stress. If the ceramic substrate of the TR series is bent or torqued, as a result of such stress, a shift in offset can be caused. Essentially, this creates a pressure error. Therefore, a radial seal can be the more effective of the two sealing methods, as the stress around the pressure port is less likely to be transferred to the ceramic substrate. But a soft O-ring may not seal well at high pressures. A hard O-ring, on the other hand, seals well at high pressures but may induce high packaging stress.

Another thing to consider is how different O-ring materials handle temperature differently. The glass transition temperature (Tg) depends on the chemical structure of the O-ring's polymer. When an O-ring is used in temperatures that are below the Tg, it will be unlikely to conform and seal properly. On the other extreme, it is likely that an O-ring used in temperatures that exceed the Tg will display excess extrusion and will ultimately fail to seal.

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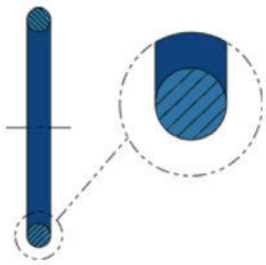
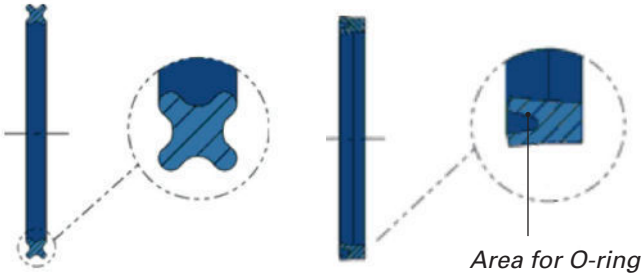
Geometry

There are several different O-ring geometries (OD and cross section) that can be used to create a seal to the TR Series pressure sensor. Each geometry has advantages and disadvantages. The most common and cost-effective geometry is the standard circular cross section. This can be used for positive and negative pressures.



Other geometries to consider are X-shaped and U-shaped cross sections. The U-shaped O-ring comes in two configurations that could work to make a seal: One with an inward-facing channel for positive-pressure applications, and the other with an outward-facing channel for negative-pressure applications.



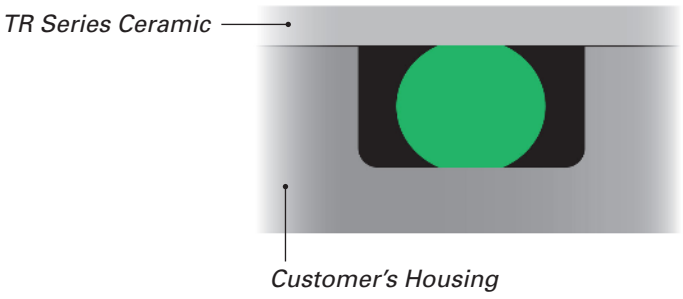
One primary requirement of any O-ring is that the seal remain impervious at minimum and maximum pressures. The O-ring should mitigate the buildup of package stress during pressure cycles and thermal cycles. To ensure a reliable seal at high pressure, you can use backing rings. They will help prevent issues related to extrusion.

Gland/Groove

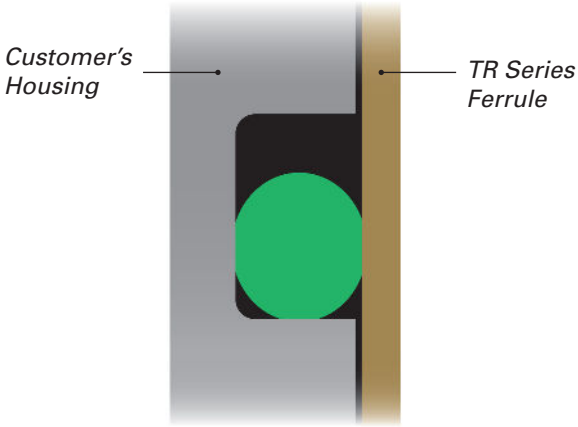
The rectangular gland is the most common type of O-ring gland/groove. It is relatively simple to design and manufacture. The gland's depth and width can be customized per the application specifications. The following aspects of an O-ring gland need to be considered:

- squeeze
- swell
- coefficients of thermal expansion

Face Seal – Standard Gland



Radial Seal – Standard Gland



The dovetail gland is the most complicated O-ring gland. It is difficult to design and expensive to manufacture. It is not recommended for small O-rings, and it is unnecessary for a radial seal. The primary benefit of the dovetail gland is that it helps to hold O-rings in place during assembly.

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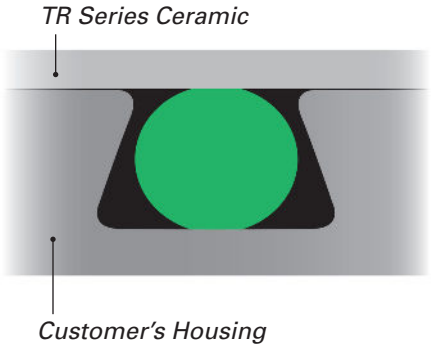
Face Seal – Dovetail Gland



Engineering Analysis

An optimal O-ring seal should function over the full temperature and pressure ranges of the end application. The efficacy of the seal should also be unaffected by the media to which the O-ring is exposed.

Temperature changes will likely cause dimensional changes. The following dimensions should be calculated at minimum and maximum temperatures: OD, ID, and cross-section width of the O-ring; width and depth of the O-ring gland; squeeze and swell of the O-ring.

The dimensional changes can result in stress on the O-ring, gland, and ultimately the MEMS sensing element. Different pressures can also impact the amount of stress.

Because every application involves a unique combination of temperature, pressure, and media, it is critical that verification testing be carried out by the customer. This will help ensure that the O-ring in combination with TR Series pressure sensor provides a robust solution in the end application.

We would like to thank Apple Rubber Products, Inc. for the use of the chart and for the valuable information referred to on their website.

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