How To Seal an O-Ring to a TR Series Pressure Sensor

Sold in North America by:
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APPLICATION NOTE:

Merit Sensor offers a fully calibrated, back side pressure, harsh media, pressure sensor for use with any media which are compatible with Silicon, glass, ceramic and solder. This sensor assembly (TR-Series) was designed to be used with an o-ring, creating a face seal to the back of the sensor.

There are many technical considerations that need to be evaluated when designing for an o-ring face seal. To ensure that a good design can be achieved during the first round of development, several factors must be clearly defined. This information will be critical in subsequent material selections (for both the o-ring and the housing into which it will be inserted) and will be required in the subsequent dimensional and stress analysis.

SPECIFICATIONS

Temperature Specification

- Identify the minimum and maximum end use temperatures for both the operation and the storage conditions. Will the use temperature will be constant or fluctuating? Will the pressure be changing at the same time?

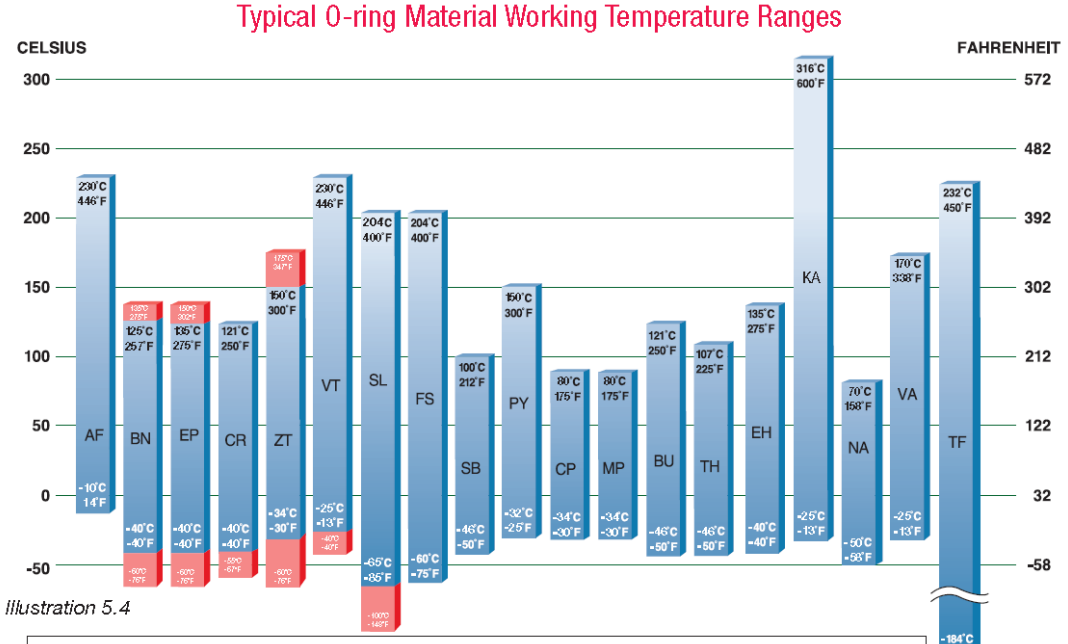

Illustration 5.4

AF	–	TETRAFLUOROETHYLENE/PROPYLENE (AFLAS)	CP	–	CAST POLYURETHANE
BN	–	NITRILE (BUNA-N)	MP	–	MILLABLE POLYURETHANE
EP	–	ETHYLENE-PROPYLENE	BU	–	BUTYL
CR	–	CHLOROPRENE (NEOPRENE)	TH	–	POLYSULFIDE (THIOKOL)
ZT	–	HYDROGENATED NITRILE	EH	–	EPICHLOROHYDRIN
VT	–	FLUOROCARBON	KA	–	PERFLUOROELASTOMER
SL	–	SILICONE	NA	–	NATURAL RUBBER
FS	–	FLUOROSILICONE	VA	–	ETHYLENE ACRYLIC (VAMAC)
SB	–	SBR	TF	–	POLYTETRAFLUOROETHYLENE (TEFLON)
PY	–	POLYACRYLATE			

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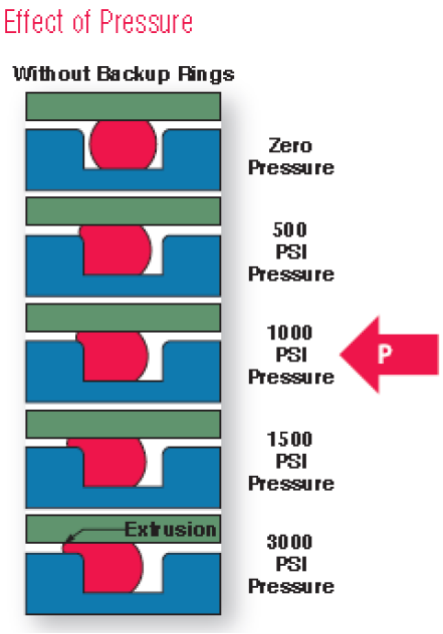
Pressure Specification

- Identify the minimum and maximum use pressures. Will the pressures be all positive, all negative or a combination of both positive and negative? Will the pressures be fluctuating or constant? Will the temperature be changing at the same time?



Media Specification

- Identify the media that will be in contact with the sensor. What chemistries do they contain? Are they compatible with Silicon, Borosilicate Glass, 96% Alumina Ceramic and Solder? What will be the exposure conditions (temperature, pressure, duration, concentration, etc.) Be sure to think about both sides of the sensor. The backside will be exposed to the harsh media. The front side will be exposed to some other environmental conditions. Be sure that the "top side" is protected from the harsh media.

  http://www.applerubber.com/src/pdf/chemical-compatibility.pdf

O-RING OPTIONS

Material Options

- The o-ring material should be selected based on the information specified above. The o-ring softness should be selected base on the maximum use pressure and the resulting packaging stresses. A soft o-ring will provide a very compliant seal which will result in very low induced packaging stresses but may not be able to seal well at high pressures. A hard o-ring conversely would seal well at high pressures but may also induce high packaging stresses. Different o-ring materials have different temperature handling capabilities. The glass transition temperature of the polymer will limit the lower functional operating temperature of the o-ring. The temperature at which the polymer begins to decompose or soften will limit the upper functional temperature of the o-ring. It is also important to look at the media compatibility of the different o-ring polymers. The longevity of the o-ring and the amount of swell that the o-ring will experience will be different depending on the o-ring material and the media. It may be difficult to find the exact right material to match all of the specification requirements.

  http://www.applerubber.com/src/pdf/general-properties-of-orings.pdf

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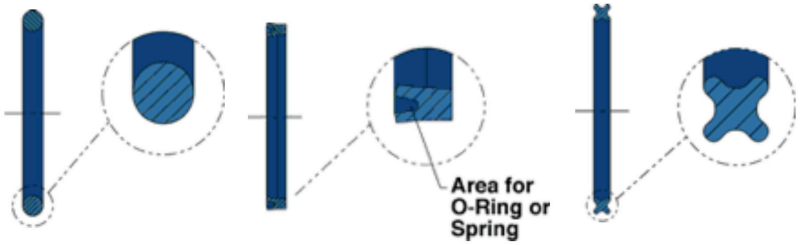
Geometry Options

- After the material selection, the determination of the o-ring size (OD and cross-section) is the next thing to consider. The o-ring should accomplish several different goals. The o-ring must ensure that the media will not leak at minimum and maximum pressures. The o-ring must ensure that the media does not leak at minimum and maximum temperatures. The o-ring should be chosen to minimize package stress buildup during pressure and thermal cycles.

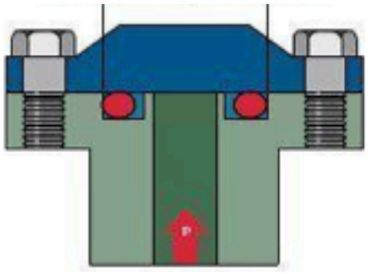
- There are several different o-ring geometries that can be used for face sealing. Each of them has advantages and disadvantages. The most common and cost effective o-ring geometry is the standard circular cross-section. This geometry can be used for both positive and negative pressures. To assist with high pressure sealing, backer rings can be used to prevent issues with squeeze-out. In addition to the circular cross-section, there are "X" and "U" shaped o-ring cross-sections. The "U" shaped o-ring comes in two configurations that could work as a face seal (inward facing channel for positive pressure applications, outward facing channel for negative pressure applications). The "X" cross-section will work in either application.



O-RING GLAND OPTIONS

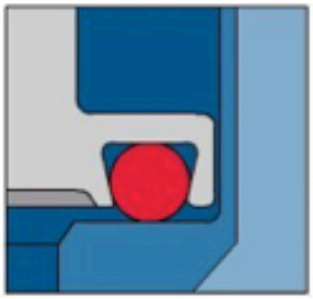
Counter Boar Gland

- The counter bore gland is the most common o-ring gland. It is relatively simple to design and manufacture. The gland depth and width can be tailored to work with the specific application specifications. Items that need to be considered are the squeeze percentage, the swell and the coefficients of thermal expansion.



Dovetail Gland

- The dovetail gland is the most complicated o-ring gland. It is difficult to design and is expensive to manufacture. The primary benefit of this gland design is that it will assist in holding the o-rings in place during assembly. It is not recommended for small o-rings. This design is even more sensitive to the squeeze percentage, the swell and the coefficients of thermal expansion.



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SUGGESTED ENGINEERING ANALYSIS AND VERIFICATION

To ensure that the o-ring will seal properly over the full temperature and pressure use ranges, several different analyses should be carried out. It is important to look at static forces, dynamic forces and the effects of temperature on each.

Static and Dynamic Analysis

- It is important to calculate the dimensional changes that will happen with temperature. The OD, ID and cross section diameters of the o-ring should be calculated at the Min and Max temperatures. The width and depth of the gland should be calculated for Min and Max temperatures. The o-ring squeeze should be calculated at each of these extremes to ensure that the gland dimensions are adequate. Be sure to take into consideration the swell for the o-ring material base on the media in contact with the o-ring. Based on these dimensions, the zero pressure stresses on the package can be estimated.

- The static model should then be used to evaluate the stresses during changes in both temperature and pressure. Based on the output of this analysis, a suitable combination of o-ring size, o-ring material and gland dimension can be selected to provide the optimal solution.

Because each application is a very unique combination of temperature, pressure and media, it is recommended that verification testing be carried out by the customer to ensure that the o-ring material, o-ring cross section and the gland dimensions will provide a robust solution in the final application

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