METAL O-RINGS

Garlock Helicoflex

High Performance Seals and Sealing Systems

GENERAL INFORMATION

Garlock Helicoflex Metal O-Rings are designed to provide a high sealing level under adverse working conditions whether the medium is gas or liquid.
Metal O-Rings are manufactured from stainless steel or high temperature alloy tubing or wire.

SEALING CONCEPT

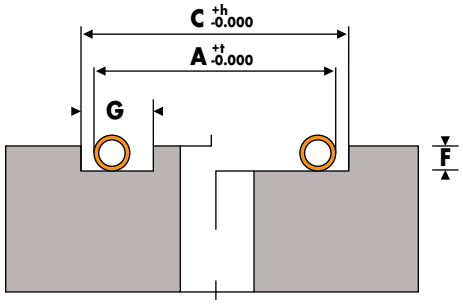
The sealing concept of Metal O-Rings is based on the elastic deformation of the tube which, during the compression cycle, gives a contact point on each sealing surface.
The tube characteristics determine the compressive load of the seal. This load combined with an accurate compression rate results in a specific pressure which is directly related to the sealing level obtained. A certain specific pressure is necessary to make the seal flow into the flange imperfections. A softer surface treatment is available to increase the plasticity of the seal and reduce the specific pressure necessary to reach the desired sealing level.
Metal O-Rings require a controlled compression by some mechanical method such as a custom machined groove or a limiter of appropriate thickness.

GENERAL CHARACTERISTICS

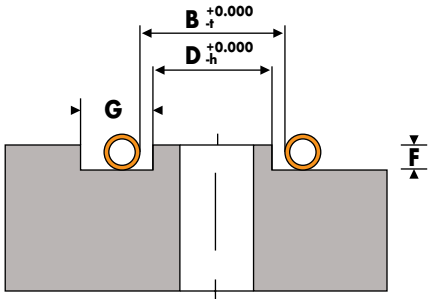
- Wide range of applications:
  - Dimensional: Diameters from 0.250 inches (6.3 mm) to 300 inches (7.6 m)
    Cross sections from 0.031 inches (0.8 mm) to 0.625 inches (15.9 mm)
  - Temperature: Cryogenic to 1800°F (982°C)
  - Pressure: Ultra High Vacuum to 60000 PSI (4100 bar)
- Excellent springback
- Adaptable to a majority of standard flanges
- Available in many shape configurations: rectangular, oval, oblong etc...
- Suited to different types of assemblies: -metal/metal with groove
  -flat flanges with a retainer
  -3 face contact
- Extended shelf life
- Excellent resistance to corrosion and radiation
- Minimum relaxation

GROOVE ASSEMBLY TYPES

RECOMMENDED GROOVE DIMENSIONS



INTERNAL PRESSURE



EXTERNAL PRESSURE

SEAL						GROOVE DESIGN									
Nominal Tubing Diameter C.S.		Seal O.D./I.D. Range*				Seal Tolerance t		Clearance** CL		Groove Tolerance h		RECOMMENDED GROOVE DEPTH F		MINIMUM GROOVE WIDTH G	
.035	0.9	0.250-	4.000	6.4-	102	.005	.13	.006	.15	.004	.10	.028/.030	0.71/0.76	.055	1.4
.063	1.6	0.500-	10.000	12.7-	254	.005	.13	.006	.15	.004	.10	.050/.052	1.27/1.32	.090	2.3
.094	2.4	1.000-	15.000	25.4-	381	.005	.13	.008	.20	.004	.10	.071/.075	1.80/1.91	.125	3.2
.125	3.2	2.000-	40.000	50.8-	1270	.005	.13	.008	.20	.004	.10	.097/.101	2.46/2.57	.160	4.1
.156	4.0	3.000-	50.000	76.2-	1270	.005	.13	.014	.36	.006	.15	.123/.127	3.12/3.23	.200	5.1
.188	4.8	4.000-	50.000	101.6-	1270	.005	.13	.014	.36	.006	.15	.147/.151	3.73/3.84	.250	6.4
.250	6.4	5.000-	50.000	127.0-	1270	.008	.20	.019	.48	.008	.20	.197/.201	5.00/5.11	.350	8.9

* Nominal Diameter(does not include plating thickness)
** Between Seal Diameter and Groove Diameter

Dimensions in inches | Dimensions in mm

Notes :

1. Please consult our engineering staff for cross sections larger than 0.250.
2. Welds are finished flush with tube OD. Rings are blended within 0.125" of weld. Dimensions at blend zone are not more than 0.002"(per side) below adjacent surfaces.
3. When restrained, the rings are round within diameter limits. (Consult our engineering staff for allowable tolerance for rings in the free state).
4. Cross-section is subject to change during forming operation. (Consult our engineering staff for details).

Calculating Groove Diameter:

Internal Pressure: Groove OD (C) = Seal OD (A) + Clearance (CL) + [Maximum plating thickness x2]
External Pressure: Groove ID (D) = Seal ID (B) - Clearance (CL) - [Maximum plating thickness x2]
Example: Calculation for U2312-03625 SEA (internal pressure)
Groove OD = 3.625 + 0.008 + [0.002 x2] = 3.637 $^{+.004}_{-.000}$

OTHER ASSEMBLY TYPES

A metal plate limiter can be added as a mechanical back-up that serves the same function as the machined groove. This allows the use of metal O-Rings on flat, raised or tongue and groove flange standards available on the market (ANSI, ASA, API, MSS SP 44, DIN etc...) usually without modification. The metal O-Ring can also be used on custom or shaped flanges.

Y2 : Ideal Compressive Load
e2 : Ideal Compression

Load characteristics change with wall thickness and material. We have selected 3 thicknesses :
Thin(T), Medium(M), Heavy(H).
The linear compressive load also depends on the material and the diameter of the seal. If we consider Y2* as the linear load for Stainless Steel 321, Km as material factor and Kd as diameter factor, the linear load Y2, under e2 will be :

Y2 = Km x Kd x Y2*

CS (Cross Section) = Tube Diameter

STANDARD TUBING

Cross Section C.S.		WALL THICKNESS					
		Thin		Medium		Heavy	
in	mm	in	mm	in	mm	in	mm
0.032	0.9	0.006	0.15	0.010	0.25	N/A	N/A
0.063	1.6	0.010	0.25	0.012	0.30	0.014	0.36
0.094	2.4	0.010	0.25	0.012	0.30	0.018	0.46
0.125	3.2	0.010	0.25	0.020	0.51	0.025	0.64
0.156	4.0	—	—	0.020	0.51	0.025	0.64
0.188	4.8	—	—	0.020	0.51	0.032	0.81
0.250	6.4	0.025	0.64	0.032	0.81	0.049	1.24

Y2* VALUES

Cross Section C.S.		Ideal Compression e2		Y2*					
				Thin		Medium		Heavy	
in	mm	in	mm	lb/in	DaN/cm	lb/in	DaN/cm	lb/in	DaN/cm
0.035	0.9	0.006	0.15	457	80	1028	180	1485	260
0.063	1.6	0.012	0.30	571	100	799	140	1256	220
0.094	2.4	0.020	0.50	343	60	514	90	1313	230
0.125	3.2	0.026	0.65	343	60	1142	200	2056	360
0.156	4.0	0.031	0.80	—	—	857	150	1428	250
0.188	4.8	0.039	1.00	—	—	657	115	2113	370
0.250	6.4	0.051	1.30	799	140	1370	240	3026	530

Km VALUES

MATERIAL	Km
321 SS	1
Alloy 600	1.1
Alloy X750	1.3

Kd VALUES

Diameter																			
from:	0.0″	0	0.75″	19	1.2″	30	2″	50	3″	75	6″	150	10″	250	18″	450
to:	0.75″	19	1.2″	30	2.0″	50	3″	75	6″	150	10″	250	18″	450		
Kd Value	1.4		1.3		1.2		1.1		1.0		0.9		0.8		0.8				

DIAMETER/C.S. GUIDELINES

Cross Section	0.035″	0.063″	0.094″	0.125″	0.156″	0.188″	0.250″
	0.9	1.6	2.4	3.2	4.0	4.8	6.4
from:	0.250″	0.500″	1″	2″	3″	4″	5″
Diameter	6	12.5	25	50	75	100	125
to:	4″	10″	20″	40″	50″	60″	80″
	100	250	500	1000	1250	1500	2000

Dimensions in inches | Dimensions in mm

MATERIALS

Garlock Helicoflex Metal O-Rings can be manufactured using different materials such as 300 series Stainless Steel, Alloy 600, Alloy X750 or other special alloys. Temperature, pressure and corrosive aspects of the media determine which material is best suited for the application.

HEAT TREATMENT

Since tensile strength and resilience of the seal are determined in part by metal temper, Garlock Helicoflex offers a choice of heat treatment (age hardening or annealing) according to AMS, MIL, ASTM or customer specification.

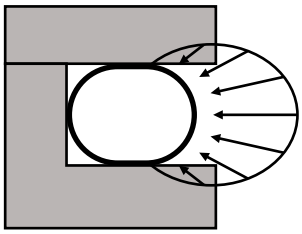
PLATING/COATING

Sealing capability can be improved by platings or coatings such as Teflon®, silver, nickel or other malleable metals. These specialized surface treatments are recommended when sealing gaseous media. The coating or plating increases the seal plasticity and yields during installation, filling minor surface imperfections and creating a positive seal.
When service conditions allow, silver is the preferred surface treatment.

DIFFERENT TYPES OF SEALS

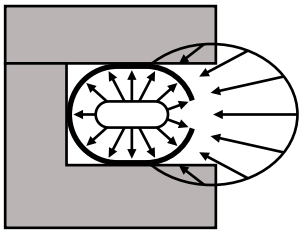
PLAIN Type : NP

The plain seal type NP (Not self energized or Pressure filled) is made of metal tubing (or wire) available in most metal alloys. This type is the most economical O-Ring. It is designed for low to moderate pressure and vacuum applications.



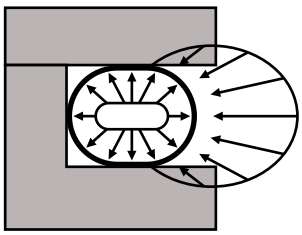
SELF-ENERGIZING Type : SE

The surface exposed to the highest pressure, usually the inner periphery, is vented by small holes or slots. Self-Energizing seal type SE is recommended for high pressure applications. This feature allows the system pressure to enter the O-Rings, creating maximum specific pressure and reducing the pressure differential across the seal. For media other than high viscosity, one hole is sufficient.



PRESSURE FILLED Type : PF

Pressure Filled O-Rings are designed for a temperature range of 800 to 2000 °F (425-1093 °C). The rings are filled with an inert gas at 600 PSI (41 bar). At elevated temperatures, gas pressure increases to offset the loss of strength in the tubing and specific pressure.



O-RING TYPE SELECTION

TYPE NP : for working conditions from vacuum to 100 PSI (7 bar)
TYPE SE : for pressure above 100 PSI (7 bar) and temperature up to 1800 °F (982 °C)
TYPE PF : for high pressure and high temperature from 800 °F (426 °C) to 2000 °F (1093 °C)

MATERIAL SELECTION

Temperature and media to be sealed determine the type of O-Ring material

TEMPERATURE	O-RING MATERIAL
Cryogenic to 700 °F (371 °C)	Stainless Steel 321
Cryogenic to 1000 °F (538 °C)	Alloy 600
Cryogenic to 1400 °F (760 °C)	Alloy X750
Above 1400 °F (760 °C)	Consult our engineering staff

Consult our engineering staff for other available materials.

O-RING SIZE SELECTION

Tubing diameter is determined by ring outside diameter, available space and sealing level required. (see table on page 6) For each cross section, we have selected 3 different wall thicknesses. Thin (T), Medium (M) and Heavy (H), which give the appropriate specific pressure according to the required sealing level. (See table on page 5).

PLATING/COATING

Different coatings or platings are available to provide better plasticity which yields and conforms to the microscopic groove or flange irregularities.
The recommended surface treatments are :

PLATING/COATING	TEMPERATURE
Teflon®	Cryogenic to 500 °F (260 °C)
Silver	Cryogenic to 1200 °F (649 °C)
Nickel	Cryogenic to 2200 °F (1204 °C)

SURFACE FINISH REQUIREMENTS

PLATING/COATING	NONE	TEFLON®	SILVER	NICKEL
Recommended Surface Finish	<16 RMS	16 To 32 RMS	16 To 63 RMS	16 To 32 RMS
Ra in µm	<0.4	0.4 To 0.8	0.4 To 1.6	0.4 To 0.8

Sealing Level

TUBE COATINGS	TUBE DIAMETER		S.Steel 321			INCONEL 600			INCONEL X750		
Wall Thickness			T	M	H	T	M	H	T	M	H
Non Plated	0.035″	0.9mm	■	■	●	■	■	●	■	●	●
	0.063″	1.6mm	■	■	■	■	■	●	■	■	●
	0.094″	2.4mm	■	■	■	■	■	●	■	■	●
	0.125″	3.2mm	■	■	●	■	■	●	■	■	●
	0.156″	4.0mm	■	■	●	■	■	●	■	■	●
	0.188″	4.8mm	■	■	●	■	■	●	■	■	●
	0.250″	6.4mm	■	●	●	■	●	●	■	●	●

Wall Thickness			T	M	H	T	M	H	T	M	H
Teflon®	0.035″	0.9mm	●	▲	▲		▲	▲	●	▲	▲
	0.063″	1.6mm	●	▲	▲		▲	▲	●	▲	▲
	0.094″	2.4mm	●	●	▲		●	▲	●	●	▲
	0.125″	3.2mm	●	▲	▲		▲	▲	●	▲	▲
	0.156″	4.0mm	■	▲	▲	■	▲	▲	■	▲	▲
	0.188″	4.8mm	■	●	▲	■	●	▲	●	●	▲
	0.250″	6.4mm	▲	▲	▲	▲	▲	▲	▲	▲	▲

Wall Thickness			T	M	H	T	M	H	T	M	H
Silver	0.035″	0.9mm	●	●	▲	●	●	▲	●	●	▲
	0.063″	1.6mm	●	●	▲	●	●	▲	●	●	▲
	0.094″	2.4mm	■	●	▲	■	●	▲	●	●	▲
	0.125″	3.2mm	■	●	▲	■	●	▲	●	●	▲
	0.156″	4.0mm	■	●	▲	■	●	▲	■	●	▲
	0.188″	4.8mm	■	●	▲	■	●	▲	■	●	▲
	0.250″	6.4mm	●	●	▲	●	●	▲	●	●	▲

Wall Thickness			T	M	H	T	M	H	T	M	H
Nickel	0.035″	0.9mm	■	●	●	■	●	●	■	●	●
	0.063″	1.6mm	■	■	●	■	●	●	■	●	●
	0.094″	2.4mm	■	■	●	■	■	●	■	■	●
	0.125″	3.2mm	■	●	●	■	●	●	■	●	●
	0.156″	4.0mm	■	●	●	■	●	●	■	●	●
	0.188″	4.8mm	■	■	●	■	■	●	■	●	●
	0.250″	6.4mm	■	●	●	●	●	●	●	●	▲

The sealing level has been determined through intensive tests.

■ : Low sealing Level Q > 10^{-5} Torr.liters.s^{-1}

● : Bubble Sealing Level 10^{-9} < Q < 10^{-5} Torr.Liters.s^{-1}

▲ : Helium Sealing Level Q <10^{-9} Torr.Liters.s^{-1}

Q : leak rate

T: Thin

M: Medium

H: Heavy

Product Number

COMMERCIAL O-RING SPECIFICATION

Denotes Metal O-Ring	Tubing OD (Thirty Seconds)	Wall Thickness (Thousandths)				
U	2	3	12	03	625*	SE	A

MATERIALS

2- Stainless Steel 321	8- Stainless Steel 316
5- Alloy 600	9- Stainless Steel 347
6- Alloy X-750	X- As Specified
7- Stainless Steel 304	

Note: Contact our engineering staff for other available materials.

METAL O-RING OD (Inches) (Thousandths)

Note: for I.D. Controlled O-Ring please contact our engineering staff for a part number.

TYPE

- SE- Self-energized on ID
- PF- Pressure Filled
- NP- Not self-energized, not pressure filled
- SO- Self-energized on OD
- SX- Self-energized as specified

COATINGS

A-Silver	.001/.002 (0.03/0.05)	E-Teflon	.003/.004 (0.08/0.10)
B-Silver	.002/.003 (0.05/0.08)	N-None	
D-Teflon	.001/.003 (0.03/0.08)	T-Nickel	.001/.002 (0.03/0.05)

Example :
U2312-03625SEA
The above example, U2312-03625SEA, indicates a type 321 stainless steel O-Ring, 3/32" (2.38mm) tube size, .012" (0.30mm) wall thickness, 3.625" (92.08mm) OD, self energized (ID) and .001-.002" (0.03/0.05mm) silver plating.

Garlock Sealing Technologies

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