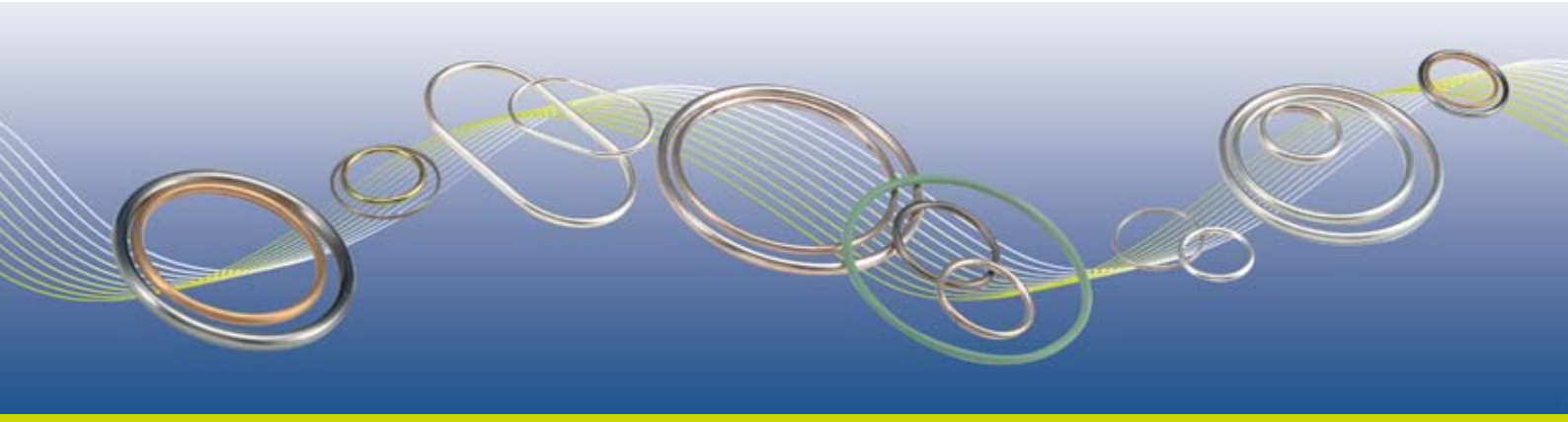

hi-tech metal seals

valves

hydraulic

vacuum

nuclear

engines

aerospace

oil & gas

compressors

pumps

turbines

heat exchangers

chemical

iron & steel

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INTRODUCTION

General Information

High Performance Seals for extreme service conditions: TFC's metal seals are generally used in static applications and are designed to provide high fluid sealing levels under the most extreme working conditions.
Our seals are produced from stainless steel or high temperature alloy tubing, strip and wire.

General Properties

- Sizes: Diameters from 5mm to 7 metres
- Temperature: Cryogenic to +750°C
- Pressure: From ultra high vacuum to over 500 MPa (72500 Psi)
- Capable of reaching tightness better than 10^{-9} mbar.l/s
- Excellent resistance to corrosion and radiation.
- Maintains elasticity or spring back over an extended service life
- Does not suffer from explosive decompression
- Radiation resistant
- Cross section from 0.8mm to 12.5mm
- Available in circular, race track, oval and other shapes.

Typical Applications

- All applications where the use of elastomer seals is restricted by temperature, corrosion, radiation, pressure, gas permeability and seal life expectancy.
- Vacuum and ultra-high vacuum
- Plastic mouldings
- Reactors and nuclear installations
- Diesel and other engines
- Aerospace
- Oil and petrochemical industries
- Hydraulic, valves, pumps & compressors
- Turbines
- Boilers and heat exchangers
- Chemical industries
- Iron and steel industries

Performance Sealing Solutions

Quality

TFC is dedicated to supplying resilient metal seals under the most stringent quality procedures. The factory is ISO9000 certified, and their quality system has been audited according to ISO9100.

- Computer controlled welding equipment
- 100% LP test on O Ring seal welds
- X-ray of weld area on request
- Helium leak test equipment
- Seating load and spring back measurement
- Heat treatment & plating facility
- Clean room environment CLASS 5 as per ISO-14644 (MIL100 as per IEST-STD-CC1246D)

Expertise

- More than 100 years of experience
- In house testing
- R&D new products

Flexibility

- Short delivery times
- Expedite production
- Dedicated staff
- Quick response time

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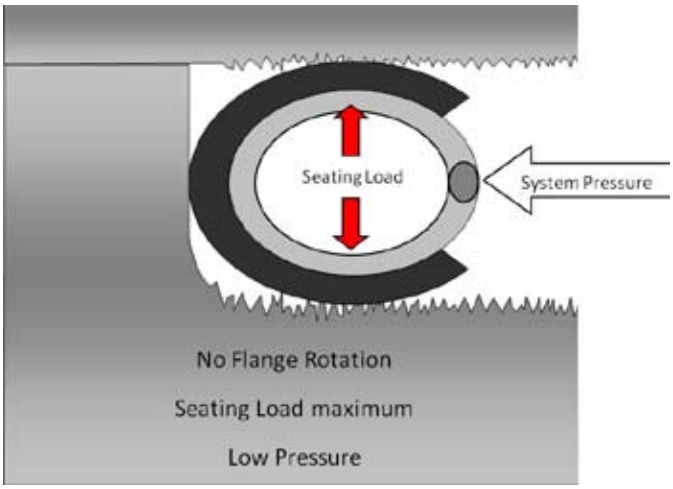
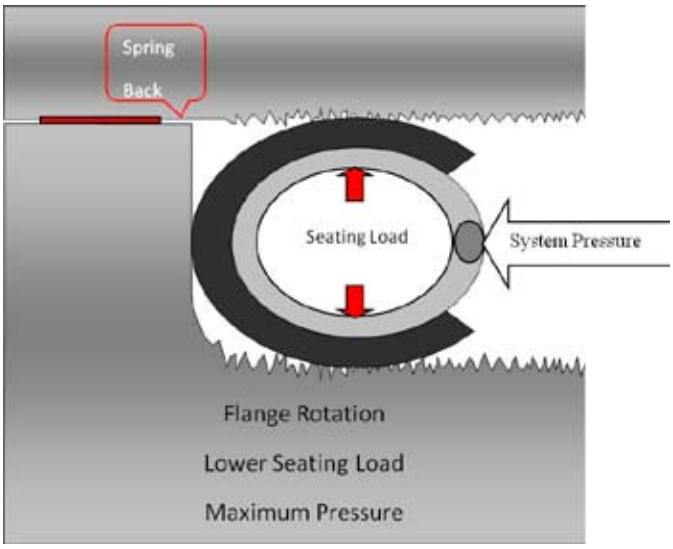
Function of a Metal Seal

The sealing concept is based on the elastic deformation of the seal under compression that, in turn, provides a constant contact point on each sealing surface.
Unlike flat gaskets metal seals do not depend upon enormous clamping loads to maintain tightness. By compressing the seal to a defined size (groove depth) a seating load is created. The shape of the seal determines the spring back or elasticity of the seal.

Compression
The seating load is a result of varying wall thickness, seal material and seal configuration. The clearance between seal OD and groove OD also has an influence on the seating load.
With a small cross section, the difference between indicated loads and real load can be substantial.



Spring back
The rate of spring back depends on seal type and material selection. The spring back and seating load improve with minimal diametric clearance.
System pressure helps maintain contact between the mating surfaces.



Energisation

Depending upon the application, there are three types of seal energisation (illustrated below) that can be utilised to provide the perfect seal:

Self Energisation – The use of different seal materials and heat treatment processes results in a variety of spring temper properties that, when under pressure loading, provide a definable and constant spring force.

Pressure Energisation – Metal seals can use either the hydrostatic forces created by the medium being sealed or are independently gas filled to obtain the highest level of sealing

Spring Energisation – Metal seals can be fitted with an internal spring to provide greater compressive loads.

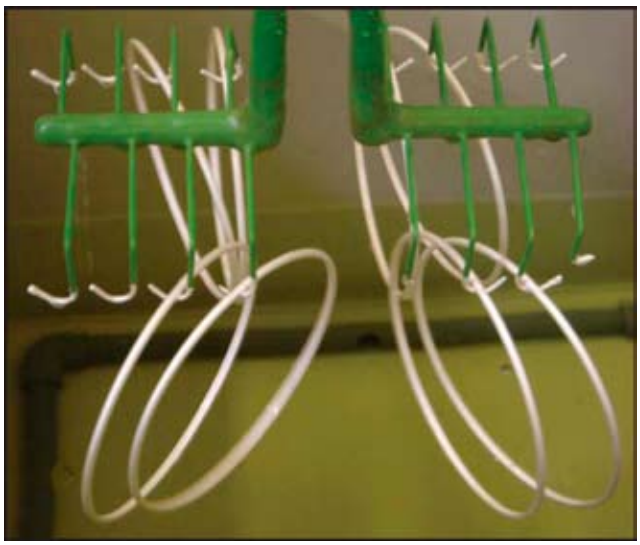
Material Selection

The application parameters determine which material should be used. Temperature and media are important aspects in selecting the material. TFC offers materials such as 321 stainless steel, Inconel® and other high temperature alloys.
Please see page 4 for further details.

Plating - Coating

In house platings or coatings are applied to improve the sealing performance of metal seals. Depending on the required tightness, the selected seal, the media to be sealed and the condition of the mating surface, a softer or harder plating or coating shall be chosen. When temperature allows, either PTFE coating or soft silver should be applied.
At seal compression the soft plating flows into the mating surface irregularities and creates the best seal performance possible.

PTFE coating can achieve leak rates around 10^{-6} mbar.l/s, measured with the vacuum method. Metal type plating, like silver, indium, and tin to name a few, can achieve leak rates better than 10^{-9} mbar.l/s up to 10^{-12} mbar.l/s.



Application checklist (page 22)

To enable TFC to offer the optimum sealing solution please send us your full application details by completing the form on page 22 and returning to us by email or fax:

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Heat Treatment

TFC recommends the heat treatment of all non spring energised Metal C Rings. High performance TFC metal seals will perform better in the heat treated condition.

Heat treatment of super alloys such as Inconel X750, Inconel 718, Haynes 214, will increase the yield strength of the material. This directly influences the seal performance because of the increased seating load and better spring back.

The higher spring back means that the intimate contact between the seal and the mating surface is maintained over a wider range in flange deflection. Such flange deflection can be a result of high temperatures, high pressures and/or a combination of the two.

Heat treatment is mostly not required for Spring Energised C Rings and Metal O Rings. However some demanding applications in Oil and Gas environments do require heat treatment to prevent material embrittlement. (Heat treatment according to NACE)

Annealing and heat treatment also improves the seal's resistance against fatigue under cyclic loads. Structural integrity will be maintained for an extended period of time. TFC offers age hardening, annealing and solution and precipitation heat treatments.

Metal O-Rings and some Spring Energized C-Rings made from austenitic stainless steels, cannot be precipitation hardened. These seals can only be supplied in the work hardened condition.
For demanding applications and for temperatures above 400°C, TFC would advise the use high alloy steels only.

Exceptions and particular cases

Metal seals often have to perform under extreme service conditions. Standard solutions as found in this catalogue may not always satisfy these requirements.
TFC can alter the standard design and materials to optimise seal performance for a given application. With high accuracy and backed by FEA, TFC can adjust the seal cross section, wall thickness, selected alloys, to name a few variables, in order to adapt seal performance to the required service.

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MATERIALS

Material Code		HT-1	HT-2	HT-3	HT-4	HT-5	HT-6	HT-7	HT-8
1	Nickel alloy X-750	X	X		X				
2	Nickel alloy 718	X	X		X	X			
3	321 SS	X							
4	Nickel alloy 600	X		X					
5	304 SS	X							
6	304 SS, high tensile	X							
7	316 SS	X							
8	Hastelloy	X							
9	302 SS	X							
A	ELGILOY	X							X
B	HAYNES 214	X						X	
C	ALUMINIUM 1050	X		X					
D	ALLOY 625	X					X		
E	NIMONIC 90	X							
F	HASTELLOY C-276	X				X			
G	HAYNES 188	X							

HT-1	Work Hardened
HT-2	Age Hardened, short cycle
HT-3	Annealing
HT-4	Solution and Precipitation Heat treatment
HT-5	Nace Heat treatment, Hardness max 40 HRC, Alloy 718
HT-6	Nace Solution Annealing
HT-7	Stress Relief
HT-8	Age Hardened, Hardness max for NACE 62 HRC

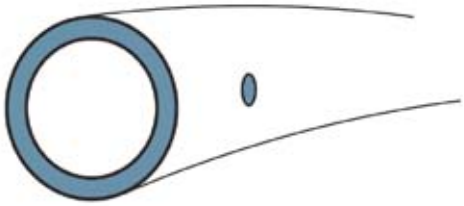
Heat treatment codes for jacket and spring materials.

SEAL TYPE OVERVIEW

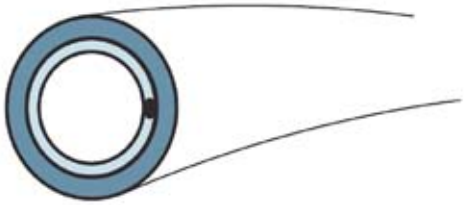
Metal O-Rings for Internal & External Pressure (pages 9 & 10.)

Non-vented rings are designed for lower pressure ranges. The perfectly closed O Ring design avoids ingress of the media into the seal.
Moderate load, moderate pressure capability.

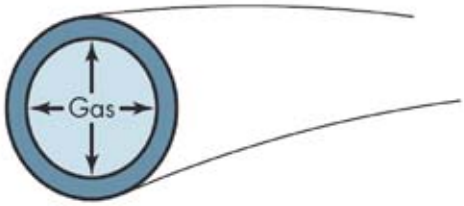
Internally or externally vented O Rings are designed for higher pressure. Besides the own seating load the seal is also energised by the system pressure.



Spring-energised metal O Ring for Internal pressure or external pressure are designed for extreme low leakage at moderate pressures.



Gas filled metal O Ring for high temperature and moderate pressure applications.



Metal C-Rings for Internal & External Pressure (pages 11 & 12.)

Metal C Ring for internal pressure and external pressure are designed for high pressure (system pressure energised). They require low bolting load and have good spring back.

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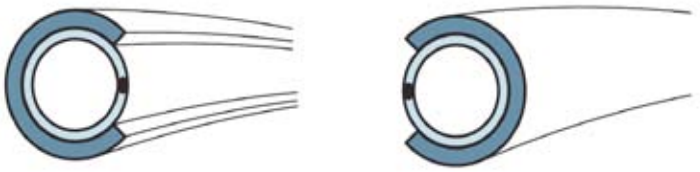
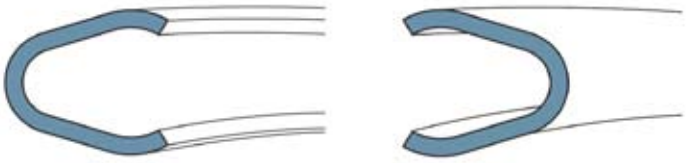
Spring Energised C-Ring for Internal & External Pressure (pages 13 & 14.)

Metal spring energised C-Ring for internal pressure and external pressure, are designed for excellent tightness and high pressure performance (system pressure energised). They require high bolting load and have good spring back.



Metal V-Ring for Internal & External Pressure (pages 15 & 16.)

The V-Ring is designed for maximum spring back, and as a consequence is a low load seal. Because of the low load it will only obtain a good tightness with very soft plating or coatings.



Metal Commaseal® for Axial Pressure and ID or OD Dynamic (pages 17 & 18.)

Commaseals® are designed for slow dynamic applications on ID or OD.

Metal C-Ring for Axial Pressure (page 19.)

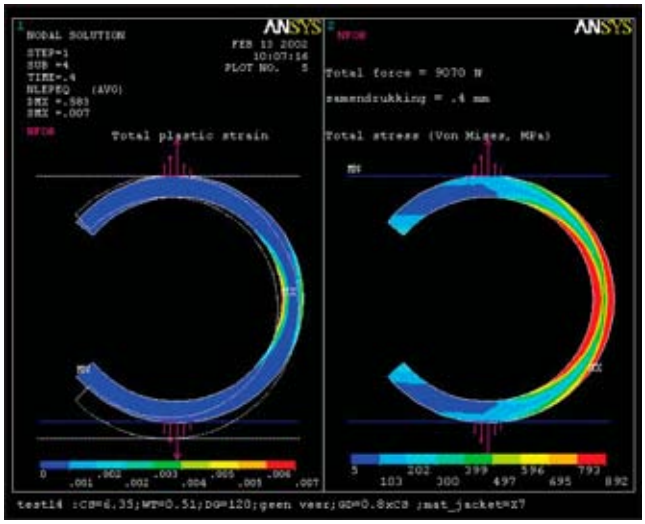
The radial C-Ring for axial pressure is designed to seal shaft to bore. Spring energised option also available for better spring back. Close tolerances on both shaft and bore are required.

SEAL SELECTION GUIDE

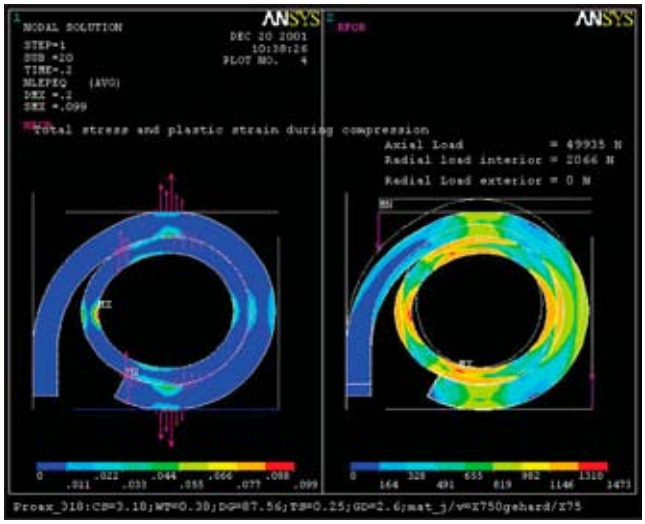
Load and Spring back

The selection of the most suitable seal for extreme service conditions is often a delicate trade off between load and spring back of the seal. The compression load or seating load has a direct relationship with the obtainable sealing tightness, whereas the spring back of the seal determines how well this tightness is maintained with varying temperatures and pressures.

For a given seal cross section and seal type it is generally true that with maximum load the spring back is lowest, and of course the seal with minimum load will generate the highest spring back.



C-Seal



Commaseal®

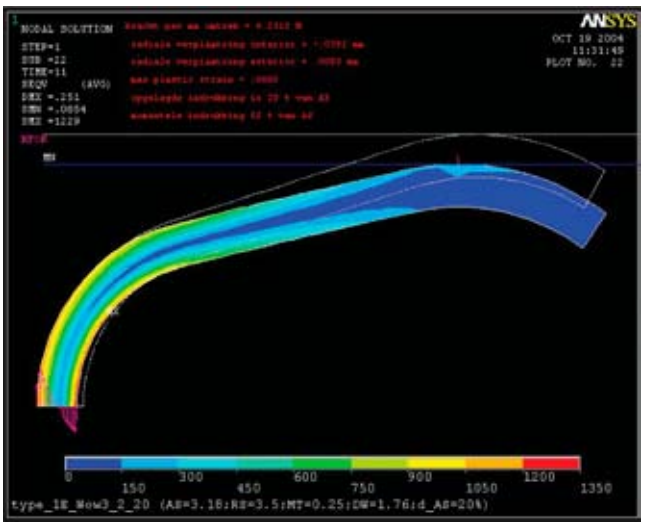
Looking at a Metal O-Ring made from stainless steel, one with a thin wall and the other with a thick wall, the one with the thin wall will require lower load to be compressed to groove depth than the one with the thick wall, where the spring back of the latter will be lower than the one with the thin wall.

Again looking at the same cross section Metal O-Ring, a seal made from Inconel X-750 or Inconel 718 will have a higher load and higher spring back than a similar wall thickness Metal O-Ring made from stainless steel.

In the case of Metal C-Rings, there is a certain similarity with spring back and seating load. The big difference is that Metal C-Rings compared with the same cross section Metal O-Rings, typically generate a lower load, and thus a better spring back than Metal O-Rings.

To overcome the low load of Metal C-Rings, the spring energised Metal C-Ring was developed. This seal, generates a relatively high and uniform seating load with a high spring back.

The Metal V-Ring, by its shape and material selection generates a high spring back, but gives only a moderate seating load.



V-Ring

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Compression or Seating Load

The compression or seating load is expressed in N/mm seal circumference. The higher the load, the better the sealing performance will be. Soft plating requires lower load than hard plating.

Rough surface finish of the sealing faces require a higher load to obtain similar seal performance.

Non plated seals typically require extremely high loads to obtain good sealing tightness. It will be difficult, regardless of the applied load, to obtain a high tightness with unplated seals.

Tightness, Plating

Depending on the required tightness, medium to be sealed and temperature, a different plating or coating may be selected.

For tightness better than 10^{-9} mbar.l/s a soft plating is always required. Indium and Tin are soft platings. PTFE is a soft coating too, but the obtainable tightness is limited to 10^{-6} mbar.l/s., because of the porosity of PTFE.

Silver, Gold and Copper are medium soft and require a higher load seal to obtain tightness ranges of 10^{-9} mbar.l/s. Silver is the most common used plating. Nickel plating, being the hardest plating, requires a high load seal selection.

Flange rotation or lift off

Large diameters and high temperatures play a decisive role in the selection of a metal seal. Flange rotation or lift off occurs under high pressure. The larger the flange diameter subjected to this high pressure, the more risk the bolds will be subjected to excessive stress and strain. This results in flange rotation or lift off.

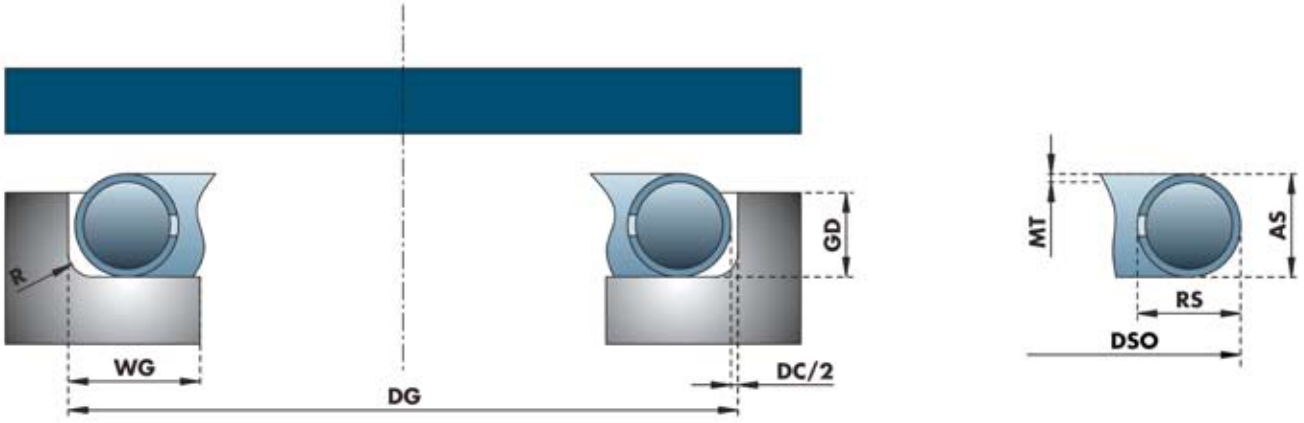
For such service conditions the biggest possible cross section for the given diameter should be selected, in order to have the best possible spring back characteristics.

Summary

- The groove surface finish for any selected seal should be equal or better then Ra = 1.8. For tightness equal or better than 10^{-9} mbar.l/s, a surface finish better than Ra = 0.8 should be applied.
- Always select the biggest possible cross section for a given diameter.
- Selected the softest plating allowed for the application.
- If bold load permits, choose the highest seal load available when medium soft plating, such as silver, gold or copper is selected.
- For temperatures above 350°C it is advised to use Inconel as base materials.
- For pressures above 35 MPa it is advised to use C-Ring type seals or vented O Rings, both with or without spring energising, depending on the required tightness.
- For high temperature applications and when an O-Ring type seal is required a gas filled seal may be the better option.

Custom built leak test

METAL O RINGS – INTERNAL PRESSURE



Seal dimension					Groove dimensions				Load	SB
AS			MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross section)	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth (min/max)	Width Groove (min.)	Radius (max.	N/mm Circum-ference	Spring Back in mm
0,89	+0,08 / -0,03	M	0,15	0,20	6,35-25	0,64-0,69	1,40	0,25	140	0,03
1,19	+0,08 / -0,03	H	0,20	0,25	10-50	0,94-1,02	1,78	0,30	100	0,03
1,57	+0,08 -0,03	L	0,15	0,28	12-200	1,14-1,27	2,29	0,38	60	0,06
		M	0,25						140	0,05
		H	0,36						200	0,04
2,39	+0,08 -0,03	L	0,15	0,33	25-200	1,88-2,01	3,18	0,51	40	0,06
		M	0,25						100	0,05
		H	0,46						200	0,04
3,18	+0,08 -0,03	M	0,25	0,43	50-400	2,54-2,67	4,06	0,76	60	0,08
		H	0,51						180	0,05
3,96	+ 0,10	M	0,41	0,61	75-650	3,18-3,30	5,08	1,27	90	0,10
		H	0,51						135	0,08
4,78	+ 0,13	M	0,51	0,71	100-800	3,84-3,99	6,35	1,27	95	0,14
		H	0,64						200	0,10
6,35	+ 0,13	M	0,64	0,76	200-1200	5,05-5,28	8,89	1,52	100	0,20
		H	0,81						250	0,15
9,53	+ 0,13	M	0,97	1,02	300-2000	8,26-8,51	12,7	1,52	150	0,25
		H	1,24						300	0,20
12,7	+ 0,15	M	1,27	1,27	800-3000	11,05-11,43	16,51	1,52	200	0,30
		H	1,65						350	0,20

Load and spring back figures are based on Inconel X-750 in the age hardened condition. 321 stainless steel will only generate $^{1}/_{3}$ of the given Inconel figures. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the larger cross section.

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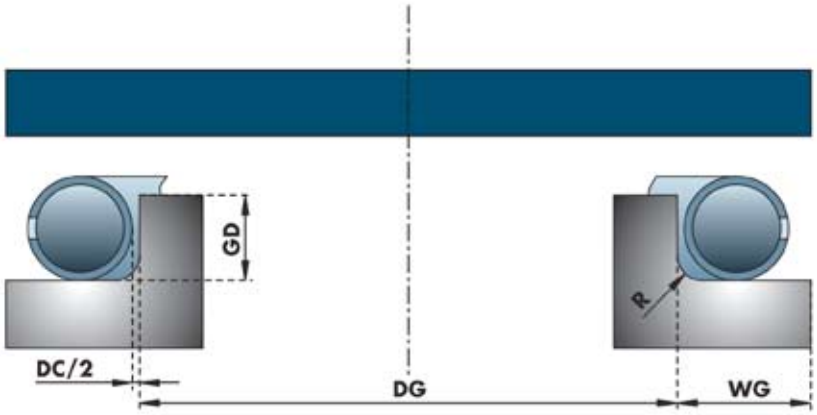
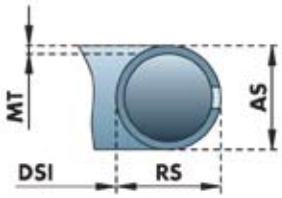
METAL O RINGS – EXTERNAL PRESSURE

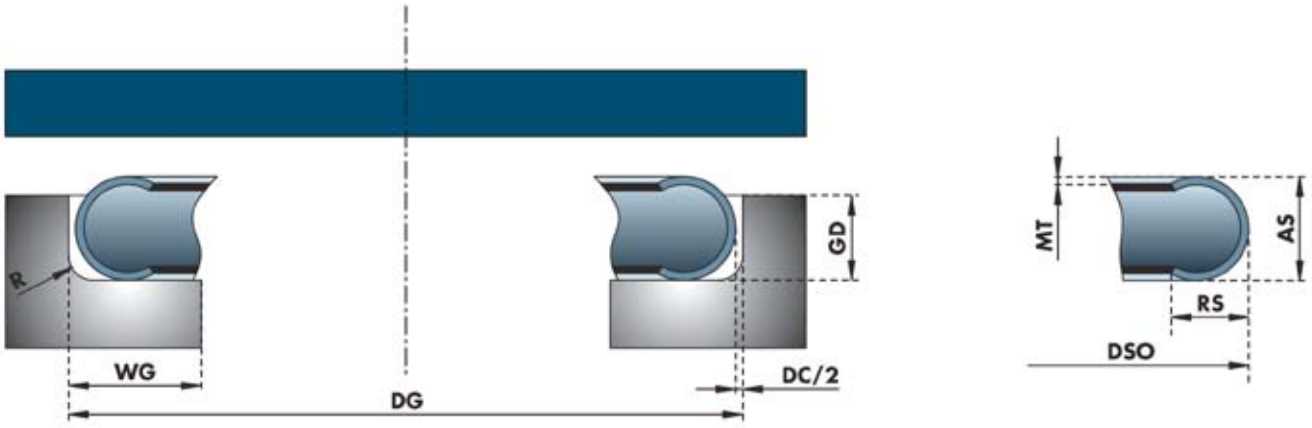




Seal dimension					Groove dimensions				Load	SB
AS			MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross section)	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth (min/max)	Width Groove (min.)	Radius (max.	N/mm Circum-ference	Spring Back in mm
0,89	+0,08 / -0,03	M	0,15	0,20	6,35-25	0,64-0,69	1,40	0,25	140	0,03
1,19	+0,08 / -0,03	H	0,20	0,25	10-50	0,94-1,02	1,78	0,30	100	0,03
1,57	+0,08 -0,03	L	0,15	0,28	12-200	1,14-1,27	2,29	0,38	60	0,06
		M	0,25						140	0,05
		H	0,36						200	0,04
2,39	+0,08 -0,03	L	0,15	0,33	25-200	1,88-2,01	3,18	0,51	40	0,06
		M	0,25						100	0,05
		H	0,46						200	0,04
3,18	+0,08 -0,03	M	0,25	0,43	50-400	2,54-2,67	4,06	0,76	60	0,08
		H	0,51						180	0,05
3,96	+ 0,10	M	0,41	0,61	75-650	3,18-3,30	5,08	1,27	90	0,10
		H	0,51						135	0,08
4,78	+ 0,13	M	0,51	0,71	100-800	3,84-3,99	6,35	1,27	95	0,14
		H	0,64						200	0,10
6,35	+ 0,13	M	0,64	0,76	200-1200	5,05-5,28	8,89	1,52	100	0,20
		H	0,81						250	0,15
9,53	+ 0,13	M	0,97	1,02	300-2000	8,26-8,51	12,7	1,52	150	0,25
		H	1,24						300	0,20
12,7	+ 0,15	M	1,27	1,27	800-3000	11,05-11,43	16,51	1,52	200	0,30
		H	1,65						350	0,20

Load and spring back figures are based on Inconel X-750 in the age hardened condition. 321 stainless steel will only generate $^{1}/_{3}$ of the given Inconel figures. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

METAL C RINGS – INTERNAL PRESSURE



Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross section)	Radial section	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth	Width Groove min.	Radius max.	N/mm Circum-ference*	Spring Back in mm
0,79	+/-0,05	0,71	M	0,12	0,05	6 - 25	0,64-0,69	1,02	0,25	30	0,04
			H	0,18						50	0,03
1,19	+/-0,05	0,96	M	0,12	0,07	8 - 50	0,94-1,02	1,40	0,30	20	0,05
			H	0,20						35	0,04
1,57	+/-0,05	1,26	M	0,15	0,10	10-200	1,27-1,37	1,91	0,38	10	0,08
			H	0,25						40	0,06
2,39	+/-0,05	1,91	M	0,25	0,15	13-400	1,91-2,01	2,67	0,51	35	0,10
			H	0,38						65	0,08
2,79	+/-0,05	2,25	M	0,25	0,15	20-500	2.23-2,31	3,10	0,55	30	0,12
3,18	+/-0,08	2,54	M	0,38	0,20	30-600	2,54-2,67	3,43	0,76	45	0,15
			H	0,51						100	0,13
3,96	+/-0,08	3,17	M	0,41	0,25	45-750	3,18-3,30	4,32	1,27	40	0,20
			H	0,61						110	0,17
4,78	+/-0,10	3,82	M	0,51	0,30	75-900	3,84-3,99	5,08	1,27	65	0,22
			H	0,76						150	0,18
5,60	+/-0,10	4,50	M	0,51	0,30	75-1000	4,48-4,65	5,90	1,27	55	0,22
6,35	+/-0,10	5,08	M	0,64	0,40	100-1200	5,08-5,28	6,60	1,52	75	0,30
			H	0,97						160	0,27
7,90	+/-0,10	6,32	M	0,64	0,50	100-1500	6,32-6,58	8,22	1,52	65	0,30
9,53	+/-0,10	7,62	M	0,97	0,60	300-2000	7,62-8,03	9,65	1,52	120	0,40
			H	1,27						250	0,32
12,70	+/-0,13	10,16	M	1,27	0,80	600-3000	10,16-10,67	12,70	1,52	150	0,55
			H	1,65						250	0,48

Load and spring back figures are based on Inconel X-750 in the age hardened condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

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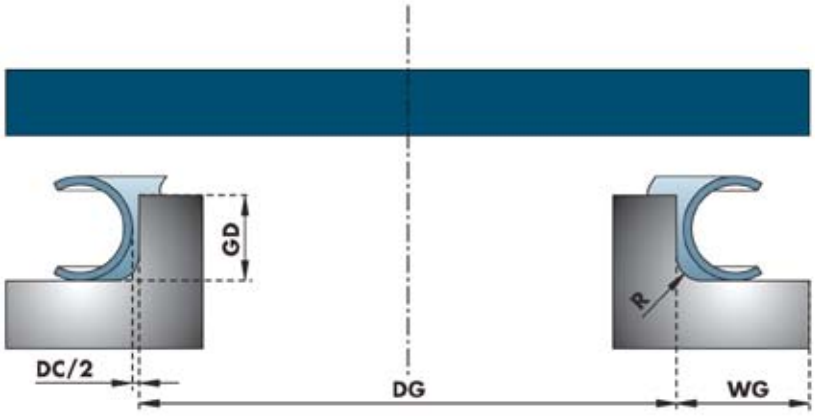
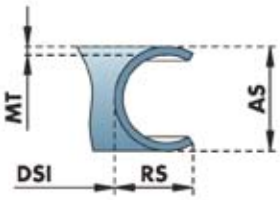
METAL C RINGS – EXTERNAL PRESSURE

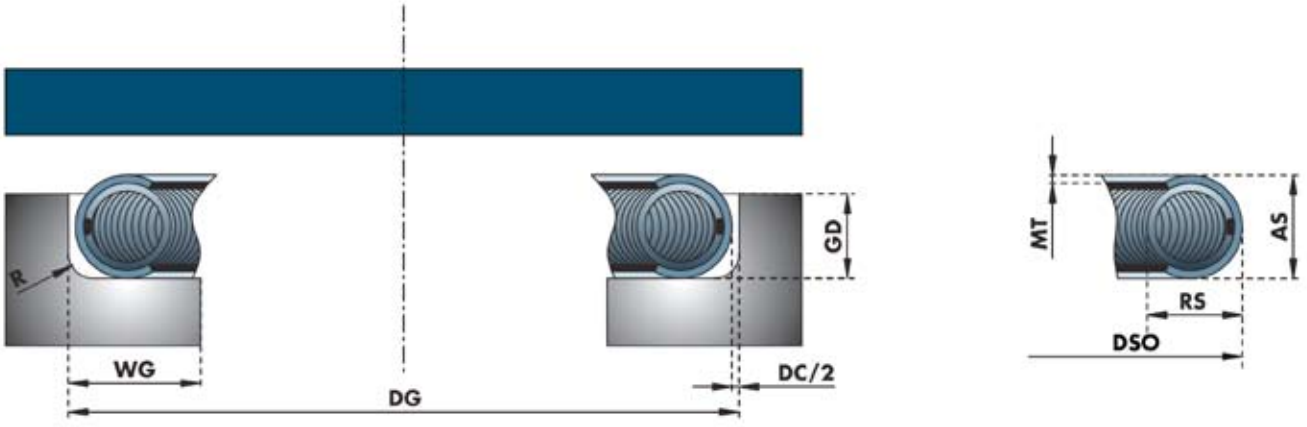




Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross section)	Radial section	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth	Width Groove min.	Radius max.	N/mm Circum-ference*	Spring Back in mm
0,79	+/-0,05	0,71	M	0,12	0,05	6 - 25	0,64-0,69	1,02	0,25	30	0,04
			H	0,18						50	0,03
1,19	+/-0,05	0,96	M	0,12	0,07	8 - 50	0,94-1,02	1,40	0,30	20	0,05
			H	0,20						35	0,04
1,57	+/-0,05	1,26	M	0,15	0,10	10-200	1,27-1,37	1,91	0,38	10	0,08
			H	0,25						40	0,06
2,39	+/-0,05	1,91	M	0,25	0,15	13-400	1,91-2,01	2,67	0,51	35	0,10
			H	0,38						65	0,08
2,79	+/-0,05	2,25	M	0,25	0,15	20-500	2.23-2,31	3,10	0,55	30	0,12
3,18	+/-0,08	2,54	M	0,38	0,20	30-600	2,54-2,67	3,43	0,76	45	0,15
			H	0,51						100	0,13
3,96	+/-0,08	3,17	M	0,41	0,25	45-750	3,18-3,30	4,32	1,27	40	0,20
			H	0,61						110	0,17
4,78	+/-0,10	3,82	M	0,51	0,30	75-900	3,84-3,99	5,08	1,27	65	0,22
			H	0,76						150	0,18
5,60	+/-0,10	4,50	M	0,51	0,30	75-1000	4,48-4,65	5,90	1,27	55	0,22
6,35	+/-0,10	5,08	M	0,64	0,40	100-1200	5,08-5,28	6,60	1,52	75	0,30
			H	0,97						160	0,27
7,90	+/-0,10	6,32	M	0,64	0,50	100-1500	6,32-6,58	8,22	1,52	65	0,30
9,53	+/-0,10	7,62	M	0,97	0,60	300-2000	7,62-8,03	9,65	1,52	120	0,40
			H	1,27						250	0,32
12,70	+/-0,13	10,16	M	1,27	0,80	600-3000	10,16-10,67	12,70	1,52	150	0,55
			H	1,65						250	0,48

Load and spring back figures are based on Inconel X-750 in the age hardened condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

METAL CS RINGS – INTERNAL PRESSURE, SPRING ENERGISED



Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R	M-Spring	
Axial section	Tolerance on AS (cross section)	Radial section	Material code Spring Load	Material thickness Jacket	Diame-trical clearance	Diameter Groove (range) ***	Groove Depth Min. Max.	Width Groove (min)	Radius (max)	N/mm Circum-ference ***	Spring Back in mm
1,57	+/-0,05	1,52	M/H	0,15	0,15	20-280	1,27-1,32	2,05	0,35	200	0,10
2,00	+/-0,05	1,85	M/H	0,25	0,20	20-300	1,60-1,68	2,50	0,40	180	0,12
2,39	+/-0,05	2,24	M/H	0,25	0,20	25-400	1,91-2,01	3,10	0,50	160	0,15
2,79	+/-0,05	2,64	M/H	0,25	0,25	25-500	2,23-2,34	3,60	0,50	200	0,18
3,18	+/-0,08	2,90	M/H	0,38	0,30	25-600	2,54-2,67	4,10	0,75	160	0,20
3,96	+/-0,08	3,60	M/H	0,41	0,41	32-750	3,18-3,30	5,10	1,20	210	0,25
4,78	+/-0,10	4,49	M/H	0,51	0,46	75-900	3,84-3,99	6,20	1,20	250	0,28
5,60	+/-0,10	5,19	M/H	0,51	0,48	75-1000	4,48-4,70	7,30	1,20	200	0,30
6,35	+/-0,10	5,81	M/H	0,64	0,51	100-1800	5,08-5,28	8,30	1,50	340	0,36
7,90	+/-0,10	7,25	M/H	0,64	0,70	150-3000	6,32-6,58	10,40	1,50	300	0,40
9,53	+/-0,10	8,66	M/H	0,97	0,75	300-3000	7,62-8,03	12,40	1,50	430	0,43
12,70	+/-0,13	11,53	M/H	1,27	1,00	600-7600	10,16-10,67	16,50	1,50	500	0,56

Load and spring back figures are based on Inconel jacket and spring. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

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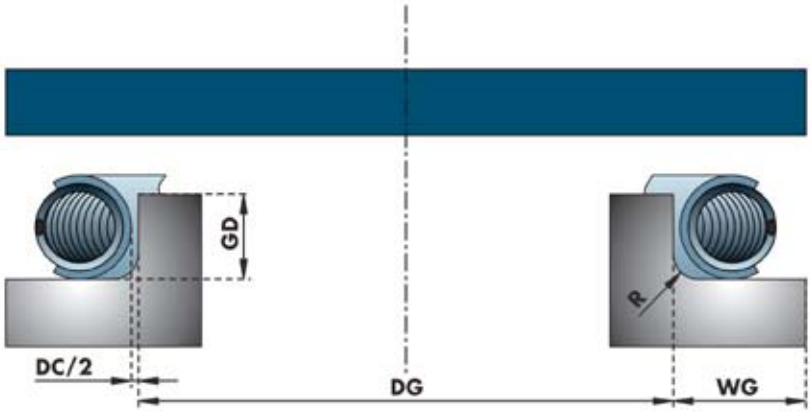
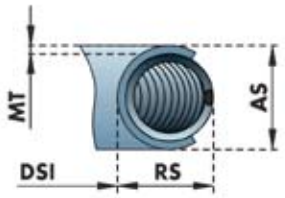
METAL CS RINGS – EXTERNAL PRESSURE, SPRING ENERGISED

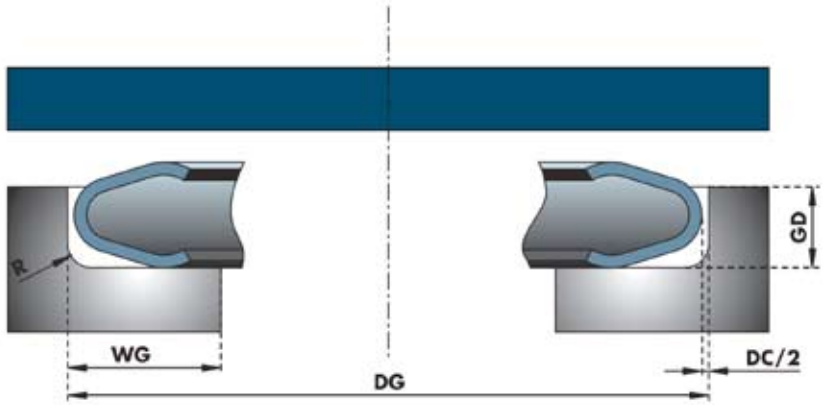


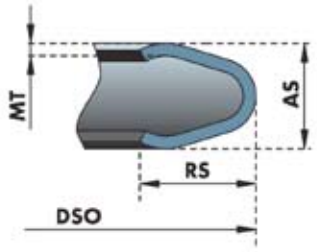


Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R	M-Spring	
Axial section	Tolerance on AS (cross section)	Radial section	Material code Spring Load	Material thickness Jacket	Diame-trical clearance	Diameter Groove (range) ***	Groove Depth Min. Max.	Width Groove (min)	Radius (max)	N/mm Circum-ference ***	Spring Back in mm
1,57	+/-0,05	1,52	M/H	0,15	0,15	20-280	1,27-1,32	2,05	0,35	200	0,10
2,00	+/-0,05	1,85	M/H	0,25	0,20	20-300	1,60-1,68	2,50	0,40	180	0,12
2,39	+/-0,05	2,24	M/H	0,25	0,20	25-400	1,91-2,01	3,10	0,50	160	0,15
2,79	+/-0,05	2,64	M/H	0,25	0,25	25-500	2,23-2,34	3,60	0,50	200	0,18
3,18	+/-0,08	2,90	M/H	0,38	0,30	25-600	2,54-2,67	4,10	0,75	160	0,20
3,96	+/-0,08	3,60	M/H	0,41	0,41	32-750	3,18-3,30	5,10	1,20	210	0,25
4,78	+/-0,10	4,49	M/H	0,51	0,46	75-900	3,84-3,99	6,20	1,20	250	0,28
5,60	+/-0,10	5,19	M/H	0,51	0,48	75-1000	4,48-4,70	7,30	1,20	200	0,30
6,35	+/-0,10	5,81	M/H	0,64	0,51	100-1800	5,08-5,28	8,30	1,50	340	0,36
7,90	+/-0,10	7,25	M/H	0,64	0,70	150-3000	6,32-6,58	10,40	1,50	300	0,40
9,53	+/-0,10	8,66	M/H	0,97	0,75	300-3000	7,62-8,03	12,40	1,50	430	0,43
12,70	+/-0,13	11,53	M/H	1,27	1,00	600-7600	10,16-10,67	16,50	1,50	500	0,56

Load and spring back figures are based on Inconel Jacket and spring. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

V-RING – INTERNAL PRESSURE





Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross	Radial section	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth Min. Max.	Width Groove (min)	Radius (max)	N/mm Circum-ference***	Spring Back in mm
2,39	+/-0,05	2,63	M	0,25	0,14	50-400	1,91-2,01	3,10	0,50	12	0,38
3,18	+/-0,08	3,50	M	0,38	0,19	65-600	2,54-2,67	4,10	0,75	9	0,51
3,96	+/-0,08	4,36	M	0,41	0,24	75-750	3,18-3,30	5,10	1,20	11	0,63
4,78	+/-0,10	5,26	M	0,51	0,29	90-900	3,84-3,99	6,20	1,20	11	0,76
5,60	+/-0,10	6,16	M	0,51	0,34	105-1000	4,48-4,70	7,30	1,20	8	0,90
6,35	+/-0,10	6,99	M	0,64	0,38	150-1800	5,08-5,28	8,30	1,50	13	1,02
9,53	+/-0,10	10,49	M	0,97	0,57	300-3000	7,62-8,03	12,40	1,50	15	1,52
12,70	+/-0,13	13,98	M	1,27	0,76	600-7600	10,16-10,67	16,50	1,50	20	2,03

Load and spring back figures are based on Inconel 718 in the heat treated condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

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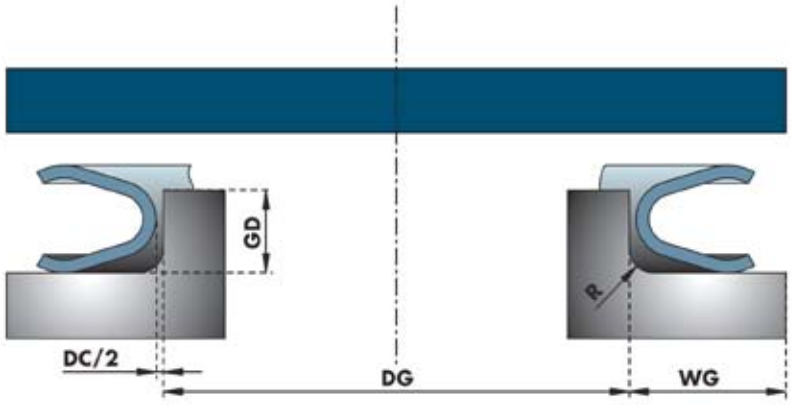
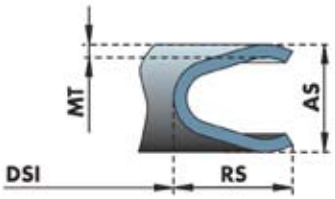
V-RING – EXTERNAL PRESSURE

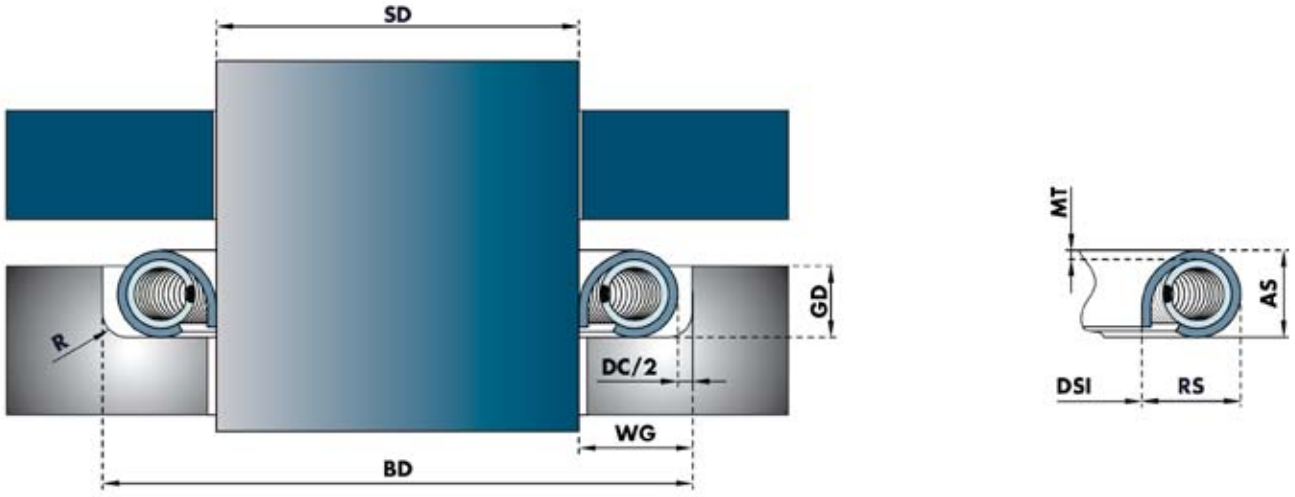




Seal dimension						Groove dimensions				Load	SB
AS		RS		MT	DC	DG	GD	WG	R		
Axial section	Tolerance on AS (cross	Radial section	Material code	Material thickness	Diame-trical clearance	Diameter Groove (range)	Groove Depth Min. Max.	Width Groove (min)	Radius (max)	N/mm Circum-ference***	Spring Back in mm
2,39	+/-0,05	2,63	M	0,25	0,14	30-400	1,91-2,01	3,10	0,50	12	0,38
3,18	+/-0,08	3,50	M	0,30	0,19	45-600	2,54-2,67	4,10	0,75	9	0,51
3,96	+/-0,08	4,36	M	0,41	0,24	65-750	3,18-3,30	5,10	1,20	11	0,63
4,78	+/-0,10	5,26	M	0,51	0,29	70-900	3,84-3,99	6,20	1,20	11	0,76
5,60	+/-0,10	6,16	M	0,51	0,34	80-1000	4,48-4,70	7,30	1,20	8	0,90
6,35	+/-0,10	6,99	M	0,64	0,38	120-1800	5,08-5,28	8,30	1,50	13	1,02
9,53	+/-0,10	10,49	M	0,97	0,57	300-3000	7,62-8,03	12,40	1,50	15	1,52
12,70	+/-0,13	13,98	M	1,27	0,76	600-7600	10,16-10,67	16,50	1,50	20	2,03

Load and spring back figures are based on Inconel 718 in the heat treated condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

COMMASEAL® – AXIAL PRESSURE



Seal dimension						Groove dimensions					Load
AS		RS		MT	DC	SD range	BD	Tol. SD	GD	R	Rad.
Axial section	Tolerance on AS (cross section)	Radial section	Material code	Material thickness	Diame-trical clearance	Shaft Diameter (range) ***	SD +	+0	Groove Depth Min. Max.	Radius (max)	N/mm Circum-ference ***
2,39	+/-0,05	2,73	M	0,25	0,42	35-200	5,88	-0,03	1,91-2,01	0,50	70
3,18	+/-0,08	3,63	M	0,38	0,55	45-200	7,81	-0,03	2,54-2,67	0,75	100
3,96	+/-0,08	4,52	M	0,41	0,67	60-200	9,71	-0,05	3,18-3,30	1,20	105
4,78	+/-0,10	5,46	M	0,51	0,79	100-200	11,71	-0,05	3,84-3,99	1,20	130

Load and spring back figures are based on Inconel 718 in the heat treated condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

Tightness

The tightness with a Commaseal® is more than with any other metal seal a function of the shaft condition. The surface finish of the shaft shall be mirror polished and the hardness shall be high enough so that the sliding motion of seal and shaft does not deteriorate either of them.
In addition we advise to silver plate Commaseal® for better tightness, reduced friction and wear.

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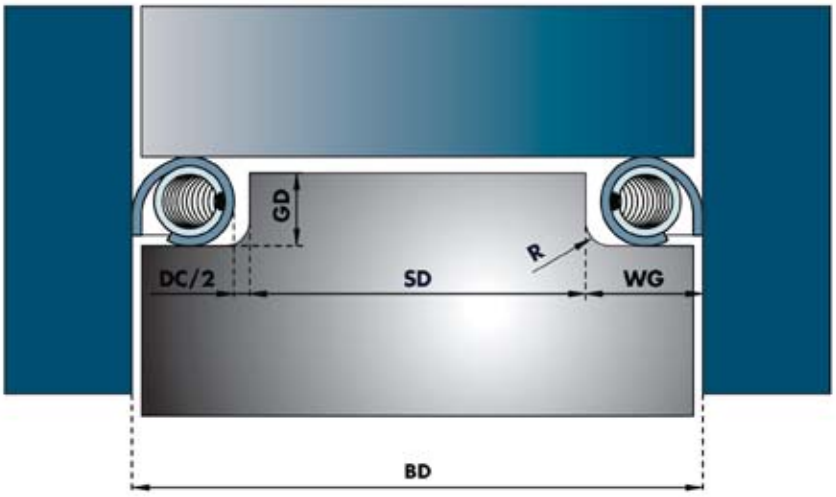
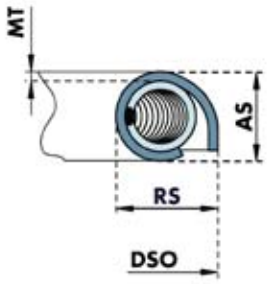
COMMASEAL® – AXIAL PRESSURE





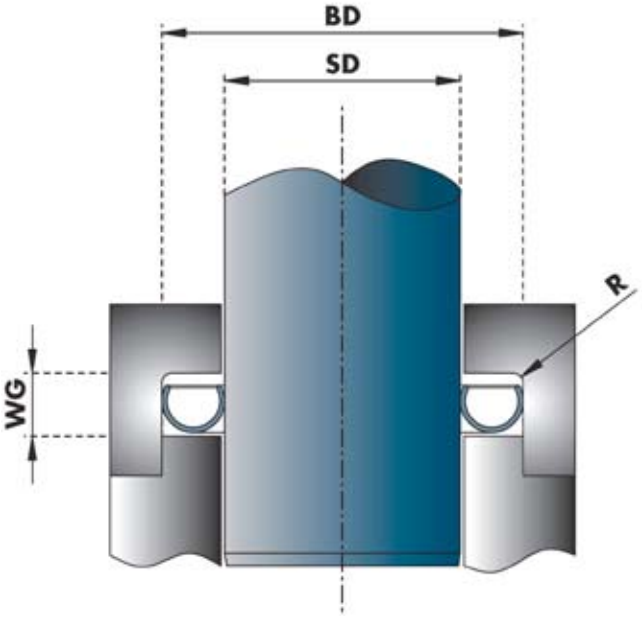
Seal dimension						Groove dimensions					Load
AS		RS		MT	DC	SD range	SD	Tol. SD	GD	R	Rad.
Axial section	Tolerance on AS (cross section)	Radial section	Material code	Material thickness	Diame-trical clearance	Shaft Diameter (range) ***	BD **minus**	-0	Groove Depth Min. Max.	Radius (max)	N/mm Circum-ference ***
2,39	+/-0,05	2,73	M	0,25	0,42	35-200	5,88	+0,03	1,91-2,01	0,50	70
3,18	+/-0,08	3,63	M	0,38	0,55	45-200	7,81	+0,03	2,54-2,67	0,75	100
3,96	+/-0,08	4,52	M	0,41	0,67	60-200	9,71	+0,05	3,18-3,30	1,20	105
4,78	+/-0,10	5,46	M	0,51	0,79	100-200	11,71	+0,05	3,84-3,99	1,20	130

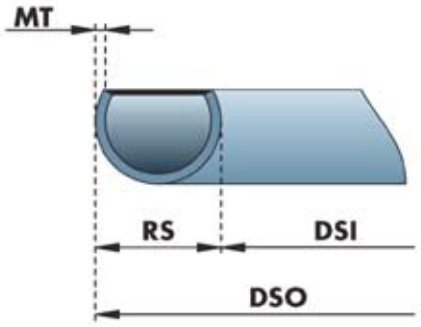
Load and spring back figures are based on Inconel 718 in the heat treated condition. Actual load figures and to a lesser extent spring back can differ hugely from the given data. Tolerances on groove depth, plating, diametrical clearance and differences in material batches can create differences of up to 100% for the smaller cross sections, down to 50% for the bigger cross section.

Tightness

The tightness with a Commaseal® is more than with any other metal seal a function of the bore condition.
The surface finish of the bore shall be mirror polished and the hardness shall be high enough so that the sliding motion of seal versus the bore does not deteriorate either of them.
In addition we advise to silver plate Commaseal® for better tightness, reduced friction and wear.

METAL C-RINGS – AXIAL PRESSURE





Range	Groove Dimensions					Seal dimension					
BD		SD		WG	R	RS		MT	DSO		
Bore Diameter range	Tol. on BD +	Shaft Dia. = BD-	Tol. on SD -	Groove Width (min)	Radius (max)	Radial section Code	Mat. code	Material thickness	Bore +	Shaft +	Tol. DSO and DSI
12,70-38	0,03	3,12	0,03	1,3	0,38	1,57	M	0,15	0,08	3,28	+/-0,03
38,01-45	0,03	3,07	0,03	1,3	0,38	1,57	M	0,15	0,10	3,28	+/-0,03
30,00-38	0,03	4,7	0,03	1,98	0,51	2,39	M	0,25	0,08	4,85	+/-0,03
38,01-85	0,03	4,65	0,03	1,98	0,51	2,39	M	0,25	0,10	4,85	+/-0,03
50,00-85	0,03	6,25	0,03	2,64	0,76	3,18	M	0,38	0,10	6,45	+/-0,03
85,01-150	0,05	6,16	0,05	2,64	0,76	3,18	M	0,38	0,15	6,45	+/-0,05
150,01-200	0,05	6,05	0,05	2,64	0,76	3,18	M	0,38	0,20	6,45	+/-0,05
85,00-150	0,05	7,72	0,05	3,28	1,27	3,96	M	0,38	0,15	8,03	+/-0,05
150,01-250	0,05	7,62	0,05	3,28	1,27	3,96	M	0,41	0,20	8,03	+/-0,05
100,00-150	0,05	9,32	0,05	3,96	1,27	4,78	M	0,51	0,15	9,63	+/-0,05
150,01-300	0,05	9,22	0,05	3,96	1,27	4,78	M	0,51	0,20	9,63	+/-0,05
150,00-300	0,05	12,4	0,05	5,28	1,52	6,35	M	0,64	0,20	12,8	+/-0,05

Bore/Shaft concentricity: for bores < 85 mm; 0.015 mm. For bores >85 mm; 0.03 mm.
Leading edge, shaft and bore size required.

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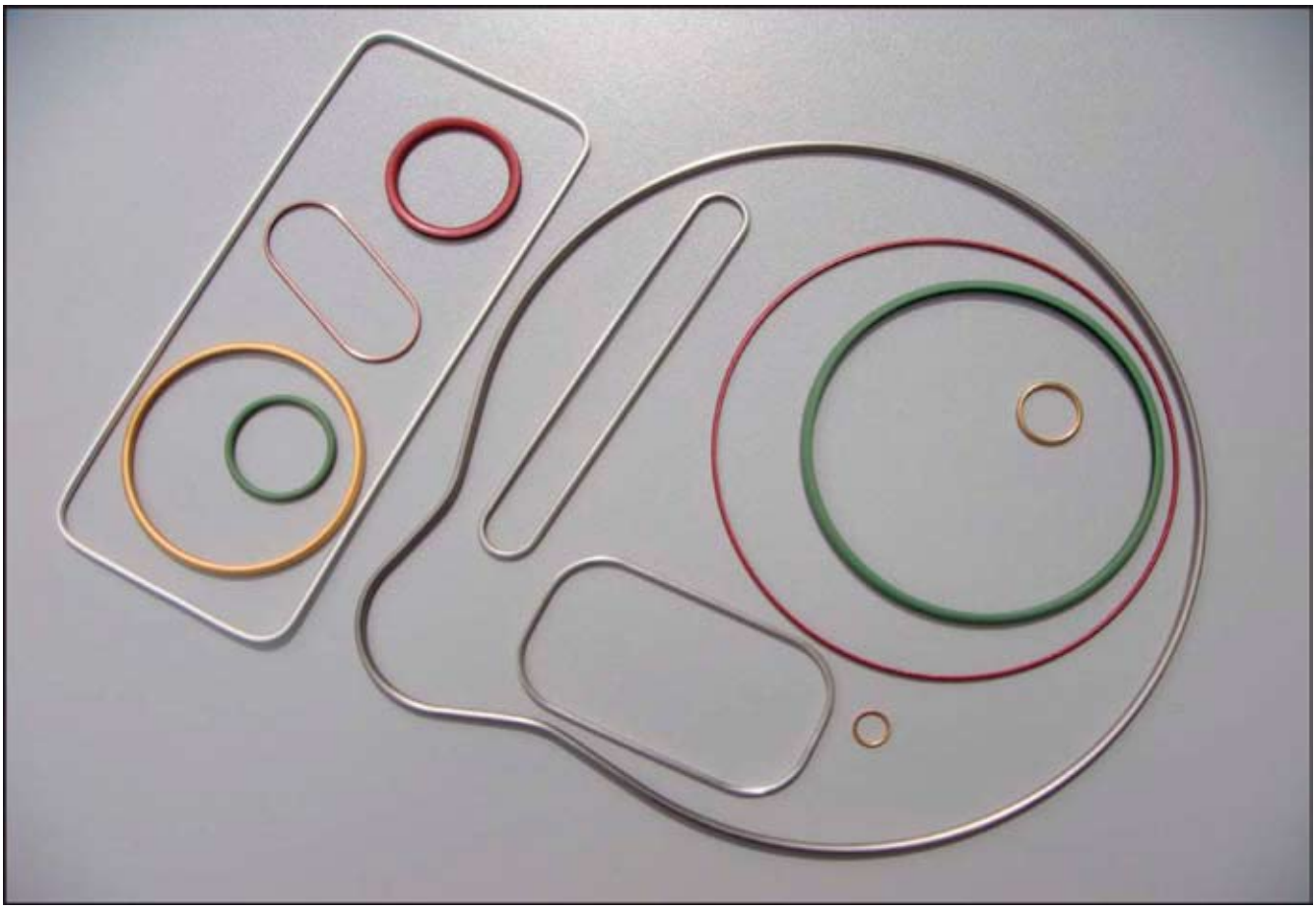
SHAPED SEALS

Non Circular seals or so called shaped seals can be manufactured in O-Ring, C-Ring and spring energised C-Ring types and from cross section 0.89 to 12.7 mm.
The picture below shows a number of examples used in the industry.

The minimum radius for each of the metal Ring types is given in the table below.
More than for other Metal Seals, TFC asks you to complete an application checklist and to provide a sketch or a drawing.

Minimum Radii in mm for shaped Seals

Free Height mm	0,89	1,57	2,39	3,18	3,96	4,78	6,35	9,53	12,7
Metal O Ring	5	10	15	25	50	75	100	200	300
Metal O Spring Ring			15	25	50	75	100	200	300
Metal C Ring	5	7	12	15	25	50	75	200	250
Metal C Spring Ring			12	15	25	50	75	200	250



TOLERANCES

The actual seal diameter shall be as close as possible to the groove diameter.
By compressing the seal in the groove, the seal outside diameter for internal pressure seals will try to grow and the seal inside diameter for external pressure will try to shrink.

This phenomenon is covered by the DC or diametrical clearance. The DC will give allowance for this increase or decrease of the seal diameter.

The seal tolerance and also groove tolerance shall be kept as small as possible. It is better for the seal performance to keep the DC in compressed condition as small as possible.

Ideally, once compressed the seal outer diameter should slightly touch the groove outer diameter or for an external pressure seal the inner seal diameter should slightly touch the groove ID.

Internal Pressure			
Groove OD Tolerance			
Type ------ Cross Section	O Ring	C Ring & V Ring	CS Ring
0,79	+ 0.05	+ 0.05	------
0,89	+ 0.10	+ 0.05	------
1,19	+ 0.10	+ 0.08	------
1,57	+ 0.10	+ 0.08	+ 0.10
2,39	+ 0.15	+ 0.10	+ 0.10
3,18	+ 0.15	+ 0.10	+ 0.13
3,96	+ 0.15	+ 0.13	+ 0.15
4,78	+ 0.20	+ 0.15	+ 0.15
6,35	+ 0.20	+ 0.20	+ 0.20
7,9	+0.20	+ 0.20	+ 0.20
9,53	+ 0.25	+ 0.25	+ 0.25
12,7	+ 0.25	+ 0.25	+ 0.25

External Pressure			
Groove ID Tolerance			
Type ------ Cross Section	O Ring	C Ring & V Ring	CS Ring
0,79	- 0.05	- 0.05	------
0,89	- 0.10	- 0.05	------
1,19	- 0.10	- 0.08	------
1,57	- 0.10	- 0.08	- 0.10
2,39	- 0.15	- 0.10	- 0.10
3,18	- 0.15	- 0.10	- 0.13
3,96	- 0.15	- 0.13	- 0.15
4,78	- 0.20	- 0.15	- 0.15
6,35	- 0.20	- 0.20	- 0.20
7,9	- 0.20	- 0.20	- 0.20
9,53	- 0.25	- 0.25	- 0.25
12,7	- 0.25	- 0.25	- 0.25

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PERFORMANCE SEALING SOLUTIONS

application checklist

Please complete and send to:
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Email: design @tfc.eu.com

General Information : Company : Address : City : Country :	Contact Name : Title : Phone : Fax : E-mail :
Product environment : Application : Fluid Medium : Temperature range: Pressure range:	Clamping/closing load : Surface finish : Flange Materials : Flange Hardness : Allowable leakrate :
Groove dimensions : Groove depth (GD) : Groove width (GW) : Groove OD (DG) for internal pressure : Groove ID (DG) for external pressure :	**Usage** Annual Requirement: Prototype quantity: Approx. timescale/requirement dates:

Sketch of application:

Additional Notes:

OTHER TFC SEALING PRODUCTS

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PTFE ROTARY SHAFT SEALS:

PTFE lip seals bridge the gap between current technologies for both gas and liquid sealing applications. In many applications PTFE Rotary Shaft Seals can remove the need to change to bulky, multi-component mechanical face seals. Our PTFE Rotary Shaft Seals offer impressive operating characteristics. They can run at speeds of 30 metres/second and cope with pressures up to 35bar and temperatures from –20°C to +250°C. They are resistant to chemical attack, have low friction characteristics and are designed to ensure long seal life even in conditions of no lubrication or when used with abrasive media.

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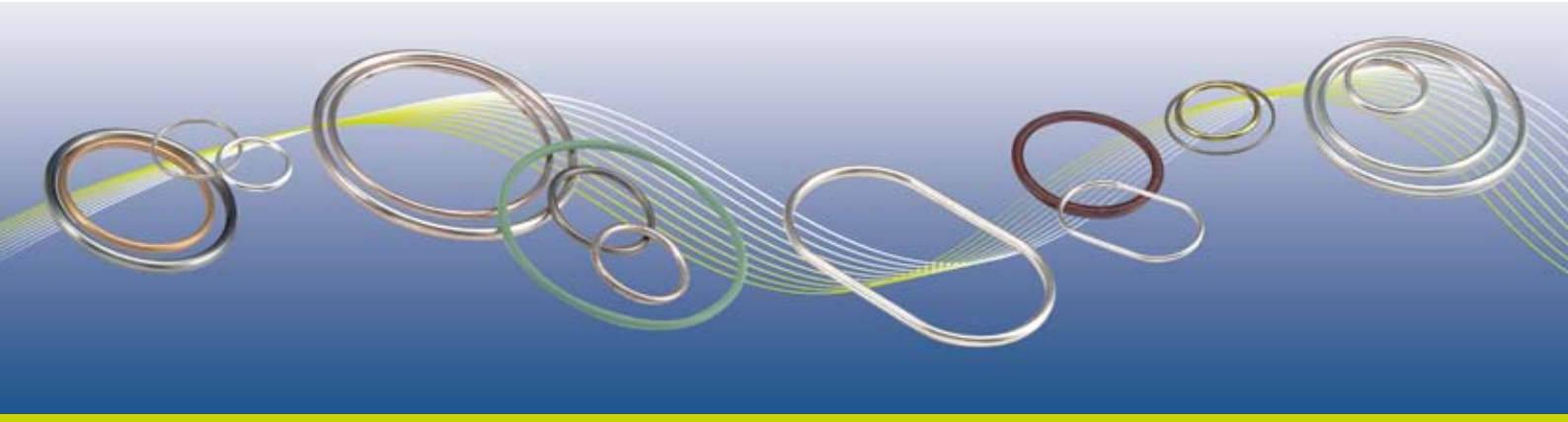

brings it together

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