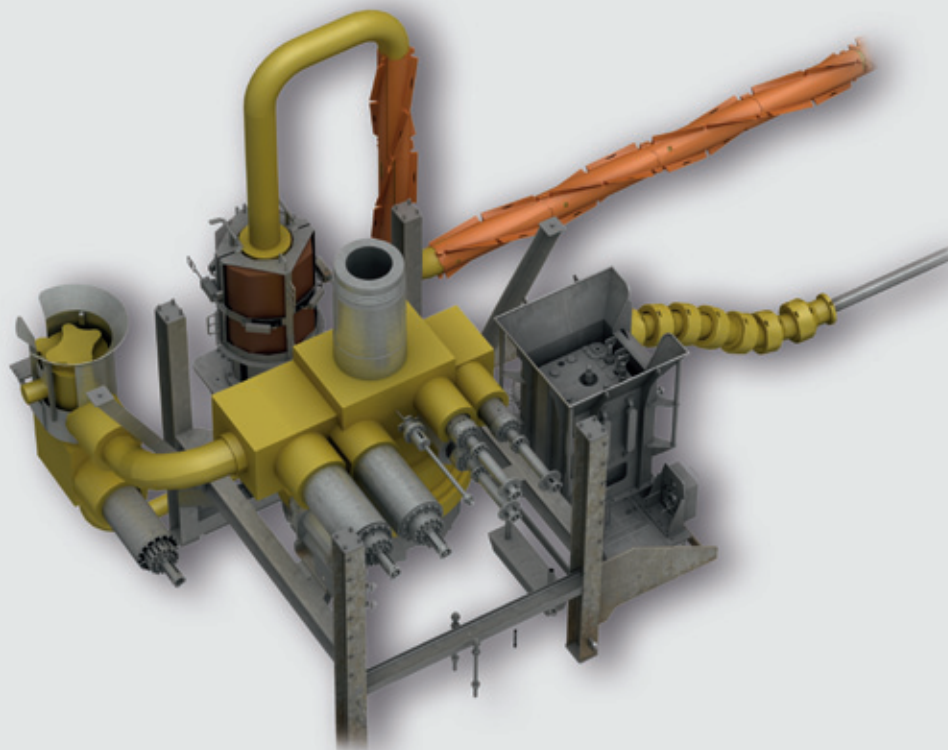


Oil & Gas Sealing Systems

Product Catalog & Engineering Guide





Your Partner for Sealing Technology

Trelleborg Sealing Solutions is a major international sealing force, uniquely placed to offer dedicated design and development from our market-leading product and material portfolio: a one-stop-shop providing the best in elastomer, thermoplastic, PTFE and composite technologies for applications in aerospace, industrial and automotive industries.

With 50 years of experience, Trelleborg Sealing Solutions engineers support customers with design, prototyping, production, test and installation using state-of-the-art design tools. An international network of over 70 facilities worldwide includes over 20 manufacturing sites, strategically-positioned research and development centers, including materials and development laboratories and locations specializing in design and applications.

Developing and formulating materials in-house, we utilize the resource of our material database, including over 2,000 proprietary compounds and a range of unique products.

Trelleborg Sealing Solutions fulfills challenging service requirements, supplying standard parts in volume or a single custom-manufactured component, through our integrated logistical support, which effectively delivers over 40,000 sealing products to customers worldwide.

Facilities are certified to ISO 9001:2008 and ISO/TS 16949:2009. Trelleborg Sealing Solutions is backed by the experiences and resources of one of the world's foremost experts in polymer technology: the Trelleborg Group.

ISO 9001:2008

ISO/TS 16949:2009

The information in this brochure is intended to be for general reference purposes only and is not intended to be a specific recommendation for any individual application. The application limits for pressure, temperature, speed and media given are maximum values determined in laboratory conditions. In application, due to the interaction of operating parameters, maximum values may not be achieved. It is vital therefore, that customers satisfy themselves as to the suitability of product and material for each of their individual applications. Any reliance on information is therefore at the user's own risk. In no event will Trelleborg Sealing Solutions be liable for any loss, damage, claim or expense directly or indirectly arising or resulting from the use of any information provided in this brochure. While every effort is made to ensure the accuracy of information contained herewith, Trelleborg Sealing Solutions cannot warrant the accuracy or completeness of information.

To obtain the best recommendation for a specific application, please contact your local Trelleborg Sealing Solutions marketing company.

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Oil & Gas Engineering Guide

■ Sealing Solutions for Demanding Oil & Gas Applications

Trelleborg Sealing Solutions is a leading player globally in the supply of oil & gas sealing solutions. With over 45 years of experience in the industry, we can provide a high performance sealing solution for nearly all applications. The materials and products included in this engineering guide can be fitted on anything from

downhole drilling motors to oil platform tensioner systems, from subsea valves to refinery separation equipment. Seals from Trelleborg Sealing Solutions provide proven performance in a wide variety of systems used in exploration, refining, production or completion activities.

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Oil & Gas Engineering Guide

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Trelleborg Sealing Solutions has the largest sealing product portfolio in the industry. With this and our engineered solutions, we can meet almost any sealing challenge. Included in this catalog are seals specifically recommended for oil & gas applications.

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■ What Trelleborg Sealing Solutions offers you

Unrivalled experience

Trelleborg Sealing Solutions has been involved in sealing oil & gas applications since the 1960s. Based on unrivalled experience the company has developed an outstanding range of sealing materials and products. Most of these are proprietary and specifically engineered to meet severe conditions faced during offshore or upstream, midstream and downstream onshore production.

The technological horizon of the oil & gas industry is ever changing. As wells become deeper and processing more aggressive, the working conditions for seals and bearings become more demanding. Through significant investment in research and development, Trelleborg Sealing Solutions meets these challenges with continuous advances that are compliant with the most stringent industry standards.

Better performance

One of the primary aims of Trelleborg Sealing Solutions is to make the job of the oil & gas engineer easier. By working with us, we can accelerate time to market, improve the efficiency of existing applications and lengthen maintenance intervals. All of which can contribute to less downtime and increased yield.

Having worked on so many major projects worldwide, we probably already know the optimum sealing solution for your application. And if we don't, Trelleborg Sealing Solutions has the engineering resources globally to provide the right solution. Using the latest Finite Element Analysis (FEA) techniques, we can rapidly go from design stage to an actual seal using knowledge from the virtual world.

Global but local

Innovation is a key to all this. Solving sealing and bearing problems using pioneering techniques, we deliver better performance and overall profitability for our customers. Operations run 24 hours a day, every day of the year. This means our global logistics network can quickly fulfill product requirements, with emergency procedures in place to minimize disruption even when there are unforeseen maintenance situations.

This engineering guide will act as a means for you to identify a sealing recommendation for your application. For the total solution you should contact your local Trelleborg Sealing Solutions marketing company. Wherever you are in the world, we speak

your language and can offer you unparalleled technical support to optimize the performance, service of life, reliability and safety of your oil & gas equipment.

www.tss.trelleborg.com/worldwide

The Trelleborg Sealing Solutions product range for oil & gas applications:

- One stop shop for the majority of the sealing and bearing needs.
- Seals from .063" / 1.2mm in size to 10.0' / 3.0m and beyond
- Seal materials specially engineered to be compatible with extremely aggressive and abrasive media and gases
- Operating temperature from cryogenic to +1,562°F/+850°C
- Withstands pressure from Ultra-high vacuum to 145,000psi / 1,000MPa
- Steam and Rapid Gas Decompression (RGD) resistant materials
- NORSOK M-710 / ISO 23936 compliant materials
- ISO 10423 Annex F compliant Materials

Quick Reference Guide

■ Quick Reference Guide to Trelleborg Sealing Solutions Basic Product Types and Materials for the Oil & Gas Industry

The Quick Reference Guide is designed to aid the oil & gas engineer in easily identifying the optimum seal type and material for their specific application, to maximize life and performance of the sealing system.

It cross references materials to product types and explores the characteristics of each of the different materials recommended for oil & gas applications.

Table 1 Basic Products and Materials by application

Area of application	Potential sealing requirements	Elastomer					Thermoplastic		Basic Product Types																	
		FKM	NBR	HNBR	Aflas®	Xplor™	Isolast®	PEEK	Turcon®	Zurcon®	O-Rings	AQ-Seal® and AQ-Seal® 5	Captive Glyd Ring®	Glyd Ring®	Roto Glyd Ring®	Roto Variseal®	Stepseal®	T-Seal	U-Cup	Variseal®	V-Stack	Wedgpak®	Custom molded	Slydring®	Excluder®	Back-up Rings
Electrical logging: Logging While Drilling (LWD) and Measurement While Drilling (MWD)	- Operate at elevated temperatures up to +572 °F / +300°C* - Withstand high pressures to 30,000 psi / 207 MPa* - Suitable for dynamic movement, linear and rotary - Resistant to corrosion and abrasion - Compact design for slim-line tools	X		X	X	X	X	X		X		X	X	X	X		X		X	X	X	X				X
Drilling and steerable tools	- High sealing capability - Resistant to abrasion and vibration - Good fluid compatibility - Low breakout and running friction	X					X		X	X		X	X	X	X					X	X					
Top drive units	- Suitable for dynamic rotary movement - Low breakout and running friction - Withstand pressure	X	X						X					X	X									X		
Reservoir sampling tools	- Operate at temperatures up to +572 °F / +300°C* - Withstand high pressures to 30,000 psi / 207 MPa* - Good abrasion resistance - Excellent media resistance	X		X	X	X	X	X	X		X		X				X			X	X					X
Subsea trees: gate/ choke valves, actuators and control modules	- Operate at temperatures from -94 °F to +392 °F / -70°C to +200 °C - Withstand high pressures to 15,000 psi / 103 MPa - Good abrasion resistance - High sealing capability - Excellent media resistance - Conforms to NORSOK standard	X		X	X	X	X	X	X	X		X	X	X			X		X		X					X

* Consult the section on materials for further details or contact your local Trelleborg Sealing Solutions marketing company.

Quick Reference Guide

Area of application	Potential sealing requirements	Elastomer					Thermoplastic			Basic Product Types																
		FKM	NBR	HNBR	Aflas®	XploR™	Isolast®	PEEK	Turcon®	Zurcon®	O-Rings	AQ-Seal® and AQ-Seal® 5	Captive Glyd Ring®	Glyd Ring®	Roto Glyd Ring®	Roto Variseal®	Stepseal®	T-Seal	U-Cup	Variseal®	V-Stack	Wedgpak®	Custom molded	Slydring®	Excluder®	Back-up Rings
Wellheads: tubing hanger seals & flow control tools	- Operate at temperatures from -50 °F to +392 °F / -45 °C to +200 °C - Withstand high pressures to 15,000 psi / 103 MPa - Low compression set - Excellent media resistance - Conforms to NORSOK standard	X		X	X	X	X	X		X		X		X			X		X	X	X	X	X			
Landing strings	- Low compression set - Excellent media resistance - Explosive Decompression Resistant - Withstand high pressure - Conforms to NORSOK standard	X		X	X	X	X	X	X		X						X		X		X					X
Blow-Out Preventers (BOPs)	- High sealing capability - Withstand high pressure - Wide operating temperature range - Explosive Decompression Resistant	X	X	X	X	X	X	X			X		X				X					X	X	X		X
Connector seals	- High sealing capability - Withstand high pressures to 30,000 psi / 207 MPa* - Extreme temperature resistance	X		X	X	X	X		X			X	X				X				X					
Risers and compensators	- Low friction - Abrasion resistant - Suitable for a splash zone cylinder environment	X	X	X				X	X			X	X			X			X		X			X	X	
FPSO swivels	- Suitable for dynamic rotary movement - Withstand high pressure - Low friction - Large diameters	X	X	X		X	X	X	X					X					X					X		X
Downhole and intervention tools	- High sealing capability - Withstand high pressure - Resistant to corrosion and abrasion	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X		X
Fishing and jar tools	- High sealing capability - Withstand high pressure - Resistant to impact and abrasion - Media resistant		X	X	X	X	X	X	X			X					X		X		X			X		X

* Consult the section on materials for further details or contact your local Trelleborg Sealing Solutions marketing company.

Quick Reference Guide

Area of application	Potential sealing requirements	Elastomer					Thermoplastic			Basic Product Types																
		FKM	NBR	HNBR	Aflas [®]	Xplor [™]	Isolast [®]	PEEK	Turcon [®]	Zurcon [®]	O-Rings	AQ-Seal [®] and AQ-Seal [®] 5	Captive Glyd Ring [®]	Glyd Ring [®]	Roto Glyd Ring [®]	Roto Variseal [®]	Stepseal [®]	T-Seal	U-Cup	Variseal [®]	V-Stack	Wedgpak [®]	Custom molded	Slydring [®]	Excluder [®]	Back-up Rings
Flow Control Equipment; Ball Valves and associated devices	• Operate at temperatures from -94 °F to +392 °F / -70 °C to +200°C • Withstand high pressures to 15,000 psi / 103 MPa • Explosive Decompression Resistance • Excellent Media Resistance • Conforms to NORSOK standard	X		X	X	X	X	X	X	X	X	X		X				X		X		X				X
Gas lifts	• High sealing capability • Withstand high and low pressure • Explosive Decompression Resistant				X		X	X				X						X		X	X	X		X		
Offshore Topside Hydraulics	• Suitable for a marine environment		X	X				X	X		X	X		X			X	X	X	X				X	X	

* Consult the section on materials for further details or contact your local Trelleborg Sealing Solutions marketing company.

Material Reference Guide

■ Material Overview

Table 2 NOR5OK M-710 Compliant Materials

Material Type	Brand Name	Material Code	Short Elastomer Code
HNBR	XploR™	H9T20	X3
FKM	XploR™	V9T20	X2
FKM	XploR™	V9T22	X4
FKM	XploR™	V9T82	X6
FFKM	XploR™	J9513	JX
FFKM	XploR™	J9523	J2
PTFE	Turcon®	T05	
PTFE	Turcon®	T07	
PTFE	Turcon®	T12	
PTFE	Turcon®	T24	
PTFE	Turcon®	T29	
PTFE	Turcon®	T42	

Material Type	Brand Name	Material Code	Short Elastomer Code
PTFE	Turcon®	T99	
PTFE	Turcon®	M12	
PTFE	TFM	Q2J	
PTFE	TFM	M02	
PEEK	Zurcon®	Z43	
PEEK	Zurcon®	Z431	
PEEK	HiMod®	550	
PEEK	HiMod®	914	
PEEK	HiMod®	921	
PEEK	HiMod®	924	
PEEK	HiMod®	960	

Table 3 API 6A / ISO 10432 Annex F Compliant Materials

Material Type	Brand Name	Material Code	Short Elastomer Code
HNBR	XploR™	H9T20	X3
FKM	XploR™	V9T22	X4
FKM	XploR™	V9T82	X6
FFKM	XploR™	J9503	J3
FFKM	XploR™	J9513	JX
FFKM	XploR™	J9523	J2
PTFE	Turcon®	T01	
PTFE	Turcon®	T07	
PTFE	Turcon®	T12	
PTFE	Turcon®	T13	
PTFE	Turcon®	T29	
PTFE	Turcon®	T42	
PTFE	Turcon®	T78	

Material Type	Brand Name	Material Code	Short Elastomer Code
PTFE	Turcon®	T99	
PTFE	Turcon®	M79	
PTFE	TFM	Q2J	
PTFE	TFM	Q1D	
PTFE	TFM	M02	
PEEK	Zurcon®	Z43	
PEEK	Zurcon®	Z431	
PEEK	HiMod®	550	
PEEK	HiMod®	914	
PEEK	HiMod®	924	
PEEK	HiMod®	959	
PEEK	HiMod®	960	
PEEK	HiMod®	Q2Q	

Table 4 API 16C Compliant Material

Material Type	Brand Name	Material Code	Short Elastomer Code
HNBR	XploR™	H9T20	X3
HNBR	XploR™	H9T80	H2
HNBR	XploR™	H9T81	H3
FKM	XploR™	V9T20	X2
FFKM	XploR™	J9513	JX
FFKM	XploR™	J9523	J2
FFKM	XploR™	J9554	JA
PTFE	Turcon®	T01	
PTFE	Turcon®	T05	
PTFE	Turcon®	T07	

Material Type	Brand Name	Material Code	Short Elastomer Code
PTFE	Turcon®	T12	
PTFE	Turcon®	T16	
PTFE	Turcon®	T29	
PTFE	Turcon®	T99	
PTFE	Turcon®	M30	
PTFE	TFM	Q2J	
PTFE	TFM	Q1D	
PEEK	HiMod®	550	
PEEK	HiMod®	960	
PEEK	HiMod®	962	

Material Reference Guide

Table 5 Elastomer Materials Short Code Description

Material Type	Brand Name	Material Code	Short Elastomer Code	Material Type	Brand Name	Material Code	Short Elastomer Code
NBR		N7T30	N7	FKM	XploR™	V9T20	X2
NBR		N8T30	N8	FKM	XploR™	V9T22	X4
NBR		N9T30	N9	FKM	XploR™	V9T82	X6
HNBR		H7T80	H7	FKM		V9T84	V4
HNBR		H8T30	H8	FKM		VCT11	VC
HNBR		H9T40	H9	FFKM	Isolast®	J9503	J3
HNBR	XploR™	H9T20	X3	FFKM	Isolast®	J9509	J9
HNBR	XploR™	H9T21	X5	FFKM	Isolast®	J8325	J8
HNBR		H9T80	H2	FFKM	Isolast®	J9513	JX
HNBR		H9T81	H3	FFKM	Isolast®	J9523	J2
FEPM		WTT90	TC	FFKM	Isolast®	J9554	JA

Table 6 Material Comparison - Elastomers

ELASTOMERS	NBR	HNBR	FKM	FEPM	Isolast® FFKM
Definition	Nitrile Butadiene Rubber	Hydrogenated Nitrile Butadiene Rubber	Fluoroelastomer	Copolymer of Tetrafluoroethylene and propylene	Proprietary Perfluoroelastomer
Media compatibility*	Mineral-based oils & greases	Improved resistance over NBR.	Improved resistance over HNBR.	Amines	Very good with virtually all oilfield media
Temperature - lowest	-76 °F / -60 °C	-40 °F / -40 °C	-60 °F / -51 °C	+5 °F / -15 °C	-13 °F / -25 °C
Temperature - highest	+248 °F / +120 °C	+320 °F / +160 °C	+437 °F / +225 °C	+419 °F / +215 °C	+617 °F / +325 °C
Hardness - lowest Standard	70 Shore	70 Shore	75 Shore	70 Shore	75 Shore
Hardness - highest Standard	95 Shore	95 Shore	95 Shore	95 Shore	95 Shore
Rapid Gas Decompression Resistant	No	Specific compounds	Specific compounds	Specific compounds	Specific compounds
NORSOK Compliant	No	Specific compounds	Specific compounds	Partial Compliance (RGD Only)	Specific compounds
Shelf life limitation	7 years	7 years	10 years	10 years	Unlimited
Aging	Good	Good	Excellent	Excellent	Excellent
Ozone resistance	Average	Good	Excellent	Excellent	Excellent

* For detail detailed data on compatibility refer to the Trelleborg Sealing Solutions O-Ring brochure.

Colored boxes indicate preferred material/product combination. Other material options are available upon request. Two digit elastomer codes are used to designate the elastomer component of a seal assembly.

Material Reference Guide

Table 7 Material Comparison - Polymers

Polymers	Turcon®	Zurcon®	Zurcon®	Zurcon® / HiMod®	Orkot®
Definition	Proprietary PTFE based compounds	Proprietary polyurethane grades	Proprietary Ultra High Molecular Polyethylene (UHMPE) grades	Proprietary PEEK™ compounds	Proprietary fabric reinforced bearing materials
Media compatibility	Excellent compatibility with most media	Very good performance with hydraulic lubricating oils	Performs well in un-lubricated systems such as air, gases and water applications.	Excellent performance with almost all downhole media	Excellent performance in water and hydraulic oil
Temperature - lowest	-328 °F / -200 °C	-58 °F / -50 °C	-40 °F / -40 °C	-65 °F / -54 °C	-76 °F / -60 °C
Temperature - highest	+500 °F / +260 °C	+230 °F / +110 °C	+176 °F / +80 °C	+500 °F / +260 °C	+482 °F / +250 °C
Hardness - lowest	58 Shore D	53 Shore D	52 Shore D	Rockwell M 90	Rockwell M 90
Hardness - highest	67 Shore D	72 Shore D	52 Shore D	Rockwell M 105	Rockwell M 100
NORSOK Compliant	Specific compounds	No	No	Yes	No
Stick-slip	Very low	Medium	Low	Low to Medium	Medium
Wear resistance	Good	Very good	Very good	Extremely good	Extremely good
Shelf life limitation	Unlimited	Ten years maximum	Six years maximum	Unlimited	Unlimited
Creep	Good performance under moderate loads	Good under medium load - will show signs of creep under higher loads and temperatures	Low creep under normal conditions.	Excellent creep resistance.	Excellent creep resistance at high loads.
Fluid absorption	Minimal except against Freon	Minimal	Minimal	Minimal	Minimal
Ozone resistance	Very good	Good	Very good	Excellent	Excellent

Table 8 Material Comparison - Variseal® Metal Spring

Variseal® Metal Spring Materials	Variseal® Spring (Stainless Steel)	Variseal® Spring (Hastelloy®)	Variseal® Spring (Elgiloy®)
Media compatibility	Standard stainless steel for normal working conditions	Selected when more aggressive media are present.	Excellent in Sour Gas service conditions.
Temperature - Minimum	-328 °F / -200 °C	-328 °F / -200 °C	-328 °F / -200 °C
Temperature - Maximum	+500 °F / +260 °C	+500 °F / +260 °C	+500 °F / +260 °C (+600 °F / +315 °C with heat treatment)
Hardness - highest	N/A	35 RC	60 RC
NACE approved	NO	NO	YES

Material Reference Guide

Table 9 Material Comparison - Metal Materials for Wills Rings®

Metal Materials for Wills Rings®	Wills Rings® (Mild Steel)	Wills Rings® (Stainless Steel 316 & 321)	Wills Rings® (Inconel® 600)	Wills Rings® (Inconel® 718)	Wills Rings® (Inconel® 750)
Media compatibility	Used for standard applications	Used in applications where corrosion resistance is required	Used in applications with sour gas service	Meets with NACE approval for sour gas service.	Meets NACE approvals for sour gas service.
Temperature - Minimum	-328 °F / -200 °C	-328 °F / -200 °C	-328 °F / -200 °C	-328 °F / -200 °C	-328 °F / -200 °C
Temperature - Maximum	+1,022 °F / +550 °C	+1,472 °F / +800 °C	+1,562 °F / +850 °C	+1,382 °F / +750 °C	+1,382 °F / +750 °C
Tensile Strength minimum	370 MPa / 54 KSI	1,585 MPa / 230 KSI	517 MPa / 75 KSI	1,034 MPa / 150 KSI	758 MPa / 110 KSI
Tensile Strength Maximum	600 MPa / 87 KSI	1,900 MPa / 275 KSI	827 MPa / 120 KSI	1,448 MPa / 210 KSI	1,379 MPa / 200 KSI
Hardness - highest	83HRB	95HRB	45HRC	45HRC	45HRC
NACE approved	NO	NO	NO	YES	YES
Vacuum operation	Very good	Very good	Very good	Very good	Very good

Table 10 Material Comparison - Metal Materials for Bonded Seals

Metal Materials for Bonded Seals	Mild Steel, Zinc plated	Stainless Steel 1.4436	High Strength Steel 1.6565
Media compatibility	Used for standard applications	Used in applications where corrosion resistance is required	Used for higher pressure applications
Tensile Strength minimum	540 MPa / 78 KSI	500 MPa / 73 KSI	1,000 MPa / 145 KSI
Tensile Strength maximum	640 MPa / 93 KSI	730 MPa / 106 KSI	1,200 MPa / 174 KSI
Vacuum operation	Very good	Very good	Very good
Non-flammability	Very good	Very good	Very good

Table 11 Nitrile Butadiene Rubber (NBR)

N Code	Shore Hardness	Temperature Range	Specific characteristics
N	70	-22 °F to +212 °F / -30 °C to +100 °C	NBR O-Ring used in seal assemblies
N7T30	70	-22 °F to +230 °F / -30 °C to +110 °C	Standard applications
N8T30	80	-40 °F to +248 °F / -40 °C to +120 °C	Use where there is moderate pressure
N9T30	90	-40 °F to +230 °F / -40 °C to +110 °C	Use when higher extrusion resistance is required

Table 12 Hydrogenated Nitrile Butadiene Rubber (HNBR)

H Code	Shore Hardness	Temperature Range	Specific characteristics
H	70	-9 °F to 266°F / -23 °C to +130 °C	Standard HNBR O-Ring used in seal assemblies
H7T80	70	-22 °F to +266°F / -30 °C to +130 °C	Standard applications
H8T30	80	-22 °F to +302 °F / -30 °C to +150 °C	Higher modulus version of H7T80
H9T40	90	-13 °F to 284 °F / -25 °C to +140 °C	Use when higher extrusion resistance is required
XploR™ H9T20	90	-13 °F to +320 °F / -25 °C to +160 °C	Fully NORSOK M-710 compliant compound
XploR™ H9T21	90	-40 °F to +320 °F / -40 °C to +160 °C	RGD Compound for low temperature applications
H9T80	90	-67 °F to +302 °F / -55 °C to +150 °C	Use in ultra low temperature applications
H9T81	90	-13 °F to +302 °F / -25 °C to +150 °C	Low compression set compound

Material Reference Guide

Table 13 Fluoroelastomer (FKM)

V Code	Shore Hardness	Temperature Range	Specific characteristics
V	70	-4 °F to +392 °F / -20 °C to +200 °C	FKM O-Ring used in seal assemblies
VCT87	75	+14 °F to +440 °F / -10 °C to +225 °C	Standard FKM Compound
VCT11	75	-60 °F to +400 °F / -51 °C to +204 °C	Ultra low temp and compression set compound
XploR™ V9T20	90	-4 °F to +392 °F / -20 °C to +200 °C	Fully NORSOK M-710 compliant compound
XploR™ V9T22	90	-40 °F to +392 °F / -40 °C to +200 °C	Low Temperature RGD compound. Fully NORSOK M-710 compliant compound
XploR™ V9T82	90	-52 °F to +401 °F / -47 °C to +205 °C	Ultra Low Temperature RGD compound. Fully NORSOK M-710 compliant compound
V9T84	90	+5 °F to +437 °F / -15 °C to +225 °C	Enhanced chemical resistant FKM compound
VCT81	75	+5 °F to +440 °F / -15 °C to +225 °C	Low compression set compound

Table 14 Copolymer of Tetrafluoroethylene and propylene (FEPM)

Material Code	Shore Hardness	Temperature Range	Specific characteristics
WTT90	75	+5 °F to +419 °F / -15 °C to +215 °C	Standard FEPM grade
XploR™ WTT80	92	+14 °F to +392 °F / -10 °C to +200 °C	RGD Compound

Two digit elastomer codes are used to designate an O-Ring for seal assemblies.

Table 15 Isolast® FFKM Perfluoroelastomer

Material Code	Shore Hardness	Temperature Range	Specific characteristics
J9503	75	-13 °F to +437 °F / -25 °C to +225 °C	Standard universal grade
J9509	90	-13 °F to +437 °F / -25 °C to +225 °C	For use in high pressure applications
J8325	75	+32 °F to +617 °F / 0 °C to +325 °C	High temperature compound
J9554	90	+14 °F to +527 °F / -10 °C to +275 °C	Outstanding chemical resistance at high temperature
J9513	95	+23 °F to +437 °F / -5 °C to +225 °C	Fully NORSOK M-710 compliant compound
J9523	90	-31 °F to +437 °F / -35 °C to +225 °C	Low Temperature RGD compound. Fully NORSOK M-710 compliant compound

Table 16 Turcon® PTFE based materials

Material Code	Material	Shore Hardness	Temperature Range	Specific characteristics
T01	Virgin PTFE	58 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Virgin PTFE material, good in cryogenic applications
T05	PTFE / Turcon®	58 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For all lubricating hydraulic fluids, hard mating surfaces, very good sliding properties, low friction. Fully NORSOK M-710 compliant
T07	PTFE / Polymer	67 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Preferred downhole material where wear and abrasion resistance are required in a Variseal® design. Fully NORSOK M-710 compliant

Material Reference Guide

Material Code	Material	Shore Hardness	Temperature Range	Specific characteristics
T08	PTFE / Turcon / Bronze	67 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Very high compressive strength, very good extrusion resistance
T10	PTFE / Carbon / Graphite	64 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For all oil hydraulics and pneumatics, lubricated and non-lubricated, high extrusion resistance, good chemical resistance
T12	PTFE / Carbon	66 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Use where poor lubrication is a problem, good performance in valve applications. Fully Norsok M-710 compliant
T16	PTFE / Polymer	67 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For hydraulics, lubricated and non-lubricated in linear & rotary motion. Preferred material for slipper seals
T24	PTFE / Carbon	62 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Standard low speed rotary material used in water or low lubricity applications. Fully Norsok M-710 compliant
T25	PTFE / Turcon® / Glass / Lubricant	58 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Excellent wear characteristics in fast-reciprocating service and hardened shafts in lubricated rotary service
T29	PTFE / High Carbon Fiber-filled	61 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For hydraulics, lubricated, non-lubricated in water, linear & rotary motion. Not suitable for gases or for electrical conducting fluids. Fully Norsok M-710 compliant
T40	PTFE / Carbon Fiber	61 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For lubricated and non-lubricated water hydraulics, soft mating surfaces. Not suitable for gases
T42	PTFE / Turcon® / Glass / Lubricant	62 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For hydraulics, lubricated and non-lubricated with good dielectric properties. Fully Norsok M-710 compliant
T46	PTFE / Turcon® / Bronze	64 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Standard material for lubricated hydraulics in linear motion with high compression strength and extrusion resistance
T47	PTFE / Turcon® / Bronze	63 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Standard linear wear ring material for hydraulic oil applications. Not recommended as a linear bearing material downhole
T51	PTFE / Carbon / Graphite	64 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Very good abrasion resistance. Standard material for linear bearing applications
T59	PTFE / Carbon Fiber	61 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Good wear resistance, good in poorly lubricated applications
T78	PTFE / Aromatic Polymer	62 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	For low pressure rotary applications and running against soft surfaces
T99	PTFE / Turcon® / Lubricant	58 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Preferred material for sealing gas in slow moving linear applications. Fully Norsok M-710 compliant
M12	Proprietary filled PTFE	62 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Low friction and wear resistant material for dynamic linear seal applications. Fully Norsok M-710 compliant
M30	Proprietary filled PTFE	62 Shore D	-328 °F to +500 °F / -200 °C to +260 °C	Very good abrasion resistance for high pressure / high temperature applications.
Q2J	Modified PTFE/Glass/Pigment	60 Shore D	-328 °F to +550 °F / -200 °C to +288 °C	Preferred material for lubricated dynamic linear seal applications. Very low friction, high wear and extrusion resistance. Fully Norsok M-710 compliant

Material Reference Guide

Material Code	Material	Shore Hardness	Temperature Range	Specific characteristics
M02	Virgin TFM	58 Shore D	-328 °F to +550 °F / -200 °C to +288 °C	Excellent for cryogenic applications and lower gas permeability than PTFE. Fully NORSOK M-710 compliant
M83	PTFE with glass fibre	58 Shore D	-76 °F to +392 °F / -60 °C to +200 °C	Preferred material for low pressure dry running in non-lubricated applications

Table 17 Zurcon® Polyurethane, UHMWPE and PEEK™

Material Code	Material	Shore Hardness	Temperature Range	Specific characteristics
Z20	Polyurethane TPU	93 +/-3 Shore A	-31 °F to +230 °F / -35 °C to +110 °C	Standard grade for hydraulic applications, good abrasion and extrusion resistance
Z22	Polyurethane TPU	93 +/-3 Shore A	-58 °F to +230 °F / -50 °C to +110 °C	Good low temperature operation capabilities
Z24	Polyurethane TPU	93 +/-3 Shore A	-31 °F to +230 °F / -35 °C to +110 °C	Very good hydrolysis resistance, good Explosive Decompression Resistance, very good extrusion resistance
Z43	Modified PEEK	92 Shore D	-65 °F to +500 °F / -54 °C to +260 °C	Excellent and most common bearing grade material for medium to high loads. Fully NORSOK M-710 compliant
Z431	Virgin PEEK	90 Shore D	-65 °F to +500 °F / -54 °C to +260 °C	Good bearing or bushing material. Popular for ball valve polymer components. Fully NORSOK M-710 compliant
Z48	Polyester Elastomer TPE	53 +/-3 Shore D	-40 °F to +212 °F / -40 °C to +100 °C	For tight sealing with long wear life, in applications where temperatures are not high and there is no corrosive media
Z53	Polyurethane CPU	70 +/- 5 Shore D	-40 °F to +176 °F / -40 °C to +80 °C	For lubricated hydraulics, high abrasion and extrusion resistance, limited media resistance
Z54	Polyurethane CPU	60 +/- 5 Shore D	-40 °F to +176 °F / -40 °C to +80 °C	For lubricating hydraulics in linear applications, limited media resistance
Z80	UHMWPE	52 Shore D	-40 °F to +176 °F / -40 °C to +80 °C	For lubricated and non-lubricated, air and gases in linear and slowly turning movements. High media, abrasion and extrusion resistance. Exceptionally suited for water applications

Material Reference Guide

Table 18 HiMod® PEEK™

	Material Code	Hardness	Temperature Range	Specific characteristics
HiMod®	550	Rockwell M 90	-65 °F to +500 °F / -54 °C to +260 °C	Virgin grade for general use as back-ups, seal components, and light duty bearing applications. Fully NORSOK M-710 compliant compound
HiMod®	903	Rockwell M 100	-65 °F to +500 °F / -54 °C to +260 °C	Standard carbon fiber-filled grade for Back-up Ring and extrusion resistant applications
HiMod®	914	Rockwell M 100	-65 °F to +500 °F / -54 °C to +260 °C	Developed for some of the most severe and critical applications. HiMod 914 offers superb chemical resistance and thermal properties. One of the best bearing grades available. (proprietary lubricant and wear resistant filler combination). Fully NORSOK M-710 compliant compound
HiMod®	921	Rockwell M 90	-65 °F to +500 °F / -54 °C to +260 °C	Highly lubricated, medium-modulus compound providing chemical resistance, lower friction and good mechanical and thermal properties. (PTFE Filler). Fully NORSOK M-710 compliant compound
HiMod®	924	Rockwell M105	-65 °F to +500 °F / -54 °C to +260 °C	High-temperature, high-modulus compound providing low thermal expansion, chemical resistance and high mechanical and thermal properties. (Carbon fiber filler). Fully NORSOK M-710 compliant compound
HiMod®	959	Rockwell M 100	-65 °F to +500 °F / -54 °C to +260 °C	Standard glass filled grade for improved extrusion resistance above virgin grades.
HiMod®	960	Rockwell M 90	-65 °F to +500 °F / -54 °C to +260 °C	Similar to HiMod 550 and used where stringent material certifications are not required. Fully NORSOK M-710 compliant compound
HiMod®	Q2Q	Rockwell M 105	-65 °F to +500 °F / -54 °C to +260 °C	High-modulus compound providing high mechanical and thermal properties, mechanical and thermal properties. (Carbon fiber filler). Fully NORSOK M-710 compliant compound

Table 19 Orkot® Fabric reinforced bearing materials

	Material Code	Shore Hardness	Temperature Range	Specific characteristics
Orkot®	C324	Rockwell M 100	-76 °F to +482 °F / -60 °C to +250 °C	Used at elevated temperatures and/or for use in chemically aggressive fluids, wear rings or bushings
Orkot®	C338	Rockwell M 100	-76 °F to +482 °F / -60 °C to +250 °C	Used for guide bearings where high temperatures are present. Wear rings or custom made bushes
Orkot®	C361 (Orkot TLMM)	Rockwell M 90	-76 °F to +265 °F -60 °C to +130 °C	Used against stainless steel counterparts, with intermittent water contact or where electrical insulation is required. Tailor made bushes and slide pads

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	Material Code	Shore Hardness	Temperature Range	Specific characteristics
Orkot®	C378 (Orkot TXMM)	Rockwell M 90	-76 °F to +265 °F / -60 °C to +130 °C	Used with stainless steel counterparts, where water is present or electrical resistance required. Tailor made bushes and slide pads
Orkot®	C380	Rockwell M 90	-76 °F to +266 °F / -60 °C to +130 °C	Standard material for Slydring® used in hydraulic cylinders
Orkot®	C480	Rockwell M 90	-76 °F to +265 °F -60 °C to +130 °C	Improved low friction and wear in hydraulic oils and can also reduce stick-slip under marginal lubrication conditions. Compatible with tungsten carbide, chrome and similar smooth, hard surfaces.

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Table 20 Cross reference of elastomer material designations, trade names and abbreviations

Designation	Trade Name*	Abbreviation		
		ISO 1629	ASTM 1418	TSS
Acrylonitrile-Butadiene Rubber (Nitrile Rubber)	Europrene® Krynac® Nipol N® Perbunan® NT Breon®	NBR	NBR	N
Hydrogenated Acrylonitrile-Butadiene Rubber	Therban® Zetpol®	HNBR	HNBR	H
Chloroprene Rubber	Baypren® Neoprene®	CR	CR	WC
Ethylene Propylene Diene Rubber	Dutral® Keltan® Vistalon® Buna EP®	EPDM	EPDM	E
Silicone Rubber	Elastoseal® Rhodorsil® Silastic® Silopren®	VMQ	VMQ	S
Fluorosilicone Rubber	Silastic®	FVMQ	FVMQ	F
Tetrafluorethylene-Propylene Copolymer Elastomer	Aflas®	FEPM	TFE / P**	WT
Butyl Rubber	Esso Butyl®	IIR	IIR	WI
Styrene-Butadiene Rubber	Buna S® Europrene® Polysar S®	SBR	SBR	WB
Natural Rubber		NR	WR	WR
Fluorocarbon	Dai-El® Fluorel® Tecnoflon® Viton®	FKM	FKM	V
Perfluoroelastomer	Isolast® Kalrez®	FFKM	FFKM	J
Polyester Urethane Polyether Urethane	Zurcon® Adiprene® Pellethan® Vulcollan® Desmopan®	AU EU	AU EU	WU WU
Chlorosulfonated Polyethylene Rubber	Hypalon®	CSM	CSM	WM
Polysulfide Elastomer	Thiokol®	-	TWT	WY
Epichlorohydrin Elastomer	Hydrin®	-	-	WO

* Selection of registered trade names ASTM = American Society for Testing and Materials.

Material Reference Guide, Industry Standards

■ Application parameters of elastomers

Elastomers, as with all other organic chemicals, have limited use. External influences such as various media, oxygen or ozone, as well as pressure and temperature will affect the material properties and therefore their sealing capability.

Elastomers will, among other things swell, shrink, harden, develop cracks or even tears.

The following information illustrates the different application parameters.

Elastomer heat resistance / swelling in oil

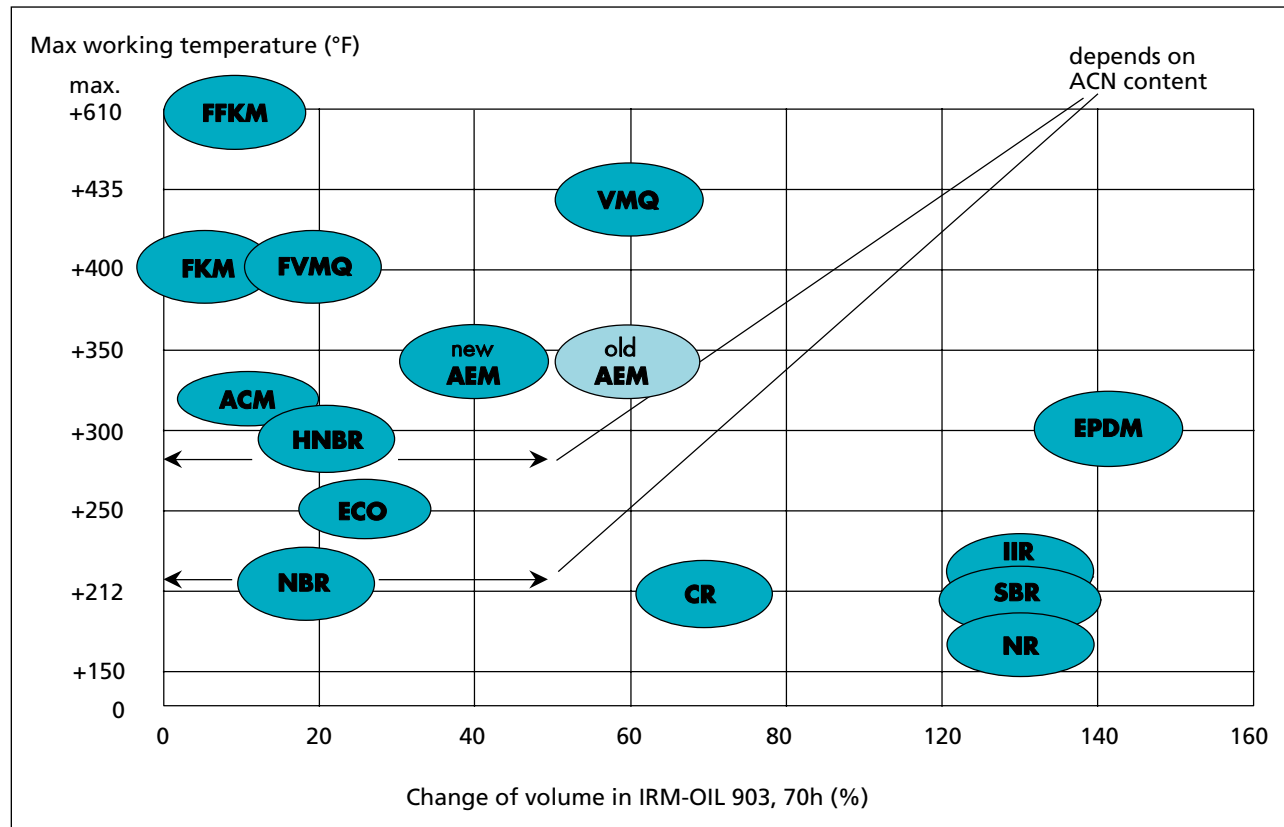


Figure 1 Change of volume in IRM-Oil 903 (old ASTM-Oil No 3)

Material Reference Guide

■ Low Temperature Sealing

Low temperature sealing is becoming more common in oil & gas applications. It is therefore important to understand and account for the glass transition temperature (Tg) when specifying seals for low temperature situations.

Standard HNBR and FKM materials offer limited sealing capability below -4 °F / -20 °C. When an elastomer reaches its Tg Point its properties change from being elastic and pliable to become more solid and brittle. As a result the elastomer is less effective as a sealing solution and can be damaged easily.

The Tg point of an elastomer is increased under pressure. In general, the Tg Value rises by +2 °F / +1°C for every 750 psi / 5 MPa increase in pressure applied. For example, a seal in V9T22 material with a Tg rating of -40 °F / -40 °C at atmosphere will have a Tg rating of -4 °F / -20 °C at 15,000psi / 100MPa.

Elastomer Activated Turcon® Piston Seals

Turcon® seal rings contract at low temperature. In case of unpressurized piston applications in temperatures below +32 °F / 0 °C the choice of seal, elastomer and / or installation dimensions must be adjusted accordingly.

Please contact our application engineers for assistance.

■ Industry Standards

■ Compliance with strict standards

Sealing challenges are numerous in the oil & gas industry in critical processes and components. Sealing materials are required to be compliant to various national and international approvals. The key ones are listed in the table below.

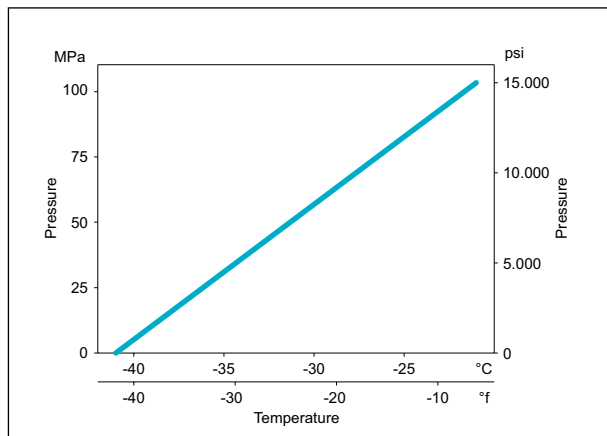


Figure 2 Pressure effect on Tg Value

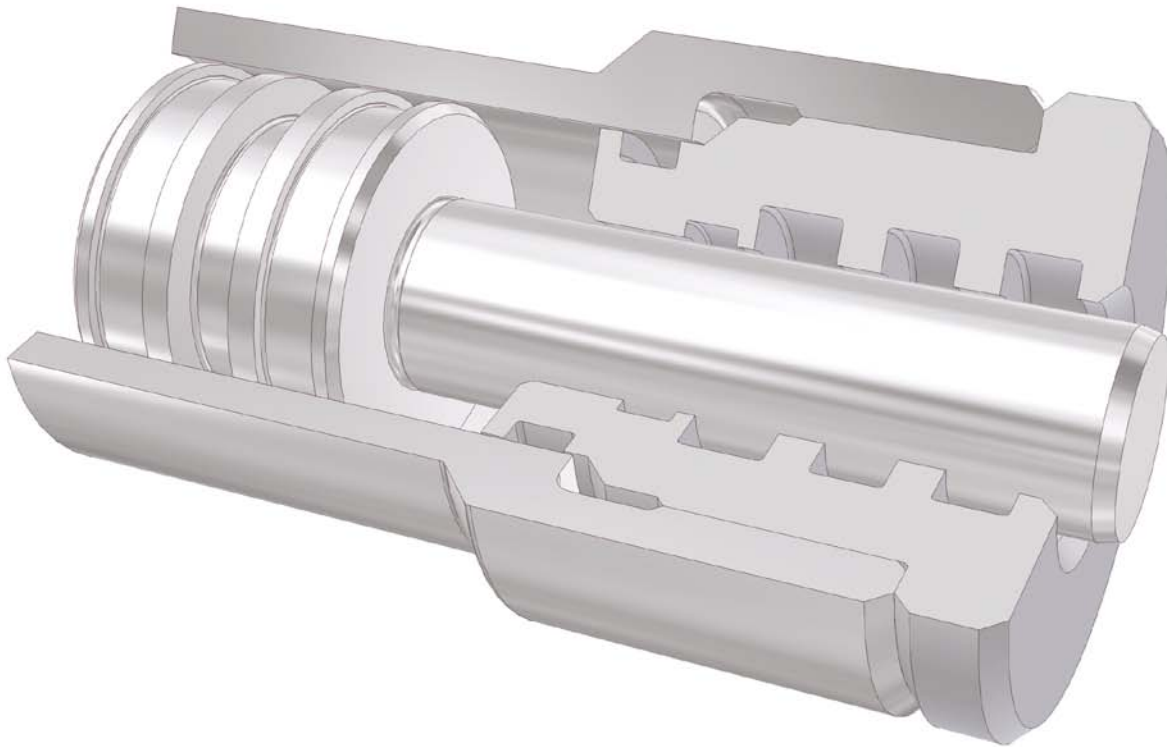
Trelleborg Sealing Solutions offers a number of industry specific compounds compliant with these standards. A range of elastomer and thermoplastic materials are available which are compliant with NORSOK M-710 specification.

Material Reference Guide

Table 21 Standard Authorities and Regulations

Standard authority	Regulations applicable to seals
API The American Petroleum Institute (API) specifications are recognized and adopted globally by oilfield equipment manufacturers.	API 6 A, 6D and 6F cover different specifications relating to flow control equipment and valves used on wellheads and in pipeline applications.
NACE® The National Association of Corrosion Engineers (NACE) governs mainly the selection of metallic materials. It also issues specifications for elastomer O-Rings.	Some Trelleborg products, such as Turcon® Variseal® and Wills Rings®, contain or are made of metal. The metal must meet NACE specifications where required.
NORSOK The Norwegian Oil & Gas industry standard (NORSOK).	NORSOK M-710 requires that all sub-components of oilfield equipment must be approved to the stated specification. Specifically, individual seal materials are vigorously tested and approved based on numerous criteria.
International Standards Organization (ISO) ISO specifications are recognized throughout the Oil & Industry sector. Many varying national standards are now being superseded by ISO standards.	Specifications such as ISO 3601 govern the sizes and tolerances of O-Rings used throughout the industry, while ISO 3320 specifies the metalwork sizes for seals and bearings.

■ Hardware Expertise



The functioning of seals not only depends on the seal itself and its operating conditions, but also on other factors. Over the years Trelleborg Sealing Solutions has developed an in-depth knowledge of applied materials technology. To maximize system performance, we can advise on relevant issues related to the hardware into which seals are fitted and significant properties of mating surfaces.

In this section we give detailed recommendations on surface finishes, and the properties of mating part surface coatings and platings. We also provide recommendations on surface finishes and hardness requirements, as well as offering advice on mating surfaces such as preferred coatings and platings.

To find out more contact your local Trelleborg Sealing Solutions marketing company. It is best to involve them at concept stage. This allows them to advise on the design of the component or housing to ensure that it will function as effectively as possible and give maximum seal life and performance.

■ Surface Finishes

Surface finish quality relates directly to dynamic seal performance. Properly defining, measuring and controlling surface finish quality is critical to the functional reliability and service life of a seal.

Developments in surface finish measurement equipment and capabilities, along with finishing methods, have resulted in functional seal testing being performed to determine and verify surface finish recommendations for improved seal performance.

Standard Recommendations

Two sets of standard recommendations that apply to linear hydraulic seals and dynamic sealing surfaces are given below. The first is for HVOF (High Velocity Oxygen Fuel) applied coatings like Tungsten Carbide and Cobalt-Chrome ($W_c-C_o-C_r$). The second is for bare steel, aluminum or chrome plating. Within the product sections you will find further product specific surface finish recommendations.

Table 22 Surface Finish Recommendations for HVOF Applied Surfaces

Measurement	Standard Recommendation
R_a	For diameters below 6 inches / 150 mm $< 8 \mu\text{in} / < 0.2 \mu\text{m}$ For diameters between 6 to 12 inches / 150 to 300 mm $8-12 \mu\text{in} / 0.2 - 0.3 \mu\text{m}$ For diameters larger than 12 inches / 300 mm, $8-16 \mu\text{in} / 0.2 - 0.4 \mu\text{m}$
R_p	$\leq 8 \mu\text{in max.} / 0.2 \mu\text{m maximum}$
$R_z (R_{tm})$	$40 \mu\text{in} / 1.0 \mu\text{m maximum}$
$T_p (M_r)$	$70 - 90\% @ \text{depth of } p = 0.25 R_z (R_{tm})$

Table 23 Surface Finish Recommendations, Chrome Plating, Anodized Surfaces, Bare Metals (Hardened) and Others (Non-HVOF)

Measurement	Standard Recommendation
R_a	For diameters below 6 inches / 150 mm $< 8 \mu\text{in} / < 0.2 \mu\text{m}$ / For diameters between 6 to 12 inches / 150 to 300 mm $8-12 \mu\text{in} / 0.2 - 0.3 \mu\text{m}$ For diameters larger than 12 inches / 300 mm, $8-16 \mu\text{in} / 0.2 - 0.4 \mu\text{m}$

Measurement	Standard Recommendation
R_p	$\leq 24 \mu\text{in} / 0.6 \mu\text{m maximum}$
R_z	$40 \mu\text{in} / 1.0 \mu\text{m maximum}$
T_p	$50 - 75\% @ \text{depth of } p = 0.25 R_z (R_{tm})$

For surface finish recommendations on the seal groove sidewalls and groove bottoms as well as static seal interfaces, please follow recommendations in AS568 / ISO 3601-2 seal groove standards. If you have any questions related to surface finish and methods please contact your local Trelleborg Sealing Solutions marketing company.

Pockets and Valleys

Values are given for the high end of the bearing ratio. The seal surface should not be completely closed or void of adequate pockets and valleys. These are needed for seal lubrication retention and build-up of operating fluid film. A bearing ratio of 100 percent is not desirable.

Optimum Profile

The optimum surface profile for seal counterparts is shown in Figure 3. A high concentration and magnitude of peaks on a surface can cause excessive seal wear, promoting unwanted leakage and egression. Surfaces relatively void of peaks but including valleys for lubrication retention are more suitable for sealing applications.

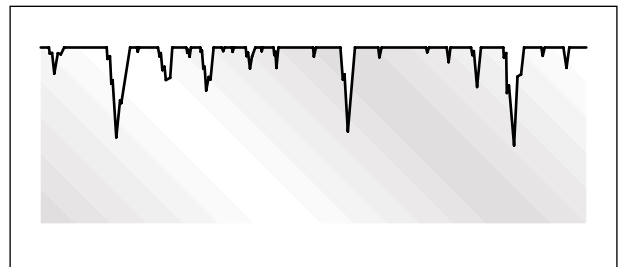


Figure 3 Optimum surface profile for seal counterparts

Direction of Lay

Each method used to obtain a specific surface finish, such as turning, grinding, honing, ball peening, polishing or superfinishing, produces a characteristic direction or lay to the surface. This can have an effect on sealing performance and wear patterns in certain applications.

To obtain the best seal performance, avoid finishing methods which promote the formation of leak paths in your application. For example, avoid a strong axial lay in a reciprocating rod seal application or a definite spiral pattern on the shaft in a rotary application.

Mating Surface Hardness

The hardness of the surface that mates with the seal affects the seal's performance in several ways.

If mating materials are too soft, the seal will burnish or damage the surface. A harder material improves wear life, resisting damage by the seal. Hard surfaces also have a tendency to lower the running friction of a seal.

A seal will polish its mating surface, especially if it is a softer metal. For example, a reciprocating rod made of stainless steel with a hardness of 28 to 30 Rockwell C and a finish of $25 \mu\text{in} / 0.635 \mu\text{m} R_a$ will generally be polished by the seal to a finish of $12 \mu\text{in} / 0.305 \mu\text{m} R_a$ or better, over a short period of time. Seal friction and wear will then decrease accordingly. Materials that are harder than 44 Rockwell C do not polish as easily.

Turcon® seal materials with reinforcing fillers, such as T29 and T25, should only be specified against harder mating surfaces. In some cases, reinforcing fillers can burnish or damage softer mating surfaces, especially in rotary applications.

When an application requires the longest possible wear life under moderate to severe conditions, the seal material should be one of the harder, highly-filled Turcon® blends.

Running In

In standard sealing systems, the seals and mating surfaces have an initial period of high wear. This phase, known as the run-in, ends once the peaks on the mating surface are broken off and the surface and seal reach an equilibrium state. Provided the seals are sufficiently lubricated, the wear rate drops significantly once the equilibrium state is reached.

By defining the surface finish using multiple surface finish parameters, the overall surface profile can be controlled more precisely. This reduces the sealing system run-in period, and once equilibrium between the seal and sealing surface is reached, gives a more optimal surface finish for leakage control, wear resistance and service life.

The abrasive nature of a rough finish can cause excessive seal wear during the early run-in period. Therefore, the harder the mating surface, the more important it is to start with the correct surface finish.

Substrates

Seals run well against unplated surfaces at moderate speeds and pressures. In high-speed rotary or high-pressure reciprocating applications, harder surfaces are preferable.

Typical mating surface materials are listed Table 24. These materials can also act as substrates for plating or coating to achieve higher hardness values.

Platings and Coatings

It is important to consider the ability of the substrate to support the plating. For example, when a high-pressure load is exerted on a seal running against hard-chrome plating supported by a soft substrate, such as 300 series Stainless Steel, the plating may peel or crack and then abrade the seal. A better substrate would be Stainless Steel Type 440C (hardened to 44 Rockwell C) or an alloy steel such as 4340 in the fully-hardened condition.

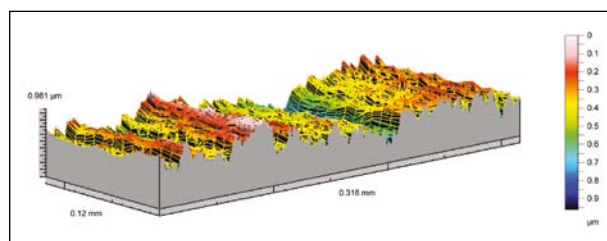


Figure 4 Three dimensional surface finish topography

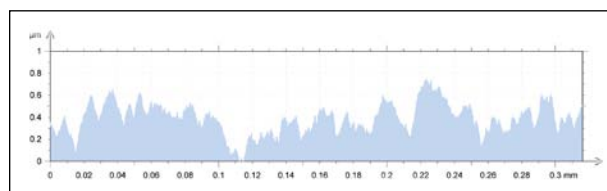


Figure 5 Two dimensional surface finish topography

The surface finish measurement illustrations above clearly show the difference between three-dimensional (3D) and two-dimensional (2D) surface finish topography. The correct surface finish profile is critical to proper seal performance.

Hardware Expertise

■ Plating and Coating

Table 24 Properties of typical types of plating and coatings used in contact with polymer seals

Coating or plating type		Hardness Rockwell C	Suggested thickness	Corrosion resistance	Abrasiveness to seal	Comments
Chrome plating	Hard chrome	65	0.0008/0.0050 in 0.020/0.127 mm	Fair to Good	High	Wear-resistant for light-duty. Not recommended for fast-rotary or corrosive applications.
	Thin dense chrome	70	0.0002/0.0006 in 0.005/0.015 mm	Excellent	Low	Higher wear resistance and lower friction than conventional chrome in light to moderate speeds.
Electroless nickel plating	Nickel as deposited	48-52	0.0010 in minimum 0.0254 mm minimum	Excellent	Low	Excellent for corrosive applications in light to moderate speeds and pressures.
	Nickel fully hardened	58-70	0.0010 in minimum 0.0254 mm minimum	Good	High	Harder but more abrasive than as-deposited nickel. Not recommended for high-speed rotary applications.
Plasma spray coating	Chromium oxide	71	0.0050/0.0300 in 0.127/0.762 mm	Excellent	Low	Recommended when wear life is the primary concern. Not recommended for high-shock loads.
	Aluminium oxide	60-69	0.0050/0.0300 in 0.127/0.762 mm	Excellent	Low	Lower-cost, less wear-resistant but greater ductility than chromium-oxide coatings.
HVOF ¹⁾	Tungsten Carbide	67-74	0.0050/0.0300 in 0.127/0.762 mm	Excellent	Low	High wear-resistance, with higher bonding strength. For high-speed and pressure combinations.

Hardware Expertise

Coating or plating type		Hardness Rockwell C	Suggested thickness	Corrosion resistance	Abrasiveness to seal	Comments
Anodizing	Hard anodized aluminum	Over 70	0.0005/0.0045 in 0.013/0.114 mm	Excellent	Low	Excellent bore material in piston-seal applications as a low-friction mating surface.
Thermal spray	Triballoy 400 & 800	55	0.001/0.02 in 0.025/0.508 mm	Excellent	High	Hard to get better than a 14 Ra so not recommended for most dynamic seal applications.
Nitriding	Titanium nitride (TiN)	Up to 70	0.000039 / 0.000197 in 0.001/0.005mm	Excellent	High	Wear resistant, low friction and resists corrosion. Thickness of coating can be an issue related to useful wear- life.

The information supplied above is intended only as a guide. Testing of the selected material in actual service conditions is recommended to determine the suitability of a plating or coating for a specific application.

¹⁾ HVOF = High Velocity Oxygen Fuel. This coating system uses high-pressure, high-temperature, high-velocity spray guns to improve coating density, hardness and bond strength.

■ Hardware Design Tips

The following recommendation for hydraulic hardware will simplify the installation of seals. AS568 / ISO3601 sizes gives recommendations. They should be considered at an early hardware design stage in order to ensure damage-free installation of seals. These are general guidelines. Further information can be found in catalogs specific to each product types.

Piston and Rod

A lead-in chamfer on the end of the rod or bore helps installation. Recommended chamfer dimensions are given below. A lead-in chamfer is especially important where lip seals are to be installed face-first into the bore or on a shaft.

Table 25 Lead-in Chamfer

Lead-in chamfers length Z min.		O-Ring cross section d ₂
15°	20°	
2.5	1.5	up to 1.78 1.80
3.0	2.0	up to 2.62 2.65
3.5	2.5	up to 3.53 3.55
4.5	3.5	up to 5.33 5.30
5.0	4.0	up to 7.00
6.0	4.5	above 7.00

The cylinder bore or rod should have a lead-in chamfer of 15 to 20 degrees by Z length minimum to gently guide the seal assembly into the hardware as shown in Figure 6 and Figure 7. The chamfer should clear the seal assembly, in a free condition, after it has been sized.

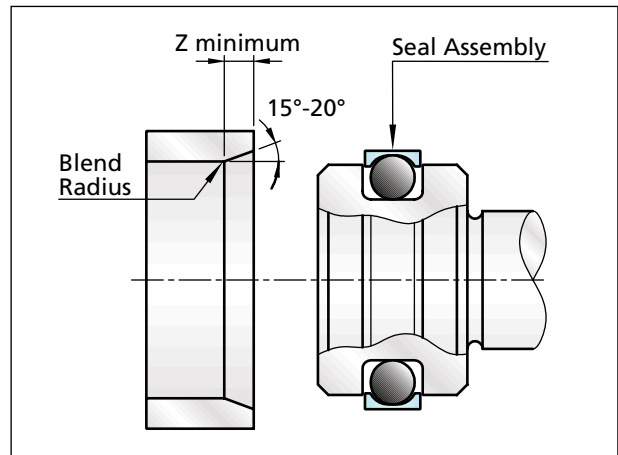


Figure 6 Piston Installation

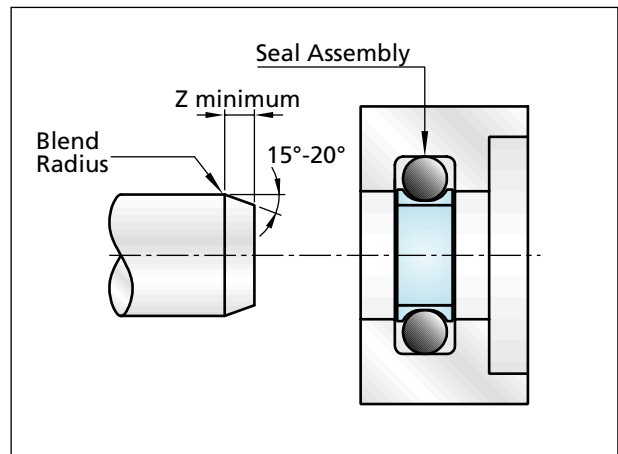


Figure 7 Rod Installation

Ports – Non-operational (Installation Only)

When installing a seal assembly across a port, in a non-operational capacity, a relief should be provided with 15 to 20 degrees by Z minimum, (shown in table on previous page) as shown in Figure 8.

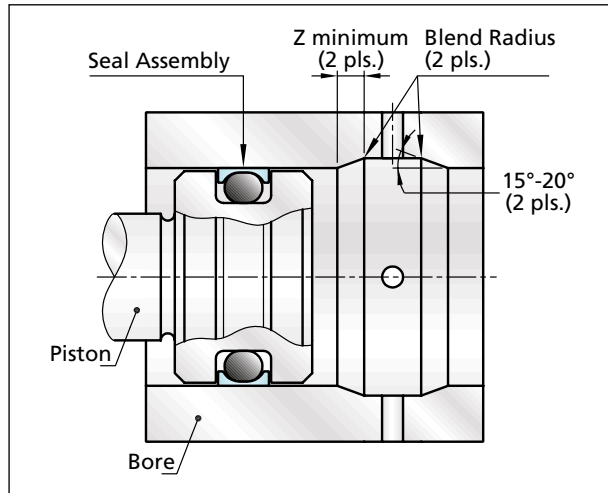


Figure 8 Relief Across Port, Non-operational, Installation Only

For dynamic seals that will cross ports during pressurized operation please contact your local Trelleborg Sealing Solutions marketing company for recommendations.

Threads

When passing over threads, the seal assembly must clear the threads or other uneven surfaces. A lead-in chamfer of 20 to 20 degrees by Z minimum will gently guide the seal assembly into the bore as shown in Figure 9.

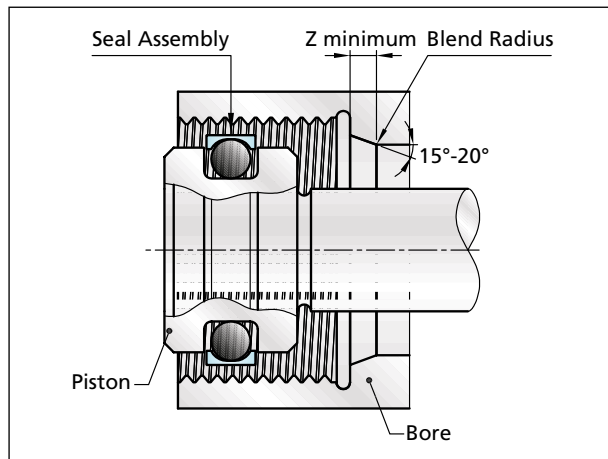


Figure 9 Threads

Material and Finish Recommendations

Recommended material hardness:

- 44-48 Rockwell "C" - Low to moderate pressure application
- 55-60 Rockwell "C" - High-pressure applications

Surface finishes:

Dynamic surfaces:

- Bare metal, hard chrome, hard anodized:
Ra = 8-12 μin / 0,2-0,3 μm

Static surface in seal groove:

- Slipper Seal (Elastomer contact):
Ra $\leq$ 32 μin / 0.8 μm
- Variseal® (PTFE contact):
Ra $\leq$ 12 μin / 0.3 μm
- Groove sidewall:
Ra $\leq$ 63 μin / 1.6 μm

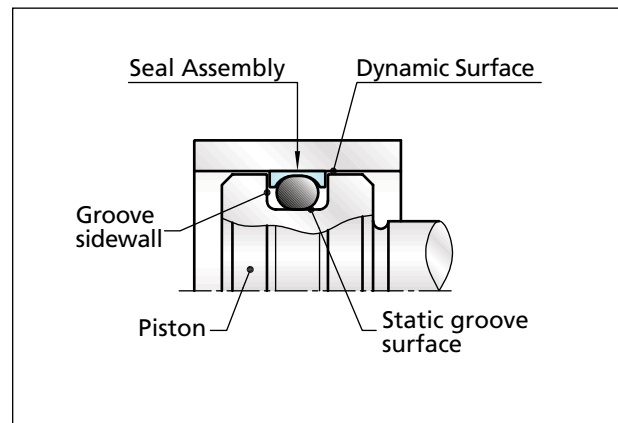


Figure 10 Surface Finishes μin

Note:

All dynamic surfaces must be either burnished, post-ground, honed or super-finished (HVOF applied coatings). All dynamic and static surfaces must be free of nicks, scratches and burrs.

■ General Guidelines

The following installation guidelines should be considered at an early hardware design stage in order to ensure damage-free installation of seals. These are

general guidelines. Further information can be found in catalogs specific to each product type.

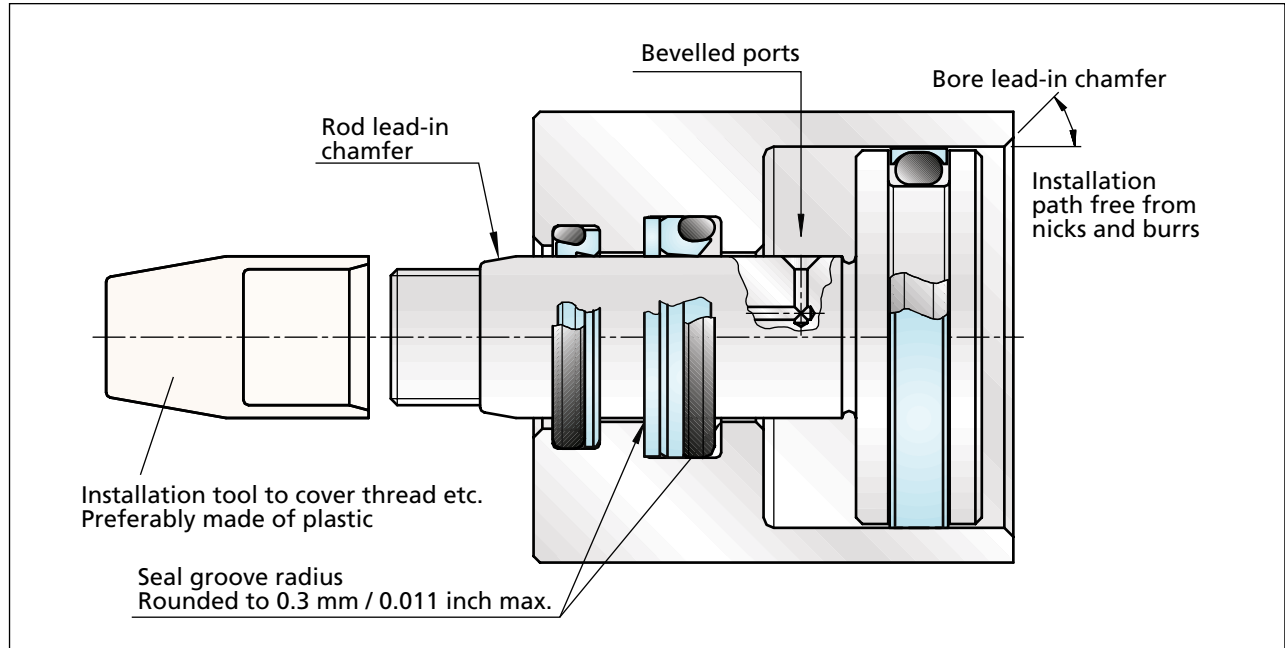


Figure 11 Methods of hardware design to prevent seal damage

- The seal installation path should be kept free of nicks, burrs, scratches or any sharp edges that could damage the seal.
- Any tool used to install a seal should be free of sharp edges. Screwdrivers often damage sealing lips and should not be used to handle seals.
- Tools should preferably be made of hard plastics such as Delrin®.
- In situations where heat is required to soften and expand Turcon® PTFE based seal components, submerge them for a few minutes in hot oil or water at +200 °F/ +93 °C. Heat should not be required to install elastomer components.
- Application of a lubricant to surfaces of the seal and hardware reduces the force required to push the seal into a difficult groove, such as a solid O-Ring groove.
- When using lubricant during installation, ensure that the elastomer component is compatible with the lubricant.
- Piston seals may be sized by freezing them prior to installing the piston in the bore. This is an advantage on spool valve pistons with multiple seals within the hardware.
- When seals are installed across ports, the edge of the ports should be smooth and rounded.
- Design splines or keyways to be of a smaller diameter than the sealing surface or use a protective sleeve to cover them during installation as illustrated in Figure 13.
- Do not side-load the seals any more than is necessary. Avoid situations in the groove where a heavy rod or piston bears against one side of the seal.

Delrin® is a registered trademark of Dupont™

Procedure for installation of piston seals

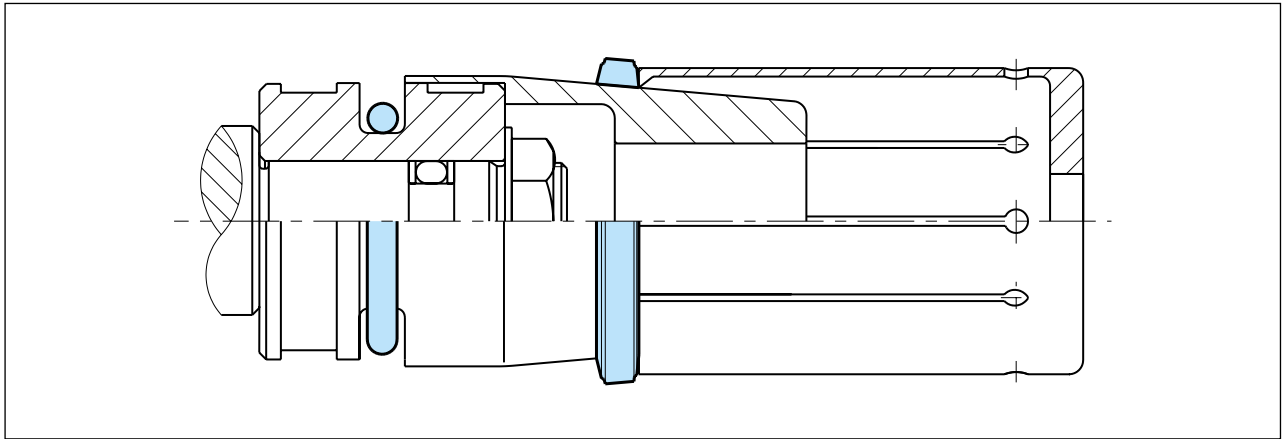


Figure 12 Expanding the Turcon® sealing element using an expanding sleeve over the installation sleeve

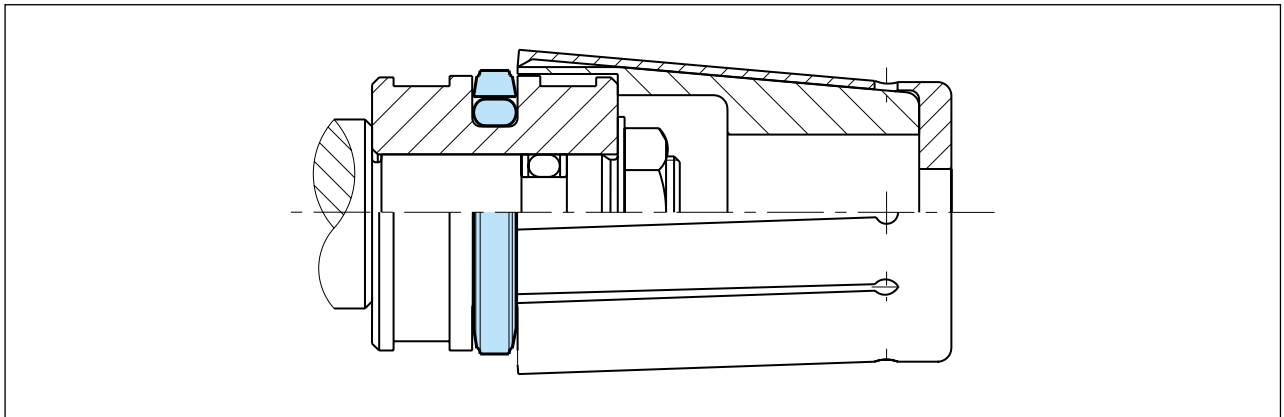


Figure 13 Sealing element after snapping into the groove

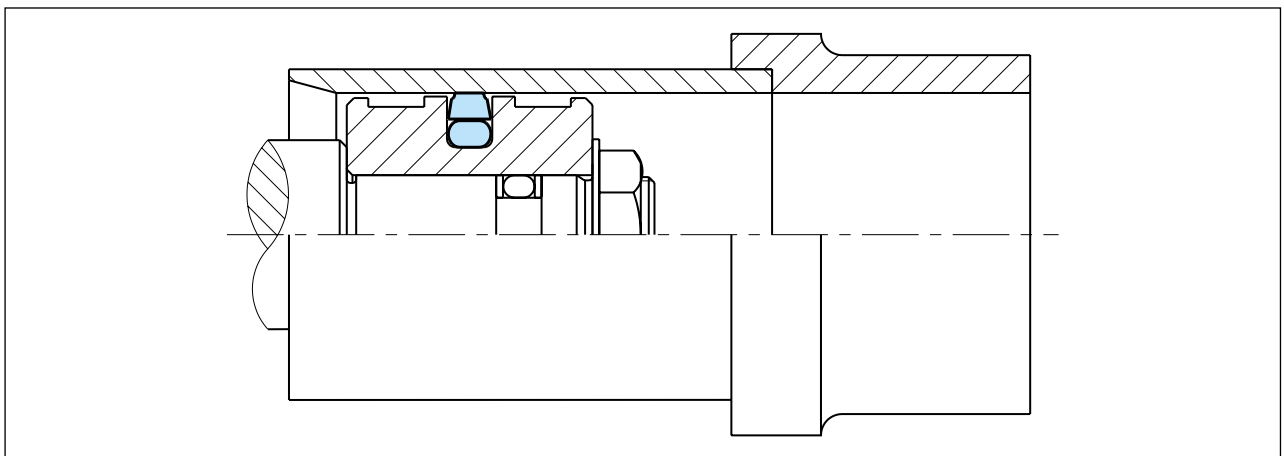


Figure 14 Sizing the sealing element with a sizing sleeve

If the Turcon® seal is expanded more than 15 percent (10 percent for the high-filled materials Turcon® T08 and Turcon® T29), a split groove is necessary.

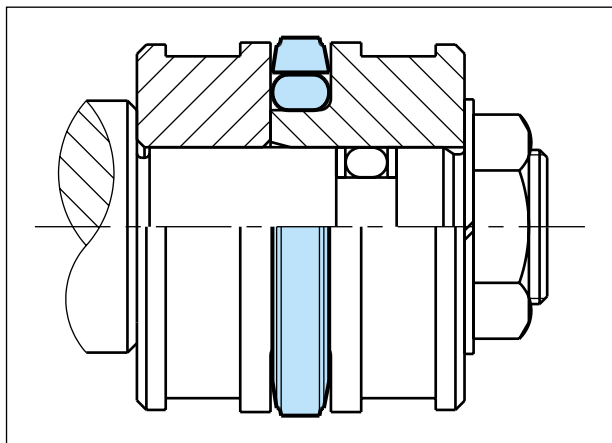


Figure 15 Installation in a split groove

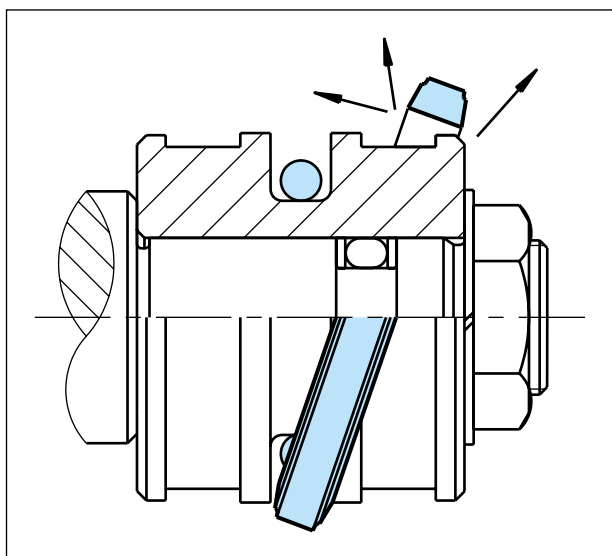


Figure 16 Fitting the seal ring onto the O-Ring in the groove, using a thin plastic strip.
Note: Plastic Strip should be inserted underneath the seal cap.

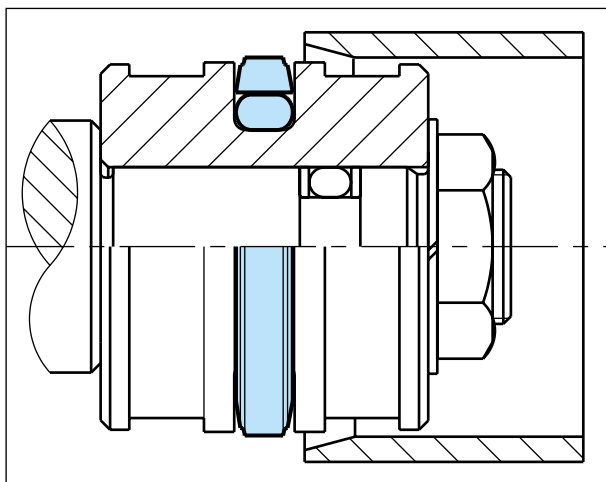


Figure 17 Re-sizing of the seal installation

Procedure for installation of rod seals

- Place the elastomer part into the groove.
- Compress the Turcon® part into a kidney shape. The seal must have no sharp bends (see Figure 18). Use a rounded object to compress the Turcon® part without pinching, creating smooth curves.

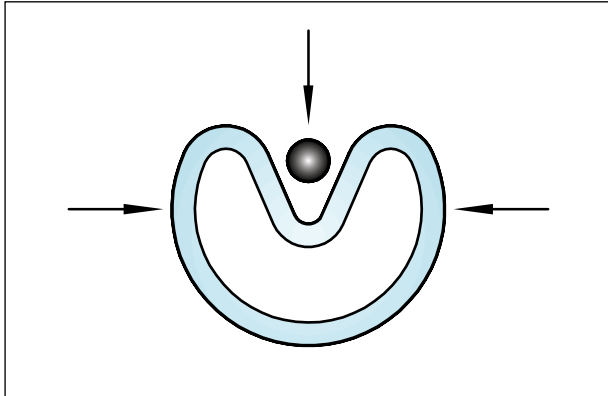


Figure 18 Kidney-shaped deformation of the seal ring

- After placing the seal into the groove, form it into a ring again by smoothing the ID by hand (see Figure 19).
- Finally, size the seal ring using a mandrel with a chamfer of 10 to 15 degrees over a length of approximately 1.18 in / 30 mm (see Figure 20).

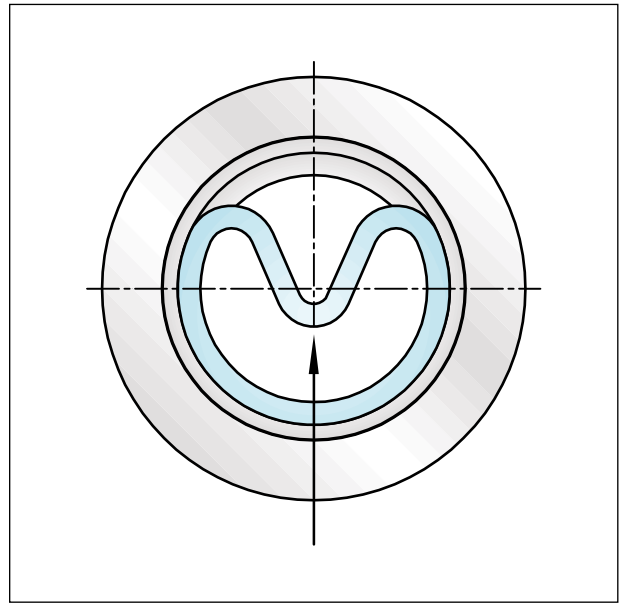


Figure 19 Inserting the seal ring into a closed groove

In order to avoid damage to the seals the sizing mandrel should be made from a polymer material with good sliding characteristics and high surface quality such as Delrin®.

The piston rod itself can also be used for calibration, provided it has a sufficiently long lead-in chamfer

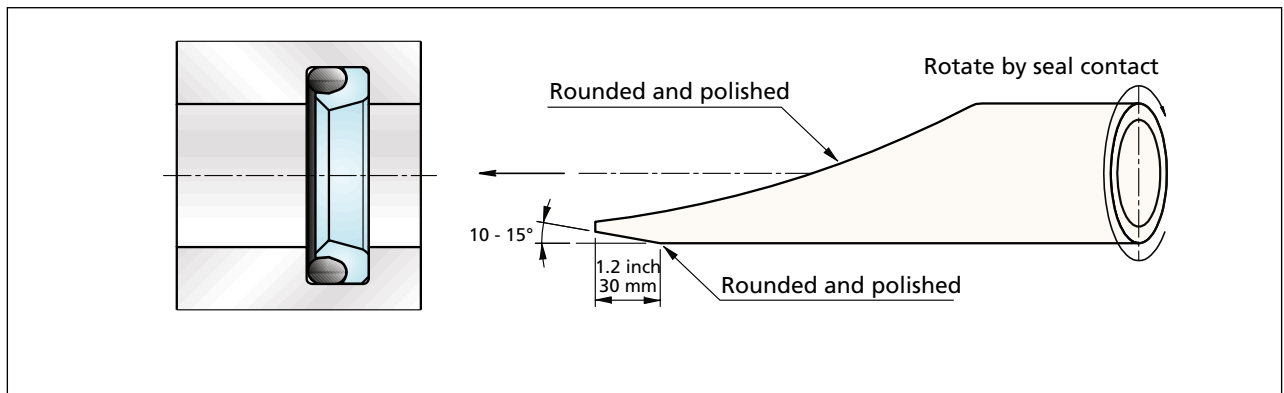


Figure 20 Sizing of the installed seal

Delrin® is a registered trademark of Dupont™

■ Products designed for optimized performance

Trelleborg Sealing Solutions offers one of the widest product portfolios of any seal supplier including many proprietary designs. They range from multi-functional O-Rings to more complex Turcon® geometries, from custom molded designs to bonded products.

Sealing elements have a decisive influence on the function and service life of the oil & gas applications into which they are fitted. It is important to select not only the correct sealing material to meet the performance parameters of an application but also the optimum seal configuration.

The most effective sealing solutions will offer:

- maximized leakage control
- low friction
- resistance to wear
- the ability to withstand aggressive media
- broad operating temperatures into the extremes, both hot and cold
- extrusion resistance
- compact form
- ease of installation

For advice on the optimum solution for your application, contact your local Trelleborg Sealing Solutions marketing company.

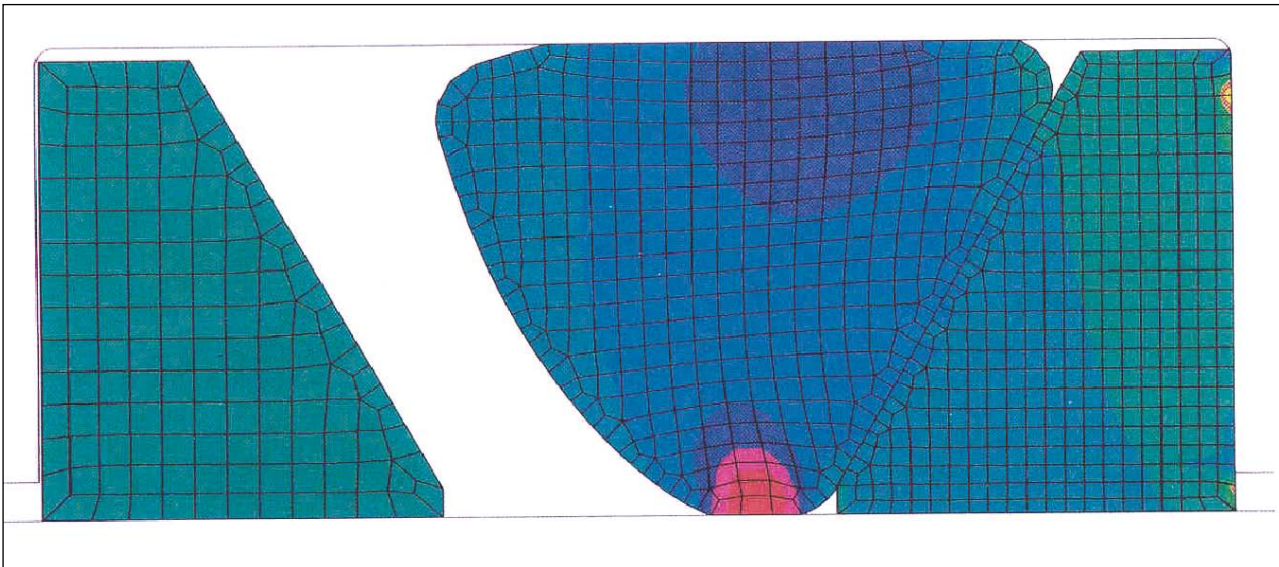
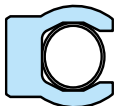


Figure 21 Trelleborg Sealing Solutions uses Finite Element Analysis (FEA) to determine the optimum seal profiles and materials for applications.

Product Range Summary

Table 26 Static Seals

Seal	Features	Application							
		Move- ment	Pressure Direction	Piston	Rod	Speed Limit	Temperature Range*	Pressure**	
O-Rings 	Versatile multi-purpose seal - Available in a wide range of materials and sizes - Used as an energizer with Turcon® PTFE based seals	R	S	B	Yes	3.3 ft/s 1 m/s	-49 °F to +617 °F -45 °C to +325 °C depending on material	1,500 psi 10 MPa With Back-up Rings	
Turcon® Back-up Ring 	- Spiral - Solid - Scarf-cut	R	S	B	Yes	-	-49 °F to +500 °F -45 °C to +260 °C	5,800 psi 40 MPa (36,260 psi 250 MPa with special Back-up Ring)	
Bonded Seals 	Elastomer sealing lip bonded to metal part - Seal bolted connections and mounted elements - Cost-effective solution for bolt/thread sealing - Large range of elastomers and metals	S		U	NA	NA	0	-40 °F to +480 °F -40 °C to +250 °C depending on elastomer	29,000 psi 200 MPa
Turcon® Variseal® HF 	Maximizes performance in face seal applications - For demanding conditions - Internal and external designs - Superior low friction	S		Inner / Outer Pressure	NA	NA	NA	-148 °F to +392 °F -100 °C to +200 °C	5,801 psi 40 MPa dynamic 11,603 psi 80 MPa static (30,000 psi 207 MPa static with Back-up Ring)
Wills Rings® C 	The original metal O-Rings - Operate in extremes of pressure and temperature - Corrosion resistant - Compatible with most media - Available in a wide range of sizes	S		Internal / External	NA	NA	0	Cryogenic to 1,550 °F 850 °C	Ultra high vacuum to 145,000 psi 1,000 MPa

KEY TO MOVEMENT:

Reciprocating = R

Rotary = T

Oscillating = O

Helix = H

Static = S

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = U

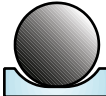
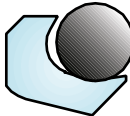
Double acting (Bidirectional) = B

* Temperature range is dependent upon material selection.

** Pressure is dependent upon material and gap dimension. Avoid combining extreme limits.

Product Range Summary

Table 27 Linear Seals

Seal	Features	Application							
		Move- ment		Pressure Direction	Piston	Rod	Speed Limit	Temperature Range*	Pressure**
Turcon® T-Seal 	Excellent static seal - Geometry prevents spiraling or rolling of seal during installation and use	R	S	B	Yes	Yes	3.3 ft/s 1 m/s	-49 °F to +500 °F -45 °C to +260 °C	10,000 psi 69 MPa (20,000 psi 138 MPa)
Turcon® Wedgpak® 	Symmetrical seal with zero-leakage - Low-friction - Excellent extrusion and wear resistance - Preferred elastomer contact dynamic seal	R	S	B	Yes	Yes	9.8 ft/s 3 m/s	-49 °F to +500 °F -45 °C to +260 °C	10,000 psi 69 MPa (30,000 psi 207 MPa in Wedgpak® CR configuration)
Turcon® Double Delta® 	The original slipper seal design - No stick-slip - Cost-effective - Can be made to suit any O-Ring groove size	R	S	B	Yes	Yes	50 ft/s 15 m/s	-49 °F to +392 °F -45 °C to +200 °C	5,076 psi 35 MPa (15,000 psi, 103 MPa with Back-up Ring)
Turcon® VL Seal® 	High performance uni-directional rod seal - Low friction - Leak-tight	R	S	U	No	Yes	50 ft/s 15 m/s	-65 °F to +392 °F -54 °C to +200 °C	7,252 psi 50 MPa (10,000 psi 69 MPa with Zurcon® Back-up Ring)
		T							
Turcon® Glyd Ring® & Glyd Ring® T  	- Optimum slipper seal - Low-friction - Long service life - Saves space by using narrow groove	R	S	B	Yes	Yes	50 ft/s 15 m/s	-49 °F to +392 °F -45 °C to +200 °C	7,252 psi 50 MPa
		T							
		O							
		H							
Turcon® Captive Glyd Ring® 	Captive version of Turcon Glyd Ring® - Designed to be used where mating surfaces have dimensional changes	R		B	Yes	Yes	50 ft/s 15 m/s	-49 °F to +392 °F -45 °C to +200 °C	5,800 psi 40 MPa
		O							

KEY TO MOVEMENT:

Reciprocating = R

Rotary = T

Oscillating = O

Helix = H

Static = S

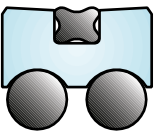
KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = U

Double acting (Bidirectional) = B

* Temperature range is dependent upon material selection.

** Pressure is dependent upon material and gap dimension. Avoid combining extreme limits.

Product Range Summary

Turcon® AQ-Seal® 5 	- Excellent sealability between gas and oil - Low-friction and leak-tight	R	S								7,252 psi 50 MPa (15,000 psi, 103 MPa with corner reinforcement)
Turcon® Stepseal® 2K 	Excellent primary seal - High-pressure capability - Pressure relieving effect	R									7,252 psi 50 MPa
V-Stack® 	Proven multi-lip seal stack, uni-directional, rod and piston configuration - Resistant to abrasive media - Resilient to imperfect surface finishes - Very robust	R	S								30,000 psi 207 MPa with custom components
Turcon® Variseal® 	- Spring-energized lip seal - Wide temperature range - Chemical resistance optimized	R									6,527 psi 45 MPa dynamic, 8,702 psi 60 MPa static (30,000 psi 207 MPa with back-up ring)
Turcon® Excluder 	- Scraper Seal to prevent contaminants causing damage to seal system - Compact Design - Excluder® 2 for standard design - Excluder® 5 for heavy duty applications	R									-

KEY TO MOVEMENT:

Reciprocating = R

Rotary = T

Oscillating = O

Helix = H

Static = S

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = U

Double acting (Bidirectional) = B

* Temperature range is dependent upon material selection.

** Pressure is dependent upon material and gap dimension. Avoid combining extreme limits.

Product Range Summary

Table 28 Rotary Seals

Seal	Features	Application						
		Move- ment	Pressure Direction	Piston	Rod	Speed Limit	Temperature Range*	Pressure**
Turcon® Roto Glyd Ring® 	- Rotary seal - Low speed - High-pressure	R	B	Yes	Yes	6.5 ft/s 2.0 m/s	-49 °F to +392 °F -45 °C to +200 °C	4,000 psi 27.5 MPa
		T						
		O						
		H						
Turcon® Roto Variseal® 	Original spring energized rotary seal - Low breakout friction - Wide operating temperature range - Excellent chemical compatibility - Anti-rotation flange	T R	U	No	Yes	Recipro- cating up to 33 ft/s / 10 m/s Rotating up to 6.5 ft/s / 2m/s	-94 °F to +500 °F -70 °C to +260 °C	2,900 psi 20 MPa dynamic (3,626 psi 25 MPa static)
		O						
		H						
Turcon® Varilip® PDR 	- Rotary seal - Low-friction - Dry running capability - Chemical resistance optimized - Outperforms traditional Oil seals	T	U	No	Yes	300 ft/s 90.0 m/s	-76 °F to +392 °F -60 °C to +200 °C	145 psi 1 MPa
		O						
		H						

KEY TO MOVEMENT:

Reciprocating = R

Rotary = T

Oscillating = O

Helix = H

Static = S

KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = U

Double acting (Bidirectional) = B

* Temperature range is dependent upon material selection.

** Pressure is dependent upon material and gap dimension. Avoid combining extreme limits.

Product Range Summary

Table 29 Slydring®

Bearings	Features	Application							
		Move- ment		Pressure Direction	Piston	Rod	Speed Limit	Temperature Range*	Pressure**
Turcite® Slydring® Orkot® Wear Ring Zurcon® Wear Ring 	- High load bearing capability - Wear resistant - No rod scoring - Protects seals	R	S	B	Yes	Yes	Depend- ing upon material choice	-321 °F to +482 °F -196 °C to +250 °C	-
		T							
		O							
		H							
Custom Wear Ring 	- Medium load bearing capability - Excellent chemical compatibility - Creep resistance - Very good thermal properties - Wear resistant	R	S	B	Yes	Yes	Depend- ing upon material choice	-321 °F to +482 °F -196 °C to +250 °C	-
		T							
		O							
		H							

KEY TO MOVEMENT:

Reciprocating = R

Rotary = T

Oscillating = O

Helix = H

Static = S

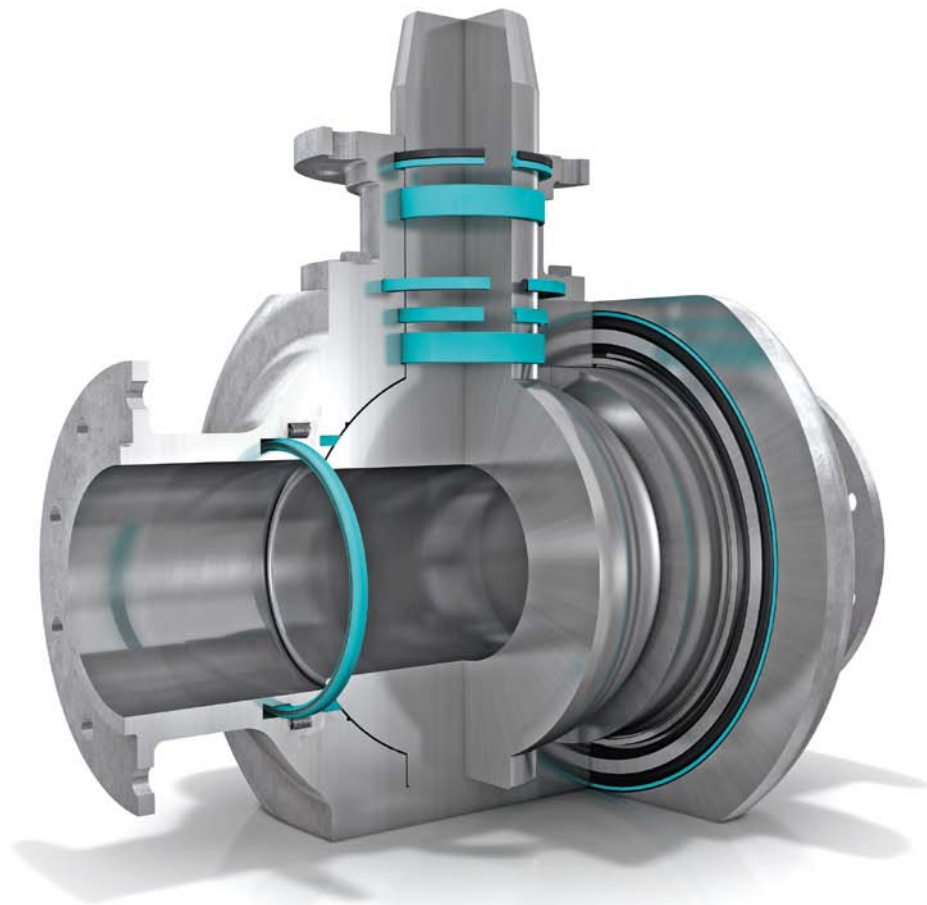
KEY TO PRESSURE DIRECTION: Single acting (Unidirectional) = U

Double acting (Bidirectional) = B

* Temperature range is dependent upon material selection.

** Pressure is dependent upon material and gap dimension. Avoid combining extreme limits.

Static Seals



O-Rings



Features and benefits

Versatile sealing element

Cost-effective in a wide range of primarily static applications

Simple one-piece groove design minimizes hardware and design costs

Compact design allows smaller hardware

Easy installation

Compounds specifically engineered for oil & gas applications provide broad chemical compatibility

Many sizes available from stock worldwide

O-Rings

Description

O-Rings are produced by molding and are characterized by their circular or torus form. The dimensions of O-Rings are defined by their inside diameter and cross section.

Efficient production methods and ease of use have made O-Rings the most widely used seals. They offer the designer an efficient, versatile and economical sealing element for a wide range of static and very light-duty dynamic applications.

O-Rings can be produced in a wide choice of elastomer materials. Compounds are available that are compatible with virtually all media commonly used in oil & gas applications.

Cross sections of .013 in / 0.35 mm up to 1.6 in / 40 mm and inside diameters of up to 196 in / 50 m and more are available. Large diameter O-Rings can be produced by Trelleborg Sealing Solutions FlexiMold™ process without the need for a dedicated tool, minimizing lead times and costs.

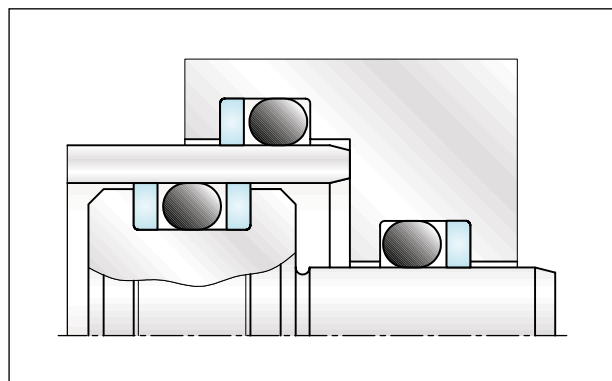


Figure 22 Typical O-Ring Application

In addition, O-Rings can be manufactured in Zurcon® polyurethane in hardness 70 to 90 Shore A. These demonstrate high wear and extrusion resistance with low friction.

O-Rings are available to meet ISO 3601, AS 568 and other recognized standards. Special sizes are also available though tooling may be required. Large diameter O-Rings can be supplied using our FlexiMold™ process.

Applications

O-Rings are used as sealing elements on their own or as energizing elements for hydraulic slipper seals and wipers. This means that they cover a large number of fields of application.

Typical oil & gas applications include:

- static seals on various types of downhole tools, valve covers, subsea manifolds
- energizers with Turcon® and Turcite® dynamic seals on drilling motors, subsea connectors, BOPs

O-Rings are not generally recommended in dynamic applications as they are limited by speed and the system pressure they are trying to seal against.

Method of Operation

O-Rings are double-acting sealing elements. The initial squeeze or compression acts in a radial or axial direction, depending on the application. This gives the O-Ring its initial sealing capability. These forces are increased by the system pressure to create the total sealing force. This increases as the system pressure increases.

Under pressure, the O-Ring behaves in a similar fashion to a fluid with high surface tension. The pressure is transmitted uniformly in all directions. The net result is efficient, reliable sealing performance.

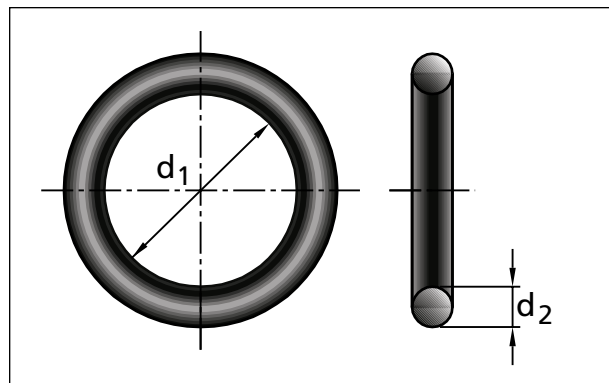


Figure 23 O-Ring Dimensioning

Trelleborg Sealing Solutions recommends O-Rings be used with Turcon® Back-up Rings at higher pressures.

O-Rings

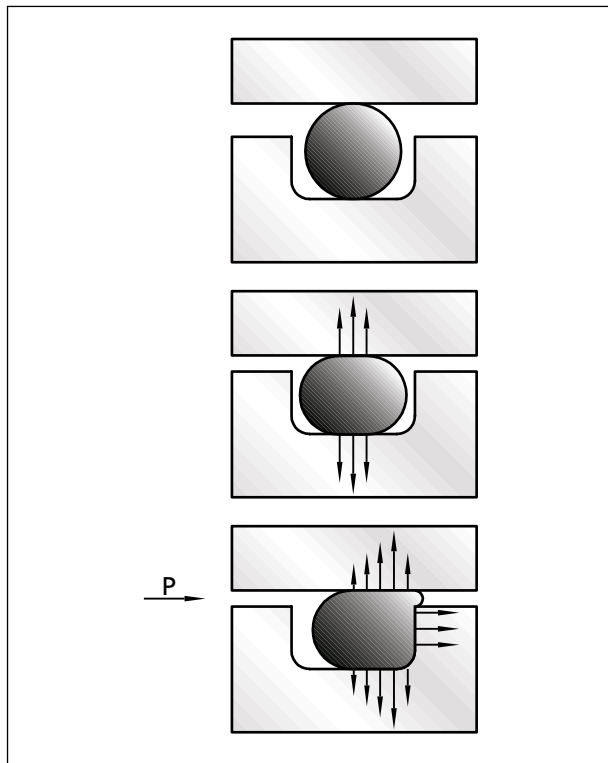


Figure 24 O-Ring Sealing Forces with and without System Pressure

Dynamic applications

Reciprocating up to 725 psi / 5 MPa without Back-up Ring

Higher pressures with Back-up Ring

Speed: Reciprocating up to 1.64 ft/s / 0.5 m/s
Rotating up to 1.64 ft/s / 0.5 m/s
Depending on material and application

Temperature: FROM -49 °F to +617 °F /
-45 °C to +305 °C
Depending on material and media resistance
Peak and continuous operating temperatures and running period should be taken into consideration when specifying material. For rotating applications the temperature increase due to frictional heat must be taken into account.

Media: Elastomer materials are available that are compatible with virtually all media and gases. To identify suitable elastomer types for a particular media use the Trelleborg Sealing Solutions online chemical compatibility check at www.tss.trelleborg.com

Technical data

O-Rings can be used in a wide range of applications. Temperature, pressure and media determine the choice of appropriate materials. In order to assess the suitability of an O-Ring as a sealing element for a given application, the interaction of all the operating parameters have to be taken into consideration.

Working Pressure

Static applications

Up to 725 psi / 5 MPa for O-Rings with inside diameter > 1.968 in / 50 mm without Back-up Ring

Up to 1,500 psi / 10 MPa for O-Rings with inside diameter < 1.968 in / 50 mm without Back-up Ring depending on the material, the cross section and clearance

Up to 5,800 psi / 40 MPa with Back-up Ring

Up to 36,260 psi / 250 MPa with special Back-up Ring

O-Rings

■ Installation Recommendations

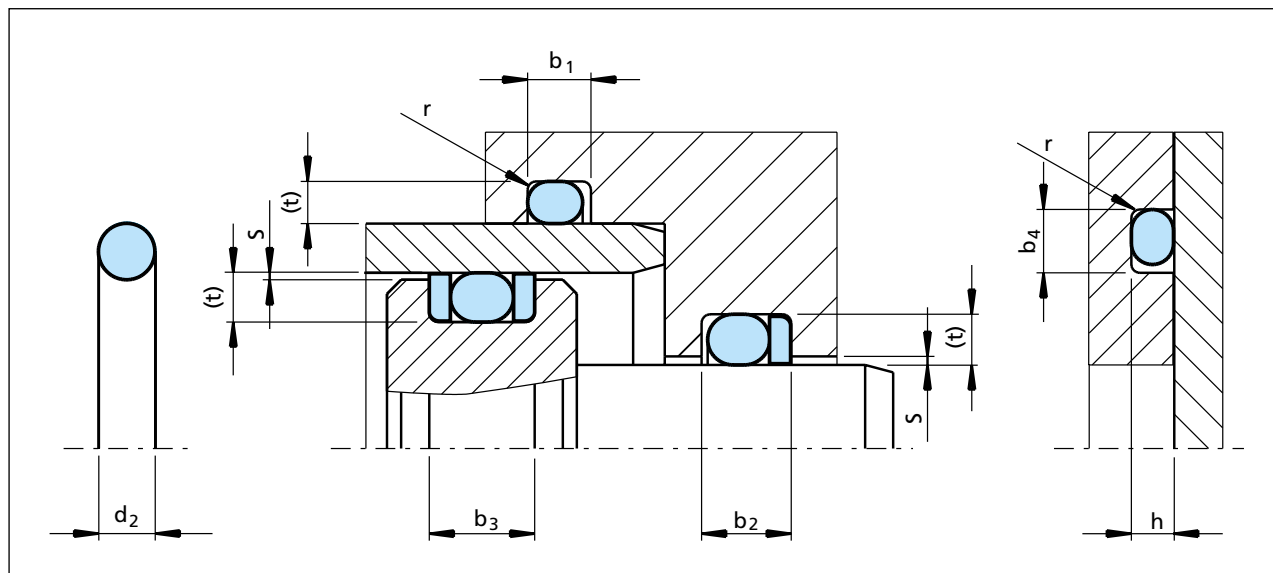


Figure 25 Installation drawing

Groove width b_2 and b_3 : When using Back-up Rings the groove is to be widened by the corresponding Back-up Ring thickness (b_2 : one Back-up Ring, b_3 : two Back-up Rings).

Table 30 Housing Dimensions

Cross section d_2	S	Radial installation			Axial installation		Radius ¹⁾
		Housing depth		Groove width	Groove depth	Groove width	
		Dynamic t	Static t	$b_1 + 0.25$	$h + 0.1$	$b_4 + 0.2$	
0.50	Consult Table 33 for diametrical clearance details	-	0.35	0.80	0.35	0.80	0.20
0.74		-	0.50	1.00	0.50	1.00	0.20
1.00		-	0.70	1.40	0.70	1.40	0.20
1.02		-	0.70	1.40	0.70	1.40	0.20
1.20		-	0.85	1.70	0.85	1.70	0.20
1.25		-	0.90	1.70	0.90	1.80	0.20
1.27		-	0.90	1.70	0.90	1.80	0.20
1.30		-	0.95	1.80	0.95	1.80	0.20
1.42		-	1.05	1.90	1.05	2.00	0.30
1.50		1.25	1.10	2.00	1.10	2.10	0.30
1.52		1.25	1.10	2.00	1.10	2.10	0.30
1.60		1.30	1.20	2.10	1.20	2.20	0.30
1.63		1.30	1.20	2.10	1.20	2.20	0.30
1.78*		1.45	1.30	2.40	1.30	2.60	0.30
1.80		1.45	1.30	2.40	1.30	2.60	0.30

O-Rings

Cross section	S	Radial installation			Axial installation		Radius ¹⁾
		Housing depth		Groove width	Groove depth	Groove width	
		Dynamic t	Static t	b ₁ +0.25	h +0.1	b ₄ +0.2	r± 0.2
d ₂							
1.83	Consult Table 33 for diametrical clearance details	1.50	1.35	2.50	1.35	2.60	0.30
1.90		1.55	1.40	2.60	1.40	2.70	0.30
1.98		1.65	1.50	2.70	1.50	2.80	0.30
2.00		1.65	1.50	2.70	1.50	2.80	0.30
2.08		1.75	1.55	2.80	1.55	2.90	0.30
2.10		1.75	1.55	2.80	1.55	2.90	0.30
2.20		1.85	1.60	3.00	1.60	3.00	0.30
2.26		1.90	1.70	3.00	1.70	3.10	0.30
2.30		1.95	1.75	3.10	1.75	3.10	0.30
2.34		1.95	1.75	3.10	1.75	3.10	0.30
2.40		2.05	1.80	3.20	1.80	3.30	0.30
2.46		2.10	1.85	3.30	1.85	3.40	0.30
2.50		2.15	1.90	3.30	1.85	3.40	0.30
2.62*		2.25	2.00	3.60	2.00	3.80	0.30
2.65		2.25	2.00	3.60	2.00	3.80	0.30
2.70		2.30	2.05	3.60	2.05	3.80	0.30
2.80		2.40	2.10	3.70	2.10	3.90	0.60
2.92		2.50	2.20	3.90	2.20	4.00	0.60
2.95		2.50	2.20	3.90	2.20	4.00	0.60
3.00		2.60	2.30	4.00	2.30	4.00	0.60
3.10		2.70	2.40	4.10	2.40	4.10	0.60
3.50		3.05	2.65	4.60	2.65	4.70	0.60
3.53*		3.10	2.70	4.80	2.70	5.00	0.60
3.55		3.10	2.70	4.80	2.70	5.00	0.60
3.60		3.15	2.80	4.80	2.80	5.10	0.60
4.00		3.50	3.10	5.20	3.10	5.30	0.60
4.50		4.00	3.50	5.80	3.50	5.90	0.60
5.00		4.40	4.00	6.60	4.00	6.70	0.60
5.30		4.70	4.30	7.10	4.30	7.30	0.60
5.33*		4.70	4.30	7.10	4.30	7.30	0.60
5.50		4.80	4.50	7.10	4.50	7.30	0.60
5.70		5.00	4.60	7.20	4.60	7.40	0.60
6.00		5.30	4.90	7.40	4.90	7.60	0.60
6.50		5.70	5.40	8.00	5.40	8.20	1.00
6.99*		6.10	5.80	9.50	5.80	9.70	1.00
7.00		6.10	5.80	9.50	5.80	9.70	1.00

O-Rings

Cross section d₂	S	Radial installation			Axial installation		Radius ¹⁾
		Housing depth		Groove width	Groove depth	Groove width	
		Dynamic t	Static t	b₁ +0.25	h +0.1	b₄ +0.2	r ± 0.2
7.50	Consult Table 33 for diametrical clearance details	6.60	6.30	9.70	6.30	9.90	1.00
8.00		7.10	6.70	9.80	6.70	10.00	1.00
8.40		7.50	7.10	10.00	7.10	10.30	1.00
9.00		8.10	7.70	10.60	7.70	10.90	1.50
9.50		8.60	8.20	11.00	8.20	11.40	1.50
10.00		9.10	8.60	11.60	8.60	12.00	2.00
12.00		11.00	10.60	13.50	10.60	14.00	2.00

 * Preferred sizes

¹⁾ If a Back-up Ring is used the recommended radius r should always be $r = 0.25 \pm 0.2\text{mm}$.

The given installation dimensions cannot be used for FFKM materials (Isolast®). Please use the Isolast® brochure or contact our specialists for further details.

O-Rings

■ Hardware Dimensions per ISO 3601 BORE

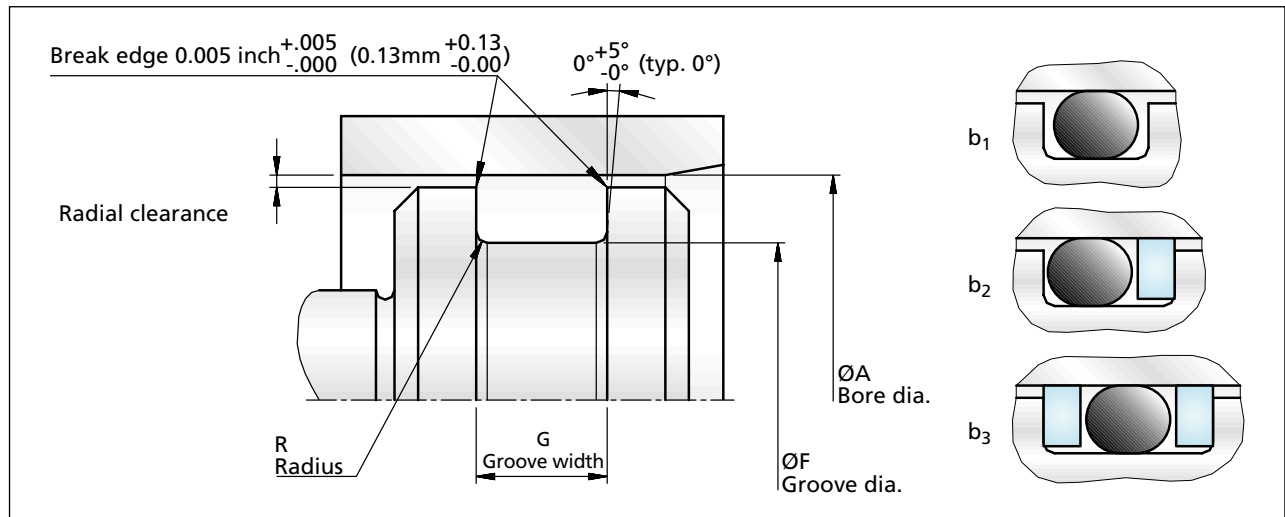


Figure 26 Installation Drawing for BORE

Groove width b_2 and b_3 : When using Back-up Rings the groove is to be widened by the corresponding Back-up Ring thickness (b_2 : one Back-up Ring, b_3 : two Back-up Rings).

Table 31 Groove Dimensions Bore

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)																							
	Inch							Metric																
Dash No	ØA Bore Dia H9	ØF Groove Dia h9	S	R Rad.	Groove Width +0.010 / -0.000			ØA Bore Dia H9	ØF Groove Dia h9	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section									
					b ₁	b ₂	b ₃				b ₁	b ₂	b ₃											
004	0.178	0.076	Consult Table 33 for dia- metrical clear- ance details	0.016 0.008	0.110	0.165	0.220	4.52	1.93	0.4 0.2	2.8			1.78	1.78									
005	0.209	0.107						5.31	2.72					2.57	1.78									
006	0.222	0.120						5.65	3.05					2.9	1.78									
007	0.253	0.151						6.43	3.84					3.68	1.78									
008	0.284	0.182						7.22	4.63					4.47	1.78									
009	0.317	0.215						8.04	5.45					5.28	1.78									
010	0.348	0.246						8.83	6.24					6.07	1.78									
011	0.410	0.308						10.42	7.83					7.65	1.78									
012	0.479	0.378						12.17	9.59					9.25	1.78									
013	0.542	0.441						13.77	11.20					10.82	1.78									
014	0.606	0.505						15.40	12.83					12.42	1.78									
015	0.672	0.570						17.06	14.49					14	1.78									
016	0.738	0.637						18.75	16.17					15.6	1.78									
017	0.801	0.700						20.35	17.78					17.17	1.78									
018	0.865	0.764						21.98	19.41					18.77	1.78									
019	0.929	0.831						23.59	21.12					20.35	1.78									
020	0.993	0.896						25.22	22.75					21.95	1.78									
021	1.056	0.959						26.83	24.36					23.52	1.78									
022	1.121	1.024						28.48	26.01					25.12	1.78									
023	1.184	1.087						30.08	27.62					26.7	1.78									
024	1.249	1.152						31.72	29.25					28.3	1.78									
025	1.313	1.217						33.35	30.91					29.87	1.78									
026	1.378	1.281						34.99	32.55					31.47	1.78									
027	1.441	1.345						36.60	34.16					33.05	1.78									
028	1.507	1.411						38.28	35.84					34.65	1.78									
110	0.528	0.372							0.016 0.008					0.150	0.205	0.260	13.41	9.44	0.4 0.2	3.8			9.19	2.62
111	0.595	0.439															15.12	11.14					10.77	2.62
112	0.659	0.503															16.75	12.77					12.37	2.62
113	0.724	0.568	18.40	14.42	13.94	2.62																		

■ Metric Sizes

O-Rings

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)														
	Inch							Metric							
Dash No	ØA	ØF	S	R Rad.	Groove Width			ØA	ØF	R Rad.	Groove Width			Inside Diameter	Cross Section
	Bore Dia H9	Groove Dia h9			+0.010 / -0.000			Bore Dia H9	Groove Dia h9		+0.25 / 0.00				
					b ₁	b ₂	b ₃				b ₁	b ₂	b ₃		
114	0.791	0.634	Consult Table 33 for dia-metrical clear-ance details	0.016 0.008	0.150	0.205	0.260	20.09	16.10	0.4 0.2	3.8	5.2	6.6	15.54	2.62
115	0.854	0.698						21.70	17.72					17.12	2.62
116	0.919	0.762						23.33	19.35					18.72	2.62
117	0.982	0.826						24.95	20.97					20.29	2.62
118	1.046	0.894						26.58	22.71					21.89	2.62
119	1.110	0.957						28.19	24.32					23.47	2.62
120	1.174	1.022						29.83	25.96					25.07	2.62
121	1.237	1.085						31.43	27.56					26.64	2.62
122	1.302	1.149						33.06	29.19					28.24	2.62
123	1.367	1.216						34.72	30.88					29.82	2.62
124	1.431	1.280						36.35	32.51					31.42	2.62
125	1.494	1.343						37.96	34.12					32.99	2.62
126	1.559	1.407						39.59	35.75					34.59	2.62
127	1.622	1.471						41.20	37.36					36.17	2.62
128	1.686	1.535						42.83	38.99					37.77	2.62
129	1.752	1.601						44.51	40.67					39.34	2.62
130	1.817	1.666						46.15	42.31					40.94	2.62
131	1.880	1.729						47.76	43.92					42.52	2.62
132	1.944	1.793						49.39	45.55					44.12	2.62
133	2.007	1.856						50.99	47.15					45.69	2.62
134	2.072	1.920						52.62	48.78					47.29	2.62
135	2.139	1.989						54.32	50.51					48.9	2.62
136	2.202	2.052						55.92	52.11					50.47	2.62
137	2.266	2.116						57.55	53.74					52.07	2.62
138	2.329	2.179		59.15	55.34	53.64	2.62								
139	2.393	2.243		60.79	56.98	55.25	2.62								
140	2.457	2.307		62.40	58.59	56.82	2.62								
141	2.524	2.374		64.11	60.30	58.42	2.62								
142	2.587	2.437		65.71	61.90	59.99	2.62								
143	2.652	2.502		67.35	63.54	61.6	2.62								
144	2.715	2.565		68.95	65.14	63.17	2.62								
145	2.779	2.629		70.59	66.78	64.77	2.62								
146	2.842	2.692		72.19	68.38	66.34	2.62								
147	2.909	2.759		73.88	70.07	67.95	2.62								
148	2.972	2.822		75.48	71.67	69.52	2.62								
149	3.036	2.886		77.11	73.30	71.12	2.62								
210	0.971	0.761		0.031 0.016	0.197	0.252	0.307	24.67	19.32	0.8 0.4	5	6.4	7.8	18.64	3.53
211	1.035	0.824						26.28	20.93					20.22	3.53
212	1.099	0.891						27.91	22.64					21.82	3.53
213	1.162	0.954						29.51	24.24					23.39	3.53
214	1.226	1.019						31.14	25.87					24.99	3.53
215	1.290	1.082						32.76	27.49					26.57	3.53
216	1.356	1.148						34.44	29.17					28.17	3.53
217	1.419	1.213						36.04	30.80					29.74	3.53
218	1.483	1.277						37.67	32.43					31.34	3.53
219	1.546	1.340						39.28	34.04					32.92	3.53
220	1.611	1.405						40.92	35.68					34.52	3.53
221	1.674	1.468						42.52	37.28					36.09	3.53
222	1.741	1.535						44.23	38.99					37.69	3.53
223	1.869	1.663						47.48	42.24					40.87	3.53
224	1.996	1.790						50.71	45.47					44.04	3.53
225	2.127	1.921						54.03	48.79					47.22	3.53
226	2.255	2.050						57.27	52.06					50.39	3.53
227	2.382	2.177						60.51	55.30					53.57	3.53
228	2.512	2.307						63.80	58.59					56.74	3.53
229	2.639	2.434						67.04	61.83					59.92	3.53
230	2.767	2.561						70.27	65.06					63.09	3.53
231	2.894	2.689						73.52	68.31					66.27	3.53
232	3.026	2.820						76.85	71.64					69.44	3.53
233	3.153	2.948						80.09	74.88					72.62	3.53
234	3.281	3.076						83.33	78.12					75.79	3.53
235	3.408	3.204						86.57	81.39					78.97	3.53

 Metric Sizes

O-Rings

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)																							
	Inch							Metric																
Dash No	ØA Bore Dia H9	ØF Groove Dia h9	S	R Rad.	Groove Width +0.010 / -0.000			ØA Bore Dia H9	ØF Groove Dia h9	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section									
					b ₁	b ₂	b ₃				b ₁	b ₂	b ₃											
236	3.536	3.332		0.031 0.016	0.197	0.252	0.307	89.81	84.63	0.8 0.4	5	6.4	7.8	82.14	3.53									
237	3.663	3.459						93.05	87.87					85.32	3.53									
238	3.791	3.587						96.28	91.10					88.49	3.53									
239	3.922	3.719						99.63	94.45					91.67	3.53									
240	4.050	3.846						102.86	97.68					94.84	3.53									
241	4.177	3.973						106.10	100.92					98.02	3.53									
242	4.305	4.101						109.34	104.16					101.19	3.53									
243	4.432	4.228						112.58	107.40					104.37	3.53									
244	4.562	4.358						115.87	110.69					107.54	3.53									
245	4.689	4.485						119.11	113.93					110.72	3.53									
246	4.817	4.613						122.34	117.16					113.89	3.53									
247	4.944	4.742						125.59	120.44					117.07	3.53									
325	1.843	1.526						Consult Table 33 for dia- metrical clear- ance details	0.031 0.016					0.283	0.354	0.429	46.81	38.77	0.8 0.4	7.2	9	10.9	37.47	5.33
326	1.970	1.654															50.04	42.00					40.64	5.33
327	2.098	1.781	53.28	45.24	43.82	5.33																		
328	2.225	1.909	56.52	48.48	46.99	5.33																		
329	2.356	2.041	59.84	51.83	50.17	5.33																		
330	2.483	2.168	63.08	55.07	53.34	5.33																		
331	2.611	2.296	66.32	58.31	56.52	5.33																		
332	2.738	2.423	69.55	61.54	59.69	5.33																		
333	2.868	2.553	72.85	64.84	62.87	5.33																		
334	2.995	2.680	76.08	68.07	66.04	5.33																		
335	3.123	2.807	79.32	71.31	69.22	5.33																		
336	3.250	2.935	82.56	74.55	72.39	5.33																		
337	3.378	3.064	85.80	77.82	75.57	5.33																		
338	3.509	3.195	89.14	81.16	78.74	5.33																		
339	3.637	3.323	92.38	84.40	81.92	5.33																		
340	3.764	3.450	95.61	87.63	85.09	5.33																		
341	3.892	3.578	98.86	90.88	88.27	5.33																		
342	4.023	3.709	102.19	94.21	91.44	5.33																		
343	4.151	3.837	105.44	97.46	94.62	5.33																		
344	4.278	3.964	108.67	100.69	97.79	5.33																		
345	4.406	4.092	111.91	103.93	100.97	5.33																		
346	4.533	4.219	115.15	107.17	104.14	5.33																		
347	4.663	4.349	118.44	110.46	107.32	5.33																		
348	4.791	4.476	121.68	113.70	110.49	5.33																		
349	4.918	4.604	124.92	116.94	113.67	5.33																		
425	5.031	4.607		0.047 0.031	0.374	0.484	0.594	127.80	117.02	1.2 0.8	9.5	12.3	15.1	113.67	6.99									
426	5.159	4.735						131.03	120.28					116.84	6.99									
427	5.287	4.863						134.28	123.53					120.02	6.99									
428	5.414	4.991						137.51	126.76					123.19	6.99									
429	5.546	5.122						140.86	130.11					126.37	6.99									
430	5.673	5.250						144.09	133.34					129.54	6.99									
431	5.800	5.377						147.33	136.58					132.72	6.99									
432	5.928	5.505						150.57	139.82					135.89	6.99									
433	6.056	5.632						153.81	143.06					139.07	6.99									
434	6.183	5.759						157.04	146.29					142.24	6.99									
435	6.311	5.887						160.29	149.54					145.42	6.99									
436	6.438	6.015						163.52	152.77					148.59	6.99									
437	6.565	6.142						166.76	156.01					151.77	6.99									
438	6.824	6.400						173.32	162.57					158.12	6.99									
439	7.079	6.656						179.80	169.05					164.47	6.99									
440	7.334	6.911						186.28	175.53					170.82	6.99									
441	7.589	7.167						192.75	182.04					177.17	6.99									
442	7.848	7.427						199.35	188.64					183.52	6.99									
443	8.104	7.682						205.83	195.12					189.87	6.99									
444	8.373	7.937						212.67	201.60					196.22	6.99									
445	8.628	8.192						219.15	208.07					202.57	6.99									
446	9.148	8.712						232.36	221.29					215.27	6.99									
447	9.658	9.222						245.31	234.25					227.97	6.99									
448	10.168	9.732						258.26	247.20					240.67	6.99									

Metric Sizes

O-Rings

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)														
	Inch							Metric							
Dash No	ØA Bore Dia H9	ØF Groove Dia h9	S	R Rad.	Groove Width +0.010 / -0.000			ØA Bore Dia H9	ØF Groove Dia h9	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section
					b ₁	b ₂	b ₃				b ₁	b ₂	b ₃		
449	10.677	10.244	Consult Table 33 for dia- metrical clear- ance details	0.047 0.031	0.374	0.484	0.594	271.20	260.19	1.2 0.8	9.5	12.3	15.1	253.37	6.99
450	11.193	10.758						284.30	273.26					266.07	6.99
451	11.703	11.269						297.25	286.22					278.77	6.99
452	12.213	11.778						310.21	299.17					291.47	6.99
453	12.723	12.296						323.16	312.32					304.17	6.99
454	13.229	12.800						336.01	325.12					316.87	6.99
455	13.743	13.310						349.07	338.07					329.57	6.99
456	14.263	13.830						362.28	351.29					342.27	6.99
457	14.773	14.341						375.23	364.25					354.97	6.99
458	15.283	14.850						388.19	377.20					367.67	6.99
459	15.793	15.360						401.14	390.15					380.37	6.99
460	16.303	15.872						414.09	403.15					393.07	6.99

 Metric Sizes

* For diametrical clearances, please contact your local Trelleborg Sealing Solutions marketing company.

O-Rings

■ Hardware Dimensions per ISO 3601 ROD

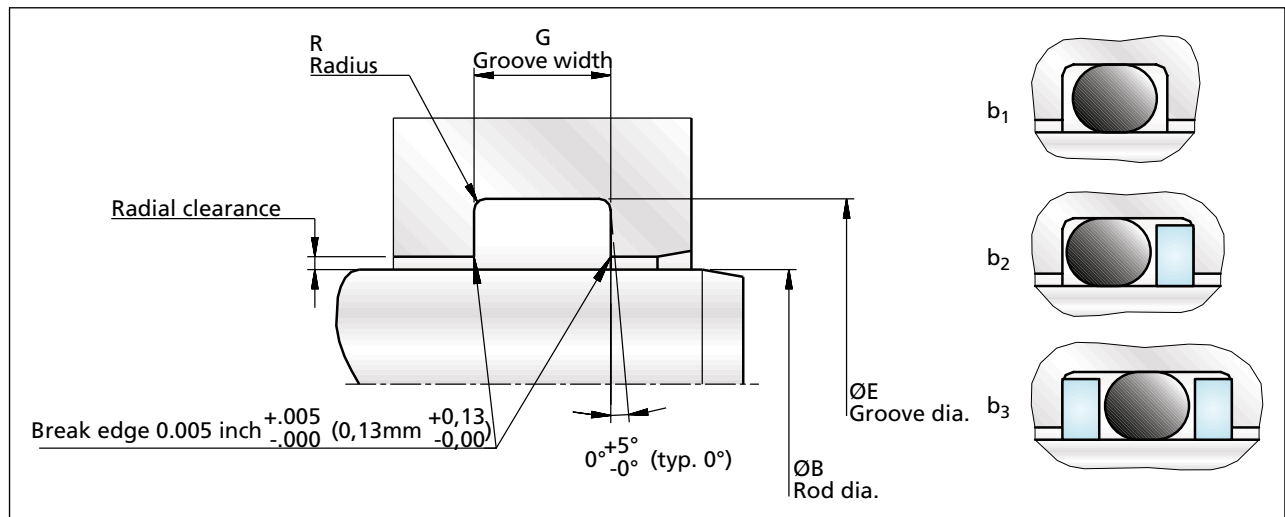


Figure 27 Installation Drawing for ROD

Groove width b_2 and b_3 : When using Back-up Rings the groove is to be widened by the corresponding Back-up Ring thickness (b_2 : one Back-up Ring, b_3 : two Back-up Rings).

Table 32 Groove Dimensions Rod

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)																	
	Inch							Metric										
Dash No	ØB Rod Dia h9	ØE Groove Dia H9	S Dia Clearance max	R Rad.	Groove Width +0.010 / -0.000			ØB Rod Dia h9	ØE Groove Dia H9	D Dia Clearance max	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section		
					b ₁	b ₂	b ₃					b ₁	b ₂	b ₃				
004	0.077	0.180	Consult Table 33 for diametrical clearance details	0.016 0.008	0.110	0.165	0.220	1.95	4.56		0.4 0.2	2.8			1.78	1.78		
005	0.109	0.213						2.76	5.40								2.57	1.78
006	0.124	0.226						3.16	5.75								2.9	1.78
007	0.152	0.256						3.87	6.50								3.68	1.78
008	0.185	0.289						4.70	7.35								4.47	1.78
009	0.217	0.321						5.50	8.15								5.28	1.78
010	0.248	0.354						6.30	9.00								6.07	1.78
011	0.315	0.421						8.00	10.70								7.65	1.78
012	0.374	0.480						9.50	12.20								9.25	1.78
013	0.441	0.547						11.20	13.90								10.82	1.78
014	0.504	0.608						12.80	15.45								12.42	1.78
015	0.571	0.676						14.50	17.17								14	1.78
016	0.634	0.736						16.10	18.70								15.6	1.78
017	0.693	0.795						17.60	20.20								17.17	1.78
018	0.760	0.861						19.30	21.88								18.77	1.78
019	0.827	0.924						21.00	23.46								20.35	1.78
020	0.886	0.986						22.50	25.05								21.95	1.78
021	0.949	1.048						24.10	26.62								23.52	1.78
022	1.012	1.110						25.70	28.20								25.12	1.78
023	1.075	1.172						27.30	29.78								26.7	1.78
024	1.142	1.235						29.00	31.38								28.3	1.78
025	1.201	1.296						30.50	32.92								29.87	1.78
026	1.266	1.359						32.15	34.52								31.47	1.78
027	1.327	1.421						33.70	36.10								33.05	1.78
110	0.374	0.535		0.016 0.008	0.150	0.205	0.260	9.50	13.60		0.4 0.2	3.8			9.19	2.62		
111	0.441	0.602						11.20	15.30						10.77	2.62		
112	0.504	0.665						12.80	16.90						12.37	2.62		
113	0.571	0.732						14.50	18.60						13.94	2.62		
114	0.630	0.791						16.00	20.10						15.54	2.62		

■ Metric Sizes

O-Rings

	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)															
	Inch							Metric								
Dash No	ØB Rod Dia h9	ØE Groove Dia H9	S Dia Clearance max	R Rad.	Groove Width +0.010 / -0.000			ØB Rod Dia h9	ØE Groove Dia H9	D Dia Clearance max	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section
					b ₁	b ₂	b ₃					b ₁	b ₂	b ₃		
115	0.697	0.854	Consult Table 33 for diametrical clearance details	0.016 0.008	0.150	0.205	0.260	17.70	21.70	0.4 0.2	3.8	5.2	6.6		17.12	2.62
116	0.760	0.921						19.30	23.40						18.72	2.62
117	0.827	0.984						21.00	25.00						20.29	2.62
118	0.886	1.047						22.50	26.60						21.89	2.62
119	0.945	1.102						24.00	28.00						23.47	2.62
120	1.012	1.173						25.70	29.80						25.07	2.62
121	1.075	1.236						27.30	31.40						26.64	2.62
122	1.142	1.299						29.00	33.00						28.24	2.62
123	1.201	1.358						30.50	34.50						29.82	2.62
124	1.264	1.421						32.10	36.10						31.42	2.62
125	1.339	1.484						34.00	37.70						32.99	2.62
126	1.398	1.547						35.50	39.30						34.59	2.62
127	1.457	1.606						37.00	40.80						36.17	2.62
128	1.516	1.669						38.50	42.40						37.77	2.62
129	1.583	1.728						40.20	43.90						39.34	2.62
130	1.646	1.791						41.80	45.50						40.94	2.62
131	1.709	1.854						43.40	47.10						42.52	2.62
132	1.772	1.917						45.00	48.70						44.12	2.62
133	1.835	1.980						46.60	50.30						45.69	2.62
134	1.898	2.043						48.20	51.90						47.29	2.62
210	0.760	0.976	Consult Table 33 for diametrical clearance details	0.031 0.016	0.197	0.252	0.307	19.30	24.80	0.8 0.4	5	6.4	7.8		18.64	3.53
211	0.827	1.043						21.00	26.50						20.22	3.53
212	0.886	1.101						22.50	27.97						21.82	3.53
213	0.949	1.165						24.10	29.60						23.39	3.53
214	1.012	1.228						25.70	31.20						24.99	3.53
215	1.071	1.287						27.20	32.70						26.57	3.53
216	1.134	1.350						28.80	34.30						28.17	3.53
217	1.197	1.411						30.40	35.85						29.74	3.53
218	1.260	1.474						32.00	37.45						31.34	3.53
219	1.323	1.539						33.60	39.10						32.92	3.53
220	1.390	1.600						35.30	40.65						34.52	3.53
221	1.449	1.661						36.80	42.20						36.09	3.53
222	1.516	1.726						38.50	43.85						37.69	3.53
223	1.654	1.861						42.00	47.28						40.87	3.53
224	1.772	1.984						45.00	50.40						44.04	3.53
225	1.898	2.108						48.20	53.54						47.22	3.53
226	2.028	2.232						51.50	56.70						50.39	3.53
227	2.154	2.358						54.70	59.89						53.57	3.53
228	2.283	2.480						58.00	63.00						56.74	3.53
229	2.406	2.606						61.10	66.19						59.92	3.53
230	2.531	2.731	64.30	69.36	63.09	3.53										
325	1.516	1.843	Consult Table 33 for diametrical clearance details	0.031 0.016	0.283	0.354	0.429	38.50	46.80	0.8 0.4	7.2	9	10.9		37.47	5.33
326	1.634	1.961						41.50	49.80						40.64	5.33
327	1.772	2.098						45.00	53.30						43.82	5.33
328	1.890	2.217						48.00	56.30						46.99	5.33
329	2.016	2.343						51.20	59.50						50.17	5.33
330	2.142	2.469						54.40	62.70						53.34	5.33
331	2.266	2.594						57.55	65.90						56.52	5.33
332	2.402	2.728						61.00	69.30						59.69	5.33
333	2.524	2.850						64.10	72.40						62.87	5.33
334	2.648	2.976						67.25	75.60						66.04	5.33
335	2.772	3.098						70.40	78.70						69.22	5.33
336	2.898	3.224						73.61	81.90						72.39	5.33
337	3.031	3.356						77.00	85.25						75.57	5.33
338	3.157	3.481						80.20	88.42						78.74	5.33
339	3.287	3.606						83.50	91.60						81.92	5.33
340	3.409	3.730						86.60	94.75						85.09	5.33
341	3.543	3.857						90.00	97.97						88.27	5.33
342	3.665	3.978						93.10	101.04						91.44	5.33
343	3.795	4.103						96.40	104.22						94.62	5.33

Metric Sizes

O-Rings

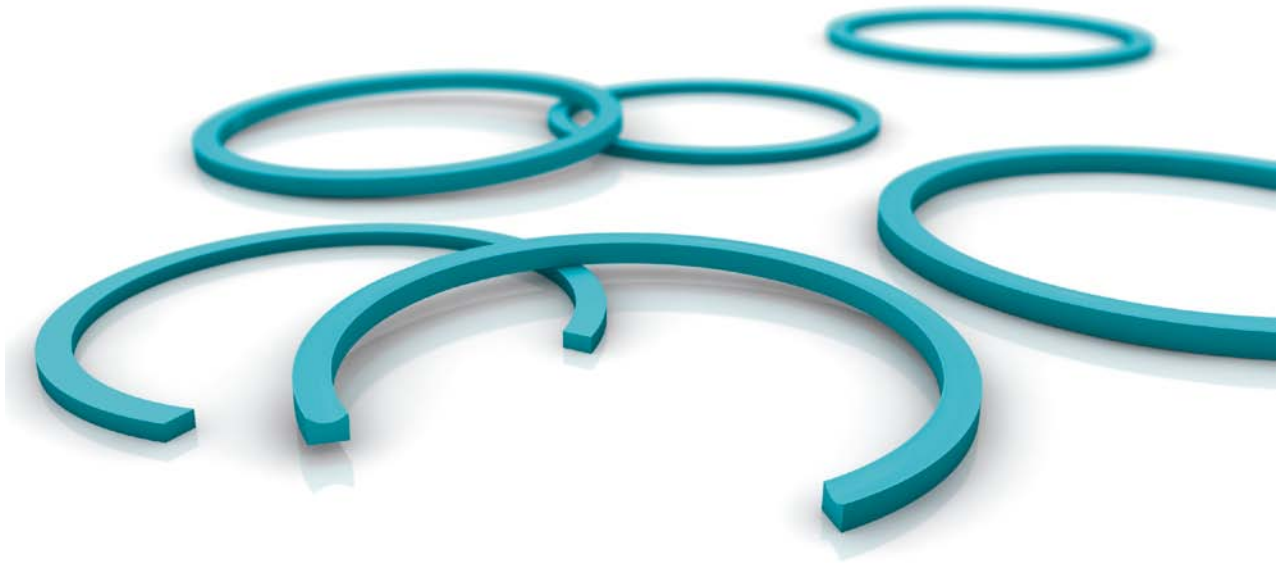
	Bore Sizes per BS ISO 3601-2:2008 (Static Housings)															
	Inch							Metric								
Dash No	ØB Rod Dia h9	ØE Groove Dia H9	S Dia Clearance max	R Rad.	Groove Width +0.010 / -0.000			ØB Rod Dia h9	ØE Groove Dia H9	D Dia Clearance max	R Rad.	Groove Width +0.25 / 0.00			Inside Diameter	Cross Section
	b ₁	b ₂	b ₃		b ₁	b ₂	b ₃									
344	3.921	4.228	Consult Table 33 for diametrical clearance details	0.031 0.016	0.283	0.354	0.429	99.60	107.39		0.8 0.4	7.2	9	10.9	97.79	5.33
345	4.047	4.353						102.80	110.57						100.97	5.33
346	4.173	4.478						106.00	113.74						104.14	5.33
347	4.297	4.601						109.15	116.87						107.32	5.33
348	4.421	4.726						112.30	120.03						110.49	5.33
349	4.547	4.851						115.50	123.21						113.67	5.33
	0.000	0.000														
425	4.555	4.976		0.047 0.031	0.374	0.484	0.594	115.70	126.40		1.2 0.8	9.5	12.3	15.1	113.67	6.99
426	4.685	5.102						119.00	129.58						116.84	6.99
427	4.803	5.227						122.00	132.76						120.02	6.99
428	4.933	5.352						125.30	135.93						123.19	6.99
429	5.059	5.473						128.50	139.01						126.37	6.99

Metric Sizes

Table 33 Radial clearance S

O-Ring cross section d ₂	up to 2	2 - 3	3 - 5	5 - 7	above 7
O-Rings with hardness of 70 Shore A					
Pressure MPa	Radial clearance S				
≤ 3.50	0.08	0.09	0.10	0.13	0.15
≤ 7.00	0.05	0.07	0.08	0.09	0.10
≤ 10.50	0.03	0.04	0.05	0.07	0.08
O-Rings with hardness of 90 Shore A					
Pressure MPa	Radial clearance S				
≤ 3.50	0.13	0.15	0.20	0.23	0.25
≤ 7.00	0.10	0.13	0.15	0.18	0.20
≤ 10.50	0.07	0.09	0.10	0.13	0.15
≤ 14.00	0.05	0.07	0.08	0.09	0.10
≤ 17.50	0.04	0.05	0.07	0.08	0.09
≤ 21.00	0.03	0.04	0.05	0.07	0.08
≤ 35.00	0.02	0.03	0.03	0.04	0.04

Back-up Ring



Features and benefits

Prevents O-Ring extrusion

Prolongs O-Ring service life

Allows O-Rings to be utilized in higher pressure applications, where larger extrusion gaps are required and where there are reciprocating or rotating movements

Compatible with virtually all media and gases

Easy installation

Wide range of geometries to meet the needs of all applications

Sizes to meet all standards

Non-standard sizes also available

Back-up Ring

Back-up Ring

Description

Back-up Rings are protective and supporting elements with no sealing function. Made from extrusion-resistant materials such as Turcon®, Zurcon®, Hi-Mod® or PEEK they usually have a rectangular cross section and are installed in a groove with an elastomer O-Ring. Due to their tight fit in the housing, Back-up Rings prevent extrusion of the pressurized elastomer sealing element into the clearance or extrusion gap.

Using Back-up Rings allows O-Rings to be utilized in higher pressure applications, where larger extrusion gaps are required and where there are reciprocating or rotating movements. They also compensate for large temperature fluctuations.

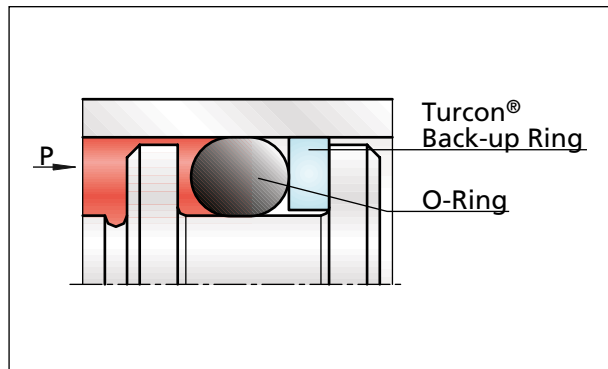


Figure 28 Turcon® Back-up Ring

Method of Operation

The Back-up Ring is installed between the O-Ring and the groove wall, separating the O-Ring from the clearance gap.

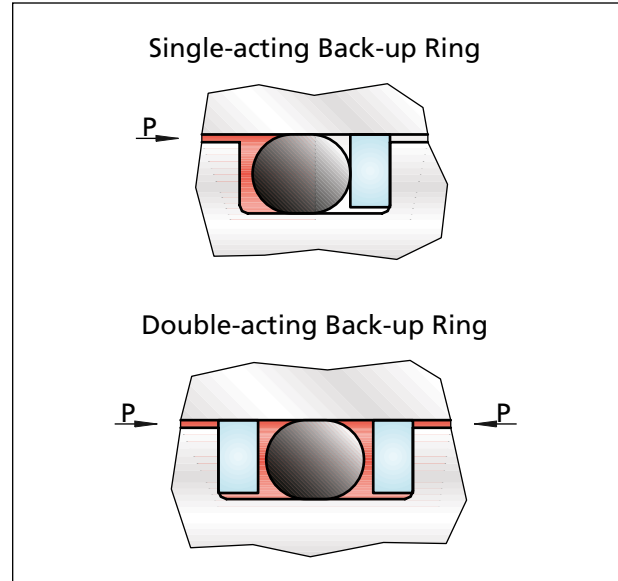


Figure 29 Single-acting and double-acting sealing configurations with Back-up Rings

Back-up Ring

Technical Data

Operating pressure:

- 5,800 psi / 40 MPa
- 36,260 psi / 250 MPa for special versions

Speed: 6.5 ft/s / 2 m/s

Temperature range: -49 °F to +500 °F /
-45 °C to +260 °C

Clearance: As per ISO 3601

Media: Compatible with virtually all media and gases

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Materials

Standard material for Back-up Rings is Turcon® T01, Virgin PTFE. Stronger materials are available for specific applications.

Ordering

O-Ring must be ordered separately from Back-up Ring.

Guidelines for Gap, Pressure and Size

Back-up Rings must be used if the pressures given in the adjacent tables are exceeded.

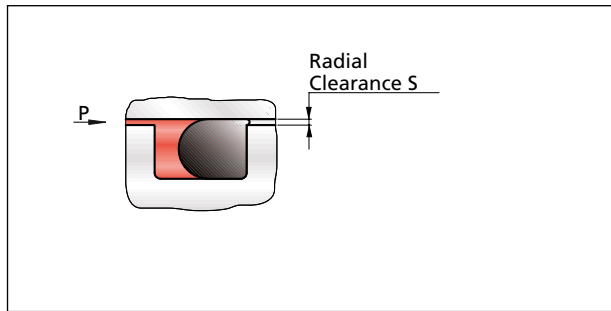


Figure 30 Radial Clearance

Table 34 Radial Clearance Size S for 70 Shore Hardness

Series	O-Ring Cross Section inch mm	Radial Clearance S inch mm		
		500 psi 3.5 Mpa	1,000 psi 7 Mpa	1,500 psi 10.5 Mpa
000	0.070 1.78	0.003 0.08	0.002 0.05	0.001 0.03
100	0.103 2.62	0.004 0.09	0.003 0.07	0.002 0.04
200	0.139 3.53	0.004 0.10	0.003 0.08	0.002 0.05
300	0.210 5.33	0.005 0.13	0.004 0.09	0.003 0.07
400	0.276 6.99	0.006 0.15	0.004 0.10	0.003 0.08

Table 35 Radial Clearance Size S for 90 Shore Hardness

Series	O-Ring Cross Section inch mm	Radial Clearance S inch mm				
		500 psi 3.5 MPa	1,000 psi 7 MPa	1,500 psi 10.5 MPa	2,000 psi 14 MPa	2,500 psi 17.5 MPa
000	0.070 1.78	0.005 0.13	0.004 0.10	0.003 0.07	0.002 0.05	0.002 0.04
100	0.103 2.62	0.006 0.15	0.005 0.13	0.004 0.09	0.003 0.07	0.002 0.05
200	0.139 3.53	0.008 0.20	0.006 0.15	0.004 0.10	0.003 0.08	0.002 0.07
300	0.210 5.33	0.009 0.23	0.007 0.18	0.005 0.13	0.003 0.08	0.003 0.07
400	0.276 6.99	0.010 0.25	0.008 0.20	0.006 0.15	0.004 0.10	0.004 0.09

* For pressures exceeding 10,000 psi / 68 MPa, please contact your local Trelleborg Marketing company.

For detailed installation recommendations refer to the Back-up Ring section of the Trelleborg Sealing Solutions O-Rings and Back-Up Rings catalog.



Back-up Ring

Design instructions

The recommendations for O-Rings (see O-Rings-catalog) are generally valid for the use of Back-up Rings. This applies to the groove design, surface roughness, lead-in chamfers, etc.

When the pressure is applied from one side only, it is sufficient to install a Back-up Ring on the downstream side of the O-Ring. When the seal is exposed to pressure from both sides, two Back-up Rings, one on each side of the O-Ring, have to be used.

Permissible sealing gap

The use of Back-up Rings allows the service pressure and/or permissible sealing gap as specified in our O-Ring catalog to be increased.

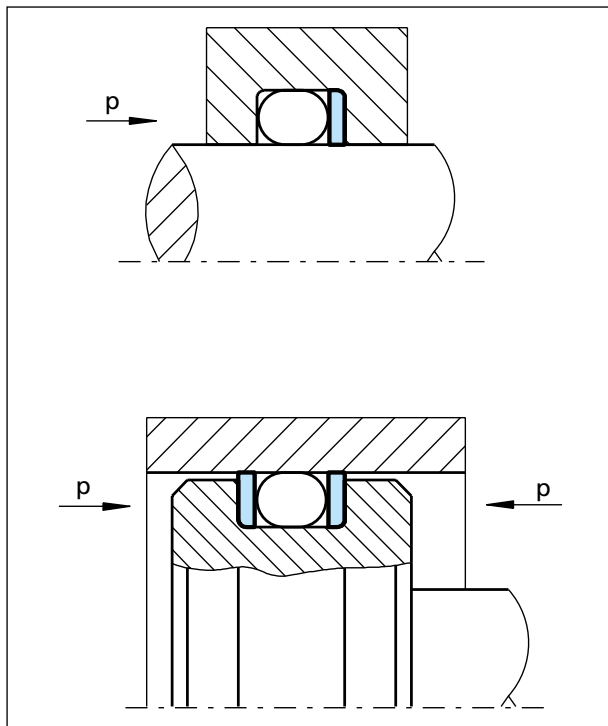


Figure 31 Back-up Ring installation, depending on the direction of the pressure

Note: If any additional information is required on O-Rings and Back-up Rings please refer to the Trelleborg Sealing Solutions O-Rings and Back-Up Rings catalog.

Back-up Ring

■ Installation recommendations static and dynamic applications

EXTERNAL SEALING (Bore), type BV (uncut) and type BH (cut), material PTFE

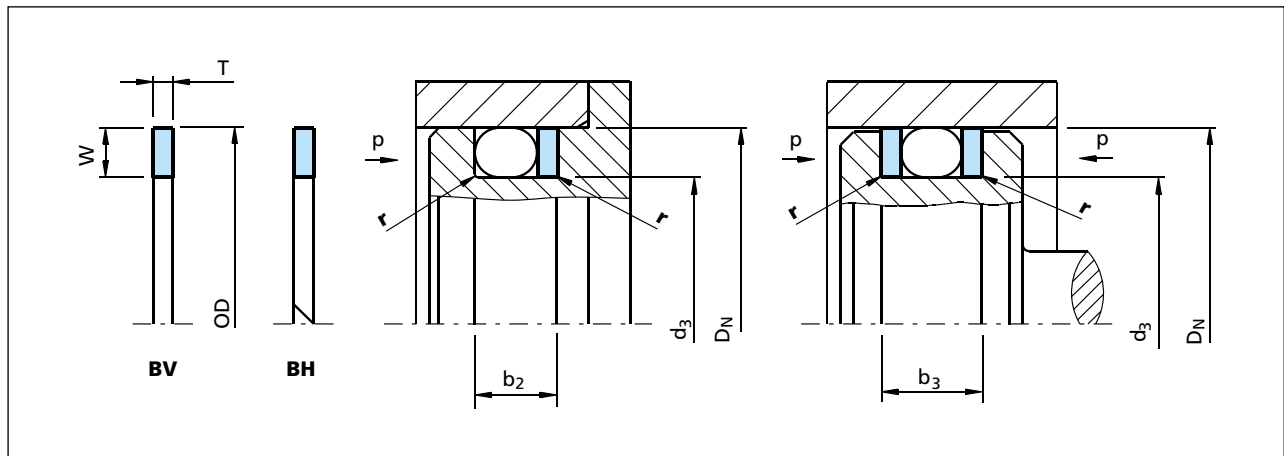


Figure 32 Installation drawing

Table 36 Installation Dimensions – Standard Recommendations

O-Ring cross section d_2	Back-up Ring cross section			Groove dimensions				
	Radial height W		Thickness T	Groove diameter		Groove width		Radius $r \pm 0.2$
	Dynamic	Static		Dynamic $d_N - 2.5$	Static $d_N - 2.2$	$b_2 + 0.2$	$b_3 + 0.2$	
1.50	1.25	1.10	1.0	$D_N - 2.5$	$D_N - 2.2$	3.0	4.0	0.25
1.60	1.30	1.20	1.0	$D_N - 2.6$	$D_N - 2.4$	3.1	4.1	0.25
1.78	1.45	1.30	1.4	$D_N - 2.9$	$D_N - 2.6$	3.8	5.2	0.25
1.80	1.45	1.30	1.4	$D_N - 2.9$	$D_N - 2.6$	3.8	5.2	0.25
2.00	1.65	1.50	1.4	$D_N - 3.3$	$D_N - 3.0$	4.1	5.5	0.25
2.40	2.05	1.80	1.4	$D_N - 4.1$	$D_N - 3.6$	4.6	6.0	0.25
2.50	2.15	1.90	1.4	$D_N - 4.3$	$D_N - 3.8$	4.7	6.1	0.25
2.62	2.25	2.00	1.4	$D_N - 4.5$	$D_N - 4.0$	5.0	6.4	0.25
2.65	2.25	2.00	1.4	$D_N - 4.5$	$D_N - 4.0$	5.0	6.4	0.25
3.00	2.60	2.30	1.4	$D_N - 5.2$	$D_N - 4.6$	5.4	6.8	0.25
3.53	3.10	2.70	1.4	$D_N - 6.2$	$D_N - 5.4$	6.2	7.6	0.25
3.55	3.10	2.70	1.4	$D_N - 6.2$	$D_N - 5.4$	6.2	7.6	0.25
4.00	3.50	3.10	1.7	$D_N - 7.0$	$D_N - 6.2$	6.9	8.6	0.25
5.00	4.40	4.00	1.7	$D_N - 8.8$	$D_N - 8.0$	8.3	10.0	0.25
5.30	4.70	4.30	1.7	$D_N - 9.4$	$D_N - 8.6$	9.0	10.9	0.25
5.33	4.70	4.00	1.7	$D_N - 9.4$	$D_N - 8.0$	9.0	10.9	0.25
5.70	5.00	4.60	1.7	$D_N - 10.0$	$D_N - 9.2$	9.0	11.0	0.25
6.00	5.30	4.90	1.7	$D_N - 10.6$	$D_N - 9.8$	9.3	11.2	0.25
6.99	6.10	5.40	2.5	$D_N - 12.2$	$D_N - 10.8$	12.3	15.1	0.25
8.00	7.10	6.70	2.5	$D_N - 14.2$	$D_N - 13.4$	12.6	15.4	0.25
8.40	7.50	7.10	2.5	$D_N - 15.0$	$D_N - 14.2$	12.8	15.6	0.25

■ Preferred sizes according to ISO-3601

Back-up Ring

■ Installation recommendations static and dynamic applications

INTERNAL SEALING (Rod), type BB (uncut) and type BC (cut), material PTFE

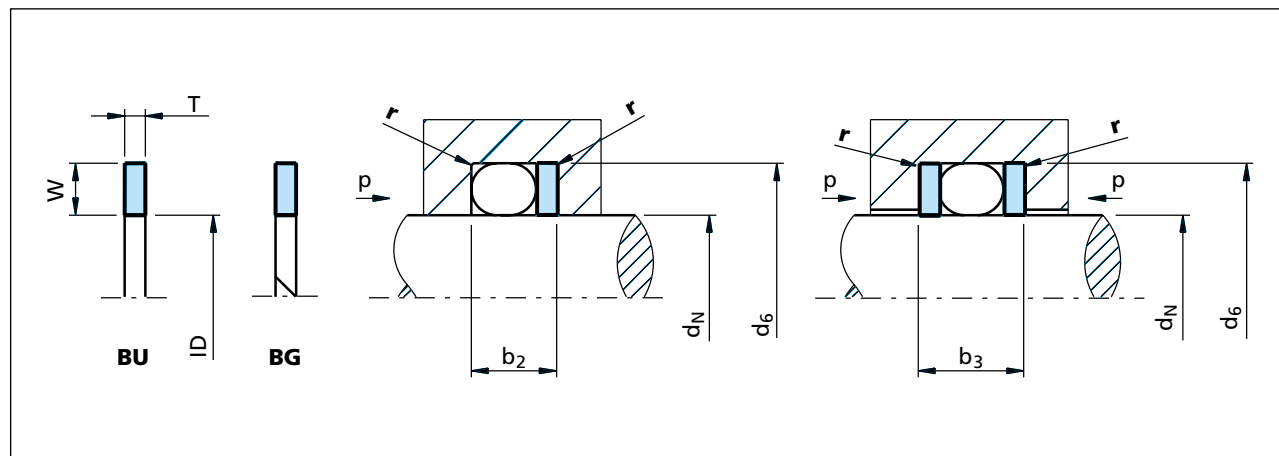


Figure 33 Installation drawing

Table 37 Installation Dimensions – Standard Recommendations

O-Ring cross section d_2	Back-up Ring cross section			Groove dimensions				
	Radial height W		Thickness	Groove diameter		Groove width		Radius
	Dynamic	Static	T	Dynamic d_6 H9	Static d_6 H9	$b_2 + 0.2$	$b_3 + 0.2$	$r \pm 0.2$
1.50	1.25	1.10	1.0	$d_N + 2.5$	$d_N + 2.2$	3.0	4.0	0.25
1.60	1.30	1.20	1.0	$d_N + 2.6$	$d_N + 2.4$	3.1	4.1	0.25
1.78	1.45	1.30	1.4	$d_N + 2.9$	$d_N + 2.6$	3.8	5.2	0.25
1.80	1.45	1.30	1.4	$d_N + 2.9$	$d_N + 2.6$	3.8	5.2	0.25
2.00	1.65	1.50	1.4	$d_N + 3.3$	$d_N + 3.0$	4.1	5.5	0.25
2.40	2.05	1.80	1.4	$d_N + 4.1$	$d_N + 3.6$	4.6	6.0	0.25
2.50	2.15	1.90	1.4	$d_N + 4.3$	$d_N + 3.8$	4.7	6.1	0.25
2.62	2.25	2.00	1.4	$d_N + 4.5$	$d_N + 4.0$	5.0	6.4	0.25
2.65	2.25	2.00	1.4	$d_N + 4.5$	$d_N + 4.0$	5.0	6.4	0.25
3.00	2.60	2.30	1.4	$d_N + 5.2$	$d_N + 4.6$	5.4	6.8	0.25
3.53	3.10	2.70	1.4	$d_N + 6.2$	$d_N + 5.4$	6.2	7.6	0.25
3.55	3.10	2.70	1.4	$d_N + 6.2$	$d_N + 5.4$	6.2	7.6	0.25
4.00	3.50	3.10	1.7	$d_N + 7.0$	$d_N + 6.2$	6.9	8.6	0.25
5.00	4.40	4.00	1.7	$d_N + 8.8$	$d_N + 8.0$	8.3	10.0	0.25
5.30	4.70	4.30	1.7	$d_N + 9.4$	$d_N + 8.6$	9.0	10.9	0.25
5.33	4.70	4.00	1.7	$d_N + 9.4$	$d_N + 8.0$	9.0	10.9	0.25
5.70	5.00	4.60	1.7	$d_N + 10.0$	$d_N + 9.2$	9.0	11.0	0.25
6.00	5.30	4.90	1.7	$d_N + 10.6$	$d_N + 9.8$	9.3	11.2	0.25
6.99	6.10	5.40	2.5	$d_N + 12.2$	$d_N + 10.8$	12.3	15.1	0.25
8.00	7.10	6.70	2.5	$d_N + 14.2$	$d_N + 13.4$	12.6	15.4	0.25
8.40	7.50	7.10	2.5	$d_N + 15.0$	$d_N + 14.2$	12.8	15.6	0.25

■ Preferred sizes according to ISO-3601

Back-up Ring

Bonded Seals



Features and benefits

Cost effective solution for bolt/thread sealing

Versatile, applicable to all threaded bolts, studs and clearance holes

Sealing washers are available for metric, Whitworth, BSP and all European thread sizes.

Large range of elastomers and metals available

Wide temperature range

Reliable high and low pressure sealing

Can be used for overhead installation

Can be automatically installed

Seals to plain surfaces with no housing required for the sealing lip

Bonded Seals

■ Materials

GM500

Standard steel

- BS EN 10139: 1998 DC01 and C490 surface treatment zinc plate yellow chromate 8-12 µm

Stainless Steel

- BS1449 (part2) type 316 (1.4436) (316S33)

Seal lip

- FKM 70 Shore A
- FKM 75 Shore A
- XploR J9513
- XploR V9T20
- XploR V9T82
- XploR H9T20
- XploR WTT80
- Isolast® J8325
- Isolast® J9554

Mating surfaces

The plane surfaces to be sealed should be free from scores and should be machined smooth.

For fluids and gases at or under 3,000 psi / 21 MPa where the machined surface is circular and concentric, the surface finish should be 64 microinch / 1.6 micron or better. For surfaces with spiral or longitudinal machined ridges, the surface finish should be 32 microinches / 0.8 micron or better.

For pressures above 3,000 psi / 21 MPa, the surface finish should be 32 microinch / 0.8 micron maximum for all machined lays.

■ Description

Bonded Seals consist of an elastomer sealing lip vulcanized to the edge of a metal washer. They are used to seal bolted connections and mounting elements in oil & gas applications such as pipe connections and couplings. When the bolted connection is tightened, the sealing lip is pressed against the flat surfaces.

The metal washer ensures that the components to be connected are reliably and securely held. The thickness of the washer limits the compression of the elastomer seal, eliminating any over torque of the joint, thereby ensuring a reliable sealing system. The internal pressure increases the sealing force by energizing the sealing lip.

The sealing lip can be supplied in materials specifically engineered for oil & gas applications including explosive decompression resistant grades and ones that are approved to NORSOK M710 standards.

For more information on Bonded Seals please refer to the Static Seals catalog.

■ GM500

- Can be used to seal clearance or tapped holes in a wide range of different bolts
- Can be used on flat flanges or with recessed bolt holes

- Article group DD

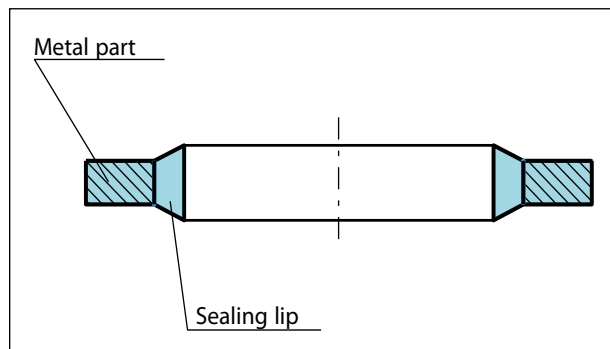


Figure 34 GM500

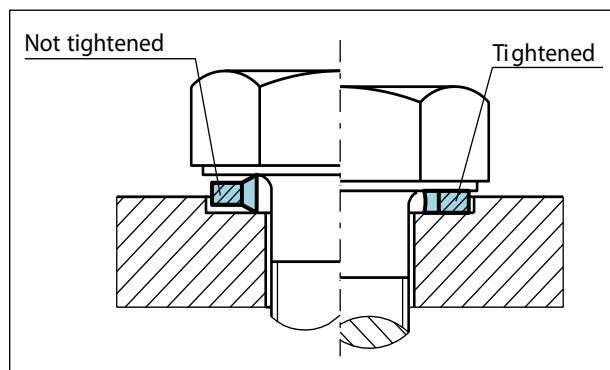


Figure 35 Installation GM500

Turcon® Variseal® HF



Features and benefits

For demanding applications

Internal and external designs

High performance materials

Very wide temperature range

Available for AS568, ISO3601 and non-standard sizes

High sealing pressure

Excellent sealing in gas and fluids

Withstands rapid temperature changes

Easy installation

Excellent sealing on imperfect surfaces

■ Turcon® Variseal® HF

Description

Turcon® Variseal® HF is the standard seal for axial (face) applications. It has the same high sealing load as Variseal® H and is available for both internal and external pressure.

The heavy helical spring in Variseal® HF makes it the best choice for vacuum, gas and low temperature flange sealing applications.

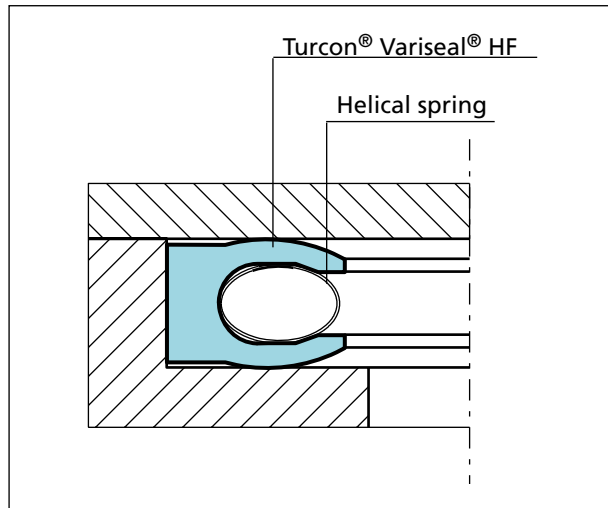


Figure 36 Turcon® Variseal® HF

Technical Data

Operating pressure:	Maximum static load: 8,702 psi (60 MPa)
Speed:	Static to slow rotating or pivoting movements
Operating temperature	-238 °F to +392 °F / -150 °C to +200 °C
Media compatibility:	Virtually all fluids, chemicals and gases.

Important Note:

The above data are maximum values and cannot be used at the same time. e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also dependent on media.

Areas of Application

- Compressor housings
- LNG processing
- Crude oil and natural gas installations
- Cryogenic engineering
- Pivot joints
- Flange connections
- Static applications

■ Installation Recommendations for Internal - Inch sizes

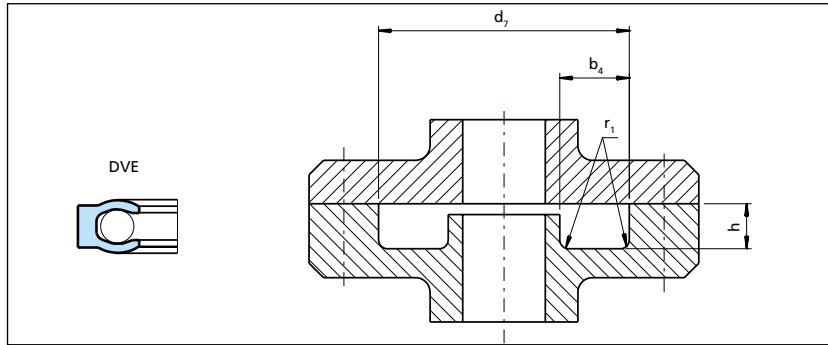


Figure 37 Installation drawing

Table 39 Diameter Tolerance

Seal ID	Groove ID	A
0.500 to 2.999	+0.000 -0.002	+0.002 -0.000
3.000 to 7.999	+0.000 -0.003	+0.003 -0.000
8.000 & up	+0.000 -0.004	+0.004 -0.000

Table 38 Installation Dimensions - Inch

Series No	h		b4	r1	Maximum Extrusion Gap at			
	Cross-Section		Groove Width	Radius	300 psi	1,500 psi	3,000 psi	5,000 psi
			(+0.010)	(Max)				
DVE0	0.057	+ 0.002	0.094	0.010	0.008	0.004	0.003	0.002
DVE1	0.089	+ 0.002	0.141	0.015	0.010	0.006	0.004	0.003
DVE2	0.122	+ 0.002	0.188	0.015	0.014	0.008	0.006	0.003
DVE3	0.186	+ 0.002	0.281	0.015	0.020	0.010	0.008	0.004
DVE4	0.238	+ 0.002	0.375	0.020	0.024	0.012	0.010	0.005
DVE5	0.374	+ 0.004	0.591	0.020	0.030	0.015	0.012	0.006

For additional size and part number details please reference the Variseal Design Guide or contact your local Trelleborg Sealing Solutions Marketing company.

■ Installation Recommendations for Internal Faceseal - Metric sizes

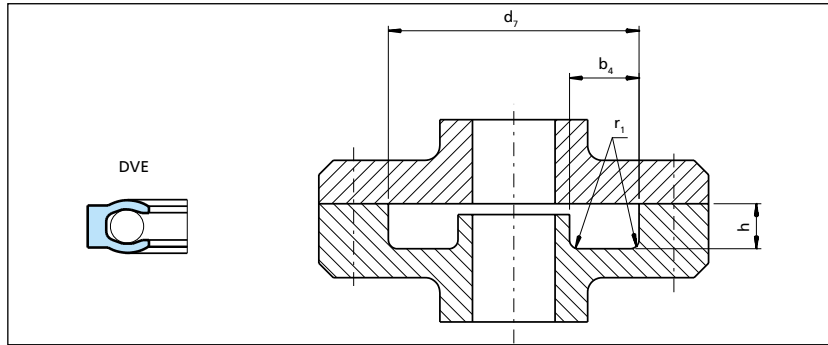


Figure 38 Installation Drawing

Table 40 Installation Dimensions - Metric

Series No.	Groove Outside Diameter A H11 mm		h		b4	r1	Maximum Extrusion Gap at			
							2 MPa	10 MPa	20 MPa	40 MPa
	Standard Range	Extended Range ¹⁾	Cross-section		Groove Width b4 mm (+0.2)	Radius (Max)				
DVE0	10.0 - 13.9	10.0 - 40.0	1.45	+0.03	2.4	0.4	0.20	0.10	0.08	0.05
DVE1	14.0 - 24.9	13.0 - 200.0	2.25	+0.05	3.6	0.4	0.25	0.15	0.10	0.07
DVE2	25.0 - 45.9	18.0 - 400.0	3.1	+0.08	4.8	0.6	0.35	0.20	0.15	0.08
DVE3	46.0 - 124.9	28.0 - 700.0*	4.7	+0.10	7.1	0.8	0.50	0.25	0.20	0.10
DVE4	125.0 - 999.9**	45.0 - 1000.0**	6.1	+0.15	9.5	0.8	0.60	0.30	0.25	0.12
DVE5	1000.0 - 2500.0***	110.0 - 2500.0***	9.5	+0.20	15.0	0.8	0.90	0.50	0.40	0.20

* For diameters above 700 mm b4 min. = 8.0 mm

** For diameters above 700 mm b4 min. = 11.0 mm

*** For diameters above 1000 mm b4 min. = 18.0 mm

¹⁾ Available on request

For additional size and part number details please reference the Variseal Design Guide or contact your local Trelleborg Sealing Solutions Marketing company.

■ Installation Recommendations for External Faceseal - Inch sizes

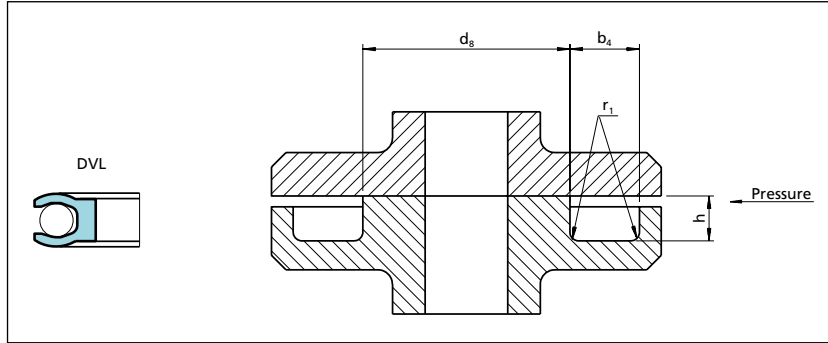


Figure 39 Installation drawing

Table 42 Diameter Tolerance

Seal ID	A Dia	Groove OD
0.125 to 2.999	+0.000 -0.002	+0.002 -0.000
3.000 to 7.999	+0.000 -0.003	+0.003 -0.000
8.000 and up	+0.000 -0.004	+0.004 -0.000

Table 41 Installation Dimensions - Inch

Series Number	h		b4	r1	Maximum Extrusion Gap at			
	Cross-section		Groove Width	Radius	300 psi	1,500 psi	3,000 psi	5,000 psi
			(+0.010)	(Max)				
DVL0	0.057	+ 0.002	0.094	0.010	0.008	0.004	0.003	0.002
DVL1	0.089	+ 0.002	0.141	0.015	0.010	0.006	0.004	0.003
DVL2	0.122	+ 0.002	0.188	0.015	0.014	0.008	0.006	0.003
DVL3	0.186	+ 0.002	0.281	0.015	0.020	0.010	0.008	0.004
DVL4	0.238	+ 0.002	0.375	0.020	0.024	0.012	0.010	0.005
DVL5	0.374	+ 0.004	0.591	0.020	0.030	0.015	0.012	0.006

For additional size and part number details please reference the Variseal Design Guide or contact your local Trelleborg Sealing Solutions Marketing company.

■ Installation Recommendations for External Faceseal - Metric sizes

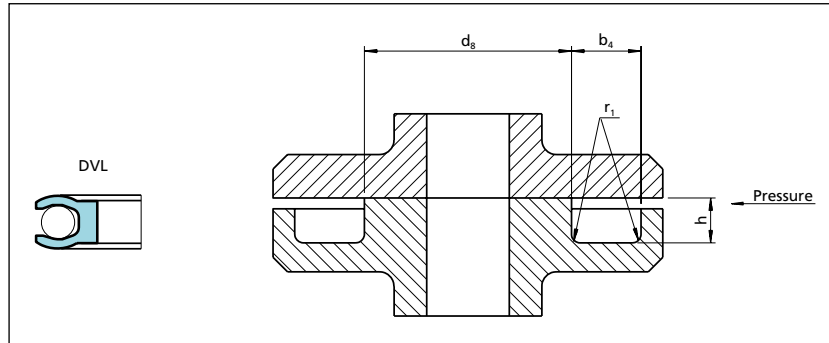


Figure 40 Installation drawing

Table 43 Installation Dimensions - Metric

Series Number	Groove Inside Diameter d h11 mm		h		b4	r1	Maximum Extrusion Gap at			
	Standard Range	Extended Range ¹⁾	Cross-section		Groove Width (+0.2)	Radius (Max)	2 MPa	10MPa	20MPa	40MPa
DVL0	3.0 - 9.9	3.0 - 40.0	1.45	+0.03	2.4	0.4	0.20	0.10	0.08	0.05
DVL1	10.0 - 19.9	8.0 - 200.0	2.25	+0.05	3.6	0.4	0.25	0.15	0.10	0.07
DVL2	20.0 - 39.9	12.0 - 400.0	3.1	+0.08	4.8	0.6	0.35	0.20	0.15	0.08
DVL3	40.0 - 119.9	20.0 - 700.0*	4.7	+0.10	7.1	0.8	0.50	0.25	0.20	0.10
DVL4	120.0 - 999.9**	35.0 - 1600.0**	6.1	+0.15	9.5	0.8	0.60	0.30	0.25	0.12
DVL5	1000.0 - 2500.0***	80.0 - 2500.0***	9.5	+0.20	15.0	0.8	0.90	0.50	0.40	0.20

* For diameters above 700 mm b4 min. = 8.0 mm

** For diameters above 700 mm b4 min. = 11.0 mm

*** For diameters above 1000 mm b4 min. = 18.0 mm

¹⁾ Available on request

For additional size and part number details please reference the Variseal Design Guide or contact your local Trelleborg Sealing Solutions Marketing company.

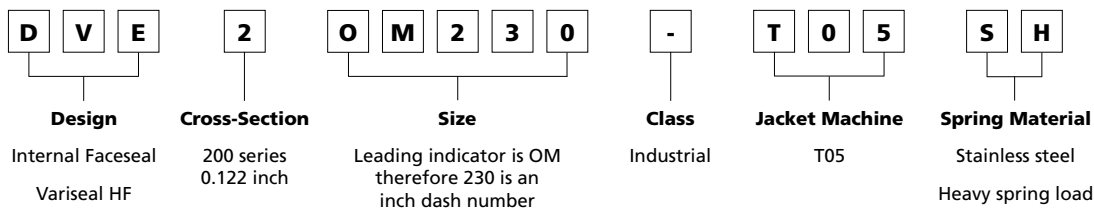
Turcon® Variseal® HF

Table 44 Part Number System for Face Seals

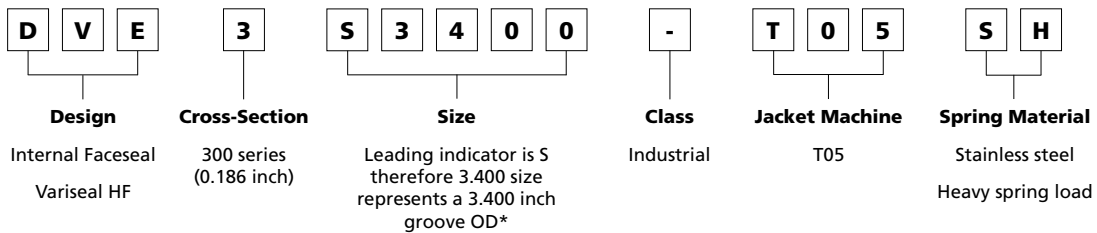
Article Code	Cross-Section	Size	Class	Seal Material	Spring Material	Spring
DVE Variseal (Internal)	0 0.056 (1.45)	OM xx Dash #	- Industrial	T01 See Table 16	S Stainless Steel	H Heavy
DVL Variseal (External)	1 0.089 (2.25)	S xxx Groove dia.* <10.0 Inch (dia x 1000.0)		T05 for material	H Hastelloy	
	2 0.122 (3.10)	L xxx Groove dia.* >= 10.0 Inch (dia x 100.0)		T07 description	E Elgiloy	
	3 0.186 (4.70)			T24		
	4 0.239 (6.10)			T40		
	5 0.375 (9.50)	O xxx Groove dia.* <1000 mm (dia x 10.0)		T78		
		X xxx Groove dia.* >= 1000 mm (dia x 1.0)		Z48		
				Z80		

* DVE use groove OD, DVL use groove ID

Ordering Example 1 - Inch example

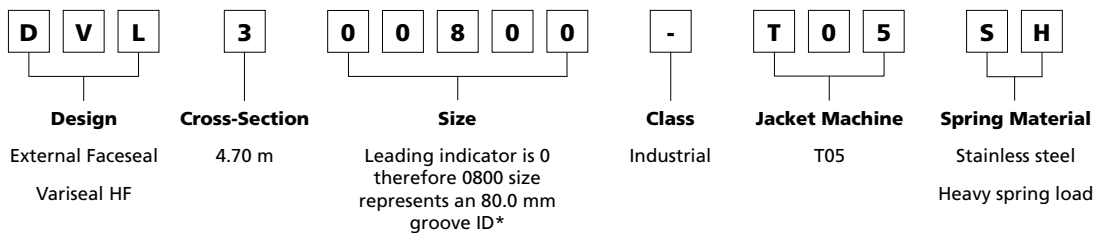


Ordering Example 2 - Inch example for non-standard diameters



*Please reference Figures 37 & 38.

Ordering Example 3 - Metric example



*Please reference Figures 39 & 40.

Wills Rings®



Features and benefits

Temperature range from cryogenic to
+1,550 °F / +850°C

Pressure range from ultra high vacuum to
145,000 psi / 1,000 MPa

Compatible with a large range of media

Corrosion resistant and radiation tolerant

Simple and reliable sealing

No outgassing

Wide range of sizes

■ Introduction

Wills Rings® are designed for extreme conditions which exceed the capabilities of elastomer and polymer seals.

Wills Rings® are metal seals which can be of two fundamental designs:

- 1) Wills Rings® O
- 2) Wills Rings® C

They are superior controlled compression type seals and are for static applications only. For best sealing results, Wills Rings® should be replaced each time the groove housing is dismantled. Wills Rings® have a degree of elastic recovery after being compressed in a housing but this is not sufficient to guarantee sealing again once the housing has been dismantled.

Wills Rings® O are the original Metal O-Ring seals. Wills Rings® were developed at the Wills factory in Bridgwater, UK. The term 'Wills Rings' is often used internationally to describe Metal O-Ring seals.

Wills Rings® O consist of a tube formed into a circular profile. Wills Rings® C are similar, but they have an open 'C' cross section. The open slot of the Wills Rings® C faces towards the system pressure and allows the seal to be pressure activated. For very high integrity sealing or for sealing on sub-prime finishes, a spring energized version of the metal C seal is also offered giving higher seating loads and increased springback.

Wills Rings® are constructed from high quality metal tubing or strip in standard or thin wall thickness. They are often coated or plated with a softer material to increase their sealing performance. There are five types of Wills Rings® depending upon the application (see Figure 41).

Typical Applications

- LNG equipment
- Offshore and marine
- Cryogenic engineering
- Extreme vacuum systems
- Fire safe valves
- Flare stacks

The design of Wills Rings® can be modified to suit the specific requirements of a system. These different designs offer a variety of sealing performances.

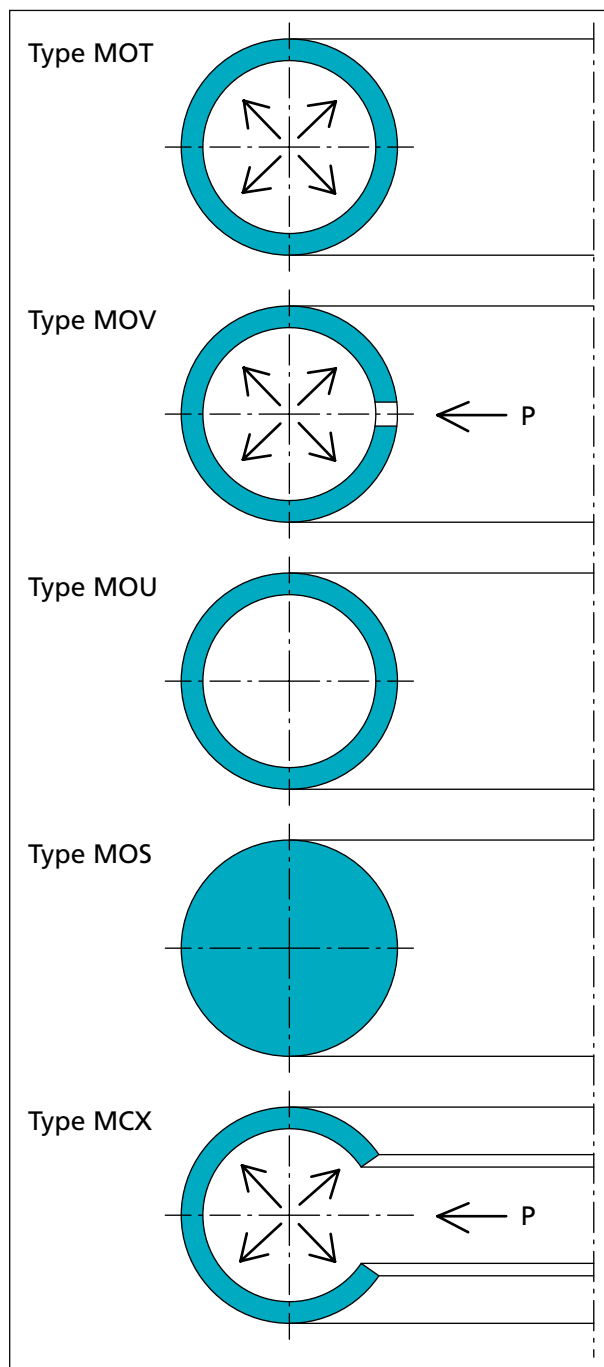


Figure 41 Wills Rings®

■ Method of Operation

Wills Rings® consist of a metal ring, often coated, which is used as a deformable seal in a static sealing situation. The ring is located between two flanges and undergoes a controlled compression.

Wills Rings® are defined by their free height which is the cross section in the axial direction of the seal. The free height d_2 of the seal is compressed down to the groove depth h .

The resistance of the ring to compression enables it to form an effective seal when compressed. The resilient effect of the seal is increased by pressurizing the internal volume of the ring (see Type MOT gas-filled Wills Rings® O).

Alternatively, if the system to be sealed is of very high pressure, this can be used to provide additional sealing effect. This is termed 'system actuation'. This is achieved by allowing the high pressure to enter the seal through either vent holes (see Type MOV), or through the open C slot (see Type MCX).

Wills Rings® have a certain degree of elasticity. This is known as spring back, the elastic part of the seal deflection when it is installed in a groove. This influences the seal's ability to absorb or compensate for hard ware variations due to temperature loadings.

A softer plating/coating material can be applied to Wills Rings® to maximize sealing performance in difficult applications. The soft coating material yields during the ring compression and fills any surface machining marks.

Performance

Because Wills Rings® are constructed from metal, their ability to handle extreme conditions exceeds that of polymeric and elastomeric seal types.

Wills Rings® seals do not suffer from the outgassing normally associated with elastomer seals that can be a problem when a seal is used on sensitive equipment.

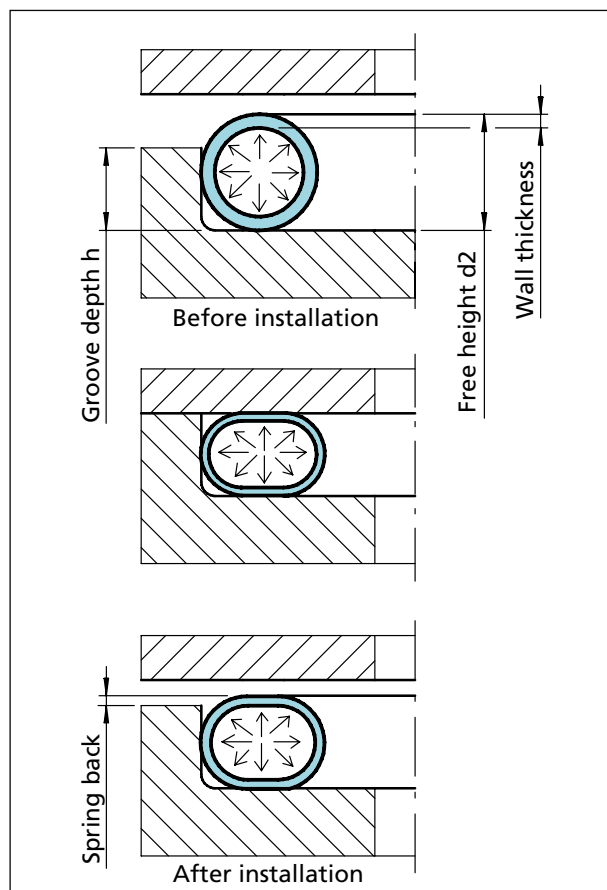


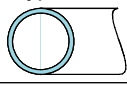
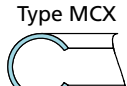
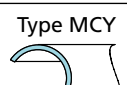
Figure 42 Method of seal operation

■ Selection Table

Use this table to select the optimum seal for a given application. The scoring for each seal type indicates relative performance.

Further information can be found in the Wills Rings® catalog.

Table 45 Selection Criteria

Seal	Description	Extreme Conditions	Seatings Loads	Spring back	Vacuum Sealing	Pressure psi/MPa	Max. Working Temp. °F/°C	Standard Material	
Code		Note 1)	Note 2)	Note 3)	Note 4)		Cryogenic to	Seal	Coating
								Note 5)	
 Type MOT	Pressurized	A	C	C	1×10^{-9} mbar.l.s ⁻¹	5,800 psi 40 MPa	1,550°F 850°C	Mild steel	
 Type MOV	Vented internal	B	B	C	-	145,000 psi 1000 MPa	1,100°F 600°C	Stainless Steel 316L	Silver
 Type MOW	Vented external							Stainless Steel 321	Nickel Copper
 Type MOU	Non-pressurized	C	B	C	1×10^{-5} mbar.l.s ⁻¹	580 psi 4 MPa	750°F 400°C	Inconel® 600 Inconel® 718	Gold Indium
 Type MOS	Solid	C	D	D	1×10^{-5} mbar.l.s ⁻¹	580 psi 4 MPa	925°F 500°C	Copper	
 Type MCX	Internal pressure	B	A	A	1×10^{-7} mbar.l.s ⁻¹	29,000 psi 200 MPa	1,375°F 750°C	Inconel® 718	Silver Nickel
 Type MCY	External pressure							Inconel® X750	Copper Gold Indium

Properties: A = Excellent B = Good C = Satisfactory D = Poor

If further information on seal selection is required please contact your local Trelleborg Sealing Solutions marketing company. Inconel® is a trade mark of INCO Alloys international, Inc.

- 1) Extreme conditions could be radiation, searching gases, exceptionally long-life.
- 2) Thin wall material should be used to give low seating loads. This must be specified as seals are wall thicknesses in standard wall unless otherwise requested.
- 3) The elastic recovery of the seal is known as the spring back. This depends upon wall thickness, and also heat treatment for Wills Rings® C. Higher seal resilience gives higher spring back and higher seating loads.
- 4) Ability to seal a hard vacuum to meet a leakage rate of $Q < 1 \times 10.9 \text{ mbar.l.s.}^{-1}$
- 5) Other material options are available. Not all materials are available in all sizes. Not all coatings available for all materials.
- 6) MOV/MOW (Vented type Wills Rings® O) seal not available in 0.035 in/ 0.89 mm Free Height size J. Use MOT type or increase to a 0.063 in/1.59 mm size instead.

■ Plating/Coating Materials for Wills Rings®

The sealing capability of Wills Rings® is greatly enhanced by the addition of a softer coating material. Table 46 gives the technical data for each coating, including the plating thickness, temperature capability and the size range.

Select plating/coating for a given application by considering the system requirements. That is:

1. The level of sealing needed and the fluid to be sealed.
2. Will the temperature of the system affect the plating?

3. Is the media corrosive to the plating?

4. For higher levels of sealing, use more layers of plating combined with a better surface finish.

Note: Increased plating and a better surface finish make the seal and the hardware more expensive to produce.

5. For less critical applications - non-plated rings may provide sufficient sealing.

Contact your Trelleborg Sealing Solutions Marketing Company for further information.

Table 46 Standard Coating Materials

Coating		Coating-Thickness		Temperature		Comments	Max. Ø	
Material	Code	inch	mm	°F	°C		inch	mm
Nickel	Q	0.0012 ± 0.0002	0.030 ± 0.005	2,200	1,200	-	39	1,000
Silver	R	0.0012 ± 0.0002	0.030 ± 0.005	1,475	800	1 layer silver	39	1,000
Silver	U	0.0022 ± 0.0002	0.055 ± 0.005	1,475	800	2 layers silver	39	1,000
Silver	S	0.0031 ± 0.0002	0.080 ± 0.005	1,475	800	3 layers silver	39	1,000
Gold	I	0.0012 ± 0.0002	0.030 ± 0.005	1,706	930	-	39	1,000
Copper	O	0.0012 ± 0.0002	0.030 ± 0.005	1,706	930	-	39	1,000

■ Installation Recommendations for Internal Pressure Sealing

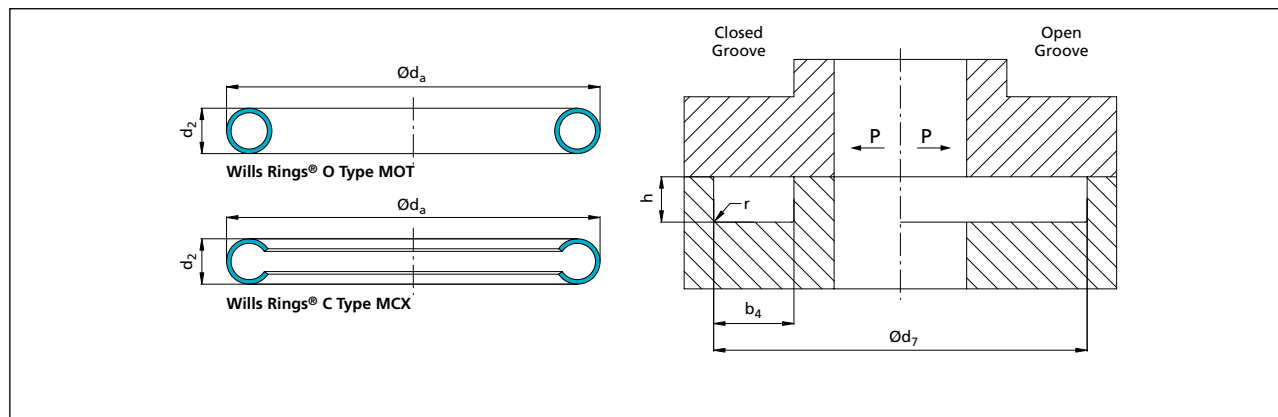


Figure 43 Installation drawing for internal pressure

Table 47 Installation Dimensions for Internal Pressure - Metric

Free Height d2 mm	Wills Rings® O Free Height Mat. Codes Stand. Thin	Wills Rings® C Free Height Mat. Codes Stand. Thin	Groove Depth h		Groove Width ¹⁾ b4 min.	Wills Rings® O ²⁾ Øda	Groove unplated only ³⁾ = da + clearance + Tolerance		Radius r_{max} mm	Wills Rings® Springback	
										O	C
										only	only
0.89	J	-	0.58	+0.08 -0	1.25	8-50	da +0.10	+0.05	0.25	0.01	-
1.59	K A	K A	1.32	+0.08 -0	2.25	12-150	da +0.10	+0.05	0.40	0.03 0.02	0.07 0.06
2.38	L B	L B	1.83	+0.08 -0	3.00	25-500 50-500	da +0.18	+0.12	0.50	0.06 0.04	0.11 0.09
3.18	M C	M C	2.54	+0.13 -0	4.00	60-1,000	da +0.18	+0.12	0.75	0.11 0.05	0.14 0.12
3.97	N D	N D	3.05	+0.13 -0	5.00	100-1,250	da +0.18	+0.12	1.25	0.13 0.06	0.16 0.11
4.76	O E	O E	3.68	+0.13 -0	6.00	115-1,500 150-1,500	da +0.25	+0.12	1.50	0.17 0.08	0.23 0.12
6.35	P F	P -	5.08	+0.13 -0	8.00	125-2,000	da +0.25	+0.12	1.50	0.14 0.10	0.27 -
7.94	G	-	6.35	+0.13 -0	10.00	500-2,500	da +0.38	+0.12	1.50	0.08	-
9.53	R H	- -	7.92	+0.13 -0	12.00	750-3,000	da +0.38	+0.12	1.50	0.09 0.08	-

Notes: 1) Minimum value. Recommended is groove width 1.5 x d2. Example: for a 3.18 mm Wills Rings® C with 3 layers of plating
2) For Wills Rings® C diameter size ranges see Table 52.
3) Calculate exact groove/seal Ø by the expression:
 $d_7 = da + (2 \times \text{maximum coating thickness}) + \text{clearance (+ tol.)}$
 $= da + \text{CTCV Table 54, for clearance tolerance correction value)}$
 $d_7 = da + (2 \times 0.085 \text{ mm} = 0.170 \text{ mm}) + \text{clearance (+ tol.)}$
 $= da + 0.170 + \text{clearance (+ tol.)}$
 $= da + 0.170 + 0.18 (+0.12)$
 $= da + 0.47 \text{ mm}$

■ Installation Recommendations for External Pressure Sealing

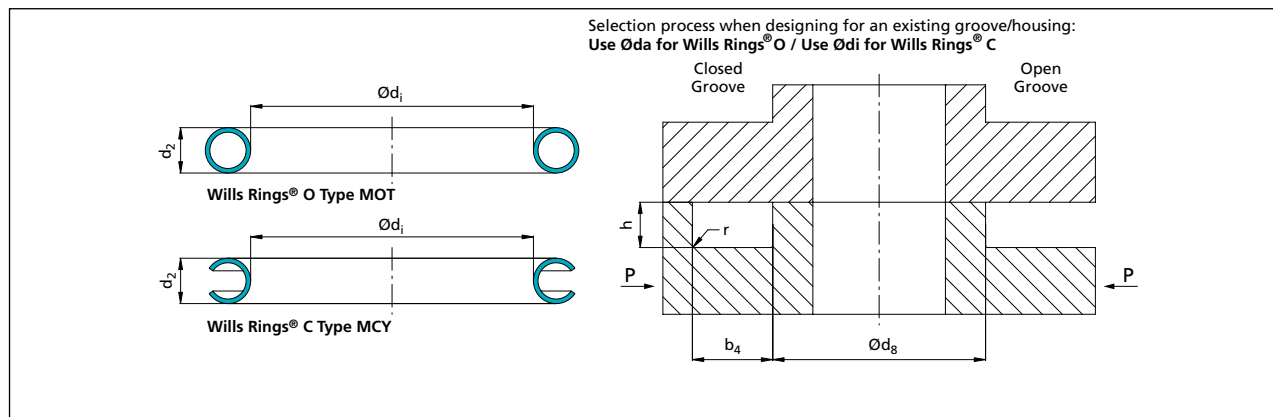


Figure 44 Installation drawing for external pressure

Table 48 Installation Dimensions for External Pressure - Metric

Free Height	Wills Rings® O Free Height Mat. Codes	Wills Rings® C Free Height Mat. Codes	Groove Depth		Groove Width ¹⁾	Wills Rings® O ²⁾	Groove unplated only ³⁾ = da + clearance + Tolerance		Radius r _{max} mm	Wills Rings® Springback	
										O	C
										only	only
d2 mm	Stand. Thin	Stand. Thin	h		b4 min.	Øda					
0.89	J	-	0.58	+0.08 -0	1.25	8-50	di +0.10	+0.05	0.25	0.01	-
1.59	K A	K A	1.32	+0.08 -0	2.25	12-150	di +0.10	+0.05	0.40	0.03 0.02	0.07 0.06
2.38	L B	L B	1.83	+0.08 -0	3.00	25-500 50-500	di +0.18	+0.12	0.50	0.06 0.04	0.11 0.09
3.18	M C	M C	2.54	+0.13 -0	4.00	60-1,000	di +0.18	+0.12	0.75	0.11 0.05	0.14 0.12
3.97	N D	N D	3.05	+0.13 -0	5.00	100-1,250	di +0.18	+0.12	1.25	0.13 0.06	0.16 0.11
4.76	O E	O E	3.68	+0.13 -0	6.00	115-1,500 150-1,500	di +0.25	+0.12	1.50	0.17 0.08	0.23 0.12
6.35	P F	P -	5.08	+0.13 -0	8.00	125-2,000	di +0.25	+0.12	1.50	0.14 0,10	0.27 -
7.94	G	-	6.35	+0.13 0	10.00	500-2,500	di +0.38	+0.12	1.50	0.08	-
9.53	R H	- -	7.92	+0.13 -0	12.00	750-3,000	di +0.38	+0.12	1.50	0.09 0.08	-

Notes: 1) Minimum value. Recommended is groove width 1.5 x d2. Example: for a 2.38 mm Wills Rings® O with 1 layers of plating
2) For Wills Rings® C diameter size ranges see Table 52
3) Calculate exact groove/seal Ø by the expression:
d8 = di + (2 x maximum coating thickness) + clearance (+ tol.)
= di + CTCV Table 54, for clearance tolerance correction value

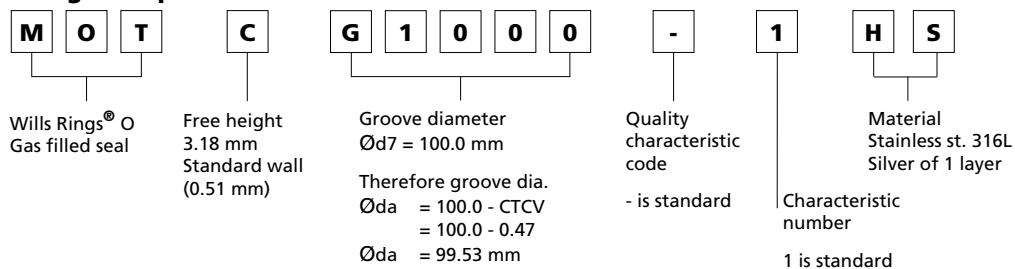
d8 = di + (2 x 3 layer coating
= 2 x 0.035 mm = 0.070 mm) + clearance (+ tol.)
= di + 0.070 + clearance (+ tol.)
= di + 0.070 + 0.18 (+0.12)
= di - 0.37 mm

Table 49 Part Number System for Wills Rings® O in Metric

Seal Type	Series	Free Height/ Wall Size mm	Seal Diameter	Quality Characteristic Code	Characteristic Number	Serial Material	Coating Material	Treatment
M: Metal O: O-Ring-profile	S Solid T Gas-filled U Non-pressurized V Pressure vented ID W Pressure vented OD	Standard wall	Diameter x 10 (up to 999.9) G - - - - this is the groove outside diameter Ød7 x 10 Use the groove method only for internal pressure/external sealing	"- " Standard Quality "K" X-Ray required "A" Aerospace use	1=Standard	B Mild steel H Stainless st. AISI 316L (1.4435) E Stainless st. AISI 321 (1.4541) M Inconel® 600 L Inconel® 718 O Copper	Q Nickel O Copper I Gold N Indium R Silver 1 layer U Silver 2 layers S Silver 3 layers	5 = Heat treat to NACE MR0175 (Inconel® 718 only)
		Thin wall						
		A 1.59 0.36 B 2.38 0.46 C 3.18 0.51 D 3.97 0.64 E 4.76 0.81 F 6.35 1.02 G 7.94 1.27 H 9.53 1.52 J 0.89 0.15 K 1.59 0.25 L 2.38 0.25 M 3.18 0.25 N 3.97 0.25 O 4.76 0.51 P 6.35 0.51 R 9.53 0.51	R - - - - this is the ring outside dia. Øda x 10					

Notes: MOV/MOW (Pressure Vented type) seal not available in 0.89 mm free height. Use MOT type or increase to a 1.59 mm size instead.
Other non-standard plating/coating options are available.
Select Quality Characteristic Code K for Thin wall rings.

Ordering Example 1



Ordering Example 2

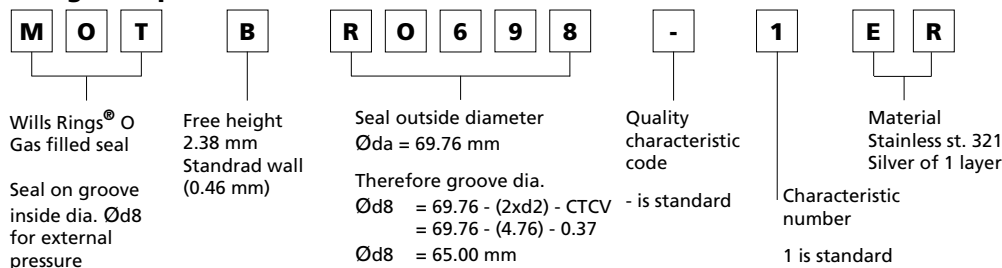
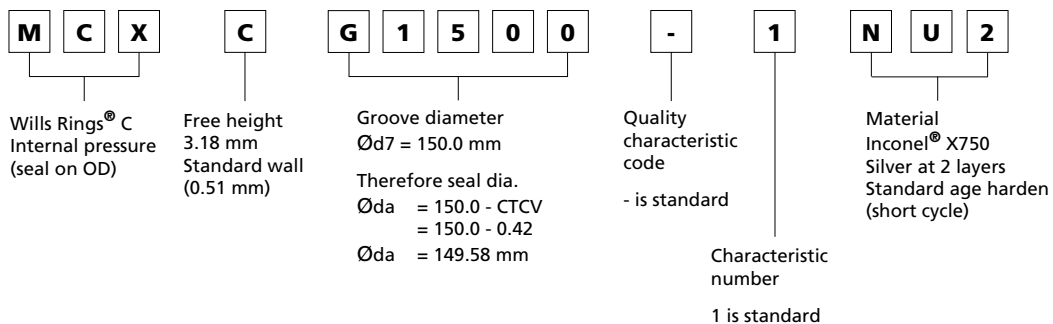


Table 50 Part Number System for Wills Rings® C in Metric

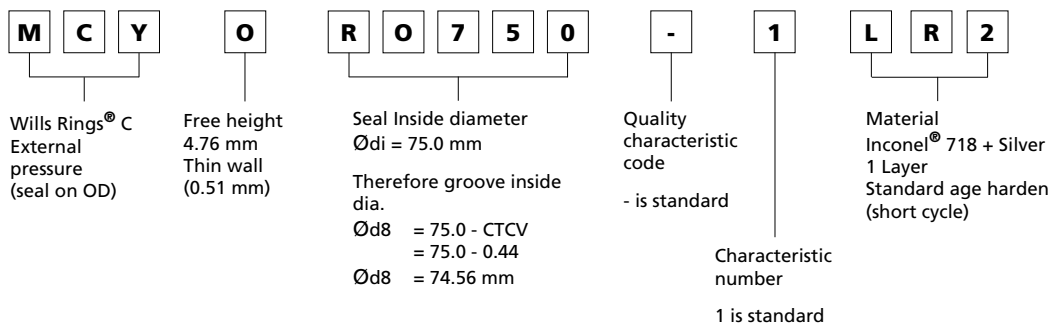
Seal Type	Series	Free Height/ Wall Size mm	Seal Diameter	Quality Characteristic Code	Characteristic Number	Serial Material	Coating Material	Treatment	
M: Metal C: C-Ring-profile	X Internal pressure	Standard wall	(up to 999.9)	"- " Standard Quality "A " Aerospace use	1=Standard	L Inconel® 718 N Inconel® X750	O Copper I Gold N Indium R Silver 1 layer U Silver 2 layers S Silver 3 layers	1 = Work harden 2 = Standard age harden (short cycle) 3 = Age harden (long cycle) 4 = Solution anneal and age harden 5 = Heat treat to NACE MR0175	
		A 1.59 0.25	G - - - -						this is the groove dia. (Ød7 or Ød8) x 10
		B 2.38 0.38							
		C 3.18 0.51							
		D 3.97 0.61	R - - - -						this is the seal dia. (Øda or Ødi) x 10
	Y External pressure	E 4.76 0.76							
		Thin wall	Use outside dia. for internal pressure/ outside sealing						
		K 1.59 0.15							
		L 2.38 0.25							
		M 3.18 0.38	Use inside dia. for external pressure/ inside saealing						
		N 3.97 0.41							
		O 4.76 0.51							
		P 6.35 0.64							

Notes: Other non-standard plating/coating options are available.
Treatment code 5 for seal material Inconel® 718 only.

Ordering Example 1



Ordering Example 2



■ Size Ranges and Free Heights in Inches

This catalog has mostly been based upon metric dimensions. However, in some markets inches are the preferred units of size. Here follows some tables giving inch nominal equivalents of the Wills Rings® metric sizes.

Wills Rings® are available in a comprehensive range of sizes. The free height ranges from 0.035" to 0.375". For each size there is a range of seal diameters which can be produced.

Table 51 Diameter Size Range in Inches for Wills Rings® O

Free Height	Wall Code	Wall	Seal	Total Groove Depth	Groove Width ¹⁾
d2 inch		inch	Øda inch	h inch	b4 min. inch
0.035	J	0.006	0.313-2	0.023 ^{+0.003} ₋₀	0.050
0.063	A	0.014	0.5-6	0.052 ^{+0.003} ₋₀	0.100
	K	0.010			
0.094	B	0.018	1-20	0.072 ^{+0.003} ₋₀	0.135
	L	0.010	2-20		
0.125	C	0.020	2.5-40	0.100 ^{+0.005} ₋₀	0.200
	M	0.010			
0.156	D	0.025	4-60	0.120 ^{+0.005} ₋₀	0.225
	N	0.010			
0.187	E	0.032	4.5-60	0.145 ^{+0.005} ₋₀	0.250
	O	0.010	6-60		
0.250	F	0.040	5-8	0.200 ^{+0.005} ₋₀	0.350
	P	0.020			
0.313	G	0.050	20-100	0.250 ^{+0.005} ₋₀	0.400
	-	-			
0.375	H	0.060	30-120	0.312 ^{+0.005} ₋₀	0.500
	R	0.020			

Table 52 Diameter Size Range in Inches for Wills Rings® C

Free Height	Wall Code	Wall	Seal	Total Groove Depth	Groove Width ¹⁾
d2 inch		inch	Øda inch	h inch	b4 min. inch
-	-	-	-	-	-
0.063	A	0.010	0.8-6	0.052 ^{+0.003} ₋₀	0.100
	K	0.006			
0.094	B	0.015	1-12	0.072 ^{+0.003} ₋₀	0.135
	L	0.010			
0.125	C	0.020	2-16	0.100 ^{+0.005} ₋₀	0.200
	M	0.015			
0.156	D	0.024	2.4-20	0.120 ^{+0.005} ₋₀	0.225
	N	0.016			
0.187	E	0.030	3.75-20	0.145 ^{+0.005} ₋₀	0.250
	O	0.020			
0.250	-	-	4.5-20	0.200 ^{+0.005} ₋₀	0.350
	P	0.020			

Note: ¹⁾ Groove width given in Table 51 and Table 52 is the minimum. Ideally the groove width b4 = 1.5 x d2.

■ Clearance Tolerance Correction Values in Inches

How to size the seal for a given groove diameter (or vice versa)

Table 53 Clearance - Tolerance Correction Value in Inches

	No Plating		1 Layer		2 Layers		3 Layers	
Max. Plating	0.00		+ 0.0015		+ 0.0025		+ 0.0035	
2 x max. Plating	0.00		+ 0.003		+ 0.005		+ .007	
Free Height	Total		Total		Total		Total	
0.035 0.063	0.004+0.002 0.004+0.002	0.006	0.007+0.002 0.007+0.002	0.009	0.009-0.002 0.009-0.002	0.011	0.011+0.002 0.011+0.002	0.013
0.094 0.125 0.156	0.007+0.005 0.007+0.005 0.007+0.005	0.012	0.010+0.005 0.010+0.005 0.010+0.005	0.015	0.012-0.005 0.012-0.005 0.012-0.005	0.017	0.014+0.005 0.014+0.005 0.014+0.005	0.019
0.187 0.250	0.010+0.005 0.010+0.005	0.015	0.013+0.005 0.013+0.005	0.018	0.015+0.005 0.015+0.005	0.020	0.017+0.005 0.017+0.005	0.022
0.313 0.375	0.015+0.005 0.015+0.005	0.020	0.018+0.005 0.018+0.005	0.023	0.020+0.005 0.020+0.005	0.025	0.022+0.005 0.022+0.005	0.022

Wills Rings® clearance and tolerance correction values (CTCV) for different plating levels for each free height size in inches.

Internal pressure $\varnothing d7 = \varnothing da + CTCV$

External pressure $\varnothing d8 = \varnothing di - CTCV$

Note:

Use $\varnothing da$ for Wills Rings® O for external pressure

Use $\varnothing di$ for Wills Rings® C for external pressure

For example

MOTOL1200K1HS

This is a 0.187" gas filled Wills Rings® O thin wall seal for a 12.00" seal diameter da . It has silver plate at 3 layers, 0.003/0.0035" thickness.

The groove diameter is found from $\varnothing d7 = \varnothing da + CTCV$

$$\begin{aligned} \text{Hence } \varnothing d7 &= \varnothing da + CTCV \\ &= 12.00 + 0.022 \\ \varnothing d7 &= 12.022" \end{aligned}$$

■ Size Ranges and Free Heights in Metric

Wills Rings® are available in a comprehensive range of sizes. The free height ranges from 0.89 mm to 9.53 mm. For each size there is a range of seal diameters which can be produced. The free height sizes are industry standard and have evolved from inch sizes. See Table 54 and Table 55.

Table 54 Diameter Size Range for Wills Rings® O

Free Height	Wall Code	Wall Thick-ness	Seal	Total Groove Depth ¹⁾	Groove Width ²⁾
d2 mm		mm	Øda mm	h mm	b4 min. mm
0.89	J	0.15	8-50	0.58 +0.08 -0	1.25
1.59	A	0.36	12-150	1.32 +0.08 -0	2.25
	K	0.25			
2.38	B	0.46	25-500	1.83 +0.08 -0	3.00
	L	0.25	50-500		
3.18	C	0.51	60-1,000	2.54 +0.13 -0	4.00
	M	0.25			
3.97	D	0.64	100-1,250	3.05 +0.13 -0	5.00
	N	0.25			
4.76	E	0.81	115-1,500	3.68 +0.13 -0	6.00
	O	0.25	150-1,500		
6.35	F	1.02	125-2,000	5.08 +0.13 -0	8.00
	P	0.51			
7.94	G	1.27	500-2,500	6.35 +0.13 -0	10.00
	-	-			
9.53	H	1.52	750-3,000	7.92 +0.13 -0	12.00
	R	0.51			

Table 55 Diameter Size Range for Wills Rings® C

Free Height	Wall Code	Wall Thick-ness	Seal	Total Groove Depth ¹⁾	Groove Width ²⁾
d2 mm		mm	Øda mm	h mm	b4 min. mm
-	-	-	-	-	-
1.59	A	0.25	20-150	1.32 +0.08 -0	2.25
	K	0.15			
2.38	B	0.38	25-300	1.83 +0.08 -0	3.00
	L	0.25			
3.18	C	0.51	50-500	2.54 +0.13 -0	4.00
	M	0.38			
3.97	D	0.61	60-500	3.05 +0.13 -0	5.00
	N	0.41			
4.76	E	0.76	95-500	3.68 +0.13 -0	6.00
	O	0.51			
6.35	-	-	115-500	5.08 +0.13 -0	8.00
	P	0.64			

See page 85 for Size Ranges and Free Heights in Inches.

Note:

- 1) When using a gasket in conjunction with Wills Rings® the groove depth must be modified.
- 2) Groove width given in Table 54 and Table 55 is the minimum.
Ideally the groove width $b4 = 1.5 \times d2$.

■ Groove Clearance and Plating Allowances in Metric

How to size the seal for a given groove diameter (or vice versa)

Table 56 Clearance - Tolerance Correction Value in mm

		No Plating		1 Layer		2 Layers		3 Layers	
Max. Plating		0.00		+ 0.035		+ 0.060		+ 0.085	
2 x max. Plating		0.00		+ 0.070		+ 0.120		+ 0.170	
Free Height									
mm	code	Total		Total		Total		Total	
0.89	- J	0.10+0.05	0.15	0.17+0.05	0.22	0.22+0.05	0.27	0.27+0.05	0.32
1.59	A K	0.10+0.05		0.17+0.05		0.22+0.05		0.27+0.05	
2.38	B L	0.18+0.12	0.30	0.30+0.12	0.37	0.30+0.12	0.42	0.35+0.12	0.47
3.18	C M	0.18+0.12		0.30+0.12		0.30+0.12		0.35+0.12	
3.97	D N	0.18+0.12		0.30+0.12		0.30+0.12		0.35+0.12	
4.76	E O	0.25+0.12	0.37	0.37+0.12	0.44	0.37+0.12	0.49	0.42+0.12	0.54
6.35	F P	0.25+0.12		0.37+0.12		0.37+0.12		0.42+0.12	
7.94	G -	0.38+0.12	0.50	0.50+0.12	0.57	0.50+0.12	0.62	0.55+0.12	0.67
9.53	H -	0.25+0.12		0.50+0.12		0.50+0.12		0.55+0.12	

Wills Rings® clearance and tolerance correction values (CTCV) for different plating levels for each free height size.

See page 86 for Clearance Tolerance Correction Values in Inches.

Internal pressure $\varnothing d7 = \varnothing da + \text{CTCV}$

External pressure $\varnothing d8 = \varnothing di - \text{CTCV}$

Note:

Use $\varnothing da$ for Wills Rings® O for external pressure

Use $\varnothing di$ for Wills Rings® C for external pressure

For example

MOTOG1500K1HS

This is a 4.76 mm gas-filled Wills Rings® O thin wall seal for a 150.0 mm groove diameter d7. It has silver plate at 3 layers, 0.075/0.085 mm thickness.

The seal diameter is found from $\varnothing d7 = \varnothing da + \text{CTCV}$

Hence $\varnothing da = \varnothing d7 - \text{CTCV}$

$= 150.0 - 0.54$

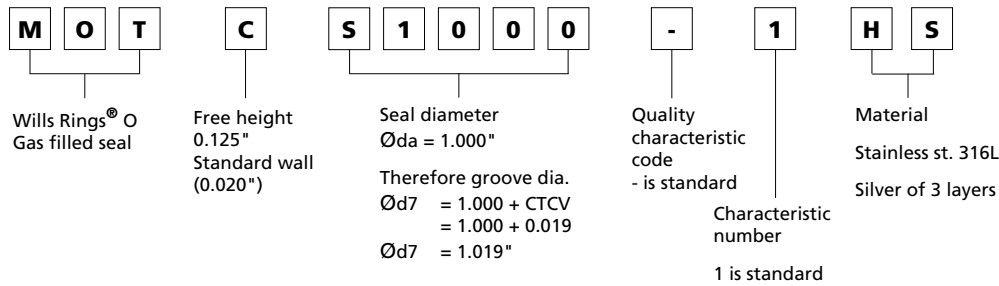
$\varnothing da = 149.46 \text{ mm}$

Table 57 Part Number System for Wills Rings® O in Inches

Seal Type	Series	Free Height/ Wall Size inch	Seal Diameter	Quality Characteristic Code	Characteristic Number	Serial Material	Coating Material	Treatment
M O	S Solid	Standard wall	For small dia. up to 9.999" use	"- " Standard Quality "K" X-Ray required	1 = Standard	B Mild steel	Q Nickel	5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		A .063 .014				H Stainless st. AISI 316L (1.4435)	O Copper	
M: Metal	T Gas-filled	C .125 .020	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard	E Stainless st. AISI 321 (1.4541)	I Gold	5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		D .156 .025				M Inconel® 600	N Indium	
O: O-Ring- profile	U Non- pre- surized	E .187 .032	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard	O Copper	R Silver 1 layer	5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		F .250 .040					S Silver 2 layers	
	V Pressure vented ID	G .313 .050	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard		U Silver 3 layers	5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		H .375 .060						
	W Pressure vented OD	Thin wall	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard			5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		J .035 .006						
		K .063 .010	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard			5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		L .094 .010						
		M .125 0.10	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard			5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		N .156 0.10						
		O .187 0.10	For larger dia. above 10.000" use	"- " Standard Quality "K" X-Ray required	1 = Standard			5 = Heat treatment to NACE MR0175 (Inconel® 718 only)
		P .250 0.20						
		R .375 .020						

Note: MOV/MOW (Vented type Wills Rings® O) seal not available in 0.89 mm (0.035"). Free Height size J.
Use MOT type or increase to a1.59 mm (0.063") size instead.
Other non-standard plating/coating options available.
Select Quality Characteristic Code K for Thin wall rings.

Ordering Example 1



Ordering Example 2

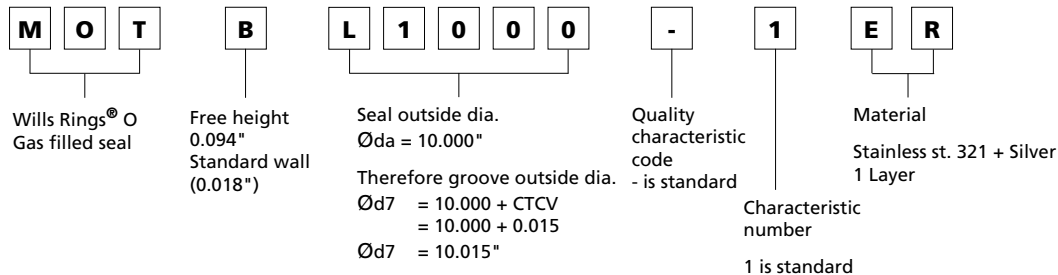
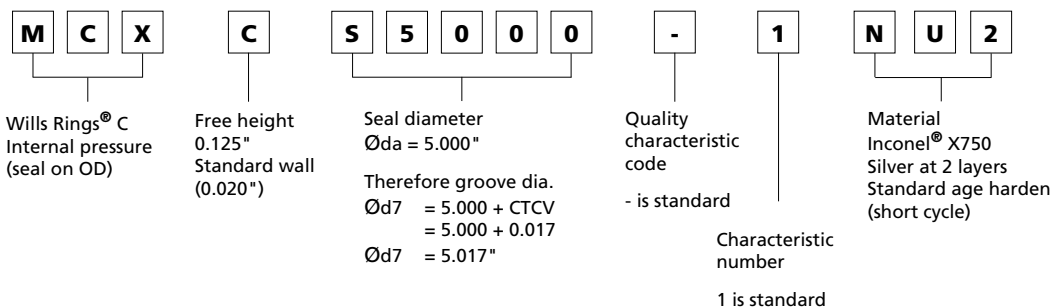


Table 58 Part Number System for Wills Rings® C in Inches

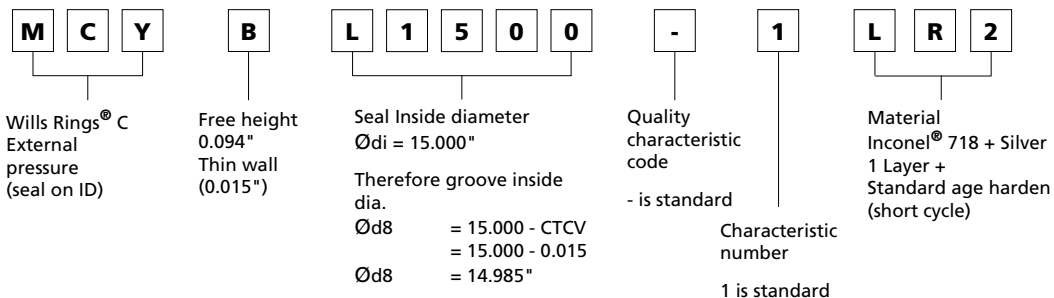
Seal Type	Series	Free Height/ Wall Size inch	Seal Diameter	Quality Characteristic Code	Characteristic Number	Serial Material	Coating Material	Treatment
M: Metal C: C-Ring-profile	X Internal pressure	Standard wall	For small dia. up to 9.999" use	"- " Standard Quality	1=Standard	L Inconel® 718 N Inconel® X750	O Copper I Gold N Indium R Silver 1 layer U Silver 2 layers S Silver 3 layers	1 = Work harden 2 = Standard age harden (short cycle) 3 = Age harden (long cycle) 4 = Solution anneal and age harden 5 = Heat treat to NACE MR0175
		A .063 .010	S - - - -					
		B .094 .015	this is the seal outside dia.					
		C .125 .020	Øda to 3 decimal places					
		D .156 .024	For larger dia. above 10.000" use					
		E .187 .030	L - - - -					
	Y External pressure	Thin wall	this is the seal outside dia.					
		K .063 .006	Øda to 2 decimal places					
		L .094 .010	Use outside dia. for internal pressure/ outside sealing					
		M .125 .015						
		N .156 .016						
		O .187 .020						
		P .250 .025	Use inside dia. for external pressure/inside sealing					

Notes: Other non-standard plating/coating options are available.
Treatment code 5 for seal material Inconel® 718 only.

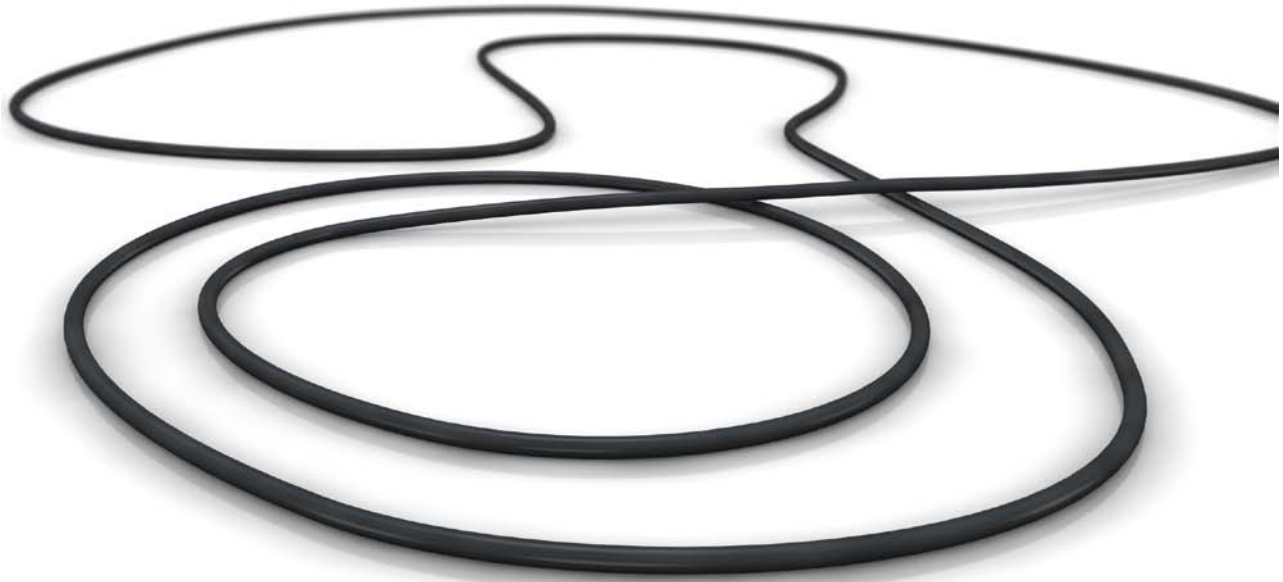
Ordering Example 1



Ordering Example 2



FlexiMold™



Features and benefits

Capable of producing any diameter above 20 inches / 500 mm

Full visual and dimensional product integrity

High quality, tight tolerances

Performance capabilities matching molded O-Rings

Elimination of leakage risks associated with spliced O-Rings

No tooling charges for standard cross sections

Available in Isolast® perfluoroelastomer, XploR™ EDR elastomers and a wide range of other standard elastomer

FlexiMold™ large diameter seals

Some equipment in the oil & gas industry can be on a large scale. The typical diameter of a FPSO swivel stack and some of the connectors used can be ten feet/ three meters. The seals required for these are beyond the sizes available as standard molded components, and usually the volumes required can never justify production with a dedicated tool.

FlexiMold™ is a proprietary technology specifically developed by Trelleborg Sealing Solutions for manufacturing large diameter O-Rings and other seal profiles. With this method, production of large diameter high quality seals is possible without the leadtime and costs associated with dedicated tooling.

The FlexiMold™ process eliminates the risks associated with splicing extruded cord, the conventional method of producing large diameter O-Rings and seals. These risks include weakness and poor surface finish at the connection joint, along with difficulty in achieving tight tolerances. Seals manufactured with FlexiMold™ technology have the full visual, dimensional and functional integrity of a molded seal.

An important use for large diameter FlexiMold™ O-Rings in oil and gas applications is as an energizer for Turcon® seals such as Roto Glyd Ring®, Turcon® VL Seal® or Glyd Ring®.

Product availability

Sizes:

- Recommended for diameters > 20 inches / 500 mm

Cross Sections:

- All standard cross sections available without purchase of dedicated tool
- Larger and special size cross sections available upon request
- Non-standard seal profiles available upon request

Materials

- Isolast® perfluoroelastomer (FFKM)
- Fluorocarbon (FKM)
- XploR™ EDR resistant elastomers (FFKM, FKM, HNBR)
- Hydrogenated Nitrile Butadiene Rubber (HNBR)

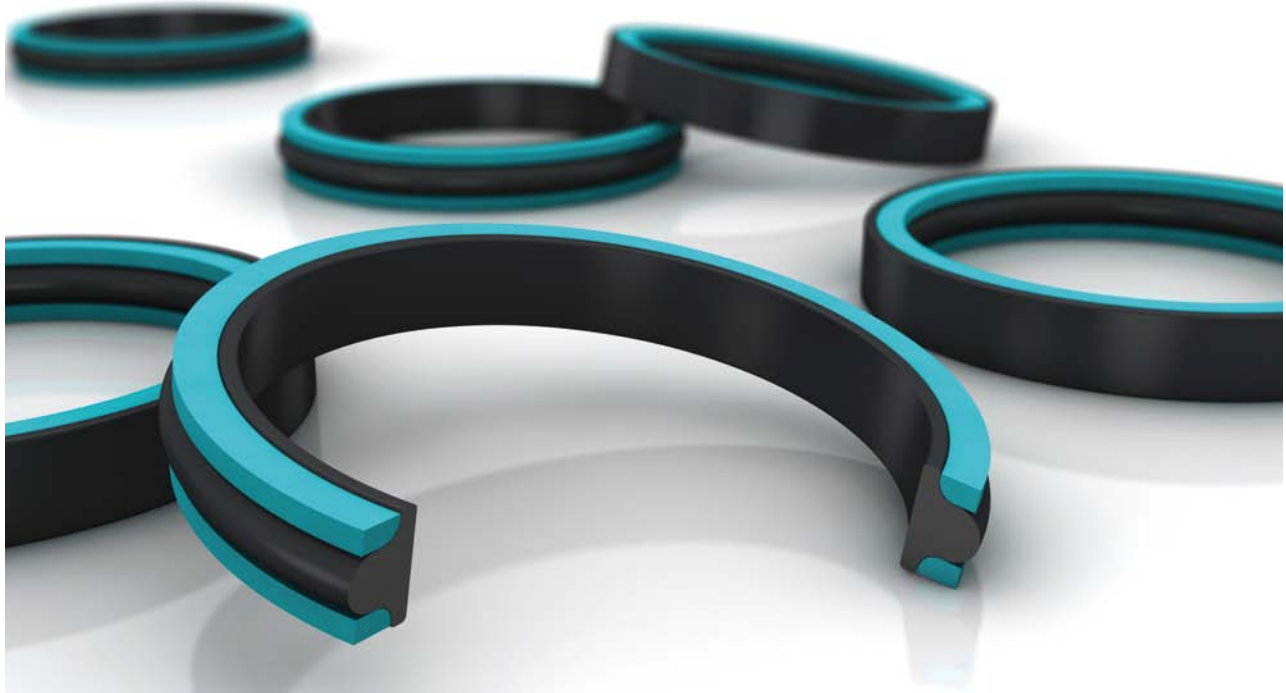
Service

- O-Rings supplied to standards ISO 3601-1, AS568 and JIS B 2401
- Product inspected to zero defect policy
- Parts packaged and labeled individually
- Washed and packed as required
- Express delivery service available

Linear Seals



Turcon® T-Seal



Features and benefits

Good static and light-duty dynamic sealing effect

Excellent resistance to rolling within the groove

Excellent extrusion resistance

Provides bidirectional sealing

Preferred option for media separation, such as fluid/
gas or fluid/fluid

Available in flash-free version

Sizes to suit all O-Ring grooves including
AS-568 and ISO-3601 seal sizes

Turcon® T-Seal

Description

Turcon® T-Seal consists of a T-shaped elastomer sealing element supported by Turcon® or Zurcon® Back-up Rings on both sides. This combination results in a stable seal, the semi-circular lip configuration ensuring positive sealing. The side flanges, which form the seal's base offer excellent resistance to rolling and act as an effective platform to position and energize the anti-extrusion rings.

Turcon® T-Seal is ideal for light and medium duty applications, both as a rod or piston seal, where they provide long-life, maximized sealing efficiency and excellent extrusion protection.

A full range of sizes is offered to suit all AS-568 and BS - 1806 seal sizes.

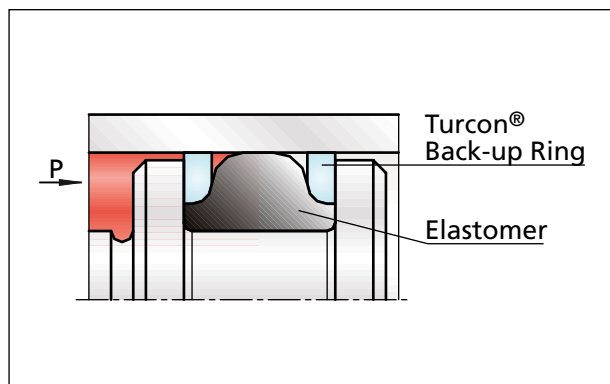


Figure 45 Turcon® T-Seal

Method of Operation

Due to its large elastomer footprint Turcon® T-Seal is a good static seal with high reliability. Providing bidirectional sealing, it is the preferred option for media separation, such as fluid/gas or fluid/fluid.

The one or two Back-up Ring widths offer especially good protection against extrusion. This is due to the additional material volume of the Back-up Rings compared to zero Back-up Ring widths.

Technical Data

Operation pressure:	10,000 psi / 69 MPa 20,000 psi / 138 MPa static with Zurcon® Back-up Rings 15,000 psi / 103 MPa dynamic with Zurcon® Back-up Rings
Speed:	3.3 ft/s / 1.0 m/s or higher for non-continuous or intermittent use
Temperature range:	-49 °F to +500 °F / -45 °C to +260 °C depending on elastomer
Clearance:	As per AS-568 and BS - 1806 seal sizes.
Media:	H ₂ S, CO ₂ , Amines, Hydrocarbons, mineral oil, drilling mud, sea water and glycols depending on elastomer.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendations for Rod

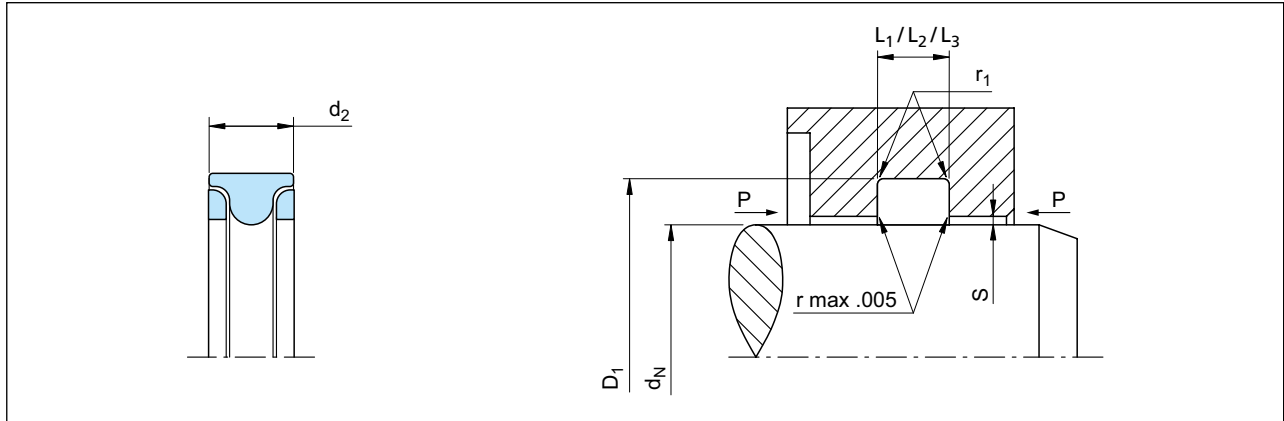


Figure 46 Installation drawing

Table 59 Installation Dimensions - Inch

Dash Sizes	Rod Diameter d_N h9	Groove Diameter D_1 H9	Groove Width $L_1 + .008$	Groove Width $L_2 + .008$	Groove Width $L_3 + .008$	Radius r_1	Radial Clearance* $S_{max.}$		
	Standard Application						1.500 psi (10 MPa)	3.000 psi (20 MPa)	5.800 psi (40 MPa)
006 - 012	.125 - .375	$d_N + .110$	.093	.154	.207	.005/.015	.004	.003	.002
110 - 116	.375 - .750	$d_N + .176$	.140	.183	.245	.005/.015	.006	.004	.003
210 - 222	.750 - 1.500	$d_N + .242$	.187	.235	.304	.010/.025	.008	.006	.003
325 - 349	1.500 - 4.500	$d_N + .370$	.281	.334	.424	.020/.035	.010	.008	.004
425 - 460	4.500 - 15.500	$d_N + .474$	.375	.475	.579	.020/.035	.012	.010	.006
625 - 656	15.500 - 31.000	$d_N + .726$	-	-	.750	.025/.040	.014	.012	.008

* For pressures >5.800 psi / 40 MPa please contact your local Trelleborg Sealing Solutions marketing company.

Table 60 Preferred Series - Inch

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L_1	Groove Width L_2	Groove Width L_3	Corner Radii
006	.124	.125	.235	.236	.093/.101	.154/.162	.207/.215	.005/.015
007	.155	.156	.266	.267	.093/.101	.154/.162	.207/.215	.005/.015
008	.186	.187	.297	.298	.093/.101	.154/.162	.207/.215	.005/.015
009	.218	.219	.329	.330	.093/.101	.154/.162	.207/.215	.005/.015
010	.249	.250	.360	.361	.093/.101	.154/.162	.207/.215	.005/.015
011	.311	.312	.422	.423	.093/.101	.154/.162	.207/.215	.005/.015
012	.374	.375	.485	.486	.093/.101	.154/.162	.207/.215	.005/.015
110	.374	.375	.551	.553	.140/.148	.183/.191	.245/.253	.005/.015
111	.435	.437	.613	.615	.140/.148	.183/.191	.245/.253	.005/.015
112	.498	.500	.676	.678	.140/.148	.183/.191	.245/.253	.005/.015
113	.560	.562	.738	.740	.140/.148	.183/.191	.245/.253	.005/.015

Turcon® T-Seal

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
114	.623	.625	.801	.803	.140/.148	.183/.191	.245/.253	.005/.015
115	.685	.687	.863	.865	.140/.148	.183/.191	.245/.253	.005/.015
116	.748	.750	.926	.928	.140/.148	.183/.191	.245/.253	.005/.015
210	.748	.750	.992	.994	.187/.195	.235/.243	.304/.312	.010/.025
211	.810	.812	1.054	1.056	.187/.195	.235/.243	.304/.312	.010/.025
212	.873	.875	1.117	1.119	.187/.195	.235/.243	.304/.312	.010/.025
213	.935	.937	1.179	1.181	.187/.195	.235/.243	.304/.312	.010/.025
214	.998	1.000	1.242	1.244	.187/.195	.235/.243	.304/.312	.010/.025
215	1.060	1.062	1.304	1.306	.187/.195	.235/.243	.304/.312	.010/.025
216	1.123	1.125	1.367	1.369	.187/.195	.235/.243	.304/.312	.010/.025
217	1.185	1.187	1.429	1.431	.187/.195	.235/.243	.304/.312	.010/.025
218	1.248	1.250	1.492	1.494	.187/.195	.235/.243	.304/.312	.010/.025
219	1.310	1.312	1.554	1.556	.187/.195	.235/.243	.304/.312	.010/.025
220	1.373	1.375	1.617	1.619	.187/.195	.235/.243	.304/.312	.010/.025
221	1.435	1.437	1.679	1.681	.187/.195	.235/.243	.304/.312	.010/.025
222	1.498	1.500	1.742	1.744	.187/.195	.235/.243	.304/.312	.010/.025
325	1.498	1.500	1.870	1.872	.281/.289	.334/.342	.424/.432	.020/.035
326	1.623	1.625	1.995	1.997	.281/.289	.334/.342	.424/.432	.020/.035
327	1.748	1.750	2.120	2.122	.281/.289	.334/.342	.424/.432	.020/.035
328	1.873	1.875	2.245	2.247	.281/.289	.334/.342	.424/.432	.020/.035
329	1.998	2.000	2.370	2.372	.281/.289	.334/.342	.424/.432	.020/.035
330	2.123	2.125	2.495	2.497	.281/.289	.334/.342	.424/.432	.020/.035
331	2.248	2.250	2.620	2.622	.281/.289	.334/.342	.424/.432	.020/.035
332	2.373	2.375	2.745	2.747	.281/.289	.334/.342	.424/.432	.020/.035
333	2.498	2.500	2.870	2.872	.281/.289	.334/.342	.424/.432	.020/.035
334	2.623	2.625	2.995	2.997	.281/.289	.334/.342	.424/.432	.020/.035
335	2.748	2.750	3.120	3.122	.281/.289	.334/.342	.424/.432	.020/.035
336	2.873	2.875	3.245	3.247	.281/.289	.334/.342	.424/.432	.020/.035
337	2.998	3.000	3.370	3.372	.281/.289	.334/.342	.424/.432	.020/.035
338	3.123	3.125	3.495	3.497	.281/.289	.334/.342	.424/.432	.020/.035
339	3.248	3.250	3.620	3.622	.281/.289	.334/.342	.424/.432	.020/.035
340	3.373	3.375	3.745	3.747	.281/.289	.334/.342	.424/.432	.020/.035
341	3.498	3.500	3.870	3.872	.281/.289	.334/.342	.424/.432	.020/.035
342	3.623	3.625	3.995	3.997	.281/.289	.334/.342	.424/.432	.020/.035
343	3.748	3.750	4.120	4.122	.281/.289	.334/.342	.424/.432	.020/.035
344	3.873	3.875	4.245	4.247	.281/.289	.334/.342	.424/.432	.020/.035
345	3.998	4.000	4.370	4.372	.281/.289	.334/.342	.424/.432	.020/.035
346	4.123	4.125	4.495	4.497	.281/.289	.334/.342	.424/.432	.020/.035
347	4.248	4.250	4.620	4.622	.281/.289	.334/.342	.424/.432	.020/.035
348	4.373	4.375	4.745	4.747	.281/.289	.334/.342	.424/.432	.020/.035
349	4.498	4.500	4.870	4.872	.281/.289	.334/.342	.424/.432	.020/.035

Turcon® T-Seal

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
425	4.497	4.500	4.974	4.977	.375/.383	.475/.483	.579/.587	.020/.035
426	4.622	4.625	5.099	5.102	.375/.383	.475/.483	.579/.587	.020/.035
427	4.747	4.750	5.224	5.227	.375/.383	.475/.483	.579/.587	.020/.035
428	4.872	4.875	5.349	5.352	.375/.383	.475/.483	.579/.587	.020/.035
429	4.997	5.000	5.474	5.477	.375/.383	.475/.483	.579/.587	.020/.035
430	5.122	5.125	5.599	5.602	.375/.383	.475/.483	.579/.587	.020/.035
431	5.247	5.250	5.724	5.727	.375/.383	.475/.483	.579/.587	.020/.035
432	5.372	5.375	5.849	5.852	.375/.383	.475/.483	.579/.587	.020/.035
433	5.497	5.500	5.974	5.977	.375/.383	.475/.483	.579/.587	.020/.035
434	5.622	5.625	6.099	6.102	.375/.383	.475/.483	.579/.587	.020/.035
435	5.747	5.750	6.224	6.227	.375/.383	.475/.483	.579/.587	.020/.035
436	5.872	5.875	6.349	6.352	.375/.383	.475/.483	.579/.587	.020/.035
437	5.997	6.000	6.474	6.477	.375/.383	.475/.483	.579/.587	.020/.035
438	6.247	6.250	6.724	6.727	.375/.383	.475/.483	.579/.587	.020/.035
439	6.497	6.500	6.974	6.977	.375/.383	.475/.483	.579/.587	.020/.035
440	6.747	6.750	7.224	7.227	.375/.383	.475/.483	.579/.587	.020/.035
441	6.997	7.000	7.474	7.477	.375/.383	.475/.483	.579/.587	.020/.035
442	7.247	7.250	7.724	7.727	.375/.383	.475/.483	.579/.587	.020/.035
443	7.497	7.500	7.974	7.977	.375/.383	.475/.483	.579/.587	.020/.035
444	7.747	7.750	8.224	8.227	.375/.383	.475/.483	.579/.587	.020/.035
445	7.997	8.000	8.474	8.477	.375/.383	.475/.483	.579/.587	.020/.035
446	8.497	8.500	8.974	8.977	.375/.383	.475/.483	.579/.587	.020/.035
447	8.996	9.000	9.474	9.477	.375/.383	.475/.483	.579/.587	.020/.035
448	9.496	9.500	9.974	9.977	.375/.383	.475/.483	.579/.587	.020/.035
449	9.996	10.000	10.474	10.477	.375/.383	.475/.483	.579/.587	.020/.035
450	10.496	10.500	10.974	10.977	.375/.383	.475/.483	.579/.587	.020/.035
451	10.996	11.000	11.474	11.477	.375/.383	.475/.483	.579/.587	.020/.035
452	11.496	11.500	11.974	11.977	.375/.383	.475/.483	.579/.587	.020/.035
453	11.996	12.000	12.474	12.477	.375/.383	.475/.483	.579/.587	.020/.035
454	12.496	12.500	12.974	12.977	.375/.383	.475/.483	.579/.587	.020/.035
455	12.996	13.000	13.474	13.477	.375/.383	.475/.483	.579/.587	.020/.035
456	13.496	13.500	13.974	13.977	.375/.383	.475/.483	.579/.587	.020/.035
457	13.996	14.000	14.474	14.477	.375/.383	.475/.483	.579/.587	.020/.035
458	14.496	14.500	14.974	14.977	.375/.383	.475/.483	.579/.587	.020/.035
459	14.996	15.000	15.474	15.477	.375/.383	.475/.483	.579/.587	.020/.035
460	15.496	15.500	15.974	15.977	.375/.383	.475/.483	.579/.587	.020/.035
625	15.496	15.500	16.226	16.232	N/A	N/A	.750/.758	.025/.040
626	15.996	16.000	16.726	16.733	N/A	N/A	.750/.758	.025/.040
627	16.496	16.500	17.226	17.233	N/A	N/A	.750/.758	.025/.040
628	16.996	17.000	17.726	17.733	N/A	N/A	.750/.758	.025/.040
629	17.496	17.500	18.226	18.233	N/A	N/A	.750/.758	.025/.040
630	17.996	18.000	18.726	18.733	N/A	N/A	.750/.758	.025/.040
631	18.496	18.500	19.226	19.233	N/A	N/A	.750/.758	.025/.040

Turcon® T-Seal

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
632	18.996	19.000	19.726	19.733	N/A	N/A	.750/.758	.025/.040
633	19.496	19.500	20.226	20.233	N/A	N/A	.750/.758	.025/.040
634	19.996	20.000	20.726	20.733	N/A	N/A	.750/.758	.025/.040
635	20.496	20.500	21.226	21.233	N/A	N/A	.750/.758	.025/.040
636	20.996	21.000	21.726	21.733	N/A	N/A	.750/.758	.025/.040
637	21.496	21.500	22.226	22.233	N/A	N/A	.750/.758	.025/.040
638	21.996	22.000	22.726	22.733	N/A	N/A	.750/.758	.025/.040
639	22.496	22.500	23.226	23.233	N/A	N/A	.750/.758	.025/.040
640	22.996	23.000	23.726	23.733	N/A	N/A	.750/.758	.025/.040
641	23.496	23.500	24.226	24.233	N/A	N/A	.750/.758	.025/.040
642	23.996	24.000	24.726	24.733	N/A	N/A	.750/.758	.025/.040
643	24.496	24.500	25.226	25.233	N/A	N/A	.750/.758	.025/.040
644	24.996	25.000	25.726	25.734	N/A	N/A	.750/.758	.025/.040
645	25.496	25.500	26.226	26.234	N/A	N/A	.750/.758	.025/.040
646	25.996	26.000	26.726	26.734	N/A	N/A	.750/.758	.025/.040
647	26.496	26.500	27.226	27.234	N/A	N/A	.750/.758	.025/.040
648	26.996	27.000	27.726	27.734	N/A	N/A	.750/.758	.025/.040
649	27.496	27.500	28.226	28.234	N/A	N/A	.750/.758	.025/.040
650	27.996	28.000	28.726	28.734	N/A	N/A	.750/.758	.025/.040
651	28.496	28.500	29.226	29.234	N/A	N/A	.750/.758	.025/.040
652	28.996	29.000	29.726	29.734	N/A	N/A	.750/.758	.025/.040
653	29.496	29.500	30.226	30.234	N/A	N/A	.750/.758	.025/.040
654	29.996	30.000	30.726	30.734	N/A	N/A	.750/.758	.025/.040
655	30.496	30.500	31.226	31.234	N/A	N/A	.750/.758	.025/.040
656	30.996	31.000	31.726	31.734	N/A	N/A	.750/.758	.025/.040

Ordering Example

Turcon® T-Seal complete with Elastomer standard application:

Series: RBG
Dash No.: 214
TSS Part No.: RBG0CB214

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Metric sizes of Rod or Bore designs of T-Seal are possible.

TSS Article No.	RBG	0	C	B	214	-	M12	N
Inches								
Series No.								
Backup Width								
0 = Zero Backup Width								
1 = One Backup Width								
2 = Two Backup Width								
Design Code								
C = Cut Delta BUR's								
0 = Solid Delta BUR's								
Groove Standard								
Dash No.								
Quality Index (Standard)								
Material Code (BUR's)								
Material Code (Elastomer)								

■ Installation Recommendations for Piston

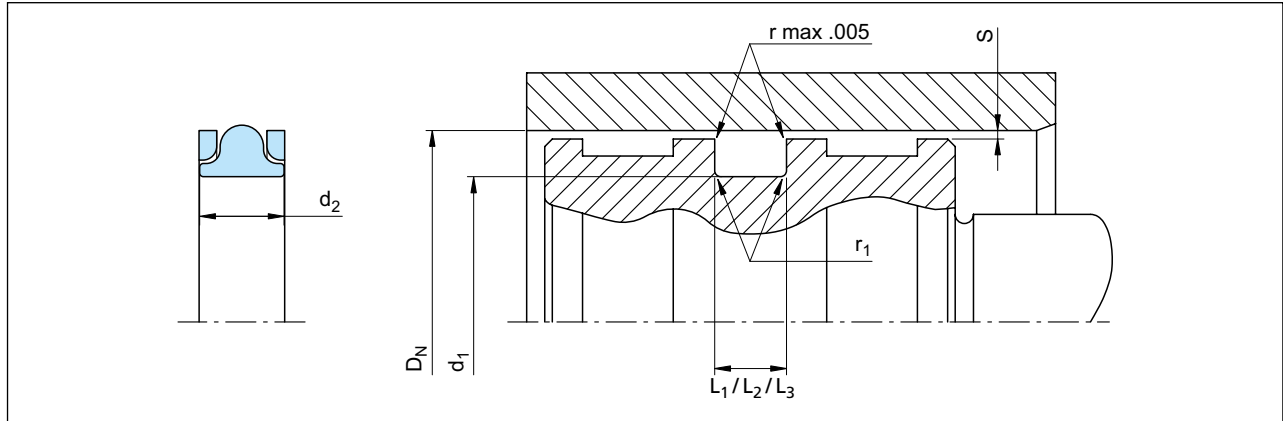


Figure 47 Installation drawing

Table 61 Installation Dimensions - Inch

Dash Sizes	Bore Diameter D_N H9	Groove Diameter d_1 h9	Groove Width L_1 +.008	Groove Width L_2 +.008	Groove Width L_3 +.008	Radius r_1	Radial Clearance* $S_{max.}$		
	Standard Application						1,500 psi (10 MPa)	3,000 psi (20 MPa)	5,800 psi (40 MPa)
006 - 012	.250 - .500	D_N - .110	.093	.154	.207	.005/.015	.004	.003	.002
110 - 116	.562 - .937	D_N - .176	.140	.183	.245	.005/.015	.006	.004	.003
210 - 222	1.000 - 1.750	D_N - .242	.187	.235	.304	.010/.025	.008	.006	.003
325 - 349	1.875 - 4.875	D_N - .370	.281	.334	.424	.020/.035	.010	.008	.004
425 - 460	5.000 - 16.000	D_N - .474	.375	.475	.579	.020/.035	.012	.010	.006
625 - 656	16.500 - 32.000	D_N - .726	-	-	.750	.025/.040	.014	.012	.008

* For pressures >5,800 psi / 40 MPa please contact your local Trelleborg Sealing Solutions marketing company.

Table 62 Preferred Series - Inch

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L_1	Groove Width L_2	Groove Width L_3	Corner Radii
006	.250	.251	.139	.140	.093/.101	.154/.162	.207/.215	.005/.015
007	.281	.282	.170	.171	.093/.101	.154/.162	.207/.215	.005/.015
008	.312	.313	.201	.202	.093/.101	.154/.162	.207/.215	.005/.015
009	.344	.345	.233	.234	.093/.101	.154/.162	.207/.215	.005/.015
010	.375	.376	.264	.265	.093/.101	.154/.162	.207/.215	.005/.015
011	.437	.438	.326	.327	.093/.101	.154/.162	.207/.215	.005/.015
012	.500	.501	.389	.390	.093/.101	.154/.162	.207/.215	.005/.015
110	.562	.564	.384	.386	.140/.148	.183/.191	.245/.253	.005/.015
111	.625	.627	.447	.449	.140/.148	.183/.191	.245/.253	.005/.015
112	.687	.689	.509	.511	.140/.148	.183/.191	.245/.253	.005/.015
113	.750	.752	.572	.574	.140/.148	.183/.191	.245/.253	.005/.015

Turcon® T-Seal

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
114	.812	.814	.634	.636	.140/.148	.183/.191	.245/.253	.005/.015
115	.875	.877	.697	.699	.140/.148	.183/.191	.245/.253	.005/.015
116	.937	.939	.759	.761	.140/.148	.183/.191	.245/.253	.005/.015
210	1.000	1.002	.756	.758	.187/.195	.235/.243	.304/.312	.010/.025
211	1.063	1.065	.819	.821	.187/.195	.235/.243	.304/.312	.010/.025
212	1.125	1.127	.881	.883	.187/.195	.235/.243	.304/.312	.010/.025
213	1.188	1.190	.944	.946	.187/.195	.235/.243	.304/.312	.010/.025
214	1.250	1.252	1.006	1.008	.187/.195	.235/.243	.304/.312	.010/.025
215	1.313	1.315	1.069	1.071	.187/.195	.235/.243	.304/.312	.010/.025
216	1.375	1.377	1.131	1.133	.187/.195	.235/.243	.304/.312	.010/.025
217	1.438	1.440	1.194	1.196	.187/.195	.235/.243	.304/.312	.010/.025
218	1.500	1.502	1.256	1.258	.187/.195	.235/.243	.304/.312	.010/.025
219	1.563	1.565	1.319	1.321	.187/.195	.235/.243	.304/.312	.010/.025
220	1.625	1.627	1.381	1.383	.187/.195	.235/.243	.304/.312	.010/.025
221	1.688	1.690	1.444	1.446	.187/.195	.235/.243	.304/.312	.010/.025
222	1.750	1.752	1.506	1.508	.187/.195	.235/.243	.304/.312	.010/.025
325	1.875	1.877	1.503	1.505	.281/.289	.334/.342	.424/.432	.020/.035
326	2.000	2.002	1.628	1.630	.281/.289	.334/.342	.424/.432	.020/.035
327	2.125	2.127	1.753	1.755	.281/.289	.334/.342	.424/.432	.020/.035
328	2.250	2.252	1.878	1.880	.281/.289	.334/.342	.424/.432	.020/.035
329	2.375	2.377	2.003	2.005	.281/.289	.334/.342	.424/.432	.020/.035
330	2.500	2.502	2.128	2.130	.281/.289	.334/.342	.424/.432	.020/.035
331	2.625	2.627	2.253	2.255	.281/.289	.334/.342	.424/.432	.020/.035
332	2.750	2.752	2.378	2.380	.281/.289	.334/.342	.424/.432	.020/.035
333	2.875	2.877	2.503	2.505	.281/.289	.334/.342	.424/.432	.020/.035
334	3.000	3.002	2.628	2.630	.281/.289	.334/.342	.424/.432	.020/.035
335	3.125	3.127	2.753	2.755	.281/.289	.334/.342	.424/.432	.020/.035
336	3.250	3.252	2.878	2.880	.281/.289	.334/.342	.424/.432	.020/.035
337	3.375	3.377	3.003	3.005	.281/.289	.334/.342	.424/.432	.020/.035
338	3.500	3.502	3.128	3.130	.281/.289	.334/.342	.424/.432	.020/.035
339	3.625	3.627	3.253	3.255	.281/.289	.334/.342	.424/.432	.020/.035
340	3.750	3.752	3.378	3.380	.281/.289	.334/.342	.424/.432	.020/.035
341	3.875	3.877	3.503	3.505	.281/.289	.334/.342	.424/.432	.020/.035
342	4.000	4.002	3.628	3.630	.281/.289	.334/.342	.424/.432	.020/.035
343	4.125	4.127	3.753	3.755	.281/.289	.334/.342	.424/.432	.020/.035
344	4.250	4.252	3.878	3.880	.281/.289	.334/.342	.424/.432	.020/.035
345	4.375	4.377	4.003	4.005	.281/.289	.334/.342	.424/.432	.020/.035
346	4.500	4.502	4.128	4.130	.281/.289	.334/.342	.424/.432	.020/.035
347	4.625	4.627	4.253	4.255	.281/.289	.334/.342	.424/.432	.020/.035
348	4.750	4.752	4.378	4.380	.281/.289	.334/.342	.424/.432	.020/.035
349	4.875	4.877	4.503	4.505	.281/.289	.334/.342	.424/.432	.020/.035

Turcon® T-Seal

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
425	5.000	5.003	4.523	4.526	.375/.383	.475/.483	.579/.587	.020/.035
426	5.125	5.128	4.648	4.651	.375/.383	.475/.483	.579/.587	.020/.035
427	5.250	5.253	4.773	4.776	.375/.383	.475/.483	.579/.587	.020/.035
428	5.375	5.378	4.898	4.901	.375/.383	.475/.483	.579/.587	.020/.035
429	5.500	5.503	5.023	5.026	.375/.383	.475/.483	.579/.587	.020/.035
430	5.625	5.628	5.148	5.151	.375/.383	.475/.483	.579/.587	.020/.035
431	5.750	5.753	5.273	5.276	.375/.383	.475/.483	.579/.587	.020/.035
432	5.875	5.878	5.398	5.401	.375/.383	.475/.483	.579/.587	.020/.035
433	6.000	6.003	5.523	5.526	.375/.383	.475/.483	.579/.587	.020/.035
434	6.125	6.128	5.648	5.651	.375/.383	.475/.483	.579/.587	.020/.035
435	6.250	6.253	5.773	5.776	.375/.383	.475/.483	.579/.587	.020/.035
436	6.375	6.378	5.898	5.901	.375/.383	.475/.483	.579/.587	.020/.035
437	6.500	6.503	6.023	6.026	.375/.383	.475/.483	.579/.587	.020/.035
438	6.750	6.753	6.273	6.276	.375/.383	.475/.483	.579/.587	.020/.035
439	7.000	7.003	6.523	6.526	.375/.383	.475/.483	.579/.587	.020/.035
440	7.250	7.253	6.773	6.776	.375/.383	.475/.483	.579/.587	.020/.035
441	7.500	7.503	7.023	7.026	.375/.383	.475/.483	.579/.587	.020/.035
442	7.750	7.753	7.273	7.276	.375/.383	.475/.483	.579/.587	.020/.035
443	8.000	8.003	7.523	7.526	.375/.383	.475/.483	.579/.587	.020/.035
444	8.250	8.253	7.773	7.776	.375/.383	.475/.483	.579/.587	.020/.035
445	8.500	8.503	8.023	8.026	.375/.383	.475/.483	.579/.587	.020/.035
446	9.000	9.003	8.523	8.526	.375/.383	.475/.483	.579/.587	.020/.035
447	9.500	.004	9.022	9.026	.375/.383	.475/.483	.579/.587	.020/.035
448	10.000	10.004	9.522	9.526	.375/.383	.475/.483	.579/.587	.020/.035
449	10.500	10.504	10.022	10.026	.375/.383	.475/.483	.579/.587	.020/.035
450	11.000	11.004	10.522	10.526	.375/.383	.475/.483	.579/.587	.020/.035
451	11.500	11.504	11.022	11.026	.375/.383	.475/.483	.579/.587	.020/.035
452	12.000	12.004	11.522	11.526	.375/.383	.475/.483	.579/.587	.020/.035
453	12.500	12.504	12.022	12.026	.375/.383	.475/.483	.579/.587	.020/.035
454	13.000	13.004	12.522	12.526	.375/.383	.475/.483	.579/.587	.020/.035
455	13.500	13.504	13.022	13.026	.375/.383	.475/.483	.579/.587	.020/.035
456	14.000	14.004	13.522	13.526	.375/.383	.475/.483	.579/.587	.020/.035
457	14.500	14.504	14.022	14.026	.375/.383	.475/.483	.579/.587	.020/.035
458	15.000	15.004	14.522	14.526	.375/.383	.475/.483	.579/.587	.020/.035
459	15.500	15.504	15.022	15.026	.375/.383	.475/.483	.579/.587	.020/.035
460	16.000	16.004	15.522	15.526	.375/.383	.475/.483	.579/.587	.020/.035
625	16.500	16.504	15.770	15.774	N/A	N/A	.750/.758	.025/.040
626	17.000	17.004	16.270	16.274	N/A	N/A	.750/.758	.025/.040
627	17.500	17.504	16.770	16.774	N/A	N/A	.750/.758	.025/.040
628	18.000	18.004	17.270	17.274	N/A	N/A	.750/.758	.025/.040
629	18.500	18.504	17.770	17.774	N/A	N/A	.750/.758	.025/.040
630	19.000	19.004	18.270	18.274	N/A	N/A	.750/.758	.025/.040

Turcon® T-Seal

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
631	19.500	19.504	18.770	18.774	N/A	N/A	.750/.758	.025/.040
632	20.000	20.004	19.270	19.274	N/A	N/A	.750/.758	.025/.040
633	20.500	20.504	19.770	19.774	N/A	N/A	.750/.758	.025/.040
634	21.000	21.004	20.270	20.274	N/A	N/A	.750/.758	.025/.040
635	21.500	21.504	20.770	20.774	N/A	N/A	.750/.758	.025/.040
636	22.000	22.004	21.270	21.274	N/A	N/A	.750/.758	.025/.040
637	22.500	22.504	21.770	21.774	N/A	N/A	.750/.758	.025/.040
638	23.000	23.004	22.270	22.274	N/A	N/A	.750/.758	.025/.040
639	23.500	23.504	22.770	22.774	N/A	N/A	.750/.758	.025/.040
640	24.000	24.004	23.270	23.274	N/A	N/A	.750/.758	.025/.040
641	24.500	24.504	23.770	23.774	N/A	N/A	.750/.758	.025/.040
642	25.000	25.004	24.270	24.274	N/A	N/A	.750/.758	.025/.040
643	25.500	25.504	24.770	24.774	N/A	N/A	.750/.758	.025/.040
644	26.000	26.004	25.270	25.274	N/A	N/A	.750/.758	.025/.040
645	26.500	26.504	25.770	25.774	N/A	N/A	.750/.758	.025/.040
646	27.000	27.004	26.270	26.274	N/A	N/A	.750/.758	.025/.040
647	27.500	27.504	26.770	26.774	N/A	N/A	.750/.758	.025/.040
648	28.000	28.004	27.270	27.274	N/A	N/A	.750/.758	.025/.040
649	28.500	28.504	27.770	27.774	N/A	N/A	.750/.758	.025/.040
650	29.000	29.004	28.270	28.274	N/A	N/A	.750/.758	.025/.040
651	29.500	29.504	28.770	28.774	N/A	N/A	.750/.758	.025/.040
652	30.000	30.004	29.270	29.274	N/A	N/A	.750/.758	.025/.040
653	30.500	30.504	29.770	29.774	N/A	N/A	.750/.758	.025/.040
654	31.000	31.004	30.270	30.274	N/A	N/A	.750/.758	.025/.040
655	31.500	31.504	30.770	30.774	N/A	N/A	.750/.758	.025/.040
656	32.000	32.004	31.270	31.274	N/A	N/A	.750/.758	.025/.040

Ordering Example

Turcon® T-Seal complete with Elastomer standard application:

Series: PBG
Dash No.: 214
TSS Part No.: PBG0CB214

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Note: The standard range of Turcon® T-Seal are only available in inch sizes. However metric sizes can be furnished upon request using a custom part number. Please contact your local Trelleborg Sealing Solutions Marketing company for further information.

TSS Article No.	PBG	0	C	B	214	-	M12	N
Inches								
Series No.								
Backup Width								
0 = Zero Backup Width								
1 = One Backup Width								
2 = Two Backup Width								
Design Code								
C = Cut Delta BUR's								
0 = Solid Delta BUR's								
Groove Standard								
Dash No.								
Quality Index (Standard)								
Material Code (BUR's)								
Material Code (Elastomer)								

Turcon® Wedgpak®



Features and benefits

Good static and dynamic sealing effect

Excellent stability of the elastomer element in severe working conditions

Unidirectional version for applications where there is pressure from one side only

Low-friction, high efficiency

Leak-tight reliable sealing performance

Easy installation

Extrusion protection version operates in higher pressures and larger clearances

Sizes to suit all O-Ring grooves including AS-568 and ISO-3601 seal sizes

Description

Turcon® Wedgpak® consists of a proprietary triangular elastomer element supported by two delta shaped Back-up Rings. The delta-shaped Back-up Rings of Turcon® Wedgpak® prevent the elastomer element from spiraling or rolling under severe working conditions.

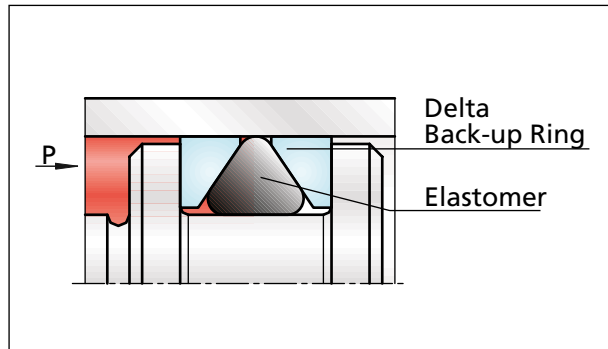


Figure 48 Turcon® Wedgpak®

Turcon® Wedgpak® CR is a version that provides superior extrusion protection at pressures above 5,000 psi / 35 MPa.

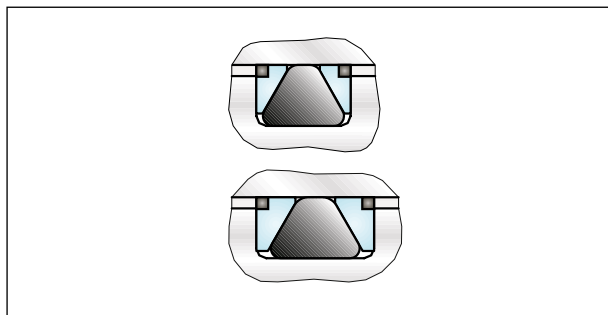


Figure 49 Turcon® Wedgpak® CR

Turcon® Unidirectional Wedgpak® consists of a delta shaped elastomer and a single delta shaped Back-up Ring. This design is used in applications with unidirectional pressure (pressure from one direction only) and provides leak-tight performance in both static and dynamic applications.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

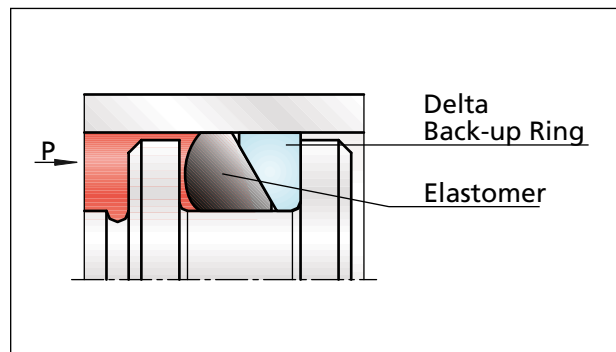


Figure 50 Turcon® Unidirectional Wedgpak®

Method of Operation

The optimized elastomer contact area of Turcon® Wedgpak® design results in a slipper seal-like performance with low static and dynamic friction. At the same time, the elastomer wipes the surface efficiently.

An outstanding load profile is the result of seal squeeze combined with the angles of the elastomer and Back-up Ring in the Unidirectional Wedgpak®. This gives effective fluid-film control and gas sealing in low and high-pressure systems.

Though originally designed as static seals, Turcon® Wedgpak® and Turcon® Unidirectional Wedgpak® are proven in dynamic applications such as special valves, BOP piston actuator seals, and downhole tools. They are also used in gas and oil separators, both at high and low pressures, as well as in various hydraulic and tubing hanger applications.

Technical Data

Operation pressure: up to 30,000 psi / 207 MPa

Speed: up to 9.8 ft/s / 3.0 m/s
Capable of higher speeds in non-continuous or intermittent use

Temperature range: -49 °F to +500 °F /
-45 °C to +260 °C
depending on elastomer material

Clearance: As per AS 568 and BS - 1806 seal sizes. Larger clearances for Turcon® Wedgpak® CR

Media: H₂S, CO₂, Amines, Hydrocarbons, mineral oil, methanol, drilling mud and glycols depending on elastomer

■ Installation Recommendation for Rod

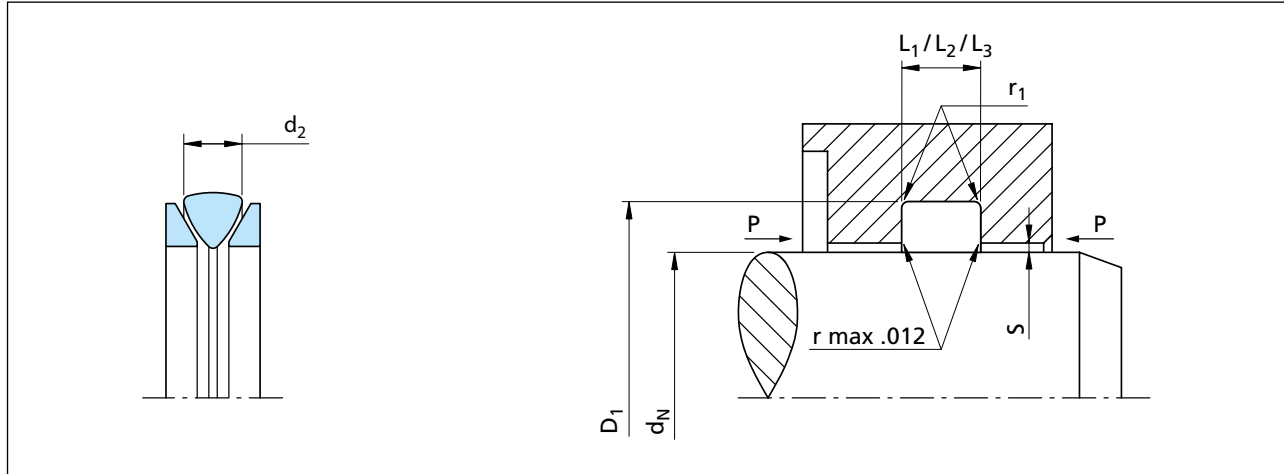


Figure 51 Installation drawing

Table 63 Installation Dimensions - Inch

Dash Sizes	Rod Diameter d_N h9 Standard Application	Groove Diameter d_1 H9	Groove Width $L_1 + 0.008$	Groove Width $L_2 + 0.008$	Groove Width $L_3 + 0.008$	Radius r_1	Radial Clearance* $S_{max.}$		
							1.500 psi (10 MPa)	3.000 psi (20 MPa)	5.800 psi (40 MPa)
006 - 012	.125 - .375	$d_N + .110$	.093	.154	.207	.005/.015	.004	.003	.002
110 - 116	.375 - .750	$d_N + .176$	.140	.183	.245	.005/.015	.006	.004	.003
210 - 222	.750 - 1.500	$d_N + .242$	.187	.235	.304	.010/.025	.008	.006	.003
325 - 349	1.500 - 4.500	$d_N + .370$	.281	.334	.424	.020/.035	.010	.008	.004
425 - 460	4.500 - 15.500	$d_N + .474$	.375	.475	.579	.020/.035	.012	.010	.006
625 - 656	15.500 - 31.000	$d_N + .726$	-	-	.750	.025/.040	.014	.012	.008

* For pressures >5.800 psi (40MPa). please contact your local Trelleborg Sealing Solutions marketing company.

Table 64 Preferred Series - Inch

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L_1	Groove Width L_2	Groove Width L_3	Corner Radii
006	.124	.125	.235	.236	.093/.101	.154/.162	.207/.215	.005/.015
007	.155	.156	.266	.267	.093/.101	.154/.162	.207/.215	.005/.015
008	.186	.187	.297	.298	.093/.101	.154/.162	.207/.215	.005/.015
009	.218	.219	.329	.330	.093/.101	.154/.162	.207/.215	.005/.015
010	.249	.250	.360	.361	.093/.101	.154/.162	.207/.215	.005/.015
011	.311	.312	.422	.423	.093/.101	.154/.162	.207/.215	.005/.015
012	.374	.375	.485	.486	.093/.101	.154/.162	.207/.215	.005/.015
110	.374	.375	.551	.553	.140/.148	.183/.191	.245/.253	.005/.015
111	.435	.437	.613	.615	.140/.148	.183/.191	.245/.253	.005/.015
112	.498	.500	.676	.678	.140/.148	.183/.191	.245/.253	.005/.015

Turcon® Wedgpak®

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
113	.560	.562	.738	.740	.140/.148	.183/.191	.245/.253	.005/.015
114	.623	.625	.801	.803	.140/.148	.183/.191	.245/.253	.005/.015
115	.685	.687	.863	.865	.140/.148	.183/.191	.245/.253	.005/.015
116	.748	.750	.926	.928	.140/.148	.183/.191	.245/.253	.005/.015
210	.748	.750	.992	.994	.187/.195	.235/.243	.304/.312	.010/.025
211	.810	.812	1.054	1.056	.187/.195	.235/.243	.304/.312	.010/.025
212	.873	.875	1.117	1.119	.187/.195	.235/.243	.304/.312	.010/.025
213	.935	.937	1.179	1.181	.187/.195	.235/.243	.304/.312	.010/.025
214	.998	1.000	1.242	1.244	.187/.195	.235/.243	.304/.312	.010/.025
215	1.060	1.062	1.304	1.306	.187/.195	.235/.243	.304/.312	.010/.025
216	1.123	1.125	1.367	1.369	.187/.195	.235/.243	.304/.312	.010/.025
217	1.185	1.187	1.429	1.431	.187/.195	.235/.243	.304/.312	.010/.025
218	1.248	1.250	1.492	1.494	.187/.195	.235/.243	.304/.312	.010/.025
219	1.310	1.312	1.554	1.556	.187/.195	.235/.243	.304/.312	.010/.025
220	1.373	1.375	1.617	1.619	.187/.195	.235/.243	.304/.312	.010/.025
221	1.435	1.437	1.679	1.681	.187/.195	.235/.243	.304/.312	.010/.025
222	1.498	1.500	1.742	1.744	.187/.195	.235/.243	.304/.312	.010/.025
325	1.498	1.500	1.870	1.872	.281/.289	.334/.342	.424/.432	.020/.035
326	1.623	1.625	1.995	1.997	.281/.289	.334/.342	.424/.432	.020/.035
327	1.748	1.750	2.120	2.122	.281/.289	.334/.342	.424/.432	.020/.035
328	1.873	1.875	2.245	2.247	.281/.289	.334/.342	.424/.432	.020/.035
329	1.998	2.000	2.370	2.372	.281/.289	.334/.342	.424/.432	.020/.035
330	2.123	2.125	2.495	2.497	.281/.289	.334/.342	.424/.432	.020/.035
331	2.248	2.250	2.620	2.622	.281/.289	.334/.342	.424/.432	.020/.035
332	2.373	2.375	2.745	2.747	.281/.289	.334/.342	.424/.432	.020/.035
333	2.498	2.500	2.870	2.872	.281/.289	.334/.342	.424/.432	.020/.035
334	2.623	2.625	2.995	2.997	.281/.289	.334/.342	.424/.432	.020/.035
335	2.748	2.750	3.120	3.122	.281/.289	.334/.342	.424/.432	.020/.035
336	2.873	2.875	3.245	3.247	.281/.289	.334/.342	.424/.432	.020/.035
337	2.998	3.000	3.370	3.372	.281/.289	.334/.342	.424/.432	.020/.035
338	3.123	3.125	3.495	3.497	.281/.289	.334/.342	.424/.432	.020/.035
339	3.248	3.250	3.620	3.622	.281/.289	.334/.342	.424/.432	.020/.035
340	3.373	3.375	3.745	3.747	.281/.289	.334/.342	.424/.432	.020/.035
341	3.498	3.500	3.870	3.872	.281/.289	.334/.342	.424/.432	.020/.035
342	3.623	3.625	3.995	3.997	.281/.289	.334/.342	.424/.432	.020/.035
343	3.748	3.750	4.120	4.122	.281/.289	.334/.342	.424/.432	.020/.035
344	3.873	3.875	4.245	4.247	.281/.289	.334/.342	.424/.432	.020/.035
345	3.998	4.000	4.370	4.372	.281/.289	.334/.342	.424/.432	.020/.035
346	4.123	4.125	4.495	4.497	.281/.289	.334/.342	.424/.432	.020/.035
347	4.248	4.250	4.620	4.622	.281/.289	.334/.342	.424/.432	.020/.035
348	4.373	4.375	4.745	4.747	.281/.289	.334/.342	.424/.432	.020/.035

Turcon® Wedgpak®

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
349	4.498	4.500	4.870	4.872	.281/.289	.334/.342	.424/.432	.020/.035
425	4.497	4.500	4.974	4.977	.375/.383	.475/.483	.579/.587	.020/.035
426	4.622	4.625	5.099	5.102	.375/.383	.475/.483	.579/.587	.020/.035
427	4.747	4.750	5.224	5.227	.375/.383	.475/.483	.579/.587	.020/.035
428	4.872	4.875	5.349	5.352	.375/.383	.475/.483	.579/.587	.020/.035
429	4.997	5.000	5.474	5.477	.375/.383	.475/.483	.579/.587	.020/.035
430	5.122	5.125	5.599	5.602	.375/.383	.475/.483	.579/.587	.020/.035
431	5.247	5.250	5.724	5.727	.375/.383	.475/.483	.579/.587	.020/.035
432	5.372	5.375	5.849	5.852	.375/.383	.475/.483	.579/.587	.020/.035
433	5.497	5.500	5.974	5.977	.375/.383	.475/.483	.579/.587	.020/.035
434	5.622	5.625	6.099	6.102	.375/.383	.475/.483	.579/.587	.020/.035
435	5.747	5.750	6.224	6.227	.375/.383	.475/.483	.579/.587	.020/.035
436	5.872	5.875	6.349	6.352	.375/.383	.475/.483	.579/.587	.020/.035
437	5.997	6.000	6.474	6.477	.375/.383	.475/.483	.579/.587	.020/.035
438	6.247	6.250	6.724	6.727	.375/.383	.475/.483	.579/.587	.020/.035
439	6.497	6.500	6.974	6.977	.375/.383	.475/.483	.579/.587	.020/.035
440	6.747	6.750	7.224	7.227	.375/.383	.475/.483	.579/.587	.020/.035
441	6.997	7.000	7.474	7.477	.375/.383	.475/.483	.579/.587	.020/.035
442	7.247	7.250	7.724	7.727	.375/.383	.475/.483	.579/.587	.020/.035
443	7.497	7.500	7.974	7.977	.375/.383	.475/.483	.579/.587	.020/.035
444	7.747	7.750	8.224	8.227	.375/.383	.475/.483	.579/.587	.020/.035
445	7.997	8.000	8.474	8.477	.375/.383	.475/.483	.579/.587	.020/.035
446	8.497	8.500	8.974	8.977	.375/.383	.475/.483	.579/.587	.020/.035
447	8.996	9.000	9.474	9.477	.375/.383	.475/.483	.579/.587	.020/.035
448	9.496	9.500	9.974	9.977	.375/.383	.475/.483	.579/.587	.020/.035
449	9.996	10.000	10.474	10.477	.375/.383	.475/.483	.579/.587	.020/.035
450	10.496	10.500	10.974	10.977	.375/.383	.475/.483	.579/.587	.020/.035
451	10.996	11.000	11.474	11.477	.375/.383	.475/.483	.579/.587	.020/.035
452	11.496	11.500	11.974	11.977	.375/.383	.475/.483	.579/.587	.020/.035
453	11.996	12.000	12.474	12.477	.375/.383	.475/.483	.579/.587	.020/.035
454	12.496	12.500	12.974	12.977	.375/.383	.475/.483	.579/.587	.020/.035
455	12.996	13.000	13.474	13.477	.375/.383	.475/.483	.579/.587	.020/.035
456	13.496	13.500	13.974	13.977	.375/.383	.475/.483	.579/.587	.020/.035
457	13.996	14.000	14.474	14.477	.375/.383	.475/.483	.579/.587	.020/.035
458	14.496	14.500	14.974	14.977	.375/.383	.475/.483	.579/.587	.020/.035
459	14.996	15.000	15.474	15.477	.375/.383	.475/.483	.579/.587	.020/.035
460	15.496	15.500	15.974	15.977	.375/.383	.475/.483	.579/.587	.020/.035
625	15.496	15.500	16.226	16.232	N/A	N/A	.750/.758	.025/.040
626	15.996	16.000	16.726	16.733	N/A	N/A	.750/.758	.025/.040
627	16.496	16.500	17.226	17.233	N/A	N/A	.750/.758	.025/.040
628	16.996	17.000	17.726	17.733	N/A	N/A	.750/.758	.025/.040

Turcon® Wedgpak®

Dash Size	Rod Min	Rod Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
629	17.496	17.500	18.226	18.233	N/A	N/A	.750/.758	.025/.040
630	17.996	18.000	18.726	18.733	N/A	N/A	.750/.758	.025/.040
631	18.496	18.500	19.226	19.233	N/A	N/A	.750/.758	.025/.040
632	18.996	19.000	19.726	19.733	N/A	N/A	.750/.758	.025/.040
633	19.496	19.500	20.226	20.233	N/A	N/A	.750/.758	.025/.040
634	19.996	20.000	20.726	20.733	N/A	N/A	.750/.758	.025/.040
635	20.496	20.500	21.226	21.233	N/A	N/A	.750/.758	.025/.040
636	20.996	21.000	21.726	21.733	N/A	N/A	.750/.758	.025/.040
637	21.496	21.500	22.226	22.233	N/A	N/A	.750/.758	.025/.040
638	21.996	22.000	22.726	22.733	N/A	N/A	.750/.758	.025/.040
639	22.496	22.500	23.226	23.233	N/A	N/A	.750/.758	.025/.040
640	22.996	23.000	23.726	23.733	N/A	N/A	.750/.758	.025/.040
641	23.496	23.500	24.226	24.233	N/A	N/A	.750/.758	.025/.040
642	23.996	24.000	24.726	24.733	N/A	N/A	.750/.758	.025/.040
643	24.496	24.500	25.226	25.233	N/A	N/A	.750/.758	.025/.040
644	24.996	25.000	25.726	25.734	N/A	N/A	.750/.758	.025/.040
645	25.496	25.500	26.226	26.234	N/A	N/A	.750/.758	.025/.040
646	25.996	26.000	26.726	26.734	N/A	N/A	.750/.758	.025/.040
647	26.496	26.500	27.226	27.234	N/A	N/A	.750/.758	.025/.040
648	26.996	27.000	27.726	27.734	N/A	N/A	.750/.758	.025/.040
649	27.496	27.500	28.226	28.234	N/A	N/A	.750/.758	.025/.040
650	27.996	28.000	28.726	28.734	N/A	N/A	.750/.758	.025/.040
651	28.496	28.500	29.226	29.234	N/A	N/A	.750/.758	.025/.040
652	28.996	29.000	29.726	29.734	N/A	N/A	.750/.758	.025/.040
653	29.496	29.500	30.226	30.234	N/A	N/A	.750/.758	.025/.040
654	29.996	30.000	30.726	30.734	N/A	N/A	.750/.758	.025/.040
655	30.496	30.500	31.226	31.234	N/A	N/A	.750/.758	.025/.040
656	30.996	31.000	31.726	31.734	N/A	N/A	.750/.758	.025/.040

Ordering Example

Turcon® Wedgpak® complete with elastomer standard application:

Series: RAG
Dash No.: 214
TSS Part No.: RAG0CB214

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Metric sizes of Rod or Bore designs of Wedgpak® are possible.

TSS Article No. RAG 0 C B 214 - M12 N
Inches
Series No.
Backup Width
0 = Zero Backup Width
1 = One Backup Width
2 = Two Backup Width
Design Code
C = Cut Delta BUR's
0 = Solid Delta BUR's
Groove Standard
Dash No.
Quality Index (Standard)
Material Code (BUR's)
Material Code (Elastomer)

■ Installation Recommendation for Piston

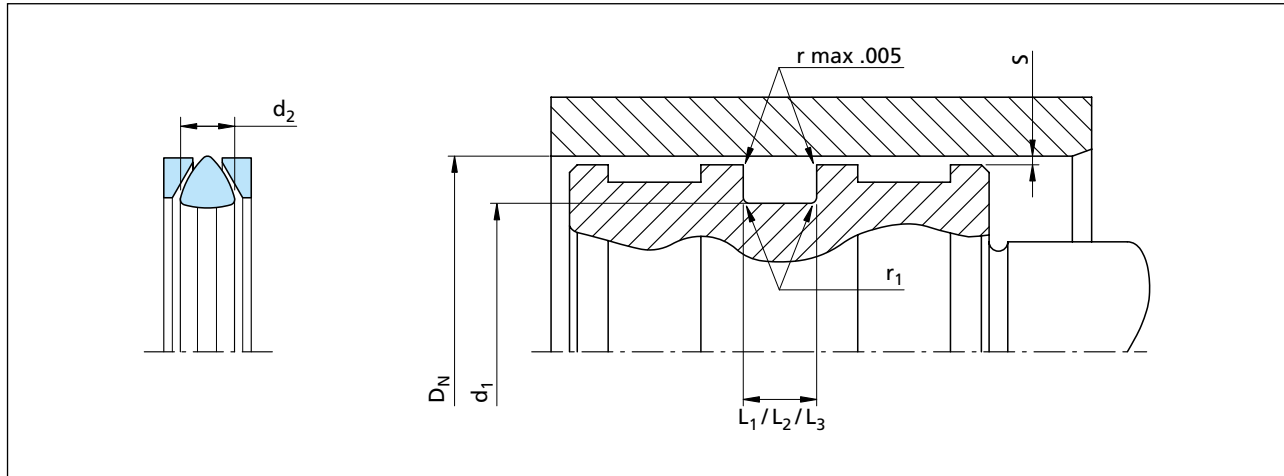


Figure 52 Installation drawing

Table 65 Installation Dimensions - Inch

Dash Sizes	Bore Diameter D_N H9 Standard Application	Groove Diameter d_1 h9	Groove Width $L_1 + 0.008$	Groove Width $L_2 + 0.008$	Groove Width $L_3 + 0.008$	Radius r_1	Radial Clearance* $S_{max.}$		
							1,500 psi (10 MPa)	3,000 psi (20 MPa)	5,800 psi (40 MPa)
006 - 012	.250 - .500	$D_N - .110$	.093	.154	.207	.005/.015	.004	.003	.002
110 - 116	.562 - .937	$D_N - .176$	.140	.183	.245	.005/.015	.006	.004	.003
210 - 222	1.000 - 1.507	$D_N - .242$	.187	.235	.304	.010/.025	.008	.006	.003
325 - 349	1.875 - 4.875	$D_N - .370$	.281	.334	.424	.020/.035	.010	.008	.004
425 - 460	5.000 - 16.000	$D_N - .474$	.375	.475	.579	.020/.035	.012	.010	.006
625 - 656	16.500 - 32.000	$D_N - .726$	-	-	.750	.025/.040	.014	.012	.008

* For pressures >5,800 psi (40MPa), please contact your local Trelleborg Sealing Solutions marketing company.

Table 66 Preferred Series - Inch

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L_1	Groove Width L_2	Groove Width L_3	Corner Radii
006	.250	.251	.139	.140	.093/.101	.154/.162	.207/.215	.005/.015
007	.281	.282	.170	.171	.093/.101	.154/.162	.207/.215	.005/.015
008	.312	.313	.201	.202	.093/.101	.154/.162	.207/.215	.005/.015
009	.344	.345	.233	.234	.093/.101	.154/.162	.207/.215	.005/.015
010	.375	.376	.264	.265	.093/.101	.154/.162	.207/.215	.005/.015
011	.437	.438	.326	.327	.093/.101	.154/.162	.207/.215	.005/.015
012	.500	.501	.389	.390	.093/.101	.154/.162	.207/.215	.005/.015
110	.562	.564	.384	.386	.140/.148	.183/.191	.245/.253	.005/.015
111	.625	.627	.447	.449	.140/.148	.183/.191	.245/.253	.005/.015
112	.687	.689	.509	.511	.140/.148	.183/.191	.245/.253	.005/.015

Turcon® Wedgpak®

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
113	.750	.752	.572	.574	.140/.148	.183/.191	.245/.253	.005/.015
114	.812	.814	.634	.636	.140/.148	.183/.191	.245/.253	.005/.015
115	.875	.877	.697	.699	.140/.148	.183/.191	.245/.253	.005/.015
116	.937	.939	.759	.761	.140/.148	.183/.191	.245/.253	.005/.015
210	1.000	1.002	.756	.758	.187/.195	.235/.243	.304/.312	.010/.025
211	1.063	1.065	.819	.821	.187/.195	.235/.243	.304/.312	.010/.025
212	1.125	1.127	.881	.883	.187/.195	.235/.243	.304/.312	.010/.025
213	1.188	1.190	.944	.946	.187/.195	.235/.243	.304/.312	.010/.025
214	1.250	1.252	1.006	1.008	.187/.195	.235/.243	.304/.312	.010/.025
215	1.313	1.315	1.069	1.071	.187/.195	.235/.243	.304/.312	.010/.025
216	1.375	1.377	1.131	1.133	.187/.195	.235/.243	.304/.312	.010/.025
217	1.438	1.440	1.194	1.196	.187/.195	.235/.243	.304/.312	.010/.025
218	1.500	1.502	1.256	1.258	.187/.195	.235/.243	.304/.312	.010/.025
219	1.563	1.565	1.319	1.321	.187/.195	.235/.243	.304/.312	.010/.025
220	1.625	1.627	1.381	1.383	.187/.195	.235/.243	.304/.312	.010/.025
221	1.688	1.690	1.444	1.446	.187/.195	.235/.243	.304/.312	.010/.025
222	1.750	1.752	1.506	1.508	.187/.195	.235/.243	.304/.312	.010/.025
325	1.875	1.877	1.503	1.505	.281/.289	.334/.342	.424/.432	.020/.035
326	2.000	2.002	1.628	1.630	.281/.289	.334/.342	.424/.432	.020/.035
327	2.125	2.127	1.753	1.755	.281/.289	.334/.342	.424/.432	.020/.035
328	2.250	2.252	1.878	1.880	.281/.289	.334/.342	.424/.432	.020/.035
329	2.375	2.377	2.003	2.005	.281/.289	.334/.342	.424/.432	.020/.035
330	2.500	2.502	2.128	2.130	.281/.289	.334/.342	.424/.432	.020/.035
331	2.625	2.627	2.253	2.255	.281/.289	.334/.342	.424/.432	.020/.035
332	2.750	2.752	2.378	2.380	.281/.289	.334/.342	.424/.432	.020/.035
333	2.875	2.877	2.503	2.505	.281/.289	.334/.342	.424/.432	.020/.035
334	3.000	3.002	2.628	2.630	.281/.289	.334/.342	.424/.432	.020/.035
335	3.125	3.127	2.753	2.755	.281/.289	.334/.342	.424/.432	.020/.035
336	3.250	3.252	2.878	2.880	.281/.289	.334/.342	.424/.432	.020/.035
337	3.375	3.377	3.003	3.005	.281/.289	.334/.342	.424/.432	.020/.035
338	3.500	3.502	3.128	3.130	.281/.289	.334/.342	.424/.432	.020/.035
339	3.625	3.627	3.253	3.255	.281/.289	.334/.342	.424/.432	.020/.035
340	3.750	3.752	3.378	3.380	.281/.289	.334/.342	.424/.432	.020/.035
341	3.875	3.877	3.503	3.505	.281/.289	.334/.342	.424/.432	.020/.035
342	4.000	4.002	3.628	3.630	.281/.289	.334/.342	.424/.432	.020/.035
343	4.125	4.127	3.753	3.755	.281/.289	.334/.342	.424/.432	.020/.035
344	4.250	4.252	3.878	3.880	.281/.289	.334/.342	.424/.432	.020/.035
345	4.375	4.377	4.003	4.005	.281/.289	.334/.342	.424/.432	.020/.035
346	4.500	4.502	4.128	4.130	.281/.289	.334/.342	.424/.432	.020/.035
347	4.625	4.627	4.253	4.255	.281/.289	.334/.342	.424/.432	.020/.035
348	4.750	4.752	4.378	4.380	.281/.289	.334/.342	.424/.432	.020/.035

Turcon® Wedgpak®

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
349	4.875	4.877	4.503	4.505	.281/.289	.334/.342	.424/.432	.020/.035
425	5.000	5.003	4.523	4.526	.375/.383	.475/.483	.579/.587	.020/.035
426	5.125	5.128	4.648	4.651	.375/.383	.475/.483	.579/.587	.020/.035
427	5.250	5.253	4.773	4.776	.375/.383	.475/.483	.579/.587	.020/.035
428	5.375	5.378	4.898	4.901	.375/.383	.475/.483	.579/.587	.020/.035
429	5.500	5.503	5.023	5.026	.375/.383	.475/.483	.579/.587	.020/.035
430	5.625	5.628	5.148	5.151	.375/.383	.475/.483	.579/.587	.020/.035
431	5.750	5.753	5.273	5.276	.375/.383	.475/.483	.579/.587	.020/.035
432	5.875	5.878	5.398	5.401	.375/.383	.475/.483	.579/.587	.020/.035
433	6.000	6.003	5.523	5.526	.375/.383	.475/.483	.579/.587	.020/.035
434	6.125	6.128	5.648	5.651	.375/.383	.475/.483	.579/.587	.020/.035
435	6.250	6.253	5.773	5.776	.375/.383	.475/.483	.579/.587	.020/.035
436	6.375	6.378	5.898	5.901	.375/.383	.475/.483	.579/.587	.020/.035
437	6.500	6.503	6.023	6.026	.375/.383	.475/.483	.579/.587	.020/.035
438	6.750	6.753	6.273	6.276	.375/.383	.475/.483	.579/.587	.020/.035
439	7.000	7.003	6.523	6.526	.375/.383	.475/.483	.579/.587	.020/.035
440	7.250	7.253	6.773	6.776	.375/.383	.475/.483	.579/.587	.020/.035
441	7.500	7.503	7.023	7.026	.375/.383	.475/.483	.579/.587	.020/.035
442	7.750	7.753	7.273	7.276	.375/.383	.475/.483	.579/.587	.020/.035
443	8.000	8.003	7.523	7.526	.375/.383	.475/.483	.579/.587	.020/.035
444	8.250	8.253	7.773	7.776	.375/.383	.475/.483	.579/.587	.020/.035
445	8.500	8.503	8.023	8.026	.375/.383	.475/.483	.579/.587	.020/.035
446	9.000	9.003	8.523	8.526	.375/.383	.475/.483	.579/.587	.020/.035
447	9.500	9.504	9.022	9.026	.375/.383	.475/.483	.579/.587	.020/.035
448	10.000	10.004	9.522	9.526	.375/.383	.475/.483	.579/.587	.020/.035
449	10.500	10.504	10.022	10.026	.375/.383	.475/.483	.579/.587	.020/.035
450	11.000	11.004	10.522	10.526	.375/.383	.475/.483	.579/.587	.020/.035
451	11.500	11.504	11.022	11.026	.375/.383	.475/.483	.579/.587	.020/.035
452	12.000	12.004	11.522	11.526	.375/.383	.475/.483	.579/.587	.020/.035
453	12.500	12.504	12.022	12.026	.375/.383	.475/.483	.579/.587	.020/.035
454	13.000	13.004	12.522	12.526	.375/.383	.475/.483	.579/.587	.020/.035
455	13.500	13.504	13.022	13.026	.375/.383	.475/.483	.579/.587	.020/.035
456	14.000	14.004	13.522	13.526	.375/.383	.475/.483	.579/.587	.020/.035
457	14.500	14.504	14.022	14.026	.375/.383	.475/.483	.579/.587	.020/.035
458	15.000	15.004	14.522	14.526	.375/.383	.475/.483	.579/.587	.020/.035
459	15.500	15.504	15.022	15.026	.375/.383	.475/.483	.579/.587	.020/.035
460	16.000	16.004	15.522	15.526	.375/.383	.475/.483	.579/.587	.020/.035
625	16.500	16.504	15.770	15.774	N/A	N/A	.750/.758	.025/.040
626	17.000	17.004	16.270	16.274	N/A	N/A	.750/.758	.025/.040
627	17.500	17.504	16.770	16.774	N/A	N/A	.750/.758	.025/.040
628	18.000	18.004	17.270	17.274	N/A	N/A	.750/.758	.025/.040

Turcon® Wedgpak®

Dash Size	Bore Min	Bore Max	Groove Min	Groove Max	Groove Width L ₁	Groove Width L ₂	Groove Width L ₃	Corner Radii
629	18.500	18.504	17.770	17.774	N/A	N/A	.750/.758	.025/.040
630	19.000	19.004	18.270	18.274	N/A	N/A	.750/.758	.025/.040
631	19.500	19.504	18.770	18.774	N/A	N/A	.750/.758	.025/.040
632	20.000	20.004	19.270	19.274	N/A	N/A	.750/.758	.025/.040
633	20.500	20.504	19.770	19.774	N/A	N/A	.750/.758	.025/.040
634	21.000	21.004	20.270	20.274	N/A	N/A	.750/.758	.025/.040
635	21.500	21.504	20.770	20.774	N/A	N/A	.750/.758	.025/.040
636	22.000	22.004	21.270	21.274	N/A	N/A	.750/.758	.025/.040
637	22.500	22.504	21.770	21.774	N/A	N/A	.750/.758	.025/.040
638	23.000	23.004	22.270	22.274	N/A	N/A	.750/.758	.025/.040
639	23.500	23.504	22.770	22.774	N/A	N/A	.750/.758	.025/.040
640	24.000	24.004	23.270	23.274	N/A	N/A	.750/.758	.025/.040
641	24.500	24.504	23.770	23.774	N/A	N/A	.750/.758	.025/.040
642	25.000	25.004	24.270	24.274	N/A	N/A	.750/.758	.025/.040
643	25.500	25.504	24.770	24.774	N/A	N/A	.750/.758	.025/.040
644	26.000	26.004	25.270	25.274	N/A	N/A	.750/.758	.025/.040
645	26.500	26.504	25.770	25.774	N/A	N/A	.750/.758	.025/.040
646	27.000	27.004	26.270	26.274	N/A	N/A	.750/.758	.025/.040
647	27.500	27.504	26.770	26.774	N/A	N/A	.750/.758	.025/.040
648	28.000	28.004	27.270	27.274	N/A	N/A	.750/.758	.025/.040
649	28.500	28.504	27.770	27.774	N/A	N/A	.750/.758	.025/.040
650	29.000	29.004	28.270	28.274	N/A	N/A	.750/.758	.025/.040
651	29.500	29.504	28.770	28.774	N/A	N/A	.750/.758	.025/.040
652	30.000	30.004	29.270	29.274	N/A	N/A	.750/.758	.025/.040
653	30.500	30.504	29.770	29.774	N/A	N/A	.750/.758	.025/.040
654	31.000	31.004	30.270	30.274	N/A	N/A	.750/.758	.025/.040
655	31.500	31.504	30.770	30.774	N/A	N/A	.750/.758	.025/.040
656	32.000	32.004	31.270	31.274	N/A	N/A	.750/.758	.025/.040

Ordering Example

Turcon® Wedgpak® complete with elastomer standard application:

Series : PAG
Dash No.: 214
TSS Part No.: PAG0CB214

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Metric sizes of Rod or Bore designs of Wedgpak® are possible.

TSS Article No.	PAG	0	C	B	214	-	M12	N
Inches								
Series No.								
Backup Width								
0 = Zero Backup Width								
1 = One Backup Width								
2 = Two Backup Width								
Design Code								
C = Cut Delta BUR's								
0 = Solid Delta BUR's								
Groove Standard								
Dash No.								
Quality Index (Standard)								
Material Code (BUR's)								
Material Code (Elastomer)								

Turcon[®] Double Delta



Features and benefits

Good static and dynamic sealing effect

Low friction, high efficiency

Operating temperatures of -49 °F to +500 °F /
-45 °C to +260 °C

Good chemical compatibility depending on
elastomer

Leak-tight reliable sealing performance

No adhesion even after extended periods of rest

Sizes to suit all O-Ring grooves including AS568 and
ISO 3601 seal sizes

High abrasion resistance

Long service life

Stick-slip-free starting

Simple installation

Turcon® Double Delta®

Description

Turcon® Double Delta® is the original slipper seal developed to improve the performance of O-Rings and Back-up Rings. It is a double-acting seal energized by an elastomer O-Ring. Demonstrating good friction properties, Turcon® Double Delta® provides stick-slip-free starting and excellent dry running. A full range of sizes is offered to suit all AS568 and ISO3601 seal sizes.

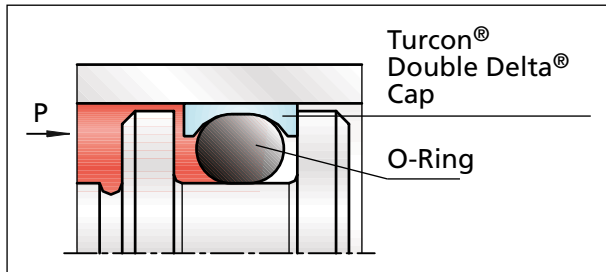


Figure 53 Turcon® Double Delta®

Method of Operation

The O-Ring in Turcon® Double Delta® preloads the seal cap in the thin, flexible middle section. This provides good leakage control even at low pressures.

In addition, when there is system pressure, the oil film under the seal is further reduced. Double Delta® will always allow an oil film to be dragged across the sealing surface. This oil film is necessary to ensure a long service life.

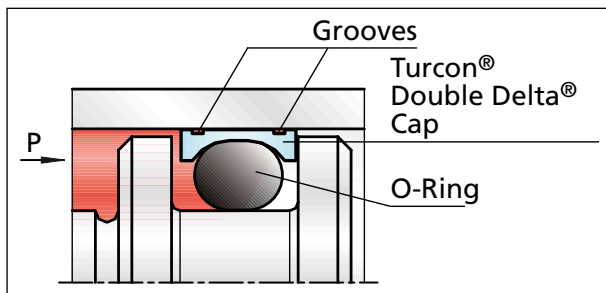


Figure 54 Grooved Turcon® Double Delta®

By choosing the grooved version, a further decrease in the film thickness can be achieved. The grooves increase the number of pressure peaks that the oil film must pass under. Another advantage of the grooved seal is that the grooves serve as an oil reservoir when the seal is static. When the seal starts to move dynamically, the oil film is quickly re-established under

the sliding surface to lubricate the seal and maintain seal friction at a minimum. This is especially important in applications where the stroke is shorter than the seal width and it provides a general improvement in wear-life.

The zero back-up width of the seal is generally preferred, even if a wider groove is available in smaller diameters. The extra space in a wider groove is used more efficiently when filled with Back-up Rings. This increases the seal life without notably affecting the friction.

Where Turcon® Double Delta® is subject to bi-directional pressure, it should always be equipped with sidewall notches. These allow the pressure to properly activate the elastomer. For piston, use Turcon® Double Delta® is equipped with notches as standard. The rod version must be specified with notches if they are deemed necessary.

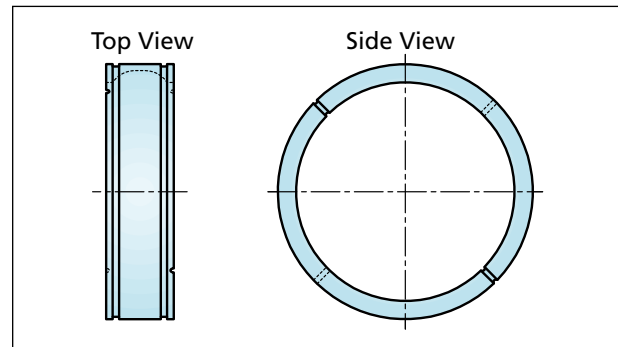


Figure 55 Turcon® Double Delta® Notches

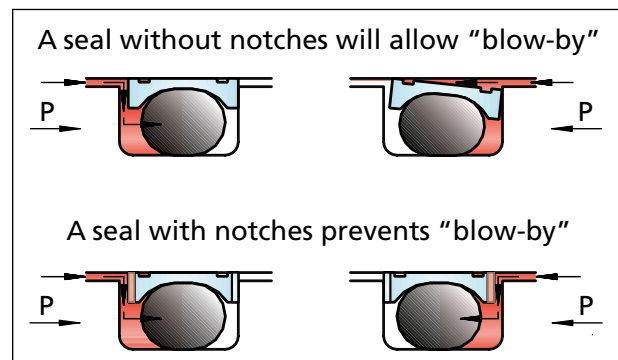


Figure 56 Turcon® Double Delta® with notches, function

Using a seal without notches may allow blow-by, where the pressure shoots over the top of the Turcon® Double Delta® cap and forces the seal down into the groove.

Technical Data

Operation pressure:	5,076 psi / 35 MPa (15,000 psi / 103 MPa with Back-up Ring)
Speed:	up to 50 ft/s / 15.0 m/s
Temperature range:	-49 °F to +392 °F / -45 °C to +200 °C depending on elastomer material
Clearance:	As per AS568 and ISO 3601 seal sizes. Larger clearance possible with Back-up Ring
Media:	Mineral oil-based hydraulic fluids, flame-retardant hydraulic fluids, environmentally-safe hydraulic fluids (bio-oils), Downhole fluids water and others depending on the elastomer material selected

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Turcon® Double Delta®

■ Installation Recommendation for Rod - Inch sizes

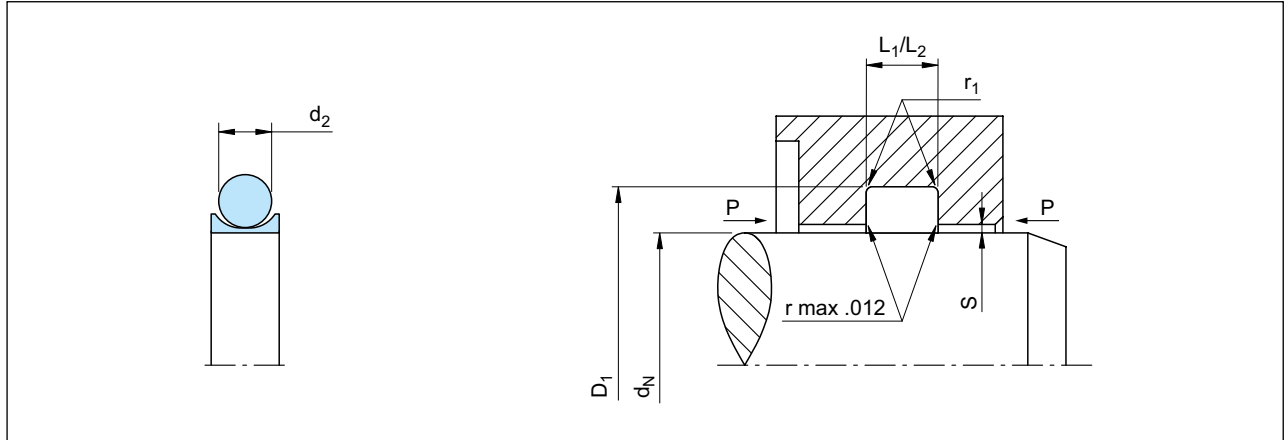


Figure 57 Installation drawing

Table 67 Installation Recommendations - Inch

TSS Dash Sizes	Rod Diameter		Groove Diameter D ₁ H9	Groove Width ** L ₁ +0.008	Groove Width *** L ₂ +0.008	Radius r ₁	Radial Clearance*			O-Ring Cross- Section d ₂
	d _N f8/h9						S _{max.}			
	Standard Application	Light Application					1500 psi	3000 psi	5800 psi	
006 - 028	.125 - .437	.500 - 1.375	d _N + .110	.093	.138	.005	.004	.003	.002	.070
104 - 151	.500 - .812	.875 - 3.000	d _N + .176	.140	.171	.005	.006	.004	.003	.103
201 - 250	.875 - 1.500	1.625 - 5.000	d _N + .242	.187	.208	.010	.008	.006	.003	.139
309- 353	1.625 - 4.375	.437 - 5.000	d _N + .370	.281	.311	.020	.010	.008	.004	.210
425 - 461	4.500 - 16.000	-	d _N + .474	.375	.408	.020	.012	.010	.006	.275

* At pressures > 5800 psi use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult your local Trelleborg Sealing Solutions marketing company for alternative material or profiles.

** L_1 is for "0" Back-up width groove - RD00_B series

*** L_2 is for "1" Back-up width groove - RD01_B series

Ordering Example

Turcon® Double Delta®, complete with O-Ring standard application:

Series: RD00
Dash No.: 445
TSS Part No.: RD0000445

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	RD00	00445	-	M12	N
Inches					
Series No.					
Size/Dash No.					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

Turcon® Double Delta®

Table 68 Installation Dimensions

Rod Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
d_N h9	D_1 H9	L_1 +.008			L_2 +.008	
.187	.297	.093	RD000B008	8	.138	RD010B008
.219	.329	.093	RD000B009	9	.138	RD010B009
.250	.360	.093	RD000B010	10	.138	RD010B010
.312	.422	.093	RD000B011	11	.138	RD010B011
.375	.485	.093	RD000B012	12	.138	RD010B012
.437	.547	.093	RD000B013	13	.138	RD010B013
.500	.610	.093	RD000B014	14	.138	RD010B014
.563	.672	.093	RD000B015	15	.138	RD010B015
.625	.735	.093	RD000B016	16	.138	RD010B016
.688	.797	.093	RD000B017	17	.138	RD010B017
.750	.860	.093	RD000B018	18	.138	RD010B018
.813	.922	.093	RD000B019	19	.138	RD010B019
.875	.985	.093	RD000B020	20	.138	RD010B020
.938	1.047	.093	RD000B021	21	.138	RD010B021
1.000	1.176	.093	RD000B0120	120	.171	RD010B0120
1.063	1.238	.140	RD000B121	121	.171	RD010B121
1.125	1.301	.140	RD000B122	122	.171	RD010B122
1.188	1.363	.140	RD000B123	123	.171	RD010B123
1.250	1.426	.140	RD000B124	124	.171	RD010B124
1.313	1.488	.140	RD000B125	125	.171	RD010B125
1.375	1.551	.140	RD000B126	126	.171	RD010B126
1.438	1.613	.140	RD000B127	127	.171	RD010B127
1.500	1.676	.140	RD000B128	128	.171	RD010B128
1.563	1.738	.140	RD000B129	129	.171	RD010B129
1.625	1.801	.140	RD000B130	130	.171	RD010B130
1.688	1.863	.140	RD000B131	131	.171	RD010B131
1.750	1.926	.140	RD000B132	132	.171	RD010B132
1.813	1.988	.140	RD000B133	133	.171	RD010B133
1.875	2.051	.140	RD000B134	134	.171	RD010B134
1.938	2.113	.140	RD000B135	135	.171	RD010B135
2.000	2.176	.140	RD000B136	136	.171	RD010B136
2.063	2.238	.140	RD000B137	137	.171	RD010B137
2.125	2.301	.140	RD000B138	138	.171	RD010B138

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

Turcon® Double Delta®

Rod Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
d_N h9	D_1 H9	L_1 +.008			L_2 +.008	
2.188	2.363	.140	RD000B139	139	.171	RD010B139
2.250	2.426	.140	RD000B140	140	.171	RD010B140
2.313	2.488	.140	RD000B141	141	.171	RD010B141
2.375	2.551	.140	RD000B142	142	.171	RD010B142
2.438	2.613	.140	RD000B143	143	.171	RD010B143
2.500	2.676	.140	RD000B144	144	.171	RD010B144
2.625	2.867	.187	RD000B231	231	.208	RD010B231
2.750	2.992	.187	RD000B232	232	.208	RD010B232
2.875	3.117	.187	RD000B233	233	.208	RD010B233
3.000	3.242	.187	RD000B234	234	.208	RD010B234
3.125	3.367	.187	RD000B235	235	.208	RD010B235
3.250	3.492	.187	RD000B236	236	.208	RD010B236
3.375	3.617	.187	RD000B237	237	.208	RD010B237
3.500	3.742	.187	RD000B238	238	.208	RD010B238
3.625	3.867	.187	RD000B239	239	.208	RD010B239
3.750	3.992	.187	RD000B240	240	.208	RD010B240
3.875	4.117	.187	RD000B241	241	.208	RD010B241
4.000	4.242	.187	RD000B242	242	.208	RD010B242
4.125	4.367	.187	RD000B243	243	.208	RD010B243
4.250	4.492	.187	RD000B244	244	.208	RD010B244
4.375	4.617	.187	RD000B245	245	.208	RD010B245
4.500	4.742	.187	RD000B246	246	.208	RD010B246
4.625	4.867	.187	RD000B247	247	.208	RD010B247
4.750	4.992	.187	RD000B248	248	.208	RD010B248
4.875	5.117	.187	RD000B249	249	.208	RD010B249
5.000	5.474	.375	RD000B429	429	.408	RD010B429
5.125	5.599	.375	RD000B430	430	.408	RD010B430
5.250	5.724	.375	RD000B431	431	.408	RD010B431
5.375	5.849	.375	RD000B432	432	.408	RD010B432
5.500	5.974	.375	RD000B433	433	.408	RD010B433
5.625	6.099	.375	RD000B434	434	.408	RD010B434
5.750	6.224	.375	RD000B435	435	.408	RD010B435
5.875	6.349	.375	RD000B436	436	.408	RD010B436

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

Turcon® Double Delta®

Rod Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
d_N h9	D_1 H9	L_1 +.008			L_2 +.008	
6.000	6.474	.375	RD000B437	437	.408	RD010B437
6.250	6.724	.375	RD000B438	438	.408	RD010B438
6.500	6.974	.375	RD000B439	439	.408	RD010B439
6.750	7.224	.375	RD000B440	440	.408	RD010B440
7.000	7.474	.375	RD000B441	441	.408	RD010B441
7.250	7.724	.375	RD000B442	442	.408	RD010B442
7.500	7.974	.375	RD000B443	443	.408	RD010B443
7.750	8.224	.375	RD000B444	444	.408	RD010B444
8.000	8.474	.375	RD000B445	445	.408	RD010B445
8.500	8.974	.375	RD000B446	446	.408	RD010B446
9.000	9.474	.375	RD000B447	447	.408	RD010B447
9.500	9.974	.375	RD000B448	448	.408	RD010B448
10.000	10.474	.375	RD000B449	449	.408	RD010B449

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

■ Installation Recommendation for Rod - Metric sizes

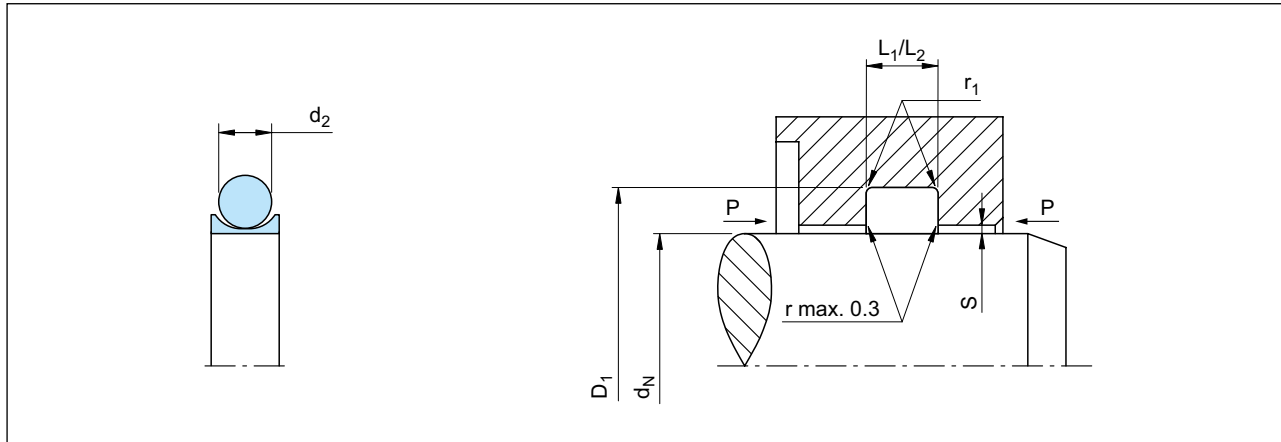


Figure 58 Installation drawing

Table 69 Installation Recommendations - Metric

Series No.	Rod Diameter		Groove Diameter D_1 H9	Groove Width** $L_1 +0.2$	Groove Width*** $L_2 +0.2$	Radius r_1	Radial Clearance*				O-Ring Cross-Section d_2
	d_N f8/h9						$S_{max.}$				
	Standard Application	Available Range					2 MPa	10 MPa	20 MPa	35 MPa	
RDD0	4 - 9.9	2 - 129.9	$d_N+2.9$	2.40	-	0.4	0.10	0.10	0.08	0.05	1.78
RDA0				-	3.80						
RDD1	10 - 19.9	5 - 249.9	$d_N+4.5$	3.60	-	0.4	0.15	0.15	0.10	0.07	2.62
RDA1				-	4.65						
RDD2	20 - 39.9	5 - 449.9	$d_N+6.2$	4.80	-	0.6	0.25	0.20	0.15	0.08	3.53
RDA2				-	5.70						
RDD3	40 - 119.9	12 - 649.9	$d_N+9.4$	7.10	-	0.8	0.35	0.25	0.20	0.10	5.33
RDA3				-	8.50						
RDD4	120 - 649.9	60 - 999.9	$d_N+12.2$	9.50	-	0.8	0.50	0.30	0.25	0.15	7.00
RDA4				-	11.20						
RDD5	650 - 999.9	110 - 999.9	$d_N+15.0$	10.00	-	1.0	0.60	0.40	0.30	0.20	8.40
RDA5				-	12.50						

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternative material or profiles.

TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

** L1 is for "0" Back-up width groove – RDD0 series

*** L2 is for "1" Back-up width groove – RDA0 series

Turcon® Double Delta®

Ordering Example

Turcon® Double Delta®, complete with O-Ring standard application:

Series: RDD3 from Table 69
Rod diameter $d_N = 80.0$ mm
TSS Part No.: RDD300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	RDD3	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)*****						
Rod diameter x 10****						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

**** For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

***** Use suffix "N" for seals with radial notches, for diameter $d_N < 1000$ mm. (Radial notches for diameter $d_N \geq 1000$ mm special part number is required).

■ Installation Recommendation for Piston - Inch sizes

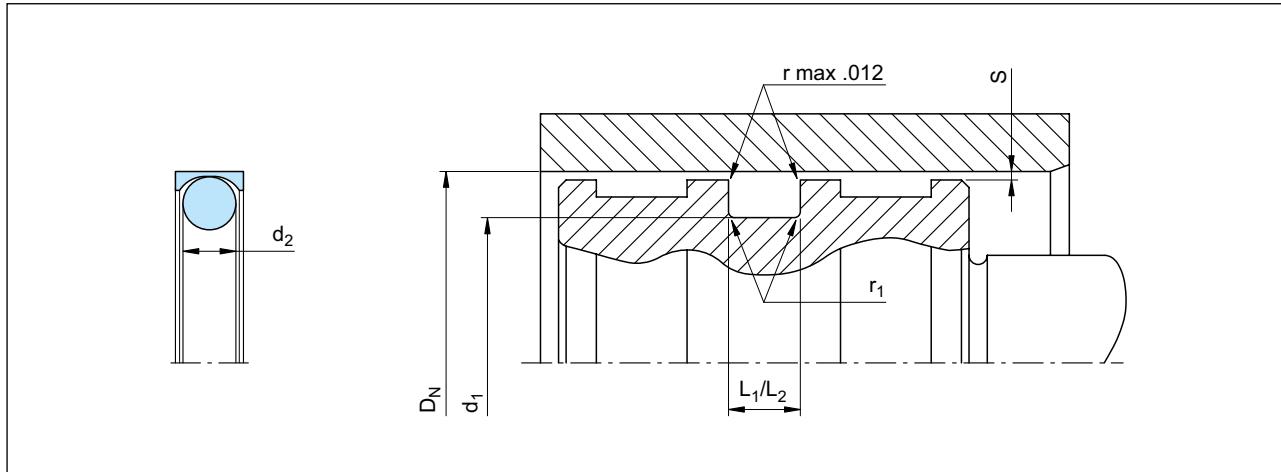


Figure 59 Installation drawing

Table 70 Installation Dimensions - Inch

TSS Dash Sizes	Bore Diameter		Groove Diameter	Groove Width **	Groove Width ***	Radius r ₁	Radial Clearance*			O-Ring Cross- Sec.
	D _N H9						S max.			
	Standard Application	Light Application					d ₁ h9	L ₁ +0.008	L ₂ +0.008	1500 psi
006 - 028	.250 - .281	.312 - 1.500	D _N - .110	.093	.138	.005	.004	.003	.002	.070
104 - 149	.312 - .406	.437 - 3.000	D _N - .176	.140	.171	.005	.006	.004	.003	.103
201 - 248	.437 - .750	.812 - 5.000	D _N - .242	.187	.208	.010	.008	.006	.003	.139
309 - 350	.812 - 4.875	5.000	D _N - .370	.281	.311	.020	.010	.008	.004	.210
425 - 460	5.000 - 16.000	-	D _N - .474	.375	.408	.020	.012	.010	.006	.275

* At pressures > 5800 psi use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearances S. Please consult the Slydring® catalog.

** L_1 is for "0" Back-up width groove - PD00_B series

*** L_2 is for "1" Back-up width groove - PD01_B series

Ordering Example

Turcon® Double Delta®, complete with O-Ring standard application:

Series: PD00 from Table 70

Dash No: 117

TSS Part No.: PD0000117

Select the material from Tables 11 to 18.

Notes:

1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.

2) The clearance stated as S in Table 70 is for when the seal is specified with Slydring® bearings. When not incorporating Slydring bearings, the diametrical clearance should be reduced.

TSS Article No.	PD00	00117	-	M12	N
Inches					
Series No.					
Size/Dash No.					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

Turcon® Double Delta®

Table 71 Installation Dimensions

Bore Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
D_N H9	d₁ h9	L₁ +.008			L₂ +.008	
.250	.140	.093	PD000B006	6	.138	PD010B006
.281	.171	.093	PD000B007	7	.138	PD010B007
.312	.202	.093	PD000B008	8	.138	PD010B008
.344	.234	.093	PD000B009	9	.138	PD010B009
.375	.265	.093	PD000B010	10	.138	PD010B010
.437	.327	.093	PD000B011	11	.138	PD010B011
.500	.390	.093	PD000B012	12	.138	PD010B012
.563	.452	.093	PD000B013	13	.138	PD010B013
.625	.515	.093	PD000B014	14	.138	PD010B014
.688	.577	.093	PD000B015	15	.138	PD010B015
.750	.640	.093	PD000B016	16	.138	PD010B016
.813	.702	.093	PD000B017	17	.138	PD010B017
.875	.765	.093	PD000B018	18	.138	PD010B018
.938	.827	.093	PD000B019	19	.138	PD010B019
1.000	.824	.140	PD000B117	117	.171	PD010B117
1.063	.886	.140	PD000B118	118	.171	PD010B118
1.125	.949	.140	PD000B119	119	.171	PD010B119
1.188	1.011	.140	PD000B120	120	.171	PD010B120
1.250	1.074	.140	PD000B121	121	.171	PD010B121
1.313	1.136	.140	PD000B122	122	.171	PD010B122
1.375	1.199	.140	PD000B123	123	.171	PD010B123
1.438	1.261	.140	PD000B124	124	.171	PD010B124
1.500	1.324	.140	PD000B125	125	.171	PD010B125
1.563	1.386	.140	PD000B126	126	.171	PD010B126
1.625	1.449	.140	PD000B127	127	.171	PD010B127
1.688	1.511	.140	PD000B128	128	.171	PD010B128
1.750	1.574	.140	PD000B129	129	.171	PD010B129
1.813	1.636	.140	PD000B130	130	.171	PD010B130
1.875	1.699	.140	PD000B131	131	.171	PD010B131
1.938	1.761	.140	PD000B132	132	.171	PD010B132
2.000	1.824	.140	PD000B133	133	.171	PD010B133
2.063	1.886	.140	PD000B134	134	.171	PD010B134
2.125	1.949	.140	PD000B135	135	.171	PD010B135

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

Turcon® Double Delta®

Bore Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
D_N H9	d₁ h9	L₁ +.008			L₂ +.008	
2.188	2.011	.140	PD000B136	136	.171	PD010B136
2.250	2.074	.140	PD000B137	137	.171	PD010B137
2.313	2.136	.140	PD000B138	138	.171	PD010B138
2.375	2.199	.140	PD000B139	139	.171	PD010B139
2.438	2.261	.140	PD000B140	140	.171	PD010B140
2.500	2.324	.140	PD000B141	141	.171	PD010B141
2.625	2.383	.187	PD000B229	229	.208	PD010B229
2.750	2.508	.187	PD000B230	230	.208	PD010B230
2.875	2.633	.187	PD000B231	231	.208	PD010B231
3.000	2.758	.187	PD000B232	232	.208	PD010B232
3.125	2.883	.187	PD000B233	233	.208	PD010B233
3.250	3.008	.187	PD000B234	234	.208	PD010B234
3.375	3.133	.187	PD000B235	235	.208	PD010B235
3.500	3.258	.187	PD000B236	236	.208	PD010B236
3.625	3.383	.187	PD000B237	237	.208	PD010B237
3.750	3.508	.187	PD000B238	238	.208	PD010B238
3.875	3.633	.187	PD000B239	239	.208	PD010B239
4.000	3.758	.187	PD000B240	240	.208	PD010B240
4.125	3.883	.187	PD000B241	241	.208	PD010B241
4.250	4.008	.187	PD000B242	242	.208	PD010B242
4.375	4.133	.187	PD000B243	243	.208	PD010B243
4.500	4.258	.187	PD000B244	244	.208	PD010B244
4.625	4.383	.187	PD000B245	245	.208	PD010B245
4.750	4.508	.187	PD000B246	246	.208	PD010B246
4.875	4.633	.187	PD000B247	247	.208	PD010B247
5.000	4.526	.375	PD000B425	425	.408	PD010B425
5.125	4.651	.375	PD000B426	426	.408	PD010B426
5.250	4.776	.375	PD000B427	427	.408	PD010B427
5.375	4.901	.375	PD000B428	428	.408	PD010B428
5.500	5.026	.375	PD000B429	429	.408	PD010B429
5.625	5.151	.375	PD000B430	430	.408	PD010B430
5.750	5.276	.375	PD000B431	431	.408	PD010B431
5.875	5.401	.375	PD000B432	432	.408	PD010B432

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

Turcon® Double Delta®

Bore Diameter	Groove Diameter	O-Ring Width		O-Ring Dash No.	O-Ring + Back-up Ring Width	
		Groove Width	TSS Part No.		Groove Width	TSS Part No.
D_N H9	d₁ h9	L₁ +.008			L₂ +.008	
6.000	5.526	.375	PD000B433	433	.408	PD010B433
6.125	5.651	.375	PD000B434	434	.408	PD010B434
6.250	5.776	.375	PD000B435	435	.408	PD010B435
6.375	5.901	.375	PD000B436	436	.408	PD010B436
6.500	6.026	.375	PD000B437	437	.408	PD010B437
6.750	6.276	.375	PD000B438	438	.408	PD010B438
7.000	6.526	.375	PD000B439	439	.408	PD010B439
7.250	6.776	.375	PD000B440	440	.408	PD010B440
7.500	7.026	.375	PD000B441	441	.408	PD010B441
7.750	7.276	.375	PD000B442	442	.408	PD010B442
8.000	7.526	.375	PD000B443	443	.408	PD010B443
8.250	7.776	.375	PD000B444	444	.408	PD010B444
8.500	8.026	.375	PD000B445	445	.408	PD010B445

The sizes listed in **bold** font are preferred sizes (more likely to be available for immediate shipment). Other dimensions and all intermediate sizes up to 102 inches (2600mm) diameter can be supplied.

■ Installation Recommendations for Piston - Metric sizes

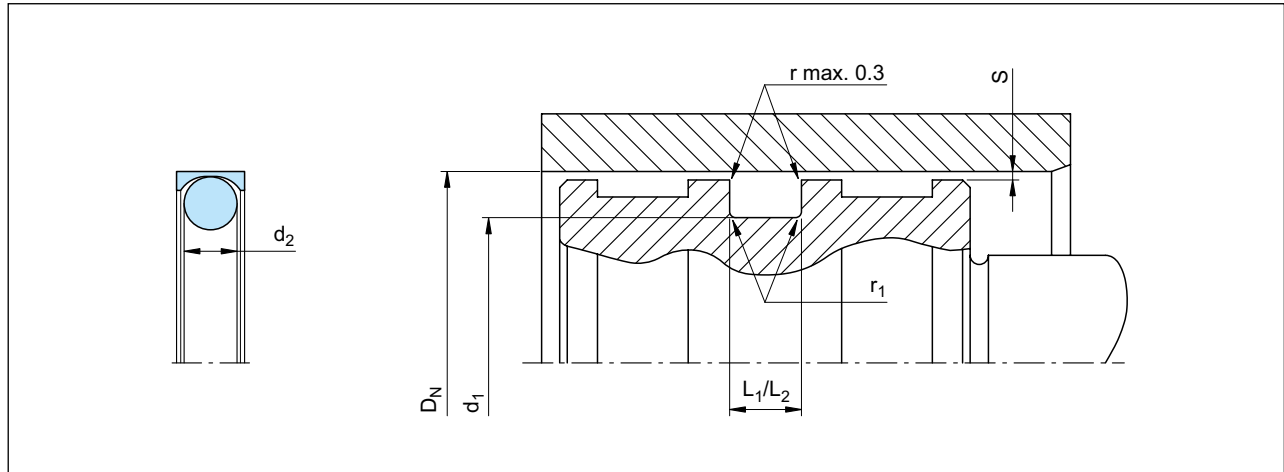


Figure 60 Installation drawing

Table 72 Installation Recommendations - Metric

Series No.	Bore Diameter		Groove Diameter	Groove Width **	Groove Width ***	Radius	Radial Clearance *				O-Ring Cross-Sec.
	D _N H9						S _{max.}				
	Standard Application	Available Range	d ₁ h9	L ₁ +0.2	L ₂ +0.2		r ₁	2 MPa	10 MPa	20 MPa	35 MPa
PDD0	5 - 13.9	5 - 139.9	D _N -2.9	2.40	-	0.4	0.10	0.10	0.08	0.05	1.78
PDA0				-	3.80						
PDD1	14 - 24.9	8 - 259.9	D _N -4.5	3.60	-	0.4	0.15	0.15	0.10	0.07	2.62
PDA1				-	4.65						
PDD2	25 - 45.9	12 - 469.9	D _N -6.2	4.80	-	0.6	0.25	0.20	0.15	0.08	3.53
PDA2				-	5.70						
PDD3	46 - 124.9	20 - 669.9	D _N -9.4	7.10	-	0.8	0.35	0.25	0.20	0.10	5.33
PDA3				-	8.50						
PDD4	125 - 669.9	80 - 999.9	D _N -12.2	9.50	-	0.8	0.50	0.30	0.25	0.15	7.00
PDA4				-	11.20						
PDD5	670 - 999.9	125 - 999.9	D _N -15.0	10.00	-	1.0	0.60	0.40	0.30	0.20	8.40
PDA5				-	12.50						

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles.

TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

** L1 is for "0" Back-up width groove – PDD0 series

*** L2 is for "1" Back-up width groove – PDA0 series

Turcon® Double Delta®

Ordering Example

Turcon® Double Delta®, complete with O-Ring, standard application:

Series: PDD3 from Table 72
Bore diameter: $D_N = 80.0$ mm
TSS Part No.: PDD300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PDD3	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)*****						
Bore diameter x 10****						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

**** For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

***** Use suffix "N" for seals with radial notches, for diameter DN < 1000 mm. (Radial notches for diameter DN ≥ 1000 mm special part number is required).

Turcon® VL Seal®



Features and benefits

Tight leakage control

Hydrodynamic back pumping effect maximizes leakage control

Avoids the trapping of pressure between tandem seals or between seals and scrapers

Low friction due to a reduced contact area between seal and mating surface

Continuously lubricated

Long service life

Simple design

Uses standard size O-Ring as an energizer

Not available in 000 Series

US Patent No. 6,497,415

Description

The Turcon® VL Seal® was developed as the next generation unidirectional seal. It incorporates leading-edge design and development techniques to optimize frictional behavior, leakage control and service life. Performance parameters are backed up with results from in-house testing and qualified customer applications.

Important to the function of the Turcon® VL Seal® is the Trelleborg Sealing Solutions back pumping effect. This prevents pressure from being trapped between tandem seals or between seals and double-acting scrapers.

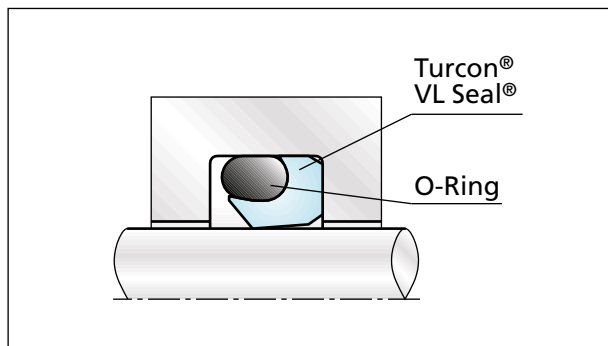


Figure 61 Turcon® VL Seal®

Method of Operation

The sealing mechanism of Turcon® VL Seal® is based on the hydrodynamic properties of the seal. The specially formed seal edge has a steep contact pressure gradient on the high-pressure side and a shallow contact pressure gradient on the low-pressure side. This ensures that the fluid film adhering to the counter surface is returned to the high-pressure chamber on the return stroke. The micro-fluid layer that is carried out of the high-pressure chamber during the dynamic movement is therefore prevented from causing leaks.

The return delivery property of the Turcon® VL Seal® prevents the build-up of the inter-stage pressure that is normally associated with tandem seal configurations. Inter-stage pressure depends on system pressure speed, stroke length and groove design.

The presence of hydraulic oil around the seal ensures a very long service life, as the seal will always be adequately lubricated.

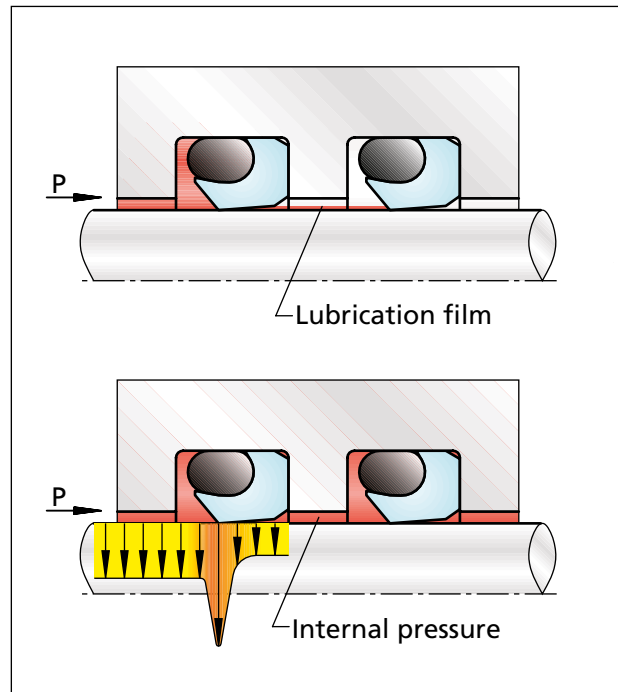


Figure 62 Pressure Distribution in Tandem Installation

Technical Data

Operation pressure:	7,252 psi / 50 MPa (10,000 psi / 69 MPa with Turcon® Back-up Ring)
Speed:	Up to 50 ft/s / 15.0 m/s with reciprocating movements
Temperature range:	-49 °F to +392 °F / -40 °C to +200 °C depending on elastomer material
Clearance:	For clearances refer to full catalog on Turcon® VL Seal®
Media:	Mineral oil-based hydraulic fluids, flame-retardant hydraulic fluids, environmentally-safe hydraulic fluids (bio-oils), water and others, depending on the elastomer material

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Dimensions for Rod - Inch sizes

The VL Seal® is suitable for standard O-Ring housings. Groove dimensions, radial clearances and recommended seal series in relation to diameter are as illustrated in table below.

VL Seal® is preferably installed in closed grooves. Depending on type and size, installation in split grooves is also possible.

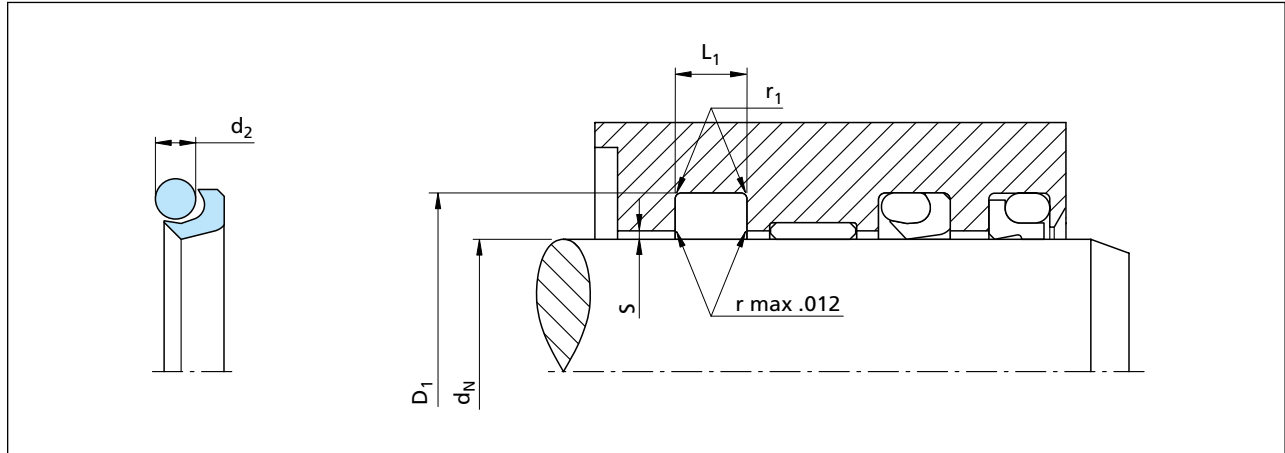


Figure 63 Installation drawing

Table 73 Installation Recommendations - Inch

Series No.	Rod Diameter d_N f8/h9		Groove Dia. D_1 H9	Groove width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring cross section d_2
	Standard Application	Available Range				1500 psi	3000 psi	5800 psi	
REL1	.375 - .749	.250 - 4.000	$d_N + .177$	.142	.160	.016	.010	.006	.070
REL2	.750 - 1.499	.438 - 8.000	$d_N + .244$	.189	.240	.016	.010	.008	.103
REL3	1.500 - 4.749	.750 - 16.000	$d_N + .370$	.280	.320	.020	.012	.008	.139
REL4	4.750 - 15.999	1.375 - 25.000	$d_N + .480$	.374	.320	.024	.014	.010	.210
REL5	16.000 - 40.000	5.000 - 40.000	$d_N + .626$	.480	.320	.028	.020	.012	.275

* At pressures > 5,800 psi use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

Ordering Example

Turcon® VL Seal® complete with O-Ring standard application:

Series: REL3 from Table 73
Rod diameter: $d_N = 2.000$ inches = 50.8 mm
TSS Part No.: REL300508

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Note: When developing a part number for the Turcon® VL Seal®, all inch diameter sizes must be converted to metric in order for the part number to be recognized in our global part number system. For detailed information please contact your local Trelleborg Sealing Solutions marketing company.

TSS Article No.	REL3	00508	-	M12	N
Inches					
Series No.					
Rod diameter x 10					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Dimensions for Rod - Metric sizes

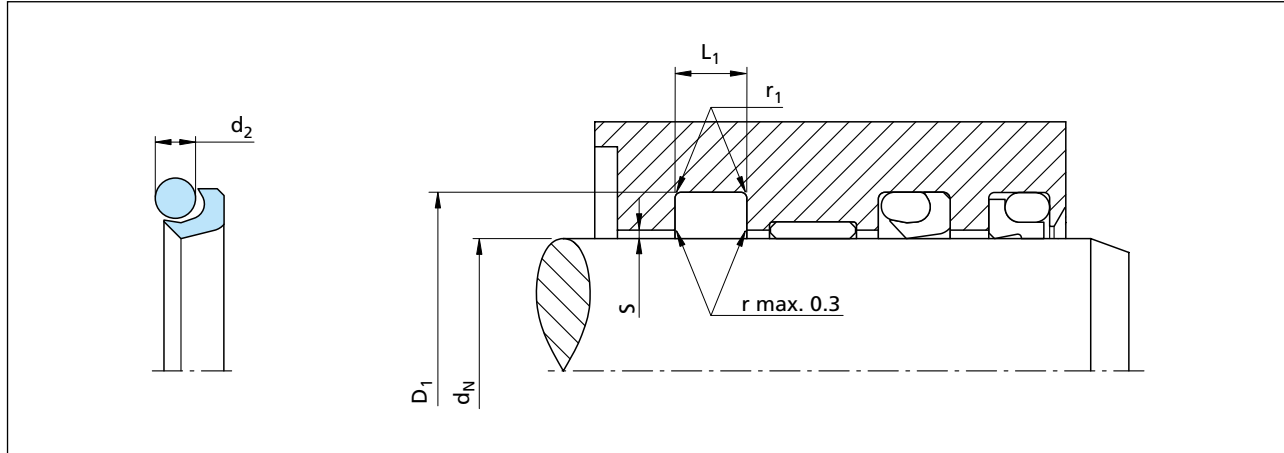


Figure 64 Installation drawing

Table 74 Installation Recommendations - Metric

Series No.	Rod Diameter d_N f8/h9		Groove Diameter	Groove width	Radius	Radial Clearance* $S_{max.}$			O-Ring cross section
	Standard Application	Available Range	D_1 H9	$L_1 + 0.2$	r_1	10 MPa	20 MPa	40 MPa	d_2
REL10	10 -19.9	6 -100.0	$d_N + 4.5$	3.6	0.4	0.40	0.25	0.15	1.78
REL20	20 -39.9	10 -200.0	$d_N + 6.2$	4.8	0.6	0.40	0.25	0.20	2.62
REL30	40 -119.9	20 -400.0	$d_N + 9.4$	7.1	0.8	0.50	0.30	0.20	3.53
REL40	120 -399.9	35 -650.0	$d_N + 12.2$	9.5	0.8	0.60	0.35	0.25	5.33
REL50	400 -649.9	125 -999.9	$d_N + 15.9$	12.2	0.8	0.70	0.50	0.30	7.00
REL60	650 -999.9	400 -999.9	$d_N + 19.0$	15.0	0.8	1.00	0.70	0.60	8.40
REL6X	≥ 1000	1000 -2600	$d_N + 19.0$	15.0	0.8	1.00	0.70	0.60	8.40

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

Ordering Example

Turcon® VL Seal® complete with O-Ring standard application:

Series: REL40 from Table 74
 Rod diameter: dN = 250.0 mm
 TSS Part No.: REL402500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three place decimal.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.

TSS Article No.	REL4	0	2500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

For diameters $\geq 1000\text{mm}$ please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

■ Installation Recommendations for Piston - Inch sizes

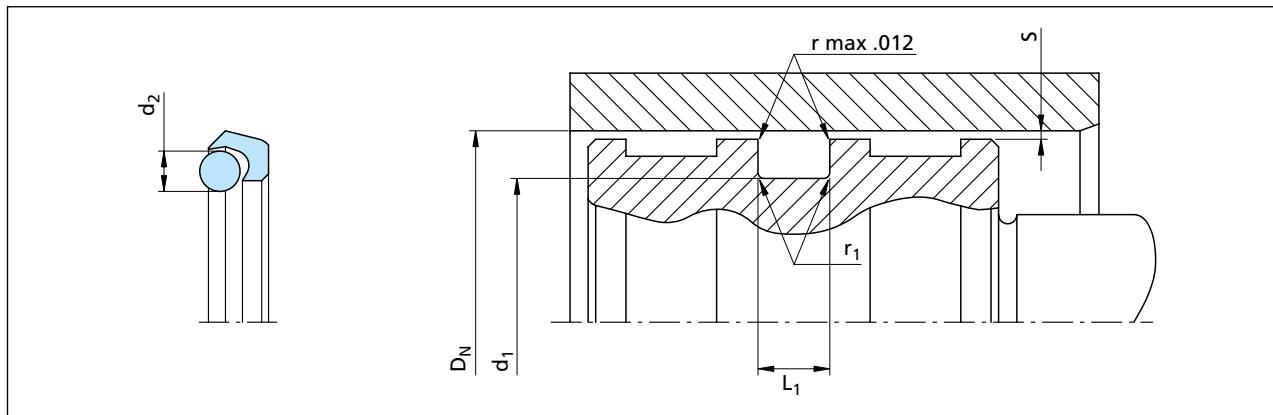


Figure 65 Installation drawing

Table 75 Installation Dimensions - Standard Recommendations inch

Series No.	Bore Diameter D_N H9		Groove Diameter d_1 h9	Groove width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring cross section d_2
	Standard Application	Available Range				1,500 psi	3,000 psi	5,800 psi	
PEL1	.500 - .999	.375 - 4.000	D_N - .177	.142	.015	.016	.010	.006	.070
PEL2	1.000 - 1.749	.625 - 8.000	D_N - .244	.189	.025	.016	.010	.008	.103
PEL3	1.750 - 4.999	1.250 - 16.000	D_N - .370	.280	.031	.020	.012	.008	.139
PEL4	5.000 - 15.749	1.750 - 26.500	D_N - .480	.374	.031	.024	.014	.010	.210
PEL5	15.750 - 26.500	5.000 - 40.000	D_N - .626	.480	.031	.028	.020	.012	.275

* At pressures > 5,800 psi use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

Ordering Example

Turcon® VL Seal® complete with O-Ring standard application:

Series: PEL3 from Table 75
Bore diameter: D_N = 4.00 inches = 101.6 mm
TSS Part No.: PEL301016

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Note: When developing a part number for the Turcon® VL Seal®, all inch diameter sizes must be converted to metric in order for the part number to be recognized in our global part number system. For detailed information please contact your local Trelleborg Sealing Solutions marketing company.

TSS Article No.	PEL3	0	1016	-	M12	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

■ Installation Recommendations for Piston - Metric sizes

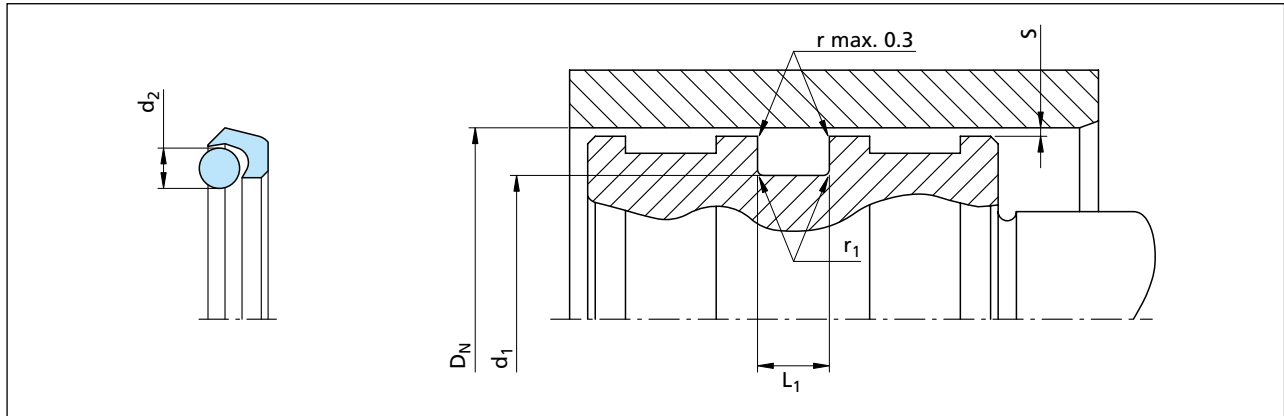


Figure 66 Installation drawing

Table 76 Installation Dimensions - Standard Recommendations metric

Series No.	Bore Diameter D_N H9		Groove Dia. d_1 h9	Groove width $L_1 + 0.2$	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring cross section d_2
	Standard Application	Available Range				10 MPa	20 MPa	40 MPa	
PEL10	14 - 24.9	10 - 100.0	$D_N - 4.5$	3.6	0.4	0.40	0.25	0.15	1.78
PEL20	25 - 45.9	16 - 200.0	$D_N - 6.2$	4.8	0.6	0.40	0.25	0.20	2.62
PEL30	46 - 124.9	28 - 400.0	$D_N - 9.4$	7.1	0.8	0.50	0.30	0.20	3.53
PEL40	125 - 399.9	45 - 650.0	$D_N - 12.2$	9.5	0.8	0.60	0.35	0.25	5.33
PEL50	400 - 649.9	125 - 999.9	$D_N - 15.9$	12.2	0.8	0.70	0.50	0.30	7.00
PEL60	650 - 999.9	400 - 999.9	$D_N - 19.0$	15.0	0.8	1.00	0.70	0.60	8.40
PEL6X	≥ 1000	1000 - 2700	$D_N - 19.0$	15.0	0.8	1.00	0.70	0.60	8.40

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

Ordering Example

Turcon® VL Seal® complete with O-Ring standard application:

Series: PEL3 from Table 76
Bore diameter: $D_N = 250.0$ mm
TSS Part No.: PEL402500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PEL4	02500	-	M12	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

Turcon® Glyd Ring® and Glyd Ring® T



Features and benefits

High sealing efficiency

Low wear

Long service life

High operational reliability

Low friction

Stick-slip-free operation

Suitable for narrow grooves

Design flexibility – adaptable for almost all groove sizes

Easy installation

Custom designs available

Bidirectional seal

Very good static leak-tightness

Increased clearance possible of approximately 50 percent, depending on the operating conditions

Simple groove design

Available for all diameters up to 102 inches / 2600 mm

Turcon® Glyd Ring® and Glyd Ring® T

Description

Turcon® Glyd Ring® T is fully interchangeable with Turcon® Glyd Ring®.

Within the seal both lateral profile flanks are inclined so that the seal profile tapers towards the seal surface. The profile can thus retain the robust and compact form typical of piston seals without losing any of the flexibility required to achieve a pressure-related maximum compression.

The edge angle created by the cross-sectional form of Turcon® Glyd Ring® T permits an additional degree of freedom of movement and enables slight tilting of the seal. The maximum compression is thus always shifted towards the area of the seal edge directly exposed to the pressure. On the lower-pressure edge of the seal, the Glyd Ring® T exhibits only zones with neutral strains without compressive or shearing loads. This effectively reduces the danger of gap extrusion.

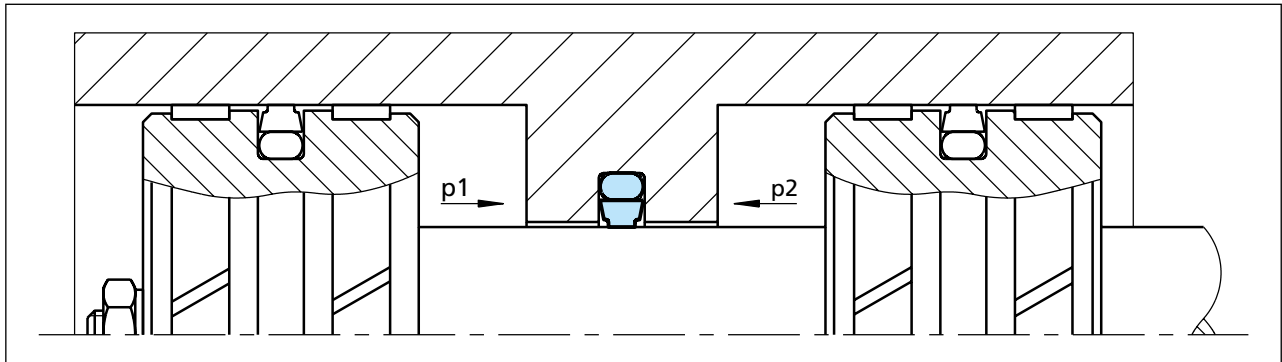


Figure 67 Turcon® Glyd Ring® T

Application Examples

The Turcon® Glyd Ring® T is the recommended sealing element for double acting sealing for hydraulic components such as:

- Valves
- Valve Actuators
- Downhole Tools
- Tensioner Cylinders

It is particularly recommended for heavy duty and large diameter applications.

Turcon® Glyd Ring® and Glyd Ring® T

Technical Data

Operating pressure:	up to 7,252 psi / 50 MPa
Speed:	up to 50 ft/s / 15 m/s
Temperature:	-49 °F to +392 °F / -40 °C to +200 °C (depending on O-Ring material)
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), water, air and others, depending on the O-Ring material.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Materials

Standard Application

For hydraulic components with reciprocating movement and good lubricating performance.

Turcon® Seal:	Turcon® M12
Energizer:	O-Ring XploR® HNBR 90 shore A or XploR® FKM 90 shore A
Set code:	M12X3 or M12X2 from Tables 11 to 18

Turcon® Glyd Ring® and Glyd Ring® T

Turcon® Glyd Ring®

■ Installation Recommendation for Rod - Inch sizes

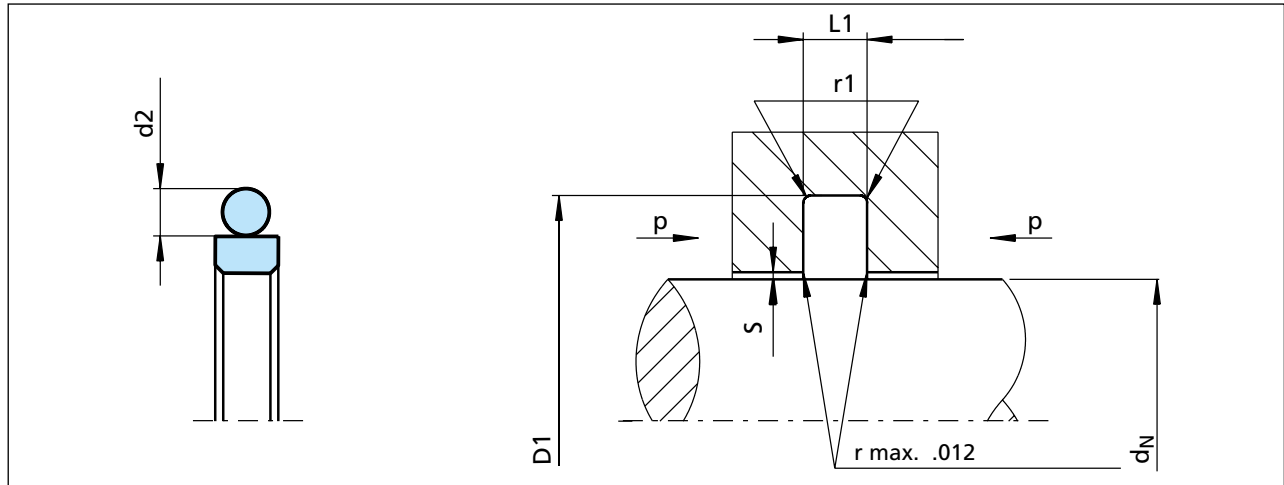


Figure 68 Installation drawing

Table 77 Installation Dimensions – Standard Recommendations inch

TSS Series No.	Rod Diameter d_N f8/h9			Groove Dia.*	Groove Width	Radius	Radial Clearance** $S_{max.}$			O-Ring Cross Sec.
	Standard Application	Light Application	Heavy Duty Application	D_1 H9	$L_1 + .008$	r_1	1,500 psi	3,000 psi	5,800 psi	d_2
RG00	.313 - .624	.625 - 1.624	-	$d_N + .193$	.087	.015	.020	.012	.008	.070
RG01	.625 - 1.624	1.625 - 3.249	-	$d_N + .287$	.126	.025	.024	.016	.008	.103
RG02	1.625 - 3.249	3.250 - 5.374	.625 - 1.624	$d_N + .421$	.165	.025	.024	.016	.008	.139
RG03	3.250 - 5.374	5.375 - 12.999	1.625 - 3.249	$d_N + .594$	.248	.035	.031	.020	.012	.210
RG04	5.375 - 12.999	13.000 - 26.000	3.250 - 5.374	$d_N + .807$	.319	.035	.031	.020	.012	.275
RG05	13.000 - 26.000	-	5.375 - 13.000	$d_N + .945$	.319	.035	.035	.020	.016	.275

* Installation with groove dimensions to ISO 7425/2 is possible.

** At pressures > 5,800 psi use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult Trelleborg Sealing Solutions for alternative material or profiles.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring®, complete with O-Ring, standard application:

Series: RG02 from Table 77
Rod diameter: $d_N = 1.625$ inches
TSS Part No.: RG0201625

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.

TSS Article No.	RG	0	2	01625	-	T46	N
TSS Series No.							
Without notch (Standard) (substitute "N" if notch is required)							
Cross-section size							
Rod diameter x 1000****							
Quality Index (Standard)							
Material Code (Seal Ring)							
Material Code (O-Ring)							

**** For diameters $d_N \geq 20$ inch please consult your local Trelleborg Sealing Solutions marketing company for special TSS Article No.

■ Installation Recommendation for Rod - Metric sizes

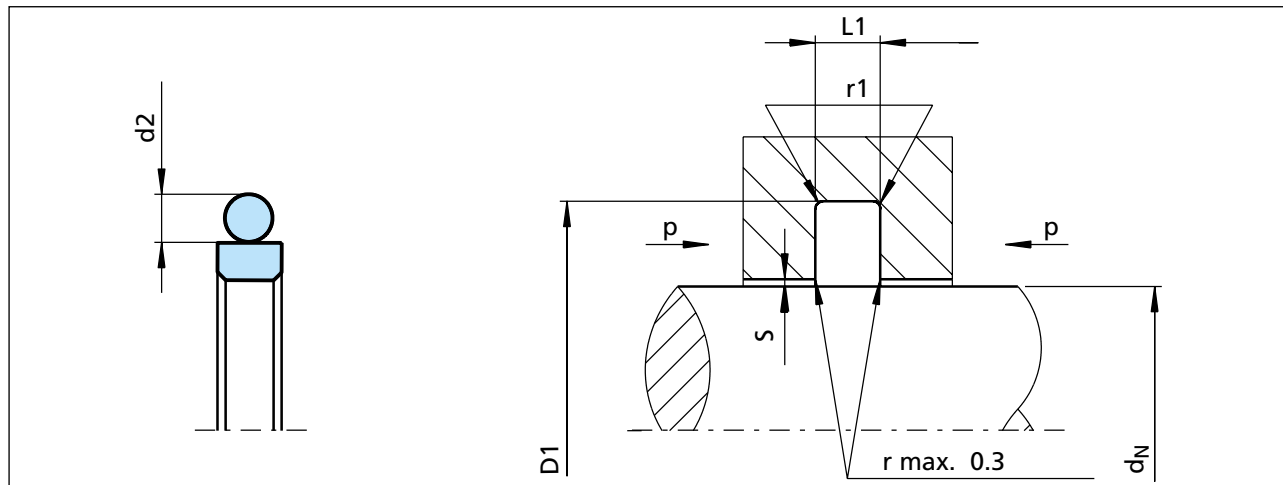


Figure 69 Installation Drawing

Table 78 Installation Dimensions - Metric

Rod Diameter d_N f8/h9			Groove Dia.* D_1 H9	Groove Width $L_1 + 0.2$	Radius r_1	Radial Clearance** $S_{max.}$			O-Ring Cross- Section d_2
Series No. RG 43 Standard Application	Series No. RG 45 Light Application	Series No. RG 41 Heavy Duty Application				10 MPa	20 MPa	40 MPa	
3 - 7.9	8 - 18.9	-	$d_N + 4.9$	2.2	0.4	0.30	0.20	0.15	1.78
8 - 18.9	19 - 37.9	-	$d_N + 7.3$	3.2	0.6	0.40	0.25	0.15	2.62
19 - 37.9	38 - 199.9	8 - 18.9	$d_N + 10.7$	4.2	1.0	0.40	0.25	0.20	3.53
38 - 199.9	200 - 255.9	19 - 37.9	$d_N + 15.1$	6.3	1.3	0.50	0.30	0.20	5.33
200 - 255.9	256 - 649.9	38 - 199.9	$d_N + 20.5$	8.1	1.8	0.60	0.35	0.25	7.00
256 - 649.9	650 - 999.9	200 - 255.9	$d_N + 24.0$	8.1	1.8	0.60	0.35	0.25	7.00
650 - 999.9	≥ 1000	256 - 649.9	$d_N + 27.3$	9.5	2.5	0.70	0.50	0.30	8.40
$\geq 1000^{***}$	-	650 - 999.9	$d_N + 38.0$	13.8	3.0	1.00	0.70	0.60	12.00

* Installation with groove dimensions to ISO 7425/2 is possible.

** At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring®/Wear Rings are not applicable at very small radial clearances S; consult the Slydring® catalog.

*** O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring®, complete with O-Ring, standard application,

Series: RG43 from Table 78
Rod diameter: $d_N = 80.0$ mm
TSS Part No.: RG4300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.

TSS Article No.	RG43	0	0800	-	M12	N
TSS Series No.						
Type (Standard)*****						
Rod diameter x 10****						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

**** For diameters $d_N \geq 20$ please contact your local Trelleborg Sealing Solutions marketing company for special TSS Article no.

***** Ordering Glyd Ring® with radial notches, please use suffix "N" in the fifth character, for diameter $d_N < 1000$ mm.

Turcon® Glyd Ring® and Glyd Ring® T

■ Installation Recommendation for Piston - Inch sizes

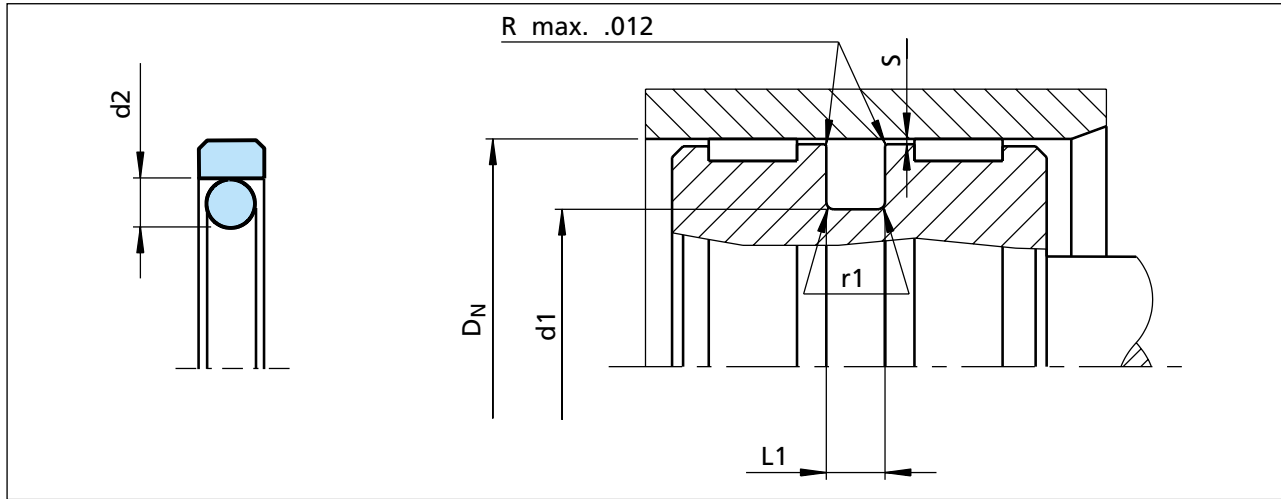


Figure 70 Installation drawing

Table 79 Installation Dimensions – Standard Recommendations inch

TSS Series-No.	Bore Diameter D_N H9			Groove Dia.	Groove Width	Radius	Radial Clearance* $S_{max.}$			O-Ring Cross Sec.
	Standard Application	Light Application	Heavy Duty Application	d_1 h9	$L_1 \pm .008$	r_1	1,500 psi	3,000 psi	5,800 psi	d_2
PG00	.312 - .562	.625 - 1.500	-	$D_N - .193$	.087	.015	.020	.012	.008	.070
PG01	.562 - 1.563	1.563 - 3.125	-	$D_N - .295$	.126	.025	.024	.016	.008	.103
PG02	1.563 - 3.125	3.125 - 5.250	.562 - 1.563	$D_N - .433$	.165	.025	.024	.016	.008	.139
PG03	3.125 - 5.250	5.250 - 12.500	1.563 - 3.125	$D_N - .610$	.248	.035	.031	.020	.012	.210
PG04	5.250 - 12.500	12.500 - 26.000	3.125 - 5.250	$D_N - .827$	.319	.035	.031	.020	.012	.275
PG05	12.500 - 26.000	-	5.250 - 12.500	$D_N - .965$	.319	.035	.035	.020	.016	.275

* At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/piston) in area of the seal.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring®, complete with O-Ring, standard application:

Series: PG02 from Table 79
Bore diameter: $D_N = 2.500$ inches
TSS Part No.: PG0202500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solution marketing company for diameters that exceed those listed in the above table.

TSS Article No.	PG	0	2	02500	-	T46	N
TSS Series No.							
0=std, N=with notches							
Cross Section							
Function Bore Dia. x 1000							
Quality Index							
Material Code (Seal ring)							
Material Code (O-Ring)							

Turcon® Glyd Ring® and Glyd Ring® T

■ Installation Recommendation for Piston - Metric sizes

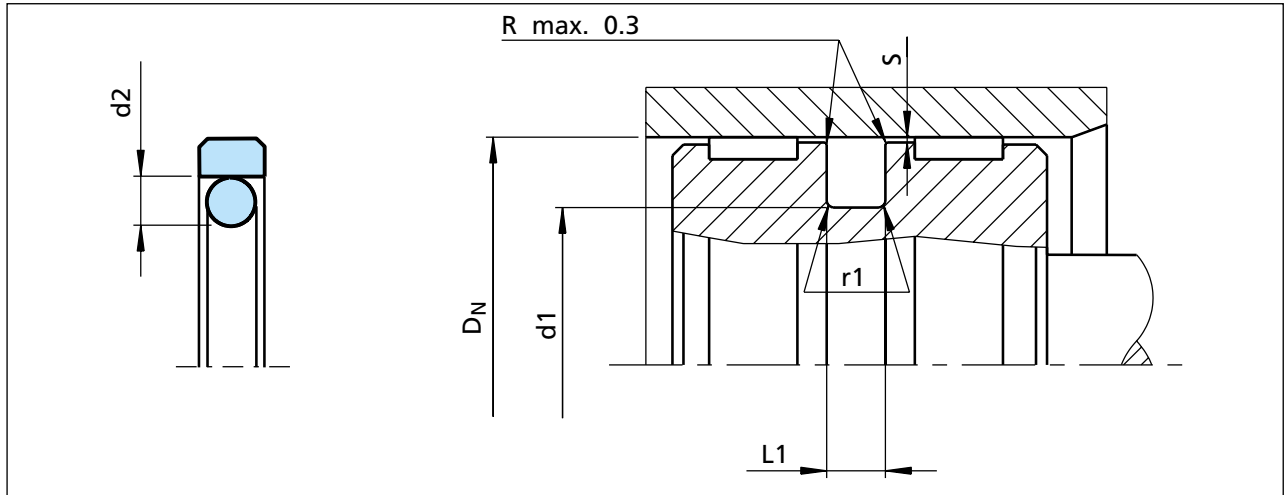


Figure 71 Installation drawing

Table 80 Installation Recommendations – Metric

Bore Diameter D_N H9			Groove Dia.	Groove Width	Radius	Radial Clearance** $S_{max.}$			O-Ring Cross Sec.
Series No. PG 44	Series No. PG 46	Series No. PG 42				10 MPa	20 MPa	40 MPa	
Standard Application	Light Application	Heavy Duty Application	d_1 h9	$L_1 + 0.2$	r_1				d_2
8 - 14.9	15 - 39.9	-	$D_N - 4.9$	2.2	0.4	0.30	0.20	0.15	1.78
15 - 39.9	40 - 79.9	8 - 14.9	$D_N - 7.5$	3.2	0.6	0.40	0.25	0.15	2.62
40 - 79.9	80 - 132.9	15 - 39.9	$D_N - 11.0$	4.2	1.0	0.40	0.25	0.20	3.53
80 - 132.9	133 - 329.9	40 - 79.9	$D_N - 15.5$	6.3	1.3	0.50	0.30	0.20	5.33
133 - 329.9	330 - 669.9	80 - 132.9	$D_N - 21.0$	8.1	1.8	0.60	0.35	0.25	7.00
330 - 669.9	670 - 999.9	133 - 329.9	$D_N - 24.5$	8.1	1.8	0.60	0.35	0.25	7.00
670 - 999.9	1000 - 2700	330 - 669.9	$D_N - 28.0$	9.5	2.5	0.70	0.50	0.30	8.40
$\geq 1000^{***}$	-	670 - 999.9	$D_N - 38.0$	13.8	3.0	1.00	0.70	0.60	12.00

** At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearances S; consult the Slydring® catalog.

*** O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring®, complete with O-Ring, standard application:

Series: PG44 from Table 80
Bore diameter: $D_N = 80.0 \text{ mm}$
TSS Part No.: PG4400800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	PG44	0	0800	-	M12	N
TSS Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material code (Seal Ring)						
Material code (O-Ring)						

Turcon® Glyd Ring® and Glyd Ring® T

Turcon® Glyd Ring® T

■ Installation Recommendation for Rod - Inch sizes

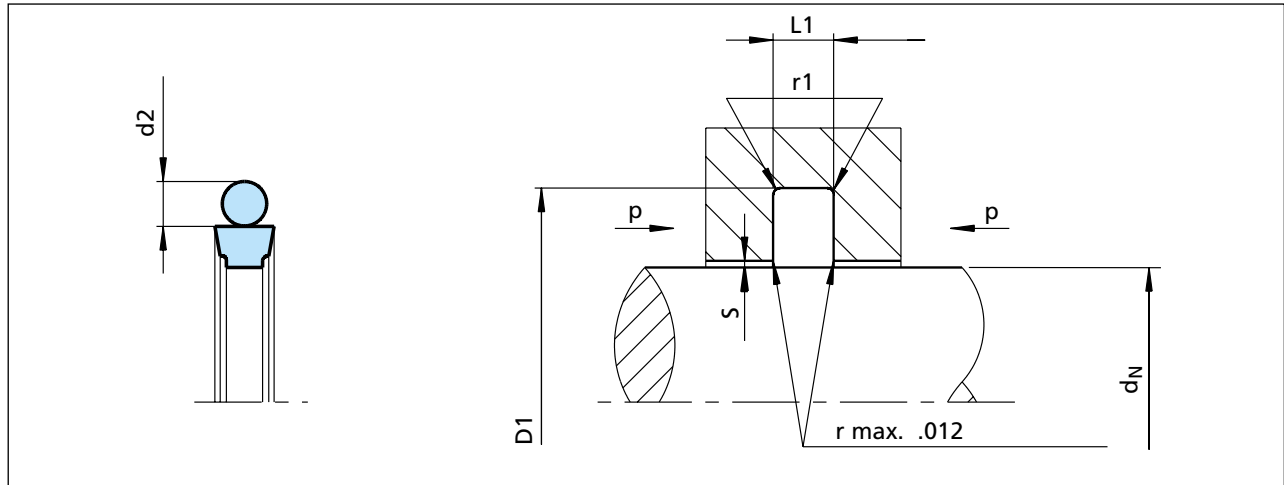


Figure 72 Installation drawing

Table 81 Installation Recommendations - Inch

TSS Series No.	Rod Diameter d_N f8/h9			Groove Dia.	Groove Width	Radius	Radial Clearance* $S_{max.}$			O-Ring Cross Sec.
	Standard Application	Light Application	Heavy Duty Application	D_1 H9	$L_1 + .008$	r_1	1,500 psi	3,000 psi	5,800 psi	d_2
RT10	-	.313 - .624	-	$d_N + .193$	.087	.020	.020	.012	.008	.070
RT11	.313 - .624	.625 - 1.624	-	$d_N + .287$	.126	.020	.024	.016	.008	.103
RT12	.625 - 1.624	1.625 - 3.249	.313 - .624	$d_N + .421$	.165	.025	.024	.016	.008	.139
RT13	1.625 - 7.749	3.250 - 5.374	.625 - 1.624	$d_N + .594$	.248	.030	.031	.020	.012	.210
RT14	7.750 - 9.999	5.375 - 12.999	1.625 - 3.249	$d_N + .807$	.319	.035	.031	.020	.012	.275
RT15	10.000 - 20.000	13.000 - 26.000	3.250 - 5.374	$d_N + .945$	.319	.035	.035	.020	.016	.275

* At pressures > 5,800 psi use diameter tolerance H8/f8 (bore/rod) in area of the seal.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring® T, complete with O-Ring, standard application:

Series RT14 from Table 81
Rod diameter: $d_N = 8.000$ inches
TSS Part No.: RT1408000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

<u>TSS Article No.</u>	<u>RT14</u>	<u>08000</u>	<u>-</u>	<u>T46</u>	<u>N</u>
<u>TSS Series No.</u>					
<u>Rod diameter x 1000</u>					
<u>Quality Index (Standard)</u>					
<u>Material code (Seal ring)</u>					
<u>Material code (O-Ring)</u>					

Turcon® Glyd Ring® and Glyd Ring® T

■ Installation Recommendation for Rod - Metric sizes

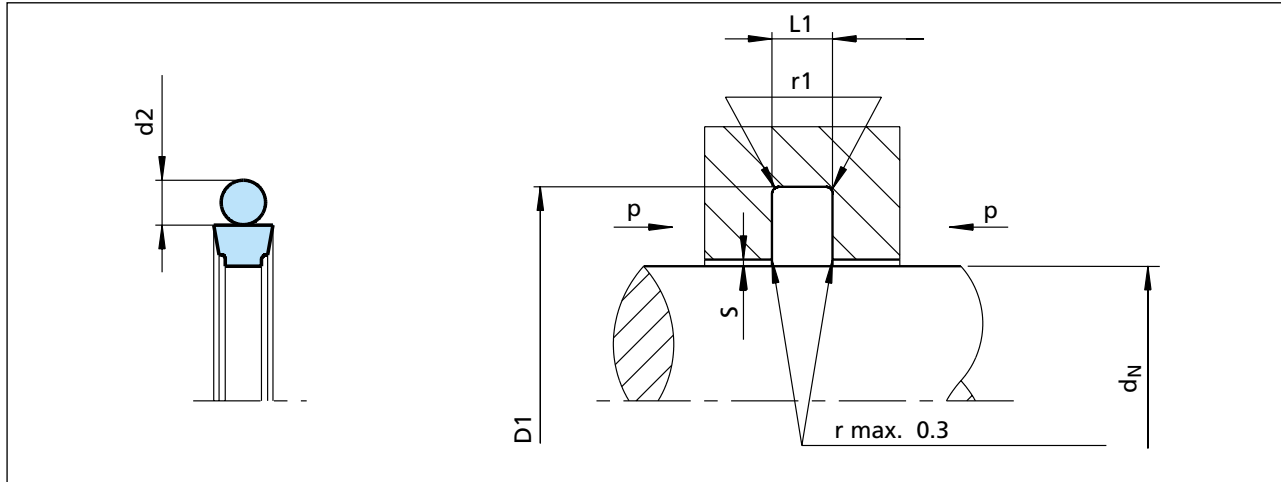


Figure 73 Installation drawing

Table 82 Installation Recommendations - Metric

Series No.	Rod Diameter d_N f8/h9			Groove Dia.* D_1 H9	Groove Width $L_1 +0.2$	Radius r_1	Radial Clearance** $S_{max.}$			O-Ring Cross Sec. d_2
	Standard Application	Light Application	Heavy Duty Application				10 MPa	20 MPa	40 MPa	
RT00	3 - 7.9	8 - 18.9	-	$d_N + 4.9$	2.2	0.4	0.40	0.30	0.20	1.78
RT01	8 - 18.9	19 - 37.9	-	$d_N + 7.3$	3.2	0.6	0.60	0.50	0.30	2.62
RT02	19 - 37.9	38 - 199.9	8 - 18.9	$d_N + 10.7$	4.2	1.0	0.70	0.50	0.30	3.53
RT03	38 - 199.9	200 - 255.9	19 - 37.9	$d_N + 15.1$	6.3	1.3	0.80	0.60	0.40	5.33
RT04	200 - 255.9	256 - 649.9	38 - 199.9	$d_N + 20.5$	8.1	1.8	0.80	0.60	0.40	7.00
RT08	256 - 649.9	650 - 999.9	200 - 255.9	$d_N + 24.0$	8.1	1.8	0.90	0.70	0.50	7.00
RT05	650 - 999.9	-	256 - 649.9	$d_N + 27.3$	9.5	2.5	1.00	0.80	0.60	8.40
RT05X		1000 - 1200		$d_N + 27.3$	9.5	2.5	1.00	0.80	0.60	8.40
RT06***		-	650 - 999.9	$d_N + 38.0$	13.8	3.0	1.20	0.90	0.70	12.00
RT06X**	1000 - 2600			$d_N + 38.0$	13.8	3.0	1.20	0.90	0.70	12.00

* Installation with groove dimensions to ISO 7425/2 is possible.

** At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternate material or profiles.

*** O-Rings with 12mm cross section are delivered as a special profile ring.

TSS Slydring®/Wear Rings are not applicable at very small radial clearances S. consult the Slydring® catalog.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring® T, complete with O-Ring, standard application:

Series: RT03 from Table 82
Rod diameter: $d_N = 80.0$ mm
TSS Part No.: RT0300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.

TSS Article No.	RT03	0	0800	-	MF6	N
TSS Series No.						
Type (Standard)						
Rod diameter x 10*						
Quality Index (Standard)						
Material code (Seal ring)						
Material code (O-Ring)						

**** For diameters $d_N \geq 1000$ mm please contact your local Trelleborg Sealing Solutions marketing company for custom TSS Article no.

Turcon® Glyd Ring® and Glyd Ring® T

■ Installation Recommendation for Piston - Inch sizes

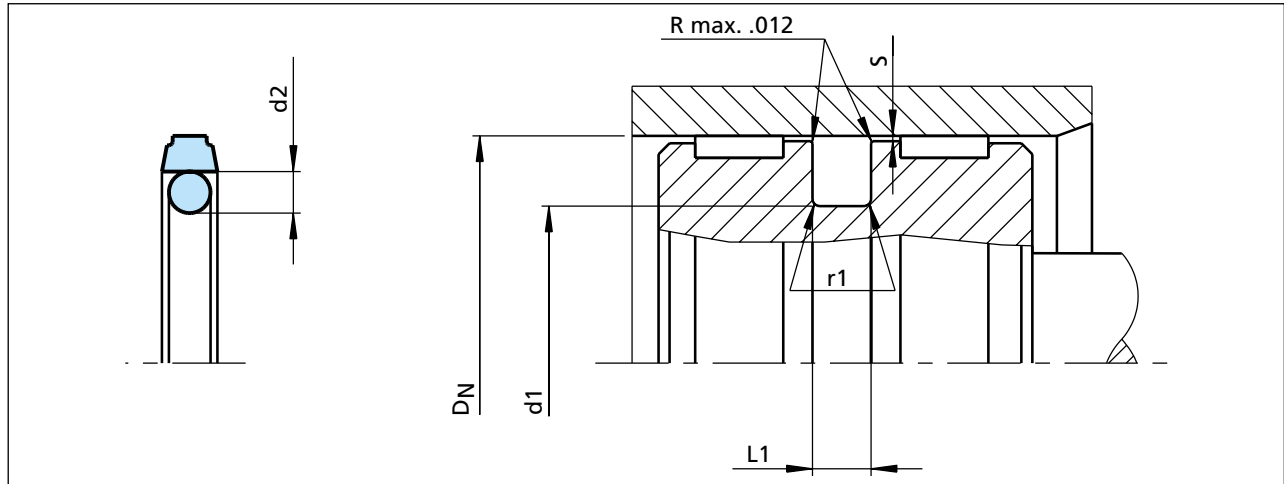


Figure 74 Installation drawing

Table 83 Installation Recommendations - Inch

TSS Series No.	Bore Diameter D_N H9			Groove Dia.	Groove Width	Radius	Radial Clearance* $S_{max.}$			O-Ring Cross Sec.
	Standard Application	Light Application	Heavy Duty Application	d_1 h9	$L_1 +.008$	r_1	1,500 psi	3,000 psi	5,800 psi	d_2
PT10	.312 - .562	.625 - 1.500	-	$D_N - .193$	.087	.015	.020	.012	.008	.070
PT11	.562 - 1.563	1.563 - 3.125	-	$D_N - .295$	.126	.025	.024	.016	.008	.103
PT12	1.563 - 3.125	3.125 - 5.250	.562 - 1.563	$D_N - .433$	.165	.025	.024	.016	.008	.139
PT13	3.125 - 5.250	5.250 - 12.500	1.563 - 3.125	$D_N - .610$	.248	.035	.031	.020	.012	.210
PT14	5.250 - 12.500	12.500 - 26.000	3.125 - 5.250	$D_N - .827$	.319	.035	.031	.020	.012	.275
PT15	12.500 - 26.000	-	5.250 - 12.500	$D_N - .965$	.319	.035	.035	.020	.016	.275

* At pressures > 5,800 psi use diameter tolerance H8/f8 (bore/rod) in area of the seal. The radial clearance is valid for material Turcon® T46 at +140 °F (+60 °C)

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring® T, complete with O-Ring, standard application:

Series: PT12 from Table 83
Bore diameter: $D_N = 3.000$ inches
TSS Part No.: PT1203000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	PT	12	03000	-	M12	N
TSS Series No.						
Cross Section Series						
Functional Bore dia x 1000						
Quality Index						
Turcon® Seal Ring Material Code						
Turel® Elastomer Material Code						

Turcon® Glyd Ring® and Glyd Ring® T

■ Installation Recommendation for Piston - Metric sizes

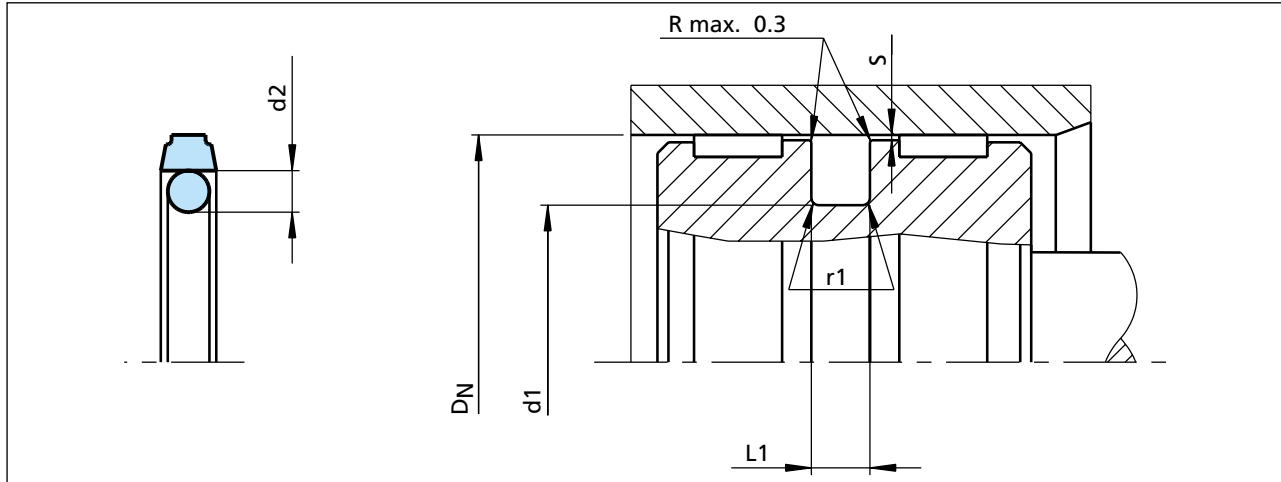


Figure 75 Installation drawing

Table 84 Installation Dimensions - Standard Recommendations metric

Series No.	Bore Diameter D_N H9			Groove Diameter* d_1 h9	Groove Width $L_1 +0.2$	Radius r_1	Radial Clearance** $S_{max.}$			O-Ring Cross Sec. d_2
	Standard Application	Light Application	Heavy Duty Application				10 MPa	20 MPa	40 MPa	
PT00	8 - 14.9	15 - 39.9	-	$D_N - 4.9$	2.2	0.4	0.40	0.30	0.20	1.78
PT01	15 - 39.9	40 - 79.9	-	$D_N - 7.5$	3.2	0.6	0.60	0.50	0.30	2.62
PT02	40 - 79.9	80 - 132.9	15 - 39.9	$D_N - 11.0$	4.2	1.0	0.70	0.50	0.30	3.53
PT03	80 - 132.9	133 - 329.9	40 - 79.9	$D_N - 15.5$	6.3	1.3	0.80	0.60	0.40	5.33
PT04	133 - 329.9	330 - 669.9	80 - 132.9	$D_N - 21.0$	8.1	1.8	0.80	0.60	0.40	7.00
PT08	330 - 669.9	670 - 999.9	133 - 329.9	$D_N - 24.5$	8.1	1.8	0.90	0.70	0.50	7.00
PT05	670 - 999.9	-	330 - 669.9	$D_N - 28.0$	9.5	2.5	1.00	0.80	0.60	8.40
PT05X	-	1000 - 1200	-	$D_N - 28.0$	9.5	2.5	1.00	0.80	0.60	8.40
PT06***	-	-	670 - 999.9	$D_N - 38.0$	13.8	3.0	1.20	0.90	0.70	12.00
PT06X***	1000 - 2700	-	-	$D_N - 38.0$	13.8	3.0	1.20	0.90	0.70	12.00

* Installation with groove dimensions to ISO 7425/2 is also recommendable.

**At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternate material or profiles. TSS Slydriing®/Wear Rings are not applicable at very small radial clearances S; consult the Slydriing® catalog.

*** O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Glyd Ring® and Glyd Ring® T

Ordering Example

Turcon® Glyd Ring® T, complete with O-Ring, standard application:

Series: PT03 from Table 84
Bore diameter: $D_N = 80.0$ mm
TSS Part No.: PT0300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

For all intermediate sizes not shown in Table 84 the TSS Article No. can be determined following the example opposite.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.

TSS Article No.	PT03	0	0800	-	M12	N
TSS Series No.						
Type (Standard)						
Cylinder diameter x 10****						
Quality Index (Standard)						
Material code (Seal ring)						
Material code (O-Ring)						

**** For diameters $d_N \geq 1000$ mm please contact your local Trelleborg Sealing Solutions marketing company for custom TSS Article no.

Turcon® Captive Glyd Ring®



Features and benefits

Same basic function as Turcon® Glyd Ring®

Protected from diameter variations of counterpart

Passes over holes in mating surface

For linear, helical and rotary service

Increased sealing effect and reduced friction due to narrow contact area

Easy mounting in split groove

Suitable for narrow grooves

Design flexibility – adaptable for almost all grooves sizes

Easy installation

Turcon® Captive Glyd Ring®

Description

Turcon® Glyd Ring® is usually recommended as a bi-directional seal for all types of pistons and grooves.

However in some applications the Glyd Ring® has to slide across mating surfaces that have dimensional changes e.g. go from a small diameter with sealing function over the seal to a large diameter with no sealing function or vice versa.

This can potentially deform, damage or even destroy the Glyd Ring® or other seal types, as they may be pressed out of the groove by the O-Ring or the system pressure.

In such applications the Turcon® Captive Glyd Ring® is the best option.

This Turcon® Captive Glyd Ring® version, shown in the figure below, is retained in a split groove. The groove prevents the sealing surface from getting damaged by a counter part with variable diameter or when passing holes.

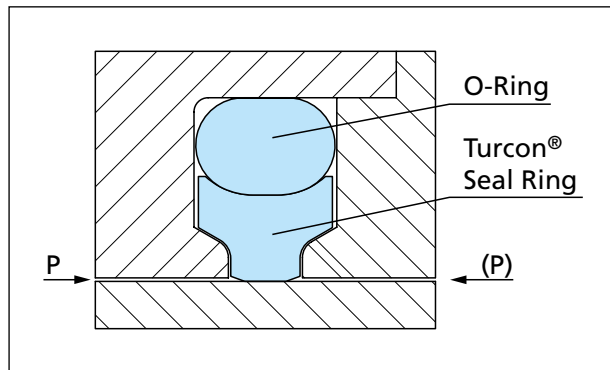


Figure 76 Turcon® Captive Glyd Ring®

Applications

The applications for the Turcon® Captive Glyd Ring® are numerous and extend the field of applications of the Turcon® Glyd Ring®:

- Valves
- Connectors
- Isolation Valves
- Pressure boosters
- Piston cushioning in cylinders
- Spool Valves
- Down hole Drilling Motors

Technical Data

Operating conditions:

The Turcon® Captive Glyd Ring® is recommended for reciprocating movements. Helical and slow turning service is possible.

Pressure: up to 5,800 psi / 40 MPa

Speed: up to 50 ft/s / 15 m/s

Frequency: up to 5 Hz.

Temperature: -49 °F to +392 °F / +45 °C to +200 °C
(depending on O-Ring Material)

Media: Mineral oil based hydraulic fluids, barely flammable hydraulic fluids HFC, environmentally safe hydraulic fluids (biological degradable oils), water, air and others. Depending on compatibility of the O-Ring material.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Turcon® Captive Glyd Ring®

Pressure Activation Ports

In applications where Turcon® Captive Glyd Ring® is exposed to rapid changes in pressure from two sides, pressure activation ports are recommended, see Figure 77.

The function of the holes is like the notch on a Turcon® Glyd Ring® i.e. it ensures that the seal is pressurized during rapid change of pressure, preventing blow by.

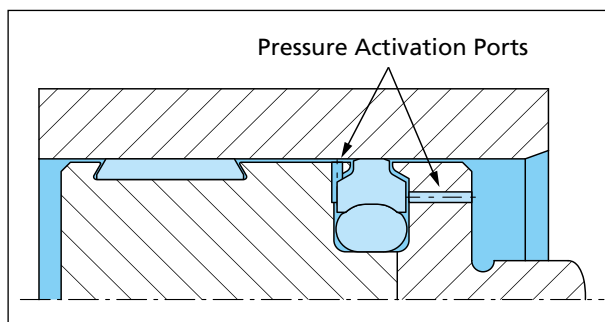


Figure 77 Pressure Activation Ports

Lead-in chamfers

Where Turcon® Captive Glyd Ring® is moving across mating surfaces with dimensional variation the angle of inlet chamfers should be as small as possible and not exceed 15 degrees (see Figure 78 and Figure 79.)

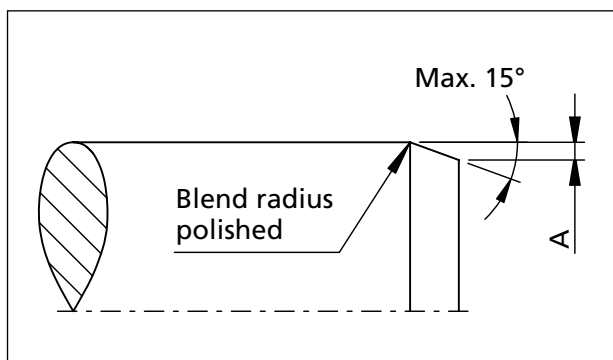


Figure 78 Lead-in chamfers Rod

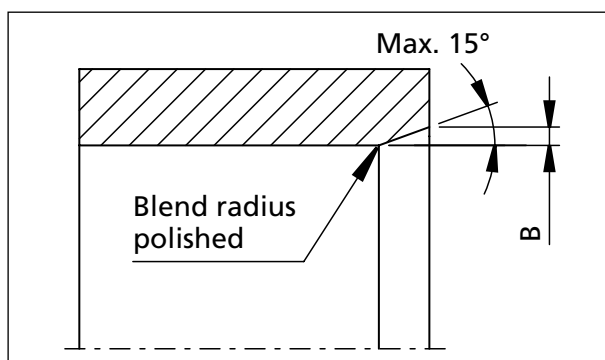


Figure 79 Lead-in chamfers Piston

Table 85 Lead In Chamfers Rod

	Min. distance mm A
RGC1	0.6
RGC2	0.6
RGC3	0.8
RGC4	0.8
RGC5	1.0
RGC6	1.5

Table 86 Lead In Chamfers Piston

	Min. distance mm B
PGC1	0.6
PGC2	0.6
PGC3	0.8
PGC4	0.8
PGC5	1.0
PGC6	1.5

Turcon® Captive Glyd Ring®

Passing Holes

The Captive Glyd Ring® is suitable for passing over holes in the counter surface. The diameter of the holes must be smaller than the width of the contact area of the seal, see table below, and have broken edges following the same rules as "Lead-in chamfers". It is preferable to divide the hole into several smaller holes.

Table 87 Maximum size of holes in counter surface

Captive Glyd Ring®	Max. diameter of hole inch (mm)
PCC1 / RGC1	.020 (0.5)
PCC2 / RGC2	.024 (0.6)
PCC3 / RGC3	.040 (1.0)
PCC4 / RGC4	.043 (1.1)
PCC5 / RGC5	.080 (2.0)
PCC6 / RGC6	.110 (2.8)

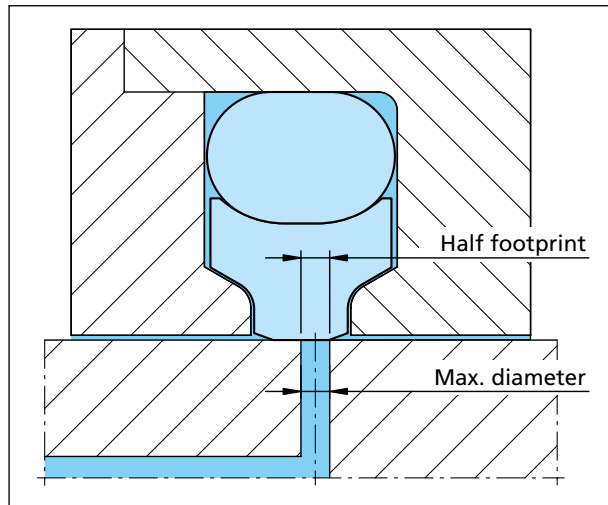


Figure 80 Half footprint = Max. hole diameter

Care should be taken if the seal passes holes at high differential fluid pressure as the seal surface may get damaged.

Preferably holes should be placed in circumferential grooves according to figure above. This is a requirement if the diameter of holes are bigger than stated in Table 87.

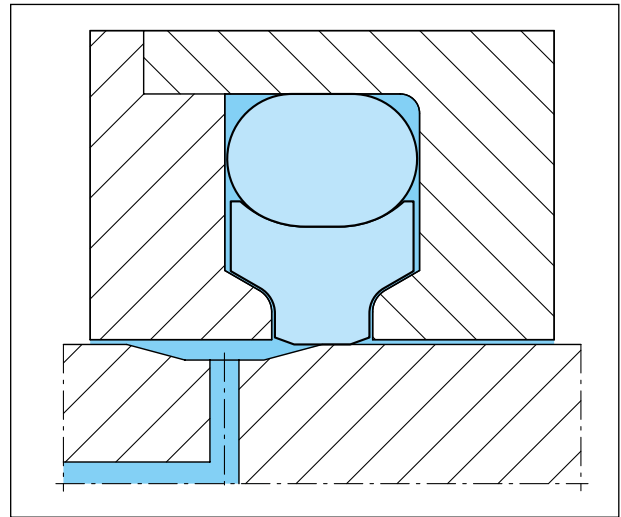


Figure 81 Holes in counter surface placed in grooves

Seal Groove Description

The Turcon® Captive Glyd Ring® uses a "split" groove design. The Installation dimensions are included in Table 88 for ID seals, and Table 89 for OD seals.

To retain this seal in the groove each seal series operates with two groove widths, which have been assigned L1 and L2. L2 indicates the smallest groove width.

There are also two different groove diameters for each series:

- For ID seals $\varnothing D_1$ and $\varnothing D_3$
- For OD seals $\varnothing d_1$ and $\varnothing d_3$

The groove diameter with suffix 3 indicates the diameter nearest the mating surface.

Captive Glyd Ring® is available as a standard seal on the following Part Numbers:

- ID seals: RGC1 to RGC6
- OD seals: PGC1 to PGC6

The last figure in the number designates the O-Ring series (e.g. 1 for 100 series).

Turcon® Captive Glyd Ring®

■ Installation Recommendation for Rod - Inch sizes

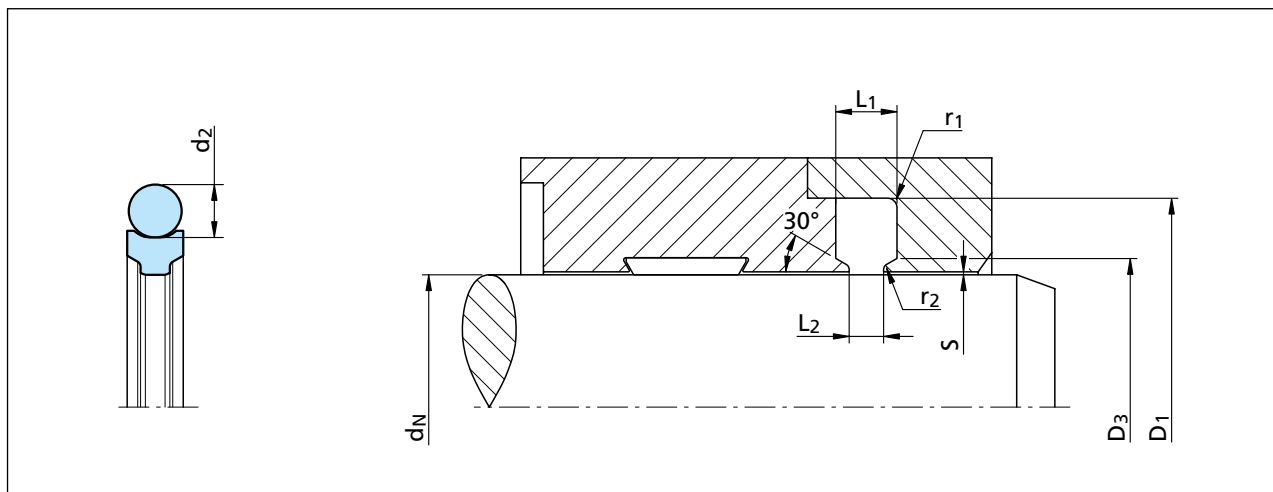


Figure 82 Installation Drawing

Table 88 Installation Recommendations - Inch

Series No.	Rod Diameter d_N f8/h8		Groove Diameter D_1 H9	Groove Diameter D_3 -.004	Groove Width L_1 +.008	Groove Width L_2 +.008	Radius r_1 max.	Radius r_2 +/- 0.002	Radial Clearance* $S_{max.}$				O-Ring Cross Sec. d_2
	Recommended Range	Available Range							0 psi	1,500 psi	3,000 psi	5,800 psi	
RGCA	.250 – 2.374	.250 – 9.750	$d_N + .315$	$d_N + .063$	.126	.071	.020	.010	.024	.014	.008	.006	.103
RGCB	2.375 – 5.249	.500 – 17.875	$d_N + .433$	$d_N + .094$	.165	.087	.025	.020	.028	.016	.010	.008	.139
RGCC	5.250 – 12.999	1.250 – 25.875	$d_N + .610$	$d_N + .150$	.248	.126	.030	.040	.031	.020	.012	.008	.210
RGCD	13.000 – 25.749	4.375 – 25.875	$d_N + .827$	$d_N + .205$	.319	.165	.030	.045	.035	.024	.014	.010	.275
RGCE	25.750 – 39.374	25.563 – 39.374	$d_N + 1.102$	$d_N + .268$	.394	.268	.030	.045	.039	.028	.018	.012	.331
RGCF	39.375 – 102.0	13.000 – 102.0	$d_N + 1.500$	$d_N + .362$	.543	.362	.045	.070	.055	.039	.028	.022	.472

* At pressures > 5800 psi use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternative material or profiles.

TSS Slydring®/Wear Rings are not applicable at very small radial clearance; consult the Slydring® catalog.

** O-Rings with .472" cross section are delivered as a special profile ring

Turcon® Captive Glyd Ring®

Ordering Example

Turcon® Captive Glyd Ring® complete with O-Ring standard application:

Series: RGCE from Table 88
Rod diameter: $D_N = 8.000$ inches
TSS Part No.: RGCE08000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	RGCE	08000	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

Turcon® Captive Glyd Ring®

■ Installation Recommendation for Rod - Metric sizes

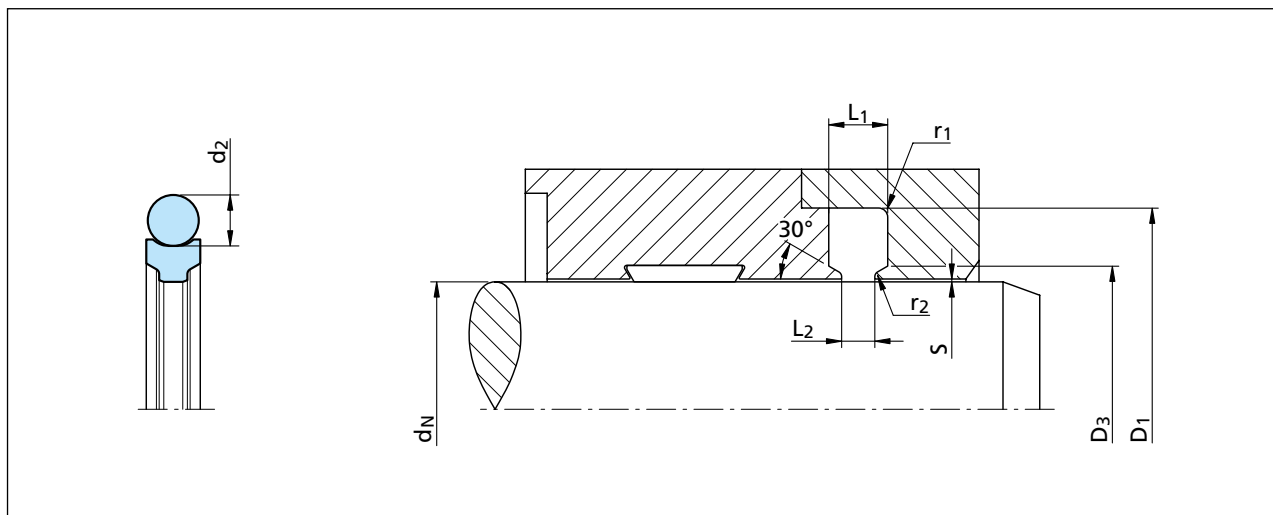


Figure 83 Installation Drawing

Table 89 Installation Dimensions - Metric

Series No.	Recommended Range d_N f8/h8	Available Range d_N f8/h8	Groove Diameter D_1 H9	Groove Diameter D_3 -0.1	Groove Width L_1 +0.2	Groove Width L_2 +0.2	r_1 max.	r_2 +/-0.05	Radial Clearance* $S_{max.}$				O-Ring Cross Sec. d_2
									0 MPa	10 MPa	20 MPa	40 MPa	
RGC1	6.0 -59.9	6.0 -250.0	$d_N +8.0$	$d_N +1.6$	3.2	1.8	0.5	0.3	0.60	0.35	0.20	0.15	2.62
RGC2	60.0 -132.9	10.0 -455.0	$d_N +11.0$	$d_N +2.4$	4.2	2.2	0.7	0.5	0.70	0.40	0.25	0.20	3.53
RGC3	133.0 -329.9	30.0 -660.0	$d_N +15.5$	$d_N +3.8$	6.3	3.2	0.8	1.0	0.80	0.50	0.30	0.20	5.33
RGC4	330.0 -654.9	110.0 - 660.0	$d_N +21.0$	$d_N +5.2$	8.1	4.2	0.8	1.2	0.90	0.60	0.35	0.25	7.00
RGC5	650.0 -999.9	650.0 -1200.0	$d_N +28.0$	$d_N +6.8$	10.0	6.8	0.8	1.2	1.00	0.70	0.45	0.30	8.40
RGC6**	1000.0 -2600.0	750.0 -2600.0	$d_N +38.0$	$d_N +9.2$	13.8	9.2	1.2	1.8	1.40	1.00	0.70	0.55	12.00

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or consult TSS for alternative material or profiles.

TSS Slydring®/Wear Rings are not applicable at very small radial clearance; consult the Slydring® catalog.

** O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Captive Glyd Ring®

Ordering Example

Turcon® Captive Glyd Ring® complete with O-Ring standard application:

Series: RGC3 from Table 89
Rod diameter: $d_N = 250.0$ mm
TSS Part No.: RGC302500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	RGC3	0	2500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

Turcon® Captive Glyd Ring®

■ Installation Recommendation for Piston - Inch sizes

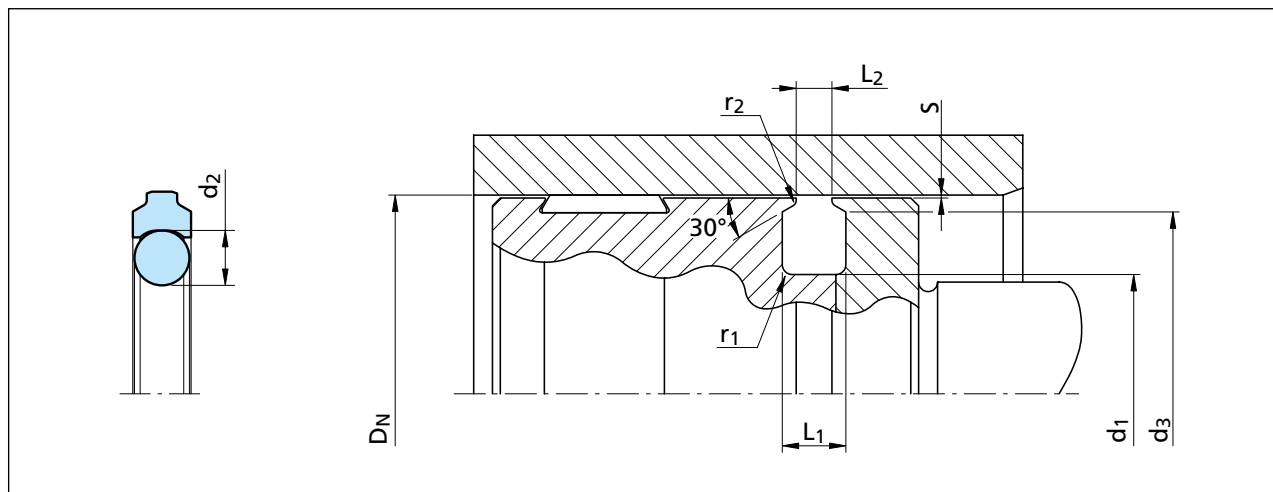


Figure 84 Installation Drawing

Table 90 Installation Dimensions - Inch

Series No.	Bore Diameter D_N H8		Groove depth d_1 h9	Groove depth d_3 -.004	Groove Width L_1 +.008	Groove Width L_2 +.008	r_1 max.	r_2 +/-0.05	Radial Clearance* $S_{max.}$				O-Ring Cross Sec. d_2
	Recommended Range	Available Range							0 psi	1500 psi	3000 psi	5800 psi	
PGCA	.625 – 2.749	.591 -10.236	D_N - .315	D_N -.063	.126	.071	.020	.010	.024	.014	.008	.006	.103
PGCB	2.750 – 5.249	.630 -18.504	D_N - .433	D_N -.094	.165	.087	.025	.020	.028	.016	.010	.008	.139
PGCC	5.250 – 12.999	.866 -26.969	D_N - .610	D_N -.150	.248	.126	.030	.040	.031	.020	.012	.008	.210
PGCD	13.000 – 27.124	4.921 – 27.165	D_N - .827	D_N -.205	.319	.165	.030	.045	.035	.024	.014	.010	.275
PGCE	27.125 – 39.332	25.985 -39.366	D_N - 1.102	D_N -.268	.394	.268	.030	.045	.039	.028	.018	.012	.331
PGCF**	39.333 – 106.0	29.528 -106.307	D_N - 1.500	D_N -.362	.543	.362	.045	.070	.055	.039	.028	.022	.472

* At pressures > 5800 psi use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles. TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

** O-Rings with .472" cross section are delivered as a special profile ring.

Turcon® Captive Glyd Ring®

Ordering Example

Turcon® Captive Glyd Ring® complete with O-Ring standard application:

Series: PGCC from Table 90
Bore diameter: $D_N = 3.000$ inches
TSS Part No.: PGCC03000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PGCC	03000	-	M12	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

■ Installation Recommendation for Piston - Metric sizes

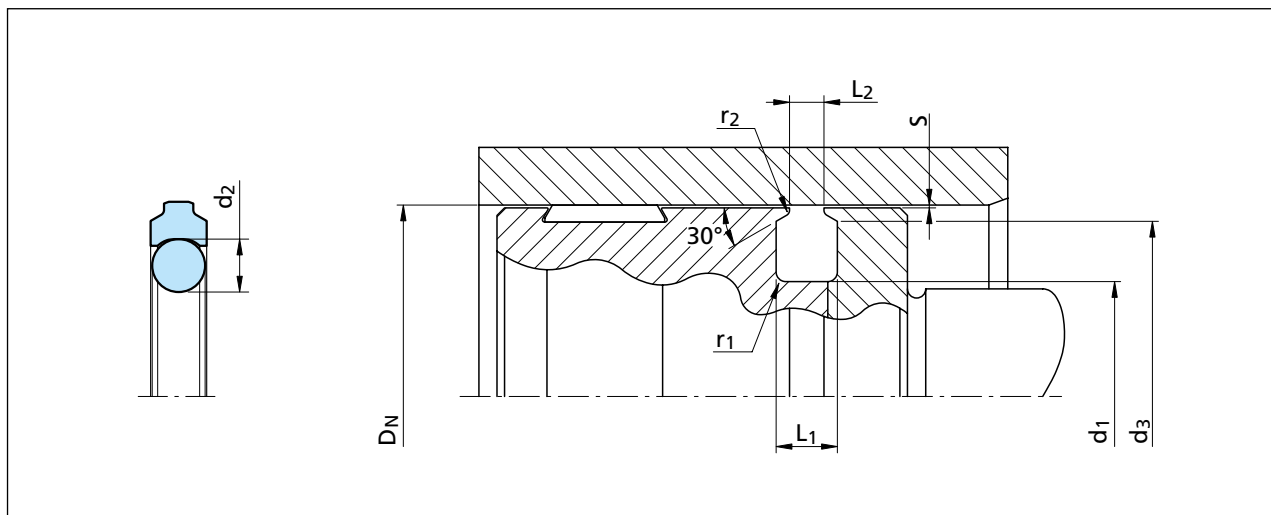


Figure 85 Installation Drawing

Table 91 Installation Dimensions - Metric

Series No.	Recommended Range D_N H8	Available Range D_N H8	Groove depth d_1 h9	Groove depth d_3 -0.1	Groove Width L_1 +0.2	Groove Width L_2 +0.2	r_1 max.	r_2 +/-0.05	Radial Clearance* $S_{max.}$				O-Ring Cross-Section d_2
									0 MPa	10 MPa	20 MPa	40 MPa	
PGC1	15.0 -69.9	15.0 -260.0	d_N -8.0	D_N -1.6	3.2	1.8	0.5	0.3	0.60	0.35	0.20	0.15	2.62
PGC2	70.0 -132.9	16.0 -470.0	d_N -11.0	D_N -2.4	4.2	2.2	0.7	0.5	0.70	0.40	0.25	0.20	3.53
PGC3	133.0 -329.9	22.0 -685.0	d_N -15.5	D_N -3.8	6.3	3.2	0.8	1.0	0.80	0.50	0.30	0.20	5.33
PGC4	330.0 -689.9	125.0 - 690.0	d_N -21.0	D_N -5.2	8.1	4.2	0.8	1.2	0.90	0.60	0.35	0.25	7.00
PGC5	690.0 -999.9	660.0 -1200.0	d_N -28.0	D_N -6.8	10.0	6.8	0.8	1.2	1.00	0.70	0.45	0.30	8.40
PGC6**	1000.0 -2700.0	750.0 -2700.0	d_N -38.0	D_N -9.2	13.8	9.2	1.2	1.8	1.40	1.00	0.70	0.55	12.00

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/piston) in area of the seal or consult TSS for alternative material or profiles.

TSS Slydring® / Wear Rings are not applicable at very small radial clearance S. Please consult the Slydring® catalog.

** O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Captive Glyd Ring®

Ordering Example

Turcon® Captive Glyd Ring® complete with O-Ring standard application:

Series: PGC3 from Table 91
Bore diameter: $D_N = 250.0$ mm
TSS Part No.: PGC302500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PGC3	0	2500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

Turcon® AQ-Seal®



Features and benefits

Combines the benefits of a low-friction Turcon® slipper seal with the high sealing characteristics of an elastomer seal

High sealing effect in applications requiring media separation, fluid/fluid or fluid/gas

Low gas permeation rate

Double security through the combination of low-friction special materials with elastomer seals

Simple groove design, small installation space, interchangeable with Turcon® Glyd Ring®, Turcon® Glyd Ring® T and Turcon® Stepseal® 2K

Capable of operating successfully at higher pressures and sliding speeds

Outstanding sliding properties, no stick-slip effect

Description

The Turcon® AQ-Seal® is a double-acting seal consisting of a seal ring of high-grade Turcon® material, an X-Ring and an O-Ring as energizing elements. The Turcon® seal ring together with the X-Ring perform the dynamic sealing function, while the O-Ring performs a static sealing function.

Design

The AQ-Seal® is supplied as standard with radial notches on both sides. These ensure direct pressurizing of the seal under all operating conditions.

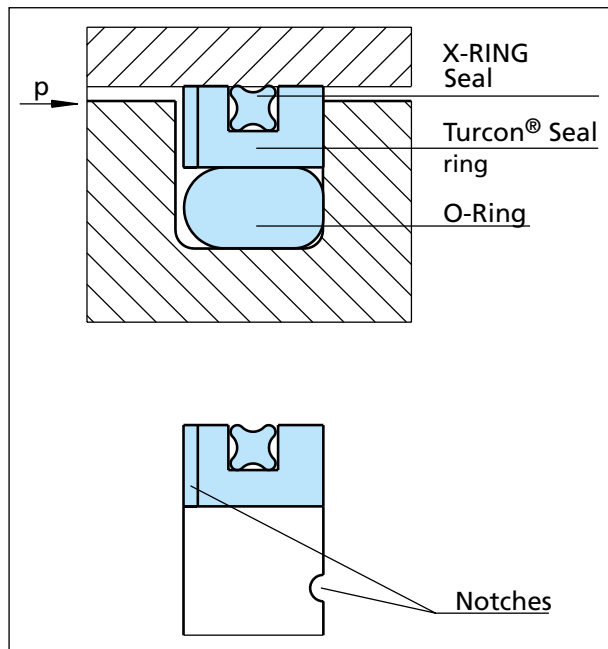


Figure 86 Turcon® AQ-Seal®

Application Examples

The Turcon® AQ-Seal® is the recommended sealing element for double acting applications such as:

- Subsea Connectors
- Hot Stab Connectors
- Piston Accumulators
- Downhole Tools
- Heavy duty tensioner cylinders

Technical Data

Operating conditions:

Pressure: up to 5,800 psi / 40 MPa with mineral oil and gases. Higher pressures can be achieved by using corner reinforcements.

Speed: up to 6.6 ft/s / 2 m/s with reciprocating movements

Temperature: -49 °F to +392 °F / -40 °C to +200 °C depending on O-Ring and X-Ring material)
For lower temperature applications please contact your local Trelleborg Sealing Solutions marketing company

Media: Hydraulic fluids
- Mineral oil
- Synthetic and natural esters
- Gas

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendation for Rod - Inch sizes

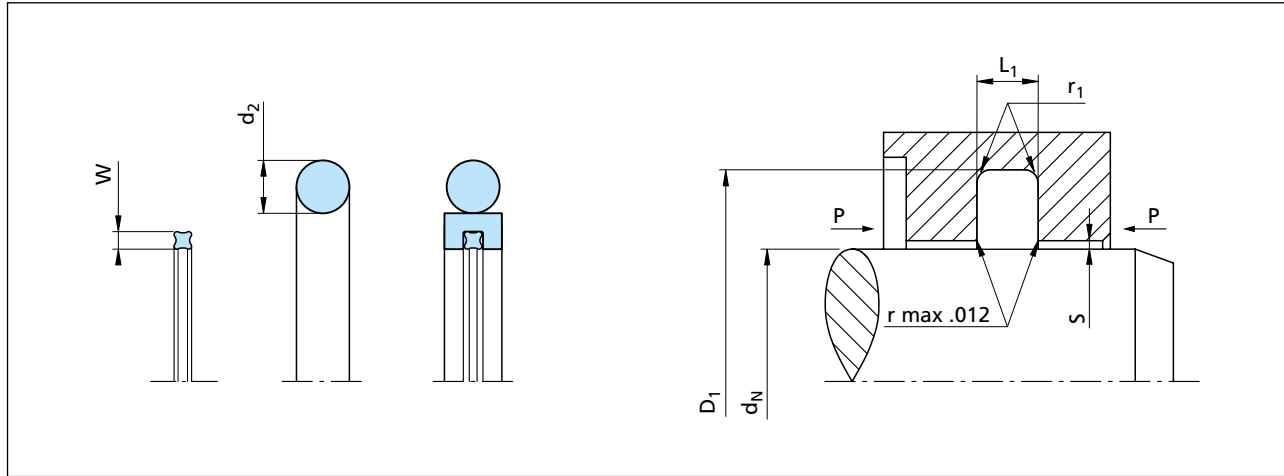


Figure 87 Installation drawing

Table 92 Installation Recommendations - Inch

Rod Diameter d_N f8/h9				Groove Dia. D_1 H9	Groove Width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Seal Cross Sec. W
Series No.	Standard Application	Series No.	Available Range				1,500 psi	3,000 psi	5,800 psi		
RQE0	.625 - 1.563	RQE4	1.564 - 3.125	$d_N + .433$	.165	.040	.010	.006	.004	.139	.070
RQE0	1.564 - 3.125	RQE4	3.126 - 5.250	$d_N + .610$	.248	.050	.012	.008	.006	.210	.070
RQE1	3.126 - 5.250	RQE5	5.251 - 9.975	$d_N + .827$	.319	.070	.012	.008	.006	.275	.103
RQE1	5.251 - 9.975	-	-	$d_N + .965$	.319	.070	.012	.008	.006	.275	.103
RQE2	9.976 - 18.225	-	-	$d_N + 1.102$	.374	.100	.018	.012	.010	.330	.139
RQE3	18.226 - 27.500	-	-	$d_N + 1.378$	.453	.120	.022	.016	.014	.394	.210

* At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearances; consult the Slydring® catalog.

Ordering Example

Turcon® AQ-Seal®, complete with X-Ring and O-Ring, Standard application:

Series: RQE1 from Table 92
 Rod diameter: $d_N = 4.000$ inches
 TSS Part No.: RQE104000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company office for diameters that exceed those listed in the above table.

TSS Article No.	RQE1	04000	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)/(X-Ring)					

■ Installation Recommendation for Rod - Metric sizes

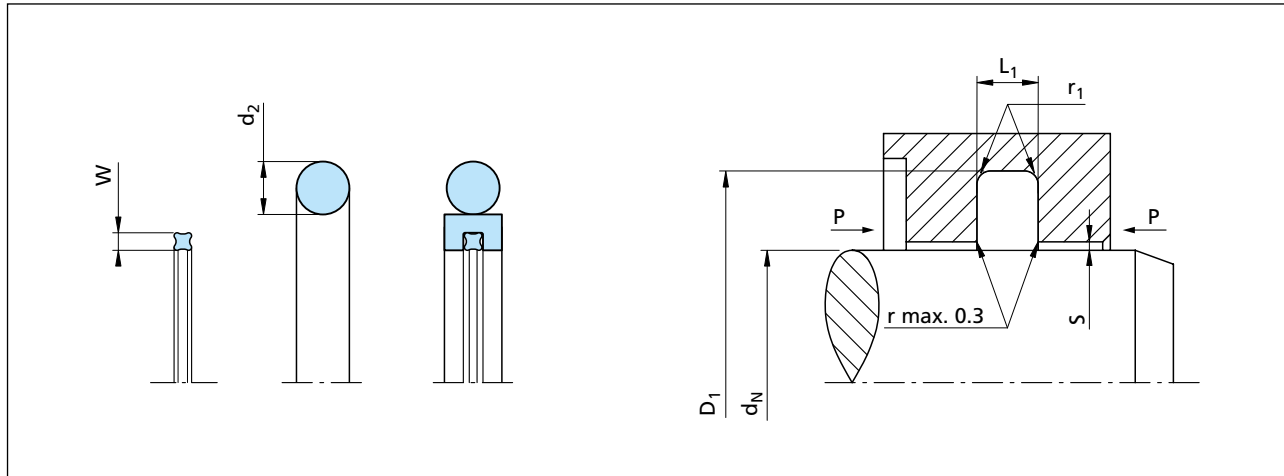


Figure 88 Installation drawing

Table 93 Installation Recommendations – Metric

Series No.	Rod Diameter d_N f8/h9		Groove Dia. D_1 H9	Groove Width $L_1 +0.2$	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Seal Cross Sec. W
	Recommended Range	Available Range				10 MPa	20 MPa	40 MPa		
RQ120	19 - 37.9	18 - 450.0	$d_N+11.0$	4.2	1.0	0.25	0.15	0.10	3.53	1.78
RQ130	38 - 199.9	30 - 650.0	$d_N+15.5$	6.3	1.3	0.30	0.20	0.15	5.33	1.78
RQ140	200 - 255.9	105 - 999.9	$d_N+21.0$	8.1	1.8	0.30	0.20	0.15	7.00	2.62
RQ180	256 - 649.9	120 - 999.9	$d_N+24.5$	8.1	1.8	0.30	0.20	0.15	7.00	2.62
RQ150	650 - 999.9	285 - 999.9	$d_N+28.0$	9.5	2.5	0.45	0.30	0.25	8.40	3.53
RQ15X	-	1000 - 1200.0	$d_N+28.0$	9.5	2.5	0.45	0.40	0.35	8.40	3.53
RQ160	-	650 - 999.9	$d_N+38.0$	13.8	3.0	0.70	0.60	0.45	12.00	5.33
RQ16X	1000 - 2200	-	$d_N+38.0$	13.8	3.0	0.70	0.60	0.45	12.00	5.33

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearances; consult the Slydring® catalog.

Ordering Example

Turcon® AQ-Seal®, complete with X-Ring and O-Ring, Standard application:

Series: RQ130 from Table 93
 Rod diameter: $d_N = 80.0$ mm
 TSS Part No.: RQ1300800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

TSS Article No.	RQ13	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)/(X-Ring)						

O-Ring Dimension

For a specific O-Ring size contact your local Trelleborg Sealing Solutions marketing company.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

■ Installation Recommendation for Piston - Inch sizes

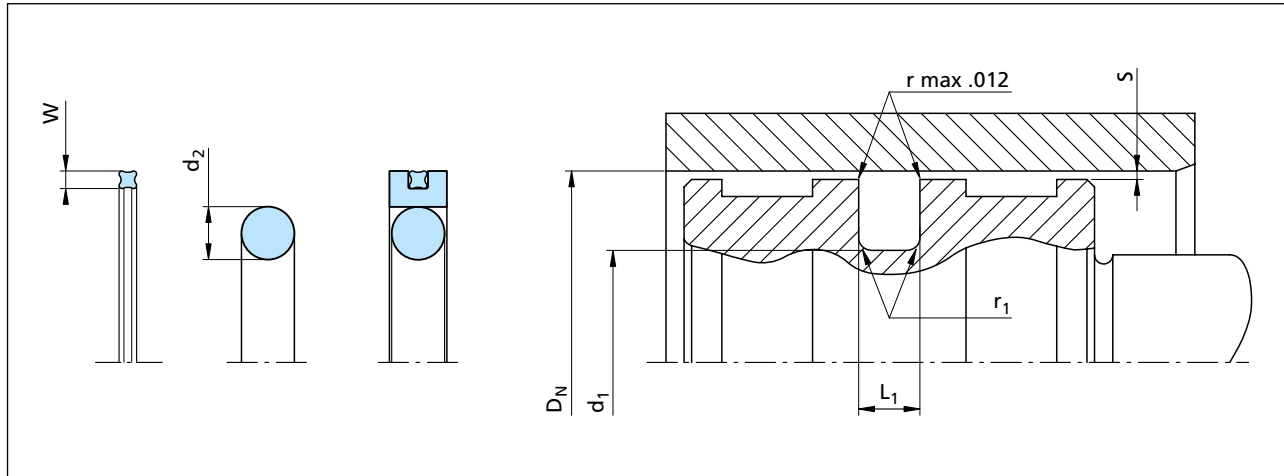


Figure 89 Installation drawing

Table 94 Installation Recommendations - Inch

Bore Diameter D_N H9				Groove Dia. d_1 h9	Groove Width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Seal Cross Sec. W
Series No.	Standard Application	Series No.	Available Range				1,500 psi	3,000 psi	5,800 psi		
PQE0	.625 - 1.563	PQE4	1.564 - 3.125	D_N -.433	.165	.040	.10	.006	.004	.139	.070
PQE0	1.564 - 3.125	PQE4	3.126 - 5.250	D_N -.610	.248	.050	.12	.008	.006	.210	.070
PQE1	3.126 - 5.250	PQE5	5.251 - 9.975	D_N -.827	.319	.070	.12	.008	.006	.275	.103
PQE1	5.251 - 9.975	-	-	D_N -.965	.319	.070	.12	.008	.006	.275	.103
PQE2	9.976 - 18.225	-	-	D_N -1.102	.374	.100	.18	.012	.010	.330	.139
PQE3	18.226 - 27.500	-	-	D_N -1.378	.453	.120	.22	.016	.014	.394	.210

* At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearances; consult the Slydring® catalog.

Ordering Example

Turcon® AQ-Seal®, complete with O-Ring and X-Ring standard application:

Series: PQE1 from Table 94
 Bore diameter: $D_N = 4.000$ inches
 TSS Part No.: PQE104000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No.

TSS Article No.	PQE1	04000	-	M12	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)/(X-Ring)					

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

■ Installation Recommendation for Piston - Metric sizes

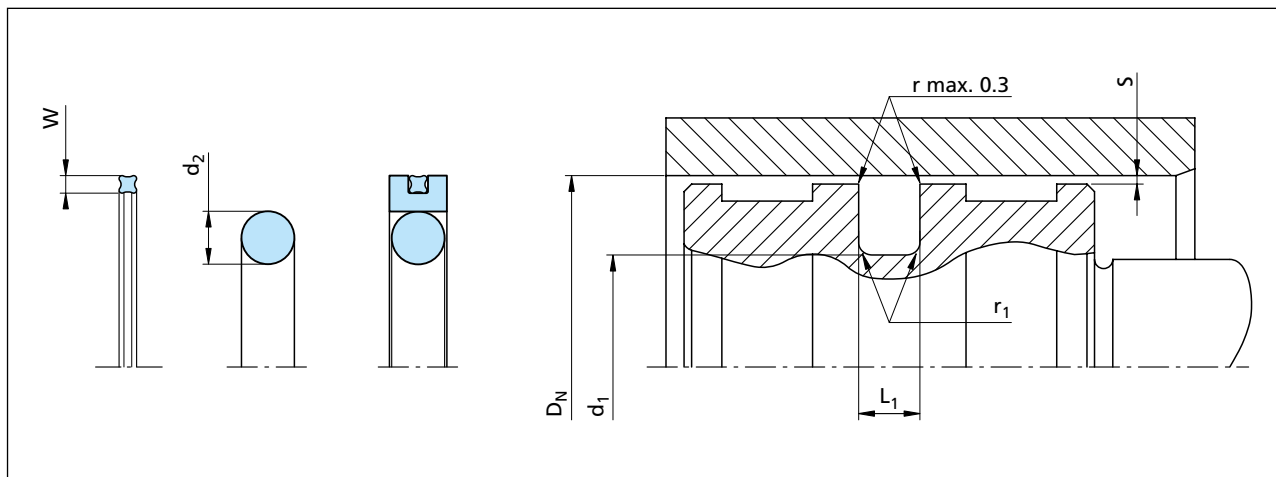


Figure 90 Installation drawing

Table 95 Installation Recommendations - Metric

Bore Diameter D_N H9				Groove Dia. d_1 h9	Groove Width $L_1 + 0.2$	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Seal Cross Sec. W
Series No.	Standard Application	Series No.	Available Range				10 MPa	20 MPa	40 MPa		
PQ12	15 - 39.9	PQ14	40 - 79.9	$D_N - 11.0$	4.2	1.0	0.25	0.15	0.10	3.53	1.78
PQ12	40 - 79.9	PQ14	80 - 132.9	$D_N - 15.5$	6.3	1.3	0.30	0.20	0.15	5.33	1.78
PQ22	80 - 132.9	PQ24	133 - 252.9	$D_N - 21.0$	8.1	1.8	0.30	0.20	0.15	7.00	2.62
PQ22	133 - 252.9	PQ24	-	$D_N - 24.5$	8.1	1.8	0.30	0.20	0.15	7.00	2.62
PQ32	253 - 462.9	-	-	$D_N - 28.0$	9.5	2.5	0.45	0.30	0.25	8.40	3.53
PQ52	463 - 700.0	-	-	$D_N - 35.0$	11.5	11.5	0.55	0.40	0.35	10.00	5.33

* At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydriing®/Wear Rings are not applicable at very small radial clearances; consult the Slydriing® catalog.

Ordering Example

Turcon® AQ-Seal®, complete with O-Ring and X-Ring, standard application:

Series: PQ22 from Table 95
Bore diameter: $D_N = 80.00$ mm
TSS Part No.: PQ2200800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PQ22	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)/(X-Ring)						

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® bearings. When not incorporating Slydring® bearings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

Turcon® AQ-Seal® 5



Features and benefits

High sealing effect in applications requiring media separation

Double security through the combination of low-friction special materials with elastomer seals

Operates in higher pressures

Improved sliding speed compared to the AQ-Seal®

Outstanding sliding properties, no stick-slip effect

Turcon® AQ-Seal® 5

Description

The Turcon® AQ-Seal® 5 is a development of the proven standard Turcon® AQ-Seal®.

The seal profile of the Turcon® ring has been redesigned on both the dynamic and static sealing surface. Two O-Rings are used to energize the seal instead of one.

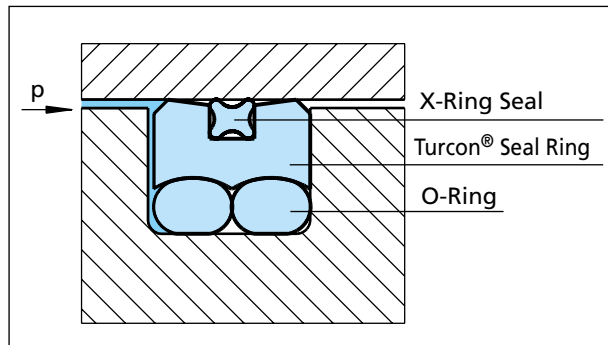


Figure 91 Turcon® AQ-Seal® 5

The AQ-Seal® 5 combines the benefits of a low-friction Turcon® slipper seal with the high sealing characteristics of an elastomer seal. It does this by incorporating a limited foot print X-Ring on the dynamic sealing face. This optimizes leakage control while minimizing friction.

The particular characteristics of the AQ-Seal® 5 are its special seal profile with a defined seal edge and the use of two O-Rings as energizing elements to optimize the pressure profile.

* Patent-No. EP 0 424 372

Application Examples

The Turcon® AQ-Seal® 5 is designed specifically for heavy duty and large stroke applications. It is recommended as a sealing element in double acting applications such as:

- Subsea Connectors
- Downhole Tools
- Off shore Valve Actuators
- Heavy-duty tensioner cylinders

Technical Data

Operating conditions:

- Pressure: up to 7,252 psi / 50 MPa with hydraulic oil
up to 4,350 psi / 30 MPa for media with reduced lubricating properties, such as water glycol based hydraulic fluids.
- Speed: up to 9.8 ft/s / 3 m/s with reciprocating movements, frequency up to 3 Hz
- Temperature: -49 °F to +392 °F / -40 °C to +200 °C depending on Seal ring, O-Ring and X-Ring material
For lower temperature applications contact your local Trelleborg Sealing Solutions marketing company.
- Media:
- Hydraulic fluids
 - Mineral oil
 - Synthetic and natural esters
 - Gases
 - Water glycol based fluids

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendation for Rod - Inch sizes

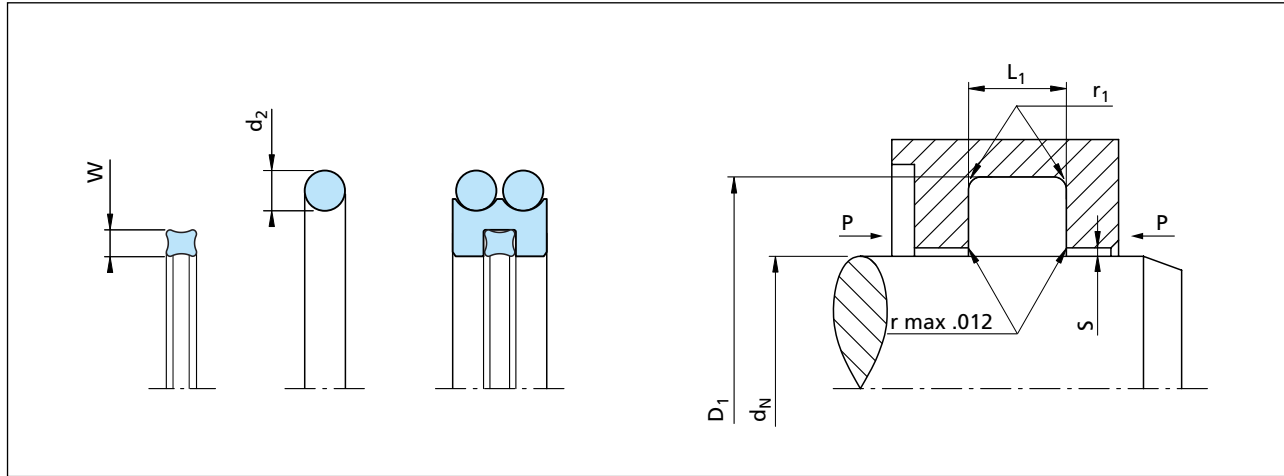


Figure 92 Installation drawing

Table 96 Installation Recommendations - Inch

Series No.	Rod Diameter d_N f8/h9		Groove Diameter D_1 H9	Groove Width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Cross Sec. W
	Standard Application	Light Application				1,500 psi	3,000 psi	5,800 psi		
RQ41	1.500 - 2.999	3.000 - 5.500	$d_N + .394$	.248	.015	.012	.009	.006	.103	.070
RQ42	3.000 - 4.999	5.000 - 10.000	$d_N + .512$	.326	.025	.013	.010	.006	.139	.103
RQ43	5.000 - 11.999	12.000 - 19.000	$d_N + .709$	.484	.035	.014	.011	.008	.210	.139
RQ44	12.000 - 26.000	-	$d_N + 1.220$	.642	.035	.016	.013	.012	.275	.210

*At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearance; consult the Slydring® catalog.

Turcon® AQ-Seal® 5

Ordering Example

Turcon® AQ-Seal® 5, complete with O-Ring and X-RING® Seal, standard application:

Series: RQ41 from Table 96
Rod diameter: $d_N = 2.000$ inches
TSS Part No. RQ4102000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	RQ41	02000	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)/(X-Ring)					

■ Installation Recommendation for Rod - Metric sizes

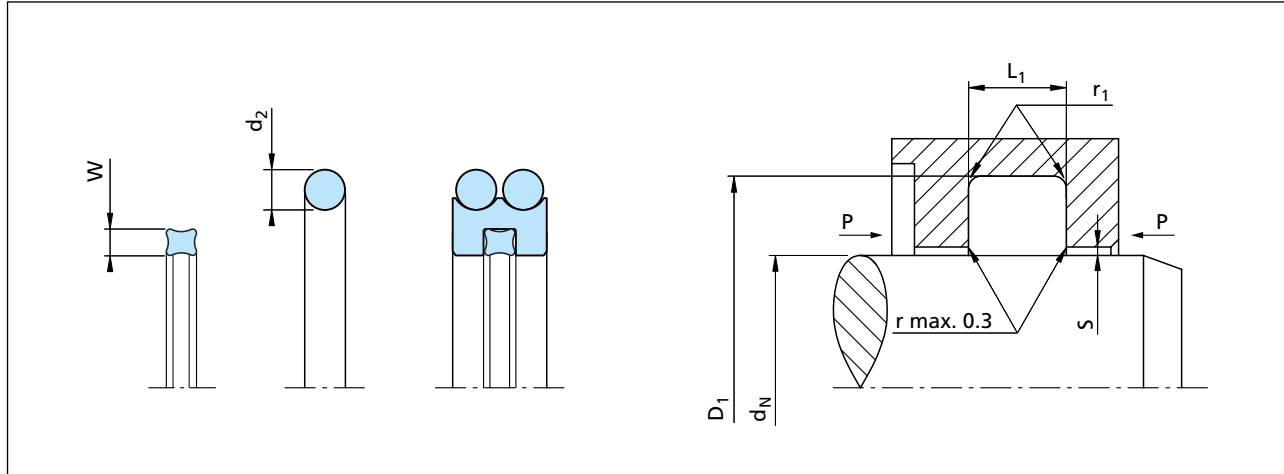


Figure 93 Installation drawing

Table 97 Installation Recommendations - Metric

Series No.	Rod Diameter d_N f8/h9		Groove Dia. D_1 H9	Groove Width $L_1 + 0.2$	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Cross Sec. W
	Recommended Range	Available Range				10 MPa	20 MPa	40 MPa		
RQ21	40 - 79.9	32 - 250.0	$d_N + 10.0$	6.3	1.0	0.25	0.15	0.10	2.62	1.78
RQ22	80 - 132.9	50 - 450.0	$d_N + 13.0$	8.3	1.3	0.30	0.20	0.15	3.53	2.62
RQ23	133 - 462.9	80 - 650.0	$d_N + 18.0$	12.3	1.8	0.30	0.20	0.15	5.33	3.53
RQ24	190 - 999.9	180 - 999.9	$d_N + 31.0$	16.3	1.8	0.30	0.20	0.15	7.00	5.33
RQ24X	1000 - 2200	-	$d_N + 31.0$	16.3	1.8	0.30	0.20	0.15	7.00	5.33

*At pressures > 40 MPa use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearance; consult the Slydring® catalog.

Turcon® AQ-Seal® 5

Ordering Example

Turcon® AQ-Seal®, complete with X-Ring and O-Rings, standard application:

Series: RQ220 from Table 97
Rod diameter: $d_N = 80.0$ mm
TSS Part No.: RQ2200800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	RQ22	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)/(X-Ring)						

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

■ Installation Recommendation for Piston - Inch sizes

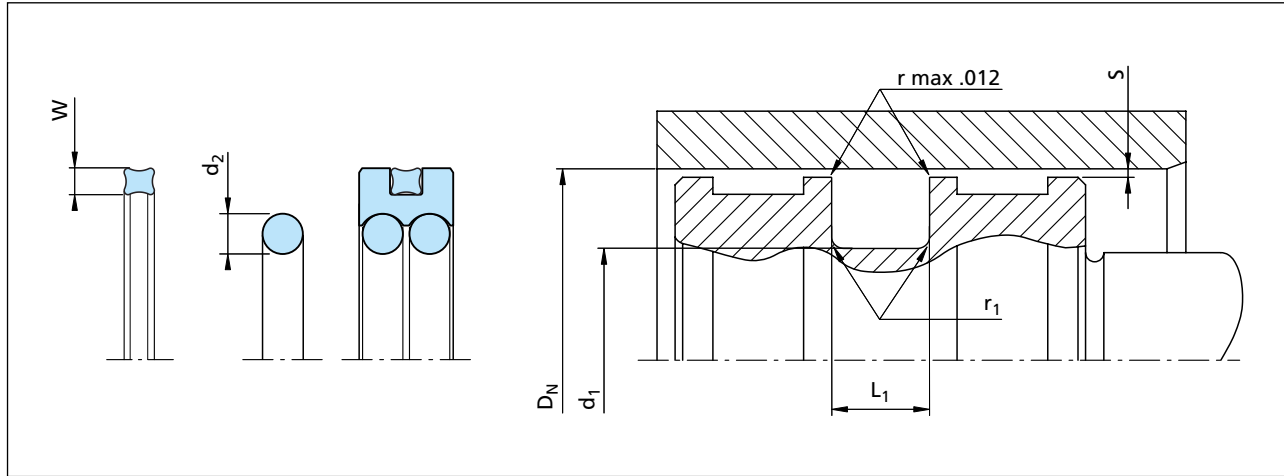


Figure 94 Installation drawing

Table 98 Installation Recommendations - Inch

Series No.	Bore Diameter D_N H9		Groove Dia. d_1 h9	Groove Width L_1 +.008	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Cross Sec. W
	Standard Application	Available Range				1,500 psi	3,000 psi	5,800 psi		
PQ41	1.500 - 2.999	3.000 - 5.500	D_N -.394	.248	.015	.012	.009	.006	.103	.070
PQ42	3.000 - 4.999	5.000 - 10.000	D_N -.512	.326	.025	.013	.010	.006	.139	.103
PQ43	5.000 - 11.999	12.000 - 19.000	D_N -.709	.484	.035	.014	.011	.008	.210	.139
PQ44	12.000 - 26.000	-	D_N -1.220	.642	.035	.016	.013	.012	.275	.210

* At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/piston) in area of the seal; or consult Trelleborg Sealing Solutions for alternative material or profiles. Trelleborg Sealing Solutions Slydri[®]/Wear Rings are not applicable at very small radial clearance; consult the Slydri[®] catalog.

Turcon® AQ-Seal® 5

Ordering Example

Turcon® AQ-Seal® 5, complete with O-Ring and X-RING® Seal, standard application:

Series: PQ41 from Table 98
Bore diameter: $D_N = 2.000$ inches
TSS Part No. PQ4102000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	PQ41	02000	-	M12	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)/(X-Ring)					

■ Installation Recommendation for Piston - Metric sizes

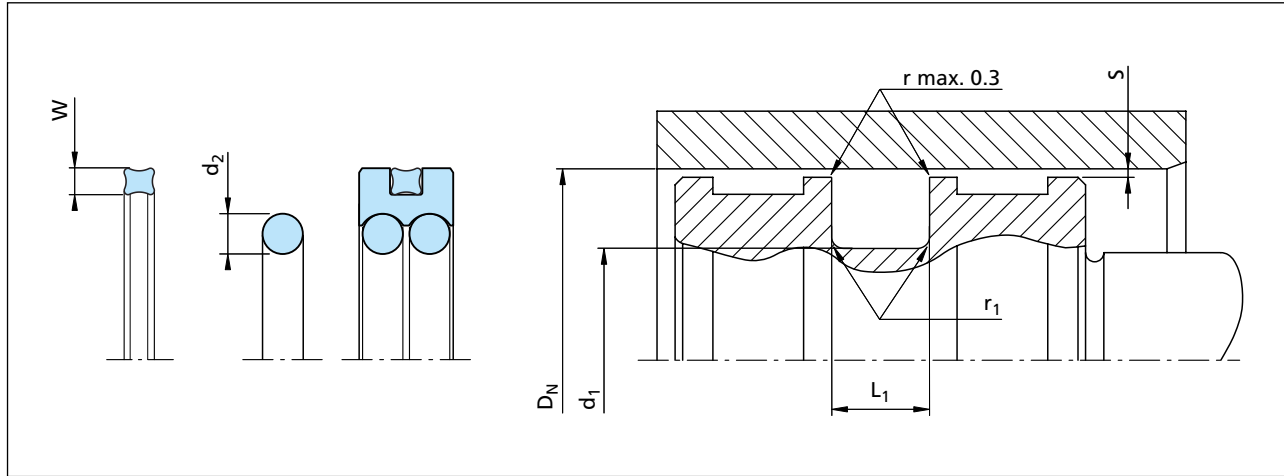


Figure 95 Installation drawing

Table 99 Installation Recommendations - Metric

Series No.	Bore Diameter D_N H9		Groove Diameter d_1 h9	Groove Width $L_1 +0.2$	Radius r_1	Radial Clearance* $S_{max.}$			O-Ring Cross Sec. d_2	X-Ring Seal Cross Sec. W
	Standard Application	Available Range				10 MPa	20 MPa	40 MPa		
PQ01	40 - 79.9	25 - 140.0	$D_N - 10.0$	6.3	0.6	0.30	0.20	0.15	2.62	1.78
PQ02	80 - 132.9	50 - 250.0	$D_N - 13.0$	8.3	1.0	0.40	0.30	0.15	3.53	2.62
PQ03	133 - 462.9	100 - 480.0	$D_N - 18.0$	12.3	1.3	0.40	0.30	0.20	5.33	3.53
PQ04	463 - 700.0	425 - 700.0	$D_N - 31.0$	16.3	1.8	0.50	0.40	0.30	7.00	5.33

* At pressures > **40 MPa** use diameter tolerance H8/f8 (bore/rod) in area of the seal or use Turcon® AQ-Seal® 5 CR. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearance; consult the Slydring® catalog.

Turcon® AQ-Seal® 5

Ordering Example

Turcon® AQ-Seal® 5, complete with O-Ring and X-RING Seal, standard application:

Series: PQ02 from Table 99
 Bore diameter: $D_N = 80.0$ mm
 TSS Part No. PQ0200800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PQ02	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)/(X-Ring)						

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

Turcon[®] Stepseal[®] 2K



Features and benefits

High static and dynamic sealing effect

Eliminates the build-up of disruptive intermediate pressures between seals

High extrusion resistance, to suit wide hardware clearances

Operational at pressures up to 8,702 psi / 60 MPa

Operational at speeds up to 50 ft/s / 15 m/s with reciprocating movements

High-frequency operation

Operating temperatures of -49 °F to +500 °F / -45 °C to +260 °C depending on the elastomer

Low friction, increasing performance and working life

Stick-slip-free starting, no sticking even after extended periods of rest

High abrasion resistance, maximum operational reliability

Compatible with virtually all media

Suited to mineral oil-based hydraulic fluids, flame-retardant hydraulic fluids, environmentally-safe hydraulic fluids (bio-oils), water and other media

Simple installation without seal edge deformation

Unidirectional seal

Turcon® Stepseal® 2K

Description

Developing a hydraulic cylinder sealing arrangement with certainty of performance over a wide range of applications has provided a long-term engineering challenge for Trelleborg Sealing Solutions. The first breakthrough was in the 1970s, when Turcon® Stepseal® revolutionized fluid sealing in cylinder applications.

Through ongoing research and development, Stepseal® has been further refined and improved, with the latest version, Turcon® Stepseal® 2K, achieving new levels in cylinder sealing performance. The primary use of Stepseal® in the oil field is for tensioner cylinders.

Turcon® Stepseal® 2K enhances sealing efficiency with better extrusion resistance giving superior leakage control and allowing larger hardware tolerances, making cylinder production more economic. It is also more uniform, showing low-friction characteristics throughout an extended life and even during the run-in period when friction forces can have the greatest effect on hydraulic seals.

Offering unsurpassed sealing security, Turcon® Stepseal® 2K can be used with all lubricating and non-lubricating hydraulic fluids, including water-based hydraulic fluids. They can also be matched to specific mating surfaces and media. Seals can be specified to meet the precise degree of extrusion and abrasion tolerance required for an application.

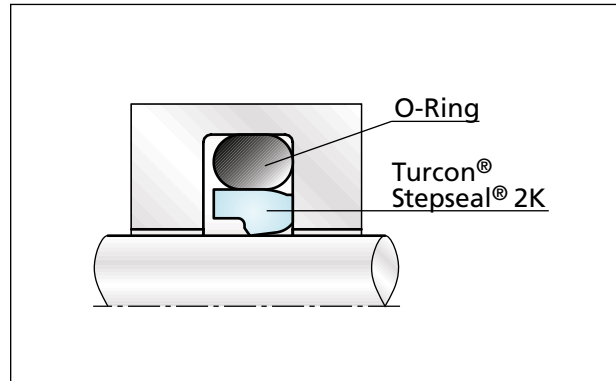


Figure 96 Turcon® Stepseal® 2K

Method of Operation

The sealing performance of Turcon® Stepseal® 2K is a result of its hydrodynamic properties. The seal edge creates a steep contact pressure gradient on the high-pressure side and a shallow contact pressure gradient on the low-pressure side. The controlled pressure gradients minimize fluid adherence to the piston rod during the extending stroke and enable residual fluid film on the rod to be returned into the system on the return stroke.

The O-Ring relief chamber reduces pressure loading on the seal. This optimizes contact with the rod, improving sealing performance at high service pressures. A special high-lift rear chamfer combines a smooth downstream sealing face with the ability to meet large radial clearances and hardware tolerances.

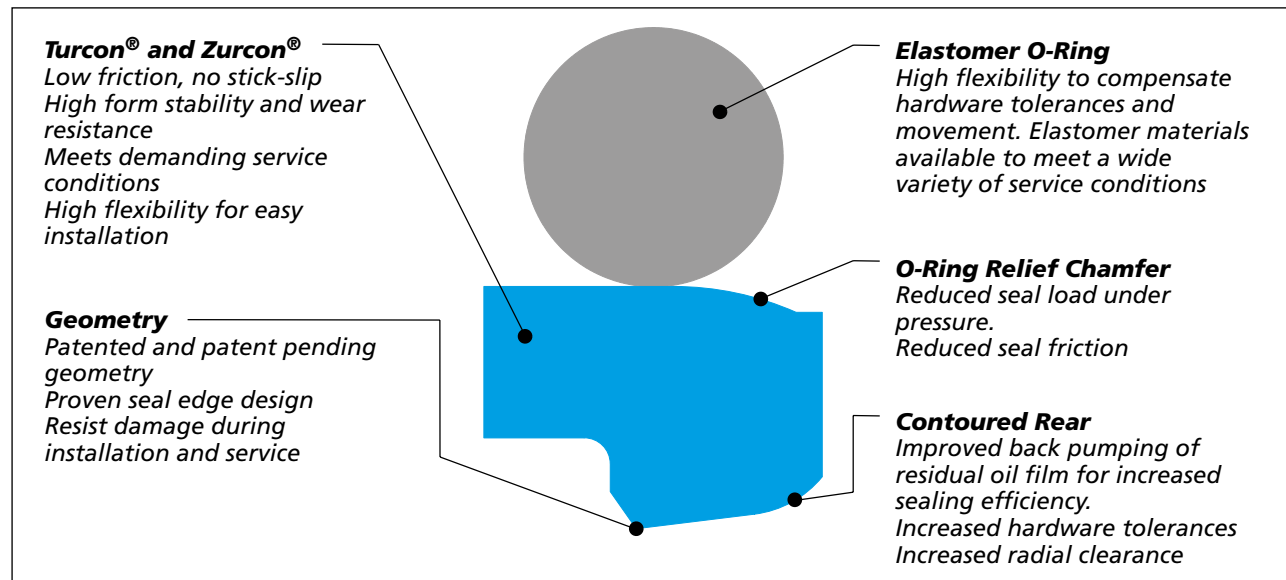


Figure 97 Features of Turcon® Stepseal® 2K

Turcon® Stepseal® 2K

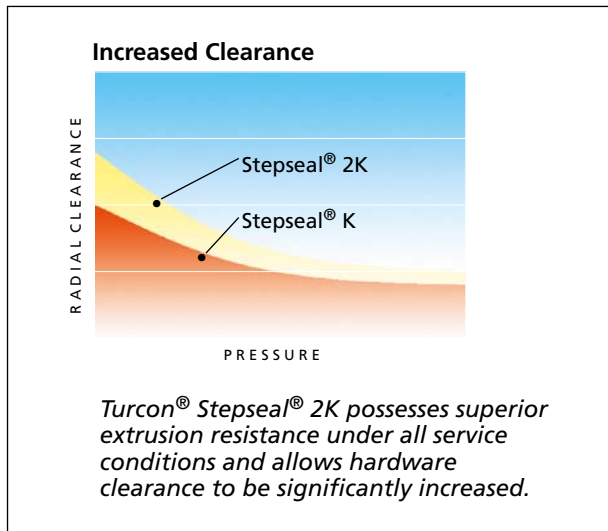


Figure 98 Extrusion resistance graph

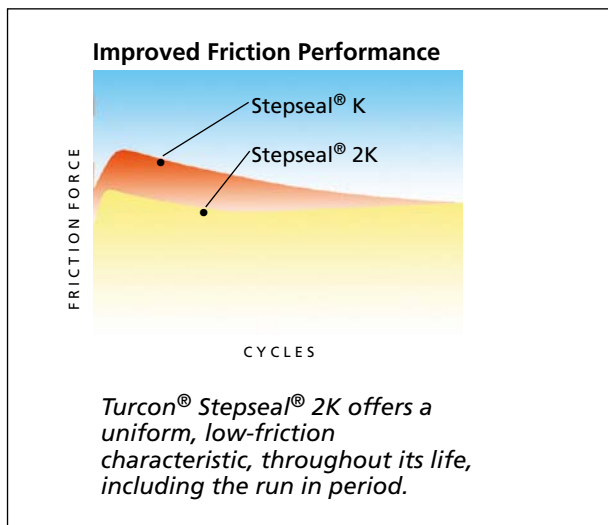


Figure 99 Friction graph

Technical Data

Operation pressure: up to 7,252 psi / 50 MPa

Speed: up to 49.2 ft/s / 15.0 m/s

Temperature range: -49 °F to +392 °F /
-40 °C to +200 °C
depending on elastomer

Clearance: Clearance can be larger when combined with a Slydring® bearing.

Media: Mineral oil-based hydraulic fluids, flame-retardant hydraulic fluids, environmentally-safe hydraulic fluids (bio-oils), water and others depending on the elastomer material selected

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendation for Rod - Inch sizes

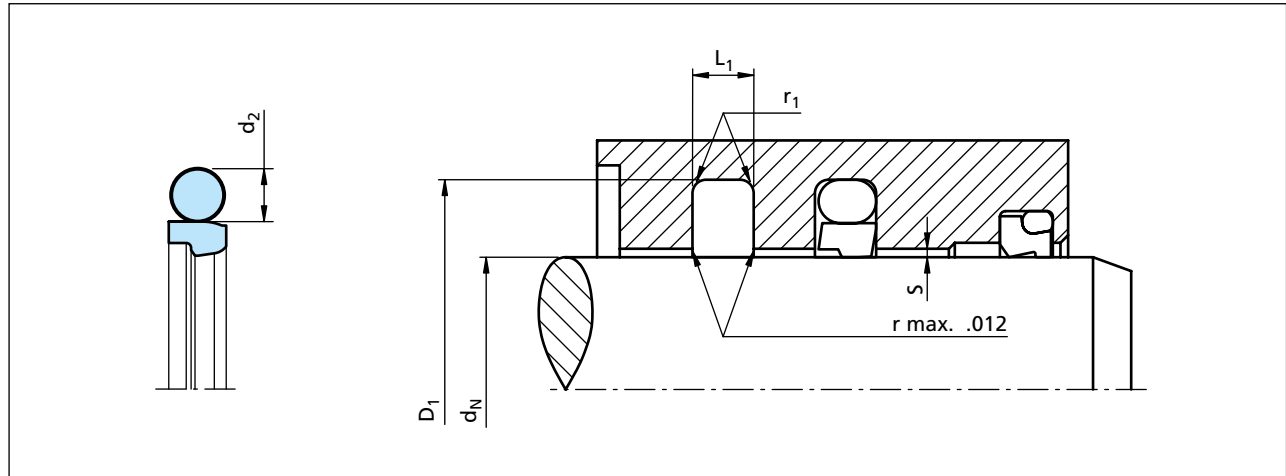


Figure 100 Installation drawing

Table 100 Installation Dimensions - Standard Recommendations inch

Series No.	Rod Diameter d_N f8/h9			Groove Dia. D_1 H9 *	Groove Width L_1 +.008	Radius r_1	Radial Clearance** $S_{max.}^{**}$			O-Ring Cross Sec. d_2
	Standard Application	Light*** Application	Heavy Duty Application				1,500 psi	3,000 psi	5,800 psi	
RSF0	.125 - .312	.313 - .749	-	$d_N + .193$	.087	.016	.012	.008	.006	.070
RSF1	.313 - .749	.750 - 1.499	-	$d_N + .287$	.126	.024	.016	.010	.006	.103
RSF2	.750 - 1.499	1.500 - 7.874	.313 - .749	$d_N + .421$	.165	.039	.020	.012	.008	.139
RSF3	1.500 - 7.874	7.875 - 9.999	.750 - 1.499	$d_N + .594$	.248	.051	.028	.016	.010	.210
RSF4	7.875 - 9.999	10.000 - 25.499	1.500 - 7.874	$d_N + .807$	.319	.071	.031	.024	.014	.275
RSF5	10.000 - 25.499	25.500 - 39.999	7.875 - 9.999	$d_N + .945$	.319	.071	.039	.031	.020	.275
RSF8	25.500 - 39.999	≥ 40.000	10.000 - 25.499	$d_N + 1.075$	.374	.098	.035	.028	.016	.331
RSF6 ****	> 40.000	-	25.500 - 39.999	$d_N + 1.496$	.543	.118	.047	.035	.024	.472

* Installation with groove dimensions to ISO 7425/2 is also recommendable.

** At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore / rod) in the area behind the seal; or consult Trelleborg Sealing Solutions for alternative material or profiles.

*** For easier installation in closed grooves with small rod diameters < 1.575 inches.

**** O-Rings with .472 inch cross section are delivered as a special profile ring.

Turcon® Stepseal® 2K

Ordering Example

Turcon® Stepseal® 2K complete with O-Ring standard application:

Series: RSF3 from Table 100
Rod diameter: $d_N = 8.000$ inches
TSS Part No.: RSF308000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number

TSS Article No.	RSF3	08000	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametral clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

■ Installation Recommendation for Rod - Metric sizes

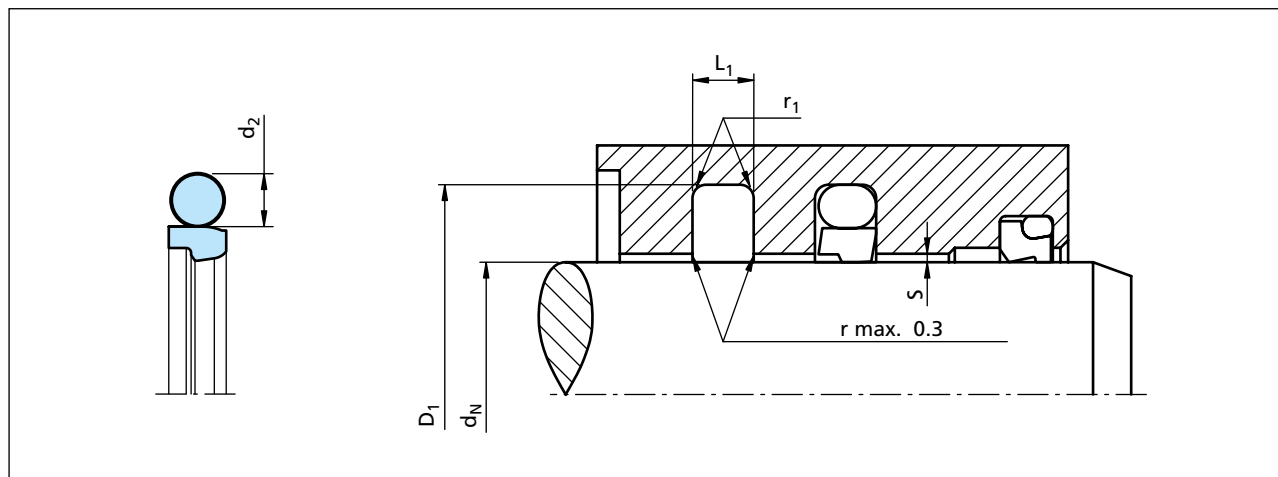


Figure 101 Installation drawing

Table 101 Installation Dimensions - Standard Recommendations metric

Series No.	Rod Diameter d_N f8/h9			Groove Dia. D_1 H9 *	Groove Width $L_1 + 0.2$	Radius r_1	Radial Clearance** $S_{max.}^{**}$			O-Ring Cross-Sec. d_2
	Standard Application	Light *** Application	Heavy Duty Application				10 MPa	20 MPa	40 MPa	
RSK0	3 - 7.9	8 - 18.9	-	$d_N + 4.9$	2.2	0.4	0.30	0.20	0.15	1.78
RSK1	8 - 18.9	19 - 37.9	-	$d_N + 7.3$	3.2	0.6	0.40	0.25	0.15	2.62
RSK2	19 - 37.9	38 - 199.9	8 - 18.9	$d_N + 10.7$	4.2	1.0	0.50	0.30	0.20	3.53
RSK3	38 - 199.9	200 - 255.9	19 - 37.9	$d_N + 15.1$	6.3	1.3	0.70	0.40	0.25	5.33
RSK4	200 - 255.9	256 - 649.9	38 - 199.9	$d_N + 20.5$	8.1	1.8	0.80	0.60	0.35	7.00
RSK8	256 - 649.9	650 - 999.9	200 - 255.9	$d_N + 24.0$	8.1	1.8	0.90	0.70	0.40	7.00
RSK5	650 - 999.9	-	256 - 649.9	$d_N + 27.3$	9.5	2.5	1.00	0.80	0.50	8.40
RSK5X	-	1000 - 1200	-	$d_N + 27.3$	9.5	2.5	1.00	0.80	0.50	8.40
RSK6 ****	1000 - 2600	-	650 - 999.9	$d_N + 38.0$	13.8	3.0	1.20	0.90	0.60	12.00

* Installation with groove dimensions to ISO 7425/2 is also recommendable.

** At pressures > **40 MPa**: Use diameter tolerance H8/f8 (bore/rod) in the area behind the seal; or consult Trelleborg Sealing Solutions for alternative material or profiles. Trelleborg Sealing Solutions Slydring®/Wear Rings are not applicable at very small radial clearance; please consult the Slydring® catalog.

*** For easier installation in closed grooves with small rod diameters (< 40 mm).

**** All O-Rings with 12 mm cross section are delivered as a special profile ring.

Turcon® Stepseal® 2K

Ordering Example

Turcon® Stepseal® 2K complete with O-Ring application:

Series: RSK4 from Table 101
Rod diameter: $d_N = 250.0$ mm
TSS Part No.: RSK402500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametral clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	RSK4	0	2500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

Turcon® Stepseal® 2K

■ Installation Recommendation for Piston - Inch sizes

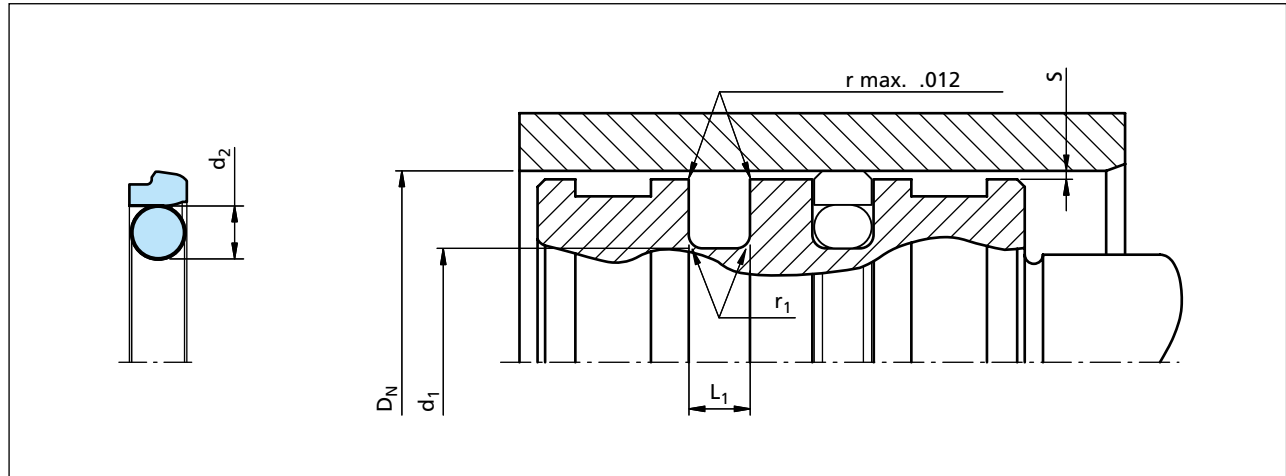


Figure 102 Installation drawing

Table 102 Installation Dimensions - Standard Recommendations inch

Series No.	Bore Diameter D_N H9			Groove Dia. d_1 h9 *	Groove Width $L_1 + .008$	Radius r_1	Radial Clearance** S_{max}^{**}			O-Ring Cross Sec. d_2
	Standard Application	Light Application	Heavy-Duty Application				1,500 psi	3,000 psi	5,800 psi	
PSF0	.313 - .749	.750 - 1.000	-	$D_N - .193$	.087	.020	.012	.009	.007	.070
PSF1	.750 - 1.499	1.500 - 2.500	-	$D_N - .287$	.126	.020	.016	.012	.008	.103
PSF2	1.500 - 2.499	2.500 - 8.000	.625 - 1.499	$D_N - .421$	.165	.025	.016	.012	.009	.139
PSF3	2.500 - 7.999	8.000 - 10.000	1.00 - 2.499	$D_N - .594$	.248	.030	.020	.014	.010	.210
PSF4	8.000 - 9.999	10.000 - 26.000	3.125 - 7.999	$D_N - .807$	.319	.035	.024	.017	.012	.275
PSF5	10.000 - 26.000	-	5.250 - 9.999	$D_N - .945$	.319	.035	.024	.017	.012	.275

* Installation with groove dimensions to ISO 7425/2 is also recommendable

** At pressures > **5,800 psi** use diameter tolerance H8/f8 (bore/piston) in area of seal or consult Trelleborg Sealing Solutions for alternative material or profiles.

Trelleborg Sealing Solutions Slydring® / Wear Rings are not applicable at very small radial clearances. Please consult the Slydring® catalog.

Turcon® Stepseal® 2K

Ordering Example

Turcon® Stepseal® 2K, complete with O-Ring standard application:

Series: PSF4 from Table 102
Piston diameter: $D_N = 6.000$ inches
TSS Part No. PSF406000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	PSF4	06000	-	M12	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Recommendation for Piston - Metric sizes

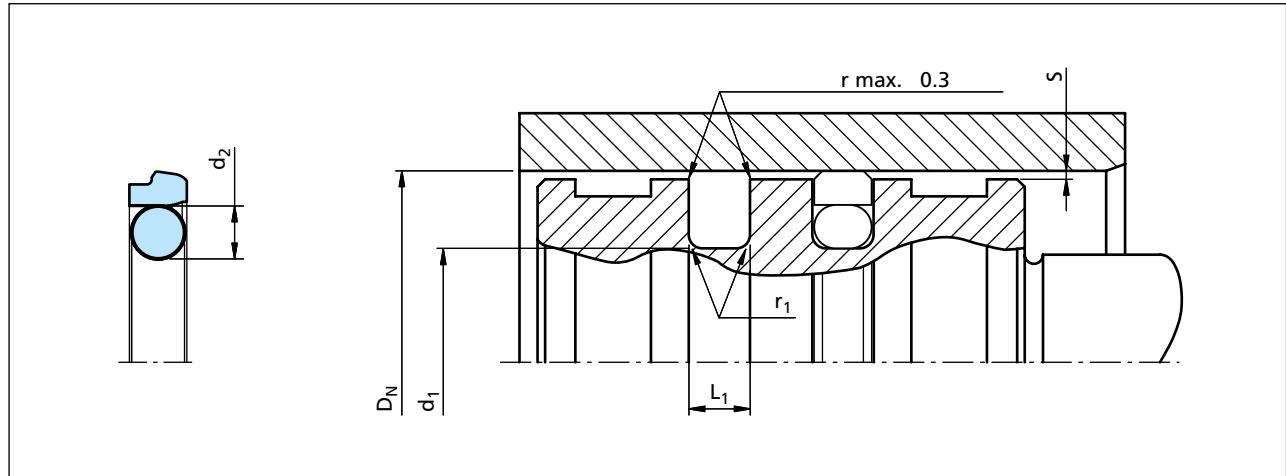


Figure 103 Installation drawing

Table 103 Installation Dimensions - Standard Recommendations metric

Series No.	Bore Diameter DN H9			Groove Dia. d1 h9*	Groove Width L1 +0.2	Radius r1	Radial Clearance** S max**			O-Ring Cross Sec. d2
	Standard Application	Light Application	Heavy-Duty Application				10 MPa	20 MPa	40 MPa	
PSK0	8 - 16.9	17 - 26.9	-	DN - 4.9	2.2	0.4	0.30	0.20	0.15	1.78
PSK1	17 - 26.9	27 - 59.9	-	DN - 7.3	3.2	0.6	0.40	0.25	0.15	2.62
PSK2	27 - 59.9	60 - 199.9	17 - 24.9	DN - 10.7	4.2	1.0	0.50	0.30	0.20	3.53
PSK3	60 - 199.9	200 - 255.9	27 - 59.9	DN - 15.1	6.3	1.3	0.70	0.40	0.25	5.33
PSK4	200 - 255.9	256 - 669.9	60 - 199.9	DN - 20.5	8.1	1.8	0.80	0.60	0.35	7.00
PSK8	256 - 669.9	670 - 999.9	200 - 255.9	DN - 24.0	8.1	1.8	0.90	0.70	0.40	7.00
PSK5	670 - 999.9	-	256 - 669.9	DN - 28.0	9.5	2.5	1.00	0.80	0.50	8.40
PSK5X	-	1000 - 1200	-	DN - 28.0	9.5	2.5	1.00	0.80	0.50	8.40
PSK6 ***	-	-	670 - 999.9	DN - 38.0	13.8	3.0	1.20	0.90	0.60	12.00
PSK6X***	1000 - 2700	-	-	DN - 38.0	13.8	3.0	1.20	0.90	0.60	12.00

* Installation with groove dimensions to ISO 7425/2 is also recommendable.

** At pressures > 40 MPa use diameter tolerance H8/f8 (bore/piston) in area of seal or consult Trelleborg Sealing Solutions for alternative material or profiles. Trelleborg Sealing Solutions Slydring® / Wear Rings are not applicable at very small radial clearances. Please consult the Slydring® catalog.

*** O-Rings with 12 mm cross section are delivered as a special profile ring

Turcon® Stepseal® 2K

Ordering Example

Turcon® Stepseal® 2K, complete with O-Ring standard application:

Series: PSK3 from Table 103
Bore diameter: $D_N = 80.0$ mm
TSS Part No. PSK300800

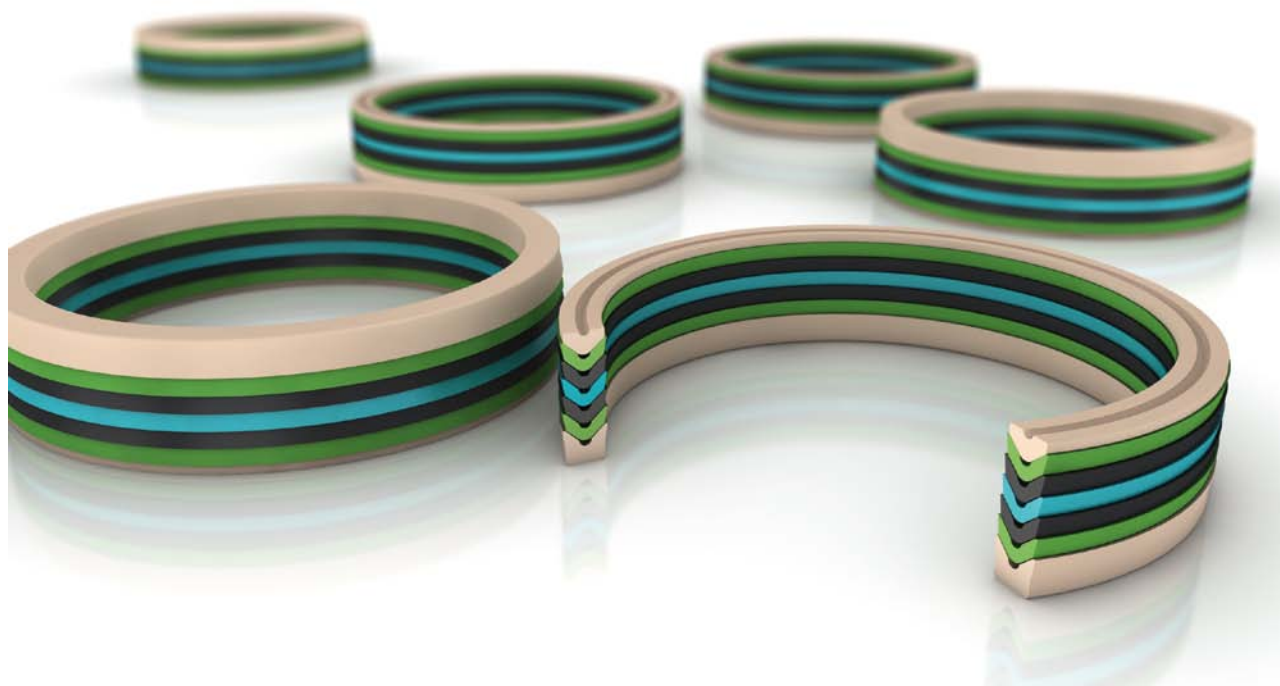
Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

TSS Article No.	PSK3	0	0800	-	M12	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametral clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

Turcon® V-Stack seal assembly



Features and benefits

Very robust seal

Multiple sealing lips for positive seal

Easy replacement in the field with split rings

Extensive range of sizes

Can be used with poor counter surfaces

Operating temperatures of -49 °F to +500 °F /
-45 °C to +260 °C depending on the elastomer

Compatible with virtually all media

V-Stack seal assembly

V-Stack seal assembly

Description

The V-Stack seal assembly is made up of a nest of Chevron rings comprising a top adapter or anti-extrusion ring (1), Vee Rings (2) and a bottom adapter (3). In the assembly the energizing axial force is transferred between the individual packing rings so that each ring is pressed into positive contact with the mating hardware surface. Special material grades are available for a large variety of working conditions.

V-Stack seal assemblies are custom made to suit specific working requirements and applications. For further information contact your local Trelleborg Sealing Solutions marketing company with sealing requirements and preferred sizes.

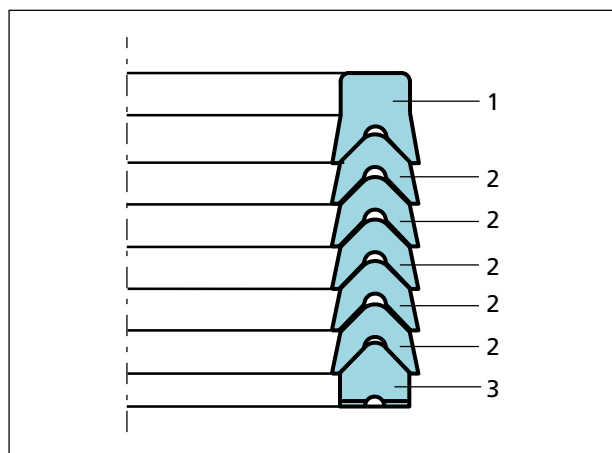


Figure 104 V-Stack seal assembly design

- 1) The top adapter or anti-extrusion ring is manufactured from a high modulus plastic, typically PEEK™, to resist extrusion. This component supports the Vee Rings, providing stability and extrusion resistance.
- 2) In the standard version Vee Rings are made entirely of Turcon® or combinations of Turcon® and elastomers (Isolast®, XploR™) to give good resilience, sealing efficiency and extrusion resistance.

Due to their specific design, Vee Rings are sensitive to fluid pressure variations, enabling them to deflect throughout their radial section, increasing the seal loading and effectiveness in proportion to the pressures applied.

- 3) The bottom adapter ring is manufactured from PEEK™ or PTFE. The function of this component is to ensure a uniform pressure distribution.

Due to this being a custom design please contact your local Trelleborg Sealing Solutions marketing company to discuss your specific working requirements.

Applications

- Downhole flow control
- Sub surface safety valves
- Polished bore receptacles
- Sliding sleeves
- Valve stem seals

Technical Data

Operating conditions

Pressure: up to 30,000 psi / 207 MPa
with custom components

Velocity: up to 3.3 ft/s / 1 m/s

Temperature: -49 °F to +500 °F / -45 °C to +260 °C
depending on material

Media: Drilling mud, downhole fluids, seawater, hydraulic fluids including water glycol based fluids

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

V-Stack seal assembly

Turcon® Variseal®



Features and benefits

Good dynamic and static sealing

Very low coefficient of friction

Very good dry-running properties

Operating temperature of -94 °F to +572 °F /
-70 °C to +300 °C

Very good thermal resistance

Almost universal chemical compatibility

Permanent elasticity unaffected by contact with
chemicals

Capable of sealing at high speeds up to 50 ft/s /
15 m/s

Capable of withstanding high pressures above 29,000
psi / 200 MPa when using Back-up Rings and special
custom designs

High resistance to wear

No extrusion into gaps

Withstands aggressive and abrasive process media

Unlimited shelf life

Compact form

Simple installation

Standard products are available from 0.079 in / 2 mm
up to 8 ft 2 in / 2,500 mm in diameter along with
custom manufactured intermediate sizes, inch sizes
or special geometries

Description

The Turcon® Variseal® range is made up of single-acting spring-energized seals that are used in dynamic and static situations. Turcon® Variseal® is available in a range of geometries and designs that allow the optimum profile to be selected for a wide range of applications.

Turcon® Variseal® is chosen when high resistance to chemical media is required, if the seal needs to operate in extremes of temperature and where good extrusion or compression characteristics are needed.

Turcon® Variseal® has three main design characteristics:

1. Application specific U-shaped seal profile
2. Spring geometry suited to the particular application
3. Proven high-performance Turcon® or Zurcon® polymers

Method of Operation

The Turcon® Variseal® spring supplies the load required for sealing at low pressures (Figure 105). The U-shaped jacket allows fluid pressure to energize the sealing lips, so total sealing pressure rises with increasing operating pressure (Figure 106).

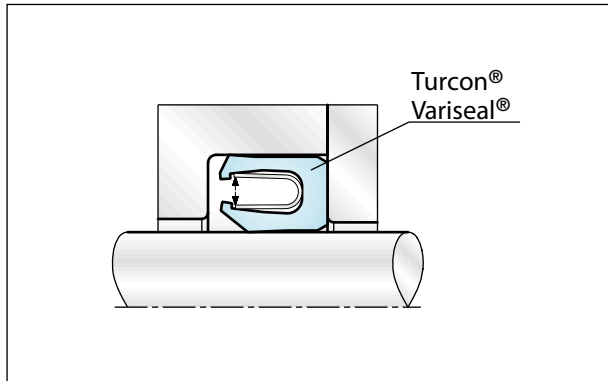


Figure 105 Turcon® Variseal® without system pressure

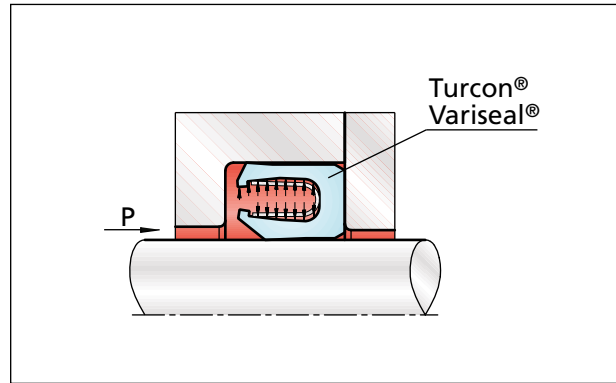


Figure 106 Turcon® Variseal® with system pressure

Spring Types

A metal spring is incorporated into Turcon® Variseal® to provide elasticity to the seal. This makes the seal permanently elastic, despite changes in operating temperature, pressure or contact chemicals.

Each of the three spring types used in Turcon® Variseal® has unique properties that give them their performance characteristics. The two most important properties of the spring, besides the corrosion resistance of the metal, are load value and deflection range. The spring load affects sealing ability, friction and the wear rate of the seal. The deflection range determines the ability of Turcon® Variseal® to withstand wear and compensates for variations in groove dimensions.

V-Spring

V-Spring is the standard spring type for Turcon® Variseal® M2, Turcon® Variseal® M2S and Turcon® Roto Variseal®. It operates as a set of cantilever beams, extending from an arc at the bottom of the spring. The shape of the spring causes the load to be focused on the front edge of the sealing lip, giving the seal a positive wiping action. The V-Spring has a moderate load and deflection range.

Helical Spring

The Helical spring, used in Turcon® Variseal® H and Turcon® Variseal® HF, is made from a flat strip formed

into a helical coil spring. It has a much higher unit load and a shorter deflection range than the other spring types. Therefore, it is best suited to static or slow dynamic applications, where friction and wear are not the key issues. Variseal® H and Variseal® HF are the best choices for vacuum, gas and low-temperature applications.

Slantcoil® Spring

The proprietary Slantcoil® spring used in Turcon® Variseal® W2 consists of round wire formed into slanted coils and has a relatively constant load over a wide deflection range. This allows accurate control of friction during the working life of the seal. Its unique design makes it almost impossible to damage the spring by excessive deformation of the seal.

Spring Materials

The standard spring material for Turcon® Variseal® is Stainless Steel AISI 301 / 302 (spring code S). In addition, Hastelloy® (spring code H) and Elgiloy® (spring code E) are available for specific applications. In most instances, Elgiloy® complies with NACE MR-1075 specifications for aggressive oilfield applications.

Note:

Hastelloy® is a registered trademark of Cabot Corporation.

Elgiloy® is a registered trademark of Elgiloy Company.

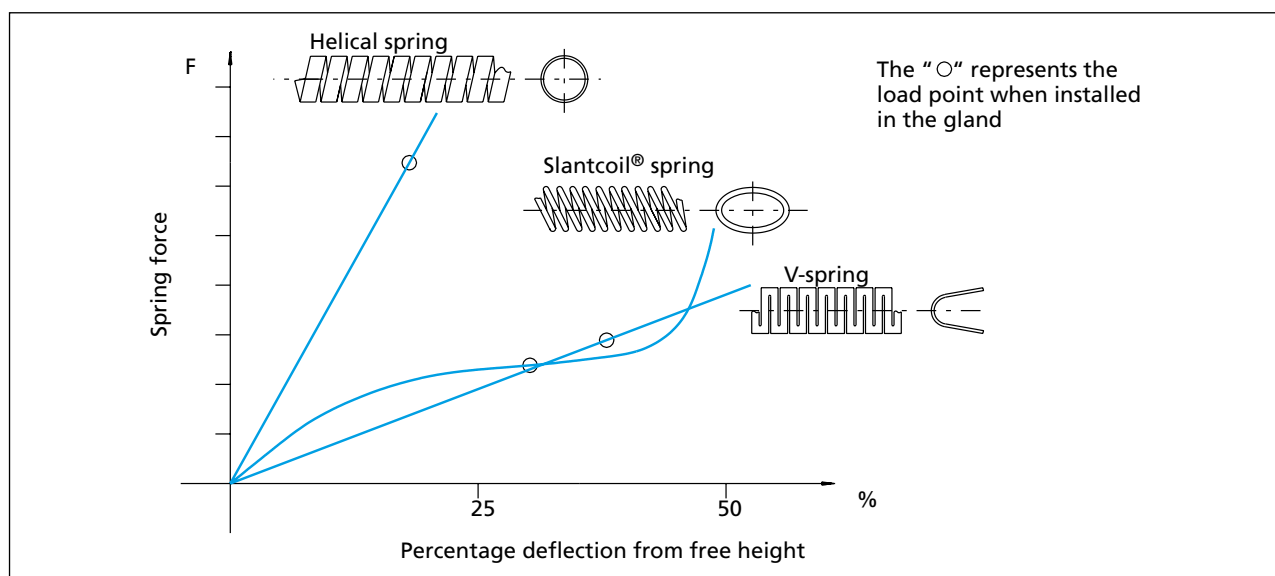


Figure 107 Comparison of load curves for the three spring types.

■ Turcon® Variseal® M2

Description

Turcon® Variseal® **M2** is a single acting seal consisting of a U-shaped jacket and a V-shaped corrosion resistant spring.

Variseal® M2 has an asymmetric seal profile. The heavy profile of its dynamic lip with an optimized front angle offers good leakage control, reduced friction and long service life.

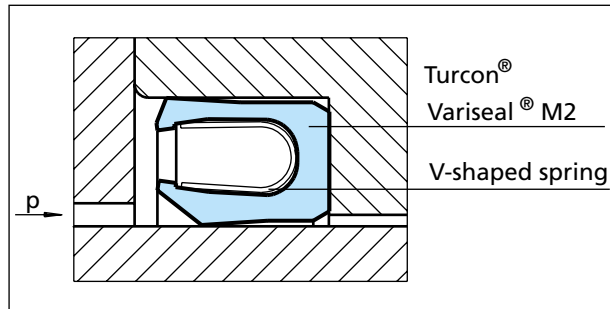


Figure 108 Turcon® Variseal® M2

Areas of Application

- Valve actuators
- Valves
- FPSO Swivel Units
- Separation equipment
- Downhole tools
- MWD Applications
- LWD Applications
- Sub-surface safety valves

Advantages

- Suitable for reciprocating and rotary applications
- Low coefficient of friction
- Stick-slip free operating
- High abrasion resistance
- Dimensionally stable
- Resistant to most fluids, chemicals and gases
- Withstands rapid changes in temperature
- No tendency for the seal to vulcanize against mating surfaces
- Excellent resistance to ageing
- Can be sterilized
- Available in Hi-Clean version
- Interchangeable with O-Ring and Back-up Ring combinations to AS4716 and ISO 6194

Technical Data

Operating pressure: Maximum dynamic load:

2,900 psi / 20 MPa

Maximum static load:

5,800 psi / 40 MPa

(30,000 psi / 207 MPa with back-up ring)

Speed:

Reciprocating up to 50 ft/s / 15 m/s

Rotating up to 4 ft/s / 1.27 m/s

Operating temperature:

-94 °F to +572 °F /

-70 °C to +300 °C

Special Turcon® and Zurcon® materials as well alternative spring materials are available for applications outside this temperature range.

Media compatibility:

Virtually all fluids, chemicals and gases

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Turcon® Variseal® M2S

Description

Turcon® Variseal® **M2S** is a single acting seal consisting of a U-shaped jacket and a V-shaped corrosion resistant spring. Variseal® M2S has an asymmetric seal profile. The heavy profile of its dynamic lip is optimized, offering long service life and a good scraping ability even in media with high viscosity.

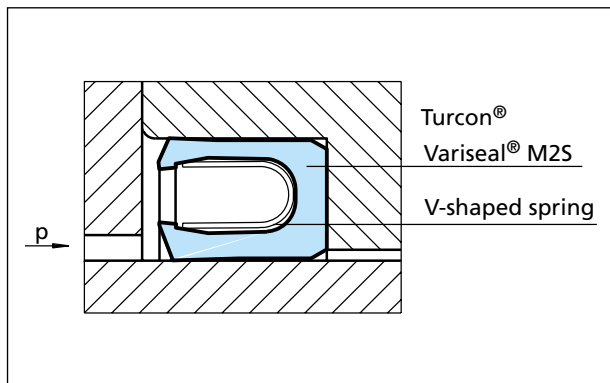


Figure 109 Turcon® Variseal® M2S

Areas of Application

- Valve actuators
- Valves
- FPSO Swivel units
- Separation equipment
- Downhole tools
- MWD applications
- LWD applications
- Sub-surface safety valves

Advantages

- Suitable for reciprocating and light duty rotary movement
- Excellent scraping ability
- High abrasion resistance
- Dimensionally stable
- Resistant to most fluids and chemicals
- Excellent resistance to aging
- Available in Hi-Clean version
- Interchangeable with O-Ring and Back-up Ring in most cases

Technical Data

Operating pressure: 2,900 psi / 20 MPa Maximum dynamic load, 5,800 psi / 40 MPa Maximum static load (30,000 psi / 207 MPa with custom designs)

Speed: Reciprocating up to 50 ft/s / 15 m/s
Rotating up to 250 fpm / 1.27 m/s

Operating temperature: -94 °F to +572 °F / -70 °C to +300 °C
Special Turcon® and Zurcon® materials as well alternative spring materials are available for applications outside this temperature range

Media compatibility: Downhole fluids that include abrasive media, such as drilling mud, sand and cement

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Turcon® Variseal® W2

Description

Turcon® Variseal® W2 is a single acting seal consisting of a U-shaped jacket and a corrosion resistant Slantcoil® spring.

The Slantcoil® spring in the Variseal® W2 provides an almost constant load irrespective of hardware tolerances, eccentricity and seal wear.

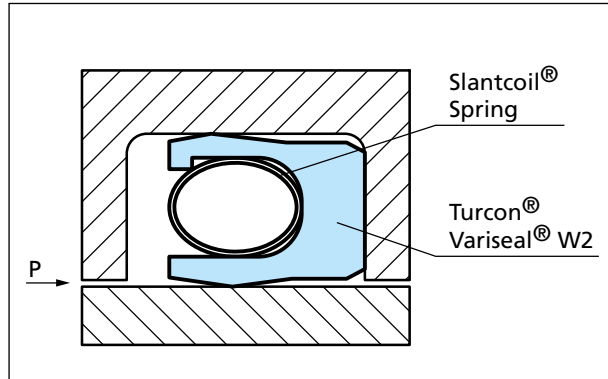


Figure 110 Turcon® Variseal® W2

Areas of Application

- Valve actuators
- Valves
- FPSO Swivel units
- Separation equipment
- Downhole tools
- MWD applications
- LWD applications
- Sub-surface safety valves

Advantages

- Suitable for reciprocating and light duty rotary movement
- Constant initial squeeze of spring over a large control area
- Interchangeable with O-Ring and Back-up Ring in most cases

Technical Data

Operating pressure: 2,900 psi / 20 MPa Maximum dynamic load, 5,800 psi / 40 MPa Maximum static load (30,000 psi / 207 MPa with custom designs)

Speed: Reciprocating up to 50 ft/s / 15 m/s
Rotating up to 250 fpm / 1.27 m/s

Operating temperature: -94 °F to +572 °F / -70 °C to +300 °C

Media compatibility: Virtually all hydraulic oils and downhole fluids, chemicals and gases

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Turcon® Variseal® H

Description

Turcon® Variseal® H is a single acting seal consisting of a U-shaped jacket and a helical wound corrosion resistant spring.

The helical spring of Variseal® H has a high spring loading, which gives excellent sealing integrity at low pressure. Variseal® H is suitable for dynamic applications and ideal in static applications.

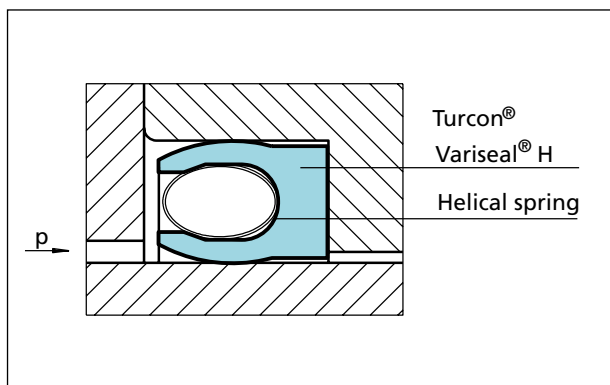


Figure 111 Turcon® Variseal® H

Areas of Application

- Ball and gate valves
- LNG processing
- Crude oil and natural gas installations
- Cryogenic engineering
- Vacuum applications
- Pivot joints
- Flange applications

Advantages

- High contact pressure
- Excellent sealing integrity in gas and fluid applications
- Withstands rapid changes in temperature
- Good sealing ability when surfaces are not ideal
- No assembly tools are required for larger diameter seals
- Excellent resistance to aging
- Interchangeable with O-Ring and Back-up Ring in most cases

Technical Data

Operating pressure: 2,900 psi / 20 MPa
Maximum dynamic load,
5,800 psi / 40 MPa
Maximum static load
(30,000 psi / 207 MPa with
custom designs)

Operating temperature: -148 °F to +392 °F /
-100 °C to 200 °C

Media compatibility: Virtually all hydraulic oil and
downhole fluids, chemicals and
gases.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Groove Configurations

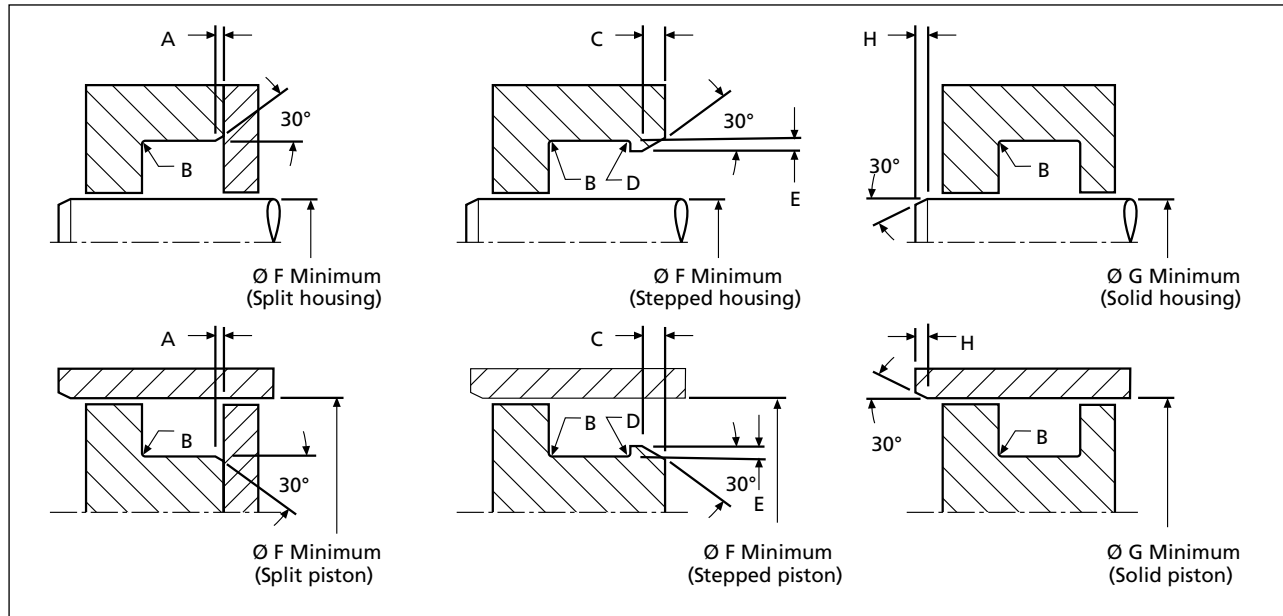


Figure 112 Variseal Groove Configurations

Table 104 Dimensions for Groove Designs - Inch (Metric)

Series	Rod / Piston Groove Dimensions					
	A Chamfer	B Maximum Radius	C Minimum Chamfer	D Maximum Radius	E Step Height	H Minimum Chamfer
000	0.010 / 0.015 (0.25 / 0.38)	0.010 (0.25)	0.025 (0.64)	0.005 (0.13)	0.008 / 0.012 (0.20 / 0.30)	0.031 (0.79)
100	0.015 / 0.020 (0.38 / 0.51)	0.015 (0.38)	0.030 (0.76)	0.005 (0.13)	0.010 / 0.015 (0.25 / 0.38)	0.050 (1.27)
200	0.015 / 0.020 (0.38 / 0.51)	0.015 (0.38)	0.040 (1.02)	0.007 (0.18)	0.015 / 0.020 (0.38 / 0.51)	0.062 (1.57)
300	0.020 / 0.027 (0.51 / 0.69)	0.015 (0.38)	0.045 (1.14)	0.010 (0.25)	0.017 / 0.023 (0.43 / 0.58)	0.093 (2.36)
400	0.020 / 0.027 (0.51 / 0.69)	0.020 (0.51)	0.055 (1.40)	0.010 (0.25)	0.022 / 0.028 (0.56 / 0.71)	0.125 (3.18)
500	0.030 / 0.040 (0.76 / 1.02)	0.020 (0.51)	0.075 (1.91)	0.015 (0.38)	0.022 / 0.028 (0.56 / 0.71)	0.188 (4.78)

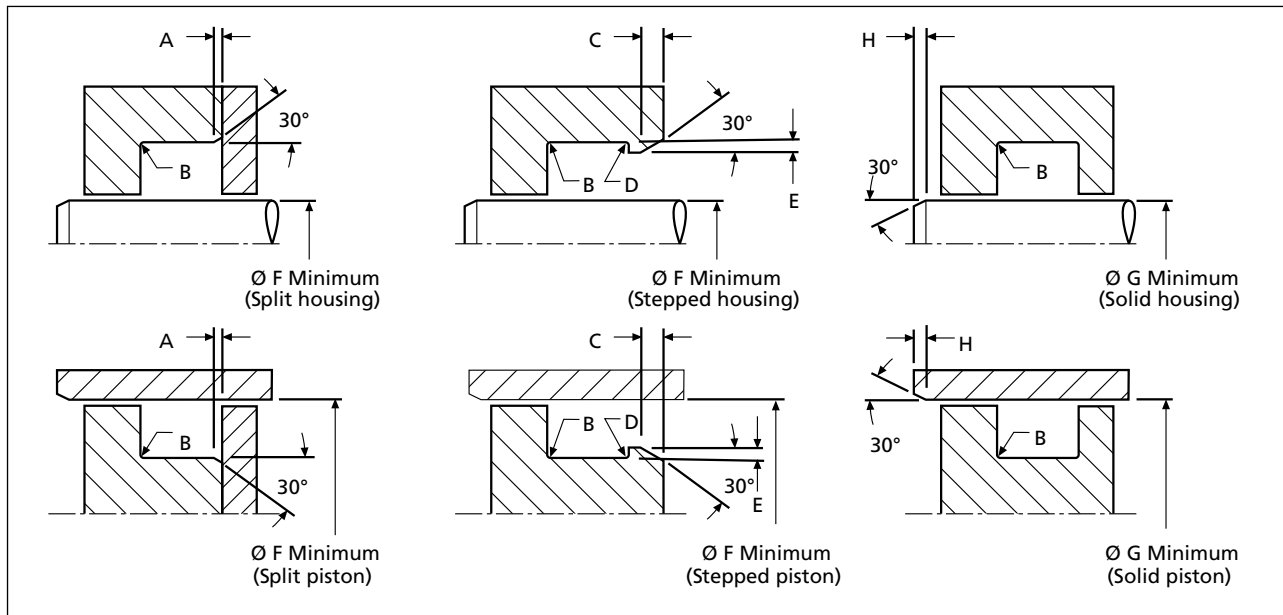


Figure 113 Variseal Groove Configurations

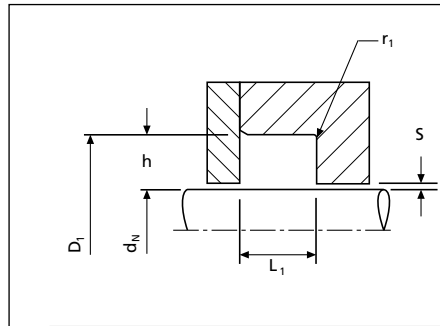
Table 105 Groove Design for Rod - Inch (Metric)

Series	Rod Diameter Recommendations			
	Ø F Minimum Type M2. W2. H	Ø G Minimum		
		Variseal M2	Variseal W2	Variseal H
000	0.250 (6.35)	1.250 (31.75)	1.000 (25.40)	1.000 (25.40)
100	0.375 (9.53)	2.750 (69.85)	2.500 (63.50)	2.500 (63.50)
200	0.750 (19.05)	4.375 (111.13)	4.250 (107.95)	4.250 (107.95)
300	1.000 (25.40)	11.750 (298.45)	9.000 (228.60)	9.000 (228.60)
400	2.000 (50.80)	19.500 (495.30)	15.750 (400.05)	15.750 (400.05)
500	2.250 (57.15)	30.000 (762.00)	25.000 (635.00)	25.000 (635.00)

Table 106 Groove Design for Piston - Inch (Metric)

Series	Piston Diameter Recommendations			
	Ø F Minimum Type M2. W2. H	Ø G Minimum		
		Variseal M2	Variseal W2	Variseal H
000	0.375 (9.53)	1.375 (34.93)	0.750 (19.05)	0.750 (19.05)
100	0.562 (14.27)	2.000 (50.80)	1.125 (28.58)	1.125 (28.58)
200	1.000 (25.40)	2.750 (69.85)	1.750 (44.45)	1.75 (44.45)
300	1.375 (34.93)	4.125 (104.78)	2.675 (60.33)	2.375 (60.33)
400	2.500 (63.50)	5.500 (139.70)	3.750 (95.25)	3.750 (95.25)
500	3.000 (76.20)	10.000 (254.00)	8.000 (203.20)	8.000 (203.20)

■ Installation Recommendations for Inch / Rod Seals - Types M2, M2S, W and H



Variseal M2	Variseal W2
RVA	RVJ
Variseal M2S	Variseal H
RVC	RVE

Table 109 Diameter Tolerance

Seal ID	Dia. d_N	Dia. D_1
0.125 to 0.374	+0.000 -0.001	+0.001 -0.000
0.375 to 2.999	+0.000 -0.002	+0.002 -0.000
3.000 to 7.999	+0.000 -0.003	+0.003 -0.000
8.000 & up	+0.000 -0.004	+0.004 -0.000

Figure 114 Installation drawing

Table 107 Installation Dimensions - Inch

Series Number for Types				h	L_1	r_1	Maximum Extrusion Gap at			
M2	M2S	W2	H	Cross-Section Table 104	Groove Width (+0.010)	Radius (Max)	300 psi	1,500 psi	3,000 psi	5,000 psi
RVAA	RVCA	RVJA	RVEA	0.062	0.094	0.010	0.008	0.004	0.003	0.002
RVAB	RVCB	RVJB	RVEB	0.093	0.141	0.015	0.010	0.006	0.004	0.003
RVAC	RVCC	RVJC	RVEC	0.125	0.188	0.015	0.014	0.008	0.006	0.003
RVAD	RVCD	RVJD	RVED	0.187	0.281	0.015	0.020	0.010	0.008	0.004
RVAE	RVCE	RVJE	RVEE	0.250	0.375	0.020	0.024	0.012	0.010	0.005
RVAG	RVCG	RVJG	RVEG	0.375	0.591	0.020	0.030	0.015	0.012	0.006

Table 108 Preferred Series

Dia. d_N	Dia. D_1	TSS Part No.	Dia. d_N	Dia. D_1	TSS Part No.	Dia. d_N	Dia. D_1	TSS Part No.
0.125	0.250	RV_A_B006	0.875	1.250	RV_D_B316	1.500	2.000	RV_E_B401
0.187	0.312	RV_A_B008	1.000	1.125	RV_A_B022	1.625	1.750	RV_A_B030
	0.375	RV_B_B106		1.187	RV_B_B120		1.812	RV_B_B130
0.250	0.375	RV_A_B010		1.250	RV_C_B214		1.875	RV_C_B223
	0.437	RV_B_B108		1.375	RV_D_B318		2.000	RV_D_B326
	0.500	RV_C_B202		1.250	RV_A_B024		2.125	RV_E_B402
0.375	0.500	RV_A_B012	1.125	1.312	RV_B_B122	1.750	1.875	RV_A_B031
	0.562	RV_B_B110		1.375	RV_C_B216		1.937	RV_B_B132
	0.625	RV_C_B204		1.500	RV_D_B320		2.000	RV_C_B224
0.500	0.625	RV_A_B014	1.250	1.375	RV_A_B026		2.125	RV_D_B327
	0.687	RV_B_B112		1.437	RV_B_B124		2.250	RV_E_B403
	0.750	RV_C_B206		1.500	RV_C_B218		2.000	RV_A_B032
0.625	0.750	RV_A_B016	1.375	1.625	RV_D_B322	1.875	2.062	RV_B_B134
	0.812	RV_B_B114		1.500	RV_A_B028		2.125	RV_C_B225
	0.875	RV_C_B208		1.562	RV_B_B126		2.250	RV_D_B328
0.750	0.875	RV_A_B018	1.500	1.625	RV_C_B220		2.375	RV_E_B404
	0.937	RV_B_B116		1.750	RV_D_B324	2.000	2.125	RV_A_B033
0.875	1.000	RV_C_B210		1.625	RV_A_B029		2.187	RV_B_B136
	1.000	RV_A_B020		1.687	RV_B_B128		2.250	RV_C_B226
	1.062	RV_B_B118		1.750	RV_C_B222		2.375	RV_D_B329
	1.125	RV_C_B212		1.875	RV_D_B325		2.500	RV_E_B405

Dia. d _N	Dia. D ₁	TSS Part No.
2.125	2.250	RV_A_B034
	2.312	RV_B_B138
	2.375	RV_C_B227
	2.500	RV_D_B330
	2.625	RV_E_B406
2.250	2.375	RV_A_B035
	2.437	RV_B_B140
	2.500	RV_C_B228
	2.625	RV_D_B331
	2.750	RV_E_B407
2.375	2.500	RV_A_B036
	2.562	RV_B_B142
	2.625	RV_C_B229
	2.750	RV_D_B332
	2.875	RV_E_B408
2.500	2.625	RV_A_B037
	2.687	RV_B_B144
	2.750	RV_C_B230
	2.875	RV_D_B333
	3.000	RV_E_B409
2.625	2.750	RV_A_B038
	2.812	RV_B_B146
	2.875	RV_C_B231
	3.000	RV_D_B334
	3.125	RV_E_B410
2.750	2.875	RV_A_B039
	2.937	RV_B_B148
	3.000	RV_C_B232
	3.125	RV_D_B335
	3.250	RV_E_B411
2.875	3.000	RV_A_B040
	3.062	RV_B_B150
	3.125	RV_C_B233
	3.250	RV_D_B336
	3.375	RV_E_B412
3.000	3.125	RV_A_B041
	3.188	RV_B_B151
	3.250	RV_C_B234
	3.375	RV_D_B337
	3.500	RV_E_B413
3.125	3.375	RV_C_B235
	3.500	RV_D_B338
	3.625	RV_E_B414
3.250	3.375	RV_A_B042

Dia. d _N	Dia. D ₁	TSS Part No.
3.250	3.437	RV_B_B152
	3.500	RV_C_B236
	3.625	RV_D_B339
	3.750	RV_E_B415
3.375	3.625	RV_C_B237
	3.750	RV_D_B340
	3.875	RV_E_B416
3.500	3.625	RV_A_B043
	3.688	RV_B_B153
	3.750	RV_C_B238
	3.875	RV_D_B341
	4.000	RV_E_B417
3.625	3.875	RV_C_B239
	4.000	RV_D_B342
	4.125	RV_E_B418
3.750	3.875	RV_A_B044
	3.937	RV_B_B154
	4.000	RV_C_B240
	4.125	RV_D_B343
	4.250	RV_E_B419
3.875	4.125	RV_C_B241
	4.250	RV_D_B344
	4.375	RV_E_B420
4.000	4.125	RV_A_B045
	4.187	RV_B_B155
	4.250	RV_C_B242
	4.375	RV_D_B345
4.250	4.500	RV_E_B421
	4.437	RV_B_B156
	4.500	RV_C_B244
	4.625	RV_D_B347
	4.750	RV_E_B423
4.500	4.687	RV_B_B157
	4.750	RV_C_B246
	4.875	RV_D_B349
	5.000	RV_E_B425
4.750	4.937	RV_B_B158
	5.000	RV_C_B248
	5.125	RV_D_B351
	5.250	RV_E_B427
5.000	5.187	RV_B_B159
	5.250	RV_C_B250
	5.375	RV_D_B353
	5.500	RV_E_B429

Dia. d _N	Dia. D ₁	TSS Part No.
5.250	5.437	RV_B_B160
	5.500	RV_C_B252
	5.625	RV_D_B355
	5.750	RV_E_B431
5.500	5.687	RV_B_B161
	5.750	RV_C_B254
	5.875	RV_D_B357
	6.000	RV_E_B433
5.750	6.000	RV_C_B256
	6.125	RV_D_B359
	6.250	RV_E_B435
6.000	6.250	RV_C_B258
	6.375	RV_D_B361
	6.500	RV_E_B437
6.250	6.500	RV_C_B259
	6.625	RV_D_B362
	6.750	RV_E_B438
6.500	6.750	RV_C_B260
	6.875	RV_D_B363
	7.000	RV_E_B439
	7.000	RV_C_B261
6.750	7.125	RV_D_B364
	7.250	RV_E_B440
7.000	7.250	RV_C_B262
	7.375	RV_D_B365
	7.500	RV_E_B441
7.500	7.750	RV_C_B264
	7.875	RV_D_B367
	8.000	RV_E_B443
	8.250	RV_C_B266
8.000	8.375	RV_D_B369
	8.500	RV_E_B445
9.000	9.250	RV_C_B270
	9.375	RV_D_B373
	9.500	RV_E_B447
10.000	10.375	RV_D_B377
	10.500	RV_E_B449
11.000	11.500	RV_E_B451
12.000	12.500	RV_E_B453
13.000	13.500	RV_E_B455
14.000	14.500	RV_E_B457
15.000	15.500	RV_E_B459

Figures in bold are standard sizes.

■ **Installation Recommendations for Metric / Rod Seals - Types M2, MS2, W2 and H**

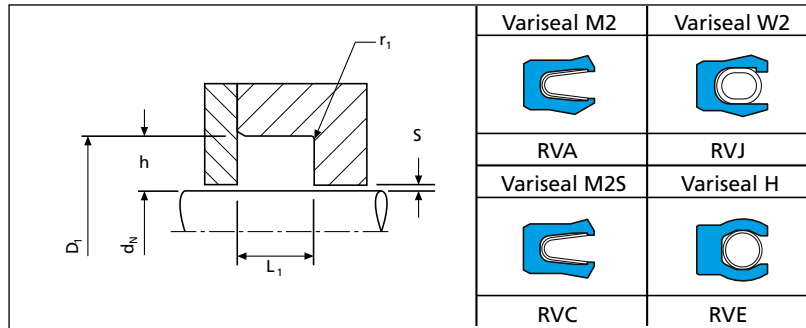


Figure 115 Installation drawing

Table 110 Installation Dimensions - Metric

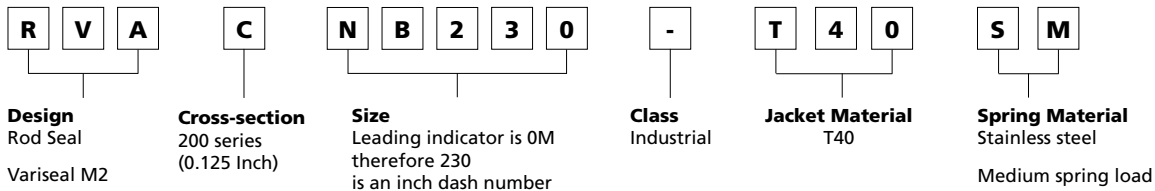
Series Number for Types				Rod Diameter d_N h9		D_1	L_1	r_1	Maximum Extrusion Gap at			
M2	M2S	W2	H	Standard Range	Extended ¹⁾ Range	Groove Diameter (H9)	Groove Width (+0.2)	Radius (Max)	2 MPa	10 MPa	20 MPa	40 MPa
RVA0	RVC0	RVJ0	RVE0	3.0 - 9.9	3.0 - 40.0	$d + 2.9$	2.4	0.4	0.20	0.10	0.08	0.05
RVA1	RVC1	RVJ1	RVE1	10.0 - 19.9	6.0 - 200.0	$d + 4.5$	3.6	0.4	0.25	0.15	0.10	0.07
RVA2	RVC2	RVJ2	RVE2	20.0 - 39.9	10.0 - 400.0	$d + 6.2$	4.8	0.6	0.35	0.20	0.15	0.08
RVA3	RVC3	RVJ3	RVE3	40.0 - 119.9	20.0 - 700.0	$d + 9.4$	7.1	0.8	0.50	0.25	0.20	0.10
RVA4	RVC4	RVJ4	RVE4	120.0 - 999.9	35.0 - 1600.0	$d + 12.2$	9.5	0.8	0.60	0.30	0.25	0.12
RVA5	RVC5	RVJ5	RVE5	1000.0 - 2500.9	80.0 - 2500.0	$d + 19.0$	15.0	0.8	0.90	0.50	0.40	0.20

¹⁾ Available on request

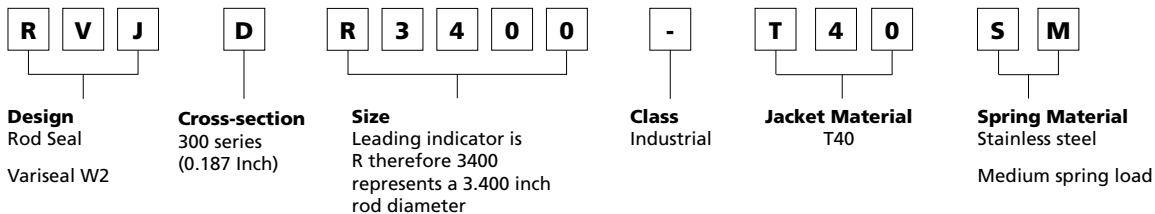
Table 111 Part Number System for Rod Variseal

Article Code	Cross-Section	Size	Class	Seal Material	Spring Material	Spring Load
RVA Variseal M2	Inch		- Industrial	T01	S Stainless Steel	Standard load for each design
RVC Variseal M2S	A 0.062	NBxxx Inch Dash #		T05	H Hastelloy	
RVE Variseal H	B 0.093	Rxxxx Rod dia <10.0 Inch		T07	E Elgiloy	
RVJ Variseal W2	C 0.125	(dia x 1000.0)		T12		RVA & RVC
	D 0.187	Kxxxx Rod dia. >= 10.0		T24		
	E 0.250	(dia x 100.0)		T40		
	G 0.375			T78		M Medium
	Metric			Z48		
				Z80		
						RVE
		0xxxx Rod dia <1000 mm				
		(dia x 10.0)				
		Xxxxx Rod dia. >= 1000 mm				RVJ
		(dia x 1.0)				
						M Medium
				See Table 16 for material description		

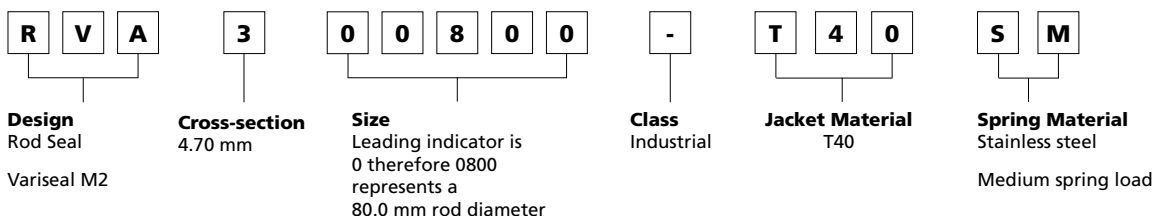
Ordering Example 1 - Inch Example



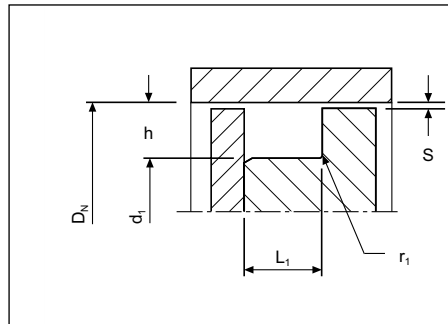
Ordering Example 2 - Inch Example



Ordering Example 3 - Metric Example



■ Installation Recommendation for Inch / Piston Seals - Types M2, M2S, W2 and H



Variseal M2	Variseal W2
PVA	PVJ
Variseal M2S	Variseal H
PVC	PVE

Table 114 Diameter Tolerance

Seal ID	Dia. d_1	Dia. D_N
0.125 to 0.374	+0.000 -0.001	+0.001 -0.000
0.375 to 2.999	+0.000 -0.002	+0.002 -0.000
3.000 to 7.999	+0.000 -0.003	+0.003 -0.000
8.000 & up	+0.000 -0.004	+0.004 -0.000

Figure 116 Installation drawing

Table 112 Installation Dimensions - Inch

Series Number for Types				h	L_1	r_1	Maximum Extrusion Gap at			
M2	M2S	W	H	Cross-Section	Groove Width	Radius	300 psi	1,500 psi	3,000 psi	5,000 psi
				Table 109	(+0.010)	(Max)				
PVAA	PVCA	PVJA	PVEA	0.062	0.094	0.010	0.008	0.004	0.003	0.002
PVAB	PVCB	PVJB	PVEB	0.093	0.141	0.015	0.010	0.006	0.004	0.003
PVAC	PVCC	PVJC	PVEC	0.125	0.188	0.015	0.014	0.008	0.006	0.003
PVAD	PVCD	PVJD	PVED	0.187	0.281	0.015	0.020	0.010	0.008	0.004
PVAE	PVCE	PVJE	PVEE	0.250	0.375	0.020	0.024	0.012	0.010	0.005
PVAF	PVAF	PVJF	PVEF	0.375	0.591	0.020	0.030	0.015	0.012	0.006

Table 113 Preferred Series

Dia. D_N	Dia. d_1	TSS Part No.	Dia. D_N	Dia. d_1	TSS Part No.	Dia. D_N	Dia. d_1	TSS Part No.
0.250	0.125	PV_A_B006	1.125	0.875	PV_C_B212	1.750	1.375	PV_D_B324
0.375	0.250	PV_A_B010	1.250	1.125	PV_A_B024	1.875	1.750	PV_A_B031
	0.187	PV_B_B106		1.062	PV_B_B121		1.687	PV_B_B131
0.500	0.375	PV_A_B012		1.000	PV_C_B214		1.625	PV_C_B223
	0.312	PV_B_B109		0.875	PV_D_B316		1.500	PV_D_B325
	0.250	PV_C_B202	1.375	1.250	PV_A_B026	2.000	1.875	PV_A_B032
0.625	0.500	PV_A_B014		1.187	PV_B_B123		1.812	PV_B_B133
	0.437	PV_B_B111		1.125	PV_C_B216		1.750	PV_C_B224
	0.375	PV_C_B204		1.000	PV_D_B318		1.625	PV_D_B326
0.750	0.625	PV_A_B016	1.500	1.375	PV_A_B028	2.125	1.500	PV_E_B401
	0.562	PV_B_B113		1.312	PV_B_B125		2.000	PV_A_B033
	0.500	PV_C_B206		1.250	PV_C_B218		1.937	PV_B_B135
0.875	0.750	PV_A_B018		1.125	PV_D_B320		1.875	PV_C_B225
	0.687	PV_B_B115	1.625	1.500	PV_A_B029		1.750	PV_D_B327
	0.625	PV_C_B208		1.437	PV_B_B127		1.625	PV_E_B402
1.000	0.875	PV_A_B020		1.375	PV_C_B220	2.250	2.125	PV_A_B034
	0.812	PV_B_B117		1.250	PV_D_B322		2.062	PV_B_B137
	0.750	PV_C_B210	1.750	1.625	PV_A_B030		2.000	PV_C_B226
1.125	1.000	PV_A_B022		1.562	PV_B_B129		1.875	PV_D_B328
	0.937	PV_B_B119		1.500	PV_C_B222		1.750	PV_E_B403

Dia. D _N	Dia. d ₁	TSS Part No.
2.375	2.250	PV_A_B035
	2.187	PV_B_B139
	2.125	PV_C_B227
	2.000	PV_D_B329
	1.875	PV_E_B404
2.500	2.375	PV_A_B036
	2.312	PV_B_B141
	2.250	PV_C_B228
	2.125	PV_D_B330
	2.000	PV_E_B405
2.625	2.500	PV_A_B037
	2.437	PV_B_B143
	2.375	PV_C_B229
	2.250	PV_D_B331
	2.125	PV_E_B406
2.750	2.625	PV_A_B038
	2.562	PV_B_B145
	2.500	PV_C_B230
	2.375	PV_D_B332
	2.250	PV_E_B407
2.875	2.750	PV_A_B039
	2.687	PV_B_B147
	2.625	PV_C_B231
	2.500	PV_D_B333
	2.375	PV_E_B408
3.000	2.875	PV_A_B040
	2.812	PV_B_B149
	2.750	PV_C_B232
	2.625	PV_D_B334
	2.500	PV_E_B409
3.125	3.000	PV_A_B041
	2.875	PV_C_B233
	2.750	PV_D_B335
	2.625	PV_E_B410
	3.000	PV_C_B234
3.250	2.875	PV_D_B336
	2.750	PV_E_B411
	3.250	PV_A_B042
3.375	3.125	PV_C_B235
	3.000	PV_D_B337
	2.875	PV_E_B412
	3.250	PV_C_B236
3.500	3.125	PV_D_B338
	3.000	PV_E_B413

Dia. D _N	Dia. d ₁	TSS Part No.
3.625	3.500	PV_A_B043
	3.375	PV_C_B237
	3.250	PV_D_B339
	3.125	PV_E_B414
3.750	3.500	PV_C_B238
	3.375	PV_D_B340
	3.250	PV_E_B415
3.875	3.750	PV_A_B044
	3.625	PV_C_B239
	3.500	PV_D_B341
	3.375	PV_E_B416
4.000	3.750	PV_C_B240
	3.625	PV_D_B342
	3.500	PV_E_B417
4.125	4.000	PV_A_B045
	3.875	PV_C_B241
	3.750	PV_D_B343
	3.625	PV_E_B418
4.250	4.000	PV_C_B242
	3.875	PV_D_B344
	3.750	PV_E_B419
4.375	4.125	PV_C_B243
	4.000	PV_D_B345
	3.875	PV_E_B420
4.500	4.250	PV_C_B244
	4.125	PV_D_B346
	4.000	PV_E_B421
4.625	4.375	PV_C_B245
	4.250	PV_D_B347
	4.125	PV_E_B422
4.750	4.500	PV_C_B246
	4.375	PV_D_B348
	4.250	PV_E_B423
4.875	4.625	PV_C_B247
	4.500	PV_D_B349
	4.375	PV_E_B424
5.000	4.750	PV_C_B248
	4.625	PV_D_B350
	4.500	PV_E_B425
5.250	5.000	PV_C_B250
	4.875	PV_D_B352
	4.750	PV_E_B427
5.500	5.250	PV_C_B252
	5.125	PV_D_B354

Dia. D _N	Dia. d ₁	TSS Part No.
5.500	5.000	PV_E_B429
5.750	5.500	PV_C_B254
	5.375	PV_D_B356
	5.250	PV_E_B431
6.000	5.750	PV_C_B256
	5.625	PV_D_B358
	5.500	PV_E_B433
6.250	6.000	PV_C_B258
	5.875	PV_D_B360
	5.750	PV_E_B435
6.500	6.250	PV_C_B259
	6.000	PV_E_B437
6.750	6.500	PV_C_B260
	6.250	PV_E_B438
7.000	6.750	PV_C_B261
	6.500	PV_E_B439
7.250	7.000	PV_C_B262
	6.750	PV_E_B440
7.500	7.250	PV_C_B263
	7.000	PV_E_B441
7.750	7.500	PV_C_B264
	7.250	PV_E_B442
8.000	7.750	PV_C_B265
	7.500	PV_E_B443
8.250	8.000	PV_C_B266
	7.750	PV_E_B444
8.500	8.250	PV_C_B267
	8.000	PV_E_B445
9.000	8.750	PV_C_B269
	8.500	PV_E_B446
9.500	9.000	PV_E_B447
10.000	9.500	PV_E_B448
10.500	10.000	PV_E_B449
11.000	10.500	PV_E_B450
11.500	11.000	PV_E_B451
12.000	11.500	PV_E_B452
12.500	12.000	PV_E_B453
13.000	12.500	PV_E_B454
13.500	13.000	PV_E_B455
14.000	13.500	PV_E_B456
14.500	14.000	PV_E_B457
15.000	14.500	PV_E_B458
15.500	15.000	PV_E_B459
16.000	15.500	PV_E_B460

Figures in bold are standard sizes.

■ **Installation Recommendations for Metric / Piston Seals - Types M2, M2S, W and H**

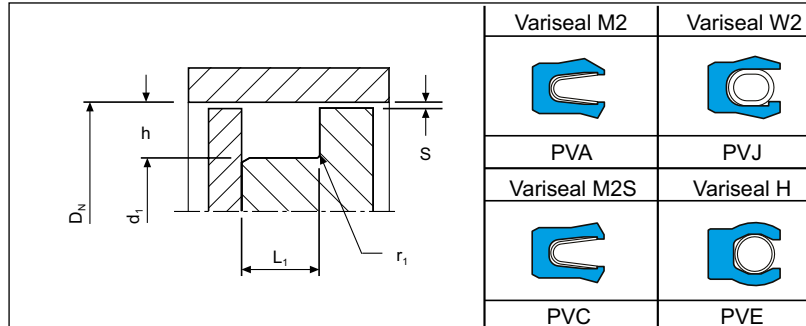


Figure 117 Installation drawing

Table 115 Installation Dimensions - Metric

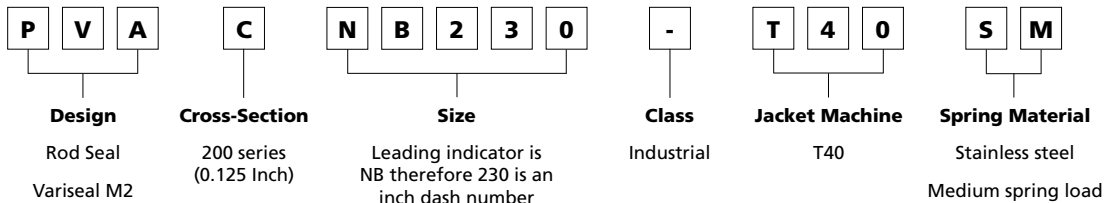
Series Number for Types				Bore Diameter D _N H9		D _N	L ₁	r ₁	Maximum Extrusion Gap at			
M2	M2S	W2	H	Standard Range	Extended Range ¹⁾	Groove Diameter	Groove Width	Radius	2 MPa	10 MPa	20 MPa	40 MPa
						h9	(+0.2)	(Max)				
PVA0	PVC0	PVJ0	PVE0	6.0 - 13.9	6.0 - 40.0	d - 2.9	2.4	0.4	0.20	0.10	0.08	0.05
PVA1	PVC1	PVJ1	PVE1	14.0 - 24.9	10.0 - 200.0	d - 4.5	3.6	0.4	0.25	0.15	0.10	0.07
PVA2	PVC2	PVJ2	PVE2	25.0 - 45.9	16.0 - 400.0	d - 6.2	4.8	0.6	0.35	0.20	0.15	0.08
PVA3	PVC3	PVJ3	PVE3	46.0 - 124.9	28.0 - 700.0	d - 9.4	7.1	0.8	0.50	0.25	0.20	0.10
PVA4	PVC4	PVJ4	PVE4	125.0 - 999.9	45.0 - 1600.0	d - 12.2	9.5	0.8	0.60	0.30	0.25	0.12
PVA5	PVC5	PVJ5	PVE5	1000.0 - 2500.0	100.0 - 2500.0	d - 19.0	15.0	0.8	0.90	0.50	0.40	0.20

¹⁾ Available on request

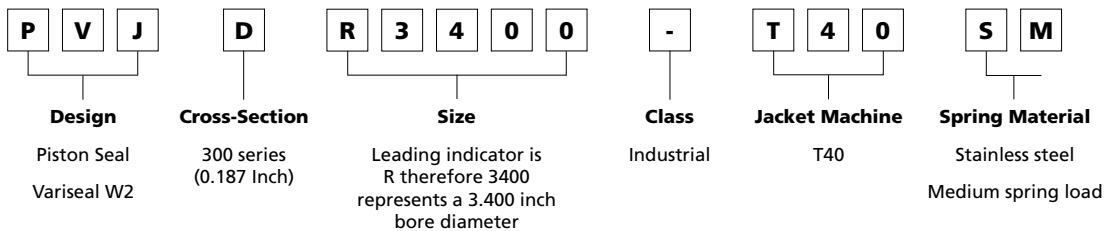
Table 116 Part Number System for Metric Piston Variseal

Article Code	Cross-Section	Size	Class	Seal Material	Spring Material	Spring Load
PVA Variseal M2	Inch		- Industrial	T01	S Stainless Steel	Standard load for each design
PVC Variseal M2S	A 0.062	NBxxx Inch Dash #		T05	H Hastelloy	
PVE Variseal H	B 0.093	Rxxxx Bore dia <10.0 Inch)		T07	E Elgiloy	
PVJ Variseal W2	C 0.125			T12		
	D 0.187	Kxxxx Bore dia. >= 1000		T24		PVA & PVC M Medium R Hi Clean
	E 0.250	(dia x 1.0)		T40		
	G 0.375			T78		
	Metric			Z48		
	0 1.45	Oxxxx Bore dia <1000		Z80		PVE H Heavy PVJ M Medium
	1 2.25	(dia x 10.0)				
	2 3.10	Xxxxx Bore dia. >= 1000				
	3 4.70	(dia x 1.0)				
	4 6.10			See Table 16 for material description		
	5 9.50					

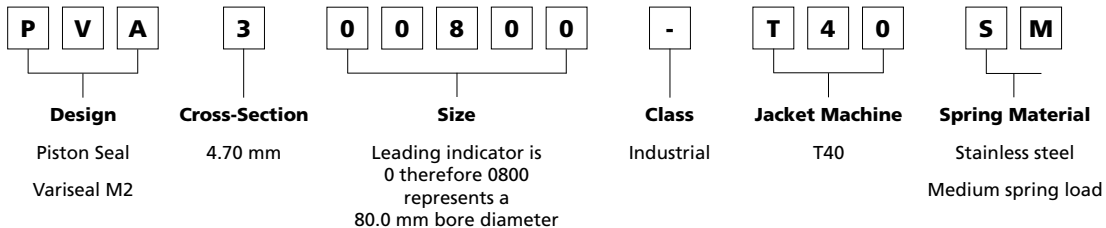
Ordering Example 1



Ordering Example 2



Ordering Example 3



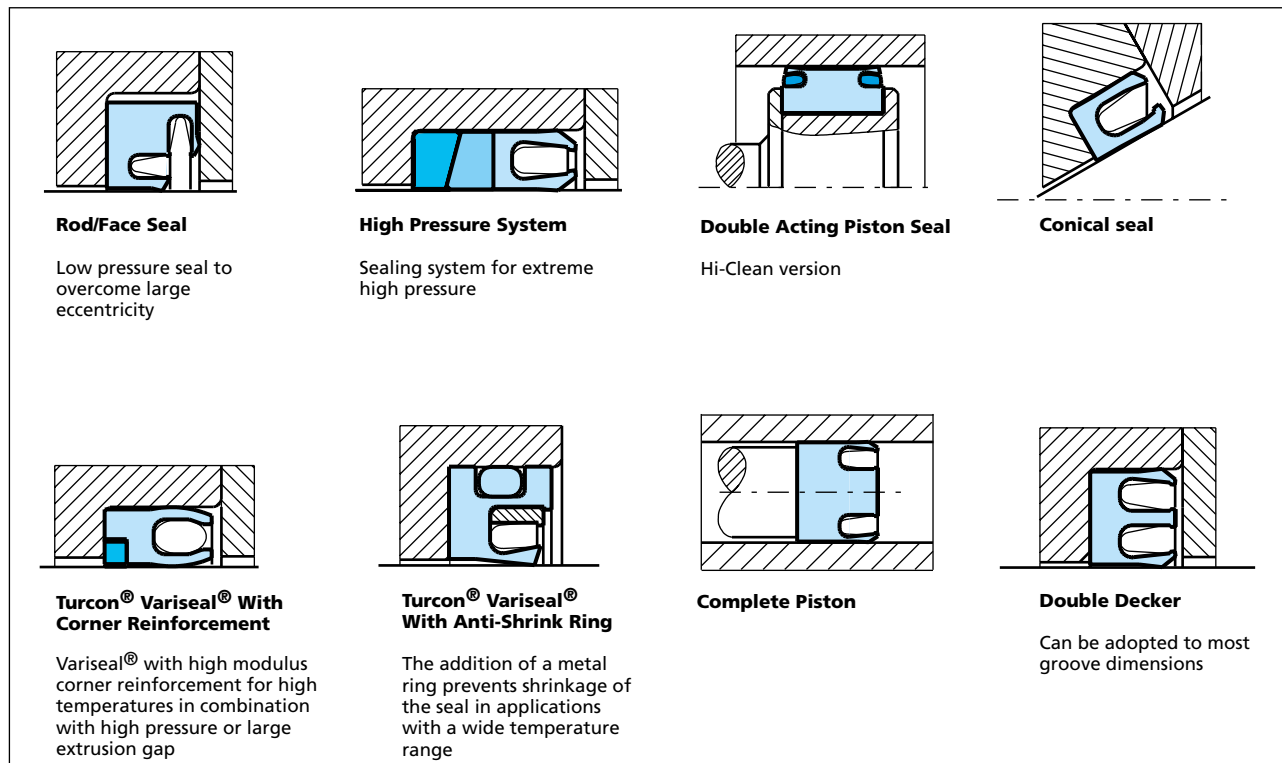


Figure 118 Customized designs

Turcon® Excluder®



Features and benefits

Prevents ingress of contaminants into sealing systems

Protects sealing systems from damage by contaminants

Can act as a secondary sealing element

Available for all diameters up to 102 inch / 2600 mm

Very good media resistance and compatibility

Space-saving construction

Very good scraping effect against outside contaminants, even when firmly adhered

Very good scraping effect from the inside against the residual oil film adhering to the surface of the piston rod

Can compensate for minor deflections of the piston rod or plunger

Outstanding sliding properties

Stick-slip-free, no sticking

Reduces rod scoring

Low-friction

Long service life

■ Turcon® Excluder® 2

Description

The Turcon® Excluder® 2 is a double-acting scraper with two geometrically different scraper lips which are installed back-to-back. The Excluder® 2 is always installed together with an elastomer O-Ring in one groove. The scraper function is performed by the Excluder® 2. The O-Ring maintains the pressure of the scraper lips against the sliding surface and can compensate for minor deflections of the rod.

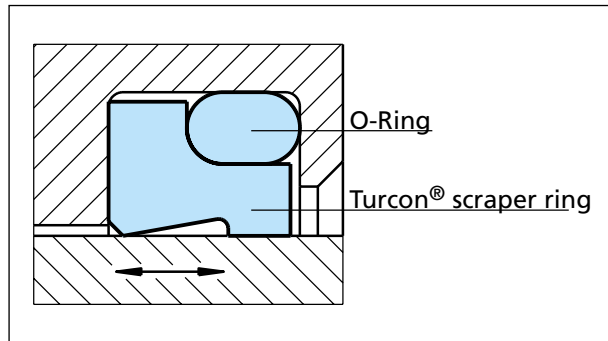


Figure 119 Turcon® Excluder® 2

Excluder® 2 has two functions:

- To scrape contaminants from the retracting rod and thus to protect the system from contamination
- To hold back the residual oil film on the extending rod on the medium side.

The Excluder® 2 is used in conjunction with our rod seals Turcon® Stepseal® 2K, i.e. seals with hydrodynamic back pumping function.

Technical Data

Operating conditions:

Speed: up to 50 ft/s / 15 m/s for Turcon® materials

up to 6.5 ft/s / 2 m/s for Zurcon® materials

Temperature: -49 °F to +392 °F / -45 °C to +200°C (depending on O-Ring materials)

Media: Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), water, air and others, depending on the O-Ring material compatibility.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendation for Rod - Inch sizes

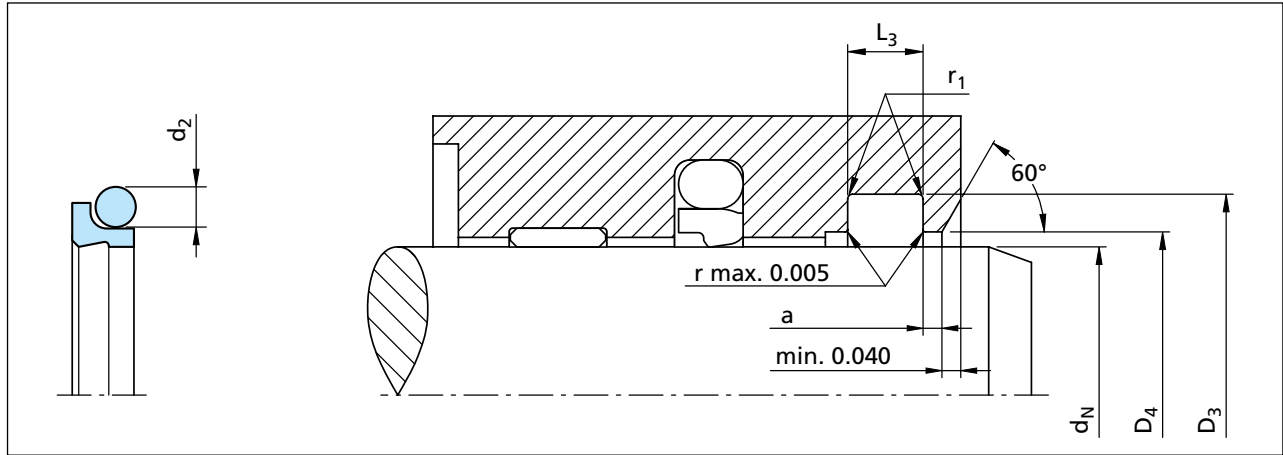


Figure 120 Installation drawing

Table 117 Installation Recommendations - Inch

Series No.	Rod Diameter d_N f8/h9		Groove Diameter D_3 H9	Groove Width L_3 +.008	Bore Diameter D_4 H11	Step Width a min.	Radius r_1	O-Ring Cross-Section d_2
	Recommended Range	Available Range						
WE20	.313 - .499	.313 - 5.125	$d_N + .190$	.146	$d_N + .060$	.079	.015	.070
WE21	.500 - 2.499	.375 - 9.625	$d_N + .270$	.196	$d_N + .060$	.118	.015	.103
WE22	2.500 - 9.999	1.000 - 15.750	$d_N + .345$	.236	$d_N + .060$	.150	.015	.139
WE23	10.000 - 16.999	1.625 - 25.750	$d_N + .480$	.332	$d_N + .080$	.150	.035	.210
WE24	17.000 - 19.999	4.375 - 25.750	$d_N + .630$	.434	$d_N + .080$	.150	.035	.275

For diameters > 15.7 inches (400 mm) we recommend the use of Turcon® Excluder® 5.

Ordering Example

Turcon® Excluder® 2 complete with O-Ring in NBR, standard application:

Series: WE22 from Table 117
Rod diameter: $d_N = 2.500$ inches
TSS Part No.: WE2202500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.

- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.

- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	WE22	02500	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Recommendation for Rod - Metric sizes

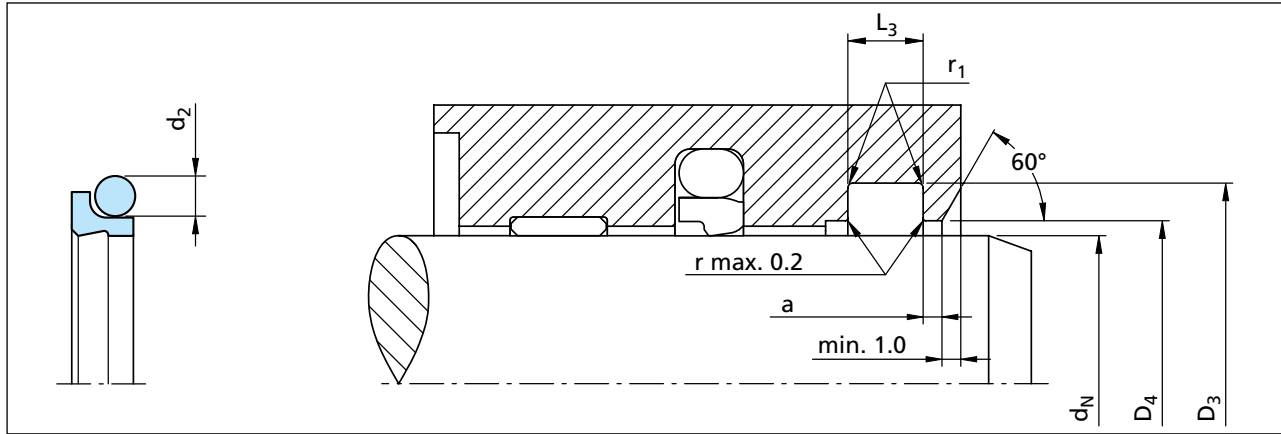


Figure 121 Installation drawing

Table 118 Installation Dimensions - Metric

Series No.	Rod Diameter d_N f8/h9		Groove Diameter D_3 H9	Groove Width L_3 +0.2	Bore Diameter D_4 H11	Step Width a min.	Radius r_1	O-Ring Cross-Section d_2
	Recommended Range	Available Range						
WE30	4.0 - 11.9	4.0 - 130.0	$d_N + 4.8$	3.7	$d + 1.5$	2.0	0.4	1.78
WE31	12.0 - 64.9	10.0 - 245.0	$d_N + 6.8$	5.0	$d + 1.5$	2.0	0.8	2.62
WE32	65.0 - 250.9	25.0 - 400.0	$d_N + 8.8$	6.0	$d + 1.5$	3.0	1.0	3.53
WE33	251.0 - 420.9	40.0 - 655.0	$d_N + 12.2$	8.4	$d + 2.0$	4.0	1.5	5.33
WE34	421.0 - 650.9	110.0 - 655.0	$d_N + 16.0$	11.0	$d + 2.0$	4.0	1.5	7.00
WE35	651.0 - 999.9	140.0 - 999.9	$d_N + 20.0$	14.0	$d + 2.5$	5.0	2.0	8.40
WE35X	≥ 1000.0		$d_N + 20.0$	14.0	$d + 2.5$	5.0	2.0	8.40

For diameters > 400 mm we recommend the use of Turcon® Excluder® 5.

Ordering Example

Turcon® Excluder® 2 complete with O-Ring in NBR, standard application:

Series: WE31 from Table 118
 Rod diameter: $d_N = 50.0$ mm
 TSS Part No.: WE3100500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.

TSS Article No.	WE31	0	0500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10*						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

* For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

■ Turcon® Excluder® 5

Description

The Turcon® Excluder® 5 is a patented double-acting scraper with two geometrically different scraper lips which are installed back-to-back. The scraper is installed together with an O-Ring elastomer energizing element in one groove. The scraper function is performed by the Excluder® 5. The O-Ring maintains the pressure of the scraper lips against the sliding surface and can compensate for minor deflections of the rod.

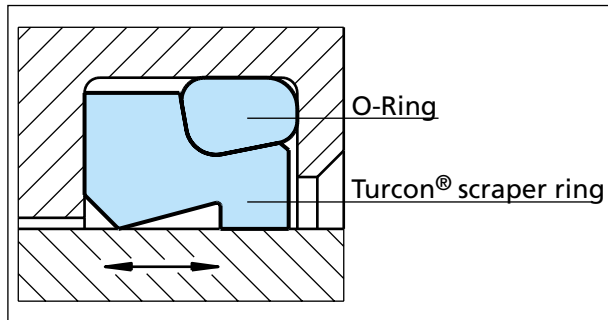


Figure 122 Turcon® Excluder® 5

Excluder® 5 has two functions:

- Scrape contaminants from the retracting rod and thus to protect the system from contamination
- Hold back the residual oil film on the extending rod on the medium side.

The Excluder® 5 is used in conjunction with our rod seals Turcon® Stepseal® 2K, i.e. seals with a hydrodynamic back pumping function. In contrast to the Excluder® 2, they are used particularly for heavy-duty applications such as in tensioner cylinders, downhole tools, mud applications, etc.

Technical Data

Operating conditions:

Speed:	up to 50 ft/s / 15 m/s for Turcon® materials
	up to 6.5 ft/s / 2 m/s for Zurcon® materials
Temperature:	-49 °F to +392 °F / -45°C to +200 °C (depending on O-Ring material)
Media:	Mineral oil-based hydraulic fluids, flame retardant hydraulic fluids, environmentally safe hydraulic fluids (bio-oils), water, air and others, depending on the scraper and O-Ring material compatibility.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

■ Installation Recommendation for Rod - Inch sizes

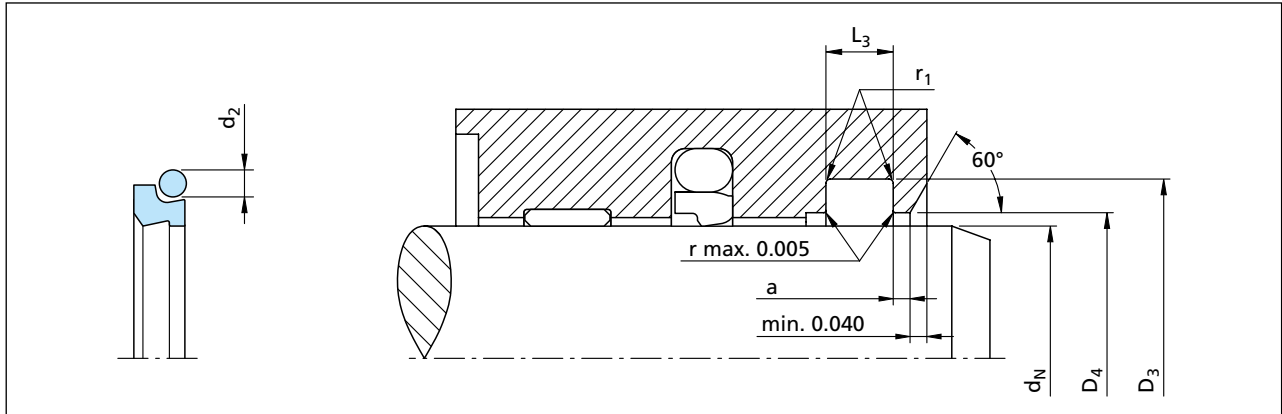


Figure 123 Installation drawing

Table 119 Installation Recommendations - Inch

TSS Series No.	Rod Diameter d_N f8/h9		Groove Diameter	Groove Width	Bore Diameter	Step Width	Radius	O-Ring Cross-Section
	Recommended Range	Available Range	D_3 H9	$L_3 +.008$	D_4 H11	a min	r_1	d_2
WEE1	1.500 - 2.749	1.188 - 7.875	$d_N + .346$	.248	$d_N + .060$	.079	.015	.103
WEE2	2.750 - 5.499	2.750 - 14.188	$d_N + .480$	.319	$d_N + .080$	.118	.015	.139
WEE3	5.500 - 15.749	4.000 - 25.500	$d_N + .630$	.374	$d_N + .100$	.150	.035	.210
WEE4	15.750 - 25.500	7.875 - 25.500	$d_N + .945$	.551	$d_N + .100$	.150	.035	.275

Ordering Example

Turcon® Excluder® 5 with O-Ring in NBR, standard application:

Series: WEE1 from Table 119
Rod diameter: $d_N = 2.500$ inches
TSS Part No.: WEE102500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings.

When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.

- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	WEE1	02500	-	M12	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Recommendation for Rod - Metric sizes

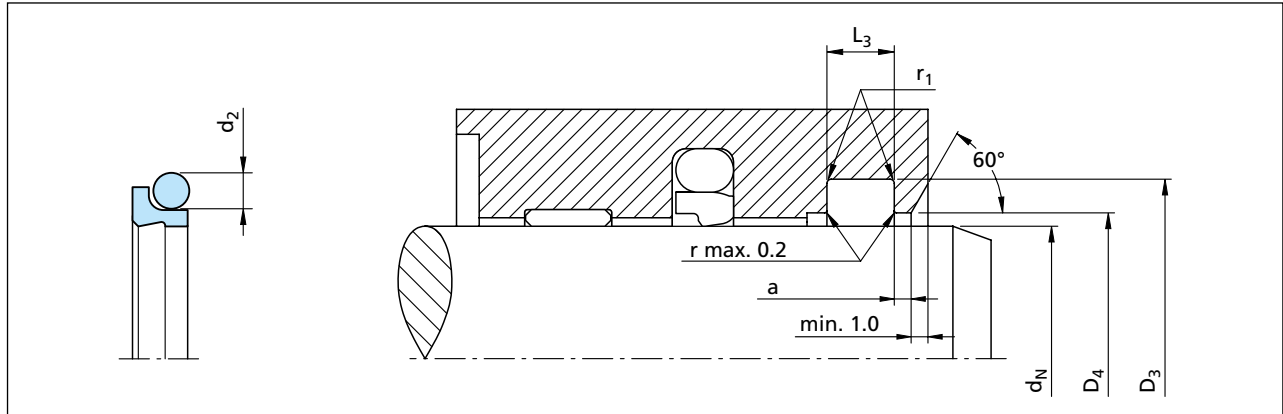


Figure 124 Installation Drawing

Table 120 Installation Dimensions - Metric

Series No.	Rod Diameter d_N f8/h9		Groove Diameter	Groove Width	Bore Diameter	Step Width	Radius r_1	O-Ring Cross-Section d_2
	Recommended Range	Available Range	D_3 H9	$L_3 +0.2$	D_4 H11	a min		
WE50	19.0 - 39.9	19.0 - 100.0	$d_N + 7.6$	4.2	$d + 1.5$	3.0	0.8	2.62
WE51	40.0 - 69.9	30.0 - 200.0	$d_N + 8.8$	6.3	$d + 1.5$	3.0	0.8	2.62
WE52	70.0 - 139.9	70.0 - 360.0	$d_N + 12.2$	8.1	$d + 2.0$	4.0	1.0	3.53
WE53	140.0 - 399.9	100.0 - 650.0	$d_N + 16.0$	9.5	$d + 2.5$	5.0	1.5	5.33
WE54	400.0 - 649.9	200.0 - 650.0	$d_N + 24.0$	14.0	$d + 2.5$	8.0	1.5	7.00
WE55	650.0 - 999.9	400.0 - 999.9	$d_N + 27.3$	16.0	$d + 2.5$	10.0	2.0	8.40
WE55X	≥ 1000		$d_N + 27.3$	16.0	$d + 2.5$	10.0	2.0	8.40

Ordering Example

Turcon® Excluder® 5 with O-Ring in NBR, standard application

Series: WE51 from Table 120
Rod diameter: $d_N = 50.0$ mm
TSS Part No.: WE5100500

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

Notes:

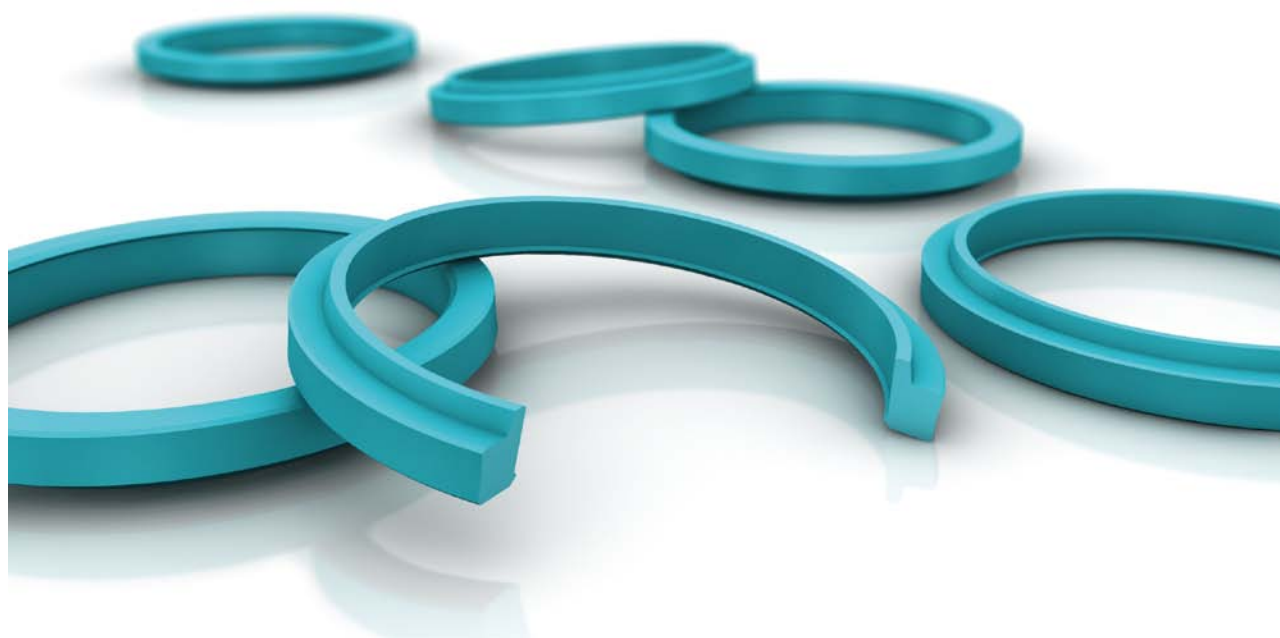
- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings.

When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.

TSS Article No.	WE51	0	0500	-	M12	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10*						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

* For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

Zurcon® Scraper WAE



Features and benefits

Simple groove design

Very good scraping effect, wear-resistant

No tilting or twisting in the groove

Simple installation

Flush fitting with the outer surface

Low friction

Zurcon® Scraper WAE

Description

The WAE is a single-acting scraper.

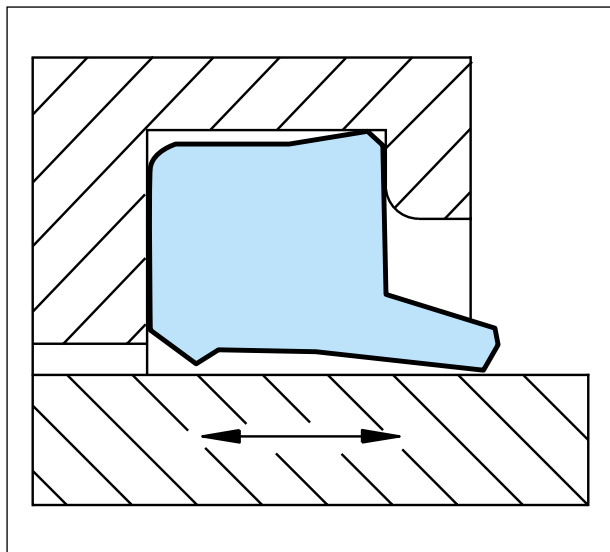


Figure 125 Scraper WAE

The special feature of this scraper is an additional support on the inner surface. It prevents tilting or twisting of the scraper in the groove. At the same time this support improves the firm seating in the groove, preventing the ingress of contaminants via the back of the scraper. This represents a technical improvement compared to similar scraper types.

Technical Data

Velocity: up to 3 ft/s (1 m/s)

Temperature: -40 °F to +275 °F / -40 °C to +135 °C depending on material. Please contact your local Trelleborg Sealing Solutions marketing company for more information.

Media: Mineral oil-based hydraulic fluids

Important Note:

The above data are maximum values and cannot be used at the same time. e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also dependent on medium.

Material

The standard material is a wear-resistant Zurcon®.

Standard material: Zurcon® Z48 or Zurcon® Z80

■ Installation Recommendation for Rod - Inch sizes

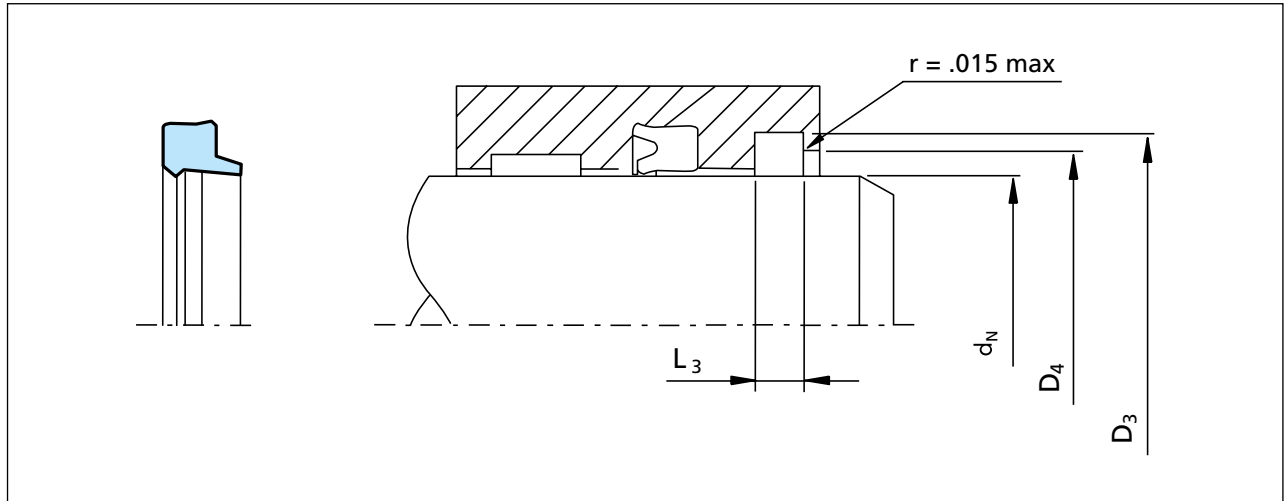


Figure 126 Installation drawing

Table 121 Installation Dimensions - Inch

TSS Series	Rod Diameter d_N f8/h9	Groove Diameter	Relief Diameter	Groove Width
		D_3 H9	D_4 H11	$L_3 + .015$
WAE1	.250 - .687	$d_N + .250$	$d_N + .160$	.125
WAE2	.688 - 1.999	$d_N + .375$	$d_N + .240$	.187
WAE3	2.000 - 4.375	$d_N + .500$	$d_N + .325$	.250
WAE4	3.625 - 4.375	$d_N + .625$	$d_N + .405$	.312
WAE5	4.376 - 8.000	$d_N + .750$	$d_N + .485$	.375
WAE6	7.000 - 10.000	$d_N + 1.000$	$d_N + .650$	.500

Ordering Example

Scraper WAE

Rod diameter: $d_N = 2.500$ inches

TSS Part No.: WAE302500 from Table 121

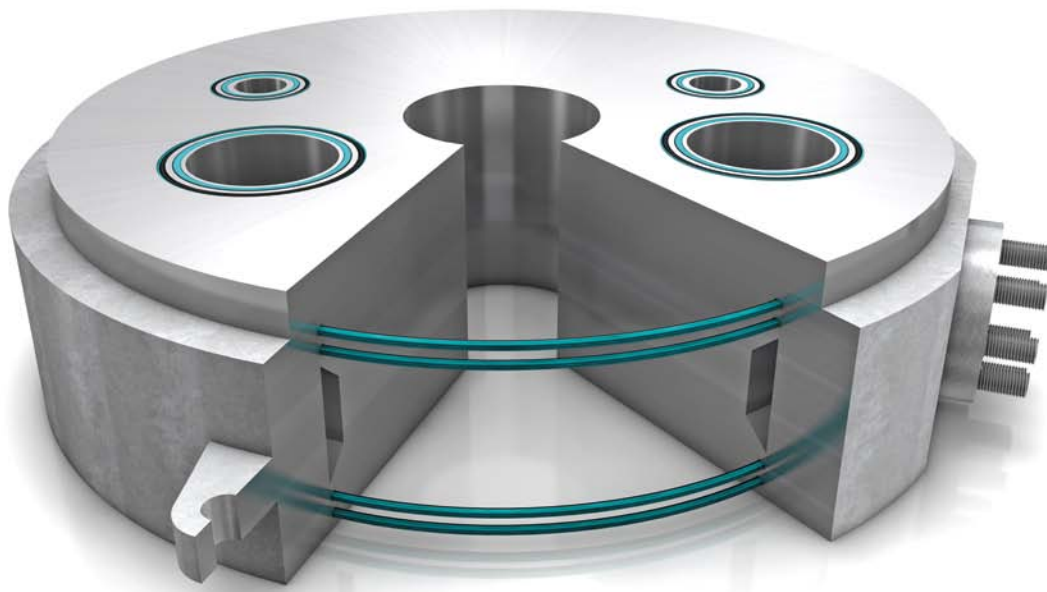
Material: Z80

Note:

There are no standard metric equivalent sizes. Please contact your local Trelleborg Sealing Solutions marketing company for metric size requests.

TSS Article No.	WAE3	02500	-	Z80
TSS Series No.				
Rod diameter x 1000				
Quality Index				
Material Code				

Rotary Seals



Specialized High-Performance Rotary Sealing Products

When it comes to successfully sealing in rotary applications, specialized products are required. Trelleborg Sealing Solutions offers a range of unique options, both standard and custom, that give exceptional performance characteristics in demanding rotary situations.

Within oil & gas applications the most commonly used types are Turcon® Roto Glyd Ring®, Turcon® Varilip® PDR and Turcon® Roto Variseal®. One of these options can provide the optimum solution for your rotary sealing requirements.

The demanding environment of oil field equipment, especially downhole tools, mean that seals are exposed to drilling mud and other abrasive media. To deal with this seals need to have superior scraping or wiping ability.

Trelleborg Sealing solutions offer a range of products for rotary applications incorporating scrapers and wipers. Due to variations in speed and temperature, contact your local Trelleborg Sealing Solutions marketing company to identify the optimum seal geometry for your particular application.

Rotary Seals

■ Critical Factors in Seal Selection

To ensure long seal life, several factors must be considered in selection of the optimum material for the elastomer or polymer element.

Chemical Compatibility

Seal materials must be compatible with system media, in particular with drilling muds, hydraulic fluids and downhole fluids.

The various media used in rotary applications have differing effects on elastomers. In oil & gas applications these are primarily hydrocarbon and synthetic hydrocarbon based oils and muds. Trelleborg Sealing Solutions offers materials that will give optimized performance in contact with this media. Turcon® PTFE based compounds are compatible with virtually all media.

Temperature Resistance

The aging of elastomers has a significant effect on their useful life and higher temperatures accelerate the aging of these materials. Elastomers can become hard and brittle, elongation may decrease and compression set increase. Axial cracks at the sealing edge are a typical indication that the seal has been exposed to excessively high temperature.

Turcon® PTFE based compounds are capable of operating at higher temperatures than elastomers.

For guidance on temperature limits for different materials, see the Quick Reference Guide.

Eccentricity

The graph below shows the maximum recommended operating envelope for various elastomer sealing materials and for Turcon® Varilip® PDR. The levels of eccentricity should be kept within the limits shown. In order to achieve a uniform radial load of the sealing lip on the shaft, the best possible coaxiality, or static offset, should be maintained between the housing bore and the shaft, as shown in the second graph below.

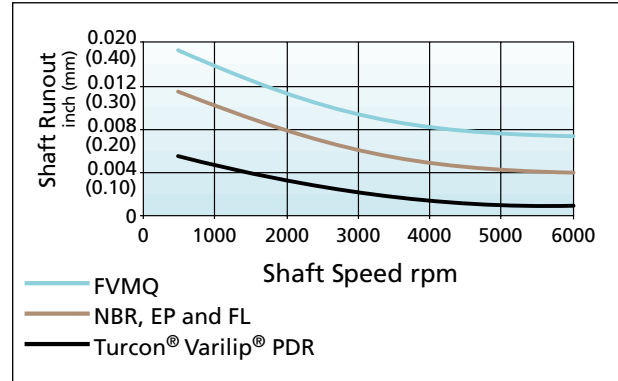


Figure 127 Dynamic Eccentricity Capability

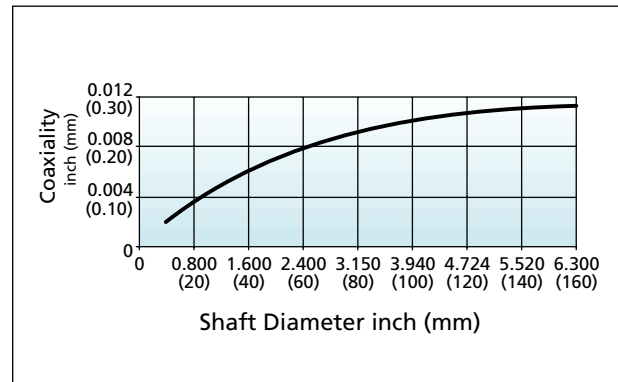


Figure 128 Coaxial Tolerance Capabilities

Surface Finish Recommendations

It is important to control the shaft preparation for rotary applications and to ensure the desired non-orientation of the shaft surface finish as it relates to sealing. The recommended shaft condition is to have no machining leads and be free from scratches, nicks or defects as well as any contamination.

Plunge grinding is recommended for the finishing process. This gives short to medium grind marks which are good for lip lubrication. It also produces a lay that is perpendicular to the shaft axis with no lead angle. Additionally, there should be traversing during the plunge grinding process to eliminate any smear or detrimental patterns on the shaft.

Surface hardness is recommended to be 55 HRc, hardness depth minimum .012 in / 0.3 mm. In certain circumstances such as low circumferential velocity, good lubrication and no contamination, surfaces with hardness levels below 55 HRc are suitable.

Table 122 Surface Finish Recommendations

Measurement	Standard Recommendation
Ra	< 8 µin / < 0.2 µm
Rz (Rtm)	39 -157 µin max. 1.0 - 4.0 µm max.
Tp (Mr)	50 - 90% @ depth of p = 0.25 Rz (Rtm) relative to reference line = 5 %
Rsk	-0.1 to -3

Turcon® Roto Glyd Ring®



Features and benefits

Available for rod or piston sealing applications

For use at high-pressure and low rotary speeds

Low friction

Stick-slip-free starting

High abrasion resistance and dimensional stability

Simple groove design, narrow space-saving groove dimensions

Lubricant reservoir

Available in a wide range of standard and custom sizes

Unidirectional or bidirectional seal

Turcon® Roto Glyd Ring®

Description

The double-acting Turcon® Roto Glyd Ring® is used to seal rods, shafts, axles, bores, rotary manifolds, journals and swivels with rotary, helical or oscillating movement. It consists of a seal ring in high-grade Turcon® material activated by an elastomer O-Ring.

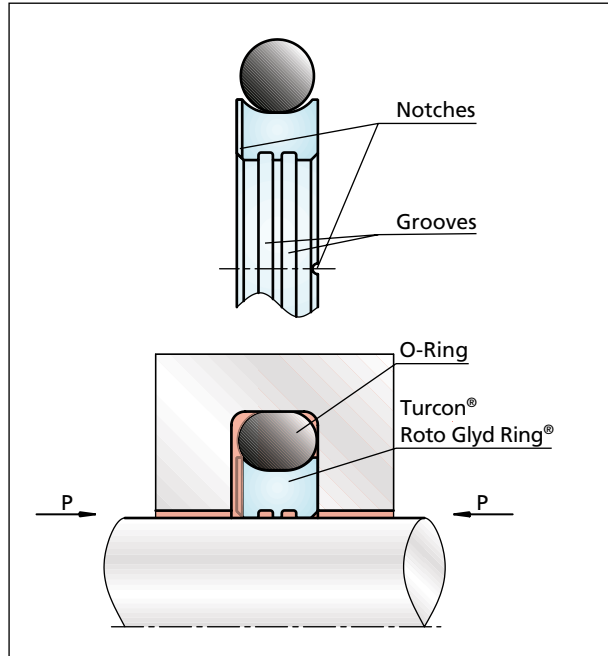


Figure 129 Turcon® Roto Glyd Ring®

The contact surface profile of the seal ring is specially designed for use at high-pressure and low sliding speeds.

Method of Operation

Depending on the cross section profile of the seal, the contact surface has one or two continuous machined grooves. These improve seal efficiency by increasing the specific surface load pressure against the sealed surface. They also form a lubricant reservoir and reduce friction.

In order to improve the pressure activation of the O-Ring, the Roto Glyd Ring® has notched end faces as standard.

The rear face which holds the O-Ring has a concave form. This increases the surface and prevents the seal from turning with the rotating surface.

Advantages

- Available for internal and external sealing application
- Single groove design
- Small groove dimensions
- Low friction
- Stick-slip free operation
- No vulcanizing to mating surfaces

Typical Applications

- FPSO swivel units
- Rotary unions
- Top drives
- Rotary tables
- Rotary steerable tools
- Core cutting equipment

Technical Data

Operation pressure: up to 4,000 psi / 27.5 MPa

Speed: up to 6.5 ft/s / 2.0 m/s

Temperature range: -49 °F to +392 °F /
-45 °C to +200 °C
depending on elastomer
For lower temperature
applications contact your
local Trelleborg Sealing Solutions
marketing company.

Media: Mineral oil-based hydraulic fluids,
flame-retardant hydraulic fluids,
environmentally-safe hydraulic
fluids (bio-oils), water and others,
depending on the elastomer
material

Mating Surface Materials

Sealing of applications with rotating movements requires very good mating surfaces. A minimum hardness of 55 HRC is recommended to a hardening depth of at least .012 in / 0.3 mm.

Coated surfaces must be finished with particular care:

- Chrome-plating must not peel off in service.
- Good heat dissipation must be assured by the coating.

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Frictional Power

Guide values for frictional power can be determined from the graph below. They are shown as a function of the sliding speed and operating pressure for a shaft diameter of 1.968 in / 50 mm with an oil temperature of +140 °F / +60 °C. At higher temperatures, these application limits must be reduced.

Formula for other diameters:

$$P \cong P_{50} \times \left(\frac{d}{50 \text{ mm}} \right) \text{ [W]}$$

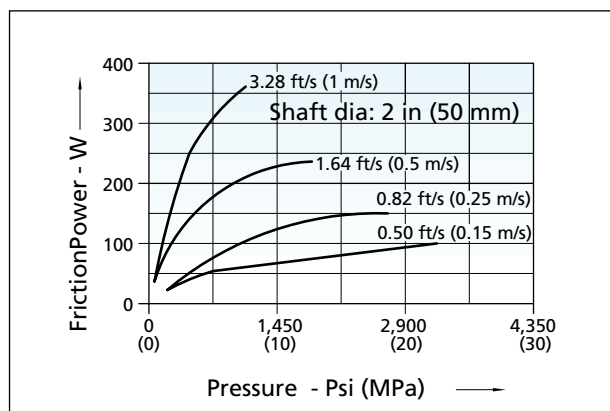


Figure 130 Friction for Turcon® Roto Glyd Ring®

Turcon® Roto Glyd Ring®

■ Installation recommendation for Rod - Inch sizes

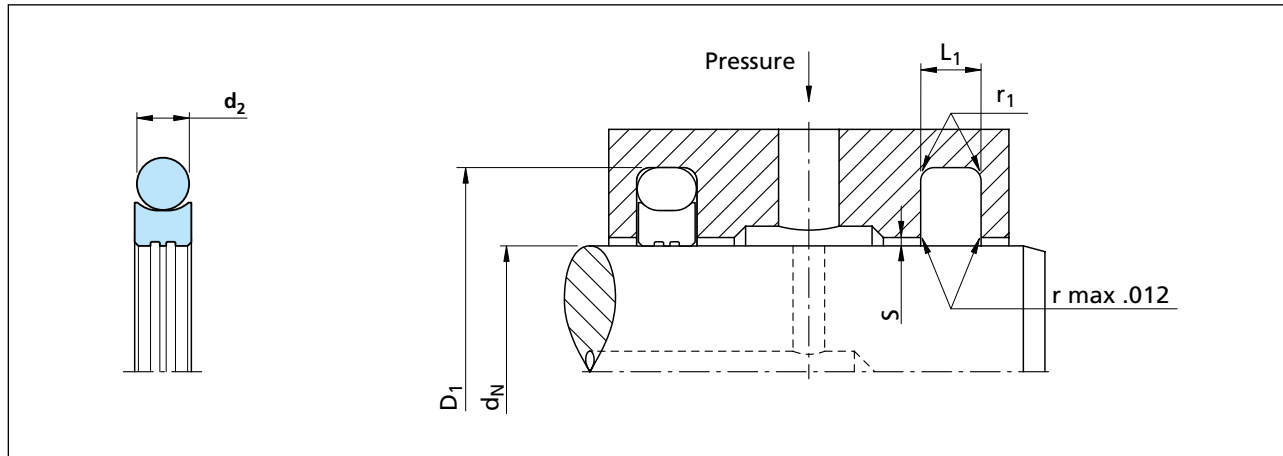


Figure 131 Installation Drawing

Table 123 Installation Recommendations - Inch

Series no.	Rod diameter d_N f8/h9		Groove diameter D_1 H9	Groove width L_1 +.008	Radius r_1	Radial clearance* $S_{max.}$		O-Ring cross sec. d_2	Number of grooves in the sealing surface
	Standard range	Available range				1,000 psi	3,000 psi		
TGR0	.25 - .749	.25 - 5.000	$d_N + .193$	.087	.015	.020	.014	.070	0
TGR1	.750 - 1.499	.375 - 10.000	$d_N + .295$	.126	.015	.030	.020	.103	1
TGR2	1.500 - 7.874	.750 - 18.000	$d_N + .433$	.165	.015	.040	.030	.139	1
TGR3	7.875 - 9.999	1.500 - 26.000	$d_N + .610$	.248	.035	.045	.035	.210	2
TGR4	10.000 - 25.500	4.500 - 26.000	$d_N + .827$	.319	.035	.050	.040	.275	2

* At pressures > **3,000 psi**: Use diameter tolerance H8/f8 (bore / rod) in area of seal.

Ordering Example

Turcon® Roto Glyd Ring®, complete with O-Ring, standard application:

Series: TGR2 from Table 123
Rod diameter: $d_N = 5.000$ inch
TSS Part No.: TGR205000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings.

When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.

- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	TGR2	05000	-	T19	N
Inches					
Series No.					
Rod diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Recommendation for Rod - Metric sizes

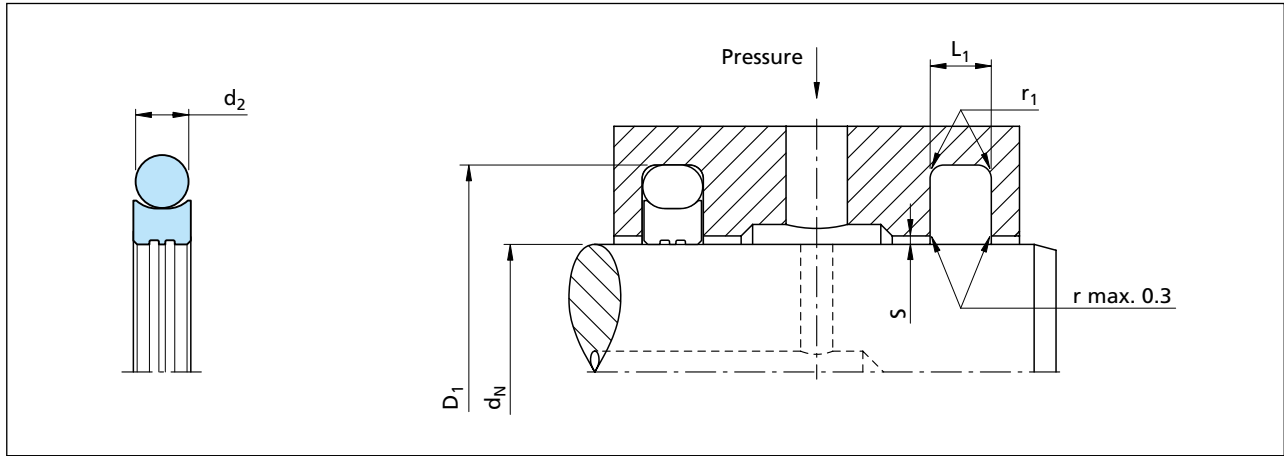


Figure 132 Installation Drawing

Table 124 Installation Recommendations - Metric

Series no.	Rod diameter		Groove diameter	Groove width	Radial clearance S _{max.}		Radius	O-Ring cross sec.	Number of grooves in the sealing surface
	d _N f8/h9				10 MPa	20 MPa			
	Standard range	Available range							
TG30	6 - 18.9	6 - 130.0	d _N + 4.9	2.20	0.15	0.10	0.40	1.78	0
TG31	19 - 37.9	10 - 245.0	d _N + 7.5	3.20	0.20	0.15	0.60	2.62	1
TG32	38 - 199.9	19 - 455.0	d _N + 11.0	4.20	0.25	0.20	1.00	3.53	1
TG33	200 - 255.9	38 - 655.0	d _N + 15.5	6.30	0.30	0.25	1.30	5.33	2
TG34	256 - 649.9	-	d _N + 21.0	8.10	0.30	0.25	1.80	7.00	2
TG35	650 - 999.9	650 - 999.9	d _N + 28.0	9.50	0.45	0.30	2.50	8.40	2
TG35X	1000 - 2500	-	d _N + 28.0	9.50	0.45	0.30	2.50	8.40	2

At pressures > **10 MPa** it is recommendable that for the cross section you choose the next larger profile according to the column "Available range" i.e. for shaft Ø80 mm: TG 33 00 800.

At pressures > **30 MPa**: Use diameter tolerance H8/f8 (bore / rod) in area of seal.

For more information contact your local Trelleborg Sealing Solutions marketing company.

Turcon® Roto Glyd Ring®

Ordering Example

Turcon® Roto Glyd Ring®, complete with O-Ring, standard application:

Series: TG32 from Table 124
Rod diameter: $d_N = 80.0$ mm
TSS Part No.: TG3200800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	TG32	0	0800	-	T19	N
Metric						
Series No.						
Type (Standard)						
Rod diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

■ Installation recommendation for Piston - Inch sizes

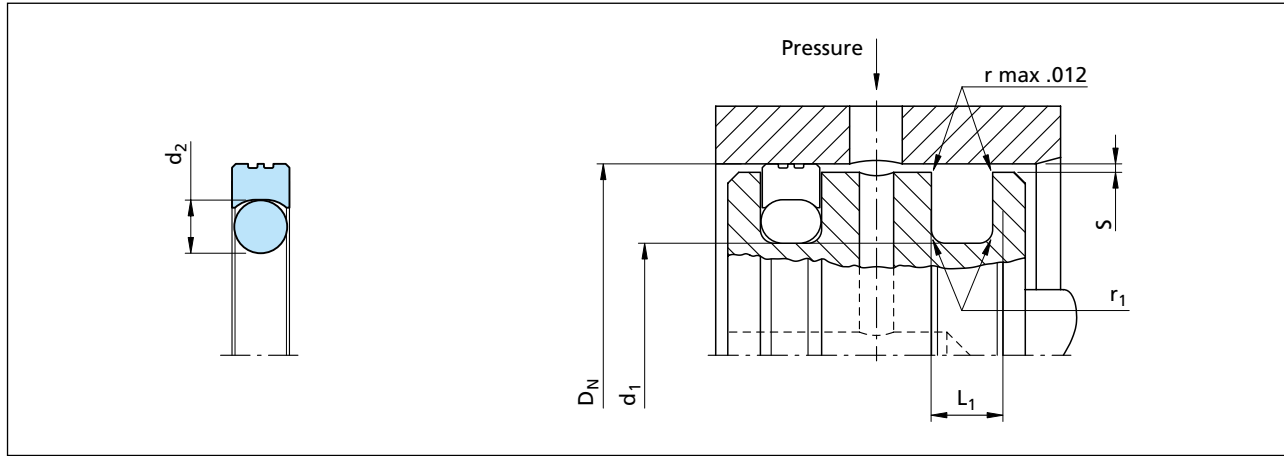


Figure 133 Installation Drawing

Table 125 Installation Recommendations - Inch

Series no.	Bore diameter		Groove diameter d ₁ h9	Groove width L ₁ +.008	Radius r ₁	Radial clearance*		O-Ring cross sec. d ₂	Number of grooves in the sealing surface
	D _N H9					S _{max.}			
	Standard range	Available range				1,000 psi	3,000 psi		
TGP0	.375 - 1.563	.375 - 5.000	D _N - .193	.087	.015	.020	.014	.070	0
TGP1	1.564 - 2.999	1.000 - 10.000	D _N - .295	.126	.015	.030	.020	.103	1
TGP2	3.000 - 5.249	2.000 - 18.000	D _N - .433	.165	.015	.040	.030	.139	1
TGP3	5.250 - 12.999	3.000 - 26.000	D _N - .610	.248	.035	.045	.035	.210	2
TGP4	13.000 - 26.375	5.500 - 27.000	D _N - .827	.319	.035	.050	.040	.275	2

* At pressures > 3,000 psi: Use diameter tolerance H8/f8 (bore / rod) in area of seal.

Turcon® Roto Glyd Ring®

Ordering Example

Turcon® Roto Glyd Ring®, complete with O-Ring, standard application:

Series: TGP2 from Table 125
Rod diameter: $d_N = 5.000$ inch
TSS Part No.: TGP205000

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

Notes:

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	TGP2	05000	-	T19	N
Inches					
Series No.					
Bore diameter x 1000					
Quality Index (Standard)					
Material Code (Seal Ring)					
Material Code (O-Ring)					

■ Installation Recommendation for Piston - Metric sizes

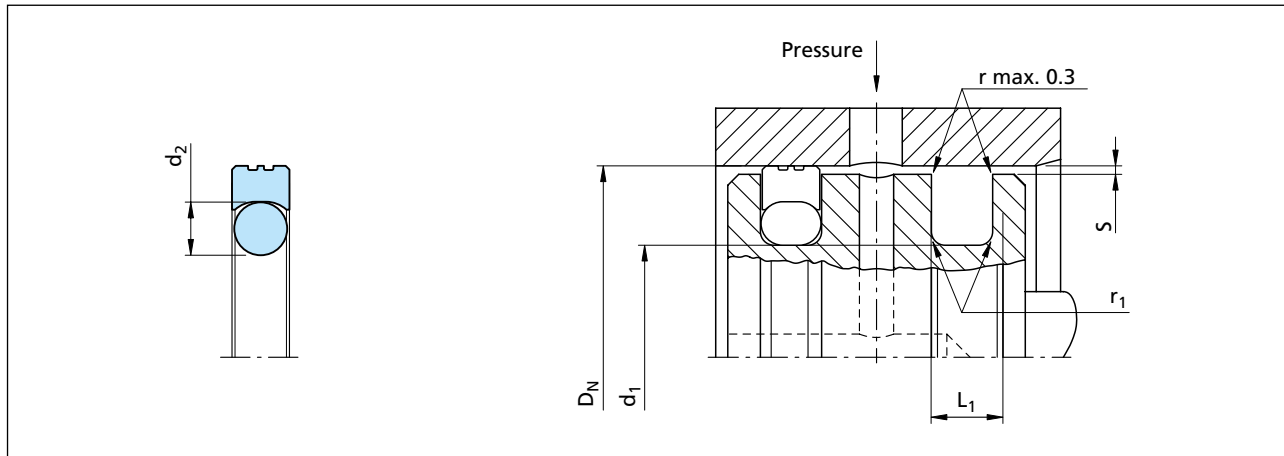


Figure 134 Installation Drawing

Table 126 Installation Dimensions - Metric

Series no.	Bore diameter D_N H9		Groove diameter	Groove width	Radius	Radial clearance* $S_{max.}$ *		O-Ring cross sec.	Number of grooves in the sealing surface
	Standard range	Available range	d_1 h9	$L_1 + 0.2$	r_1	10 MPa	20 MPa	d_2	
TG40	8 - 39.9	8 - 135.0	$D_N - 4.9$	2.20	0.40	0.15	0.10	1.78	0
TG41	40 - 79.9	14 - 250.0	$D_N - 7.5$	3.20	0.60	0.20	0.15	2.62	1
TG42	80 - 132.9	22 - 460.0	$D_N - 11.0$	4.20	1.00	0.25	0.20	3.53	1
TG43	133 - 329.9	40 - 675.0	$D_N - 15.5$	6.30	1.30	0.30	0.25	5.33	2
TG44	330 - 669.9	133 - 690.0	$D_N - 21.0$	8.10	1.80	0.30	0.25	7.00	2
TG45	670 - 999.9	-	$D_N - 28.0$	9.50	2.50	0.45	0.30	8.40	2
TG45X	1000 - 2600	-	$D_N - 28.0$	9.50	2.50	0.45	0.30	8.40	2

At pressures > **10 MPa** it is recommended that for the cross section you choose the next larger profile according to the column "Available Range" i.e. for bore Ø80 mm: TG 43 00 800

* At pressures > **20 MPa**: Use diameter tolerance H8/f8 (bore / rod) in area of seal.

For more information contact your local Trelleborg Sealing Solutions marketing company.

Turcon® Roto Glyd Ring®

Ordering Example

Turcon® Roto Glyd Ring®, complete with O-Ring, standard application:

Series: TG42 from Table 126
Bore diameter: DN = 80.0 mm
TSS Part No.: TG4200800

Select the material from Tables 11 to 18. The corresponding code numbers are appended to the TSS Part No. Together they form the TSS Article No.

- 1) Tolerances used are per ISO-286; ISO System of Limits and Fits. The tolerances are converted from metric and rounded to the nearest three decimal places.
- 2) The clearances stated as S in the above table are for when the seal is specified with Slydring® Wear Rings. When not incorporating Slydring® Wear Rings, the diametrical clearance should be reduced.
- 3) Consult your local Trelleborg Sealing Solutions marketing company for diameters that exceed those listed in the above table.

TSS Article No.	TG42	0	0800	-	T19	N
Metric						
Series No.						
Type (Standard)						
Bore diameter x 10						
Quality Index (Standard)						
Material Code (Seal Ring)						
Material Code (O-Ring)						

Turcon® Roto Variseal®



Features and benefits

Suitable for rotary, reciprocating and static service

Remains tight in the groove even when subject to oscillating or helical movements

Low coefficient of friction

Protects against mechanical torsion

Good scraping effect

Stick-slip-free operating for precise control

High abrasion resistance and dimensional stability

Withstands rapid changes in temperature

Protects against mechanical torsion

Excellent resistance to aging

Unlimited shelf life

Unidirectional seal

Anti-rotation flange secures seal in hardware

Turcon® Roto Variseal®

Description

Turcon® Roto Variseal® is excellent in rotary, reciprocating and static applications, when there is a need to lock the seal in the groove.

The standard Variseal® for rotary applications, Turcon® Roto Variseal® is a single acting seal consisting of a U-shaped jacket and a V-shaped corrosion resistant spring.

Turcon® Roto Variseal® has a flanged heel, which prevents the seal from rotating in the groove and a short heavy dynamic lip that reduces friction. This gives a long service life and good scraping ability, even in media of high viscosity.

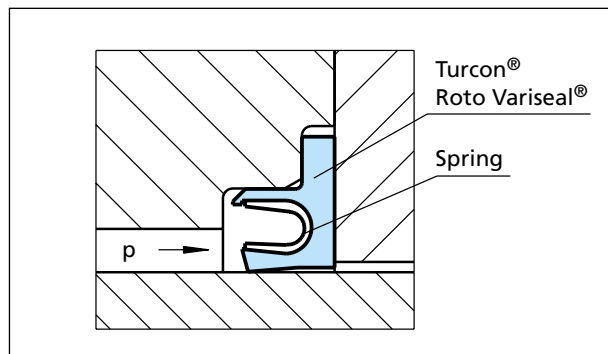


Figure 135 Turcon® Roto Variseal®

Technical Data

Operating pressure:	Maximum dynamic load: 2,900 psi / 20 MPa Maximum static load: 3,626 psi / 25 MPa
Speed:	Reciprocating up to 33 ft/s / 10 m/s, Rotating up to 6.5 ft/s / 2 m/s
Temperature:	-76 °F to +392 °F / -60 °C to +260 °C
Media compatibility:	Virtually all fluids, chemicals and gases

Important Note:

The above data are maximum values and cannot be used at the same time, e.g. the maximum operating speed depends on material type, pressure, temperature and gap value. Temperature range also depends on the media.

Areas of Application

- Rotary shafts on general hydraulic applications
- Rotating and pivoting arms
- Gearbox shafts
- Drive shafts on ROV's.
- Rotary BOP applications
- Rotary hydraulic manifolds
- Rotating heads

Frictional Force

Indicative values for frictional force are included in figure below. Frictional force is given as a function of sliding speed and operating pressure for a shaft diameter of 2 in / 50 mm at an oil temperature of +140 °F / 60°C. The operating limits are lower at higher temperatures.

Indicative values for other shaft diameters can be calculated from the formula:

$$P \equiv P_{50} \times \left(\frac{d}{50 \text{ mm}} \right) \text{ [W]}$$

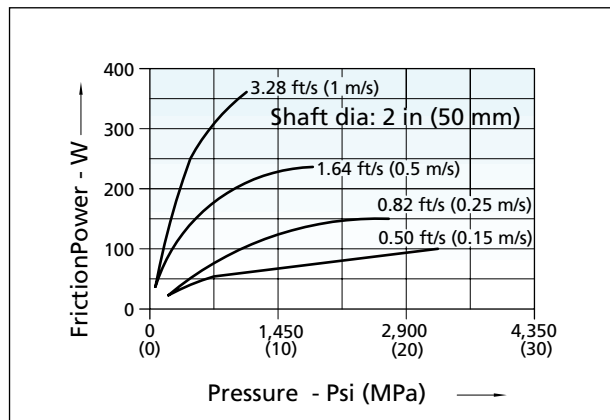


Figure 136 Frictional Force for Turcon® Roto Variseal®

The indicative values apply for constant operating conditions. Changes in these, such as pressure fluctuations or direction of rotation can result in significantly higher frictional values.

Application Limits

The maximum operating limits for temperature, pressure and speed are dependent upon one another and therefore cannot all apply at the same time.

The lubrication properties of the media to be sealed and heat dissipation must also be taken into consideration.

The following PV values can be used as general guidelines:

Poor lubrication up to PV = 2 MPa x m/s

Good lubrication up to PV = 5 MPa x m/s

Very good cooling up to PV = 8 MPa x m/s

These values are lower for diameters < 50 mm / 2 inches. Tests of these characteristics are recommended to establish application limits.

Mating Surface Materials

Sealing of applications with rotating movements require very good mating surfaces. A minimum hardness 55 HRC is recommended to a hardening depth of at least 0.01 inch / 0.3 mm.

Particular attention must be paid to coated surfaces and good heat dissipation through the coating is required.

■ Installation Recommendations for Rod - Inch sizes

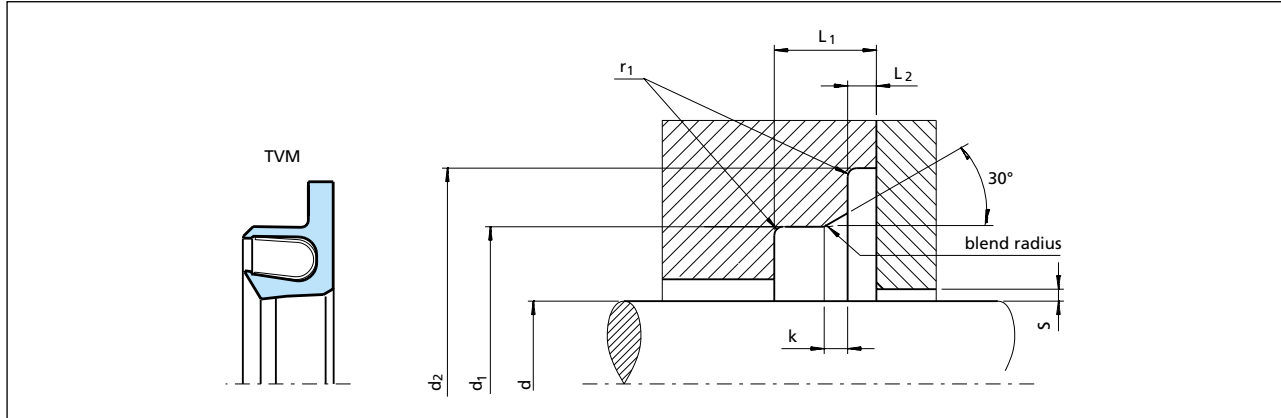


Figure 137 Installation drawing

Table 127 Installation Dimensions - Inch

Series No.	Rod Diameter d f8/h8		d1	d2	L1	L2		k	R	Maximum Extrusion Gap		
	Standard Range	Extended Range ¹⁾	Groove Dia.	Flange Groove Dia.	Groove Width	Flange Groove Width		Lead-in Chamfer	Radius	2 MPa	10 MPa	20 MPa
					Min				Max			
TVM1	0.187 - 0.749	0.187 - 8.000	d + .197	d + .354	0.141	0.033	+0.004	0.031	0.016	0.010	0.006	0.004
TVM2	0.750 - 1.499	0.375 - 16.000	d + .276	d + .492	0.189	0.053	+0.006	0.043	0.016	0.014	0.008	0.006
TVM3	1.500 - 14.999	0.750 - 28.000	d + .413	d + .689	0.280	0.071	+0.008	0.055	0.024	0.020	0.010	0.008
TVM4	15.000 -39.999	1.500 - 39.999	d + .551	d + .866	0.374	0.110	+0.008	0.063	0.031	0.024	0.012	0.010

¹⁾ Extended range available on request. Please contact your local Trelleborg Sealing Solutions marketing company for more information.

Table 128 Diameter Tolerance

Seal ID	Dia. d	Dia. d ₁
0.125 to 0.374	+0.000 -0.001	+0.001 -0.000
0.375 to 2.999	+0.000 -0.002	+0.002 -0.000
3.000 to 7.999	+0.000 -0.003	+0.003 -0.000
8.000 & up	+0.000 -0.004	+0.004 -0.000

■ Installation Recommendations for Roto Variseal - Metric sizes

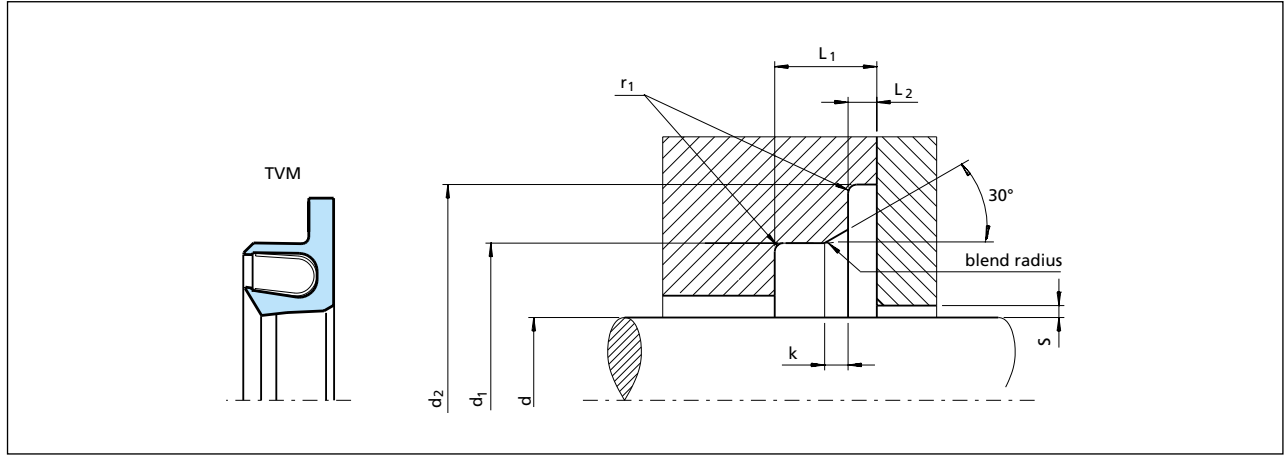


Figure 138 Installation drawing

Table 129 Installation Dimensions - Metric

Series No.	Rod Diameter d		d1	d2	L1	L2		k	R	Maximum Extrusion Gap		
	Standard Range	Extended ¹⁾ Range	Groove Diameter	Flange Diameter	Groove Width	Flange Groove Width		Lead-in Chamfer	Radius	2 MPa	10 MPa	20 MPa
			H9	H10	Min				(Max)			
TVM1	5.0 - 19.9	5.0 - 200.0	d + 5.0	d + 9.0	3.6	0.85	+0.10	0.8	0.4	0.25	0.15	0.10
TVM2	20.0 - 39.9	10.0 - 400.0	d + 7.0	d + 12.5	4.8	1.35	+0.15	1.1	0.4	0.35	0.20	0.15
TVM3	40.0 - 399.9	20.0 - 700.0	d + 10.5	d + 17.5	7.1	1.80	+0.20	1.4	0.6	0.50	0.25	0.20
TVM4	400.0 - 999.9	35.0 - 999.9	d + 14.0	d + 22.0	9.5	2.80	+0.20	1.6	0.8	0.60	0.30	0.25

¹⁾ Extended range available on request. Please contact your local Trelleborg Sealing Solutions marketing company for more information.

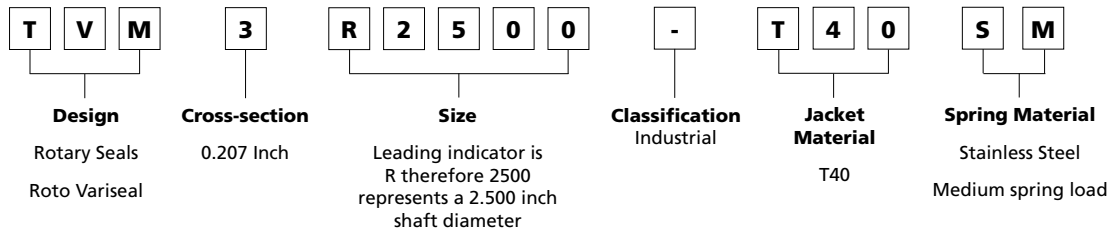
Turcon® Roto Variseal®

Table 130 Part Number System for Roto Variseal

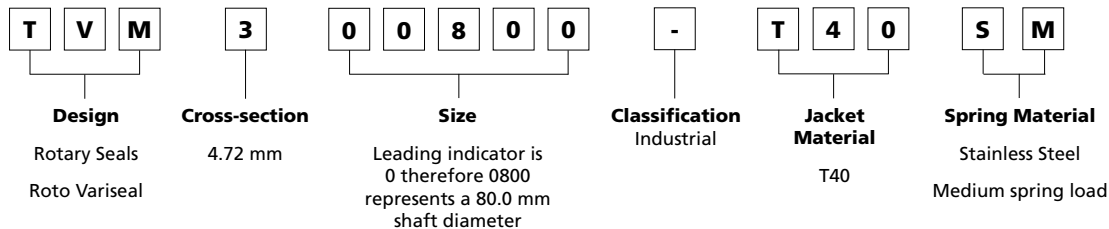
Article Code	Cross-Section	Size	Classification	Seal Material	Spring Material	Spring Load
TVM Roto Variseal	Inches 1 0.098 2 0.138 3 0.207 4 0.276 Metric 1 2.50 2 3.50 3 5.25 4 7.00	Rxxx Rod dia < 10.0 Inch (dia x 1000.0) Kxxx Rod dia. >= 10. (dia x 100.0) Oxxx Rod dia < 1000 mm (dia x 10.0) Xxxx Rod dia. >= 1000 (dia x 1.0)	- Industrial	T01 T05 T07 T12 T24 T40 T78 Z48 Z80 See Table 16 for material description	S Stainless Steel H Hastelloy E Elgiloy	M Medium R Hi-Clean*

* Available with spring groove high temperature silicone

Ordering Example 1 - Inch Example



Ordering Example 2 - Metric Example



Turcon® Varilip® PDR



Features and benefits

Low-friction to facilitate reduced power loss and friction-induced heat

Unique self-lubricating hydrodynamic feature further reduces friction

High speed capability up to 197 ft/s / 60 m/s

Wide operating temperature range from -76 °F to +392 °F / -60 °C to +200 °C

Options available for dry-running applications and for soft shafts

Retrofits in radial oil seal grooves

Unlimited shelf life with no special storage requirements

Compatible with virtually all media

Turcon® Varilip® PDR

Description

Turcon® Varilip® PDR rotary shaft seal is a metal-bodied seal with a mechanically retained Turcon® sealing element. It extends the boundaries imposed by elastomer radial shaft seals, utilizing advanced materials and design techniques to provide optimum sealing performance for each application. The outcome is a superior sealing solution, which retains a compact seal envelope.

Turcon® Varilip® PDR rotary shaft seals are characterized in particular by low friction and their stick-slip-free running, reducing temperature generation and permitting higher peripheral speeds.

Method of operation

Turcon® Varilip® PDR seals are constructed from two parts – a precision manufactured metal body and a mechanically retained Turcon® sealing element. Unlike seals with pressed metal cases, Turcon® Varilip® PDR does not require a gasket to provide mechanical retention of the lip. This improves both the chemical resistance and temperature range of the sealing system.

Turcon® has inherent memory. A distorted Turcon® component will attempt to recover to the profile it had during the sintering cycle of its manufacturing process. This feature is used to provide the necessary radial loading of the sealing lip onto the shaft.

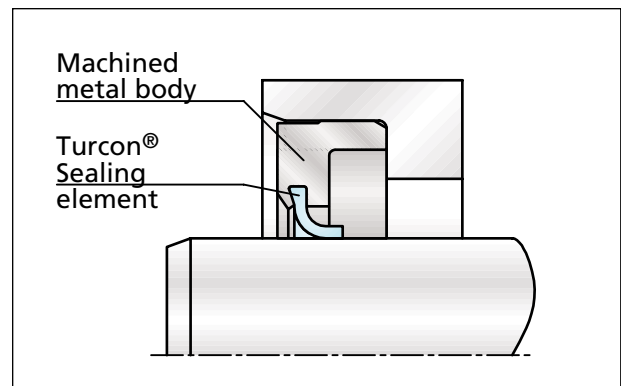


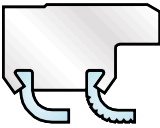
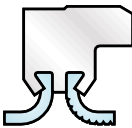
Figure 139 Turcon® Varilip® PDR seal

When required, Turcon® Varilip® PDR is available with a hydrodynamic feature on the Turcon® sealing lip. This provides a positive displacement of fluid as a result of shaft rotation, giving improved sealing in applications where the shaft only rotates in a single direction. The feature also increases the flexibility of the lip, allowing a wider contact band between the Turcon® lip and the shaft. This helps to reduce shaft load and associated wear.

Turcon® Varilip® PDR

Table 131 Turcon® Varilip® PDR Types

Turcon® Varilip® PDR seals are produced in one of five basic design styles, detailed in table below.

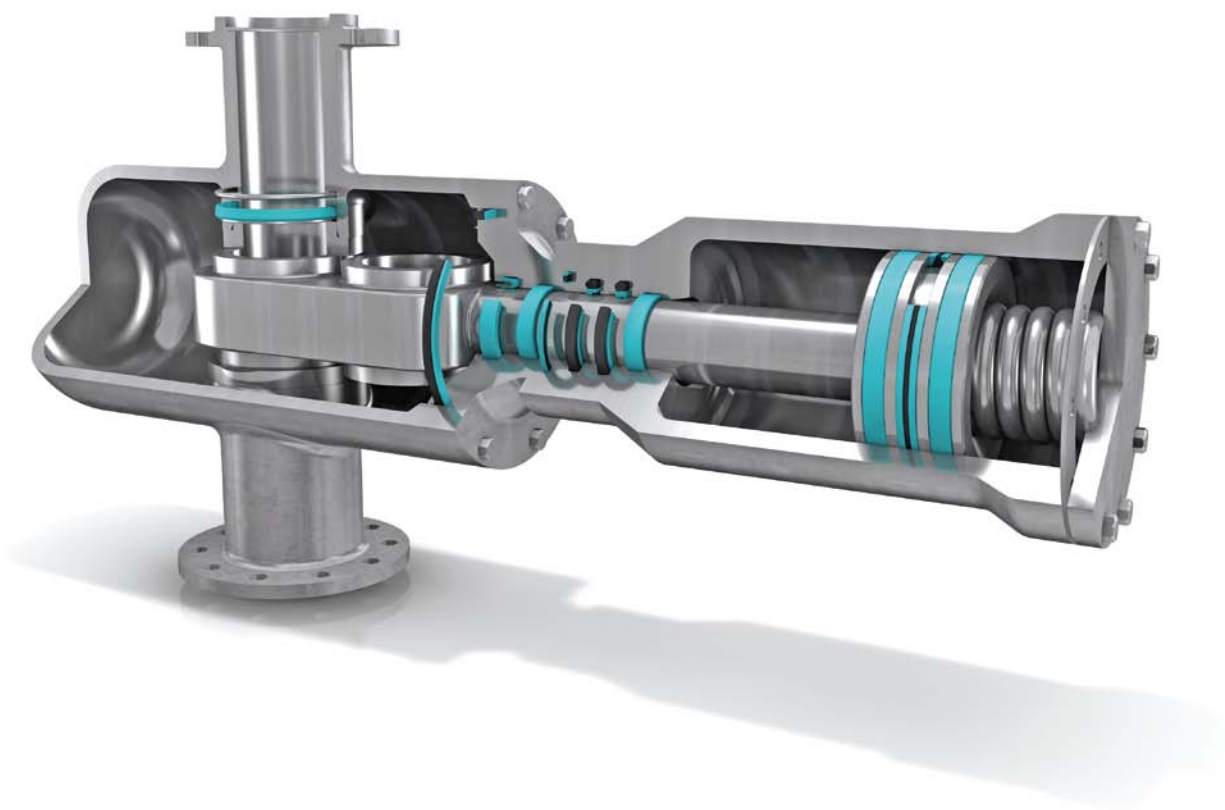
Cross Section	Part Number	Description
 Turcon® Varilip® PDR Type A / Type 1	TJ1 _ B (Inch) TJA _ B (Metric)	Type A is a single lip seal suitable for applications up to a pressure of 73 psi / 0.5 MPa. It is used when an elastomer radial shaft seal is unable to withstand the temperature or friction, in medium or poor lubrication. It operates at sealing surface speeds up to 197 fps (60 m/s) with sufficient cooling and lubrication of the sealing lip. Speeds up to 297 fps (90 m/s) are achievable with special designs.
 Turcon® Varilip® PDR Type B / Type 3	TJ3 _ B (Inch) TJB _ B (Metric)	Type B is the preferred choice for applications in which high seal integrity is demanded or where contaminated media are to be sealed. This type offers a Back-up sealing lip to provide secondary sealing. Pressure limit is 73 psi / 0.5 MPa.
 Turcon® Varilip® PDR Type C / Type 4	TJ4 _ B (Inch) TJC _ B (Metric)	Type C can be used for applications with higher pressures when an elastomer radial shaft seal can no longer be considered. Due to reinforcement of the sealing lip, pressures up to 145 psi / 1 MPa are possible as pump, shaft or rotor seals.
 Turcon® Varilip® PDR Type D / Type 5	TJ5 _ B (Inch) TJD _ B (Metric)	Type D can operate with pressure from both sides. Pressure differential of up to 73 psi / 0.5 MPa is permissible. It is also possible to separate two different media with this single seal.
 Turcon® Varilip® PDR Type G / Type 6	TJ6 _ B (Inch) TJG _ B (Metric)	Type G is similar to Type D but has a non-contacting environmental sealing element rather than a full lay-down lip. This prevents ingress of dust and dirt into the system while also ensuring torque and resulting power consumption are kept to a minimum.

Lip style B is selected as default for bi-directional shaft rotation. For anti-clockwise shaft rotation select A and for clock-wise shaft rotation select C.

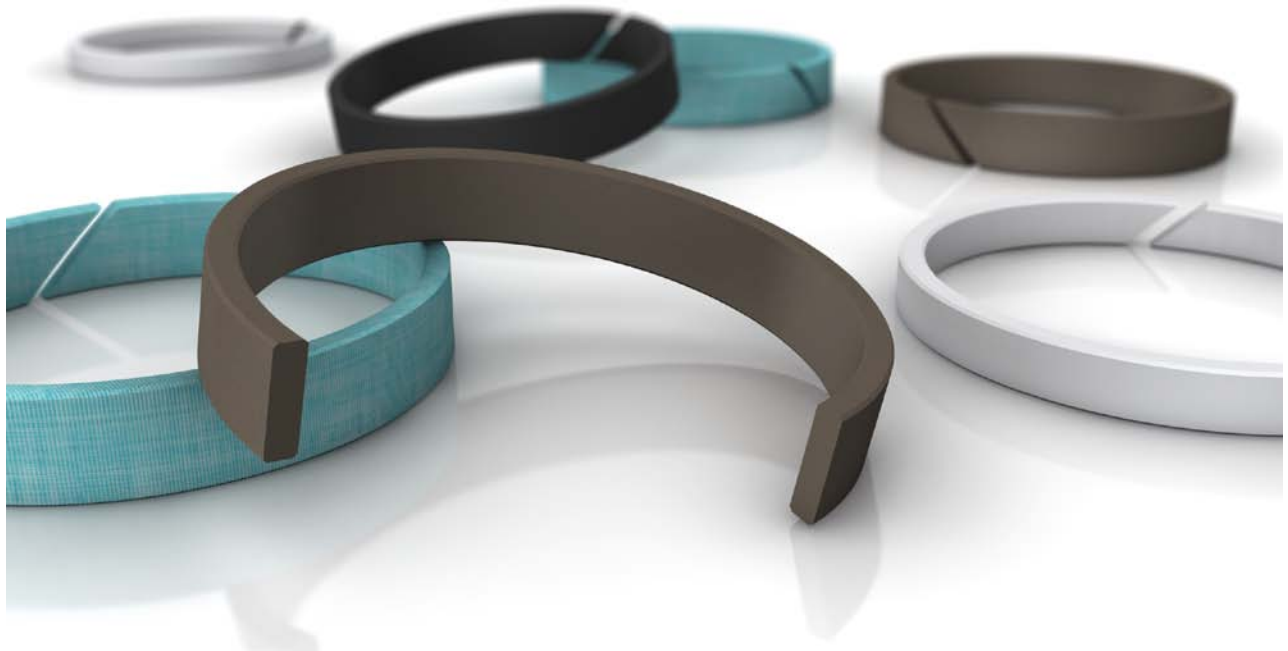
Materials recommended for Turcon® Varilip® PDR are Turcon® T25, T40, T78 and M83. For further details on these go to the Quick Selection Guide.

For further information on Turcon® Varilip® PDR, please reference our Turcon® Varilip® PDR catalog on the Trelleborg Sealing Solutions website.

Other elements used in sealing configurations



Polymer Bearings



Features and benefits

Prevent metal-to-metal contact

Low friction

Resist side loading

Weight saving potential of 4:1 compared to metal bearings, depending on material and configuration selection

Cost-effective

High load bearing capacity, both static and dynamic operation

Eliminate local stress concentrations

Eliminate hydrodynamic problems in the guide system

Very wear-resistant, providing long service life

Eliminates galling between components

Good friction characteristics

Damp mechanical vibrations

Protect against diesel effect

Low maintenance costs

Easy installation

Polymer Bearings

Description

The purpose of polymer bearings is to guide the piston and rod within cylindrical applications, absorbing any transverse forces which may occur. They prevent metal-to-metal contact, optimizing the performance of the sealing system.

Bearings are needed to protect primary seal components and hardware so optimum sealing performance and service life can be achieved.

Cost-effective, polymer bearings are very wear-resistant, providing long service life. They offer high load bearing capacity in static and dynamic operation, have good friction characteristics and dampen mechanical vibrations. They also eliminate local stress concentrations, galling between components and hydrodynamic problems in the guide system. In addition, they protect against the diesel effect where combustion of pockets of oil vapor caused by rapid changes of pressure can damage seals.

Designs

Four different types of bearing materials under the brand name Slydring® are available depending on application demands:

- Highly wear-resistant, low-friction, specially modified **Turcon**® PTFE based materials. For low to medium loads.
- **Orkot**® fabric composite materials for high loads and transverse forces.
- **Zurcon**® high-modulus thermoplastic provides long service life in high loads and temperatures.
- **HiMod**® high-modulus thermoplastic for use in extreme working conditions.

Bearing Features

Though bearings appear to be simple in design, their function of preventing metal-to-metal contact within a sealing system is complex. Selection of the correct material and configuration is critical to ensure optimized performance and service life.

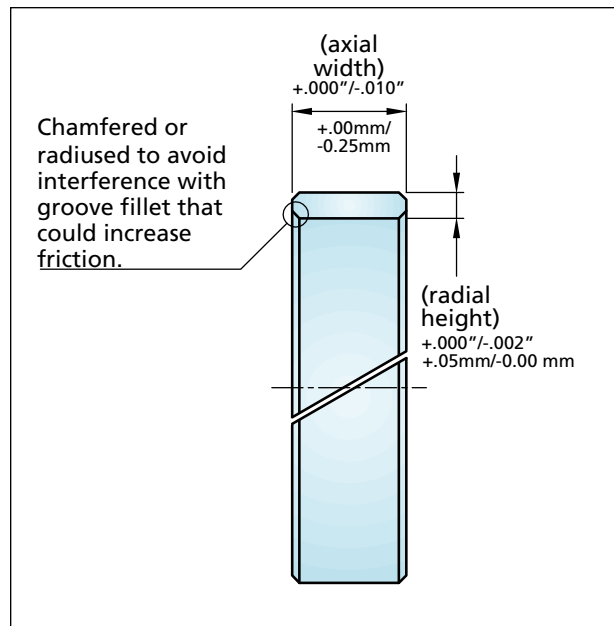


Figure 140 Bearing Features

Polymer Bearings

Table 132 Selection Criteria for bearings

Material	Filler	Technical Data		Application
		Temperature	Velocity	
Turcite® T47 	Bronze-filled medium PTFE	-76 °F to +302 °F -60 °C to +150 °C	50 ft/s 15 m/s	Excellent deformation resistance and stability. Used for applications above 5,800 psi / 40 MPa. Not recommended for non-lubricated applications.
Turcite® T51 	Carbon and graphite-filled PTFE	-76 °F to +302 °F -60 °C to +150 °C	50 ft/s 15 m/s	Good wear resistance and low friction. A bearing material used in poorly lubricated applications.
Orkot® C324 	HT Polymer Composite	76 °F to +482 °F -60 °C to +250 °C	3.3 ft/s 1 m/s	Developed for high-temperature applications. Preferred material for bridge plugs. HT Wear Rings.
Orkot® C338 	HT Polymer composite with Moly and PTFE	76 °F to +482 °F -60 °C to +250 °C	3.3 ft/s / 1 m/s in oil, up to 23.3 ft/s / 7 m/s in water	For chemically aggressive media Wear Rings or Custom made bushes
Orkot® C361 (Orkot® TLMM) 	Polymer Composite with Moly and PTFE	76 °F to +266 °F -60 °C to +130 °C	3.3 ft/s / 1 m/s in oil, 23.3 ft/s / up to 7 m/s in water	For applications requiring extra lubrication or slow movements in dry conditions. Tailor-made bearings.
Orkot® C378 (Orkot® TXMM) 	Advanced version of TLMM with added TX- low friction layers	-76 °F to +266 °F -60 °C to +130 °C	3.3 ft/s / 1 m/s in oil, 23.3 ft/s / up to 7 m/s in water	Gives excellent low friction operating capability. Tailor-made bearings.
Orkot® C380 	Polymer composite and PTFE	76 °F to +266 °F -60 °C to +130 °C	3.3 ft/s 1 m/s	High wear resistance with good sliding properties. Excellent load carrying capabilities for heavy duty applications, such as tensioner cylinders. Standard Wear Rings.
Zurcon® Z43 	PEEK™, PTFE and carbon	-65 °F to +500 °F -54 °C to +260 °C	16 ft/s 5 m/s	For high-temperature and pressure service. Good chemical compatibility. Can be used for structural parts, such as piston heads. Typically referred to as bearing grade PEEK™.

Polymer Bearings

Material	Filler	Technical Data		Application
		Temperature	Velocity	
HiMod® 914 	PEEK™, thermoplastic, carbon and PTFE	-65 °F to +500 °F -54 °C to +250 °C	16 ft/s 5 m/s	Self-lubricating, chemical-resistant bearing developed for the most severe and critical applications.
HiMod® 924 	PEEK and carbon fiber	-65 °F to +500 °F -54 °C to +250 °C	8 ft/s 2.4 m/s	High-temperature, high-modulus material with low thermal expansion, high strength and high compressive properties.

Turcite® from the roll, calculation of the Linear Length

The linear length of Turcite® is calculated such that a gap "Z" is created at the ends of the strip after installation. This is required for the following reasons:

- Compensation of the linear expansion of the strips due to the effects of temperature
- Avoidance of intermediate pressures and entrained pressures.

When ordering strips off-the-roll for manufacturing of Turcite® Slydring® in your own works, the length of the strip can be calculated using the following formulae:

Piston Slydring®:

$$L = c \times (D_N - W) - k \text{ [mm]}$$

Note: Strip material is only available in Turcite® and ORKOT® above certain diameters. Other high modulus wear ring materials, such as Z43 and Himod, are available upon request using custom part numbers.

Rod Slydring®:

$$L = c \times (d_N + W) - k \text{ [mm]}$$

$$D_N = \text{Bore diameter [mm]}$$

$$d_N = \text{Rod diameter [mm]}$$

$$W = \text{Ring thickness [mm]}$$

$$c = 3.11 \text{ material factor, valid for Turcite® Materials}$$

$$k = \text{Temperature constant:}$$

0.8 for operating temperatures up to +248 °F / +120 °C.
2.0 only for applications > +248 °F / +120 °C.

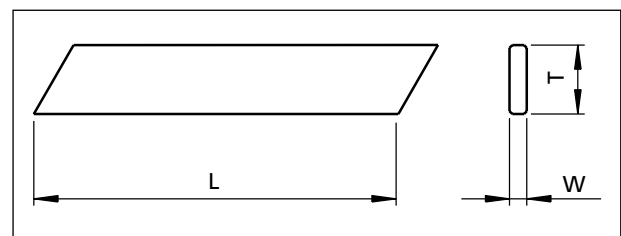


Figure 141 Cut length

Polymer Bearings

Calculating the Proper Bearing Exposure

The bearing running clearance, or bearing exposure, is the least understood and the most frequently encountered problem in the design of polymer bearings. Due to the difference in thermal behavior during operation of polymer materials, they require larger running clearances than those recommended for metal bearings. Insufficient running clearances are often the cause of polymer bearing failures, so care should be taken in specifying these.

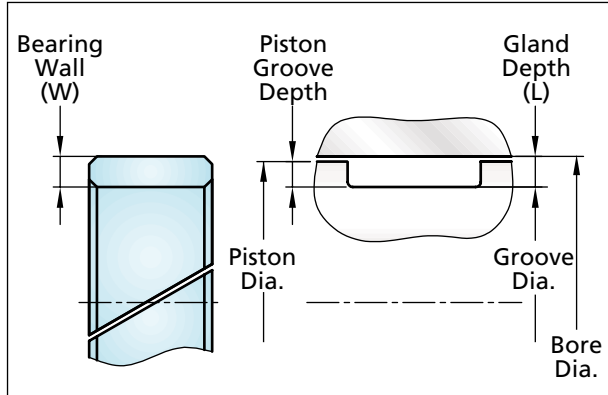


Figure 142 Bearing Exposure Variables

It is recommended that unless side load is extremely low, start with a bearing exposure of .005 inch / 0.127 mm minimum.

As a guide:

- Piston groove depth maximum equals piston diameter maximum minus groove diameter minimum.
- Piston groove depth minimum equals piston diameter minimum minus groove diameter maximum.
- Bearing exposure minimum equals bearing wall minimum minus piston groove depth maximum.
- Bearing exposure maximum equals bearing wall maximum minus piston groove depth minimum.

To ensure that bearing exposure is correctly specified consult your local Trelleborg Sealing Solutions marketing company.

Calculate Bearing Length

A rough estimate of the number and width of the bearings required within an application can be calculated from the formula in the figure below.

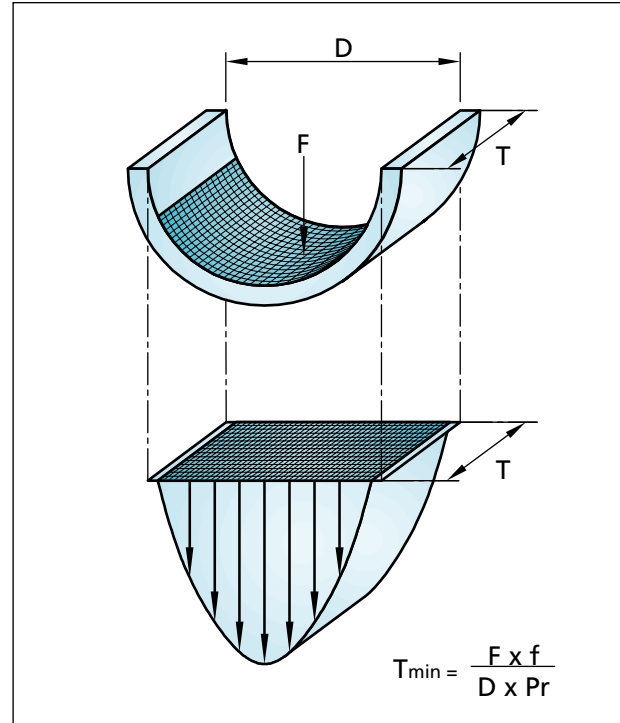


Figure 143 Bearing T

Where:

- F = Maximum radial load
- f = Safety factor
- D = Rod/Bore diameter
- Pr = Permissible dynamic load

Running Velocity

Bearing surface speed is calculated as follows:

For rotary applications:

- $V = (D \times \pi \times \text{RPM}) / 12$

For reciprocating applications:

- $V = (LS \times C \times 2) / 12$

Where:

- V = Velocity
- D = Dynamic diameter
- LS = Length of stroke
- C = Cycles per minute

Multiply V by the system pressure to get PV.

Polymer Bearings

■ Installation Recommendation, Turcite® and Orkot® Slydring® for Rod - Inch sizes

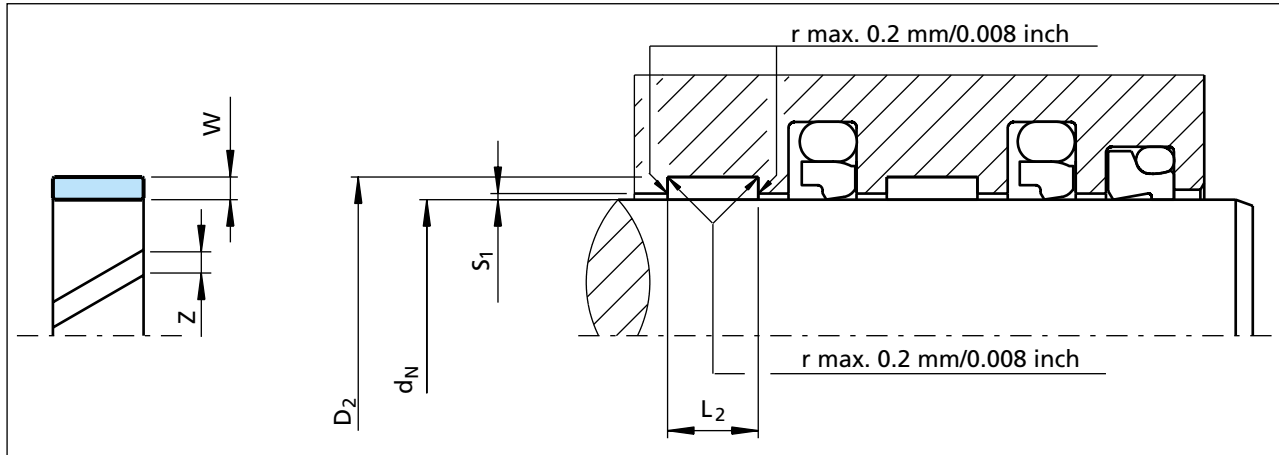


Figure 144 Installation Drawing

Table 133 Installation Dimensions - Inch

TSS Serial No.	Rod Diameter	Groove Diameter	Groove Width	Thickness
	d_N f8/h9	D_2 H8	L_2 +.010	W (max)
GR0B	.750 - 2.500	d_N + .126	.385	.063
GR0C	1.250 - 4.000	d_N + .126	.510	.063
GR2B	1.250 - 4.000	d_N + .250	.385	.125
GR2C	1.250 - 8.000	d_N + .250	.510	.125
GR2D	1.500 - 10.000	d_N + .250	.635	.125
GR2E	2.500 - 12.000	d_N + .250	.760	.125
GR2F	3.000 - 16.000	d_N + .250	1.010	.125
GR2G	3.500 - 20.000	d_N + .250	1.260	.125
GR2H	4.000 - 20.000	d_N + .250	1.510	.125
GR2J	6.000 - 20.000	d_N + .250	1.760	.125
GR2K	8.000 - 20.000	d_N + .250	2.010	.125
GR2L	10.000 - 20.000	d_N + .250	2.510	.125

Notes:

- (1) Tolerances used are per ISO-286 system of limits and fits.
- (2) **Bold** Print indicates preferred series

Polymer Bearings

Ordering Example

Slydring® for Rod diameter $d_N = 3.250$ inches
Series GR2C from Table 133

Groove width: .510 inches,
ring thickness: .125 inches

Material: Turcite® T47
Standard With angle cut

Design: With angle cut and teardrop
structure
Design code: 0 as in original pdf
on page 271

TSS Part No.: GR2C03250

TSS Article No. GR2C 03250 - T47

TSS Series No.

Rod Diameter x 1000

Quality Index (Standard)

Material code

Polymer Bearings

■ Installation Recommendation, Turcite® and Orkot® Slydring® for Rod - Metric sizes

Table 134 Installation Dimensions - Metric

Serial No.	Rod Diameter ¹⁾	Groove Diameter	Groove Width	Ring Thickness	Ring Gap
	d_N h9	D_2 H8	L_2 +0.2	W	Z
GR41	8 - 20.0	d_N +3.10	2.50	1.55	Calculation of the linear length, see page 287
GR43	10 - 50.0	d_N +3.10	4.00	1.55	
GR65	15 - 140.0	d_N +5.00	5.60	2.50	
GR69	20 - 220.0	d_N +5.00	9.70	2.50	
GR73	80 - 400.0	d_N +5.00	15.00	2.50	
GR75	200 - 999.9	d_N +5.00	25.00	2.50	
GR75X	1000 - 4200.0	d_N +5.00	25.00	2.50	
GR98	280 - 999.9	d_N +8.00	25.00	4.00	
GR98X	1000 - 2200.0	d_N +8.00	25.00	4.00	

¹⁾ Recommended diameter ranges.

²⁾ Non ISO-10766 standard.

Ordering Example

Slydring® for rod diameter d_N = 63.00 mm
Series GR 65 from Table 134

Groove width: 5.60 mm, ring thickness: 2.50 mm

Material: Turcite® T47
(other materials see Tables 11 to 18)

Standard With angle cut and teardrop structure
Design code: 0

TSS Part No.: GR6500630

The TSS Article No. can be formed from the example below.

TSS Article No.	GR65	0	0630	-	T47
TSS Series No.					
Design code, standard					
Rod diameter x 10					
Quality Index (Standard)					
Material No.					

For diameters ≥ 1000.0 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

Polymer Bearings

■ Installation Recommendation, Turcite® and Orkot® Slydring® for Piston - Inch sizes

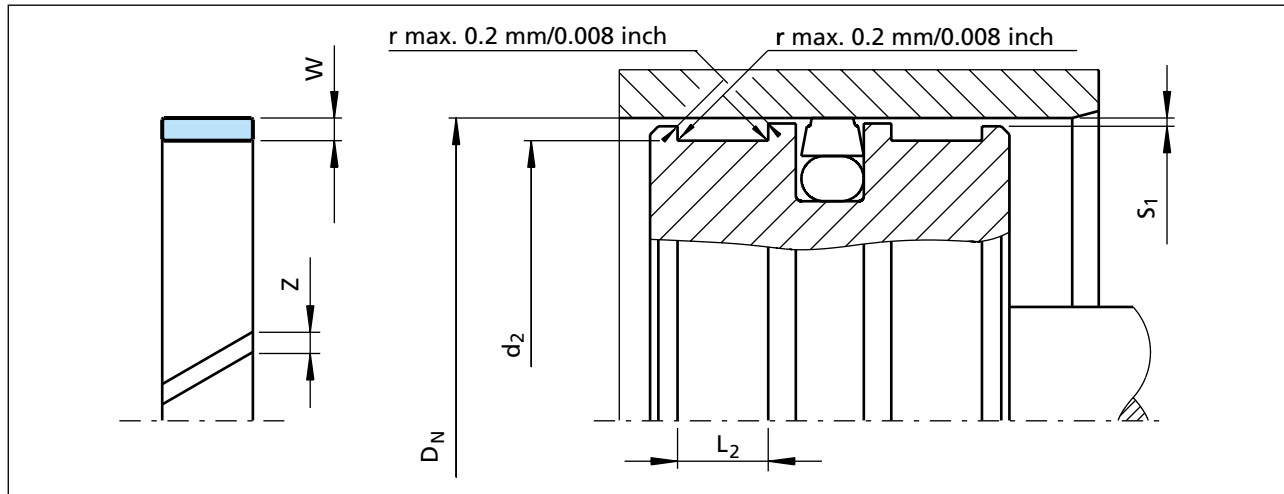


Figure 145 Installation Drawing

Table 135 Installation Dimensions - Inch

TSS Serial No.	Bore Diameter	Groove Diameter	Groove Width	Thickness
	$D_N \text{ H9}$	$d_2 \text{ h8}$	$L_2 +.010$	$W \text{ (max)}$
GP0B	1.000 - 4.000	$D_N - .126$	.385	.063
GP0C	1.000 - 4.000	$D_N - .126$	.510	.063
GP2B	1.000 - 4.000	$D_N - .250$	.385	.125
GP2C	1.250 - 10.000	$D_N - .250$	.510	.125
GP2D	1.500 - 10.000	$D_N - .250$	.635	.125
GP2E	2.000 - 12.000	$D_N - .250$	.760	.125
GP2F	2.500 - 16.000	$D_N - .250$	1.010	.125
GP2G	3.000 - 20.000	$D_N - .250$	1.260	.125
GP2H	4.000 - 20.000	$D_N - .250$	1.510	.125
GP2J	6.000 - 20.000	$D_N - .250$	1.760	.125
GP2K	8.000 - 20.000	$D_N - .250$	2.010	.125
GP2L	10.000 - 20.000	$D_N - .250$	2.510	.125

Notes:

(1) Tolerances used are per ISO-286 system of limits and fits.

(2) **Bold Print** indicates preferred series

Polymer Bearings

Ordering Example

Slydring® for Bore diameter $D_N = 3.250$ inches
Series GP 2C from Table 135

Groove width: .510 inches,
ring thickness: .125 inches

Material: Orkot® C380
Standard With angle cut

Design With angle cut and teardrop
structure
Design code: 0

TSS Part No.: GP2C03250

TSS Article No.	GP2C	03250	-	C380
TSS Series No.				
Bore Diameter x 1000				
Quality Index (Standard)				
Material code				

Polymer Bearings

■ Installation Recommendation, Turcite® and Orkot® Slydring® for Piston - Metric sizes

Table 136 Installation Dimensions - Metric

Serial No.	Bore Diameter ¹⁾	Groove Diameter	Groove Width	Ring Thickness	Ring Gap
	D _N H9	d ₂ h8	L ₂ +0.2	W	Z
GP41	8 - 20.0	D _N - 3.10	2.50	1.55	³⁾
GP43	10 - 50.0	D _N - 3.10	4.00	1.55	³⁾
GP65	16 - 140.0	D _N - 5.00	5.60	2.50	³⁾
GP69	60 - 220.0	D _N - 5.00	9.70	2.50	³⁾
GP73	130 - 400.0	D _N - 5.00	15.00	2.50	³⁾
GP75	280 - 999.9	D _N - 5.00	25.00	2.50	³⁾
GP75X	1000 - 4200.0	D _N - 5.00	25.00	2.50	³⁾
GP98	280 - 999.9	D _N - 8.00	25.00	4.00	³⁾
GP98X	1000 - 2200.0	D _N - 8.00	25.00	4.00	³⁾
GP99 ²⁾	100 - 999.9	D _N - 8.00	9.70	4.00	³⁾

¹⁾ Recommended diameter ranges.

²⁾ Non ISO-10766 standard.

³⁾ See linear calculation of the length on page 287.

Ordering Example

Slydring® for piston diameter D_N = 100.0 mm
Series GP 69 from Table 136

Groove width: 9.70 mm, ring thickness: 2.50 mm

Material: Turcite® T47
(other materials see Tables 11 to 18)

Standard design: With angle cut and teardrop structure
Design code: 0

TSS Part No.: GP6901000

The TSS Article No. can be formed from the example below.

TSS Article No.	GP69	0	1000	-	T47
TSS Series No.					
Design code, standard					
Bore diameter x 10					
Quality Index (Standard)					
Material No.					

For diameters ≥ 1000.0 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

Turcite® Captive Slydring®



Features and benefits

No stick-slip effect when starting for smooth operation even at very low speeds

Minimum static and dynamic friction coefficient for low operating temperature and energy loss

Suitable for non lubricating fluids, depending on Turcite® material, gives optimum design flexibility

High wear resistance ensures long service life

Suitable for most hydraulic fluids and gasses depending on material selected.

Any debris in the system is absorbed by the Slydring® to avoid damage to harder mating surfaces.

Good damping effect

Protected from diameter variations of counterpart

Passes over holes in its mating surface

For linear and rotary service

Safe assembly when Slydring® is fixed in the groove

Teardrop pattern promotes formation of a lubricant film

Turcite® Captive Slydring®

General

The Turcite® Slydring® series has gained wide use as piston and rod Wear Rings due to their excellent performance and simple Installation.

Applications where the Wear Rings move from a smaller to a larger bore size and have to be held in the groove or cannot be accessed during assembly are difficult. Special precautions may be needed to ensure that the Wear Rings stay in position during assembly.

Traditional solutions have been to use turned and (if possible) uncut Wear Rings, or to ensure positioning with cyanoacrylate ("instant glue") or high viscosity grease.

The drawbacks of these solutions are that they are costly, laborious and unreliable.

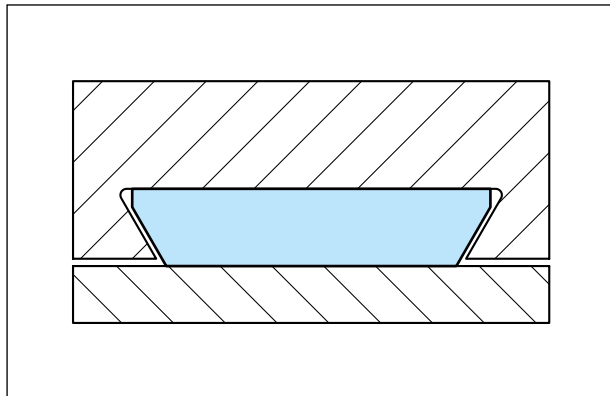


Figure 146 Captive Slydring®

Turcite® Captive Slydring®

The Turcite® Captive Slydring® has been developed to combine the bearing performance of the Slydring® with safe installation under all conditions. In particular, in situations where the Slydring® has to pass dimensional variations or holes.

Turcite® Captive Slydring®, with a Teardrop structure as standard, is supplied as a strip with a dovetail shaped profile and is mounted in grooves with a corresponding shape.

Groove design

The grooves, as illustrated in the figure below, are fairly simple and can be machined on any type of lathe without additional cost or special tooling. The installation inlets of the grooves do not require exact dimensions and can be made with a suitable hand operated grinder.

Mounting

Mounting is easy and straightforward. The end of the strip is inserted in the groove inlet and pushed into the groove and along the circumference. On large diameters, installation may be eased by punching a hole in the strip and pulling it along the groove with a suitable tool.

After mounting, the Turcite® Captive Slydring® is locked in the groove and will not require special care during assembly.

Applications

The Turcite® Captive Slydring® is ideal for all types of equipment where positioning of the Wear Ring cannot be controlled during assembly or where its function requires it to be kept fixed in the groove:

- Valves
- Connectors
- Wave compensators
- Downhole Tools
- Pressure boosters
- Jacks

For piston Wear Rings, it would typically be used where the piston is inserted through a long cylinder head, where there are thread and grooves. It could also be expected to pass holes or diameter variations in the bore during dynamic operation.

On rod bearings, the Captive Slydring® will ease installation of rods in large diameter bushings or save the expense of long seal/Wear Ring carriers in plunger type cylinders. In cases where the rod end is moving in and out of the Wear Ring area, this type of Captive Slydring® installation is required.

Turcite® Captive Slydring®

Operating conditions

- Bearing load: See Figure 143
- Media: Most fluids and gases, depending on compatibility of the Turcite® Orkot® material.
- Clearance: The maximum permissible radial clearance $D_{\max}$ and $d_{\min}$ depending on the sealing system used. See Figure 149 and Figure 151.

Speed and Dynamic load:

Depends greatly on the heat generation in the area where the Slydring® is positioned.

- Temperature: The acceptable Wear Rings load of Turcite® Orkot® decreases with increasing temperatures. The load Wear Rings ability for dynamic applications is dependent primarily on the operating temperature. This should therefore generally not exceed +400 °F / +200 °C for Turcite®.

Calculation of Linear length L

Turcite® Captive Slydring® is supplied as a strip off-the-roll for cutting to size. Calculations of required cut length L are made as shown below or refer to the Hydraulic seals – linear catalog:

The required cut length L is determined as follows.

k = Temperature constant: 0.8 for operating temperatures up to +248 °F / +120 °C.

k = 2.0 for applications > +248 °F / +120 °C.

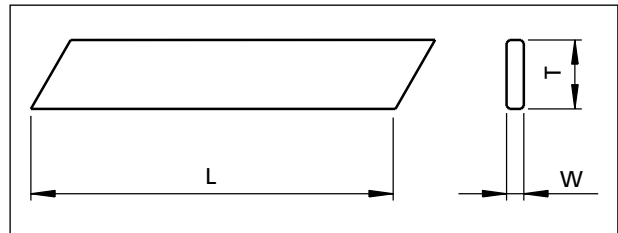


Figure 147 Cut length

Turcite® Captive Slydring® is at request supplied on special part numbers as pieces for specific diameters.

Type of cut

Turcite® Captive Slydring® with an angle cut is recommended for linear movements

Turcite® Captive Slydring® with a straight cut is recommended for turning, rotary and helical movements

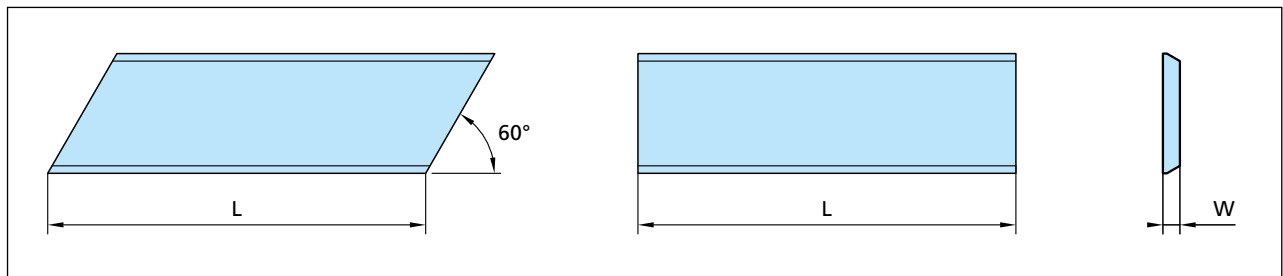


Figure 148 Slydring® with an angle cut, design code 0, and with a straight cut, design code B

■ Installation Recommendation for Rod - Metric sizes

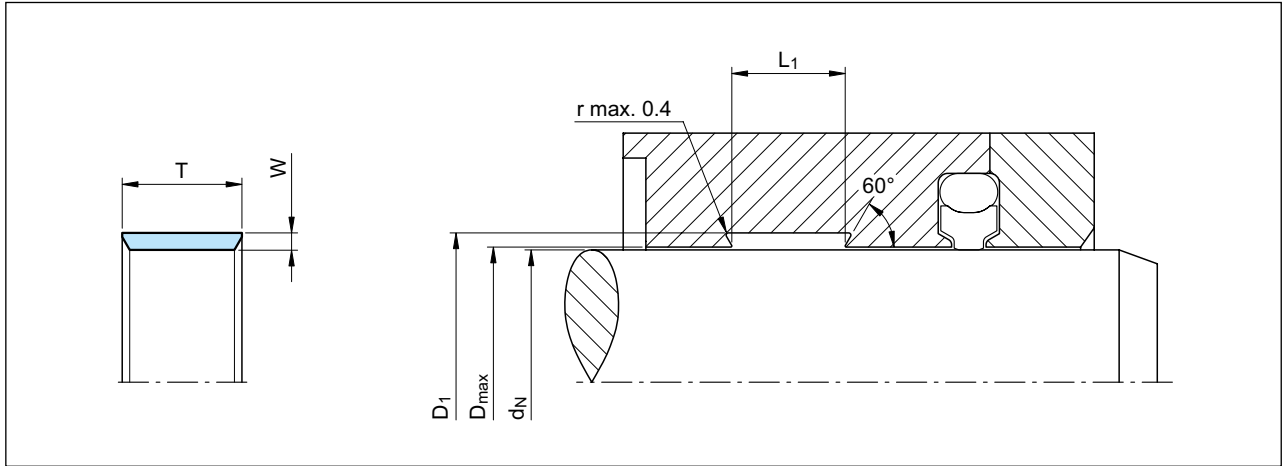


Figure 149 Installation Drawing

Table 137 Installation Recommendations - Metric

Part No.	Recommended Range d_N f8/h9	D_1 Groove Dia. +0.05/-0	L_1 Groove Width +0.2/-0	D_{max} Maximum Dia.	T Slydring Width Inspection tolerance ± 0.15	W Slydring Thickness +0/-0.08
GRC1	≥ 100	$d_N + 5.0$	8.0	See Table 138	9.45	2.5
GRC2	≥ 150	$d_N + 5.0$	13.0	See Table 138	14.45	2.5
GRC3	≥ 150	$d_N + 5.0$	18.0	See Table 138	19.45	2.5
GRC4	≥ 200	$d_N + 6.0$	28.0	See Table 138	29.80	3.0

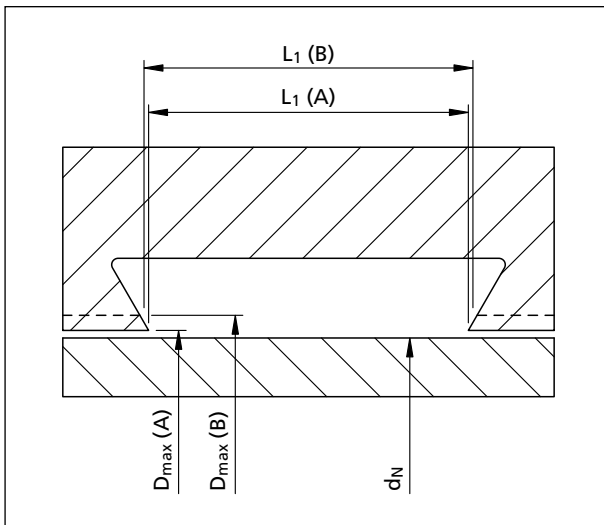


Figure 150 The groove width L_1 depends on the D_{max} in Table 138

Table 138 Groove width L_1 based on D_{max}

L_1 Groove Width +0.2 / -0	D_{max} Maximum Dia. +0.1/-0
8.0 8.1	$d_N + 0.5$ $d_N + 0.7$
13.0 13.1	$d_N + 0.5$ $d_N + 0.7$
18.0 18.1	$d_N + 0.5$ $d_N + 0.7$
28.0 28.1 28.2	$d_N + 0.5$ $d_N + 0.7$ $d_N + 0.9$

Turcite® Captive Slydring®

Ordering Example

Turcite® Captive Slydring® cut for specific rod diameter:

Rod diameter: $d_N = 250.0 \text{ mm}$
Series: from Table 137
Groove width: $L_1 = 13.0 \text{ mm}$

Standard design: Design code: 0 - with angle cut and teardrop structure

Material: Turcite® M12
(other materials see Tables 11 to 18)

Part number: GRC202500

The corresponding code numbers are appended to the TSS Part No.

Together these form the TSS Article Number. The Article No. can be determined following the example to the right.

TSS Article No.	GRC2	0	2500	-	M12
Metric					
Series No.					
Type (Standard)					
Rod diameter x 10 *					
Quality Index (Standard)					
Material Code (Seal Ring)					

* For diameters $\geq 1000\text{mm}$ please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

■ Installation Recommendation for Piston - Metric sizes

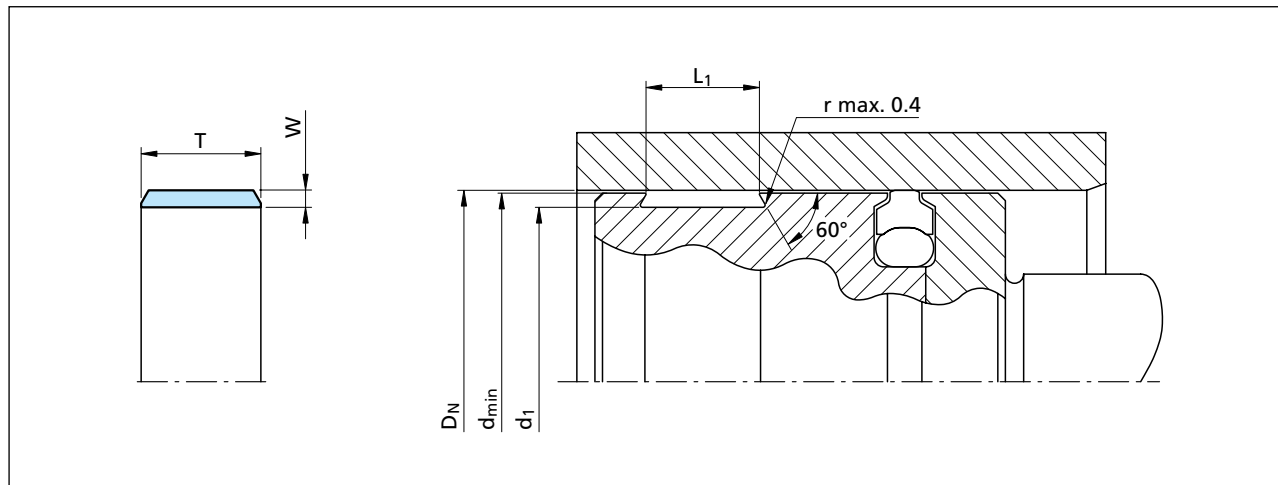


Figure 151 Installation Drawing

Table 139 Installation Recommendations - Metric

Part No.	Recommended Range D_N H10	d_1 Groove Dia. +0.05/-0	L_1 Groove Width +0.2/-0	d_{min} Minimum Dia.	T Slydring Width Inspection tolerance ± 0.15	W Slydring Thickness +0/-0.08
GPC1	≥ 60	$D_N - 5.0$	8.0	See Table 140	9.45	2.5
GPC2	≥ 80	$D_N - 5.0$	13.0	See Table 140	14.45	2.5
GPC3	≥ 100	$D_N - 5.0$	18.0	See Table 140	19.45	2.5
GPC4	≥ 200	$D_N - 6.0$	28.0	See Table 140	29.80	3.0

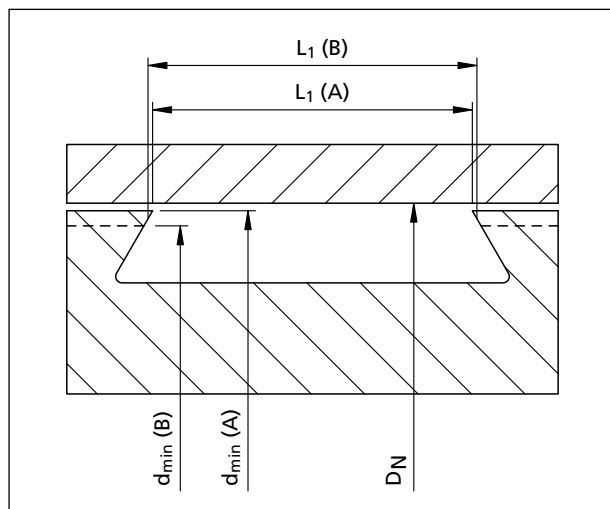


Figure 152 The groove width L_1 depends on the d_{min} in Table 140

Table 140 Groove width L_1 based on d_{min}

L_1 Groove Width +0.2 / -0	d_{min} Minimum Dia. +0.1/-0
8.0 8.1	$D_N - 0.5$ $D_N - 0.7$
13.0 13.1	$D_N - 0.5$ $D_N - 0.7$
18.0 18.1	$D_N - 0.5$ $D_N - 0.7$
28.0 28.1 28.2	$D_N - 0.5$ $D_N - 0.7$ $D_N - 0.9$

Turcite® Captive Slydring®

Ordering Example

Turcite® Captive Slydring® cut for specific bore diameter:

Piston diameter: $D_N = 250.0$ mm

Series: from Table 139

Groove width: $L_1 = 28$

Standard design: Design code: 0 - with angle cut and teardrop structure.

Material: Turcite® M12
(other materials see Tables 11 to 18)

TSS Part No.: GPC402500

The corresponding code numbers are appended to the TSS Part No. Together these form the TSS Article Number.

The Article No. can be determined following the example to the right.

TSS Article No.	GPC4	0	2500	-	M12
Metric					
Series No.					
Type (Standard)					
Bore diameter x 10 *					
Quality Index (Standard)					
Material Code (Seal Ring)					

* For diameters ≥ 1000 mm please contact your local Trelleborg Sealing Solutions marketing company for custom article no.

■ Turcite® Captive Slydring® installation

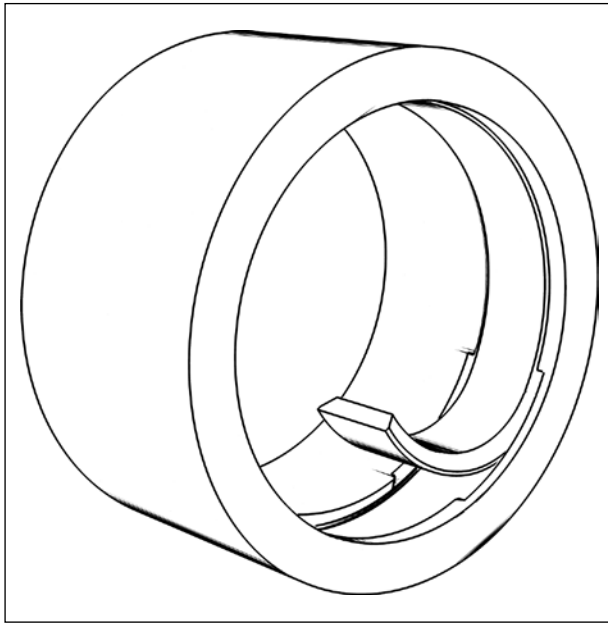


Figure 153 Installation groove inlet

The installation inlets of the grooves do not require exact dimensions and can be made with a suitable hand operated grinder.



Figure 154 Installing Captive Slydring®

The end of the strip is inserted in the groove inlet and pushed into the groove and along the circumference.

On large diameters, installation may be eased by punching a hole in the strip and pulling it along the groove with a suitable "tool".

Storage Advice



Storage Advice

■ Guidelines for the storage of polymer products based on ISO 2230

Many polymer products and components are stored for long periods of time before being put into service, so it is important they are stored in conditions that minimize unwanted changes in properties. Changes from degradation may include excessive hardening, softening, cracking, crazing or other surface effects. Other changes may be caused by deformation, contamination or mechanical damage.

Packaging

Unless otherwise specified in the appropriate product specification, rubber products should be enclosed in individual sealed envelopes. The packaging should be carried out in an atmosphere in which the relative humidity is less than 70%, or if polyurethanes are being packed, less than 65 %. Where there is serious risk of ingress of moisture (e.g. rubber-metal-bonded parts), aluminum foil/paper/polyethylene laminate or other similar means of protection should be used to ensure the quality of the seal is preserved.

Temperature

The storage temperature should be below 25 °C and the products should be stored away from direct sources of heat such as boilers, radiators and direct sunlight. If the storage temperature is below 15 °C, care should be exercised during handling of stored products, as they may have stiffened and have become susceptible to distortion.

Humidity

The relative humidity of a storage environment should be such that condensation does not occur with variations in temperature. In all cases, the relative humidity of the atmosphere in storage should be less than 70 %, or if polyurethanes are being stored, less than 65 %.

Light

Rubber should be protected from light sources, in particular direct sunlight or intense light with high ultra-violet content. It is advisable that any windows of storage rooms be covered with a red or orange coating or screen.

Radiation

Precautions should be taken to protect stored products from all sources of ionizing radiation likely to cause damage to the products.

Ozone

Ozone has a particularly harmful effect on rubber. Storage rooms should not contain any equipment that is capable of generating ozone, such as mercury vapor

lamps or high-voltage electrical equipment giving rise to electric sparks or electrical discharges. Combustion gases and organic vapors should also be excluded, as they may give rise to ozone via photo-chemical processes. When equipment such as a fork-lift truck is used to handle large rubber products, care needs to be taken to ensure this equipment is not a source of pollution that may affect the rubber. Combustion gases should be considered separately. While they are responsible for generating ground-level ozone, they may also contain unburned fuel which, by condensing on rubber products, can cause additional deterioration.

Deformation

Rubber should be stored free from tension, compressive stresses or other causes of deformation. Where products are packaged in a strain-free condition, they should be stored in their original packaging. In case of doubt, the manufacturer's advice should be sought. It is advisable that rings of large internal diameter are formed into three equal loops so as to avoid creasing or twisting. It is not possible to achieve this condition by forming just two loops.

Contact with liquids and semi-liquid materials

Rubber should not be allowed to come into contact with liquid or semi-liquid materials (for example, petrol, greases, acids, disinfectants, cleaning fluids) or their vapors at any time during storage, unless these materials are by design an integral part of the product or the manufacturer's packaging. When rubber products are received coated with their operational media, they should be stored in this condition.

Contact with metals

Certain metals and their alloys (in particular, copper and manganese) are known to have harmful effects on some rubbers. Rubber should not be stored in contact with such metals except when bonded to them. They should be protected by wrapping in, or by separation with, a suitable material, e.g. paper or polyethylene.

Contact with dusting powder

Dusting powders should only be used for the packaging of rubber items in order to prevent adhesion. In such cases, the minimum quantity of powder to prevent adhesion should be used. Any powder used should be free from any constituent that would have a harmful effect on the rubber or the subsequent application of the rubber.

Contact between different products

Contact between products made from rubbers of different compositions should be avoided. This includes products of the same type but differing in color.

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Rubber-to-metal bonded products

The metal part of rubber-to-metal bonded products should not come into contact with the rubber of other products. Preservative used on the metal should be of a type that it will not adversely affect the rubber or the bond to such an extent that it does not comply with the product specification.

Storage life

This is the maximum period of time that a rubber product, appropriately packaged, may be stored. After this time the product is regarded as unserviceable for the purposes for which it was originally manufactured. The storage life of a rubber product is influenced by its shape and size as well as its composition. Thick products usually undergo slower changes through degradation than thinner ones.

Initial storage period

This is the maximum period, starting from the time of manufacture, for which a rubber product, appropriately packaged, may be stored under specified conditions before a sample needs to be inspected or re-tested.

Extension storage period

This is the period for which a rubber product, appropriately packaged, may be stored after the initial storage period, before further inspection and re-testing is necessary.

Assembly

These are products or components containing more than one element in addition to rubber. Generally it is not recommended to store elastomeric products in an assembled condition. If it is necessary to do so, the units should be checked more often. The inspection interval depends on the design and geometry of the components.

Inspection before extension storage

Before any items are to be stored for an extension storage period, representative samples of each product should be selected for inspection at the end of the appropriate initial storage period. Inspection should be in accordance with the relevant product specification.

Visual inspection

Inspect each of the items for the following:

1. Permanent distortions, such as creases or flats.
2. Mechanical damage, such as cuts, tears, abraded areas or delaminated plies.
3. Surface cracking when viewed under a microscope at x10 magnification.
4. Changes in surface condition, such as hardening, softening or tackiness.

Assessment at the end of the initial period

If, following the visual inspection procedure, the items are not satisfactory, they should not be stored for an extended period. If the items are satisfactory and are stored for an extended period a record should be kept of the date that initial storage began, as well as the date the extended storage period began. Items stored for an extended period should be inspected and tested at, or before, the expiry of the extension storage period before they are put into service or stored for a further extended period.

Table 141 Initial and extension storage periods for unassembled components

Material group	Initial storage period	Extension storage period
AU, EU, NR, SBR	5 years	2 years
ACM, AEM, CR, ECO, HNBR, IIR, NBR	7 years	3 years
CSM, EPDM, FKM, FMQ, FVMQ	10 years	5 years
FFKM e.g. Isolast®	20 years	5 years
Zurcon®	10 years	5 years
PTFE	unlimited	
Note 1: If the storage temperature is over or under 25 °C this will influence the storage time. Storage at 10 °C higher will reduce the storage time by about 50%. Storage at 10 °C lower will increase the storage time by around 100 %.		
Note 2: In application areas such as aerospace the storage periods can differ from this specification. These specific storage conditions have to be agreed between the supplier and the buyer.		

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