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

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

TRELLEBORG
SEALING SOLUTIONS

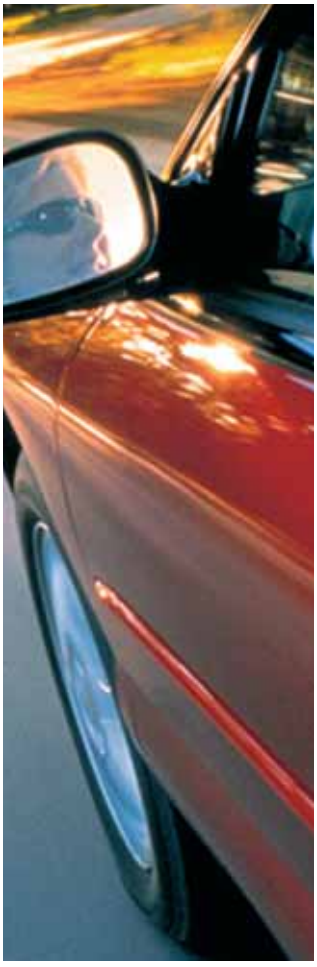
Contents

Part II: Back-up Ring

Part III: General quality criteria and storage guidelines

Introduction

The Trelleborg Group



Automotive

- Antivibration Systems
- Noise and Vibration Dampening
- Fluid Systems

Wheel Systems

- Agricultural and Forestry Tires
- Industrial Tires

Engineered Systems

- Engineering Solutions
- Marine Fenders
- Industrial Fluid Control
- Sealing Profiles for Buildings
- Water Proofing
- Offshore

Sealing Solutions

- Precision seals for the Industrial, Automotive and Aerospace markets

Trelleborg Sealing Solutions

Food, Pharmaceutical and Chemical Processing

Machine Tools

Oil and Gas

Semiconductor

Automotive

Aerospace

Fluid power

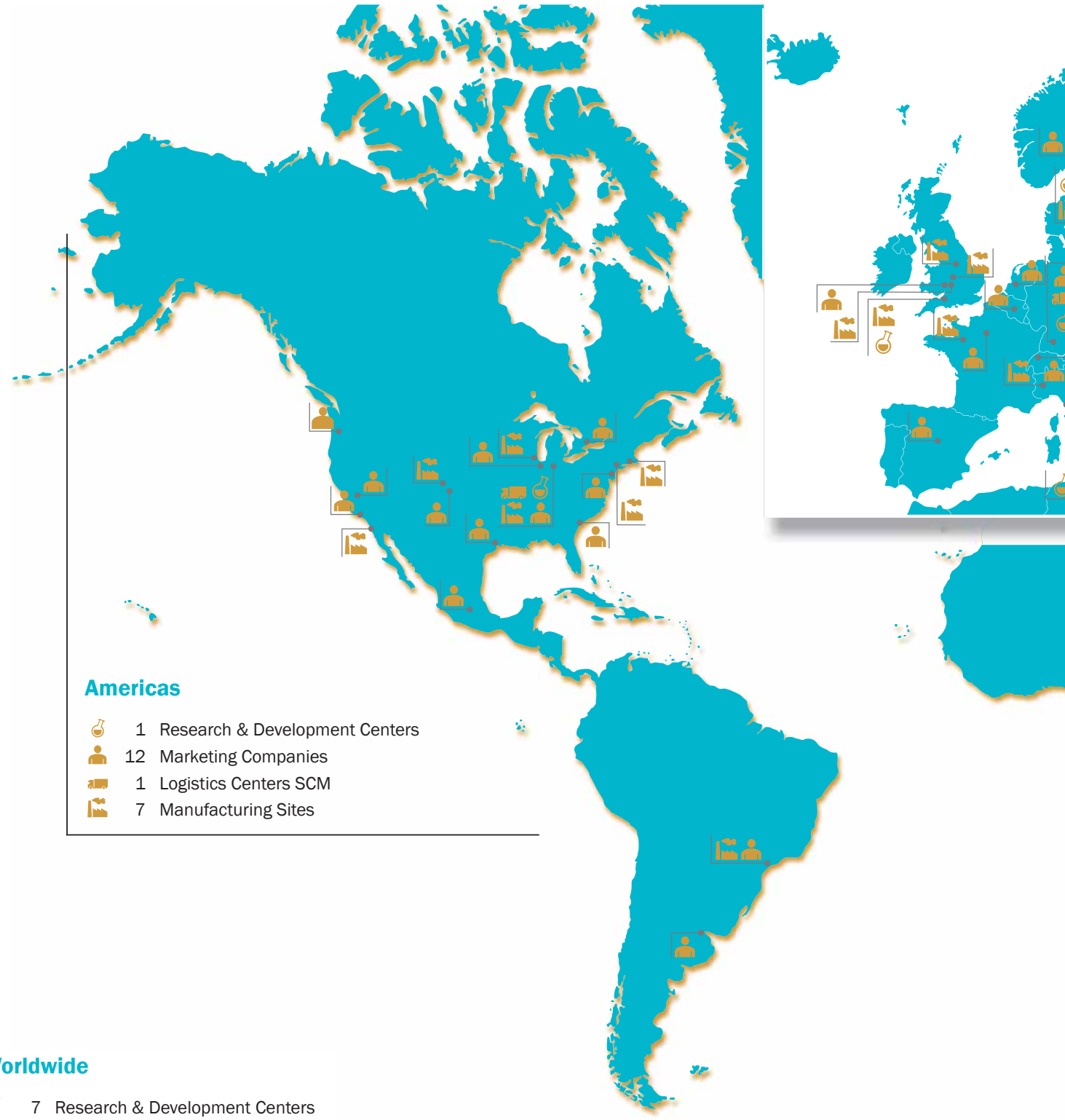
Life Sciences

Off-Highway

We build long term partnerships with customers and suppliers by providing leading technology and excellent service

Renewable Energy

Trelleborg Sealing Solutions - Global Resources



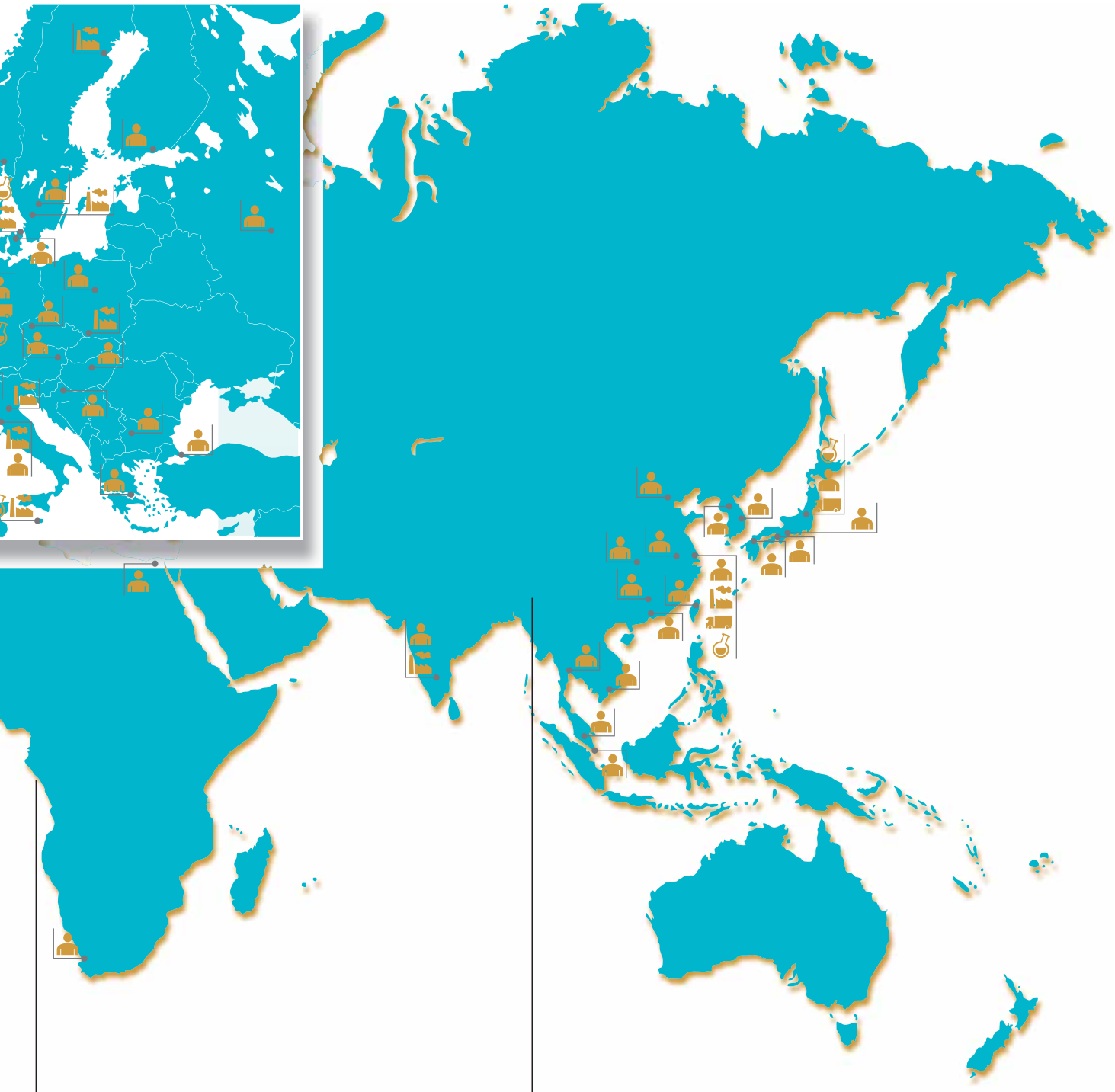
Americas

1 Research & Development Centers
12 Marketing Companies
1 Logistics Centers SCM
7 Manufacturing Sites

Worldwide

7 Research & Development Centers
49 Marketing Companies
4 Logistics Centers SCM
22 Manufacturing Sites

Trelleborg Sealing Solutions - Global Resources



Europe

- 4 Research & Development Centers
- 19 Marketing Companies
- 1 Logistics Centers SCM
- 13 Manufacturing Sites

Asia

- 2 Research & Development Centers
- 18 Marketing Companies
- 2 Logistics Centers SCM
- 2 Manufacturing Sites

Your partner for sealing technology

Our mission

We will be the supply partner of first choice within our chosen markets, working globally through our local teams. We will build long-term partnerships with customers and suppliers by providing leading technology and excellent service. We are determined to be different.

Sealing technology

Trelleborg Sealing Solutions offers an outstandingly comprehensive sealing portfolio – a one-stop-shop providing the best in elastomer, thermoplastic, Polytetrafluoroethylene (PTFE) and composite technologies; our solutions are featured in virtually every application conceivable within the aerospace, automotive and industrial industries.

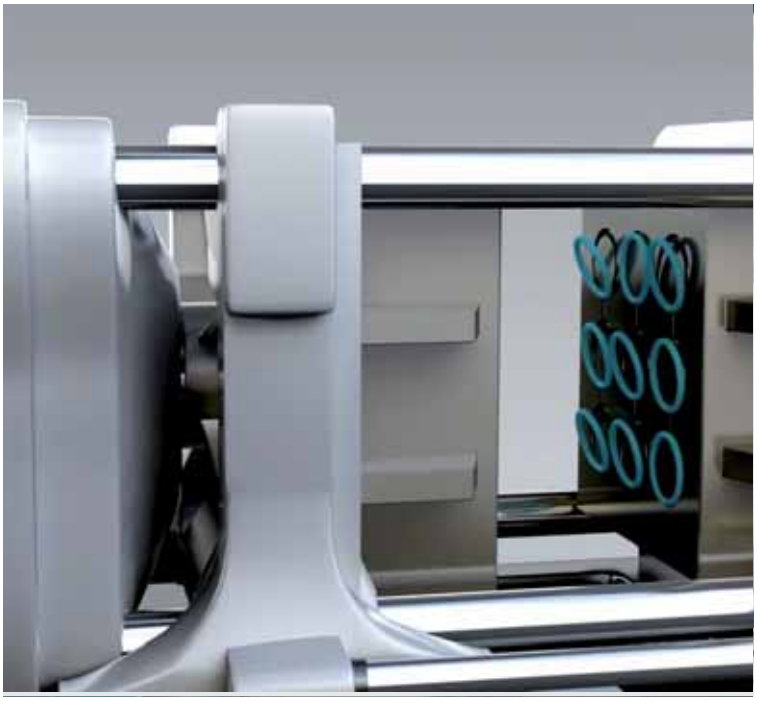
A worldwide presence

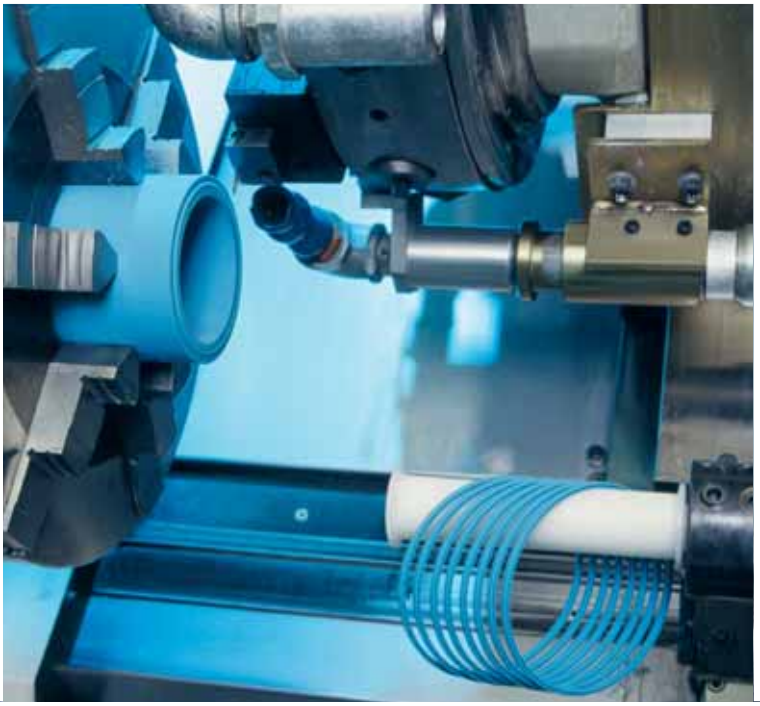
We are uniquely placed to offer a dedicated design and development service for sealing solutions, globally servicing, supporting and supplying our customers through an unrivalled international network.

- Over 70 facilities worldwide
- More than 20 manufacturing sites
- 7 strategically positioned materials and development laboratories
- Internationally linked design and application centers

Commitment - To customers' needs long-term

The aim of Trelleborg Sealing Solutions is to facilitate customers in the achievement of cost effective, durable solutions that match their specific business requirements and needs. We are one of the world's foremost experts in polymer sealing technology. We develop and manufacture market safety-critical polymer-based precision seals and associated systems.





Our pioneering products

Trelleborg Sealing Solutions is pioneering within the sealing industry and continuously developing innovative products.

- Turcon® AQ Seal®
- D-A-S Compact Seal®
- Turcon® Double Delta®
- Turcon® Excluder®
- Turcon® Glyd Ring®
- Turcon® Hatseal®
- Zurcon® L-Cup®
- Turcite® Slydring®
- Turcite®-B Slydway®
- Turcon® Stepseal®
- V-Ring®
- Turcon® Varilip® PDR
- Turcon® Variseal®
- Turcon® VL Seal®
- Turcon® Wedgpak®
- Wills Rings®
- Zurcon® Wynseal

World renowned names

We own many of the longest established and leading names within the seal industry. These include:

- American Variseal
- Busak+Shamban
- Dowty Seals
- Chase Walton
- Forsheda
- GNL
- Hydro-Components
- Impervia
- Nordex
- Orkot
- Palmer Chenard
- Polypac
- SF Medical
- Shamban
- Silcofab
- Skega
- Stefa
- Wills

Proprietary materials

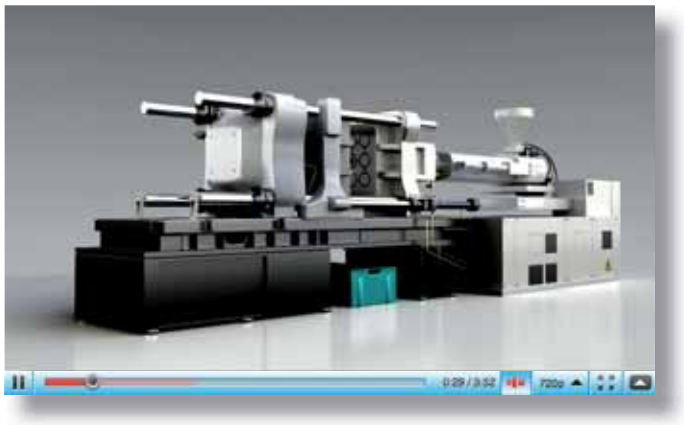
Ongoing development has yielded some of the most successful sealing materials available.

- HiMod®
- Isolast®
- Orkot®
- Turcite®
- Turcon®
- Turel®
- Zurcon®

Seals get animated

Complex sealing configurations can feature a large number of sealing elements. Trying to illustrate these on a 2D page is difficult and can never properly show their function or characteristics. Trelleborg Sealing Solutions turned to the latest graphic technologies to produce 3D animations of applications and typical sealing solutions for them.

A range of films specific to different industries and products are available to view on the Trelleborg Sealing Solutions website or via YouTube.



You can now link to our films and animations from

www. **tss.trelleborg.com/films**

or view them on YouTube at

www. **YouTube.com/trelleborgseals**

TRELLEBORG
SEALING SOLUTIONS

YouTube™

Online tools make life easier

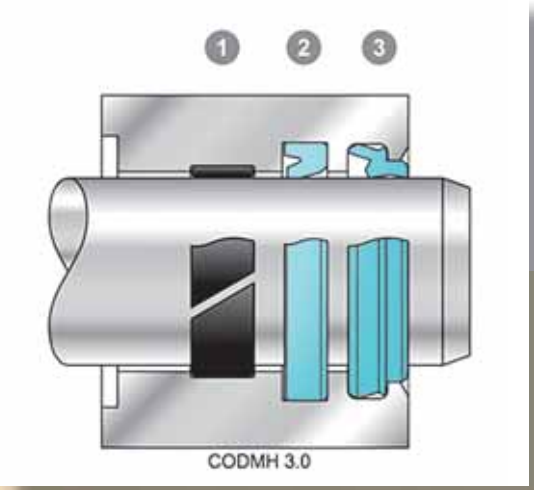
Trelleborg Sealing Solutions has developed a number of online tools that make the working life of an engineer specifying seals easier.

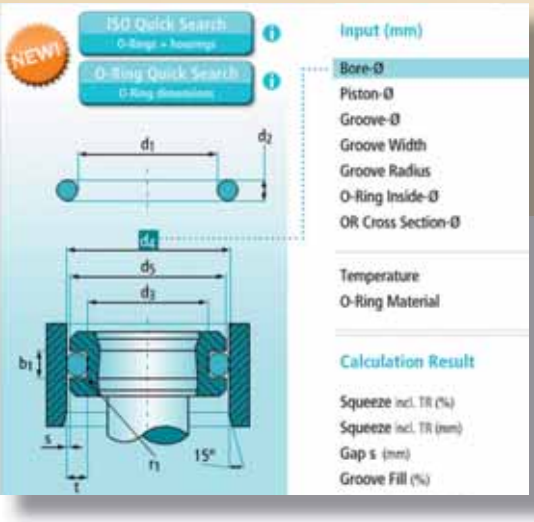
All these industry-leading online tools are available free-of-charge from the Trelleborg Sealing Solutions website at www.tss.trelleborg.com. To use these advanced services all you have to do is register in the Members Area.

www. tss.trelleborg.com

Sealing Solutions Configurator

The Sealing Solutions Configurator is the first tool of its kind offered by any seal supplier. It allows engineers to identify a proven sealing solution for their specific application in just four easy steps.





O-Ring Calculator

An industry-leading tool, the easy to use O-Ring calculator includes a sizing capability, design parameter recommendations and complete measurements. Results and comments may be printed, saved online or filed as a PDF.

Online tools

Powerful Electronic Catalog

With the powerful electronic catalog you can search through over 100,000 seals by item number or by their properties. Comprehensive and detailed information can be accessed along with an interactive quote facility.

Versatile CAD Service

The CAD download facility provides thousands of drawings from a wide seal range. It gives the option of 2- or 3-dimensional files, in a range of formats to suit most commonly used CAD systems.

Materials Search and Chemical Compatibility Check

These two programs allow you to find out the compatibility of sealing materials to hundreds of different media and help identify the most suitable material for your application.

Part I
O-Ring

Double Acting

Static and partly dynamic sealing applications

Material:
Elastomers, Zurcon® and others

A General information

A.1 Description

O-Rings offer the designer an efficient and economical sealing element for a wide range of static or dynamic applications.

Inexpensive production methods and its ease of use have made the O-Ring the most widely used seal.

A wide choice of elastomer materials for both standard and special applications allow the O-Ring to be used to seal practically all liquid and gaseous media.

O-Rings are vulcanized in molds and are characterised by their circular form with annular cross section. The dimensions of the O-Ring are defined by the inside diameter d_1 and the cross section d_2 (Figure 1).

Cross sections of approx. 0.35 to 40 mm and inside diameters up to 5,000 mm and more are available.

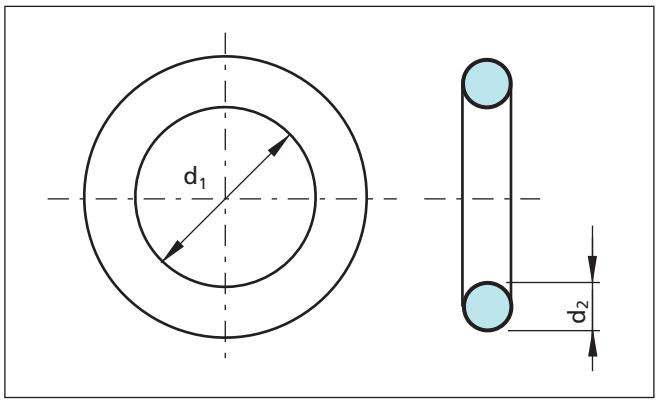


Figure 1 O-Ring dimensioning

Advantages

Compared with other sealing elements, the O-Ring has a wide range of advantages:

Simple, one piece groove design reduces hardware and design costs

- Compact design allows smaller hardware
- Easy, foolproof installation reduces risk
- Applicable to a wide range of sealing problems, static, dynamic, single or double acting
- Wide compound choice for compatibility with most fluids
- Ex stock availability of many sizes worldwide for easy maintenance and repair

A.2 Applications

O-Rings are used as sealing elements or as energizing elements for hydraulic slipper seals and wipers and thus cover a large number of fields of application. There are no fields of industry where the O-Ring is not used. From an individual seal for repairs or maintenance to a quality assured application in aerospace, automotive or general engineering. The O-Ring is used predominantly for static sealing applications:

- As a radial static seal, e.g. for bushings, covers, pipes, cylinders
- As an axial static seal, e.g. for flanges, plates, caps.

O-Rings in dynamic applications are recommended **only for moderate service conditions**. They are limited by the speed and the pressure against which they are to seal:

- For low duty sealing of reciprocating pistons, rods, plungers, etc.
- For sealing of slowly pivoting, rotating or spiral movements on shafts, spindles, rotary transmission leadthroughs, etc.

A.3 Method of operation

O-Rings are double-acting sealing elements. The inital squeeze, which acts in a radial or axial direction depending on the installation, gives the O-Ring its initial sealing capability. These forces are superimposed by the system pressure to create the total sealing force which increases as the systeme pressure increases (Figure 2).

Under pressure, the O-Ring behaves in a similar way to a fluid with high surface tension. The pressure is transmitted uniformly to all directions.

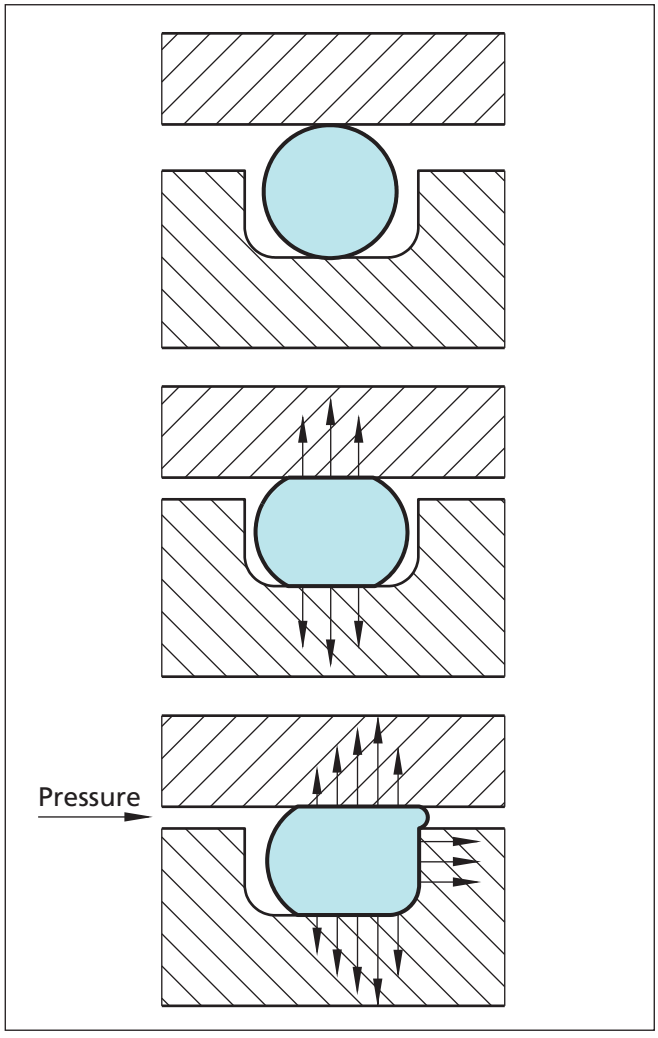


Figure 2 O-Ring sealing forces with and without system pressure

B Technical information

B.1 Materials

B.1.1 Elastomers

Equipment manufacturers and end users expect sealing systems to operate leak free and to maintain long service life. Reliability is crucial to effective low maintenance cost operations. To find the perfect sealing solution in each individual case both material performance and seal design are critically important. One of the main used material groups for sealings are the elastomers. They show good properties like elasticity or good chemical compatibility.

The following tables provide a summary of the various elastomer material groups. Trelleborg Sealing Solutions can offer a large number of materials within each group.

If no particular specifications are given for the material, standard NBR (Nitrile Rubber) in 70 Shore A will be supplied (see chapter "B.1.5 Standard materials").

Table 1 Elastomer

Designation	Trade Name*	Abbreviation		
		ISO 1629	ASTM D 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
Polyacrylate Rubber	Noxtite® Hytemp® Nipol AR®	ACM	ACM	A
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 Rubber	Dai-El® Fluorel® Tecnoflon® Viton®	FKM	FKM	V
Perfluoro Rubber	Isolast® Kalrez®	FFKM	FFKM	J
Polyester Urethane Polyether Urethane	Zurcon® Adiprene® Pellethan® Vulcollan® Desmopan®	AU EU	AU EU	WU WU

* Selection of registered trade names
** Abbreviation not yet standardised.

ASTM = American Society for Testing and Materials
ISO = International Organisation for Standardisation

Designation	Trade Name*	Abbreviation		
		ISO 1629	ASTM D 1418	TSS
Chlorosulphonated Polyethylene Rubber	Hypalon®	CSM	CSM	WM
Polysulphide Elastomer	Thiokol®	-	TWT	WY
Epichlorohydrin Elastomer	Hydrin®	-	-	WO

* Selection of registered trade names
** Abbreviation not yet standardised.

ASTM = American Society for Testing and Materials
ISO = International Organisation for Standardisation

Table 2 The most important types of synthetic rubber, their grouping and abbreviations

Chemical name	Abbreviation	
	ISO 1629	ASTM D 1418
M - Group (saturated carbon molecules in main macro-molecule-chain)		
- Polyacrylate Rubber	AC**M**	AC**M**
- Ethylene Acrylate Rubber	AE**M**	
- Chlorosulfonated Polyethylene Rubber	CS**M**	CS**M**
- Ethylene Propylene Diene Rubber	EPD**M**	EPD**M**
- Ethylene Propylene Rubber	EP**M**	EP**M**
- Fluorocarbon Rubber	FK**M**	FK**M**
- Perfluoro Rubber	FFK**M**	FFK**M**
O - Group (with oxygen molecules in the main macro-molecule chain)		
- Epichlorohydrin Rubber	C**O**	C**O**
- Epichlorohydrin Copolymer Rubber	EC**O**	EC**O**
R - Group (unsaturated hydrogene carbon chain)		
- Chloroprene Rubber	C**R**	C**R**
- Butyl Rubber	II**R**	II**R**
- Nitrile Butadiene Rubber	NB**R**	NB**R**
- Natural Rubber	N**R**	N**R**
- Styrene Butadiene Rubber	SB**R**	SB**R**
- Hydrogenated Nitrile Butadiene Rubber	HNB**R**	HNB**R**
Q - Group (with Silicone in the main chain)		
- Fluorosilicone Rubber	FVMQ	FVMQ
- Methyl Vinyl Silicone Rubber	VMQ	VMQ
U - Group (with carbon, oxygen and nitrogen in the main chain)		
- Polyester Urethane	A**U**	A**U**
- Polyether Urethane	E**U**	E**U**

B.1.2 Application parameters of elastomers

Elastomers as 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 amongst others swell, shrink or harden and develop cracks or even tears.
The following information illustrates the different application parameters.

Elastomer heat resistance / swelling in oil

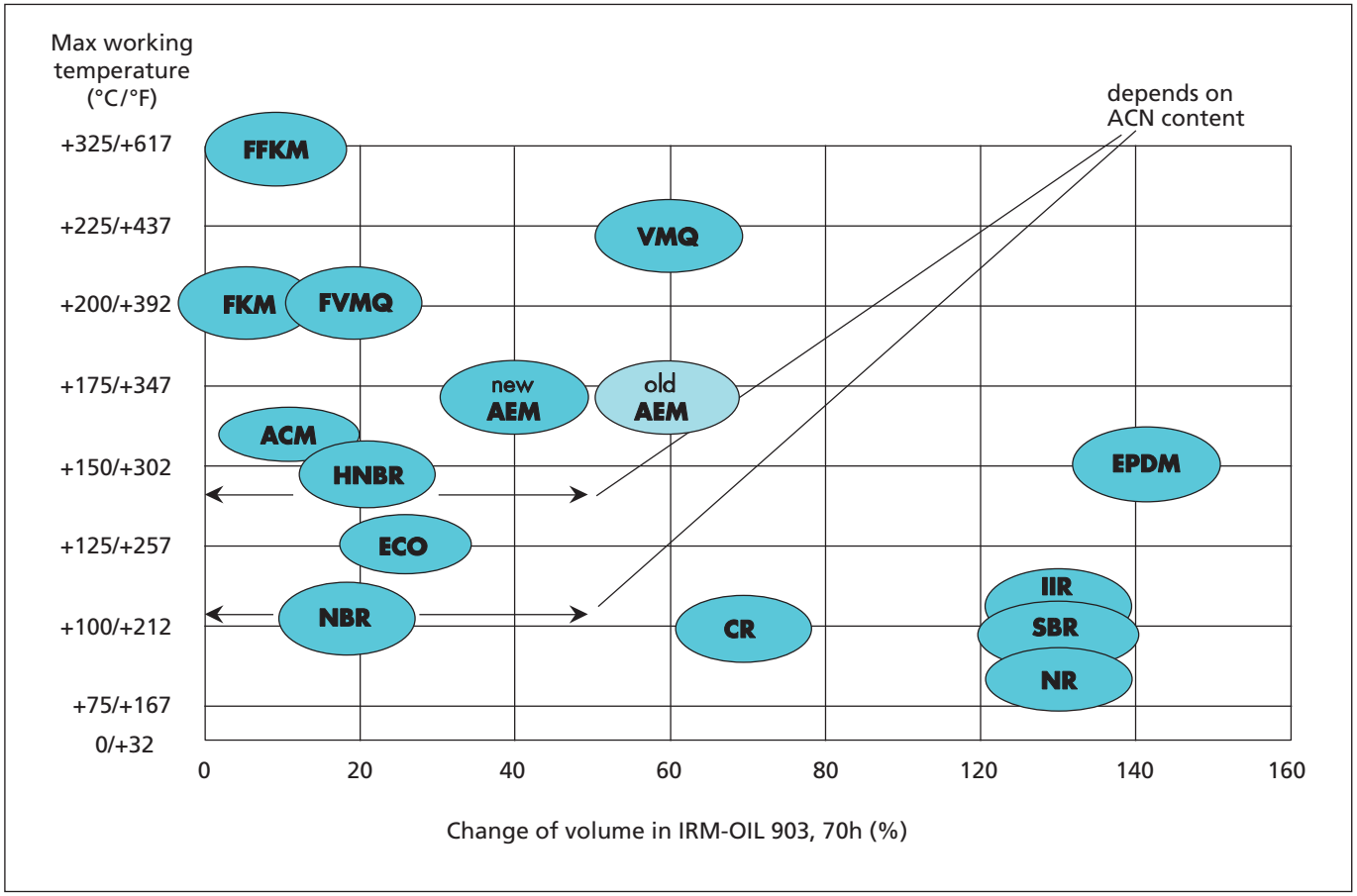


Figure 3 Change of volume in IRM-Oil 903 (old ASTM-Oil No 3)

Temperature range

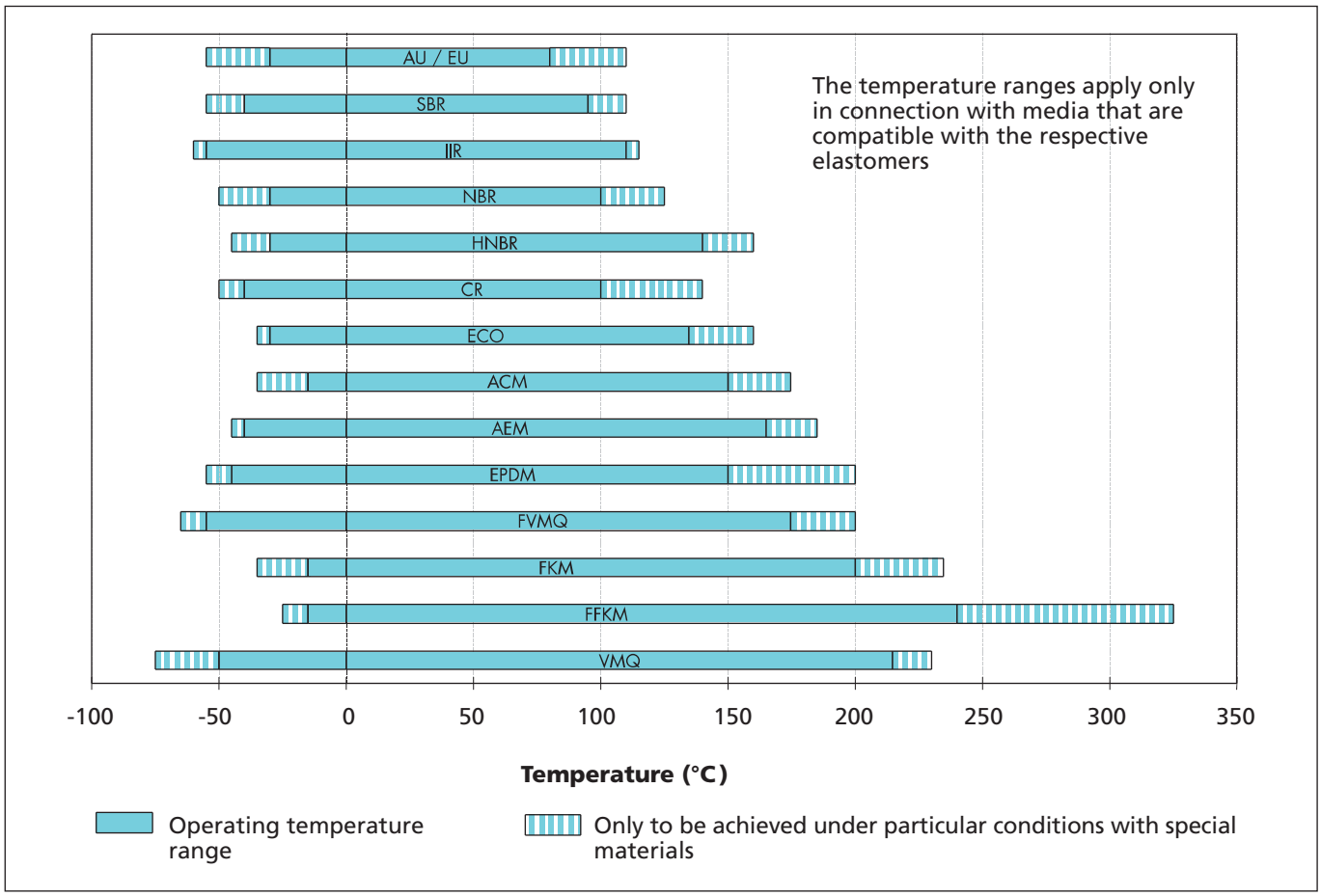


Figure 4 Temperature range of various elastomers

General field of application

Elastomer materials are used to cover a large number of fields of application. The various elastomers can be characterised as follows:

ACM (Polyacrylate Rubber)

ACM shows excellent resistance to ozone, weathering and hot air, although it shows only a medium physical strength, low elasticity and a relatively limited low temperature capability. The operating temperatures range from -20 °C and +150 °C (for a short period of time up to +175 °C). Special types can be used down to -35 °C. ACM-materials are mainly used in automotive applications which require special resistance to lubricants containing many additives (incl. sulphur) at high temperatures.

CR (Chloroprene Rubber)

In general the CR materials show relatively good resistances to ozone, weathering, chemicals and aging. Also they show good non-flammability, good mechanical properties and cold flexibility. The operating temperatures range between -35 °C and +90 °C (for a short period of time up to +120 °C). Special types can be used down to -55 °C. CR materials are found in sealing applications such as refrigerants, for outdoor applications and in the glue industry.

EPDM (Ethylene Propylene Diene Rubber)

EPDM shows good heat, ozone and aging resistance. In addition they also exhibit high levels of elasticity, good low temperature behaviour as well as good insulating properties. The operating temperatures of applications for EPDM range between -45 °C and +150 °C (for a short period of time up to +175 °C). With sulphur cured types the range is reduced to -45 °C and +130 °C (for short period of time up to +150 °C). EPDM can often be found in applications with brake fluids (based on glycol) and hot water.

FFKM (Perfluoro Rubber)

Perfluoroelastomers show broad chemical resistance similar to PTFE as well as good heat resistance. They show low swelling with almost all media. Depending on the material the operating temperatures range between -25 °C and +240 °C Special types can be used up to +325 °C. Applications for FFKM can be mostly found in the chemical and process industries and in all applications with either aggressive environments or high temperatures.

FKM (Fluorocarbon Rubber)

Depending on structure and fluorine content FKM materials can differ with regards to their chemical resistance and cold-flexibility. FKM is known especially for its non-flammability, low gas permeability and excellent resistance to ozone, weathering and aging. The operating temperatures of the Fluorocarbon Rubber range between -20 °C and +200 °C (for a short period of time up to +230 °C). Suitable formulated FKM can be used down to -35 °C. FKM is also often used with mineral based oils and greases at high temperatures.

FVMQ (Fluorosilicone Rubber)

FVMQ has a good heat resistance, very good low temperature flexibility, good electrical properties and excellent resistance to weather, ozone and UV rays. FVMQ shows a significant better chemical resistance than standard Silicone especially in hydrocarbons, aromatic mineral oils, fuel and low molecular aromatic hydrocarbons e.g. Benzene and Toluene. The temperature range is between -50 °C and +175 °C (temporary up to +200 °C).

HNBR (Hydrogenated Nitrile Butadiene Rubber)

HNBR is made via selective hydrogenation of the NBR butadiene groups. The properties of the HNBR rubber depend on the ACN content which ranges between 18 % and 50 % as well as on the degree of saturation. HNBR shows good mechanical properties. The operating temperature of HNBR ranges between -30 °C and +140 °C (for a short period of time up to +160 °C) in contact with mineral oils and greases. Special types can be used down to -40 °C.

IIR (Butyl Rubber)

Butyl Rubber shows a very low gas and moisture permeability. In addition IIR also exhibits a good resistance to a large number of organic and inorganic chemicals, ozone, weathering and aging. The electrical insulating properties of IIR are excellent. Its temperature range is between -40 °C and +110 °C and for a short period of time up to +120 °C.

NBR (Nitrile Butadiene Rubber)

The properties of the Nitrile Rubber depend mainly on the ACN content which ranges between 18 % and 50 %. In general they show good mechanical properties. The operating temperatures range between -30 °C and +100 °C (for a short period of time up to +120 °C). Suitable formulated NBR can be used down to -60 °C. NBR is mostly used with mineral based oils and greases.

Polyurethane (Zurcon® Polyurethane)

Polyurethanes are an exceptionally complex material group. They are individually designed and fit various applications' needs. Therefore it is not possible to unify the materials' properties.
Zurcon® polyurethane materials from Trelleborg Sealing Solutions are customized to appropriate applications and stand out due to their excellent elastic properties and optimum abrasion resistance. Outstanding tensile strength, low compression set and good resistance to O_2 and O_3 are further significant characteristics. Depending on the individual Zurcon® polyurethane type the application temperature range from below -50 °C up to +110 °C, temporary even higher, is feasible.

VMQ (Silicone Rubber)

VMQ shows excellent heat resistance, cold flexibility, dielectric properties and especially good resistance to weather, ozone an UV rays. Specific VMQ formulations are resistant to aliphatic engine and gear oils, water up to +100 °C and high-molecular chlorinated hydrocarbons. The temperature range is between -50 °C and +175 °C (temporary up to +230 °C).

Chemical compatibility

For the pre-selection of a suitable material group a comprehensive chemical compatibility guide is available. This can be downloaded from our website www.tss.trelleborg.com or you can contact your local Trelleborg Sealing Solutions company for further details.

It is important to recognise that when using this guide, the ratings shown are based on published data and immersion tests. These tests are conducted under laboratory conditions predominantly at room temperature and may not represent adequately the conditions in the field. Relative short term laboratory tests may not pick up all the additives and impurities which may exist in long term service applications.

Care must be taken to ensure that all aspects of the application are considered carefully before a material is selected. For example at elevated temperatures some aggressive fluids can cause a much more marked effect on an elastomer than at room temperature.

Physical properties as well as fluid compatibility need to be considered. Compression set, hardness, abrasion resistance and thermal expansion can influence the suitability of a material for a particular application.

It is recommended that users conduct their own tests to confirm the suitability of the selected material for each application.

Our experienced technical staff can be consulted for further information on specific applications.

B.1.3 Characteristics and inspection of elastomers

Hardness

One of the most often named properties regarding Polymer materials is hardness. Even so the values can be quite misleading.

Hardness is the resistance of a body against penetration of an even harder body - of a standard shape defined pressure.

There are two procedures for hardness tests regarding test samples and finished parts made out of elastomer material:

1. Shore A / D according to ISO 868 / ISO 7619-1 / ASTM D 2240
   Measurement for test samples
2. Durometer IRHD (International Rubber Hardness Degree) according to ISO 48 / ASTM 1414 and 1415
   Measurement of test samples and finished parts

The hardness scale has a range of 0 (softest) to 100 (hardest). The measured values depend on the elastic qualities of the elastomers, especially on the tensile strength.

The test should be carried out at temperatures of 23 ±2 °C - not earlier than 16 hours after the last vulcanisation process (manufacturing stage). If other temperatures are being used this should be mentioned in the test report.

Tests should only be carried out with samples which have not been previously stressed mechanically.

Hardness tests according to Shore A / D

The hardness test device Shore A (indentor with pyramid base) is a sensible application in the hardness range 10 to 90. Samples with a larger hardness should be tested with the device Shore D (indentor with spike).

Test specimen:
Diameter min. 1.181 inches (30 mm)
Thickness min. .240 inches (6 mm)
Upper and lower sides smooth and flat

When thin material is being tested it can be layered providing minimal sample thickness is achieved by a maximum of 3 layers. All layers must be at minimum .080 inches (2 mm) thick.

The measurement is done at five different places at a defined distance and time.

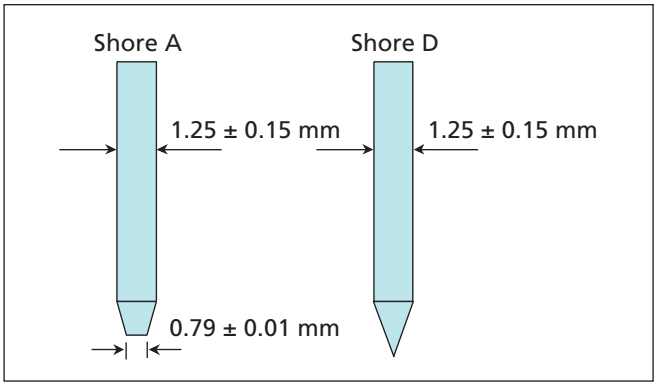


Figure 5 Indentor according to Shore A / D

Hardness test according to IRHD

The test of the Durometer according to IRHD is used with test samples as well as with finished goods.

The thickness of the test material has to be adjusted according to the range of hardness. According to ISO 48 there are two hardness ranges:

Soft: 10 to 35 IRHD ⇒ Sample thickness .394 to .591 inches (10 to 15 mm) / procedure "L"

Normal: over 35 IRHD ⇒ Sample thickness .315 to .394 inches (8 to 10 mm) / procedure "N"
Sample thickness .059 to .098 inches (1.5 to 2.5 mm) / procedure "M"

The hardness determined with finished parts or samples usually vary in hardness determined from specimen samples, especially those with a curved surface.

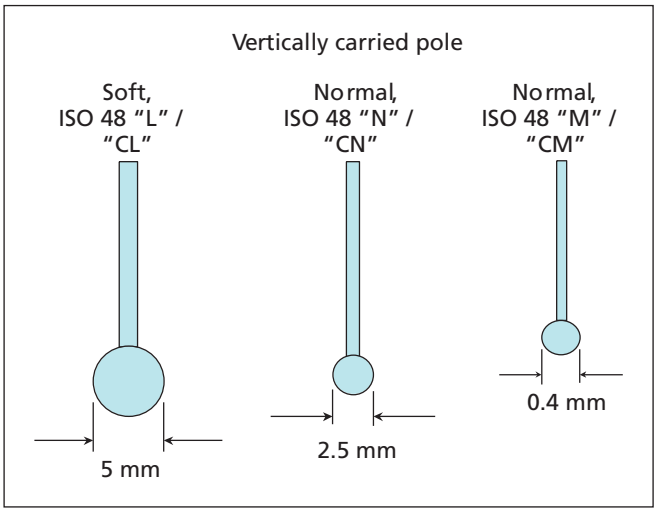


Figure 6 Indentor according to IRHD

Influencing parameters on the hardness test for polymer materials

Various sample thicknesses and geometries as well as various tests can show different hardness values even though the same materials have been used.

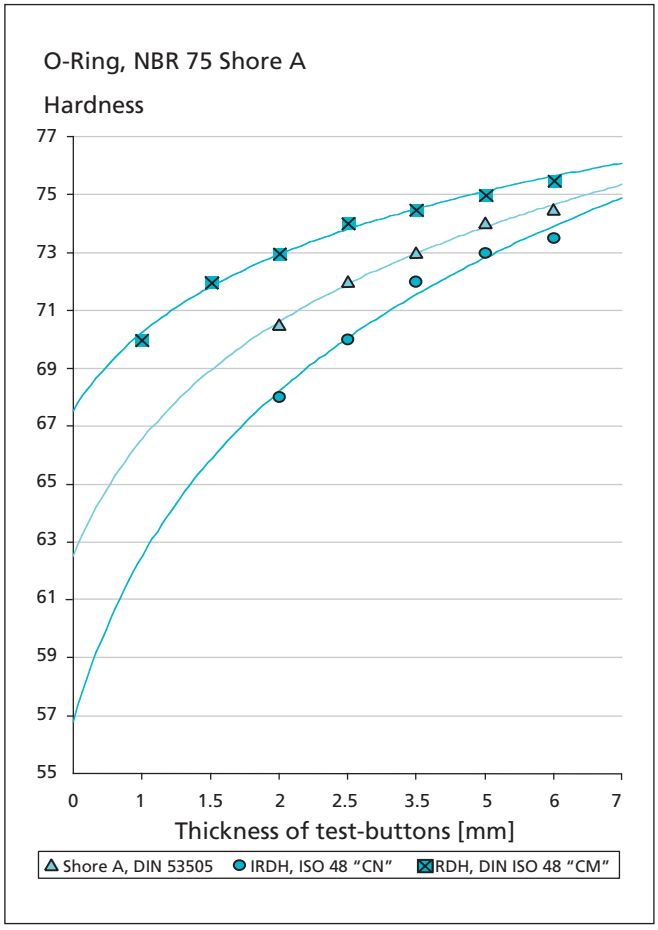


Figure 7 Ranges of hardness depending on sample thickness and test method

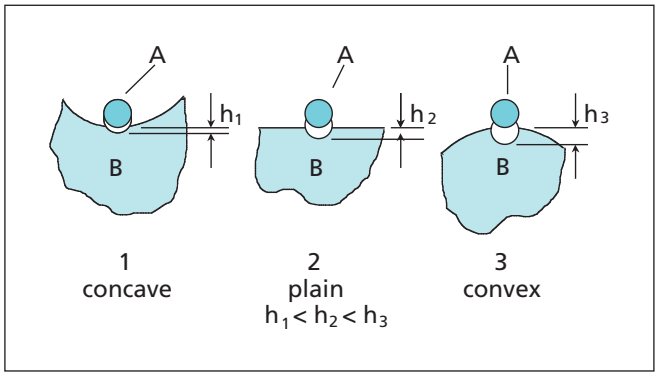


Figure 8 Range of hardness depending on surface geometry for the equivalent material characteristics

With equivalent material characteristics of the elastomer sample B, the indentor penetrates the deepest at the surface 3 (convex) and therefore establishes the softest area.

As the convex geometry (3) has a stronger effect on smaller width O-Rings, the tolerances on hardness for widths under 2.0 mm should be increased up to +5 / -8 IRHD based on the valid IRHD nominal value.

Compression set

An important parameter regarding the sealing capability is the compression set (CS) of the O-Ring material. Elastomers when under compression show aside from an elastic element also a permanent plastic deformation (Figure 9).

The compression set is determined in accordance with ISO 815 as follows:

Standard test piece:	Cylindrical disc, diameter .512 and height .236 inches (13 mm and height 6 mm)
Deformation:	25 %
Tension release time:	30 minutes

$$CS = \frac{h_0 - h_2}{h_0 - h_1} \cdot 100(\%)$$

Where h_0 = Original height (cross section d_2)
h_1 = Height in the compressed state
h_2 = Height after tension release

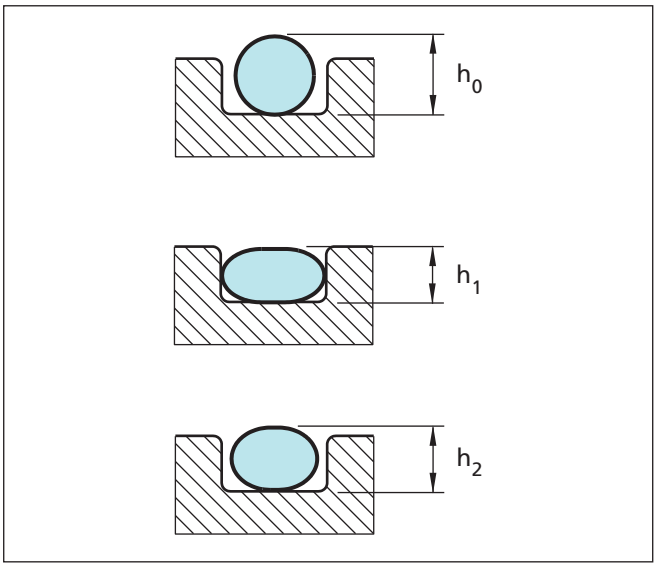


Figure 9 Illustration of the compression set

The accuracy of the measured value depends on:

- Test sample thickness
- Deformation
- Measurement deviations

Therefore the values which have been identified with the test sample cannot be transferred onto the finished part. The result of the measured finished parts are strongly influenced by geometrics and measurements as well as the measuring accuracy of the test equipment.

The following illustration shows the influence of various measuring deviations (in mm) in respect to the established compression set CS depending on the cross section of the measured O-Rings.

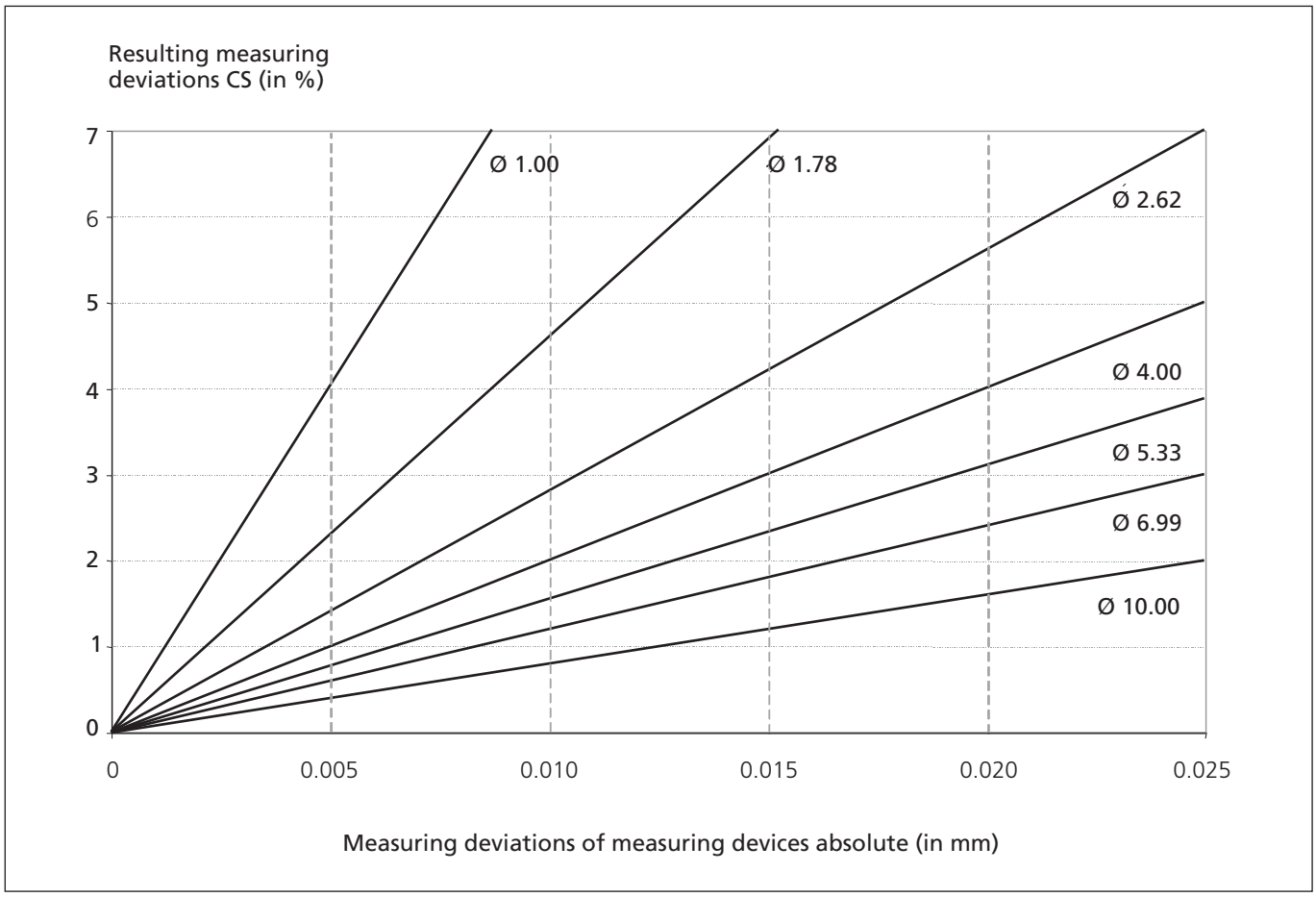


Figure 10 Measuring deviations CS depending on O-Ring cross section and measuring accuracy of the test equipment (schematic illustration)

B.1.4 Special requirements - authorities and approvals

Seals often have to meet the highest performance standards and the most stringent of environment and safety demands.
Also official authorities and associations make great demands on seals or materials which are to be used in their industries. This is often the case if seals are used for water or gas applications.
The following table shows common authorities and their requirements.

Table 3 Authorities and approvals

Approval / Examination Certificate / Guideline	Application	Criteria / Standards	Tests / Examinations / Contents	Authorities / Associations	Institutes / Laboratories
ACS Licensing	Polymers exposed to drinking water	French Standard AFNOR XP P41-250, part 1-3 Synoptic Paper 1226	- Analysis of dispensing according "Synoptic - Documents - "Storage test (microbe analysis)	ACS (Accréditation de conformité sanitaire)	3 certified test laboratories in France: Paris / Vandoevre / Lille
BAM Recommendation	Seals for the use in gas or oxygen fittings	- reactive behaviour with lubricants - limits for pressure and temperature (DIN 4060) - seals and components		BAM (Bundesanstalt für Materialforschung und -prüfung)	BAM, Berlin
BfR Recommendation (former: BgVV)	Polymers exposed to food	BfR Guidelines ("Polymers exposed to food") various paragraphs, depending on the application of the seal	- Chemical and physical tests - Biological tests - Sterilisation tests - Taste tests	BfR (Bundesanstalt für Risikobewertung)	BAM, Berlin HY (Hygiene-Institut, Gelsenkirchen)
DVGW Release for Gas	Seals for gas services and gas applications	EN 549 EN 682		DVGW, Bonn (Deutscher Verein des Gas- und Wasserfaches e.V.)	Test Laboratory for Gas, Karlsruhe, MPA NRW, Dortmund
DVGW W270 Recommendation	Materials exposed to drinking water	DVGW, worksheet W 270	Microbiological testing: reproduction of microorganisms on materials	DVGW, Bonn (Deutscher Verein des Gas- und Wasserfaches e.V.)	TZW, Karlsruhe HY (Hygiene Institution), Gelsenkirchen
FDA Guideline	Materials for food and pharmaceutical	"White List" (Register of permitted dispensing components), e.g. according to 21. CFR Part 177.2600	- Component test according "White List" - Extended for foods containing water or oi - Extraction test for polar / non polar solvents	FDA (Food and Drug Administration)	In house or external laboratories
International Military Releases	Applications for military devices	Various military specifications and standards depending on the application	Depending on application and specification		Various test laboratories
KTW Certificate[1]	Polymers exposed to drinking water, Cold- warm- and hot water	BfR Guidelines ("Polymers exposed to food") part 1.3.13	Extraction testOdour- and taste testRegister of permitted components	DVGW, Bonn (Deutscher Verein des Gas- und Wasserfaches e.V.)	Environmental Hygiene Institute, Gelsenkirchen TZW, Karlsruhe BAM, Berlin

Approval / Examination Certificate / Guideline	Application	Criteria / Standards	Tests / Examinations / Contents	Authorities / Associations	Institutes / Laboratories
NSF Release	Food and Sanitary	NSF Standard criteria	Depending on application: - Test of components - Test of component group - Physical and chemical material tests - Toxicological and microbiological tests	NSF (National Sanitation Foundation)	NSF, USA UL, USA
Regulation (EC) 1935/2004	Food Products	Regulation (EU) 10/2011 Regulation (EC) 2023/2006 national regulations (e.g. BfR)	Amongst others: - Union list of authorized substances - Migration tests with limits for the total migration	EU	Different test laboratories
UL Listing	Application of seals for electrical equipment + appliances	UL-guidelines	Chemical comparability test Additional tests depending on application	UL (Underwriters Laboratory)	Underwriters laboratory in USA/England
USP Examination	For medical and pharmaceutical use	Different specifications: USP 26 et seqq., chapter 87, 88, Class I to VI,...	Depending on specification: - Intracutaneous reactive tests - Systemic Injections - Muscle implantations	USP (United States Pharmacopeia, USA)	Different authorized test laboratories
WRAS Release (former: WRC)	Polymers exposed to drinking water	British Standard BS 6920 BS 2494	Dispensing testMicrobe testExtraction testHot water test	WRAS (Water Regulations Advisory Scheme)	Various accredited test laboratories in England
18-03 3-A Sanitary	Food Products	18-03 3-A Sanitary Standards for multiple-use rubber and rubber-like materials used as product contact surfaces in dairy equipment	Chemical and physical properties according to Class I to III	Organisations: LAFIS, IAFP, USPHS, EHEDG, DIC	Various laboratories

[1] Date of validity May 2011, subject to change

B.1.5 Standard materials

The following tables show the physical properties of Trelleborg Sealing Solutions standard materials. They concern minimum values. That means that a standard material meets at least the given values. Many of the Trelleborg Sealing Solutions materials (even when defined as standard) have better physical properties.

Table 4 Material specification for standard NBR

				NBR 50 Shore A	NBR 60 Shore A	NBR 70 Shore A	NBR 80 Shore A	NBR 90 Shore A
TSS Material Code				**N50**	**N60**	**N70**	**N80**	**N90**
Hardness		DIN 53 505 ASTM D 2240	Shore A	50 ± 5	60 ± 5	70 ± 5	80 ± 5	90 ± 5
Tensile strength		DIN 53 504 ASTM D 412	MPa N/ mm²	≥ 8	≥ 10	≥ 14	≥ 12	≥ 10
Elongation at break		DIN 53 504 ASTM D 412	%	≥ 200	≥ 200	≥ 200	≥ 150	≥ 100
Compression set	24h / 100 °C	DIN ISO 815B ASTM D 395B	%	< 30	< 30	< 25	< 30	< 30
Heat aging	72h / 100 °C	DIN 53 508 ASTM D 573						
Change of hardness			Shore A	max. +8	max. +8	max. +8	max. +8	max. +8
Change of tensile strength			%	max. -25	max. -25	max. -25	max. -25	max. -30
Change of elongation at break			%	max. -25	max. -25	max. -25	max. -25	max. -30
Resistance in ASTM-OIL # 1	72h / 100 °C	DIN 53 521 ASTM D 471						
Change of hardness			Shore A	max. +6	max. +6	max. +6	max. +6	max. +6
Change of volume			%	max. -8	max. -8	max. -8	max. -8	max. -8
Resistance in ASTM-OIL # 3	72h / 100 °C	DIN 53 521 ASTM D 471						
Change of hardness			Shore A	max. -10	max. -10	max. -10	max. -10	max. -10
Change of volume			%	max. +15	max. +15	max. +15	max. +15	max. +15
Temperature range Maximum and minimum operating temperatures depend on the specific application criteria.				-30 °C to +100 °C	-30 °C to +100 °C	-30 °C to +100 °C	-25 °C to +100 °C	-25 °C to +100 °C

Table 5 Material specification for standard EPDM

				EPDM 70 Shore A sulphur cured	EPDM 70 Shore A peroxide cured	EPDM 75 Shore A peroxide cured
TSS Material Code				**E70**	**E75**	**EC5**
Hardness		DIN 53 505 ASTM D 2240	Shore A	70 ± 5	70 ± 5	75 ± 5
Tensile strength		DIN 53 504 ASTM D 412	MPa N/mm²	≥ 10	≥ 10	≥ 10
Elongation at break		DIN 53 504 ASTM D 412	%	≥ 150	≥ 125	≥ 125
Compression set	24h / 100 °C	DIN ISO 815B ASTM D 395B	%	< 20		
	24h / 150 °C		%		< 30	< 30
Heat aging	72h / 100 °C	DIN 53 508 ASTM D 573		x		
	72h / 150 °C				x	x
Change of hardness			Shore A	max. +10	max. +10	max. +10
Change of tensile strength			%	max. -10	max. -20	max. -20
Change of elongation at break			%	max. -20	max. -20	max. -20
Resistance in water	72h / 100 °C	DIN 53 521 ASTM D 471				
Change of hardness			Shore A	max. -10	max. -3	max. -3
Change of volume			%	max. +10	max. +3	max. +3
Temperature range Maximum and minimum operating temperatures depend on the specific application criteria.				-45 °C to +130 °C	-45 °C to +150 °C	-45 °C to +150 °C

Table 6 Material specification for standard VMQ

				VMQ 50 Shore A	VMQ 60 Shore A	VMQ 70 Shore A
TSS Material Code				**S50T**	**S60**	**S70R**
Hardness		DIN 53 505 ASTM D 2240	Shore A	50 ± 5	60 ± 5	70 ± 5
Tensile strength		DIN 53 504 ASTM D 412	MPa N/mm²	≥ 5	≥ 5	≥ 5
Elongation at break		DIN 53 504 ASTM D 412	%	≥ 150	≥ 100	≥ 100
Compression set	24h / 175 °C	DIN ISO 815B ASTM D 395B	%	< 35	< 35	< 35
Heat aging	72h / 225 °C	DIN 53 508 ASTM D 573				
Change of hardness			Shore A	max. +15	max. +15	max. +15
Change of tensile strength			%	max. -40	max. -40	max. -40
Change of elongation at break			%	max. -40	max. -40	max. -40
Resistance in ASTM-Oil # 1	72h / 100 °C	DIN 53 521 ASTM D 471				
Change of hardness			Shore A	max. -10	max. -10	max. -10
Change of volume			%	max. +20	max. +20	max. +20
Temperature range Maximum and minimum operating temperatures depend on the specific application criteria.				-50 °C to +175 °C	-50 °C to +175C	-50 °C to +175 °C

Table 7 Material specification for standard FKM

				FKM 70 Shore A	FKM 75 Shore A	FKM 80 Shore A	FKM 90 Shore A
TSS Material Code				**V70**	**VC0**	**V80**	**V90**
Hardness		DIN 53 505 ASTM D 2240	Shore A	70 ± 5	75 ± 5	80 ± 5	90 ± 5
Tensile strength		DIN 53 504 ASTM D 412	MPa N/mm²	≥ 10	≥ 10	≥ 10	≥ 10
Elongation at break		DIN 53 504 ASTM D 412	%	≥ 125	≥ 125	≥ 120	≥ 100
Compression set	24h / 175 °C	DIN ISO 815B ASTM D 395B	%	< 20	< 20	< 20	< 20
Heat aging	72h / 250 °C	DIN 53 508 ASTM D 573					
Change of hardness			Shore A	max. +10	max. +10	max. +10	max. +10
Change of tensile strength			%	max. -25	max. -25	max. -25	max. -25
Change of elongation at break			%	max. -25	max. -25	max. -25	max. -25
Resistance in ASTM-Oil # 3	72h / 150 °C	DIN 53 521 ASTM D 471					
Change of hardness			Shore A	max. -5	max. -5	max. -5	max. -5
Change of volume			%	max +5	max. +5	max. +5	max. +5
Resistance in ASTM-FUEL C	72h / RT	DIN 53 521 ASTM D 471					
Change of hardness			Shore A	max. -5	max. -5	max. -5	max. -5
Change of volume			%	max. +10	max. +10	max. +10	max. +10
Temperature range Maximum and minimum operating temperatures depend on the specific application criteria.				-20 °C to +200 °C	-20 °C to +200 °C	-20 °C to +200 °C	-15 °C to +200 °C

Table 8 Material specification for standard HNBR

				HNBR 70 Shore A partially saturated	HNBR 75 Shore A partially saturated
TSS Material Code				**H70**	**HC0**
Hardness		DIN 53 505 ASTM D 2240	Shore A	70 ± 5	75 ± 5
Tensile strength		DIN 53 504 ASTM D 412	MPa N/mm²	≥ 15	≥ 15
Elongation at break		DIN 53 504 ASTM D 412	%	≥ 250	≥ 250
Compression set	24h / 125 °C	DIN ISO 815B ASTM D 395B	%	< 35	< 35
Heat aging	72h / 150 °C	DIN 53 508 ASTM D 573			
Change of hardness			Shore A	max. +10	max. +10
Change of tensile strength			%	max. -30	max. -30
Change of elongation at break			%	max. -30	max. -30
Resistance in ASTM-Oil # 1	72h / 150 °C	DIN 53 521 ASTM D 471			
Change of hardness			Shore A	max. +10	max. +10
Change of volume			%	max. -10	max. -10
Resistance in ASTM-Oil # 3	72h / 150 °C	DIN 53 521 ASTM D 471			
Change of hardness			Shore A	max. -15	max. -15
Change of volume			%	max. +20	max. +20
Temperature range Maximum and minimum operating temperatures depend on the specific application criteria.				-30 °C to +130 °C	-30 °C to +130 °C

Table 9 Material specification for standard PTFE

			PTFE virgin	PTFE glass fibre 25 %	PTFE bronze 40 %	PTFE carbon 25 % graphite 25 %
TSS Material Code			**PT00**	**PTGC**	**PTB4**	**PTKC**
Hardness	DIN 53 505 ASTM D 2240	Shore D	55 ± 5	62 ± 5	65 ± 5	65 ± 5
Specific gravity	DIN EN ISO 1183-1 ASTM D 792	g/cm³	2.17 ± 0.05	2.25 ± 0.05	3.10 ± 0.1	2.09 ± 0.04
Tensile strength	EN ISO 527	N/mm²	≥ 20	≥ 12	≥ 20	≥ 11
Elongation at break	EN ISO 527	%	≥ 200	≥ 150	≥ 200	≥ 90

Trelleborg Sealing Solutions offers various materials, which provide additional advantages, in addition to the standard materials previously described. The advantages include a wide range of available molds, special operating temperature range, special media resistance and institutional approvals for the portable water, pharmaceutical and beverage industries.

The following table shows preferred materials, which are characterized by their wide spectrum of use. They can be used for standard applications as well as for special industrial applications.

Table 10 Preferred materials

Material Type	Hardness Shore A (± 5)	Color	Operating temperature range	Material code	Description
NBR Nitrile Butadiene Rubber	70	black	-30 °C to +100 °C	N7083	Preferable for **sizes according to ISO 3601-1/AS 568**, preferably used for energizing elements, good overall performance
			-55 °C to +80 °C	N7T40	"Polar", **extremely good low temperature properties**, preferably used for static applications in mineral oil and for energizing elements, preferable for sizes according **to ISO 3601-1/AS 568**
			-30 °C to +100 °C	N7003	Preferable for metric sizes, good overall performance, wide range of molds available
			-30 °C to +100 °C	N7024	Good overall performance, **preferable for large quantities**
	90	black	-25 °C to +100 °C	N9002	Good overall performance, **wide range of molds available**
HNBR Hydrogenated Nitrile Butadiene Rubber	70	black	-30 °C to +140 °C	H7671	Good overall performance, **wide range of molds available**
			-25 °C to +140 °C	H7503	**Wide range of operating temperature,** good resistance to mineral oil, good overall performance
FKM Fluorocarbon Rubber	70	green	-20 °C to +200 °C	V70GA	Preferable for **sizes according to ISO 3601-1/AS 568,** preferably used for energizing elements, good overall performance, **DVGW DIN EN 549, BAM**
			-20 °C to +200 °C	V70G2	Preferable for **sizes according to ISO 3601-1/AS 568,** good overall performance
	75	black	-20 °C to +200 °C	VC009	Preferable for **sizes according to BS 4518** (metric), standard FKM
	80	green	-20 °C to +200 °C	V80G2	Good overall performance, **wide range of molds available**
		black	-20 °C to +200 °C	V8003	Good overall performance, **wide range of molds available**
			-20 °C to +200 °C	V8605	For pharmaceutical and food and beverage industries, **FDA 21.CFR § 177.2600, Regulation (EC) 1935/2004**
			-20 °C to +200 °C	V8T41	For pharmaceutical and food and beverage industries, good steam resistance, **FDA 21. CFR § 177.2600, USP Class VI, 3A Sanitary Number 18-03, Regulation (EC) 1935/2004**
	90	green	-15 °C to +200 °C	V90G1	Good overall performance, **wide range of molds available**
		black	-15 °C to +200 °C	V9670	Good overall performance, **wide range of molds available**
EPDM Ethylene Propylene Diene Rubber	70	black	-45 °C to +150 °C	E7502	Peroxide cured, for pharmaceutical and food and beverage industries, **KTW**[1]**, WRAS, FDA 21.CFR § 177.2600, USP Class VI, USP 26, Regulation (EC) 1935/2004,** plasticizer content < 3 %
			-45 °C to +130 °C	E7002	**Sulfur cured,** standard EPDM, wide range of molds available
			-45 °C to +150 °C	E7T41	Peroxide cured, **very low compression set** in hot water / steam. Excellent resistance to ozone, can be used with copper and brass
			-45 °C to +150 °C	E7518	Peroxide cured, for the use in potable water: **KTW**[1]**, WRAS, FDA 21.CFR § 177.2600, NSF61, W270, EN 681, ACS, USP Class VI, USP 26, Regulation (EC) 1935/2004,** plasticizer content < 1%
VMQ Methyl Vinyl Silicon Rubber	60	red	-50 °C to +175 °C	S60R1	Good overall performance, **wide range of molds available**
	70	red	-50 °C to +175 °C	S70R2	Good overall performance, **wide range of molds available**

[1] Date of validity May 2011, subject to change

The stated operating temperatures exclude any kind of load. Actual operating temperatures may differ depending on media and load type. At time of publication the information contained in this literature, including availability or institutional approvals, is believed to be correct and accurate. Further materials are available on request.

B.2 Installation and design recommendations

The following design recommendations are mainly based on the recommendations given in the ISO 3601-2. They cannot be deployed for the special Isolast® materials. Please use the Isolast® brochure or contact our specialists for further details.

Use the Trelleborg Sealing Solutions O-Ring calculator to help design O-Ring housings. It can be downloaded from the Trelleborg Sealing Solutions website at www.tss.trelleborg.com.

B.2.1 Installation recommendations

General recommendations

Before starting installation, check the following points:

- Lead-in chamfers made according to drawing?
- Bores deburred and edges rounded?
- Machining residues, e.g. chips, dirt and foreign particles, removed?
- Screw thread tips covered?
- Seals and components greased or oiled?
  Ensure media compatibility with the elastomer material. Trelleborg Sealing Solutions recommends to use the fluid to be sealed.
- Do not use lubricants with solid additives, e.g. molybdenum disulphide or zinc sulphide.

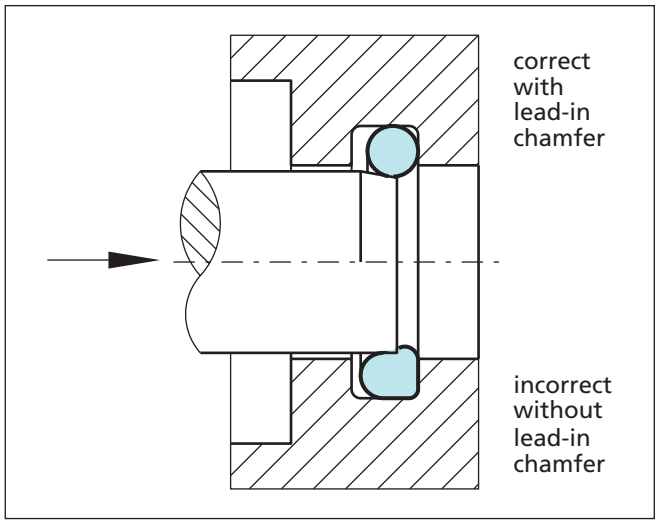


Figure 11 Rod installation with O-Ring

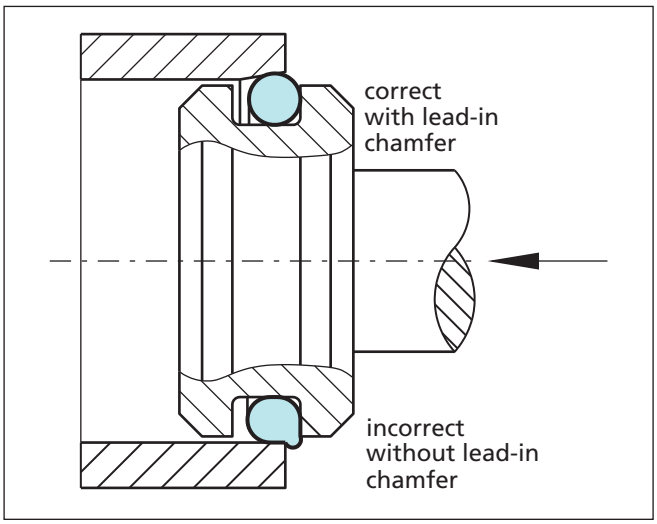


Figure 12 Piston installation with O-Ring

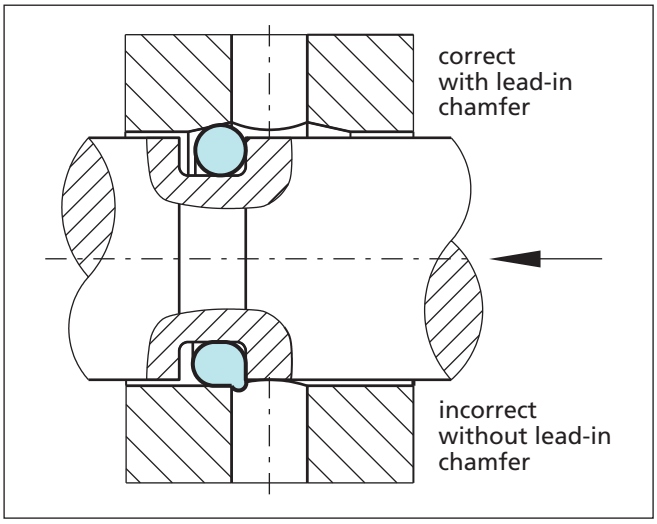


Figure 13 O-Ring installation over transverse bores

Manual installation

- Use tools without sharp edges!
- Ensure that the O-Ring is not twisted, use installation aids to assist correct positioning
- Use installation aids wherever possible
- Do not over stretch O-Rings
- Do not stretch O-Rings made out of cord at the joint.

Installation over threads, splines etc.

Should the O-Ring have to be stretched over threads, splines, keyways etc., then an assembly mandrel is essential. This mandrel can either be manufactured in a soft metal or a plastic material obviously without burrs or sharp edges.

Automatic installation

Automatic O-Ring installation requires good preparation. The surfaces of the O-Rings are frequently treated by several methods (see brochure "Flexcoat™ – Friction-free Running"). This offers a number of benefits during installation by

- Reducing the installation forces
- Non-stick effects, easy removal

The handling and installation of dimensionally unstable components requires a great deal of experience. Reliable automated installation thus demands special handling and packing of the O-Rings.

Please ask our specialists for further details.

B.2.2 Methods of installation and design of seal housing

Methods of installation

O-Rings can be used in components in a wide variety of ways.

During the design stage installation must be taken into consideration. In order to avoid damage during installation it should not be necessary to pass the O-Ring over edges or bores. When long sliding movements are involved, the seal seat should be recessed, if possible, or the O-Rings arranged so that they only have to travel short distances during installation to reduce risk of twisting.

Radial installation (static and dynamic)

Inner sealing (rod sealing)
The O-Ring size should be selected so that the O-Ring outside diameter ($d_1 + 2*d_2$) is at least equal to or larger than the groove outside diameter d_6 (Figure 14).

Outer sealing (piston sealing)
The O-Ring size should be selected so that the inside diameter d_1 is equal to or smaller than groove diameter d_3 (Figure 14).

Axial installation (static)

During axial-static installation, the direction of the pressure should be taken into consideration when choosing the O-Ring size (Figure 15). With internal pressure the O-Ring should be chosen so that the outside diameter of the O-Ring is equal or larger than the outer groove diameter d_7. With external pressure the O-Ring inside diameter is chosen smaller than the inner groove diameter d_8.

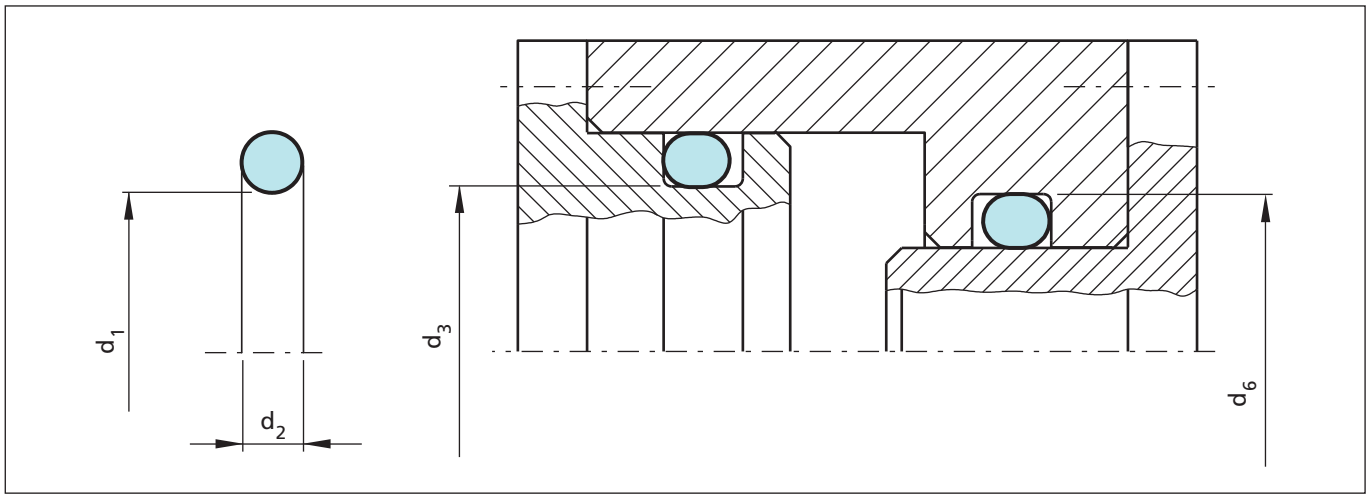


Figure 14 Radial installation, static and dynamic

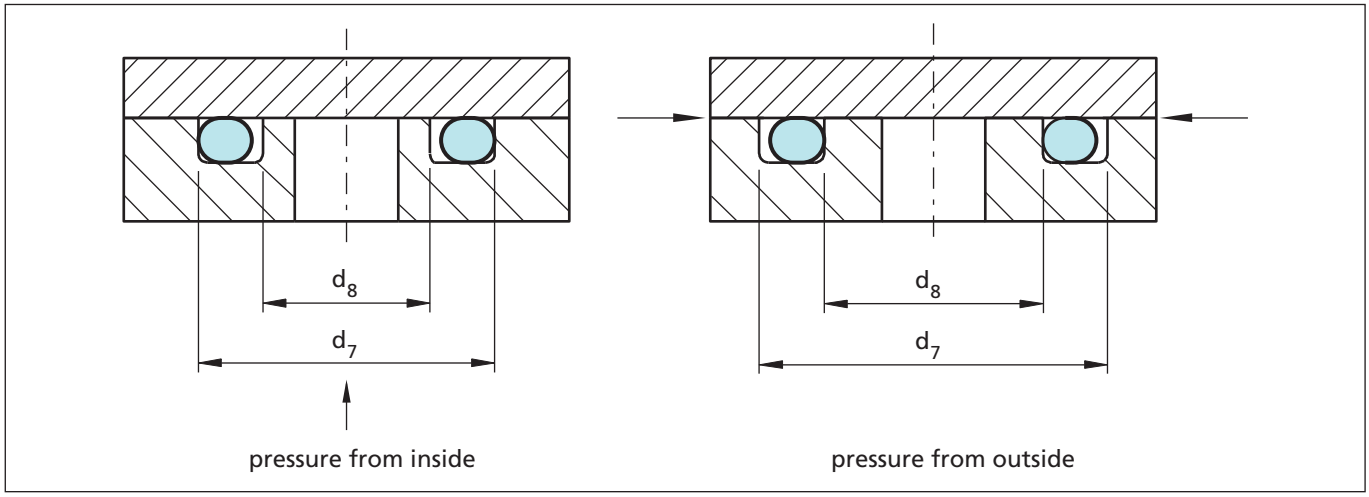


Figure 15 Axial installation, static

B.2.3 Elongation - outside diameter interference

Radial Installation, piston and rod sealing, static and dynamic

If the O-Ring is used as a piston seal (outer sealing), the nominal O-Ring inside diameter, d_1 (see Figure 14), should be stretched between 2 % and 5 % for dynamic applications and between 2 % and 8 % for static applications.

For O-Rings with a diameter d_1 smaller than 20 mm, this is not always possible so the stretch range is wider. To minimize this range and the maximum stretch, it is necessary to minimize the tolerances of the housing diameter, d_3 (see Figure 14), and have a less stringent requirement for the minimum O-Ring stretch. In dynamic applications, it is important to keep the maximum stretch to 5 % or less to avoid detrimental effects on sealing performance. Exceeding these values will result in too great a decrease in the O-Ring cross section which can affect the service life of an O-Ring.

If the O-Ring is used as a rod seal (inner sealing), the O-Ring outside diameter ($d_1 + 2*d_2$) should be at least equal to or larger than the housing (groove) outside diameter d_6 (see Figure 14), to give interference on the outside diameter. The O-Ring outside diameter shall not exceed 3 % of the housing outside diameter for O-Rings with a diameter d_1 greater than 250 mm, or 5 % for O-Rings with a diameter d_1 smaller than 250 mm.

For O-Rings with a diameter d_1 smaller than 20 mm, this is not always possible due to tolerance issues and can result in a greater outside diameter interference. Exceeding these values will result in too great an increase in the O-Ring cross section which can affect the service life of an O-Ring.

Axial installation, static

If the O-Ring is used as a static axial seal, the direction of the pressure should be taken into consideration when choosing the O-Ring size (Figure 15). If the O-Ring is pressurized the groove should be designed so that, prior to the pressure being applied, the O-Ring is in contact with the groove wall that is away from the side that is pressurized.

If there is internal pressure, the O-Ring should be chosen so that the outside diameter ($d_1 + 2*d_2$) of the O-Ring is equal or larger (at most 1 to 2%) than the outer groove diameter d_7.

If there is external pressure the O-Ring should be chosen so that the inside diameter d_1 of the O-Ring is approximately 1 % to 3 % smaller than the inner groove diameter d_8.

Reduction in O-Ring cross section through elongation

When an O-Ring is stretched its cross section is reduced and flattened and when installed in the housing, its cross section is no longer circular. The percentage that the cross section is reduced depends on the percentage, S, that the inside diameter is stretched.

The percentage cross sectional reduction R resulting from diametric stretch for an O-Ring whose inside diameter is stretched between 0 % to 3 % (inclusive) is calculated in accordance with the following equation:

$$R = 0.01 + 1.06 \cdot S - 0.1 \cdot S^2 \ [\%]$$

The percentage cross sectional reduction R resulting from diametric stretch for an O-Ring whose inside diameter is stretched more than 3 % but less than 25 % is calculated in accordance with this equation:

$$R = 0.56 + 0.59 \cdot S - 0.0046 \cdot S^2 \ [\%]$$

For piston applications the percentage stretch S is calculated in accordance with:

$$S = \left(\frac{d_3 - d_1}{d_1} \right) \cdot 100 \ [\%]$$

with d_3 = housing inside diameter for piston applications.

For rod applications the percentage stretch S is calculated in accordance with:

$$S = \left(\frac{d_5 - d_1}{d_1} \right) \cdot 100 \ [\%]$$

with d_5 = rod diameter.

Example: For an O-Ring whose inside diameter is stretched 2 % the effective percentage cross section reduction is calculated as follows:

$$R = 0.01 + 1.06 \cdot 2 - 0.1 \cdot 2^2 \ [\%]$$

$$R = 1.73 \ \%$$

O-Ring as a rotary seal

In some applications, e.g. with short running periods, the O-Ring can also be used as a rotary seal for sealing shafts. In this case, the following points should be observed:

In order to be able to function as a rotary seal, O-Rings must be installed in accordance with specific guidelines, the rotary seal principle.

The rotary seal principle is based on the fact that an elongated elastomer ring contracts when heated (Joule effect). With the normal design criteria the O-Ring inside diameter d_1 will be slightly smaller than the shaft diameter, and the heat generated by friction would cause the ring to contract even more. This results in a higher pressure on the rotating shaft so that a lubricating film is prevented from forming under the seal and even higher friction occurs. The result would be increased wear and a premature failure of the seal.

Using the rotary seal principle, this is prevented by the seal ring being selected so that its inside diameter is approximately 2 to 5 % larger than the shaft diameter to be sealed. The installation in the groove means that the seal ring is compressed radially and is pressed against the shaft by the groove diameter. The seal ring is thus slightly corrugated in the groove, a fact which helps to improve the lubrication.

Special materials are available for rotary seal applications. Trelleborg Sealing Solutions does not recommend the use of O-Rings as rotary seals. Please contact your local Trelleborg Sealing Solutions company for further details.

B.2.4 Initial compression

An initial compression of the O-Ring cross section in the groove is essential to ensure its function as a primary or secondary sealing element (Figure 16). It serves to:

- Achieve the initial sealing capability
- Bridge production tolerances
- Assure defined frictional forces
- Compensate for the compression set
- Compensate for wear

Depending on the application, the following values are recommended for the initial compression as a proportion of the cross section (d_2):

Dynamic applications:	6 to 20 %
Static applications:	15 to 30 %

The design of the grooves can be based on the guide values for the initial compression shown in the diagrams in Figure 17 and Figure 18. These take into account the relationship between loads and cross sections according to ISO 3601-2.

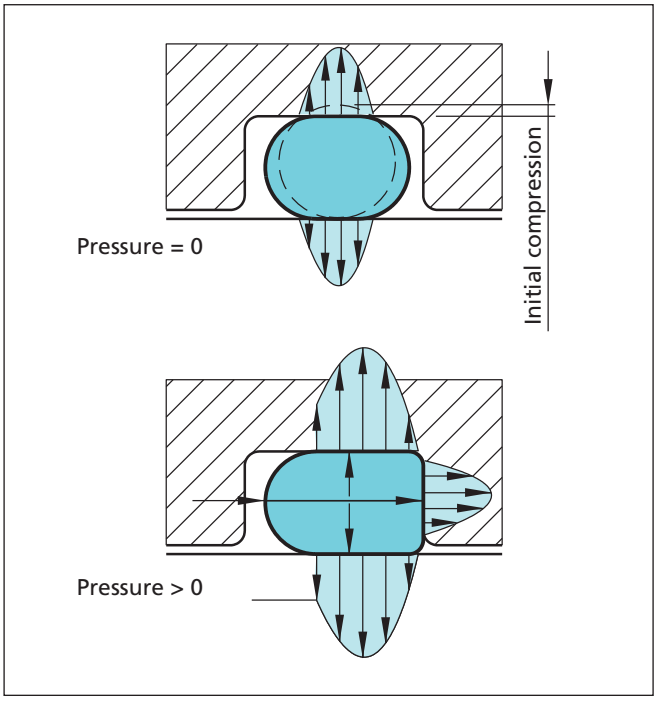


Figure 16 O-Ring contact pressure installed and under service pressure

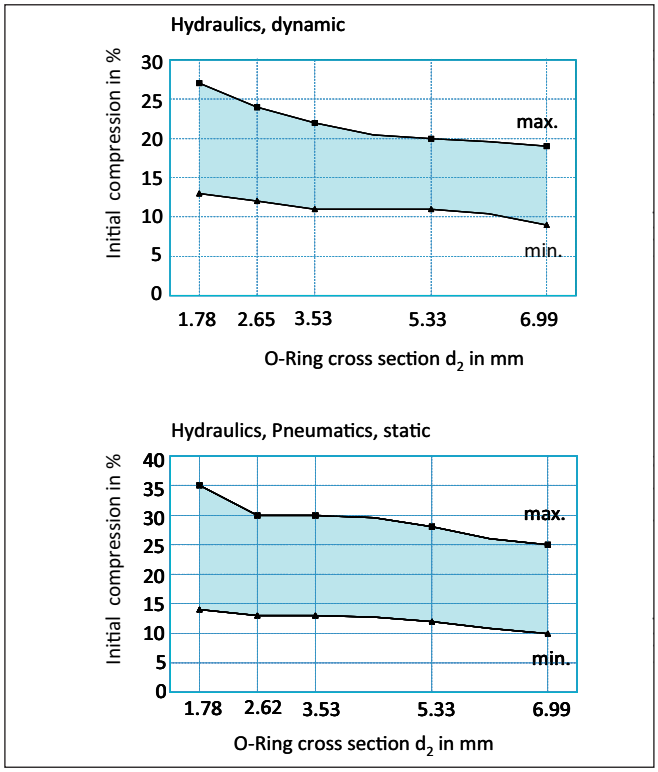


Figure 17 Permissible range of initial compression as a function of cross section, radial dynamic

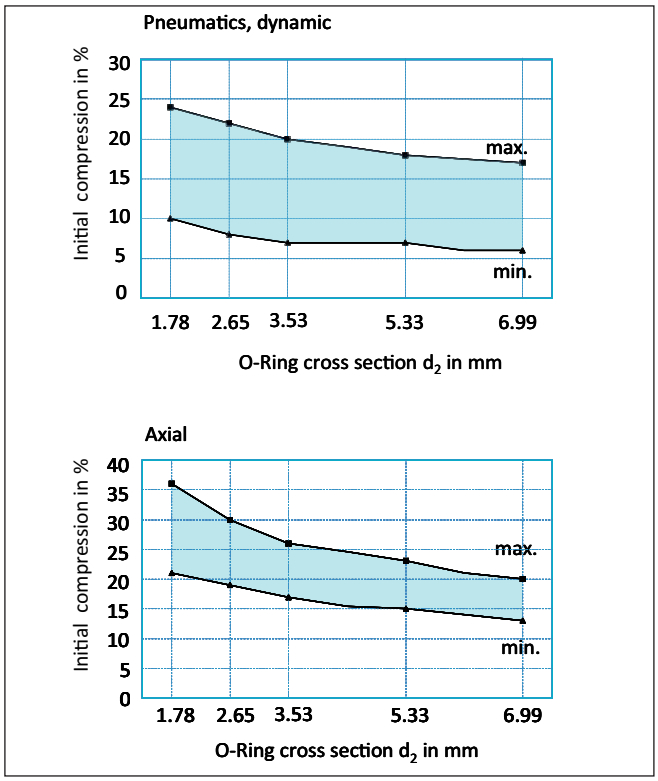


Figure 18 Permissible range of initial compression as a function of cross section, radial static and axial

Compression forces

The compression forces of O-Rings vary, depending among other things, on the extent of initial compression, the material, the material hardness, the O-Ring's inside diameter and its cross section.

Figures 19 – 21 show guide values for the uniform load of O-Rings taking into consideration the O-Ring's cross section, material type, material hardness and its compression.

These uniform loads can be used to estimate the total compression force to be applied for static installation of O-Rings.

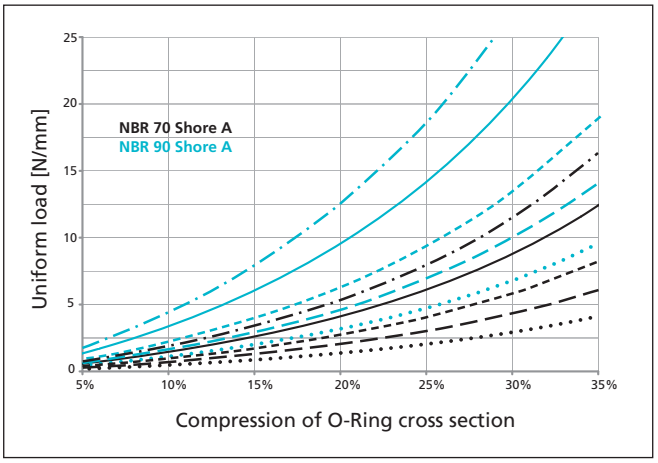


Figure 19 Guiding values for the uniform load [N/mm] of compressed O-Rings, material types NBR 70 Sh A and NBR 90 Sh A

Legend:

NBR 70 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

NBR 90 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

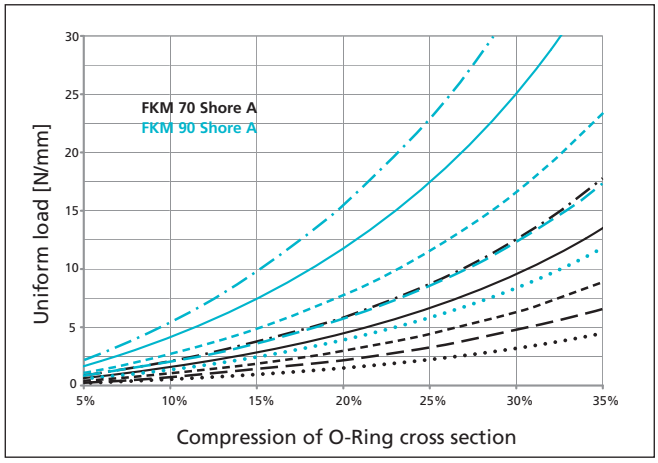


Figure 20 Guiding values for the uniform load [N/mm] of compressed O-Rings, material types FKM 70 Sh A and FKM 90 Sh A

Legend:

FKM 70 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

FKM 90 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

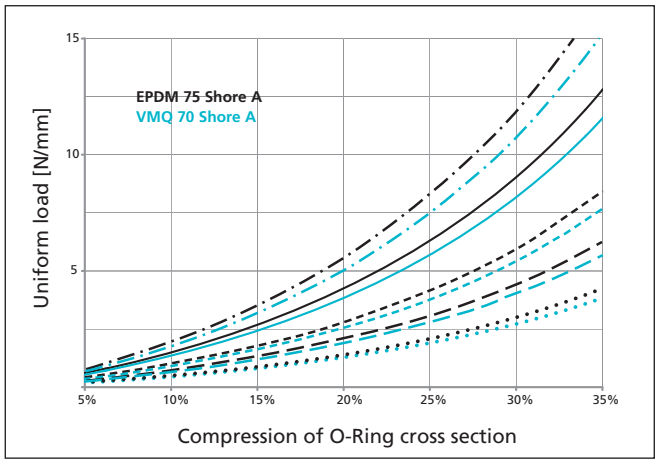


Figure 21 Guiding values for the uniform load [N/mm] of compressed O-Rings, material types EPDM 75 Sh A and VMQ 70 Sh

Legend:

EPDM 75 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

VMQ 70 Shore A

- cross section 1.78
- cross section 2.62
- cross section 3.53
- cross section 5.33
- cross section 6.99

B.2.5 Groove fill

It is important to consider groove fill of the O-Ring to avoid any detrimental effects on radial sealing performance. It is recommended that groove fill should not be more than 85 percent to allow for thermal expansion, volume swell due to fluid exposure and tolerance effects.

B.2.6 General 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 be able to assess the suitability of the 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 application

- up to 5 MPa for O-Rings with inside diameter > 50 mm without Back-up Ring
- up to 10 MPa for O-Rings with inside diameter < 50 mm without Back-up Ring (depends on the material, the cross section and the clearance)
- up to 40 MPa with Back-up Ring
- up to 250 MPa with special Back-up Ring

Please note the permissible extrusion gaps.

Dynamic application

- Reciprocating up to 5 MPa without Back-up Ring
- Higher pressures with Back-up Ring

Speed

Reciprocating up to 0.5 m/s
Rotating up to 0.5 m/s
Depending on material and application.

Temperature

From -60 °C to +325 °C
Depending on material and media resistance.

When assessing the application criteria, the peak and continuous operating temperature and the running period must be taken into consideration. For rotating applications the temperature increase due to frictional heat must be taken into account.

Media

With the wide range of the available materials, each with different properties, it is possible to seal against practically all liquids, gases and chemicals. Please note when selecting the most suitable material the information in chapter "B.1 Materials".

B.2.7 Housing design and dimensions

Correct design can help to eliminate possible sources of damage and seal failure from the outset.

Since O-Ring are squeezed during installation, lead-in chamfers and rounded edges must be provided (Figure 22 and Figure 23).

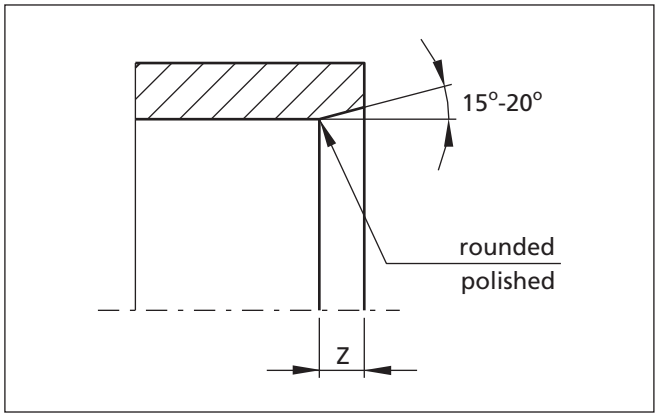


Figure 22 Lead-in chamfers for bores, tubes

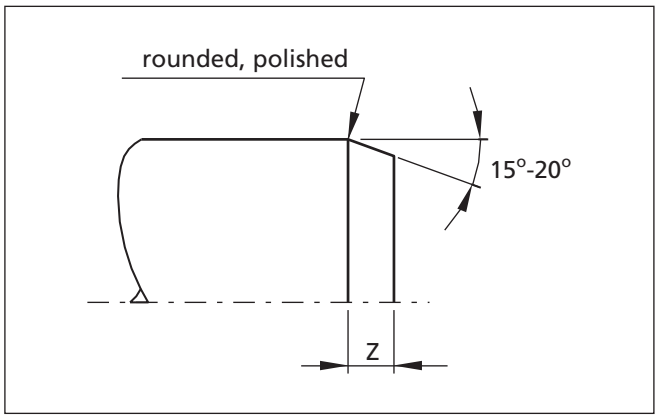


Figure 23 Lead-in chamfers for shafts, rods

The minimum length of the lead-in chamfer is listed in Table 11 as a function of the cross section d_2.

Table 11 Lead-in chamfers

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 surface roughness of a lead-in chamfer is: $R_Z \leq 6.3$ µm $R_a \leq 0.8$ µm

Radial clearance

The tolerances given in Table 16 and the maximum permissible radial clearance S (extrusion gap) given in the Table 12 must be maintained.

If the clearance is too large, there is a risk of seal extrusion which can result in the destruction of the O-Ring (Figure 24).

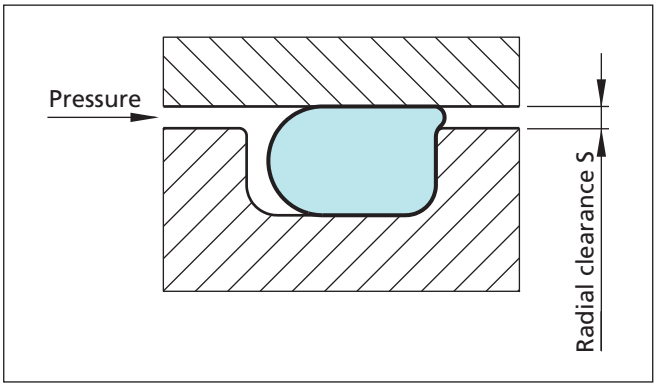


Figure 24 Radial clearance "S"

The permissible radial clearance S between the sealed parts depends on the system pressure, the cross section and the hardness of the O-Ring.

Table 12 contains recommendations for the permissible clearance S as a function of O-Ring cross section and shore hardness. The table is valid for elastomeric materials with the exception of polyurethane and FEP / PFA encapsulated O-Rings.

For pressure above 5 MPa for O-Rings with Inside diameter > 50 mm and above 10 MPa for O-Rings with Inside diameter < 50 mm we recommend the use of Back-up Rings.

Table 12 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

These values assume that the parts are fitted concentrically to one another and do not expand under pressure. If this is not the case, the clearance should be kept correspondingly smaller.

For static applications we recommend a fit of H8/f7.

O-Rings made from polyurethane can bridge larger clearances thanks to their high extrusion resistance and greater dimensional stability. See also chapter "Polyurethane O-Rings".

Surfaces

Under pressure, elastomers adapt to irregular surfaces. For gas or liquid tight joints, however, certain minimum demands must be made on the surface quality of the surfaces to be sealed.

Fundamentally grooves, scratches, pit marks, concentric or spiral machining scores, etc. are not permissible. Higher demands must be placed on dynamic mating surfaces than on static surfaces.

At present no uniform definitions exist for describing the mating surfaces. In practice, the specification of the R_a value is not sufficient to permit an assessment of the surface quality. Our recommendations therefore contain amongst others various terms and definitions in accordance with DIN 4768 and DIN EN ISO 4287.

Table 13 Surface finish

Type of Load	Surface	R_t µm	R_z µm	R_a µm
Radial-dynamic	Mating surface * (bore, rod, shaft)	≤ 2.5	≤ 1.6	≤ 0.4
	Groove flanks, groove diameter	≤ 10.0	≤ 6.3	≤ 1.6
Radial-static Axial-static	Mating surface Groove flanks, groove diameter	≤ 10.0 ≤ 16.0	≤ 6.3	≤ 1.6
	For pulsating pressures Mating surface Groove flanks, groove diameter	 ≤ 6.3 ≤ 10.0	 ≤ 6.3	 ≤ 0.8 ≤ 1.6

* spiralfree grinding

The above is for guidance only and covers the majority of sealing applications. However Trelleborg Sealing Solutions should be consulted in areas of particular concern.

Trapezoidal groove

The trapezoidal (dovetail) groove should only be used in special cases, e.g. overhead installation, in order to retain the O-Ring (Figure 25). The installation dimensions are summarised in Table 14. The trapezoidal groove is only recommended for O-Ring cross section from 3.53 mm. The inside diameter of the O-Ring results from the mean groove diameter minus the cross section.

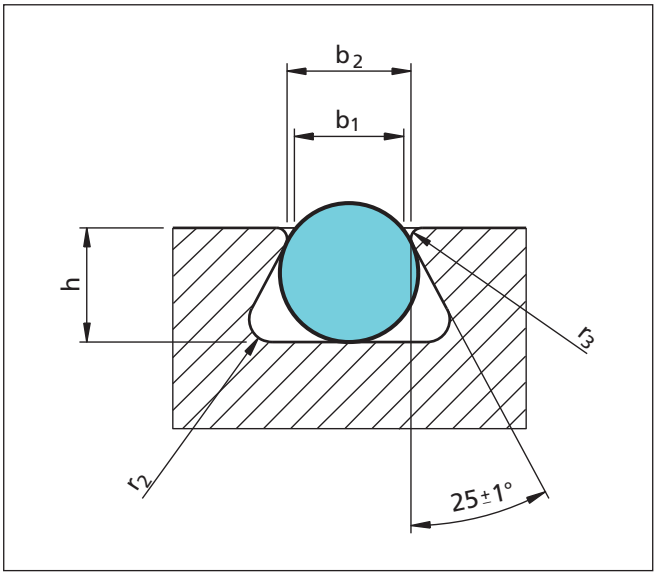


Figure 25 Installation in trapezoidal groove

Table 14 Installation dimensions for trapezoidal groove

O-Ring cross section	Groove dimensions				
	Groove width	Groove width	Groove depth	Radius (max.)	
d_2	b_1 ±0.05	b_2 ±0.05	h ±0.05	r_3	r_2
3.53 3.55	2.90	3.20	2.90	0.25	0.80
4.00	3.40	3.70	3.20	0.25	0.80
5.00	4.30	4.60	4.20	0.25	0.80
5.33 5.30	4.60	4.90	4.60	0.25	0.80
5.70	4.75	5.25	4.80	0.40	0.80
6.00	5.05	5.55	5.10	0.40	0.80
7.00	6.00	6.50	6.00	0.40	1.60
8.00	6.85	7.45	6.90	0.50	1.60
8.40	7.25	7.85	7.30	0.50	1.60

Rectangular groove

A rectangular groove is preferred for all new designs. Designs with bevelled groove flanks up to 5° are permissible. If Back-up Rings are used, straight groove flanks are necessary.

To reduce risk of extrusion the radius r ideally should not exceed the maximum permissible radial clearance S (see Table 12).

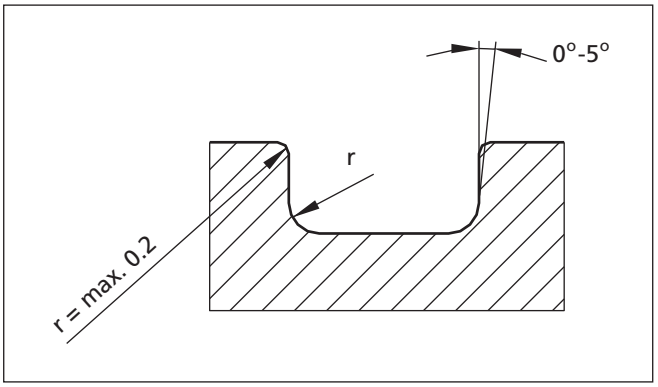


Figure 26 Groove specifications

Housing dimensions recommendations

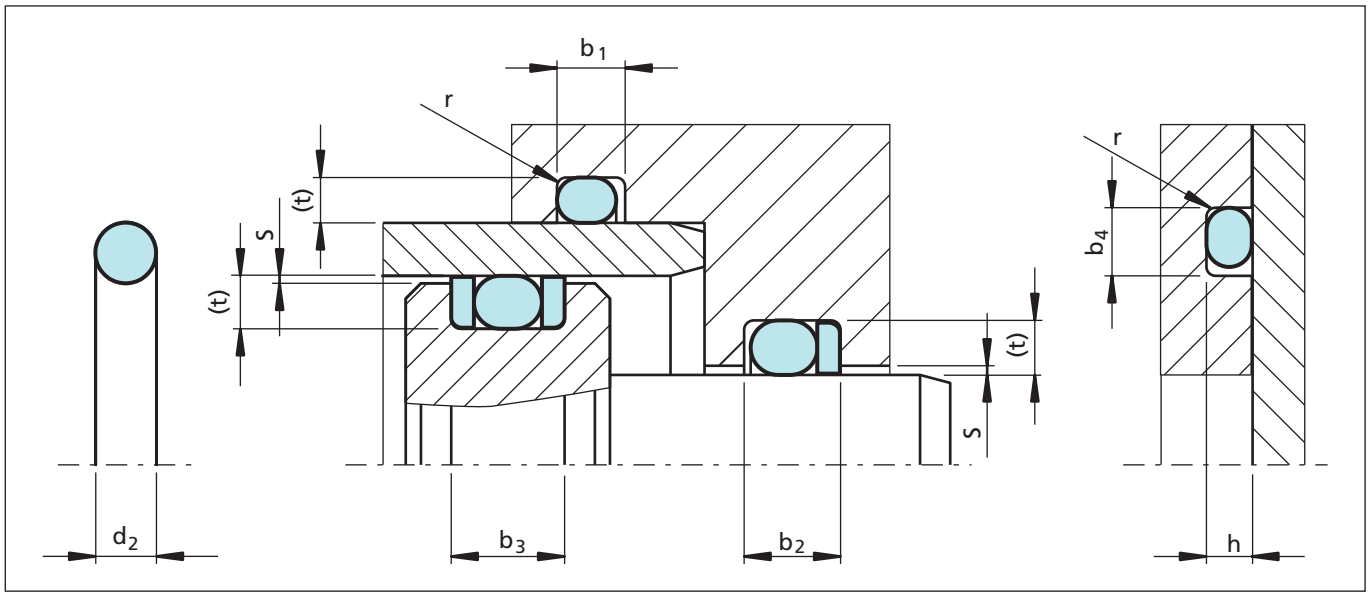


Figure 27 Installation drawing

Radial clearance S and surface finish see beginning of this chapter "B.2.7 Housing design and dimensions".

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).

The generally recommended fit is H8/f7.

Table 15 Housing dimensions

Cross section	Radial installation			Axial installation		Radius[1]
	Housing depth[2]		Groove width	Groove depth	Groove width	
d_2	Dynamic (t)	Static (t)	b_1 +0.25	h +0.1	b_4 +0.2	r ± 0.2
0.50	-	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
1.83	1.50	1.35	2.50	1.35	2.60	0.30

Cross section	Radial installation			Axial installation		Radius[1]
	Housing depth[2]		Groove width	Groove depth	Groove width	
d_2	Dynamic (t)	Static (t)	b_1 +0.25	h +0.1	b_4 +0.2	r ± 0.2
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	1.90	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
7.50	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

Cross section	Radial installation			Axial installation		Radius[1]
	Housing depth[2]		Groove width	Groove depth	Groove width	
d_2	Dynamic (t)	Static (t)	b_1 +0.25	h +0.1	b_4 +0.2	r ± 0.2
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 ±0.2mm.

2) The given values for the housing depth are based on the nominal O-Ring cross section dimensions. The O-Ring inside diameter and its stretch are not considered.

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

C Quality criteria and product range

C.1 Quality criteria

C.1.1 Standard quality

If no quality requirements are specified with an order, standard quality O-Rings are supplied.

The standard quality is defined by a "-" as the 10th digit in the O-Ring article number.

A standard quality O-Ring has dimensional tolerances to Trelleborg Sealing Solutions standard TBS-00024 according to ISO 3601-1, class B and standard surface quality according to Trelleborg Sealing Solutions standard TBS-00005. based on ISO 3601-3, grade N.

Surface deviations are according to ISO 2859-1:2004-01 AQL 1.0 general inspection level II, normal inspection is standard. Higher quality levels are available on request.

If no material type or hardness are specified, the O-Ring will be delivered in a standard material for the material type requested. The material specifications of standard materials can be seen in chapter B.1.5 Standard materials.

Example:

TSS Article No.	OR	30	04000	-	N70
TSS Art. - Group					
Cross section x 10					
Inside diameter x 100					
Quality index for standard					
Material code for standard NBR 70 ShA					

C.1.2 Flatness and roundness

The flatness and roundness of O-Rings are not specified in either international O-Ring standard ISO 3601 or any other national O-Ring standards so these properties are not observed or limited during production unless specifically stated.

Generally O-Rings conforming to standard quality specifications can be assembled automatically, in some cases it can be important to specify flatness and roundness.

By implementing special process steps during production, the following equation and graphs show the possible limits in flatness and roundness of elastomeric O-Rings.

In general, the adherence to flatness and roundness depends on the material and on the dimension ratio of the O-Ring, and can be checked and approved in advance.

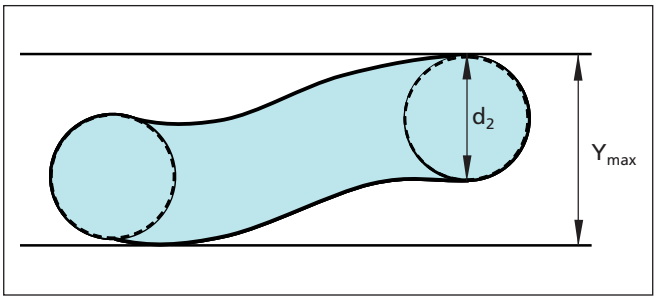


Figure 28 Flatness tolerance Y_{max}

The flatness tolerance depends on the dimension ratio and is calculated according to the following equations:

1. $Y_{max}=1.5 * d_2$ for $0.11 < \frac{d_2}{d_1} \leq 0.21$
2. $Y_{max}=1.3 * d_2$ for $\frac{d_2}{d_1} > 0.21$

For all other dimension ratios the flatness tolerance must be requested seperately.

Not every material can be offered with these flatness tolerances. Please contact your local Trelleborg Sealing Solutions marketing company for further details.

Roundness

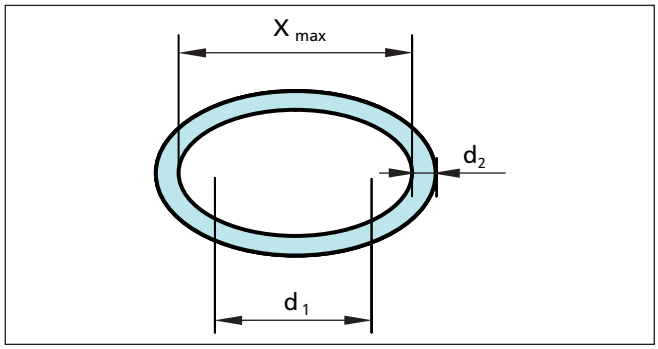


Figure 29 Roundness tolerance X_{max}

The roundness tolerance is calculated as follows:

$X_{max} = (1.1*d_1) + 2*d_2$

Not every material can be offered with these roundness tolerances. Please contact your local Trelleborg Sealing Solutions marketing company for further details.

The flexibility of elastomeric O-Rings can lead to deformations during handling e.g. after long storage times or when added to a vibrating conveyor. These deformations cannot be covered by these flatness and roundness specifications.

C.1.3 Dimension tolerances

During vulcanization, elastomers are subject to dimensional changes due to shrinkage. The degree of shrinkage depends on the material, mold geometry and on the vulcanization process. To meet dimensional tolerances molds need to be adapted to the material to be processed.

O-Ring molds are often designed for NBR 70 Shore A materials. If other materials are produced with these molds they may exhibit different dimensional tolerances due to the different shrinkage rates.

To guarantee high, constant quality levels, it might be necessary to produce new or additional molds accruing extra cost.

If deviations from tolerances are acceptable, O-Rings can be produced from existing molds to avoid the cost of producing molds. This must be confirmed in writing by the customer.

The following tables show the tolerances for the inside diameter (d_1) and cross section (d_2) of O-Rings. All tolerances given are according to Trelleborg Sealing Solutions standard TBS-00024 according to ISO 3601-1, class B.

Precision O-Rings with reduced tolerances are also available - please contact your local Trelleborg Sealing Solutions marketing company.

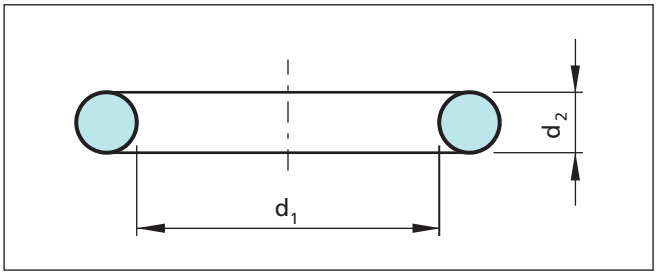


Figure 30 O-Ring dimensions

Tolerances for O-Ring cross sections d_2

Valid tolerances for elastomeric O-Ring cross sections d_2 are listed in the following Table 16.

Table 16 Tolerances for O-Ring cross sections d_2 according to the TSS standard TBS-00024, complying with ISO 3601-1, class B, table A.1

Cross section d_2					Tolerance ±
		d_2	≤	0.80	on request
0.80	<	d_2	≤	2.25	0.08
2.25	<	d_2	≤	3.15	0.09
3.15	<	d_2	≤	4.50	0.10
4.50	<	d_2	≤	6.30	0.13
6.30	<	d_2	≤	8.40	0.15
8.40	<	d_2	≤	10.00	0.21
10.00	<	d_2	≤	12.00	0.25
		d_2	>	12.00	on request

Tolerances for O-Ring inside diameters d_1

Tolerances given in Trelleborg Sealing Solutions standard TBS-00024 according to ISO 3601-1, class B apply for the elastomeric O-Rings inside diameters d_1. The appropriate tolerances for the inside diameters d_1 according to ISO 3601-1, class B are calculated with the following equation:

$$\Delta d = \pm\left[d_1^{0.95} \times 0.009 + 0.11\right]$$

This equation applies only for metric dimensions. The tolerances for the inside diameters d_1 up to 500 mm are listed in the following table.

Table 17 Tolerances for inside diameters d_1 according to the TSS standard TBS-00024, complying with ISO 3601-1, class B

Inside diameter d_1					Tolerance ±
		d_1	≤	1.71	0.12
1.71	<	d_1	≤	2.93	0.13
2.93	<	d_1	≤	4.17	0.14
4.17	<	d_1	≤	5.44	0.15
5.44	<	d_1	≤	6.72	0.16
6.72	<	d_1	≤	8.01	0.17
8.01	<	d_1	≤	9.31	0.18
9.31	<	d_1	≤	10.62	0.19
10.62	<	d_1	≤	11.94	0.20
11.94	<	d_1	≤	13.27	0.21
13.27	<	d_1	≤	14.61	0.22
14.61	<	d_1	≤	15.95	0.23
15.95	<	d_1	≤	17.29	0.24
17.29	<	d_1	≤	18.64	0.25
18.64	<	d_1	≤	20.00	0.26
20.00	<	d_1	≤	21.36	0.27
21.36	<	d_1	≤	22.73	0.28
22.73	<	d_1	≤	24.10	0.29
24.10	<	d_1	≤	25.47	0.30
25.47	<	d_1	≤	26.85	0.31
26.85	<	d_1	≤	28.23	0.32
28.23	<	d_1	≤	29.61	0.33
29.61	<	d_1	≤	31.00	0.34
31.00	<	d_1	≤	32.39	0.35
32.39	<	d_1	≤	33.78	0.36
33.78	<	d_1	≤	35.18	0.37
35.18	<	d_1	≤	36.58	0.38
36.58	<	d_1	≤	37.98	0.39
37.98	<	d_1	≤	39.38	0.40
39.38	<	d_1	≤	40.79	0.41
40.79	<	d_1	≤	42.20	0.42
42.20	<	d_1	≤	43.61	0.43
43.61	<	d_1	≤	45.02	0.44
45.02	<	d_1	≤	46.44	0.45
46.44	<	d_1	≤	47.86	0.46
47.86	<	d_1	≤	49.28	0.47
49.28	<	d_1	≤	50.70	0.48
50.70	<	d_1	≤	52.12	0.49
52.12	<	d_1	≤	53.55	0.50
53.55	<	d_1	≤	54.98	0.51
54.98	<	d_1	≤	56.41	0.52
56.41	<	d_1	≤	57.84	0.53
57.84	<	d_1	≤	59.27	0.54
59.27	<	d_1	≤	60.71	0.55
60.71	<	d_1	≤	62.14	0.56
62.14	<	d_1	≤	63.58	0.57
63.58	<	d_1	≤	65.02	0.58
65.02	<	d_1	≤	66.47	0.59
66.47	<	d_1	≤	67.91	0.60
67.91	<	d_1	≤	69.35	0.61
69.35	<	d_1	≤	70.80	0.62
70.80	<	d_1	≤	72.25	0.63
72.25	<	d_1	≤	73.70	0.64
73.70	<	d_1	≤	75.15	0.65
75.15	<	d_1	≤	76.60	0.66
76.60	<	d_1	≤	78.05	0.67
78.05	<	d_1	≤	79.51	0.68
79.51	<	d_1	≤	80.97	0.69
80.97	<	d_1	≤	82.42	0.70
82.42	<	d_1	≤	83.88	0.71
83.88	<	d_1	≤	85.34	0.72
85.34	<	d_1	≤	86.80	0.73
86.80	<	d_1	≤	88.27	0.74
88.27	<	d_1	≤	89.73	0.75
89.73	<	d_1	≤	91.20	0.76
91.20	<	d_1	≤	92.66	0.77
92.66	<	d_1	≤	94.13	0.78
94.13	<	d_1	≤	95.60	0.79
95.60	<	d_1	≤	97.07	0.80
97.07	<	d_1	≤	98.54	0.81
98.54	<	d_1	≤	100.01	0.82
100.01	<	d_1	≤	101.48	0.83
101.48	<	d_1	≤	102.96	0.84
102.96	<	d_1	≤	104.43	0.85
104.43	<	d_1	≤	105.91	0.86
105.91	<	d_1	≤	107.39	0.87
107.39	<	d_1	≤	108.86	0.88
108.86	<	d_1	≤	110.34	0.89
110.34	<	d_1	≤	111.82	0.90
111.82	<	d_1	≤	113.30	0.91
113.30	<	d_1	≤	114.79	0.92
114.79	<	d_1	≤	116.27	0.93
116.27	<	d_1	≤	117.75	0.94
117.75	<	d_1	≤	119.24	0.95
119.24	<	d_1	≤	120.72	0.96
120.72	<	d_1	≤	122.21	0.97
122.21	<	d_1	≤	123.70	0.98
123.70	<	d_1	≤	125.19	0.99
125.19	<	d_1	≤	126.68	1.00
126.68	<	d_1	≤	128.17	1.01
128.17	<	d_1	≤	129.66	1.02

Inside diameter d_1					Tolerance ±
129.66	<	d_1	≤	131.15	1.03
131.15	<	d_1	≤	132.64	1.04
132.64	<	d_1	≤	134.14	1.05
134.14	<	d_1	≤	135.63	1.06
135.63	<	d_1	≤	137.13	1.07
137.13	<	d_1	≤	138.62	1.08
138.62	<	d_1	≤	140.12	1.09
140.12	<	d_1	≤	141.62	1.10
141.62	<	d_1	≤	143.12	1.11
143.12	<	d_1	≤	144.62	1.12
144.62	<	d_1	≤	146.12	1.13
146.12	<	d_1	≤	147.62	1.14
147.62	<	d_1	≤	149.12	1.15
149.12	<	d_1	≤	150.62	1.16
150.62	<	d_1	≤	152.13	1.17
152.13	<	d_1	≤	153.63	1.18
153.63	<	d_1	≤	155.13	1.19
155.13	<	d_1	≤	156.64	1.20
156.64	<	d_1	≤	158.15	1.21
158.15	<	d_1	≤	159.65	1.22
159.65	<	d_1	≤	161.16	1.23
161.16	<	d_1	≤	162.67	1.24
162.67	<	d_1	≤	164.18	1.25
164.18	<	d_1	≤	165.69	1.26
165.69	<	d_1	≤	167.20	1.27
167.20	<	d_1	≤	168.71	1.28
168.71	<	d_1	≤	170.22	1.29
170.22	<	d_1	≤	171.73	1.30
171.73	<	d_1	≤	173.25	1.31
173.25	<	d_1	≤	174.76	1.32
174.76	<	d_1	≤	176.28	1.33
176.28	<	d_1	≤	177.79	1.34
177.79	<	d_1	≤	179.31	1.35
179.31	<	d_1	≤	180.82	1.36
180.82	<	d_1	≤	182.34	1.37
182.34	<	d_1	≤	183.86	1.38
183.86	<	d_1	≤	185.38	1.39
185.38	<	d_1	≤	186.89	1.40
186.89	<	d_1	≤	188.41	1.41
188.41	<	d_1	≤	189.93	1.42
189.93	<	d_1	≤	191.45	1.43
191.45	<	d_1	≤	192.98	1.44
192.98	<	d_1	≤	194.50	1.45
194.50	<	d_1	≤	196.02	1.46
196.02	<	d_1	≤	197.54	1.47
197.54	<	d_1	≤	199.07	1.48
199.07	<	d_1	≤	200.59	1.49

Inside diameter d_1					Tolerance ±
200.59	<	d_1	≤	202.12	1.50
202.12	<	d_1	≤	203.64	1.51
203.64	<	d_1	≤	205.17	1.52
205.17	<	d_1	≤	206.69	1.53
206.69	<	d_1	≤	208.22	1.54
208.22	<	d_1	≤	209.75	1.55
209.75	<	d_1	≤	211.28	1.56
211.28	<	d_1	≤	212.81	1.57
212.81	<	d_1	≤	214.34	1.58
214.34	<	d_1	≤	215.87	1.59
215.87	<	d_1	≤	217.40	1.60
217.40	<	d_1	≤	218.93	1.61
218.93	<	d_1	≤	220.46	1.62
220.46	<	d_1	≤	221.99	1.63
221.99	<	d_1	≤	223.52	1.64
223.52	<	d_1	≤	225.06	1.65
225.06	<	d_1	≤	226.59	1.66
226.59	<	d_1	≤	228.12	1.67
228.12	<	d_1	≤	229.66	1.68
229.66	<	d_1	≤	231.19	1.69
231.19	<	d_1	≤	232.73	1.70
232.73	<	d_1	≤	234.27	1.71
234.27	<	d_1	≤	235.80	1.72
235.80	<	d_1	≤	237.34	1.73
237.34	<	d_1	≤	238.88	1.74
238.88	<	d_1	≤	240.42	1.75
240.42	<	d_1	≤	241.95	1.76
241.95	<	d_1	≤	243.49	1.77
243.49	<	d_1	≤	245.03	1.78
245.03	<	d_1	≤	246.57	1.79
246.57	<	d_1	≤	248.11	1.80
248.11	<	d_1	≤	249.66	1.81
249.66	<	d_1	≤	251.20	1.82
251.20	<	d_1	≤	252.74	1.83
252.74	<	d_1	≤	254.28	1.84
254.28	<	d_1	≤	255.82	1.85
255.82	<	d_1	≤	257.37	1.86
257.37	<	d_1	≤	258.91	1.87
258.91	<	d_1	≤	260.46	1.88
260.46	<	d_1	≤	262.00	1.89
262.00	<	d_1	≤	263.55	1.90
263.55	<	d_1	≤	265.09	1.91
265.09	<	d_1	≤	266.64	1.92
266.64	<	d_1	≤	268.18	1.93
268.18	<	d_1	≤	269.73	1.94
269.73	<	d_1	≤	271.28	1.95
271.28	<	d_1	≤	272.83	1.96

Inside diameter d_1					Tolerance ±
272.83	<	d_1	≤	274.38	1.97
274.38	<	d_1	≤	275.92	1.98
275.92	<	d_1	≤	277.47	1.99
277.47	<	d_1	≤	279.02	2.00
279.02	<	d_1	≤	280.57	2.01
280.57	<	d_1	≤	282.12	2.02
282.12	<	d_1	≤	283.68	2.03
283.68	<	d_1	≤	285.23	2.04
285.23	<	d_1	≤	286.78	2.05
286.78	<	d_1	≤	288.33	2.06
288.33	<	d_1	≤	289.88	2.07
289.88	<	d_1	≤	291.44	2.08
291.44	<	d_1	≤	292.99	2.09
292.99	<	d_1	≤	294.54	2.10
294.54	<	d_1	≤	296.10	2.11
296.10	<	d_1	≤	297.65	2.12
297.65	<	d_1	≤	299.21	2.13
299.21	<	d_1	≤	300.76	2.14
300.76	<	d_1	≤	302.32	2.15
302.32	<	d_1	≤	303.88	2.16
303.88	<	d_1	≤	305.43	2.17
305.43	<	d_1	≤	306.99	2.18
306.99	<	d_1	≤	308.55	2.19
308.55	<	d_1	≤	310.11	2.20
310.11	<	d_1	≤	311.66	2.21
311.66	<	d_1	≤	313.22	2.22
313.22	<	d_1	≤	314.78	2.23
314.78	<	d_1	≤	316.34	2.24
316.34	<	d_1	≤	317.90	2.25
317.90	<	d_1	≤	319.46	2.26
319.46	<	d_1	≤	321.02	2.27
321.02	<	d_1	≤	322.58	2.28
322.58	<	d_1	≤	324.15	2.29
324.15	<	d_1	≤	325.71	2.30
325.71	<	d_1	≤	327.27	2.31
327.27	<	d_1	≤	328.83	2.32
328.83	<	d_1	≤	330.39	2.33
330.39	<	d_1	≤	331.96	2.34
331.96	<	d_1	≤	333.52	2.35
333.52	<	d_1	≤	335.09	2.36
335.09	<	d_1	≤	336.65	2.37
336.65	<	d_1	≤	338.21	2.38
338.21	<	d_1	≤	339.78	2.39
339.78	<	d_1	≤	341.35	2.40
341.35	<	d_1	≤	342.91	2.41
342.91	<	d_1	≤	344.48	2.42
344.48	<	d_1	≤	346.04	2.43

Inside diameter d_1					Tolerance ±
346.04	<	d_1	≤	347.61	2.44
347.61	<	d_1	≤	349.18	2.45
349.18	<	d_1	≤	350.75	2.46
350.75	<	d_1	≤	352.31	2.47
352.31	<	d_1	≤	353.88	2.48
353.88	<	d_1	≤	355.45	2.49
355.45	<	d_1	≤	357.02	2.50
357.02	<	d_1	≤	358.59	2.51
358.59	<	d_1	≤	360.16	2.52
360.16	<	d_1	≤	361.73	2.53
361.73	<	d_1	≤	363.30	2.54
363.30	<	d_1	≤	364.87	2.55
364.87	<	d_1	≤	366.44	2.56
366.44	<	d_1	≤	368.01	2.57
368.01	<	d_1	≤	369.58	2.58
369.58	<	d_1	≤	371.16	2.59
371.16	<	d_1	≤	372.73	2.60
372.73	<	d_1	≤	374.30	2.61
374.30	<	d_1	≤	375.87	2.62
375.87	<	d_1	≤	377.45	2.63
377.45	<	d_1	≤	379.02	2.64
379.02	<	d_1	≤	380.59	2.65
380.59	<	d_1	≤	382.17	2.66
382.17	<	d_1	≤	383.74	2.67
383.74	<	d_1	≤	385.32	2.68
385.32	<	d_1	≤	386.89	2.69
386.89	<	d_1	≤	388.47	2.70
388.47	<	d_1	≤	390.05	2.71
390.05	<	d_1	≤	391.62	2.72
391.62	<	d_1	≤	393.20	2.73
393.20	<	d_1	≤	394.78	2.74
394.78	<	d_1	≤	396.35	2.75
396.35	<	d_1	≤	397.93	2.76
397.93	<	d_1	≤	399.51	2.77
399.51	<	d_1	≤	401.09	2.78
401.09	<	d_1	≤	402.66	2.79
402.66	<	d_1	≤	404.24	2.80
404.24	<	d_1	≤	405.82	2.81
405.82	<	d_1	≤	407.40	2.82
407.40	<	d_1	≤	408.98	2.83
408.98	<	d_1	≤	410.56	2.84
410.56	<	d_1	≤	412.14	2.85
412.14	<	d_1	≤	413.72	2.86
413.72	<	d_1	≤	415.30	2.87
415.30	<	d_1	≤	416.89	2.88
416.89	<	d_1	≤	418.47	2.89
418.47	<	d_1	≤	420.05	2.90

Inside diameter d_1					Tolerance ±
420.05	<	d_1	≤	421.63	2.91
421.63	<	d_1	≤	423.21	2.92
423.21	<	d_1	≤	424.80	2.93
424.80	<	d_1	≤	426.38	2.94
426.38	<	d_1	≤	427.96	2.95
427.96	<	d_1	≤	429.55	2.96
429.55	<	d_1	≤	431.13	2.97
431.13	<	d_1	≤	432.71	2.98
432.71	<	d_1	≤	434.30	2.99
434.30	<	d_1	≤	435.88	3.00
435.88	<	d_1	≤	437.47	3.01
437.47	<	d_1	≤	439.05	3.02
439.05	<	d_1	≤	440.64	3.03
440.64	<	d_1	≤	442.22	3.04
442.22	<	d_1	≤	443.81	3.05
443.81	<	d_1	≤	445.40	3.06
445.40	<	d_1	≤	446.98	3.07
446.98	<	d_1	≤	448.57	3.08
448.57	<	d_1	≤	450.16	3.09
450.16	<	d_1	≤	451.75	3.10
451.75	<	d_1	≤	453.33	3.11
453.33	<	d_1	≤	454.92	3.12
454.92	<	d_1	≤	456.51	3.13
456.51	<	d_1	≤	458.10	3.14
458.10	<	d_1	≤	459.69	3.15
459.69	<	d_1	≤	461.28	3.16
461.28	<	d_1	≤	462.87	3.17
462.87	<	d_1	≤	464.46	3.18
464.46	<	d_1	≤	466.05	3.19
466.05	<	d_1	≤	467.64	3.20
467.64	<	d_1	≤	469.23	3.21
469.23	<	d_1	≤	470.82	3.22
470.82	<	d_1	≤	472.41	3.23
472.41	<	d_1	≤	474.00	3.24
474.00	<	d_1	≤	475.59	3.25
475.59	<	d_1	≤	477.19	3.26
477.19	<	d_1	≤	478.78	3.27
478.78	<	d_1	≤	480.37	3.28
480.37	<	d_1	≤	481.96	3.29
481.96	<	d_1	≤	483.56	3.30
483.56	<	d_1	≤	485.15	3.31
485.15	<	d_1	≤	486.74	3.32
486.74	<	d_1	≤	488.34	3.33
488.34	<	d_1	≤	489.93	3.34
489.93	<	d_1	≤	491.52	3.35
491.52	<	d_1	≤	493.12	3.36
493.12	<	d_1	≤	494.71	3.37

Inside diameter d_1					Tolerance ±
494.71	<	d_1	≤	496.31	3.38
496.31	<	d_1	≤	497.90	3.39
497.90	<	d_1	≤	499.50	3.40
499.50	<	d_1	≤	500.00	3.41
		d_1	>	500.00	according to equation

C.1.4 Surface quality acceptance criteria

ISO 3601-3 defines and classifies surface imperfections on O-Rings and specifies the maximum acceptable limits for these imperfections depending on the defined Grade.

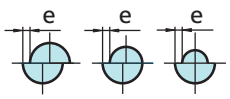
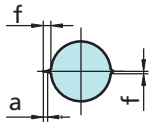
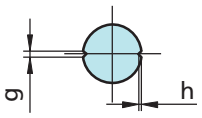
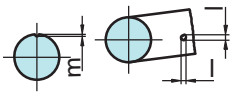
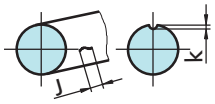
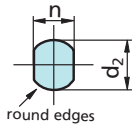
Grade N (general purpose)
Grade N identifies surface acceptance criteria for O-Rings intended for general industrial use.

Grade S (special)
Grade S identifies surface quality acceptance criteria for O-Rings intended for applications requiring a higher level of quality with respect to tolerances of surface imperfections, e.g. for safety relevant components in automotive engineering.

The following Table 18 defines standard form and surface deviations of Trelleborg Sealing Solutions elastomeric O-Rings according to the TSS standard TBS-00005, based on ISO 3601:2005, grade N (general purpose).

If no quality requirements are specified with the order, O-Rings are supplied with standard specification according to Table 18.

Table 18 Standard surface specification for O-Rings according to the TSS standard TBS-00005, based on ISO 3601-3:2005, grade N

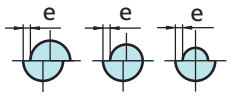
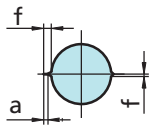
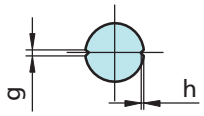
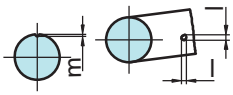
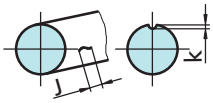
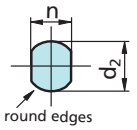
Standard form and surface deviations, grade N											
Type of defects according to TSS standard TBS-00005***		Schematic illustration		maximum acceptable limits according to TSS standard TBS-00005***, **Grade N**							
				Cross section d_2							
				≤ 0.80	≤ 2.25	≤ 3.15	≤ 4.50	≤ 6.30	≤ 8.40	≤ 10.00	≤ 15.00	> 15.00
1.	Offset		e	by agreement	0.08	0.10	0.13	0.15	0.15	0.20	0.25	by agreement
2.	Flash		f		0.10	0.12	0.14	0.16	0.18	0.20	0.25	
			a		When the flash can be differentiated, it shall not exceed 0.07 mm							
3.	Backrind		g		0.18	0.27	0.36	0.53	0.70	0.90	1.20	
			h		0.08	0.08	0.10	0.10	0.13	0.13	0.15	
4.	Non-fills and indentations		l		0.60	0.80	1.00	1.30	1.70	2.00	2.50	
			m		0.08	0.08	0.10	0.10	0.13	0.13	0.15	
5.	Flow marks (radial orientation is not permitted)		j**		1.50	1.50	6.50	6.50	6.50	6.50	8.00	
					or 0.05 x d_1*							
			k		0.08	0.08	0.08	0.08	0.08	0.10	0.10	
6.	Area of excessive trimming (radial tool marks not allowed)		n		Trimming is allowed provided the dimension n is not reduced below the minimum diameter d_2 for the O-Ring							
7.	Foreign material (embedded in the surface)		-	not permitted when viewed 2-times-magnified								
8.	Straightness tolerance		-	-								
9.	Roundness		-	-								
10.	The O-Ring surface shall be free from cracks, ruptures, blisters and other imperfections that are greater than the limits given in the table when inspected at 2-times-magnification with adequate illumination. The unstretched Ring is viewed.											
11.	Flow marks, non-fills and indentations within the limits given in the table shall not be allowed if a) there are more than three in any 25 mm length of circumference, b) they interconnect c) there are more than three that are separated from each other by a distance that is less than the maximum length of such imperfection											

all dimensions in mm * d_1 = Inside Diameter ** whichever is the greater *** based on ISO 3601-3:2005

The following Table 19 defines restriced form and surface deviations of Trelleborg Sealing Solutions elastomeric O-Rings according to the TSS standard TBS-00005, based on ISO 3601:2005, grade S (special).

The permissible flaw sizes are very limited. This demands a greater process technology and stricter quality control procedures.

Table 19 Surface specification with reduced tolerances for O-Rings according to the TSS standard TBS-00005, based on ISO 3601-3:2005, grade S

Restricted form and surface deviations, grade S											
Type of defects according to TSS standard TBS-00005***		Schematic illustration		maximum acceptable limits according to TSS standard TBS-00005***, **Grade S**							
				Cross section d_2							
				≤ 0.80	≤ 2.25	≤ 3.15	≤ 4.50	≤ 6.30	≤ 8.40	≤ 10.00	≤ 15.00	> 15.00
1.	Offset		e	by agreement	0.08	0.08	0.10	0.12	0.13	0.15	0.20	by agreement
2.	Flash		f		0.10	0.10	0.13	0.15	0.15	0.18	0.20	
			a		When the flash can be differentiated, it shall not exceed 0.05 mm							
3.	Backrind		g		0.10	0.15	0.20	0.20	0.30	0.50	0.75	
			h		0.05	0.08	0.10	0.10	0.13	0.13	0.15	
4.	Non-fills and indentations		l		0.15	0.25	0.40	0.63	1.00	1.50	2.00	
			m		0.08	0.08	0.10	0.10	0.13	0.13	0.15	
5.	Flow marks (radial orientation is not permitted)		j**		1.50	1.50	5.00	5.00	5.00	5.00	7.00	
					or 0.05 x d_1*							
			k		0.05	0.05	0.05	0.05	0.05	0.08	0.08	
6.	Area of excessive trimming (radial tool marks not allowed)		n		Trimming is allowed provided the dimension n is not reduced below the minimum diameter d_2 for the O-Ring							
7.	Foreign material (embedded in the surface)		-	not permitted when viewed 2-times-magnified								
8.	Straightness tolerance		-	-								
9.	Roundness		-	-								
10.	The O-Ring surface shall be free from cracks, ruptures, blisters and other imperfections that are greater than the limits given in the table when inspected at 2-times-magnification with adequate illumination. The unstretched Ring is viewed.											
11.	Flow marks, non-fills and indentations within the limits given in the table shall not be allowed if a) there are more than three in any 25 mm length of circumference, b) they interconnect c) there are more than three that are separated from each other by a distance that is less than the maximum length of such imperfection											

all dimensions in mm * d_1 = Inside Diameter ** whichever is the greater *** based on ISO 3601-3:2005

For surface deviations ISO 2859-1:2004-01 AQL 1,0 general inspection level II, normal inspection, is supplied as standard. Higher quality levels are available on request.

C.2 Product range

The following tables provide a summary of available O-Ring dimensions, Trelleborg Sealing Solutions part numbers and valid standards. The tables represent a guide to common dimensions with or without a valid standard but does not include a complete range of sizes, which is more extensive. Special dimensions are also available on request. Contact your local Trelleborg Sealing Solutions marketing company for further details.

For the dimensions given molds generally exist. Due to different shrinkage factors of various materials, it may not be possible to process certain materials with the existing molds. To guarantee high constant quality levels, it might be necessary to produce new or additional molds accruing extra costs.

Ordering example 1

O-Ring, metric 40 x 3

Dimensions:	Inside diameter	= 40.0 mm
	Cross section	= 3.0 mm
Material:	NBR 70 (Nitrile-Butadiene Rubber 70 Shore A)	

TSS Article No. OR 30 04000 - N70

- TSS Article - Group
- Cross section x 10
- Inside diameter x 100
- Quality Index (Standard)
- Material code (Standard)

Ordering example 2

O-Ring, ISO 3601-1 and AS 568 reference no. 149

Dimensions:	Inside diameter	= 71.12 mm
	Cross section	= 2.62 mm
Material:	FKM 80 (Fluorocarbon Rubber 80 Shore A)	

TSS Article No. OR AR 00149 - V80

- TSS Article - Group
- Standard ISO 3601-1 / AS 568
- Part No. (Dash-No.)
- Quality Index (Standard)
- Material code (Standard)

O-Ring dimensions and TSS part numbers see following tables.

Elastomer type codes for standard product order see Table 1 (last column).

The required Shore A hardness must be given with the order.

When a special material is required the exact five-digit Trelleborg Sealing Solutions material code must be given with the order. In this respect please refer to the information provided in Table 10 Preferred materials or contact your local Trelleborg Sealing Solutions company.

C.2.1 O-Ring dimensions according to ISO 3601-1 and AS 568

The following table shows the preferred O-Ring dimensions according to the international standard ISO 3601-1 and the American standard AS 568, including appropriate reference numbers.

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the table below.

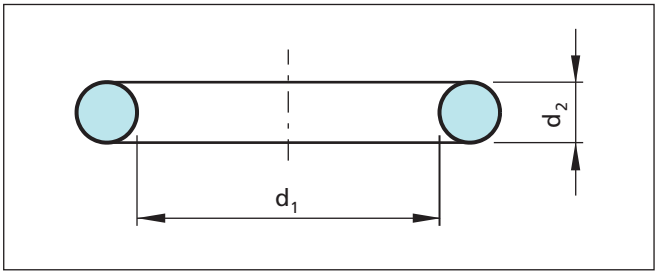


Figure 31 O-Ring dimensions

Table 20 Preferred O-Ring dimensions according to ISO 3601-1 and AS 568 with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00001	001	0.74	0.12	1.02	0.08
ORAR00002	002	1.07	0.12	1.27	
ORAR00003	003	1.42	0.12	1.52	
ORAR00004	004	1.78	0.13	1.78	0.08
ORAR00005	005	2.57	0.13	1.78	
ORAR00006	006	2.90	0.13	1.78	
ORAR00007	007	3.68	0.14	1.78	
ORAR00008	008	4.47	0.15	1.78	
ORAR00009	009	5.28	0.15	1.78	
ORAR00010	010	6.07	0.16	1.78	
ORAR00011	011	7.65	0.17	1.78	
ORAR00012	012	9.25	0.18	1.78	
ORAR00013	013	10.82	0.20	1.78	
ORAR00014	014	12.42	0.21	1.78	
ORAR00015	015	14.00	0.22	1.78	
ORAR00016	016	15.60	0.23	1.78	
ORAR00017	017	17.17	0.24	1.78	
ORAR00018	018	18.77	0.26	1.78	
ORAR00019	019	20.35	0.27	1.78	
ORAR00020	020	21.95	0.28	1.78	
ORAR00021	021	23.52	0.29	1.78	
ORAR00022	022	25.12	0.30	1.78	
ORAR00023	023	26.70	0.31	1.78	
ORAR00024	024	28.30	0.33	1.78	
ORAR00025	025	29.87	0.34	1.78	
ORAR00026	026	31.47	0.35	1.78	
ORAR00027	027	33.05	0.36	1.78	
ORAR00028	028	34.65	0.37	1.78	
ORAR00029	029	37.82	0.39	1.78	
ORAR00030	030	41.00	0.42	1.78	
ORAR00031	031	44.17	0.44	1.78	
ORAR00032	032	47.35	0.46	1.78	
ORAR00033	033	50.52	0.48	1.78	
ORAR00034	034	53.70	0.51	1.78	
ORAR00035	035	56.87	0.53	1.78	
ORAR00036	036	60.05	0.55	1.78	
ORAR00037	037	63.22	0.57	1.78	
ORAR00038	038	66.40	0.59	1.78	
ORAR00039	039	69.57	0.62	1.78	
ORAR00040	040	72.75	0.64	1.78	
ORAR00041	041	75.92	0.66	1.78	
ORAR00042	042	82.27	0.70	1.78	
ORAR00043	043	88.62	0.75	1.78	
ORAR00044	044	94.97	0.79	1.78	
ORAR00045	045	101.32	0.83	1.78	
ORAR00046	046	107.67	0.88	1.78	
ORAR00047	047	114.02	0.92	1.78	
ORAR00048	048	120.37	0.96	1.78	
ORAR00049	049	126.72	1.01	1.78	
ORAR00050	050	133.07	1.05	1.78	
ORAR00102	102	1.24	0.12	2.62	0.09
ORAR00103	103	2.06	0.13	2.62	
ORAR00104	104	2.84	0.13	2.62	
ORAR00105	105	3.63	0.14	2.62	
ORAR00106	106	4.42	0.15	2.62	
ORAR00107	107	5.23	0.15	2.62	
ORAR00108	108	6.02	0.16	2.62	
ORAR00109	109	7.59	0.17	2.62	
ORAR00110	110	9.19	0.18	2.62	
ORAR00111	111	10.77	0.20	2.62	
ORAR00112	112	12.37	0.21	2.62	
ORAR00113	113	13.94	0.22	2.62	
ORAR00114	114	15.54	0.23	2.62	
ORAR00115	115	17.12	0.24	2.62	
ORAR00116	116	18.72	0.26	2.62	
ORAR00117	117	20.30	0.27	2.62	
ORAR00118	118	21.89	0.28	2.62	
ORAR00119	119	23.47	0.29	2.62	
ORAR00120	120	25.07	0.30	2.62	
ORAR00121	121	26.64	0.31	2.62	
ORAR00122	122	28.24	0.33	2.62	
ORAR00123	123	29.82	0.34	2.62	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00124	124	31.42	0.35	2.62	
ORAR00125	125	32.99	0.36	2.62	
ORAR00126	126	34.59	0.37	2.62	
ORAR00127	127	36.17	0.38	2.62	
ORAR00128	128	37.77	0.39	2.62	
ORAR00129	129	39.34	0.40	2.62	
ORAR00130	130	40.94	0.42	2.62	
ORAR00131	131	42.52	0.43	2.62	
ORAR00132	132	44.12	0.44	2.62	
ORAR00133	133	45.69	0.45	2.62	
ORAR00134	134	47.29	0.46	2.62	
ORAR00135	135	48.90	0.47	2.62	
ORAR00136	136	50.47	0.48	2.62	
ORAR00137	137	52.07	0.49	2.62	
ORAR00138	138	53.64	0.51	2.62	
ORAR00139	139	55.25	0.52	2.62	
ORAR00140	140	56.82	0.53	2.62	
ORAR00141	141	58.42	0.54	2.62	
ORAR00142	142	59.99	0.55	2.62	0.09
ORAR00143	143	61.60	0.56	2.62	
ORAR00144	144	63.17	0.57	2.62	
ORAR00145	145	64.77	0.58	2.62	
ORAR00146	146	66.34	0.59	2.62	
ORAR00147	147	67.95	0.61	2.62	
ORAR00148	148	69.52	0.62	2.62	
ORAR00149	149	71.12	0.63	2.62	
ORAR00150	150	72.69	0.64	2.62	
ORAR00151	151	75.87	0.66	2.62	
ORAR00152	152	82.22	0.70	2.62	
ORAR00153	153	88.57	0.75	2.62	
ORAR00154	154	94.92	0.79	2.62	
ORAR00155	155	101.27	0.83	2.62	
ORAR00156	156	107.62	0.88	2.62	
ORAR00157	157	113.97	0.92	2.62	
ORAR00158	158	120.32	0.96	2.62	
ORAR00159	159	126.67	1.00	2.62	
ORAR00160	160	133.02	1.05	2.62	
ORAR00161	161	139.37	1.09	2.62	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00162	162	145.72	1.13	2.62	
ORAR00163	163	152.07	1.17	2.62	
ORAR00164	164	158.42	1.22	2.62	
ORAR00165	165	164.77	1.26	2.62	
ORAR00166	166	171.12	1.30	2.62	
ORAR00167	167	177.47	1.34	2.62	
ORAR00168	168	183.82	1.38	2.62	
ORAR00169	169	190.17	1.43	2.62	
ORAR00170	170	196.52	1.47	2.62	0.09
ORAR00171	171	202.87	1.51	2.62	
ORAR00172	172	209.22	1.55	2.62	
ORAR00173	173	215.57	1.59	2.62	
ORAR00174	174	221.92	1.63	2.62	
ORAR00175	175	228.27	1.68	2.62	
ORAR00176	176	234.62	1.72	2.62	
ORAR00177	177	240.97	1.76	2.62	
ORAR00178	178	247.32	1.80	2.62	
ORAR00201	201	4.34	0.15	3.53	
ORAR00202	202	5.94	0.16	3.53	
ORAR00203	203	7.52	0.17	3.53	
ORAR00204	204	9.12	0.18	3.53	
ORAR00205	205	10.69	0.20	3.53	
ORAR00206	206	12.29	0.21	3.53	
ORAR00207	207	13.87	0.22	3.53	
ORAR00208	208	15.47	0.23	3.53	
ORAR00209	209	17.04	0.24	3.53	
ORAR00210	210	18.64	0.25	3.53	0.10
ORAR00211	211	20.22	0.27	3.53	
ORAR00212	212	21.82	0.28	3.53	
ORAR00213	213	23.39	0.29	3.53	
ORAR00214	214	24.99	0.30	3.53	
ORAR00215	215	26.57	0.31	3.53	
ORAR00216	216	28.17	0.32	3.53	
ORAR00217	217	29.74	0.34	3.53	
ORAR00218	218	31.34	0.35	3.53	
ORAR00219	219	32.92	0.36	3.53	
ORAR00220	220	34.52	0.37	3.53	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00221	221	36.09	0.38	3.53	
ORAR00222	222	37.69	0.39	3.53	
ORAR00223	223	40.87	0.42	3.53	
ORAR00224	224	44.04	0.44	3.53	
ORAR00225	225	47.22	0.46	3.53	
ORAR00226	226	50.39	0.48	3.53	
ORAR00227	227	53.57	0.51	3.53	
ORAR00228	228	56.74	0.53	3.53	
ORAR00229	229	59.92	0.55	3.53	
ORAR00230	230	63.09	0.57	3.53	
ORAR00231	231	66.27	0.59	3.53	
ORAR00232	232	69.44	0.62	3.53	
ORAR00233	233	72.62	0.64	3.53	
ORAR00234	234	75.79	0.66	3.53	
ORAR00235	235	78.97	0.68	3.53	
ORAR00236	236	82.14	0.70	3.53	
ORAR00237	237	85.32	0.72	3.53	
ORAR00238	238	88.49	0.75	3.53	
ORAR00239	239	91.67	0.77	3.53	0.10
ORAR00240	240	94.84	0.79	3.53	
ORAR00241	241	98.02	0.81	3.53	
ORAR00242	242	101.19	0.83	3.53	
ORAR00243	243	104.37	0.85	3.53	
ORAR00244	244	107.54	0.88	3.53	
ORAR00245	245	110.72	0.90	3.53	
ORAR00246	246	113.89	0.92	3.53	
ORAR00247	247	117.07	0.94	3.53	
ORAR00248	248	120.24	0.96	3.53	
ORAR00249	249	123.42	0.98	3.53	
ORAR00250	250	126.59	1.00	3.53	
ORAR00251	251	129.77	1.03	3.53	
ORAR00252	252	132.94	1.05	3.53	
ORAR00253	253	136.12	1.07	3.53	
ORAR00254	254	139.29	1.09	3.53	
ORAR00255	255	142.47	1.11	3.53	
ORAR00256	256	145.64	1.13	3.53	
ORAR00257	257	148.82	1.15	3.53	
ORAR00258	258	151.99	1.17	3.53	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00259	259	158.34	1.22	3.53	
ORAR00260	260	164.69	1.26	3.53	
ORAR00261	261	171.04	1.30	3.53	
ORAR00262	262	177.39	1.34	3.53	
ORAR00263	263	183.74	1.38	3.53	
ORAR00264	264	190.09	1.43	3.53	
ORAR00265	265	196.44	1.47	3.53	
ORAR00266	266	202.79	1.51	3.53	
ORAR00267	267	209.14	1.55	3.53	
ORAR00268	268	215.49	1.59	3.53	
ORAR00269	269	221.84	1.63	3.53	
ORAR00270	270	228.19	1.68	3.53	
ORAR00271	271	234.54	1.72	3.53	0.10
ORAR00272	272	240.89	1.76	3.53	
ORAR00273	273	247.24	1.80	3.53	
ORAR00274	274	253.59	1.84	3.53	
ORAR00275	275	266.29	1.92	3.53	
ORAR00276	276	278.99	2.00	3.53	
ORAR00277	277	291.69	2.09	3.53	
ORAR00278	278	304.39	2.17	3.53	
ORAR00279	279	329.79	2.33	3.53	
ORAR00280	280	355.19	2.49	3.53	
ORAR00281	281	380.59	2.65	3.53	
ORAR00282	282	405.26	2.81	3.53	
ORAR00283	283	430.66	2.97	3.53	
ORAR00284	284	456.06	3.13	3.53	
ORAR00309	309	10.46	0.19	5.33	
ORAR00310	310	12.07	0.21	5.33	
ORAR00311	311	13.64	0.22	5.33	
ORAR00312	312	15.24	0.23	5.33	
ORAR00313	313	16.81	0.24	5.33	
ORAR00314	314	18.42	0.25	5.33	0.13
ORAR00315	315	19.99	0.26	5.33	
ORAR00316	316	21.59	0.28	5.33	
ORAR00317	317	23.16	0.29	5.33	
ORAR00318	318	24.77	0.30	5.33	
ORAR00319	319	26.34	0.31	5.33	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00320	320	27.94	0.32	5.33	
ORAR00321	321	29.51	0.33	5.33	
ORAR00322	322	31.12	0.35	5.33	
ORAR00323	323	32.69	0.36	5.33	
ORAR00324	324	34.29	0.37	5.33	
ORAR00325	325	37.47	0.39	5.33	
ORAR00326	326	40.64	0.41	5.33	
ORAR00327	327	43.82	0.44	5.33	
ORAR00328	328	46.99	0.46	5.33	
ORAR00329	329	50.17	0.48	5.33	
ORAR00330	330	53.34	0.50	5.33	
ORAR00331	331	56.52	0.53	5.33	
ORAR00332	332	59.69	0.55	5.33	
ORAR00333	333	62.87	0.57	5.33	
ORAR00334	334	66.04	0.59	5.33	
ORAR00335	335	69.22	0.61	5.33	
ORAR00336	336	72.39	0.64	5.33	
ORAR00337	337	75.57	0.66	5.33	
ORAR00338	338	78.74	0.68	5.33	0.13
ORAR00339	339	81.92	0.70	5.33	
ORAR00340	340	85.09	0.72	5.33	
ORAR00341	341	88.27	0.74	5.33	
ORAR00342	342	91.44	0.77	5.33	
ORAR00343	343	94.62	0.79	5.33	
ORAR00344	344	97.79	0.81	5.33	
ORAR00345	345	100.97	0.83	5.33	
ORAR00346	346	104.14	0.85	5.33	
ORAR00347	347	107.32	0.87	5.33	
ORAR00348	348	110.49	0.90	5.33	
ORAR00349	349	113.67	0.92	5.33	
ORAR00350	350	116.84	0.94	5.33	
ORAR00351	351	120.02	0.96	5.33	
ORAR00352	352	123.19	0.98	5.33	
ORAR00353	353	126.37	1.00	5.33	
ORAR00354	354	129.54	1.02	5.33	
ORAR00355	355	132.72	1.05	5.33	
ORAR00356	356	135.89	1.07	5.33	
ORAR00357	357	139.07	1.09	5.33	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00358	358	142.24	1.11	5.33	
ORAR00359	359	145.42	1.13	5.33	
ORAR00360	360	148.59	1.15	5.33	
ORAR00361	361	151.77	1.17	5.33	
ORAR00362	362	158.12	1.21	5.33	
ORAR00363	363	164.47	1.26	5.33	
ORAR00364	364	170.82	1.30	5.33	
ORAR00365	365	177.17	1.34	5.33	
ORAR00366	366	183.52	1.38	5.33	
ORAR00367	367	189.87	1.42	5.33	
ORAR00368	368	196.22	1.47	5.33	
ORAR00369	369	202.57	1.51	5.33	
ORAR00370	370	208.92	1.55	5.33	
ORAR00371	371	215.27	1.59	5.33	
ORAR00372	372	221.62	1.63	5.33	
ORAR00373	373	227.97	1.67	5.33	
ORAR00374	374	234.32	1.72	5.33	
ORAR00375	375	240.67	1.76	5.33	
ORAR00376	376	247.02	1.80	5.33	0.13
ORAR00377	377	253.37	1.84	5.33	
ORAR00378	378	266.07	1.92	5.33	
ORAR00379	379	278.77	2.00	5.33	
ORAR00380	380	291.47	2.09	5.33	
ORAR00381	381	304.17	2.17	5.33	
ORAR00382	382	329.57	2.33	5.33	
ORAR00383	383	354.97	2.49	5.33	
ORAR00384	384	380.37	2.65	5.33	
ORAR00385	385	405.26	2.81	5.33	
ORAR00386	386	430.66	2.97	5.33	
ORAR00387	387	456.06	3.13	5.33	
ORAR00388	388	481.46	3.29	5.33	
ORAR00389	389	506.86	3.45	5.33	
ORAR00390	390	532.26	3.61	5.33	
ORAR00391	391	557.66	3.77	5.33	
ORAR00392	392	582.68	3.92	5.33	
ORAR00393	393	608.08	4.08	5.33	
ORAR00394	394	633.48	4.24	5.33	
ORAR00395	395	658.88	4.40	5.33	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00425	425	113.67	0.92	6.99	0.15
ORAR00426	426	116.84	0.94	6.99	
ORAR00427	427	120.02	0.96	6.99	
ORAR00428	428	123.19	0.98	6.99	
ORAR00429	429	126.37	1.00	6.99	
ORAR00430	430	129.54	1.02	6.99	
ORAR00431	431	132.72	1.05	6.99	
ORAR00432	432	135.89	1.07	6.99	
ORAR00433	433	139.07	1.09	6.99	
ORAR00434	434	142.24	1.11	6.99	
ORAR00435	435	145.42	1.13	6.99	
ORAR00436	436	148.59	1.15	6.99	
ORAR00437	437	151.77	1.17	6.99	
ORAR00438	438	158.12	1.21	6.99	
ORAR00439	439	164.47	1.26	6.99	
ORAR00440	440	170.82	1.30	6.99	
ORAR00441	441	177.17	1.34	6.99	
ORAR00442	442	183.52	1.38	6.99	
ORAR00443	443	189.87	1.42	6.99	
ORAR00444	444	196.22	1.47	6.99	
ORAR00445	445	202.57	1.51	6.99	
ORAR00446	446	215.27	1.59	6.99	
ORAR00447	447	227.97	1.67	6.99	
ORAR00448	448	240.67	1.76	6.99	
ORAR00449	449	253.37	1.84	6.99	
ORAR00450	450	266.07	1.92	6.99	
ORAR00451	451	278.77	2.00	6.99	
ORAR00452	452	291.47	2.09	6.99	
ORAR00453	453	304.17	2.17	6.99	
ORAR00454	454	316.87	2.25	6.99	
ORAR00455	455	329.57	2.33	6.99	
ORAR00456	456	342.27	2.41	6.99	
ORAR00457	457	354.97	2.49	6.99	
ORAR00458	458	367.67	2.57	6.99	
ORAR00459	459	380.37	2.65	6.99	
ORAR00460	460	393.07	2.73	6.99	

TSS Part-No.	Ident-No. ISO 3601-1 AS 568	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
ORAR00461	461	405.26	2.81	6.99	0.15
ORAR00462	462	417.96	2.89	6.99	
ORAR00463	463	430.66	2.97	6.99	
ORAR00464	464	443.36	3.05	6.99	
ORAR00465	465	456.06	3.13	6.99	
ORAR00466	466	468.76	3.21	6.99	
ORAR00467	467	481.46	3.29	6.99	
ORAR00468	468	494.16	3.37	6.99	
ORAR00469	469	506.86	3.45	6.99	
ORAR00470	470	532.26	3.61	6.99	
ORAR00471	471	557.66	3.77	6.99	
ORAR00472	472	582.68	3.92	6.99	
ORAR00473	473	608.08	4.08	6.99	
ORAR00474	474	633.48	4.24	6.99	
ORAR00475	475	658.88	4.40	6.99	

C.2.2 O-Ring dimensions according to Swedish standard SMS 1586

The following two tables show the O-Ring dimensions according to Swedish standard SMS 1586.

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the tables below.

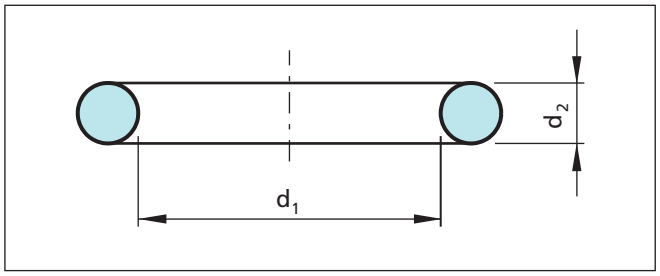


Figure 32 O-Ring dimensions

Table 21 O-Ring dimensions according to SMS 1586, table 1 (dynamic use) with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR2400330	3.30	0.14	2.40	
OR2400430	4.30	0.15	2.40	
OR2400530	5.30	0.15	2.40	
OR2400630	6.30	0.16	2.40	
OR2400730	7.30	0.17	2.40	
OR2400830	8.30	0.18	2.40	
OR2400930	9.30	0.18	2.40	
OR2401030	10.30	0.19	2.40	0.09
OR2401130	11.30	0.20	2.40	
OR2401230	12.30	0.21	2.40	
OR2401330	13.30	0.22	2.40	
OR2401430	14.30	0.22	2.40	
OR2401530	15.30	0.23	2.40	
OR2401630	16.30	0.24	2.40	
OR2401730	17.30	0.25	2.40	
OR3001920	19.20	0.26	3.00	
OR3002220	22.20	0.28	3.00	
OR3002420	24.20	0.30	3.00	0.09
OR3002620	26.20	0.31	3.00	
OR3002920	29.20	0.33	3.00	
OR3003220	32.20	0.35	3.00	
OR3003420	34.20	0.37	3.00	
OR3003620	36.20	0.38	3.00	0.09
OR3003920	39.20	0.40	3.00	
OR3004220	42.20	0.42	3.00	
OR3004420	44.20	0.44	3.00	
OR5704420	44.20	0.44	5.70	
OR5704920	49.20	0.47	5.70	
OR5705420	54.20	0.51	5.70	
OR5705920	59.20	0.54	5.70	
OR5706420	64.20	0.58	5.70	
OR5706920	69.20	0.61	5.70	
OR5707420	74.20	0.65	5.70	
OR5707920	79.20	0.68	5.70	
OR5708410	84.10	0.72	5.70	
OR5708910	89.10	0.75	5.70	
OR5709410	94.10	0.78	5.70	0.13
OR5709910	99.10	0.82	5.70	
OR5710410	104.10	0.85	5.70	
OR5710910	109.10	0.89	5.70	
OR5711430	114.30	0.92	5.70	
OR5711930	119.30	0.96	5.70	
OR5712430	124.30	0.99	5.70	
OR5712930	129.30	1.02	5.70	
OR5713430	134.30	1.06	5.70	
OR5713930	139.30	1.09	5.70	
OR5714430	144.30	1.12	5.70	
OR8414410	144.10	1.12	8.40	
OR8414910	149.10	1.15	8.40	
OR8415410	154.10	1.19	8.40	
OR8415910	159.10	1.22	8.40	
OR8416410	164.10	1.25	8.40	
OR8416910	169.10	1.29	8.40	0.15
OR8417410	174.10	1.32	8.40	
OR8417910	179.10	1.35	8.40	
OR8418410	184.10	1.39	8.40	
OR8418910	189.10	1.42	8.40	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR8419410	194.10	1.45	8.40	0.15
OR8419910	199.10	1.49	8.40	
OR8420910	209.10	1.55	8.40	
OR8421910	219.10	1.62	8.40	
OR8422910	229.10	1.68	8.40	
OR8423910	239.10	1.75	8.40	
OR8424910	249.10	1.81	8.40	

Table 22 O-Ring dimensions according to SMS 1586, table 2 (static use) with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR1600310	3.10	0.14	1.60	0.08
OR1600410	4.10	0.14	1.60	
OR1600510	5.10	0.15	1.60	
OR1600610	6.10	0.16	1.60	
OR1600710	7.10	0.17	1.60	
OR1600810	8.10	0.18	1.60	
OR1600910	9.10	0.18	1.60	
OR1601010	10.10	0.19	1.60	
OR1601110	11.10	0.20	1.60	
OR1601210	12.10	0.21	1.60	
OR1601310	13.10	0.21	1.60	
OR1601410	14.10	0.22	1.60	
OR1601510	15.10	0.23	1.60	
OR1601610	16.10	0.24	1.60	
OR1601710	17.10	0.24	1.60	
OR1601810	18.10	0.25	1.60	
OR1601910	19.10	0.26	1.60	
OR1602210	22.10	0.28	1.60	
OR1602510	25.10	0.30	1.60	
OR1602710	27.10	0.32	1.60	
OR1602910	29.10	0.33	1.60	
OR1603210	32.10	0.35	1.60	
OR1603510	35.10	0.37	1.60	
OR1603710	37.10	0.39	1.60	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR3004950	49.50	0.48	3.00	0.09
OR3005450	54.50	0.51	3.00	
OR3005950	59.50	0.55	3.00	
OR3006450	64.50	0.58	3.00	
OR3006950	69.50	0.62	3.00	
OR3007450	74.50	0.65	3.00	
OR3007950	79.50	0.68	3.00	
OR3008450	84.50	0.72	3.00	
OR3008950	89.50	0.75	3.00	
OR3009450	94.50	0.79	3.00	
OR3009950	99.50	0.82	3.00	
OR3010450	104.50	0.86	3.00	
OR3010950	109.50	0.89	3.00	
OR3011450	114.50	0.92	3.00	
OR3011950	119.50	0.96	3.00	
OR3012450	124.50	0.99	3.00	
OR3012950	129.50	1.02	3.00	
OR3013450	134.50	1.06	3.00	
OR3013950	139.50	1.09	3.00	
OR3014450	144.50	1.12	3.00	
OR5714930	149.30	1.16	5.70	0.13
OR5715430	154.30	1.19	5.70	
OR5715930	159.30	1.22	5.70	
OR5716430	164.30	1.26	5.70	
OR5716930	169.30	1.29	5.70	
OR5717430	174.30	1.32	5.70	
OR5717930	179.30	1.35	5.70	
OR5718430	184.30	1.39	5.70	
OR5718930	189.30	1.42	5.70	
OR5719430	194.30	1.45	5.70	
OR5719930	199.30	1.49	5.70	
OR5720930	209.30	1.55	5.70	
OR5721930	219.30	1.62	5.70	
OR5722930	229.30	1.68	5.70	
OR5723930	239.30	1.75	5.70	
OR5724930	249.30	1.81	5.70	
OR5725930	259.30	1.88	5.70	
OR5726930	269.30	1.94	5.70	
OR5727930	279.30	2.01	5.70	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR5728930	289.30	2.07	5.70	0.13
OR5729930	299.30	2.14	5.70	
OR5731930	319.30	2.26	5.70	
OR5733930	339.30	2.39	5.70	
OR5735930	359.30	2.52	5.70	
OR5737930	379.30	2.65	5.70	
OR5739930	399.30	2.77	5.70	
OR5741930	419.30	2.90	5.70	
OR5743930	439.30	3.03	5.70	
OR5745930	459.30	3.15	5.70	
OR5747930	479.30	3.28	5.70	
OR5749930	499.30	3.40	5.70	

C.2.3 O-Ring dimensions according to Japanese standard JIS B 2401

The following two tables show O-Ring dimensions according to the Japanese standard JIS B 2401 for dynamic use (P) and for static use (G).

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the tables below.

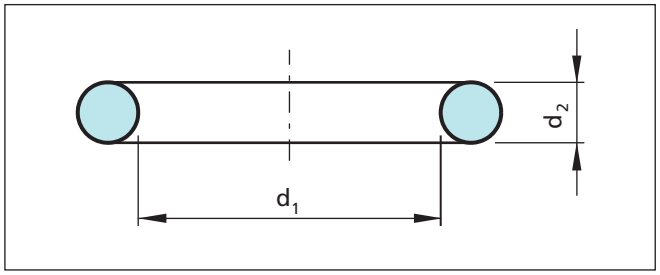


Figure 33 O-Ring dimensions

Table 23 O-Ring dimensions according to JIS B 2401 for dynamic use (P) with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Ident-No. JIS B 2401	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
OR1900280	P3	2.80	0.13	1.90	0.08
OR1900380	P4	3.80	0.14	1.90	
OR1900480	P5	4.80	0.15	1.90	
OR1900580	P6	5.80	0.16	1.90	
OR1900680	P7	6.80	0.17	1.90	
OR1900780	P8	7.80	0.17	1.90	
OR1900880	P9	8.80	0.18	1.90	
OR1900980	P10	9.80	0.19	1.90	
OR2400980	P10A	9.80	0.19	2.40	0.09
OR2401080	P11	10.80	0.20	2.40	
OR2401100	P11.2	11.00	0.20	2.40	
OR2401180	P12	11.80	0.20	2.40	
OR2401230	P12.5	12.30	0.21	2.40	
OR2401380	P14	13.80	0.22	2.40	
OR2401480	P15	14.80	0.23	2.40	
OR2401580	P16	15.80	0.23	2.40	
OR2401780	P18	17.80	0.25	2.40	
OR2401980	P20	19.80	0.26	2.40	
OR2402080	P21	20.80	0.27	2.40	
OR2402180	P22	21.80	0.28	2.40	
OR3502170	P22A	21.70	0.28	3.50	0.10
OR3502210	P22.4	22.10	0.28	3.50	
OR3502378	P24	23.78	0.29	3.50	
OR3502470	P25	24.70	0.30	3.50	
OR3502520	P25.5	25.20	0.30	3.50	
OR3502570	P26	25.70	0.31	3.50	
OR3502770	P28	27.70	0.32	3.50	
OR3502870	P29	28.70	0.33	3.50	
OR3502920	P29.5	29.20	0.33	3.50	
OR3502970	P30	29.70	0.34	3.50	
OR3503070	P31	30.70	0.34	3.50	
OR3503120	P31.5	31.20	0.35	3.50	
OR3503170	P32	31.70	0.35	3.50	
OR3503370	P34	33.70	0.36	3.50	
OR3503470	P35	34.70	0.37	3.50	
OR3503520	P35.5	35.20	0.38	3.50	
OR3503570	P36	35.70	0.38	3.50	
OR3503770	P38	37.70	0.39	3.50	
OR3503870	P39	38.70	0.40	3.50	
OR3503970	P40	39.70	0.41	3.50	
OR3504070	P41	40.70	0.41	3.50	

TSS Part-No.	Ident-No. JIS B 2401	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
OR3504170	P42	41.70	0.42	3.50	
OR3504370	P44	43.70	0.44	3.50	
OR3504470	P45	44.70	0.44	3.50	
OR3504570	P46	45.70	0.45	3.50	0.10
OR3504770	P48	47.70	0.46	3.50	
OR3504870	P49	48.70	0.47	3.50	
OR3504970	P50	49.70	0.48	3.50	
OR5704760	P48A	47.60	0.46	5.70	
OR5704960	P50A	49.60	0.48	5.70	
OR5705160	P52	51.60	0.49	5.70	
OR5705260	P53	52.60	0.50	5.70	
OR5705460	P55	54.60	0.51	5.70	
OR5705560	P56	55.60	0.52	5.70	
OR5705760	P58	57.60	0.53	5.70	
OR5705960	P60	59.60	0.55	5.70	
OR5706160	P62	61.60	0.56	5.70	
OR5706260	P63	62.60	0.57	5.70	
OR5706460	P65	64.60	0.58	5.70	
OR5706660	P67	66.60	0.60	5.70	
OR5706960	P70	69.60	0.62	5.70	
OR5707060	P71	70.60	0.62	5.70	
OR5707460	P75	74.60	0.65	5.70	
OR5707960	P80	79.60	0.69	5.70	
OR5708460	P85	84.60	0.72	5.70	0.13
OR5708960	P90	89.60	0.75	5.70	
OR5709460	P95	94.60	0.79	5.70	
OR5709960	P100	99.60	0.82	5.70	
OR5710160	P102	101.60	0.84	5.70	
OR5710460	P105	104.60	0.86	5.70	
OR5710960	P110	109.60	0.89	5.70	
OR5711160	P112	111.60	0.90	5.70	
OR5711460	P115	114.60	0.92	5.70	
OR5711960	P120	119.60	0.96	5.70	
OR5712460	P125	124.60	0.99	5.70	
OR5712960	P130	129.60	1.02	5.70	
OR5713160	P13	131.6	1.0	5.7	
OR5713460	P135	134.60	1.06	5.70	
OR5713960	P140	139.60	1.09	5.70	
OR5714460	P145	144.60	1.12	5.70	
OR5714960	P150	149.60	1.16	5.70	

TSS Part-No.	Ident-No. JIS B 2401	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
OR8414950	P150A	149.50	1.16	8.40	
OR8415450	P155	154.50	1.19	8.40	
OR8415950	P160	159.50	1.22	8.40	
OR8416450	P165	164.50	1.26	8.40	
OR8416950	P170	169.50	1.29	8.40	
OR8417450	P175	174.50	1.32	8.40	
OR8417950	P180	179.50	1.36	8.40	
OR8418450	P185	184.50	1.39	8.40	
OR8418950	P190	189.50	1.42	8.40	
OR8419450	P195	194.50	1.45	8.40	
OR8419950	P200	199.50	1.49	8.40	
OR8420450	P205	204.50	1.52	8.40	
OR8420850	P209	208.50	1.55	8.40	
OR8420950	P210	209.50	1.55	8.40	
OR8421450	P215	214.50	1.59	8.40	
OR8421950	P220	219.50	1.62	8.40	
OR8422450	P225	224.50	1.65	8.40	
OR8422950	P230	229.50	1.68	8.40	
OR8423450	P235	234.50	1.72	8.40	
OR8423950	P240	239.50	1.75	8.40	
OR8424450	P245	244.50	1.78	8.40	0.15
OR8424950	P250	249.50	1.81	8.40	
OR8425450	P255	254.50	1.85	8.40	
OR8425950	P260	259.50	1.88	8.40	
OR8426450	P265	264.50	1.91	8.40	
OR8426950	P270	269.50	1.94	8.40	
OR8427450	P275	274.50	1.98	8.40	
OR8427950	P280	279.50	2.01	8.40	
OR8428450	P285	284.50	2.04	8.40	
OR8428950	P290	289.50	2.07	8.40	
OR8429450	P295	294.50	2.10	8.40	
OR8429950	P300	299.50	2.14	8.40	
OR8431450	P315	314.50	2.23	8.40	
OR8431950	P320	319.50	2.27	8.40	
OR8433450	P335	334.50	2.36	8.40	
OR8433950	P340	339.50	2.39	8.40	
OR8435450	P355	354.50	2.49	8.40	
OR8435950	P360	359.50	2.52	8.40	
OR8437450	P375	374.50	2.62	8.40	
OR8438450	P385	384.50	2.68	8.40	
OR8439950	P400	399.50	2.77	8.40	

Table 24 O-Ring dimensions according to JIS B 2401 for static use (G) with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Ident-No. JIS B 2401	Inside-Ø		Cross section	
		d_1	Tolerance ±	d_2	Tolerance ±
OR3102440	G25	24.40	0.30	3.10	
OR3102940	G30	29.40	0.33	3.10	
OR3103440	G35	34.40	0.37	3.10	
OR3103940	G40	39.40	0.41	3.10	
OR3104440	G45	44.40	0.44	3.10	
OR3104940	G50	49.40	0.48	3.10	
OR3105440	G55	54.40	0.51	3.10	
OR3105940	G60	59.40	0.55	3.10	
OR3106440	G65	64.40	0.58	3.10	
OR3106940	G70	69.40	0.62	3.10	
OR3107440	G75	74.40	0.65	3.10	
OR3107940	G80	79.40	0.68	3.10	0.09
OR3108440	G85	84.40	0.72	3.10	
OR3108940	G90	89.40	0.75	3.10	
OR3109440	G95	94.40	0.79	3.10	
OR3109940	G100	99.40	0.82	3.10	
OR3110440	G105	104.40	0.85	3.10	
OR3110940	G110	109.40	0.89	3.10	
OR3111440	G115	114.40	0.92	3.10	
OR3111940	G120	119.40	0.96	3.10	
OR3112440	G125	124.40	0.99	3.10	
OR3112940	G130	129.40	1.02	3.10	
OR3113440	G135	134.40	1.06	3.10	
OR3113940	G140	139.40	1.09	3.10	0.09
OR3114440	G145	144.40	1.12	3.10	
OR5714930	G150	149.30	1.16	5.70	
OR5715430	G155	154.30	1.19	5.70	
OR5715930	G160	159.30	1.22	5.70	
OR5716430	G165	164.30	1.26	5.70	
OR5716930	G170	169.30	1.29	5.70	
OR5717430	G175	174.30	1.32	5.70	
OR5717930	G180	179.30	1.35	5.70	0.13
OR5718430	G185	184.30	1.39	5.70	
OR5718930	G190	189.30	1.42	5.70	
OR5719430	G195	194.30	1.45	5.70	
OR5719930	G200	199.30	1.49	5.70	
OR5720930	G210	209.30	1.55	5.70	
OR5721930	G220	219.30	1.62	5.70	
OR5722930	G230	229.30	1.68	5.70	
OR5723930	G240	239.30	1.75	5.70	
OR5724930	G250	249.30	1.81	5.70	
OR5725930	G260	259.30	1.88	5.70	
OR5726930	G270	269.30	1.94	5.70	
OR5727930	G280	279.30	2.01	5.70	
OR5728930	G290	289.30	2.07	5.70	
OR5729930	G300	299.30	2.14	5.70	

C.2.4 O-Ring dimensions for straight thread tube fittings according to AS 568

The following table shows the O-Ring dimensions for straight thread tube fittings according to AS 568.

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the tables below.

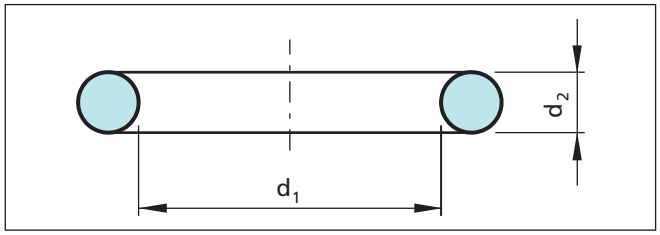


Figure 34 O-Ring dimensions

Table 25 O-Ring dimensions for straight thread tube fittings according to AS 568 with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Ident-No. AS 568	Inside-Ø		Cross section		Tube size
		d_1	Tolerance ±	d_2	Tolerance ±	Outside diameter (OD) inch
ORAR00901	901	4.70	0.15	1.42	0.08	3/32
ORAR00902	902	6.07	0.16	1.63	0.08	1/8
ORAR00903	903	7.65	0.17	1.63	0.08	3/16
ORAR00904	904	8.92	0.18	1.83	0.08	1/4
ORAR00905	905	10.52	0.19	1.83	0.08	5/16
ORAR00906	906	11.89	0.20	1.98	0.08	3/8
ORAR00907	907	13.46	0.22	2.08	0.08	7/16
ORAR00908	908	16.36	0.24	2.20	0.08	1/2
ORAR00909	909	17.93	0.25	2.46	0.09	9/16
ORAR00910	910	19.18	0.26	2.46	0.09	5/8
ORAR00911	911	21.92	0.28	2.95	0.09	11/16
ORAR00912	912	23.47	0.29	2.95	0.09	3/4
ORAR00913	913	25.04	0.30	2.95	0.09	13/16
ORAR00914	914	26.62	0.31	2.95	0.09	7/8
ORAR00916	916	29.74	0.34	2.95	0.09	1
ORAR00918	918	34.42	0.37	2.95	0.09	11/8
ORAR00920	920	37.47	0.39	3.00	0.09	11/4
ORAR00924	924	43.69	0.44	3.00	0.09	11/2
ORAR00928	928	53.09	0.50	3.00	0.09	13/4
ORAR00932	932	59.36	0.55	3.00	0.09	13/4

C.2.5 O-Ring dimensions for metric thread with conical recess according to ISO 6149

The following table shows the O-Ring dimensions for metric thread with conical recess according to ISO 6149.

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the tables below.

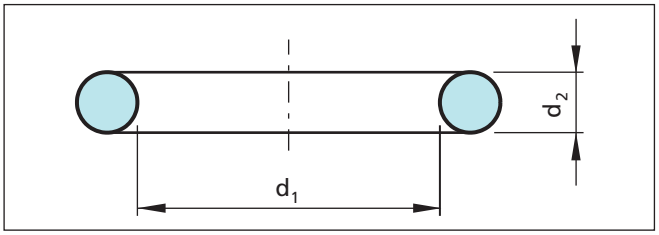


Figure 35 O-Ring dimensions

Table 26 O-Ring dimensions for metric thread with conical recess according to ISO 6149 with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Inside-Ø		Cross section		Thread (metric)
	d_1	Tolerance ±	d_2	Tolerance ±	
OR1600610	6.10	0.16	1.6	0.08	M8 x 1
OR1600810	8.10	0.18	1.6		M10 x 1
OR2200930	9.30	0.18	2.2	0.08	M12 x 1.5
OR2201130	11.30	0.20	2.2		M14 x 1.5
OR2201330	13.30	0.22	2.2		M16 x 1.5
OR2201530	15.30	0.23	2.2		M18 x 1.5
OR2201730	17.30	0.25	2.2		M20 x 1.5
OR2201930	19.30	0.26	2.2		M22 x 1.5
OR2902360	23.60	0.29	2.9	0.09	M27 x 2
OR2902960	29.60	0.33	2.9		M33 x 2
OR2903860	38.60	0.40	2.9		M42 x 2
OR2904460	44.60	0.44	2.9		M48 x 2
OR2905660	56.60	0.53	2.9		M60 x 2

C.2.6 Preferred metric O-Ring dimensions

The following table shows preferred metric O-Ring dimensions unrelated to national or international O-Ring standards.

For all O-Ring inside diameters d_1 and cross sections d_2 the tolerances according to ISO 3601-1, class B are valid. The appropriate tolerance values for each dimension are listed in the tables below.

Table 27 Preferred metric O-Ring dimensions with valid tolerances according to ISO 3601-1, class B

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR1000150	1.50	0.12	1.00	0.08
OR1000200	2.00	0.13	1.00	
OR1000250	2.50	0.13	1.00	
OR1000350	3.50	0.14	1.00	
OR1000400	4.00	0.14	1.00	
OR1000450	4.50	0.15	1.00	
OR1000600	6.00	0.16	1.00	
OR1000700	7.00	0.17	1.00	
OR1000800	8.00	0.17	1.00	
OR1000850	8.50	0.18	1.00	
OR1001000	10.00	0.19	1.00	
OR1001100	11.00	0.20	1.00	
OR1001200	12.00	0.21	1.00	
OR1001300	13.00	0.21	1.00	
OR1001500	15.00	0.23	1.00	
OR1001600	16.00	0.24	1.00	
OR1001800	18.00	0.25	1.00	
OR1002000	20.00	0.26	1.00	
OR1002200	22.00	0.28	1.00	
OR1002300	23.00	0.29	1.00	
OR1003000	30.00	0.34	1.00	
OR1003400	34.00	0.37	1.00	
OR1003800	38.00	0.40	1.00	
OR1004000	40.00	0.41	1.00	
OR1200180	1.80	0.13	1.20	0.08
OR1200250	2.50	0.13	1.20	
OR1200300	3.00	0.14	1.20	
OR1200350	3.50	0.14	1.20	
OR1200400	4.00	0.14	1.20	
OR1200500	5.00	0.15	1.20	
OR1200600	6.00	0.16	1.20	
OR4U01600	16.00	0.24	1.25	0.08
OR1301000	10.00	0.19	1.30	0.08
OR1500300	3.00	0.14	1.50	0.08
OR1500350	3.50	0.14	1.50	
OR1500400	4.00	0.14	1.50	
OR1500450	4.50	0.15	1.50	
OR1500500	5.00	0.15	1.50	
OR1500600	6.00	0.16	1.50	
OR1500650	6.50	0.16	1.50	
OR1500700	7.00	0.17	1.50	
OR1500750	7.50	0.17	1.50	
OR1500800	8.00	0.17	1.50	
OR1500850	8.50	0.18	1.50	
OR1500900	9.00	0.18	1.50	
OR1501000	10.00	0.19	1.50	
OR1501050	10.50	0.19	1.50	
OR1501100	11.00	0.20	1.50	
OR1501200	12.00	0.21	1.50	
OR1501300	13.00	0.21	1.50	
OR1501400	14.00	0.22	1.50	
OR1501500	15.00	0.23	1.50	
OR1501600	16.00	0.24	1.50	
OR1501700	17.00	0.24	1.50	
OR1501900	19.00	0.26	1.50	
OR1502000	20.00	0.26	1.50	
OR1502300	23.00	0.29	1.50	
OR1502400	24.00	0.29	1.50	
OR1502600	26.00	0.31	1.50	
OR1502700	27.00	0.32	1.50	
OR1502800	28.00	0.32	1.50	
OR1503000	30.00	0.34	1.50	
OR1503200	32.00	0.35	1.50	
OR1503500	35.00	0.37	1.50	
OR1503600	36.00	0.38	1.50	
OR1504000	40.00	0.41	1.50	
OR1504200	42.00	0.42	1.50	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR1504500	45.00	0.44	1.50	
OR1504700	47.00	0.46	1.50	
OR1505000	50.00	0.48	1.50	
OR1505200	52.00	0.49	1.50	0.08
OR1505400	54.00	0.51	1.50	
OR1505500	55.00	0.52	1.50	
OR1506000	60.00	0.55	1.50	
OR1600660	6.60	0.16	1.60	0.08
OR1600800	8.00	0.17	1.60	
ORIA00710	7.10	0.17	1.80	
ORIA00900	9.00	0.18	1.80	0.08
ORIA01050	10.50	0.19	1.80	
ORIA01900	19.00	0.26	1.80	
OR2000350	3.50	0.14	2.00	
OR2000400	4.00	0.14	2.00	
OR2000500	5.00	0.15	2.00	
OR2000800	8.00	0.17	2.00	
OR2000900	9.00	0.18	2.00	
OR2001000	10.00	0.19	2.00	
OR2001100	11.00	0.20	2.00	
OR2001150	11.50	0.20	2.00	
OR2001200	12.00	0.21	2.00	
OR2001300	13.00	0.21	2.00	
OR2001400	14.00	0.22	2.00	
OR2001500	15.00	0.23	2.00	
OR2001600	16.00	0.24	2.00	0.08
OR2001700	17.00	0.24	2.00	
OR2001800	18.00	0.25	2.00	
OR2001900	19.00	0.26	2.00	
OR2002000	20.00	0.26	2.00	
OR2002100	21.00	0.27	2.00	
OR2002200	22.00	0.28	2.00	
OR2002300	23.00	0.29	2.00	
OR2002400	24.00	0.29	2.00	
OR2002600	26.00	0.31	2.00	
OR2002700	27.00	0.32	2.00	
OR2003100	31.00	0.34	2.00	
OR2003200	32.00	0.35	2.00	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR2003300	33.00	0.36	2.00	
OR2003500	35.00	0.37	2.00	
OR2003600	36.00	0.38	2.00	
OR2003800	38.00	0.40	2.00	
OR2004000	40.00	0.41	2.00	
OR2004200	42.00	0.42	2.00	
OR2004400	44.00	0.44	2.00	
OR2004500	45.00	0.44	2.00	
OR2004600	46.00	0.45	2.00	
OR2004700	47.00	0.46	2.00	
OR2004800	48.00	0.47	2.00	
OR2005000	50.00	0.48	2.00	
OR2005200	52.00	0.49	2.00	0.08
OR2006000	60.00	0.55	2.00	
OR2006200	62.00	0.56	2.00	
OR2007000	70.00	0.62	2.00	
OR2007600	76.00	0.66	2.00	
OR2008000	80.00	0.69	2.00	
OR2008300	83.00	0.71	2.00	
OR2008500	85.00	0.72	2.00	
OR2009000	90.00	0.76	2.00	
OR2009500	95.00	0.79	2.00	
OR2010500	105.00	0.86	2.00	
OR2011000	110.00	0.89	2.00	
OR2012800	128.00	1.01	2.00	
OR2101540	15.40	0.23	2.10	0.08
OR2101940	19.40	0.26	2.10	
OR2200930	9.30	0.18	2.20	
OR2201130	11.30	0.20	2.20	
OR2201330	13.30	0.22	2.20	0.08
OR2201530	15.30	0.23	2.20	
OR2201930	19.30	0.26	2.20	
OR2401460	14.60	0.22	2.40	
OR2401930	19.30	0.26	2.40	
OR2402030	20.30	0.27	2.40	0.09
OR2402130	21.30	0.27	2.40	
OR2402230	22.30	0.28	2.40	
OR2402330	23.30	0.29	2.40	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR2402530	25.30	0.30	2.40	0.09
OR2402730	27.30	0.32	2.40	
OR2500700	7.00	0.17	2.50	
OR2500900	9.00	0.18	2.50	
OR2501000	10.00	0.19	2.50	
OR2501100	11.00	0.20	2.50	
OR2501200	12.00	0.21	2.50	
OR2501400	14.00	0.22	2.50	
OR2501500	15.00	0.23	2.50	
OR2501700	17.00	0.24	2.50	
OR2501800	18.00	0.25	2.50	
OR2501900	19.00	0.26	2.50	
OR2502200	22.00	0.28	2.50	
OR2502400	24.00	0.29	2.50	
OR2502500	25.00	0.30	2.50	
OR2502700	27.00	0.32	2.50	
OR2502800	28.00	0.32	2.50	
OR2502900	29.00	0.33	2.50	
OR2503000	30.00	0.34	2.50	0.09
OR2503200	32.00	0.35	2.50	
OR2503300	33.00	0.36	2.50	
OR2503400	34.00	0.37	2.50	
OR2503600	36.00	0.38	2.50	
OR2503800	38.00	0.40	2.50	
OR2504000	40.00	0.41	2.50	
OR2504200	42.00	0.42	2.50	
OR2504500	45.00	0.44	2.50	
OR2504600	46.00	0.45	2.50	
OR2505000	50.00	0.48	2.50	
OR2505500	55.00	0.52	2.50	
OR2505700	57.00	0.53	2.50	
OR2506500	65.00	0.58	2.50	
OR2507000	70.00	0.62	2.50	
OR2507200	72.00	0.63	2.50	
OR2508000	80.00	0.69	2.50	
OR2701050	10.50	0.19	2.70	0.09
OR2802370	23.70	0.29	2.80	0.09

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR3000800	8.00	0.17	3.00	
OR3000900	9.00	0.18	3.00	
OR3000950	9.50	0.19	3.00	
OR3001000	10.00	0.19	3.00	
OR3001100	11.00	0.20	3.00	
OR3001200	12.00	0.21	3.00	
OR3001400	14.00	0.22	3.00	
OR3001600	16.00	0.24	3.00	
OR3001800	18.00	0.25	3.00	
OR3002000	20.00	0.26	3.00	
OR3002100	21.00	0.27	3.00	
OR3002150	21.50	0.28	3.00	
OR3002200	22.00	0.28	3.00	
OR3002300	23.00	0.29	3.00	
OR3002400	24.00	0.29	3.00	
OR3002500	25.00	0.30	3.00	
OR3002600	26.00	0.31	3.00	
OR3002800	28.00	0.32	3.00	
OR3002900	29.00	0.33	3.00	
OR3003000	30.00	0.34	3.00	
OR3003200	32.00	0.35	3.00	0.09
OR3003250	32.50	0.36	3.00	
OR3003400	34.00	0.37	3.00	
OR3003700	37.00	0.39	3.00	
OR3003800	38.00	0.40	3.00	
OR3003900	39.00	0.40	3.00	
OR3004000	40.00	0.41	3.00	
OR3004100	41.00	0.42	3.00	
OR3004300	43.00	0.43	3.00	
OR3004400	44.00	0.44	3.00	
OR3004500	45.00	0.44	3.00	
OR3004600	46.00	0.45	3.00	
OR3004800	48.00	0.47	3.00	
OR3004900	49.00	0.47	3.00	
OR3005000	50.00	0.48	3.00	
OR3005200	52.00	0.49	3.00	
OR3005400	54.00	0.51	3.00	
OR3005500	55.00	0.52	3.00	
OR3005700	57.00	0.53	3.00	
OR3005800	58.00	0.54	3.00	

TSS Part-No.	Inside-Ø		Cross section	
	d_1	Tolerance ±	d_2	Tolerance ±
OR3005900	59.00	0.54	3.00	
OR3006000	60.00	0.55	3.00	
OR3006200	62.00	0.56	3.00	
OR3006300	63.00	0.57	3.00	
OR3006500	65.00	0.58	3.00	
OR3006900	69.00	0.61	3.00	
OR3007000	70.00	0.62	3.00	
OR3007500	75.00	0.65	3.00	
OR3009000	90.00	0.76	3.00	
OR3009600	96.00	0.80	3.00	0.09
OR3010000	100.00	0.82	3.00	
OR3010500	105.00	0.86	3.00	
OR3011000	110.00	0.89	3.00	
OR3011500	115.00	0.93	3.00	
OR3012000	120.00	0.96	3.00	
OR3013200	132.00	1.04	3.00	
OR3013500	135.00	1.06	3.00	
OR3014000	140.00	1.09	3.00	
OR3016000	160.00	1.23	3.00	
OR3020000	200.00	1.49	3.00	
OR3501000	10.00	0.19	3.50	
OR3501300	13.00	0.21	3.50	0.10
OR3501600	16.00	0.24	3.50	
OR4003000	30.00	0.34	4.00	
OR4004000	40.00	0.41	4.00	
OR4004200	42.00	0.42	4.00	0.10
OR4005000	50.00	0.48	4.00	
OR4006000	60.00	0.55	4.00	
OR4007200	72.00	0.63	4.00	
OR5010000	100.00	0.82	5.00	0.13

C.3 O-Ring seal sets

The rapid availability of spare parts is very important during the servicing maintenance and repair of machines and equipment.

We offer a variety of standard ranges which are supplied in sturdy cases as a set with foam inlays.

Table 28 O-Ring Set, Type A

390 O-Rings in 24 different sizes according to ISO 3601-1 / AS 568				
TSS Article No. ORSETAASS-N7 (NBR 70)				
Quantity	Dimensions (mm)		Quantity	Dimensions (mm)
30	2.90 x 1.78		10	18.77 x 1.78
30	3.69 x 1.78		15	9.20 x 2.62
30	4.47 x 1.78		15	10.78 x 2.62
30	5.28 x 1.78		15	12.37 x 2.62
30	6.07 x 1.78		10	17.12 x 2.62
30	7.65 x 1.78		10	18.72 x 2.62
30	9.25 x 1.78		10	20.30 x 2.62
20	10.82 x 1.78		5	18.64 x 3.53
20	12.42 x 1.78		5	20.22 x 3.53
10	14.00 x 1.78		5	21.82 x 3.53
10	15.60 x 1.78		5	23.38 x 3.53
10	17.17 x 1.78		5	24.99 x 3.53

Table 29 O-Ring Set, Type C

380 O-Rings in 24 different sizes, common metric sizes				
TSS Article No. ORSETCMET-N7 (NBR 70)				
Quantity	Dimensions (mm)		Quantity	Dimensions (mm)
20	4.00 x 2.00		15	10.30 x 2.40
20	6.00 x 2.00		15	11.20 x 2.40
20	8.00 x 2.00		15	12.30 x 2.40
20	10.00 x 2.00		15	13.30 x 2.40
20	12.00 x 2.00		15	14.30 x 2.40
20	3.30 x 2.40		10	10.00 x 3.00
20	4.30 x 2.40		10	12.00 x 3.00
20	5.30 x 2.40		10	14.00 x 3.00
20	6.30 x 2.40		10	16.00 x 3.00
20	7.30 x 2.40		10	18.00 x 3.00
20	8.30 x 2.40		10	19.20 x 3.00
20	9.20 x 2.40		5	20.00 x 3.00

Table 30 O-Ring Set, Type B

295 O-Rings in 24 different sizes according to ISO 3601-1 / AS 568				
TSS Article No. ORSETBASS-N7 (NBR 70)				
Quantity	Dimensions (mm)		Quantity	Dimensions (mm)
15	20.35 x 1.78		15	34.52 x 3.53
15	21.95 x 1.78		10	36.09 x 3.53
15	25.07 x 2.62		10	37.69 x 3.53
15	26.64 x 2.62		10	40.87 x 3.53
15	28.24 x 2.62		10	44.04 x 3.53
15	29.82 x 2.62		10	47.22 x 3.53
15	31.42 x 2.62		10	50.39 x 3.53
15	32.99 x 2.62		10	37.47 x 5.33
15	34.59 x 2.62		10	40.64 x 5.33
15	29.74 x 3.53		10	43.82 x 5.33
15	31.34 x 3.53		5	46.99 x 5.33
15	32.92 x 3.53		5	50.17 x 5.33

Table 31 O-Ring Set, Type D

295 O-Rings in 24 different sizes, common metric sizes				
TSS Article No. ORSETDMET-N7 (NBR 70)				
Quantity	Dimensions (mm)		Quantity	Dimensions (mm)
15	18.00 x 2.00		15	35.00 x 4.00
15	20.00 x 2.00		15	38.00 x 4.00
15	25.00 x 3.00		15	40.00 x 4.00
15	26.20 x 3.00		10	42.00 x 4.00
15	28.00 x 3.00		10	45.00 x 4.00
15	29.20 x 3.00		10	46.00 x 4.00
15	32.20 x 3.00		10	48.00 x 4.00
15	34.20 x 3.00		10	35.00 x 5.00
15	36.20 x 3.00		10	40.00 x 5.00
15	30.00 x 4.00		10	45.00 x 5.00
15	32.00 x 4.00		5	48.00 x 5.00
15	34.00 x 4.00		5	50.00 x 5.00

D Special O-Rings

D.1 Isolast® (FFKM) O-Rings

Information about our Isolast® (FFKM) O-Rings are available either in our special Isolast® brochure or through your local Trelleborg Sealing Solutions company.

D.2 FEP/PFA encapsulated O-Rings

FEP/PFA encapsulated O-Rings consist of an elastomer inner ring and a seamless FEP/PFA sheath which surrounds the elastomer ring.

Similar to PTFE O-Rings FEP/PFA encapsulated O-Rings are used wherever the chemical resistance of normal elastomer O-Rings are not sufficient.

The required elasticity is provided by the elastomer ring, the chemical resistance by the seamless FEP/PFA sheath.

Advantages

- Very good chemical resistance to most liquids and chemicals, with the exception of liquid alkaline metals and some fluorine compounds
- Temperature application range from approx. -60 °C up to +200 °C (depending on the material for the inner ring)
- Can be used with foodstuffs, pharmaceutical and medicinal products
- Physiologically safe and can be sterilised
- Low friction, no adhesion or stick-slip effect
- Adequate elastic behaviour for improved sealibility.

Versions

Standard versions:	Elastomer O-Ring with FEP sheath
Special versions:	Hollow elastomer ring with FEP sheath
	Elastomer O-Ring with PFA sheath

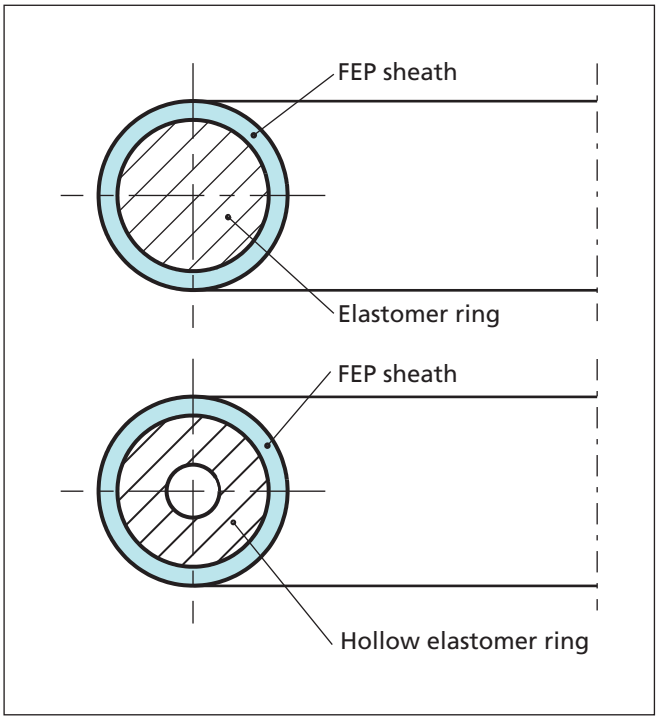


Figure 36 Different versions of FEP/PFA O-Ring

Applications

Fields of application

FEP encapsulated O-Rings are ideally suited for use in the chemical, petrochemicals, medical technology, foodstuffs, water, sewage and similar sectors of industry. A typical application for FEP encapsulated O-Rings is the sealing of valve spindles and as secondary sealing elements for mechanical seals.

FEP encapsulated O-Rings are used primarily as static seals. They are also suitable for use as sealing elements for slow switching and rotary movements.

Technical data

Working pressure:	up to 25 MPa
Temperature:	-60 °C up to +200 °C - depending on the elastomer material
Media:	Practically all liquids, gases and chemicals

Materials

FEP sheath

FEP is the abbreviated designation for Tetrafluoroethylene-hexafluoropropylene. This material has similar properties to those of Polytetrafluoroethylene (PTFE). It also has a very high chemical resistance and exhibits a good resistance to abrasion.

In contrast to PTFE, however, FEP is thermoplastically moldable. This allows the material to be processed to form flexible semifinished products, such as thin-walled hoses.

PFA sheath

PFA is the abbreviation for Perfluoralkoxy. This material is a type of Fluoropolymer with properties similar to Polytetrafluoroethylene (PTFE). Differing from PTFE, like FEP, PFA it is melt-processable but shares PTFE's useful properties of low coefficient of friction and non-reactivity.

PFA is preferable to FEP in high temperature situations. PFA is more affected by water absorption and weathering than FEP, but is superior in terms of salt spray resistance.

Inner ring

A choice of three materials is available for the elastomer inner rings with FEP encapsulation and two materials for the inner ring with PFA encapsulation. The choice of the material also determines the service temperature range.

- Fluorocarbon rubber (FKM),
  temperature range -20 °C up to +200 °C
  material code with FEP sheath: VZ00R
  material code with PFA sheath: VZ01R
- Silicone Rubber (VMQ),
  temperature range: -50 °C up to +175 °C
  material code with FEP sheath: SZ00R
  material code with PFA sheath: SZ01R
- Ethylene Propylen Dien Rubber,
  temperature range: -45 °C up to +150 °C
  material code with FEP sheath: EZ00R

The specified temperature ranges are limits which must always be considered in conjunction with the medium to be sealed and the working pressure. The permissible continous operating temperatures are always lower than the given upper limits.

Design recommendations

FEP encapsulated O-Rings are fully interchangeable with standard O-Ring seals. There is no need to modify the groove dimensions. The FEP sheath is relatively thin-walled.

All the specifications given in this catalogue therefore refer to the installation dimensions of elastomer O-Rings.

As a result of the FEP sheath, the O-Rings are less flexible than elastomer O-Rings. They have limited stretch and higher permanent deformation.

Split grooves are recommended, especially for outside sealing FEP encapsulated O-Rings, in order to avoid overstretching during installation.

The general information on the construction, design and surfaces given for the elastomer O-Rings applies also to FEP encapsulated O-Rings.

At higher pressures, additional concave Back-up Rings should be used.

Application in gases

Where the O-Ring is used to seal gases, the permeation rate must be taken into consideration. In this case the material of the inner ring must also have a good resistance to the medium to be sealed. The permeation rate depends on the exposed surface area, the temperature, the working pressure and the thickness of the FEP sheath.

The thickness of the FEP sheath can be found in Table 32.

Compliances and approvals

The FEP-sheath of material VZ00R, SZ00R and EZ00R is in compliance with the following regulations governing plastic materials for food contact applications:

- Commission Directive 2002/72/EC and amendments 2004/1/EC, 2004/19/EC 2005/79/EC, 2007/19/EC, 2008/39/EC, Reg. (EC) 975/2009
- Requirement of the German Food and Feed Code, LFGB and regulation (EC) 1935/2004, article 5

OML (Overall Migration Limits):
Migration testing was done according to 82/711/EEC and 85/572/EEC and amendments. The OML was below the required limit of 10 mg/dm² in aqueous, acidic and fatty food in repeated contact.

Sensory Tests:
The material meets the requirements of the LFGB and Regulation (EC) 1935/2004 for aqueous, acidic and fatty food in repeated contact. Test condition: 30 min at 95 °C. Surface volume ratio: 30 cm²/1000 ml.

Both the FEP and the PFA sheath are also in compliance with the FDA Regulation 21 CFR Part 177.1550.

Table 32 Thickness of the FEP and PFA sheath

O-Ring		Thickness of the FEP/PFA Sheath
Cross section d_2	Tolerance ±	
1.78 1.80	0.10	0.20
2.62 2.65	0.10	0.30
3.53 3.55	0.12	0.38
5.34 5.30	0.25	0.50
7.00	0.38	0.50

The diagram (Figure 37) gives guide values for the permeation of different gases.

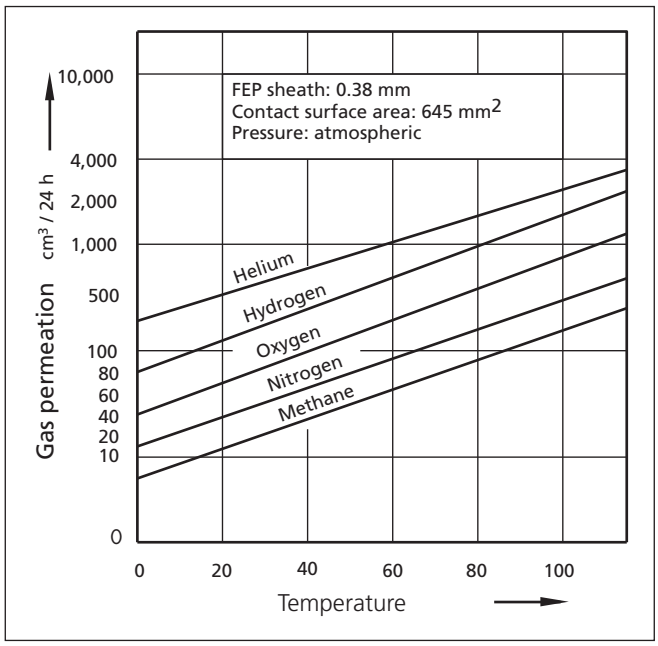


Figure 37 Gas permeation rates for FEP O-Rings

The diagram (Figure 38) gives guide values for the permeation of water vapour.

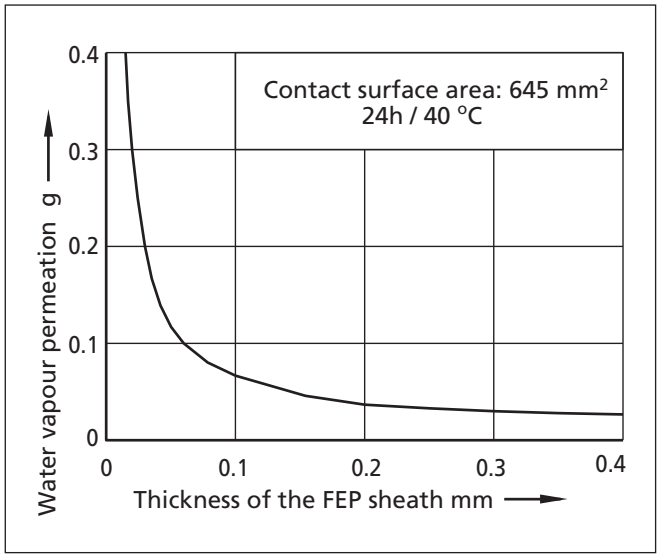


Figure 38 Water vapour permeation for FEP O-Rings

Methods of installation

The same recommendations apply to the installation of FEP/PFA encapsulated O-Rings as for standard elastomer O-Rings. It should be noted, however, that the O-Rings have only limited stretch due to the FEP/PFA sheath.

If, for design reasons, a split groove is not possible, auxiliary tools must be used for installation.

For inside sealing applications (e.g. rod), FEP/PFA encapsulated O-Rings can be installed with larger diameters without tools. On no account should the seal ring be forced into the groove (e. g. by bending), otherwise the sealing function cannot be assured.

Dimensions

FEP/PFA encapsulated O-Rings are available in the same sizes as the elastomer O-Rings. Table 34 shows the smallest available inside diameters for the different cord diameters.

Table 33 Tolerances inside diameter (d_1)

Inside diameter d_1	Tolerance ±
$d_1 > 7.64$	not available
$7.64 \leq d_1 \leq 30.00$	0.25
$30.00 < d_1 \leq 130.00$	0.38
$130.00 < d_1 \leq 170.00$	0.51
$170.00 < d_1 \leq 380.00$	0.64
$380.00 < d_1 \leq 650.00$	0.76
$650.00 < d_1 \leq 1000.00$	1.52
$d_1 > 1000.00$	on request

Table 34 Smallest available sizes and cross section tolerances

O-Ring		Minimum inside diameter d_1
Cross section d_2	Tolerance ±	
1.60	0.10	7.60
1.78		7.64
2.00		8.00
2.40		9.30
2.50		10.00
2.62		9.19
2.80		10.50
3.00	0.13	10.00
3.10		10.00
3.20		12.00
3.53		12.00
3.75		12.00

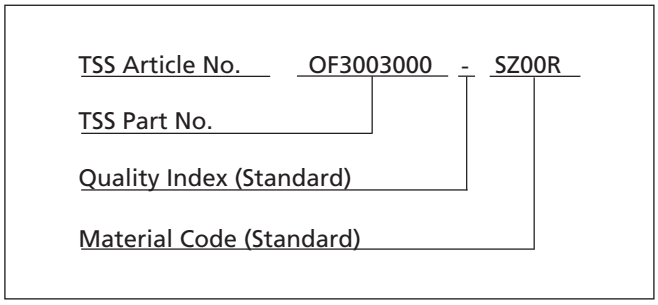
O-Ring		Minimum inside diameter d_1
Cross section d_2	Tolerance ±	
4.00	0.25	12.00
4.20		15.00
4.50		15.00
4.70		18.00
5.00		18.00
5.33		18.42
5.50		30.00
5.70		30.00
6.00	0.38	30.00
6.30		41.00
6.50		41.00
7.00		41.00
7.50		101.60
8.00		70.00
8.40		102.00
9.00	0.51	102.00
9.50		102.00
10.00		108.00
10.50		127.00
11.00		127.00
12.00		152.40
12.70		177.80
13.00		254.00
14.00		254.00
15.00		254.00
16.00		305.00
18.00		422.00
19.00		422.00
20.00		508.00

Ordering example

O-Ring 30 x 3, FEP encapsulated

Dimensions: Inside diameter d_1 = 30.0 mm
Cross section d_2 = 3.0 mm

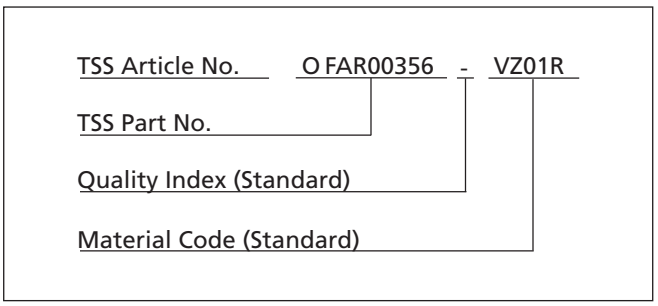
Material of the inner ring: Silicone Rubber (VMQ)



Ordering example

O-Ring, PFA encapsulated
ISO 3601 resp. AS 568 reference no. 356
Dimensions: Inside diameter d_1 = 135.89 mm
Cross section d_2 = 5.33 mm

Material of the inner ring: Fluorocarbon Rubber (FKM)



O-Ring dimensions and TSS Part No. see Tables 20-27, pages 58-72.

Housing dimensions, see Table 15, page 46.

Ordering can also be made according to O-Ring dimensions and material.

D.3 PTFE O-Rings

O-Rings in Polytetrafluoroethylene (PTFE) are closed, circular rings with annular cross section. The dimensions are - as with the elastomer O-Ring - characterised by the inside diameter d_1 and the cord diameter d_2 (Figure 39). PTFE O-Rings are not molded but produced by machining. The rings can therefore be manufactured in all sizes.

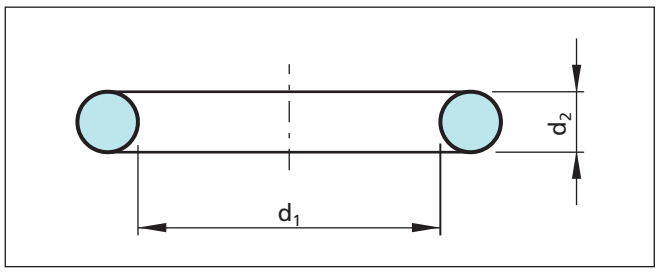


Figure 39 O-Ring dimensions

Advantages

- Very good chemical resistance, compatible with most liquids and chemicals, with the exception of liquid alkaline metals and some fluorine compounds.
- Wide temperature range from approx. -200 °C up to +260 °C
- Suitable for contact with foodstuffs, pharmaceutical and medicinal products
- Physiologically safe, can be sterilised
- Low friction, no adhesion
- Available for all diameters up to approx. 1,000 mm.

Applications

Fields of application

PTFE O-Rings are used wherever the chemical and thermal resistance of the normal elastomer O-Rings is no longer sufficient. These are primarily applications in the chemical industry, foodstuffs industry, pharmaceuticals and medical technology. PTFE O-Rings are used only as static seals, e.g. on flange connections, on covers, etc.

Technical data

Working pressure:	Up to 25 MPa
Temperature:	-60 °C up to +200 °C - depending on the elastomer material
Media:	Practically all liquids, gases and chemicals

Materials

Standard material: Virgin, unfilled PTFE (polytetrafluoroethylene), Material Code PT00

PTFE is a partially crystalline thermoplastic characterised by a very high chemical and thermal resistance. PTFE has the highest resistance to chemicals of all plastics and can be used for almost any application. It has a slightly limited resistance to molten alkaline metals, to elementary fluorine and to certain halogen materials.

The material undergoes no changes on exposure to ageing, light and ozone. The water absorption rate is less than 0.01 %.

Design recommendations

PTFE O-Rings have low elasticity. The O-Ring size should therefore be chosen to suit the nominal diameter (rod or bore) to be scaled. Installation in axial easily accessible and radial split grooves is to be preferred.

The general information on the construction, design and surfaces given for the elastomer O-Rings applies also to PTFE O-Rings.

Methods of installation

PTFE O-Ring can only be stretched or compressed to a very limited extent during installation.

During installation, e.g. on flanges, the cold flow tendency of the thermoplastic PTFE should be taken into consideration. Under pressure, PTFE deforms plastically also in the cold state, i.e. a permanent deformation takes place. If flange seals are not tightened sufficiently to give metal/metal contact, the elastic deformation and thus the elastic tension can deteriorate.

Installation recommendations

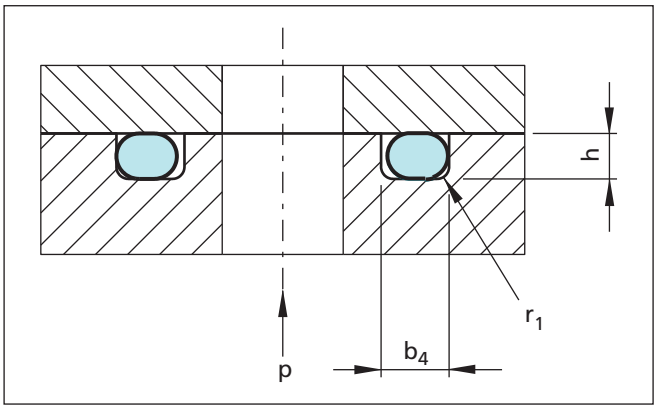


Figure 40 Axial installation, static, inside pressure

Table 35 Installation dimensions

Cross section d_2	Groove dimensions		Radius r_1
	Groove depth **h** +0.05	Groove width b_4 +0.1	
1.50	1.30	1.7	0.2
1.60	1.40	1.8	0.3
1.78 1.80	1.60	2.0	0.4
2.00	1.80	2.2	0.5
2.40	2.15	2.6	0.5
2.50	2.25	2.8	0.5
2.62 2.65	2.35	2.9	0.6
3.00	2.70	3.3	0.8
3.53 3.55	3.15	3.9	1.0
4.00	3.60	4.4	1.0
5.00	4.50	5.5	1.0
5.33 5.30	4.80	5.9	1.2
5.70	5.10	6.3	1.2
6.00	5.60	6.6	1.2
7.00	6.30	7.7	1.5
8.00	7.20	8.8	1.5
8.40	7.55	9.2	2.0

Available dimensions

PTFE O-Rings are available in the same dimensions as the elastomer O-Rings. See O-Ring dimensions, Tables 20-27, pages 58-72.

Ordering Example

O-Ring, 40 x 3
Dimensions: Inside diameter d_1 = 40.0 mm
Cross section d_2 = 3.0 mm

O-Ring dimensions and TSS Part No. see Tables 20-27, pages 58-72.

Ordering can also be made according to O-Ring dimensions and material.

TSS Article No. OR3004000 - PT00

TSS Part No.

Quality Index (Standard)

Material Code (Standard)

D.4 Polyurethane O-Rings

Polyurethane is becoming more and more widely used as a sealing material due to its exceptionally high abrasion resistance and high extrusion resistance.

The polyurethane materials from Trelleborg Sealing Solutions have a number of improved properties.

Polyurethane is therefore an ideal material for O-Rings and sealing elements.

The outstanding properties of the materials play a major role particularly in our Zurcon® materials.

Polyurethane O-Rings are available in dimensions to American Standard AS 568 (see dimension list, Table 36, page 80).

The dimensions are given with the inside diameter "d_1" and the cord diameter "d_2" (Figure 41, page 80).

Advantages

The main adavantages of a polyurethane material for O-Rings compared with other elastomer are the outstanding mechanical properties:

- High abrasion and wear resistance tolerates aggressive operating conditions
- High extrusion resistance allows increased pressures or extrusion gaps
- Good mechanical properties improve service life
- Low friction reduces breakout forces on start up

Applications

Fields of application

Polyurethane O-Rings are especially suited wherever O-Rings are subject to dynamic loads.

This includes for example, applications in hydraulics, pneumatics and in a wide range of other critical areas. In many cases, polyurethane O-Rings are used instead of NBR in view of their high mechanical strengths.

Due to their particularly high abrasion resistance, polyurethane O-Rings are more suitable than other materials in applications where bores have to be crossed or where frequent opening and closing is demanded, e.g. plug connectors and couplings.

Polyurethane O-Rings in 70 Shore A hardness material WU7TI can, with advance, be used in applications such as pneumatics where low compression set and low friction are essential.

Technical data

Working pressure:	Static up to approx. 60 MPa without Back-up Ring (depending on the extrusion gap) Dynamic up to 25 MPa
Speed:	Reciprocating up to 0.2 m/s
Temperature:	-45 °C up to +100 °C depending on the material
Media:	Hydraulic fluids and mineral oil-based greases and air.

Materials

The most important characteristics of these polyurethanes are:

- High tensile strength
- Low compression set
- Very good cold flexibility
- Constant shear modulus even at high temperatures
- Resistant to weathering and ageing
- High damping properties
- Low gas permeability
- Good hydrolysis resistance
- High tear propagation resistance
- Free from substances which hinder paint coverage

Polyurethane materials are resistant in:
Mineral oils and greases, oxygen, ozone.

Polyurethane compounds are not resistant in:
Esters, aromatic and chlorinated hydrocarbons, concentrated acids and lyes.

Polyurethane O-Rings are available on request in the following grades:

Polyurethane, 70 Shore A
Material code WU7T1

Polyurethane, 92 Shore A
Material code WU9T2

Polyurethane, 93 Shore A, Zurcon®:
Material code Z22 and Z24

Polyurethane, 94 Shore A, Zurcon®:
Material code Z20

Depending on the production method Zurcon® O-Rings can have an injection point on the inside diameter. This marking is placed at a 45° angle from the flash.

Design instructions

The same design rules apply to polyurethane O-Rings as to other elastomer O-Rings, i.e. the same installation dimensions (groove depth, groove width), see Table 15, page 46.

Radial clearance

In view of the high extrusion resistance of polyurethane, larger clearances can be bridged with polyurethane O-Rings than with other elastomers, without the additional installation of Back-up Rings.

The permissible radial clearance is depending on the used material, on the O-Ring cross section and on the application properties, e. g. the temperature.

O-Ring dimensions

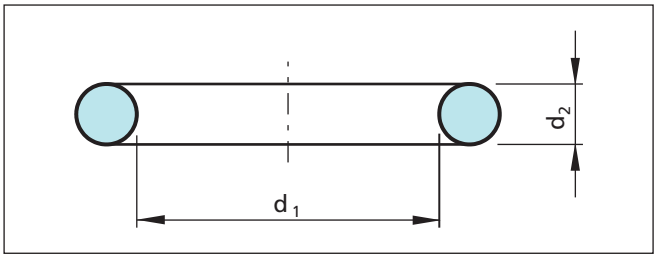


Figure 41 O-Ring dimensions

Table 36 Dimensions according to ISO 3601-1 / AS 568 (Further sizes on request)

TSS Part No.	Inside-Ø d_1	Cross section d_2
ORAR00005	2.57	1.78
ORAR00006	2.90	1.78
ORAR00008	4.47	1.78
ORAR00009	5.28	1.78
ORAR00010	6.07	1.78
ORAR00011	7.65	1.78
ORAR00012	9.25	1.78
ORAR00013	10.82	1.78
ORAR00014	12.42	1.78
ORAR00015	14.00	1.78
ORAR00017	17.17	1.78
ORAR00018	18.77	1.78
ORAR00019	20.35	1.78
ORAR00020	21.95	1.78
ORAR00022	25.12	1.78
ORAR00023	26.70	1.78
ORAR00025	29.87	1.78

TSS Part No.	Inside-Ø d_1	Cross section d_2
ORAR00027	33.05	1.78
ORAR00029	37.82	1.78
ORAR00034	53.70	1.78
ORAR00036	60.05	1.78
ORAR00039	69.57	1.78
ORAR00040	72.75	1.78
ORAR00041	75.92	1.78
ORAR00045	101.32	1.78
ORAR00046	107.67	1.78
ORAR00047	114.02	1.78
ORAR00050	133.07	1.78
ORAR00110	9.19	2.62
ORAR00111	10.77	2.62
ORAR00112	12.37	2.62
ORAR00113	13.94	2.62
ORAR00114	15.54	2.62
ORAR00115	17.12	2.62
ORAR00116	18.72	2.62
ORAR00117	20.29	2.62
ORAR00118	21.89	2.62
ORAR00119	23.47	2.62
ORAR00120	25.07	2.62
ORAR00122	28.24	2.62
ORAR00124	31.42	2.62
ORAR00125	32.99	2.62
ORAR00126	34.59	2.62
ORAR00127	36.17	2.62
ORAR00128	37.77	2.62
ORAR00129	39.34	2.62
ORAR00132	44.12	2.62
ORAR00133	45.69	2.62
ORAR00134	47.29	2.62
ORAR00135	48.90	2.62
ORAR00136	50.47	2.62
ORAR00137	52.07	2.62
ORAR00138	53.64	2.62
ORAR00141	58.42	2.62
ORAR00142	59.99	2.62
ORAR00145	64.77	2.62
ORAR00146	66.34	2.62
ORAR00147	67.95	2.62

TSS Part No.	Inside-Ø d_1	Cross section d_2
ORAR00210	18.64	3.53
ORAR00211	20.22	3.53
ORAR00213	23.39	3.53
ORAR00214	24.99	3.53
ORAR00215	26.57	3.53
ORAR00216	28.17	3.53
ORAR00217	29.74	3.53
ORAR00218	31.34	3.53
ORAR00220	34.52	3.53
ORAR00222	37.69	3.53
ORAR00224	44.04	3.53
ORAR00225	47.22	3.53
ORAR00226	50.39	3.53
ORAR00227	53.57	3.53
ORAR00228	56.74	3.53
ORAR00229	59.92	3.53
ORAR00230	63.09	3.53
ORAR00231	66.27	3.53
ORAR00232	69.44	3.53
ORAR00234	75.79	3.53
ORAR00235	78.97	3.53
ORAR00236	82.14	3.53
ORAR00237	85.32	3.53
ORAR00238	88.49	3.53
ORAR00239	91.67	3.53
ORAR00240	94.84	3.53
ORAR00325	37.47	5.33
ORAR00326	40.64	5.33
ORAR00327	43.82	5.33
ORAR00328	46.99	5.33
ORAR00329	50.17	5.33
ORAR00330	53.34	5.33
ORAR00331	56.52	5.33
ORAR00332	59.69	5.33
ORAR00334	66.04	5.33
ORAR00336	72.39	5.33
ORAR00337	75.57	5.33
ORAR00338	78.74	5.33
ORAR00339	81.92	5.33
ORAR00340	85.09	5.33

Tolerances based on ISO 3601-1, class B. See Table 16 and 17, pages 50-51.

Ordering Example

O-Ring, ISO 3601 resp. AS 568, ref. 214

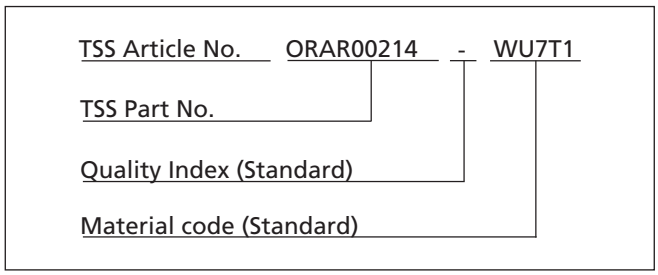
Dimensions: Inside diameter d_1 = 30.0 mm
Cross section d_2 = 3.0 mm

Material: Polyurethane (AU 70 Shore A)

O-Ring dimensions and TSS Part No. see Table 36.

Installation dimensions, see Table 15, page 46.

Ordering can also be made according to O-Ring dimensions and material.



D.5 Fleximold™ O-Rings - large dimensions

Trelleborg Sealing Solutions has developed a new proprietary manufacturing technology, FlexiMold™ that allows the manufacture of large, high quality O-Rings without the lead time and cost associated with dedicated tooling.

Compared to conventional techniques such as the splicing of extruded cord, the FlexiMold™ process ensures full visual and dimensional integrity. It also gives the circular form stability of a molded O-Ring, along with its intended thermal and chemical resistance capability.

Large O-Rings are used across all process industries including Chemical and Hydrocarbon, Pharmaceutical, Food & Beverage, the Electronics industry, in particular the production of flat panel displays applications.

Features

- Infinite diameter capability
- No tooling charges for standard cross sections
- High quality, tight tolerances
- Full performance integrity of an O-Ring
- Available in many elastomer types

Materials

- Isolast® FFKM
- Resifluor™ High Performance Fluoroelastomers
- FKM, EPDM, HNBR and others
- FDA, USP Class VI, EDR type compounds available

Dimensions

The Fleximold™ technology is recommended for O-Rings with inside diameters d_1 > 500 mm. The tolerances according to ISO 3601-1, class B apply for the inside diameters of Fleximold™ O-Rings.

Standard cross sections for Fleximold™ O-Rings are listed in the table below. Further cross sections are available on request. Other seal profiles may be requested.

Table 37 Available standard cross sections and valid tolerances according to ISO 3601-1, class B, table A.1

Cross section	
d_2	Tolerance ±
3.00	0.09
3.10	0.09
3.50	0.10
3.53	0.10
3.55	0.10
4.00	0.10
5.00	0.13
5.30	0.13
5.33	0.13
5.70	0.13
6.99	0.15
7.00	0.15
8.00	0.15
8.40	0.15
10.00	0.21

D.6 Round cord rings (butt vulcanized)

Round cords are produced by extrusion. They are supplied as cut lengths. The most common materials are NBR 70 Shore A, EPDM 65 Shore A and FKM 75 Shore A. Other materials are available on request.

In contrast to mold-vulcanized O-Rings, round cord rings made from continuously extruded cord can be made up to any desired diameter.

The junction point always has poorer mechanical properties than the basic material. For this reason, round cord rings should be used with caution for dynamic applications, gaseous media or vacuum.

The O-Ring tolerances according to ISO 3601-1 (resp. TBS-00024) are applicable for the inside diameter d_1 but not for the cross section d_2. Tolerances for the cross sections see tables below.

For the use of round cord rings in high-vacuum applications it is recommendable to use FKM. In that case the joint has to be manufactured in a special high-vacuum quality and has to be ordered accordingly. Please contact your local Trelleborg Sealing Solutions company for further details.

The tolerances stated are valid for round cord rings (butt-vulcanized) only and refer to the cross section. Due to the applied pressure during the vulcanisation process the junction point can be thinner than the cord. In general this has no negative effect on the sealing function.

The article number of round cord rings starts wih OV.

Table 38 Available cross sections and valid tolerances for NBR 70 Shore A

Cross section d_2	Tolerance
1.00 1.50 1.78 2.00 2.50	± 0.20
3.00 3.20 3.53 4.00	± 0.25
4.75 5.00 5.33 5.70 6.00	± 0.35
6.40 7.00 7.50 8.00 8.40 9.00 9.50 10.00	± 0.40
11.00 12.00 12.70 13.00 14.00 15.00 16.00	± 0.50
18.00 20.00 22.00 25.00	± 0.70
30.00	± 0.80