

Stefa® Radial Oil Seal





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■ Stefa® Radial Oil Seal

■ General Seal Description

GENERAL

Radial Oil Seals, also known as rotary shaft lip seals, are round sealing devices used to seal between two machine parts that rotate relative to each other. They are used to seal lubrication in and/or contamination out, or to separate dissimilar media. Trelleborg Sealing Solutions supplies these products under the Stefa® name.

SEAL DESIGN

Although there are many styles of Radial Oil Seal, they all generally consist of a flexible rubber lip bonded to a rigid metal case. Most also contain a third element - a garter spring - fitted

into the rubber lip to provide additional sealing force, both initially and over the life of the seal. The total radial force of the sealing lip is a function of the rubber pre-tension, coupled with the tensile spring force. The sealing lip may be lathe cut or ready molded, and may feature molded-in hydrodynamic aids to assist sealing in demanding applications. The metal case may be exposed or have rubber molded around it for ease of assembly or improved static sealing.

Trelleborg Sealing Solutions offers state-of-the-art Radial Oil Seal design standards based on many years of experience in a wide range of application fields.

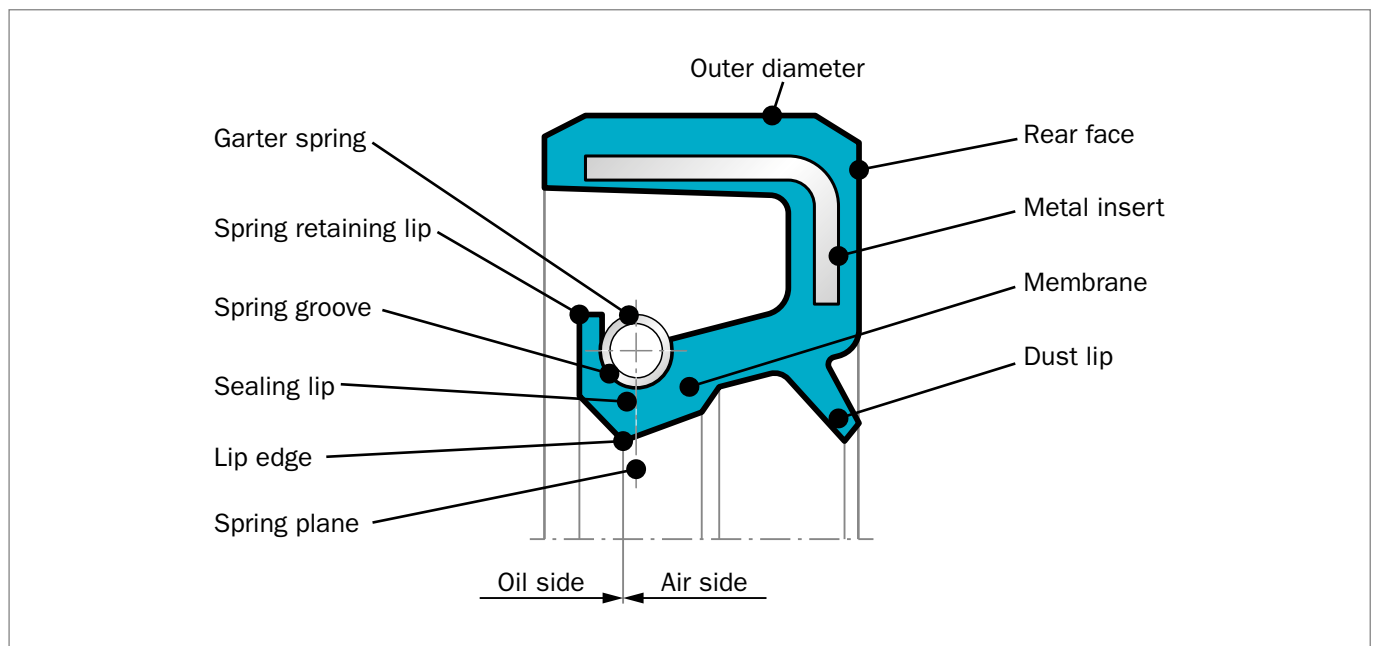


Figure 1: Designation for rotary shaft lip seals (extract from ISO 6194)



METAL CASE

The metal case is normally made out of formed, cold-rolled steel sheet in accordance with DIN EN 10139. Another material, such as stainless steel, brass or aluminum, may be used depending on application requirements. If the metal case is rubber-covered, the outside diameter may be either smooth or ribbed. In all cases, the seal outer diameter tolerance is in accordance with ISO6194-1 and the bore tolerance is in accordance with ISO H8.

Table 1: Outer Diameter Tolerances in Accordance with ISO6194-1

Nominal Outside Diameter d_2	Diametral Tolerance	
	Metal Cased	Rubber Covered
$d_2 \leq 50$	+0.20 / +0.08	+0.30 / +0.15
$50 < d_2 \leq 80$	+0.23 / +0.09	+0.35 / +0.20
$80 < d_2 \leq 120$	+0.25 / +0.10	+0.35 / +0.20
$120 < d_2 \leq 180$	+0.28 / +0.12	+0.45 / +0.25
$180 < d_2 \leq 300$	+0.35 / +0.15	+0.45 / +0.25
$300 < d_2 \leq 530$	+0.45 / +0.20	+0.55 / +0.30

Note: Ribbed O.D tolerances on request.

GARTER SPRING

Function

When rubber is exposed to heat, pressure or chemical attack, it will gradually lose its original properties. The rubber is then said to have aged, causing the original radial force exerted by the sealing element to diminish. The function of the garter spring is to maintain the radial force during this period.

Experiments have shown that the radial force must vary with the size and type of seal. They have also clearly indicated the significance of maintaining the radial force within narrow limits during the service life of the seal. Extensive investigations in the laboratory have formed the basis for defining the radial force.

The garter spring is closely wound and carries an initial tension. The total force exerted by the spring consists of the force required to overcome the initial tension and the force due to the spring rate. The use of a garter spring with initial tension ensures that, as the sealing element wears, the total radial force from the initial tension will not change.

Material

Spring steel is normally used. If resistance to corrosion is required, stainless steel can be substituted. Garter springs of bronze or similar materials are not recommended, since they tend to fatigue after long service life, or as a result of exposure to high temperatures. In special cases, the garter spring can be protected against damage by means of a thin rubber cover.



■ Design Instructions: Shaft

SURFACE FINISH, HARDNESS AND MACHINING METHODS

The shaft design is vital for sealing performance and ensures maximum service life for the seal (see Figure 4). As a basic principle, the hardness of the shaft should be higher as peripheral speeds increase. DIN 3760 specifies that the shaft must be hardened to at least 45 HRC.

As the peripheral speeds increase, the hardness must be increased, and at 10 m/s a hardness of 60 HRC is required. The choice of a suitable hardness is dependent not only on the peripheral speed but also on factors such as lubrication and the presence of abrasive particles. Poor lubrication and difficult environmental conditions require a higher shaft hardness. DIN 3760 specifies a surface roughness of Ra 0.2 - Ra 0.8 μm . Laboratory tests have however proved that the most suitable roughness is $R_t = 2 \mu\text{m}$ ($R_a = 0.3 \mu\text{m}$). Both rougher and smoother surfaces generate higher friction, resulting in increased temperature and wear. Trelleborg Sealing Solutions suggest a surface roughness of Ra 0.2 - 0.5 μm .

Measurements of friction and temperature have also shown that grinding of the shaft is the best method of machining. However, spiral grinding marks may cause a pumping effect. Therefore, plunge grinding should be used, during which even ratios between grinding wheel speed and work-piece should be avoided. Polishing of the shaft surface with a polishing cloth produces a surface which causes higher friction and increases heat generated when compared with plunge grinding. In certain cases, it may be impossible to provide the necessary hardness, surface finish and corrosion resistance required for the shaft. This problem can be solved by fitting a separate sleeve onto the shaft. If wear should occur, only the sleeve needs to be replaced (see page 147, Shaft Repair Kit).

SHAFT RUN OUT

Shaft run out should as far as possible be avoided or kept to a minimum. At higher speeds, there is a risk that the inertia of the sealing lip prevents it from following the shaft movement. The seal must be located next to the bearing and the bearing play should be maintained at the minimum value possible (see Figure 2).

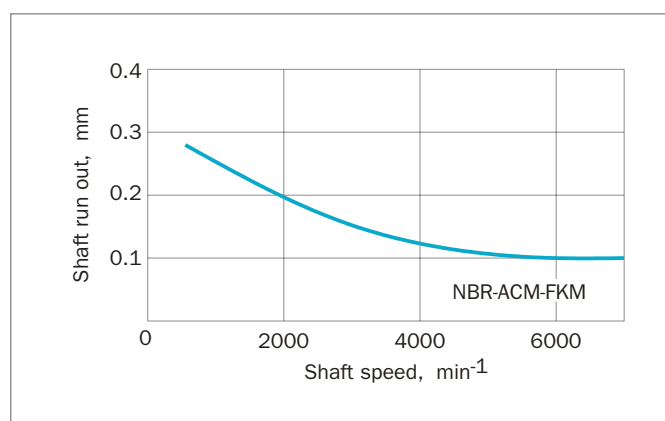


Figure 2: Shaft run out

ECCENTRICITY

Eccentricity between shaft and housing bore centers should be avoided in order to eliminate unilateral load of the lip (see Figure 3).

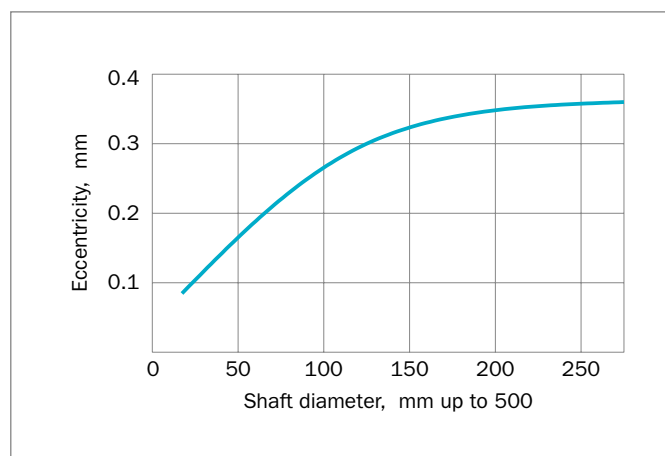


Figure 3: Eccentricity

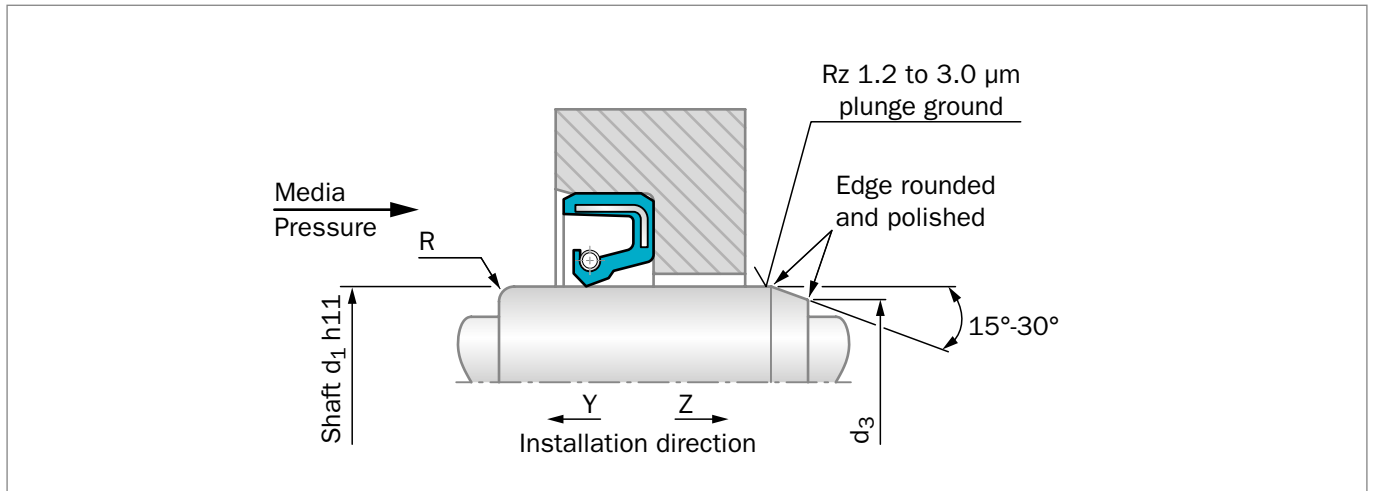


Figure 4: Installation of the Stefa® Radial Oil Seal

Depending on the installation direction (Y or Z), a chamfer or radius on the shaft is recommended. The dimensions for this are shown in Figure 4 and Table 2.

Table 2: Chamfer Length for Shaft End

d_1	d_3	R
< 10	$d_1 - 1.5$	2
over 10 to 20	$d_1 - 2.0$	2
over 20 to 30	$d_1 - 2.5$	3
over 30 to 40	$d_1 - 3.0$	3
over 40 to 50	$d_1 - 3.5$	4
over 50 to 70	$d_1 - 4.0$	4
over 70 to 95	$d_1 - 4.5$	5
over 95 to 130	$d_1 - 5.5$	6
over 130 to 240	$d_1 - 7.0$	8
over 240 to 480	$d_1 - 11.0$	12

CHARACTERISTICS OF THE SHAFT SURFACE

The running surface for Stefa® Radial Oil Seals is specified in DIN 3760 and DIN 3761. The surface should meet the following requirements:

Hardness:	55 HRC or 600 HV, hardness depth min. 0.3 mm
Surface roughness:	Ra = 0.2 to 0.5 µm Rz = 1.2 to 3.0 µm Rmr = 50-70%, c = 0.25 x Rz

SURFACE ROUGHNESS

The functional reliability and service life of a seal depends to a great extent on the quality and surface finish of the mating surface to be sealed. Scores, scratches, pores and concentric or spiral machining marks are not permitted. Higher demands must be made on the surface finish of dynamic mating surfaces than on static mating surfaces. Plunge grinding is recommended to eliminate the presence of helical “lead” on the shaft.

The characteristics most frequently used to describe the surface microfinish, Ra, Rz and Rz1max, are defined in ISO 4287. These characteristics alone, however, are not sufficient for assessing suitability for seal engineering. In addition, the material contact area, Rmr, in accordance with ISO 4287 should be considered. The significance of these surface specifications is illustrated in Figure 5. It shows clearly that specification of Ra or Rz alone does not describe the profile form accurately enough and is thus not sufficient for assessing suitability.

The material contact area, Rmr, is essential for assessing surfaces, as this parameter is determined by the specific profile form. This directly depends on the machining process employed.

Surface profile	Ra	Rz	Rmr
Closed profile form 	0.1 µm	1.0 µm	70%
Open profile form 	0.2 µm	1.0 µm	15%

Figure 5: Examples of various surface profile parameters



■ Design Instructions: Housing Bore

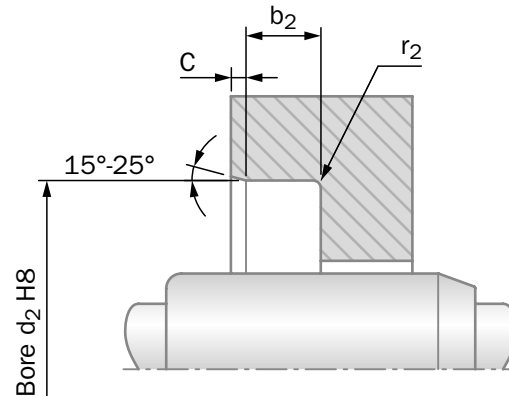


Figure 6: Installation depth and lead-in chamfer

HOUSING BORE

For metric sizes, the tolerances are in accordance with ISO6194-1, which provides a suitable press fit for the bore tolerance in ISO H8. The inch sizes are in accordance with ARPM OS-4. In cases where the housing bore has a different tolerance, the seal can be made to a suitable size. For bearing housings made of soft materials, e.g. light metals, and for bearing housings with thin walls, a special fit between the seal and the housing may be necessary. The tolerances for the seal and housing should then be determined by practical assembly trials. If a component such as a bearing is assembled through the housing bore for the seal, the bore may be damaged. In order to avoid damaging the bore, a seal with a larger outside diameter than that of the bearing should be selected.

Table 3: Housing Dimensions

Seal Width b	C mm	b ₂ mm	r ₂ max.
7	0.7 to 1.0	8.2	0.5
8	0.7 to 1.0	9.2	0.5
10	0.7 to 1.0	11.2	0.5
12	1.0 to 1.3	13.5	0.75
15	1.0 to 1.3	16.5	0.75
20	1.0 to 1.3	21.5	0.75

SURFACE ROUGHNESS OF THE HOUSING

Values for the surface roughness in the gland are specified in ISO 6194/1.

General values: Ra = 1.6 - 3.2 µm
 Rz = 6.3 - 12.5 µm

For metal-to-metal sealing or gas sealing, a good score-free and spiral-free surface finish is necessary. If the rotary shaft lip seal is bonded into the housing, ensure that no adhesive comes into contact with the sealing lip or the shaft.



SEALING ELEMENT

Compound

The material selected must take into account environmental conditions and functional requirements.

Some of the requirements associated with environmental considerations are:

- Good chemical resistance
- Good resistance to heat and low temperature
- Good resistance to ozone and weathering

The functional demands include:

- High resistance to wear
- Low friction
- Low compression set
- Good elasticity

In addition, cost considerations render ease of processing a desirable feature. For the optimum material recommendation for your application, contact your local Customer Solution Center.

Type and Designations of Materials

Nitrile rubber	(NBR)
Acrylic rubber	(ACM)
Fluorinated rubber	(FKM)
Hydrogenated Nitrile rubber	(HNBR)

In order to satisfy the wide range of demands made on seals, Trelleborg Sealing Solutions has developed special, unique compounds of each type of rubber. Other material compounds are also available to meet extreme requirements.

Table 4: Material Recommendations

Materials for Sealing Common Media		Material Designation			
		Acrylonitrile Butadiene Rubber NBR	Fluorocarbon Rubber FKM	Polyacrylate Rubber ACM	Hydrogenated Acrylonitrile Butadiene Rubber HNBR
		Material Abbreviation			
		N	V	A	H
		Max. Permissible Constant Temperature (°C)			
Mineral fluids	Engine oils	100	170	125	130
	Transmission oils	80	150	125	110
	Hypoid transmission oils	80	150	125	110
	ATF oils	100	170	125	130
	Hydraulic fluids (DIN 51524)	90	150	120	130
	Greases	90	-	-	100
Flame retardant hydraulic fluids (VDMA 24317) (VDMA 24320)	Oil-water emulsion	70	-	-	70
	Water-oil emulsion	70	-	-	70
	Aqueous solutions	70	-	-	70
	Water-free fluids	-	150	-	-
Other media	Fuel oils	90	-	-	100
	Water	90	100	-	100
	Lyes	90	100	-	100
	Air	100	200	150	130

Due to the different configurations of the media, the above-mentioned temperature ranges are for guidance only. Depending on the media, significant deviations may occur.



■ Description of Rubber Materials

NITRILE RUBBER (NBR)

FEATURES AND BENEFITS:

- Good oil resistance
- Good heat resistance, up to +100 °C in oil
- High tensile strength (special compounds over 20 MPa)
- High elongation at break
- Low swelling in water

Limitations:

- Poor weather and ozone resistance
- Poor resistance against polar fluids (ester, ether, ketones and aniline)
- Poor resistance against chlorinated hydrocarbons (carbon tetrachloride, trichlorethylene)
- Poor resistance against aromatic fluids (e.g. benzene, toluene)

Fluids, mineral oils and, above all, high-alloyed mineral oils (hypoid oils) containing larger quantities of aromatic hydrocarbons have a high swelling effect on NBR compounds. The swelling behavior can be improved by increasing the acrylonitrile content.

However an inferior cold flexibility and resistance to compression set must be accepted. The additives in high-alloyed oils can in certain cases cause an additional interaction between the elastomer and the additive, thus influencing the elasticity.

HYDROGENATED NITRILE RUBBER (HNBR)

FEATURES AND BENEFITS:

- Good oil resistance, also in hypoid oils
- Good heat resistance, up to +150 °C
- Good mechanical properties
- Good weather and ozone resistance

Limitations:

- Poor resistance against polar fluids (esters, ethers, ketones and aniline)
- Poor resistance against chlorinated hydrocarbons (carbon tetrachloride, trichlorethylene)
- Poor resistance against aromatic fluids (benzene, toluene)

POLYACRYLIC RUBBER (ACM)

FEATURES AND BENEFITS:

- Good resistance against oils and fuels (better than Nitrile rubber)
- Heat resistance about +50 °C better than Nitrile rubber, +150 °C in oil and +125 °C in air
- Good weathering and ozone resistance

Limitations:

- Not usable in contact with water and water solutions, even smaller quantities of water in oil
- Limited cold flexibility to about -20 °C, somewhat poorer than normal NBR
- Limited tensile strength and tear resistance, especially above +100 °C
- Poor wear resistance (considerably inferior compared with NBR)
- Poor resistance against polar and aromatic fluids and chlorinated hydrocarbons

FLUORINATED RUBBER (FKM)

FEATURES AND BENEFITS:

- Resistance against oils and fuels is better than for any other rubber type
- The only highly elastic rubber material that is resistant to aromatic and chlorinated hydrocarbons
- Excellent heat resistance, up to +200 °C
- Excellent weather and ozone resistance
- Excellent acid resistance (only inorganic acids, not suitable for organic acids, e.g. acetic acid)

Limitations:

- Limited cold flexibility, from approximately -25 °C to +20 °C
- Limited tensile and tear strength, especially above +100 °C
- High compression set in hot water
- Poor resistance to polar solvents



FLUOROSILICONE (FVMQ)

FEATURES AND BENEFITS:

- Very low temperature flexibility, down to -60 °C
- Excellent heat resistance, up to +230 °C
- Good compatibility with most mineral oils

LIMITATIONS:

- Not suitable for polar fluids

FDA-COMPLIANT COMPOUNDS

Trelleborg Sealing Solutions has engineered a set of compounds suitable for use in rotary sealing applications, like gearboxes, mixers and other equipment requiring a separation between lubricants and food or any external chemicals.

The elastomeric lip is energized by a spring and can be designed like any Stefa® Radial Oil Seal in order to effectively work under pressure, with shaft eccentricities and vibrations, and with axial play.

Available types of compounds are updated according to state-of-the-art regulations like those from the FDA. Most available Stefa® Radial Oil Seals are molded from EPDM and FKM polymers, bonded to stainless steel metal inserts and energized with special INOX springs. The engineering of these items is usually made according to customer specifications.



■ Working Parameters

TEMPERATURE RESISTANCE

Increasing temperature accelerates the aging of the rubber, the material becomes hard and brittle, the elongation decreases and the compression set increases. Axial cracks at the sealing edge are a typical indication that the seal has been exposed to excessively high temperature.

The aging of the rubber has appreciable significance on the useful life of the seal. The temperature limits for the principal materials are illustrated in Figure 7. They should only be regarded as approximate, since the materials are also affected by contact media. It can generally be said that a temperature increase of +10 °C (in air) will halve the theoretical useful life of the rubber.

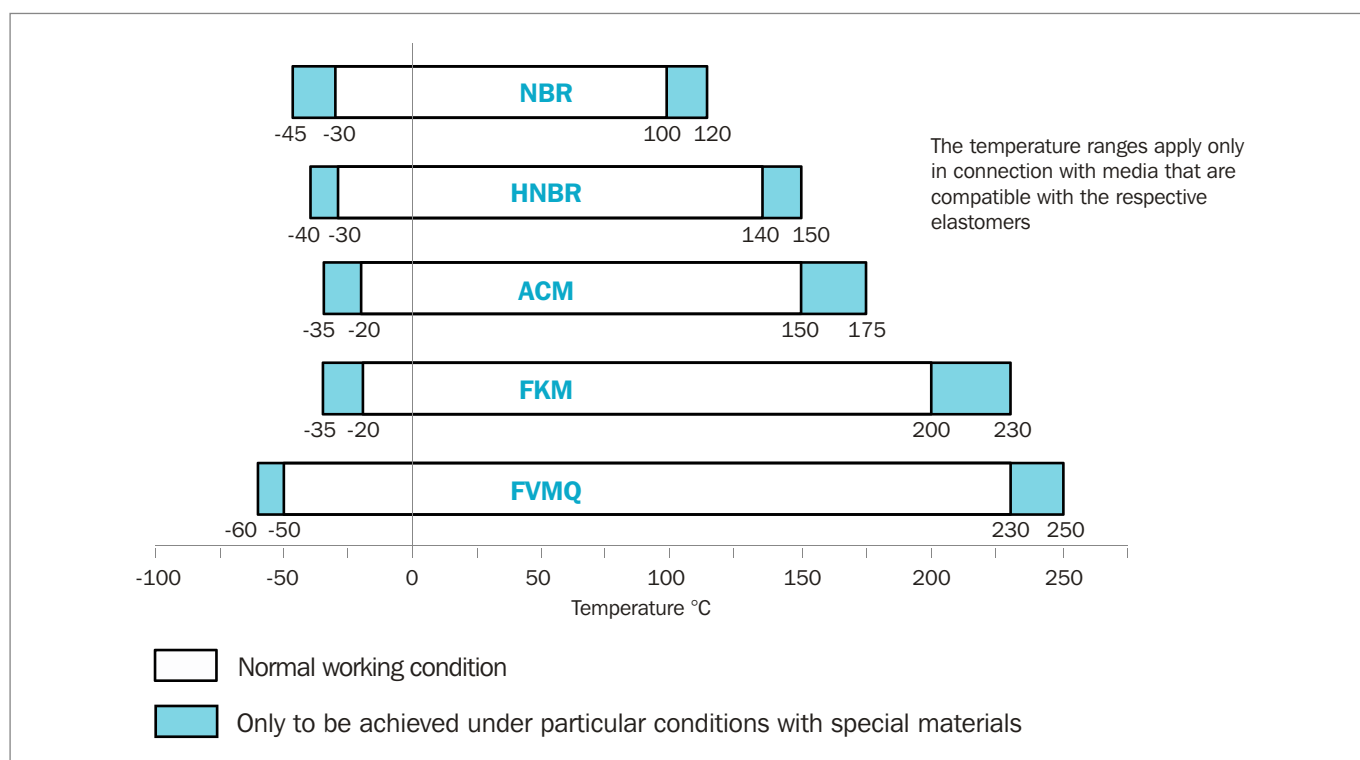


Figure 7: Temperature limits for some common types of rubber

TEMPERATURE

Temperature is the most critical criteria to be considered when selecting a rotary seal.

The temperature limits indicated in the selection tables are maximum operating temperatures of the sealing material in fluids to which the sealing material is compatible (good chemical resistance and controlled swelling/shrinkage).

The above descriptions show that the temperature in the sealing area is influenced by various parameters, especially:

- The lubricating capability of the fluid and its ability to dissipate the heat generated under the sealing lip
- The circumferential velocity
- The pressure applied

The resulting temperature in the sealing area must be considered to select the appropriate material. The initial temperature of the fluid can increase by up to 50% depending on operating parameters. For all applications, please refer to the recommendations in the various chapters or contact your local Customer Solution Center.



MEDIA

The media to be sealed heavily influences the choice of the seal and material type. Usually in rotary applications, liquid media are being contained. Pasty media generally restricts the use of rotary seals, especially with regards to circumferential velocity. Gaseous media require specially adapted seal designs.

Liquid media:

Most applications relate to lubricating fluids, but there are also those with hydraulic fluids based on mineral oils in accordance with DIN 51524 or ISO 6743, or fire-resistant and environmentally friendly hydraulic fluids. More rarely, very aggressive media with low lubricating capabilities must be sealed. Sealing of other fluids such as water or FDA-compliant fluids require a special sealing solution in many cases and will not be covered in detail in this catalog. For specific requirements, please contact your local Customer Solution Center. The media is the first criteria to be considered when selecting the sealing material type. It will also influence the seal family and profile.

Evaluation of the compatibility of the seal material with the media to be sealed is based on the analysis of the values of tensile strength, elongation, volume change and hardness change resulting from an immersion test. Please contact your local Customer Solution Center to select the optimum material for your application.

Mineral oils:

Mainly used in transmissions, elastomer materials have good compatibility with mineral oils within the recommended temperature range. Some mineral oils, such as hypoid transmission oils, contain special additives that produce more demanding operating conditions, e.g. temperature range and/or high pressure. For these, fields testing is recommended.

Synthetic oils:

For improvement of the viscosity, high temperature performance and/or service life, new oils with specific additives have been launched as partial or full synthetic oils. Elastomer sealing materials give the same good compatibility to synthetic mineral oils as they do to standard mineral oils. However, compatibility needs to be checked.

Grease:

Often used for roller and plain bearings, this media requires a specially adapted sealing solution. To reduce the risk of tilting and to allow the sealing lip to open under increasing pressure, the seal is installed in the reverse direction. Another important parameter to be considered is the maximum circumferential velocity. The maximum speed must be reduced to 50% of the permitted speed in oil due to the poor heat exchange the grease can provide.

Above this limit, a change from grease to oil or installation of a seal with a PTFE-based lip (Turcon®) should be considered.

Poor lubricating media:

For poor lubricating media, an initial lubrication of the seal is required to avoid dry-running. In such applications, we recommend a Stefa® Radial Oil Seal with dust lip. The area between the lips will be used as a lubricant reservoir. Two seals in tandem, such as Stefa® Radial Oil Seal/ Stefa® Radial Oil Seal or Stefa® Radial Oil Seal/GAMMA Seal, will provide the same result.

Aggressive media:

Generally, aggressive media (e.g. solvents) have poor lubricating properties and therefore Trelleborg Sealing Solutions recommends Turcon® Varilip® or PDR seals. Turcon® and other PTFE materials, solve the problem of chemical resistance, and the metal cage can be produced from various Stainless Steel materials to increase performance and product lifetime.



ENVIRONMENTALLY FRIENDLY HYDRAULIC FLUIDS (BIO OILS)

When machines or process equipment are hydraulically operated, escaping hydraulic oil can pollute surface waters and the ground. One way of minimizing the danger posed by unwanted leakage is the use of biologically degradable, non-toxic oils. In many countries, there are already statutory regulations and catalogs of requirements for dealing with materials that endanger water. Hydraulic and transmission fluids that protect the environment are already specified in some cases. Figure 8 shows types of biodegradable fluids.

Environmentally friendly fluids have applications in all systems that operate in mobile and agricultural machinery and in industries such as water and forestry. In stationary systems, they are employed in plants where water is at risk, such as locks or water turbines, and for food and pharmaceutical production.

An important criterion for biologically rapidly-degradable fluids is their compatibility with seals. In Table 5, the resistances of elastomeric materials against "bio-oils" are given.

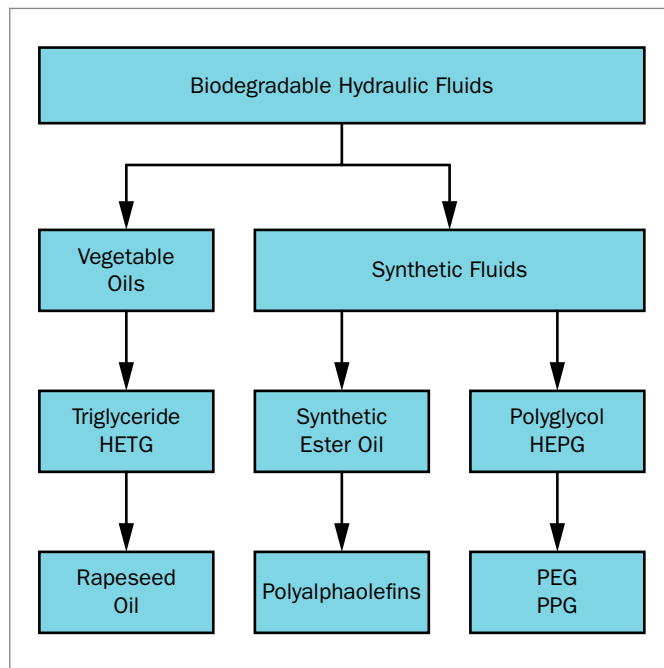


Figure 8: Biodegradable hydraulic fluids

Table 5: Recommendations for the Use of Standard Elastomer Materials in Accordance with ISO VG 32 to 68 and VDMA Directive 24569

Oil Temperature	< 60 °C	< 80 °C	< 100 °C	< 120 °C
Oil Type / ISO VG	32 - 68	32 - 68	32 - 68	32 - 68
HETG (Rapeseed)	NBR HNBR FKM	NBR HNBR FKM	- - -	- - -
HEES	NBR* HNBR* FKM*	NBR* HNBR* FKM	- - FKM	- - FKM
HEPG (PAG)	NBR* HNBR* FKM*	NBR HNBR FKM**	- HNBR FKM**	- HNBR FKM**
HEPR (PAO)	not yet specified	not yet specified	not yet specified	not yet specified

* For dynamic applications, specific test required

** Preferred peroxide-cured FKM



OVERPRESSURE

When the sealing element is exposed to pressure, it is forced against the shaft and the area of the lip in contact with the shaft increases. The friction, as well as the generated heat, increases. As a result, when the seal is under pressure, the specified values of peripheral speed cannot be maintained but must be reduced in relation to the magnitude of the pressure. At high peripheral speeds even overpressures of 0.01 to 0.02 MPa may cause difficulties. By fitting a separate Back-up Ring, the types TRA, TRC and TRB can be used for overpressure above 0.5 MPa. The separate Back-up Ring shape follows the rear profile of the sealing element but without mutual contact when no pressure differential exists (see Figure 9). However, the Back-up Ring requires accurate fitting.

Please ask your local Customer Solution Center for suitable Back-up Ring drawings. Seal type SPV is formed to support the sealing element (see Figure 9). The type TRP/6CC is designed with a short and sturdy sealing lip, which allows overpressures without using a separate Back-up Ring. When a Back-up Ring is installed or when the types SPV or TRP/6CC are used, overpressures of 0.4 to 0.5 MPa are permissible at moderate peripheral speeds.

At very high pressures, seals with rubber-covered cases should be used to avoid leakage between the periphery of the seal and the housing bore. When the seal is under pressure, there is a risk of axial movement in the housing bore (pop-out). This effect can be prevented by locating the seal against a shoulder, with a spacer ring or a circlip.

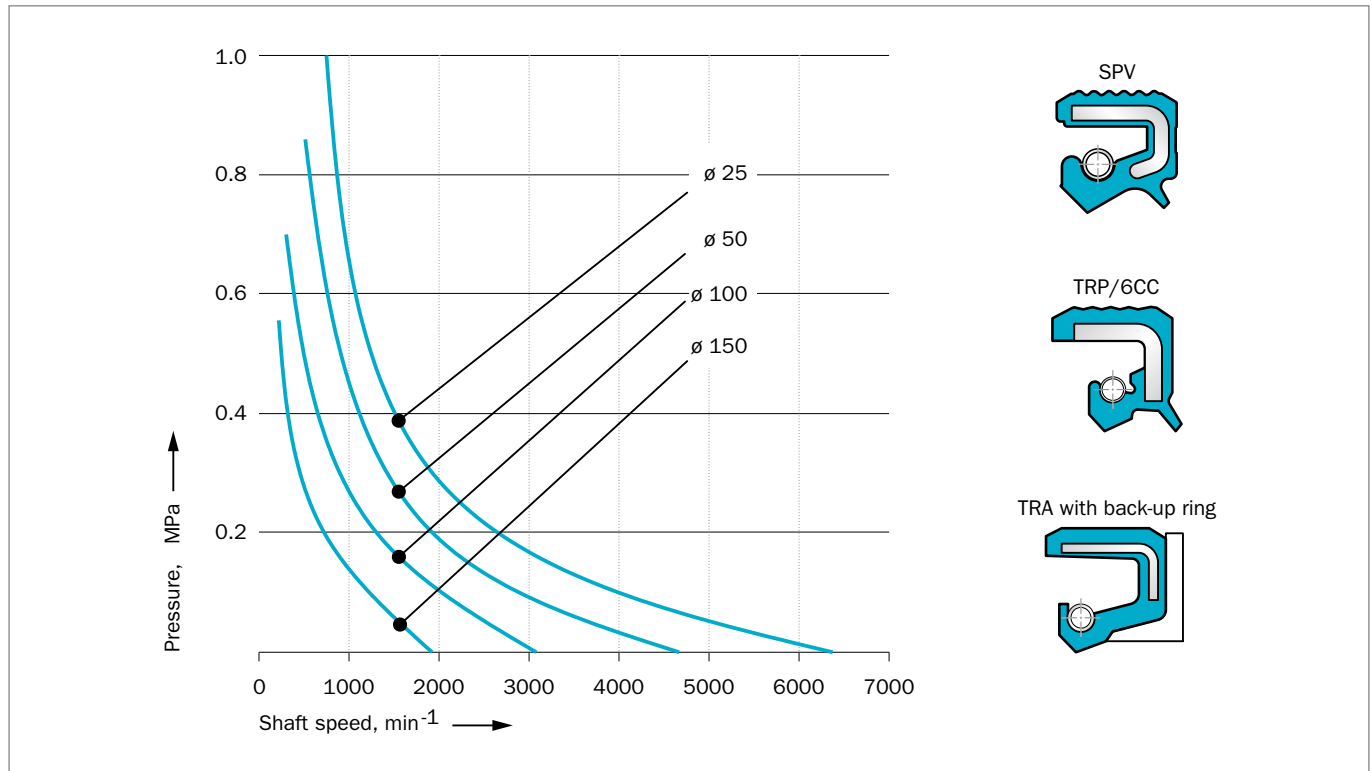


Figure 9: Permissible overpressure for supported lip seals and for pressure seals



PERIPHERAL SPEED AND NUMBER OF REVOLUTIONS

Different designs of the sealing element affect the magnitude of the friction and thus result in varying temperature rises. Various designs of the sealing element allow different maximum peripheral speeds. Figure 10 shows the approximate maximum values for the permissible peripheral speed for sealing elements (without dust lip), i.e. seal types TRC, TRA,

TRB, etc. made with NBR or FKM, with no differential pressure, and where adequate lubrication or cooling of the sealing edge by the sealed media exists. In addition, the maximum permissible operating temperatures shown in Table 4 must not be exceeded. The curve shows that higher peripheral speeds are permissible for larger shaft diameters more than for the smaller. This is due to the fact that the cross-sectional area increases in proportion to the square of the diameter, thus increasing the heat dissipation capacity.

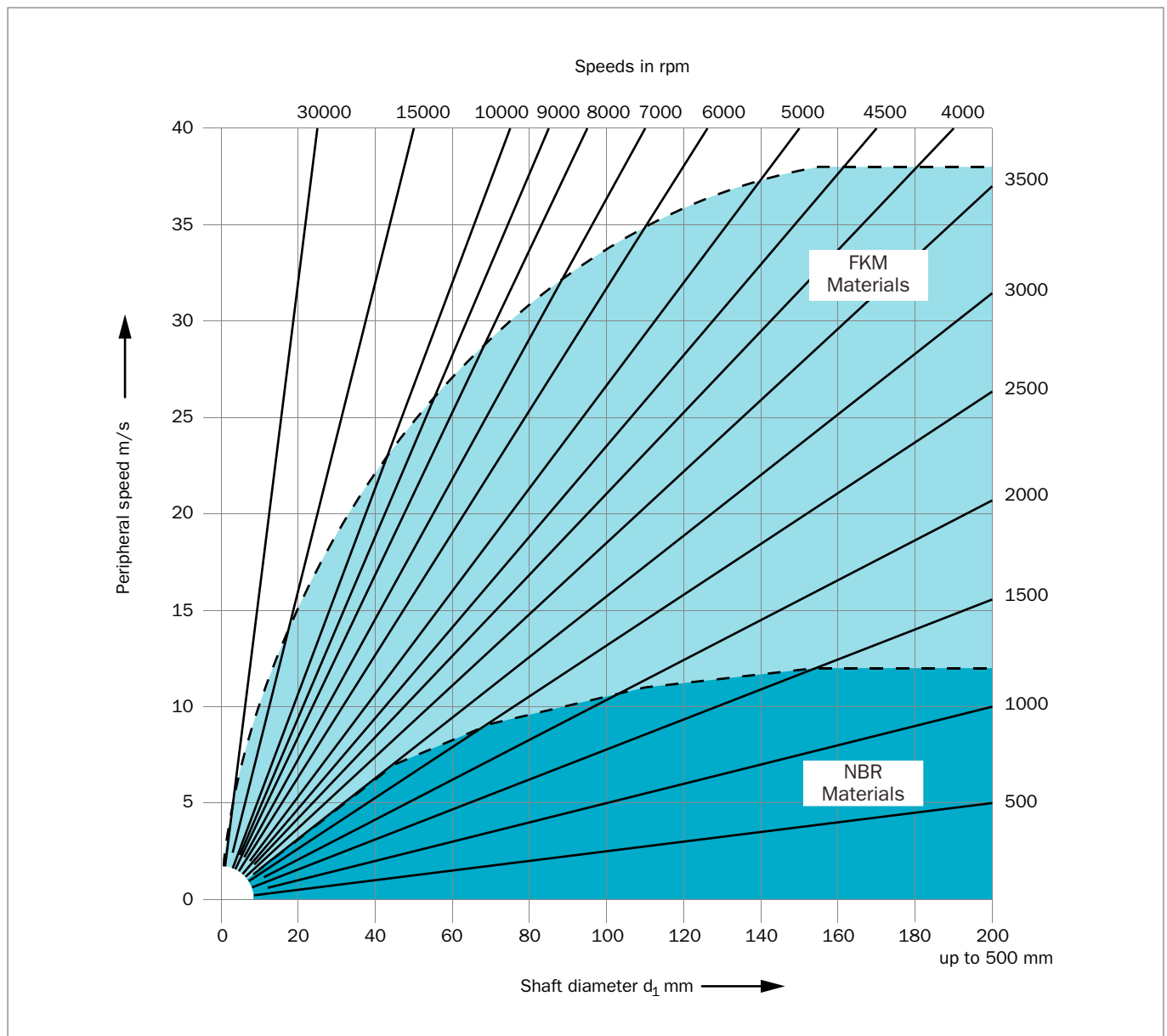


Figure 10: Permissible speeds in pressure-free state to DIN 3761



FRictional LOSS

The frictional loss is often of significant magnitude, particularly when low powers are transmitted. The frictional loss is affected by the following parameters: seal design and material, spring force, speed, temperature, media, shaft design, and lubrication. Figure 11 shows the frictional losses in watts caused by a seal without dust lip when fitted in accordance with our technical instructions. In certain cases, the frictional loss can be reduced by a special design of the sealing lip, reduction of the spring force or by employing a special grade of rubber. Trelleborg Sealing Solutions engineering teams will be pleased to provide advice on such matters. It should be noted that the frictional loss during the running in period is greater than shown in the figure. The normal running in period is a few hours.

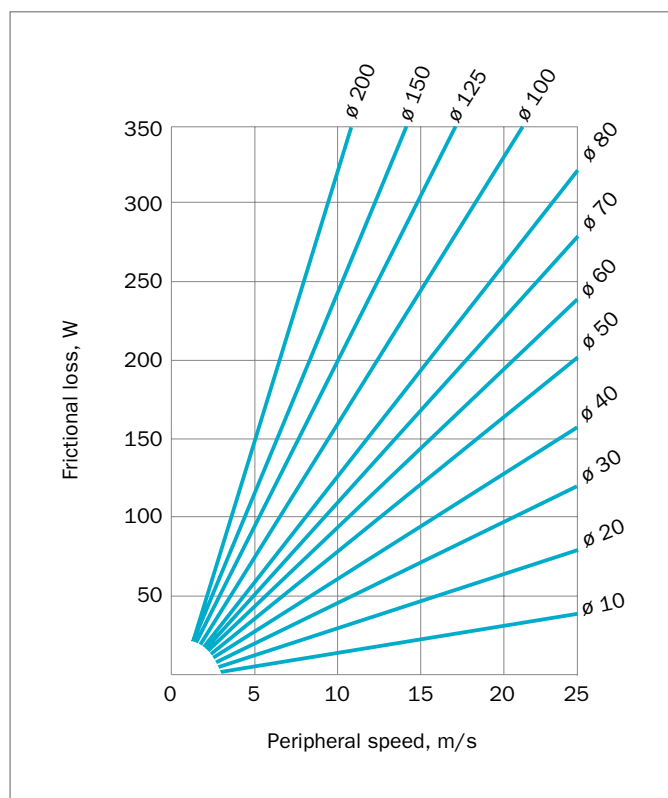


Figure 11: Frictional loss for a TRA type seal in Nitrile rubber

LEAKAGE CONTROL

When defining leakage control, one must differentiate between static sealing (sealing of two surfaces without motion relative to one another) and dynamic sealing (relative motion between the two surfaces).

With a moving seal surface, a fluid film separates the sliding surfaces from one another forming a dynamic seal gap. Unlike in static sealing, the leakage path is not fully closed off, so small quantities may escape. Seals in which a dynamic seal gap forms between the seal body and a rotating shaft cannot be tight in the physical sense.

Absolute tightness in the physical sense cannot be achieved with a seal gap alone when sealing moving parts.

For many technical applications, however, it is quite adequate if the leakage is reduced to such an extent that there are no negative consequences for the environment or the operation of the assembly. This is called technical tightness.

Technical tightness must be specified by the user or manufacturer of an assembly, i.e. in some circumstances, maximum permitted leakage rates must be defined.

For example, leakage classes are defined for Stefa® Radial Oil Seals in DIN 3761 Part II (Motor vehicles).

The German standard DIN 3761 classifies the tightness of lip seals into leakage classes 1 to 3. Zero-leakage is also defined. Zero-leakage means a function-related film of moisture at the sealing edge to a non-drip formation of media over the back-face of the seal is allowed. It is better to accept this "minimum leakage" rather than risk the lip being damaged due to insufficient lubrication. The permissible leakage in class 1 to 3 is max 1 g to 3 g per seal for a test time of 240 hours.



■ Installation Instructions

The following points must be observed when installing rotary shaft lip seals:

- Before installing, clean the shaft and bore of debris or contamination
- Lubricate the shaft and inner diameter of the seal with a light coating of grease or oil
- Any sharp-edged transitions on the shaft or bore must either be chamfered or rounded
- When pressing the seal into the bore, take care that it does not deform
- The pressing force must be applied as close as possible to the outer circumference of the seal
- After installation, the seal must be concentric with the bore and at right angles to the shaft
- The end face of the mounting bore is generally used as a depth locator; the seal can also be fixed with a shoulder or a spacer washer

Figure 12 shows various force fit situations of the rotary shaft lip seal with suitable installation tools or devices.

IMPORTANT NOTE

The installation of Stefa® Radial Oil Seals is covered in detail in the Trelleborg Sealing Solutions Installation Instructions app. Search for 'Trelleborg' in the App Store or Google Play to find and download it.

DISMANTLING AND REPLACEMENT

Dismantling of the seal can be accomplished using a screwdriver or similar tool. Take care not to damage the shaft or bore. The seal will be damaged during dismantling and should not be reused.

After repair or maintenance of a machine, a new rotary shaft lip seal must always be installed, even if the old one seems to be still usable. The sealing edge of the new seal should not ride on the same contact area on the shaft as the old seal. This can be achieved by:

- Replacement of shaft sleeves
- Fitting the seal into the bore to a different depth
- Reworking of the shaft and assembling a wear sleeve (see page 147, Shaft Repair Kit)

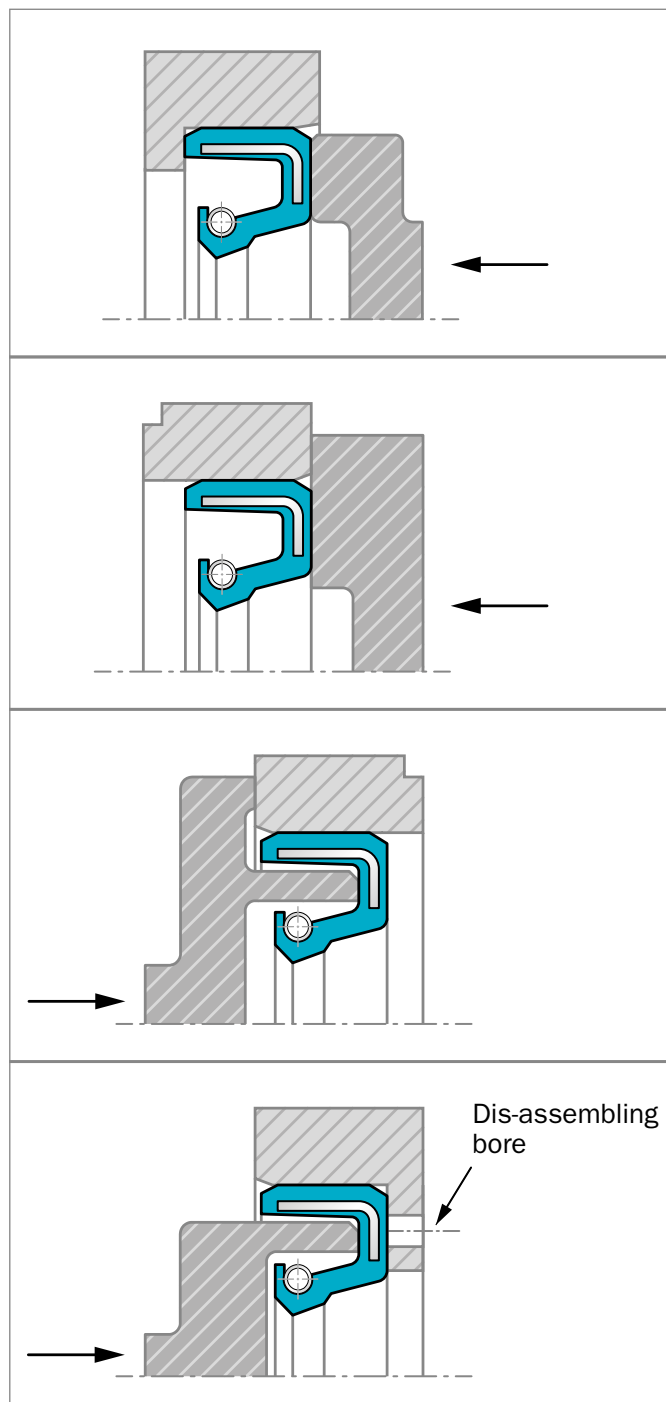


Figure 12: Installation aids for fitting rotary shaft lip seals



■ Standard Stefa® Radial Oil Seal

Standard elastomeric Stefa® Radial Oil Seals are designed according to DIN 3760, DIN 3761 and ISO 6194/1

recommendations. Types DIN A and DIN AS may have **a wavy or flat outer sheath**.

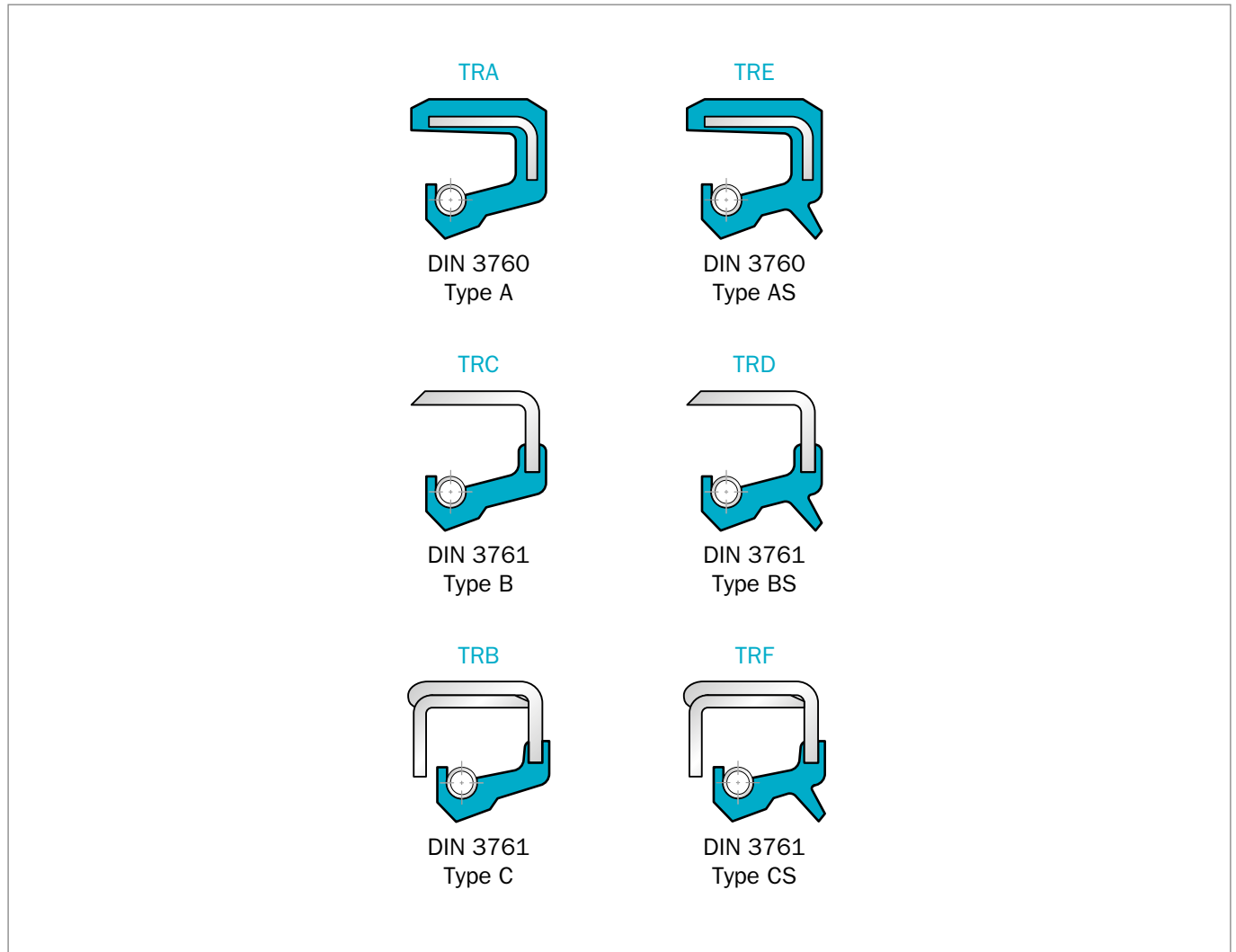


Figure 13: Standard types



■ Type TRA: DIN 3760 Type A

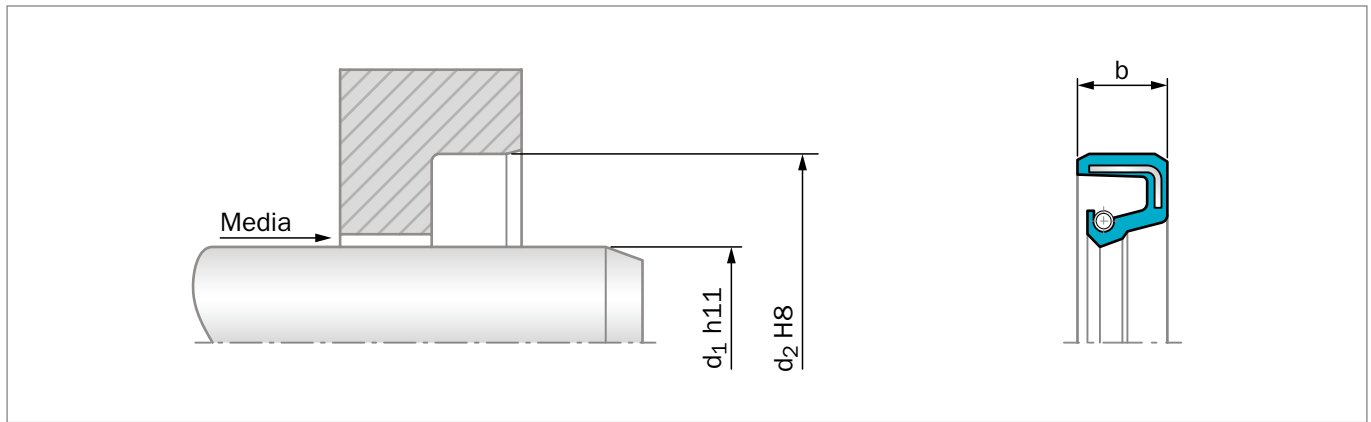


Figure 14: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions type TRA are seals with completely rubber-covered outer diameters. Two different O.D design are available: flat rubber sheath and wavy.

This type is not recommended for use in heavily polluted environments.

FEATURES AND BENEFITS

- Good static sealing
- Compensation of different thermal expansions
- Reduced risk of fretting corrosion
- Higher bore surface roughness is allowed
- Installation in split-housings
- Modern lip design provides low radial forces

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Electrical motors
- Machine tools

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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


Table 6: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal Insert	Standard Spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR/VCM02	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRA

TSS Type:	A
Code:	TRA
Dimensions:	Shaft diameter 25 mm Housing diameter 40 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. TRA B 00250 - N7MMR

Code _____
Type _____
Shaft Diameter x 10 _____
Quality Index (Standard) _____
Material Code (Standard) _____

Table 7: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
4	12	6	TRA100040	●	
5	16	7	TRA100050	●	
5	19	5	TRA400050	●	
5.5	22	7	TRA000055	●	
6	12	5.5	TRA400060	●	●
6	15	4	TRA000060	●	●
6	16	5	TRA100060	●	
6	16	7	TRAA00060	●	●
7	17	7	TRA200070	●	
7	22	7	TRAA00070	●	●
8	14	4	TRA700080	●	
8	16	5	TRA100080	●	
8	16	7	TRA200080	●	●
8	18	5	TRA300080	●	●
8	20	8	TRA800080	●	●
8	22	4	TRA500080	●	●
8	22	7	TRAA00080	●	●
9	22	7	TRAA00090	●	
9.5	25.4	8	TRA000095	●	
10	16	4	TRA000100		●
10	18	4	TRA200100	●	●
10	19	7	TRA400100	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
10	20	5	TRAH00100	●	
10	22	6	TRAE00100		●
10	22	7	TRAA00100	●	●
10	24	7	TRAB00100	●	●
10	26	7	TRAC00100	●	●
11	19	7	TRA100110	●	
11	26	7	TRAB00110	●	
12	19	5	TRA000120	●	●
12	20	5	TRA200120	●	
12	22	4	TRAF00120	●	●
12	22	7	TRAA00120	●	●
12	24	7	TRAB00120	●	●
12	25	5	TRA600120	●	
12	26	7	TRA800120	●	●
12	28	7	TRAC00120	●	●
12	30	7	TRAD00120	●	●
12	32	7	TRAH00120	●	
12	37	10	TRAK00120	●	
13	25	5	TRA100130	●	
13	26	7	TRA200130	●	

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
13	30	8	TRA300130	●	
14	22	4	TRA000140	●	●
14	22	7	TRA400140	●	
14	24	4	TRA000140		
14	24	7	TRA000140	●	●
14	25	5	TRA100140	●	
14	28	7	TRAB00140	●	●
14	30	7	TRAC00140	●	●
15	24	5	TRAF00150	●	●
15	24	7	TRA200150	●	●
15	25	5	TRA300150	●	
15	26	6	TRA400150	●	
15	28	7	TRA600150	●	●
15	30	7	TRAB00150	●	●
15	32	7	TRAC00150	●	●
15	32	9	TRA800150	●	
15	35	7	TRAD00150	●	●
15	37	7	TRA000150	●	
15	40	7	TRAN00150		●
15	42	7	TRAG00150	●	●
16	24	4	TRA500160	●	●
16	24	5	TRA200160	●	
16	24	7	TRA300160	●	●
16	26	7	TRA400160	●	●
16	28	7	TRA000160	●	●
16	30	7	TRAB00160	●	●
16	32	7	TRAC00160	●	
17	25	4	TRA100170	●	●
17	26	6	TRA300170	●	
17	28	5	TRA400170	●	●
17	28	7	TRA000170	●	●
17	30	7	TRAB00170	●	●
17	32	7	TRAC00170	●	●
17	35	7	TRAD00170	●	●
17	37	7	TRAN00170	●	
17	40	7	TRA000170	●	●
17	47	7	TRAG00170	●	●
18	24	4	TRA500180		●
18	30	7	TRA000180	●	●
18	35	7	TRAC00180	●	●
18	35	10	TRA300180	●	
19	27	6	TRA600190	●	
19	32	7	TRA200190	●	
19	35	7	TRA300190	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
19.3	35	6	TRA000193	●	
20	28	6	TRA100200	●	
20	30	5	TRA200200	●	●
20	30	7	TRA000200	●	●
20	30	8	TRAJ00200		●
20	32	7	TRAB00200	●	●
20	35	6	TRA600200	●	
20	35	7	TRAC00200	●	●
20	37	7	TRAM00200	●	
20	37	8	TRA900200	●	
20	40	4	TRAL00200	●	
20	40	7	TRAD00200	●	●
20	42	7	TRAG00200	●	●
20	47	7	TRA000200	●	●
20	52	7	TRA400200	●	
20	52	10	TRAK00200	●	
21	30	6.5	TRA100210	●	
22	32	7	TRA000220	●	●
22	35	5	TRA200220	●	
22	35	7	TRAB00220	●	●
22	37	7	TRA300220	●	
22	40	7	TRAC00220	●	●
22	52	7	TRAN00220		●
22.5	53	10	TRA000225		●
23	40	10	TRA100230	●	
24	35	7	TRA000240	●	●
24	37	7	TRAB00240	●	
24	40	7	TRAC00240	●	●
24	47	7	TRAD00240	●	●
25	32	6	TRA000250	●	●
25	33	6	TRA300250	●	●
25	35	7	TRA000250	●	●
25	37	7	TRA700250	●	●
25	38	7	TRA800250	●	●
25	40	5	TRA900250	●	
25	40	7	TRAB00250	●	●
25	40	10	TRAG00250	●	●
25	42	7	TRAC00250	●	●
25	43	10	TRAU00250		●
25	45	7	TRAIO0250	●	●
25	47	7	TRAD00250	●	●
25	47	8	TRAK00250	●	●

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
25	47	10	TRAL00250	●	●
25	52	7	TRAE00250	●	●
25	52	10	TRA000250	●	
25	62	10	TRAR00250	●	
26	34	4	TRA100260	●	
26	37	7	TRAA00260	●	
26	47	7	TRAC00260	●	●
27	37	7	TRA300270	●	
27	42	7	TRA000270	●	
27	50	8	TRA100270	●	
28	38	7	TRA000280	●	●
28	40	7	TRAA00280	●	●
28	47	7	TRAB00280	●	●
28	47	10	TRA500280	●	●
28	52	7	TRAC00280	●	●
28	80	7	TRA100280	●	
30	40	7	TRAA00300	●	●
30	42	5	TRAMGA004	●	
30	42	5.7	TRAV00300	●	
30	42	7	TRAB00300	●	●
30	45	7	TRA400300	●	●
30	45	8	TRA500300	●	
30	47	4	TRA800300	●	
30	47	7	TRAC00300	●	●
30	47	8	TRA900300	●	
30	47	10	TRAF00300	●	●
30	48	8	TRAG00300	●	
30	48	10	TRAMGA008	●	
30	52	7	TRAD00300	●	●
30	55	7	TRAN00300	●	●
30	55	10	TRA000300	●	●
30	62	7	TRAE00300	●	●
30	62	10	TRAR00300	●	●
30	72	8	TRAT00300	●	
30	72	10	TRAU00300	●	●
31	47	7	TRA000310	●	
32	45	7	TRAA00320	●	●
32	47	7	TRAB00320	●	●
32	47	10	TRAM00320	●	
32	50	8	TRA400320	●	●
32	52	6	TRAJ00320	●	
32	52	7	TRAC00320	●	●
32	54	8	TRA900320		●
34	52	8	TRA300340	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
34	62	10	TRA600340	●	
35	45	7	TRA000350	●	●
35	47	7	TRAA00350	●	●
35	50	7	TRAB00350	●	●
35	52	7	TRAC00350	●	●
35	52	10	TRA500350	●	●
35	55	8	TRA600350	●	●
35	55	10	TRA700350	●	●
35	56	10	TRA900350	●	●
35	60	10	TRAH00350	●	
35	62	7	TRAD00350	●	●
35	62	10	TRAJ00350	●	●
35	68	10	TRAW00350		●
35	72	7	TRAM00350	●	
35	72	10	TRAN00350	●	●
35	72	12	TRA000350	●	
35	80	10	TRAQ00350	●	
35	80	13	TRAS00350	●	
36	47	7	TRAA00360	●	●
36	50	7	TRAB00360	●	
36	52	7	TRAC00360		●
37	62	10	TRA200370	●	
38	50	7	TRA000380	●	●
38	52	7	TRAA00380	●	●
38	54	6.5	TRA900380	●	●
38	55	7	TRAB00380	●	●
38	62	7	TRAC00380	●	●
38	65	8	TRAK00380	●	
40	50	8	TRA000400	●	●
40	52	7	TRAA00400	●	●
40	55	7	TRAB00400	●	●
40	55	10	TRA500400	●	
40	58	10	TRAF00400		●
40	60	10	TRAH00400	●	●
40	62	7	TRAC00400	●	●
40	62	10	TRAIO0400	●	●
40	65	10	TRAK00400	●	●
40	68	7	TRAM00400	●	●
40	68	10	TRAN00400		●
40	72	7	TRAD00400	●	●
40	72	10	TRAQ00400	●	●
40	80	7	TRAS00400		●

- In one of the preferred materials
- In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
40	80	10	TRAT00400	●	●
40	85	10	TRAU00400	●	
40	90	8	TRAV00400	●	
40	90	12	TRAW00400	●	
42	55	7	TRA000420	●	●
42	55	8	TAA00420	●	●
42	56	7	TRA100420	●	●
42	60	10	TRA200420	●	
42	62	7	TRA300420	●	●
42	62	8	TRAB00420	●	●
42	62	10	TRA400420	●	
42	72	7	TRA700420	●	
42	72	8	TRAC00420	●	
42	72	10	TRA800420	●	
44	62	10	TRA100440	●	
45	55	7	TRA200450	●	
45	60	7	TRA400450	●	●
45	60	8	TAA00450	●	●
45	62	7	TRA600450	●	●
45	62	8	TRAB00450	●	●
45	62	10	TRA800450	●	●
45	65	8	TRAC00450	●	●
45	65	10	TRAF00450	●	●
45	72	8	TRAD00450	●	●
45	72	10	TRAK00450	●	●
45	72	12	TRAW00450		●
45	75	8	TRAM00450	●	
45	75	10	TRAN00450	●	●
45	80	8	TRA000450	●	
45	80	10	TRAP00450	●	
45	85	10	TRAR00450	●	
47	62	6	TRA000470	●	
48	62	8	TAA00480	●	●
48	72	8	TRAB00480	●	●
48	80	10	TRA600480	●	
50	62	7	TRA000500	●	●
50	65	7	TRA200500		●
50	65	8	TAA00500	●	●
50	65	10	TRA200500	●	●
50	68	8	TRAB00500	●	●
50	68	10	TRA300500	●	●
50	70	8	TRA500500	●	●
50	70	10	TRA600500	●	●
50	72	6	TRA800500	●	
50	72	7	TRAE00500	●	
50	72	8	TRAC00500	●	●
50	75	10	TRAG00500	●	
50	80	8	TRAD00500	●	
50	80	10	TRAH00500	●	
50	90	10	TRAK00500	●	
52	68	8	TAA00520	●	●
52	72	8	TRAB00520	●	●
52	75	12	TRA300520		●
52	85	10	TRA700520	●	
54	80	10	TRA400540	●	
55	68	8	TRA000550	●	●
55	70	8	TAA00550	●	●
55	70	10	TRA100550	●	
55	72	8	TRAB00550	●	●
55	72	10	TRA200550	●	
55	75	10	TRA400550	●	●
55	80	7	TRAL00550	●	●
55	80	8	TRAC00550	●	●
55	80	10	TRA600550	●	●
55	85	8	TRAD00550	●	
55	85	10	TRA900550	●	●
55	90	8	TRAP00550	●	
55	90	10	TRAG00550	●	
55	100	12	TRAK00550	●	
56	72	8	TRAB00560	●	
58	72	8	TAA00580	●	
58	80	8	TRAB00580	●	●
58	80	10	TRA200580	●	
58.5	100	12	TRA000585	●	
60	70	7	TRA000600	●	
60	72	8	TRA100600	●	●
60	75	8	TAA00600	●	●
60	78	10	TRA300600		●
60	80	7	TRA400600		●
60	80	8	TRAB00600	●	●
60	80	10	TRA500600	●	●
60	85	8	TRAC00600	●	●
60	90	8	TRAD00600	●	●
60	90	10	TRAF00600	●	●
60	95	10	TRAH00600	●	●
60	100	10	TRAI00600		●

- In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
60	110	10	TRA200600	●	
60	110	12	TRAN00600	●	
60	110	13	TRAJ00600	●	●
62	75	10	TRA000620	●	
62	80	9	TRA100620	●	
62	80	10	TRA200620	●	●
62	85	10	TRAA00620	●	●
62	90	10	TRAB00620	●	
62	95	10	TRA300620	●	
63	85	10	TRAA00630	●	●
65	80	8	TRA000650	●	
65	85	8	TRA200650		●
65	85	10	TRAA00650	●	●
65	90	7	TRAD00650		●
65	90	10	TRAB00650	●	●
65	95	10	TRA600650	●	
65	100	10	TRAC00650	●	●
65	110	10	TRA900650		●
68	85	10	TRA000680	●	
68	90	10	TRAA00680	●	●
70	85	7	TRA000700	●	
70	85	8	TRA100700	●	●
70	85	10	TRAC00700	●	
70	90	7	TRA800700	●	●
70	90	10	TRAA00700	●	●
70	95	10	TRA400700	●	
70	100	6	TRAJ00700	●	
70	100	10	TRAB00700	●	●
70	110	8	TRA900700	●	
70	110	12	TRAG00700	●	
72	95	10	TRAA00720	●	●
72	100	10	TRAB00720	●	
75	90	8	TRA000750	●	●
75	90	10	TRA100750	●	●
75	95	7	TRAD00750		●
75	95	10	TRAA00750	●	●
75	100	10	TRAB00750	●	●
75	110	10	TRA600750		●
75	115	10	TRA500750	●	
77	95.5	9.5	TRA000770	●	
78	100	10	TRAA00780	●	
80	95	8	TRA000800		●
80	100	7	TRAC00800		●
80	100	10	TRAA00800	●	●
80	100	13	TRA100800	●	●
80	105	13	TRA300800	●	
80	110	10	TRAB00800	●	●
80	110	12	TRA400800		●
80	115	10	TRA600800	●	●
80	120	12	TRA700800		●
80	120	13	TRA900800	●	
85	100	9	TRA300850		●
85	105	12	TRAG00850		●
85	110	10	TRA100850	●	
85	110	12	TRAA00850	●	●
85	120	12	TRAB00850	●	●
88	110	12	TRA000880	●	
90	110	7.5	TRAE00900		●
90	110	8	TRA100900	●	
90	110	10	TRA200900	●	●
90	110	12	TRAA00900	●	●
90	115	12	TRAF00900		●
90	120	12	TRAB00900	●	●
90	130	13	TRA800900	●	
90	140	13	TRA900900	●	●
95	110	12	TRA500950		●
95	115	13	TRA100950	●	●
95	120	12	TRAA00950	●	●
95	125	12	TRAB00950	●	●
95	140	12	TRAC00950	●	●
95	145	13	TRA700950	●	
96	117	10	TRA000960		●
100	115	9	TRAG01000	●	●
100	120	6	TRAD01000	●	
100	120	7.5	TRAE01000		●
100	120	10	TRA001000	●	
100	120	12	TRAA01000	●	●
100	125	12	TRAB01000	●	●
100	130	12	TRAC01000	●	●
105	130	12	TRAA01050	●	●
105	140	12	TRAB01050	●	
105	140	13	TRA601050	●	
110	128	12	TRA501100		●
110	130	12	TRAA01100	●	●
110	130	13	TRA201100	●	●
110	140	12	TRAB01100	●	●

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
110	150	13	TRA801100	●	
115	135	10	TRA101150	●	●
115	140	12	TRAA01150	●	●
115	140	13	TRA201150		●
118	150	12	TRA101180	●	
120	140	7.5	TRA901200	●	
120	140	13	TRA201200	●	●
120	145	15	TRAF01200	●	
120	150	12	TRAA01200	●	●
120	160	12	TRAB01200	●	●
125	150	12	TRAA01250	●	●
125	160	12	TRAB01250	●	●
127	146	11.2	TRA001270	●	
130	150	10	TRA001300	●	●
130	150	12	TRA801300		●
130	160	12	TRAA01300	●	●
130	160	13	TRA101300	●	●
130	160	15	TRA301300	●	●
130	170	12	TRAB01300	●	●
130	180	15	TRA401300		●
135	170	12	TRAA01350	●	●
140	160	10	TRAE01400		●
140	160	12	TRA201400	●	●
140	160	13	TRA001400	●	●
140	165	12	TRA101400	●	●
140	170	12	TRA301400	●	●
140	170	13	TRA401400	●	
140	170	15	TRAA01400	●	●
140	180	12	TRA801400		●
145	175	15	TRAA01450	●	●
150	170	10	TRA401500	●	
150	170	15	TRA101500		●
150	180	12	TRA201500	●	●
150	180	15	TRAA01500	●	●
155	180	15	TRA101550	●	
160	180	15	TRA001600		●
160	185	10	TRA101600	●	
160	185	14	TRAF01600	●	
160	190	15	TRAA01600	●	●
160	200	12	TRA401600	●	●
165	190	13	TRA001650	●	●
170	190	10	TRA301700	●	
170	200	12	TRA201700	●	●
170	200	15	TRAA01700	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
175	200	10	TRA001750		●
175	205	15	TRAR01750		●
178	203	11.2	TRA001780	●	
180	200	15	TRA001800	●	
180	210	15	TRAA01800	●	●
180	215	15	TRA401800	●	
180	215	16	TRA101800	●	
184	216	16	TRA001840	●	
185	210	10	TRA001850		●
185	210	13	TRA101850	●	
190	220	15	TRAA01900	●	●
190	220	12	TRA601900		●
190	225	16	TRA101900	●	
190	230	15	TRA301900		●
190	240	15	TRA501900	●	
191	216	12.7	TRA001910	●	
195	230	16	TRA001950	●	
200	230	15	TRAA02000	●	●
210	240	15	TRAA02100	●	●
210	250	16	TRA102100	●	
215	235	10	TRA202150	●	
220	250	15	TRAA02200	●	●
220	270	15	TRA402200	●	
222	254	16	TRA002220	●	
230	260	15	TRAA02300	●	●
240	270	15	TRAA02400	●	●
240	280	15	TRA002400	●	
248	286	19	TRA002480	●	
250	280	15	TRAA02500	●	●
250	290	16	TRA102500	●	
260	280	10	TRA202600	●	
260	290	15	TRA102600	○	
260	290	16	TRA002600	●	●
260	300	20	TRAA02600	○	○
265	290	16	TRA002650	○	○
275	305	12	TRA002750	●	
280	310	15	TRA202800		○
280	320	20	TRAA02800	●	●
285.7	323.8	16	TRA002857	●	
290	330	20	TRA002900	●	
300	340	18	TRA103000		○
300	340	20	TRAA03000	●	○

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
320	360	20	TRAA03200	●	○
330	360	12	TRA103300	●	
340	380	18	TRAA03400	●	○
340	380	20	TRAA03400	○	○
350	390	18	TRAA03500	●	●
360	400	20	TRAA03600	○	
370	410	15	TRAA03700	○	○
380	420	20	TRAA03800	○	○
385	425	15	TRAA03850	○	
394	420	16	TRAA03940	○	
400	440	20	TRAA04000	○	○
420	450	15	TRAA04200	●	
420	460	20	TRAA04200	○	○
440	480	20	TRAA04400	○	○
480	520	20	TRAA04800	○	○
500	540	20	TRAA05000	○	○
560	610	20	TRAA05600	○	
670	710	20	TRAA06700	○	
800	840	20	TRAA08000	○	

● In one of the preferred materials

○ In other commercial materials



■ Type TRE: DIN 3760 Type AS

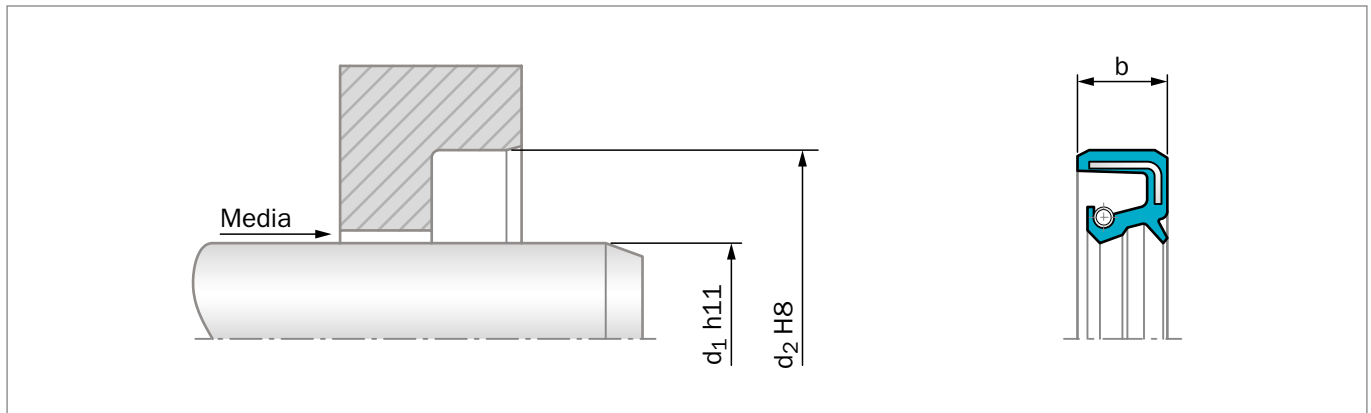


Figure 15: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type TRE are seals with completely rubber-covered outer diameters. Two different O.D. design are available: flat rubber sheath and wavy. The additional dust lip protects the main sealing lip against dust and other fine solid contaminants and therefore this type is recommended for use in polluted environments. To achieve a long lifetime, a suitable lubricant between the two sealing lips should be applied.

FEATURES AND BENEFITS

- Good static sealing
- Compensation of different thermal expansions
- Reduced risk of fretting corrosion
- Effective protection against air-side contaminants
- Higher bore surface roughness is allowed
- Installation in split-housings
- Modern lip design provides low radial forces

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Electrical motors
- Machine tools

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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


Table 8: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal Insert	Standard Spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR/VCM02	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRE

TSS Type:	E
Code:	TRE
Dimensions:	Shaft diameter 15 mm Housing diameter 30 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. **TRE** **B** **00150** **-** **N7MMR**

Code _____

Type _____

Shaft Diameter x 10 _____

Quality Index (Standard) _____

Material Code (Standard) _____

Table 9: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
6	16	5	TRE000060	●	
6	16	7	TREA00060	●	
8	16	5	TRE500080		
8	16	7	TRE000080	●	
8	18	5	TRE300080		●
8	22	7	TRE100080	●	
10	18	6	TRE100100	●	
10	19	7	TRE200100	●	
10	20	5	TRE300100	●	
10	22	7	TREA00100	●	
10	26	7	TREC00100	●	
11	17	4	TRE000110	●	
12	19	5	TRE000120	●	●
12	20	5	TRE400120	●	
12	22	7	TREA00120	●	●
12	25	7	TREE00120	●	
12	28	7	TREC00120	●	●
12	32	7	TRE300120	●	●
12	37	10	TRE900120	●	
14	21	4	TRE300140	●	
14	22	4	TRE400140		●
14	23	5	TRE100140		●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
14	24	7	TREA00140	●	●
14	35	7	TRED00140		●
15	24	5	TREH00150	●	
15	24	7	TRE000150	●	
15	25	5	TRE600150		●
15	26	7	TREA00150	●	
15	28	7	TRE100150	●	
15	30	7	TREB00150	●	●
15	30	10	TRE700150		●
15	32	7	TREC00150	●	●
15	35	7	TRED00150	●	
15	42	7	TRE300150	●	
16	22	7	TRE500160	●	
16	28	7	TREA00160	●	●
16	29	4	TRE400160	●	
16	30	7	TREB00160	●	●
16	32	7	TREC00160		●
17	28	6	TRE000170	●	
17	28	7	TREA00170	●	●
17	30	7	TREB00170	●	●

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
17	35	7	TRED00170	●	
17	40	7	TREE00170	●	●
17	42	7	TRE200170	●	
18	28	7	TRE000180	●	
18	30	6	TRE400180	●	
18	30	7	TREA00180	●	
18	32	7	TREB00180	●	●
18	47	6	TRE800180	●	
18	47	10	TRE900180	●	
20	30	5	TRES00200		
20	30	7	TREA00200	●	●
20	32	7	TREB00200	●	
20	34	7	TRE100200	●	
20	35	7	TREC00200	●	●
20	36	7	TRE200200	●	
20	40	7	TRED00200	●	
20	42	7	TRE300200	●	●
20	47	7	TREE00200	●	●
20	52	7	TRE600200	●	
20	52	8	TREG00200		●
20	55	7	TREF00200	●	●
20	62	7	TRER00200		●
21.4	29.5	4	TRE000214	●	
22	28	4	TRE700220	●	●
22	32	7	TREA00220	●	●
22	35	7	TREB00220	●	●
22	37	7	TRE000220		●
22	40	7	TREC00220	●	●
22	52	7	TRE600220	●	
22	52	10	TREG00220		●
22	62	6	TRE800220	●	
22	62	10	TREE00220	●	
23	32	5	TRE100230	●	●
23	34	5	TRE200230	●	●
24	32	7	TRE000240	●	
24	35	7	TREA00240	●	
24	40	7	TREC00240	●	●
24	47	7	TRED00240	●	●
25	32	6	TRER00250		●
25	35	6	TRE000250	●	
25	35	7	TREA00250	●	●
25	38	8	TREK00250	●	
25	40	5	TREF00250	●	
25	40	7	TREB00250	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
25	40	8	TRE100250	●	
25	42	7	TREC00250	●	
25	44	7	TREQ00250		●
25	47	7	TRED00250	●	●
25	47	10	TRE700250	●	
25	52	7	TREE00250	●	●
25	52	10	TRE900250	●	
25	62	7	TREG00250	●	●
26	37	7	TREA00260	●	
26	52	8	TRE100260	●	
27	37	7	TRE200270	●	
28	38	7	TRE700280		●
28	40	7	TREA00280	●	●
28	45	7	TREE00280		●
28	47	7	TREB00280	●	
28	47	10	TRE400280	●	
29	52	7	TRE100290	●	
30	40	7	TREA00300	●	●
30	42	6	TRE000300	●	
30	42	7	TREB00300	●	●
30	42	8	TRE100300	●	
30	43	8	TRER00300	●	
30	45	8	TRE200300	●	
30	47	7	TREC00300	●	●
30	47	8	TREK00300	●	●
30	50	7	TRE300300	●	●
30	50	8	TREP00300	●	
30	50	10	TRE600300	●	
30	52	7	TRED00300	●	●
30	52	10	TRE700300	●	
30	55	7	TRE800300	●	●
30	55	10	TRE900300	●	
30	62	7	TREE00300	●	●
30	62	10	TREF00300	●	●
30	72	10	TREG00300	●	●
30	80	10	TREI00300	●	
32	42	5	TRE300320	●	
32	42	7	TRE800320		
32	45	7	TREA00320	●	
32	47	7	TREB00320	●	●
32	50	10	TRE100320	●	
32	52	7	TREC00320	●	●

- In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
32	80	7	TREM00320	●	
34	65	8	TRE400340		●
35	42	4	TREX00350		●
35	45	7	TRE000350	●	
35	47	7	TREA00350	●	●
35	47	8	TRES00350	●	
35	50	7	TREB00350	●	
35	50	8	TREW00350	●	
35	50	10	TREL00350	●	
35	52	6	TRE100350	●	
35	52	7	TREC00350	●	●
35	52	10	TRE200350	●	
35	55	8	TREK00350	●	
35	56	10	TRE300350	●	
35	58	10	TREG00350	●	●
35	62	7	TRED00350	●	
35	62	8	TREU00350	●	
35	62	10	TRE400350	●	●
35	62	12	TRE500350		●
35	65	10	TRE600350	●	
35	65	12	TREP00350	●	
35	72	7	TREH00350		●
35	72	8	TREJ00350	●	
35	72	10	TRE700350	●	●
35	72	12	TRE800350	●	●
35	80	12	TRE000350	●	
36	52	6.3	TRE200360	●	
36	54	7	TRE100360	●	
37	62	7	TRE100370		●
37.5	75	8	TRE000375	●	
38	52	7	TREA00380	●	
38	55	8	TRE100380		●
38	62	7	TREC00380	●	●
38	62	10	TRE500380	●	
38	69	9.5	TREH00380	●	
38	72	10	TRED00380	●	●
38	80	8	TREG00380		●
40	52	5	TRE000400	●	
40	52	7	TREA00400	●	●
40	55	6	TRE000400	●	
40	55	7	TREB00400	●	●
40	55	8	TRE100400	●	●
40	56	8	TREG00400	●	●
40	60	10	TRE400400	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
40	62	6	TREMGE003	●	
40	62	7	TREC00400	●	●
40	62	10	TRE600400	●	●
40	62	12	TREJ00400	●	
40	65	8	TREM00400	●	
40	68	7	TRE700400	●	
40	68	8	TREY00400		●
40	68	10	TREW00400		●
40	72	7	TRED00400	●	●
40	72	10	TRE800400	●	
40	80	7	TRE900400	●	
40	80	10	TREF00400	●	●
40	90	12	TREH00400	●	●
40	90	13.5	TRE000400	●	
42	62	7	TRE300420	●	
42	62	10	TRE800420		●
42	72	8	TREC00420	●	
42	72	10	TRE600420	●	●
44	65	10	TRE000440		●
45	52	4	TREX00450	●	
45	55	7	TREL00450	●	
45	60	7	TRE000450	●	●
45	60	8	TREA00450	●	
45	62	7	TRE100450	●	●
45	62	8	TREB00450	●	●
45	65	7	TREU00450		●
45	65	8	TREC00450	●	●
45	65	10	TRE300450	●	●
45	68	10	TRE500450	●	
45	70	10	TRE000450	●	
45	72	8	TRED00450	●	●
45	75	7	TRE800450	●	●
45	75	8	TREI00450	●	●
45	75	10	TRE900450	●	●
45	80	10	TREF00450	●	
45	85	8	TRET00450	●	
45	85	10	TREG00450	●	●
45	90	10	TREH00450	●	●
45	100	8	TREW00450	●	
47	90	10	TRE000470	●	
48	62	8	TREA00480	●	●
48	65	10	TRE000480	●	

- In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
48	68	10	TRE100480	●	
48	70	10	TRE500480		●
48	72	7	TRE200480	●	
48	72	8	TREB00480	●	
48	72	10	TRE700480		●
48	72	12	TRE300480	●	
48	90	13	TRE600480	●	
50	62	7	TRE200500	●	
50	65	8	TREA00500	●	●
50	68	7	TREK00500	●	
50	68	8	TREB00500	●	●
50	68	9	TREG00500		
50	70	10	TRE100500	●	●
50	72	7	TREF00500	●	
50	72	8	TREC00500	●	●
50	72	10	TRE300500	●	●
50	75	10	TRE500500	●	●
50	80	8	TRED00500	●	●
50	80	10	TRE600500	●	
50	90	8	TRE800500	●	●
50	90	10	TRE900500	●	●
50	100	10	TREM00500		●
50	110	10	TREH00500		●
52	62	8	TRE600520		●
52	68	8	TREA00520	●	●
52	72	8	TREB00520	●	●
52	85	10	TRE400520	●	
52	100	10	TRE500520	●	
55	68	8	TRE000550	●	
55	70	8	TREA00550	●	●
55	72	7	TREE00550	●	
55	72	8	TREB00550	●	●
55	72	10	TRE200550	●	●
55	75	8	TRE300550	●	●
55	75	12	TRE500550	●	
55	80	8	TREC00550	●	●
55	80	10	TRE600550	●	●
55	85	10	TRE700550	●	
55	90	5	TRE100550	●	
55	90	8	TREG00550	●	●
55	90	10	TRE800550	●	
55	100	8	TRED00550	●	●
55	100	10	TRE900550	●	
57	80	12	TRE000570		●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
58	80	10	TRE000580	●	●
60	72	8	TREL00600	●	●
60	75	6	TREJ00600	●	
60	75	8	TREA00600	●	●
60	80	6	TREE00600	●	
60	80	8	TREB00600	●	●
60	80	10	TRE100600	●	●
60	82	9	TRE200600	●	
60	85	8	TREC00600	●	●
60	85	10	TRE300600	●	
60	90	8	TRED00600	●	●
60	90	8	TREN00600	●	
60	90	10	TRE400600		●
60	95	8	TREK00600		●
60	95	10	TRE500600	●	
60	100	10	TREM00600	●	●
60	110	8	TRE900600	●	
60	110	10	TRE700600	●	●
60	110	13	TREG00600	●	
62	110	10	TRE100620	●	
62	120	12	TRE200620	●	
64	85	10	TRE100640		●
65	80	8	TRE000650	●	●
65	85	10	TREA00650	●	●
65	85	12	TREG00650	●	
65	85	13	TRE300650		●
65	90	10	TREB00650	●	●
65	100	10	TREC00650	●	●
65	110	10	TRED00650	●	●
65	120	13	TREF00650	●	
68	90	10	TREA00680	●	
68	92	10	TRE400680	●	
68	110	13	TRE100680	●	
70	85	8	TRE000700	●	
70	90	7	TRE800700	●	
70	90	10	TREA00700	●	●
70	100	10	TREB00700	●	●
70	110	8	TRE700700	●	
70	110	13	TRE400700	●	
70	125	12	TRE600700	●	
70	160	12	TREG00700	●	
72	86	7	TRE100720	●	

- In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
72	95	10	TREA00720	●	
72	95	12	TRE000720	●	
72	100	10	TREB00720		●
72	110	13	TRE400720	●	
72	140	12	TRE300720	●	
75	90	8	TRE400750	●	
75	90	10	TREC00750		●
75	95	9	TRE600750	●	
75	95	10	TREA00750	●	●
75	100	10	TREB00750	●	●
75	110	10	TRED00750		●
75	115	10	TRE800750	●	
75	120	12	TRE300750	●	
78	100	10	TREA00780	●	
79	120	13	TRE000790	●	
80	95	8	TREC00800	●	
80	100	7	TRE000800	●	●
80	100	10	TREA00800	●	●
80	100	13	TRE100800	●	●
80	105	13	TRE200800	●	●
80	110	10	TREB00800	●	
80	115	10	TRE300800	●	●
80	120	13	TRE400800	●	
80	140	13	TRE900800	●	
80	140	15	TRE600800	●	
85	105	12	TRE800850		●
85	110	12	TREA00850	●	●
85	110	13	TRE200850		●
85	120	12	TREB00850	●	●
85	130	10	TRE400850	●	
85	130	12	TRE700850	●	●
85	132	12	TRED00850		●
85	140	12	TREG00850		●
85	150	12	TRE600850	●	
90	110	7.5	TRE800900	●	●
90	110	8	TRE600900	●	●
90	110	12	TREA00900	●	●
90	120	12	TREB00900	●	●
90	120	13	TRE200900	●	●
90	125	13	TRE700900	●	●
90	140	12	TRE400900	●	
95	110	12	TREC00950		●
95	115	12	TRE000950	●	
95	120	12	TREA00950	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
95	120	13	TRE200950	●	●
95	125	12	TREB00950	●	●
95	130	13	TRE300950	●	
95	140	12	TRED00950		●
97	112	8	TRE000970	●	
100	120	10	TRE001000	●	
100	120	12	TREA01000	●	●
100	125	12	TREB01000	●	
100	125	13	TRE101000	●	
100	130	12	TREC01000	●	
100	130	13	TRE201000	●	●
100	140	12	TRE701000	●	
100	150	12	TRE501000	●	
100	160	14	TRE301000		●
100	180	12	TRE401000	●	
105	120	7	TRE001050	●	
105	125	13	TRE101050	●	
105	130	12	TREA01050	●	●
105	140	12	TREB01050	●	●
110	130	12	TREA01100	●	
110	140	12	TREB01100	●	●
110	140	13	TRE401100	●	●
110	150	13	TRE601100	●	
110	165	12	TRE001100		●
110	170	14	TRE301100	●	
110	215	15	TRE701100	●	
115	130	12	TRE101150	●	
115	140	12	TREA01150	●	●
115	150	12	TREB01150	●	●
115	160	12	TRE301150		●
117	200	15	TRE001170		●
118	150	12	TRE001180	●	
120	140	7.5	TRE701200	●	
120	140	13	TRE001200	●	●
120	142	12	TRE501200	●	
120	150	12	TREA01200	●	●
120	150	15	TRE201200	●	●
120	160	12	TREB01200	●	
120	160	15	TRE601200	●	
120	180	15	TRE401200	●	●
125	150	12	TREA01250	●	●
125	155	14	TRE301250	●	

- In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
127	158.75	17.46	TRE001270		●
130	150	10	TREF01300		●
130	150	12	TRE301300		●
130	160	7.5	TRE401300	●	
130	160	12	TREA01300	●	●
130	160	15	TRE001300	●	●
130	170	12	TREB01300	●	
132	152	6	TRE101320	●	
135	160	15	TRE001350	●	
135	170	10	TRE301350	●	
135	170	12	TREA01350	●	●
140	160	10	TRE801400	●	
140	160	12	TRE601400		●
140	160	13	TRE001400	●	
140	170	12	TRE201400	●	
140	170	13	TRE901400		●
140	170	15	TREA01400	●	
140	180	12	TRE501400		●
140	210	15	TRE301400	●	
144	160	12	TRE001440	●	
145	175	15	TREA01450	●	●
150	170	10	TRE101500		●
150	170	12	TRE301500		●
150	180	15	TREA01500	●	●
155	174	12	TRE401550		●
155	180	15	TRE001550	●	●
155	190	13	TRE301550		●
160	185	15	TRE601600	●	●
160	190	15	TREA01600	●	●
160	200	15	TRE001600	●	
160	210	15	TRE401600	●	
160	240	14	TRE701600	●	
165	190	8	TRE101650	●	
165	190	13	TRE201650	●	●
166	179	8	TRE001660		●
170	185	9.5	TRE301700		●
170	195	7.5	TRE401700	●	
170	200	15	TREA01700	●	●
174	190	5	TRE001740	●	
175	205	15	TRE001750	●	
178	205	15	TREA01780	●	
180	200	13	TRE101800	●	
180	210	15	TREA01800	●	●
180	215	15	TRE201800	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
180	215	16	TRE501800		●
180	220	16	TRE401800	●	
185	210	13	TRE101850	●	
190	215	15	TRE401900	●	
190	220	12	TRE001900	●	
190	220	15	TREA01900	●	●
195	215	15	TRE201950	●	
200	225	8.5	TRE202000	●	
200	230	15	TREA02000	●	●
210	240	15	TREA02100	●	
220	250	15	TREA02200	●	●
230	260	15	TREA02300	●	
240	270	15	TREA02400	●	○
240	320	20	TRE002400		●
250	280	11	TRE102500	●	
250	280	15	TREA02500	●	●
260	280	16	TRE002600	●	●
260	290	16	TRE102600	●	●
260	300	20	TREA02600	●	●
265	290	15	TRE002650	●	
280	320	20	TREA02800	●	●
300	340	16	TRE103000	●	○
300	340	20	TREA03000	○	○
320	360	20	TREA03200	○	○
350	380	16	TRE003500	●	●
360	400	20	TREA03600	○	○
380	420	20	TREA03800	○	
394	420	16	TRE003940	○	
420	450	12	TRE104200	●	
420	460	20	TREA04200	○	
440	480	20	TREA04800	○	
920	970	20	TRE009200		

● In one of the preferred materials

○ In other commercial materials



■ Type TRC: DIN 3761 Type B

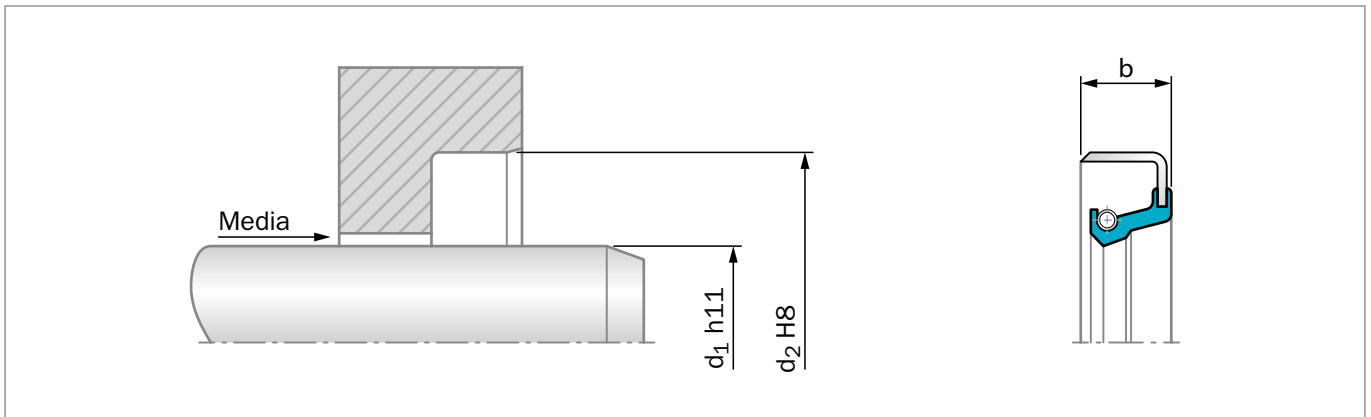


Figure 16: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type TRC are metal-cased radial lip seals. This type is not recommended for use in heavily polluted environments. As the static sealing between housing and metallic shell is limited, low viscosity media can "creep". Better performance can be achieved with an epoxy-based resin O.D. coating. This special treatment is on request.

FEATURES AND BENEFITS

- Good radial stiffness, especially for large diameters
- Good fitting stability, avoiding pop-out of the seal
- Modern lip design provides low radial forces
- Cost effective
- Suitable for use in combination with axial seals (V-Ring and GAMMA Seal)

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Electrical motors
- Machine tools
- Heavy engineering applications

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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

**Table 10: Materials**

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal Insert	Standard Spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4NO11/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRC

TSS Type:	C
Code:	TRC
Dimensions:	Shaft diameter 20 mm Housing diameter 35 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. **TRC** **C** **00200** - **N7MMR**

Code _____

Type _____

Shaft Diameter x 10 _____

Quality Index (Standard) _____

Material Code (Standard) _____

Table 11: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
8	16	7	TRC000080	●	
10	22	7	TRCA00100	●	
11	17	4	TRC000110	●	
12	22	7	TRCA00120	●	
12	24	7	TRCB00120	●	
12	28	7	TRCC00120	●	
20	30	5	TRC100200		●
20	30	7	TRCA00200	●	
20	32	7	TRCB00200	●	●
20	35	7	TRCC00200	●	
20	40	7	TRCD00200	●	
20	42	7	TRC300200	●	●
20	47	7	TRCE00200	●	
24	35	7	TRCA00240	●	
25	47	7	TRCD00250	●	
30	40	7	TRCA00300	●	
30	42	7	TRCB00300	●	
30	62	7	TRCE00300	●	
35	45	7	TRC000350	●	●
35	47	7	TRCA00350	●	
35	56	12	TRC500350	●	
35	62	12	TRC700350	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
38	52	7	TRCA00380	●	●
38	52	9	TRC400380	●	
40	52	7	TRCA00400	●	
42	55	7	TRC000420	●	
45	55	7	TRC000450	●	
45	60	10	TRC200450	●	
45	62	7	TRC300450	●	
45	62	8	TRCB00450	●	
49	65	10	TRC000490	●	
49	68	12	TRC100490	●	
50	62	7	TRC000500	●	
50	65	8	TRCA00500	●	
50	68	8	TRCB00500	●	
50	80	8	TRCD00500	●	
55	70	8	TRCA00550	●	
60	70	7	TRC000600	●	
60	72	8	TRC100600	●	
60	75	8	TRCA00600	●	
65	80	8	TRC000650	●	
68	90	10	TRCA00680		●

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
70	90	10	TRCA00700	●	
70	100	10	TRCB00700	●	
75	95	5	TRC000750	●	
75	100	10	TRCB000750	●	
76	110	13	TRC000760	●	
80	100	10	TRCA00800	●	
80	110	10	TRCB00800	●	
80	115	13	TRC200800	●	
85	100	9	TRC000850	●	
85	105	10	TRC100850	●	
90	110	8	TRC000900	●	
95	110	10	TRC300950	●	
100	115	9	TRC001000	●	
100	120	12	TRCA01000	●	
105	125	12	TRC001050	●	
110	126	9	TRC101100		●
110	130	8	TRC301100		●
120	140	13	TRC001200	●	
130	160	13	TRC001300	●	
140	160	13	TRC101400	●	
170	200	15	TRCA01700	●	
180	200	12	TRC201800	●	
180	215	16	TRC101800	●	
190	215	15	TRC001900	●	
250	280	15	TRCA02500	●	
270	310	16	TRC002700	○	
350	380	16	TRC003500	○	
370	410	15	TRC003700		○
370	410	15	TRC003700	○	
400	440	20	TRCA04000		○
440	480	20	TRCA04400	○	
460	500	20	TRCA04600	○	
460	500	20	TRCA04600		○

● In one of the preferred materials

○ In other commercial materials



■ Type TRD: DIN 3761 Type BS

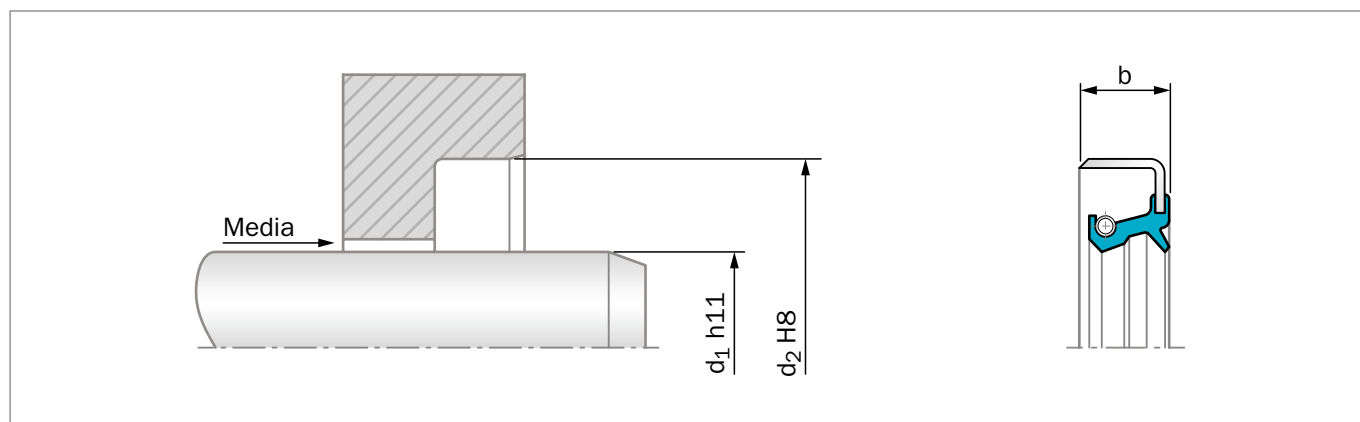


Figure 17: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type TRD are metal-cased radial lip seals. The additional dust lip protects the main sealing lip against dust and other fine solid contaminants and therefore this type is recommended for use in polluted environments. To achieve a long lifetime, a suitable lubricant between the two sealing lips should be applied. As the static sealing between housing and metallic shell is somewhat limited, low viscosity media can "creep". Better performance can be achieved with an epoxy-based resin O.D. coating. This special treatment is on request.

FEATURES AND BENEFITS

- Effective protection against air side contaminants
- Good radial stiffness, especially for large diameters
- Good fitting stability, avoiding pop-out of the seal
- Modern lip design provides low radial forces
- Cost effective

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Electrical motors
- Machine tools
- Heavy engineering applications

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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



Table 12: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal Insert	Standard Spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRD

TSS Type:	D
Code:	TRD
Dimensions:	Shaft diameter 40 mm Housing diameter 52 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No.	TRD	A	00400	-	N7MMR
Code					
Type					
Shaft Diameter x 10					
Quality Index (Standard)					
Material Code (Standard)					

Table 13: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
15	21	4	TRD000150	●	
25	52	7	TRDE00250	●	
35	62	12	TRD100350	●	
38	50	7	TRD000380	●	
40	54	7	TRD500400	●	
40	55	6.5	TRD100400	●	
40	55	7	TRDB00400	●	
40	90	10	TRD200400		●
41.27	57.15	7.93	TRD004127	●	
42	55	7	TRD000420	●	
42	62	7	TRD100420	●	●
45	72	8	TRDD00450	●	
48	68	10	TRD100480	●	
50	65	8	TRDA00500	●	
50	90	10	TRD200500	●	
55	90	10	TRD000550	●	
59	72	12	TRD000590	●	
65	85	12	TRD200650	●	
74	90	10	TRD000740	●	
79	120	13	TRD000790	●	
80	100	13	TRD200800	●	
100	120	12.5	TRD101000	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
120	140	13	TRD001200	●	
155	180	15	TRD001550	●	
240	270	15	TRDA02400	●	
270	310	16	TRD002700	●	
400	440	20	TRDA04000	●	
580	630	22	TRD005800	●	

- In one of the preferred materials
- In other commercial materials



■ Type TRB: DIN 3761 Type C

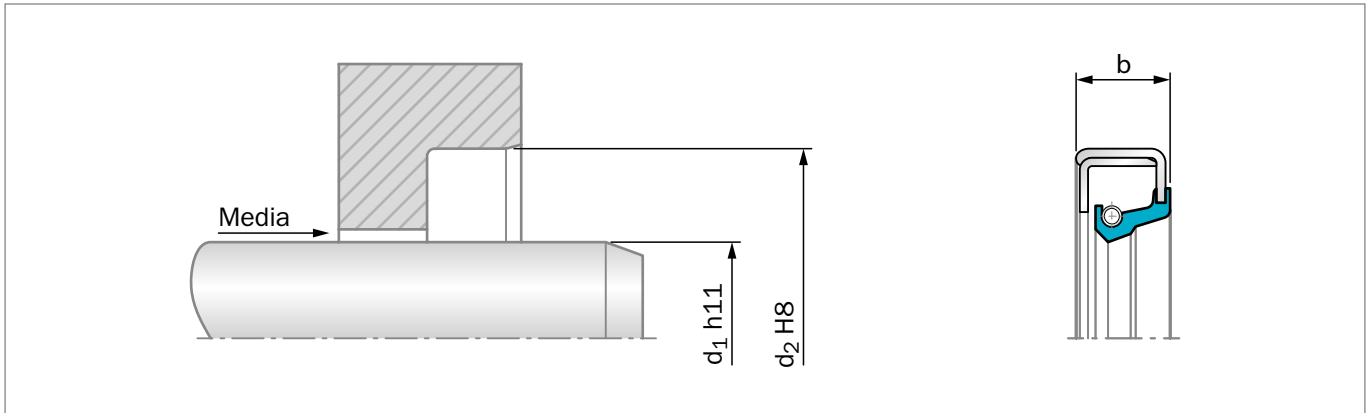


Figure 18: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type TRB are reinforced metal-cased radial lip seals. The supplementary metal inner ring provides superior stiffness. This type is not recommended for use in heavily polluted environments. As the static sealing between housing and metallic shell is limited, low viscosity media can "creep". Better performance can be achieved with an epoxy-based resin O.D. coating. This special treatment is on request.

FEATURES AND BENEFITS

- Superior radial stiffness, especially for very large diameters
- Very good fitting stability, avoiding pop-out of the seal
- Modern lip design provides low radial forces
- Cost effective
- Suitable for use in combination with axial seals (V-Ring and GAMMA Seal)

APPLICATION EXAMPLES

- Electrical motors
- Machine tools
- Heavy engineering applications (e.g. mills in steel industry)

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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


Table 14: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal Insert	Standard Spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRB

TSS Type:	B
Code:	TRB
Dimensions:	Shaft diameter 45 mm Housing diameter 60 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. **TRB 5 00450 - N7MMR**

Code _____
Type _____
Shaft Diameter x 10 _____
Quality Index (Standard) _____
Material Code (Standard) _____

Table 15: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
30	47	9	TRB800300	●	
30	47	10	TRB100300	●	
30	50	10	TRB300300	●	
30	62	10	TRB600300	●	
35	56	10	TRB300350		●
40	60	10	TRB200400	●	
45	60	10	TRB500450	●	
45	65	10	TRB200450	●	
45	72	10	TRB600450	●	
45	72	12	TRB000450	●	
50	72	12	TRB700500	●	○
50	90	10	TRBE00500	●	
50.80 (2.00")	73.10 (2.88")	12.70 (0.50")	TRB000508	●	
60	80	10	TRB000600	●	●
65	90	10	TRBB00650	●	
65.10 (2.56")	92.20 (3.63")	12.70 (0.50")	TRB000651	●	
66.70 (2.63")	88.50 (3.48")	12.70 (0.50")	TRB000667	●	
66.70 (2.63")	92.20 (3.63")	12.70 (0.50")	TRB100667	●	
69.85 (2.75")	90.12 (3.55")	12.70 (0.50")	TRB000698	●	
70	105	13	TRB400700	●	
73.02 (2.87")	95.40 (3.76")	12.70 (0.50")	TRB100730	●	

● In one of the preferred materials

○ In other commercial materials

Values in brackets are inch sizes.



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
75	100	10	TRBB00750	●	
75	100	12	TRB400750	●	○
75	105	13	TRBF00750	○	
75	115	13	TRB300750	●	
76.20 (3.00")	95.40 (3.76")	12.70 (0.50")	TRB000762	●	
76.20 (3.00")	98.60 (3.88")	11.90 (0.47")	TRB100762	●	
76.20 (3.00")	101.80 (4.00")	11.90 (0.47")	TRB200762	●	
80	100	10	TRBA00800	●	
80	100	12	TRB000800	●	●
80	110	12	TRB200800	●	
80	120	13	TRB400800	●	
85	130	13	TRB400850	●	
85.72 (3.37")	108.05 (4.25")	12.70 (0.50")	TRB000857	●	
90	130	13	TRB500900	●	
95	120	12	TRBA00950		●
98.42 (3.87")	120.81 (4.76")	12.70 (0.50")	TRB000984	●	
98.42 (3.87")	127.10 (5.00")	11.91 (0.47")	TRB100984	●	
100	120	12	TRBA01000		○
100	120	13	TRB101000	●	
101.60 (4.00")	127.10 (5.00")	12.70 (0.50")	TRB101016	●	●
114.30 (4.50")	139.85 (5.50")	12.70 (0.50")	TRB001143	●	
125	150	15	TRB301250	●	
127.00 (5.00")	158.90 (6.25")	12.70 (0.50")	TRB001270	●	
130	160	15	TRB401300	○	
130	180	15	TRB301300	●	
140	160	13	TRB001400	●	
140	190	15	TRB301400	●	
145	165	13	TRB001450	●	
145	170	13	TRB101450	●	
145	180	15	TRB301450	●	
148	170	15	TRB001480	●	
150	180	15	TRBA01500		○
160	180	15	TRB001600	●	
160	190	13	TRB001600	●	●
165.10 (6.50")	193.88 (7.63")	15.75 (0.62")	TRB001651	●	
174.60 (6.87")	200.23 (7.88")	15.90 (0.63")	TRB001746	●	
180	210	15	TRBA01800	●	
180	220	16	TRB001800	●	
190	220	15	TRBA01900	○	
210	240	15	TRBA02100		○
220	250	15	TRB002200	●	
230	260	15	TRBA02300	○	
240	270	15	TRBA02400	●	●

● In one of the preferred materials

○ In other commercial materials

Values in brackets are inch sizes.



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
250	280	15	TRBA02500	●	
260	290	16	TRB002600	○	●
270	310	16	TRB102700		○
280	310	16	TRB002800	○	
280	320	20	TRBA02800	○	
290	330	18	TRB202900	○	
300	332	16	TRB003000	●	
300	340	20	TRBA03000	○	○
310	350	18	TRB003100	●	
320	360	18	TRB103200	●	
325	365	16	TRBA03250	●	
330	370	18	TRB003300	○	
340	372	16	TRB003400	○	
340	380	20	TRBA03400	●	●
360	400	18	TRB003600	●	
360	400	20	TRBA03600		●
374.65 (14.75")	419.00 (16.50")	22.20 (0.87")	TRB003746	●	
380	420	20	TRBA03800	●	
390	430	18	TRB003900	○	○
400	440	20	TRBA04000	○	○
440	470	20	TRB004400	○	
460	500	20	TRBA04600	●	
467	510	20	TRB004670	●	
490	530	20	TRB004900	○	
500	540	20	TRBA05000	○	
500	540	20	TRBA05000		○
500	550	22	TRB005000	○	
530	570	20	TRB005300	○	
560	610	20	TRB005600		○
560	610	20	TRB005600	○	
580	620	20	TRB105800	○	
600	640	20	TRB006000	○	○
600	640	20	TRB006000	○	
620	660	20	TRB006200	○	
650	690	25	TRB206500	○	
700	750	25	TRB007000	○	
700	764	25	TRB107000	○	
720	780	25	TRB207200		○
740	780	20	TRB107400		○
760	800	20	TRB107600		○
960	1,000	20	TRB009600	○	
1,120	1,170	20	TRB011200		○
1,120	1,170	20	TRB011200		○

● In one of the preferred materials

○ In other commercial materials

Values in brackets are inch sizes.



■ Type TRF: DIN 3761 Type CS

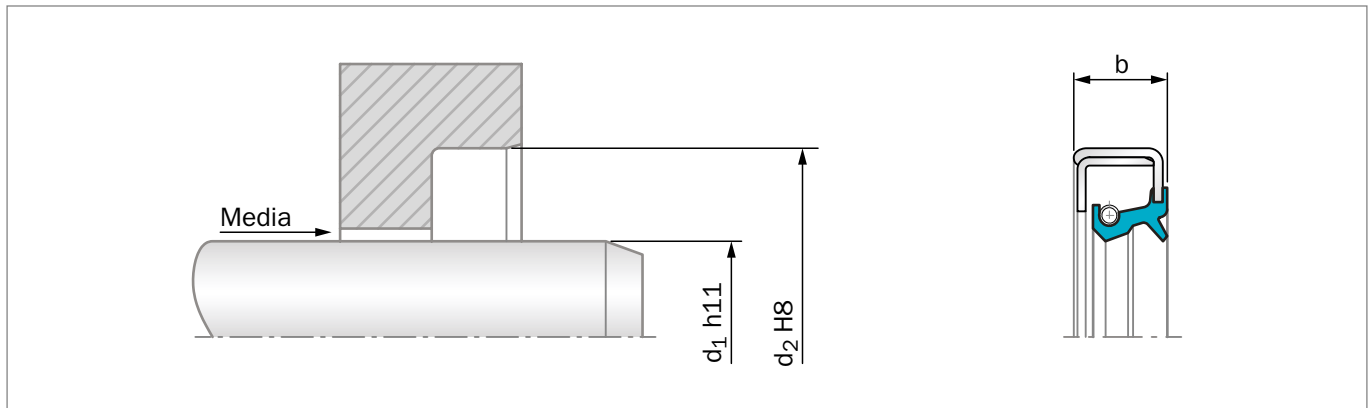


Figure 19: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type TRF are reinforced metal-cased radial lip seals with dust lip. The supplementary metal inner ring provides superior stiffness. This type is recommended for use in heavily polluted environments. To achieve a long lifetime, a suitable lubricant between the two sealing lips should be applied. As the static sealing between housing and metallic shell is limited, low viscosity media can "creep". Better performance can be achieved with an epoxy-based resin O.D. coating. This special treatment is on request.

FEATURES AND BENEFITS

- Superior radial stiffness, especially for very large diameters
- Very good fitting stability, avoiding pop-out of the seal
- Modern lip design provides low radial forces
- Cost effective
- Suitable for use in combination with axial seals (V-Ring and GAMMA Seal)

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Electrical motors
- Machine tools
- Heavy engineering applications (e.g. mills in steel industry)

OPERATING CONDITIONS

Pressure:	Up to 0.05 MPa
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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


Table 16: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal insert	Standard spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRF

TSS Type:	F
Code:	TRF
Dimensions:	Shaft diameter 110 mm Housing diameter 140 mm Width 13 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. **TRF** **0** **01100** - **N7MMR**

Code _____

Type _____

Shaft Diameter x 10 _____

Quality Index (Standard) _____

Material Code (Standard) _____

Table 17: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
35	52	9	TRF000350	●	
40	55	9	TRF000400	●	
41	53	7	TRF000410	●	
50	65	10	TRF300500	●	
50	80	10	TRF100500	●	
60	80	8	TRFB00600	●	
90	130	13	TRF100900	●	
100	130	13	TRF101000		○
105	140	13	TRF001050		●
110	140	13	TRF001100	●	●
115	140	11	TRF001150	●	
120	140	13	TRF001200		●
125	150	12	TRFA01250		●
130	155	10	TRF001300	●	
130	170	15	TRF101300	●	
132	160	13	TRF001320	●	
140	170	15	TRFA01400	●	
148	170	14.5	TRF101480	●	●
148	170	15	TRF001480	●	
150	180	15	TRFA01500	●	
170	200	15	TRFA01700	●	
200	225	15	TRF102000	○	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
240	270	15	TRFA02400	○	●
240	280	16	TRF002400	●	
265	290	16	TRF002650		○
275	310	16	TRF102750		○
380	420	20	TRF003800	●	●
467	510	20	TRF004670	○	
920	970	20	TRF009200		○

● In one of the preferred materials
○ In other commercial materials



■ Non-standard Stefa® Radial Oil Seals

When standard seals in accordance with DIN 3760/3761 (Figure 13) can not fulfill the technical requirements of the application, special seals are required.

Special seals are used for high speed, medium or high pressure or heavy-duty applications, for example.

If using a non-standard or special seal design, media compatibility with the compound must be verified. See Page 48 for general information or contact your local Customer Solution Center for guidance and support.

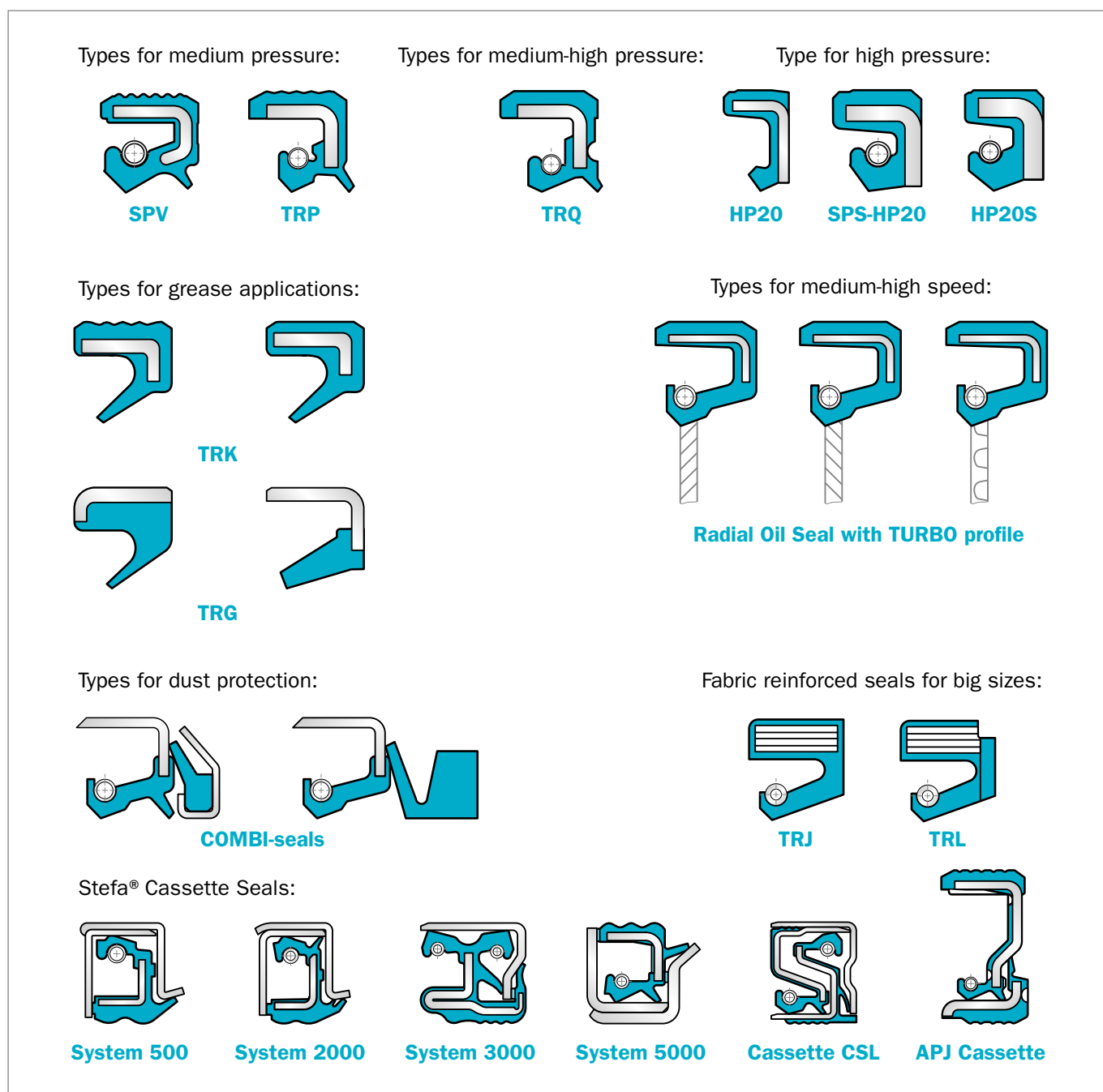


Figure 20: Selection of special radial seals



■ Type SPV – Medium Pressure Oil Seal

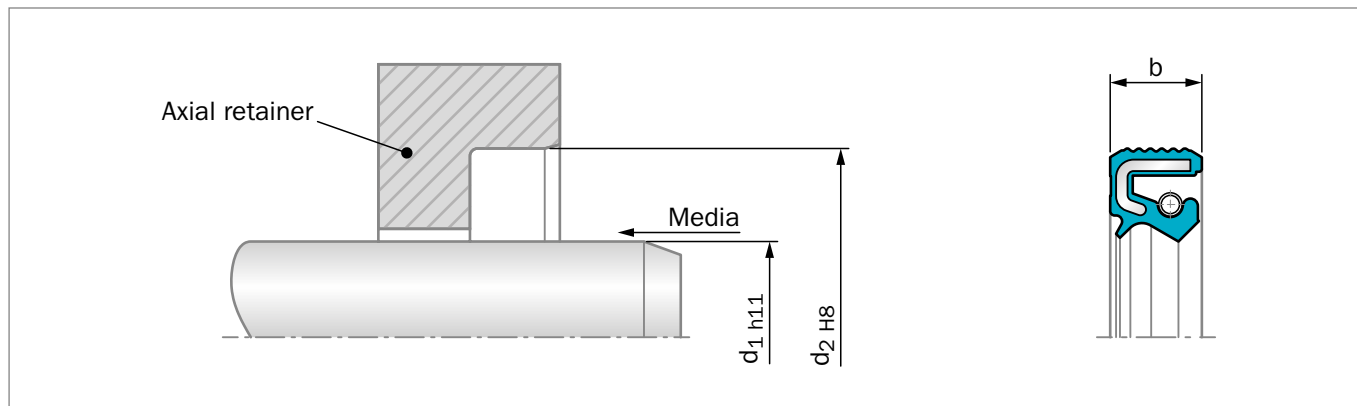


Figure 21: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Type SPV is a seal with a completely rubber-covered outer diameter. This type of seal is designed with an extended metallic support of the diaphragm that allows pressures up to 0.5 MPa. In order to avoid "pop-out" of the seal, we suggest fitting an axial retainer (e.g. circlip, shoulder, etc.). The additional dust lip protects the main sealing lip against dust and other fine solid contaminants and therefore this type is recommended for use in polluted environments. To achieve a long lifetime, a suitable lubricant between the two sealing lips should be applied.

FEATURES AND BENEFITS

- Good static sealing
- Compensation of different thermal expansions
- Reduced risk of fretting corrosion
- Up to 0.5 MPa pressure at moderate peripheral speeds
- Effective protection against air side contaminants
- No need for Back-up Ring

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Hydraulic motors
- Machinery industry

OPERATING CONDITIONS

Pressure:	Up to 1 MPa
Temperature:	-40 °C to +100 °C (depending on material)
Speed:	Up to 17 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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



■ Type TRP – Medium Pressure Oil Seal

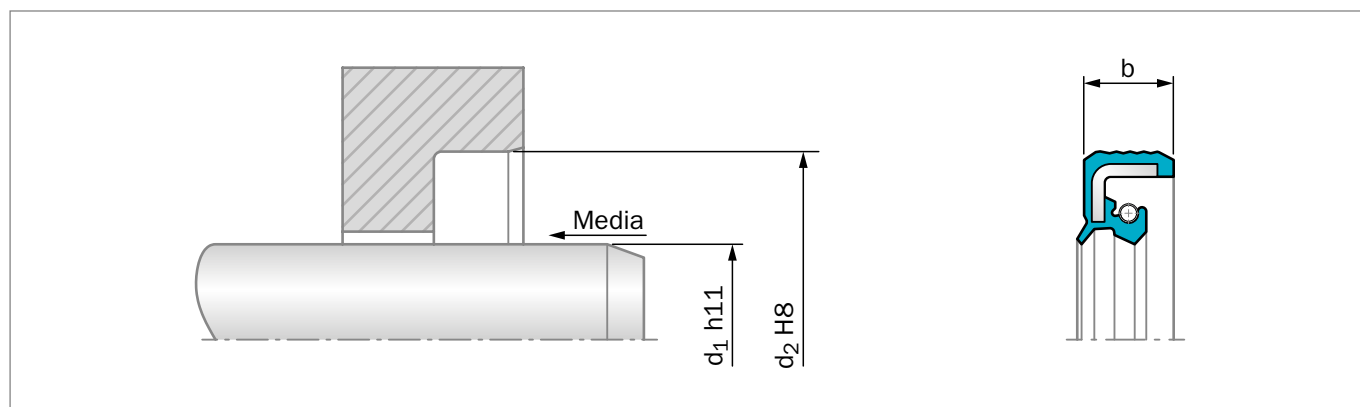


Figure 22: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions type TRP are seals with a completely rubber-covered outer diameter. This type of seal is designed for pressures up to 0.5 MPa. In order to avoid "pop-out" of the seal, we suggest to fit an axial retainer (e.g. circlip, shoulder, etc.) The additional dust lip protects the main sealing lip against dust and other fine solid contaminants and therefore this type is recommended for use in polluted environments. To achieve a long lifetime, a suitable lubricant between the two sealing lips should be applied. The OD can be provided flat or waved.

FEATURES AND BENEFITS

- Good static sealing
- Compensation of different thermal expansions
- Reduced risk of fretting corrosion
- Up to 0.5 MPa pressure at moderate peripheral speeds
- Low lip and shaft wear at low pressure
- Effective protection against air side contaminants
- No need for Back-up Ring

APPLICATION EXAMPLES

- Transmission systems (e.g. gearboxes)
- Pumps
- Hydraulic motors
- Machinery industry

OPERATING CONDITIONS

Pressure:	Up to 0.5 MPa
Temperature:	-40 °C to +100 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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


Table 18: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal insert	Standard spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR/VCM02	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V022	FKM (75 Shore A)	-20 °C - 200 °C	Stainless steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.

Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRP

TSS Type:	P
Code:	TRP
Dimensions:	Shaft diameter 50 mm Housing diameter 72 mm Width 7 mm
Material:	NBR
Material Code:	N7MMR

TSS Article No. **TRP 0 00500 - N7MMR**

Code _____
Type _____
Shaft Diameter x 10 _____
Quality Index (Standard) _____
Material Code (Standard) _____



Table 19: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
8	22	6	TRP000080	●	
10	22	7	TRP000100	●	
10	27	7	TRP100100		●
11	19	6	TRP000110	●	
12	22	6	TRP000120	●	●
13	22	5	TRP000130		●
16	26	7	TRP000160	●	
17	30	7/7.9	TRP000170		●
18	30	7	TRP000180		●
18	35	7	TRPC00180		●
19	27	5	TRP000190	●	
19	32	5	TRP200190	●	
19.5	30	6	TRP000195	●	●
21.5	30	6	TRP000215	●	●
21.5	33	6	TRP100215		●
20	35	6	TRP100200		●
20	40	7	TRP000200		●
22	32	6	TRP100220		●
22	35	6	TRP200220	●	
22	40	6	TRP000220		●
25	35	6	TRP100250	●	●
25	40	7	TRP000250	●	●
28	40	6	TRP000280		●
28	40	9	TRP100280	●	
30	42	6	TRP000300	●	
33	45	5	TRP000330	●	●
35	47	6	TRP100350	●	
35	52	6	TRPON0350	●	●
35	52	7	TRP000350	●	
36	48	5.5	TRP000360	●	
40	55	7	TRPB00400	●	●
40	62	6	TRP100400	●	●
40	67	7	TRP000400		●
45	62	7	TRP000450	●	
50	72	7	TRP000500	●	●
55	70	7	TRP000550	●	●
60	80	7	TRP000600	●	●
70	90	7	TRP000700	●	●
80	100	7/8	TRP000800	●	●
85	105	7.5	TRP000850	●	
85	110	8	TRP100850		●
90	110	7.5	TRP000900		●
95	120	12	TRP000950	●	
100	120	7.5	TRP001000		●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
105	130	7.5	TRP101050		●
120	140	7	TRP001200		●
124	139	8	TRP001240		●
130	150	8	TRP001300		●
190	220	12	TRP001900	●	

● In one of the preferred materials
 ○ In other commercial materials

**Table 20: Materials**

TSS Material Code	Standard Material*	Standard Metal Insert**	Standard Spring**
4N011	NBR (75 Shore A)	Carbon steel	Carbon steel
4V012	FKM (75 Shore A)	Carbon steel	Stainless steel

* Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.

** Metal insert and spring can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRQ

Stefa® Type:	12CC
Code:	TRQ_D
Dimensions:	Shaft diameter 24 mm Housing diameter 40 mm Width 6 mm
Material:	NBR 1452
Material Code:	4N011

TSS Article No. **TRQ0D 0240 - 4N011**

Type _____
 Shaft Diameter x 10 _____
 Quality Index (Standard) _____
 Material Code (Standard) _____

Table 21: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
24	40	6	TRQ0D0240	●	
25	35	6	TRQ0D0250		●
27	44	7	TRQ0D0270	●	●
32	47	6	TRQ0D0320		●
35	47	6	TRQ0D0350		●
40	55	7	TRQBD0400		●
40	62	5.5	TRQ0D0400	●	
40	62	6	TRQ1D0400	●	
50	72	6.5	TRQ1D0500	●	
50	72	7	TRQ0D0500		●
60	80	7	TRQ0D0600		●
60	80	6.5	TRQ1D0600	●	
60	80	8	TRQ2D0600	●	
70	90	7	TRQ0D0700		●
130	160	11	TRQ0D1300	●	●

● In one of the preferred materials

○ In other commercial materials



■ Types HP20, HP20S and SPS-HP20: High Pressure Stefa® Radial Oil Seal

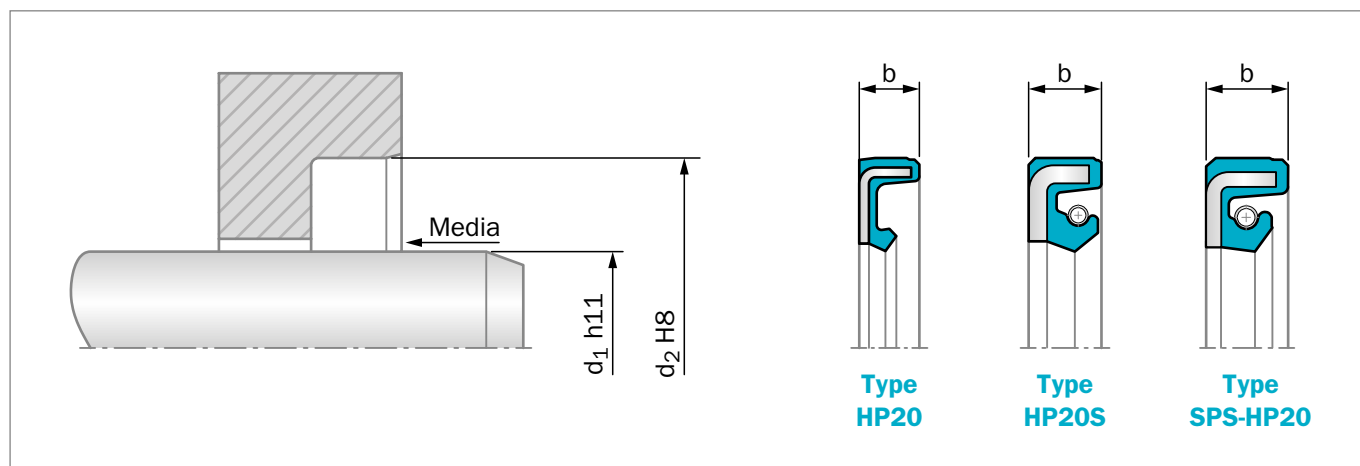


Figure 24: Installation Drawing

GENERAL DESCRIPTION

High Pressure Stefa® Radial Oil Seals are a family of products to optimize rotary sealing performance and extend service life at high pressures.

HP20 is a patented, state-of-the-art Stefa® Radial Oil Seal that provides the optimal solution for hydraulic devices with rotating shafts at working pressures from 5 up to 20 MPa.

Two additional design variations, SPS-HP20 and HP20S, have been developed from the HP20 design to meet specific working requirements.

FEATURES AND BENEFITS

- Effective rotary sealing at pressures up to 20 MPa depending on design variant
- Improved service life by enhancing heat dissipation through metal-to-metal contact
- Specialized designs to meet specific application requirements, such as pressure, speed and side-loading
- Proprietary material options to withstand high pressure hydraulic oils

APPLICATION EXAMPLES

- Hydraulic drive motors
- Material handling
- Forestry and agricultural machinery
- Construction and mining machinery
- Presses and winches

OPERATING CONDITIONS

Pressure:	Up to 20 MPa (depending on design)
Temperature:	-40 °C to +100 °C (depending on material)
Speed:	Up to 5 m/s (depending on design)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

IMPORTANT NOTE

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



SPECIAL DESIGN FEATURES

High Pressure Stefa® Radial Oil Seals are characterized by tailored lip designs, proprietary compounds and fine-tuned manufacturing methods to make seals that better prevent lip extrusion and oil leakage at high pressures. Heat dissipation is also improved through contact between the metal retainer and the housing plate, extending service life.

HP20

A patented sealing lip geometry that self-balances when strong pressure is applied, from 5 up to a maximum pressure of 20 MPa.

HP20S

An energizing spring and special pads engraved under the lip allow the seal to perform at higher shaft speeds than a standard HP20, up to a maximum pressure of 15 MPa.

SPS-HP20

A more flexible lip geometry with an energizing spring lets the seal work effectively when side load is applied to the shaft.

HYDRAULIC OIL COMPATIBILITY

High Pressure Stefa® Radial Oil Seals comprise a metal retainer and an elastomeric sealing lip, with an optional energizing spring. The lip is made from proprietary elastomers that have been specifically developed for working in high pressure hydraulic oils.

Standard available grades are Hydrogenated Nitrile Butadiene Rubber (HNBR), Low Temperature Hydrogenated Nitrile Butadiene Rubber (LT-HNBR) and Fluoroelastomer (FKM). Other special elastomer compounds can be used according to customer specifications.

The HNBR version operates with mineral oils in accordance with ISO VG46. Contact your local Customer Solution Center for more information on chemical compatibility.

FKM versions are also applicable with bio-degradable hydraulic oils (compatibility testing is recommended).

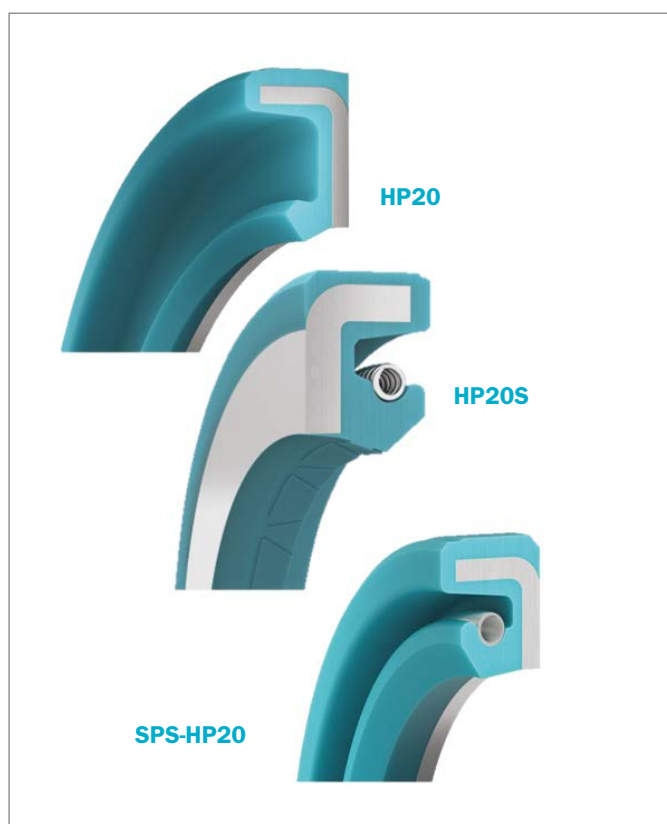


Figure 25: High Pressure Stefa® Radial Oil Seals



WORKING CONDITIONS

Speed and pressure

The main factors affecting the performance of High Pressure Rotary Oil Seals are the combination of pressure and speed, and the type, temperature and flow amount of the oil.

The rated pressure versus shaft speed working conditions are given in Figure 26.

Several tests have been performed to define this curve using hydraulic mineral oil ISO VG46 at +60 °C, an oil flow above two liters per minute, and a Shaft-to-Bore Misalignment (STBM) eccentricity below 0.1 mm.

The real performance of High Pressure Rotary Oil Seals in the field is affected by other parameters that are not possible to reproduce in the laboratory, such as shaft acceleration, thermal conductivity of the shaft and bore, oil contamination, system vibration and pressure transients in the oil. Trelleborg Sealing Solutions recommends customer testing in normal and worst-case scenarios to validate sealing functionality.

Contact your local Customer Solution Center for assistance with evaluating special working conditions and specifying the optimum configuration of High Pressure Rotary Oil Seals in terms of compound, metal retainer and sealing lip shape.

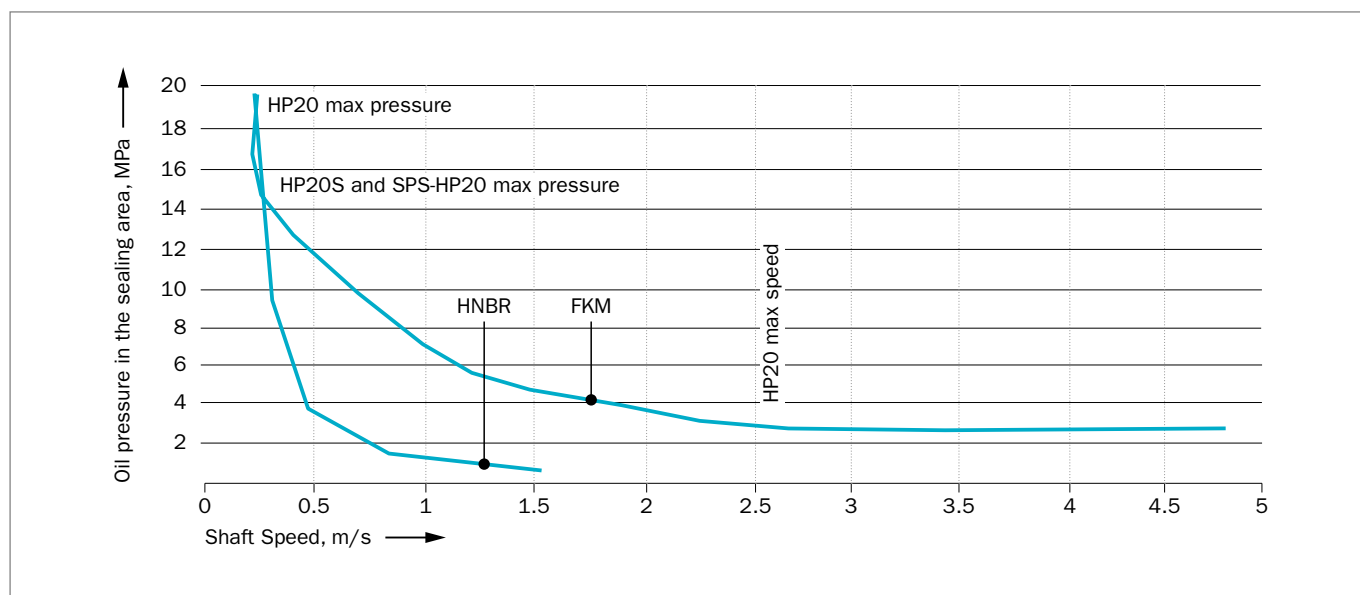


Figure 26: High Pressure Rotary Oil Seals rated working conditions for HNBR and FKM materials

Eccentricity

To work properly, High Pressure Stefa® Radial Oil Seals require the STBM value to be kept below the threshold given in Figure 27.

The STBM value depends on tolerances given during the motor design, by proper machining and installation, and by adoption of bearings capable of supporting axial loads on the shaft without wear.

The SPS-HP20 design uses an energizing spring and more flexible sealing lip to be able to work with a higher STBM than HP20 and HP20S designs.

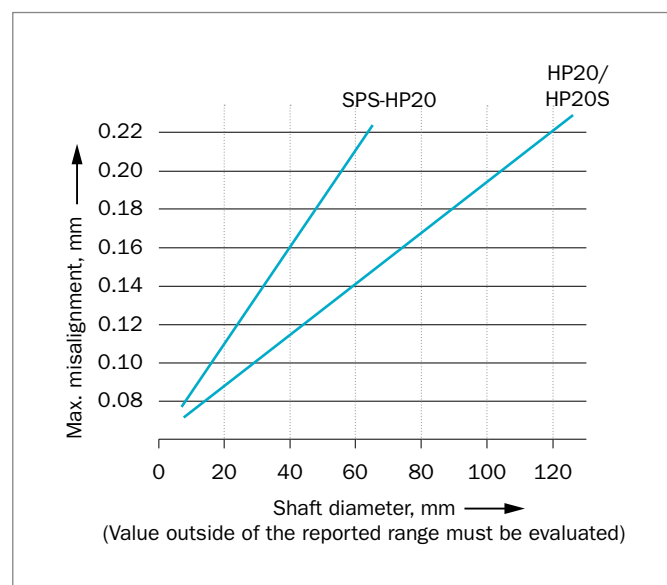


Figure 27: Maximum Shaft-to-Bore Misalignment (STBM) Values



HOUSING AND SHAFT DESIGN

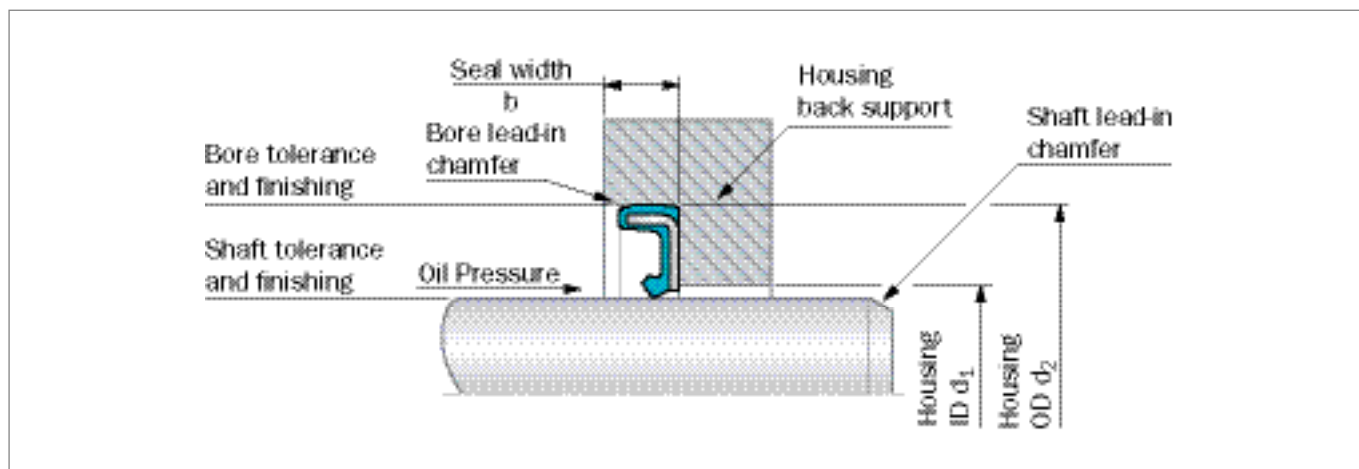


Figure 28: Installation drawing

Shaft materials

High Pressure Stefa® Radial Oil Seals are for use with shafts manufactured from mild steel or stainless steel.

Shaft hardness

Required hardness is Rockwell-C 55; recommended 60 HRC.

Shaft finish

Required roughness is between 0.2 and 0.5 micrometers R_a with no machine lead. The most accepted method of obtaining this finish is plunge grinding.

Shaft geometry

High Pressure Rotary Oil Seals are designed to work with shaft tolerance h11. The shaft chamfer must be aligned with the values given in Table 22 and sharp edges radiused to avoid damaging sealing lips during installation. The shaft surfaces over which the seal lip slides during installation should be kept smooth and free from any burrs or rough patches.

Housing materials

High Pressure Rotary Oil Seals benefit from being installed in a highly thermally conductive material housing.

Bore finishing

A finish of 2.5 micrometers R_a or better is recommended.

Bore geometry

- Bore tolerance is H8.
- Bore lead-in chamfer must be in accordance with Table 23.
- Housing must have back-support to retain pressure force and dissipate heat from the back face of the seal. The back support must have the same ID as the metal retainer.

Shaft to bore misalignment

- The maximum assembly and working misalignment must be in accordance with Figure 27.

Table 22: Shaft Lead-in Chamfers

Ø Shaft mm	Shaft Chamfer Length mm	Shaft Chamfer Angle deg
16 - 30	2.00 (±0.10)	20°
30 - 40	2.20 (±0.10)	20°
40 - 50	2.50 (±0.10)	20°
50 - 70	3.20 (±0.10)	20°
70 - 120	4.50 (±0.12)	20°

Table 23: Bore Lead-in Chamfers

Ø Shaft mm	Seal Width mm	Bore Chamfer Length mm	Bore Chamfer Angle deg
16 - 30	4.2 - 5.5 (±0.20)	1.00	15°
30 - 40	4.5 - 6.5 (±0.20)	1.20	15°
40 - 50	5.5 - 7.0 (±0.20)	1.30	15°
50 - 70	6.0 - 7.5 (±0.25)	1.50	15°
70 - 120	7.5 - 9.5 (±0.30)	1.70	15°



INSTALLATION

High Pressure Rotary Oil Seals are usually first assembled on to the metal housing. The shaft is then fitted inside the seal from the air or oil side, depending on device and bearing positioning.

During the assembly operation, apply a good layer of grease to both the sealing lip and shaft to:

- Provide smooth sliding of the lip on the shaft during assembly.
- Provide pre-lubrication during the first turns of the shaft.

LS-EP2 grease is recommended for this operation.

The cover and the shaft must be aligned with a pre-centering system to avoid stress on the sealing lip. While fitting the shaft inside the seal, gently rotate the shaft to reduce assembly tension created during the installation process.

Never install a seal over splines or keyways without using a special installation tool that protects the seal lip from contact with sharp edges.

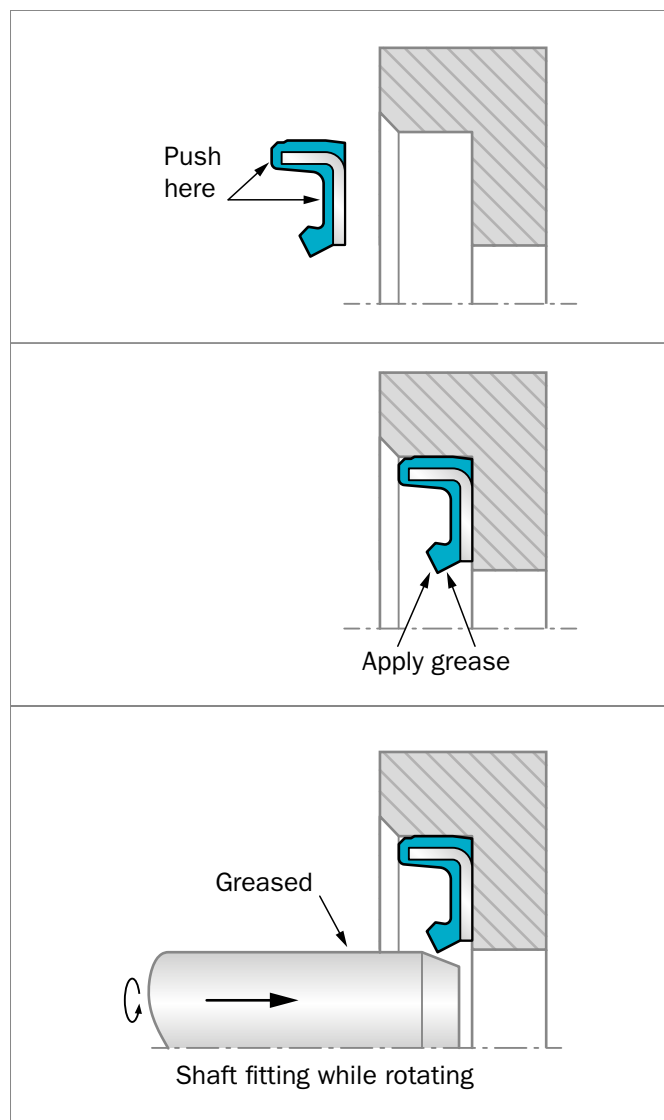


Figure 29: Installation instructions



Table 24: Materials

TSS Compound	Rated hydraulic oil viscosity	Minimum working environment temperature	Maximum working oil temperature	Chemical compatibility with hydraulic oils
HNBR	46 cSt	-30 °C	+100 °C	Mineral oils
LT-HNBR	46 cSt	-40 °C	+100 °C	Mineral oils
FKM	46 cSt	-20 °C	+140 °C	Mineral oils, synthetic oils, bio-degradable oils

Table 25: Standard Installation Dimensions / TSS Part Number for HP20 design

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		HNBR	FKM
16.9	28	5.35	TRTOA0169	●	●
27	37.3	4.10	TRTOA0270	●	
28.56	38	4.72	TRT1A0286	●	●
28.56	42	4.72	TRTOA0286	●	●
31.75	41.28	5.00	TRTOA0318		●
33.3	46	4.20	TRTOA0333	●	
35	48	4.72	TRTOA0350	●	●
38.1	50	4.29	TRTOA0381	●	●

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		HNBR	FKM
45	65	4.45	TRTOA0450	●	●
50	70	5.08	TRTOA0500	●	●
60	80	5.97	TRTOA0600	●	●
72	95	7.00	TRTOA0720	●	

Please contact your local Customer Solution Center for sizes and materials not listed above.

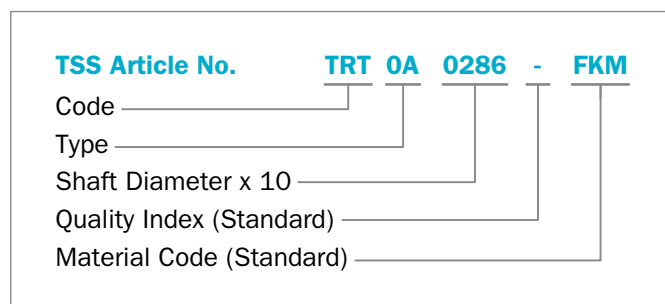
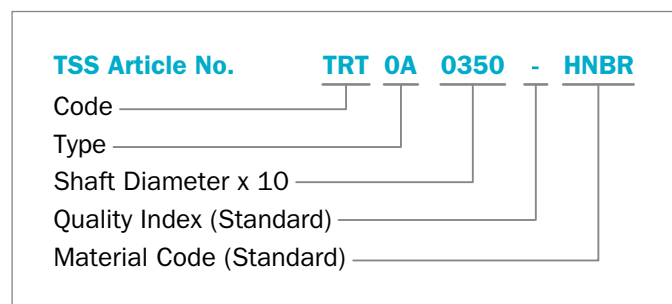
ORDERING EXAMPLE FOR A HP20 DESIGN

High Pressure Stefa® Radial Oil Seal, type HP20

TSS Type:	T
Design Code:	TRT
Design Type HP20:	OA
Dimensions:	Shaft diameter 35 mm Housing 48 mm Diameter width 4.72 mm
Size Code:	TRTOA0350
Elastomer:	HNBR

High Pressure Stefa® Radial Oil Seal, type HP20

TSS Type:	T
Design Code:	TRT
Design Type HP20:	OA
Dimensions:	Shaft diameter 28.56 mm Housing 42 mm Diameter width 4.72 mm
Size Code:	TRTOA0286
Elastomer:	FKM



Please contact your local Customer Solution Center for SPS-HP20 and HP20S designs.



■ HiSpin® HS40

GENERAL DESCRIPTION

HiSpin® HS40 offers e-Mobility and high speed electric motor manufacturers a long life and energy saving bi-directional rotary seal. It consists of a flexible lip made from proprietary, high-performance XLT fluoroelastomer material and supported by a metal core to provide cost-effective performance and reliability. A compact footprint reduces the amount of installation space required and its back-pumping feature further reduces friction and improves sealing performance.

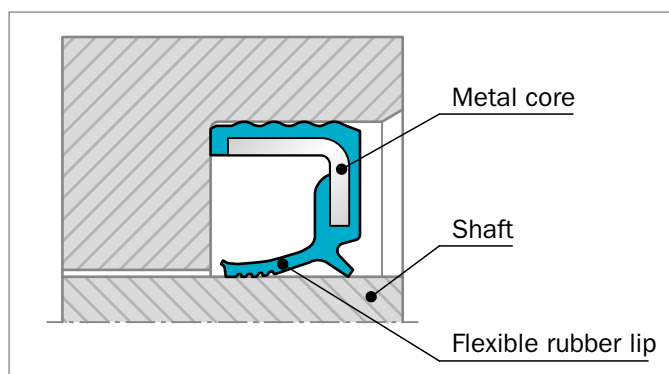


Figure 30: HiSpin® HS40

METHOD OF OPERATION

Developers are continuously improving the effectiveness of the electric drive unit – a combined electric motor and gearbox in a shared housing.

The drive unit is the main cost-driver of future electric vehicle development and offers new challenges for automotive manufacturers. While the gearbox requires efficient lubrication, it is essential that the motor remains dry. Therefore, a highly reliable seal is required between the two parts.

Providing outstanding low friction capabilities, HiSpin® HS40 meets the demanding conditions of automotive high-speed electric motors. A unique hydrodynamic feature helps reduce frictional torque, while oil back-pumping leads to improved sealing performance without causing any shaft damage.

Our proprietary XLT high-performance fluoroelastomer (FKM) range provides outstanding resistance to extreme engine conditions resulting from high motor speeds and aggressive synthetic ATF fluids. Testing of the new generation XLT compounds has proven that these low temperature FKM grades outperform and extend the temperature performance capability of traditional FKM elastomers.

FEATURES AND BENEFITS

- High speed operation (up to 40 m/s)
- Bi-directional sealing capability
- Compact design to reduce assembly space
- Wide temperature range, from -45 °C to +200 °C
- Can handle run-out of up to 0.1 mm
- Excellent sealing performance in different lubricated environments
- Adds value with low frictional torque
- Reduces heat development
- Proven compatibility with various e-Mobility transmission fluids
- Negligible shaft wear
- Easy installation
- Cost-effective
- Available in different outer diameter configurations, e.g. partially rubber covered and grooves on the outer diameter
- Available in other materials, such as ACM
- Provide in accordance with IATF 16949

APPLICATION EXAMPLES

HiSpin® HS40 provides optimal sealing in:

- Electric drive units for e-Mobility applications
- High speed electric drive units
- Automotive transmissions
- Servo-motors
- Pumps

OPERATING CONDITIONS

Seal performance is influenced by factors such as lubrication capability of the sealed media and heat dissipation in the hardware. It follows that testing should always be performed. With good lubrication, the following values can be assumed as a guideline:

Pressure:	0.5 bar
Temperature:	-45 °C to +200 °C
Speed:	Up to 40 m/s
PV:	dependent upon design and application
Acceleration:	dependent upon design and application
Media:	Commonly specified fluids for e-Mobility & transmission applications



MATING SURFACE MATERIALS

Sealing of applications with rotating movements requires very good mating surfaces. A minimum hardness of 55 HRC to a hardening depth of at least 0.5 mm is recommended.

Ra:	0.1 - 0.2 µm
Rz:	1.0 µm
Bearing ratio (Tp (Mr)):	(50 - 70% @ depth of p = 0.25 Rz (Rtm); relative to a ref. line c: 5% tp)
Mating surface hardness:	min. 55 HRC

IMPORTANT NOTE

Housing design and correct installation are important for the performance of the HiSpin® HS40. Information on shaft and housing design with installation guides are available from your local Customer Solution Center.

AGING AND TORQUE

To prove the performance and longevity of HiSpin® HS40, testing using real-world speeds and media likely to be encountered during operation has been undertaken. Test conditions are given in Table 26 and the running profile is shown in Figure 31.

Table 26: Test Conditions for HiSpin® HS40

Shaft diameter:	Ø 38 mm
Shaft speed:	21,000 rpm
Temperatures:	up to +150° C
Media:	ATF Fluid
Test cycle:	Load cycle according to Figure 31 and ISO 6194
Test duration:	500 hours

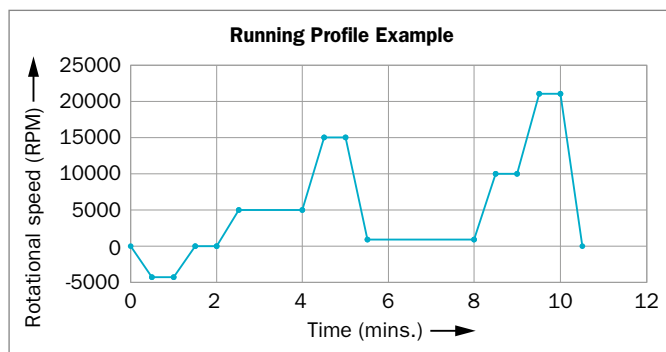


Figure 31: Example running profile showing varying rotational speeds throughout testing

Testing demonstrated noticeably lower volume change in Mobil LV ATF HP media than other commonly used materials (Figure 32). Similarly, when compared with standard Stefa® Radial Oil Seals, HiSpin® HS40 generates significantly less torque, even at high rotational speeds (Figure 33).

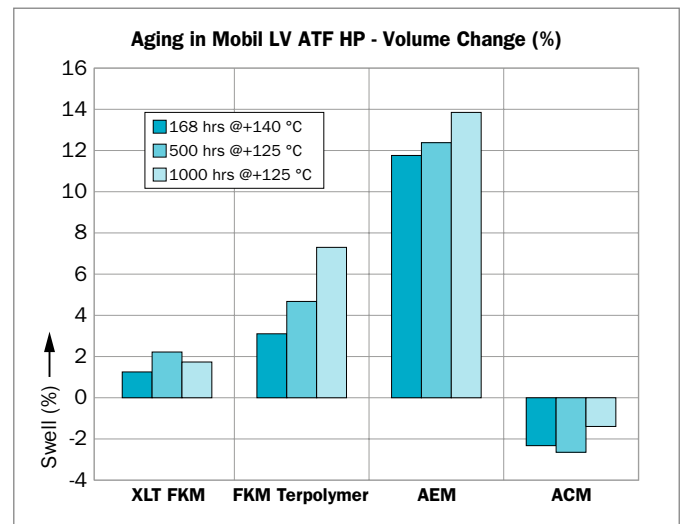


Figure 32: Volume Change (%) for HiSpin® HS40 in Mobil LV ATF HP

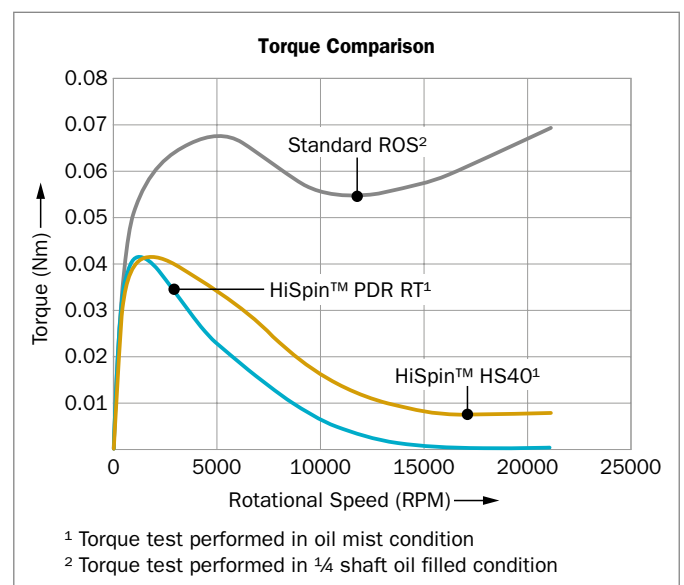


Figure 33: Torque comparison for HiSpin® products versus standard Stefa® Radial Oil Seals.

ORDERING INFORMATION

Due to the design requirements of this product, contact your local Customer Solution Center to place an order or for further information.



EXEMPLARY DIMENSIONS FOR HS40

Shaft X Bore X Width

50 X 60 X 8

35 X 47 X 7

28 X 47 X 7

30 X 45 X 8

38 X 52 X 7

AVAILABLE IN STANDARD COMPOUNDS

4V01

4H01

For more information on available dimensions, please contact your local Customer Solution Center.



■ Type TRK – Medium Grease

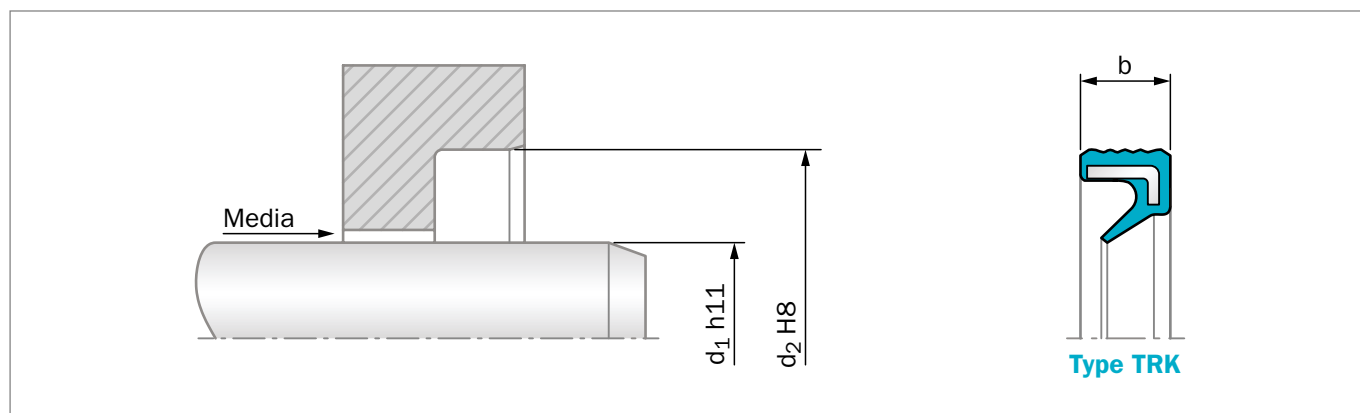


Figure 34: Installation Drawing

GENERAL DESCRIPTION

The Trelleborg Sealing Solutions Type TRK are specially designed Stefa® Radial Oil Seals reinforced with a metal insert, but without a spring-energized sealing lip, and a wavy rubber covered outer diameter. A flat rubber-covered outer diameter is available on request. These types are not recommended for use in heavily polluted environments.

FEATURES AND BENEFITS

- Good static sealing and thermal expansion compensation
- Low friction and heat generation
- Extremely compact design
- Low radial force provides low break-out torque
- Suitable for scraper applications

APPLICATION EXAMPLES

- Roller bearings
- Tooling fixtures (e.g. drilling machines)
- Sealing against viscous media (e.g. grease)
- Supplementary excluders (shaft ends)
- Axle King Pin seals

OPERATING CONDITIONS

Pressure:	Without pressure
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s
Media:	Mineral and synthetic base greases

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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



Table 27: Materials

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal insert
N7LMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel
VCBMR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRK

TSS Type:	K
Code:	TRK
Dimensions:	Shaft diameter 17 mm Housing diameter 23 mm Width 3 mm
Material:	NBR
Material Code:	N7LMR

TSS Article No. **TRK 0 00170 - N7LMR**

Code _____
Type _____
Shaft Diameter x 10 _____
Quality Index (Standard) _____
Material Code (Standard) _____

Table 28: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
4	8	2	TRK000040	●	●
4	9	2	TRK100040	●	
5	9	2	TRK000050	●	●
5	10	2	TRK100050	●	●
6	10	2	TRK000060	●	●
6	15	3	TRK400060	●	
6	15	4	TRK200060	●	●
6	19	4	TRK300060	●	
7	11	2	TRK000070	●	
8	12	3	TRK000080	●	
8	15	3	TRK200080	●	
9	13	3	TRK000090	●	●
9	16	3	TRK200090	●	
10	12	2	TRK100060	●	
10	14	3	TRK000100	●	●
10	17	3	TRK100100	●	●
10	19	3	TRK200100	●	
10	26	4	TRK400100	●	
11	15	3	TRK000110	●	
12	16	3	TRK000120	●	●
12	18	3	TRK100120	●	●
12	19	3	TRK200120	●	●
13	19	3	TRK000130	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
14	20	3	TRK000140	●	●
14	21	3	TRK100140	●	
15	21	3	TRK000150	●	●
15	23	3	TRK100150	●	●
16	22	3	TRK000160	●	●
16	22	4	TRK100160		●
16	24	3	TRK200160	●	
16	25	3	TRK300160		●
17	23	3	TRK000170	●	●
17	23.5	3.4	TRK200170	●	
17	25	3	TRK100170	●	
18	24	3	TRK000180	●	
19	26	4	TRK100190	●	
19	27	4	TRK000190	●	
20	26	3	TRK000200	●	●
20	26	4	TRK100200	●	
20	28	4	TRK200200	●	●
20	48	4	TRK300200	●	
22	28	4	TRK000220	●	●
24	32	4	TRK000240	●	
25	32	4	TRK000250	●	●

● In one of the preferred materials
○ In other commercial materials



Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
25	33	4	TRK100250	●	●
25	35	4	TRK200250	●	●
26	34	4	TRK000260	●	●
28	35	4	TRK000280	●	
28	35	5	TRK400280	●	
28	37	4	TRK100280		●
30	37	4	TRK000300	●	●
30	40	4	TRK100300	●	●
32	42	4	TRK000320	●	●
33	40	3	TRK100330	●	
35	41	4	TRK000350	●	●
35	42	2	TRK300350	●	
35	42	4	TRK100350	●	
35	45	4	TRK200350	●	
38	48	4	TRK000380	●	
40	47	4	TRK000400	●	
40	48	4	TRK100400		
40	50	4	TRK200400	●	●
42	49	3	TRK100420		●
42	52	4	TRK000420	●	
45	52	4	TRK000450	●	
45	55	4	TRK100450	●	
45	62	8	TRKB00450	●	
48	58	4	TRK000480	●	
50	58	4	TRK000500	●	●
50	60	6	TRK100500	●	
50	62	5	TRK200500	●	
55	63	5	TRK000550	●	●
55	73	8.5	TRK100550	●	
60	68	4	TRK200600		●
60	72	3	TRK100600	●	
60	72	4	TRK000600	●	
70	78	5	TRK000700	●	●
70	81.5	6	TRK100700	●	
74	83	6	TRK100740	●	
74	83	11	TRK000740	●	
75	95	7	TRK000750	●	
120	130	7	TRK001200	●	

- In one of the preferred materials
○ In other commercial materials



■ Type TRG – Medium Grease

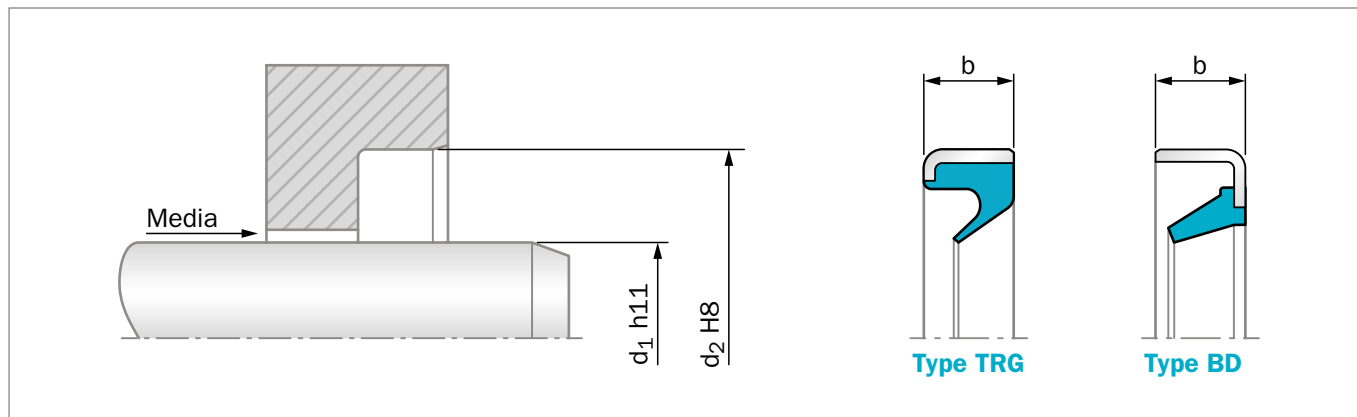


Figure 35: Installation Drawin

GENERAL DESCRIPTION

The Trelleborg Sealing Solutions Type TRG and Type BD are special metal-cased Stefa® Radial Oil Seals without spring-energized sealing lips. These types are not recommended for use in heavily polluted environments. As the static sealing between the housing and metallic shell is limited, low viscosity media can "creep". Better performance can be achieved with epoxy-based resin outer diameter coatings. This special treatment is available on request.

FEATURES AND BENEFITS

- Good radial stiffness
- Good fitting stability, avoiding pop-out of the seal
- Low friction and low heat generation
- Extremely compact design
- Low radial force provides a low break-out torque
- Suitable for scraper applications

APPLICATION EXAMPLES

- Roller bearings
- Tooling fixtures (e.g. drilling machines)
- Sealing against viscous media (e.g. grease)
- Supplementary excluders (shaft ends)
- Axle King Pin seals

OPERATING CONDITIONS

Pressure:	Without pressure
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s
Media:	Mineral and synthetic base greases

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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

**Table 29: Materials**

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal insert
N7MLR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel
4N01	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel
VCBMR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel
4V01	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.
Metal insert can be supplied in different materials on request.

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRG

TSS Type:	G
Code:	TRG
Dimensions:	Shaft diameter 70 mm Housing diameter 78 mm Width 5 mm
Material:	NBR
Material Code:	N7LMR

TSS Article No. **TRG 0 00700 - N7LMR**

Code _____

Type _____

Shaft Diameter x 10 _____

Quality Index (Standard) _____

Material Code (Standard) _____



Table 30: Preferred Series / Dimension, TSS Part Numbers

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
3	8	2	TRG000030	●	
3	10	6	TRG100030		●
4	8	2	TRG000040		●
5	9	2	TRG000050	●	
6	10	2	TRG000060	●	●
6	12	2	TRG100060	●	
7	11	2	TRG000070	●	●
8	14	2	TRG100080	●	
8	15	3	TRG200080	●	
12	16	3	TRG000120	●	●
13	19	3	TRG000130	●	
14	22	3	TRG200140	●	
15	21	3	TRG000150	●	
15	23	3	TRG100150		●
16	20	2.5	TRG000160	●	
16	24	3	TRG200160	●	
16	24	4	TRG100160		●
16	25	3	TRG300160	●	
17	23	3	TRG000170	●	
18	24	3	TRG000180	●	●
19	26	2	TRG400190	●	
20	24	2.5	TRG300200	●	
20	26	3	TRG100200	●	●
20	26	4	TRG100200	●	
20	28	4	TRG200200	●	●
22	28	4	TRG000220	●	
24	32	4	TRG000240	●	
25	32	4	TRG000250	●	●
25	33	4	TRG100250	●	
25	35	4	TRG200250	●	
27	35	2	TRG000270	●	
28	37	4	TRG100280	●	
30	37	4	TRG000300	●	
30	40	4	TRG100300	●	
32	42	4	TRG000320	●	
35	42	2	TRG200350	●	
35	42	4	TRG100350	●	●
35	72	4	TRG400350	●	
38	48	4	TRG000380	●	
38.1	48	2	TRG000381	●	
40	47	4	TRG000400	●	
40	50	4	TRG200400	●	

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
40	52	5	TRG300400	●	
43	53	4	TRG000430	●	
45	52	4	TRG000450	●	
45	52	3	TRG200450	●	
45	55	4	TRG100450	●	●
50	58	4	TRG000500	●	
55	63	5	TRG000550	●	●
60	72	3	TRG000600		
67	75.5	4.3	TRG000670	●	
77	85.5	4.8	TRG000770	●	

● In one of the preferred materials
○ In other commercial materials



Turbo Seals with Hydrodynamic Sealing Aids

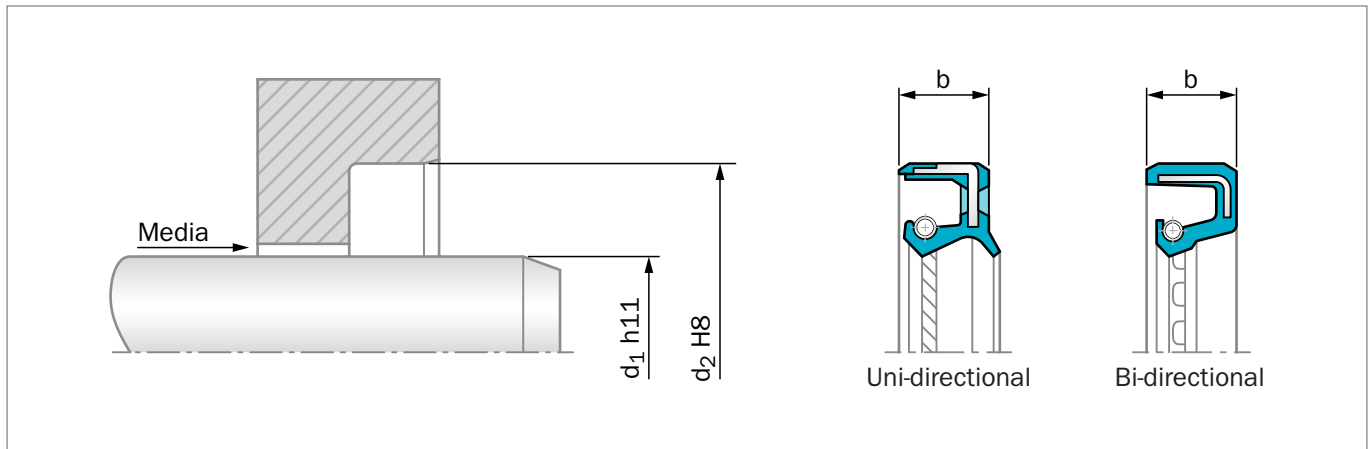


Figure 36: Installation Drawing

GENERAL DESCRIPTION

Trelleborg Sealing Solutions Turbo Seals are a range of seals with specially-shaped lips, including added ribs or other geometric features.

Optimum conditions are attained when a thin film of lubricant is formed so that the lip does not come in to contact with the shaft, which the Turbo Seals create. The hydrodynamic sealing aids support the sealing function by increasing shaft speed.

The frictional loss of the Turbo Seals is significantly lower than that caused by conventional radial seals without hydrodynamic sealing aids.

The pumping effect starts at a relatively low shaft speed. The pumping effect is understood as the capacity of the seal to pump the sealed media from the air side to the media side. In order to avoid leakage at low speed or at standstill, Turbo Seals include a static sealing edge which provides a continuous contact line against the shaft.

FRICTION

The use of certain materials for the sealing element is limited primarily by the heat generated by friction, superimposed on the ambient temperature.

Owing to the enhanced formation of a lubrication film, Turbo Seals can be used for appreciably higher peripheral speeds than conventional seals made from the same material. Figure 37 shows the frictional losses from conventional seals, single-acting and bi-directional Turbo Seals, as determined during comparative laboratory tests. Turbo Seals can withstand speeds of 16 m/s before reaching the same frictional losses as a conventional seal operating at 10 m/s.

OPERATING CONDITIONS

Speed:	Up to 20 m/s (depending on material)
Media:	Mineral and synthetic lubricants (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

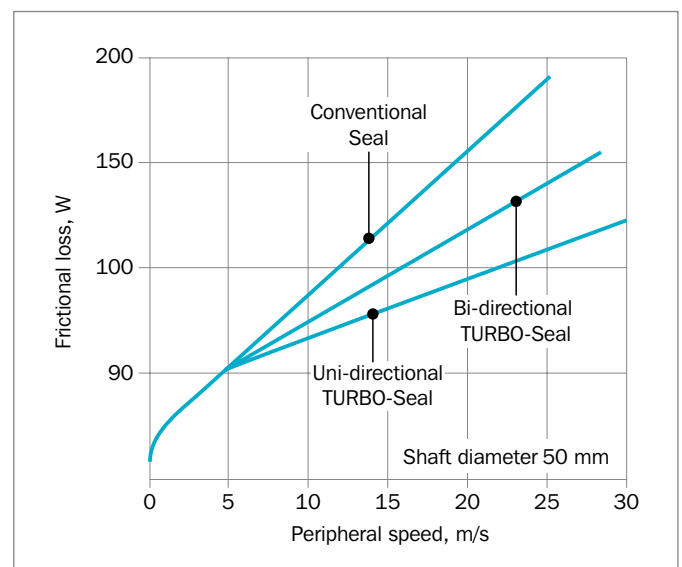


Figure 37: Friction loss

**Table 31: Materials**

TSS Compound Reference	Standard Compound	Temperature °C	Standard Metal insert	Standard spring
N7MMR	NBR (70 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
4N011/4NV11	NBR (75 Shore A)	-30 °C - 100 °C	Carbon steel	Carbon steel
VCBVR	FKM (70 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel
4V012	FKM (75 Shore A)	-20 °C - 200 °C	Carbon steel	Stainless steel

Special grades and other materials (ACM, EPDM, HNBR, VMQ) on request.

Metal insert and spring can be supplied in different materials on request.

For ordering information, please contact your local Customer Solution Center.



■ Rotary and Axial Seal Combination

GENERAL DESCRIPTION

Lip seals often fail because of the destruction of the lubricant film due to the ingress of dirt, dust and moisture, resulting in rapid wear. The use of shaft seals with one or more auxiliary sealing lips (dust lips) provides limited improvement, but is not always sufficient. In order to meet the constantly increasing sealing requirements, especially for increased environmental protection and longer service life, the Trelleborg Sealing Solutions COMBI-seal offers a simple solution. It is particularly well suited to critical applications with heavy contamination. The COMBI-seal consists of a GAMMA seal and a rotary shaft lip seal working together. The lip seal provides the counterface for the GAMMA seal which is fixed to the shaft by press fit (see Figure 38 and Figure 39).

Another frequently used alternative for these types of application consists of a V-Ring with a standard Stefa® Radial Oil Seal type TRC, TRD, TRB or TRF.

The rotary shaft seal should be ordered **"Without Markings"** on the air side.

STefa® RADIAL OIL SEAL + GAMMA SEAL

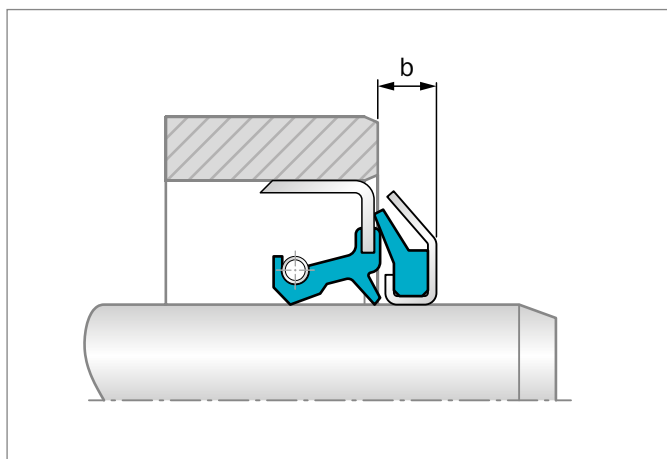


Figure 38: GAMMA seal fitted on the shaft end

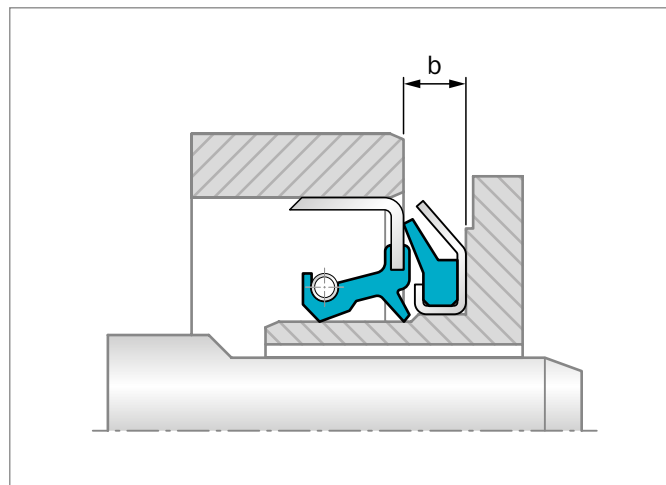


Figure 39: GAMMA seal fitted on the shaft boss

STefa® RADIAL OIL SEAL + V-RING

The function of the rotary axial seal is to prevent intrusion of particles and water through centrifugal forces.

In other words, it adds its original protection capacity to the radial seal's functionality. Sufficient space is required on the shaft to host the axial seal width (see Figure 40).

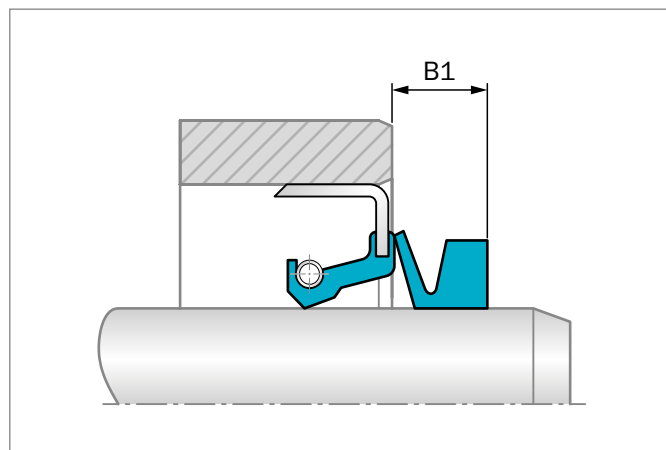


Figure 40: V-Ring fitted on the shaft end

HOUSING AND SHAFT DESIGN

The radial lip seal needs to be assembled in the housing according to usual fitting instructions. Both the V-Ring and GAMMA seal are assembled later on the shaft. The shaft design requires adaptation by an elongation corresponding at least to B1 (b) dimensions. In case of very high peripheral speeds, the V-Ring body should be radially supported. Also see page 157.



PRODUCT DESCRIPTION

The combination of radial shaft seal with V-Ring or GAMMA Seal is recommended for use in heavily polluted environments.

Both the radial shaft seal and the GAMMA Seal housing may also be manufactured with a different metal shell, as well as different rubber types for sealing elements

FEATURES AND BENEFITS

- Longer service life and high function reliability
- Good IP protection for electrical motors (VDE-Norm 0470-1)
- Good protection against water splash and welding sparks
- Simple handling
- Superior total economy
- Friction loss decreases with increasing shaft speed

APPLICATION EXAMPLES

Typical applications are all equipment working in contaminated environments where dust, foreign matter and liquid splatter are present.

Some examples:

- Gear motors
- Journal and gear transmissions
- Bearing housings
- Power saws
- Utility vehicles
- Agricultural machinery and equipment
- Wheel hubs
- Propeller shafts
- Pumps
- Hydraulic motors
- Tool machinery
- Equipment for steel manufacturing
- Metal working machinery

OPERATING CONDITIONS

Pressure:	See radial seal data
Temperature:	-40 °C to +200 °C (depending on material)
Speed:	Up to 10 m/s (depending on material)
Media:	Mineral and synthetic oils (CLP, HLP, APGL, etc.)

Trelleborg Sealing Solutions has carried out several thousand compatibility tests. Please ask your local Customer Solution Center for details.

IMPORTANT NOTE

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

MATERIALS

Please refer Pages 44, 45 and 46.

ORDERING EXAMPLE

Order components separately as per specific chapters. Order the Stefa® Radial Oil Seals "**without marking**".



■ Type TRJ/TRL

FIBER-REINFORCED OIL SEALS FOR LARGE DIAMETERS

Fiber-reinforced oil seals contain no metal parts with the exception of the spring. Instead of the metal insert, a reinforced-fiber component is molded into the body of the seal. Damage through transport and mounting is consequently excluded.

Fiber-reinforced oil seals are mainly used for installation in equipment with large diameters.

The use of an axial retaining plate is necessary, except for the type TRJ/F and respectively for the type TRL/F.

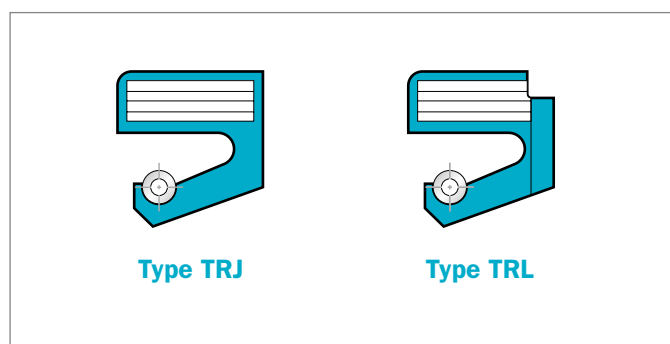


Figure 41: Fiber-reinforced design for large diameters

SPLIT VERSION

To ease mounting, or in case of repair, the types TRJ and TRL are also available in split versions.

To ensure effective sealing at the split ends, a full rubber section is molded at the joint so that contact between homogeneous elastic surfaces maximizes sealing effect. The interface should always be above the oil level.

If two seals in split versions are mounted together, the interface should be turned a minimum of 30° to the side.

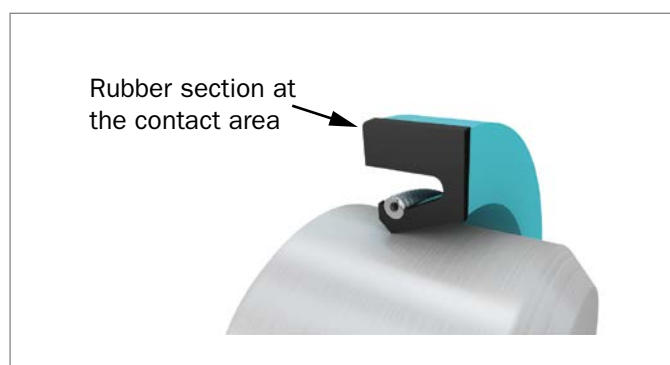


Figure 42: Contact area, split seal

SEPARATION OF TWO MEDIA WITH TYPE TRL

A single oil seal should not be used for the separation of two media. In such cases, two seals are fitted in a back-to-back arrangement. Type TRL is suitable for the sealing of large diameters. It is a special design with peripheral and radial grooves where a lubricant could be applied.

The peripheral groove on the seal reduces the need to cut a groove in the housing (see Figure 43).

The seal can be used:

- To isolate of two media
- If lubrication is necessary from the outside

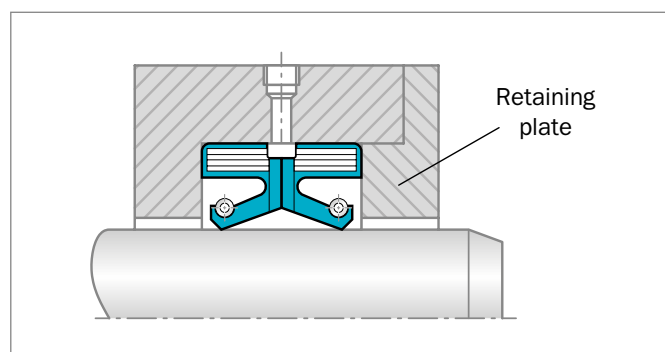


Figure 43: Type TRL mounted back-to-back

SPECIAL DESIGN TRJ/F AND TRL/F WITH REINFORCED SHOULDER

Whenever a retaining plate cannot be fitted, we can supply a seal made in a special hardened compound, namely type TRJ/F and TRL/F, which makes the seal self-retaining and provides effective sealing at the O.D.

Trelleborg Sealing Solutions type TRJ/F and TRL/F are supplied in standard forms and are not available in split versions (see Figure 44).

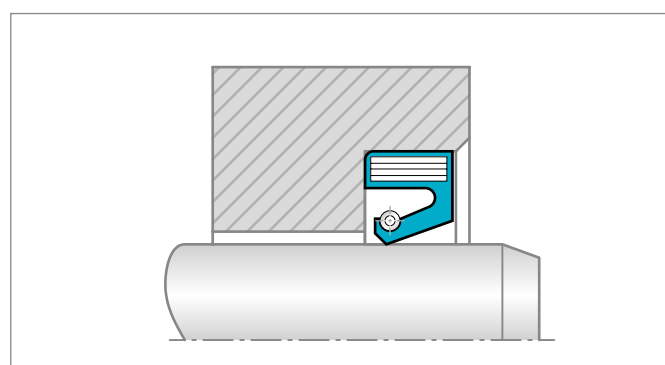


Figure 44: Type TRJ/F mounted without axial retaining plate



DESIGN INSTRUCTIONS

Installation on the shaft

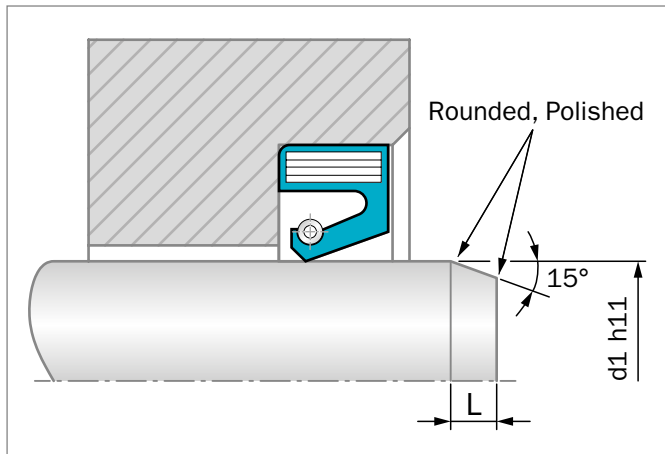


Figure 45: Installation of the oil seal

To facilitate the installation of the seal with minimum risk of lip damage, the shaft requires a 15° chamfer with length (L) as the function of its diameter (d1).

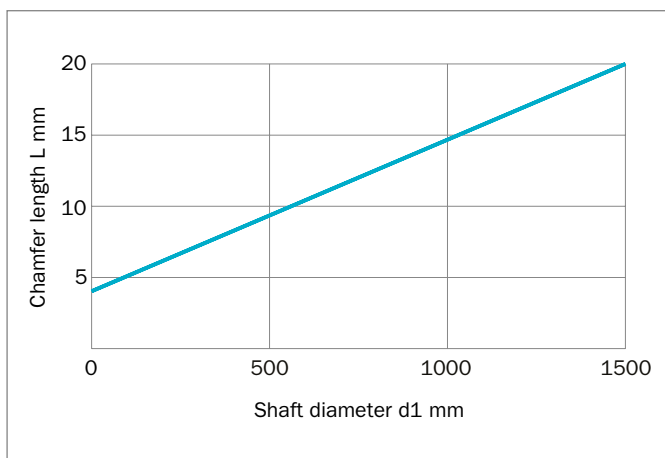


Figure 46: Chamfer length as a function of the shaft diameter

Eccentricity

Eccentricity between the shaft and housing bore centers should be avoided in order to eliminate unilateral load of the lip.

Table 32: Static Eccentricity

d1	b x f (mm)	max. stat. Ecc. (mm)
100 - 250	16 x 20	0.50
250 - 400	20 x 22	0.55
400 - 600	22 x 25	0.62
> 600	25 x 32	0.70

Shaft run out

Shaft run out should be avoided or kept to a minimum. At higher speeds, there is a risk that the inertia of the sealing lip prevents it from following the shaft movement. The seal must be located next to the bearing and the bearing play should be maintained at the minimum value possible.

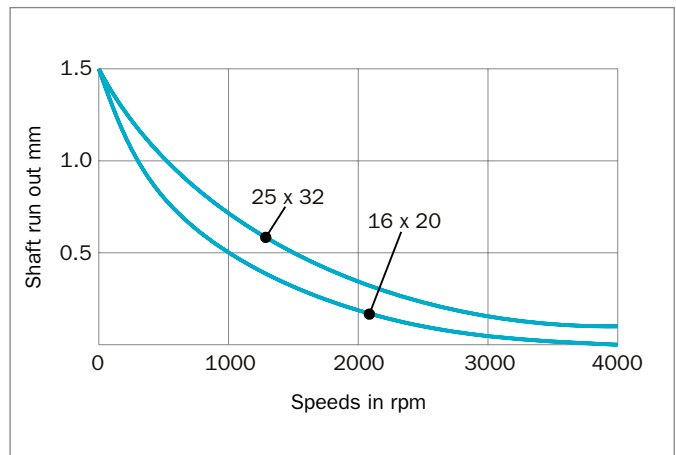


Figure 47: Shaft run out

Installation in the gland

The static seal in the mounting bore is provided by the corresponding force fit allowance at the outer sheath of the seal.

The bore tolerance is specified to DIN ISO 286T2-H8.

Values for the surface roughness in the gland are specified in ISO 6194/1.

General values:	Ra	=	1.6 - 3.2 µm
	Rz	=	6.3 - 12.5 µm

For gas sealing, a good score-free and spiral-free surface finish is necessary. If the rotary shaft lip seal is bonded into the housing, ensure that no adhesive comes into contact with the sealing lip or the shaft.

The bore (d2) of the housing is a function of the shaft diameter (d1), as indicated in Table 32 and Table 33, page 109.



INSTALLATION, TYPE TRJ

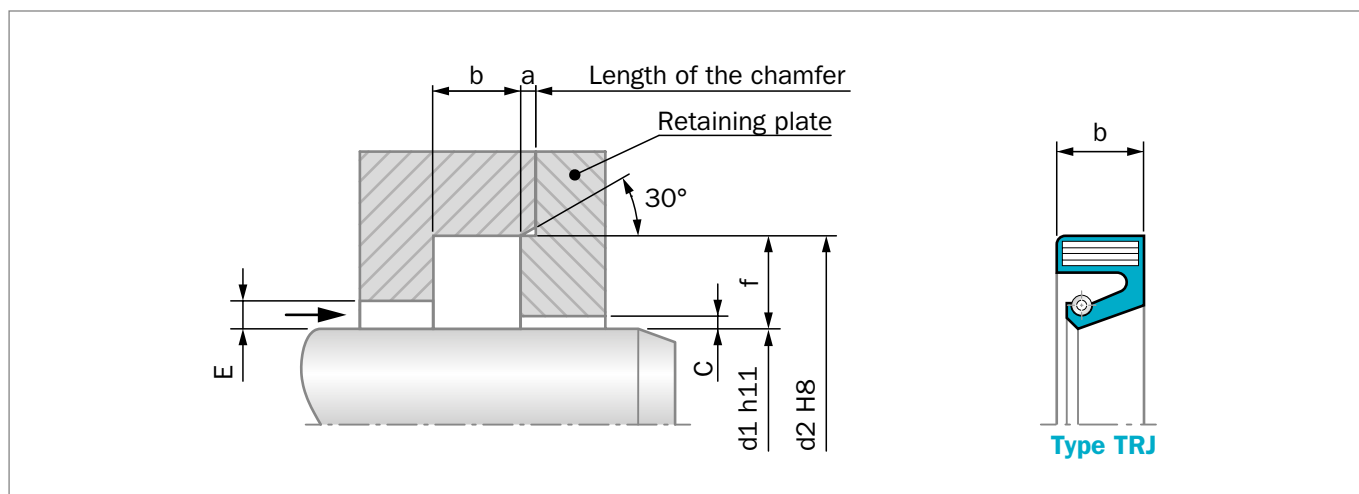


Figure 48: Installation Drawing

INSTALLATION, TYPE TRL

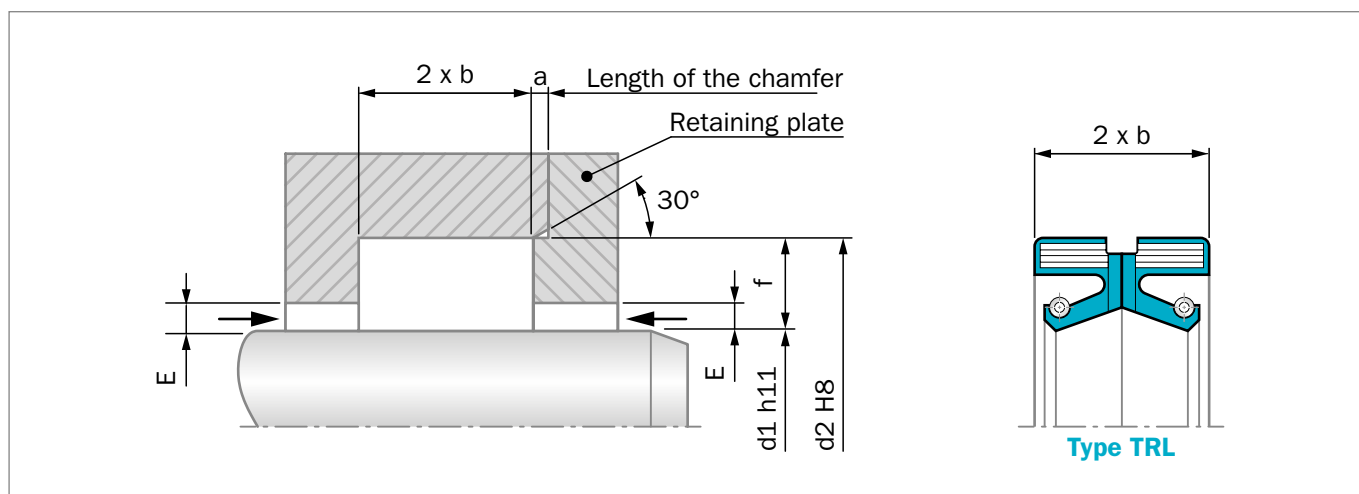


Figure 49: Installation Drawing

Table 33: Dimensions

d1	b x f	a	E	C	b
100 - 250	16 x 20	2.0	9	4	16 ±0.1
250 - 400	20 x 22	2.2	11	6	20 ±0.2
400 - 600	22 x 25	2.5	11	7	22 ±0.2
> 600	25 x 32	3.2	14	8	25 ±0.2



OPERATING CONDITIONS, TYPE TRJ AND TRL

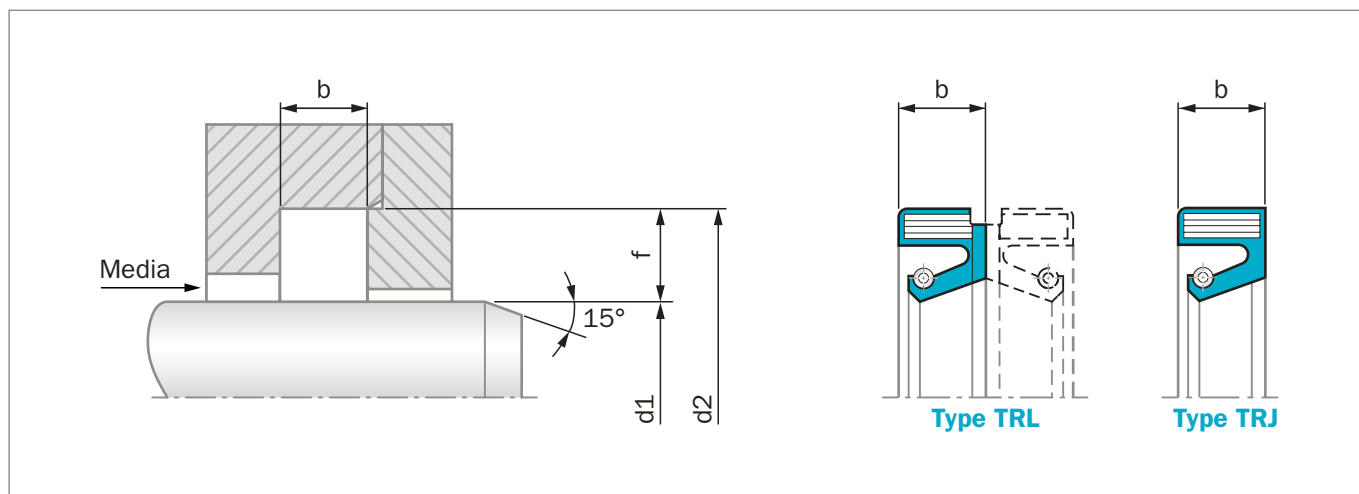


Figure 50: Installation Drawing

Table 34: Material

Standard Material*	TSS Material Code	Standard Spring
NBR (75 Shore A)	4NC01	Carbon steel
HNBR (75 Shore A)	4HC01	Carbon steel
FKM (75 Shore A)	4VC02	Stainless steel

* The spring can be supplied in different materials on request.

Table 35: Operating Conditions

Type	Temperature	Speed	Pressure	Dimensions
TRJ	-30 °C to +200 °C	up to 25 m/s	0.05 MPa	100 - 1,890
TRL	-30 °C to +200 °C	up to 25 m/s	0.05 MPa	100 - 1,890

ORDERING EXAMPLE

Stefa® Radial Oil Seal Type TRJ

TSS Type:	J
Code:	TRJ
Dimensions:	Shaft diameter 100 mm Housing diameter 125 mm Width 12.5 mm
Material:	NBR
Material Code:	4NC01

TSS Article No. **TRJ** **001000** - **4NC01**
TSS Code _____
Shaft Diameter x 10 _____
Quality Index (Standard) _____
Material _____



Table 36: Standard Installation Dimensions / TSS Part Number

Dimension			TSS Part No.	Material	
d ₁	d ₂	b		NBR	FKM
100	125	12.5	TRJ001000	●	
115	140	15	TRJ001150		●
120	150	13	TRJ001200	●	
125	160	12	TRJ001250	●	
130	170	16	TRJ001300	●	
133	165	12.5	TRL001330	●	
145	175	15	TRJ001450	●	
150	180	13	TRJ001500	●	●
170	200	15	TRJ001700	●	
175	215	16	TRL001750	●	
180	218.1	15.9	TRJ001800	●	
190	220	16	TRJ001900	●	
200	230	14	TRL002000	●	
200	240	16	TRJ002000	●	
220	260	16	TRJ002200	●	
220	270	16	TRJ002200	●	
230	260	15.7	TRJ002300	●	
240	270	15	TRJ002400	●	
240	280	16	TRJ002400	●	
250	280	16	TRL002500	●	
250	290	16	TRJ002500		●
260	290	16	TRJ002600	●	
260	300	14	TRL002600	●	
260	304	20	TRJ002600	●	●
270	310	18	TRL002700	●	
270	310	20	TRJ002700	●	●
280	320	16	TRJ002800	●	
280	324	20	TRJ002800	●	
290	334	20	TRJ002900	●	
300	340	18	TRL003000	●	
310	340	14.5	TRJ003100	●	
310	350	20	TRJ003100	●	
315	355	16	TRJ003150		●
320	360	18	TRJ003200	●	
320	364	20	TRJ003200	●	
330	370	20	TRJ003300	●	
350	394	20	TRL003500	●	
370	410	18	TRL003700	●	
380	420	18	TRL003800	●	
380	420	20	TRJ003800	●	
390	434	20	TRJ003900	●	
400	440	18	TRL004000	●	
400	444	20	TRJ004000	●	
405	445	20	TRJ004050	●	
430	474	20	TRL004300	●	●
440	490	22	TRJ004400	●	●
445	495	22	TRJ004450	●	
450	500	22	TRJ004500	●	
460	504	20	TRL004600	●	
470	520	25	TRJ004700	●	
480	530	22	TRJ004800	●	●
480	530	22	TRL004800	●	
490	534	20	TRL004900	●	
500	544	22	TRJ005000	●	
530	580	22	TRJ005300	●	
540	590	22	TRJ005400	●	
540	590	22	TRL005400	●	●
560	610	22	TRJ005600	●	
570	620	22	TRL005700	●	●
596	660	32	TRL005960	●	
600	650	22	TRJ006000	●	
625	670	20	TRJ006250	●	
630	680	22	TRL006300	●	●
640	690	22	TRJ006400	●	
650	700	22	TRJ006500	●	
650	714	25	TRL006500	●	
660	704	20	TRJ006600	●	
680	730	20	TRJ006800	●	
696	760	32	TRL006960	●	
700	750	25	TRL007000	●	
710	760	24.5	TRL007100	●	
710	760	25.5	TRL007100	●	
730	794	25	TRJ007300	●	
735	799	25	TRJ007350		●
750	810	25	TRL007500	●	
750	814	25	TRL007500	●	
762	810	20	TRL007620	●	
766	830	32	TRL007660	●	
775	839	25	TRL007750	●	
790	854	25	TRL007900	●	
820	870	22	TRL008200	●	
860	900	18	TRJ008600	●	
860	924	25	TRL008600	●	
880	944	25	TRL008800	●	●
970	1,034	25	TRJ009700		●
1,100	1,164	25	TRL01100	●	●



Table 37: Further dimensions for Type TRJ/TRL

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
100.0	115.0	8.9	7.5	●	
100.0	115.0	9.0	7.5		
100.0	120.0	13.0	10.0	●	
100.0	125.0	13.0	12.5	●	
100.0	125.0	15.0	12.5	●	
100.0	125.4	12.7	12.7	●	●
100.0	130.0	12.0	15.0	●	
100.0	130.0	15.0	15.0	●	
100.0	132.0	12.5	16.0	●	●
100.0	140.0	16.0	20.0	●	
105.0	129.0	13.0	12.0	●	
105.0	130.0	12.0	12.5	●	
105.0	130.0	13.0	12.5	●	
105.0	133.5	12.7	14.3	●	
105.0	137.0	16.0	16.0	●	
105.0	140.0	12.0	17.5	●	
105.0	143.0	16.0	19.0	●	
105.0	145.0	16.0	20.0	●	
110.0	126.0	9.0	8.0	●	
110.0	126.0	12.0	8.0	●	
110.0	130.0	9.0	10.0	●	
110.0	130.0	12.0	10.0	●	
110.0	130.0	13.0	10.0	●	
110.0	135.0	12.0	12.5	●	
110.0	140.0	12.0	15.0	●	
110.0	140.0	14.0	15.0	●	
110.0	140.0	15.0	15.0	●	
110.0	140.0	16.0	15.0	●	
110.0	141.0	13.7	15.5	●	
110.0	145.0	19.0	17.5	●	
110.0	150.0	16.0	20.0	●	
115.0	137.0	8.8	11.0	●	
115.0	137.0	9.0	11.0		●
115.0	140.0	12.0	12.5	●	
115.0	140.0	13.0	12.5	●	●
115.0	140.4	9.5	12.7	●	
115.0	145.0	12.0	15.0	●	
115.0	145.0	15.0	15.0	●	
115.0	150.0	15.0	17.5	●	
115.0	155.0	16.0	20.0	●	
118.0	140.0	14.0	11.0	●	
120.0	140.0	12.5	10.0	●	
120.0	140.0	13.0	10.0	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
120.0	144.0	14.5	10.0	●	
120.0	144.0	15.5	12.0	●	
120.0	145.0	15.5	12.5	●	
120.0	150.0	13.0	15.0	●	
120.0	150.0	15.0	15.0	●	
120.0	150.0	16.0	15.0	●	
120.0	152.0	16.0	16.0	●	
120.0	160.0	12.0	20.0	●	
120.0	160.0	16.0	20.0	●	
120.0	170.0	15.0	25.0	●	
125.0	140.0	10.0	7.5	●	
125.0	150.0	12.0	12.5	●	
125.0	150.0	15.0	12.5	●	
125.0	153.5	12.7	14.2	●	
125.0	155.0	12.0	15.0	●	
125.0	160.0	12.0	17.5	●	
125.0	160.0	13.0	17.5	●	
125.0	160.0	15.0	17.5	●	
125.0	165.0	15.0	20.0	●	
125.0	165.0	16.0	20.0	●	
127.0	157.0	15.0	15.0	●	
128.0	165.0	15.0	18.5	●	
130.0	150.0	10.0	10.0	●	
130.0	150.0	12.0	10.0	●	
130.0	155.0	10.0	12.5	●	
130.0	155.0	15.5	12.5	●	
130.0	160.0	12.0	15.0	●	
130.0	160.0	15.0	15.0	●	
130.0	160.0	16.0	15.0	●	
130.0	165.0	13.0	17.5	●	
130.0	170.0	13.0	20.0	●	
130.0	170.0	16.0	20.0	●	
133.0	165.0	12.5	16.0		●
134.0	169.0	15.0	17.5	●	
135.0	157.0	8.0	11.0	●	
135.0	160.0	12.0	12.5	●	
135.0	165.0	13.0	15.0	●	
135.0	167.0	15.0	16.0	●	
135.0	160.0	12.0	12.5	●	
135.0	165.0	13.0	15.0	●	
135.0	167.0	15.0	16.0	●	

Additional dimensions are available on request.
Contact your local Customer Solution Center for more information.



Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
135.0	160.0	12.0	12.5	●	
135.0	165.0	13.0	15.0	●	
135.0	167.0	15.0	16.0	●	
135.0	170.0	12.0	17.5	●	
135.0	170.0	13.0	17.5	●	
135.0	170.0	16.5	17.5	●	
135.0	175.0	16.0	20.0	●	
136.0	160.0	10.0	12.0	●	
138.0	180.0	15.0	21.0	●	
139.0	155.0	10.0	8.0	●	
139.0	169.0	14.6	15.0	●	
140.0	155.0	10.0	7.5	●	
140.0	160.0	13.0	10.0	●	
140.0	165.0	15.0	12.5	●	
140.0	168.0	21.0	14.0	●	
140.0	170.0	15.0	15.0	●	
140.0	180.0	12.0	20.0	●	
140.0	180.0	15.0	20.0	●	
140.0	180.0	16.0	20.0	●	●
140.0	190.0	15.0	25.0	●	
143.0	165.0	10.0	11.0	●	
144.0	180.0	15.0	18.0	●	
145.0	170.0	13.0	12.5	●	
145.0	170.0	15.0	12.5	●	
145.0	180.0	12.0	17.5	●	
145.0	180.0	14.0	17.5	●	
149.0	179.0	13.0	15.0	●	
149.0	180.0	16.0	15.5	●	
150.0	172.0	12.7	11.0	●	
150.0	180.0	12.0	15.0	●	●
150.0	180.0	13.0	15.0	●	
150.0	180.0	14.0	15.0	●	
150.0	180.0	15.0	15.0	●	
150.0	185.0	15.0	17.5	●	
150.0	188.0	16.0	19.0	●	
150.0	190.0	16.0	20.0	●	●
150.0	190.0	20.0	20.0	●	
152.0	180.0	14.0	14.0	●	
152.0	190.0	19.0	19.0	●	
154.0	180.0	12.2	13.0	●	
155.0	175.0	10.8	10.0	●	
155.0	180.0	12.5	12.5	●	
155.0	180.0	15.0	12.5	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
155.0	190.0	13.0	17.5	●	
156.0	195.0	15.0	19.5		●
159.0	200.0	16.0	20.5	●	
160.0	188.0	21.0	14.0	●	
160.0	190.0	15.0	15.0	●	
160.0	190.0	16.0	15.0	●	
160.0	200.0	16.0	20.0	●	●
165.0	190.0	15.0	12.5	●	
165.0	195.0	15.0	15.0	●	●
165.0	200.0	15.0	17.5	●	
165.0	203.0	19.0	19.0	●	
165.0	205.0	16.0	20.0	●	
168.0	200.0	16.0	16.0	●	
169.0	200.0	12.0	15.5	●	
169.0	201.0	12.5	16.0	●	
170.0	192.0	10.7	11.0	●	
170.0	195.0	14.2	12.5	●	
170.0	200.0	12.0	15.0	●	●
170.0	200.0	15.0	15.0	●	
170.0	205.0	18.0	17.5	●	
170.0	210.0	16.0	20.0	●	●
170.0	220.0	15.0	25.0	●	
170.0	223.0	20.0	26.5	●	
174.0	214.0	16.0	20.0	●	
175.0	200.0	15.0	12.7	●	
175.0	205.0	15.0	15.0	●	●
175.0	215.0	15.0	20.0	●	
175.0	215.0	16.0	20.0	●	
180.0	200.0	15.0	10.0	●	
180.0	205.0	12.5	12.5	●	
180.0	210.0	12.0	15.0	●	
180.0	210.0	15.0	15.0	●	●
180.0	212.0	16.0	16.0	●	
180.0	215.0	15.0	17.5	●	
180.0	216.0	21.8	18.0	●	
180.0	220.0	13.0	20.0	●	
180.0	220.0	16.0	20.0	●	●
180.0	230.0	16.0	25.0	●	
182.0	215.0	16.0	16.5	●	
185.0	210.0	13.0	12.5	●	
185.0	215.0	15.0	15.0		●

Additional dimensions are available on request.

Contact your local Customer Solution Center for more information.



Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
185.0	215.0	16.0	15.0	●	
185.0	220.0	16.0	17.5	●	
185.0	225.0	16.0	20.0	●	●
185.0	230.0	16.0	22.5	●	
190.0	210.0	15.0	10.0	●	
190.0	212.0	11.7	11.0	●	
190.0	215.0	16.0	12.5	●	
190.0	220.0	15.0	15.0	●	●
190.0	220.0	16.0	15.0	●	
190.0	225.0	18.0	17.5	●	
190.0	230.0	15.0	20.0	●	
190.0	230.0	16.0	20.0	●	●
195.0	220.0	15.0	12.5	●	
195.0	230.0	15.0	17.5	●	
195.0	230.0	16.0	17.5	●	
195.0	235.0	16.0	20.0	●	
196.0	228.0	16.0	16.0	●	
196.0	235.0	19.0	19.5	●	
200.0	225.0	15.0	12.5	●	
200.0	230.0	15.0	15.0	●	●
200.0	230.0	16.0	15.0	●	
200.0	235.0	18.2	17.5	●	
200.0	240.0	15.0	20.0	●	
200.0	240.0	16.0	20.0	●	●
200.0	250.0	15.0	25.0	●	
200.0	250.0	18.0	25.0	●	
205.0	230.0	16.0	12.5	●	
205.0	245.0	16.0	20.0	●	
205.0	245.0	20.0	20.0	●	
205.0	250.0	16.0	22.5	●	
210.0	240.0	13.0	15.0	●	
210.0	245.0	15.0	17.5	●	
210.0	245.0	18.0	17.5	●	
210.0	246.0	16.0	18.0	●	
210.0	250.0	15.0	20.0	●	
210.0	250.0	16.0	20.0	●	●
210.0	274.0	26.0	32.0	●	
213.0	248.0	16.0	17.5	●	
215.0	240.0	12.0	12.5	●	
215.0	245.0	16.0	15.0	●	●
215.0	247.0	12.5	16.0	●	
215.0	248.0	15.0	16.5	●	
215.0	251.0	12.5	18.0	●	
215.0	265.0	17.0	25.0	●	
216.0	241.5	12.7	12.7	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
216.0	254.0	16.0	19.0	●	
216.0	254.0	19.0	19.0	●	
216.9	254.0	19.0	18.5	●	
218.0	245.0	12.5	13.5	●	
218.0	270.0	22.0	26.0	●	
220.0	245.0	12.5	12.5	●	●
220.0	250.0	12.0	15.0	●	
220.0	250.0	15.0	15.0	●	●
220.0	250.0	16.0	15.0	●	
220.0	250.0	19.0	15.0	●	
220.0	254.0	16.0	17.0	●	
220.0	255.0	16.0	17.5	●	
220.0	255.0	18.0	17.5	●	
220.0	258.0	25.4	19.0	●	
220.0	260.0	15.0	20.0	●	
220.0	260.0	16.0	20.0	●	●
220.0	260.0	20.0	20.0	●	
220.0	260.0	22.0	20.0	●	
220.0	270.0	16.0	25.0	●	
225.0	250.0	12.5	12.5	●	
225.0	260.0	16.0	17.5	●	
225.0	270.0	16.0	22.5	●	
226.0	258.0	16.0	16.0	●	
228.0	268.0	16.0	20.0		●
228.0	268.0	20.0	20.0	●	
230.0	255.0	10.0	12.5	●	
230.0	255.0	11.7	12.5	●	
230.0	255.0	15.0	12.5	●	
230.0	260.0	12.5	15.0	●	
230.0	260.0	15.0	15.0	●	
230.0	260.0	16.0	15.0	●	
230.0	265.0	18.0	17.5	●	
230.0	270.0	16.0	20.0	●	●
230.0	280.0	15.0	25.0	●	
230.0	280.0	23.0	25.0		●
230.0	285.0	23.0	27.5	●	
234.9	273.0	19.0	19.1	●	
235.0	270.0	16.0	17.5	●	
235.0	270.0	18.0	17.5	●	
235.0	275.0	20.0	17.5	●	
236.0	276.0	16.0	20.0		●
240.0	270.0	15.0	15.0	●	
240.0	270.0	17.0	15.0	●	

Additional dimensions are available on request.
Contact your local Customer Solution Center for more information.



Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
240.0	275.0	18.0	20.0	●	
240.0	278.0	17.0	19.0	●	
240.0	280.0	16.0	20.0	●	●
240.0	280.0	17.5	20.0	●	
245.0	270.0	13.0	12.5	●	
245.0	270.0	16.0	12.5	●	●
250.0	280.0	15.0	15.0	●	
250.0	280.0	16.0	15.0	●	●
250.0	285.0	18.0	17.5	●	
250.0	285.0	20.0	17.5	●	
250.0	288.0	19.0	19.0	●	
250.0	290.0	16.0	20.0	●	●
250.0	300.0	20.0	25.0	●	
250.0	303.0	20.0	26.5	●	
250.0	310.0	25.0	30.0	●	
253.0	285.0	11.0	16.0	●	
254.0	279.0	9.3	12.5	●	
254.0	292.0	15.9	19.0	●	
255.0	285.0	11.0	15.0	●	●
255.0	285.0	15.0	15.0	●	
255.0	295.0	16.0	20.0	●	●
255.0	310.0	18.0	27.5	●	
258.0	290.0	16.0	16.0	●	●
260.0	285.0	18.0	12.5	●	
260.0	290.0	16.0	15.0	●	●
260.0	290.0	19.0	15.0	●	
260.0	292.0	12.5	16.0	●	
260.0	298.0	17.0	19.0	●	
260.0	300.0	18.0	20.0	●	
260.0	300.0	20.0	20.0	●	
260.0	304.0	20.0	22.0	●	●
260.0	305.0	16.0	22.5	●	
260.0	305.0	22.0	22.5	●	
260.0	310.0	16.0	25.0	●	
260.0	310.0	18.0	25.0	●	
264.0	309.0	21.5	22.5	●	
265.0	300.0	16.0	17.5	●	●
265.0	310.0	16.0	22.5	●	
265.0	310.0	22.0	22.5	●	
270.0	300.0	15.0	15.0	●	●
270.0	310.0	16.0	20.0	●	
270.0	310.0	20.0	22.0	●	
270.0	314.0	20.0	22.0	●	●
272.0	304.0	16.0	16.0	●	
272.0	304.0	16.5	16.0	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
273.0	317.0	19.0	22.0	●	
275.0	310.0	15.0	17.5	●	
277.0	317.0	19.0	20.0	●	
280.0	310.0	15.0	15.0	●	
280.0	310.0	16.0	15.0	●	
280.0	318.0	15.0	19.0	●	
280.0	320.0	16.0	20.0	●	●
280.0	320.0	18.0	20.0	●	
280.0	320.0	20.0	20.0	●	
280.0	324.0	20.0	22.0	●	
280.0	325.0	24.0	22.5	●	
285.0	310.0	16.0	12.5	●	
285.0	325.0	16.0	20.0		●
285.0	325.0	18.0	20.0	●	
286.0	330.0	16.0	22.0	●	
290.0	320.0	15.0	15.0	●	
290.0	322.0	12.5	16.0	●	
290.0	330.0	16.0	20.0	●	
290.0	330.0	18.0	20.0	●	
290.0	330.0	20.0	20.0	●	
290.0	334.0	20.0	22.0	●	●
290.0	335.0	20.0	22.5	●	
290.0	350.0	25.0	30.0	●	
295.0	325.0	15.0	15.0	●	
295.0	335.0	15.0	20.0		●
295.0	335.0	16.0	20.0	●	
295.0	339.0	20.0	22.0	●	
300.0	330.0	14.0	15.0		●
300.0	332.0	15.0	16.0	●	
300.0	332.0	16.0	16.0	●	
300.0	335.0	16.0	17.5	●	
300.0	335.0	18.0	17.5	●	●
300.0	340.0	16.0	20.0	●	●
300.0	340.0	18.0	20.0	●	●
300.0	340.0	20.0	20.0	●	
300.0	340.0	25.0	20.0	●	
300.0	344.0	20.0	22.0	●	●
300.0	344.0	22.0	22.0	●	
300.0	350.0	22.0	25.0	●	
300.0	350.0	25.0	25.0	●	
300.0	360.0	25.0	30.0	●	
300.0	364.0	25.0	32.0	●	
300.0	370.0	18.0	35.0	●	

Additional dimensions are available on request.

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Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
305.0	340.0	15.0	17.5	●	
305.0	349.0	20.0	22.0	●	
305.0	355.0	15.0	25.0	●	
305.0	362.0	19.0	28.5	●	
310.0	350.0	17.5	20.0	●	
310.0	350.0	18.0	20.0	●	●
310.0	354.0	20.0	22.0	●	
310.0	355.0	24.0	22.5	●	
310.0	370.0	28.0	30.0	●	
314.0	355.0	20.0	20.5	●	
315.0	347.0	13.0	16.0	●	
315.0	355.0	18.0	20.0	●	
315.0	359.0	20.0	22.0	●	
315.0	360.0	20.0	22.5		●
315.0	365.0	20.0	25.0	●	
315.0	380.0	29.0	32.5	●	
317.0	361.0	20.0	22.0	●	●
320.0	350.0	15.0	15.0	●	
320.0	355.0	16.0	17.5	●	●
320.0	360.0	18.0	20.0	●	●
320.0	360.0	20.0	20.0	●	●
320.0	364.0	20.0	22.0	●	●
323.0	363.0	16.0	20.0	●	
325.0	365.0	16.0	20.0	●	●
325.0	365.0	20.0	20.0	●	
325.0	369.0	22.0	20.0	●	
325.0	369.0	20.0	22.0	●	
325.0	375.0	22.0	25.0		●
328.0	372.0	20.2	22.0	●	
330.0	370.0	18.0	20.0	●	
330.0	370.0	20.0	20.0	●	●
330.0	374.0	19.0	22.0	●	
330.0	374.0	20.0	22.0	●	●
330.0	374.0	22.0	22.0	●	
335.0	375.0	18.0	20.0	●	
335.0	379.0	20.0	22.0	●	●
335.0	400.0	35.0	32.5	●	
338.0	382.0	20.0	22.0	●	
340.0	370.0	15.0	15.0	●	
340.0	370.0	18.0	15.0	●	
340.0	370.0	20.0	15.0	●	
340.0	372.0	16.0	16.0	●	
340.0	373.0	16.0	16.5	●	
340.0	378.0	16.0	19.0	●	
340.0	380.0	18.0	20.0	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
340.0	380.0	20.0	20.0	●	
340.0	384.0	20.0	22.0	●	
340.0	400.0	28.0	30.0	●	
345.0	389.0	20.0	22.0	●	
345.0	395.0	20.0	25.0	●	
346.0	390.0	20.0	22.0	●	
348.0	380.0	16.0	16.0	●	
350.0	380.0	16.0	15.0	●	
350.0	390.0	15.0	20.0	●	
350.0	390.0	16.0	20.0	●	
350.0	390.0	18.0	20.0	●	
350.0	390.0	20.0	20.0	●	●
350.0	394.0	20.0	22.0	●	●
350.0	394.0	22.0	22.0	●	
350.0	405.0	20.0	27.5	●	
355.0	379.0	20.0	12.0	●	
355.0	385.0	16.0	15.0		●
355.0	394.0	20.0	19.5	●	
355.0	410.0	25.0	27.5		●
360.0	390.0	18.0	15.0	●	
360.0	400.0	16.0	20.0	●	
360.0	400.0	18.0	20.0	●	
360.0	400.0	20.0	20.0	●	
360.0	404.0	20.0	22.0	●	●
360.0	410.0	22.0	25.0	●	
362.0	400.0	20.0	19.0	●	
362.0	406.0	19.5	22.0	●	
362.0	406.0	20.0	22.0	●	
362.0	406.0	22.0	22.0	●	
363.0	418.0	20.0	27.5	●	
365.0	405.0	18.0	20.0	●	
365.0	409.0	20.0	22.0	●	●
370.0	410.0	15.0	20.0	●	
370.0	410.0	18.0	20.0		●
370.0	410.0	20.0	20.0	●	
370.0	414.0	19.0	22.0	●	●
370.0	414.0	20.0	22.0	●	●
370.0	414.0	25.0	22.0	●	
375.0	419.0	20.0	22.0	●	
375.0	419.0	22.2	22.0	●	
375.0	420.0	16.0	22.5	●	
378.0	428.0	18.5	25.0	●	
380.0	410.0	12.5	15.0	●	

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Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
380.0	420.0	15.0	20.0	●	
380.0	420.0	15.0	20.0		●
380.0	420.0	18.0	20.0	●	●
380.0	420.0	20.0	20.0	●	
380.0	420.0	20.0	20.0	●	
380.0	420.0	22.0	20.0	●	
380.0	424.0	20.0	22.0	●	●
380.0	435.0	25.0	27.5	●	
380.0	438.0	23.0	29.0	●	
380.0	440.0	25.0	30.0	●	
381.0	432.0	25.0	25.5	●	
384.0	414.0	15.0	15.0	●	
384.0	428.0	20.0	22.0		●
385.0	430.0	25.0	22.5	●	
385.0	438.0	32.0	26.5	●	
387.0	431.0	22.5	22.0	●	●
390.0	420.0	14.0	15.0	●	
390.0	420.0	16.0	15.0	●	
390.0	430.0	18.0	20.0	●	
390.0	430.0	20.0	20.0	●	
390.0	434.0	19.2	22.0	●	
390.0	434.0	20.0	22.0	●	●
390.0	440.0	22.0	25.0		●
390.0	464.0	20.0	37.0		●
395.0	430.0	18.0	17.5	●	●
395.0	431.0	18.0	18.0	●	
395.0	439.0	20.0	22.0	●	●
400.0	438.0	17.5	19.0	●	
400.0	440.0	14.0	20.0		●
400.0	440.0	18.0	20.0	●	
400.0	444.0	20.0	20.0	●	●
400.0	444.0	19.2	22.0	●	
400.0	444.0	20.0	22.0	●	●
400.0	445.5	22.0	22.7	●	
400.0	450.0	20.0	25.0	●	
400.0	450.0	22.0	25.0	●	●
405.0	455.0	22.0	25.0	●	
410.0	450.0	18.0	20.0		●
410.0	450.0	20.0	20.0	●	
413.0	455.0	20.0	21.0	●	
415.0	445.0	20.0	15.0	●	
415.0	455.0	20.0	20.0	●	
415.0	459.0	20.0	22.0	●	
417.0	467.0	25.0	25.0	●	
420.0	460.0	18.0	20.0		●

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
420.0	460.0	19.0	20.0	●	
420.0	460.0	20.0	20.0	●	
420.0	470.0	20.0	25.0	●	
420.0	470.0	22.0	25.0	●	●
420.0	470.0	25.0	25.0	●	
430.0	470.0	20.0	20.0	●	
430.0	474.0	20.0	22.0	●	
430.0	480.0	20.0	25.0	●	
430.0	480.0	22.0	25.0	●	●
430.0	480.0	25.0	25.0	●	
430.0	490.0	25.0	30.0	●	
435.0	485.0	22.0	25.0	●	
435.0	485.0	30.0	25.0		●
437.0	487.0	19.8	25.0	●	
437.0	487.0	21.5	25.0	●	
440.0	469.0	12.5	14.5	●	
440.0	480.0	20.0	20.0	●	
440.0	490.0	20.0	25.0	●	
440.0	490.0	20.5	25.0	●	
440.0	490.0	22.0	25.0	●	●
440.0	490.0	25.0	25.0	●	
440.0	490.0	28.0	25.0		●
445.0	495.0	22.0	25.0	●	
446.0	486.0	16.0	20.0	●	●
447.0	497.0	22.0	25.0	●	
450.0	490.0	18.0	20.0		●
450.0	494.0	20.0	22.0	●	
450.0	500.0	20.0	25.0	●	
450.0	500.0	20.0	25.0		●
450.0	500.0	22.0	25.0	●	●
450.0	500.0	25.0	25.0	●	
454.0	500.0	18.0	23.0	●	
455.0	505.0	22.0	25.0		●
458.0	494.0	12.0	18.0	●	
460.0	500.0	18.0	20.0	●	
460.0	500.0	20.0	20.0	●	
460.0	510.0	22.0	25.0	●	●
460.0	510.0	25.0	25.0	●	
460.0	510.8	20.6	25.4	●	
460.0	510.8	25.4	25.4	●	
460.0	520.0	30.0	30.0	●	
467.0	510.0	20.0	21.5	●	
467.0	510.0	25.0	21.5		●

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Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
470.0	520.0	22.0	25.0	●	●
470.0	520.0	25.0	25.0	●	
474.0	514.0	20.0	20.0	●	
475.0	530.0	18.0	27.5	●	●
475.0	530.0	20.0	27.5	●	
477.0	527.0	22.0	25.0		●
480.0	520.0	16.0	20.0	●	
480.0	520.0	20.0	20.0	●	
480.0	530.0	22.0	25.0	●	●
480.0	530.0	25.0	25.0	●	
482.0	530.0	20.0	24.0	●	
485.0	535.0	22.0	25.0	●	
490.0	540.0	22.0	25.0		●
495.0	545.0	25.0	25.0		●
497.0	538.0	20.0	20.5	●	
500.0	540.0	20.0	20.0	●	
500.0	544.0	20.0	22.0	●	
500.0	550.0	22.0	25.0	●	
500.0	550.0	22.0	25.0	●	●
503.0	552.0	20.0	24.5	●	
508.0	555.0	22.0	23.5	●	
508.0	558.0	22.0	25.0	●	
508.0	558.0	25.0	25.0	●	
510.0	550.0	20.0	20.0	●	
510.0	554.0	20.0	22.0	●	
510.0	560.0	20.0	25.0	●	
510.0	560.0	22.0	25.0	●	
520.0	564.0	20.0	22.0	●	
520.0	570.0	19.0	25.0	●	
520.0	570.0	22.0	25.0	●	
520.0	570.0	25.0	25.0	●	
520.0	570.8	20.6	25.4	●	
520.0	572.0	25.0	26.0	●	
525.0	575.0	22.0	25.0	●	●
527.0	587.0	30.0	30.0	●	
527.0	587.0	38.0	30.0		●
528.0	578.0	22.0	25.0		●
530.0	565.0	20.0	17.5	●	
530.0	566.0	18.0	18.0	●	
530.0	570.0	22.0	20.0	●	
530.0	580.0	20.0	25.0	●	
530.0	580.0	22.0	25.0	●	
530.0	580.0	25.0	25.0	●	
530.0	580.8	22.2	25.4	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
533.0	577.0	25.0	22.0	●	
540.0	584.0	20.0	22.0	●	
540.0	590.0	22.0	25.0	●	●
540.0	590.0	25.0	25.0		●
542.0	578.0	18.0	18.0	●	
545.0	595.0	22.0	25.0	●	
550.0	600.0	22.0	25.0	●	●
550.0	610.0	25.0	30.0	●	
555.0	605.0	22.0	25.0		●
556.0	600.0	22.0	22.0	●	
558.0	589.0	19.0	15.5	●	
560.0	598.0	19.0	19.0	●	
560.0	610.0	20.0	25.0	●	
560.0	610.0	22.0	25.0	●	
570.0	620.0	22.0	25.0	●	●
570.0	620.0	25.0	25.0	●	
575.0	611.0	16.0	18.0	●	
575.0	625.0	22.0	25.0	●	
580.0	605.4	12.7	12.7	●	
580.0	615.0	20.0	17.5	●	
580.0	616.0	16.0	18.0	●	●
580.0	630.0	22.0	25.0	●	
580.0	630.0	34.0	25.0	●	
586.0	646.0	22.0	30.0	●	
590.0	640.0	20.0	25.0	●	
590.0	640.0	22.0	25.0	●	
596.0	646.0	22.0	25.0	●	
600.0	632.0	12.5	16.0	●	
600.0	640.0	20.0	20.0	●	
600.0	650.0	22.0	25.0	●	
600.0	650.0	30.0	25.0	●	
600.0	664.0	25.0	32.0		●
603.0	640.0	16.0	18.5	●	
604.0	640.0	18.0	18.0	●	
610.0	660.0	22.0	25.0	●	
614.0	659.0	20.0	22.5	●	
615.0	665.0	24.5	25.0	●	
615.0	679.0	24.5	32.0	●	
620.0	670.0	22.0	25.0	●	
620.0	684.0	25.0	32.0	●	●
625.0	689.0	25.0	32.0	●	
640.0	680.0	20.0	20.0		●

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Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
650.0	689.0	19.0	19.5	●	
650.0	690.0	20.0	20.0	●	
650.0	700.0	22.0	25.0		●
650.0	714.0	25.0	32.0	●	●
650.0	720.0	28.5	35.0		●
660.0	710.0	22.0	25.0	●	
660.0	724.0	25.0	32.0	●	
660.0	724.0	28.0	32.0		●
665.0	729.0	25.0	32.0	●	●
670.0	714.0	22.0	22.0		●
670.0	735.0	25.0	32.5	●	
680.0	730.0	20.0	25.0	●	
681.0	744.5	25.4	31.7	●	
685.0	749.0	25.0	32.0	●	
686.0	740.0	25.0	27.0	●	
700.0	764.0	25.0	32.0	●	●
710.0	760.0	20.0	25.0	●	
710.0	770.0	30.0	30.0	●	
710.0	774.0	25.0	32.0	●	●
715.0	779.0	25.0	32.0	●	
720.0	760.0	18.0	20.0		●
730.0	794.0	25.0	32.0	●	●
735.0	793.0	25.0	29.0		●
740.0	780.0	18.0	20.0		●
740.0	790.0	20.0	25.0	●	
744.0	794.0	25.0	25.0		●
744.0	808.0	25.0	32.0	●	
750.0	780.0	18.0	15.0	●	
750.0	789.0	19.0	19.5	●	
750.0	810.0	30.0	30.0	●	
750.0	814.0	25.0	32.0	●	
760.0	800.0	20.0	20.0	●	
760.0	820.0	30.0	30.0	●	
762.0	803.0	25.4	20.5		●
762.0	825.5	25.4	31.7	●	
765.0	825.0	26.0	30.0	●	
770.0	845.0	27.5	37.5		●
775.0	839.0	25.0	32.0	●	
775.0	839.0	31.0	32.0		●
777.0	841.0	25.0	32.0	●	
780.0	820.0	18.0	20.0	●	●
780.0	844.0	25.0	32.0	●	
786.0	836.0	25.0	25.0	●	
790.0	850.0	30.0	30.0	●	

Dimensions				Type	
d ₁	d ₂	b	f	TRJ	TRL
790.0	854.0	25.0	32.0	●	
800.0	860.0	30.0	30.0	●	
800.0	864.0	25.0	32.0	●	●
800.0	870.0	30.0	35.0	●	
810.0	860.0	25.0	25.0	●	
810.0	870.0	25.0	30.0	●	
810.0	874.0	25.0	32.0		●
820.0	884.0	25.0	32.0	●	
832.0	870.0	19.0	19.0	●	
840.0	904.0	25.0	32.0	●	
850.0	914.0	25.0	32.0	●	●
860.0	920.0	25.0	30.0	●	
860.0	924.0	25.0	32.0		●
870.0	934.0	25.0	32.0		●
880.0	944.0	25.0	32.0	●	
889.0	970.0	21.0	40.5		●
890.0	954.0	25.0	32.0	●	
898.0	960.0	30.0	31.0		●
900.0	960.0	30.0	30.0	●	
910.0	966.0	25.0	28.0		●
920.0	984.0	25.0	32.0	●	
935.0	999.0	25.0	32.0	●	
940.0	995.0	25.0	27.5		●
940.0	1,000.0	30.0	30.0	●	
950.0	1,000.0	25.0	25.0	●	
950.0	1,010.0	30.0	30.0	●	
960.0	1,024.0	25.0	32.0	●	
1,000.0	1,050.0	25.0	25.0		●
1,000.0	1,064.0	25.0	32.0	●	
1,020.0	1,084.0	25.0	32.0	●	
1,055.0	1,119.0	25.0	32.0		●
1,060.0	1,124.0	25.0	32.0		●
1,150.0	1,214.0	25.0	32.0	●	
1,220.0	1,284.0	25.0	32.0		●
1,250.0	1,300.0	22.0	25.0		●
1,250.0	1,314.0	25.0	32.0	●	
1,320.0	1,398.0	32.0	39.0	●	
1,320.0	1,420.0	49.0	50.0		●
1,580.0	1,644.0	25.0	32.0		●
1,790.0	1,854.0	24.7	32.0		●
1,890.0	1,954.0	25.0	32.0		●

Additional dimensions are available on request.

Contact your local Customer Solution Center for more information.

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Stefa® Cassette Seal



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■ Stefa® Cassette Seal

■ General Description

The Stefa® Cassette Seal has been developed to meet the ever-increasing requirements of long service life, high functional reliability, environmental safety, simple handling and superior total economy. Stefa® Cassette Seals are fully enclosed seals with an integrated sealing system that perform the function of oil seal, wear sleeve and dust protection in one unit. No extra components such as shaft sleeves or dirt protection are needed.

Unique to all the Trelleborg Sealing Solutions Cassette Seals is that the sealing lip is fixed on the stationary part of the hardware. Because of this, the sealing force is constant, independent of the rotary speed. Stefa® Cassette Seals consist of several individual features working together, built into one unit and for this reason they are called "Systems".

■ System 500

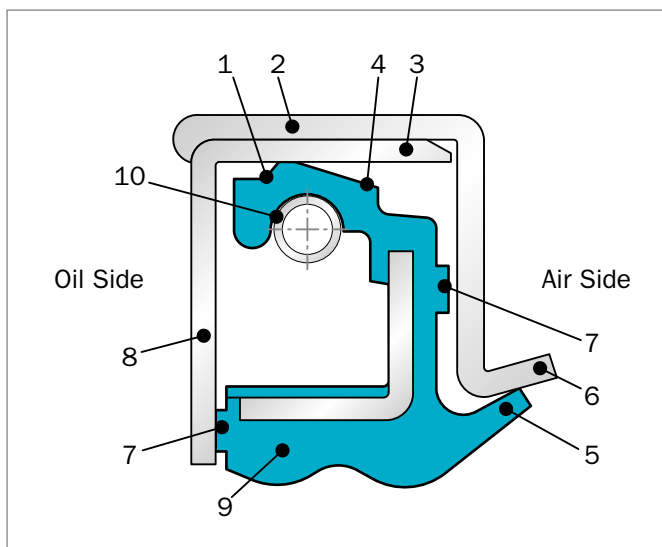


Figure 51: System 500

System 500, the original Unitized Wheel Hub Seal for heavy-duty vehicles, is designed for rotating hubs. The inner section of the System 500 is secured against the shaft. The outer section, press fitted into the wheel hub, rotates together with the hub around the inner section, creating a completely enclosed seal. Dirt and water, the major enemies of hub seals, are effectively kept at distance, whilst the lubrication of the rubber lip remains intact. This decreases friction and increases seal life accordingly.

THE MAIN FEATURES OF THE SYSTEM 500 ARE:

- The sealing (1) element is non-rotating, which means that the radial force is kept unchanged at various speeds.
- The sealing surface (2) is in close contact with the wheel hub, which gives an excellent heat transfer.
- The structure of the sealing counterface (3) has been chosen after several thousands of test hours. The position of the sealing lip ensures best lubrication.
- The sealing lip (4) normally has bi-directional TURBO pattern (see page 126).
- Integral prelubricated dust-sealing (5) functions.
- The protruding conical part (6) of the case deflects heavier particles due to the centrifugal force.
- The excluding lip (5) protects against water splash and finer particles.
- Molded distance lugs (7) automatically locate the sealing element in the right position.
- The lugs (7) are spaced and dimensioned to ensure the sealing lip has adequate lubrication.
- The inner case (8) also protects the sealing lip from direct oil spray caused by taper roller bearings.
- The robust ribs (9) give:
 - A firm seat on the shaft
 - Smooth sliding during installation
 - A positive static seal even if one of the ribs is located on a defective shaft surface
- The compression spring (10) maintains the radial force. The initial force exerted by the sealing element will in some applications reduce due to aging of the rubber exposed to heat, load or chemical action.
- For such applications where the seal is exposed to dirty environments, i.e. off road use, the System 500, can be equipped with additional specially developed dirt protection, the HRV seal.
- In cases where the space does not allow the use of the HRV seal, the System 500HD, a derivative of System 2000 (with additional dust lip), can be used. It has the same outside dimensions, but an extra dust lip inside. Since the casing is identical to System 500, it is readily available in the same sizes. Please contact your local Customer Solution Center for more details.



■ System 2000

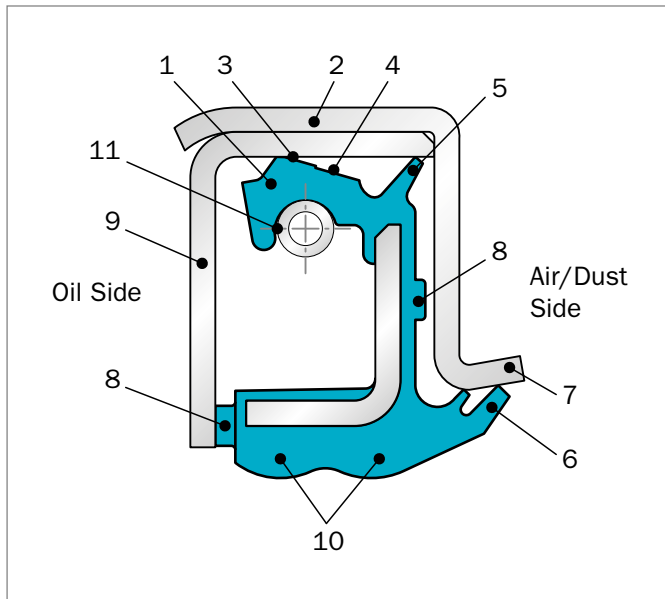


Figure 52: System 2000

System 2000 is a Unitized Stefa® Cassette Seal suitable for wheel hubs working in heavily polluted environments, like agricultural and construction vehicles.

As with System 500 and System 3000, the inner section of the System 2000 is secured against the shaft and is rubberized, while the outer section is press fitted into the bore, and rotates together with the hub around the inner section, creating a completely enclosed seal; the outer diameter can be provided by a sealing paint to increase the static sealing functionality in critical conditions, for example when the bore surface is porous or scratched.

Dirt and water, the major enemies of the off-road hub seals, are effectively kept at a distance due to the many sealing lips, whilst the lubrication of the rubber lip remains intact and is assured by the packing grease. This decreases friction and increases seal life accordingly.

System 2000 is limited in speed compared to System 500, due to the higher number of internal dust sealing lips.

MAIN FEATURES OF SYSTEM 2000

- The sealing (1) lip, if the Cassette Seal is assembled in rotating wheel hubs, is non-rotating and this feature allows the radial force to be kept stable at various speeds.
- The outer sealing surface (2) is in close contact with the wheel hub, which gives excellent heat transfer.
- The structure of the sealing counterface (3) has been chosen after several thousand test hours. The position of the sealing lip ensures optimal lubrication.
- The sealing lip (4) normally has a bi-directional TURBO pattern engraved, that improves sealing capability.
- The internal dust-sealing lip (5), located just behind the primary sealing lip, creates a supplementary grease lubrication chamber near the sealing edge and guarantees an extra barrier against dirt/pollution/water ingress
- External double dust-sealing lips (6) with tailored progressive contact load, provides optimized protection against contaminants while keeping friction low.
- The protruding conical part (7) of the case deflects heavier particles thanks to the centrifugal force.
- Molded distance lugs (8) automatically locate the sealing element in the right position during assembly; they are spaced and dimensioned to ensure adequate lubrication to the sealing lip.
- The inner case (9) protects the sealing lip from direct oil spray caused by tapered roller bearings.
- The inner diameter is provided by two robust ribs (10) that provide a smooth sliding during installation and a positive static seal on scratched shaft surfaces.
- The compression spring (11) energizes the sealing lip keeping a constant radial force during life time.

For such applications where the seal is exposed to extremely dirty and wet environments, i.e. heavy-duty tractors, the System 2000 can be also equipped with an additional specially developed HRV seal lip that looks like an external V-Ring lip sliding against the shaft on the dust side.



■ System 3000

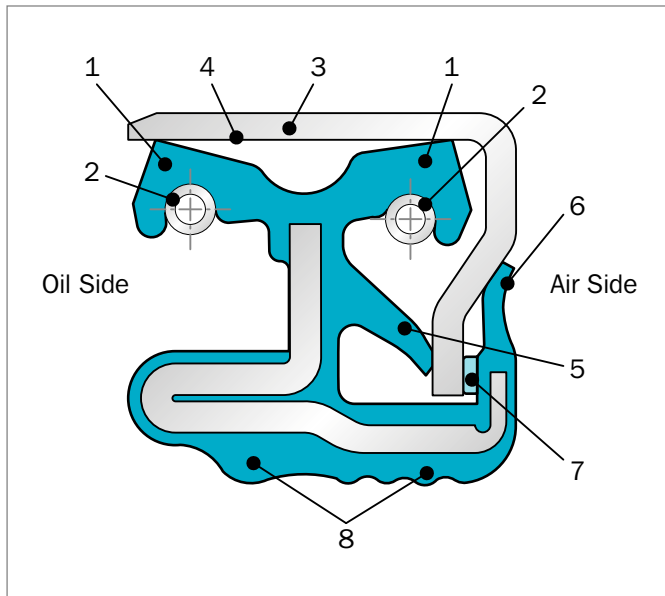


Figure 53: System 3000

System 3000 is a specifically designed Stefa® Cassette Seal for rotating hubs working in very heavily polluted environments, like tractors operating in rice fields, forestry machinery and dumper trucks operating in quarries and mines.

The design of System 3000 has been specifically developed for long term sealing effectiveness; the internal labyrinth lips have been optimized for friction reduction and flexibility.

Mud-box tests realized in laboratories according to the most demanding customer specifications are showing a significant improvement in life time performance compared to other Cassette Seals. System 3000 has excellent ability to seal in oil while excluding water, dust and mud.

Thanks to its optimized design, System 3000 keeps the same ability to sustain eccentricities, over-pressure and shaft misalignment as standard Stefa® Radial Oil Seals.

MAIN FEATURES OF SYSTEM 3000

- System 3000 has tandem energized sealing lips (1) that are stationary against the rotating hub; this feature lets the two lips effectively seal oil and contaminants and are effectively lubricated by the intermediate grease chamber.
- The twin compression springs (2) energize the tandem sealing lips, keeping a constant radial force during life time.
- The outer sealing surface (3) is in close contact with the wheel hub, which gives excellent heat transfer.
- The structure of the sealing counterface (4) has been chosen after several thousand test hours. The position of the sealing lip ensures optimal lubrication.
- Tailored internal axial dust sealing lip (5), has a steady contact with the metal counter-face even in case of eccentricity or axial play. It creates a double labyrinth chamber that effectively traps any pollution.
- An external dust-sealing lip (6), is working again with an axial load minimizing friction and wear, and provides the first barrier against contaminants.
- Molded distance lugs (7) locate the sealing element in the right position during assembly of the shaft.
- The inner diameter combines a large rib and multiple smaller ribs (8) in order to provide smooth sliding during installation and secure sealing against scratched shafts.

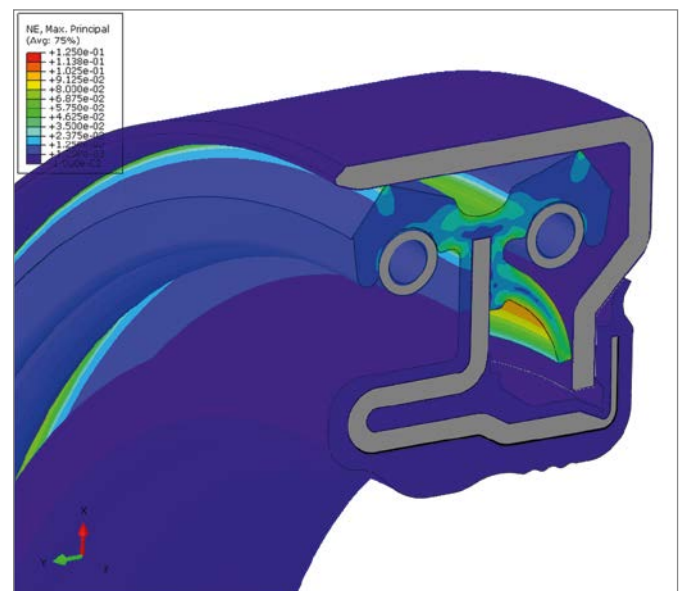


Figure 54: Friction optimization through FEA



■ System 5000

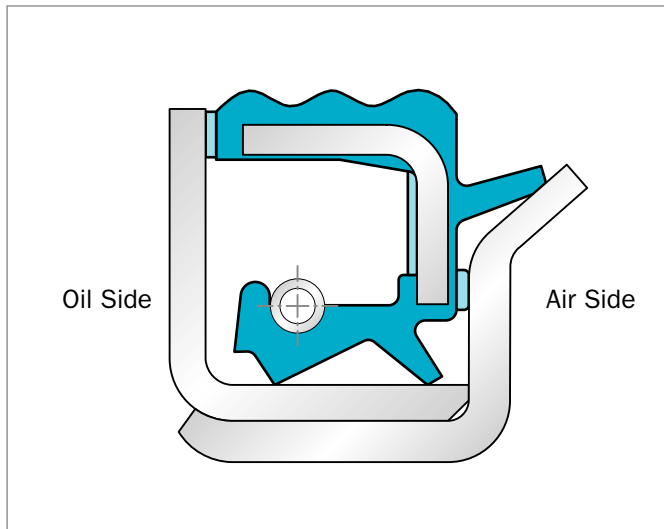


Figure 55: System 5000

System 5000 is, like System 500 and System 3000, a fully enclosed seal, but is designed for rotating shafts. The System 5000 has the same features, but the design has been inverted, i.e. the sealing element is fixed in the stationary housing and the casing components rotate with the shaft.

System 5000 is used to prevent oil from leaking out of a bearing housing, i.e. a differential pinion housing for rear axles on trucks, and at the same time preventing road dirt, salt and water splashes from entering.

The design is compact and integrates the necessary shaft counterface as well as providing dirt exclusion. The dirt exclusion function consists of two rubber lips, one axial and one radial, the space between these filled with grease, and the rotating seal case, which acts as an effective deflector due to the centrifugal force.

TURBO PATTERN - HYDRODYNAMIC SEALING AIDS

TURBO is the Trelleborg Sealing Solutions designation of a range of hydrodynamic sealing aids supporting sealing function. The hydrodynamic sealing aids are located on the air side of the main sealing lip in the form of ribs or other geometrical shapes. Optimum sealing conditions are attained when a thin film of lubricant is formed so that the lip does not come in contact with the sealing counterface. Such conditions are created by the TURBO pattern, which brings about a pumping effect. The pumping effect starts at relatively low shaft speed, and is understood as the capacity of the seal lip to pump the media to be sealed back from the air side to the media side.

In order to avoid leakage at standstill or low speed, the TURBO pattern includes a static edge, which provides a continuous contact line against the counterface. The frictional loss of the seals provided with TURBO pattern is significantly lower than that caused by seals without hydrodynamic sealing aids. A lower friction does also allow higher-rotary speeds, or provides longer service life.

The TURBO pattern is available in three versions: bi-directional, left-hand or right-hand rotation. The standard is bi-directional as most applications have alternating movement of the hub or shaft. If an application has rotation in one direction only, the corresponding left- or right-hand type can be specified. The direction of rotation is always defined as seen from the air side.



■ System CSL 1500

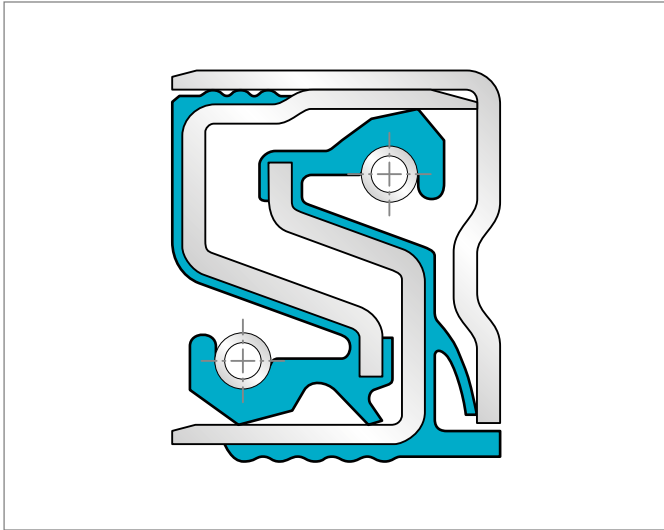


Figure 56: System CSL 1500

CSL 1500 was specially designed for applications in agriculture, vehicle axles, hubs and industrial gearboxes. Its design provides more protection against pollution due to an enlarged space for the grease between the sealing lips, which have also been improved in order to reduce friction and wear.

In the course of this, the oil-side lip based on worldclass standards is open to the oil and thus better cooled.

Design is not only characterized by excellent static sealing and optimized heat dissipation, but also by lower production costs, since crimping and grinding are not necessary.

During assembly, a double metal frame that adds further stability protects the seal from deformation.

Various endurance tests have proven that System CSL 1500 causes no measurable leakage in hot oil tests or any oil contamination in slurry tests. For that reason, System CSL 1500 is a pioneer in enhancing performance in heavy-duty applications.

CSL 1500 is a customized product and will be designed to specifically meet application requirements. Please contact your local Customer Solution Center for more information.

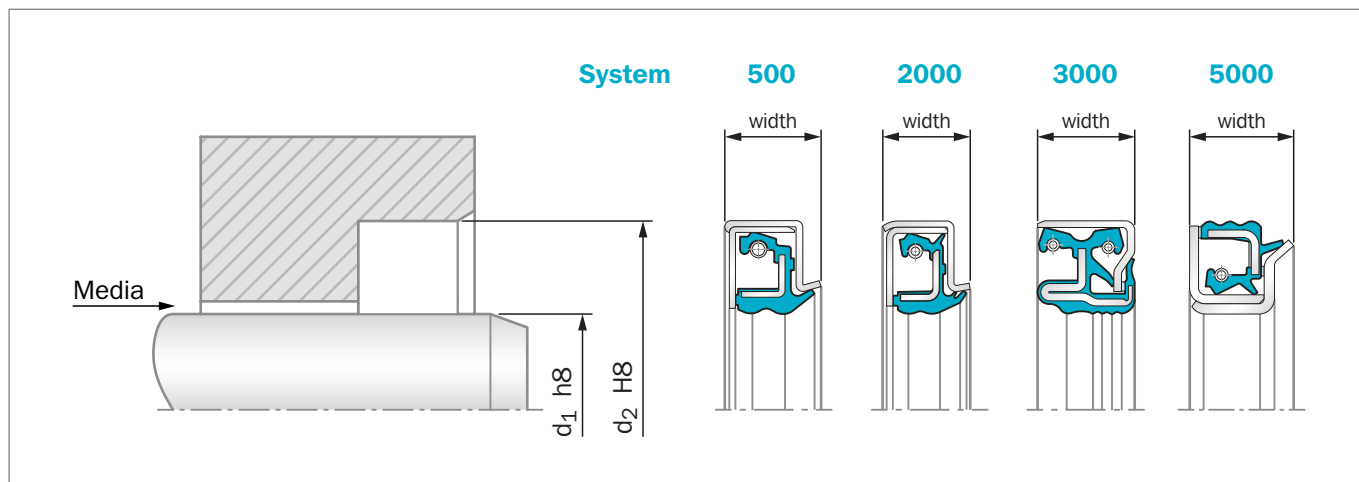


Figure 57: Installation Drawing

Table 38: Standard Dimensions

ID d_1	OD d_2	Width	System 500			System 2000		System 3000		System 5000		
			NBR	HNBR	FKM	NBR	HNBR	NBR	HNBR	NBR	HNBR	FKM
85	140	17								•	•	•
90	130	17	•	•	•							
100	130	17	•	•	•							
100	140	17	•	•	•							
110	140	17	•	•	•							
111	146	17	•	•	•							
120	160	17	•	•	•							
125	160	17	•	•	•							
128	164	17	•	•	•							
130	160	17	•	•	•			•	•			
130	170	17	•	•	•							
135	165	17	•	•	•							
140	170	17	•	•	•							
143.3	190.5	16				•	•					
145	175	17	•	•	•							
149.9	176	16	•	•								
150	180	17						•	•			
155	190	17	•	•	•							
158	188	16					•					
160	191.5	16.5							•			
160	196	17	•	•		•	•					
178	205	17	•	•	•							
178	207.7	16.5						•	•			
187	230	17	•	•	•							