PTFE SEALS HANDBOOK

SECOND EDITION, 2021

NEW DEAL SEALS
SEALING SOLUTIONS

< Preface >

WHO WE ARE

NewDealSeals, a family owned company, was founded in 1994. With a sound business model based on strong family ties, we have created a unique sense of solidarity, flexibility and commitment that underpin our long-term focus on clients, staff, suppliers and the community at large.

WHAT WE MAKE

We design, develop and manufacture the highest quality O-rings and sealing components in the industry. Over 100,000 different sealing components are manufactured each year, from standard O-rings to complex custom made parts,
each available in a wide number of different dimensions, shapes and materials.

KEY FACTS

- 20+ years of sealing expertise
- Design and engineering department
- Material laboratory
- Over 100,000 different sealing components available
- OEM supplier to many different industries

THIS BROCHURE

For the last 20 years, NewDealSeals has been advising companies on the use of PTFE, drawing on the extensive knowledge gained from many different industries, the producers of PTFE and the professional literature.
Our engineers often receive requests to put their recommendations on paper and as a result we have produced The PTFE Handbook. This handbook is not complete, but according to us, it is the best guide on the subject of PTFE products currently available.

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PTFE COMPOUNDS

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HISTORY

In April 1938 during tests with the refrigerant Freon® Dr. Roy J. Plunkett from the Du Pont laboratory in Jackson, New Jersey, discovered a white wax-type polymer which, after further detailed testing at a later undisclosed date, exhibited extraordinary material properties.
The material did not exhibit any change whatsoever when subjected to practically all known chemicals and its surface was so smooth that hardly any foreign substances remained.
Moisture and solar radiation (sunshine) caused neither volumetric change nor disintegration and brittleness. The crystalline change associated with the melting point of the material starts at 327°C without there being any typical thermoplastic liquefaction.

PROCESSING

For the above reasons, process technology similar to powder metallurgy is utilized. PTFE powder is compressed into blocks, rods or tubes, sintered and then mechanically machined to the required shapes. In the meantime, the materials industry has developed PTFE types that for certain defined applications can also be thermoplastically processed.

APPLICATION

The possibility of compounding, i.e. matching physical properties to specific applications through the addition of fillers, is an important factor for the use of PTFE in the manufacture of seals and guide elements.
In spite of its remarkable properties, pure unmixed PTFE has limited use for applications where high mechanical loading is required due to its tendency towards cold extrusion (creep).
Furthermore PTFE is not elastic. For this reason, PTFE seals are provided with a slight amount of tension in relation to the installation diameter. Reliable contact force – even in the absence of system pressure – is guaranteed by an elastomer-expander shaped as an O-ring or rectangular ring or a stainless steel spring. Corresponding to the variances in system pressure, the contact force of the seal changes resulting in a reliable sealing performance across the entire specified pressure area.

FILLERS

The influence of filler materials is particularly illustrated by:

- Improvement in the flow strength
- Reduction of friction and wear
- Increase in strength
- Increase in thermal shape stability
- Increase in hardness

The most important fillers are:

Glass fibres

Improve creep strength over a wide temperature range and increase the chemical stability (with exception of strong alkaline solutions and hydrofluoric acid).

Bronze

Copper/tin alloys mixed with PTFE produce significant improvement in the creep strength and thermal conductivity. High wear resistance in applications with hydraulic media.

Carbon/Graphite

Creep strength, hardness and thermal conductivity are increased. There is also a distinct improvement in wear resistance. Machining of carbon-filled compounds has much less tool wear, and is therefore a favoured method of producing parts to close tolerances. Graphite is the crystalline form of high purity carbon, is chemically inert, and can resist high pressures.

Molybdenum sulphide (MoS_2)

Improved hardness and rigidity and less friction. Only used in small proportions and in conjunction with other fillers.

Calcium fluoride (CaF_2)

Added if the material is to be in contact with chemicals such as hydrofluoric acid or strong alkaline solution.

Polymers

Polymer fillers that are resistant to high temperatures improve friction in contact with soft metals.

Pigments

Pigments are added as colouring agents and have practically no effect on the material properties.

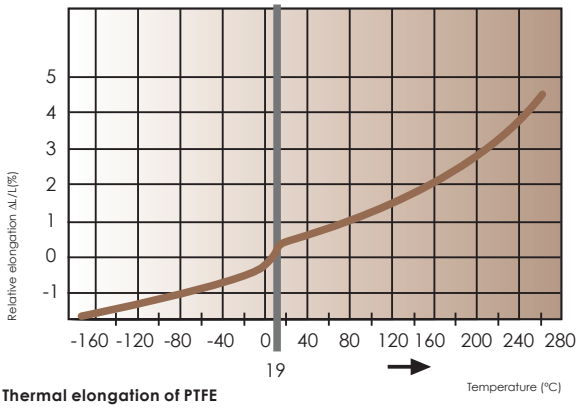
THERMAL BEHAVIOUR OF PTFE

At low temperatures

Even at -269°C (boiling point of Helium) PTFE still has residual extensibility, so that it can also be used under extreme conditions, e.g. in space. The temperature-dependent elongation or shrinking that occurs as with other plastics is reduced by fillers.

At high temperatures

PTFE has exceptional thermal resistance, so that it can be used at prolonged temperatures of 260°C and up to 320°C for limited periods. Fillers have no influence on the PTFE's own thermal resistance. Furthermore, most fillers are themselves stable up to 400°C, so that they do not restrict high temperature use.



Thermal elongation of PTFE

SPECIAL CHARACTERISTICS OF PTFE

Behaviour under vacuum
There are no problems associated with the use of PTFE under vacuum as it has an extremely low vapour pressure (< 10^{-5} mbar at 120°C). There are however restrictions when using graphite fillers.

Adhesion properties with compound components
On account of its exceptional anti-adhesion characteristics, pure PTFE cannot be glued, except with special treatment. Filled compounds have substantially better adhesion properties, but it is recommended that the surface is etched before application of the adhesive. Carbon/graphite filled compounds have the best adhesion properties.

Contact with foodstuffs
Generally, PTFE is suitable for contact with foodstuffs and satisfies FDA requirements. However, it remains the responsibility of the component manufacturer (e.g. in case of seals, the cylinder manufacturer) to ensure that the finished product complies with the standards specified by the FDA.

Electrical properties
PTFE is an excellent insulator with a high dielectric strength, low permittivity and a very high electrical resistance. Apart from carbon and bronze, the familiar fillers do not impair the electrical properties.

Tribological properties
The coefficient of friction is only marginally influenced by fillers. The lowest value is achieved by compounds containing graphite or MoS_2 alone or in combination with glass fibres. The type of filler material strongly influences the wear characteristics. Less wear is experienced with fibrous fillers than with particulates.

PTFE compounds can be used without lubrication. The use of lubricants reduces the coefficient of friction, regardless of whether it is water or lubricating oil. However, it increases the wear rate because in the dry state, the mating surface is "teflonized" by the PTFE compound. This pick-up is restricted by the presence of a liquid. Water greatly increases the wear rate, particularly when using a glass filler. Carbon/Graphite filled materials behave more favourably. With the addition of surface-active agents in water, its surface tension is reduced together with the wear rate of the material.

< PTFE Compounds >

Reference	Compound	Colour	Temperature		Application	Characteristics
			min.	max.		
NDS-100	PTFE virgin	White	-190	+230	Chemical Industry Food Industry	High chemical restistance
NDS-123	PTFE + 15% glass + 5% molybdenum disulfide	Grey	-190	+290	Medium-duty	High chemical restistance High creep resistance Electrical properties like virgin PTFE
NDS-150	PTFE modified	Blue	-190	+230	Low-duty hydraulic applications	Improved wear resistance
NDS-225	PTFE + 25% carbon	Black	-190	+315	Pneumatics Rotary sealing	High wear and creep restistance
NDS-235	PTFE + 10% carbon fibre	Black	-260	+310	Water hydraulics Seawater Short strokes with high frequency	Very good wear properties
NDS-415	PTFE + 15% graphite	Antrachite	-190	+230	Low mechanical stress Soft sealing Surfaces	Chemical resistance
NDS-640	PTFE + 40% bronze	Bronze	-156	+260	Medium and heavy mechanical stress Hydraulic applications	Outstanding wear and creep resistance
NDS-660	PTFE + 60% bronze	Bronze	-156	+260	Heavy mechanical stress Hydraulic applications	Outstanding wear and creep resistance
NDS-750	PTFE + polyimide	Tan	-260	+310	High speed rotating applications	Use against soft metals

Standard Compounds

O-RING MATERIALS FOR PTFE GLIDERING SEALS

Material	Hardness (Shore A)	Temp. (°C)	
		min.	max.
NBR	70 up to 90	-40	108
FKM	70 up to 90	-25	204
FFKM	70 up to 90	-30	325
PU	70 up to 90	-50	108

O-ring materials for PTFE glidering seals

GENERAL INSTALLATION GUIDELINES

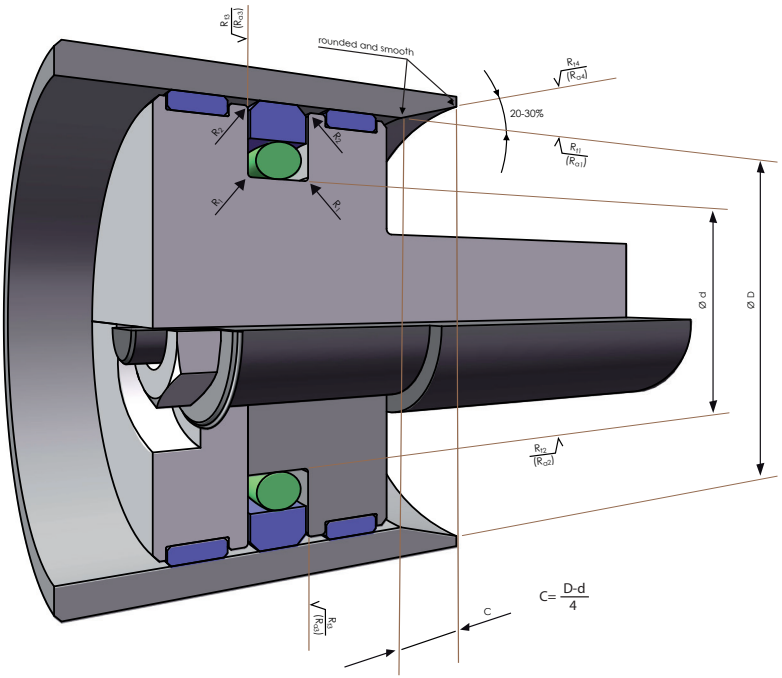
< General installation guidelines >

GUIDELINES FOR PISTON SEALS

International standards (ISO) for seal housing dimensions are in place and should be considered. For seals requiring a special groove, e.g. special seals, valve seals, rotor seals etc., the groove dimensions stated here have already proved themselves and will mostly be found in the standards.
We recommend that customers adhere to the tolerances and surface finishes stated in this catalogue. Only by working to these values will the fitting of seals be made easy and assembly damage avoided.

Surfaces: Grinding as final machining process for dynamic sealing surfaces is not sufficient. These surfaces have to be polished afterwards.

Radii: As for the necessary radii please refer to the respective profile data or the applicable standards.



Solid and split piston

< General installation guidelines >

Dynamic sealing surfaces

$0{,}8\ \mu m \leq R_{t1} \leq 2{,}5\ \mu m$ (R_t 2,5 µm ≙ R_a ≅ 0,28 … 0,6 µm, RMS ≅ 12,5 … 28,3 µin)
$80\ \% \leq {}^*t_{p1} \leq 95\ \%$ (R_t 0,8 µm ≙ R_a ≅ 0,28 … 0,18 µm, RMS ≅ 3,3 … 8,6 µin)
For rubber and PTFE products

$60\ \% \leq {}^*t_{p1} \leq 80\ \%$ (R_t 0,8 µm ≙ R_a ≅ 0,28 … 0,18 µm, RMS ≅ 3,3 … 8,6 µin)
For polyurethane products

Static sealing surfaces

$R_{t2} \leq 6{,}3\ \mu m$ (R_a ≅ 0,81 … 1,59 µm, RMS ≅ 35,6 … 76,3 µin)
${}^*t_{p2} \geq 60\ \%$

Non-sealing surfaces and lead-in chamfers

$R_{t3} \leq 15\ \mu m$ (R_a ≅ 2,2 … 4,0 µm, RMS ≅ 97 … 194 µin)
$R_{t4} \leq 10\ \mu m$ (R_a ≅ 1,4 … 2,6 µm, RMS ≅ 62 … 125 µin)

*Measured in a depth of 25% of the R_t-value, based on a reference level (zero line) set at 5% bearing area.

Installation guidelines for piston seals

The grooves must be carefully cleaned and deburred. The cylinder bore must have a leading edge chamfer. When fitting the piston sealing ring there is always the danger that the ring may tilt and be sheared off by normal leading edge chamfers (see fig. 1). We therefore recommend that up to a cylinder diameter if 230 mm a leading edge chamfer according to fig. 2 or detail A is considered. In the case of smaller rings which are especially liable to bending we recommend an open groove design for diameters smaller than 30 mm.

Assembly instruction for piston seals

Install the O-ring in the groove as per normal practice. Piston sealing rings of up to 100 mm diameter and wall thickness of over 1,6 mm should be slowly expanded and fitted with an assembly tool (see fig. 3). Pre-heating to 60°C in hydraulic oil is advantageous. Larger rings can be expanded by hand. Uneven stretching or overstretching must under all circumstances be avoided.
Should it be necessary to draw the rings over existing guide ring grooves, then these grooves must be covered with plastic tape, or alternatively the expanding mandrel must reach the groove in question (see fig. 3). In this way it is ensured that the piston sealing ring does not snap into the wrong groove. The use of a burnishing shell is recommended when the assembly of a piston is made difficult by an overstretched ring or when the cylinder has an inadequate leading edge chamfer (see fig. 4).
Assembly aids can be manufactured conveniently out of metal. However, in many cases polyamide or POM is also suitable.

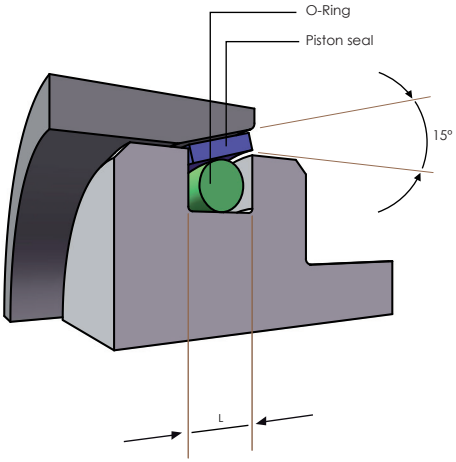
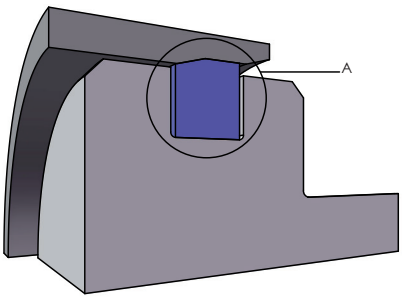
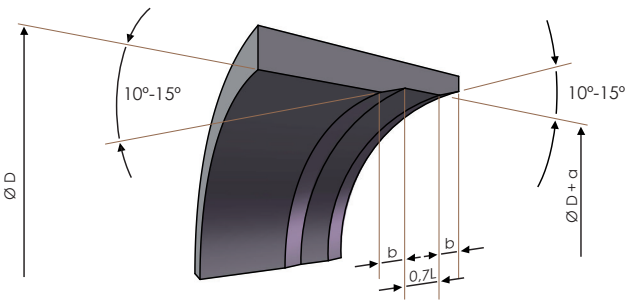


Figure 1





Ø D	min. a	min. b
≤ 45	0,8	2,4
45 - 175	1,0	3,0
175 - 230	1,5	4,5

Figure 2

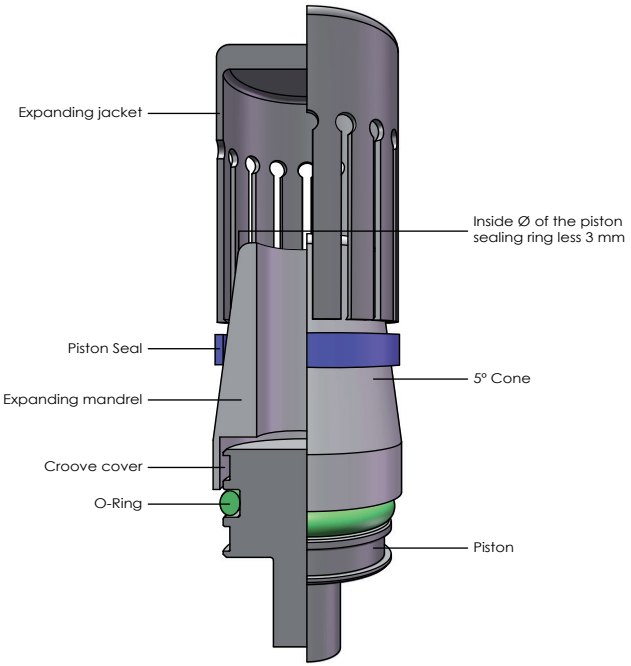


Figure 3

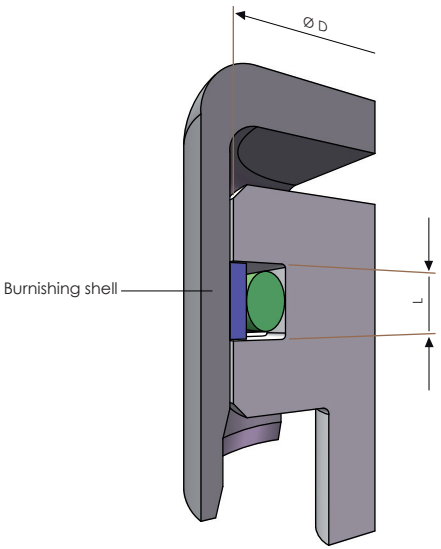


Figure 4

< General installation guidelines >

GUIDELINES FOR ROD SEALS

International standards (ISO) for seal housing dimensions are in place and should be considered. For seals requiring a special groove, e.g. special seals, valve seals, rotor seals etc., the groove dimensions are stated separately. In general, the surface finishes, leading edge chamfers and dimensions stated here have already proved themselves and will mostly be found in the standards.
We recommend that customers adhere to the tolerances and surface finishes stated in this catalogue. Only by working to these values will the fitting of seals be made easy and assembly damage avoided.

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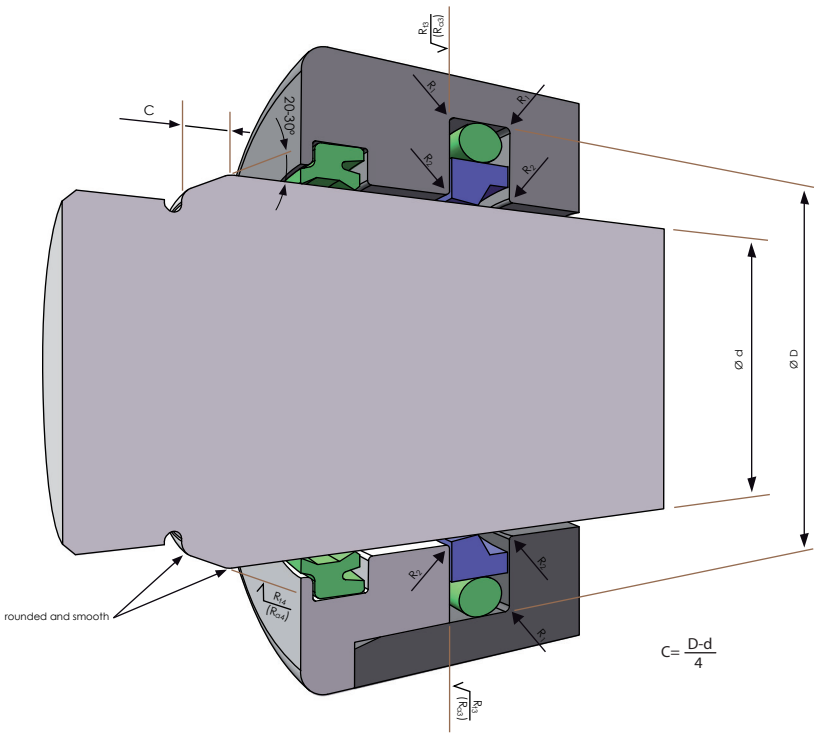


Closed groove and open groove

< General installation guidelines >

Dynamic sealing surfaces

$0{,}8\ \mu m \leq R_{t1} \leq 2{,}5\ \mu m$ (R_t 2,5 µm ≙ $R_a \cong 0{,}28 \ldots 0{,}6$ µm, RMS ≅ 12,5 … 28,3 µin)
$80\ \% \leq {}^*t_{p1} \leq 95\ \%$ (R_t 0,8 µm ≙ $R_a \cong 0{,}28 \ldots 0{,}18$ µm, RMS ≅ 3,3 … 8,6 µin)
For rubber and PTFE products

$60\ \% \leq {}^*t_{p1} \leq 80\ \%$ (R_t 0,8 µm ≙ $R_a \cong 0{,}28 \ldots 0{,}18$ µm, RMS ≅ 3,3 … 8,6 µin)
For polyurethane products

Static sealing surfaces

$R_{t2} \leq 6{,}3\ \mu m$ ($R_a \cong 0{,}81 \ldots 1{,}59$ µm, RMS ≅ 35,6 … 76,3 µin)
${}^*t_{p2} \geq 60\ \%$

Non-sealing surfaces and lead-in chamfers

$R_{t3} \leq 15\ \mu m$ ($R_a \cong 2{,}2 \ldots 4{,}0$ µm, RMS ≅ 97 … 194 µin)
$R_{t4} \leq 10\ \mu m$ ($R_a \cong 1{,}4 \ldots 2{,}6$ µm, RMS ≅ 62 … 125 µin)

*Measured in a depth of 25% of the R_t-value, based on a reference level (zero line) set at 5% bearing area.

Installation guidelines for rod seals

The grooves must be carefully cleaned and deburred. The rods must have a lead-in chamfer (see picture on previous page).
We recommend open groove designs for rod diameters smaller than 30 mm as these rings are prone to breaking if deformed as above.

Assembly instruction for rod seals

First the O-ring must be installed in the groove. Then the rod seal should be carefully formed into a kidney shape without sharp bends as shown in fig.1. This deformed ring is placed in the groove and reformed rounded with the aid of a pin.

Fig. 1: Another type of installation aid. It consists of a metal pin which has a female cone-shaped recess at one of its front-ends. The PTFE ring can be easily placed in the recess deforming it by hand (see fig. 2). Due to the reduced diameter the PTFE ring (still placed on the pin) can now be installed into the groove. After removal of the pin the PTFE ring can be pressed into the grove and reformed.

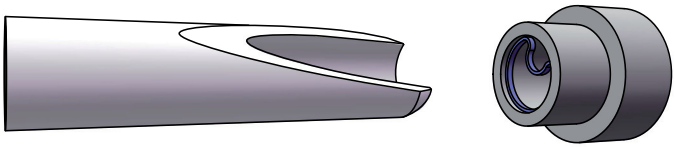


Figure 1

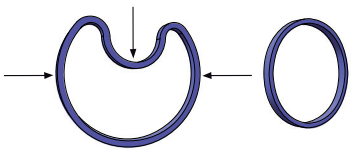
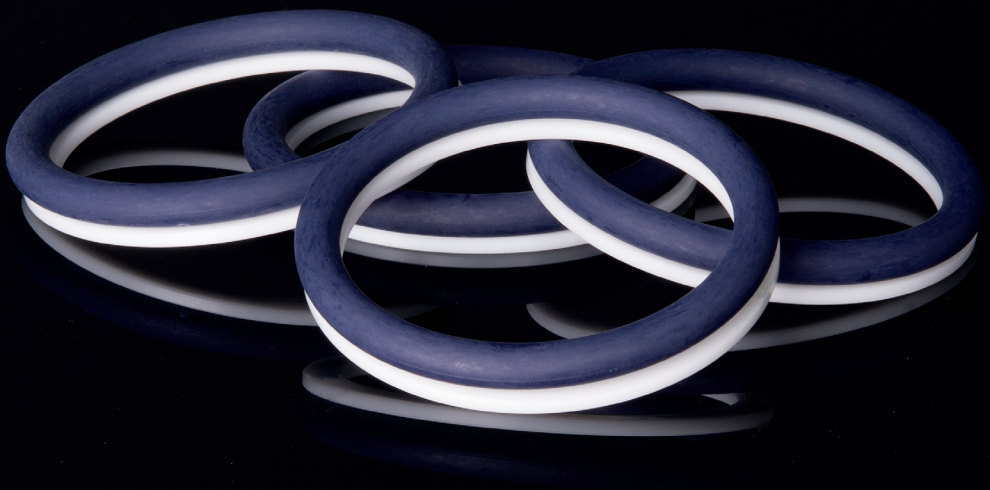


Figure 2

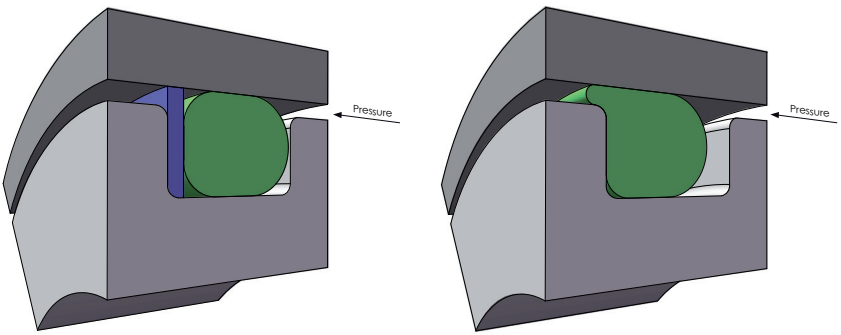
< Notes >



BACK-UP RINGS

< Back-up rings >

Back-up rings are used for static and dynamic applications in connection with O-rings, to prevent extrusion of the O-ring into the diametrical clearance.
The single cut and spiral design rings are easily installed into closed grooves while the single solid designs, recommended for highest pressures, are for installation in open grooves.



O-ring installation with and without back-up ring

We recommend to specify back-up rings when at least one of the following working conditions is present in cases where the intention is to seal with O-rings only:

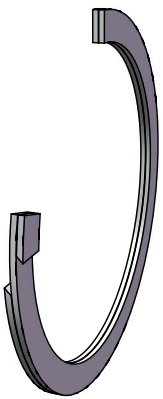
- Pressure above 50 bar.
- Diametrical clearance exceeding 0,25 mm at p > 10 bar.
- High stroke frequency.
- High temperatures.
- Contaminated medium.
- Strong pressure pulsing or pressure changes.

PROFILE T1

- Rectangular cross-section.
- Cut angle of 30°.
- Consists as standard two spiral windings which are cut at the ends at an angle.
- Static and dynamic use.
- For reciprocating movements only.

Advantage compared to T2, T3, T4 and T5:

- Compensation of large temperature changes and tolerances.



Back-up ring type T1

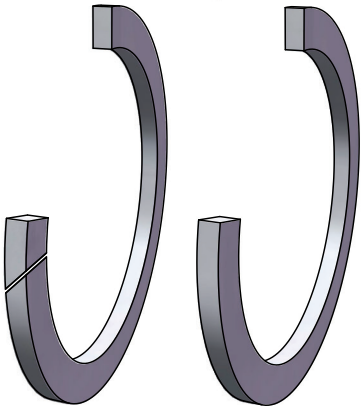
< Back-up rings >

PROFILE T2 & T3

- Rectangular cross-section.
- T2 (cut angle of 30°) and T3 (no cut).
- Static and dynamic use.
- A divisible groove is recommended for external sealing for the T3 type, the T2 type is preferred for internal sealing applications when installed in closed grooves where uncut back-up rings are not suitable.

Advantage compared to T1, T4 and T5:

- Reciprocating and rotating movements possible.
- Economic price level.



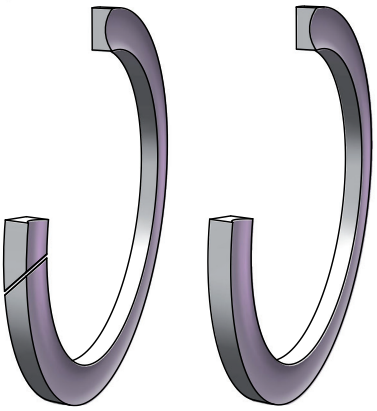
Back-up ring type T2 & T3

PROFILE T4 & T5

- Concave cross-section.
- T4 (cut angle of 45°) and T5 (no cut).
- Static and dynamic use.
- A divisible groove is recommended for external sealing for the T5 type, the T4 type is preferred for internal sealing applications when installed in closed grooves where uncut back-up rings are not suitable.

Advantage compared to T1, T2 and T3:

- Reciprocating and rotating movements possible.
- The large contact surface protects the O-ring against deformation in case of high pulsating pressure.
- Dimensional stability of the O-ring improves the sealing force and increases the service life.

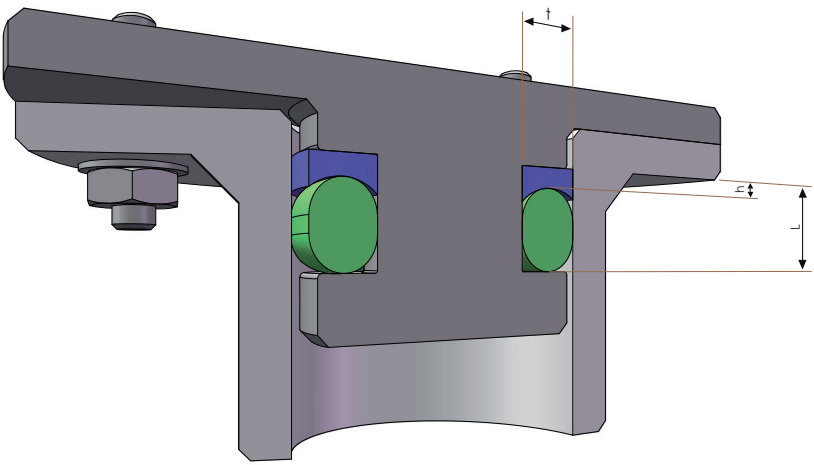


Back-up ring type T4 & T5

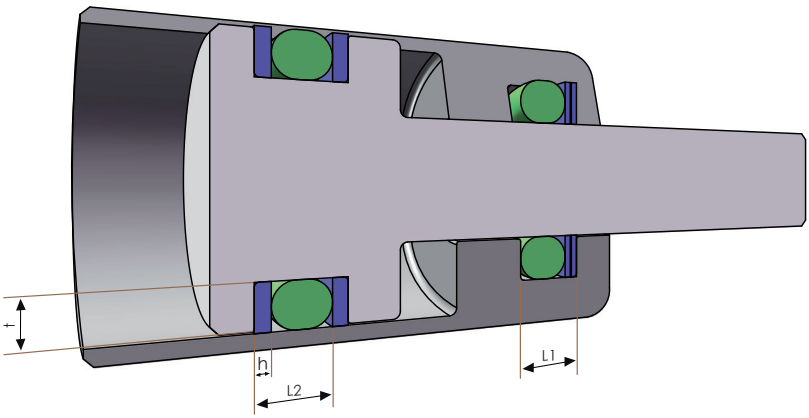
Housing dimensions and installation

In case of single-acting O-rings, it is sufficient to install only one back-up ring on the leeside of the O-rings. In case of double-acting sealing, two back-up rings are required.

Installation grooves should basically be produced with a rectangular cross-section (parallel side walls). If this for machining reasons is impossible, max. deviation of 5° is allowed.



Installation back-up ring static application



Installation back-up ring dynamic application

< Back-up rings >

O-ring cross-section (mm)	Back-up ring dimension h (mm)	Groove depth		
		Static t (mm)	Dynamic Hydraulic t (mm)	Dynamic Pneumatic t (mm)
1,78 (1,80)	1,0 ±0,1	1,30 ±0,05	1,45 ±0,02	1,55 ±0,02
2,00	1,0 ±0,1	1,50 ±0,05	1,65 ±0,02	1,75 ±0,02
2,40	1,5 ±0,1	1,85 ±0,05	2,00 ±0,02	2,10 ±0,02
2,50	1,5 ±0,1	1,95 ±0,05	2,10 ±0,02	2,20 ±0,02
2,62 (2,65)	1,5 ±0,1	2,05 ±0,05	2,25 ±0,02	2,35 ±0,02
3,00	1,5 ±0,1	2,40 ±0,05	2,55 ±0,02	2,70 ±0,02
3,53 (3,55)	1,5 ±0,1	2,85 ±0,07	3,10 ±0,05	3,25 ±0,05
4,00	1,5 ±0,1	3,25 ±0,07	3,50 ±0,05	3,65 ±0,05
5,00	2,0 ±0,1	4,15 ±0,10	4,45 ±0,05	4,65 ±0,05
5,33 (5,30)	2,0 ±0,1	4,40 ±0,10	4,70 ±0,05	4,90 ±0,05
5,70	2,0 ±0,1	4,70 ±0,10	5,10 ±0,05	5,30 ±0,05
6,00	2,0 ±0,1	5,00 ±0,10	5,40 ±0,05	5,60 ±0,05
6,99 (7,00)	2,5 ±0,1	5,85 ±0,10	6,25 ±0,05	6,55 ±0,05
8,00	2,5 ±0,1	6,70 ±0,10	7,10 ±0,05	7,45 ±0,05
8,40	2,5 ±0,1	7,00 ±0,10	7,55 ±0,05	7,90 ±0,05
2,00	1,4 ±0,1	1,55 ±0,05	1,65 ±0,02	1,75 ±0,02
2,40	1,4 ±0,1	1,80 ±0,05	2,05 ±0,02	2,10 ±0,02
2,50	1,4 ±0,1	1,90 ±0,05	2,15 ±0,02	2,20 ±0,02
2,62 (2,65)	1,4 ±0,1	2,00 ±0,05	2,25 ±0,02	2,35 ±0,02
3,00	1,4 ±0,1	2,30 ±0,05	2,60 ±0,02	2,70 ±0,02
3,53 (3,55)	1,4 ±0,1	2,70 ±0,07	3,10 ±0,05	3,25 ±0,05
4,00	1,4 ±0,1	3,10 ±0,07	3,50 ±0,05	3,65 ±0,05
5,00	1,7 ±0,1	4,00 ±0,10	4,40 ±0,05	4,65 ±0,05
5,33 (5,30)	1,7 ±0,1	4,30 ±0,10	4,70 ±0,05	4,90 ±0,05
5,70	1,7 ±0,1	4,60 ±0,10	5,00 ±0,05	5,30 ±0,05
6,00	1,7 ±0,1	4,90 ±0,10	5,30 ±0,05	5,60 ±0,05

Housing dimensions

< Back-up rings >

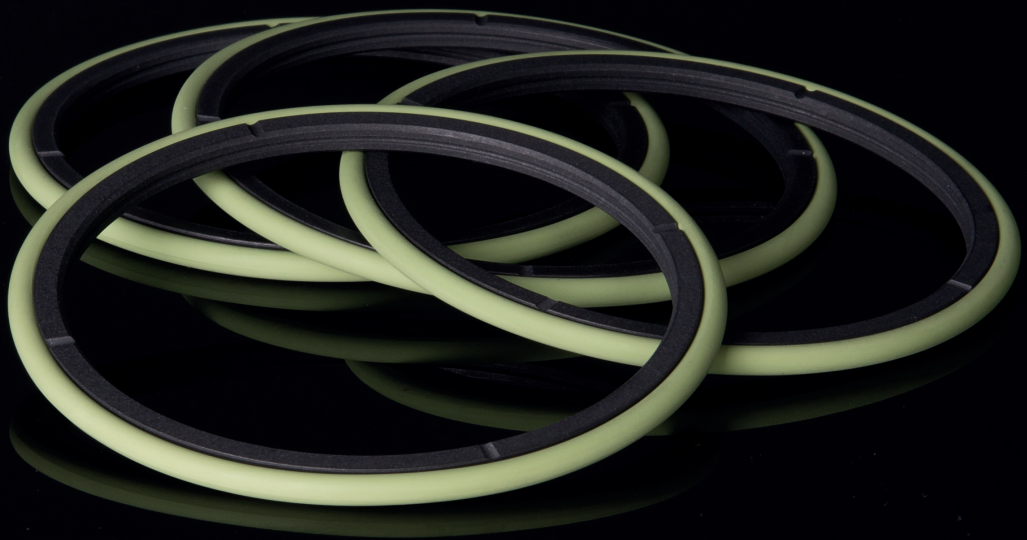
O-ring cross-section	Back-up ring dimension	Groove width			Radius
(mm)	h (mm)	Without back-up ring (mm)	1 Back-up ring L1 (mm)	2 Back-up ring L2 (mm)	Max. t (mm)
1,78 (1,80)	1,0 ±0,1	2,4 +0,2/-0,0	3,4 +0,2/-0,0	4,4 +0,2/-0,0	0,25 ±0,20
2,00	1,0 ±0,1	2,7 +0,2/-0,0	3,7 +0,2/-0,0	4,7 +0,2/-0,0	0,25 ±0,20
2,40	1,5 ±0,1	3,3 +0,2/-0,0	4,7 +0,2/-0,0	6,1 +0,2/-0,0	0,25 ±0,20
2,50	1,5 ±0,1	3,4 +0,2/-0,0	4,9 +0,2/-0,0	6,4 +0,2/-0,0	0,25 ±0,20
2,62 (2,65)	1,5 ±0,1	3,6 +0,2/-0,0	5,1 +0,2/-0,0	6,6 +0,2/-0,0	0,25 ±0,20
3,00	1,5 ±0,1	4,2 +0,2/-0,0	5,7 +0,2/-0,0	7,2 +0,2/-0,0	0,25 ±0,20
3,53 (3,55)	1,5 ±0,1	4,8 +0,2/-0,0	6,3 +0,2/-0,0	7,8 +0,2/-0,0	0,25 ±0,20
4,00	1,5 ±0,1	5,4 +0,2/-0,0	6,9 +0,2/-0,0	8,4 +0,2/-0,0	0,25 ±0,20
5,00	2,0 ±0,1	6,8 +0,2/-0,0	8,8 +0,2/-0,0	10,8 +0,2/-0,0	0,25 ±0,20
5,33 (5,30)	2,0 ±0,1	7,2 +0,2/-0,0	9,2 +0,2/-0,0	11,2 +0,2/-0,0	0,25 ±0,20
5,70	2,0 ±0,1	7,7 +0,2/-0,0	9,9 +0,2/-0,0	12,0 +0,2/-0,0	0,25 ±0,20
6,00	2,0 ±0,1	7,9 +0,2/-0,0	10,2 +0,2/-0,0	12,5 +0,2/-0,0	0,25 ±0,20
6,99 (7,00)	2,5 ±0,1	9,6 +0,2/-0,0	12,1 +0,2/-0,0	14,6 +0,2/-0,0	0,25 ±0,20
8,00	2,5 ±0,1	10,7 +0,2/-0,0	13,4 +0,2/-0,0	16,1 +0,2/-0,0	0,25 ±0,20
8,40	2,5 ±0,1	11,5 +0,2/-0,0	14,6 +0,2/-0,0	17,6 +0,2/-0,0	0,25 ±0,20
2,00	1,4 ±0,1	2,7 +0,2/-0,0	4,1 +0,2/-0,0	5,5 +0,2/-0,0	0,25 ±0,20
2,40	1,4 ±0,1	3,2 +0,2/-0,0	4,6 +0,2/-0,0	6,0 +0,2/-0,0	0,25 ±0,20
2,50	1,4 ±0,1	3,3 +0,2/-0,0	4,7 +0,2/-0,0	6,1 +0,2/-0,0	0,25 ±0,20
2,62 (2,65)	1,4 ±0,1	3,6 +0,2/-0,0	5,0 +0,2/-0,0	6,4 +0,2/-0,0	0,25 ±0,20
3,00	1,4 ±0,1	4,0 +0,2/-0,0	5,4 +0,2/-0,0	6,8 +0,2/-0,0	0,25 ±0,20
3,53 (3,55)	1,4 ±0,1	4,8 +0,2/-0,0	6,2 +0,2/-0,0	7,6 +0,2/-0,0	0,25 ±0,20
4,00	1,4 ±0,1	5,5 +0,2/-0,0	6,9 +0,2/-0,0	8,6 +0,2/-0,0	0,25 ±0,20
5,00	1,7 ±0,1	6,6 +0,2/-0,0	8,3 +0,2/-0,0	10,0 +0,2/-0,0	0,25 ±0,20
5,33 (5,30)	1,7 ±0,1	7,1 +0,2/-0,0	8,8 +0,2/-0,0	10,5 +0,2/-0,0	0,25 ±0,20
5,70	1,7 ±0,1	7,2 +0,2/-0,0	8,9 +0,2/-0,0	10,6 +0,2/-0,0	0,25 ±0,20
6,00	1,7 ±0,1	7,4 +0,2/-0,0	9,3 +0,2/-0,0	11,2 +0,2/-0,0	0,25 ±0,20

Housing dimensions

Compounds

Compounds back-up ring: NDS-100, PTFE virgin
NDS-660, PTFE + 60% bronze
Materials O-ring: NBR, FKM, PU

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

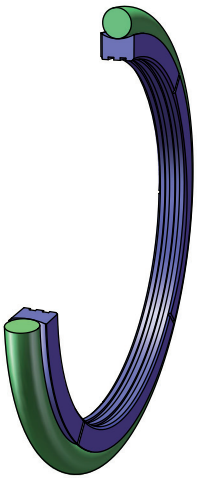


ROTARY SEALS

< Rotary seals >

Producers of rotary transmissions prefer simplified seal designs. This can be achieved by means of internally sealing rotary sealing set profile Y1. They consist of wear resistant glide rings of low friction and of NBR or FKM O-rings as energizer. The rotary sealing set profile Y1 is suitable mainly for applications where the pressure alternates from one side of the seal to the other, such as pivots for rotating track rings, swivel joints, hose reels, and in machine tool hydraulics. If the sealing set is used as an end seal, it is recommended to install a wiper ring at the end of the components.

PROFILE Y1



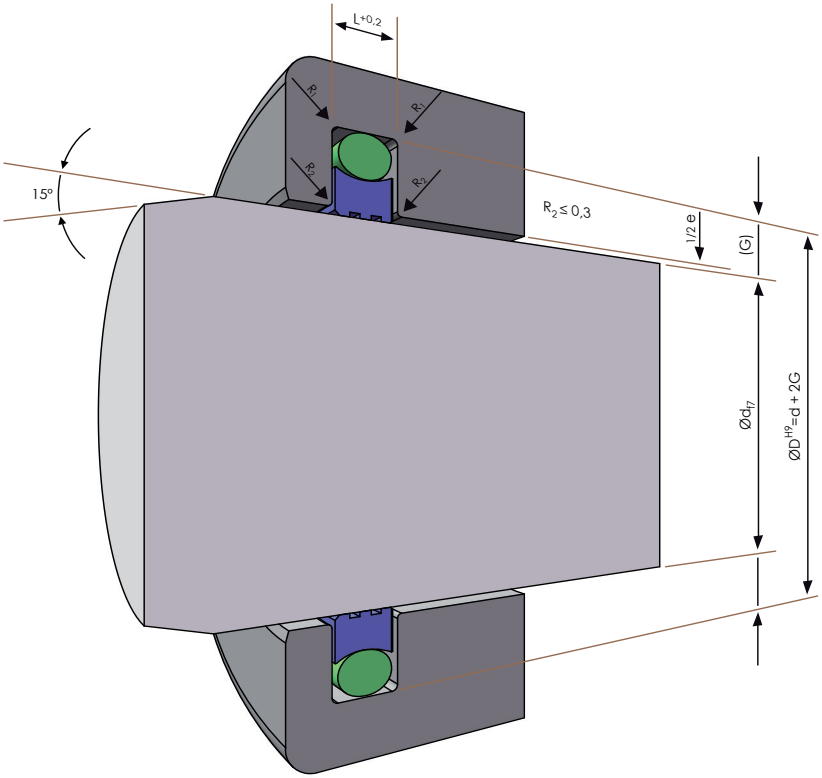
Profile Y1

Considering the special working conditions, the rotary sealing set profile Y1 is equipped with one or two circumferential lubricating grooves.

Advantages:

- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended shaft Ø range d (mm) ≥	<	Groove width L (mm)	Groove depth G (mm)	Gap max. 0-200 bar e (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
1,78	4	8	2,2	2,45	0,4 - 0,2	0,2 - 0,1	0,5
2,62	8	19	3,2	3,75	0,4 - 0,2	0,2 - 0,1	0,5
3,53	19	38	4,2	5,50	0,6 - 0,3	0,3 - 0,2	0,5
5,33	38	200	6,3	7,75	0,8 - 0,4	0,4 - 0,2	0,9
6,99	200	256	8,1	10,50	1,0 - 0,5	0,5 - 0,3	0,9
6,99	256	650	8,1	12,25	1,0 - 0,5	0,5 - 0,3	0,9
8,40	650	1000	9,5	14,00	1,0 - 0,5	0,5 - 0,3	0,9

Housing dimensions

For diameters < 30 mm open grooves are required.

< Rotary seals >

Range of application

Working pressure:	≤ 300 bar
Working temperature	
> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 1,0 m/s

Please apply this seal only in combination with closed guiding elements.

Standard compounds and range

Compounds rotary seal:	NDS-225, PTFE + 25% carbon
Materials O-ring:	NBR, FKM

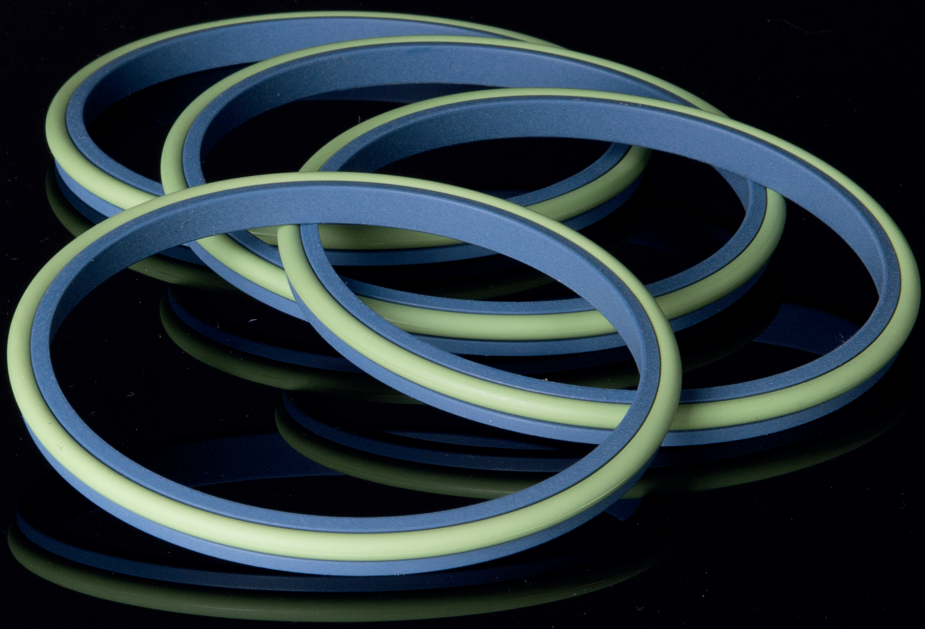
Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
4	8,9	2,2	1,78	6,07
5	9,9	2,2	1,78	6,07
7	11,9	2,2	1,78	9,25
8	15,5	3,2	2,62	10,77
10	17,5	3,2	2,62	12,37
12	19,5	3,2	2,62	15,54
14	21,5	3,2	2,62	17,12
15	22,5	3,2	2,62	18,72
16	23,5	3,2	2,62	18,72
18	25,5	3,2	2,62	20,29
20	31,0	4,2	3,53	24,99
22	33,0	4,2	3,53	26,57
24	35,0	4,2	3,53	28,17
25	36,0	4,2	3,53	29,32
26	37,0	4,2	3,53	31,34
28	39,0	4,2	3,53	32,92
30	41,0	4,2	3,53	34,52
32	43,0	4,2	3,53	36,09
35	46,0	4,2	3,53	37,69
37	48,0	4,2	3,53	40,87
38	53,5	6,3	5,33	43,82
40	55,5	6,3	5,33	46,99
42	57,5	6,3	5,33	46,99
45	60,5	6,3	5,33	50,17
48	63,5	6,3	5,33	53,34
50	65,5	6,3	5,33	56,52
52	67,5	6,3	5,33	56,52
55	70,5	6,3	5,33	59,69
58	73,5	6,3	5,33	62,87
60	75,5	6,3	5,33	66,04
65	80,5	6,3	5,33	69,22
70	85,5	6,3	5,33	75,57
75	90,5	6,3	5,33	81,92
80	95,5	6,3	5,33	85,09
85	100,5	6,3	5,33	91,44
90	105,5	6,3	5,33	94,62
95	110,5	6,3	5,33	100,97
100	115,5	6,3	5,33	104,14
110	125,5	6,3	5,33	116,84
120	135,5	6,3	5,33	126,37
125	140,5	6,3	5,33	129,54
130	145,5	6,3	5,33	135,89

Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
140	155,5	6,3	5,33	145,42
150	165,5	6,3	5,33	151,77
155	170,5	6,3	5,33	158,12
160	175,5	6,3	5,33	164,47
170	185,5	6,3	5,33	177,17
175	190,5	6,3	5,33	177,17
180	195,5	6,3	5,33	183,52
185	200,5	6,3	5,33	189,87
190	205,5	6,3	5,33	196,22
195	210,5	6,3	5,33	196,22
200	221,0	8,1	6,99	202,57
210	231,0	8,1	6,99	215,27
220	241,0	8,1	6,99	227,97
225	246,0	8,1	6,99	227,97
230	251,0	8,1	6,99	240,67
240	261,0	8,1	6,99	240,67
250	271,0	8,1	6,99	253,37
260	284,5	8,1	6,99	266,07
270	294,5	8,1	6,99	278,77
280	304,5	8,1	6,99	291,47
290	314,5	8,1	6,99	304,17
300	324,5	8,1	6,99	304,17
310	334,5	8,1	6,99	316,87
320	344,5	8,1	6,99	329,57
330	354,5	8,1	6,99	342,27
340	364,5	8,1	6,99	354,97
350	374,5	8,1	6,99	354,97
360	384,5	8,1	6,99	367,67
370	394,5	8,1	6,99	380,37
380	404,5	8,1	6,99	393,07
390	414,5	8,1	6,99	405,26
400	424,5	8,1	6,99	405,26
410	434,5	8,1	6,99	417,96
420	444,5	8,1	6,99	430,66
430	454,5	8,1	6,99	443,36
440	464,5	8,1	6,99	443,36
450	474,5	8,1	6,99	456,06
460	484,5	8,1	6,99	468,76
470	494,5	8,1	6,99	481,46
480	504,5	8,1	6,99	494,16
490	514,5	8,1	6,99	494,16
500	524,5	8,1	6,99	506,86

Standard range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

< Notes >

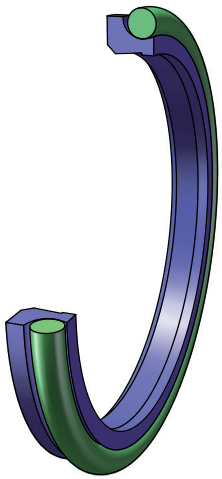


WIPERS

< Wipers >

The function of wiper rings is to prevent dust, dirt, grains of sand and metal dwarf from penetrating into axially moving rods and plungers. Thus the development of scratches is largely prevented, guiding elements are protected and the working life of seals is extended.

PROFILE W1



Profile W1

Profile W1 consists of a double-acting PTFE wiper ring and an O-ring as pretensioning element.

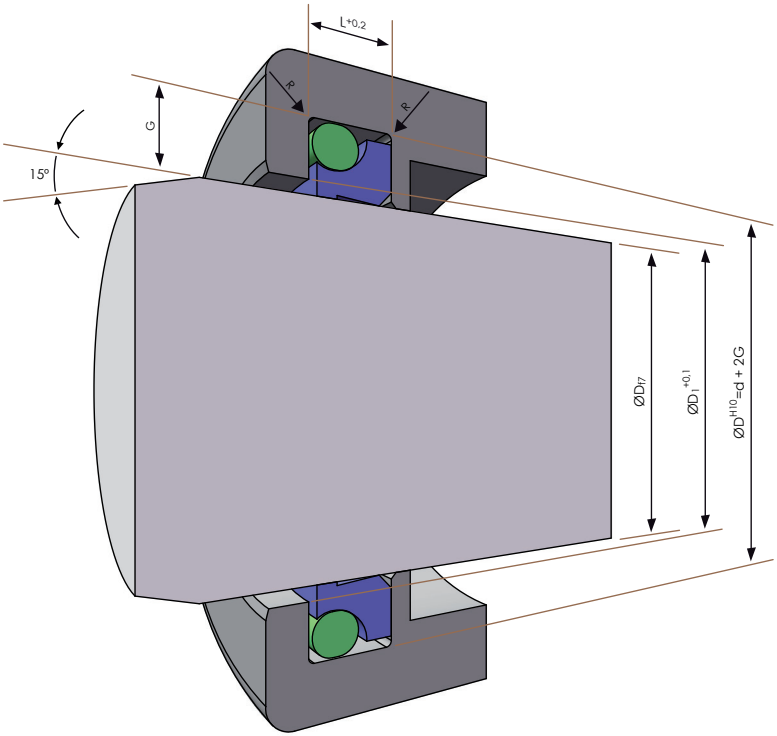
Advantages:

- Small installation grooves.
- Minimal break-out and dynamic sliding friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Excellent sliding properties.
- High wear resistance, therefore long service life.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to W2:

- Capable of sealing dynamic pressure from both sides (bidirectional) at high pressure.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended rod Ø range d (mm)		Groove width	Groove depth	Ø Retainer Ring	Radius max.
	≥	<	L (mm)	G (mm)	D_1 (mm)	R (mm)
1,78	6	12	3,7	2,4	d + 1,5	0,4
2,62	12	65	5,0	3,4	d + 1,5	0,4
3,53	65	250	6,0	4,4	d + 2,0	0,4
5,33	250	420	8,4	6,1	d + 2,0	0,4
6,99	420	650	11,0	8,0	d + 2,5	0,4
8,40	650	1000	14,0	10,0	d + 2,5	0,4
1,78	6	25	4,0	3,0	d + 2,5	0,4
2,62	28	50	5,0	4,0	d + 3,0	0,4
3,53	56	100	6,0	5,0	d + 3,0	0,4
5,33	110	200	8,5	7,5	d + 4,0	0,4
6,99	220	360	12,0	10,0	d + 6,0	0,4

Housing dimensions

< Wipers >

Range of application

Working temperature

> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

Standard compounds and range

Compounds wiper:	NDS-660, PTFE + 60% bronze
Materials O-ring:	NBR, FKM

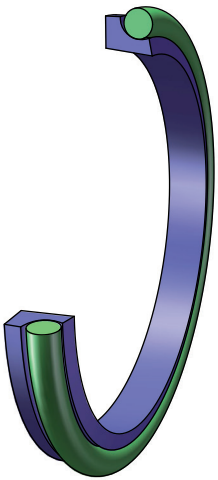
Groove			O-ring	
Ø d (mm)	Ø D (mm)	Ø D_1 (mm)	CS (mm)	ID (mm)
4	8,8	5,5	1,78	5,28
5	9,8	6,5	1,78	6,07
7	11,8	8,5	1,78	7,65
8	12,8	9,5	1,78	9,25
10	14,8	11,5	1,78	10,82
12	18,8	13,5	2,62	13,94
14	20,8	15,5	2,62	15,54
15	21,8	16,5	2,62	17,12
16	22,8	17,5	2,62	18,72
18	24,8	19,5	2,62	20,29
20	26,8	21,5	2,62	21,89
24	30,8	25,5	2,62	25,07
25	31,8	26,5	2,62	26,64
26	32,8	27,5	2,62	28,24
28	34,8	29,5	2,62	29,82
30	36,8	31,5	2,62	31,42
32	38,8	33,5	2,62	34,59
35	41,8	36,5	2,62	36,17
37	43,8	38,5	2,62	39,34
38	44,8	39,5	2,62	40,94
40	46,8	41,5	2,62	42,52
42	48,8	43,5	2,62	44,12
45	51,8	46,5	2,62	47,29
48	54,8	49,5	2,62	50,47
50	56,8	51,5	2,62	52,07
52	58,8	53,5	2,62	53,64
55	61,8	56,5	2,62	56,82
58	64,8	59,5	2,62	59,99
60	66,8	61,5	2,62	61,60
65	73,8	67,0	3,53	66,27
70	78,8	72,0	3,53	72,62
75	83,8	77,0	3,53	75,79
80	88,8	82,0	3,53	82,14
85	93,8	87,0	3,53	85,32
90	98,8	92,0	3,53	91,67
95	103,8	97,0	3,53	98,02
100	108,8	102,0	3,53	101,19
110	118,8	112,0	3,53	110,72
120	128,8	122,0	3,53	123,42
125	133,8	127,0	3,53	126,59
130	138,8	132,0	3,53	132,94
140	148,8	142,0	3,53	142,47

Groove			O-ring	
Ø d (mm)	Ø D (mm)	Ø D_1 (mm)	CS (mm)	ID (mm)
150	158,8	152,0	3,53	151,99
155	163,8	157,0	3,53	158,34
160	168,8	162,0	3,53	164,69
170	178,8	172,0	3,53	171,04
175	183,8	177,0	3,53	177,39
180	188,8	182,0	3,53	183,74
185	193,8	187,0	3,53	183,74
190	198,8	192,0	3,53	190,09
195	203,8	197,0	3,53	196,44
200	208,8	202,0	3,53	202,79
210	218,8	212,0	3,53	209,14
220	228,8	222,0	3,53	221,84
225	233,8	227,0	3,53	228,19
230	238,8	232,0	3,53	234,54
240	248,8	242,0	3,53	240,89
250	258,8	252,0	3,53	253,59
260	272,2	262,0	5,33	266,07
270	282,2	272,0	5,33	278,77
280	292,2	282,0	5,33	278,77
290	302,2	292,0	5,33	291,47
300	312,2	302,0	5,33	304,17
310	322,2	312,0	5,33	304,17
320	332,2	322,0	5,33	329,57
330	342,2	332,0	5,33	329,57
340	352,2	342,0	5,33	329,57
350	362,2	352,0	5,33	354,97
360	372,2	362,0	5,33	354,97
370	382,2	372,0	5,33	354,97
380	392,2	382,0	5,33	380,37
390	402,2	392,0	5,33	380,37
400	412,2	402,0	5,33	405,26
410	422,2	412,0	5,33	405,26
420	432,2	422,5	5,33	430,66
430	446,0	432,5	6,99	430,66
440	456,0	442,5	6,99	443,36
450	466,0	452,5	6,99	456,06
460	476,0	462,5	6,99	468,76
470	486,0	472,5	6,99	468,76
480	496,0	482,5	6,99	481,46
490	506,0	492,5	6,99	494,16
500	516,0	502,5	6,99	506,86

Standard range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE W2



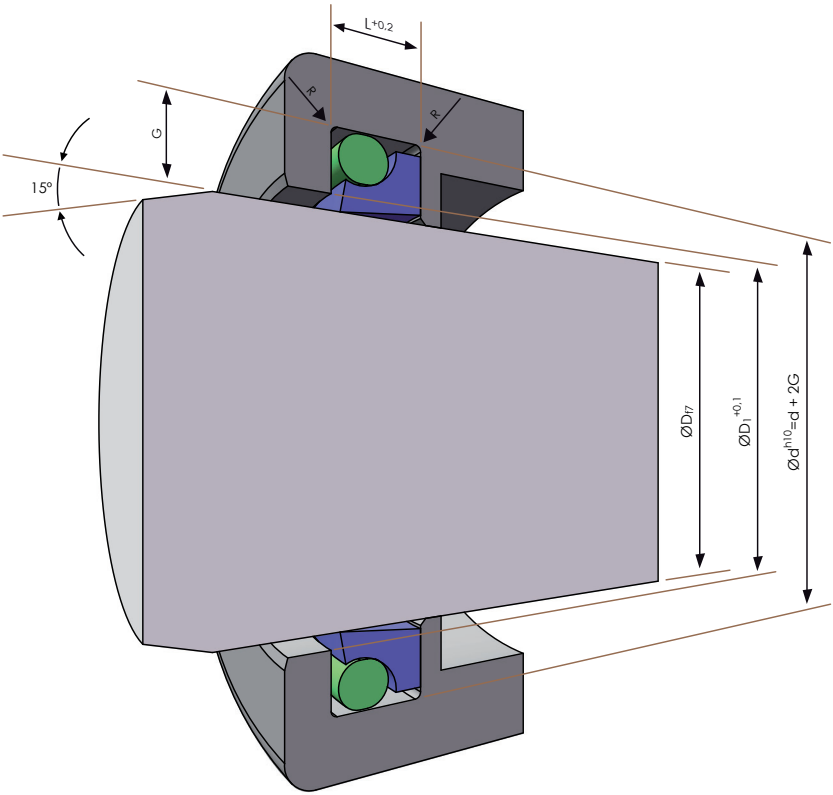
Profile W2

Profile W2 consists of a single-acting PTFE wiper ring and an O-ring as pretensioning element.

Advantages:
- Small installation grooves.
- Minimal break-out and dynamic sliding friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Excellent sliding properties.
- High wear resistance, therefore long service life.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to W1:
- Economic price level.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended rod Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Ø Retainer Ring D_1 (mm)	Radius max. R_1 (mm)
	≥	<				
1,78	6	12	3,7	2,4	d + 2,7	0,4
2,62	12	65	5,0	3,4	d + 3,5	0,4
3,53	65	250	6,0	4,4	d + 4,0	0,4
5,33	250	420	8,4	6,1	d + 4,5	0,4
6,99	420	650	11,0	8,0	d + 5,2	0,4
8,40	650	1000	14,0	10,0	d + 6,6	0,4

Housing dimensions

< Wipers >

Range of application

Working temperature

> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

Standard compounds and range

Compounds wiper:	NDS-150, PTFE modified
Materials O-ring:	NBR, FKM

Groove			O-ring	
Ø d (mm)	Ø D (mm)	Ø D_1 (mm)	CS (mm)	ID (mm)
4	8,8	6,7	1,78	5,28
5	9,8	7,7	1,78	6,07
7	11,8	9,7	1,78	7,65
8	12,8	10,7	1,78	9,25
10	14,8	12,7	1,78	10,82
12	18,8	15,5	2,62	13,94
14	20,8	17,5	2,62	15,54
15	21,8	18,5	2,62	17,12
16	22,8	19,5	2,62	18,72
18	24,8	21,5	2,62	20,29
20	26,8	23,5	2,62	21,89
24	30,8	27,5	2,62	25,07
25	31,8	28,5	2,62	26,64
26	32,8	29,5	2,62	28,24
28	34,8	31,5	2,62	29,82
30	36,8	33,5	2,62	31,42
32	38,8	35,5	2,62	34,59
35	41,8	38,5	2,62	36,17
37	43,8	40,5	2,62	39,34
38	44,8	41,5	2,62	40,94
40	46,8	43,5	2,62	42,52
42	48,8	45,5	2,62	44,12
45	51,8	48,5	2,62	47,29
48	54,8	51,5	2,62	50,47
50	56,8	53,5	2,62	52,07
52	58,8	55,5	2,62	53,64
55	61,8	58,5	2,62	56,82
58	64,8	61,5	2,62	59,99
60	66,8	63,5	2,62	61,60
65	73,8	69,0	3,53	66,27
70	78,8	74,0	3,53	72,62
75	83,8	79,0	3,53	75,79
80	88,8	84,0	3,53	82,14
85	93,8	89,0	3,53	85,32
90	98,8	94,0	3,53	91,67
95	103,8	99,0	3,53	98,02
100	108,8	104,0	3,53	101,19
110	118,8	114,0	3,53	110,72
120	128,8	124,0	3,53	123,42
125	133,8	129,0	3,53	126,59
130	138,8	134,0	3,53	132,94
140	148,8	144,0	3,53	142,47

Groove			O-ring	
Ø d (mm)	Ø D (mm)	Ø D_1 (mm)	CS (mm)	ID (mm)
150	158,8	154,0	3,53	151,99
155	163,8	159,0	3,53	158,34
160	168,8	164,0	3,53	164,69
170	178,8	174,0	3,53	171,04
175	183,8	179,0	3,53	177,39
180	188,8	184,0	3,53	183,74
185	193,8	189,0	3,53	183,74
190	198,8	194,0	3,53	190,09
195	203,8	199,0	3,53	196,44
200	208,8	204,0	3,53	202,79
210	218,8	214,0	3,53	209,14
220	228,8	224,0	3,53	221,84
225	233,8	229,0	3,53	228,19
230	238,8	234,0	3,53	234,54
240	248,8	244,0	3,53	240,89
250	258,8	254,0	3,53	253,59
260	272,2	264,5	5,33	266,07
270	282,2	274,5	5,33	278,77
280	292,2	284,5	5,33	278,77
290	302,2	294,5	5,33	291,47
300	312,2	304,5	5,33	304,17
310	322,2	314,5	5,33	304,17
320	332,2	324,5	5,33	329,57
330	342,2	334,5	5,33	329,57
340	352,2	344,5	5,33	329,57
350	362,2	354,5	5,33	354,97
360	372,2	364,5	5,33	354,97
370	382,2	374,5	5,33	354,97
380	392,2	384,5	5,33	380,37
390	402,2	394,5	5,33	380,37
400	412,2	404,5	5,33	405,26
410	422,2	414,5	5,33	405,26
420	432,2	424,5	5,33	430,66
430	446,0	435,2	6,99	430,66
440	456,0	445,2	6,99	443,36
450	466,0	455,2	6,99	456,06
460	476,0	465,2	6,99	468,76
470	486,0	475,2	6,99	468,76
480	496,0	485,2	6,99	481,46
490	506,0	495,2	6,99	494,16
500	516,0	505,2	6,99	506,86

Standard range

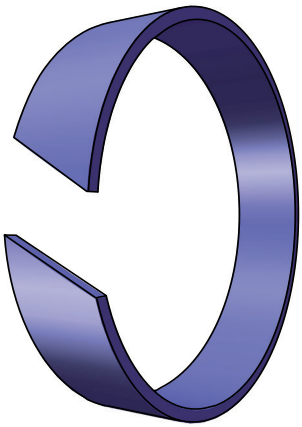
For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

< Notes >

GUIDING TAPES

< Guiding tapes >

GUIDING TAPE G1



Guiding tape G1

The PTFE guidance tape profile G1 is specially designed for use in pneumatic cylinders.

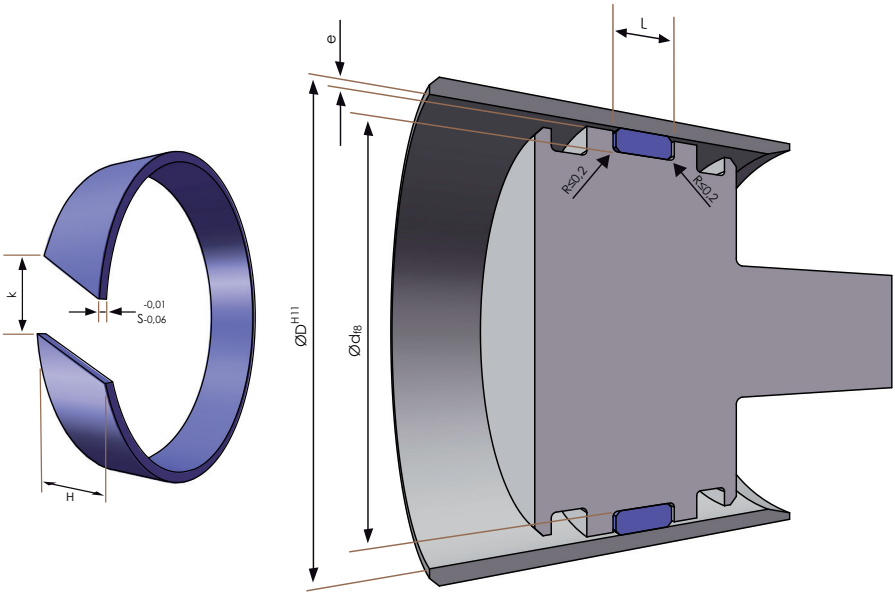
Advantages:

- The tapes can be supplied either cut to length or by the meter, to be cut according to requirement.
- High load capacity (compressive strength), low wear and reduced friction due to an additive of carbon to the PTFE material.
- No tendency to stick-slip in the case of low sliding speed.
- Available in practical dimensions.
- Simple groove designs.
- Simple piston designs without metallic contact of the sliding surfaces.
- Profile geometry which is exactly suited to work in lubricated air as well as dry and oil-free air.

Advantage compared to G2:

- Can be used for pneumatic applications.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

Guiding	Groove			
S (mm)	L (mm)	H (mm)	d (mm)	e (mm)
1,55	4,0 +0,1	3,9 -0,15	D -3,1	0,25
1,55	5,0 +0,1	4,9 -0,15	D -3,1	0,25
1,55	8,0 +0,1	7,8 -0,2	D -3,1	0,25
1,55	9,0 +0,1	8,8 -0,2	D -3,1	0,25
1,55	10,0 +0,1	9,8 -0,2	D -3,1	0,25
1,55	12,0 +0,1	11,8 -0,2	D -3,1	0,25
1,55	13,0 +0,1	12,8 -0,2	D -3,1	0,35
1,55	15,0 +0,1	14,8 -0,3	D -3,1	0,35
1,55	20,0 +0,1	19,5 -0,4	D -3,1	0,35
1,55	25,0 +0,1	24,5 -0,4	D -3,1	0,35

Housing dimensions

< Guiding tapes >

The gap dimensions "e" guarantee an optimum service life of the guiding tapes. For the seals, however, the gaps as mentioned on the respective catalogue pages are to be considered when it is essential to observe full working conditions ("Range of Application").

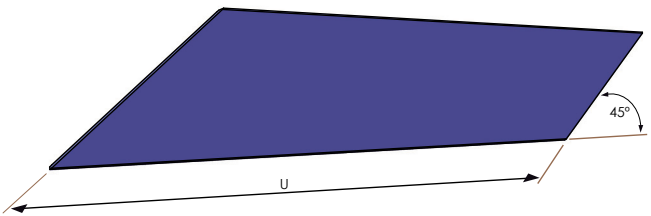
The inner diameter of the groove can be calculated by: d= D-2S. The gap "e" between the cylinder and piston is the maximum value and should not be exceeded.

Calculation of stretched length "U"

The length "U" of the tape is to be calculated from the mean circumferential length less the clearance at the joint "k". The k-values stated in the table are based on a temperature of 120°C.

Cyl.	Stretched length		Gap
Ø D^{H11}	U	Tol. U	k
≤ 45	U = π . (D-S) - k	± 0,25	1,8
> 45		± 0,40	3,5
> 80		± 0,60	4,4
> 100		± 0,80	5,6
> 125		± 1,00	6,6
> 150		± 1,20	8,0
> 180		± 1,40	9,5
> 215		± 1,60	12,0
> 270		± 1,80	15,5
> 330		± 2,00	19,0

Table for calculation of stretched lengths



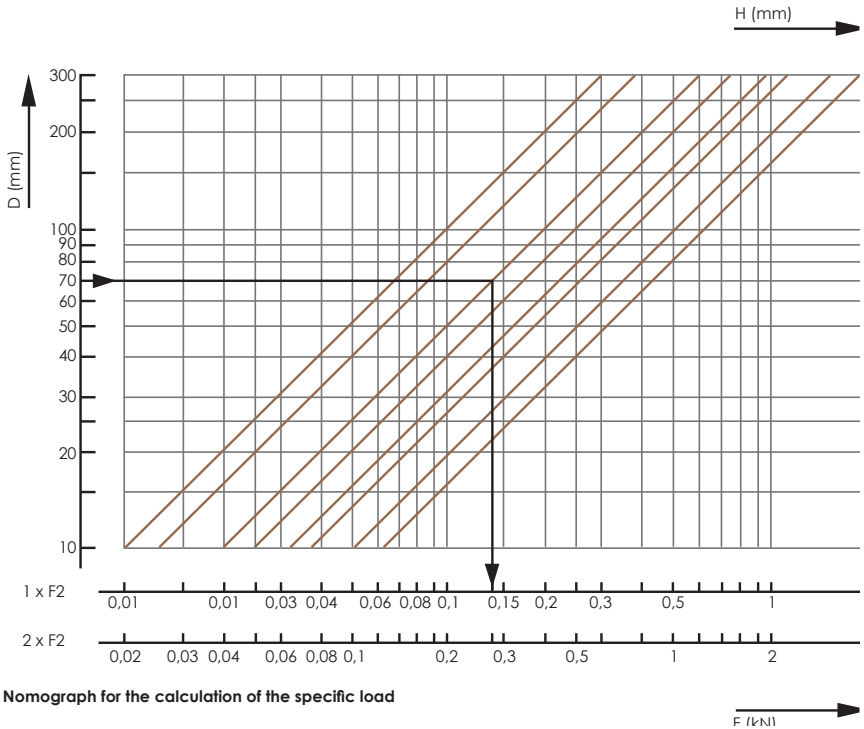
Visualization of stretched length

Selection of the appropriate height "H"

The height H of the tape has to be calculated for the worst possible conditions considering the maximum radial force. The specific load at the tape should in case of working temperatures of ≤ 100°C not exceed q = 2,5 N/mm^2. The calculation of this figure is based on the area from the projection of the height H of the guiding tape multiplied by the cylinder diameter D. The maximum permissible radial force $F_{perm.}$ can be obtained with the formula: $F_{perm.} = H \times D \times q_{perm.}$

< Guiding tapes >

Specific data can be found in the nomograph.



Nomograph for the calculation of the specific load

Example:
A guidance tape diameter D of 70 mm and a guidance tape height of 8 mm result in a maximum permissible radial force of 0,14 kN or 1400 N.

Range of application

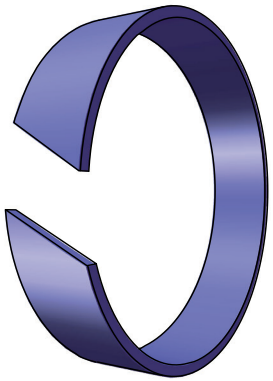
Working temperature:	-100 to +200°C
Surface speed:	≤ 10,0 m/s
Permissible specific load q at working temperature < 100°C:	2,5 N/mm^2

Compounds

Compounds guiding tape:	NDS-225, PTFE + 25% carbon
	NDS-150, PTFE modified

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

GUIDING TAPE G2



Guiding tape G2

The PTFE guidance tape profile G2 is specially designed for use in hydraulic cylinders.

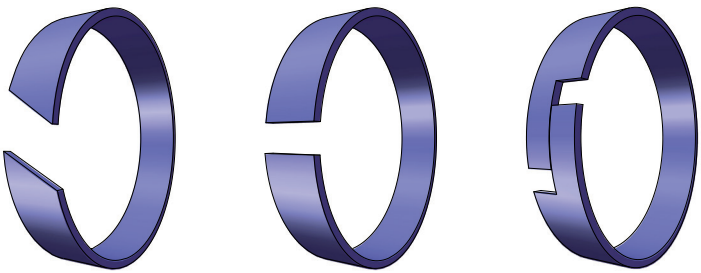
Advantages:

- Tape is available either cut to length or by the meter to be cut according to requirement.
- High load capacity (compressive strength), low wear and reduced friction due to a special additive of bronze to the PTFE material.
- No tendency to stick-slip in the case of low sliding speeds and high radial forces.
- Available in practical dimensions.
- Even with simple groove designs no metallic contact of the sliding surfaces.

Advantage compared to G1:

- Can be used for hydraulic applications.

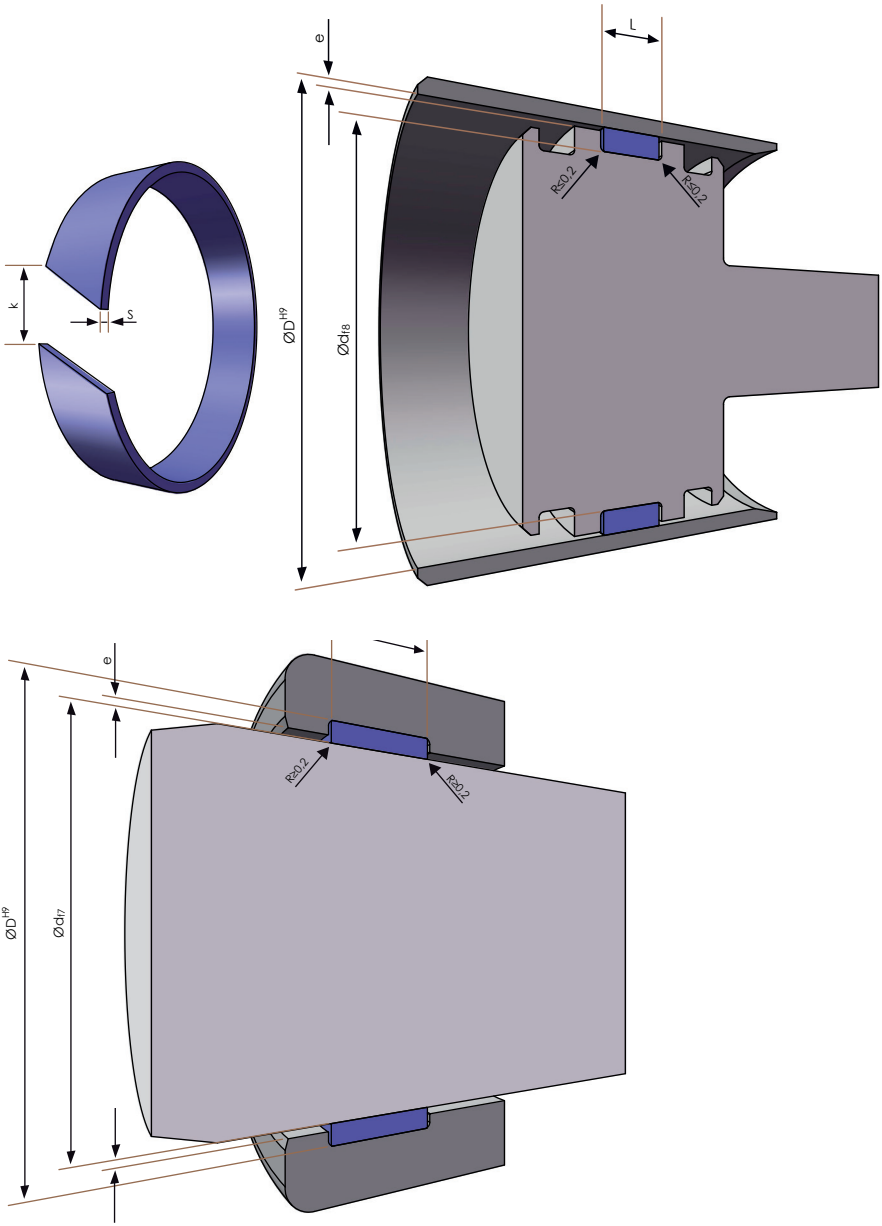
Types of cut



Type A: angle cut **Type B: straight cut** **Type C: Step-cut**

Types A and B are used for bearings where it is imperative that the system pressure is carried on the seals. They are designed as open bearings with a well defined gap. Type C is a closed bearing, which in certain applications is used as a combined seal and bearing.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

< Guiding tapes >

Recommended Ø range	Guiding tape		Groove			
d/D (mm)	S (mm)	Tol. (mm)	L (mm)	d (mm)	D (mm)	e (mm)
≤ 50	1,50	+0,02/-0,03	6,3 +0,1	D -3,0	d +3,0	0,25
≤ 50	1,50	+0,02/-0,03	10,0 +0,1	D -3,0	d +3,0	0,25
≤ 50	1,55	+0,02/-0,03	2,5 +0,1	D -3,1	d +3,1	0,25
≤ 51	1,55	+0,02/-0,03	4,0 +0,1	D -3,1	d +3,1	0,25
≤ 50	1,60	-0,05	2,5 +0,1	D -3,2	d +3,2	0,25
≤ 51	1,60	-0,05	4,0 +0,1	D -3,2	d +3,2	0,25
> 50	2,50	-0,05	4,2 +0,1	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	5,6 +0,1	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	6,3 +0,1	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	8,1 +0,1	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	9,7 +0,1	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	12,7 +0,2	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	15,0 +0,2	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	16,0 +0,2	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	20,0 +0,2	D -5,0	d +5,0	0,40
> 50	2,50	-0,05	25,0 +0,2	D -5,0	d +5,0	0,40

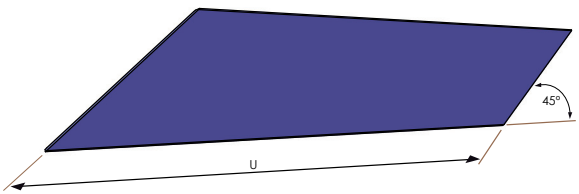
Housing dimensions

The gap dimensions “e” guarantee an optimum service life of the guidance tapes. For the seals, however, the gaps as mentioned on the respective catalogue pages are to be considered when it is essential to observe full working conditions (“Field of Application") for the seals.

CALCULATION OF STRETCHED LENGTH "U"

Cyl. Ø D^{H8} / Rod Ø d^{f7}	Stretched length		Tol.	Gap
	Piston U	Rod U	U	k
≤ 45	U = π . (D-S) - k	U = π . (d+S) - k	± 0,25	1,8
> 45			± 0,40	3,5
> 80			± 0,60	4,4
> 100			± 0,80	5,6
> 125			± 1,00	6,6
> 150			± 1,20	8,0
> 180			± 1,40	9,5
> 215			± 1,60	12,0
> 270			± 1,80	15,5
> 330			± 2,00	19,0

Table of calculation of stretched lengths



Visualization of stretched length

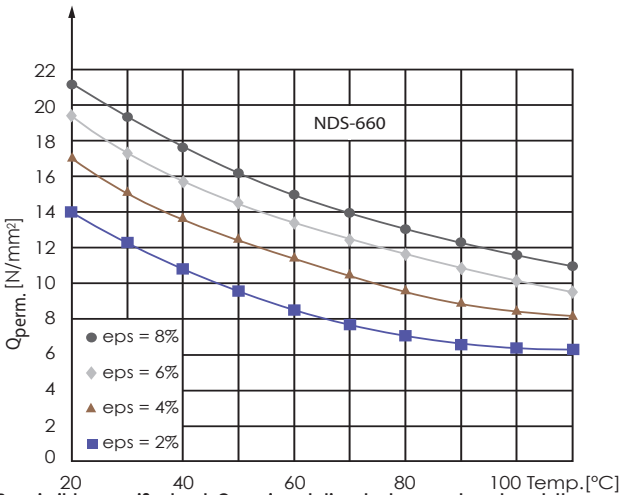
Selection of the axial guiding width L

Choose the appropriate curve for the applicable guide tolerances. Note that the more precise the guidance, the lower the value for the selected eps. The following formula provides the minimum guidance width:

$$L \geq \frac{F}{Q\,(d_i - k \cdot \sqrt{2})}$$

d = inner diameter (mm)
k = gap (mm)
L = guidance width (mm)
$Q_{perm.}$ = permissible specific load (N/mm²)
F = lateral force (N)

We recommend that the largest possible guidance length always be used even if the calculation yields a smaller value.



Permissible specific load $Q_{perm.}$ in relation to temperature t and the respective permanent set for the compounds NDS-660.

Range of application

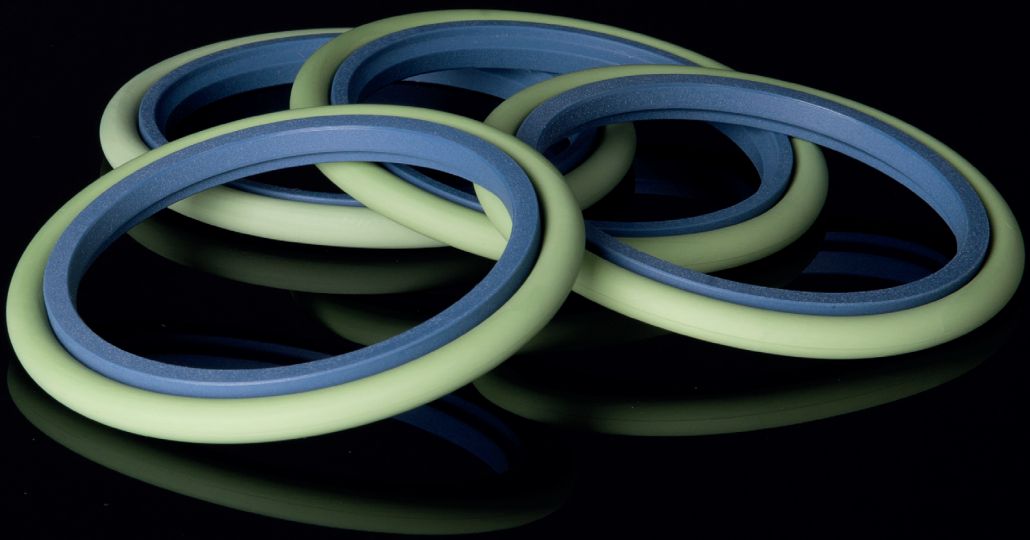
Working temperature:	-100 to +200°C
Surface speed:	≤ 5,0 m/s

Compounds

Compounds guiding tape:	NDS-660, PTFE + 60% bronze

For cylinders made of alloys, light metal and high-grade steel, we recommend the use of compound NDS-225 (PTFE + 25% carbon).

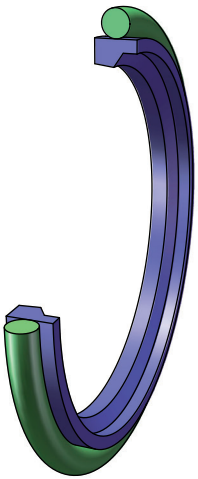
For special requirements (pressure, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.



ROD SEALS

< Rod seals >

PROFILE R1



Profile R1

The rod sealing set profile R1 consists of a single-acting PTFE rod sealing ring and an O-ring. They are combined as a single unit and are appropriate for rods and plungers in hydraulic cylinders.

Profile R1 is particularly suitable for rods in control cylinders, servo-assisted equipment, machine tools and quick acting cylinders. The sealing set is also suitable for applications in the automotive (e.g. shock absorbers) and process industries. An optimal sealing performance will be obtained if the rod sealing set is used in tandem with a double-wiper.

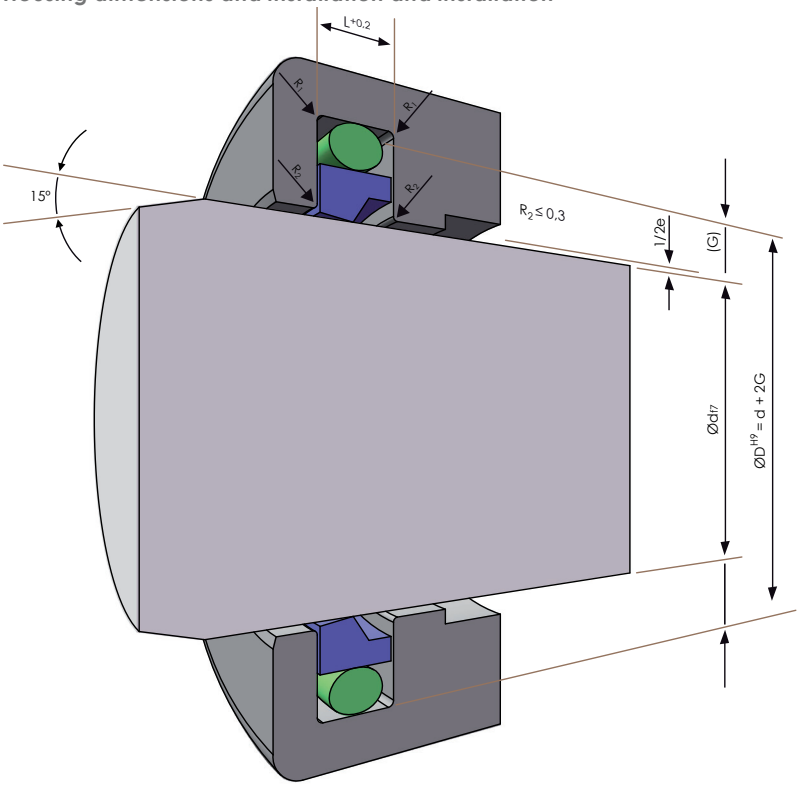
Advantages:

- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to R2 and R3:

- Good back-transport of oil film due to special shape of sealing edge.

Housing dimensions and installation and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended rod Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 0-200 bar e (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<					
1,78	4	8	2,2	2,45	0,6-0,4	0,4-0,2	0,5
2,62	8	19	3,2	3,65	0,8-0,5	0,5-0,3	0,5
3,53	19	38	4,2	5,35	0,8-0,5	0,5-0,3	0,5
5,33	38	200	6,3	7,55	1,0-0,6	0,6-0,4	0,9
6,99	200	256	8,1	10,25	1,0-0,6	0,6-0,4	0,9
6,99	256	650	8,1	12,00	1,2-0,7	0,7-0,5	0,9
8,40	650	100	9,5	13,65	1,4-0,8	0,8-0,6	0,9
12,00	1000		13,8	19,00	1,4-0,8	0,8-0,6	0,9

Housing dimensions

For diameters < 30 mm open grooves are required.

< Rod seals >

Range of application

Working pressure

> standard:	≤ 400 bar
> in case of reduced extrusion gap (H7/f7) and large cross-sections:	≤ 600 bar

Working temperature

> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and range

Compounds rod seal:	NDS-150, PTFE modified NDS-660, PTFE + 60% bronze
Materials O-ring:	NBR, FKM

< Rod seals >

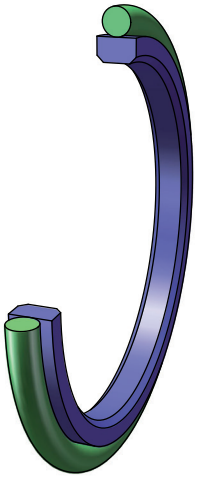
Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
4	8,9	2,2	1,78	6,07
5	9,9	2,2	1,78	6,07
7	11,9	2,2	1,78	9,25
8	15,3	3,2	2,62	10,77
10	17,3	3,2	2,62	12,37
12	19,3	3,2	2,62	15,54
14	21,3	3,2	2,62	17,12
15	22,3	3,2	2,62	18,72
16	23,3	3,2	2,62	18,72
18	25,3	3,2	2,62	20,29
20	30,7	4,2	3,53	24,99
22	32,7	4,2	3,53	26,57
24	34,7	4,2	3,53	28,17
25	35,7	4,2	3,53	29,32
26	36,7	4,2	3,53	31,34
28	38,7	4,2	3,53	32,92
30	40,7	4,2	3,53	34,52
32	42,7	4,2	3,53	36,09
35	45,7	4,2	3,53	37,69
37	47,7	4,2	3,53	40,87
38	53,1	6,3	5,33	43,82
40	55,1	6,3	5,33	46,99
42	57,1	6,3	5,33	46,99
45	60,1	6,3	5,33	50,17
48	63,1	6,3	5,33	53,34
50	65,1	6,3	5,33	56,52
52	67,1	6,3	5,33	56,52
55	70,1	6,3	5,33	59,69
58	73,1	6,3	5,33	62,87
60	75,1	6,3	5,33	66,04
65	80,1	6,3	5,33	69,22
70	85,1	6,3	5,33	75,57
75	90,1	6,3	5,33	81,92
80	95,1	6,3	5,33	85,09
85	100,1	6,3	5,33	91,44
90	105,1	6,3	5,33	94,62
95	110,1	6,3	5,33	100,97
100	115,1	6,3	5,33	104,14
110	125,1	6,3	5,33	116,84
120	135,1	6,3	5,33	126,37
125	140,1	6,3	5,33	129,54
130	145,1	6,3	5,33	135,89

Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
140	155,1	6,3	5,33	145,42
150	165,1	6,3	5,33	151,77
155	170,1	6,3	5,33	158,12
160	175,1	6,3	5,33	164,47
170	185,1	6,3	5,33	177,17
175	190,1	6,3	5,33	177,17
180	195,1	6,3	5,33	183,52
185	200,1	6,3	5,33	189,87
190	205,1	6,3	5,33	196,22
195	210,1	6,3	5,33	196,22
200	220,5	8,1	6,99	202,57
210	230,5	8,1	6,99	215,27
220	240,5	8,1	6,99	227,97
225	245,5	8,1	6,99	227,97
230	250,5	8,1	6,99	240,67
240	260,5	8,1	6,99	240,67
250	270,5	8,1	6,99	253,37
260	284,0	8,1	6,99	266,07
270	294,0	8,1	6,99	278,77
280	304,0	8,1	6,99	291,47
290	314,0	8,1	6,99	304,17
300	324,0	8,1	6,99	304,17
310	334,0	8,1	6,99	316,87
320	344,0	8,1	6,99	329,57
330	354,0	8,1	6,99	342,27
340	364,0	8,1	6,99	354,97
350	374,0	8,1	6,99	354,97
360	384,0	8,1	6,99	367,67
370	394,0	8,1	6,99	380,37
380	404,0	8,1	6,99	393,07
390	414,0	8,1	6,99	405,26
400	424,0	8,1	6,99	405,26
410	434,0	8,1	6,99	417,96
420	444,0	8,1	6,99	430,66
430	454,0	8,1	6,99	443,36
440	464,0	8,1	6,99	443,36
450	474,0	8,1	6,99	456,06
460	484,0	8,1	6,99	468,76
470	494,0	8,1	6,99	481,46
480	504,0	8,1	6,99	494,16
490	514,0	8,1	6,99	506,86
500	524,0	8,1	6,99	506,86

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE R2



Profile R2

The rod sealing set profile R2 consists of a double-acting PTFE rod sealing ring and an O-ring. They are combined as a single unit and are appropriate for rods and plungers in hydraulic cylinders.

Profile R2 is particularly suitable for rods in control cylinders, servo-assisted equipment, machine tools, quick acting cylinders and in construction machiner

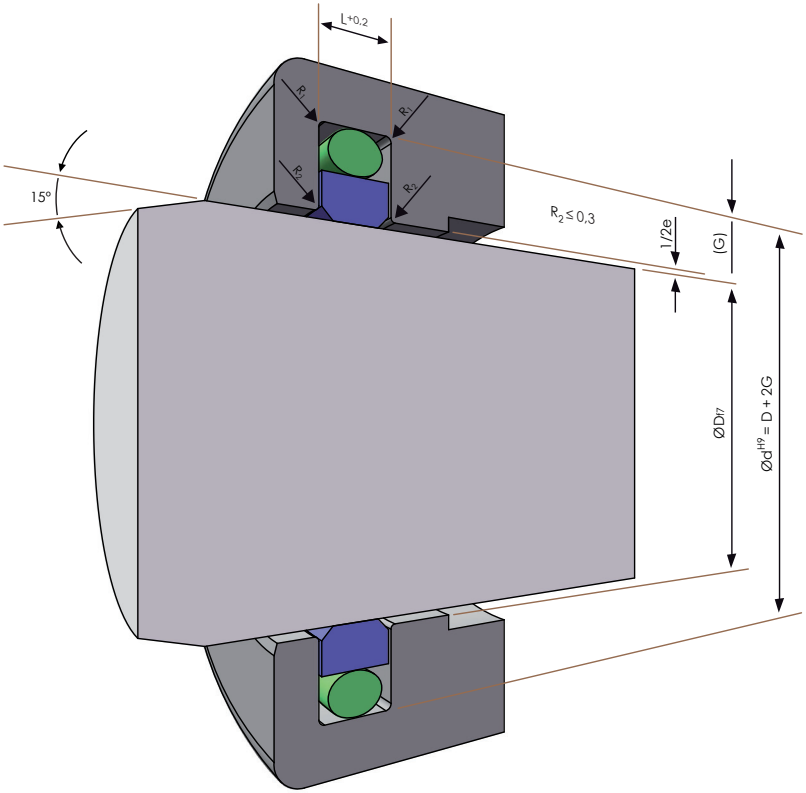
Advantages:

- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to R1 and R3:

- Capable of sealing dynamic pressure from both sides (bidirectional) at high pressure.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended rod Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 0-200 bar e (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<					
1,78	4	8	2,2	2,45	0,6 - 0,4	0,4 - 0,2	0,5
2,62	8	19	3,2	3,65	0,8 - 0,5	0,5 - 0,3	0,5
3,53	19	38	4,2	5,35	0,8 - 0,5	0,5 - 0,3	0,5
5,33	38	200	6,3	7,55	1,0 - 0,6	0,6 - 0,4	0,9
6,99	200	256	8,1	10,25	1,0 - 0,6	0,6 - 0,4	0,9
6,99	256	650	8,1	12,00	1,2 - 0,7	0,7 - 0,5	0,9
8,40	650	100	9,5	13,65	1,4 - 0,8	0,8 - 0,6	0,9
12,00	1000		13,8	19,00	1,4 - 0,8	0,8 - 0,6	0,9

Housing dimensions

For diameters < 30 mm open grooves are required.

< Rod seals >

Range of application

Working pressure

- standard: ≤ 400 bar
- in case of reduced extrusion gap (H7/f7): ≤ 600 bar

Working temperature

- standard: -30 to +108°C
- with FKM O-ring: -25 to +204°C

Surface speed: ≤ 4,0 m/s

With deviation from standard temperature range, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and range

Compounds rod seal:	NDS-123, PTFE 15% glass + 5% molybdenum disulfide
	NDS-150, PTFE modified
	NDS-660, PTFE + 60% bronze
Materials O-ring:	NBR, FKM

< Rod seals >

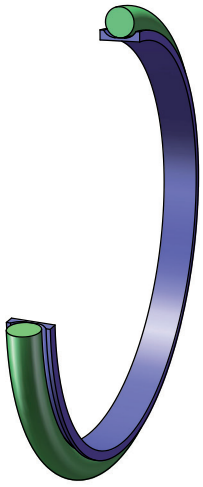
Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
4	8,9	2,2	1,78	6,07
5	9,9	2,2	1,78	6,07
7	11,9	2,2	1,78	9,25
8	15,3	3,2	2,62	10,77
10	17,3	3,2	2,62	12,37
12	19,3	3,2	2,62	15,54
14	21,3	3,2	2,62	17,12
15	22,3	3,2	2,62	18,72
16	23,3	3,2	2,62	18,72
18	25,3	3,2	2,62	20,29
20	30,7	4,2	3,53	24,99
22	32,7	4,2	3,53	26,57
24	34,7	4,2	3,53	28,17
25	35,7	4,2	3,53	29,32
26	36,7	4,2	3,53	31,34
28	38,7	4,2	3,53	32,92
30	40,7	4,2	3,53	34,52
32	42,7	4,2	3,53	36,09
35	45,7	4,2	3,53	37,69
37	47,7	4,2	3,53	40,87
38	53,1	6,3	5,33	43,82
40	55,1	6,3	5,33	46,99
42	57,1	6,3	5,33	46,99
45	60,1	6,3	5,33	50,17
48	63,1	6,3	5,33	53,34
50	65,1	6,3	5,33	56,52
52	67,1	6,3	5,33	56,52
55	70,1	6,3	5,33	59,69
58	73,1	6,3	5,33	62,87
60	75,1	6,3	5,33	66,04
65	80,1	6,3	5,33	69,22
70	85,1	6,3	5,33	75,57
75	90,1	6,3	5,33	81,92
80	95,1	6,3	5,33	85,09
85	100,1	6,3	5,33	91,44
90	105,1	6,3	5,33	94,62
95	110,1	6,3	5,33	100,97
100	115,1	6,3	5,33	104,14
110	125,1	6,3	5,33	116,84
120	135,1	6,3	5,33	126,37
125	140,1	6,3	5,33	129,54
130	145,1	6,3	5,33	135,89

Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
140	155,1	6,3	5,33	145,42
150	165,1	6,3	5,33	151,77
155	170,1	6,3	5,33	158,12
160	175,1	6,3	5,33	164,47
170	185,1	6,3	5,33	177,17
175	190,1	6,3	5,33	177,17
180	195,1	6,3	5,33	183,52
185	200,1	6,3	5,33	189,87
190	205,1	6,3	5,33	196,22
195	210,1	6,3	5,33	196,22
200	220,5	8,1	6,99	202,57
210	230,5	8,1	6,99	215,27
220	240,5	8,1	6,99	227,97
225	245,5	8,1	6,99	227,97
230	250,5	8,1	6,99	240,67
240	260,5	8,1	6,99	240,67
250	270,5	8,1	6,99	253,37
260	284,0	8,1	6,99	266,07
270	294,0	8,1	6,99	278,77
280	304,0	8,1	6,99	291,47
290	314,0	8,1	6,99	304,17
300	324,0	8,1	6,99	304,17
310	334,0	8,1	6,99	316,87
320	344,0	8,1	6,99	329,57
330	354,0	8,1	6,99	342,27
340	364,0	8,1	6,99	354,97
350	374,0	8,1	6,99	354,97
360	384,0	8,1	6,99	367,67
370	394,0	8,1	6,99	380,37
380	404,0	8,1	6,99	393,07
390	414,0	8,1	6,99	405,26
400	424,0	8,1	6,99	405,26
410	434,0	8,1	6,99	417,96
420	444,0	8,1	6,99	430,66
430	454,0	8,1	6,99	443,36
440	464,0	8,1	6,99	443,36
450	474,0	8,1	6,99	456,06
460	484,0	8,1	6,99	468,76
470	494,0	8,1	6,99	481,46
480	504,0	8,1	6,99	494,16
490	514,0	8,1	6,99	506,86
500	524,0	8,1	6,99	506,86

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE R3



Profile R3

The rod sealing set profile R3, consisting of a double-acting PTFE rod sealing ring and an O-ring, is a system for sealing rods and plungers in hydraulic cylinders. The sealing set R3 is appropriate for dynamic applications as an alternative to an O-ring, for situations where sealing performance and friction have to be optimized.

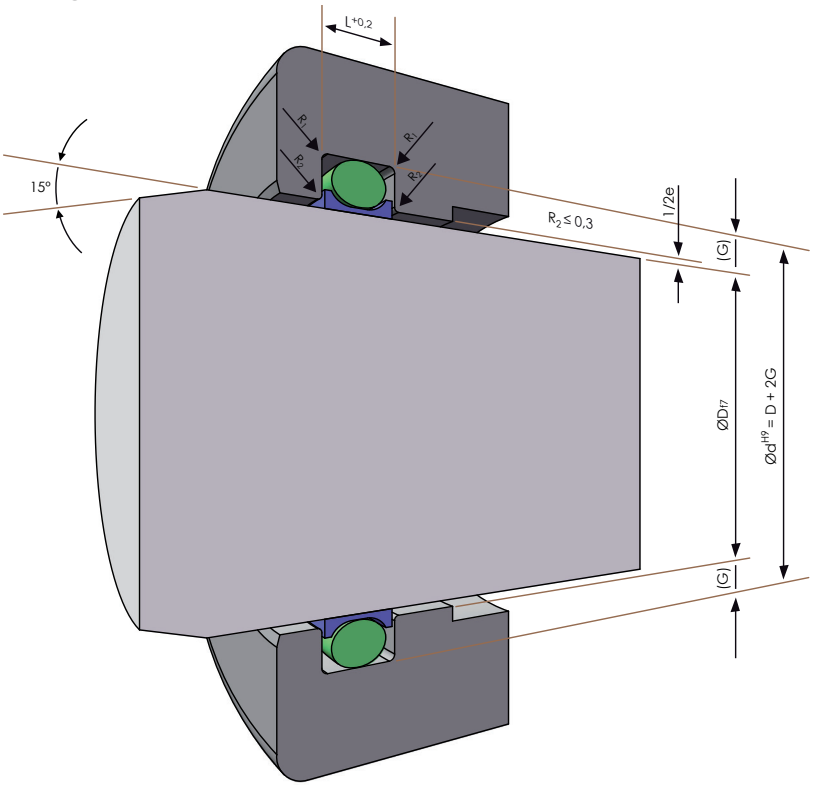
Advantages:

- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the rod sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to R1 and R2:

- Can be used in existing O-ring grooves.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended rod Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<				
1,78	4	10	2,4	1,45	0,15	0,5
2,62	10	20	3,6	2,25	0,20	0,5
3,53	20	40	4,8	3,10	0,20	0,5
5,33	40	120	7,1	4,70	0,25	0,9
6,99	120	400	9,5	6,10	0,30	0,9

Housing dimensions

For diameters < 10 mm open grooves are required.

Concerning design modifications of the groove, please contact our Engineering Department.

< Rod seals >

Range of application

The R3 profile range has been designed exclusively to replace standard O-rings. For dynamic applications we recommend our R2 profile range.

Working pressure:	≤ 160 bar
Working temperature	
> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range or questions considering media compatibility, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and range

Compounds rod seal:	NDS-150, PTFE modified
Materials O-ring:	NBR, FKM

< Rod seals >

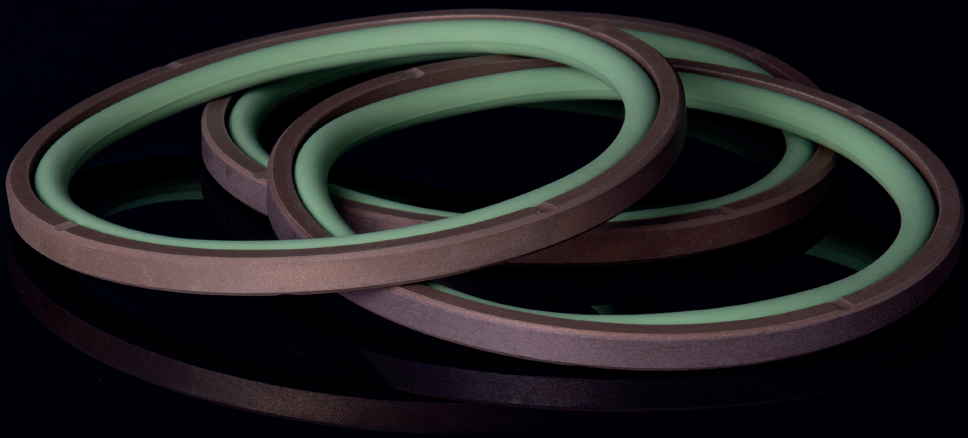
Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
4	6,9	2,4	1,78	4,47
5	7,9	2,4	1,78	5,28
6	8,9	2,4	1,78	6,07
8	10,9	2,4	1,78	7,65
10	14,5	3,6	2,62	10,77
12	16,5	3,6	2,62	12,37
14	18,5	3,6	2,62	13,94
15	19,5	3,6	2,62	15,54
16	20,5	3,6	2,62	15,54
18	22,5	3,6	2,62	18,72
20	26,2	4,8	3,53	20,22
22	28,2	4,8	3,53	21,82
25	31,2	4,8	3,53	24,99
30	36,2	4,8	3,53	29,32
32	38,2	4,8	3,53	32,92
35	41,2	4,8	3,53	34,52
36	42,2	4,8	3,53	36,09
40	49,2	7,1	5,33	40,64
45	54,4	7,1	5,33	43,82
48	57,4	7,1	5,33	46,99
50	59,4	7,1	5,33	50,17
52	61,4	7,1	5,33	50,17
56	65,4	7,1	5,33	56,52
60	69,4	7,1	5,33	59,69
63	72,4	7,1	5,33	62,87
65	74,4	7,1	5,33	66,04
70	79,4	7,1	5,33	69,22
75	84,4	7,1	5,33	75,57
80	89,4	7,1	5,33	78,74
85	94,4	7,1	5,33	85,09
90	99,4	7,1	5,33	91,44
95	104,4	7,1	5,33	94,62
100	109,4	7,1	5,33	100,97
105	114,4	7,1	5,33	104,14
110	119,4	7,1	5,33	110,94
115	124,4	7,1	5,33	116,84
120	132,2	9,5	6,99	120,02
125	137,2	9,5	6,99	126,37
130	142,2	9,5	6,99	129,54
135	147,2	9,5	6,99	135,89

Groove			O-ring	
Ø d (mm)	Ø D (mm)	L (mm)	CS (mm)	ID (mm)
140	152,2	9,5	6,99	139,07
150	162,2	9,5	6,99	151,77
160	172,2	9,5	6,99	158,12
170	182,2	9,5	6,99	170,82
180	192,2	9,5	6,99	183,52
190	202,2	9,5	6,99	189,87
200	212,2	9,5	6,99	202,57
210	222,2	9,5	6,99	215,27
220	232,2	9,5	6,99	215,27
230	242,2	9,5	6,99	227,97
240	252,2	9,5	6,99	240,67
250	262,2	9,5	6,99	53,37
260	272,2	9,5	6,99	266,07
270	282,2	9,5	6,99	266,07
280	292,2	9,5	6,99	278,77
290	302,2	9,5	6,99	291,47
300	312,2	9,5	6,99	304,17
310	322,2	9,5	6,99	316,87
320	332,2	9,5	6,99	316,87
330	342,2	9,5	6,99	329,57
340	352,2	9,5	6,99	342,27
350	362,2	9,5	6,99	354,97
360	372,2	9,5	6,99	354,97
370	382,2	9,5	6,99	367,67
380	392,2	9,5	6,99	380,37
390	402,2	9,5	6,99	393,07
400	412,2	9,5	6,99	405,26

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

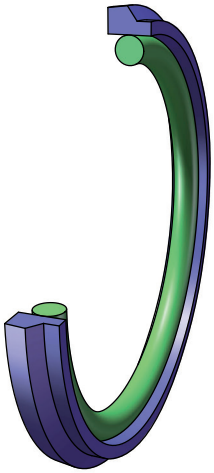
< Notes >



PISTON SEALS

< Piston seals >

PROFILE P1



Profile P1

The piston sealing set profile P1 consists of a single-acting PTFE piston sealing ring and an O-ring. They are combined as a single unit and are appropriate for single-acting pistons in hydraulic cylinders.

Profile P1 is particularly suitable for single-acting pistons in control cylinders, in servo controlled systems, machine tools and in construction machinery. An optimal sealing performance will be obtained if the piston sealing set is used in tandem.

Advantages:

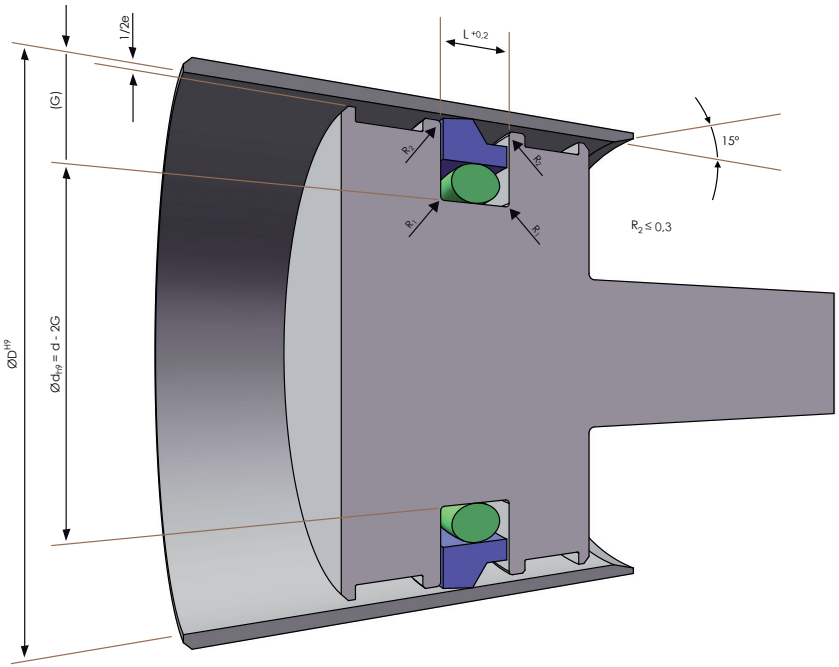
- Assembly on one-piece piston.
- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the piston sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to P2, P3 and P4:

- Good back-transport of oil film due to special shape of sealing edge.

< Piston seals >

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended piston Ø range D (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 0-200 bar e (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<					
1,78	8	15	2,2	2,45	0,6 - 0,4	0,4 - 0,2	0,5
2,62	15	40	3,2	3,75	0,8 - 0,5	0,5 - 0,3	0,5
3,53	40	80	4,2	5,50	0,8 - 0,5	0,5 - 0,3	0,5
5,33	80	133	6,3	7,75	1,0 - 0,6	0,6 - 0,4	0,9
6,99	133	330	8,1	10,50	1,0 - 0,6	0,6 - 0,4	0,9
6,99	330	670	8,1	12,25	1,2 - 0,7	0,7 - 0,5	0,9
8,40	670	1000	9,5	14,00	1,4 - 0,8	0,8 - 0,6	0,9
12,00	1000		13,8	19,00	1,4 - 0,8	0,8 - 0,6	0,9

Housing dimensions

For diameters < 30 mm open grooves are required.

< Piston seals >

Range of application

Working pressure

> standard:	≤ 400 bar
> in case of reduced extrusion gap (H7/f7):	≤ 600 bar

Working temperature

> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and range

Compounds piston seal:	NDS-150, PTFE modified
	NDS-660, PTFE + 60% bronze
Materials O-ring:	NBR, FKM

< Piston seals >

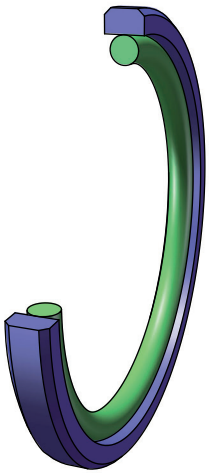
Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
8	3,1	2,2	1,78	2,90
10	5,1	2,2	1,78	5,28
12	7,1	2,2	1,78	6,07
15	7,5	3,2	2,62	7,59
16	8,5	3,2	2,62	7,59
18	10,5	3,2	2,62	9,19
20	12,5	3,2	2,62	10,77
22	14,5	3,2	2,62	13,94
24	16,5	3,2	2,62	15,54
25	17,5	3,2	2,62	17,12
28	20,5	3,2	2,62	18,72
30	22,5	3,2	2,62	21,89
32	24,5	3,2	2,62	23,47
35	27,5	3,2	2,62	26,64
39	31,5	3,2	2,62	31,42
40	29,0	4,2	3,53	28,17
42	31,0	4,2	3,53	29,74
45	34,0	4,2	3,53	32,89
48	37,0	4,2	3,53	36,09
50	39,0	4,2	3,53	37,69
52	41,0	4,2	3,53	40,87
55	44,0	4,2	3,53	44,04
60	49,0	4,2	3,53	47,22
63	52,0	4,2	3,53	50,39
65	54,0	4,2	3,53	53,57
70	59,0	4,2	3,53	56,74
79	68,0	4,2	3,53	66,27
80	64,5	6,3	5,33	62,87
85	69,5	6,3	5,33	69,22
90	74,5	6,3	5,33	72,39
95	79,5	6,3	5,33	78,74
100	84,5	6,3	5,33	81,92
105	89,5	6,3	5,33	88,27
110	94,5	6,3	5,33	94,62
115	99,5	6,3	5,33	97,79
120	104,5	6,3	5,33	104,14
125	109,5	6,3	5,33	107,32
130	114,5	6,3	5,33	113,67
135	114,0	8,1	6,99	113,67
140	119,0	8,1	6,99	116,84
145	124,0	8,1	6,99	123,19
150	129,0	8,1	6,99	126,37

Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
155	134,0	8,1	6,99	132,72
160	139,0	8,1	6,99	139,07
165	144,0	8,1	6,99	142,24
170	149,0	8,1	6,99	148,59
175	154,0	8,1	6,99	151,77
180	159,0	8,1	6,99	158,12
185	164,0	8,1	6,99	164,47
190	169,0	8,1	6,99	164,47
195	174,0	8,1	6,99	170,82
200	179,0	8,1	6,99	177,17
205	184,0	8,1	6,99	183,52
210	189,0	8,1	6,99	183,52
220	199,0	8,1	6,99	196,22
225	204,0	8,1	6,99	202,57
230	209,0	8,1	6,99	202,57
240	219,0	8,1	6,99	215,27
250	229,0	8,1	6,99	227,97
260	239,0	8,1	6,99	227,97
270	249,0	8,1	6,99	240,67
280	259,0	8,1	6,99	253,37
290	269,0	8,1	6,99	266,07
300	279,0	8,1	6,99	278,77
310	289,0	8,1	6,99	278,77
320	299,0	8,1	6,99	291,47
330	305,5	8,1	6,99	304,17
340	315,5	8,1	6,99	304,17
350	325,5	8,1	6,99	316,87
360	335,5	8,1	6,99	329,57
370	345,5	8,1	6,99	342,27
380	355,5	8,1	6,99	354,97
390	365,5	8,1	6,99	354,97
400	375,5	8,1	6,99	367,67
410	385,5	8,1	6,99	380,37
420	395,5	8,1	6,99	393,07
430	405,5	8,1	6,99	405,26
440	415,5	8,1	6,99	405,26
450	425,5	8,1	6,99	417,96
460	435,5	8,1	6,99	430,66
470	445,5	8,1	6,99	443,36
480	455,5	8,1	6,99	456,06
490	465,5	8,1	6,99	456,06
500	475,5	8,1	6,99	468,76

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE P2



Profile P2

The piston sealing set profile P2 consists of a double-acting PTFE piston sealing ring and an O-ring. They are combined as a single unit and are appropriate for double-acting pistons in hydraulic cylinders.

Profile P2 is particularly suitable for double-acting pistons in control cylinders, servo-controlled systems, machine tools, quick acting and steering cylinders.

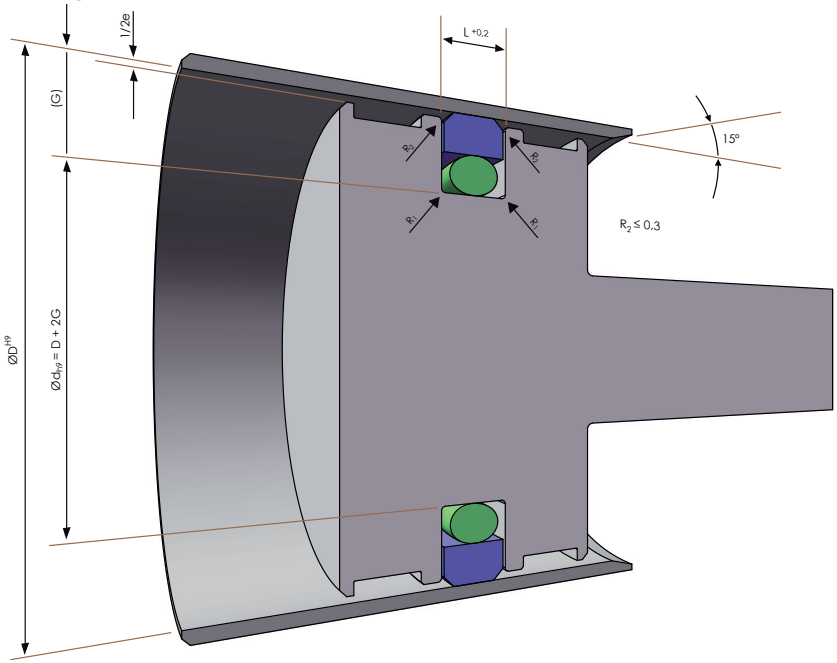
Advantages:

- Assembly on one-piece pistons.
- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the piston sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to P1, P3 and P4:

- Capable of sealing dynamic pressure from both sides (bidirectional) at high pressure.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended piston Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 0-200 bar e (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<					
1,78	8	15	2,2	2,45	0,6 - 0,4	0,4 - 0,2	0,5
2,62	15	40	3,2	3,75	0,8 - 0,5	0,5 - 0,3	0,5
3,53	40	80	4,2	5,50	0,8 - 0,5	0,5 - 0,3	0,5
5,33	80	133	6,3	7,75	1,0 - 0,6	0,6 - 0,4	0,9
6,99	133	330	8,1	10,50	1,0 - 0,6	0,6 - 0,4	0,9
6,99	330	670	8,1	12,25	1,2 - 0,7	0,7 - 0,5	0,9
8,40	670	1000	9,5	14,00	1,4 - 0,8	0,8 - 0,6	0,9
12,00	1000		13,8	19,00	1,4 - 0,8	0,8 - 0,6	0,9

Housing dimensions

For diameters < 30 mm open grooves are required.

< Piston seals >

Range of application

Working pressure

> standard:	≤ 400 bar
> in case of reduced extrusion gap (H7/f7) and large cross-sections:	≤ 600 bar

Working temperature

> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and installation

Compounds piston seal:	NDS-123, PTFE 15% glass + 5% molybdenum disulfide NDS-150, PTFE modified NDS-660, PTFE + 60% bronze
Materials O-ring:	NBR, FKM

< Piston seals >

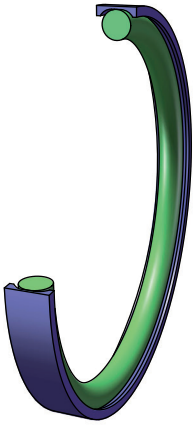
Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
8	3,1	2,2	1,78	2,90
10	5,1	2,2	1,78	5,28
12	7,1	2,2	1,78	6,07
15	7,5	3,2	2,62	7,59
16	8,5	3,2	2,62	7,59
18	10,5	3,2	2,62	9,19
20	12,5	3,2	2,62	10,77
22	14,5	3,2	2,62	13,94
24	16,5	3,2	2,62	15,54
25	17,5	3,2	2,62	17,12
28	20,5	3,2	2,62	18,72
30	22,5	3,2	2,62	21,89
32	24,5	3,2	2,62	23,47
35	27,5	3,2	2,62	26,64
39	31,5	3,2	2,62	31,42
40	29,0	4,2	3,53	28,17
42	31,0	4,2	3,53	29,74
45	34,0	4,2	3,53	32,89
48	37,0	4,2	3,53	36,09
50	39,0	4,2	3,53	37,69
52	41,0	4,2	3,53	40,87
55	44,0	4,2	3,53	44,04
60	49,0	4,2	3,53	47,22
63	52,0	4,2	3,53	50,39
65	54,0	4,2	3,53	53,57
70	59,0	4,2	3,53	56,74
79	68,0	4,2	3,53	66,27
80	64,5	6,3	5,33	62,87
85	69,5	6,3	5,33	69,22
90	74,5	6,3	5,33	72,39
95	79,5	6,3	5,33	78,74
100	84,5	6,3	5,33	81,92
105	89,5	6,3	5,33	88,27
110	94,5	6,3	5,33	94,62
115	99,5	6,3	5,33	97,79
120	104,5	6,3	5,33	104,14
125	109,5	6,3	5,33	107,32
130	114,5	6,3	5,33	113,67
135	114,0	8,1	6,99	113,67
140	119,0	8,1	6,99	116,84
145	124,0	8,1	6,99	123,19
150	129,0	8,1	6,99	126,37

Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
155	134,0	8,1	6,99	132,72
160	139,0	8,1	6,99	139,07
165	144,0	8,1	6,99	142,24
170	149,0	8,1	6,99	148,59
175	154,0	8,1	6,99	151,77
180	159,0	8,1	6,99	158,12
185	164,0	8,1	6,99	164,47
190	169,0	8,1	6,99	164,47
195	174,0	8,1	6,99	170,82
200	179,0	8,1	6,99	177,17
205	184,0	8,1	6,99	183,52
210	189,0	8,1	6,99	183,52
220	199,0	8,1	6,99	196,22
225	204,0	8,1	6,99	202,57
230	209,0	8,1	6,99	202,57
240	219,0	8,1	6,99	215,27
250	229,0	8,1	6,99	227,97
260	239,0	8,1	6,99	227,97
270	249,0	8,1	6,99	240,67
280	259,0	8,1	6,99	253,37
290	269,0	8,1	6,99	266,07
300	279,0	8,1	6,99	278,77
310	289,0	8,1	6,99	278,77
320	299,0	8,1	6,99	291,47
330	305,5	8,1	6,99	304,17
340	315,5	8,1	6,99	304,17
350	325,5	8,1	6,99	316,87
360	335,5	8,1	6,99	329,57
370	345,5	8,1	6,99	342,27
380	355,5	8,1	6,99	354,97
390	365,5	8,1	6,99	354,97
400	375,5	8,1	6,99	367,67
410	385,5	8,1	6,99	380,37
420	395,5	8,1	6,99	393,07
430	405,5	8,1	6,99	405,26
440	415,5	8,1	6,99	405,26
450	425,5	8,1	6,99	417,96
460	435,5	8,1	6,99	430,66
470	445,5	8,1	6,99	443,36
480	455,5	8,1	6,99	456,06
490	465,5	8,1	6,99	456,06
500	475,5	8,1	6,99	468,76

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE P3



Profile P3

The profile P3 piston sealing set consists of a PTFE piston sealing ring and an O-ring. It is a system for sealing double-acting pistons. The profile P3 is appropriate for dynamic applications as an alternative to an O-ring in situations where sealing performance and friction have to be optimized.

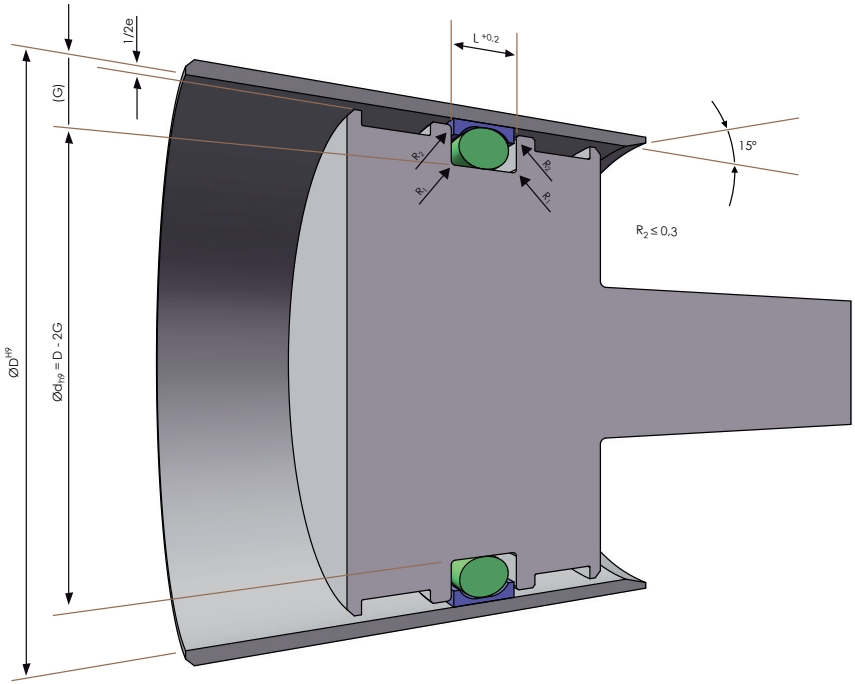
Advantages:

- Assembly on one-piece pistons.
- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the piston sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to P1, P2 and P4:

- Can be used in existing O-ring grooves.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended piston Ø range D (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<				
1,78	8	14	2,4	1,45	0,15	0,5
2,62	14	25	3,6	2,25	0,20	0,5
3,53	25	46	4,8	3,10	0,20	0,5
5,33	46	125	7,1	4,70	0,25	0,9
6,99	125	400	9,5	6,10	0,30	0,9

Housing dimensions

Concerning design modifications of the groove, please contact our Engineering Department.

< Piston seals >

Range of application

The P3 profile range has been designed exclusively to replace standard O-rings. For dynamic applications we recommend our P4 (pneumatics) or P2 (hydraulics) profile ranges.

Working pressure:	≤ 160 bar
Working temperature	
> standard:	-30 to +108°C
> with FKM O-ring:	-25 to +204°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range or questions considering media compatibility, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only with guiding elements (e.g. G2).

Standard compounds and range

Compounds piston seal:	NDS-150, PTFE modified
Materials O-ring:	NBR, FKM

< Piston seals >

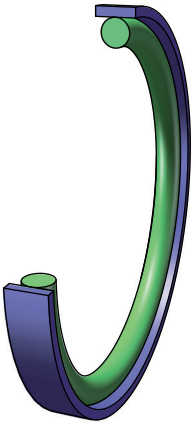
Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
8	5,1	2,4	1,78	4,47
10	7,1	2,4	1,78	6,07
12	9,1	2,4	1,78	7,65
15	10,5	3,6	2,62	9,19
16	11,5	3,6	2,62	10,77
18	13,5	3,6	2,62	12,37
20	15,5	3,6	2,62	15,54
22	17,5	3,6	2,62	17,12
24	19,5	3,6	2,62	18,72
25	18,8	4,8	3,53	17,04
25,4	19,2	4,8	3,53	18,64
28	21,8	4,8	3,53	21,82
30	23,8	4,8	3,53	23,39
32	25,8	4,8	3,53	24,99
35	28,8	4,8	3,53	28,17
40	33,8	4,8	3,53	32,92
42	35,8	4,8	3,53	34,52
45	38,8	4,8	3,53	37,69
48	38,6	7,1	5,33	37,47
50	40,6	7,1	5,33	40,64
50,8	41,4	7,1	5,33	40,64
52	42,6	7,1	5,33	40,64
55	45,6	7,1	5,33	43,82
60	50,6	7,1	5,33	50,17
63	53,6	7,1	5,33	53,34
65	55,6	7,1	5,33	53,34
70	60,6	7,1	5,33	59,69
75	65,6	7,1	5,33	62,87
80	70,6	7,1	5,33	69,22
85	75,6	7,1	5,33	75,57
90	80,6	7,1	5,33	78,74
95	85,6	7,1	5,33	85,09
100	90,6	7,1	5,33	88,27
105	95,6	7,1	5,33	94,62
110	100,6	7,1	5,33	97,79
115	105,6	7,1	5,33	104,14
120	110,6	7,1	5,33	110,49
125	112,8	9,5	6,99	113,67
130	117,8	9,5	6,99	116,84
135	122,8	9,5	6,99	120,02

Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
140	127,8	9,5	6,99	126,37
145	132,8	9,5	6,99	129,54
150	137,8	9,5	6,99	135,89
155	142,8	9,5	6,99	133,97
160	147,8	9,5	6,99	145,42
165	152,8	9,5	6,99	151,77
170	157,8	9,5	6,99	151,77
175	162,8	9,5	6,99	158,12
180	167,8	9,5	6,99	164,47
190	177,8	9,5	6,99	177,17
200	187,8	9,5	6,99	183,52
210	197,8	9,5	6,99	196,22
220	207,8	9,5	6,99	202,57
230	217,8	9,5	6,99	215,27
240	227,8	9,5	6,99	227,97
250	237,8	9,5	6,99	227,97
260	247,8	9,5	6,99	240,67
270	257,8	9,5	6,99	253,37
280	267,8	9,5	6,99	266,07
290	277,8	9,5	6,99	266,07
300	287,8	9,5	6,99	278,77
310	297,8	9,5	6,99	291,47
320	307,8	9,5	6,99	304,17
330	317,8	9,5	6,99	316,87
340	327,8	9,5	6,99	316,87
350	337,8	9,5	6,99	329,54
360	347,8	9,5	6,99	342,27
370	357,8	9,5	6,99	354,97
380	367,8	9,5	6,99	367,67
390	377,8	9,5	6,99	367,67
400	387,8	9,5	6,99	380,37

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

PROFILE P4



Profile P4

The piston sealing set profile P4 consists of a PTFE piston sealing ring and an O-ring. They are combined as a single unit and are appropriate for double-acting pistons in pneumatic cylinders.

Profile P4 is particularly suitable for double-acting pneumatic pistons, e.g. in control cylinders, servo-assisted equipment, and in quick-acting cylinders.

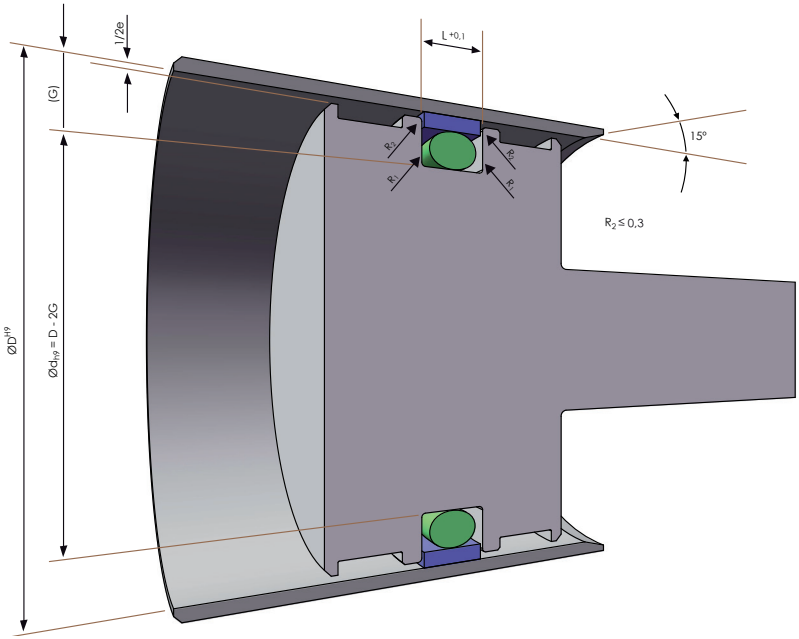
Advantages:

- Assembly on one-piece pistons.
- Minimal break-out and dynamic slide friction. Therefore no stick-slip. Steady movement is guaranteed even at low velocities.
- Low wear.
- High extrusion resistance.
- High temperature resistance.
- Compatibility with nearly all media due to the high chemical resistance of the piston sealing ring, and a wide selection of O-ring compounds.
- Available in diameters up to 1500 mm.

Advantage compared to P1, P2 and P3:

- Can be used for pneumatic applications.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "General installation guidelines"

O-ring cross-section (mm)	Recommended Piston Ø range D (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. 200-400 bar e (mm)	Radius max. R_1 (mm)
	≥	<				
1,78	7	16	2,00	2,00	0,20	0,5
2,62	16	27	2,85	3,00	0,25	0,5
3,53	27	50	3,80	3,75	0,25	0,5
5,33	50	130	5,60	6,25	0,50	0,9
6,99	130	180	7,55	7,50	0,50	0,9
6,99	180	240	7,55	9,00	0,75	0,9
6,99	240	420	7,55	12,00	1,00	0,9

Housing dimensions

The grooves must be carefully cleaned and deburred. The cylinder bore must have a leading chamfer. When fitting the piston sealing ring there is always the danger that the ring may tilt and be sheared off by normal leading edge chamfers (see drawing general installation guidelines). We therefore recommend that up to a cylinder diameter of 230 mm a leading chamfer according to the drawing in the general installation guidelines is considered. In the case of smaller rings which are especially liable to bending we recommend an open groove design for diameters smaller than 30 mm.

< Piston seals >

Range of application

Piston sealing set for pneumatic applications.

Working pressure:	≤ 16 bar
Working temperature:	-30 to +80°C
Surface speed:	≤ 4,0 m/s

With deviation from standard temperature range, please contact our Engineering Department for adequate O-ring material.

Please apply this seal only in combination with guiding elements (e.g. profile G1).

Standard compounds and range

Compounds piston seal:	NDS-225, PTFE + 25% carbon
Materials O-ring:	NBR, FKM

< Piston seals >

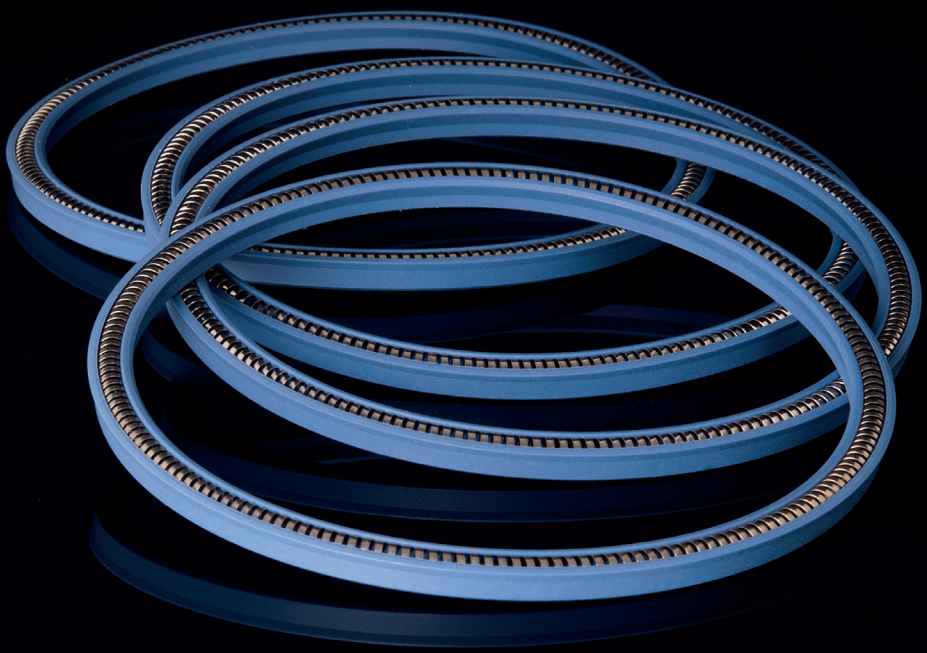
Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
7	3,0	2,00	1,78	2,90
8	4,0	2,00	1,78	3,68
9	5,0	2,00	1,78	4,47
10	6,0	2,00	1,78	6,07
11	7,0	2,00	1,78	6,07
12	8,0	2,00	1,78	7,65
14	10,0	2,00	1,78	9,25
16	10,0	2,85	2,62	9,19
18	12,0	2,85	2,62	12,37
19	13,0	2,85	2,62	12,37
20	14,0	2,85	2,62	13,94
22	16,0	2,85	2,62	15,54
25	19,0	2,85	2,62	18,72
28	20,5	3,80	3,53	20,22
30	22,5	3,80	3,53	21,82
32	24,5	3,80	3,53	24,99
35	27,5	3,80	3,53	26,57
36	28,5	3,80	3,53	28,17
38	30,5	3,80	3,53	29,74
40	32,5	3,80	3,53	32,92
42	34,5	3,80	3,53	34,52
45	37,5	3,80	3,53	37,69
48	40,5	3,80	3,53	40,87
50	37,5	5,60	5,33	37,47
55	42,5	5,60	5,33	40,64
60	47,5	5,60	5,33	46,99
63	50,5	5,60	5,33	50,17
65	52,5	5,60	5,33	50,17
70	57,5	5,60	5,33	56,52
74	61,5	5,60	5,33	59,69
75	62,5	5,60	5,33	62,87
80	67,5	5,60	5,33	66,04
85	72,5	5,60	5,33	72,39
90	77,5	5,60	5,33	75,57
92	79,5	5,60	5,33	78,74
100	87,5	5,60	5,33	85,09
105	92,5	5,60	5,33	91,44
110	97,5	5,60	5,33	97,79
115	102,5	5,60	5,33	100,97
120	107,5	5,60	5,33	107,32

Groove			O-ring	
Ø D (mm)	Ø d (mm)	L (mm)	CS (mm)	ID (mm)
125	112,5	5,60	5,33	110,49
130	115,0	7,55	6,99	113,67
140	125,0	7,55	6,99	123,19
150	135,0	7,55	6,99	132,72
160	145,0	7,55	6,99	142,24
200	182,0	7,55	6,99	177,17
220	202,0	7,55	6,99	196,22

Standard Range

For special requirements (pressure, dimensions, temperature, speed, application in water, HFA-, HFB-fluids etc.), please contact our Engineering Department, so that suitable materials and/or designs can be recommended. Working data stated above are valid for standard materials and use in standard media. The exact permissible temperature range for the whole assembly including the seal, must be determined in application conditions.

< Notes >



SYNERINGS®

< Synerings® >

THE SYNERING® SYSTEM

The Synering® system is an advanced sealing concept designed to meet extreme demands regarding temperature, medium, etc. which cannot be covered by conventional sealing compounds (like elastomers, PUR, fabric materials, etc.)
PTFE is hardly elastic. Therefore, PTFE sealing elements have to be combined with an elastic component, usually an O-ring. Synerings® consist of a PTFE part, made of a specially modified compound, and an energizing spring (standard: stainless steel). So, the outstanding thermal and chemical properties of PTFE can be used to full advantage.

Field of Application

Profiles for static applications as well as for reciprocating, rotating and helical movements are available.

Working Conditions

Synerings® with V-spring:

Velocity:	Reciprocating: 15-20 m/s
	Helical and rotating: max. 4 m/s
Pressure:	max. 350 bar
Temperature:	-150 to +225 °C

Synerings® with O-spring:

Velocity:	Reciprocating: 15-20 m/s
	Helical and rotating: max. 4 m/s
Pressure:	max. 800 bar
Temperature:	-150 to +260 °C

Not all maximum stresses can be applied to the seal at one time.
Under certain circumstances, some of them can be exceeded. Do not hesitate to contact us for technical advice.

Recommendations for New Designs

Synerings® can be installed in grooves designed for O-rings in existing equipment with no or just one back-up ring. In all tables, the O-ring sections are just stated as a guide. For new designs, we recommend grooves without back-up ring.

< Synerings® >

Advantages

- To make this sealing system readily available for existing equipment, the standard designs are dimensionally adapted too to be installed in standard O-ring grooves.
- Outstandingly high chemical and thermal resistance.
- Unlimited storing time.
- Synerings® can be sterilized in autoclaves or with any possible agent – except radioactive radiation.
- Easy to clean in assembled as well as in disassembled state.
- As Synerings® contain only PTFE and stainless steel, contacting media will not receive any contamination from the seal.
- No stick-slip effect.
- Very low friction.
- High sealing efficiency after a short running-in period.

As PTFE has almost no elasticity, Synerings® are provided with a metal spring (standard material: stainless steel) which makes the seal permanently elastic despite changes in operating temperature, pressure etc.

How the Synerings® work

The Synering® is compressed radially resp. axially when installed in the seal gland. The resilient spring responds with constant force, pushing out the sealing lips. As system pressure is applied, the seal is additionally energized, increasing the sealing force.
In dynamic applications, the spring expands, compensating for seal wear while continuing to provide load. In conditions that see thermal cycling, the spring continues to energize the seal lips without taking a compression set or becoming too soft or too hard.
The flexible spring provides a wide tolerance range that can help overcome hardware misalignment and eccentricity without causing excessive friction or leakage.
The main characteristics of the spring are the spring force and the deflection range. The spring force influences the sealing function, friction and wear. The deflection range determines the ability of the seal to compensate for seal wear and variations in gland tolerances.

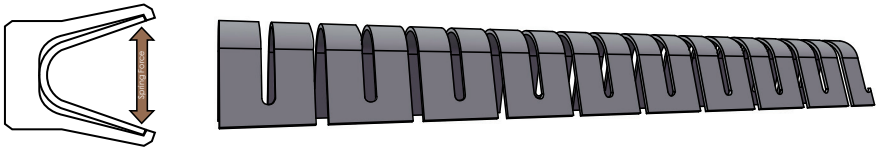
The Synering® is available with different spring types

V-Spring

The V-spring shows a moderate load vs. deflection. The long beam-leg design puts the spring load out at the leading edge of the seal – right on the sealing edge.
The wide range of flexibility of the spring allows to compensate for larger deviations in the gland tolerances and seal wear.

Recommended applications:

- Dynamic rod and piston seals
- Rotary seals



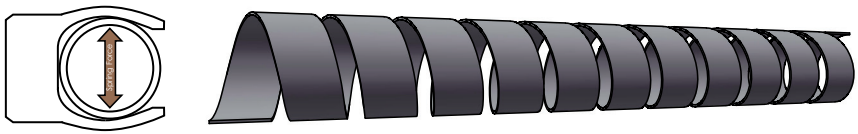
V-Spring

O-Spring

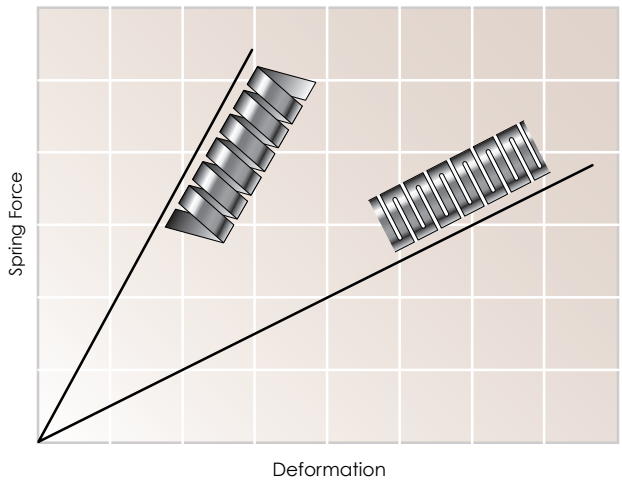
The helically wound ribbon spring shows a high load versus deflection. The load of the O-spring is provided directly through its center line.
Due to the low deflection range, the O-spring is not suitable for applications with big gland tolerances or eccentricity.

Recommended applications:

- Static applications
- Low temperatures
- In very slow or infrequent dynamic conditions when friction and wear are secondary concerns to positive sealing.



O-Spring

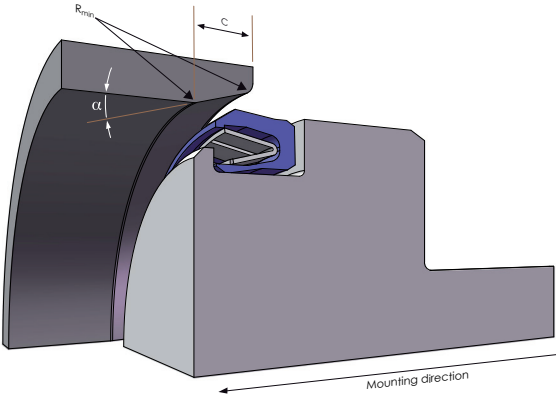


Graph deformation vs. spring force

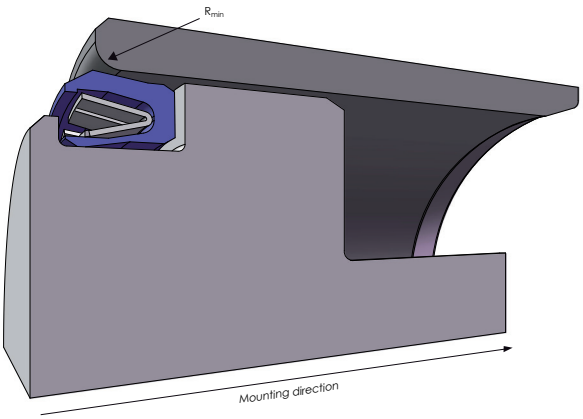
INSTALLATION

Standard Synerings® can be installed in grooves for O-rings according to DIN 3771, ISO 3601, AS 568 (US-Standard), BS 1806 (British Standard) and NF-T47-501 (French Standard).

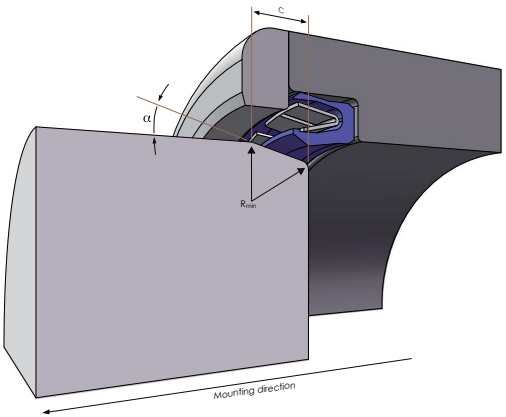
For installation in open grooves:



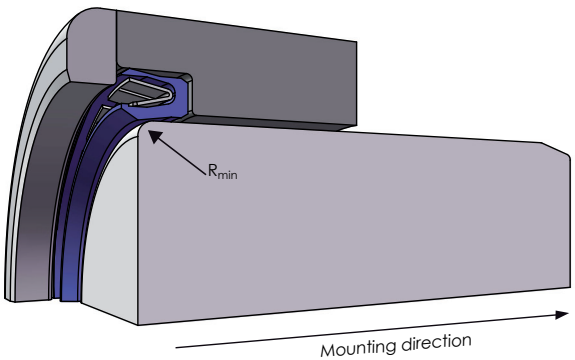
Assembly of piston seal in open groove.
Sealing lips in mounting direction.
Values for lead-in chamfer: see table on next page.
All edges rounded.
We recommend: R_{min} = 0,5 mm.



Assembly of piston seal in open groove.
Back of the seal in mounting direction
All edges rounded.
We recommend: R_{min} = 1 mm.



Assembly of rod seal in open groove.
Sealing lips in mounting direction.
Values for lead-in chamfer: see table below.
All edges rounded.
We recommend: R_{min} = 0,5 mm.
Assembly of rod seal in open groove.

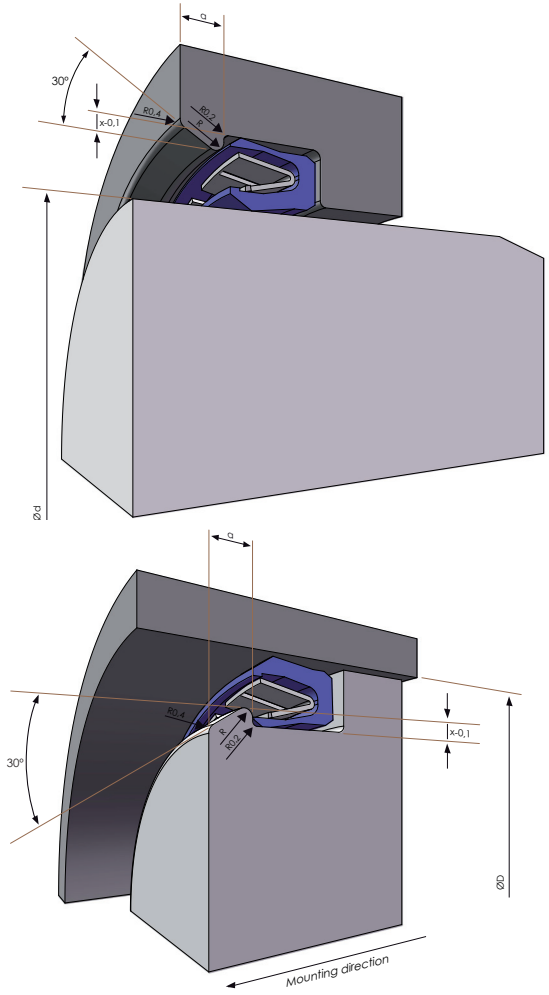


Back of the seal in mounting direction
All edges rounded.
We recommend: R_{min} = 1 mm.

O-ring cross- section (mm)	C min for α = 15 (mm)	C min for α = 30 (mm)
1,78	4,2	2,0
2,62	4,7	2,2
3,53	5,2	2,4
5,33	8,2	3,8
6,99	11,9	5,5

Recommended values for C, depending on the angle of lead-in chamfer (α)

Groove design for snap-in assembly



O-ring cross-section (mm)	d min (mm)	D min (mm)	$X_{-0,1}$ (mm)	R (mm)	a (mm)
1,78	12,0	15,0	0,5	0,4	2,0
2,62	20,0	21,0	0,6	0,4	2,0
3,53	30,0	25,0	0,7	0,6	2,5
5,33	40,0	30,0	0,9	0,8	3,0
6,99	55,0	45,0	0,9	0,8	

Recommended groove dimensions for snap-in assembly

Mating surfaces

As sealing efficiency and working time directly depend on the condition of the mating surfaces, we recommend the values stated in the table below.

For dynamic sealing surfaces:
Bearing area t_p: 80% < t_p* < 95%

Measured in a depth of 25% if the R_t-value, based on a reference level (zero line) set at 5% bearing area.

Medium	Static	Dynamic	Rotary
Low-molecular gases and fluids Fluids with low surface tension Low temperatures	$R_t \leq 1{,}2$ µm ($R_a \leq 0{,}3$ µm)	$R_t \leq 0{,}8$ µm ($R_a \leq 0{,}2$ µm)	$R_t \leq 0{,}4$ µm ($R_a \leq 0{,}1$ µm)
Low viscosity fluids High molecular gases, air and natural gas	$R_t \leq 2{,}4$ µm ($R_a \leq 0{,}6$ µm)	$R_t \leq 1{,}2$ µm ($R_a \leq 0{,}3$ µm)	$R_t \leq 0{,}8$ µm ($R_a \leq 0{,}2$ µm)
Normal and high viscosity fluids Water, oils and phosphate esters	$R_t \leq 3{,}2$ µm ($R_a \leq 0{,}8$ µm)	$R_t \leq 1{,}6$ µm ($R_a \leq 0{,}4$ µm)	$R_t \leq 0{,}8$ µm ($R_a \leq 0{,}2$ µm)

Mating surfaces

Grinding as final machining process for dynamic sealing surface is not sufficient. These surfaces have to be polished afterwards.

During assembly, it is imperative that all surfaces and roundings of the equipment are smooth and free from burrs and contamination.

COMPOUNDS AND SPRING MATERIALS FOR SYNERINGS®

Compounds

Sealing surface	Medium	NDS® PTFE compound
Steel	Hydraulic oils, Mineral oils, Lubrication oils	NDS-150 NDS-660
Steel chromium plated	Water/oil emulsions, Hot water and steam	NDS-235
Cast iron	Unlubricated and lubricated air, Fire resistant fluids, Phosphate ester	NDS-150 NDS-235
Stainless steel	Unlubricated and lubricated air, Fire resistant fluids, Phosphate ester	NDS-235
Aluminium -hard - soft	All above listed	NDS-415

Compounds

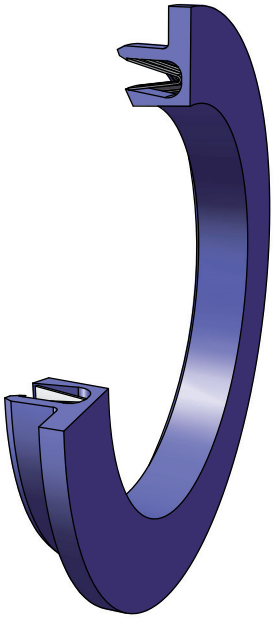
For contact with food, we recommend NDS-100.
Seals for radioactive environments require our proposals according to your specifications.

Spring materials

Standard spring material is stainless steel according to US standard AISI 302, DIN material no. 1.4319. For aggressive media or special requirements in the food industry or medical applications other materials are available on request.

< Notes >

PROFILE S1: FOR ROTATING MOVEMENT – ROD SEAL

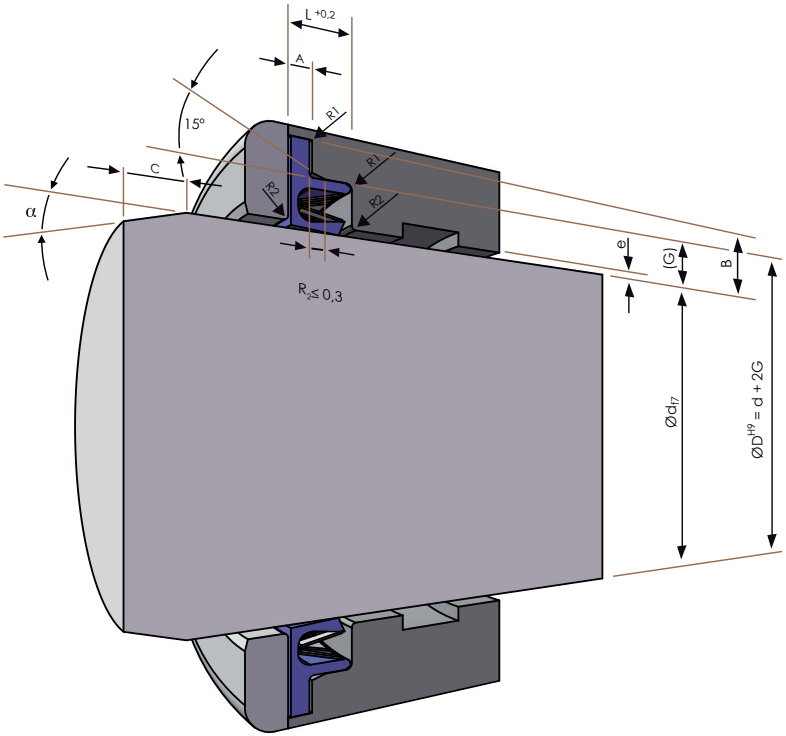


Profile S1

The profile S1 consists of a PTFE sealing ring with a V-spring. The profile S1 is appropriate for rotating applications as an alternative to an O-ring in situations where sealing performance and friction have to be optimized.

< Synerings® >

Housing dimensions and installation



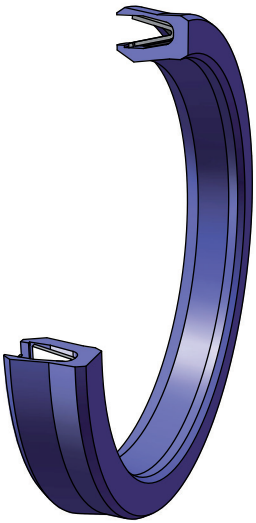
For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Flange width A (mm)	Flange depth B (mm)	Chamfer width C (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<							
2,62	8	20	3,6	$2,50^{+0,05}$	$0,85_{-0,10}$	$4,50^{+0,08}$	0,8	0,13	0,3
3,53	20	40	4,8	$3,50^{+0,08}$	$1,35_{-0,15}$	$6,25^{+0,10}$	1,1	0,15	0,4
5,33	40	400	7,1	$5,25^{+0,10}$	$1,75_{-0,20}$	$8,75^{+0,15}$	1,4	0,17	0,5
6,99	400	700	9,5	$7,00^{+0,10}$	$2,80_{-0,20}$	$11,00^{+0,15}$	1,6	0,25	0,5

Housing dimensions

This design is also available for rotating movements against cylinder. Please contact our Engineering Department before using.

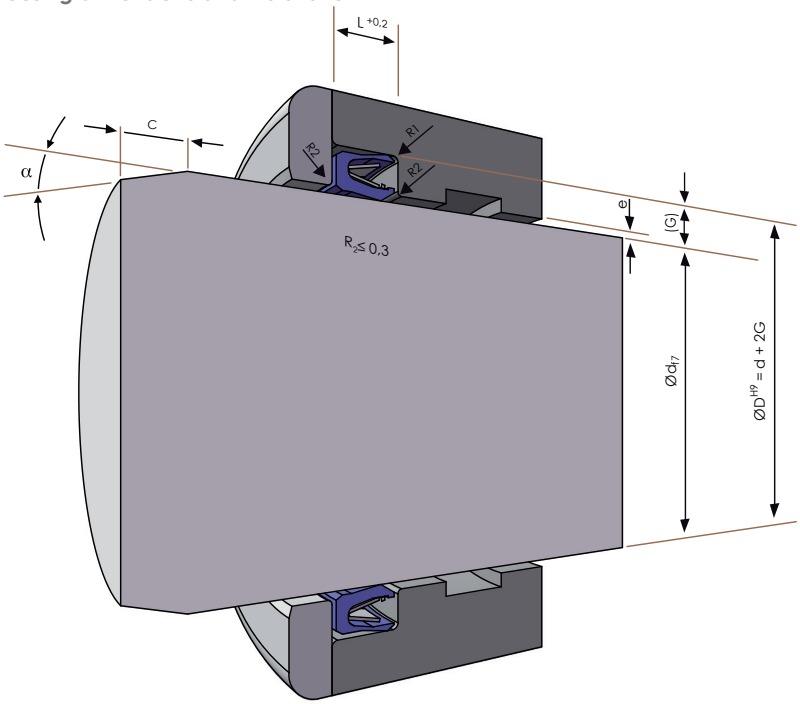
PROFILE S2: FOR DYNAMIC ROD SEALING



Profile S2

The profile S2 consists of a PTFE sealing ring with a V-spring. The profile S2 is appropriate for dynamic rod sealing applications as an alternative to an O-ring in situations where sealing performance and friction have to be optimized.

Housing dimensions and installation

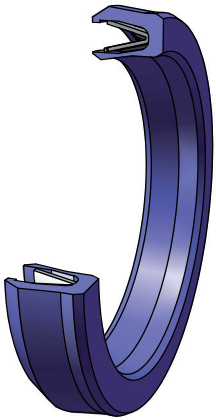


For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<				
Housing dimensions for O-ring grooves without back-up ring						
1,78	4	10	2,40	1,45	0,13	0,4
2,62	10	20	3,60	2,25	0,13	0,4
3,53	20	40	4,80	3,10	0,15	0,6
5,33	40	120	7,10	4,70	0,17	0,8
6,99	120	700	9,50	6,10	0,25	0,8
Housing dimensions for O-ring grooves with 1 back-up ring						
1,78	4	10	3,80	1,45	0,13	0,4
2,62	10	20	4,65	2,25	0,13	0,4
3,53	20	40	5,70	3,10	0,15	0,6
5,33	40	120	8,50	4,70	0,17	0,8
6,99	120	700	11,20	6,10	0,25	0,8

Housing dimensions

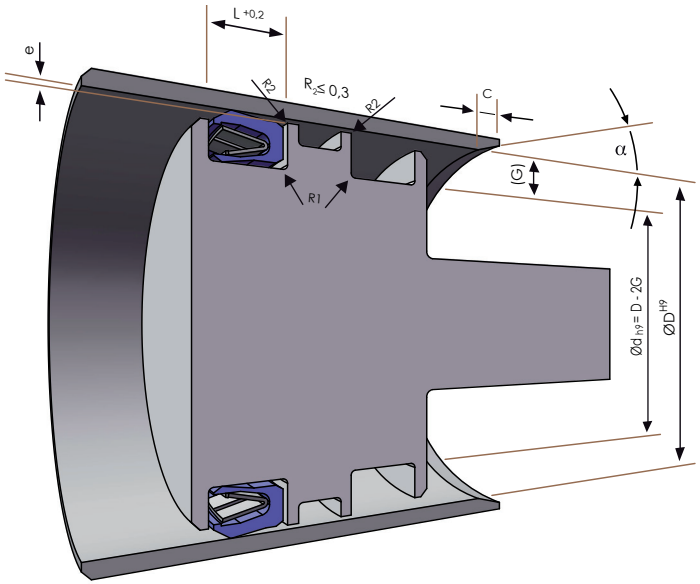
PROFILE S3: FOR DYNAMIC PISTON SEALING



Profile S3

The profile S3 consists of a PTFE sealing ring with a V-spring. The profile S3 is appropriate for dynamic piston sealing applications as an alternative to an O-ring in situations where sealing performance and friction have to be optimized.

Housing dimensions and installation

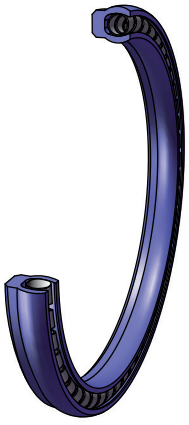


For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<				
Housing dimensions for O-ring grooves without back-up ring						
1,78	6	14	2,40	1,45	0,13	0,4
2,62	14	25	3,60	2,25	0,13	0,4
3,53	25	46	4,80	3,10	0,15	0,6
5,33	46	125	7,10	4,70	0,17	0,8
6,99	125	700	9,50	6,10	0,25	0,8
Housing dimensions for O-ring grooves with 1 back-up ring						
1,78	6	14	3,80	1,45	0,13	0,4
2,62	14	25	4,65	2,25	0,13	0,4
3,53	25	46	5,70	3,10	0,15	0,6
5,33	46	125	8,50	4,70	0,17	0,8
6,99	125	700	11,20	6,10	0,25	0,8

Housing dimension

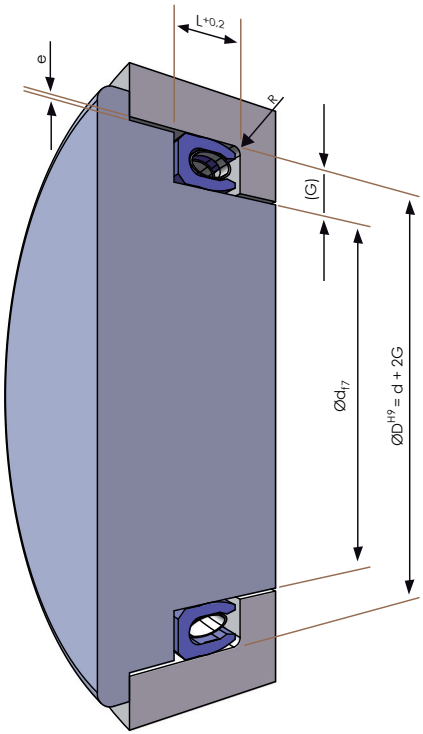
PROFILE S4: FOR STATIC INSIDE SEALING



Profile S4

The profile S4 consists of a PTFE sealing ring with an O-spring. The profile S4 is appropriate for static inside sealing applications as an alternative to an O-ring in situations where sealing performance has to be optimized.

Housing dimensions and installation

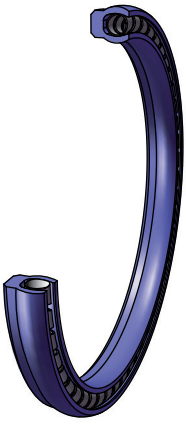


For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<				
Housing dimensions for O-ring grooves without back-up ring						
1,78	4	10	2,40	1,45	0,13	0,4
2,62	10	20	3,60	2,25	0,13	0,4
3,53	20	40	4,80	3,10	0,15	0,6
5,33	40	120	7,10	4,70	0,17	0,8
6,99	120	700	9,50	6,10	0,25	0,8
Housing dimensions for O-ring grooves with 1 back-up ring						
1,78	4	10	3,80	1,45	0,13	0,4
2,62	10	20	4,65	2,25	0,13	0,4
3,53	20	40	5,70	3,10	0,15	0,6
5,33	40	120	8,50	4,70	0,17	0,8
6,99	120	700	11,20	6,10	0,25	0,8

Housing dimensions

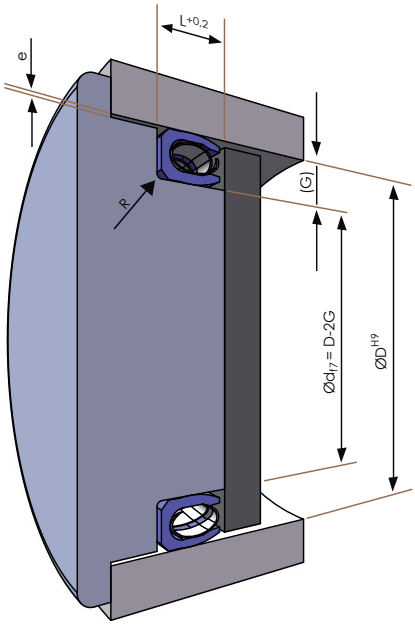
PROFILE S5: FOR STATIC OUTSIDE SEALING



Profile S5

The profile S5 consists of a PTFE sealing ring with an O-spring. The profile S5 is appropriate for static outside sealing applications as an alternative to an O-ring in situations where sealing performance has to be optimized.

Housing dimensions and installation

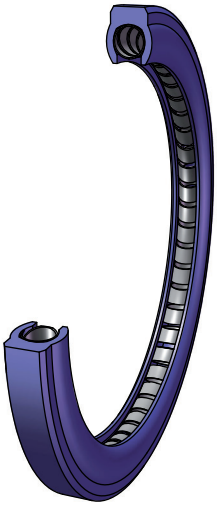


For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Gap max. e (mm)	Radius max. R_1 (mm)
	≥	<				
Housing dimensions for O-ring grooves without back-up ring						
1,78	8	14	2,40	1,45	0,13	0,4
2,62	14	25	3,60	2,25	0,13	0,4
3,53	25	46	4,80	3,10	0,15	0,6
5,33	46	125	7,10	4,70	0,17	0,8
6,99	125	700	9,50	6,10	0,25	0,8
Housing dimensions for O-ring grooves with 1 back-up ring						
1,78	8	14	3,80	1,45	0,13	0,4
2,62	14	25	4,65	2,25	0,13	0,4
3,53	25	46	5,70	3,10	0,15	0,6
5,33	46	125	8,50	4,70	0,17	0,8
6,99	125	700	11,20	6,10	0,25	0,8

Housing dimensions

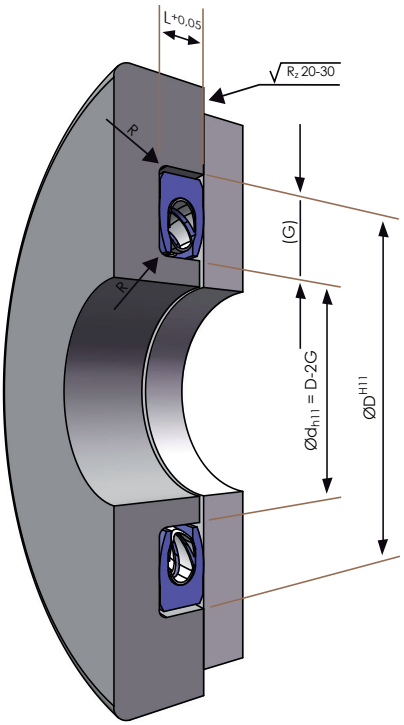
PROFILE S6: FOR FLANGE SEALING - INTERNAL PRESSURE



Profile S6

The profile S6 consists of a PTFE sealing ring with an O-spring. The profile S6 is appropriate for flange sealing applications with internal pressure as an alternative to an O-ring in situations where sealing performance has to be optimized.

Housing dimensions and installation

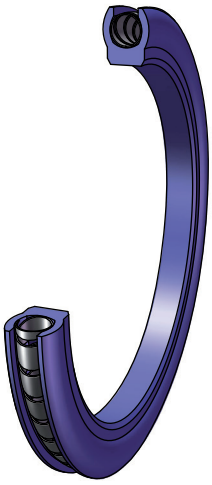


For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Radius max. R_1 (mm)
	≥	<			
2,62	32	45	3,6	2,25	0,4
3,53	45	80	4,8	3,10	0,6
5,33	80	110	7,1	4,70	0,8
6,99	110		9,5	6,10	0,8

Housing dimensions

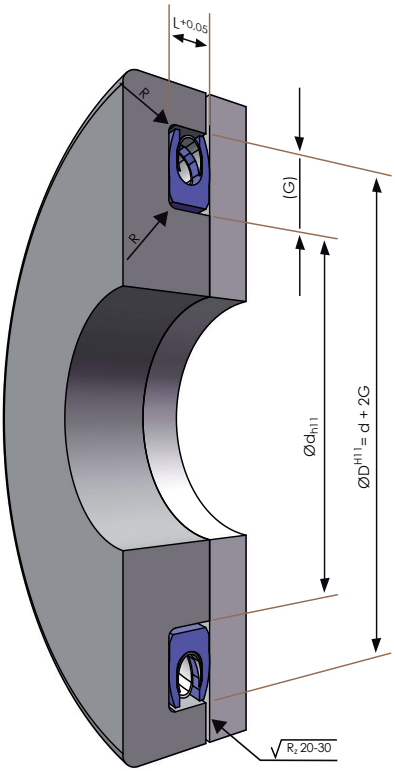
PROFILE S7: FOR FLANGE SEALING - EXTERNAL PRESSURE



Profile S7

The profile S7 consists of a PTFE sealing ring with an O-spring. The profile S7 is appropriate for flange sealing applications with external pressure as an alternative to an O-ring in situations where sealing performance has to be optimized.

Housing dimensions and installation



For surface finish, lead in chamfer and other installation dimensions see "The Synering® System"

O-ring cross-section (mm)	Recommended inner Ø range d (mm)		Groove width L (mm)	Groove depth G (mm)	Radius max. R_1 (mm)
	≥	<			
2,62	40	45	3,6	2,25	0,4
3,53	45	80	4,8	3,10	0,6
5,33	80	110	7,1	4,70	0,8
6,99	110		9,5	6,10	0,8

Housing dimensions

< Notes >

< Notes >

< Notes >

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