Installation housings, design

Design of the shaft

For reliable functioning and long lifespan of the sealing system, the accurate design of the shaft in the contact surface area is decisive. The following data on designing the shaft must be followed implicitly in order to avoid an imbalance of the dynamic sealing mechanism in the contact area between the sealing lip and shaft.

Tolerance

Shaft diameter tolerance:	ISO h11
Roundness tolerance:	IT 8

Surface roughness

The contact surface area of the shaft should adhere to the following surface parameters:

Ra = 0.2 - 0.8 µm
Rz = 1 - 5 µm
Rmax ≤ 6.3 µm

The surface roughness should lie within the stipulated ranges. Shaft surfaces with higher roughness create increased wear on the sealing edge and lead to a decrease in the lifespan.

Better surface roughness than those recommended have the opposite effect and the moisturizing of the shaft surface with lubricant is disrupted. Friction and temperature increase resulting in damage to the sealing edge and the eventual premature breakdown.

Hardness

The surface hardness of the shaft also has a great influence on the lifespan of the whole sealing system.

Hardness
min. 45 HRC for normal applications

min. 55 HRC for intrusion of dirt from the outside or polluted media as well as at peripheral speeds > 4m/s

The hardening depth should be at least 0.3mm.
The grey layer is to be smoothed following nitration.

Processing procedure

The processing procedure of the shaft surface in the shaft seal area has a great influence on the reliable functioning of the whole sealing system. In particular, achievement of the required "absence of lead" depends on the selection and quality of the processing procedure.

Lead-free

The contact surface of the shaft must be orientation-free.

In the processing of a shaft surface, the formation of orientation (similar to a micro thread) can ensue which causes a leading effect. Depending on the direction of rotation, this either supports or works against the sealing effect of the shaft seal. In an unfavourable case, if the leading effect of the shaft is higher than that of the shaft seal, leakage can result.

In applications with only one rotational direction, this behaviour can purposely be used to support the sealing effect.

Plunge grinding

We recommend plunge grinding (without axial feed) as a processing procedure to create a lead free surface. However, some parameters must be observed for plunge grinding to guarantee a lead-free surface.

- The rotational frequency ratio between the grinding wheel and the workpiece must not be an integer.
- An orientation can also be transmitted when the grinding wheel is trued. For this reason, multi-grain dresser tools with as little axial feed as possible or profile truing rolls should be used
- The sparking out time should be set for as long as total sparking out takes

Hard turning

For economic reasons, more and more surfaces for shaft seals are not plunge-cut ground but done by hard turning. An orientation is created on the shaft surface by the tool feed when turning. This results in a shaft pumping effect when rotating.

For applications with only one rotation direction and concurring directions of the pumping effect of the seal and shaft, the effect is positive and the application of shaft seals is generally not critical in this case.

For shafts with alternating rotation directions, it inevitably counteracts the pumping effect of the seal and the shaft. In order to prevent leakage under these circumstances, the feed effect of the shaft seal must be greater than that of the shaft. The degree to which the individual feed effects and the sum of these is theoretical and cannot be accurately predicted. To prevent leakage under all operating conditions, we strongly recommend that appropriate test runs are carried out.

The feed effect of the seal can be minimized by specific processing parameters. Please contact us for further information.

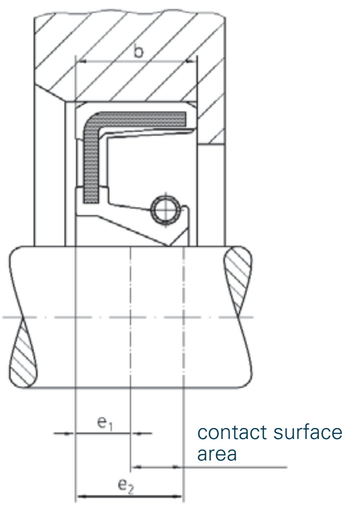
Shaft contact surface area

All the demands described for the design of the shaft refer to the shaft surface which means the contact area between the shaft and the seal. The position of the shaft contact surface area for shaft seals with and without protection lip related to the sealing width b is specified in the following table and figure.

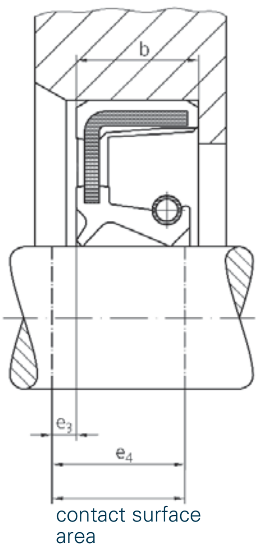
Contact surface areas for shaft seals acc. to DIN 3760

Sealing width	Contact surface area for			
	shaft seals without protection lip		shaft seals with protection lip	
b	e_1	$e_{2\ min.}$	e_3	$e_{4\ min.}$
7	3.5	6.1	1.5	7.6
8	3.5	6.8	1.5	8.3
10	4.5	8.5	2	10.5
12	5	10	2	12
15	6	12	3	15
20	9	16.5	3	19.5

Contact surface area without protective lip



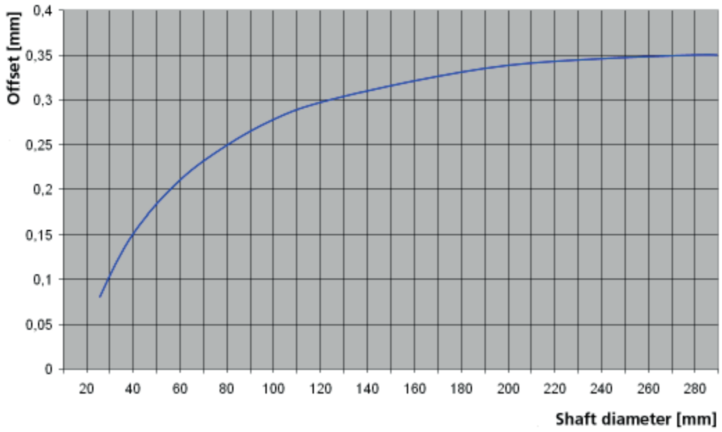
Contact surface area with protective lip



Offset

If the central axis of the shaft and the housing bore do not exactly correspond, one speaks of offset. The result of offset is an uneven distribution of radial force at the circumference of the shaft. On the one side of the shaft, the contact pressure is maximal which leads to greater wear. On the opposite side, the contact pressure is minimum, which can lead to reduction of the sealing action.

The figure on the right shows the maximum permitted values.

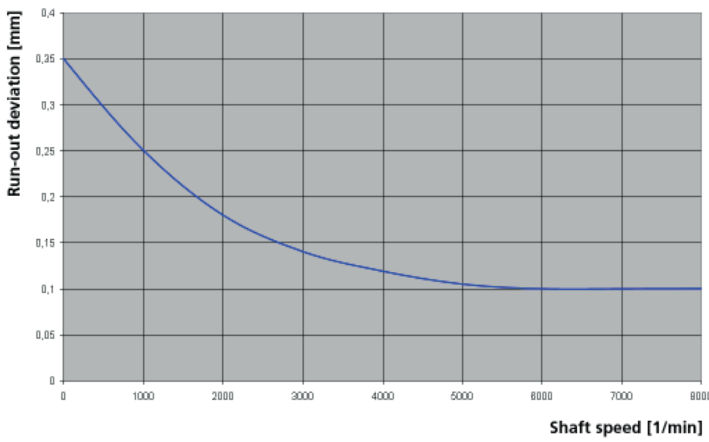


Permissible offset

Dynamic run-out deviation

Dynamic run-out deviations of the shaft at higher peripheral speeds can lead to leakage. If you observe a point on the sealing edge of a shaft seal, a run-out running shaft underneath makes an up and down movement which the sealing lip, due to its mass inertia, can no longer follow after a specific peripheral speed has been reached. A gap is then created through which the medium can escape as leakage.

The figure shows the maximum permitted values for NBR and FKM (limited values apply for pressurizable types).

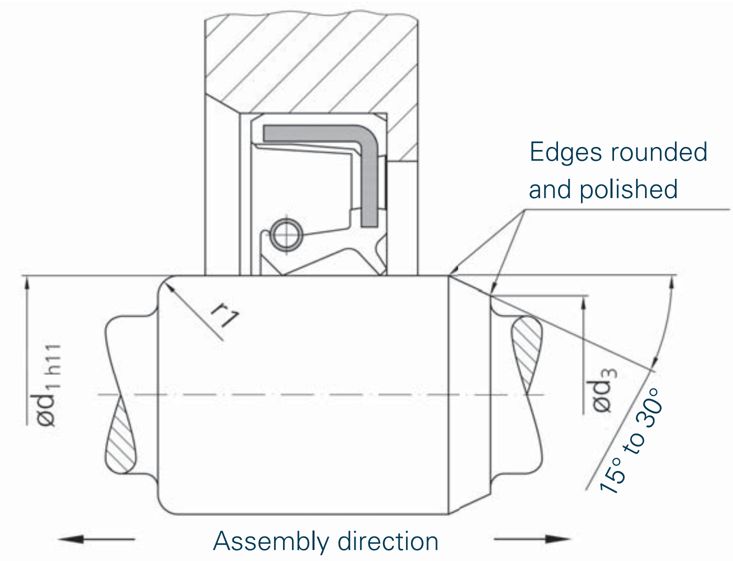


Permissible run-out for NBR and FKM

Chamfers

Depending on the installation direction, a chamfer or a radius should be provided. This can prevent damage of the sealing lip on installation.

You will find the angle, radius and diameter in the figure and tables.



Chamfer diameter

	d_1 [mm]			d_3 [mm]
		to	10	d1 - 1.5
>	10	to	20	d1 - 2.0
>	20	to	30	d1 - 2.5
>	30	to	40	d1 - 3.0
>	40	to	50	d1 - 3.5
>	50	to	70	d1 - 4.0
>	70	to	95	d1 - 4.5
>	95	to	130	d1 - 5.5
>	130	to	240	d1 - 7.0
>	240	to	500	d1 -11.0

Type	r1 min. [mm]
without protective lip	0.6
with protective lip	1.0

Protection of the shaft

The shaft surface must be free of all damage in the contact area of the seal. Scratching, scoring, dents or corrosion marks very soon lead to leakage and failure of the seal.

After meticulous processing, it is, therefore, important that appropriate care of the surface is taken during transport and storage of the shaft up to installation. This is facilitated by suitable protective covers and transport containers.

Shaft materials	Application / remarks
Common steels for shafts in mechanical engineering	General
Hardenable stainless steels	Aqueous media Corrosive media
Nonferrous metals	Aqueous media at low peripheral speeds
Casting materials (Fe)	free of shrink holes, fine-pored (<0.05mm)
Hard chromium-plated contact surfaces	tSometimes problematic due to irregular and wear and disruption of the lubricant moisturisati-on, improvement with plunge grinding finish, if necessary.
Ceramic coating	Very wear resistant but also "aggressive": roughness and pore size to be considered. If necessary, surface must be sealed. Adherence to base material must be guaranteed.
Plastics	Problematic due to poor thermal conduction, so only for very slow movements

anyseals

Design of the bore

Apart from the dynamic sealing between the sealing lip and the shaft, a shaft seal also provides static sealing between its outer diameter and the bore. Accurate design of the bore is important to prevent leakage between the outer diameter of the seal and the housing and to guarantee the secure and tight fit of the seal in the housing.

Tolerance

For the diameter of the bore, the ISO tolerance field H8 is applicable. Specially adjusted tolerances with less interference can become necessary with thin-walled housings and housings made of brittle materials or materials with low strength.

For light metal or plastic housings, we recommend application of types with rubber covered outer diameter as these can better follow the greater thermal expansion of the housing.

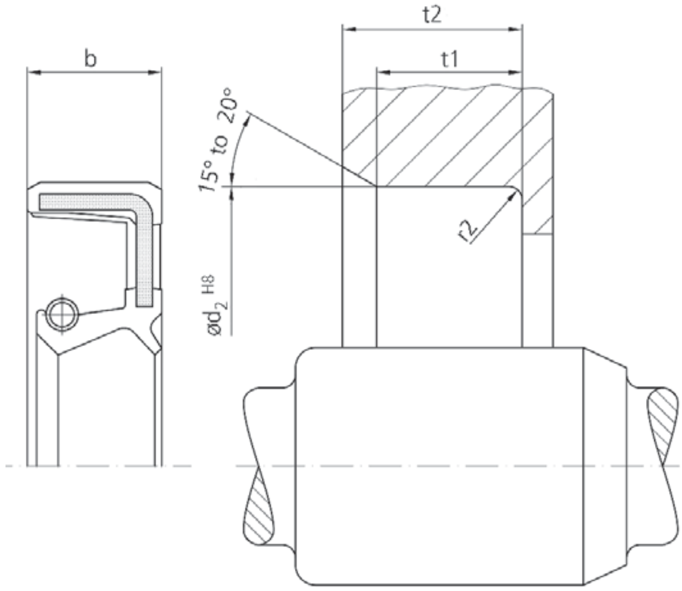
Surface roughness

Type	Permitted surface roughness [µm]
according to DIN type A, elastomer outer diameter	R_a = 1.6 - 6.3 R_z = 10 - 20 R_{max} < 25
according to DIN types B & C, metal outer diameter	R_a = 0.8 - 3.2 R_z = 6.3 - 16 R_{max} < 16

Installation depth and chamfers

The depth of the bore is illustrated in the figure and table.

The angle of the lead-in chamfer should be 15° to 20°. The transition between the chamfer and cylindrical surface should be burr-free



Dimensions of the bore

b	t1 min. (0.85xb)	t2 min. (b+0.3)	r2 max.
7	5.95	7.3	0.5
8	6.8	8.3	
10	8.5	10.3	
12	10.3	12.3	0.7
15	12.75	15.3	
20	17	20.3	

All dimensions in mm