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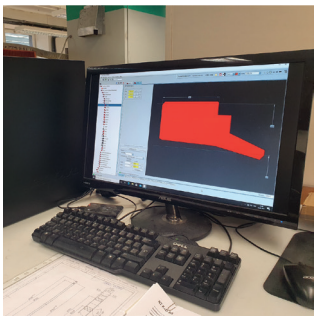
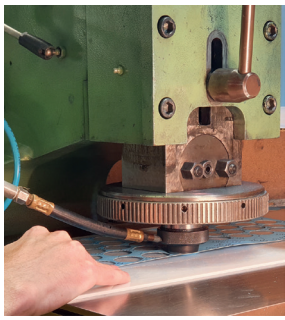
NT
K+D AG
Plastics & sealing technology
3D printing





Design guidelines

Making your components just the way you want them

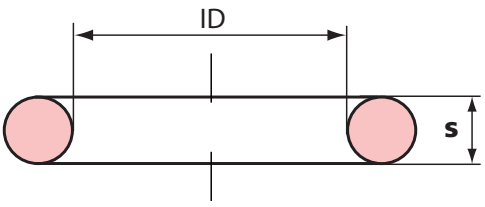
Introduction

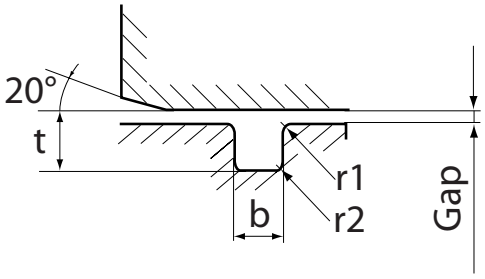
Here you can find out all the key data on design, production and other information worth knowing. Particular attention should be paid to the fact that in the case of material combinations, it is essential that the selected materials correspond to the respective operating conditions. Minus and maximum temperatures from data sheets and brochures are only approximate values and are often indicated as peak loads. Furthermore, maximum temperatures and maximum pressures are inversely proportional. Special profiles and turned parts are manufactured according to drawings or the corresponding requirements of the customer.

Surface finish

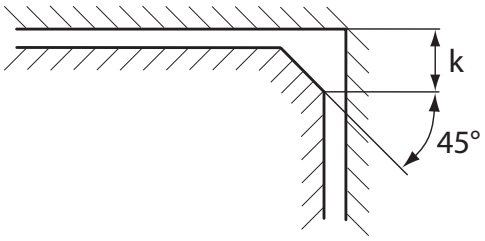
For machining the running surfaces on cylinders and rods, we recommend µ RA 0.3 - 0.5 (N5) or better for cast iron and steel; observe RZ value! Light metal cylinders become very wear resistant by hard anodizing. Electroplated piston rods ensure good tightness and longer service life. Subsequent polishing increases the sealing effect. The shaft hardness of rotating seals must be at least 50 HRC; for dynamic seals, such as a piston seal, the components should have >25 HRC.

O-ring groove dimensions for imperial sizes





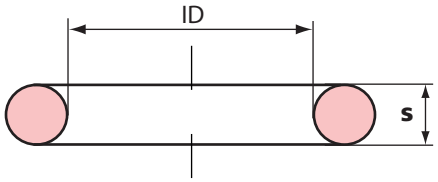
Groove dimensions [mm] for dynamic seals							
s	Groove width		Groove depth		r1	r2	Gap (guide value)
	b	Tolerance	t	Tolerance			
1.78	2,5	+0,2 / -0	1,45	± 0,03	0,1	0,25	0,06
2.62	3,5	+0.2 / -0	2,25	± 0,05			0,06
3.53	4,5	+0,3 / -0	3,1	± 0,1	0,2	0,5	0,08
5.34	7	+0,3 / -0	4,7	± 0,1			0,1
6.99	9,5	+0,3 / -0	6,1	± 0,1			0,12

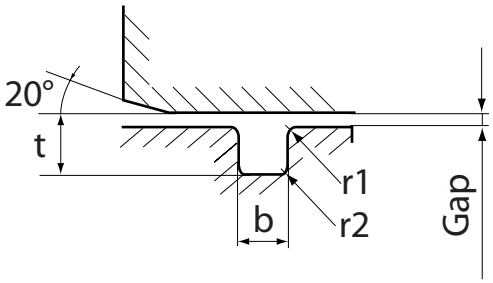


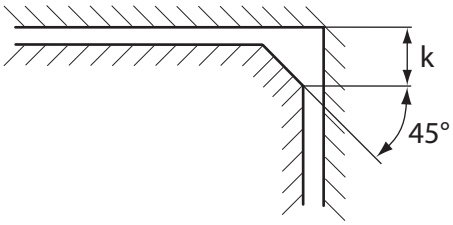
Groove dimensions [mm] for static seals								
s	Groove width		Groove depth		r1	r2	k	Gap (guide value)
	b	Tolerance	t	Tolerance				
1.78	2,5	+0,2 / -0	1,3	± 0,03	0,1	0,25	2,3	0,1
2.62	3,5	+0,2 / -0	2,1	± 0,1			3,5	0,1
3.53	4,5	+0,3 / -0	2,9	± 0,1	0,2	0,5	5,0	0,12
5.34	7	+0,3 / -0	4,4	± 0,1			7,4	0,12
6.99	9,5	+0,3 / -0	5,8	± 0,1			9,8	0,12

The given dimensions are guide values

O-ring groove dimensions for metric sizes







Groove dimensions [mm] for dynamic seals							
s	Groove width		Groove depth		r1	r2	Gap (guide value)
	b	Tolerance	t	Tolerance			
1,0	1,5	+0,1 / -0	0,8	± 0,05	0,1	0,25	0,04
1,5	2,0	+0,1 / -0	1,2	± 0,05			0,04
1,6	2,3	+0,1 / -0	1,2	± 0,05			0,06
2,0	2,5	+0,15 / -0	1,7	± 0,05			0,06
2,4	3,2	+0,2 / -0	2,0	± 0,05			0,06
2,5	3,5	+0,2 / -0	2,1	± 0,05			0,06
3,0	4,0	+0,3 / -0	2,6	± 0,1	0,2	0,5	0,08
4,0	5,0	+0,3 / -0	3,5	± 0,1			0,1
5,0	6,5	+0,3 / -0	4,5	± 0,1			0,1
5,7	7,5	+0,3 / -0	4,8	± 0,1			0,1
7,0	9,5	+0,4 / -0	6,1	± 0,1			0,12
10	12	+0,4 / -0	9,0	± 0,15			0,2

Groove dimensions [mm] for static seals								
s	Groove width		Groove depth		r1	r2	k	Gap (guide value)
	b	Tolerance	t	Tolerance				
1,0	1,5	+0,1 / -0	0,7	± 0,05	0,1	0,25	1,4	0,06
1,5	2,0	+0,1 / -0	1,1	± 0,05			2,0	0,08
1,6	2,3	+0,1 / -0	1,2	± 0,05			2,1	0,08
2,0	2,5	+0,15 / -0	1,5	± 0,1			2,6	0,1
2,4	3,2	+0,15 / -0	1,9	± 0,1			3,3	0,1
2,5	3,5	+0,2 / -0	2,0	± 0,1			3,5	0,1
3,0	4,0	+0,2 / -0	2,4	± 0,1	0,2	0,5	4,0	0,12
4,0	5,0	+0,3 / -0	3,3	± 0,1			5,5	0,12
5,0	6,5	+0,3 / -0	4,2	± 0,1			7,0	0,12
5,7	7,5	+0,3 / -0	4,6	± 0,1			8,0	0,15
7,0	9,5	+0,4 / -0	5,8	± 0,1			10,0	0,15
10	12	+0,4 / -0	8,5	± 0,15			15,0	0,25

The given dimensions are guide values

Waterjet cutting

Our CNC-controlled system cuts the material with consistently high precision and without any material stress, using a jet of water that is barely thicker than a human hair. There is no deformation and no contamination of the cut surfaces.

Minimum dimensions:

Wall thickness:	2 mm	
Internal:	1 x 1 mm	ø 1 mm
External:	3 x 3 mm	ø 3 mm

Tolerance range – Elastomers:

H: 0,3 - 5 mm Dims.: +/- 0,2 mm | H: +/- 10 % - 20 %
H: 5,1 - 10 mm Dims.: +/- 0,4 mm | H: +/- 10 % - 20 %

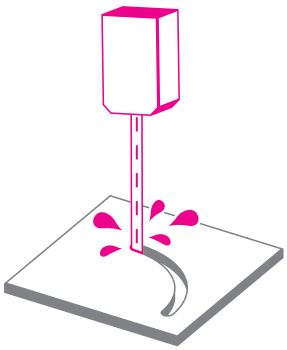
Tolerance range – Plastics:

H: 0,3 - 5 mm Dims.: +/- 0,2 mm | H: +/- 0,5 mm
H: 5,1 - 15 mm Dims.: +/- 0,4 mm | H: +/- 0,5 mm

Notes:
Graphite is not suitable for waterjet cutting. Method suitable for water-resistant materials only. For material thicknesses of 5 mm or greater, a slight deformation (typically "cone shaped") may result.

Maximum dimensions:

Internal:	1400 x 1400 mm
External:	2500 x 2000 mm
Height (H) - Plastic:	With water: Up to 8 mm
	Abrasive: Up to 25 mm
Height (H) - Rubber:	15 mm



Cutting plotter

Based on digital inputs, our cutting plotter can cut any shape quickly and easily using a guided knife. Depending on the material being cut, the knife can be made to oscillate for easier cutting.

Minimum dimensions:

Wall thickness:	4 mm	
Internal ø:	2 x sheet thickness	
External :	4 x 4 mm	ø 4 mm

Tolerance range – Elastomers:

H: 0,3 - 3,0 mm Dims.: +/- 0,25 mm | H: +/- 10 % - 20 %

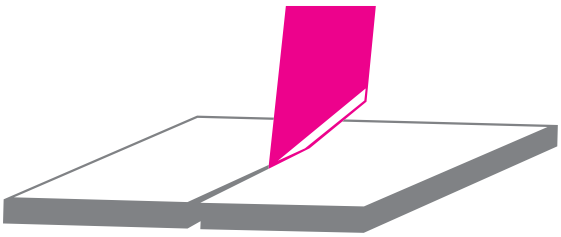
Tolerance range – Plastics:

H: 0,1 - 1,5 mm Dims.: +/- 0,25 mm | H: +/- 0,5 mm

Note:
Elastomers can be cut with a very fine sealing edge.

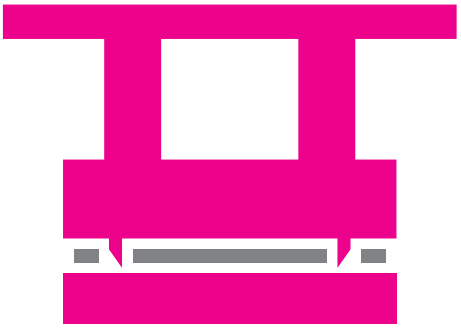
Maximum dimensions:

Internal:	1400 x 1900 mm
External:	1500 x 2000 mm
Height (H) – Plastic:	0,5 mm
Height (H) – Rubber:	8 mm



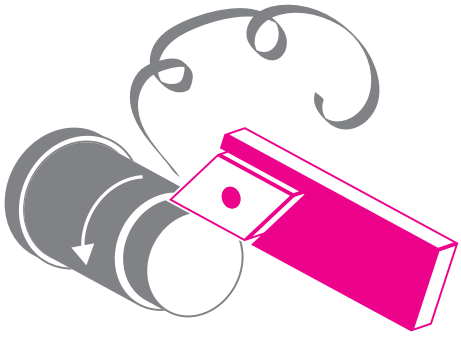
Die-cutting / Stamping

Using our reliable punching (die-cutting) machines we can work with all non-metallic materials, efficiently and precisely – including elastomers, plastics and soft fibrous materials in particular.

Minimum dimensions:	Maximum dimensions:
wall thickness: 4 mm Internal ø: 2 mm External ø: 3 mm	Internal ø: 1 mm External ø: 240 mm Height (H) – Plastic: 3 mm Height (H) – Rubber: 8 mm
Tolerance range – Elastomers: OD: +/- 0,3 mm ID: +/- 0,3 mm H: +/- 10 % - 20 % The thicker the material, the more concave the cut sides. **Tolerance range – Plastics:** OD: +/- 0,3 mm ID: +/- 0,3 mm H: +/- 0,5 %	
Note: Outer and inner diameters can be selected in millimetre increments. For intermediate diameters (e.g. 10.5 mm), please contact us to discuss.	

CNC turning

Our special lathes for plastics and elastomers can be used to produce all variations of components and seals.

Minimum dimensions:	Maximum dimensions:
Wall thickness – Plastic: 1 mm Wall thickness – Rubber: 2 mm Internal ø: 6 mm External ø: 5 mm (max. 2 mm long)	Internal ø: 650 mm External ø: 680 mm Height (H) – Plastic: 30 mm Height (H) – Rubber: 30 mm
Tolerance range – Elastomers: ≥ ø 8 mm OD/ID +/- 0,2 mm | H: +/- 0,2 mm ≥ ø 250 mm OD/ID +/- 0,4 mm | H: +/- 0,2 mm ≥ ø 400 mm OD/ID +/- 0,5 mm | H: +/- 0,2 mm **Tolerance range – Plastics:** ≥ ø 8 mm OD/ID +/- 0,1 mm | H: +/- 0,1 mm ≥ ø 400 mm OD/ID +/- 0,2 mm | H: +/- 0,1 mm	
Notes: Articles must be round. Undercuts not possible. O-ring cord diameter must be at least 1,5 mm.	

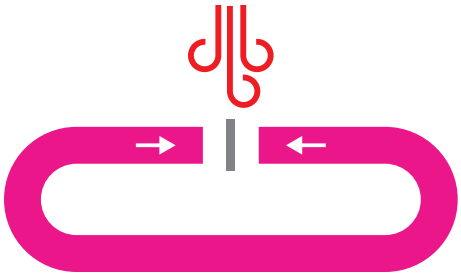
CNC milling

Using our CNC milling equipment, we machine materials into the shape you want. Our modern CNC machines can be used with all plastics and some elastomers.

Minimum dimensions:			**Maximum dimensions:**
Wall thickness – Plastic:	2 mm		Outer volume: 500 x 300 x 300 mm
Wall thickness – Rubber:	90 Sh A		
Internal ø:	6 mm		
External ø:	5 mm		
Tolerance range – Plastics:			
≥ 8 mm	+/- 0,15 mm	H: +/- 0,1 mm	
≥ 250 mm	+/- 0,2 mm	H: +/- 0,1 mm	
Note: Manufacturability must be clarified in detail.			

Hot vulcanization

Meter goods are cut to customer requirements and hot vulcanized at the joint using liquid rubber. These seals are only suitable for dynamic applications to a limited extent.

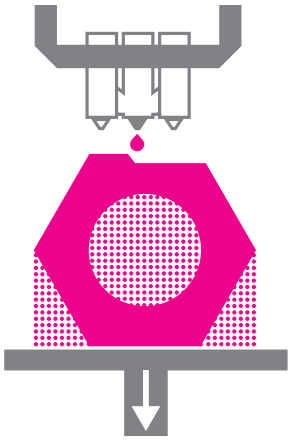
Minimum		**Maximum**	
Internal ø:	110 mm	Internal ø:	∞
Cord ø:	1,5 mm	Cord ø:	14,0 mm
Tolerance range:			
ID mm	**Tolerance mm**		
110,0 - 160,0	± 1,20		
160,0 - 220,0	± 1,60		
220,0 - 480,0	± 2,00		
480,0 - 650,0	± 3,00		
> 650,0	± 3.5/0.5%		
Standard cord diameter mm:			
1,5	3,5	5,7	10,0
1,78	4,0	6,0	11,0
2,0	4,5	7,0	12,0
2,5	5,0	8,0	14,0
3,0	5,33	9,0	
Other dimensions or profiles on request.			
Standard materials are FPM, NBR, EPDM, MVQ			

PolyJet 3D printing

PolyJet is a generative manufacturing process. Thanks to a microscopically fine layer resolution with an accuracy of up to +/- 0,1 mm and the most extensive range of digital materials, thin walls and complex shapes can be precisely produced.

Technical parameters

Max. dimensions:	**490 x 390 x 200 mm**
Layer thickness:	**0,024 mm**
Min. wall thickness (X- / Y-direction):	0,5 mm
Min. wall thickness (Z-direction):	0,5 mm
Recommended wall thickness (X-, Y- Z-direction):	>1,3 mm
Min. wall spacing:	0,5 mm
Min. distance between parts:	0,5 mm
Resolution:	**600 dpi**
Min. writing size:	2,1 mm
Detail accuracy:	0,1 mm
Tolerance range:	**≥ +/- 0,1 mm**



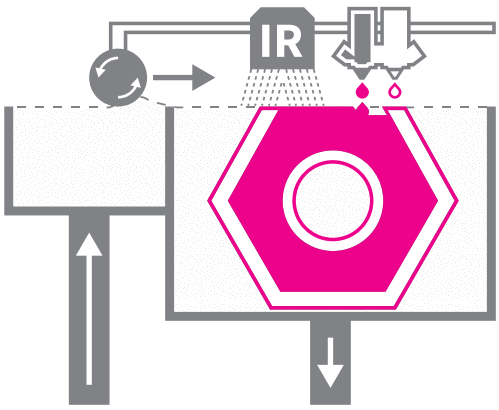
Notes:
For an optimal result, walls should be at least 1,3 mm thick.
Closed cavities should be avoided as these will be filled. Support material is removed as far as possible.

Multi Jet Fusion 3D printing

Multi Jet Fusion, or MJF for short, is a new powder-based 3D printing process that is used to produce high-resolution, precisely dimensioned 3D objects with low porosity and high surface quality. In contrast to Selective Laser Sintering (SLS), MJF does not involve the use of laser radiation, making a higher level of detail accuracy possible.

Technical parameters

Max. dimensions:	**330 x 240 x 185 mm**
Layer thickness:	**0,08 mm**
Min. wall thickness (X- / Y-direction):	0,5 mm
Min. wall thickness (Z-direction):	0,5 mm
Recommended wall thickness (X-, Y- Z-direction):	>1,5 mm
Min. wall spacing:	0,5 mm
Min. distance between parts:	0,7 mm
Resolution:	**1200 dpi**
Min. writing size:	2,4 mm
Detail accuracy:	0,1 mm
Tolerance range:	**≥ +/- 0,25 % (min. +/- 0,15mm)**



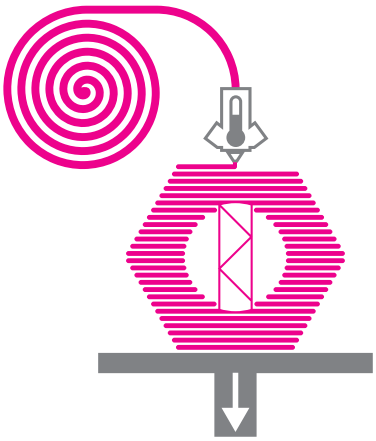
Notes:
During 3D printing, details such as labels, logos, instructions, or QR codes can be printed onto components in any color without requiring support material. However, closed cavities should be avoided, as they will be filled. Holes less than 2.6 mm across and over 50 mm deep may require additional mechanical post-processing due to compact residual powder that cannot be removed by standard methods.

Fused Deposition Modeling 3D printing

In Fused Deposition Modelling (FDM), a strand-like plastic, a so-called "filament", is passed through a heating block with a nozzle which melts it, and the material is built up layer by layer.

Technical parameters

Max. dimensions:	**600 x 1200 x 600 mm**
Layer thickness:	**0,1 mm to 0,8 mm**
Min. wall thickness (X- / Y-direction):	2 mm
Min. wall thickness (Z-direction):	2 mm
Recommended wall thickness (X-, Y- Z-direction):	2,4 mm
Min. wall spacing:	4 mm
Min. distance between parts:	0,7 mm
Min. writing size:	3,5 mm
Detail accuracy:	0,1 to 0,6 mm
Tolerance range:	**+/- 0,3 mm** (+/- 0,1 to +/- 1,0 mm)



Notes:
The greatest variety of materials and the least expensive process. Closed cavities should be avoided as these will be filled. Support material is removed as far as possible. Due to the supports in the build-up direction, the underside/inside does not have the same quality as the outer surface.

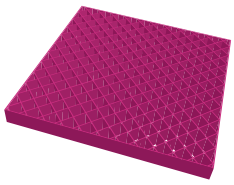
Attention:

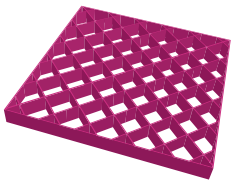
- Details are produced to the specified resolution.
- If not specified, we will determine component orientation.
- Wall thicknesses below 2 mm unstable (> 0,8 mm printable).
- Holes must be > ø 2 mm (smaller holes drilled subsequently).
- Angles ≥ 45°can be printed without support.
- Columns should be > ø 3 mm.
- No inaccessible voids.
- Models should always be drawn at the upper end of the tolerance range because the materials experience shrinkage.

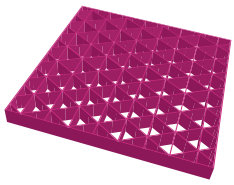
Strength and robustness of items produced by Fused Deposition Modelling:

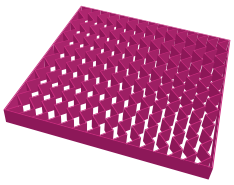
As a rule, we print items with a 15% to 30% degree of structure filling with a "triangular" structure type (see below). How much loading the 3D printed object can withstand depends strongly on the degree of filling and the orientation of the object. The way the material is deposited in layers during printing results in different abilities to resist vertical and horizontal loads. The best tensile strength is achieved parallel to the layers. If the object will be equally loaded parallel to and perpendicular to the layers, it can be printed at an angle of 45°.

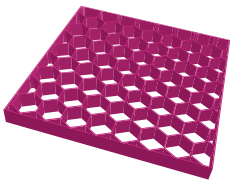
Structure types:


Reclinear


Grid


Triangular

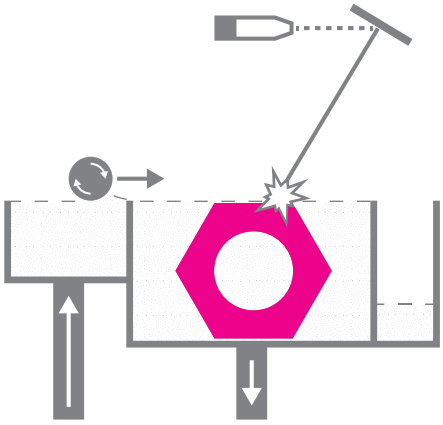

Wiggle


Honeycomb

Selective Laser Sintering 3D printing

Selective Laser Sintering, or SLS for short, is a 3D printing process in which powder is precisely melted on using a laser.

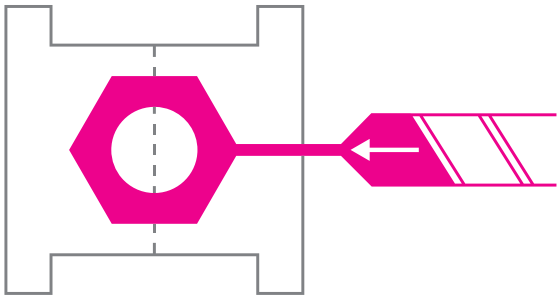
Technical parameters	
Max. dimensions::	**650 x 330 x 560 mm**
Layer thickness:	**0,1 to 0,14 mm**
Min. wall thickness (X- / Y-direction):	0,5 mm
Min. wall thickness (Z-direction):	0,5 mm
Recommended wall thickness (X-, Y- Z-direction):	>1,5 mm
Min. wall spacing:	0,5 mm
Min. distance between parts:	1,0 mm
Min. writing size:	3,5 mm
Detail accuracy:	0,25 mm
Tolerance range:	**≥ +/- 0,25 % (min. +/- 0,15mm)**



Notes:
Does not require any support material. Almost any geometry can be realised. Closed cavities should be avoided as these will be filled. Support material is removed as far as possible. Holes less than 2,6 mm across and more than approx. 50 mm deep may contain very compact residual powder that cannot be removed by standard post-processing, so additional mechanical post-processing may be required.

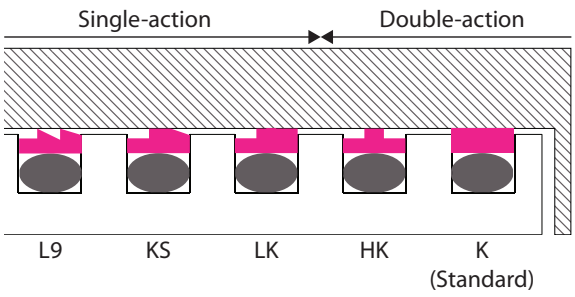
Injection moulding

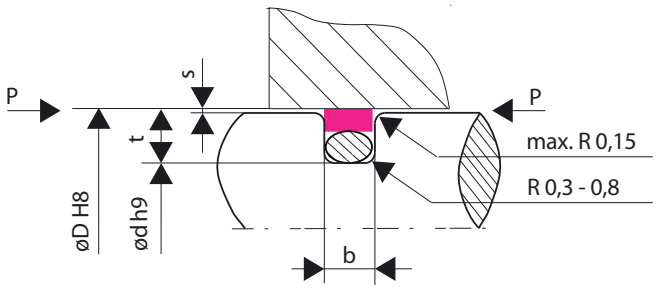
In the case of injection moulding, an elastomer or a plastic is injected into a mould. This process is particularly suitable for parts that are needed in batches of 250 or more.

Minimum dimensions:		Maximum dimensions:
Outer volume:	6 x 6 x 6 mm	Outer volume: 350 x 350 x 90 mm Larger on request
Wall thickness:	0,8 mm	
Tolerance range – Elastomers: +/- 0,1 mm to +/- 0,3 mm **Tolerance range – Plastics:** +/- 0,08 mm to +/- 0,2 mm		
Notes: The draft angle of the mould must be taken into account. To produce the required moulds, the use of the PolyJet 3D printing process may be considered. Multi-component injection moulding is possible.		

NTH-Rings for pistons

Universal piston seals for hydraulic and pneumatic applications, with minimal installation dimensions.





Installation dimensions for standard profiles					
Piston	Groove dimensions			Gap	Order No.
ø D	b $^{+0,15}_{0}$	t	d-h9	s	
8	2,0	2,25	3,5	0,10 ±0,02	08007
10			5,5		10009
12	2,0	2,50	7,0	0,12 ±0,02	12010
15			10,0		15012
16			11,0		16013
18			13,0		18014
20			15,0		20015
22			17,0		22017
25			20,0		25019
26			21,0		26019
28	3,0	3,75	20,5	0,15 ±0,05	28117
30			22,5		30118
32			24,5		32119
35			27,5		35121
36			28,5		36122
38			30,5		38123
40			32,5		40124
42			34,5		42126
45			37,5		45128
48			40,5		48129
50	4,0	5,00	40,0	0,15 ±0,05	50223
55			45,0		55224
60			50,0		60226
63			53,0		63227
65			55,0		65227
70			60,0		70229
75			65,0		75230
80			70,0		80232
84			74,0		84233
85			75,0		85234
90			80,0		90235
100	4,0	5,50	89,0	0,20 ±0,05	100238
110			99,0		110241
120			109,0		120244
125			114,0		125246
130			119,0		130247
140			129,0		140250
150			139,0		150253
160			149,0		160257

Installation dimensions for standard profiles					
Piston	Groove dimensions			Gap	Order No.
ø D	b $^{+0,15}_{0}$	t	d-h9	s	
170	6,0	7,50	155,0	0,25 ±0,05	170361
180			165,0		180363
190			175,0		190364
200			185,0		200366
210			195,0		210367
220			205,0		220369
230			215,0		230371
240			225,0		240372
250			235,0		250374
280			265,0		280378
300			285,0		300379
315	6,0	8,50	298,0	0,30 ±0,05	315380
320			303,0		320381
350			333,0		350382
360			343,0		360000
380			363,0		380383
400			383,0		400384
420			403,0		420385
450			433,0		450386
480	8,0	11,00	458,0	0,40 ±0,05	480465
500			478,0		500467
530			508,0		530469
550			528,0		550470
560			538,0		560000
600			578,0		600472
630	10,0	12,50	605,0	0,40 ±0,05	630000
650			625,0		650000
670			645,0		670000
700			675,0		700000
730			705,0		730000
750			725,0		750000
800			775,0		800000

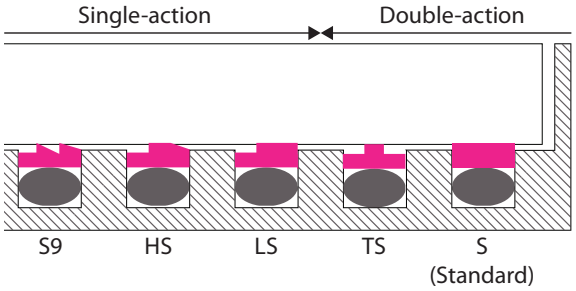
When ordering, please specify the Type and Order No.

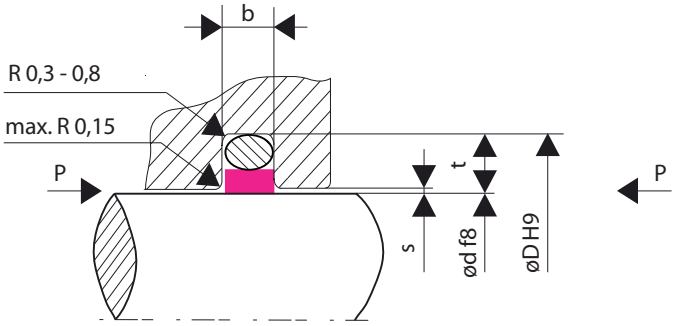
Intermediate dimensions are available at short notice.

Diameters over 800 mm on request.

NTH-Rings for rods – “Standard” type

Universal rod seals for hydraulic and pneumatic applications, with minimal installation dimensions, double-acting





Installation dimensions for standard profiles					
Rod	Groove dimensions			Gap	Order No.
ø d	b $^{+0,15}_{0}$	t	D H9	s	
6	2,0	2,25	10,5	0,10 ±0,02	S 06011
8			12,5		S 08012
10			14,5		S 10013
12	2,0	2,50	17,0	0,12 ±0,02	S 12015
15			20,0		S 15017
16			21,0		S 16017
18			23,0		S 18019
20			25,0		S 20020
22			27,0		S 22021
25			30,0		S 25023
26			31,0		S 26024
28	3,0	3,75	35,5	0,15 ±0,05	S 28124
30			37,5		S 30125
32			39,5		S 32126
35			42,5		S 35128
36			43,5		S 36129
38			45,5		S 38130
40			47,5		S 40131
42			49,5		S 42133
45			52,5		S 45134
48			55,5		S 48136
50	4,0	5,00	60,0	0,15 ±0,05	S 50227
55			65,0		S 55229
60			70,0		S 60230
63			73,0		S 63231
65			75,0		S 65232
70			80,0		S 70234
75			85,0		S 75235
80			90,0		S 80237
85			95,0		S 85238
90			100,0		S 90240

Installation dimensions for standard profiles					
Rod	Groove dimensions			Gap	Order No.
ø d	b $^{+0,15}_{0}$	t	D H9	s	
100	4,0	5,50	111,0	0,20 ±0,05	S 100243
110			121,0		S 110246
120			131,0		S 120250
125			136,0		S 125251
130			141,0		S 130253
140			151,0		S 140256
150			161,0		S 150259
160			171,0		S 160260
170	6,0	7,50	185,0	0,15 ±0,05	S 170365
180			195,0		S 180366
190			205,0		S 190368
200			215,0		S 200369
210			225,0		S 210371
220			235,0		S 220373
230			245,0		S 230374
240			255,0		S 240376
250			265,0		S 250377
280			295,0		S 280380
300			315,0		S 300381
320	6,0	8,50	337,0	0,30 ±0,05	S 320382
350			367,0		S 350383
360			377,0		S 360000
380			397,0		S 380384
400			417,0		S 400385
420			437,0		S 420386
450			467,0		S 450387

When ordering, please specify the Type and Order No.

Intermediate dimensions are available at short notice.

Diameters over 800 mm on request.

Dateiformate

STEP
STEP, or STP, is a standard for describing product data in the additive industry. A formula can be used, for example, to describe a perfect sphere.

STL
The STL format describes the surface of a 3D body by means of triangular facets. It is not possible to define a perfect sphere, but rather individual triangles by their coordinates.

OBJ + MTL (accompanying file format MTL for textures/colours)
An OBJ file is a standard 3D image format including an object's three-dimensional coordinates, texture maps, polygon surfaces and other information about the object.

3MF
The 3MF format comprises a 3D model that includes details of textures, mesh, colours, materials and scaling, and a print ticket with recommended print options.

WRL
This is the modelling language for virtual reality, which can be navigated in three dimensions and contains coordinates and colours to define every object and shape.

DVG / DVGW
Used to save 2D CAD drawings such as mechanical illustrations and assembly or installation instructions.

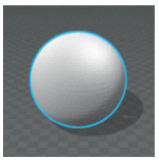
DXF
This is very similar to the DWG format but is more compatible with other ASCII-based programs.

PDF
The Portable Document Format is the most common format for data such as image, vector and even 3D models.

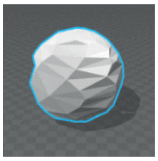
Parameters

3D

Resolution



STL resol. 0,01mm



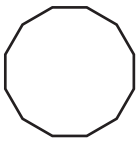
STL resol. 0,8mm

Recommended resolution: 0,1 mm

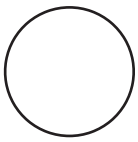
Multi-component file
With assembled 3D data or component combinations, it is important that all individual models have the same zero point.

2D

Resolution
Circles must not be divided into segments, but must be exported as a polyline.



Segmente



Polyline

Materialien

Plastics:	ABS, ASA, FEP, HDPE, HIPS, LCP, PA, PAI, PBI, PC, PC-ABS, PE, PEEK, PEI, PES, PETG, PFA, PI, PLA, PMMA, POM, PP, PPS, PPSU, PS, PVC, PVDF, Rulon, Thordon,
Elastomers:	CR, EPDM, FFKM, FPM, H-NBR, MVQ, NBR, NR, PU, Silicone, TPC, TPE, TPU, TPV in many colours and with a wide range of hardness levels
Sheets:	NT Classic, NT Unit, NT Flex, NT Chem beige/blau, BA-50, BA-GL, BA-U, Novapress 850, Novapress Universal, Novatec Premium II, Novamica Thermex, Novaphit SSTC, Novaphit VS, Novaphit MST,
PTFE:	PTFE pure, PTFE glass, PTFE glass/Moly, PTFE carbon/graphite, PTFE bronze
Lip seals:	DL 5000, DL 6000, DL 6010, DL 6020, DL 6030

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