

## O-rings



### Description

O-rings are circular sealing elements with a circular cross-section. The simplicity of the shape of an O-ring combined with the elasticity of the materials of which O-rings are made give the O-ring universal properties and make it the most widely used sealing element.

O-rings can be produced from many different elastomer materials and a wide range of O-rings of standard materials is available from stock. The bandwidth of available O-rings is so wide and so closely graded that almost any application is covered. O-rings are standardized in DIN ISO 3601 (former DIN 3771).

### Special properties

- high operational reliability
- small installation grooves
- simple installation
- cost-effective production
- high availability

### Applications

O-ring seals are used in all areas of industrial technology. The applications are divided into static applications (no relative movement between the sealed parts of a machine) and dynamic applications (the sealed parts of a machine move in relation to each other). The vast majority of O-ring are used for static or slowly moving machine parts.

### Designation

The common designation of an O-ring provides information on the inner diameter, the cross section, the material and the hardness:

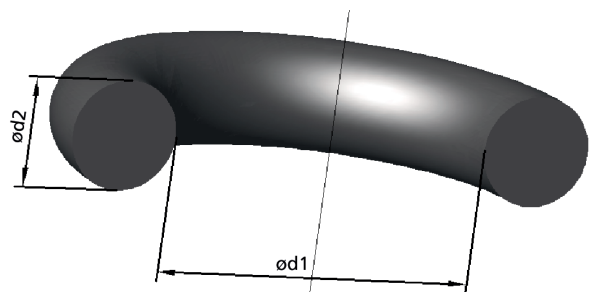
O-ring 50 - 3 NBR 70

inner diameter  $d_1$  in mm

cross section  $d_2$  in mm

material code according to DIN ISO 1629

hardness in Shore A



## Quality

### Delivery quality

The following delivery quality applies to all standard O-rings for which no other special arrangement has been made:

tolerances according to DIN ISO 3601-1 class B (former DIN 3771-1)

form and surface deviations according to DIN ISO 3601-3 type grade N (former DIN 3771-4 type grade N)

acceptable quality level DIN ISO 2859-1 AQL 1.5

### Internal diameter XXL

Many applications of large O-rings are faced with the question of whether O-rings of the required sizes are available, how much they cost and also how they are manufactured.

In addition to the traditional O-rings produced by endless molding, round cord rings of butt-glued or butt-vulcanized round cords are available. The drawbacks of these versions include the distinctly higher cord thickness tolerances and the lower stress bearing capacity of the glued joint. Mold-made O-rings do not have these drawbacks but are substantially more expensive due to the large size of the molds and the need for large presses.

A special manufacturing method with special mold design now enables us to make large O-rings (of 700mm O.D. and larger) as another alternative at a very attractive price.

These O-rings are also made by endless molding. The only difference to the traditional O-ring is the outer shape in the uncompressed state, which is not ideally round. When the ring is slightly expanded when fitted, that deviation disappears. With this development, we can offer you the advantages of endless molded O-rings at distinctly better prices.

## Tolerances

### Inner diameter tolerances

according to DIN ISO 3601-1 class B (former DIN 3771-1)

The inner diameter tolerances in the table below were calculated using the formula according to DIN ISO 3601-1:

$$\Delta d_1 = \pm [(d_{10,95} \times 0,009) + 0,11]$$

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
$d_1 \leq 0.53$	$\pm 0.11$
$0.53 < d_1 \leq 1.71$	$\pm 0.12$
$1.71 < d_1 \leq 2.93$	$\pm 0.13$
$2.93 < d_1 \leq 4.17$	$\pm 0.14$
$4.17 < d_1 \leq 5.44$	$\pm 0.15$
$5.44 < d_1 \leq 6.72$	$\pm 0.16$
$6.72 < d_1 \leq 8.01$	$\pm 0.17$
$8.01 < d_1 \leq 9.31$	$\pm 0.18$
$9.31 < d_1 \leq 10.62$	$\pm 0.19$
$10.62 < d_1 \leq 11.94$	$\pm 0.20$
$11.94 < d_1 \leq 13.27$	$\pm 0.21$
$13.27 < d_1 \leq 14.61$	$\pm 0.22$
$14.61 < d_1 \leq 15.95$	$\pm 0.23$
$15.95 < d_1 \leq 17.29$	$\pm 0.24$
$17.29 < d_1 \leq 18.64$	$\pm 0.25$
$18.64 < d_1 \leq 20.00$	$\pm 0.26$
$20.00 < d_1 \leq 21.36$	$\pm 0.27$
$21.36 < d_1 \leq 22.73$	$\pm 0.28$
$22.73 < d_1 \leq 24.10$	$\pm 0.29$
$24.10 < d_1 \leq 25.47$	$\pm 0.30$
$25.47 < d_1 \leq 26.85$	$\pm 0.31$
$26.85 < d_1 \leq 28.23$	$\pm 0.32$
$28.23 < d_1 \leq 29.61$	$\pm 0.33$
$29.61 < d_1 \leq 31.00$	$\pm 0.34$
$31.00 < d_1 \leq 32.39$	$\pm 0.35$
$32.39 < d_1 \leq 33.78$	$\pm 0.36$
$33.78 < d_1 \leq 35.18$	$\pm 0.37$
$35.18 < d_1 \leq 36.58$	$\pm 0.38$
$36.58 < d_1 \leq 37.98$	$\pm 0.39$
$37.98 < d_1 \leq 39.38$	$\pm 0.40$
$39.38 < d_1 \leq 40.79$	$\pm 0.41$
$40.79 < d_1 \leq 42.20$	$\pm 0.42$
$42.20 < d_1 \leq 43.61$	$\pm 0.43$
$43.61 < d_1 \leq 45.02$	$\pm 0.44$
$45.02 < d_1 \leq 46.44$	$\pm 0.45$
$46.44 < d_1 \leq 47.86$	$\pm 0.46$
$47.86 < d_1 \leq 49.28$	$\pm 0.47$
$49.28 < d_1 \leq 50.70$	$\pm 0.48$
$50.70 < d_1 \leq 52.12$	$\pm 0.49$
$52.12 < d_1 \leq 53.55$	$\pm 0.50$
$53.55 < d_1 \leq 54.98$	$\pm 0.51$
$54.98 < d_1 \leq 56.41$	$\pm 0.52$
$56.41 < d_1 \leq 57.84$	$\pm 0.53$
$57.84 < d_1 \leq 59.27$	$\pm 0.54$

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
$59.27 < d_1 \leq 60.71$	$\pm 0.55$
$60.71 < d_1 \leq 62.14$	$\pm 0.56$
$62.14 < d_1 \leq 63.58$	$\pm 0.57$
$63.58 < d_1 \leq 65.02$	$\pm 0.58$
$65.02 < d_1 \leq 66.47$	$\pm 0.59$
$66.47 < d_1 \leq 67.91$	$\pm 0.60$
$67.91 < d_1 \leq 69.35$	$\pm 0.61$
$69.35 < d_1 \leq 70.80$	$\pm 0.62$
$70.80 < d_1 \leq 72.25$	$\pm 0.63$
$72.25 < d_1 \leq 73.70$	$\pm 0.64$
$73.70 < d_1 \leq 75.15$	$\pm 0.65$
$75.15 < d_1 \leq 76.60$	$\pm 0.66$
$76.60 < d_1 \leq 78.05$	$\pm 0.67$
$78.05 < d_1 \leq 79.51$	$\pm 0.68$
$79.51 < d_1 \leq 80.97$	$\pm 0.69$
$80.97 < d_1 \leq 82.42$	$\pm 0.70$
$82.42 < d_1 \leq 83.88$	$\pm 0.71$
$83.88 < d_1 \leq 85.34$	$\pm 0.72$
$85.34 < d_1 \leq 86.80$	$\pm 0.73$
$86.80 < d_1 \leq 88.27$	$\pm 0.74$
$88.27 < d_1 \leq 89.73$	$\pm 0.75$
$89.73 < d_1 \leq 91.20$	$\pm 0.76$
$91.20 < d_1 \leq 92.66$	$\pm 0.77$
$92.66 < d_1 \leq 94.13$	$\pm 0.78$
$94.13 < d_1 \leq 95.60$	$\pm 0.79$
$95.60 < d_1 \leq 97.07$	$\pm 0.80$
$97.07 < d_1 \leq 98.54$	$\pm 0.81$
$98.54 < d_1 \leq 100.01$	$\pm 0.82$
$100.01 < d_1 \leq 101.48$	$\pm 0.83$
$101.48 < d_1 \leq 102.96$	$\pm 0.84$
$102.96 < d_1 \leq 104.43$	$\pm 0.85$
$104.43 < d_1 \leq 105.91$	$\pm 0.86$
$105.91 < d_1 \leq 107.39$	$\pm 0.87$
$107.39 < d_1 \leq 108.86$	$\pm 0.88$
$108.86 < d_1 \leq 110.34$	$\pm 0.89$
$110.34 < d_1 \leq 111.82$	$\pm 0.90$
$111.82 < d_1 \leq 113.30$	$\pm 0.91$
$113.30 < d_1 \leq 114.79$	$\pm 0.92$
$114.79 < d_1 \leq 116.27$	$\pm 0.93$
$116.27 < d_1 \leq 117.75$	$\pm 0.94$
$117.75 < d_1 \leq 119.24$	$\pm 0.95$
$119.24 < d_1 \leq 120.72$	$\pm 0.96$
$120.72 < d_1 \leq 122.21$	$\pm 0.97$
$122.21 < d_1 \leq 123.70$	$\pm 0.98$

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
123.70 < $d_1$ ≤ 125.19	± 0.99
125.19 < $d_1$ ≤ 126.68	± 1.00
126.68 < $d_1$ ≤ 128.17	± 1.01
128.17 < $d_1$ ≤ 129.66	± 1.02
129.66 < $d_1$ ≤ 131.15	± 1.03
131.15 < $d_1$ ≤ 132.64	± 1.04
132.64 < $d_1$ ≤ 134.14	± 1.05
134.14 < $d_1$ ≤ 135.63	± 1.06
135.63 < $d_1$ ≤ 137.13	± 1.07
137.13 < $d_1$ ≤ 138.62	± 1.08
138.62 < $d_1$ ≤ 140.12	± 1.09
140.12 < $d_1$ ≤ 141.62	± 1.10
141.62 < $d_1$ ≤ 143.12	± 1.11
143.12 < $d_1$ ≤ 144.62	± 1.12
144.62 < $d_1$ ≤ 146.12	± 1.13
146.12 < $d_1$ ≤ 147.62	± 1.14
147.62 < $d_1$ ≤ 149.12	± 1.15
149.12 < $d_1$ ≤ 150.62	± 1.16
150.62 < $d_1$ ≤ 152.13	± 1.17
152.13 < $d_1$ ≤ 153.63	± 1.18
153.63 < $d_1$ ≤ 155.13	± 1.19
155.13 < $d_1$ ≤ 156.64	± 1.20
156.64 < $d_1$ ≤ 158.15	± 1.21
158.15 < $d_1$ ≤ 159.65	± 1.22
159.65 < $d_1$ ≤ 161.16	± 1.23
161.16 < $d_1$ ≤ 162.67	± 1.24
162.67 < $d_1$ ≤ 164.18	± 1.25
164.18 < $d_1$ ≤ 165.69	± 1.26
165.69 < $d_1$ ≤ 167.20	± 1.27
167.20 < $d_1$ ≤ 168.71	± 1.28
168.71 < $d_1$ ≤ 170.22	± 1.29
170.22 < $d_1$ ≤ 171.73	± 1.30
171.73 < $d_1$ ≤ 173.25	± 1.31
173.25 < $d_1$ ≤ 174.76	± 1.32
174.76 < $d_1$ ≤ 176.28	± 1.33
176.28 < $d_1$ ≤ 177.79	± 1.34
177.79 < $d_1$ ≤ 179.31	± 1.35
179.31 < $d_1$ ≤ 180.82	± 1.36
180.82 < $d_1$ ≤ 182.34	± 1.37
182.34 < $d_1$ ≤ 183.86	± 1.38
183.86 < $d_1$ ≤ 185.38	± 1.39
185.38 < $d_1$ ≤ 186.89	± 1.40
186.89 < $d_1$ ≤ 188.41	± 1.41
188.41 < $d_1$ ≤ 189.93	± 1.42

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
189.93 < $d_1$ ≤ 191.45	± 1.43
191.45 < $d_1$ ≤ 192.98	± 1.44
192.98 < $d_1$ ≤ 194.50	± 1.45
194.50 < $d_1$ ≤ 196.02	± 1.46
196.02 < $d_1$ ≤ 197.54	± 1.47
197.54 < $d_1$ ≤ 199.07	± 1.48
199.07 < $d_1$ ≤ 200.59	± 1.49
200.59 < $d_1$ ≤ 202.12	± 1.50
202.12 < $d_1$ ≤ 203.64	± 1.51
203.64 < $d_1$ ≤ 205.17	± 1.52
205.17 < $d_1$ ≤ 206.69	± 1.53
206.69 < $d_1$ ≤ 208.22	± 1.54
208.22 < $d_1$ ≤ 209.75	± 1.55
209.75 < $d_1$ ≤ 211.28	± 1.56
211.28 < $d_1$ ≤ 212.81	± 1.57
212.81 < $d_1$ ≤ 214.34	± 1.58
214.34 < $d_1$ ≤ 215.87	± 1.59
215.87 < $d_1$ ≤ 217.40	± 1.60
217.40 < $d_1$ ≤ 218.93	± 1.61
218.93 < $d_1$ ≤ 220.46	± 1.62
220.46 < $d_1$ ≤ 221.99	± 1.63
221.99 < $d_1$ ≤ 223.52	± 1.64
223.52 < $d_1$ ≤ 225.06	± 1.65
225.06 < $d_1$ ≤ 226.59	± 1.66
226.59 < $d_1$ ≤ 228.12	± 1.67
228.12 < $d_1$ ≤ 229.66	± 1.68
229.66 < $d_1$ ≤ 231.19	± 1.69
231.19 < $d_1$ ≤ 232.73	± 1.70
232.73 < $d_1$ ≤ 234.27	± 1.71
234.27 < $d_1$ ≤ 235.80	± 1.72
235.80 < $d_1$ ≤ 237.34	± 1.73
237.34 < $d_1$ ≤ 238.88	± 1.74
238.88 < $d_1$ ≤ 240.42	± 1.75
240.42 < $d_1$ ≤ 241.95	± 1.76
241.95 < $d_1$ ≤ 243.49	± 1.77
243.49 < $d_1$ ≤ 245.03	± 1.78
245.03 < $d_1$ ≤ 246.57	± 1.79
246.57 < $d_1$ ≤ 248.11	± 1.80
248.11 < $d_1$ ≤ 249.66	± 1.81
249.66 < $d_1$ ≤ 251.20	± 1.82
251.20 < $d_1$ ≤ 252.74	± 1.83
252.74 < $d_1$ ≤ 254.28	± 1.84
254.28 < $d_1$ ≤ 255.82	± 1.85
255.82 < $d_1$ ≤ 257.37	± 1.86

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
257.37 < $d_1$ ≤ 258.91	± 1.87
258.91 < $d_1$ ≤ 260.46	± 1.88
260.46 < $d_1$ ≤ 262.00	± 1.89
262.00 < $d_1$ ≤ 263.55	± 1.90
263.55 < $d_1$ ≤ 265.09	± 1.91
265.09 < $d_1$ ≤ 266.64	± 1.92
266.64 < $d_1$ ≤ 268.18	± 1.93
268.18 < $d_1$ ≤ 269.73	± 1.94
269.73 < $d_1$ ≤ 271.28	± 1.95
271.28 < $d_1$ ≤ 272.83	± 1.96
272.83 < $d_1$ ≤ 274.38	± 1.97
274.38 < $d_1$ ≤ 275.92	± 1.98
275.92 < $d_1$ ≤ 277.47	± 1.99
277.47 < $d_1$ ≤ 279.02	± 2.00
279.02 < $d_1$ ≤ 280.57	± 2.01
280.57 < $d_1$ ≤ 282.12	± 2.02
282.12 < $d_1$ ≤ 283.68	± 2.03
283.68 < $d_1$ ≤ 285.23	± 2.04
285.23 < $d_1$ ≤ 286.78	± 2.05
286.78 < $d_1$ ≤ 288.33	± 2.06
288.33 < $d_1$ ≤ 289.88	± 2.07
289.88 < $d_1$ ≤ 291.44	± 2.08
291.44 < $d_1$ ≤ 292.99	± 2.09
292.99 < $d_1$ ≤ 294.54	± 2.10
294.54 < $d_1$ ≤ 296.10	± 2.11
296.10 < $d_1$ ≤ 297.65	± 2.12
297.65 < $d_1$ ≤ 299.21	± 2.13
299.21 < $d_1$ ≤ 300.76	± 2.14
300.76 < $d_1$ ≤ 302.32	± 2.15
302.32 < $d_1$ ≤ 303.88	± 2.16
303.88 < $d_1$ ≤ 305.43	± 2.17
305.43 < $d_1$ ≤ 306.99	± 2.18
306.99 < $d_1$ ≤ 308.55	± 2.19
308.55 < $d_1$ ≤ 310.11	± 2.20
310.11 < $d_1$ ≤ 311.66	± 2.21
311.66 < $d_1$ ≤ 313.22	± 2.22
313.22 < $d_1$ ≤ 314.78	± 2.23
314.78 < $d_1$ ≤ 316.34	± 2.24
316.34 < $d_1$ ≤ 317.90	± 2.25
317.90 < $d_1$ ≤ 319.46	± 2.26
319.46 < $d_1$ ≤ 321.02	± 2.27
321.02 < $d_1$ ≤ 322.58	± 2.28
322.58 < $d_1$ ≤ 324.15	± 2.29
324.15 < $d_1$ ≤ 325.71	± 2.30

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
325.71 < $d_1$ ≤ 327.27	± 2.31
327.27 < $d_1$ ≤ 328.83	± 2.32
328.83 < $d_1$ ≤ 330.39	± 2.33
330.39 < $d_1$ ≤ 331.96	± 2.34
331.96 < $d_1$ ≤ 333.52	± 2.35
333.52 < $d_1$ ≤ 335.09	± 2.36
335.09 < $d_1$ ≤ 336.65	± 2.37
336.65 < $d_1$ ≤ 338.21	± 2.38
338.21 < $d_1$ ≤ 339.78	± 2.39
339.78 < $d_1$ ≤ 341.35	± 2.40
341.35 < $d_1$ ≤ 342.91	± 2.41
342.91 < $d_1$ ≤ 344.48	± 2.42
344.48 < $d_1$ ≤ 346.04	± 2.43
346.04 < $d_1$ ≤ 347.61	± 2.44
347.61 < $d_1$ ≤ 349.18	± 2.45
349.18 < $d_1$ ≤ 350.75	± 2.46
350.75 < $d_1$ ≤ 352.31	± 2.47
352.31 < $d_1$ ≤ 353.88	± 2.48
353.88 < $d_1$ ≤ 355.45	± 2.49
355.45 < $d_1$ ≤ 357.02	± 2.50
357.02 < $d_1$ ≤ 358.59	± 2.51
358.59 < $d_1$ ≤ 360.16	± 2.52
360.16 < $d_1$ ≤ 361.73	± 2.53
361.73 < $d_1$ ≤ 363.30	± 2.54
363.30 < $d_1$ ≤ 364.87	± 2.55
364.87 < $d_1$ ≤ 366.44	± 2.56
366.44 < $d_1$ ≤ 368.01	± 2.57
368.01 < $d_1$ ≤ 369.58	± 2.58
369.58 < $d_1$ ≤ 371.16	± 2.59
371.16 < $d_1$ ≤ 372.73	± 2.60
372.73 < $d_1$ ≤ 374.30	± 2.61
374.30 < $d_1$ ≤ 375.87	± 2.62
375.87 < $d_1$ ≤ 377.45	± 2.63
377.45 < $d_1$ ≤ 379.02	± 2.64
379.02 < $d_1$ ≤ 380.59	± 2.65
380.59 < $d_1$ ≤ 382.17	± 2.66
382.17 < $d_1$ ≤ 383.74	± 2.67
383.74 < $d_1$ ≤ 385.32	± 2.68
385.32 < $d_1$ ≤ 386.89	± 2.69
386.89 < $d_1$ ≤ 388.47	± 2.70
388.47 < $d_1$ ≤ 390.05	± 2.71
390.05 < $d_1$ ≤ 391.62	± 2.72
391.62 < $d_1$ ≤ 393.20	± 2.73
393.20 < $d_1$ ≤ 394.78	± 2.74

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
394.78 < $d_1$ ≤ 396.35	± 2.75
396.35 < $d_1$ ≤ 397.93	± 2.76
397.93 < $d_1$ ≤ 399.51	± 2.77
399.51 < $d_1$ ≤ 401.09	± 2.78
401.09 < $d_1$ ≤ 402.66	± 2.79
402.66 < $d_1$ ≤ 404.24	± 2.80
404.24 < $d_1$ ≤ 405.82	± 2.81
405.82 < $d_1$ ≤ 407.40	± 2.82
407.40 < $d_1$ ≤ 408.98	± 2.83
408.98 < $d_1$ ≤ 410.56	± 2.84
410.56 < $d_1$ ≤ 412.14	± 2.85
412.14 < $d_1$ ≤ 413.72	± 2.86
413.72 < $d_1$ ≤ 415.30	± 2.87
415.30 < $d_1$ ≤ 416.89	± 2.88
416.89 < $d_1$ ≤ 418.47	± 2.89
418.47 < $d_1$ ≤ 420.05	± 2.90
420.05 < $d_1$ ≤ 421.63	± 2.91
421.63 < $d_1$ ≤ 423.21	± 2.92
423.21 < $d_1$ ≤ 424.80	± 2.93
424.80 < $d_1$ ≤ 426.38	± 2.94
426.38 < $d_1$ ≤ 427.96	± 2.95
427.96 < $d_1$ ≤ 429.55	± 2.96
429.55 < $d_1$ ≤ 431.13	± 2.97
431.13 < $d_1$ ≤ 432.71	± 2.98
432.71 < $d_1$ ≤ 434.30	± 2.99
434.30 < $d_1$ ≤ 435.88	± 3.00
435.88 < $d_1$ ≤ 437.47	± 3.01
437.47 < $d_1$ ≤ 439.05	± 3.02
439.05 < $d_1$ ≤ 440.64	± 3.03
440.64 < $d_1$ ≤ 442.22	± 3.04
442.22 < $d_1$ ≤ 443.81	± 3.05
443.81 < $d_1$ ≤ 445.40	± 3.06
445.40 < $d_1$ ≤ 446.98	± 3.07
446.98 < $d_1$ ≤ 448.57	± 3.08
448.57 < $d_1$ ≤ 450.16	± 3.09
450.16 < $d_1$ ≤ 451.75	± 3.10
451.75 < $d_1$ ≤ 453.33	± 3.11
453.33 < $d_1$ ≤ 454.92	± 3.12
454.92 < $d_1$ ≤ 456.51	± 3.13
456.51 < $d_1$ ≤ 458.10	± 3.14
458.10 < $d_1$ ≤ 459.69	± 3.15
459.69 < $d_1$ ≤ 461.28	± 3.16
461.28 < $d_1$ ≤ 462.87	± 3.17
462.87 < $d_1$ ≤ 464.46	± 3.18

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
464.46 < $d_1$ ≤ 466.05	± 3.19
466.05 < $d_1$ ≤ 467.64	± 3.20
467.64 < $d_1$ ≤ 469.23	± 3.21
469.23 < $d_1$ ≤ 470.82	± 3.22
470.82 < $d_1$ ≤ 472.41	± 3.23
472.41 < $d_1$ ≤ 474.00	± 3.24
474.00 < $d_1$ ≤ 475.59	± 3.25
475.59 < $d_1$ ≤ 477.19	± 3.26
477.19 < $d_1$ ≤ 478.78	± 3.27
478.78 < $d_1$ ≤ 480.37	± 3.28
480.37 < $d_1$ ≤ 481.96	± 3.29
481.96 < $d_1$ ≤ 483.56	± 3.30
483.56 < $d_1$ ≤ 485.15	± 3.31
485.15 < $d_1$ ≤ 486.74	± 3.32
486.74 < $d_1$ ≤ 488.34	± 3.33
488.34 < $d_1$ ≤ 489.93	± 3.34
489.93 < $d_1$ ≤ 491.52	± 3.35
491.52 < $d_1$ ≤ 493.12	± 3.36
493.12 < $d_1$ ≤ 494.71	± 3.37
494.71 < $d_1$ ≤ 496.31	± 3.38
496.31 < $d_1$ ≤ 497.90	± 3.39
497.90 < $d_1$ ≤ 499.50	± 3.40
499.50 < $d_1$ ≤ 501.10	± 3.41
501.10 < $d_1$ ≤ 502.69	± 3.42
502.69 < $d_1$ ≤ 504.29	± 3.43
504.29 < $d_1$ ≤ 505.89	± 3.44
505.89 < $d_1$ ≤ 507.48	± 3.45
507.48 < $d_1$ ≤ 509.08	± 3.46
509.08 < $d_1$ ≤ 510.68	± 3.47
510.68 < $d_1$ ≤ 512.27	± 3.48
512.27 < $d_1$ ≤ 513.87	± 3.49
513.87 < $d_1$ ≤ 515.47	± 3.50
515.47 < $d_1$ ≤ 517.07	± 3.51
517.07 < $d_1$ ≤ 518.67	± 3.52
518.67 < $d_1$ ≤ 520.27	± 3.53
520.27 < $d_1$ ≤ 521.87	± 3.54
521.87 < $d_1$ ≤ 523.46	± 3.55
523.46 < $d_1$ ≤ 525.06	± 3.56
525.06 < $d_1$ ≤ 526.66	± 3.57
526.66 < $d_1$ ≤ 528.26	± 3.58
528.26 < $d_1$ ≤ 529.86	± 3.59
529.86 < $d_1$ ≤ 531.46	± 3.60
531.46 < $d_1$ ≤ 533.07	± 3.61
533.07 < $d_1$ ≤ 534.67	± 3.62

Inner diameter $d_1$ [mm]	Tolerance $\Delta d_1$ [mm]
534.67 < $d_1$ ≤ 536.27	± 3.63
536.27 < $d_1$ ≤ 537.87	± 3.64
537.87 < $d_1$ ≤ 539.47	± 3.65
539.47 < $d_1$ ≤ 541.07	± 3.66
541.07 < $d_1$ ≤ 542.68	± 3.67
542.68 < $d_1$ ≤ 544.28	± 3.68
544.28 < $d_1$ ≤ 545.88	± 3.69
545.88 < $d_1$ ≤ 547.48	± 3.70
547.48 < $d_1$ ≤ 549.09	± 3.71
549.09 < $d_1$ ≤ 550.69	± 3.72
550.69 < $d_1$ ≤ 552.29	± 3.73
552.29 < $d_1$ ≤ 553.90	± 3.74
553.90 < $d_1$ ≤ 555.50	± 3.75
555.50 < $d_1$ ≤ 557.11	± 3.76
557.11 < $d_1$ ≤ 558.71	± 3.77
558.71 < $d_1$ ≤ 560.32	± 3.78
560.32 < $d_1$ ≤ 561.92	± 3.79
561.92 < $d_1$ ≤ 563.53	± 3.80
563.53 < $d_1$ ≤ 565.13	± 3.81
565.13 < $d_1$ ≤ 566.74	± 3.82
566.74 < $d_1$ ≤ 568.34	± 3.83
568.34 < $d_1$ ≤ 569.95	± 3.84
569.95 < $d_1$ ≤ 571.56	± 3.85
571.56 < $d_1$ ≤ 573.16	± 3.86
573.16 < $d_1$ ≤ 574.77	± 3.87
574.77 < $d_1$ ≤ 576.38	± 3.88
576.38 < $d_1$ ≤ 577.98	± 3.89
577.98 < $d_1$ ≤ 579.59	± 3.90
579.59 < $d_1$ ≤ 581.20	± 3.91
581.20 < $d_1$ ≤ 582.81	± 3.92
582.81 < $d_1$ ≤ 584.42	± 3.93
584.42 < $d_1$ ≤ 586.02	± 3.94
586.02 < $d_1$ ≤ 587.63	± 3.95
587.63 < $d_1$ ≤ 589.24	± 3.96
589.24 < $d_1$ ≤ 590.85	± 3.97
590.85 < $d_1$ ≤ 592.46	± 3.98
592.46 < $d_1$ ≤ 594.07	± 3.99
594.07 < $d_1$ ≤ 595.68	± 4.00
595.68 < $d_1$ ≤ 597.29	± 4.01
597.29 < $d_1$ ≤ 598.90	± 4.02
598.90 < $d_1$ ≤ 600.00	± 4.03
$d_1$ > 600.00	acc. to formula

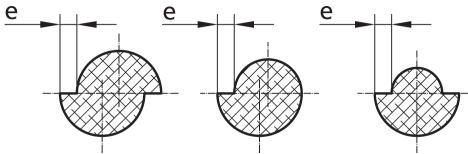
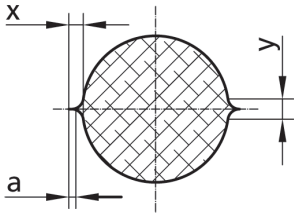
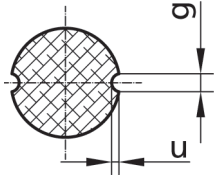
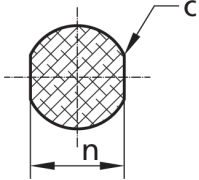
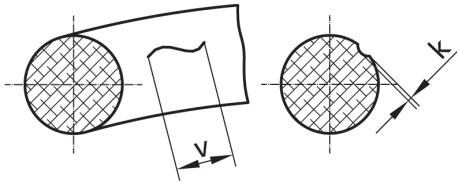
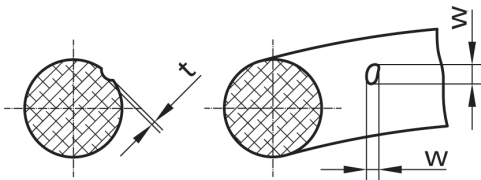
### Cross section tolerances

acc. to DIN ISO 3601-1 class B (former DIN 3771-1)

Cross section $d_2$ [mm]	Tolerance [mm]
$d_2$ ≤ 0.80	± 0.08
0.80 < $d_2$ ≤ 2.25	± 0.08
2.25 < $d_2$ ≤ 3.15	± 0.09
3.15 < $d_2$ ≤ 4.50	± 0.10
4.50 < $d_2$ ≤ 6.30	± 0.13
6.30 < $d_2$ ≤ 8.40	± 0.15
8.40 < $d_2$ ≤ 10.00	± 0.20
10.00 < $d_2$ ≤ 12.00	± 0.25
$d_2$ > 12.00	on inquiry

## Surface imperfections acc. to ISO 3601-3

Maximum limits of imperfection for O-rings **Grade N**

Surface imperfection type	Diagrammatic representation	Dimensions	Maximum limits of imperfection Grade N for O-rings Cross section, $d_2$				
			> 0.80 <sup>b</sup> ≤ 2.25	> 2.25 ≤ 3.15	> 3.15 ≤ 4.50	> 4.50 ≤ 6.30	> 6.30 ≤ 8,40 <sup>b</sup>
Off-register, mismatch (offset)		e	0.08	0.10	0.13	0.15	0.15
Combined flash (combination of offset, flash and parting line projection)		x	0.10	0.12	0.14	0.16	0.18
		y	0.10	0.12	0.14	0.16	0.18
		a	When the flash can be differentiated, it shall not exceed 0.07mm.				
Backrind		g	0.18	0.27	0.36	0.53	0.70
		u	0.08	0.08	0.10	0.10	0.13
Excessive trimming (radial tool marks not allowed)		n	Trimming is allowed provided the dimension n is not reduced below the minimum diameter $d_2$ for the O-ring.				
Flow marks (radial orientation of flow marks is not permissible)		v	1.50 <sup>a</sup>	1.50 <sup>a</sup>	6.50 <sup>a</sup>	6.50 <sup>a</sup>	6.50 <sup>a</sup>
		k	0.08	0.08	0.08	0.08	0.08
Non-fills and indentations (including parting line indentations)		w	0.60	0.80	1.00	1.30	1.70
		t	0.08	0.08	0.10	0.10	0.13
Foreign material	-	-	not allowed				

<sup>a</sup> Or 0.05 times the O-rings diameter ( $d_1$ ) whichever is greater.

<sup>b</sup> Limits of imperfections for cross sections < 0.80 mm or > 8.40 mm shall be agreed upon between manufacturer and customer.

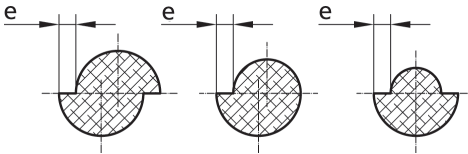
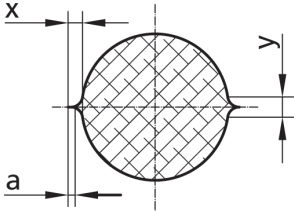
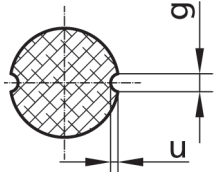
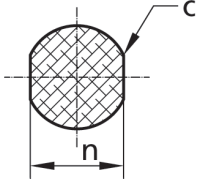
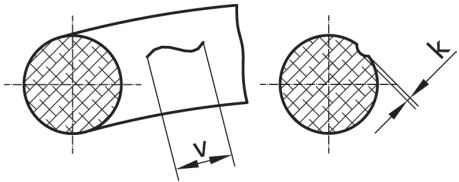
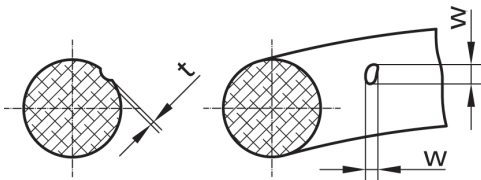
<sup>c</sup> Rounded edges.

All dimensions in mm.



**Surface imperfections**  
acc. to ISO 3601-3

Maximum limits of imperfection for O-rings **Grade S**

Surface imperfection type	Diagrammatic representation	Dimensions	Maximum limits of imperfection Grade S for O-rings Cross section, $d_2$				
			$> 0.80^b$ $\leq 2.25$	$> 2.25$ $\leq 3.15$	$> 3.15$ $\leq 4.50$	$> 4.50$ $\leq 6.30$	$> 6.30$ $\leq 8,40^b$
Off-register, mismatch (offset)		e	0.08	0.08	0.10	0.12	0.13
Combined flash (combination of offset, flash and parting line projection)		x	0.10	0.10	0.13	0.15	0.15
		y	0.10	0.10	0.13	0.15	0.15
		a	When the flash can be differentiated, it shall not exceed 0.07mm.				
Backrind		g	0.10	0.15	0.20	0.20	0.30
		u	0.05	0.08	0.10	0.10	0.13
Excessive trimming (radial tool marks not allowed)		n	Trimming is allowed provided the dimension n is not reduced below the minimum diameter $d_2$ for the O-ring.				
Flow marks (radial orientation of flow marks is not permissible)		v	1.50 <sup>a</sup>	1.50 <sup>a</sup>	5.00 <sup>a</sup>	5.00 <sup>a</sup>	5.00 <sup>a</sup>
		k	0.05	0.05	0.05	0.05	0.05
Non-fills and indentations (including parting line indentations)		w	0.15	0.25	0.40	0.63	1.00
		t	0.08	0.08	0.10	0.10	0.13
Foreign material	-	-	not allowed				

<sup>a</sup> Or 0.05 times the O-rings diameter ( $d_1$ ) whichever is greater.

<sup>b</sup> Limits of imperfections for cross sections  $< 0.80$  mm or  $> 8.40$  mm shall be agreed upon between manufacturer and customer.

<sup>c</sup> Rounded edges.

All dimensions in mm.

## Tests on O-rings

The inner diameter d1 is measured by conical plug gauges or stepped plug gauges. Alternatively the inner diameter can be measured by optical instruments or a circumference tape is used for large diameters.

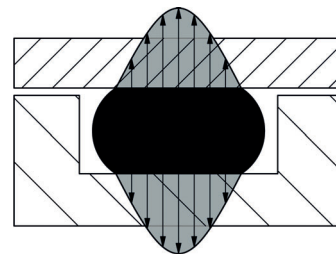
The cross section d2 is measured by a thickness gauge with reduced contact pressure. Alternatively, optical measuring methods can be applied. Form and surface accuracy is tested visually.

The hardness test, depending on the size of the O-ring, is made according to DIN ISO 7619-1 (DIN 53505) Shore A or DIN ISO 48 (IRHD Micro). The tolerance for hardness tests is  $\pm 5$  points.

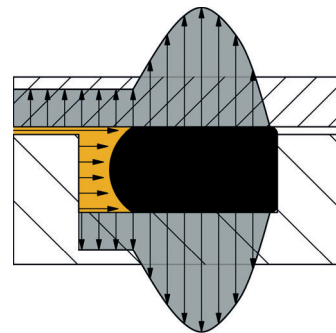
## Function

The sealing action of an O-ring is due to the compression of the cross-section of the O-ring between two sealing surfaces. When the sealed machine parts are installed, the cross-section of the O-ring is compressed within a geometrically defined installation groove in such a way that it completely closes the gap between the machine parts. The resulting forces produce the initial preload between the O-ring and the sealing surface and therefore the sealing action in depressurized state.

When pressure builds in the sealed medium, the sealing action „automatically“ also increases. The O-ring is pressed against the non-pressure side of the groove and also comes under pressure. The initial preload is blanketed by the media pressure and thereby is automatically raised to a level that is always higher than the media pressure.



initial preload after installation



O-ring under pressure

## Installation types

The type of application is important to the selection of the right installation groove for an O-ring:

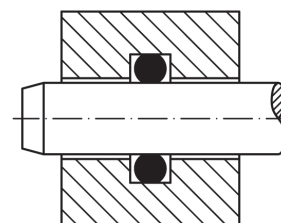
### Static sealing

(no relative movement between the sealed machine parts)

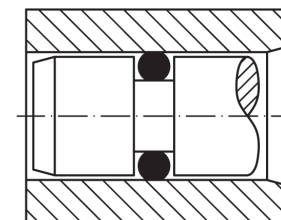
### Dynamic sealing

(the sealed machine parts move relative to each other: reciprocating, rotating or oscillating movement)

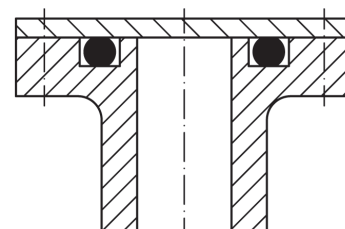
In addition, the types of installation depend on the direction in which the O-ring is deformed and on the location of the installation groove (in the inner or outer part). Accordingly, there are the following installation types:



radial compression, inside sealing



radial compression, outside sealing



axial compression

## O-ring selection

The selection of an O-ring is governed by a number of criteria. In addition to the dimensions of the O-ring the material and the hardness must be determined.

### Material selection

The best suitable material can only be selected if all media with which the O-ring has contact and the actual temperatures to which the O-ring will be exposed are known. More information in the chapter „Materials“.

### Material hardness

The choice of the right O-ring hardness depends on the following criteria:

- Pressure
- Gap size (between the machine parts on the non-pressure side)
- Pressure characteristic (constant or pulsating)
- Surface roughness of the sealed components

The O-ring material is pressed into the gap at the non- pressure side. This so called gap extrusion can damage or destroy the O-ring. The resistance of the O-ring material to the gap extrusion rises with the hardness of the material.

For standard applications, O-rings with a hardness of 70 – 80 Shore A have shown to be practicable. Where high or pulsed pressures must be sealed, materials of 80 or 90 Shore A can be used. More information is available in the chapter „Installation grooves - gap dimensions“.

### Inner diameter d1

The inner diameter of the O-ring is chosen for the intended application. For example, a radial O-ring sealing on the outside (groove provided in the inner part) should sit firmly in the groove and therefore be slightly expanded on the inner diameter. The amount of expansion should not be more than 6% of the O-ring inner diameter.

A radial O-ring sealing on the inside (groove provided in the outer part) should make full contact with the outer diameter of the groove and therefore be slightly compressed. The amount of compression should not exceed 1% to 3%.

### Cross section d2

The correct selection of the cross section of an O-ring is critical to the sealing action. The correct ratio of cross section and groove depth provides the initial preload of the O-ring cross section during installation. Depending on the application, the compression should be within the following amount ranges:

#### static sealing

approx. 15% - 30%

#### dynamic sealing

hydraulic

approx. 10% - 20% (min. 8% after tolerance evaluation)

pneumatic

approx. 6% - 15% (min. 4% after tolerance evaluation)

### Groove filling ratio (gland fill)

The design of the installation grooves of O-rings should consider the ratio of the O-ring cross-section and the cross-sectional area of the groove. The so called gland fill is normally about 75%. This means the cross-sectional area of the groove is approximately 25% larger than the cross-sectional area of the O-ring. This ensures that sufficient volume is available if the O-ring swells. The application related data of groove depth and groove width in chapter „Installation grooves, design notes“ already consider this requirement.

## Materials

Most O-rings are made of elastomers or rubber materials. The term „elastomer“ refers to the elasticity of rubber materials which change their shape already when exposed to a minor force and recover their original shape instantly when the force is removed. The basis of these elastomers is caoutchouc. Caoutchouc can be obtained as natural caoutchouc from plantations or as is common for O-rings today almost exclusively from synthetic caoutchouc in the chemical industry.

To meet the different requirements on modern sealing materials several different basic caoutchoucs and within these many different compounds are available. Each compound follows a specific, defined and controlled recipe and consists, in addition of the basic caoutchouc, of fillers, softeners, vulcanising agents, processing aids and other additives.

The actual O-ring is shaped from the caoutchouc mixture in a second technological step. During this step, the plastic caoutchouc is converted to resilient rubber material in a mold under pressure and temperature.

## Abbreviations

### Chemical designation of the basic polymer

### Abbreviations acc. to DIN ISO 1629 ASTM D 1418

Acrylonitrile-butadiene rubber	NBR	NBR
Hydrogenated acrylonitrile-butadiene rubber	HNBR	HNBR
Fluoro rubber	FKM	FKM
Perfluorinated rubber	FFKM	FFKM
Ethylene propylene diene rubber	EPDM	EPDM
Silicone rubber / vinyl methyl polysiloxane	VMQ	VMQ
Fluoro silicone rubber/ fluoromethyl polysiloxane	FVMQ	FVMQ
Tetrafluoroethylene propylene rubber	FEPM	FEPM
Polyacrylate rubber	ACM	ACM
Chloroprene rubber	CR	CR
Styrene butadiene rubber	SBR	SBR
Chloro sulfonyl polyethylene	CSM	CSM
Epichlorohydrine rubber	ECO	ECO
Butadiene rubber	BR	BR
Isobutene-isoprene rubber	IIR	IIR
Isoprene rubber	IR	IR
Polyester urethane	AU	AU
Polyether urethane	EU	EU
Natural rubber	NR	NR

## Standard materials on stock

Properties	Hardness [Shore A]	Color	Low temp [°C]	High temp. [°C]	short term [°C]
NBR	70	black	-30	+100	+120
	80	black	-25	+100	+120
	90	black	-25	+100	+120
FKM	80	brown	-15	+200	
EPDM standard	70	black	-45	+130	
EPDM peroxide	70	black	-50	+150	
VMQ (silicone)	70	red	-55	+200	

## General descriptions of the materials

### Acrylonitrile-butadiene rubber – NBR

Among standard seals such as O-rings and radial shaft seals, NBR is the most widely used material. The reasons for this are good mechanical properties, high abrasion resistance, low gas permeability and the high resistance to mineral oil based oils and greases.

NBR is a copolymer of butadiene and acrylonitrile. Depending on the application, the content of acrylonitrile can vary between 18% and 50%. Low ACN content improves cold flexibility at the expense of the resistance to oil and fuel. High ACN content improves the resistance to oil and fuel while reducing the cold flexibility and increasing compression set.

To obtain balanced properties, our standard NBR materials have an average ACN content around 30%.

#### NBR has good resistance to:

- mineral oil-based oils and greases
- aliphatic hydrocarbons
- vegetable and animal oils and fats
- hydraulic oils H, H-L, H-LP
- hydraulic fluids HFA, HFB, HFC
- silicone oils and silicone greases
- water (max. 80°C)

#### NBR is not resistant to:

- fuels with high aromatic content
- aromatic hydrocarbons
- chlorinated hydrocarbons
- non-polar solvents
- hydraulic fluid HFD
- glycol-based brake fluids
- ozone, weathering, ageing, UV resistance

#### Application temperature range:

- Standard types -30°C to +100°C (short term +120°C)
- Special grades possible down to -50°C

### Hydrogenated acrylonitrile-butadiene rubber – HNBR

HNBR is obtained by selective hydrogenation of the double bond of the butadiene molecules of the NBR rubber. With higher degrees of hydrogenation HNBR exhibits distinctly better resistance to high temperatures, ozone, ageing and UV resistance as well as improved mechanical properties.

The media resistance of HNBR is the same as that of NBR.

#### Application temperature range:

- -30°C to +150°C
- down to -50°C is realistic with special grades

### Fluoro rubber – FKM

FKM materials have conquered many applications in which high thermal and / or chemical resistance is required. FKM also has excellent resistance to ozone, weathering and ageing. Very low gas permeability, FKM is recommended for vacuum applications.

#### FKM has good resistance to:

- mineral oil-based oils and greases
- aliphatic hydrocarbons
- aromatic hydrocarbons
- chlorinated hydrocarbons
- hydraulic fluids HFD
- vegetable and animal oils and fats
- silicone oils and silicone greases
- fuels
- non-polar solvents
- ozone, weathering, ageing, UV resistance

#### FKM is not resistant to:

- glycol-based brake fluids
- polar solvents (e.g., acetone)
- superheated steam (special grades)
- hot water (special grades)
- amines, alkalis (special grades)
- low-molecular organic acids (e.g., acetic acid)
- 

#### Application temperature range:

- -15 to +200°C (short term +220°C)
- down to -61°C and up to 260°C is realistic with special grades

## Perfluorinated rubber – FFKM

FFKM materials are elastomers with the highest chemical and heat resistance. Some FFKM types can be exposed to temperatures above 300°C. The resistance to chemicals is nearly universal and compares to that of PTFE. The advantage of FFKM is the combination of the chemical and thermal stability of PTFE with the elastic properties of an elastomer material.

These special-purpose elastomers are used wherever safety requirements and high maintenance input justify the high price of these materials and where standard elastomers cannot be used.

### FFKM has good resistance to:

- virtually all chemicals
- ozone, weathering, ageing, UV resistance

### FFKM is not resistant to:

- fluorinated compounds

### Application temperature range:

- -25°C to +270°C
- special grades can be used down between -15°C and -40°C or up between +240°C and +340°C

## Ethylene propylene diene rubber – EPDM

EPDM can be used in a wide temperature range, has good resistance to ozone, weathering and ageing and is resistant to hot water and steam. Peroxide cured EPDM materials have better resistance to temperature and chemicals and obtain better compression set values than sulfur cured EPDM.

### EPDM has good resistance to:

- hot water and hot steam
- many polar solvents (e.g., alcohols, ketones, esters)
- many organic and inorganic acids and bases
- washing brines
- silicone oils and silicone greases
- glycol-based brake fluids (special grades required)
- ozone, weathering, ageing, UV resistance

### EPDM is not resistant to:

- all kinds of mineral oil products (oils, greases, fuels)

### Application temperature range:

- -45°C to +130°C (sulfur cured)
- -55°C to +150°C (peroxide cured)

## Silicone rubber – VMQ

Silicone materials have excellent aging resistance, oxygen, ozone, ultraviolet radiation and weathering and a very wide application temperature range with excellent cold flexibility. Silicone is physiologically harmless and therefore very good in food and medical product applications. Silicone has good electrical insulation properties and is highly permeable to gas. Due to the weak mechanical properties, silicone O-rings are preferably used in static.

### Silicone has good resistance to:

- animal and vegetable oils and fats
- water (max. 100°C)
- aliphatic engine and gear oils
- ozone, weathering, ageing, UV resistance

### Silicone is not resistant to:

- silicone oils and greases
- aromatic mineral oils
- fuels
- steam over 120°C
- acids and alkalis

### Application temperature range:

- -60°C to +200°C
- +230°C can be obtained by special grades

## Fluoro silicone rubber – FVMQ

Fluorosilicones have substantially better resistance to mineral oils and fuels than normal silicones. The mechanical/technological properties are similar to those of silicones, with some restrictions on temperature resistance.

### Application temperature range:

- -60°C to +200°C

## **Tetrafluoroethylene-propylene rubber – FEPM (Aflas® Asahi Glass Co. Ltd.)**

FEPM materials are special elastomers from the group of fluoroelastomers.

They have good chemical resistance and cover a wide range of temperature applications. Their main applications include oil field and chemical industry applications.

### **FEPM has good resistance to:**

- crude oil
- sour gas
- hot water, steam
- polar solvents, alcohols, amines
- many concentrated acids and bases
- engine and gear oil containing additives

### **Application temperature range:**

- -10°C (-20°C) to +200°C (short term +230°C)

## **Acrylate rubber – ACM**

ACM has good resistance to mineral oils with additives at higher temperatures. This makes ACM a preferred material in the automotive industry.

### **ACM has good resistance to:**

- mineral oil-based engine, gear and ATF oils
- ozone, weathering, ageing, UV resistance

### **ACM is not resistant to:**

- glycol-based brake fluids
- aromatic and chlorinated hydrocarbons
- hot water, steam
- acids and bases

### **Application temperature range:**

- 30°C to +160°C

## **Chloroprene rubber – CR**

CR has good mechanical properties and good resistance to ozone, weathering and ageing. This makes the material preferred for outdoor applications or for bellows.

### **CR has good resistance to:**

- many refrigerants (ammonia, carbon dioxide, freons)
- ozone, weathering, ageing, UV resistance

### **Application temperature range:**

- -40°C to +100°C

## **Polyurethanes (polyester urethane – AU / polyether urethane – EU)**

Most of the polyurethanes used for the production of seals are in the group of thermoplastic elastomers. Within the limits of application temperatures, the elastic behavior of polyurethane is typical for elastomers. Polyurethanes have excellent mechanical properties such as extrusion resistance, high resistance to abrasion and wear, tensile strength and tear resistance. This makes polyurethanes suitable for applications with high dynamic loads.

### **Polyurethane has good resistance to:**

- mineral oils and greases
- water, water-oil mixtures (max.50°C)
- aliphatic engine and gear oils
- silicone oils and greases
- ozone, oxygen, ageing, UV resistance

### **Polyurethane is not resistant to:**

- hot water, steam
- aromatic and chlorinated hydrocarbons
- acids, alkalis, amines
- glycol-based brake fluids
- alcohols, glycols, ketones, esters, ether

### **Application temperature range:**

- -40°C to +100°C



## Material resistance

The choice of the right material depends essentially on the temperature and media resistance.

The application temperature ranges of the different materials specified above apply to air or in media with no aggressive effect on the elastomer within that temperature range. If a material is exposed to higher temperatures than permitted, that material will normally become hard and increasingly permanently deformed. Generally, temperatures higher than permitted (even short term) reduce the life of the material.

Media compatibility is assessed on how the properties of the elastomer change under the physical and chemical effect of the medium. Such changes of properties can be, e.g.:

- volume change
  - swelling due to absorption of the medium in the material
  - shrinkage due to the extraction of soluble components in the compound (mostly softeners) of the material
- change of hardness (softening or hardening)
- change of tensile strength and ultimate elongation

The permitted limits within which properties can change are not fixed and depend on the concrete application (static, dynamic, standard or critical).

## Material tests

The quality compounds of material and of finished products include exactly specified regular tests of materials.

All relevant properties of the materials are monitored on the basis of standard tests. When interpreting and comparing test results, note that the results obtained from standard test specimens and finished parts can deviate strongly from each other. Comparable, repeatable results can only be obtained from the same test specimens and the same parameters.

Important tests for documentation in our materials data sheets are the following:

### Hardness

The hardness of standard test specimens and finished products is tested as follows:

Shore A according to DIN ISO 7619-1 (former DIN 53505) or ASTM D 2240

or

IRHD according to DIN ISO 48 micro hardness IRHD (International Rubber Hardness Degrees)

In the hardness test, the resistance of the rubber specimen against penetration of an indenter under a defined compressive force is measured. Shore A and micro IRHD are different from each other in the shape of the indenter and the magnitude of the test force applied. Accordingly, the micro IRHD test is suitable specially for specimens with a small cross section.

In both cases, the hardness scale extends from 0 / 10 to 100, with 100 as the highest hardness. The tolerance of the nominal hardness of a material is  $\pm 5$  Shore A / IRHD.

Hardness comparisons in data sheets (test specimens with parallel surfaces) with values of O-ring tests (curved surface) can deviate substantially from each other.

### Tensile strength and ultimate elongation

Both parameters are determined in the tensile test according to DIN 53504 / ASTM D 412. The tensile strength is the force needed to tear a standard specimen related to the cross section of the unelongated specimen. The ultimate elongation is the elongation obtained by a standard specimen at the moment of tearing (expressed in % of the marked measuring distance).

## Tear resistance

The tear resistance can be measured on a strip test specimen or an angle specimen. In both cases, the force at which a defined notched standard test specimen resists to the propagation of tear is measured (related to the thickness of the specimen).

## Resistance to low temperatures

The mechanical properties of elastomers change with temperature. If the temperature drops, ultimate elongation and elasticity are reduced whereas hardness, tensile strength and compression set increase. Sooner or later, each elastomer arrives at a point at which the material becomes so brittle and hard that it breaks like glass under impact stress.

To be able to assess the behavior of a material at low temperatures, several tests can be performed. For example, the TR10 (temperature retraction) value or the brittleness point are defined. The low temperature limit of the material can be estimated from the interpretation of the results.

## Compression set

Compression set is the permanent set of a test specimen, which has been deformed in defined conditions, after its complete relaxation. Depending on the temperature and duration of the deforming the test specimen will not return completely to its original thickness.

The test is made according to DIN ISO 815 or ASTM D 395 B; the result is expressed in %. Ideally, the test specimen fully recovers its original height, which would be equivalent to 0% compression set. If a test specimen does not recover at all after compression, this means its compression set is 100%.

Compression set results can only be compared with each other if test method, compression, geometry of the test specimen, the test temperature and the test time are the same. The compression set is often referred to for assessing the long-term behavior of seals in installed, i.e., compressed state under the effect of temperature.

## Change of properties after ageing

To assess the behavior of sealing materials under the action of heat and / or media, ageing tests are performed. Elastomer samples are placed in a heating oven and aged artificially in air or in a contact medium at a defined temperature for a defined period of time. Hardness, tensile strength, ultimate elongation and volume are measured and compared before and after ageing. The less these values change, the better is the material suited for the medium for which it is tested.

## Material approval

Many of our materials have special approvals or releases for certain safety related applications, e.g., gas, drinking water or food, petrochemical or oil and gas applications. Compliance with the applicable norms and regulations is tested and certified by an independent testing body or testing laboratory and such tests are repeated regularly.

If one material is certified for different applications, the applications of this material can be bundled, which saves cost. In this way, one seal can supply the needs of several international markets.

## Material approval / certification:

Approval / certification Test specification	Institute	Application	Scope
EN 549 (former DIN 3535 part 1+ part 2)	DVGW Deutscher Verein des Gas und Wasserfaches e.V.	Gas	Europe
EN 682 (former DIN 3535 part 3)		Gas	Europe
KTW		Drinking water	Germany
DVGW W270		Drinking water	Germany
DVGW W534		Drinking water	Germany
EN 681-1		Drinking water	Europa
WRAS (former WRC) BS 6920	WRAS Water Regulations Advisory Scheme	Drinking water	UK
NSF 61	NSF National Sanitary Foundation	Drinking water	USA
ACS Attestation Conformité Sanitaire	Institut Pasteur	Drinking water	France
KIWA	KIWA	Drinking water	Netherlands
BelgAqua	BelgAqua	Drinking water	Belgium
acc. to FDA	FDA Food and Drug Administration	Food	USA
BfR (former BGVV)	BfR Bundesinstitut für Risikobewertung	Food	Germany
UL94	UL Underwriter Laboratories	Fire protection	USA
BAM	BAM Bundesanstalt für Materialforschung und -prüfung	Gaseous oxygen	Germany
AED / Sour gas environments			

## Antifriction treatments / surface coatings

Reduced friction is an ever more topical subject. Whether for minimizing installation forces, ease of singling and further handling in automatic installation or for extension of service life in dynamic applications, reduced friction generally has many advantages.

We will be glad to advise you and recommend a method suitable for your application.

Method	Application	Durability of the coating / treatment
Talcum treatment	Prevention of sticking together	Short to medium-term
Siliconizing Molykoting	+ Reduction of the force of installation	
Graphitizing		
Halogenating	+ automatic installation, Dynamic applications	Medium to long-term
PTFE solid coating		Long-term
Bonded solid coatings		

## O-Ring grooves

### Static sealing

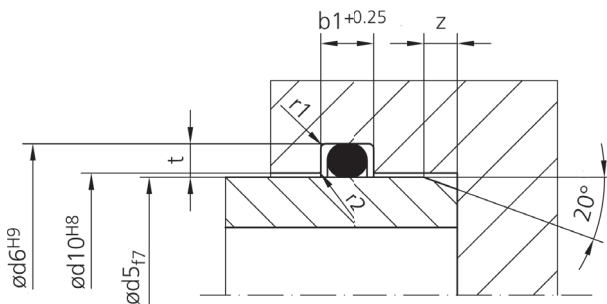
If the sealed machine parts do not move relative to each other, the seal is a static seal. O-rings are ideal for static sealing.

The recommended installation dimensions should be observed to ensure reliable sealing.

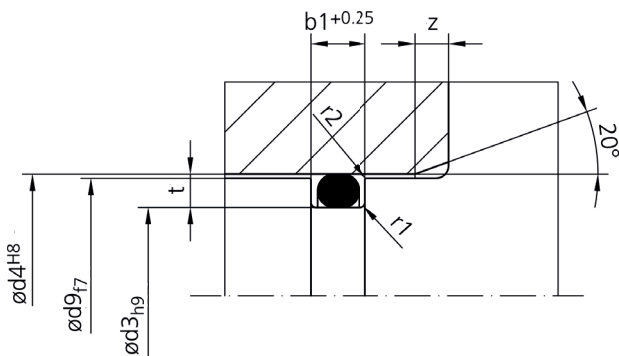
### Static sealing, radial compression

With this type of installation, the cross section of the O-ring is compressed in radial direction. The O-ring groove is provided on the inner or outer component part.

static, radial, inside sealing



static, radial, outside sealing



$d_2$	$t^{+0.05}$	$b_1^{+0.25}$	$z$	$r_1$	$r_2$
0.50	0.35	0.70	1.0	0.3	0.1
0.74	0.50	1.10	1.0	0.3	0.1
1.00	0.70	1.40	1.2	0.3	0.1
1.02	0.70	1.40	1.2	0.3	0.1
1.20	0.85	1.70	1.2	0.3	0.1
1.25	0.90	1.70	1.2	0.3	0.1
1.27	0.90	1.70	1.2	0.3	0.1
1.30	0.95	1.80	1.2	0.3	0.1
1.42	1.05	1.90	1.2	0.3	0.1
1.50	1.10	2.00	1.5	0.3	0.1
1.52	1.10	2.00	1.5	0.3	0.1
1.60	1.20	2.20	1.5	0.3	0.1
1.63	1.20	2.20	1.5	0.3	0.1
1.78	1.30	2.40	1.5	0.3	0.2
1.80	1.30	2.40	1.5	0.3	0.2
1.83	1.35	2.50	1.5	0.3	0.2
1.90	1.40	2.60	2.0	0.3	0.2
1.98	1.50	2.70	2.0	0.3	0.2
2.00	1.50	2.70	2.0	0.3	0.2
2.08	1.55	2.80	2.0	0.3	0.2
2.10	1.55	2.80	2.0	0.3	0.2
2.20	1.65	3.00	2.0	0.3	0.2
2.26	1.70	3.00	2.0	0.3	0.2
2.30	1.75	3.00	2.0	0.3	0.2
2.34	1.75	3.10	2.0	0.3	0.2
2.40	1.80	3.20	2.0	0.3	0.2
2.46	1.85	3.30	2.0	0.3	0.2
2.50	1.90	3.30	2.0	0.3	0.2
2.60	2.00	3.50	2.0	0.3	0.2
2.62	2.00	3.50	2.0	0.3	0.2
2.65	2.00	3.60	2.5	0.3	0.2
2.70	2.05	3.60	2.5	0.3	0.2
2.80	2.15	3.70	2.5	0.3	0.2
2.92	2.20	3.90	2.5	0.3	0.2
2.95	2.20	3.90	2.5	0.3	0.2
3.00	2.30	4.00	2.5	0.3	0.2
3.10	2.40	4.10	2.5	0.6	0.2
3.50	2.70	4.60	2.5	0.6	0.2
3.53	2.70	4.70	2.5	0.6	0.2
3.55	2.70	4.70	2.5	0.6	0.2
3.60	2.80	4.80	2.5	0.6	0.2
3.70	2.90	4.90	2.5	0.6	0.2
4.00	3.10	5.30	3.0	0.6	0.2
4.30	3.40	5.60	3.0	0.6	0.2

$d_2$	$t +0.05$	$b_1 +0.25$	$z$	$r_1$	$r_2$
4.50	3.50	5.90	3.0	0.6	0.2
5.00	4.00	6.60	3.0	0.6	0.2
5.30	4.30	7.00	3.0	0.6	0.2
5.33	4.30	7.00	3.0	0.6	0.2
5.50	4.40	7.20	3.5	0.6	0.2
5.70	4.60	7.50	3.5	0.6	0.2
6.00	4.90	7.80	3.5	0.6	0.2
6.50	5.30	8.50	4.0	1.0	0.2
6.99	5.80	9.20	4.0	1.0	0.2
7.00	5.80	9.20	4.0	1.0	0.2
7.50	6.20	9.90	4.5	1.0	0.2
8.00	6.70	10.50	4.5	1.0	0.2
8.40	7.00	11.00	4.5	1.0	0.2
8.50	7.10	11.20	4.5	1.0	0.2
9.00	7.60	11.80	4.5	1.0	0.2
9.50	8.10	12.40	4.5	1.0	0.2
10.00	8.50	13.00	5.0	1.0	0.2
10.50	9.00	13.60	5.0	1.0	0.2
11.00	9.50	14.20	5.0	1.0	0.2
11.50	9.90	14.80	5.0	1.0	0.2
12.00	10.40	15.40	5.0	1.0	0.2
12.50	10.80	16.00	5.0	1.5	0.2
13.00	11.30	16.60	5.0	1.5	0.2
13.50	11.80	17.20	5.0	1.5	0.2
14.00	12.20	17.80	6.0	1.5	0.2
14.50	12.70	18.40	6.0	1.5	0.2
15.00	13.20	19.10	6.0	1.5	0.2

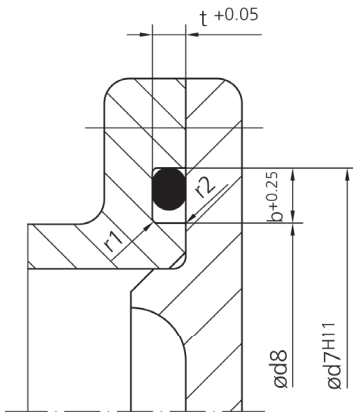
## Static sealing, axial compression

With this type of installation, the cross section of the O-ring is compressed in axial direction.

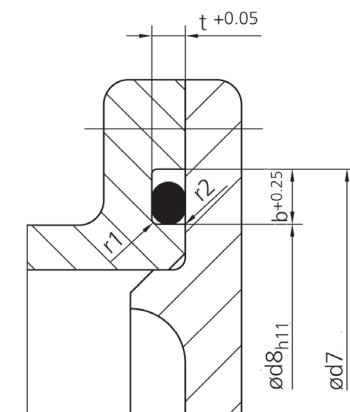
If pressure acts from inside, the O-ring should make contact at the outer diameter of the groove and be slightly compressed about 1% to maximum 3%.

If pressure acts from outside, the O-ring should make contact at the inner diameter of the groove and be stretched slightly (up to max. 6%).

static, axial pressure from inside



static, axial, pressure from outside



$d_2$	$t +0.05$	$b +0.25$	$r_1$	$r_2$
0.50	0.35	0.70	0.3	0.1
0.74	0.50	1.10	0.3	0.1
1.00	0.70	1.40	0.3	0.1
1.02	0.75	1.40	0.3	0.1
1.20	0.85	1.70	0.3	0.1
1.25	0.90	1.70	0.3	0.1
1.27	0.90	1.80	0.3	0.1
1.30	0.95	1.80	0.3	0.1
1.42	1.05	1.90	0.3	0.1
1.50	1.10	2.10	0.3	0.1
1.52	1.10	2.10	0.3	0.1
1.60	1.20	2.20	0.3	0.1
1.63	1.20	2.20	0.3	0.1
1.78	1.30	2.60	0.3	0.2
1.80	1.30	2.60	0.3	0.2
1.83	1.35	2.60	0.3	0.2
1.90	1.40	2.70	0.3	0.2
1.98	1.50	2.80	0.3	0.2
2.00	1.50	2.80	0.3	0.2
2.08	1.55	2.90	0.3	0.2
2.10	1.55	2.90	0.3	0.2
2.20	1.60	3.10	0.3	0.2
2.26	1.70	3.10	0.3	0.2
2.30	1.75	3.10	0.3	0.2
2.34	1.75	3.10	0.3	0.2
2.40	1.80	3.30	0.3	0.2
2.46	1.85	3.40	0.3	0.2
2.50	1.90	3.40	0.3	0.2
2.60	2.00	3.50	0.3	0.2
2.62	2.00	3.60	0.3	0.2
2.65	2.00	3.70	0.3	0.2
2.70	2.05	3.70	0.3	0.2
2.80	2.10	3.90	0.3	0.2
2.92	2.20	4.00	0.3	0.2
2.95	2.20	4.00	0.3	0.2
3.00	2.30	4.00	0.3	0.2
3.10	2.40	4.10	0.6	0.2
3.50	2.70	4.80	0.6	0.2
3.53	2.70	4.80	0.6	0.2
3.55	2.70	4.90	0.6	0.2
3.60	2.80	5.00	0.6	0.2
3.70	2.90	5.10	0.6	0.2
4.00	3.10	5.40	0.6	0.2
4.30	3.40	5.80	0.6	0.2

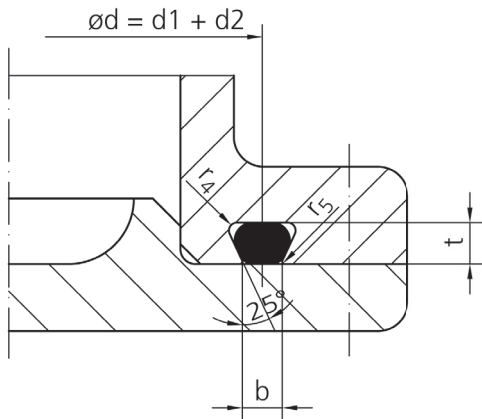
<b>d<sub>2</sub></b>	<b>t +0.05</b>	<b>b +0.25</b>	<b>r<sub>1</sub></b>	<b>r<sub>2</sub></b>
4.50	3.50	6.00	0.6	0.2
5.00	4.00	6.60	0.6	0.2
5.30	4.30	7.10	0.6	0.2
5.33	4.30	7.10	0.6	0.2
5.50	4.40	7.40	0.6	0.2
5.70	4.60	7.50	0.6	0.2
6.00	4.90	7.80	0.6	0.2
6.50	5.30	8.50	1.0	0.2
6.99	5.70	9.60	1.0	0.2
7.00	5.70	9.60	1.0	0.2
7.50	6.20	10.10	1.0	0.2
8.00	6.60	10.70	1.0	0.2
8.40	7.00	11.10	1.0	0.2
8.50	7.10	11.30	1.0	0.2
9.00	7.60	11.80	1.0	0.2
9.50	8.10	12.40	1.0	0.2
10.00	8.50	13.10	1.0	0.2
10.50	8.90	13.70	1.0	0.2
11.00	9.40	14.30	1.0	0.2
11.50	9.90	14.80	1.0	0.2
12.00	10.40	15.40	1.0	0.2
12.50	10.80	16.00	1.5	0.2
13.00	11.30	16.60	1.5	0.2
13.50	11.80	17.20	1.5	0.2
14.00	12.20	17.80	1.5	0.2
14.50	12.70	18.40	1.5	0.2
15.00	13.20	19.10	1.5	0.2
13.50	11.80	17.20	1.5	0.2
14.00	12.20	17.80	1.5	0.2
14.50	12.70	18.40	1.5	0.2
15.00	13.20	19.10	1.5	0.2



## Static sealing, trapezoidal groove

The special geometry of the trapezoidal groove which is expensive to make makes it impossible for the O-ring to fall out after installation. For this reason, the trapezoidal groove is of advantage, e.g., for overhead installations or in machine parts that open and close regularly.

static, trapezoidal groove

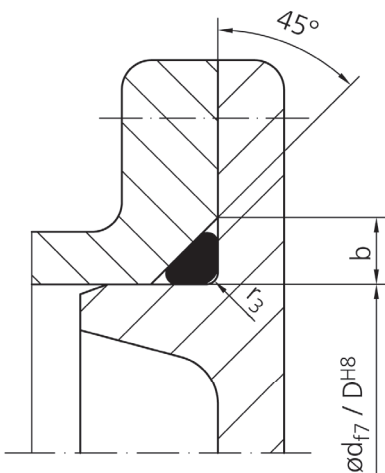


$d_2$	$t \pm 0.05$	$b \pm 0.05$	$r_4$	$r_5$
2.50	2.00	2.00	0.40	0.25
2.60	2.10	2.10	0.40	0.25
2.62	2.10	2.10	0.40	0.25
2.65	2.10	2.20	0.40	0.25
2.70	2.20	2.20	0.40	0.25
2.80	2.25	2.25	0.40	0.25
3.00	2.40	2.40	0.40	0.25
3.10	2.50	2.50	0.40	0.25
3.50	2.80	2.90	0.80	0.25
3.53	2.80	2.90	0.80	0.25
3.55	2.80	2.90	0.80	0.25
3.60	2.90	2.90	0.80	0.25
3.70	2.95	3.00	0.80	0.25
4.00	3.20	3.30	0.80	0.25
4.30	3.40	3.50	0.80	0.25
4.50	3.70	3.70	0.80	0.25
5.00	4.15	4.00	0.80	0.25
5.30	4.40	4.30	0.80	0.40
5.33	4.40	4.30	0.80	0.40
5.50	4.60	4.40	0.80	0.40
5.70	4.80	4.60	0.80	0.40
6.00	5.00	4.80	0.80	0.40
6.50	5.50	5.20	0.80	0.40
6.99	5.90	5.60	1.60	0.40
7.00	5.90	5.60	1.60	0.40
7.50	6.40	6.10	1.60	0.40
8.00	6.85	6.50	1.60	0.40
8.40	7.20	6.80	1.60	0.40
8.50	7.30	6.90	1.60	0.50
9.00	7.80	7.30	1.60	0.50
9.50	8.20	7.70	1.60	0.50
10.00	8.70	8.10	1.60	0.50

## Static sealing, triangular groove

Normally, we recommend a rectangular groove for O-ring seals. Where covers or flanges must be sealed, design reasons may require a triangular groove. Strict keeping within tolerance is a precondition for the safe function in this case.

static, triangular groove

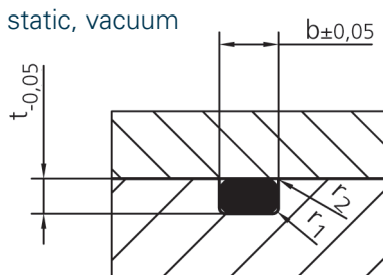


$d_2$	$b$	Tol.	$r_3$
1.50	2.05	+0.1	0.3
1.60	2.20	+0.1	0.3
1.78	2.40	+0.1	0.3
1.80	2.40	+0.1	0.3
1.90	2.60	+0.1	0.4
2.00	2.70	+0.1	0.4
2.20	3.00	+0.1	0.4
2.40	3.20	+0.15	0.4
2.50	3.40	+0.15	0.5
2.60	3.60	+0.15	0.5
2.62	3.60	+0.15	0.5
2.65	3.60	+0.15	0.5
2.70	3.70	+0.15	0.6
2.80	3.80	+0.15	0.6
3.00	4.10	+0.2	0.6
3.10	4.20	+0.2	0.6
3.50	4.80	+0.2	0.8
3.53	4.80	+0.2	0.8
3.55	4.80	+0.2	0.8
3.60	4.90	+0.2	0.9
3.70	5.00	+0.2	0.9
4.00	5.50	+0.2	1.2
4.30	5.90	+0.2	1.2
4.50	6.20	+0.2	1.2
5.00	6.80	+0.25	1.2
5.30	7.20	+0.25	1.4
5.33	7.30	+0.25	1.4
5.50	7.50	+0.25	1.5
5.70	7.80	+0.25	1.5
6.00	8.20	+0.3	1.5
6.50	8.80	+0.3	1.7
6.99	9.60	+0.3	2.0
7.00	9.60	+0.3	2.0
7.50	10.20	+0.3	2.0
8.00	10.90	+0.3	2.0
8.40	11.40	+0.3	2.0
8.50	11.60	+0.4	2.0
9.00	12.50	+0.4	2.5
9.50	13.10	+0.4	2.5
10.00	13.70	+0.4	2.5
10.50	14.30	+0.4	2.5
11.00	15.00	+0.4	2.5
12.00	16.50	+0.4	3.0
15.00	20.40	+0.4	3.0

## Static vacuum sealing

The recommendations for sealing vacuum are slightly different than those for standard seals:

- The surface quality of all sealing faces must be distinctly better.
- Compliance with the recommended installation dimensions ensures a higher preload of the O-ring and the O-ring cross section fills the groove almost completely. The diffusion path of the gas through the elastomer becomes longer.
- The total leak rate can be reduced by using two O-rings one after the other and the application of vacuum grease.
- O-rings of fluoro rubber have shown to produce excellent results in many vacuum sealing applications.



$d_2$	$t_{-0,05}$	$b_{\pm 0,05}$	$r_1$	$r_2$
1.50	1.05	1.80	0.2	0.1
1.78	1.25	2.10	0.2	0.1
1.80	1.25	2.10	0.2	0.1
2.00	1.40	2.35	0.2	0.1
2.50	1.75	2.90	0.2	0.2
2.60	1.80	3.05	0.2	0.2
2.62	1.85	3.05	0.2	0.2
2.65	1.85	3.10	0.2	0.2
2.70	1.90	3.15	0.2	0.2
2.80	1.95	3.30	0.2	0.2
3.00	2.10	3.50	0.2	0.2
3.10	2.20	3.60	0.4	0.2
3.50	2.45	4.10	0.4	0.2
3.53	2.50	4.10	0.4	0.2
3.55	2.50	4.15	0.4	0.2
3.60	2.50	4.20	0.4	0.2
3.70	2.60	4.30	0.4	0.2
4.00	2.80	4.70	0.4	0.2
4.50	3.15	5.30	0.4	0.2
5.00	3.50	5.90	0.4	0.2
5.30	3.70	6.30	0.4	0.2
5.33	3.70	6.30	0.4	0.2
5.50	3.85	6.50	0.4	0.2
5.70	4.00	6.70	0.4	0.2
6.00	4.20	7.10	0.4	0.2
6.50	4.60	7.60	0.6	0.2
6.99	4.90	8.20	0.6	0.2
7.00	4.90	8.20	0.6	0.2
7.50	5.30	8.70	0.6	0.2
8.00	5.60	9.40	0.6	0.2
8.40	5.90	9.90	0.6	0.2
8.50	6.00	10.00	0.6	0.2
9.00	6.40	10.50	0.6	0.2
9.50	6.70	11.10	0.6	0.2
10.00	7.10	11.70	0.6	0.2

## Dynamic sealing

If the sealed machine parts move relative to each other, the seal is a dynamic seal.

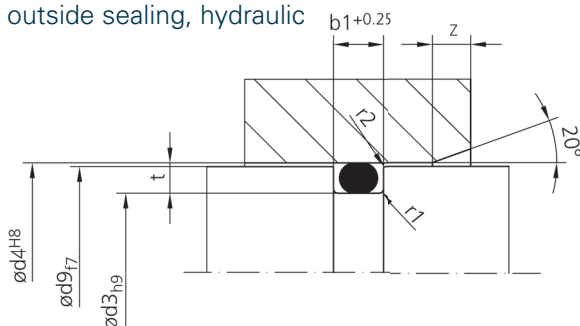
Due to friction, the compression of the O-ring cross-section is less in dynamic sealing than in a static sealing.

The recommended installation dimensions should be observed to ensure reliable sealing.

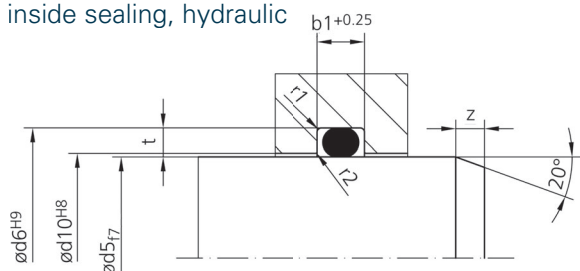
## Dynamic sealing, radial compression, hydraulic

O-ring seals in hydraulic systems are used for reciprocating, sometimes also for helical movements. They are particularly suitable if only little installation space is available. When higher demands on the sealing and less friction are required it should be seen whether special piston or rod seals can be used.

dynamic, radial,  
outside sealing, hydraulic



dynamic, radial,  
inside sealing, hydraulic



$d_2$	$t +0.05$	$b_1 +0.25$	$z$	$r_1$	$r_2$
1.00	0.85	1.30	1.0	0.3	0.1
1.02	0.85	1.40	1.0	0.3	0.1
1.20	1.00	1.60	1.0	0.3	0.1
1.25	1.05	1.60	1.0	0.3	0.1
1.27	1.10	1.70	1.0	0.3	0.1
1.30	1.10	1.70	1.0	0.3	0.1
1.42	1.20	1.90	1.2	0.3	0.1
1.50	1.30	2.00	1.2	0.3	0.1
1.52	1.30	2.00	1.2	0.3	0.1
1.60	1.35	2.10	1.2	0.3	0.1
1.63	1.40	2.10	1.2	0.3	0.1
1.78	1.50	2.30	1.4	0.3	0.2
1.80	1.50	2.40	1.4	0.3	0.2
1.83	1.55	2.40	1.4	0.3	0.2
1.90	1.60	2.50	1.4	0.3	0.2
1.98	1.70	2.60	1.4	0.3	0.2
2.00	1.70	2.60	1.4	0.3	0.2
2.08	1.75	2.70	1.4	0.3	0.2
2.10	1.80	2.80	1.4	0.3	0.2
2.20	1.90	2.90	1.4	0.3	0.2
2.26	1.90	3.00	1.4	0.3	0.2
2.30	1.95	3.00	1.4	0.3	0.2
2.34	2.00	3.10	1.4	0.3	0.2
2.40	2.05	3.20	1.4	0.3	0.2
2.46	2.10	3.20	1.4	0.3	0.2
2.50	2.15	3.30	1.4	0.3	0.2
2.60	2.20	3.40	1.6	0.3	0.2
2.62	2.25	3.40	1.6	0.3	0.2
2.65	2.25	3.40	1.6	0.3	0.2
2.70	2.30	3.50	1.6	0.3	0.2
2.80	2.40	3.70	1.6	0.3	0.2
2.92	2.50	3.80	1.8	0.3	0.2
2.95	2.50	3.90	1.8	0.3	0.2
3.00	2.60	3.90	1.8	0.3	0.2
3.10	2.70	4.00	1.8	0.6	0.2
3.50	3.10	4.50	2.0	0.6	0.2
3.53	3.10	4.50	2.0	0.6	0.2
3.55	3.10	4.60	2.0	0.6	0.2
3.60	3.10	4.60	2.0	0.6	0.2
3.70	3.20	4.80	2.0	0.6	0.2
4.00	3.50	5.10	2.5	0.6	0.2
4.30	3.80	5.50	2.5	0.6	0.2
4.50	4.00	5.70	2.5	0.6	0.2
5.00	4.40	6.40	2.8	0.6	0.2

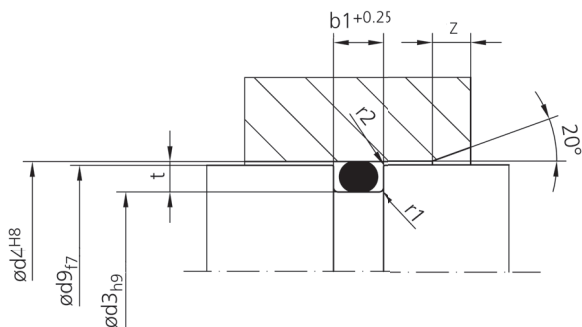
$d_2$	$t +0.05$	$b_1 +0.25$	$z$	$r_1$	$r_2$
5.30	4.70	6.80	2.8	0.6	0.2
5.33	4.70	6.80	2.8	0.6	0.2
5.50	4.80	7.00	3.0	0.6	0.2
5.70	5.00	7.30	3.0	0.6	0.2
6.00	5.30	7.60	3.5	0.6	0.2
6.50	5.80	8.20	3.5	1.0	0.2
6.99	6.20	8.80	4.0	1.0	0.2
7.00	6.20	8.80	4.0	1.0	0.2
7.50	6.70	9.50	4.0	1.0	0.2
8.00	7.10	10.10	4.5	1.0	0.2
8.40	7.50	10.60	4.5	1.0	0.2
8.50	7.60	10.70	4.5	1.0	0.2
9.00	8.10	11.20	4.5	1.0	0.2
9.50	8.50	11.80	4.5	1.0	0.2
10.00	9.00	12.50	4.5	1.0	0.2
10.50	9.40	13.10	5.0	1.0	0.2
11.00	9.90	13.70	5.0	1.0	0.2
11.50	10.30	14.40	5.0	1.0	0.2
12.00	10.80	15.00	5.0	1.0	0.2
15.00	13.60	18.50	5.0	1.5	0.2

## Dynamic sealing, radial compression, pneumatic

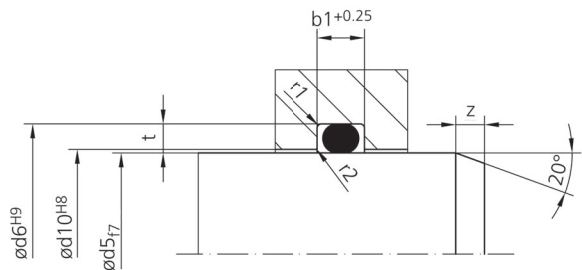
O-ring seals in pneumatic systems are used for reciprocating movements.

In comparison with hydraulic applications, the compression of the O-ring cross-section is slightly less to keep the friction level as low as possible.

dynamic, radial,  
outside sealing, pneumatic



dynamic, radial,  
inside sealing, pneumatic



$d_2$	$t +0.05$	$b_1 +0.25$	$z$	$r_1$	$r_2$
1.50	1.30	1.80	1.2	0.3	0.1
1.52	1.30	1.80	1.2	0.3	0.1
1.60	1.40	1.90	1.2	0.3	0.1
1.63	1.40	2.00	1.2	0.3	0.1
1.78	1.55	2.10	1.4	0.3	0.2
1.80	1.60	2.10	1.4	0.3	0.2
1.83	1.60	2.20	1.4	0.3	0.2
1.90	1.65	2.30	1.4	0.3	0.2
1.98	1.75	2.30	1.4	0.3	0.2
2.00	1.75	2.40	1.4	0.3	0.2
2.08	1.85	2.40	1.4	0.3	0.2
2.10	1.85	2.50	1.4	0.3	0.2
2.20	1.95	2.60	1.4	0.3	0.2
2.26	2.00	2.60	1.4	0.3	0.2
2.30	2.05	2.70	1.4	0.3	0.2
2.34	2.10	2.70	1.4	0.3	0.2
2.40	2.15	2.80	1.4	0.3	0.2
2.46	2.20	2.90	1.4	0.3	0.2
2.50	2.25	2.90	1.4	0.3	0.2
2.60	2.35	3.00	1.6	0.3	0.2
2.62	2.35	3.00	1.6	0.3	0.2
2.65	2.40	3.10	1.6	0.3	0.2
2.70	2.40	3.10	1.6	0.3	0.2
2.80	2.50	3.30	1.6	0.3	0.2
2.92	2.65	3.40	1.8	0.3	0.2
2.95	2.65	3.40	1.8	0.3	0.2
3.00	2.70	3.50	1.8	0.3	0.2
3.10	2.80	3.70	1.8	0.6	0.2
3.50	3.15	4.20	2.0	0.6	0.2
3.53	3.20	4.20	2.0	0.6	0.2
3.55	3.20	4.20	2.0	0.6	0.2
3.60	3.25	4.30	2.0	0.6	0.2
3.70	3.35	4.40	2.0	0.6	0.2
4.00	3.65	4.70	2.5	0.6	0.2
4.30	3.90	5.20	2.5	0.6	0.2
4.50	4.10	5.50	2.5	0.6	0.2
5.00	4.60	6.10	2.8	0.6	0.2
5.30	4.90	6.50	2.8	0.6	0.2
5.33	4.90	6.50	2.8	0.6	0.2
5.50	5.05	6.70	3.0	0.6	0.2
5.70	5.25	6.90	3.0	0.6	0.2
6.00	5.50	7.30	3.5	0.6	0.2
6.50	6.00	7.90	3.5	1.0	0.2
6.99	6.45	8.50	4.0	1.0	0.2

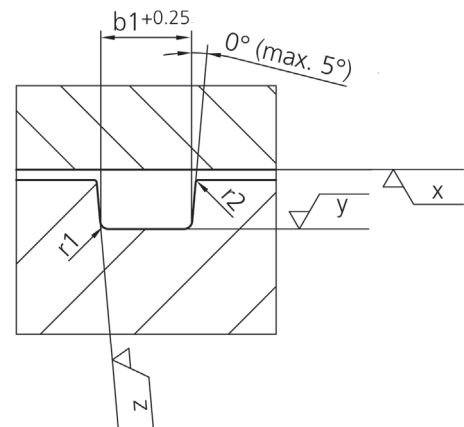
$d_2$	$t +0.05$	$b_1 +0.25$	$z$	$r_1$	$r_2$
7.00	6.45	8.50	4.0	1.0	0.2
7.50	6.95	9.10	4.0	1.0	0.2
8.00	7.40	9.70	4.5	1.0	0.2
8.40	7.80	10.20	4.5	1.0	0.2
8.50	7.85	10.30	4.5	1.0	0.2
9.00	8.35	10.90	4.5	1.0	0.2
9.50	8.80	11.50	4.5	1.0	0.2
10.00	9.30	12.10	4.5	1.0	0.2
10.50	9.75	12.70	5.0	1.0	0.2
11.00	10.25	13.30	5.0	1.0	0.2
11.50	10.70	13.90	5.0	1.0	0.2
12.00	11.15	14.50	5.0	1.0	0.2

## O-ring groove, design

The following parameters should be considered for the design of O-ring grooves:

### Groove design

Normally, rectangular grooves are preferred for O-ring seals. If required for technological reasons, the groove flanks can have bevels not exceeding 5 degrees.



d2	r1	r2
-3	0.3	0.2
3-6	0.6	
6-10	1.0	
12-15	1.5	

### Surfaces

The correct surface roughness of the sealing surfaces is decisive for good and efficient sealing. Dynamic seals must meet higher requirements than the surfaces of static seals. Generally, all surfaces in the area of the seal should be free from scratches, cavities or deep machining grooves.

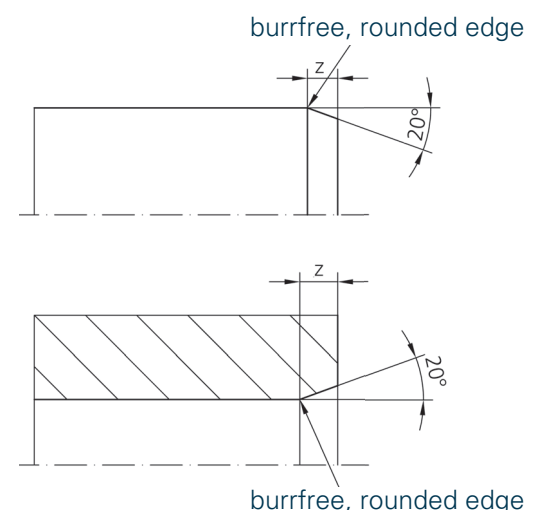
### Surface

#### Sealing type

	dynamic			static			static pulsating pressure		
	R <sub>a</sub> [μm]	R <sub>z</sub> [μm]	R <sub>max</sub> [μm]	R <sub>a</sub> [μm]	R <sub>z</sub> [μm]	R <sub>max</sub> [μm]	R <sub>a</sub> [μm]	R <sub>z</sub> [μm]	R <sub>max</sub> [μm]
Sealing surface x ≤	0.4	1.2	1.6	1.6	6.3	10	0.8	1.6	3.2
Groove base y ≤	1.6	3.2	6.3	3.2	10	12.5	1.6	3.2	6.3
Groove flanks z ≤	3.2	6.3	10	6.3	12.5	16	3.2	6.3	10

### Lead-in chamfers

In relation to the installation space, O-rings are designed with some oversize and are compressed during installation between the machine parts. To avoid damage (e.g., shearing of the O-ring) appropriate lead-in chamfers must be provided at the parts. The angle of the lead-in chamfer should be 15° – 20°. The length of the chamfer depends on the cross section and is specified in the appropriate groove dimension tables.





## Gap dimensions

The gap dimension between the sealed machine parts should be small as required for the application. The gap is too wide, gap extrusion may occur. This means that the O-ring material is compressed into the gap at the side opposite the pressure and is destroyed.

Type of sealing	Pressure [bar]	Hardness [Shore A]		
		70	80	90
<b>static</b>	≤ 63	0.2	0.25	0.3
	63 – 100	0.1	0.2	0.25
	100 – 160	0.05	0.1	0.2
	160 – 250	-	0.05	0.1
	250 – 350	-	-	0.05
<b>dynamic</b>	≤ 30	0.2	0.25	0.3
	30 – 63	0.1	0.15	0.2
	63 – 80	-	0.1	0.15
	80 – 100	-	-	0.1

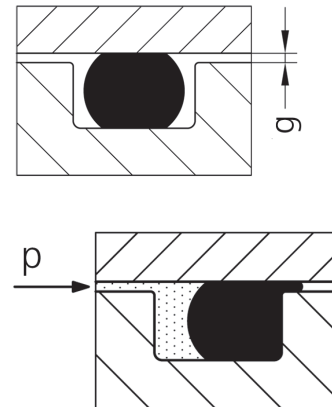
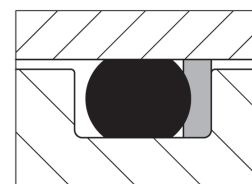


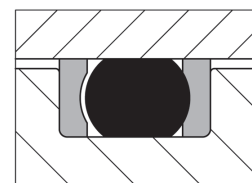
Table: Permitted gap width  $g$  [mm] valid for temperatures up to 70°C.

For silicone materials the values for the gap sizes are to be halved

Where gaps are wider or pressures higher, we recommend back-up rings.



Pressure from one side



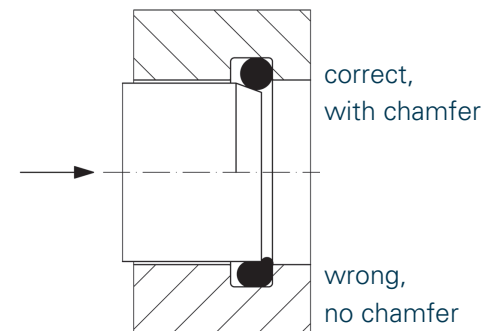
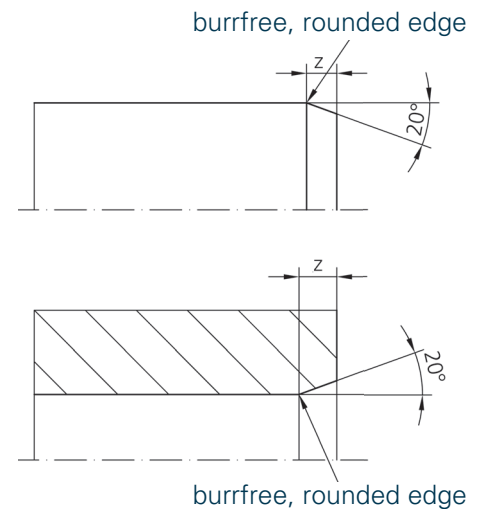
Pressure from both sides

## Installation

The reliable function of an O-ring depends on the correct installation. The O-ring must not be damaged during installation.

The following points are important for the installation of O-rings:

- Before the seal is installed, all components should be cleaned from machining residue, e.g., chips and contamination of any kind.
- The seal and the installation groove should be lubricated with suitable grease before the installation (check lubricant for compatibility with the sealing material).
- All components of the installation groove should have lead-in chamfers.
- Sharp edges should carefully be deburred or - better even - avoided by the designer by providing suitable chamfers or radii.
- Seals should in no case be drawn over sharp edges. Threads, key grooves, boreholes, etc. should be covered during installation of the O-ring. We recommend using installation sleeves or installation mandrels.
- Make sure not to damage the O-ring when you expand it for installation (especially small O-rings).
- Heating to approximately 80°C in oil or water facilitates expansion and recovery of the O-ring.
- The O-ring should not be rolled during installation and not be twisted when it rests in the groove.



## Storage of Elastomers

The optimum storage conditions for Elastomer products are described in DIN 7716 and ISO 2230. Adherence to these instructions allows the storage of Elastomers for a period of several years without reduction in quality.

The most harmful factors for accelerated ageing of Elastomers are

- mechanical stress (compression, tension, bending, ...),
- subjection to oxygen,
- ozone,
- light,
- heat,
- humidity
- and solvents.

For this reason, the following basic rules should be observed:

## Warehouse

The warehouse should be cool, dry, dustfree and moderately aired. The relative humidity should not exceed 65%.

There should be no ozone producing electrical equipment set up in the warehouse. The warehouse should also not be simultaneously used for the storage of solvents, fuels, lubricants, chemicals or other gas emitting substances.

## Storage temperature

The temperature should be approx. 15°C although fluctuations from +20°C to -10°C are permissible. Sources of heat e.g. radiators should be at a distance of at least 1m from the goods to avoid direct heat radiation.

## Lighting

Elastomers must be protected from direct sunshine and artificial lighting with a high UV ratio. It is advisable to light the warehouse with conventional bulbs.

## Packaging

Sealed packaging e.g. airtight containers or polyethylene bags protect the goods from the surrounding atmosphere and thereby from oxygen and ozone. Packaging materials may not include softeners or other substances harmful to elastomer.

## Mechanical stress

Elastomer products should be stored stress-free. This means they should not be subjected to tension, compression, bending or any other stress.

## Storage of components

Particular care must be taken in the storage of e.g. screw couplings with external, prefitted seals. The tensile stress of a stretched seal results in severe acceleration of the ageing process. For this reason, the stretching of a seal should be kept to a minimum in the constructive design.

Despite optimum storage conditions, the components should not be stored for long periods and is imperative they are promptly further processed in accordance with the principle of "first-in first-out".