

TECHNICAL REFERENCE

SLIDE GUIDE

BALL SPLINE
ROTARY BALL SPLINE

TOPBALL® PRODUCTS

SLIDE BUSH

SLIDE UNIT

STROKE BUSH
SLIDE ROTARY BUSH

SLIDE SHAFT

SLIDE WAY
SLIDE TABLE
GONIO WAY

ACTUATOR

SLIDE SCREW



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DEFINITIONS AND INDICATIONS OF GEOMETRICAL DEVIATIONS

INDICATIONS OF GEOMETRICAL TOLERANCES ON DRAWINGS

STRAIGHTNESS Straightness indicates the degree of deviation of a straight portion from the geometrical straight line.

<p>Straightness of two directions perpendicular to each other (Axis of a rectangular parallelepiped)</p>	<p>Space inside the prism enclosed by two pairs of parallel planes with intervals of 0.2 mm and 0.1 mm in the directions of indicated arrows</p>
<p>Straightness with no direction defined (Axis of a cylinder)</p>	<p>Space inside a cylinder with a diameter of 0.08 mm</p>
<p>Straightness of a surface element (Generatrix of a cylinder)</p>	<p>Space between a pair of parallel straight lines with an interval of 0.1 mm on an arbitrary plane including an axis</p>

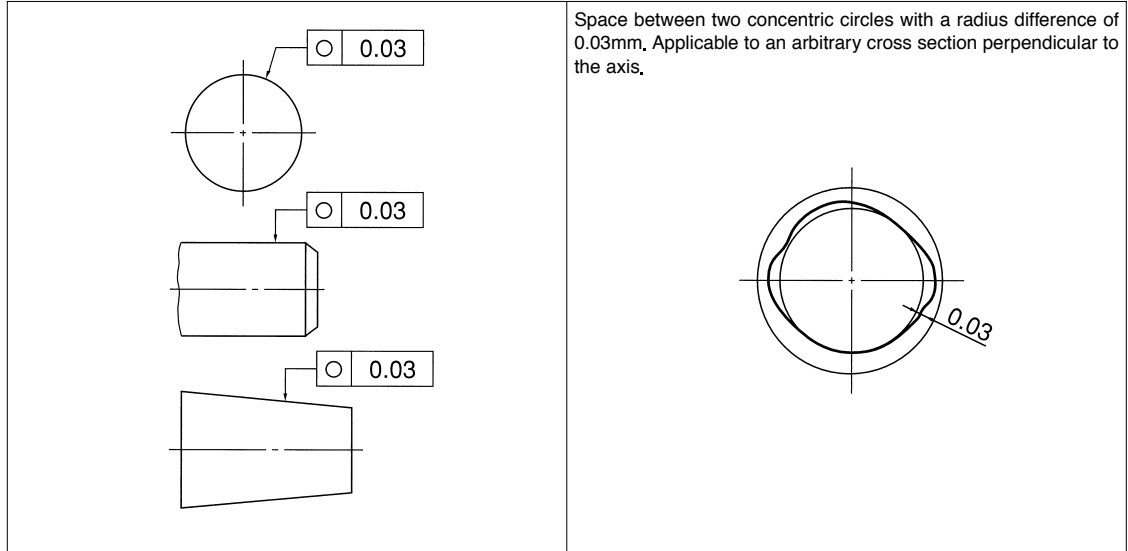
FLATNESS Flatness indicates the degree of deviation of a flat portion from the geometrical plane

<p>General flatness</p>	<p>Space between a pair of parallel planes with an interval of 0.1 mm</p>
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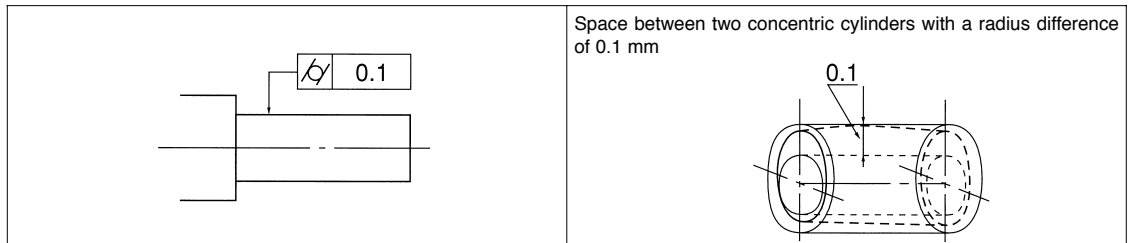
ROUNDNESS

Roundness indicates the degree of deviation of a round portion from the geometrical circle.



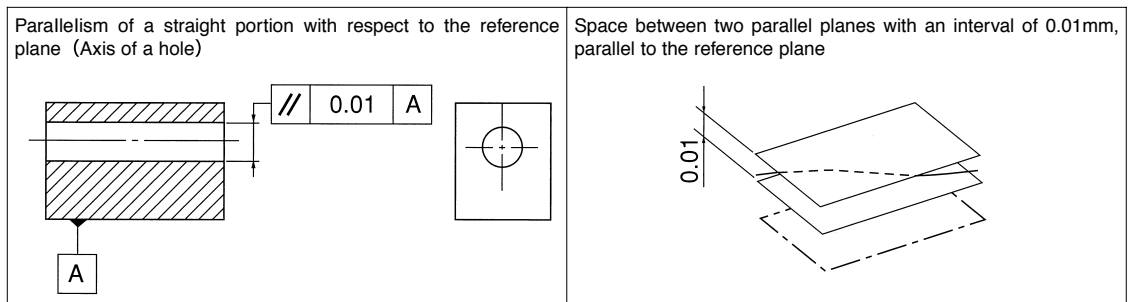
CYLINDRICITY

Cylindricity indicates the degree of deviation of a cylindrical portion from the geometrical cylindrical surface.



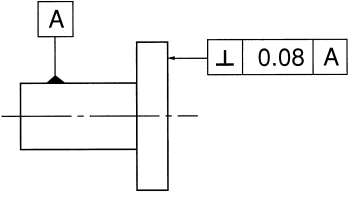
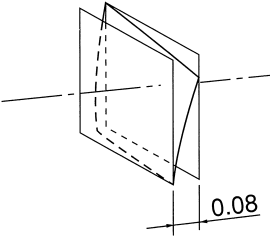
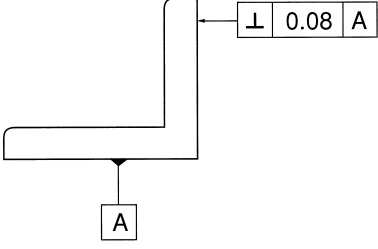
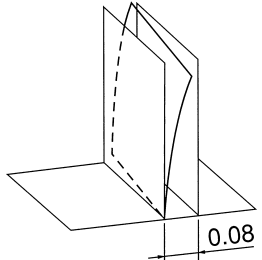
PARALLELISM

Parallelism assumes a combination of two straight portions, a straight portion and a flat portion, or two flat portions which must be parallel to each other. Parallelism indicates, with one of the two portions as a reference, the degree of deviation of the other straight or flat portion from the geometrical straight line or plane parallel to the reference straight line or plane.



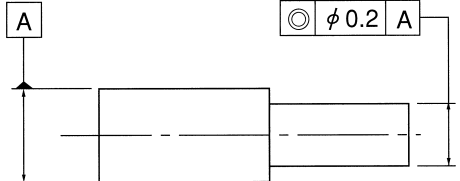
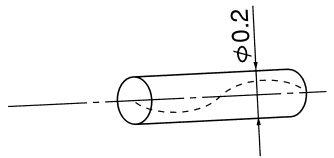
SQUARENESS

Squareness assumes a combination of two straight portions, a straight portion and a flat portion, or two flat portions which must be perpendicular to each other. Squareness indicates, with one of the two portions as a reference, the degree of deviation of the other straight or flat portion from the geometrical straight line or plane perpendicular to the reference straight line or plane.

<p>Squareness of a flat portion with respect to the reference straight line (with the axis of a cylinder as a reference)</p> 	<p>Space between two parallel planes with an interval of 0.08 mm, perpendicular to the reference straight line</p> 
<p>Squareness of a flat portion with respect to the reference plane</p> 	<p>Space between two parallel planes with an interval of 0.08 mm, perpendicular to the reference plane</p> 

CONCENTRICITY

Concentricity indicate the degree of deviation from the axis which must be on the same straight line as the reference axis.

<p>Concentricity of a cylindrical portion</p> 	<p>Space inside a cylinder with a diameter of 0.2 mm, concentric with the reference axis</p> 
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Hardness conversion table

Rockwell C scale hardness HRC (load 150 kg)	Vickers Hardness HV	Brinell hardness HB		Rockwell hardness		Shore hardness HS
		standard sphere	tungsten sphere	HRA A scale load 60 kg Barle pressure point	HRB B scale load 100 kg 1/16-inch-diameter sphere	
68	940	-	-	85.6	-	97
67	900	-	-	85.0	-	95
66	865	-	-	84.5	-	92
65	832	-	-	83.9	-	91
64	800	-	739	83.4	-	88
63	772	-	722	82.8	-	87
62	746	-	705	82.3	-	85
61	720	-	688	81.8	-	83
60	697	-	670	81.2	-	81
59	674	-	654	80.7	-	80
58	653	-	634	80.1	-	78
57	633	-	615	79.6	-	76
56	613	-	595	79.0	-	75
55	595	-	577	78.5	-	74
54	577	-	560	78.0	-	72
53	560	-	543	77.4	-	71
52	544	500	525	76.8	-	69
51	528	487	512	76.3	-	68
50	513	475	496	75.9	-	67
49	498	464	481	75.2	-	66
48	484	451	469	74.7	-	64
47	471	442	455	74.1	-	63
46	458	432	443	73.6	-	62
45	446	421	432	73.1	-	60
44	434	409	421	72.5	-	58
43	423	400	409	72.0	-	57
42	412	390	400	71.5	-	56
41	402	381	390	70.9	-	55
40	392	371	381	70.4	-	54
39	382	362	371	69.9	-	52
38	372	353	362	69.4	-	51
37	363	344	353	68.9	-	50
36	354	336	344	68.4	(109.0)	49
35	345	327	336	67.9	(108.5)	48
34	336	319	327	67.4	(108.0)	47
33	327	311	319	66.8	(107.5)	46
32	318	301	311	66.3	(107.0)	44
31	310	294	301	65.8	(106.0)	43
30	302	286	294	65.3	(105.5)	42
29	294	279	286	64.7	(104.5)	41
28	286	271	279	64.3	(104.0)	41
27	279	264	271	63.8	(103.0)	40
26	272	258	264	63.3	(102.5)	38
25	266	253	258	62.8	(101.5)	38
24	260	247	253	62.4	(101.0)	37
23	254	243	247	62.0	100.0	36
22	248	237	243	61.5	99.0	35
21	243	231	237	61.0	98.5	35
20	238	226	231	60.5	97.8	34
(18)	230	219	226	-	96.7	33
(16)	222	212	219	-	95.5	32
(14)	213	203	212	-	93.9	31
(12)	204	194	203	-	92.3	29
(10)	196	187	194	-	90.7	28
(8)	188	179	187	-	89.5	27
(6)	180	171	179	-	87.1	26
(4)	173	165	171	-	85.5	25
(2)	166	158	165	-	83.5	24
(0)	160	152	158	-	81.7	24

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diameter category mm	a13		c12		d6		e6		f5		f6		g5		g6		h5		h6		h7		h8		h9		h10				
	greater than	or less	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower			
3	6	-270	-450	-70	-190	-30	-38	-20	-28	-10	-15	-10	-18	-4	-9	-4	-12	0	-5	0	-8	0	-12	0	-18	0	-30	0	-48		
6	10	-280	-500	-80	-230	-40	-49	-25	-34	-13	-19	-13	-22	-5	-11	-5	-14	0	-6	0	-9	0	-15	0	-22	0	-36	0	-58		
10	14	14	18	-290	-560	-95	-275	-50	-61	-32	-43	-16	-24	-16	-27	-6	-14	-6	-17	0	-8	0	-11	0	-18	0	-27	0	-43	0	-70
18	24	24	30	-300	-630	-110	-320	-65	-78	-40	-53	-20	-29	-20	-33	-7	-16	-7	-20	0	-9	0	-13	0	-21	0	-33	0	-52	0	-84
30	40	40	50	-310	-700	-120	-370	-80	-96	-50	-66	-25	-36	-25	-41	-9	-20	-9	-25	0	-11	0	-16	0	-25	0	-39	0	-62	0	-100
50	65	65	80	-340	-800	-140	-440	-100	-119	-60	-79	-30	-43	-30	-49	-10	-23	-10	-29	0	-13	0	-19	0	-30	0	-46	0	-74	0	-120
80	100	100	120	-380	-920	-170	-520	-120	-142	-72	-94	-36	-51	-36	-58	-12	-27	-12	-34	0	-15	0	-22	0	-35	0	-54	0	-87	0	-140
120	140	140	160	-460	-1090	-200	-600	-145	-170	-85	-110	-43	-61	-43	-68	-14	-32	-14	-39	0	-18	0	-25	0	-40	0	-63	0	-100	0	-160
180	200	200	225	-660	-1380	-240	-700	-170	-199	-100	-129	-50	-70	-50	-79	-15	-35	-15	-44	0	-20	0	-29	0	-46	0	-72	0	-115	0	-185
250	280	280	315	-920	-1730	-300	-820	-190	-222	-110	-142	-56	-79	-56	-88	-17	-40	-17	-49	0	-23	0	-32	0	-52	0	-81	0	-130	0	-210
315	355	355	400	-1200	-2090	-360	-930	-210	-246	-125	-161	-62	-87	-62	-98	-18	-43	-18	-54	0	-25	0	-36	0	-57	0	-89	0	-140	0	-230
400	450	450	500	-1500	-2470	-440	-1070	-230	-270	-135	-175	-68	-95	-68	-108	-20	-47	-20	-60	0	-27	0	-40	0	-63	0	-97	0	-155	0	-250

housing bore dimensional tolerance

diameter category mm	E10		E11		F6		F7		F8		G6		G7		H5		H6		H7		H8		H9		H10				
	greater than	or less	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower			
3	6	+68	+20	+95	+20	+18	+10	+22	+10	+28	+10	+12	+4	+16	+4	+5	0	+8	0	+12	0	+18	0	+30	0	+48	0		
6	10	+83	+25	+115	+25	+22	+13	+28	+13	+35	+13	+14	+5	+20	+5	+6	0	+9	0	+15	0	+22	0	+36	0	+58	0		
10	14	14	18	+102	+32	+142	+32	+27	+16	+34	+16	+43	+16	+17	+6	+24	+6	+8	0	+11	0	+18	0	+27	0	+43	0	+70	0
18	24	24	30	+124	+40	+170	+40	+33	+20	+41	+20	+53	+20	+20	+7	+28	+7	+9	0	+13	0	+21	0	+33	0	+52	0	+84	0
30	40	40	50	+150	+50	+210	+50	+41	+25	+50	+25	+64	+25	+25	+9	+34	+9	+11	0	+16	0	+25	0	+39	0	+62	0	+100	0
50	65	65	80	+180	+60	+250	+60	+49	+30	+60	+30	+76	+30	+29	+10	+40	+10	+13	0	+19	0	+30	0	+46	0	+74	0	+120	0
80	100	100	120	+212	+72	+292	+72	+58	+36	+71	+36	+90	+36	+34	+12	+47	+12	+15	0	+22	0	+35	0	+54	0	+87	0	+140	0
120	140	140	160	+245	+85	+335	+85	+68	+43	+83	+43	+106	+43	+39	+14	+54	+14	+18	0	+25	0	+40	0	+63	0	+100	0	+160	0
180	200	200	225	+285	+100	+390	+100	+79	+50	+96	+50	+122	+50	+44	+15	+61	+15	+20	0	+29	0	+46	0	+72	0	+115	0	+185	0
250	280	280	315	+320	+110	+430	+110	+88	+56	+108	+56	+137	+56	+49	+17	+69	+17	+23	0	+32	0	+52	0	+81	0	+130	0	+210	0
315	355	355	400	+355	+125	+485	+125	+98	+62	+119	+62	+151	+62	+54	+18	+75	+18	+25	0	+36	0	+57	0	+89	0	+140	0	+230	0
400	450	450	500	+385	+135	+535	+135	+108	+68	+131	+68	+165	+68	+60	+20	+83	+20	+27	0	+40	0	+63	0	+97	0	+155	0	+250	0

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js5	js6	j5	j6	k5	k6	m5	m6	n5	n6	p5	p6	r6	r7	diameter category mm	
upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	greater than	or less
± 2.5	± 4	+ 3 - 2	+ 6 - 2	+ 6 + 1	+ 9 + 1	+ 9 + 4	+12 + 4	+13 + 8	+16 + 8	+17 +12	+ 20 + 12	+ 23 + 15	+ 27 + 15	3	6
± 3	± 4.5	+ 4 - 2	+ 7 - 2	+ 7 + 1	+10 + 1	+12 + 6	+15 + 6	+16 +10	+19 +10	+21 +15	+ 24 + 15	+ 28 + 19	+ 34 + 19	6	10
± 4	± 5.5	+ 5 - 3	+ 8 - 3	+ 9 + 1	+12 + 1	+15 + 7	+18 + 7	+20 +12	+23 +12	+26 +18	+ 29 + 18	+ 34 + 23	+ 41 + 23	10 14	14 18
± 4.5	± 6.5	+ 5 - 4	+ 9 - 4	+11 + 2	+15 + 2	+17 + 8	+21 + 8	+24 +15	+28 +15	+31 +22	+ 35 + 22	+ 41 + 28	+ 49 + 28	18 24	24 30
± 5.5	± 8	+ 6 - 5	+11 - 5	+13 + 2	+18 + 2	+20 + 9	+25 + 9	+28 +17	+33 +17	+37 +26	+ 42 + 26	+ 50 + 34	+ 59 + 34	30 40	40 50
± 6.5	± 9.5	+ 6 - 7	+12 - 7	+15 + 2	+21 + 2	+24 +11	+30 +11	+33 +20	+39 +20	+45 +32	+ 51 + 32	+ 60 + 41 + 62 + 43	+ 71 + 41 + 73 + 43	50 65	65 80
± 7.5	±11	+ 6 - 9	+13 - 9	+18 + 3	+25 + 3	+28 +13	+35 +13	+38 +23	+45 +23	+52 +37	+ 59 + 37	+ 73 + 51 + 76 + 54	+ 86 + 51 + 89 + 54	80 100	100 120
± 9	±12.5	+ 7 -11	+14 -11	+21 + 3	+28 + 3	+33 +15	+40 +15	+45 +27	+52 +27	+61 +43	+ 68 + 43	+ 88 + 63 + 90 + 65 + 93 + 68	+103 + 63 +105 + 65 +108 + 68	120 140 160	140 160 180
±10	±14.5	+ 7 -13	+16 -13	+24 + 4	+33 + 4	+37 +17	+46 +17	+51 +31	+60 +31	+70 +50	+ 79 + 50	+106 + 77 +109 + 80 +113 + 84	+123 + 77 +126 + 80 +130 + 84	180 200 225	200 225 250
±11.5	±16	+ 7 -16	+16 -16	+27 + 4	+36 + 4	+43 +20	+52 +20	+57 +34	+66 +34	+79 +56	+ 88 + 56	+126 + 94 +130 + 98	+146 + 94 +150 + 98	250 280	280 315
±12.5	±18	+ 7 -18	+18 -18	+29 + 4	+40 + 4	+46 +21	+57 +21	+62 +37	+73 +37	+87 +62	+ 98 + 62	+144 +108 +150 +114	+165 +108 +171 +114	315 355	355 400
±13.5	±20	+ 7 -20	+20 -20	+32 + 5	+45 + 5	+50 +23	+63 +23	+67 +40	+80 +40	+95 +68	+108 + 68	+166 +126 +172 +132	+189 +126 +195 +132	400 450	450 500

JS6	JS7	J6	J7	K6	K7	M6	M7	N6	N7	P6	P7	R6	R7	diameter category mm	
upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	greater than	or less
± 4	± 6	+ 5 - 3	+ 6 - 6	+ 2 - 6	+ 3 - 9	- 1 - 9	0 -12	- 5 -13	- 4 -16	- 9 -17	- 8 -20	- 12 -20	- 11 -23	3	6
± 4.5	± 7.5	+ 5 - 4	+ 8 - 7	+ 2 - 7	+ 5 -10	- 3 -12	0 -15	- 7 -16	- 4 -19	-12 -21	- 9 -24	- 16 -25	- 13 -28	6	10
± 5.5	± 9	+ 6 - 5	+10 - 8	+ 2 - 9	+ 6 -12	- 4 -15	0 -18	- 9 -20	- 5 -23	-15 -26	- 11 -29	- 20 -31	- 16 -34	10 14	14 18
± 6.5	±10.5	+ 8 - 5	+12 - 9	+ 2 -11	+ 6 -15	- 4 -17	0 -21	-11 -24	- 7 -28	-18 -31	- 14 -35	- 24 -37	- 20 -41	18 24	24 30
± 8	±12.5	+10 - 6	+14 -11	+ 3 -13	+ 7 -18	- 4 -20	0 -25	-12 -28	- 8 -33	-21 -37	- 17 -42	- 29 -45	- 25 -50	30 40	40 50
± 9.5	±15	+13 - 6	+18 -12	+ 4 -15	+ 9 -21	- 5 -24	0 -30	-14 -33	- 9 -39	-26 -45	- 21 -51	- 35 -54 - 37 -56	- 30 -60 - 32 -62	50 65	65 80
±11	±17.5	+16 - 6	+22 -13	+ 4 -18	+10 -25	- 6 -28	0 -35	-16 -38	-10 -45	-30 -52	- 24 -59	- 44 -66 - 47 -69	- 38 -73 - 41 -76	80 100	100 120
±12.5	±20	+18 - 7	+26 -14	+ 4 -21	+12 -28	- 8 -33	0 -40	-20 -45	-12 -52	-36 -61	- 28 -68	- 56 -81 - 58 -83 - 61 -86	- 48 -88 - 50 -90 - 53 -93	120 140 160	140 160 180
±14.5	±23	+22 - 7	+30 -16	+ 5 -24	+13 -33	- 8 -37	0 -46	-22 -51	-14 -60	-41 -70	- 33 -79	- 68 -97 - 71 -100 - 75 -104	- 60 -106 - 63 -109 - 67 -113	180 200 225	200 225 250
±16	±26	+25 - 7	+36 -16	+ 5 -27	+16 -36	- 9 -41	0 -52	-25 -57	-14 -66	-47 -79	- 36 -88	- 85 -117 - 89 -121	- 74 -126 - 78 -130	250 280	280 315
±18	±28.5	+29 - 7	+39 -18	+ 7 -29	+17 -40	-10 -46	0 -57	-26 -62	-16 -73	-51 -87	- 41 -98	- 97 -133 -103 -139	- 87 -144 - 93 -150	315 355	355 400
±20	±31.5	+33 - 7	+43 -20	+ 8 -32	+18 -45	-10 -50	0 -63	-27 -67	-17 -80	-55 -95	- 45 -108	-113 -153 -119 -159	-103 -166 -109 -172	400 450	450 500