

TIGHTENING / TEST TORQUE

Suggested bolt tightening torque in Nm (Newton metres)							Wrench/spanner test torques in accordance with DIN ISO 1711-1 (minimum guaranteed values) Nm							
These torque levels are guideline values for metric standard threads in accordance with DIN ISO 261 and head sizes in accordance with DIN EN ISO 4762, DIN EN ISO 4032, DIN EN ISO 4014, and DIN 931-2, 6912, 7984 and 7990. These produce a 90% utilization of the bolt yield strength. The calculations are based on a friction coefficient of 0.14 (new bolt) without any after treatment, non-lubricated). Please note: in extreme cases, e.g. for bolts lubricated with MoS₂ compound and with cadmium-plated connecting elements on both sides, the tightening torque should be reduced by around 20%.								No. 2, 2A, 2B No. 1B, 308, 7	No. 4	No. 6, No. 1B, 7, 400	No. 25	No. 26 R No. 626	No. 35 A No. 35 B No. 3112	No. 894 No. 895
							mm							
Tightening values for quality grade as per DIN 267														
	4.6	5.6	6.9	8.8	10.9	12.9								
M 2	0,123	0,162	0,314	0,373	0,520	0,628	4			1,90				
M 2,2	0,196	0,265	0,510	0,598	0,843	1,010	4,5*			2,64				
M 2,5	0,284	0,373	0,726	0,863	1,206	1,451	5	11,5		3,55				
M 3	0,441	0,588	1,128	1,344	1,883	2,256	5,5	14,4		4,64		14,4		2,32
M 3,5	0,677	0,902	1,736	2,060	2,893	3,481	6*	17,6	7,4	5,92		17,6		2,96
M 4	1,000	1,344	2,599	3,040	4,315	5,148	7	25,2	11,4	9,12		25,2		4,56
M 5	1,916	2,648	5,099	6,031	8,483	10,200	8 9*	34,5 45,4	16,6 23	13,3 18,4		34,5 45,4	34,5 45,4	6,65 9,20
M 6	3,432	4,511	8,728	10,300	14,710	17,652	10	58,1	31	24,8	58,1	58,1	58,1	12,4
M 7	5,590	7,453	14,220	17,162	24,517	28,439	11 12*	72,7 89,1	40,4 51,5	32,3 41,2	72,7 89,1	72,7 89,1	72,7 89,1	16,1 20,6
M 8	8,238	10,787	21,575	25,497	35,304	42,168	13 14*	107 128	64,5 79,4	51,6 63,5	107 128	107 128	107 128	25,8 31,7
M 10	16,67	21,575	42,168	50,014	70,608	85,317	15 16 17*	150 175 201	96,2 115 134	77,0 92,3 107	150 175 201	150 175 201	150 175 201	38,5 46,1 53,5
M 12	28,44	38,246	73,550	87,279	122,60	147,10	18 19* 20*	230 261 294	160 186 215	128 149 172	230 261 294	230 261 294	230 261 294	64,0 74,5 86,0
M 14	45,11	60,801	116,70	138,30	194,20	235,40	21 22* 23*	330 368 408	247 281 319	198 225 255	330 368 408	330 368 408	330 368 408	99,0 112 127
M 16	69,63	93,163	178,5	210,80	299,10	357,90	24 25* 26*	451 496 544	359 402 449	287 322 359	451 496 544	451 496 544	451 496 544	143 161 179
M 18	95,12	127,50	245,20	289,3	411,90	490,30	27 28*	594 647	499 552	399 442	594 647	594 647	594 647	199 221
M 20	135,3	180,45	384,10	411,90	578,60	696,30	30	760	670	536	760	760	760	268
M 22	182,4	245,16	470,70	559,00	784,50	941,40	32* 34	884 1019	804 951	643 761	884 1019	884 1019	884 1019	321 381
M 24	230,5	308,91	598,20	711,00	1000	1196	36	1165	1117	894	1165	1165	1165	447
M 27	343,2	460,90	887,50	1049	1481	1775	41	1579	1442	1154	1579	1579	1579	577
M 30	465,8	622,72	1206	1422	2010	2403	46	2067	1816	1453	2067	2067	2067	726
M 33	632,5	848,30	1628	1932	2716	3266	50	2512	2145	1716	2512	2512	2512	858
M 36	814,0	1089	2099	2481	3491	4197	55	3140		2077	3140	3140	3140	1038
M 39	1059	1412	2716	3226	4531	5443	60	3849		2471	3849		3849	1235
M 42	1304	1746	3364	3991	5609	6727	65	4021		2900	4021		4021	1422
M 45	1638	2177	4207	4992	7012	8414	70	4658		3364	4658		4658	1618
M 48	1981	2638	5080	6021	8473	10150	75	5394		3862			5394	1765
M 52	2540	3393	6541	7747	10885	13092	80	6178		4394			6178	1912
M 56	3168	4227	8149	9650	13582	16279	85	6963					6963	2059
M 60	3932	5247	10101	11964	16867	20202	90	7845					7845	-
M 64	4737	6306	12160	14416	20300	24320	95	8336					8336	-

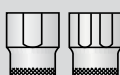
*These sizes are not included in DIN ISO 272

Note:

In reference to the "spanner test torque as per DIN ISO 1711-1" column, we explicitly point out that these are minimum guarantee values. Bolts from M39 in quality grades 4.6, 5.6, 6.9, 8.8, 10.9 and 12.9 are not standardized.



TIGHTENING / TEST TORQUE

Wrench/spanner test torques in accordance with DIN ISO 1711-1 (minimum guaranteed values) Nm							Test torques for tightening tools for hexagon socket head screws									
		With square socket head as per DIN 3120					DIN EN ISO 4762		No. 42T, DT42	No. 42, 42EL	No. IN 34	With hexagon head as per DIN 7422				
		6,3	10	12,5	20	25						6,3	10	12,5	20	25
		No. 20	No. 30	No. 19	No. 32	No. D 21						No. IN 20	No. IN30	No. IN 19	No. IN 32	No. IN 21
		No. D 20	No. D 30	No. D 19	No. D 32											
																
	mm	1/4"	3/8"	1/2"	3/4"	1"			1/4"	3/8"	1/2"	3/4"	1"			
M 2	4	10,4					1,5	0,82								
M 2,2	4,5*	12,6					2	1,9		1,9						
M 2,5	5	15,1														
M 3	5,5	17,8					2,5	3,8		3,8						
M 3,5	6*	20,6	23,2													
M 4	7	26,8	33,2				3	6,6	6,6	6,6						
M 5	8	33,6	45,5	94,1			4	16	16	16	16	16				
	9*	41,1	59,9	119,2												
M 6	10	49,1	76,7	147			5	30	30	30	30	30				
M 7	11	57,8	96	178												
	12*	67,0	118	212												
M 8	13	68,6	141	249			6	52	52	52	52	52				
	14*	68,6	169	288			7	80		80	80	80				
M 10	15		198	331			8	120	120	120	120	120				
	16		225	377												
	17*		225	425			9	165			165					
M 12	18		225	477			10	220	220		220	220				
	19*		225	531												
	20*		225	569			12	370	370		370					
M 14	21		225	569												
	22*		225	569	569											
	23*			569	569											
M 16	24			569	569		14	590	590		590	590				
	25*			569	583											
	26*			569	624											
M 18	27			569	665											
	28*			569	707											
M 20	30			569	795		17	980	980		1000	1000	1000			
M 22	32*			569	888											
	34			569	984											
M 24	36				1084	1677	19	1360	1360		1400	1400	1400			
M 27	41				1353	1910										
M 30	46				1569	2143	22	2110				2100	2100			
M 33	50				1569	2329	24	2750								
M 36	55				1569	2562	27	3910					2700			
M 39	60				1569	2795	30	4000								
M 42	65					2795	32	4000								
M 45	70					2795										
M 48	75					2795	36	4000								
M 52	80					2795										
M 56	85															
M 60	90															
M 64	95															

The matching test torques are derived from the theoretical load capability of the connecting square drive.

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Attention:

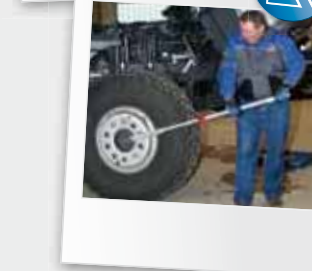
Hand tightening sockets are unsuited to use with impact drivers. Inappropriate use poses an accident risk. Power driver sockets can be found up from page 137.



HEAD WIDTHS AND THREAD DIAMETERS

mm 				Head widths		Thread Ø		Head widths	
	Metric as per DIN ISO 272	Metric for high-tensile bolted structural joints as per EN 14399-4	"AF" 	inch	mm	Whitw. 	BS 916 1083	inch	mm
2,5 3 3,2	1 1,4 and 1,2 1,6								
4 4,5 5	2 2,3 2,5		5/32 3/16	0,1562 0,1875	3,97 4,76	8 BA 7 BA 6 BA		0,152 0,172 0,193	3,86 4,37 4,90
5,5 6	3 3,5		7/32 1/4	0,2187 0,2500	5,56 6,35	5 BA 4 BA 1/16 W		0,220 0,248 0,256	5,59 6,30 6,90
7 7+8	4 5		9/32 5/16	0,2812 0,3125	7,14 7,94	3 BA 3/32 W 2 BA		0,282 0,297 0,324	7,16 7,54 8,23
9 8+10	5 Old 6		11/32 3/8 13/32	0,3438 0,3750 0,4062	8,73 9,52 10,32	1/8 W 1 BA 0 BA	(3/16) (7/32)	0,340 0,365 0,413	8,64 9,27 10,49
11 12 10+13	7 8		7/16 1/2	0,4375 0,5000	11,11 12,70	3/16 W 1/4 W	1/4 5/16	0,445 0,525	11,30 13,34
14* 15 16	8 Old 10 KFZ 10		9/16 19/32 5/8	0,5625 0,5938 0,6250	14,29 15,08 15,88	5/16 W	3/8	0,600	15,24
13+15+17 18 15+18+19	10 12 12		11/16 3/4	0,6875 0,7500	17,46 19,05	3/8 W	7/16	0,710	18,03
20* 18+21 22+24	14 14	12	25/32 13/16 7/8	0,7812 0,8125 0,8750	19,84 20,64 22,22	7/16 W	1/2	0,820	20,83
23* 21+24* 25*+27*	16		15/16 1.	0,9375 1,0000	23,81 25,40	1/2 W	9/16	0,920	23,37
26* 27 27+28*+30	18	16	1.1/16	1,0625	26,99	9/16 W 5/8 W	5/8 (11/16)	1,010 1,100	25,65 27,94
27+30+34 32+36+41	20 22	20	1.1/8 1.3/16 1.1/4	1,1250 1,1875 1,2500	28,58 30,16 31,75	11/16 W	3/4	1,200	30,48
34 36+41	22 24	22	1.5/16 1.3/8 1.7/16	1,3125 1,3750 1,4375	33,34 34,92 36,51	3/4 W 13/16 W	7/8 (15/16)	1,300 1,390	33,02 35,31
38* 41+46	27	24	1.1/2 1.5/8 1.11/16	1,5000 1,6250 1,6875	38,10 41,28 42,86	7/8 W 1. W	1. 1.1/8	1,480 1,670	37,59 42,42
46+50	30	27	1.3/4 1.13/16 1.7/8	1,7500 1,8125 1,8750	44,45 46,04 47,62	1.1/8 W	1.1/4	1,860	47,24
50+55 55+60	33 36	30	2. 2.1/16 2.3/16	2,0000 2,0625 2,1875	50,80 52,39 55,56	1.1/4 W	1.3/8	2,050	52,07
60+65	39	36	2.1/4 2.3/8 2.7/16	2,2500 2,3750 2,4375	57,15 60,32 61,91	1.3/8 W 1.1/2 W	1.1/2 1.5/8	2,220 2,410	56,39 61,21
65 70	42 45		2.9/16 2.5/8 2.3/4	2,5625 2,3750 2,7500	65,09 66,68 69,85	1.5/8 W 1.3/4 W	1.3/4 2.	2,580 2,760	65,53 70,10
75	48		2.13/16 2.15/16 3	2,8125 2,9375 3,0000	71,44 74,61 76,20	(1.7/8 W)			76,70
80 85 90	52 56 60		3.1/8 3.3/8 3.1/2	3,1250 3,3750 3,5000	79,38 85,72 88,90		2.1/4 2.1/2	3,150 3,550	80,01 90,17
95 100	64 68		3.3/4 3.7/8	3,7500 3,8750	95,25 98,42		2.3/4	3,890	98,81
105 110 115	72 76 80		4.1/8 4.1/4 4.1/2	4,1250 4,2500 4,5000	104,78 107,95 114,30		3. 3.1/4	4,180 4,530	106,17 115,06
120 125*	85		4.5/8 4.7/8 5.	4,6250 4,8750 5,0000	117,48 123,82 127,00		3.1/2	4,850	123,19
130 135 140*	90 95		5.1/4 5.3/8 5.5/8	5,2500 5,3750 5,6250	133,35 136,52 142,88		3.3/4 4.	5,180 5,550	131,57 140,97
145 150 155	100 105 110		5.3/4 6. 6.1/8	5,7500 6,0000 6,1250	146,05 152,40 155,58		4.1/2	6,380	162,05
160* 165 170	115 120								
175* 180 185	125 130								
200 210	140 150								

* not standardised

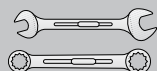




Conversion tables inches to decimal-inches and mm

in.	dec. in.	mm	in.	dec. in.	mm
0	0	0	1/2	0.5	12,7000
1/64	0.015625	0,3969	33/64	0.515625	13,0969
1/32	0.03125	0,7938	17/32	0.53125	13,4938
3/64	0.046875	1,1906	35/64	0.546875	13,8906
1/16	0.0625	1,5875	9/16	0.5625	14,2875
5/64	0.078125	1,9844	37/64	0.578125	14,6844
3/32	0.09375	2,3812	19/32	0.59375	15,0812
7/64	0.109375	2,7781	39/64	0.609375	15,4781
1/8	0.125	3,1750	5/8	0.625	15,8750
9/64	0.140625	3,5719	41/64	0.640625	16,2719
5/32	0.15625	3,9688	21/32	0.65625	16,6688
11/64	0.171875	4,3656	43/64	0.671875	17,0656
3/16	0.1875	4,7625	11/16	0.6875	17,4625
13/64	0.203125	5,1594	45/64	0.703125	17,8594
7/32	0.21875	5,5562	23/32	0.71875	18,2562
15/64	0.234375	5,9531	47/64	0.734375	18,6531
1/4	0.25	6,3500	3/4	0.75	19,0500
17/64	0.265625	6,7469	49/64	0.765625	19,4469
9/32	0.28125	7,1438	25/32	0.78125	19,8438
19/64	0.296875	7,5406	51/64	0.796875	20,2406
5/16	0.3125	7,9375	13/16	0.8125	20,6375
21/64	0.328125	8,3344	53/64	0.828125	21,0344
11/32	0.34375	8,7312	27/32	0.84375	21,4312
23/64	0.359375	9,1281	55/64	0.859375	21,8281
3/8	0.375	9,5250	7/8	0.875	22,2250
25/64	0.390625	9,9219	57/64	0.890625	22,6219
13/32	0.40625	10,3188	29/32	0.90625	23,0188
27/64	0.421875	10,7156	59/64	0.921875	23,4156
7/16	0.4375	11,1125	15/16	0.9375	23,8125
29/64	0.453125	11,5094	61/64	0.953125	24,2094
15/32	0.46875	11,9062	31/32	0.96875	24,6062
31/64	0.484375	12,3031	63/64	0.984375	25,0031
			1	1	25,4000

mm

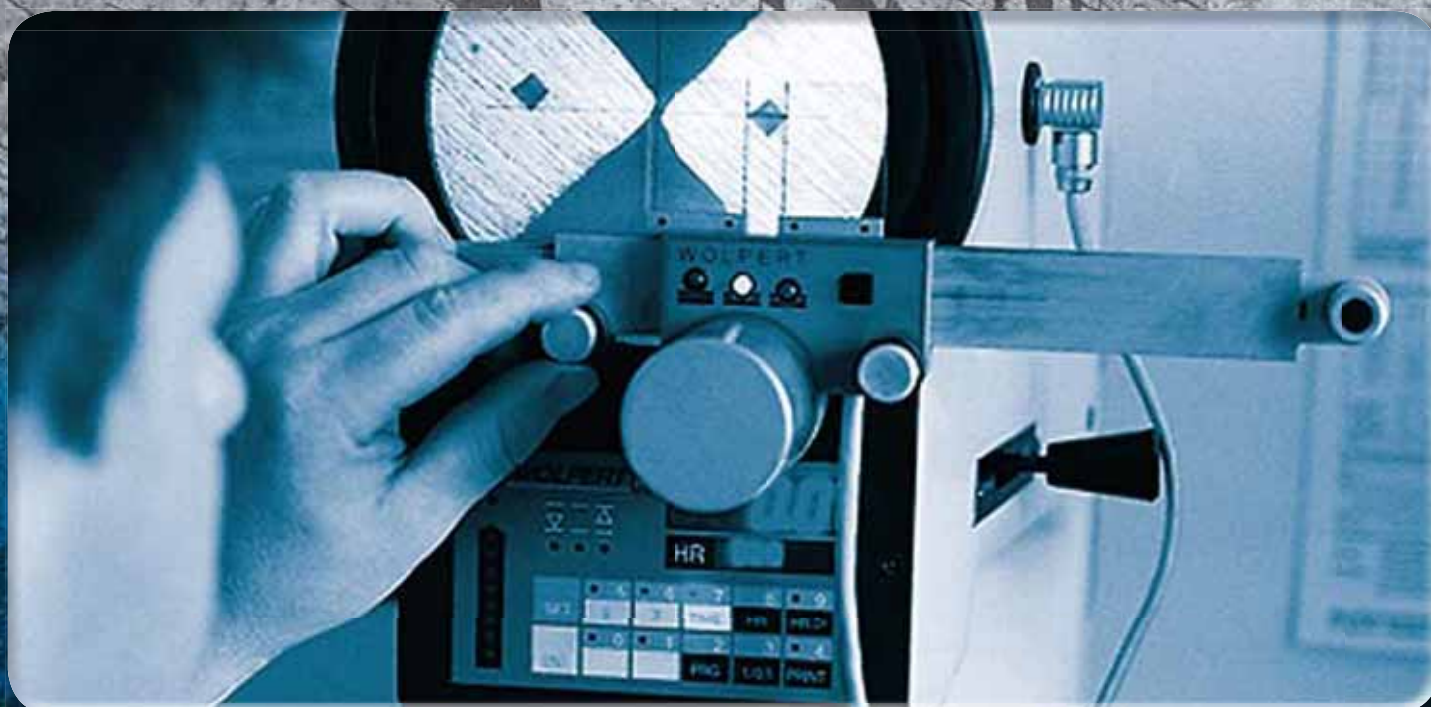


Nominal size/s in mm	Tolerance class 1 as per ISO 691 dimensions		Tolerance class 2 ^a as per ISO 691 dimensions	
	min.	max.	min.	max.
2 ≤ s < 3	+ 0,02	+ 0,08	+ 0,02	+ 0,12
3 ≤ s < 4	+ 0,02	+ 0,10	+ 0,02	+ 0,14
4 ≤ s < 6	+ 0,02	+ 0,12	+ 0,02	+ 0,16
6 ≤ s < 10	+ 0,03	+ 0,15	+ 0,03	+ 0,19
10 ≤ s < 12	+ 0,04	+ 0,19	+ 0,04	+ 0,24
12 ≤ s < 14	+ 0,04	+ 0,24	+ 0,04	+ 0,30
14 ≤ s < 17	+ 0,05	+ 0,27	+ 0,05	+ 0,35
17 ≤ s < 19	+ 0,05	+ 0,30	+ 0,05	+ 0,40
19 ≤ s < 26	+ 0,06	+ 0,36	+ 0,06	+ 0,46
26 ≤ s < 33	+ 0,08	+ 0,48	+ 0,08	+ 0,58
33 ≤ s < 55	+ 0,10	+ 0,60	+ 0,10	+ 0,70
55 ≤ s < 75	+ 0,12	+ 0,72	+ 0,12	+ 0,92
75 ≤ s < 105	+ 0,15	+ 0,85	+ 0,15	+ 1,15
105 ≤ s < 150	+ 0,20	+ 1,00	+ 0,20	+ 1,40
150 ≤ s < 210	+ 0,25	+ 1,25	-	-

^a This tolerance class applies only to ring spanners that have not been manufactured by material removal.

Spanner sizes in accordance with this international standard must be marked with:

- Spanner head size
- Reference to the international standard, i.e. ISO 691
- Nominal size s in millimetres
- Tolerance class 1 or 2



TORQUE CONVERSION TABLES

Torque conversion factors

Units to be	= mN-m	= cN-m	= N-m	= ozf-in	= lbf-in	= lbf-ft	= gf-cm	= kgf-cm (kp-cm)	= kgf-m (kp-m)
1 mN-m	1	0,1	0,001	0,142	0,009	0,0007	10,2	0,01	0,0001
1 cN-m	10	1	0,01	1,416	0,088	0,007	102	0,102	0,001
1 N-m	1000	100	1	141,6	8,851	0,738	10197	10,2	0,102
1 ozf-in	7,062	0,706	0,007	1	0,0625	0,005	72	0,072	0,0007
1 lbf-in	113	11,3	0,113	16	1	0,083	1152,1	1,152	0,0115
→ 1 lbf-ft	1356	<u>135,6</u>	1,356	192	12	1	13826	13,83	0,138
1 gf-cm	0,098	0,01	0,0001	0,014	0,0009	0,00007	1	0,001	0,00001
1 kgf-cm (kp-cm)	98,07	9,807	0,098	13,89	0,868	0,072	1000	1	0,01
1 kgf-m (kp-m)	9807	980,7	9,807	1389	86,8	7,233	100000	100	1

APPLICATION

Conversion formula:

Units to be converted x factor = corresponding unit

Example:

Convert of 5 lbf-ft in cN-m

Solution:

5 x 135,6 = 678 cN-m

Conversion from N-m in kgf-m (kp-m)								1N-m = 0,102 kgf-m		
N-m	0	1	2	3	4	5	6	7	8	9
0	0,00	0,10	0,20	0,31	0,41	0,51	0,61	0,71	0,82	0,92
10	1,02	1,12	1,22	1,33	1,43	1,53	1,63	1,73	1,84	1,94
20	2,04	2,14	2,24	2,35	2,45	2,55	2,65	2,75	2,86	2,96
30	3,06	3,16	3,26	3,37	3,47	3,57	3,67	3,77	3,87	3,98
40	4,08	4,18	4,28	4,38	4,49	4,59	4,69	4,79	4,89	5,00
50	5,10	5,20	5,30	5,40	5,51	5,61	5,71	5,81	5,91	6,02
60	6,12	6,22	6,32	6,42	6,53	6,63	6,73	6,83	6,93	7,04
70	7,14	7,24	7,34	7,44	7,55	7,65	7,75	7,85	7,95	8,06
80	8,16	8,26	8,36	8,46	8,57	8,67	8,77	8,87	8,97	9,08
90	9,18	9,28	9,38	9,48	9,59	9,69	9,79	9,89	9,99	10,10
100	10,20	10,30	10,40	10,50	10,60	10,71	10,81	10,91	11,01	11,11

Conversion from kgf·m(kp·m) in N·m						1 kgf·m (kp·m) = 9,807 N·m				
kgf·m(kp·m)	0	1	2	3	4	5	6	7	8	9
0	0,00	9,81	19,61	29,42	39,23	49,03	58,84	68,65	78,45	88,26
10	98,07	107,87	117,68	127,49	137,29	147,10	156,91	166,71	176,52	186,33
20	196,13	205,94	215,75	225,55	235,36	245,17	254,97	264,78	274,59	284,39
30	294,20	304,01	313,81	323,62	333,43	343,23	353,04	362,85	372,65	382,46
40	392,27	402,07	411,88	421,69	431,49	441,30	451,11	460,91	470,72	480,53
50	490,33	500,14	509,95	519,75	529,56	539,37	549,17	558,98	568,79	578,59
60	588,40	598,21	608,01	617,82	627,63	637,43	647,24	657,05	666,85	676,66
70	686,47	696,27	706,08	715,89	725,69	735,50	745,31	755,11	764,92	774,73
80	784,53	794,34	804,15	813,95	823,76	833,57	843,37	853,18	862,99	872,79
90	882,60	892,41	902,21	912,02	921,83	931,63	941,44	951,25	961,05	970,86
100	980,67	990,47	1000,28	1010,08	1019,89	1029,70	1039,50	1049,31	1059,12	1068,92

Conversion from N-m in lbf-ft								1N-m=0,7386 lbf-ft		
N-m	0	1	2	3	4	5	6	7	8	9
0	0,00	0,74	1,48	2,21	2,95	3,69	4,43	5,16	5,90	6,64
10	7,38	8,11	8,85	9,59	10,33	11,06	11,80	12,54	13,28	14,01
20	14,75	15,49	16,23	16,96	17,70	18,44	19,18	19,91	20,65	21,39
30	22,13	22,86	23,60	24,34	25,08	25,81	26,55	27,29	28,03	28,76
40	29,50	30,24	30,98	31,72	32,45	33,19	33,93	34,67	35,40	36,14
50	36,88	37,62	38,35	39,09	39,83	40,57	41,30	42,04	42,87	43,52
60	44,25	44,99	45,73	46,47	47,20	47,94	48,68	49,42	50,15	50,89
70	51,63	52,37	53,10	53,84	54,58	55,32	56,05	56,79	57,53	58,27
80	59,00	59,74	60,48	61,22	61,96	62,69	63,43	64,17	64,91	65,64
90	66,38	67,12	67,86	68,59	69,33	70,07	70,81	71,54	72,28	73,02
100	73,76	74,49	75,23	75,97	76,71	77,44	78,18	78,92	79,66	80,39

Conversion from lbf-ft in N-m								1 lbf-ft = 1,356 N-m		
lbf-ft	0	1	2	3	4	5	6	7	8	9
0	0,00	1,36	2,71	4,07	5,42	6,78	8,13	9,49	10,85	12,20
10	13,56	14,91	16,27	17,63	18,98	20,34	21,69	23,05	24,40	25,76
20	27,12	28,47	29,83	31,18	32,54	33,90	35,25	36,61	37,96	39,32
30	40,67	42,03	43,39	44,74	46,10	47,45	48,81	50,16	51,52	52,88
40	54,23	55,59	56,94	58,30	59,66	61,01	62,37	63,72	65,08	66,43
50	67,79	69,15	70,50	71,86	73,21	74,57	75,93	77,28	78,64	79,99
60	81,35	82,70	84,06	85,42	86,77	88,13	89,48	90,84	92,20	93,55
70	94,91	96,26	97,62	98,97	100,33	101,69	103,04	104,40	105,75	107,11
80	108,46	109,82	111,18	112,53	113,89	115,24	116,60	117,96	119,31	120,67
90	122,02	123,38	124,73	126,09	127,45	128,80	130,16	131,51	132,87	134,23
100	135,58	136,94	138,29	139,65	141,00	142,36	143,72	145,07	146,43	147,78

Conversion from N-m in lbf-in							1 N-m = 8,851 lbf-in			
N-m	0	1	2	3	4	5	6	7	8	9
0	0,00	8,85	17,70	26,55	35,40	44,25	53,10	61,96	70,81	79,66
10	88,51	97,36	106,21	115,06	123,91	132,76	141,61	150,46	159,31	168,16
20	177,02	185,87	194,72	203,57	212,42	221,27	230,12	238,97	247,82	256,67
30	265,52	274,37	283,22	292,08	300,93	309,78	318,63	327,48	336,33	345,18
40	354,03	362,88	371,73	380,58	389,43	398,28	407,14	415,99	424,84	433,69
50	442,54	451,39	460,24	469,09	477,94	486,79	495,64	504,49	513,34	522,20
60	531,05	539,90	548,75	557,60	566,45	575,30	584,15	593,00	601,85	610,70
70	619,55	628,40	637,26	646,11	654,96	663,81	672,66	681,51	690,36	699,21
80	708,06	716,91	725,76	734,61	743,46	752,32	761,17	770,02	778,87	787,72
90	796,57	805,42	814,27	823,12	831,97	840,82	849,67	858,52	867,38	876,23
100	885,08	893,93	902,78	911,63	920,48	929,33	938,18	947,03	955,88	964,73

Conversion from lbf-in in N-m								1 lbf-in = 0,113 N-m		
lbf-in	0	1	2	3	4	5	6	7	8	9
0	0,00	0,11	0,23	0,34	0,45	0,56	0,68	0,79	0,90	1,02
10	1,13	1,24	1,36	1,47	1,58	1,69	1,81	1,92	2,03	2,15
20	2,26	2,37	2,49	2,60	2,71	2,82	2,94	3,05	3,16	3,28
30	3,39	3,50	3,62	3,73	3,84	3,95	4,07	4,18	4,29	4,41
40	4,52	4,63	4,75	4,86	4,97	5,08	5,20	5,31	5,42	5,54
50	5,65	5,76	5,87	5,99	6,10	6,21	6,33	6,44	6,55	6,67
60	6,78	6,89	7,00	7,12	7,23	7,34	7,46	7,57	7,68	7,80
70	7,91	8,02	8,13	8,25	8,36	8,47	8,59	8,70	8,81	8,93
80	9,04	9,15	9,26	9,38	9,49	9,60	9,72	9,83	9,94	10,06
90	10,17	10,28	10,39	10,51	10,62	10,73	10,85	10,96	11,07	11,19
100	11,30	11,41	11,52	11,64	11,75	11,86	11,98	12,09	12,20	12,31



Important prefix characters

Giga	G	1.000.000.000	= 10 ⁹
Mega	M	1.000.000	= 10 ⁶
Kilo	k	1.000	= 10 ³
Hecto	H	100	= 10 ²
Deca	Da	10	= 10 ¹
Deci	d	0,1	= 10 ⁻¹
Centi	c	0,01	= 10 ⁻²
Milli	m	0,001	= 10 ⁻³
Micro	μ	0,000001	= 10 ⁻⁶
Nano	n	0,000000001	= 10 ⁻⁹

Important SI units with conversions to old but still commonly used units

Length	metre	m		
Masa	kilogramme	kg		
Time	second	s		
Force	newton	N	= kg m/s ²	1 N = 0,102 kp
Torque	newton metre	N·m		9,81 N·m = 1 kp·m
Energy (work)	joule	J	= N·m	
Heat quantity	joule	J		1 J = 0,239 cal
Power	watt	W	= N·m/s	1 kW = 1,36 PS = 860 kcal/h
Pressure	pascal	Pa	= N/m ²	100 000 Pa = 1 bar = 10 mWS
Electrical current	ampere	A		
Temperature	kelvin	K		1 K = 1 °C

Conversion table, mass and weight

1 megagramme (Mg)	= 1.000 kg	= 10.000 hg	= 100.000 dag	= 1.000.000 g
1 ton (to.)	= 1.000 kg			
1 kilogramme (kg)		= 10 hg	= 100 dag	= 1000 g
1 hectogramme (hg)			= 10 dag	= 100 g
1 decagramme (dag)				= 10 g
1 gramme (g)	= 10 dg	= 100 cg	= 1000 mg	
1 decigramme (dg)		= 10 cg	= 100 mg	
1 centigramme (cg)			= 10 mg	
1 miligramme (mg)			= 1 mg	

Conversion table, force and torque

1 newton (N)	= 0,102 kp
1 kilopond (kp)*	= 9,81 N
1 kilopond metre (kp·m)*	= 9,81 N·m

* Statutory unit in the Federal Republic of Germany until 1977

Material properties

	Density g/cm ³	Expansion 1/°C	Melting point °C	Modulus of elasticity N/mm
Aluminium	2,7	0,000024	660,1	72 000
Lead	11,3	0,000029	327,3	16 000
Iron (steel)	7,86	0,000012	1540	210 000
Gold	19,3	0,000014	1063	79 000
Copper	8,9	0,000017	1083	126 000
Zinc	7,1	0,000026	419	94 000
Glass	2,2–2,9	0,000008	800–1500	68 000
Air	0,0013	0,0036		
Wood	0,5–0,7			10 000
Plastics/synthetic materials:				
PS	1,05	0,00008		3 400
PP	0,9	0,00018		1 200
ABS	1,05	0,00010		2 500

EXAMPLES

Example 1: Expansion of a steel body of 100 mm in length at a temperature of 10 °C. Length y expansion coefficient
 $x \text{ °C exp.} = 100 \text{ mm} \times 0,000012 \times 10 = 0,012 \text{ mm} = 12 \text{ μm}$

Example 2: Elastic expansion $e = s/E$.

A body of 100 mm in length made of ABS is stretched with $s = 50 \text{ N/mm}^2$; $e = 50 \text{ N/mm}^2 : 2500 \text{ N/mm}^2 = 0,02$.
The expansion is: $100 \text{ mm} \times 0,02 = 2 \text{ mm}$.

Example 3: Two steel plates with a total thickness of 20 mm are pre-stressed by means of a screw connection of $s = 50 \text{ N/mm}^2$; $e = 50 : 210000 = 0,00024$.
The compression in the surrounding area of the screw is $20 \text{ mm} \times 0,00024 = 0,0048 \text{ mm} = 5 \text{ μm}$.

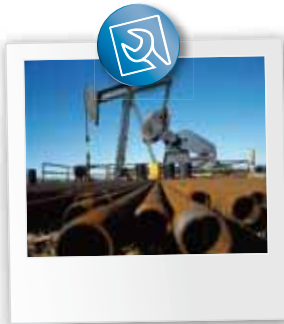
The elastic compression induces a continuous pre-tension of the screw connection. A properly tensed screw connection is selfinhibiting.

COMPARISON TABLE OF VICKERS-BRINELL-ROCKWELL HARDNESS AND TENSILE STRENGTH

Vickers hardness HV 30	Brinell hardness HB 30	Rockwell hardness HRB	Rockwell hardness HRC	Tensile strength sB N/mm ²
80	80,7	36,4	–	270
85	85	42,4	–	290
90	90	47,4	–	310
95	95	52,0	–	320
100	100	56,4	–	340
105	105	60,0	–	360
110	110	63,4	–	380
115	115	66,4	–	390
120	120	69,4	–	410
125	125	72,0	–	420
130	130	74,4	–	440
135	135	76,4	–	460
140	140	78,4	–	470
145	145	80,4	–	490
150	150	82,2	–	500
155	155	83,8	–	520
160	160	85,4	–	540
165	165	86,8	–	550
170	170	88,2	–	570
175	175	89,6	–	590
180	180	90,8	–	600
185	185	91,8	–	620
190	190	91,5	–	640
195	195	94,0	–	660
200	200	95,0	–	670
205	205	95,8	–	680
210	210	96,6	–	710
215	215	97,4	–	720
220	220	98,2	–	730
225	225	99,0	–	750
230	230	–	19,2	760
235	235	–	20,2	780
240	240	–	21,2	800
245	245	–	22,1	820
250	250	–	23,0	830
255	255	–	23,8	850
260	260	–	24,6	870
265	265	–	25,4	880
270	270	–	26,9	900
275	275	–	27,1	920
280	280	–	27,6	940
285	285	–	28,3	950
290	290	–	29,0	970
295	295	–	29,6	990
300	300	–	30,3	1010
310	310	–	31,5	1040
320	320	–	32,7	1080
330	330	–	33,8	1110
340	340	–	34,9	1140
350	350	–	36,0	1170
360	359	–	37,0	1200
370	368	–	38,0	1230
380	376	–	38,9	1260
390	385	–	39,8	1290
400	392	–	40,7	1320
410	400	–	41,5	1350
420	408	–	42,4	1380
430	415	–	43,2	1410
440	423	–	44,0	1430
450	430	–	44,8	1460
460	–	–	45,6	(1490)
470	–	–	46,3	(1520)
480	–	–	47,0	(1550)
490	–	–	47,7	(1580)
500	–	–	48,3	(1600)
510	–	–	49,1	(1630)
520	–	–	49,7	(1660)
530	–	–	50,4	(1690)
540	–	–	51,0	(1710)
550	–	–	51,6	(1740)
560	–	–	52,2	(1770)
570	–	–	52,8	(1790)
580	–	–	53,3	(1820)
590	–	–	53,9	(1850)
600	–	–	54,4	(1870)
610	–	–	55,0	(1900)
620	–	–	55,5	(1930)
630	–	–	56,0	(1950)
640	–	–	56,5	(1980)
650	–	–	57,0	(2000)
660	–	–	57,5	(2030)
670	–	–	58,0	(2050)
680	–	–	58,5	(2080)
690	–	–	59,0	(2110)
700	–	–	59,5	(2130)
720	–	–	60,4	(2170)
740	–	–	61,2	(2220)
760	–	–	62,0	(2260)
780	–	–	62,8	(2300)
800	–	–	63,6	–
820	–	–	64,3	–
840	–	–	65,0	–
860	–	–	65,7	–
880	–	–	66,3	–
900	–	–	66,9	–
920	–	–	67,5	–
940	–	–	68,0	–



GUIDELINE VALUES FOR THE COEFFICIENT OF FRICTION μ



Screw thread			blackened or Zinc-phosphate			Steel		
						pressed rolled	rolled cut	sharpened
Nut thread								
Steel	ground	Zn-phosphat.	Slightly oiled	0,14	0,10	0,16	0,10	0,10
	sharpened			0,16	0,10	0,16	0,10	0,10
	ground sharpened			0,14	0,10			
	turned sharpened			0,10				
	turned sharpened			0,10	0,10		0,10	0,10
	cadmium-plated	6 μ	Dry				0,14	
	zinc-plated							0,10
	cadmium-plated			0,10	0,10		0,14	
	zinc-plated			0,10	0,10			0,14

Choosing the right friction value

In order to exactly define the pre-tension force and the tightening torque, it is essential to know the coefficient friction.

However, it would seem almost impossible to specify definite values for the coefficients of friction for the large variety of possible surface and lubrication conditions and above all for their variance.

Added to this are the variances of the various different tightening methods which also constitute a greater or lesser factor of uncertainty. For this reason, it is only possible to make recommendations on the choice of the coefficient of friction. 80% of the tightening-torque values apply for countersunk head screws on account of the remaining base thickness.

Guideline values for the coefficient of friction μ

In order to exactly define the pre-tension force and the tightening torque, it is essential to know the coefficient of friction. However, it would seem almost impossible to specify definite values for the coefficients of friction for the large variety of possible surface and lubrication conditions and above all for their variance.

The following circumstances influence the friction value:

The surfaces and the nature of the materials being screwed, the method of lubrication, the sliding path due to the flexibility and the tightening method, i.e. the number and the speed of the tightening cycles and finally the tightening path – the so-called hard or soft screw case. The sum total of these items represents a greater or lesser factor of uncertainty. Even DIN-equivalent screws can differ considerably in their friction value because of being delivered by different suppliers, depending on the screw lot and depending on their storage and, in particular, on the oiling or greasing performed in the course of installation. Please note that around 80 to 90% of the tightening torque in most tightening procedures is required for overcoming the friction in the screw.

Important remark:

For this reason, it is only possible to give recommendations on the choice of the friction value. We point out explicitly that the following tables only contain guideline values. In all cases, a detailed screw calculation is more reliable than these tables! That applies particularly for parts which are relevant to safety, are subject to official regulations or perform sealing functions. The tables should only be utilised where the manufacturer of the screws or elements being connected has made no specifications on the required tightening torques.





FRICION VALUE μ_{ges} 0,10 AND 0,14

Friction value μ_{ges} 0,10		Shank screws with metric ISO-medium threads in accordance with DIN 13 Part 12 (selection)													
μ_{ges} 0,10	P mm	4.6		5.6		6.8		8.8		10.9		12.9			
		Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m		
M 2	0,4	367	0,108	459	0,135	734	0,216	979	0,288	1.376	0,405	1.651	0,486		
M 2,5	0,45	610	0,221	763	0,276	1.221	0,441	1.628	0,588	2.289	0,827	2.747	0,993		
M 3	0,5	915	0,392	1.144	0,491	1.830	0,785	2.441	1,047	3.432	1,472	4.118	1,766		
M 3,5	0,6	1.228	0,617	1.535	0,771	2.456	1,234	3.274	1,645	4.605	2,313	5.526	2,776		
M 4	0,7	1.587	0,914	1.983	1,142	3.173	1,827	4.231	2,436	5.950	3,426	7.139	4,111		
M 4,5	0,75	2.059	1,325	2.574	1,656	4.118	2,649	5.491	3,532	7.722	4,967	9.266	5,961		
M 5	0,8	2.593	1,843	3.242	2,304	5.187	3,686	6.915	4,915	9.725	6,912	11.670	8,294		
M 6	1	3.661	3,140	4.576	3,925	7.322	6,280	9.762	8,373	13.728	11,775	16.473	14,130		
M 8	1,25	6.713	7,609	8.391	9,511	13.426	15,218	17.901	20,291	25.173	28,534	30.208	34,240		
M 10	1,5	10.683	15,06	13.354	18,82	21.366	30,11	28.488	40,15	40.061	56,46	48.073	67,75		
M 12	1,75	15.571	26,24	19.463	32,80	31.142	52,48	41.522	69,97	58.390	98,39	70.068	118,07		
M 14	2	21.377	41,92	26.721	52,40	42.753	83,83	57.004	111,78	80.162	157,19	96.195	188,62		
M 16	2	29.373	64,80	36.717	81,01	58.747	129,61	78.329	172,81	110.150	243,02	132.180	291,62		
M 18	2,5	35.742	89,80	44.678	112,25	71.484	179,60	95.312	239,46	134.033	336,75	160.840	404,09		
M 20	2,5	45.896	126,57	57.370	158,21	91.792	253,14	122.389	337,52	172.109	474,64	206.531	569,57		
M 22	2,5	57.312	172,1	71.640	215,1	114.623	344,2	152.831	459,0	214.919	645,4	257.902	774,5		
M 24	3	66.090	218,7	82.612	273,4	132.180	437,4	176.240	583,2	247.837	820,2	297.405	984,2		
M 27	3	86.922	319,7	108.653	399,6	173.845	639,3	231.793	852,4	325.959	1.198,7	391.150	1.438,4		
M 30	3,5	105.686	434,0	132.107	542,5	211.371	868,0	281.828	1.157,3	396.321	1.627,4	475.585	1.952,9		
M 33	3,5	131.646	589,0	164.557	736,3	263.292	1.178,1	351.056	1.570,8	493.672	2.208,9	592.407	2.650,7		
M 36	4	154.529	757,7	193.161	947,1	309.057	1.515,4	412.076	2.020,5	579.482	2.841,4	695.379	3.409,6		
M 39	4	185.617	978	232.021	1.223	371.233	1.957	494.978	2.609	696.062	3.669	835.275	4.403		
M 42	4,5	212.619	1.212	265.774	1.515	425.238	2.424	566.983	3.232	797.321	4.545	956.785	5.454		
M 45	4,5	248.834	1.510	311.043	1.888	497.669	3.020	663.559	4.027	933.129	5.663	1.119.755	6.795		
M 48	5	279.956	1.819	349.945	2.274	559.912	3.638	746.550	4.850	1.049.836	6.821	1.259.803	8.185		
M 52	5	335.711	2.346	419.639	2.932	671.422	4.692	895.229	6.256	1.258.916	8.797	1.510.700	10.557		
M 56	5,5	387.206	2.919	484.007	3.649	774.412	5.839	1.032.549	7.785	1.452.022	10.948	1.742.427	13.137		
M 60	5,5	452.319	3.632	565.399	4.540	904.639	7.265	1.206.185	9.686	1.696.198	13.621	2.035.438	16.345		
M 64	6	511.800	4.392	639.751	5.490	1.023.601	8.784	1.364.801	11.713	1.919.252	16.471	2.303.102	19.765		
M 68	6	586.272	5.319	732.840	6.649	1.172.545	10.638	1.563.393	14.184	2.198.521	19.947	2.638.225	23.936		
Shank screws with metric ISO-fine-pitch thread in accordance with DIN 13 Part 12 (selection)															
M 8	1	7.343	8,10	9.179	10,13	14.687	16,20	19.582	21,60	27.537	30,38	33.045	36,45		
M 10	1	12.288	16,57	15.360	20,71	24.576	33,14	32.768	44,19	46.080	62,14	55.297	74,57		
M 12	1,5	16.522	27,34	20.653	34,17	33.045	54,68	44.060	72,91	61.959	102,52	74.351	123,03		
M 14	1,5	23.624	44,89	29.530	56,11	47.249	89,78	62.998	119,70	88.591	168,33	106.309	202,00		
M 16	1,5	31.988	68,63	39.984	85,79	63.975	137,26	85.300	183,01	119.953	257,36	143.944	308,83		
M 18	1,5	41.612	99,49	52.015	124,36	83.223	198,98	110.965	265,30	156.044	373,08	187.253	447,70		
M 20	1,5	52.497	138,4	65.621	173,0	104.993	276,8	139.991	369,1	196.862	519,0	236.235	622,8		
M 22	1,5	64.642	186,3	80.803	232,8	129.284	372,6	172.379	496,7	242.408	698,5	290.890	838,3		
M 24	1,5	78.048	244,1	97.560	305,1	156.096	488,1	208.129	650,8	292.681	915,2	351.217	1.098,3		
Friction value μ_{ges} 0,14		Shank screws with metric ISO-medium threads in accordance with DIN 13 Part 12 (selection)													
μ_{ges} 0,14	P mm	4.6		5.6		6.8		8.8		10.9		12.9			
		Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m		
M 2	0,4	338	0,130	422	0,163	675	0,261	901	0,348	1.267	0,489	1.520	0,587		
M 2,5	0,45	563	0,269	703	0,336	1.125	0,537	1.500	0,716	2.110	1,007	2.532	1,209		
M 3	0,5	845	0,480	1.056	0,600	1.689	0,961	2.253	1,281	3.168	1,801	3.801	2,161		
M 3,5	0,6	1.133	0,754	1.416	0,942	2.266	1,507	3.021	2,009	4.248	2,826	5.098	3,391		
M 4	0,7	1.463	1,115	1.829	1,393	2.927	2,229	3.902	2,972	5.487	4,180	6.585	5,016		
M 4,5	0,75	1.901	1,621	2.376	2,026	3.801	3,242	5.068	4,323	7.127	6,079	8.553	7,295		
M 5	0,8	2.395	2,261	2.994	2,827	4.790	4,523	6.387	6,030	8.982	8,480	10.778	10,176		
M 6	1	3.379	3,843	4.224	4,803	6.758	7,685	9.011	10,247	12.671	14,410	15.205	17,292		
M 8	1,25	6.202	9,349	7.753	11,686	12.404	18,698	16.539	24,931	23.258	35,059	27.909	42,070		
M 10	1,5	9.876	18,54	12.345	23,18	19.752	37,09	26.336	49,45	37.034	69,54	44.441	83,44		
M 12	1,75	14.400	32,37	18.000	40,46	28.801	64,74	38.401	86,32	54.001	121,38	64.801	145,66		
M 14	2	19.775	51,77	24.719	64,71	39.551	103,54	52.734	138,06	74.158	194,14	88.989	232,97		
M 16	2	27.221	80,62	34.027	100,77	54.443	161,24	72.591	214,98	102.080	302,32	122.497	362,78		
M 18	2,5	33.078	111,09	41.347	138,86	66.155	222,17	88.207	296,23	124.041	416,58	148.850	499,89		
M 20	2,5	42.534	157,46	53.167	196,82	85.067	314,91	113.423	419,88	159.501	590,46	191.401	708,55		
M 22	2,5	53.175	215,1	66.469	268,9	106.350	430,2	141.800	573,7	199.406	806,7	239.288	968,0		
M 24	3	61.248	272,1	76.560	340,1	122.497	544,2	163.329	725,6	229.681	1.020,3	275.617	1.224,4		
M 27	3	80.670	399,9	100.837	499,9	161.339	799,9	215.119	1.066,5	302.512	1.499,7	363.014	1.799,7		
M 30	3,5	98.027	541,7	122.533	677,2	196.054	1.083,4	261.405	1.444,6	367.600	2.031,5	441.120	2.437,7		
M 33	3,5	122.241	738,5	152.801	923,2	244.482	1.477,1	325.976	1.969,4	458.404	2.769,5	550.084	3.323,4		
M 36	4	143.413	948,0	179.266	1.185,0	286.826	1.896,0	382.434	2.528,0	537.798	3.555,0	645.358	4.265,9		
M 39	4	172.420	1.229	215.525	1.536	344.839	2.457	459.786	3.276	646.574	4.607	775.888	5.529		
M 42	4,5	197.407	1.519	246.758	1.899	394.813	3.038	526.417	4.050	740.275	5.696	888.329	6.835		
M 45	4,5	231.206	1.898	289.007	2.373	462.412	3.796	616.549	5.062	867.022	7.118	1.040.426	8.541		
M 48	5	260.008	2.282	325.010	2.853	520.015	4.565	693.354	6.086	975.029	8.559	1.170.035	10.211		
M 52	5	312.056	2.954	390.070	3.692	624.112	5.907	832.149	7.876	1.170.209	11.076	1.404.251	13.292		
M 56	5,5	359.843	3.672	449.804	4.591	719.686	7.345	959.581	9.793	1.349.411	13.772	1.619.293	16.526		
M 60	5,5	420.651	4.582	525.813	5.728	841.301	9.164	1.121.735	12.219	1.577.440	17.183	1.892.928	20.619		
M 64	6	475.860	5.536	594.825	6.920	951.720	11.071	1.268.960	14.762	1.784.476	20.759	2.141.371	24.911		

FRICION VALUE μ_{ges} 0,16

Shank screws with metric ISO medium threads in accordance with DIN 13 Part 12 (selection)													
Friction value μ_{ges} 0,16													
μ_{ges} 0,16	P mm	4.6		5.6		6.8		8.8		10.9		12.9	
		Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m	Fsp N	M _A N-m
M 2	0,4	324	0,140	405	0,175	647	0,280	863	0,373	1.214	0,525	1.456	0,630
M 2,5	0,45	539	0,289	674	0,361	1.079	0,578	1.439	0,770	2.023	1,083	2.428	1,300
M 3	0,5	810	0,517	1.013	0,647	1.620	1,035	2.161	1,380	3.038	1,940	3.646	2,328
M 3,5	0,6	1.086	0,811	1.358	1,014	2.173	1,622	2.897	2,163	4.074	3,042	4.889	3,650
M 4	0,7	1.403	1,199	1.754	1,499	2.806	2,398	3.742	3,198	5.262	4,497	6.314	5,396
M 4,5	0,75	1.823	1,746	2.279	2,182	3.646	3,492	4.861	4,656	6.836	6,547	8.204	7,857
M 5	0,8	2.298	2,438	2.872	3,047	4.596	4,875	6.127	6,500	8.617	9,141	10.340	10,969
M 6	1	3.241	4,139	4.051	5,173	6.482	8,277	8.643	11,036	12.154	15,520	14.584	18,623
M 8	1,25	5.951	10,083	7.438	12,603	11.901	20,165	15.868	26,887	22.315	37,809	26.778	45,371
M 10	1,5	9.477	20,01	11.847	25,02	18.955	40,03	25.273	53,37	35.540	75,05	42.648	90,06
M 12	1,75	13.821	34,96	17.277	43,69	27.642	69,91	36.857	93,22	51.830	131,08	62.195	157,30
M 14	2	18.982	55,93	23.728	69,91	37.964	111,86	50.619	149,15	71.183	209,74	85.419	251,69
M 16	2	26.145	87,30	32.682	109,13	52.291	174,61	69.721	232,81	98.045	327,39	117.654	392,87
M 18	2,5	31.755	120,08	39.694	150,10	63.510	240,15	84.680	320,20	119.081	450,29	142.897	540,34
M 20	2,5	40.852	170,52	51.065	213,14	81.704	341,03	108.939	454,71	153.195	639,43	183.834	767,32
M 22	2,5	51.093	233,3	63.867	291,7	102.187	466,6	136.249	622,2	191.600	875,0	229.921	1.050,0
M 24	3	58.827	294,7	73.534	368,3	117.654	589,3	156.872	785,7	220.601	1.104,9	264.721	1.325,9
M 27	3	77.519	433,9	96.899	542,4	155.038	867,9	206.717	1.157,2	290.696	1.627,2	348.835	1.952,7
M 30	3,5	94.179	587,3	117.724	734,2	188.358	1.174,6	251.144	1.566,2	353.172	2.202,5	423.806	2.642,9
M 33	3,5	117.488	801,9	146.860	1.002,3	234.977	1.603,8	313.302	2.138,3	440.581	3.007,0	528.697	3.608,5
M 36	4	137.811	1.028,6	172.264	1.285,7	275.623	2.057,2	367.497	2.742,9	516.793	3.857,2	620.152	4.628,6
M 39	4	165.738	1.335	207.172	1.668	331.475	2.669	441.967	3.559	621.516	5.005	745.819	6.006
M 42	4,5	189.724	1.649	237.155	2.061	379.448	3.298	505.930	4.397	711.465	6.183	853.758	7.420
M 45	4,5	222.267	2.063	277.834	2.578	444.534	4.125	592.712	5.500	833.501	7.735	1.000.201	9.282
M 48	5	249.916	2.479	312.395	3.099	499.833	4.958	666.444	6.610	937.186	9.296	1.124.624	11.155
M 52	5	300.035	3.212	375.043	4.014	600.069	6.423	800.093	8.564	1.125.130	12.043	1.350.156	14.452
M 56	5,5	345.954	3.992	432.442	4.990	691.908	7.984	922.544	10.645	1.297.327	14.969	1.556.793	17.963
M 60	5,5	404.516	4.985	505.645	6.232	809.031	9.970	1.078.709	13.294	1.516.934	18.695	1.820.321	22.433
M 64	6	457.571	6.021	571.964	7.526	915.142	12.042	1.220.189	16.056	1.715.891	22.579	2.059.069	27.095
M 68	6	524.576	7.315	655.720	9.143	1.049.152	14.629	1.398.869	19.506	1.967.160	27.430	2.360.592	32.916
Shank screws with metric ISO-fine-pitch thread in accordance with DIN 13 Part 12 (selection)													
M 8	1	6.536	10,91	8.170	13,64	13.073	21,83	17.430	29,10	24.511	40,92	29.413	49,11
M 10	1	10.976	22,64	13.720	28,29	21.952	45,27	29.270	60,36	41.161	84,88	49.393	101,86
M 12	1,5	14.707	36,83	18.383	46,04	29.413	73,66	39.218	98,22	55.150	138,12	66.180	165,74
M 14	1,5	21.080	61,07	26.351	76,34	42.161	122,14	56.214	162,86	79.052	229,02	94.862	274,82
M 16	1,5	28.598	94,08	35.748	117,60	57.196	188,16	76.262	250,88	107.243	352,80	128.692	423,35
M 18	1,5	37.260	137,20	46.575	171,50	74.519	274,40	99.359	365,87	139.724	514,51	167.669	617,41
M 20	1,5	47.065	191,8	58.831	239,7	94.130	383,6	125.506	511,4	176.494	719,2	211.792	863,0
M 22	1,5	58.014	259,2	72.517	324,0	116.027	518,4	154.703	691,2	217.551	971,9	261.062	1.166,3
M 24	1,5	70.106	340,7	87.632	425,9	140.212	681,5	186.949	908,6	262.897	1.277,7	315.477	1.533,3

Specifications given without warranty.

LEGEND

- μ_{ges} = Average friction value for thread and underhead seat
- P = Pitch of the thread
- F_{sp} = Axial pre-tension force in the screw for 90 % utilisation of the screw yield point (determined in accordance with the shape-changing-energy hypothesis)
- M_A = Tightening torque during installation

Important remarks:

Please make sure to read our information relating to the guideline values of the thread friction values on page 416. Taking into consideration the friction values, the above-specified table values only apply for headless screws (expanding screws generally require lower tightening values). The effective friction diameter in the screw underhead seat was defined as 1.3 x external thread diameter. For this reason, it is only possible to use them in the case of normal shank screws, generally hexagon-headed and cylindrical-head screws (e.g. DIN EN ISO 4014, 4017, 4764, DIN 7984). When screws of high strengths (8.8 to 12.9) and tensed parts made of „soft“ construction materials are used, a verification of the interfacial pressure under the screw head is strongly recommended.





The properties of screws and nuts are described with the aid of strength classes.

This is shown in the table below on the basis of 10 strength classes for which the properties such as tensile strength, hardness, yield point, elongation after fracture etc. are shown.

Section ISO 898-1	Mechanical and physical properties		Strength class											
			3.6	4.6	4.8	5.6	5.8	6.8	8.8	8.8	9.8	10.9	12.9	
									d ≤16 mm	1 2 d>16 mm 3				
5.1	Norm, tensile strength R _m , nominal	N/mm ²	300	400	400	500	500	600	800	800	900	1000	1200	
5.2	Norm, tensile strength R _m , min. 4 5	N/mm ²	330	400	420	500	520	600	800	830	900	1040	1220	
5.3	Vickers hardness HV F ≥ 98 N	min. max.	95	120	130	155	160	190	250	255	290	320	385	
			220 6	220 6	220 6	220 6	220 6	250	320	335	360	380	435	
5.4	Brinell hardness HB F = 30 D ²	min. max.	90	114	124	147	152	181	238	242	276	304	366	
					209 6			238	304	318	342	361	414	
5.5	Rockwell hardness HR	min. min. max. max.	HRB	52	67	71	79	82	89	—	—	—	—	
			HRC	—	—	—	—	—	—	22	23	28	32	39
			HRB	95,0 6	95,0 6	95,0 6	95,0 6	95,0 6	99,5	—	—	—	—	—
			HRC	—	—	—	—	—	—	32	34	37	39	44
5.6	Surface hardness HV 0,3	max.	—	—	—	—	—	—				7		
5.7	Lower yield point Rel 8 in N/mm ²	Nominal value min.	180	240	320	300	400	480	—	—	—	—	—	
			190	240	340	300	420	480	—	—	—	—	—	
5.8	0,2%-yield strength Rp0,2 9 in N/mm ² raised	Nominal value min.	—	—	—	—	—	—	640	640	720	900	1080	
			—	—	—	—	—	—	640	660	720	940	1100	
5.9	Wind-up force under test force	Sp/ReL Sp/Rp0,2 Sp	0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88	
			180	225	310	280	380	440	580	600	650	830	970	
5.10	Fracture torque M ₈	N·m min.	—	—	—	—	—	—	see ISO 898-7					
5.11	Elongation after fracture A in	% min.	25	22	—	20	—	—	12	12	10	9	8	
5.12	Fracture construction Z	% min.	—	—	—	—	—	—	52	52	48	48	44	
5.13	Strength under diagonal pull strain 5		The values under diagonal pull strain for whole screws (not pin screws) must not fall below the minimum tensile strengths stated in Section.											
5.14	Notched bar impact KU	J min.	—	—	—	25	—	—	30	30	25	20	15	
5.15	Notched impact strength		No fracture											
5.16	Minimum height of the non- decarbonised thread zone E		—	—	—	—	—	—	1/2 H _t	1/2 H _t	1/2 H _t	2/3 H _t	3/4 H _t	
	Maximum depth of decarburisation G	mm	—	—	—	—	—	—	0,015	0,015	0,015	0,015	0,015	
5.17	Hardness after tempering		—	—	—	—	—	—	Hardness drop max. 20 HV					
5.18	Surface condition		in accordance with ISO 6157-1 or ISO 6157-3, where applicable											

1 In the case of screws of the strength class 8.8 having a thread diameter $d \leq 16$ mm, an increased danger of scraping exists for nuts if the screw connection is tightened with a force exceeding the test force of the screw. It is recommended to comply with the standard ISO 898-2.

2 The strength class 9.8 only applies for nominal thread diameters ≤ 16 mm.

3 For steel screws, the limit is 12 mm.

4 The minimum tensile strengths apply for screws with nominal lengths $l \geq 2,5 d$. The minimum hardness values apply for screws with nominal length $l < 2,5 d$ and for those products which cannot be tested in a tensile test (e.g. on account of their head shape).

5 For tests on full screws, the fracture forces used to calculate R_m must concur with the properties of the screws at higher temperature.

6 A hardness value at the end of the screw is permitted to be 250 HV, 238 HB or 99,5 HRB at most.

7 The surface hardness on the relevant product must not exceed 30 Vickers points of the measured core hardness if both the surface hardness and the core hardness are determined with HV 0.3. For the strength class 10.9, a surface hardness of 390 HV must not be exceeded.

8 If the lower yield point ReL cannot be determined, the 0.2 % yield strength R_{p0,2}, lower, applies. For the strength classes 4.8, 5.8 and 6.8, the values for ReL are only specified as a calculation basis – they are not tested.

9 The yield point ratio corresponding to the description of the strength class and the minimum wind-up force on the 0.2 % yield strength R_{p0,2} both apply for machine-processed test pieces. When full screws are tested, these values vary on account of the effects of the manufacturing process and the size factors.

Excerpt from EN ISO 898-1

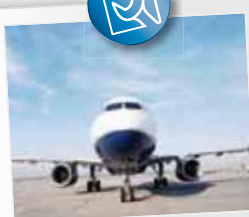


TIGHTENING TORQUES FOR THE WHEEL NUTS AND WHEEL SCREWS OF INDUSTRIAL VEHICLES, SERIAL WHEEL RIMS

Lorry (in the case of aluminium wheel rims, comply with the manufacturer's specifications!)

Vehicle manufacturer	Thread	Tightening value N-m Pin centring	Tightening value N-m Middle centring	Vehicle manufacturer	Thread	Tightening value N-m Pin centring	Tightening value N-m Middle centring
DAF	Sherpa 1,7-2,5; 400/500 Turbo F1100-F95		90	MITSUBISHI	L 300 2500 case	M 12 x 1,5	120 - 140
			176 - 203		L 300 1600 case	M 12 x 1,5	120 - 140
		M 18 x 1,5	216 - 270		Canter T 35		165 - 225
		M 20 x 1,5	297 - 351		Canter T 60		400 - 540
		M 22 x 1,5			Canter T 75		370 - 410
	F45 F45 F55 F65CF, F75CF, F85CF, F95CF	M 22 x 2	378 - 459	NEOPLAN		M 22 x 1,5	450
		M 18 x 1,5				M 20 x 1,5	360
		M 20 x 1,5		OPEL		7/16"	70
		M 20 x 1,5				18 mm	300
		M 22 x 1,5				7/8"	380
FAUN		M 18 x 1,5	290 - 320	PEUGEOT	All models		180
		M 20 x 1,5	370 - 400				
		M 22 x 1,5	430 - 460	RVI/RENAULT	S 100; S 110; S 130		320
FIAT	Transporter	M 20 x 1,5			S 150		400
		M 22 x 1,5			S 170		500
FORD					Master		160
		7/8" BSF	575 (SMMT-wheel)			M 22 x 1,5	500 ± 50
		M 22 x 1,5	575 without R. rear axle [R = Rockwell]	TATRA			480 ± 80
		M 22 x 1,5	575 with R. rear axle, 10 bolts	UNIMOG	407 V 600		290
			465 with R. rear axle, 8 bolts		417 V 900, 1150; 1250; 227 V 1200		320
IVECO MAGIRUS	65-75E, Euro Cargo 80-100E, 120-130E	M 18 x 1,5	335 - 410		427 V 1400, 1600		600
		M 20 x 1,5	440 - 540		2100, 437 V 1700		
				VOLVO	FL 6	M 18 x 1,5	375 ± 65
KÄSSBOHRER/SETRA		M 18 x 1,5	300		FL 6	M 20 x 1,5	525 ± 75
		M 20 x 1,5	400		Other models	M 22 x 1,5	670 ± 30
		M 22 x 1,5				7/8" - 14 UNF	670 ± 30
MAN		M 18 x 1,5		VW	LT 1997, Van Typ 2	M 14 x 1,5	180
		M 20 x 1,5	370 - 410		LT 28, 31	M 14 x 1,5	200
		M 22 x 1,5	450 - 500		LT 35, 40, 45, 50	M 18 x 1,5	360
					Caddy, Pick-up		110
MAZDA	E2000, 2200 B2500	M 12 x 1,25	90 - 120	TRAILER		M 14 x 1,5	110 - 120
		M 12 x 1,25	120 - 150			M 18 x 1,5	270
MERCEDES		M 14 x 1,5	170			M 20 x 1,5	350
		M 18 x 1,5	250			M 22 x 1,5	450 - 500
		M 20 x 1,5	300				600 - 650
		M 22 x 1,5	450				
			600				

Specifications given without warranty.





TIGHTENING TORQUES FOR WHEEL NUTS AND WHEEL SCREWS OF CARS AND ESTATE CARS

Cars (in the case of aluminium wheel rims, comply with the manufacturer's specifications!)

Vehicle manufacturer		Tightening torque value N·m	Vehicle manufacturer		Tightening torque value N·m	Vehicle manufacturer		Tightening torque value N·m
ALFA ROMEO	Alfa 33	88-108	ISUZU	Trooper (until 92)	80-118	NISSAN	Micra (1992-02)/X-Trail	98-117
	Alfa 145/146/147/Spider/GTV	83-103		Trooper (from 92)	118		Almera (2002-02)/Maxima	
	Alfa 155 (V6)	73-90		Campo (until 97)	78-98		(2000-02)/Serena (1996-02)	98-118
	Alfa 156	98		Campo (from 98)	82		Terrano II/Patrol GR/Pick-Up	118-147
	Alfa 164	95-105	JAGUAR	X-Type (2001-02)	68-92	OPEL	Agila	85
AUDI	Alfa 166	86		S-Type	128		Frontera-B (1999-02)	120
	A2/A3/S3/A4/A6/100/A8/S8/TT	120		XJ6	65-85		Other models	110
	Audi 80/Coupé/Cabriolet/Audi	200		XJR/XJ12	88-102	PEUGEOT	106/206/Estate	85
	Audi Quattro	110		XJ8/XJ-S	66-82		306	80
BMW	3 Serie/5 Serie	90-110	KIA	Pride/Mentor/Sephia/	88-118		307/406/605/607	90
	M5	100		Clarus/Carens			806/Expert	100
	Z3	100-110		Sedona/Sportage	88-108		Boxer	160-180
	X5	140		Besta	90-120	PORSCHE	All models	130
CHRYSLER	Neon (1994-99)/Stratus/	109-150	LADA	Samara/Riva	70-78	RENAULT	Twingo/Clio/Megane/	90
	Neon (1999-02)/PT Cruiser	115-155		Niva	88-91		Safrane/Kangoo	
	Voyager (1987-90)/Caravan	129	LANCIA	Other models	86		R5	80
	Voyager (2001-02)	110-135		Dedra/Kappa	98		Clio Sport/Scenix RX4	105
	Jeep Wrangler (1993-96)	102	LAND ROVER	Freelander	115		Laguna/Espace	100
	Jeep Wrangler (1996-02)	109-150		Discovery (bis 98)	100-120		Trafic (2000-02)	142
	Jeep Cherokee (1997-01)	115-150		Discovery (ab 98)	129		Master	155
CITROËN	Jeep Grand Cherokee (1997-01)	115-150		Range Rover (ab 94)	140	ROVER	Mini Cooper	57
	AX10/AX11/AX14/AX GT/AX	90	LEXUS	All models	103		25/45/MG	110
	GTI/AX Sport/ZK	85		Elise (lighthweight metal wheel rims)	90		75 Tourer/MG ZT-T	125
	Saxo/Xsara	90	LOTUS	Elan (lighthweight metal wheel rims)	80-88	SAAB	900 (1993-98)	90-110
	Xantia/XM	80-100		Excel (lighthweight metal wheel rims)	88		9000 (1989-97)	105-125
	C5	70		Esprit (lighthweight metal wheel rims)	100		9-3	110
	C15E	85	MAZDA	121 (from 1995)	85		9-5	120
DAEWOO	Berlingo	85		323 (from 1998)	90-117	SEAT	Arosa/Inca	110
	Dispatch	100		626 (from 1997)	80-115		Ibiza/Cordoba	110
	C25	180		Xedos 6 (from 1994)/			Toledo (1999-02)/Leon	120
	Matiz	90-110		MX-6 (from 1994)/			Alhambra	140
	Nexia/Lanos/Espero/Nubira	80	MERCEDES-BENZ	MVP (from 1999)	89-117	SKODA	Fabia/Octavia	120
	Leganza	100		Xedos 9	88-127		All models	78-98
	Tacuma	108		MX-5 (from 1998)	90-117	SUZUKI	Alto	70-100
FIAT	Musso/Korando/	80-120		Demio	87-117		Swift	80-80
	Cuore/Applause/YRV/Move/		MINI	Premacy	80-117		Liana/Ignis/Baleono/Wagon	
	Grand Move/Terios	88-118		Tribute	133		R/Super Carry (1999-02)	85
	Charade/Sirion/Hi-Jet	89-118		E-Series	90-120		Jimmy/Grand Vitara	95
	Sportrak	90-120	MITSUBISHI	Other models	110		Vitara	80-100
	Other models	86		S-Class (1998-02)/M-Class	150	TOYOTA	Yaris, Corolla, Carina,	
	Stilo/Croma/Coupé/	98		CL (1999-02)	150		Avensis, Camry, MR2, Paseo,	
FORD	Ulysee/Scudo	100		V-Class (1995-02)/Vito	175		Celica, Supra, Picnic, Previa,	
	Ducato/Talento	160		200GE/230GE	190		RAV4, 4 Runner	
	Ducato Maxi	180	MITSUBISHI	Sprinter (1995-02)	180 + 20		Landcruiser Colorado/Prado	
	KA/Mondeo (1996-00)/	85		MB 100D	140		(1996-02)	110
	Scorpio/Puma	70-100		508D/510	160-180		Landcruiser Amazon (1998-02)	209
	Fiesta (1990-93)	85		814 DA	250		Hi-Ace Power Van (1996-02)	102
	Fiesta (1994-02)/		VOLKSWAGEN	Mini One/Mini Cooper	90-110		Lupo, Caddy, Golf, Polo	
HONDA	Focus (1998-02)	100		Colt/Lancer (1996-02)/	98		Passat (1996-02), Beetle	
	Escort/Estate (1995-00)/Sierra	88-117		Galant (1997-02)	98		Sharan (2001-02)	170
	Probe	128		Carisma	117-137		Transporter (1996-02),	180
	Cougar	170	VOLVO	Eclipse (1996-02)	120-140		LT (1996-02)	
	Galaxy (2001-02)	133		3000 GT (1993-01)/L200	98		S40/V40 (1998-02), S70/V70	
	Maverick (2001-02)	135		Space Star	98-117		(1997-00), C70	110
	Explorer	75-95		Space Runner (1998-02)	98		S60 (2002-02), V70 (2000-02),	140
HYUNDAI	Transit 80/100 (1991-00)	155-180 (175)		Space Wagon (1998-02)	98		S80	
	Transit 130 (außer 1995)/150	200		Shogun Pinin	100-120			
	Transit (2002-02)	200		Shogun Pajero				
	All models	108-110						

10 N·m ≈ 1 kp·m

Specifications given without warranty.

Mounting wheels:

Using a torque wrench, lighten the wheel nuts and screws uniformly over the cross up to the specified torque. Without fail, check the torque following a travelling distance of approx. 50 km after the wheel is mounted and at regular intervals. If a wheel-specific general operating licence is the case, it must comply with the tightening torque specified here.

Use regulation-compliant wheel attachment elements

(Do not mix up spherical and conical, different lengths, parts for steel and lightweight-metal wheels etc.! Ensure sound strength quality!) Replace difficult-to-manipulate or corroded screws and nuts! Exercise caution with lubricants!

