MARYLAND METRICS
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faxes: (410) 358-3142 (800) 872-9329
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Maryland Metrics Metric Fastener Technical Information and Data -- Index

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Maryland Metrics
Metric Fastener Technical Information and Data
Section 2 Index

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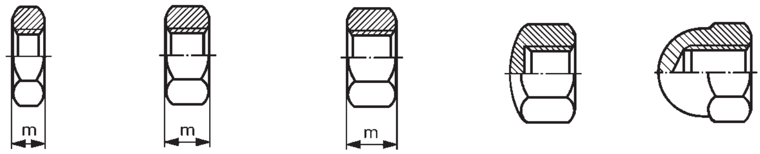
TECHNICAL INFORMATION and DATA

Weights in kg / 100 pieces

Nuts



m	0,5 d	0,8 d	1 d		
	DIN 439 B	DIN 934	VSM 13 756	DIN 917	DIN 1587
d M	ISO 4035	ISO 4032	ISO 4033		
1		0,0030			
1,2		0,0054			
1,4		0,0063			
1,6	0,0057	0,0074			
1,8	0,0067	0,0094			
2	0,111	0,0142	0,0178		
2,2	0,0136	0,0204	0,0251		
2,5	0,0192	0,0276	0,0346		
3	0,0254	0,0383	0,0480		0,0738
3,5	0,0327	0,0512	0,0642		
4	0,051	0,0808	0,101	0,131	0,157
5	0,077	0,123	0,154	0,220	0,251
6	0,148	0,249	0,324	0,429	0,466
8	0,326	0,534	0,658	0,950	1,150
10	0,717	1,160	1,480	1,930	2,010
12	1,020	1,700	2,220	2,550	2,830
14	1,580	2,490	2,950	3,700	4,150
16	2,030	3,320	4,090	4,810	5,430
18	2,920	4,900	6,040	7,000	9,500
20	3,960	6,380	7,590	9,410	10,400
22	5,190	7,830	10,000	11,900	12,900
24	6,840	10,900	13,200	16,500	21,600
27	9,630	16,400	19,400	22,900	
30	14,200	22,900	27,700	31,000	
33	17,500	28,700	35,400	41,800	
36	24,800	39,200	47,400	57,700	
39	30,400	49,900	61,300	75,200	
42	39,800	64,900			
45	48,300	79,600			
48	61,000	97,200			
52	73,600	119,000			
56	88,300	143,000			

Weights have been calculated for steel:
- Brass nuts weigh about 1,08 times these values
- Aluminium nuts weigh about 0,35 times these values
- Polyamid (nylon) nuts weigh about 0,15 times these values

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TECHNICAL INFORMATION and DATA

Hex head screws
fully threaded

Weights in kg / 100 pieces

Weights have been calculated for steel:
- Brass screws weigh about 1,08 times these values
- Aluminium screws weigh about 0,35 times these values
- Polyamid screws weigh about 0,15 times these values

ISO 4017 / DIN 933

L	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 39	M 42	M 45	M 48	L
5	0,063	0,131	0,213																			5
6	0,067	0,139	0,225	0,375																		6
8	0,076	0,154	0,250	0,410	0,880																	8
10	0,085	0,170	0,275	0,445	0,944	1,870																10
12	0,093	0,185	0,299	0,480	1,010	1,970	2,820															12
14	0,102	0,201	0,324	0,516	1,070	2,070	2,960	4,330														14
16	0,111	0,216	0,349	0,551	1,140	2,170	3,110	4,530	6,010													16
18	0,120	0,232	0,374	0,586	1,200	2,270	3,250	4,720	6,280	8,880												18
20	0,129	0,247	0,398	0,622	1,260	2,370	3,400	4,920	6,550	9,210	12,10											20
22	0,138	0,263	0,423	0,657	1,330	2,470	3,550	5,120	6,810	9,540	12,50	15,30										22
25	0,151	0,286	0,460	0,710	1,420	2,620	3,760	5,420	7,210	10,00	13,10	16,10	20,60									25
28	0,164	0,309	0,497	0,763	1,520	2,770	3,980	5,720	7,610	10,50	13,70	16,80	21,50	30,10								28
30	0,173	0,325	0,522	0,798	1,580	2,870	4,130	5,920	7,880	10,90	14,10	17,40	22,10	30,90	41,30							30
35	0,195	0,363	0,584	0,886	1,740	3,120	4,490	6,420	8,550	11,70	15,20	18,60	23,60	32,80	43,70	55,80	71,00					35
40	0,217	0,402	0,646	0,975	1,900	3,370	4,850	6,910	9,210	12,50	16,20	19,90	25,10	34,70	46,10	58,70	74,50	93,40	112,0			40
45		0,441	0,708	1,060	2,060	3,620	5,220	7,410	9,880	13,13	17,30	21,20	26,60	36,70	48,40	61,60	77,90	97,50	117,0	142,0		45
50		0,480	0,770	1,150	2,220	3,870	5,580	7,910	10,50	14,20	18,30	22,50	28,10	38,60	50,80	64,50	81,30	102,0	121,0	174,0	176,0	50
55		0,518	0,831	1,240	2,380	4,130	5,950	8,400	11,20	15,00	19,30	23,80	29,60	40,50	53,20	67,40	84,80	106,0	126,0	153,0	182,0	55
60		0,557	0,893	1,330	2,540	4,380	6,310	8,900	11,90	15,80	20,40	25,00	31,10	42,50	55,60	70,30	88,20	110,0	131,0	158,0	188,0	60
65		0,596	0,955	1,420	2,700	4,630	6,670	9,400	12,50	16,60	21,40	26,30	32,60	44,40	57,90	73,30	91,70	114,0	135,0	164,0	194,0	65
70		0,635	1,020	1,500	2,860	4,880	7,040	9,900	13,20	17,50	22,50	27,60	34,10	46,40	60,30	76,20	95,10	118,0	140,0	169,0	200,0	70
80		0,712	1,140	1,680	3,170	5,380	7,770	10,90	14,50	19,10	24,50	30,20	37,10	50,20	65,00	82,00	102,0	126,0	149,0	180,0	213,0	80
90			1,260	1,860	3,490	5,880	8,490	11,90	15,90	20,80	26,60	32,70	40,10	54,10	69,80	87,80	109,0	134,0	159,0	191,0	225,0	90
100				2,030	3,810	6,390	9,220	12,90	17,20	22,40	28,70	35,30	43,10	58,00	74,50	93,60	116,0	142,0	168,0	202,0	237,0	100
110					4,130	6,890	9,950	13,90	18,50	24,10	30,80	37,80	46,10	61.80	79,30	99,50	123,0	151,0	178,0	213,0	250,0	110
120					4,450	7,390	10,70	14,90	19,90	25,70	32,90	40,40	49,10	65,70	84,00	105,0	129,0	159,0	187,0	224,0	262,0	120
130					4,770	7,890	11,40	15,90	21,20	27,450	35,00	43,00	52,10	69,60	88,70	111,0	136,0	167,0	197,0	235,0	274,0	130
140						8,390	12,10	16,90	22,50	29,00	37,00	45,50	55,10	73,40	93,50	117,0	143,0	175,0	206,0	245,0	287,0	140

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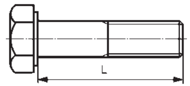
TECHNICAL INFORMATION and DATA

Hex head bolts
partially threaded

Weights in kg / 100 pieces



Weights have been calculated for steel:
– Brass bolts weigh about 1,08 times these values
– Aluminium bolts weigh about 0,35 times these values
– Polyamid (nylon) bolts weigh about 0,15 times these values

ISO 4014 / DIN 931

L	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 39	M 42	M 45	M 48	L
16	0,116	0,220																				16
18	0,127	0,240																				18
20	0,138	0,260	0,410																			20
22	0,149	0,280	0,441	0,675																		22
25	0,166	0,309	0,488	0,742																		25
28	0,182	0,339	0,534	0,808	1,560																	28
30	0,193	0,358	0,565	0,853	1,640																	30
35	0,221	0,408	0,642	0,964	1,840	3,220																35
40	0,249	0,457	0,719	1,070	2,040	3,530	5,020															40
45	0,277	0,506	0,796	1,190	2,230	3,840	5,460	7,640	10,10													45
50	0,304	0,556	0,873	1,300	2,430	4,150	5,900	8,250	10,80	14,40												50
55		0,605	0,950	1,410	2,630	4,460	6,350	8,885	11,60	15,40	19,70											55
60		0,654	1,030	1,520	2,830	4,760	6,790	9,460	12,40	16,40	20,90	25,50										60
65		0,704	1,100	1,630	3,020	5,070	7,230	10,10	13,20	17,40	22,20	26,90	33,20									65
70		0,753	1,180	1,740	3,220	5,380	7,680	10,70	14,00	18,40	23,40	28,40	35,00	47,00								70
80		0,852	1,340	1,960	3,620	6,000	8,570	11,90	15,60	20,40	25,90	31,40	38,50	51,50	66,20							80
90			1,490	2,180	4,010	6,610	9,450	13,10	17,20	22,40	28,30	34,40	42,10	56,00	71,70	89,40	110,0					90
100			1,640	2,410	4,400	7,230	10,30	14,30	18,70	24,40	30,80	37,40	45,60	60,50	77,30	96,10	118,0	144,0				100
110				2,630	4,800	7,850	11,20	15,50	20,30	26,40	33,30	40,40	49,20	65,00	82,80	103,0	126,0	154,0	181,0	215,0		110
120				2,850	5,190	8,460	12,10	16,70	21,90	28,40	35,70	43,40	52,70	69,50	88,40	110,0	134,0	163,0	192,0	227,0	265,0	120
130				3,040	5,540	9,010	12,90	17,80	23,30	30,20	38,00	46,10	56,00	73,60	93,40	116,0	141,0	172,0	202,0	239,0	278,0	130
140				3,270	5,940	9,630	13,80	19,00	24,90	32,20	40,40	49,10	59,50	78,10	99,00	122,0	149,0	181,0	212,0	251,0	293,0	140
150				3,490	6,330	10,20	14,70	20,20	26,50	34,20	42,90	52,10	63,10	82,60	105,0	129,0	157,0	191,0	223,0	264,0	307,0	150
160					6,730	10,90	15,60	21,40	28,10	36,20	45,40	55,00	66,60	87,10	110,0	136,0	165,0	200,0	234,0	276,0	321,0	160
170					7,120	11,50	16,50	22,60	29,60	38,20	47,80	58,00	70,20	91,50	116,0	143,0	173,0	209,0	245,0	289,0	335,0	170
180					7,520	12,10	17,30	23,80	31,20	40,20	50,30	61,00	73,70	96,00	121,0	149,0	181,0	219,0	256,0	301,0	349,0	180
190					7,910	12,70	18,20	25,00	32,80	42,20	52,80	64,00	77,30	101,0	127,0	156,0	189,0	228,0	267,0	314,0	364,0	190
200					8,300	13,30	19,10	26,20	34,40	44,20	55,20	67,00	80,80	105,0	132,0	163,0	197,0	237,0	278,0	326,0	378,0	200

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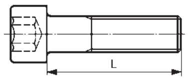
TECHNICAL INFORMATION and DATA

Socket head cap screws

Weights in kg / 100 pieces



Weights have been calculated for steel

L	M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 42	L
3	0,009	0,015	0,030																			3
4	0,010	0,017	0,034	0,063																		4
5	0,011	0,019	0,037	0,067																		5
6	0,012	0,021	0,040	0,071	0,150																	6
8	0,014	0,025	0,046	0,080	0,165																	8
10	0,016	0,029	0,052	0,088	0,180	0,270	0,470															10
12	0,018	0,035	0,058	0,096	0,195	0,295	0,507															12
14	0,020	0,041	0,064	0,105	0,210	0,320	0,546	1,15	1,99													14
16	0,022	0,047	0,070	0,116	0,225	0,345	0,575	1,21	2,09													16
18			0,076	0,126	0,245	0,370	0,614	1,27	2,19													18
20			0,082	0,136	0,265	0,401	0,653	1,34	2,29	3,21												20
22			0,089	0,146	0,285	0,432	0,692	1,40	2,39	3,35												22
25			0,097	0,161	0,315	0,478	0,759	1,50	2,59	3,57												25
30				0,186	0,365	0,555	0,870	1,69	2,79	3,93	5,3	7,7										30
35				0,211	0,415	0,632	0,99	1,89	3,10	4,29	5,8	8,4										35
40				0,236	0,465	0,709	1,10	2,09	3,41	4,73	6,3	9,1	12,9	15,0								40
45				0,261	0,515	0,786	1,21	2,29	3,72	5,17	6,9	9,7	13,7	16,1								45
50				0,286	0,565	0,863	1,32	2,49	4,03	5,61	7,5	10,6	14,7	17,2	25,0	30,0						50
55				0,311	0,615	0,940	1,43	2,69	4,34	6,05	8,1	11,4	15,7	18,3	26,3	31,6						55
60				0,336	0,665	1,02	1,54	2,89	4,65	6,49	8,7	12,2	16,7	19,5	27,6	33,0						60
65					0,715	1,10	1,65	3,10	4,96	6,93	9,3	13,0	17,7	20,7	29,1	34,5						65
70					0,765	1,18	1,76	3,30	5,27	7,37	9,9	13,8	18,7	22,0	30,6	36,3	44,0					70
75					0,815	1,25	1,87	3,50	5,58	7,81	10,5	14,6	19,7	23,2	32,1	38,1	46,2					75
80					0,865	1,33	1,98	3,70	5,89	8,25	11,1	15,4	20,7	24,4	33,6	39,9	48,4	69,0				80
90					0,970	1,48	2,20	4,10	6,51	9,13	12,3	17,0	22,7	26,9	36,6	43,5	52,9	74,5				90
100					1,070	1,64	2,42	4,50	7,13	10,00	13,5	18,6	24,7	29,4	39,6	47,1	57,4	80,0	97	123		100
110						1,80	2,64	4,90	7,74	10,90	14,7	20,2	26,7	31,9	42,6	50,7	61,9	85,5	104	131		110
120						1,95	2,86	5,40	8,36	11,80	15,9	21,8	28,7	34,4	45,6	54,3	66,4	91,0	111	139	200	120
130							3,08	5,70	9,01	12,50	16,8	23,4	30,7	36,9	48,6	57,9	70,9	96,5	118	147	210	130
140							3,30	6,10	9,64	13,40	18,0	25,0	32,7	39,4	51,6	61,5	75,4	102	125	155	221	140
150							3,52	6,50	10,27	14,30	19,2	26,6	34,7	41,9	54,6	65,5	79,9	108	132	163	232	150

——— Above dash line: fully threaded

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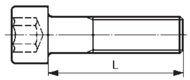
Socket head cap screws

Weights in kg / 100 pieces



Weights have been calculated for steel

ISO 4762 / DIN 912

L	M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 42	L
160							3,74	6,90	10,90	15,2	20,4	28,2	34,7	44,4	57,6	68,7	84,4	113	139	171	242	160
170							3,96	7,30	11,50	16,1	21,7	29,8	36,7	46,9	60,6	72,3	88,9	119	146	179	253	170
180							4,18	7,70	12,10	17,0	24,0	31,4	38,7	49,4	63,6	75,9	93,4	124	153	187	264	180
190							4,40	8,10	12,70	17,9	25,2	33,0	40,7	51,9	66,6	78,5	97,9	130	160	195	275	190
200							4,62	8,50	13,42	18,8	26,4	34,6	42,7	54,4	69,6	82,0	102,0	135	167	203	286	200
210								9,30	14,05	19,7	27,6	36,2	44,7	56,9	72,6	86,7	106,5	140	174	211	297	210
220								10,10	14,68	20,6	28,9	37,8	46,7	59,4	75,6	90,3	111,0	146	181	219	308	220
230								10,90	15,31	21,5	30,1	39,4	48,7	61,9	78,6	93,9	115,5	151	188	227	319	230
240								11,70	15,94	22,4	31,2	41,0	50,7	64,4	81,6	97,5	120,0	157	195	235	330	240
250								12,30	16,57	23,5	32,3	42,6	52,7	66,9	84,6	101,1	124,5	162	202	243	341	250
260								12,90	17,20	24,2	33,4	44,2	54,7	69,4	87,6	104,7	129,0	168	209	251	352	260
270								13,50	17,83	25,3	34,6	45,8	56,7	71,9	90,6	108,3	133,5	173	216	259	363	270
280								14,20	18,46	26,2	35,9	47,4	58,7	74,4	93,6	111,9	138,0	179	223	267	374	280
290								14,90	19,07	27,1	37,2	49,0	60,7	76,9	96,6	113,5	143,0	180	230	275	385	290
300								15,50	20,50	28,0	38,5	50,6	62,7	79,4	99,6	119,1	147,5	190	237	283	396	300
320												53,8	66,7	84,5	105,6	126,3	157,0	201	251	299	418	320
340												57,0	70,7	89,5	108,6	130,0	166,0	212	265	315	440	340
350												58,6	72,7	92,0	111,6	133,5	170,5	217	272	323	451	350
360												60,2	74,7	94,5	114,6	137,0	175,0	223	279	331	462	360
380												63,4	78,7	99,5	120,6	144,7	184,0	234	293	347	484	380
400												66,6	82,7	104,5	126,6	152,0	193,0	245	307	363	506	400

Socket head cap screws with low head (DIN 7984, DIN 6912) weigh about 0,7-0,9 times these values.

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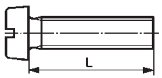
Slotted machine screws



Weights in kg / 100 pieces

DIN 84, DIN 85

DIN 963, DIN 964

Weights have been calculated for steel:

– Brass screws weigh about 1,08 times these values

– Aluminium screws weigh about 0,35 times these values

– Polyamid (nylon) screws weigh about 0,15 times these values

L	M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10		M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 16	L
2	0,007										0,004											2
3	0,008	0,016	0,027	0,047							0,005	0,010	0,017									3
4	0,009	0,017	0,030	0,051	0,102						0,006	0,011	0,020	0,029								4
5	0,010	0,019	0,033	0,056	0,109						0,008	0,013	0,023	0,0335	0,0676							5
6	0,011	0,021	0,036	0,060	0,117	0,206					0,009	0,015	0,026	0,0379	0,0754	0,121						6
8	0,014	0,025	0,042	0,069	0,133	0,220	0,35				0,011	0,019	0,032	0,0467	0,091	0,145	0,219					8
10	0,016	0,029	0,048	0,078	0,147	0,255	0,39	0,78			0,013	0,023	0,038	0,0555	0,106	0,170	0,254	0,50				10
12	0,018	0,032	0,054	0,086	0,163	0,280	0,42	0,84	1,46			0,026	0,044	0,0643	0,122	0,195	0,289	0,56	0,95			12
(14)	0,020	0,036	0,060	0,093	0,179	0,305	0,46	0,91	1,56			0,030	0,050	0,0731	0,137	0,219	0,325	0,63	1,06			(14)
16	0,023	0,040	0,066	0,104	0,195	0,330	0,49	0,97	1,66			0,034	0,056	0,082	0,153	0,244	0,360	0,69	1,16			16
(18)		0,044	0,072	0,113	0,210	0,354	0,53	1,04	1,76			0,038	0,062	0,0908	0,168	0,269	0,395	0,75	1,26			(18)
20		0,047	0,078	0,122	0,225	0,378	0,56	1,10	1,86			0,042	0,068	0,0996	0,184	0,294	0,431	0,82	1,36	2,08		20
(22)		0,051	0.084	0,131	0,240	0,402	0,60	1,17	1,96				0,074	0,108	0,199	0,318	0,466	0,88	1,46	2,22		(22)
25			0,093	0,144	0,264	0,440	0,65	1,26	2,11				0,083	0,122	0,222	0,355	0,519	0,97	1,61	2,44	4,7	25
(28)			0,102	0,157	0,287	0,467	0,71	1,36	2,26				0,092	0,135	0,246	0,393	0,572	1.07	1,76	2,66	5,1	(28)
30			0,111	0,166	0,302	0,502	0,74	1,42	2,36				0,098	0,144	0,261	0,416	0,608	1,14	1,86	2,81	5,4	30
35			0,120	0,188	0,349	0,562	0,82	1,58	2,61					0,166	0,300	0,465	0,696	1,30	2,11	3,17	6,1	35
40			0,129	0,210	0,380	0,625	0,92	1,74	2,86					0,188	0,338	0,540	0,784	1,46	2,36	3,53	6,7	40
45			0,138	0,232	0,417	0,688	1,00	1,89	3,11					0,210	0,376	0,602	0,873	1,62	2,61	3,90	7,4	45
50				0,254	0,457	0,750	1,09	2,06	3,36					0,232	0,414	0,665	0,961	1,78	2,86	4.26	8,1	50
55				0,276	0,471	0,810	1,17	2,21	3,61					0,254	0,452	0,728	1,049	1,94	3,11	4,62	8,7	55
60				0,298	0,490	0,875	1,26	2,36	3,86					0,276	0,490	0,791	1,137	2,10	3,37	4,98	9,4	60
70					0,566	1,000	1,43	2,70	4,36						0,566	0,917	1,313	2,42	3,80	5,17	10,8	70
80					0,642	1,130	1,60	3,01	4,86						0,642	1,043	1,489	2,74	4,39	6,44	12,1	80
90					0,718	1,255	1,77	3,33	5,35						0,718	1,169	1,665	3,06	4,9	7,71	13,4	90
100						1,380	1,94	3,65	5,85							1,295	1,841	3,38	5,41	8,98	14,8	100

DIN 7985, DIN 965, DIN 966

Cross recessed screws weigh about 1,10 times these values

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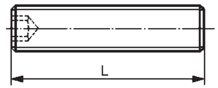
TECHNICAL INFORMATION and DATA

Set screws

Weights in kg / 100 pieces



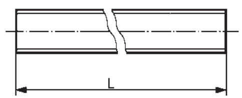
Weights have been calculated for steel:

- Brass screws weigh about 1,08 times these values
- Aluminium screws weigh about 0,35 times these values
- Polyamid (nylon) screws weigh about 0,15 times these values

ISO 4026-4029 / DIN 913–DIN 916 ISO 4766, 7434-6 / DIN 417, DIN 438, DIN 551, DIN 553

L	M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 42	L
3	0,0029	0,0044	0,0075	0,010																		3
4	0,0037	0,0059	0,01	0,014	0,022																	4
5	0,0046	0,0074	0,0125	0,018	0,030																	5
6	0,0056	0,0089	0,015	0,022	0,038	0,056																6
8		0,0119	0,0199	0,031	0,053	0,080	0,111	0,189														8
10		0,0148	0,0249	0,040	0,068	0,104	0,146	0,252	0,378													10
12				0,049	0,083	0,128	0,181	0,315	0,478													12
16				0,067	0,113	0,176	0,251	0,441	0,678	0,96												16
18				0,076	0,128	0,200	0,286	0,504	0,777	1,10	1,56											18
20				0,085	0,143	0,224	0,321	0,567	0,876	1,24	1,76	2,15	2,75									20
22				0,094	0,158	0,248	0,356	0,630	0,975	1,38	1,96	2,47	3,12									22
25						0,284	0,409	0,726	1,120	1,60	2,25	2,80	3,55	4,26	5,15							25
30							0,497	0,885	1,370	1,96	2,55	3,46	4,42	5,29	6,40	7,2						30
35							0,585	1,040	1,620	2,32	3,15	4,11	5,22	6,32	7,45	8,7						35
40								1,200	1,870	2,68	3,65	4,77	6,00	7,35	8,73	10,2						40
45								1,360	2,120	3,04	4,13	5,43	6,87	8,38	10,02	11,7						45
50								1,520	2,370	3,40	4,64	6,09	7,68	9,41	11,30	13,2						50
55								1,680	2,620	3,76	5,16	6,75	8,55	10,40	12,60	14,7						55
60								1,840	2,870	4,12	5,70	7,41	9,35	11,47	13,85	16,2						60
70								2,160	3.,370	4,84	6,73	8,67	10,93	13,53	16,42	19,2						70
80								2,480	3,870	5,56	7,76	10,00	12,60	15,60	19,00	22,2						80
90								2,780	4,370	6,28	8,80	11,27	14,20	17,65	12,60	25,2						90
100								3,10	4,870	7,00	9,82	12,57	15,85	19,71	24,11	28,2						100

Threaded rods DIN 975



Weights in kg / 100 pieces

L	M 1,6	M 2	M 2,5	M 3	M 4	M 5	M 6	M 8	M 10	M 12	M 14	M 16	M 18	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M42	L
1000	1,2	1,87	3	4,4	7,8	12,4	17,7	31,9	50	72,5	97	133	165	208	254	300	385	475	590	690	940	1000

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TECHNICAL INFORMATION and DATA

Weights in kg / 100 pieces

Washers

d	DIN 125	DIN 9021	DIN 127	DIN 128	DIN 434	DIN 6916
1,6	0,002					
1,8	0,003					
2	0,004		0,003	0,003		
2,2	0,009		0,005			
2,5	0,010	0,025	0,005	0,005		
3	0,012	0,034	0,011	0,009		
3,5	0,015	0,052	0,012	0,010		
4	0,030	0,077	0,018	0,015		
5	0,044	0,194	0,036	0,03		
6	0,114	0,279	0,083	0,07		
8	0,214	0,684	0,160	0,13	0,95	
10	0,408	1,22	0,253	0,21	0,88	
12	0,627	2,65	0,382	0,32	1,83	0,703
14	0,86	3,33	0,601	0,48		
16	1,13	4,09	0,891	0,70	3,41	1,46
18	1,47	6,74	0,973	0,78		
20	1,72	7,82	1,52	1,22	5,7	1,96
22	1,84		1,65	1,33	8,25	2,43
24	3,23		2,62	2,15	1,28	3,06
27	4,23		2,87	2,37	11,9	5,02
30	5,36		4,43	4,25		6,32
33	7,44					
36	9,2		6,73	6,8		11,5
39	13,3		7,17			
42	18,3		11,1	11,1		
45	22,0		11,7			
48	29,4		12,3	12,3		
52	33,0		18,2			
56	42,5		19,3	19,3		
60	45,8		20,3			
64	49,2					

Weights have been calculated for steel:
– Brass washers weigh about 1,08 times these values
– Aluminium washers weigh about 0,35 times these values
– Polyamid (nylon) washers weigh about 0,15 times these values

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Calculation of screw dimensions

For the calculation of screw dimensions, yield stress is the most important factor, assuming sufficient nut strength or thread engagement is provided. It is the basis for calculating the highest load not causing plastic deformation of the fastener. When yield stress is exceeded, the fastener will extend more and more and finally break under the increasing load. The highest operating force must neither equal nor surpass the relevant yield load (load at yield stress and at Rp 0.2 respectively: see page T9), but must remain within an adequate safety limit below this factor. For simple static joints, operating force is permitted to reach approx. 90% of the yield load. When safety issues arise, or the load becomes dynamic, operating force must be a smaller portion of the yield load.

The selection of the most suitable property class for bolted joints depends on the force to be transferred and on the designed dimensions. As a rule of thumb, property class 8.8 is to be selected unless special requirements need to be met. Property class 8.8 is not subject to any limiting conditions as a result of electrolytic plating.

Note the following with regard to relevant fields of application:

- For lightweight construction, small given joint sizes are to be used to avoid extra weight, so the highest possible property classes with high mechanical properties should be selected.

- The higher the selected property class, the higher the pressure on the bearing surface under screw head and nut. Check material specifications for maximum bearing stresses.

- The possibility of brittle fracture, especially in case of unforeseen overstressing - or in case of a catastrophe - grows with increasing mechanical properties. This may be compensated to a certain extent by specific designing of the structural parts and by favorable fastening conditions - i.e. longer clamping length or reduced shank diameters.

- With increasing mechanical properties, consider using a plating or coating without embrittling effect.

- Different conditions, such as low-temperature ductility, heat resistance or corrosion resistance have special requirements. Fasteners made of steel according to standardized property classes should only be used within the temperature range of -50° to +300°C.

- Regulations from official authorities defining material and mechanical properties of fasteners, such as pressure vessel codes, structural bolting and apparatus engineering, are to be duly complied with.

- Production cost of the fully assembled joint should be the guideline for choosing a suitable combination of property class and fastener dimension, and not the price of the fasteners alone. Choosing less expensive screws will often cost more in the end than smaller, high-tensile fasteners, which may be more expensive, but allow smaller joints. Storage and assembly costs need also be considered.

- High-tensile bolted joints are to be used as high-capacity components. Therefore, they require more precise calculations, more careful manufacturing, and quality assurance guarantees which only brand name companies can provide. They further require adequate storage (maintaining finish and tightening friction) and more careful assembly by means of proper tightening methods.

Guidelines for maximum permissible operation force

Type of force	Permissible operating force in % of the yield load		
Property class	3.6 – 6.6	4.8 – 8.8	10.9 – 14.9
Constant tensile force Safety limit against fracture: 2	85%	62%	55%
Repeated tensile shocks Safety limit against fracture: 2 Notch factor of thread: K = 3,5	24%	18%	16%
Constantly alternating (dynamic) tensile force (rotating parts, over 10 000 changes of load) Safety limit against fracture: 2 Notch factor of thread: Kw = 3 Fatigue strength under bending stress = 55% of the tensile strength	15%	12%	10%
Constantly alternating (dynamic) tensile and compressive forces. (rotating parts, flexure, over 10 000 changes of load) Safety limit against fracture:2 Notch factor of thread: Kw = 3 Fatigue strength under reversing stress = 40% of the tensile strength	11%	8%	7%

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TECHNICAL INFORMATION and DATA

Minimum yield load

at yield stress (property classes 3.6 - 6.8) and at Rp 0.2 at (stress at permanent set limit of 0.2% for property classes 8.8 - 12.9) respectively.

	Dimension (with pitch P)	Nominal thread stress area A_S (mm^2)	Minor thread stress area A_3 (mm^2)	Yield load for property classes 3.6 [N]	4.6 [N]	4.8 [N]	5.6 [N]	5.8 [N]	6.8 [N]	8.8 [N]	10.9 [N]	12.9 [N]
coarse pitch	M 4 x 0,7	8,78	7,75	1 700	2 100	3 000	2 700	3 700	4 200	5 700	8 300	9 700
	M 5 x 0,8	14,2	12,69	2 700	3 400	4 900	4 300	6 000	6 900	9 100	13 500	16 000
	M 6 x 1	20,1	17,89	3 900	4 900	6 900	6 100	8 500	9 700	13 000	19 000	22 000
	M 8 x 1,25	36,6	32,84	7 000	8 800	12 500	11 000	15 500	18 000	23 500	35 000	40 000
	M 10 x 1,5	58,0	52,3	11 000	14 000	20 000	17500	24 500	28 000	37 500	55 000	64 000
	M 12 x 1,75	84,3	76,25	16 000	20 500	29 000	25 500	36 000	41 000	54 000	79 000	93 000
	M 14 x 2	115	104,7	22 000	28 000	39 000	35 000	49 000	55 000	74 000	108 000	127 000
	M 16 x 2	157	144,1	30 000	38 000	54 000	47 000	66 000	76 000	101 000	148 000	173 000
	M 18 x 2,5	192	175,1	37 000	46 000	65 000	58 000	81 000	92 000	127 000	181 000	211 000
	M 20 x 2,5	245	225,2	47 000	59 000	84 000	74 000	103 000	118 000	162 000	231 000	270 000
	M 22 x 2,5	303	281,5	58 000	73 000	103 000	91 000	127 000	146 000	200 000	285 000	334 000
	M 24 x 3	353	324,3	67 000	85 000	120 000	106 000	148 000	170 000	233 000	332 000	389 000
	M 27 x 3	459	427,1	87 000	110 000	156 000	138 000	193 000	221 000	303 000	432 000	505 000
	M 30 x 3,5	561	519,0	107 000	135 000	191 000	169 000	236 000	270 000	370 000	528 000	618 000
	M 33 x 3,5	694	647,2	132 000	167 000	236 000	208 000	292 000	333 000	459 000	653 000	764 000
	M 36 x 4,0	817	759,3	155 000	196 000	278 00	245 000	343 000	392 000	540 000	768 000	899 000
fine pitch	M 8 x 1	39,2	36,03	7 500	9 400	13 500	12 000	16 500	19 000	25 000	37 000	43 000
	M 10 x 1	64,5	60,45	12 500	15 500	22 000	19 500	27 000	31 000	41 000	61 000	71 000
	M 10 x 1,25	61,2	56,29	12 000	15 000	21 000	18 500	26 000	29 500	39 000	58 000	68 000
	M 12 x 1,25	92,1	86,03	17 500	22 000	32 000	28 000	39 000	45 000	59 000	87 000	102 000
	M 12 x 1,5	88,1	81,07	17 000	21 500	30 000	26 500	37 000	42 000	57 000	83 000	97 000
	M 14 x 1,5	125	116,1	24 000	30 000	43 000	38 500	53 000	60 000	80 000	118 000	138 000
	M 16 x 1,5	167	157,5	32 000	40 000	57 000	50 000	70 000	80 000	107 000	157 000	184 000
	M 18 x 1,5	216	205,1	41 000	52 000	74 000	65 000	91 000	104 000	143 000	203 000	238 000
	M 20 x 1,5	272	259,0	52 000	65 000	93 000	82 000	114 000	131 000	180 000	256 000	299 000
	M 22 x 1,5	333	319,2	63 000	80 000	113 000	100 000	140 000	160 000	220 000	313 000	367 000
	M 24 x 2	384	364,9	73 000	92 000	131 000	115 000	161 000	185 000	254 000	361 000	423 000
	M 27 x 2	496	473,2	94 000	119 000	169 000	149 000	209 000	238 000	328 000	467 000	546 000
	M 30 x 2	621	596,0	118 000	149 000	211 000	187 000	261 000	298 000	410 000	584 000	684 000
	M 33 x 2	761	732,8	145 000	183 000	259 000	229 000	320 000	365 000	502 000	716 000	838 000
	M 36 x 3	865	820,4	165 000	208 000	294 000	260 000	364 000	416 000	571 000	814 000	952 000

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Estimation of screw diameters (according to VDI* 2230)

The following procedure enables an estimation of screw diameter depending on the operating force at temperature of 20°C (15° - 25°C) and on tightening method.

The result has to be double checked by either exact calculation or testing the joint.

Special conditions as mentioned e.g. on page T 10, are not taken into consideration for this estimation.

1	2	3	4
Force in N	Nominal diameter in mm		
	Property class		
	12.9	10.9	8.8
250			
400			
630			
1 000			
1 600	3	3	3
2 500	3	3	4
4 000	4	4	5
6 300	4	5	5
10 000	5	6	8
16 000	6	8	8
25 000	8	10	10
40 000	10	12	14
63 000	12	14	16
100 000	16	16	20
160 000	20	20	24
250 000	24	27	30
400 000	30	36	
630 000	36		

Example:

A joint is dynamically and eccentrically loaded by the axial force F_A = 5800 N.
A screw with property class 8.8 is to be assembled using a manual torque wrench.

A 6300 N is the next higher force to F_A in column 1.

B 2 steps for “eccentric and dynamic axial force” add up to $F_{M\,min}$ = 16 000 N.

C 1 step for “tightening with manual torque wrench” adds up to $F_{M\,max}$ = 25 000 N.

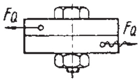
D For the force $F_{M\,max}$ = 25 000 N, you will find thread size M 10 in column 4 (property class 8.8)

* VDI = Association of German Engineers

A Choose the next higher force value to *operating force* $F_{A,\,Q}$ acting on the bolted joint.

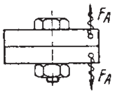
B The required *minimum preload force* $F_{M\,min}$ is found by proceeding from this force with:

- 4 steps for static or dynamic transverse shear force,



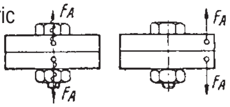
or

- 2 steps for dynamic and eccentric axial force,



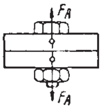
or

- 1 step for either dynamic and concentric or static and eccentric axial force,



or

- 0 step for static and concentric axial force.



C The required *maximum preload force* $F_{M\,max}$ is found by proceeding from force $F_{M\,min}$ *with:*

- 2 steps for tightening the screw with a simple mechanical, motorized or pneumatic screw driver, which is set for a certain tightening torque,

or

- 1 step for tightening with a torque wrench or precision screw driver, which is set and checked by means of the dynamic torque measurement or elongation of the screw.

or

- 0 step for tightening by angle control or by computerized yield point control.

D Once the maximum preload force is estimated, the correct *screw size in mm* is found next to it in column 2 to 4 underneath the appropriate property class.

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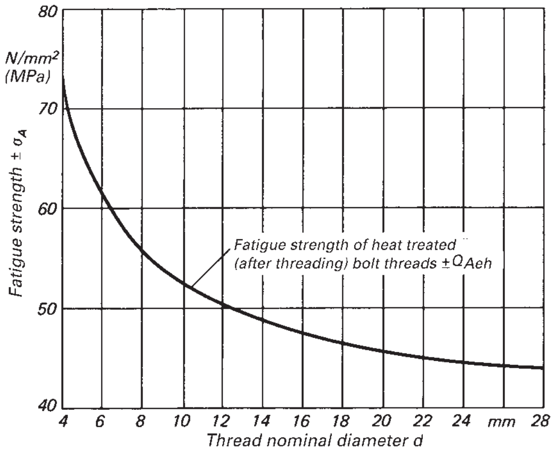
Fatigue strength

In the first loaded thread of a screw there is a strong notch effect. Dynamic stress (may it be from axial , bending or torque load) reduces the capacity of a threaded fasteners to a fraction of the strength under static conditions. Independent from value of the static load and independent from the property class of the screw, the fatigue strength of threaded fasteners is between ± 40 and ± 70 N/mm^2.

Thread	Fatigue strength (N/mm^2)	Range (standard value only)	Preload depending
heat treated after threading (eh)	$\pm Q_{Aeh} < 0{,}75\left(\frac{180}{d} + 52\right)$	$0{,}2F_{0,2} < F_V < 0{,}8F_{0,2}$	no
threaded after heat treating (et)	$\pm Q_{Aet} < \left(2 - \frac{F_V}{F_{0,2}}\right) \cdot Q_{Aeh}$		yes



Fatigue strength of bolt threads of fasteners of property class 8.8 , 10.9 and 12.9

By appropriate design of the threaded joint and controlled tightening the dynamic component of the load has to be eliminated or at least reduced to an acceptable minimum:

– Use smaller screw diameters (higher property classes)
– Increase preload (use higher property classes and a controlled tightening method)
– Keep the screw elastic and the joint parts rigid (use long, thin screws or bolts with reduced shank)
– Use sufficient thread engagement
– Use "special" nuts (e.g. stretch nuts of conical shape, nuts of lower property class)
– Keep (or move) the operating force as near to the parting plane as possible.
– Reduce eccentricity of the external force relative to the joint center.
– (Also, see page T 78 "Locking of fasteners")

Property classes

The symbol for the property classes of bolts, screws and studs consists of two numbers separated by a point. The first number, when multiplied by one hundred, indicates the nominal tensile strength in newtons per square millimeter. The second figure, multiplied by ten, states the ratio between the lower yield stress and the nominal tensile strength (yield stress ratio) as a percentage. The multiplication of these two figures will give one tenth of the yield stress in newtons per square millimeter.

Example of a screw in property class 5.8

Nominal tensile strength
5 ¥ 100 = 500 N/mm² (MPa)

Yield stress ratio
8 ¥ 10 = 80%

Yield stress
80% of 500 = 400 N/mm² (MPa)

For nuts, the main characteristic property is the thread stripping strength (proof stress).

The property classes of nuts are designated by a figure to indicate the maximum appropriate property class of bolts with which they may be mated. Thus, nut property class is the same as the first figure of the bolt designation.

Internationally, mechanical stress is expressed in newtons per square area, in bolting N/mm². US practice is to use the term megapascal (MPa), which correspond to N/mm².

Ex. 500 /mm² = 500 MPa

In this cataloque the term N/mm² is used only.

Mating screws and nuts

Property classes bolts, screws, studs	3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9	14.9
Property classes nuts	5					6	8	9	10	12	14

Nuts of a higher property class can nomally be used in the place of nuts of a lower property class.

* Property classes 14.9 are not ISO or ANSI standard

= quenched and tempered

Mechanical properties of bolts, screws, and studs according DIN-ISO 898, part 1

Property (at 20 °C)		3.6	4.6	4.8	5.6	5.8	6.8	8.8 [1] ≤ M 16	8.8 [1] > M 16 [2]	9.8 [3]	10.9	12.9
Tensile strength, R_m[4], [5], N/mm²	nominal	300	400		500		600	800	800	900	1000	1200
	min.	330	400	420	500	520	600	800	830	900	1040	1220
Vickers hardness HV, F $ 98 N	min.	95	120	130	155	160	190	250	255	290	320	385
	max.	220 (250 at the screw end)					250	320	335	360	380	435
Brinell hardness HB, F = 30 D²	min.	90	114	124	147	152	181	238	242	276	304	366
	max.	209 (238 at the screw end)					238	304	318	342	361	414
Rockwell hardness HR	min. HRB	52	67	71	79	82	89	–	–	–	–	–
	min. HRC	–	–	–	–	–	–	22	23	28	32	39
	max. HRB	95,0 (99,5 at the screw end)					99,5	–	–	–	–	–
	max. HRC	–						32	34	37	39	44
Surface hardness, HV 0,3		–						see foot note [6]				
Lower yield stress, R_{el}[7], N/mm²	nominal	180	240	320	300	400	480	–	–	–	–	–
	min.	190	240	340	300	420	480	–	–	–	–	–
Stress at 0,2% non-proportional elongation, $R_{p0,2}$, in N/mm²	nominal	–						640	640	720	900	1080
	min.	–						640	660	720	940	1100
Stress ratio	S_p/R_{eL} or $S_p/R_{p0,2}$	0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
Stress under proof load S_p	N/mm²	180	225	310	280	380	440	580	600	650	830	970
Elongation after fracture, A	min. %	25	22	–	20	–	–	12	12	10	9	8
Reduction of area after fracture	min. %	–	52	52	48	48	44					
Strength under wedge loading [5]		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength.										
Impact strength, J	min.	–			25	–		30	30	25	20	15
Head soundness		no fracture										
Minimum height of non-decarburized thread zone, E		–						½ H_1			⅔ H_1	¾ H_1
Maximum depth of complete decarburization, G	mm	–						0,015				

[1]) For bolts of property class 8.8 in diameters d ≤ 16 mm, there is an increased risk of nut stripping in the case of inadvertent over-tightening inducing a load in excess of proof load. Reference to ISO 898-2 is recommended..

[2]) For structural bolting the limit is 12 mm.

[3]) Property class 9.8 applies only to nominal thread diameters d ≤ 16 mm.

[4]) Minimum tensile properties apply to products of nominal length 1 ≥ 2,5 d. Minimum hardness applies to products of length 1 < 2,5 and other products which cannot be tensile-tested (e.g. due to head configuration.)

[6]) Surface hardness shall not be more than 30 Vickers points above the measured core hardness on the product when readings of both surface and core are carried out at HV 0,3. For property class 10.9, any increase in hardness at the surface which indicates that the surface hardness exceeds 390 HV is not acceptable.

[7]) In cases where the lower yield stress ReL cannot be determined, it is permissible to measure the stress at 0,2% non-proportional elongation $R_{0.2}$

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Minimum breaking torques ($M_{B\ min}$) for bolts and screws of property classes according DIN-ISO 898/1

Thread diameter	Pitch P mm	Minimum breaking torque $M_{B\ min}$ for property class Nm			
		5.8	8.8	10.9	12.9
M 1	0,25	0,022	0,033	0,040	0,045
M 1,2	0,25	0,05	0,075	0,092	0,10
M 1,4	0,3	0,08	0,12	0,14	0,16
M 1,6	0,35	0,11	0,16	0,20	0,22
M 2	0,4	0,25	0,37	0,45	0,50
M 2,5	0,45	0,55	0,82	1,0	1,1
M 3	0,5	1,0	1,5	1,9	2,1
M 3,5	0,6	1,6	2,4	3,0	3,3
M 4	0,7	2,4	3,6	4,4	4,9
M 5	0,8	5,1	7,6	9,3	10
M 6	1	8,7	13	16	17
M 8	1,25	22	33	40	44
M 8 × 1	–	25	38	46	52
M 10	1,5	44	66	81	90
M 10 × 1	–	56	84	102	114
M 10 × 1,25	–	50	75	91	102

Materials for nuts

Property class		Chemical composition limits (check analysis), %			
		C max.	Mn min.	P max.	S max.
4 [1]), **5** [1]), **6** [1])	–	0,50	–	0,060	0,150
8, **9**	**04** [1])	0,58	0,25	0,060	0,150
10 [2])	**05** [2])	0,58	0,30	0,048	0,058
12 [2])	–	0,58	0,45	0,048	0,058

[1]) Nuts of these property classes may be manufactured from free-cutting steel unless otherwise agreed between the purchaser and the manufacturer. In such cases the following maximum sulphur, phosphorus and lead contents are permissible:

sulphur 0,34% phosphorus 0,11% lead 0,35%

[2]) Alloying elements may be added if necessary to develop the mechanical properties of the nuts.

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TECHNICAL INFORMATION and DATA

Materials for bolts, screws and studs

Property class	Materials and treatment	Chemical composition limits (check analysis) % C min.	C max.	P max.	S max.	B[9]) max.	Tempering temperature °C min.
3.6[1])	Carbon steel	–	0,20	0,05	0,06	0,003	–
4.6[1])		–	0,55	0,05	0,06	0,003	
4.8[1])							
5.6		0,15	0,55	0,05	0,06	0,003	
5.8[1])		–	0,55	0,05	0,06	0,003	
6.8[1])							
8.8[2])	Carbon steel with additives (e.g. Boron or Mn or Cr), quenched and tempered or	0,15[3])	0,40	0,035	0,035	0,003	425
	Carbon steel quenched and tempered	0,25	0,55	0,035	0,035		
9.8	Carbon steel with additives (e.g. Boron or Mn or Cr), quenched and tempered or	0,15[3])	0,35	0,035	0,035	0,003	425
	Carbon steel quenched and tempered	0,25	0,55	0,035	0,035		
<u>10,9</u>[4])	Carbon steel with additives (e.g. Boron or Mn or Cr), quenched and tempered	0,15[3])	0,35	0,035	0,035	0,003	340
10.9[5])	Carbon steel quenched and tempered or	0,25	0,55	0,035	0,035		425
	Carbon steel with additives (e.g. Boron or Mn or Cr), quenched and tempered or	0,20[3])	0,55	0,035	0,035		
	Alloy steel quenched and tempered[7])	0,20	0,55	0,035	0,035	0,003	
12.9[5), 6)]	Alloy steel quenched and tempered[7])	0,28	0,50	0,035	0,035	0,003	380

[1]) Free cutting steel is allowed for these property classes with the following maximum sulfur, phosphorus and lea contents:
sulfur 0,34%; phosphorus 0,11%; lead 0,35%.

[2]) For nominal diameters above 20 mm the steels specified for property classe 10.9 may be necessary in order to achieve sufficient hardenability.

[3]) In case of plain carbon boron alloyed steel with a carbon content below 0,25% (ladle analysis), the minimum manganese content shall be 0,6% for property class 8.8 and 0,7% for 9.8 and 10.9.

[4]) Products shall be additionally identified by underlining the symbol of the property class.

[5]) For the materials of these property classes, it is intended that there should be a sufficient hardenability to ensure a structure consisting of aproximately 90% martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering.

[6]) A metallographically detectable white phosphorous enriched layer is not permitted for property class 12.9 on surfaces subjected to tensile stress.

[7]) This alloy steel shall contain at least one of the following elements in the minimum quantity given: chromium 0,30%, nickel 0,30%, molybdenum 0,20%, vanadium 0,10%. Where elements are specified in combinations of two, three or four and have alloy contents less than those given above the limit value to be applied for classification is 70% of the sum of the individual limit values shown above for the two, three or four elements concerned.

[9]) Boron content can reach 0,005% providing that non-effective boron is controlled by titanium and/or aluminium additions.

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TECHNICAL INFORMATION and DATA

Mechanical properties for nuts according DIN (only valid for DIN 934/DIN 985)

DIN 267/part 4

Mechanical properties		Property class					
		4	5	6	8	10	12
Nominal proof load stress	N/mm^2	400	500	600	800	1000	1200
Vickers hardness ... HV 5	max.	302	302	302	302	353	353
Brinell hardness ... HB 30	max.	290	290	290	290	335	335
Rockwell hardness ... HRC	max.	30	30	30	30	36	36

Mechanical properties for nuts according ISO (for all other DIN-ISO-nuts)

ISO 898/part 2

Nominal size (thread diameter) mm		Property class 04			05			5			6		
		Stress under proof load Sp	Vickers hardness HV		Stress under proof load Sp	Vickers hardness HV		Stress under proof load Sp	Vickers hardness HV [1]		Stress under proof load Sp	Vickers hardness HV [1]	
over	to	N/mm^2	min.	max.	N/mm^2	min.	max.	N/mm^2	min.	max.	N/mm^2	min.	max.
–	4	380	188	302	500	272	353	520	130	302	600	150	302
4	7							580			670		
7	10							590			680		
10	16							610			700		
16	39							630	146		720	170	
39	100	–			–			–	128		–	142	

Nominal size (thread diameter) mm		Property class 8			10			12			
		Stress under proof load Sp	Vickers hardness [1] + [2]		Stress under proof load Sp	Vickers hardness proof [1] + [2]		Stress under load Sp	Vickers hardness [2]		
over	to	N/mm^2	min.	max.	N/mm^2	min.	max.	N/mm^2	min.		max
–	4	800	180	302	1040	272	353	1140[1] 1150[2]	295[1]	272[2]	353
4	7	855	200		1040			1140[1] 1150[2]			
7	10	870			1040			1140[1] 1160[2]			
10	16	880			1050			1170[1] 1190[2]			
16	39	920[1] 890[2]	233[1] 180[2]	353[1] 302[2]	1060			1200[2]	–		
39	100	–	207		–			–	–	–	–

[1] Nuts style 1 (ISO 4032) ≈ 0,8 d nuts

[2] Nuts style 2 (ISO 4033) ≈ 1,0 d nuts

Note:
- Minimum hardness is mandatory only for heat-treated nuts and nuts too large to be proof-load tested. For all other nuts, minimum hardness is provided for guidance only.
- Nuts of property class 05, 8 (Style 1 > M 16 only), 10 and 12 shall be hardened and tempered.
- Hardness values for nominal sizes (thread diameters) over 39 up to and including 100 mm are to be used for information and guidance only.

Mechanical properties for fine thread nuts according DIN-ISO

ISO 898/part 6

<table>
<tr><th colspan="2" rowspan="3">Nominal size (thread diameter) mm</th><th colspan="12">Property class</th></tr>
<tr><th colspan="3">04</th><th colspan="3">05</th><th colspan="3">5</th><th colspan="3">6</th></tr>
<tr><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30</th><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30</th><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30 1)</th><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30 1)</th></tr>
<tr><th>over</th><th>to</th><th>min.</th><th>max.</th><th>min.</th><th>max.</th><th>min.</th><th>max.</th><th>min.</th><th>max.</th></tr>
<tr><td>7</td><td>10</td><td rowspan="4">380</td><td rowspan="4">188</td><td rowspan="4">302</td><td rowspan="4">500</td><td rowspan="4">272</td><td rowspan="4">353</td><td>690</td><td>175</td><td rowspan="4">302</td><td>770</td><td rowspan="2">188</td><td rowspan="4">302</td></tr>
<tr><td>10</td><td>16</td><td>720</td><td>190</td><td>780</td></tr>
<tr><td>16</td><td>33</td><td rowspan="2"></td><td rowspan="2"></td><td>870</td><td rowspan="2">233</td></tr>
<tr><td>33</td><td>39</td><td>920</td></tr>
</table>

<table>
<tr><th colspan="2" rowspan="3">Nominal size (thread diameter mm</th><th colspan="9">Property class</th></tr>
<tr><th colspan="3">8</th><th colspan="3">10</th><th colspan="3">12</th></tr>
<tr><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30 1) + 2)</th><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30 1) + 2)</th><th rowspan="2">Stress under proof load Sp N/mm²</th><th colspan="2">Vickers hardness HV 30 2)</th></tr>
<tr><th>over</th><th>to</th><th>min.</th><th>max.</th><th>min.</th><th>max.</th><th>min.</th><th>max.</th></tr>
<tr><td>7</td><td>10</td><td rowspan="2">955 1) 890 2)</td><td rowspan="2">250 1) 195 2)</td><td rowspan="2">353 1) 302 2)</td><td rowspan="2">1100 1)
1110 1) 1055 2)</td><td rowspan="2">295 1) 250 2)</td><td rowspan="2">353</td><td rowspan="2">1200</td><td rowspan="2">295</td><td rowspan="2">353</td></tr>
<tr><td>10</td><td>16</td></tr>
<tr><td>16</td><td>33</td><td>1030 1)</td><td rowspan="2">295 1)</td><td rowspan="2">353 1)</td><td rowspan="2">1080 2)</td><td rowspan="2">260 2)</td><td rowspan="2">353</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>33</td><td>39</td><td>1090 1)</td></tr>
<tr><td colspan="11">1) Nuts style 1 (ISO 8673/DIN 971 part 1) < 0,8 d nuts
2) Nuts style 2 (ISO 8674/DIN 971 part 2) < 1,0 d nuts</td></tr>
</table>

Failure loads for nuts with nominal height of 0,5 D

The values of failure loads given for guidance in the following table apply to different bolt classes. Bolt stripping is the expected failure mode for lower strength bolts, while nut stripping can be expected for bolts of higher property classes.

Minimum failure loads for nuts in % of the screws proof load (for guidance only)

Property class of the nut	Property class of the bolt			
	6.8	8.8	10.9	12.9
04	85	65	45	40
05	100	85	60	50

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Steels for low and high temperature applications

Temperatures from –253 to –10 °C

Material: Designation	Material number	according to	Symbol	Guideline for lower standard limit of temperature in continuous operation[2])
26 CrMo 4	1.7219	steel-iron standard 680	KA	– 65 °C
12 Ni 19	1.5680		KB	– 140 °C
X 12 CrNi 18 9	1.6900		KC	– 253 °C
X 10 CrNiTi 18 10	1.6903		KD	– 253 °C
X 5 CrNi 18 9	1.4301	ISO 3506/part 1 resp. AD-W 10	A2[1])	– 196 °C
X 5 CrNi 19 11	1.4303		A2[1])	– 196 °C
X 10 CrNiTi 18 9	1.4541		A2[1])	– 196 °C
X 5 CrNiMo 18 10	1.4401		A4[1])	– 60 °C
X 10 CrNiMoTi 18 10	1.4571		A4[1])	– 60 °C

[1])If there is space enough on the fastener, it has to be marked with the property class additionally to the steel grade A2 and A4: e.g. A2-70 (see ISO 3506/part 1). If a specific steel is required the fastener has to be marked with the standard number or the designation. This is valid also for fasteners larger than M 39 .

[2])Refer to the DIN worksheet W 10 and the steel-iron-standard 680.

Temperatures from –10 to +300 °C

Hot yield-point (as information only, not subject to acceptance inspection)

Property classes	Mating nuts	Temperature + 20 °C	+ 100 °C	+ 200 °C	+ 250 °C	+ 300 °C
		Lover yield stress R_{eL} or 0,2% permanent strain R_p 0,2 (as guideline only) N/mm^2				
4.6–2[1])	5-2[1])	240	210	190	170	140
5.6	5-2[1])	300	270	230	215	195
8.8	8	640	590	540	510	480
10.9	10	940	875	790	745	705
12.9	12	1100	1020	925	875	825

Continuous stress at higher temperature may cause warm creep (e.g. 100 hours operation at 300° C may cause loss of preload up to 25%).

1) Index -2 states that "Thomas" steel is not accepted for this property class. For screws of property class 4.6-2 impact strength of min. 25 J is required (is equal as for 5.6 screws).

Temperatures above +300 °C

according DIN 17 240			Guideline for upper standard limit of temperature in continuous operation (acc. DIN 17 240)
Designation	Material number	Symbol	
C 35 N[2]	1.0501	Y	+ 350 °C
Ck 35	1.1181	YK	+ 350 °C[3]
Cq 35	1.1172	YQ	+ 350 °C[3]
24 CrMo 5	1.7258	G	+ 400 °C[4]
21 CrMoV 5 7	1.7709	GA	+ 540 °C
40 CrMoV 4 7	1.7711	GB	+ 540 °C
X 22 CrMoV 12 1	1.4923	V[6]	+ 580 °C
X 19 CrMoVNbN 11 1	1.4913	VW	+ 580 °C
X 8 CrNiMoBNb 16 16	1.4986	S	+ 650 °C
X 5 NiCrTi 26 15[5]	1.4980	SD	+ 700 °C
NiCr 20 TiAl	2.4952	SB	+ 700 °C

2) Not for screws or bolts
3) For nuts the upper limit of temperature in continuous operation may be 50°C higher.
4) For nuts of steel 24 CrMo5 there is no indication in DIN 17240 for use at even higher temperature. But, based on the strength of the material and on practical experience, this temperature limit may be exceeded according to DIN 17240 section 1.1 (edition July 1976). Indications are given in DIN 2507, part 2.
5) Not mentioned in DIN 17240 (aero-space material number 1.4944).
6) Symbol VH for steel X 22 CrMoV 12 1 with higher strength (yield stress $R_{p\ 02} \perp 700$ N/mm^2) than according DIN 17 240.

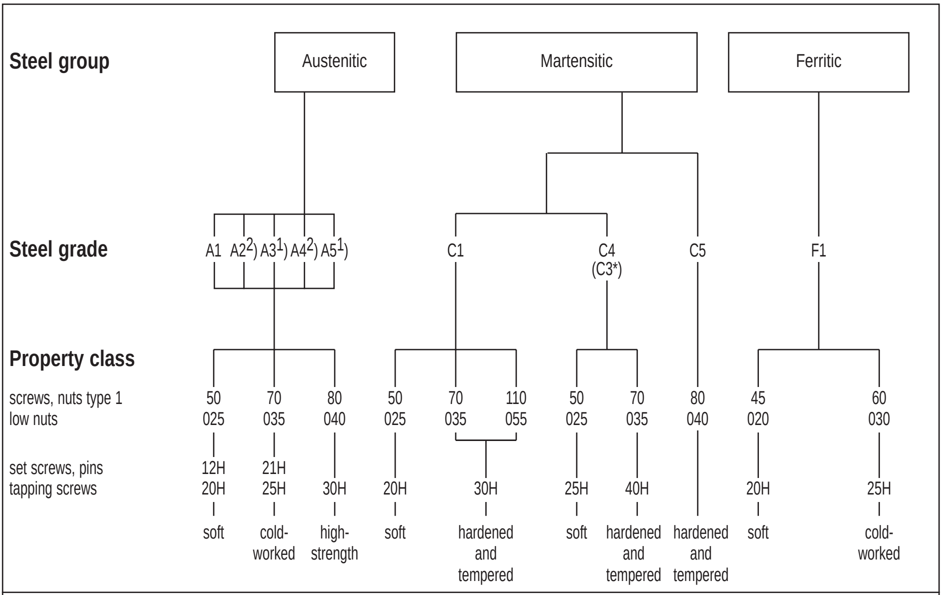
Suitable mating materials for bolts and nuts

Materials	
Bolt	Nut
Ck 35 Cq 35	C 35 N, Ck 35, Cq 35
24 CrMo 5	Ck 35, Cq 35, 24 CrMo 5
21 CrMoV 5 7	24 CrMo 5 21 CrMoV 5 7
40 CrMoV 4 7	21 CrMoV 5 7
X 22 CrMoV 12 1 X 19 CrMoVNbN 11 1	X 22 CrMoV 12 1
X 8 CrNiMoBNb 16 16	X 8 CrNiMoBNb 16 16
X 5 NiCrTi 26 15	X 5 NiCrTi 26 15
NiCr20TiAl	NiCr20TiAl

N o t e: If in bolted joints fasteners of these materials together with extension sleeves are used, sleeves of the same material as the bolts are recommended.

Stainless steel

Designation system



1) Stabilized by titanium, niobium or tantalum to reduce risk of inter-granular corrosion
2) Low carbon stainless steels with carbon content not exceeding 0,03% may additionally be marked with an L. Example: A4L - 80
*) For tapping screws grade C3 is used.

Ferritic steel group

These corrosion resistant, magnetic steels can not normally be hardened. Even if possible in certain cases, hardening should not be done.

F1: Steel type, e.g.: **1.4016** 1.4113
Steels normally used for simpler equipment with the exception of the superferrites which have extreme low contents of C and N. The steels within grade F1 could successfully replace steels of grades A2 and A3 and be used at higher chloride contents.

Ferritic-austenitic steel group

“Duplex” steels which combine the advantages of A4 and F1 grade.

FA: Steels with better properties than steels of grade A4 and A5, especially as far as strength is concerned. They are also superior to resist pitting and crack corrosion.

Austenitic steel group

Chromium-nickel steels which are made resistant to corrosion by the self-generated chromium oxide. If the chromium oxide film is damaged, it will restore itself as long as there is oxygen in the enviroment. However, if access of oxygen is hampered by unfavorable designs or contamination, corrosion will occur.
All austenitic stainless steel fasteners are normally non-magnetic; after cold working some magnetic properties may be evident particularly for A2. When there is a risk of inter-granular corrosion, steel grades A3 and A5 (=stabilized steels) or A2L and A4L (=low carbon steel) are recommended.

Common stainless grades are:
- **A2-70 / A4-80** **for bolts, screws, studs and nuts**
- **A1-50** **for machined pins, slotted set screws, specials**

A1: Steel type, e.g.: **1.4305** 1.4300
Chromium-nickel-steels specially designed for machining. Due to the elevated content of sulphur, the steels within this grade have lower resistance to corrosion than corresponding steels with normal content of sulphur. Weldability is possible but not good.

A2: Steel type, e.g.: **1.4301** 1.4303 1.4306** (= A2L) 1.4311 (= A2L)
Chromium-nickel steels most frequently used **(stainless steel)**. They are suitable for kitchen equipments and apparatus for the chemical industry. Steels within this grade are not suitable for use in non-oxidizing acid and agents with chloride content, i. e. swimming pools and sea water. Good weldability.

A3: Steel type, e.g.: **1.4541** 1.4550
Stabilized “stainless steels” with properties similar to A2.

A4: Steel type, e.g.: **1.4401** 1.4435** (= A4L) 1.4436 1.4406** (= A4L) 1.4429** (= A4L)
Acid proof steel. Chromium-nickel steels which are molybdenum alloyed and give a considerably better resistance to corrosion than A1, A2 and A3.
A4 is used to a great extent by the cellulose industry as this steel grade is developed for boiling sulfuric acid (thus given the name “acid proof”) and is to a certain extent also suitable in an environment with chloride content. A4 is also frequently used by the food processing industry and by the marine industry. Good weldability.

A5: Steel type, e.g.: **1.4571** 1.4580
Stabilized “acid proof steels” with properties similar to A4.

Other types: Steel type e.g.: 1.4439 1.4539 1.4529 1.4565 1.4426
Austenitic stainless steels with particular resistance to chloride induced stress corrosion. The risk of failure of bolts, screws and studs due to chloride induced stress corrosion (for example in indoor swimming pools) can be reduced by using these types of steels.

** = Excellent resistance to inter-granular corrosion

Martensitic steel group

Steels with somewhat limited resistance to corrosion, but which can be heat treated to excellent strength. Magnetic.

C1: Steel type, e.g.: **1.4006** 1.4021 1.4028
Steels used in turbines, pumps and knives.

C3: Steel type, e.g.: **1.4057**
Resistance to corrosion better than C1. Used in pumps, valves and apparatus.

C4: Steel type, e.g.: (**1.4104** most commonly used)
Steels intended for machining, otherwise they are similar to steels of grade C1.

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TECHNICAL INFORMATION and DATA

Stainless steel grades

Mechanical properties according DIN-ISO 3506

Steel group	Steel grade	Property class	low nuts	Diameter range	Bolts: Tensile strength R_m[1]) N/mm² min.	Bolts: Stress 0,2% permanent strain $R_{p\ 0,2}$[1]) N/mm² min.	Bolts: Elongation after fracture A_L[2]) mm min.	Nuts: Stress under proof load S_p N/mm²	Nuts: low nuts	Bolts and nuts: Hardness HV min.	Bolts and nuts: Hardness HV max.
Austenitic	A 1 A 2, A 4 A 3, A 5	50	025	≤ M 39	500	210	0,6 d	500	250		
		70	035	≤ M 24[5])	700	450	0,4 d	700	350		
		80	040	≤ M 24[5])	800	600	0,3 d	800	400		
		100[4])		≤ M 16	1000	750	0,25 d	1000			
		12 H		≤ M 24						125	200
		21 H		≤ M 24						210	–
Martensitic	C 1	50	025		500	250	0,2 d	500	250	155	220
		70			700	410	0,2 d	700	350	220	330
		110	055		1100	820	0,2 d	1100	550	350	440
	C 3	80	040		800	640	0,2 d	800	400	240	340
	C 4	50			500	250	0,2 d	500		155	220
		70	035		700	410	0,2 d	700	350	220	330
Ferritic	F 1[3])	45	020		450	250	0,2 d	450	200	135	220
		60	030		600	410	0,2 d	600	300	180	285

[1]) The tensile stress is calculated on the thread stress area.
[2]) To be determined on the actual screw length and not on a prepared test piece. d = nominal diameter.
[3]) For grade F 1 diameter M 24 is maximum.
[4]) Not in the standard: A4 - 100 in production quantity upon request.
[5]) For fasteners with nominal thread diameters d > 24 mm the mechanical properties shall be agreed upon between user and manufacturer.

Note: M 22 and M 24 screws according old DIN standard have lower properties (approximately class 50).

Lower yield stress (R_{eL}) and stress at 0,2% permanent strain ($R_{p\ 0,2}$) at elevated temperatures in % of the values at room temperature.

Steel grade	+ 100 °C	+ 200 °C	+ 300 °C	+ 400 °C
A 2, A 4, A 3, A 5	85[1])	80[1])	75[1])	70[1])
C 1	95	90	80	65
C 3	90	85	80	60

[1]) This applies to property classes 70 and 80 only. For property class 50 see DIN 17440.

Fasteners of grade A1, F1 and C4 are not to be used at elevated temperatures.

Coefficients of friction for the bearing area (bolt or nut) and the thread μ_{total}

		type of joint	**Nut** A2 or A4: plain or slighly lubricated	**Nut** A2 or A4: MoS_2 lubricated
Bolt: cold formed A2/A4 rolled thread	plain	hard	0,20 (to 0,30)	0,10 (to 0,14)
		soft	0,30 (to 0,50)	0,16 (to 0,20)

Preload F_V and tightening torque Ma for screws and nuts with bearing surfaces according to ISO 4762/4014, 4017, resp. 4032/DIN 912, 931, 933 resp. 934

	μ tot. = 0,10						μ tot. = 0,20 (μ thr = 0,25, μ hd = 0,16)					
Thread diameter	Preload F_V in N			Tightening torque M_A in Nm			Preload F_V in N			Tightening torque M_A in Nm		
	A2-50 A4-50	A2-70 A4-70	A2-80 A4-80	A2-50 A4-50	A2-70 A4-70	A2-80 A4-80	A2-50 A4-50	A2-70 A4-70	A2-80 A4-80	A2-50 A4-50	A2-70 A4-70	A2-80 A4-80
M4	1400	3000	4000	0,8	1,7	2,3	1110	1700	3200	1,2	2,6	3,5
M5	2260	4800	6500	1,6	3,4	4,5	1790	2700	5100	2,4	5,1	6,8
M6	3200	6800	9100	2,7	5,8	7,8	2560	5500	7500	4,1	8,7	12
M8	5900	12500	16800	6,6	14	19	4720	10200	13500	10	22	29
M10*	9400	20000	26700	13	28	36	7520	16800	21400	21	43	57
M12*	13600	29200	38900	23	49	65	10900	23400	31200	35	75	99
M14*	18700	40000	53400	36	77	103	15000	32100	42800	55	119	157
M16	25800	55200	73600	56	120	160	20500	44000	58600	86	189	249
M18	32200	69000	91800	80	175	230	26000	55600	74100	124	265	351
M20	41300	88600	118000	112	240	320	33200	71100	94800	173	373	497
M22**	51800	109000 A)	–	150	315 A)	–	41500	88000 A)	–	238	495 A)	–
M24	59700	128000 A)	–	195	412 A)	–	48000	102000 A)	–	297	641 A)	–
M27	78400	–	–	285	–	–	63100	–	–	443	–	–
M30	95500	–	–	400	–	–	76900	–	–	605	–	–
M8 x1	6400	13800	18400	7,2	15	21	5150	11000	14700	11	24	31
M10 x1,25*	10000	21500	28700	14	30	39	8100	17300	23000	22	46	60
M12 x1,25*	15300	32800	43700	25	53	70	12300	26400	35300	38	82	108
M12 x1,5*	14400	31000	41300	24	51	68	11700	24910	33200	37	78	104
M14 x1,5*	20700	44300	45900	39	84	113	16600	35700	47600	61	130	173
M16 x1,5	28000	60000	80200	60	126	170	22700	48200	64300	91	195	259
M18 x1,5	37400	80000	107000	90	190	255	30400	65200	86800	141	303	400
M20 x1,5	47300	100000	1350000	125	265	350	38300	82000	109100	200	421	562
M22 x1,5**	58400	122000 A)	–	165	351 A)	–	47200	100000 A)	–	265	556 A)	–
M24 x2	66600	140000 A)	–	210	446 A)	–	54000	115000 A)	–	330	709 A)	–
M27 x2	86600	–	–	300	–	–	70000	–	–	486	–	–
M30 x2	109000	–	–	430	–	–	88600	–	–	681	–	–

*, **: refer to page T 21
A) **Note: For M22 and M24 screws according old DIN standard use 45% lower torque values (preload also 45% lower)**

Minimum breaking torques ($M_{B\ min}$) for bolts and screws of stainless steel grades A1, A2, A3, A4, A5

Thread diameter	Minimum breaking torques in Nm: class 50	class 70	class 80
M 1,6	0,15	0,2	0,24
M 2	0,3	0,4	0,48
M 2,5	0,6	0,9	0,96
M 3	1,1	1,6	1,8
M 4	2,7	3,8	4,3
M 5	5,5	7,8	8,8
M 6	9,3	13,0	15,0
M 8	23,0	32,0	37,0
M 10	46,0	65,0	74,0
M 12	80,0	110,0	130,0
M 16	210,0	290,0	330,0

Stainless steel grades

Chemical composition

Group	Grade	Chemical composition, mass content %[1]									
		C	Si	Mn	P	S	Cr	Mo[7]	Ni	Cu	Notes
Austenitic	A 1	0,12	1	6,5	0,2	0,15–0,35	16–19	0,7	5–10	1,75–2,25	[2] [8] [13]
	A 2	0,1	1	2	0,05	0,03	15–20	–	8–19	4	[6] [9] [12]
	A 3	0,08	1	2	0,045	0,03	17–19	–	9–12	1	[3] [4] [8]
	A 4	0,08	1	2	0,045	0,03	16–18,5	2–3	10–15	1	[5] [12]
	A 5	0,08	1	2	0,045	0,03	16–18,5	2–3	10,5–14	1	[3] [4] [5]
Martensitic	C 1	0,09–0,15	1	1	0,05	0,03	11,5–14	–	1	–	[5]
	C 3	0,17–0,25	1	1	0,04	0,03	16–18	–	1,5–2,5	–	
	C 4	0,08–0,15	1	1,5	0,06	0,15–0,35	12–14	0,6	1	–	[2] [5]
Ferritic	F 1	0,12	1	1	0,04	0,03	15–18	–	1	–	[6] [10] [11]
Austenitic-Ferritic	FA[14]	0,03	1,7	1,5	–	–	18–19	2–2,7	4,5–5	–	N = 0,07
		0,03	1	2	–	–	21–23	2,5–3	5–5,5	–	N = 0,14

[1]) Values are maximum unless otherwise indicated.
[2]) Sulphur may be replaced by selenium.
[3]) Must contain titanium ≥ 5 x C up to 0,8% maximum for stabilization, or[4]).
[4]) Must contain niobium (columbium) and/or tantalum ≥ 10 x C up to 1% maximum for stabilization, or[3]).
[5]) At the option of the manufacturer the carbon content may be higher where required to obtain the specified mechanical properties at larger diameters, but shall not exceed 0,12% for austenitic steels.
[6]) Molybdenum may also be present at the option of the manufacturer.
[7]) If for some applications a maximum molybdenum content is essential, this must be stated.
[8]) If the nickel content is below 8%, the minimum manganese content must be 5%.
[9]) If the chromium content is below 17%, the minimum nickel content should be 12%.
[10]) May contain titanium ≥ 5 x C up to 0,8% maximum.
[11]) May contain niobium (columbium) and/or tantalum ≥ 10 x C up to 1,0% maximum.
[12]) For austenitic stainless steels having a maximum carbon content of 0,03%, nitrogen may be present to a maximum of 0,22%.
[13]) There is no minimum limit to the copper content providing that the nickel content is greater than 8%.
[14]) For information only, will most probably be included in the future.

Corrosion resistance

Resistance group	Loss of material g/m^2 h	Loss of material in mm per year	Comments
0	max. 0,1	max. 0,11	completely resistant
1	> 0,1–1,0	> 0,11–1,1	sufficiently resistant
2	> 1,0–10,0	> 1,1–11,0	less resistant
3	> 10,0	> 11,0	not resistant
X	Risk of pitting even in resistance group 0		

The data listed are based on laboratory tests. If parts are intended for a critical application, they should be tested in a practice oriented experiment (consult an expert if necessary).

If there is a risk of inter-granular corrosion (mainly in chlorine bearing environments) use titanium or niobium stabilized steels (grade A3 or A5) or low carbon stainless steels (grade A2L or A4L). For details see ISO 3506 or consult an expert.

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TECHNICAL INFORMATION and DATA

Table of Resistance

Corrosive Agent	Concentration	L	Temperature	Material Nr. C 4021 4104	C + F 4016 4510 4057	A2 4301 4306 4541 4305 4540	A4 4401 4404 4436 4571 4435	div. 4449° 4577^ 4506+ 4539*
Acetic acid	10 %		20°C	-	0	0	0	
CH_3 COOH			boiling	2	2	0	0	
	50 %		20°C	2	1	0	0	
			boiling	3	2	1	0	
Acetic acid	100 %		20°C	1	0	0	0	
			boiling	3	2	1	1	0°
Acetic acid	10 % & 50 %		20°C	1	0	0	0	
+ hydrogen peroxide			50°C	2	0	0	0	
CH_3 COOH + H_2O_2			90°C	3	1	0	0	
Acetic anhydride	-		20°C	0	0	0	0	
$(CH_3 CO)_2 O$			boiling	2	1	0	0	
Acetone $CH_3 COCH_3$	all		20°C	1	0	0	0	
	concentrated		boiling	2	1	0	0	
Acetyl Chloride CH_3 COCl	-	x	boiling	2	1	1	0	
Acetylic acid HOOC.C_6H_4.$OCOCH_3$	-		20°C	0	0	0	0	
Acid-salt mixtures:	-		boiling	-	-	1	1	
H NO_3 fuming + 10 % potassium nitrate								
H NO_3 fuming + 10% aluminium nitrate	-		boiling	-	-	1	1	
10 % H_2 SO_4 + 10 % copper sulphate	-		boiling	2	1	0	0	
10 % H_2 SO_4 + 2 % ferric-lll-sulphate	-		boiling	3	2	2	1	
Aluminium Al	molten		750°C	3	3	3	3	
Aluminium acetate $(CH_3 COO)_3$	saturated		20°C	-	0	0	0	
	saturated		boiling	-	0	0	0	
Aluminium ammonium sulphate	-		20°C	-	-	0	0	
Al (NH_4) $(SO_4)_2$, $12H_2O$			boiling	-	-	3	2	0+°
Aluminium chloride Al Cl_3, $6H_2O$	5 %	x	50°C	-	-	2	1	0+
	25 %	x	20°C	-	-	3	2	2+
Aluminium nitrate Al $(No_3)_3$, 9H2O	-		20°C	0	0	0	0	
Aluminium sulphate Al_2 $(SO_4)_3$, 18H2O	10 %		20°C	2	1	0	0	
			boiling	3	2	1	0	
	saturated		20°C	2	2	1	0	
			boiling	3	3	2	1	0+
Ammonia NH_3	-		-	0	0	0	0	
Ammonium bifluoride NH_4 HF_2	cold saturated		20°C	3	3	0	0	
Ammonium bicarbonate NH_4 HCO_3	-		20°C	0	0	0	0	
Ammonium chloride	10 %		boiling	1	0	0	0	
(sal-ammoniac)	25 %	x	boiling	1	1	1	1	
NH_4 Cl	50 %		boiling	-	-	2	1	1+
	saturated		20°C	-	0	0	0	
	saturated		boiling	-	-	2	1	1+
with copper and zinc chlorides	cold saturated		boiling	3	3	3	3	
Ammonium hydroxide = liquid ammonia	any		20°C	0	0	0	0	
NH4 OH			boiling					
Ammonium carbonate	saturated		20°C	0	0	0	0	
$(NH_4)_2$ CO_3, H_2O	saturated		boiling	0	0	0	0	
Ammonium hexachlorostannate (IV)	cold saturated	x	20°C	2	2	1	0	
= pink salt $(NH_4)_2$ $[SnCl_6]$			60°C	3	3	3	3	
Ammonium nitrate	saturated		20°C	0	0	0	0	
NH_4 NO_3, $9H_2O$	saturated		boiling	1	0	0	0	
Ammonium oxalate	-		20°C	1	1	0	0	
$(NH_4)_2$ C_2O_4, H_2O			boiling	2	2	0	0	
Ammonium perchlorate	10 %	x	20°C	-	0	0	0	
NH_4, ClO_4			boiling	2	2	0	0	
Ammonium sulphate	saturated		20°C	1	1	0	0	
$(NH_4)_2$ SO_4	saturated		boiling	2	2	1	0	
sulphuric acid	+ 5 %		100°C	3	3	1	1	0+^
Ammonium sulphite	saturated		20°C	-	0	0	0	
$(NH_4)_2$, SO_3, H_2O	saturated		boiling	2	2	0	0	
Aniline $C_6H_5NH_2$	-		20°C	0	0	0	0	
Aniline hydrochloride $C_6H_5NH_2HCl$	5 %	x	20°C	3	3	3	3	
Antimony Sb	molten		650°C	3	3	3	3	
Antimony chloride Sb Cl_3	-		20°C	3	3	3	3	
Aqua regia H Cl + H N O_3	-	x	20°C	3	3	3	3	
Arsenic acid H_3 A_5 O_4, $^1/_2$ H_2O	-		-	0	0	0	0	
Atmosphere	-		-	1	1	0	0	
Barium chloride Ba Cl_2	-		fused mass	3	3	3	3	3°
Ba Cl_2, 2 H_2O	saturated solution	x	20°C	1	0	0	0	
			boiling	2	2	1	0	

Corrisive Agent	Concentration	L	Temperature	C	C + F	A2	A4	div.
Barium hydroxide	saturated		20°C	0	0	0	0	
$Ba(OH)_2$	saturated		boiling	0	0	0	0	
Barium nitrate $Ba(NO_3)_2$	any		boiling	0	0	0	0	
Beer	-		20°C	-	-	0	0	
			70°C	-	-	0	0	
Benzine (Gasoline) C_6H_6	-		20°C or. boiling	0	0	0	0	
Benzoic acid	all		20°C	-	0	0	0	
C_6H_5COOH	concentrated		boiling	-	0	0	0	
Blood	-		20°C	-	-	0	0	
Boric acid	all		20°C	-	0	0	0	
H_3BO_3	concentrated		boiling	1	1	0	0	
Brandy	-		20 °C	-	-	0	0	
			boiling	-	-	0	0	
Brine	-	x	20°C	-	0	0	0	
			boiling	-	-	2	1	0°
Bromine Br	-	x	20 °C	3	3	3	3	
			boiling	3	3	3	3	
Bromine water	0,03 %	x	20°C	-	-	0	0	
	0,3 %	x	20°C	-	-	1	1	
	1,0 %	x	20°C	-	-	3	3	
Buttermilk	-		20°C	1	0	0	0	
Butyric acid	100 %		20°C	-	0	0	0	
C_3H_7COOH			boiling	2	2	1	0	
Cadmium Cd	-		molten	-	-	2	2	
Calcium sulphate $CaSO_4$	saturated		20°C	-	-	0	0	
Calcium sulphite $CaSO_3$	cold saturated		20°C	-	-	0	0	
Camphor $C_{10}H_{16}O$	-		20°C	0	0	0	0	
Carbon dioxide = carbonic acid	dry		hot	0	0	0	0	
CO_2	humid		hot	1	1	0	0	
Carbon disulphide CS_2	-		20°C	0	0	0	0	
Carbon tetrachloride CCl_4	water-free		20°C	0	0	0	0	
= tetrachloromethane			boiling	0	0	0	0	
Carbonate of ammonia	cold saturated		20°C	0	0	0	0	
$NH_4HCO_3 + NH_4CO_2NH_2$			boiling	0	0	0	0	
Carnallite	cold saturated	x	20°C	2	2	-	-	0°
$KCl, MgCl_2, 6 H_2O$			boiling	3	3	1	1	0°
Cheese	-		20°C	-	-	0	0	
Chlorbenzene	dry		20°C	2	1	0	0	
C_5H_5Cl			boiling	3	2	0	0	
Chloric acid $HClO_3$	-	x	20°C	-	-	3	3	1°
Chloride of lime	dry	x	20°C	3	3	0	0	
$Ca(ClO)_2, CaO, 2H_2O$	humid		20°C	3	3	1	1	0°
bleaching solution	2,5g Cl/l		20°C	3	3	1	0	
Chlorine gas Cl gas in dry state	-		20°C	0	0	0	0	
	-		20°C	3	3	3	3	
in humid state		x	100°C	3	3	3	3	
Chloroform	water-free		20°C	0	0	0	0	
$CHCl_3$			boiling	0	0	0	0	
Chlorosulphonate acid	10 %	x	20°C	3	3	3	3	
HSO_3Cl	concentated	x	20°C	3	3	0	0	
Chlorine water water saturated with Cl	-	x	20°C	3	3	1	1	0°
Chocolate	-		20°C	0	0	0	0	
Chrimic acid	10 % pure		20°C	0	0	0	0	
CrO_2	SO_3-free		boiling	3	3	2	1	0+
	50 % pure		20°C	3	3	1	1	0+
	SO_3-free		boiling	3	3	3	2	2+
	50 % comm.		20°C	3	3	1	1	-
	with SO_3		boiling	3	3	3	3	-
Chrome sulphate $Cr_2(SO_4)_3, 18 H_2O$	hot saturated		20°C	-	0	0	0	
Cider	-		20°C	-	-	0	0	
Citric acid	1 %		20°C	1	0	0	0	
$HOC(CH_2COOH)_2COOH, H_2O$			boiling	2	1	0	0	
	10 %		20°C	2	1	0	0	
			boiling	3	2	0	0	
	25 %		20°C	2	1	0	0	
			boiling	3	3	2	0	
	50 %		20°C	2	1	0	0	
			boiling	3	3	2	1	0+
	5 %, 3 at		140°C	2	1	1	0	
Coal tar, pure	-		20°C	0	0	0	0	
			and hot					
Coffee	-		20°C	-	-	0	0	
			boiling	-	-	0	0	
Copper-ll-acetate	-		20°C	-	0	0	0	
$(CH_3COO)_2Cu, H_2O$			boiling	-	0	0	0	
Copper-ll-chloride $CuCl_2, 2 H_2O$	cold saturated	x	20°C	3	3	3	3	

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TECHNICAL INFORMATION and DATA

Corrosive Agent		Concentration	L	Temperature	C 4021 4104	C + F 4016 4510 4057	A2 4301 4306 4541 4305 4540	A4 4401 4404 4436 4571 4435	div. 4449° 4577^ 4506+ 4539*
Copper carbonate	$2\ CuCO_3,\ Cu\ (OH)_2$	-		20°C	0	0	0	0	
Copper-II-cyanide	$Cu\ (CN)_2$	hot saturated		boiling	3	2	0	0	
Copper-II-nitrate	$Cu\ (NO_3)_2,\ 3\ H_2O$	50 %		20° C	0	0	0	0	
				boiling	0	0	0	0	
Copper-II-sulphate		all		20°C and	0	0	0	0	
	$Cu\ SO_4,\ 5\ H_2O$	concentrated		boiling					
	= blue vitriol			20°C	0	0	0	0	
	+ 3 % $H_2\ SO_4$			boiling	2	2	0	0	
Creosote		-		20°C	1	1	0	0	
				boiling	2	1	0	0	
Cresol	$CH_3\ C_6\ H_4\ OH$	-		20°C	0	0	0	0	
Crude oil		-		-	0	0	0	0	
Curing solution	-	x		20°C	1	0	0	0	
Dichloroethane	$CH_2\ Cl\ .\ CH_2Cl$	-		20°C	-	-	0	0	
Dichloroethylene	CHCl : CHCl	water-free		boiling	0	0	0	0	
Diethyl ether	$(C_2\ H_5)_2\ \cdot 0$	-		boiling	0	0	0	0	
Disulphur dichloride		water-free		20°C	1	1	0	0	
	$S_2\ Cl_2$			boiling	2	2	0	0	
Drainage water		acidic		20°C	1	0	0	0	
Drainage water	= acidic water	-		20°C	1	1	0	0	
Dye bath		-		20°C	-	-	0	0	
	alkaline or neutral			boiling	-	-	0	0	
	organic acid	-		20°C	-	-	0	0	
				boiling	-	-	0	0	
	weak sulphuric acid or organic	-		20°C	-	-	0	0	
	+ sulphuric acid (H_2SO_4 below 1%)			boiling	-	-	1	0	
	strong sulphuric acid or organic			20°C	-	-	1	0	
	+ sulphuric acid (H_2SO_4 above 1 %)			boiling	-	-	1	1	0+°
Ethyl alcohol	$C_2\ H_5\ OH$	all		20°C	0	0	0	0	
(alcohol)		concentrated		boiling	0	0	0	0	
Ethyl chloride	$C_2\ H_5\ Cl$	water-free		boiling	0	0	0	0	
Ethyl glycol	CH^2OH-CH_2OH	-		20°C	2	1	0	0	
Fatty acid		commercial grade		150°C	0	0	0	0	
	= oleic acid	30 at		180°C	2	2	1	0	
	$C_{17}\ H_{33}\ COOH$			235°C	3	2	1	0	
				300°C	3	3	2	0	
Fatty acid	+ traces $H_2\ SO_4$	-		hot	-	-	2	1	0+^
Ferric-III-chloride		30 %	x	20°C	3	3	3	2	
	$Fe\ Cl_3$	50 %	x	50°C	3	3	3	3	
Ferric-III-nitrate	$Fe\ (NO_3)_3,\ 9\ H_2O$	all concentrated		20°C	0	0	0	0	
Ferro-gallic ink		-	x	20°C	1	0	0	0	
Ferrous-II-sulphate	$Fe\ (SO_4),\ 7\ H_2O$	10 %		20°C	0	0	0	0	
Ferric-III-sulphate	$Fe_2\ (SO_4)_3$	10 %		boiling	1	1	0	0	
Fluorosilicic acid (= sand acid)	$H_2\ Si\ F_6$	vapours		100°C	3	2	1	1	0°
Formaldehyde		40 %		20°C	-	0	0	0	
	HC HO			boiling	-	0	0	0	
Formic acid	H.COOH	10 %		20°C	2	1	0	0	
				70°C	3	2	1	0	
				boiling	3	3	2	1	0+
		50 %		20°C	2	2	0	0	
				70°C	3	2	2	1	
				boiling	3	3	3	1	1+
		80 %		20°C	2	2	0	0	
				boiling	3	3	2	1	1+
		100 %		20°C	1	1	0	0	
				boiling	3	3	2	1	0+
Fruit juices		-		20°C	-	-	0	0	
and fruit acids				boiling	-	-	0	0	
Fruit pulp	containing SO_2	-		-	-	1	0	0	
fuming		-		20°C	-	0	0	0	
	(11 % free SO_3)			100°C	3	3	1	0	
fuming		-		20°C	-	0	0	0	
	(60 % free SO_3)			80°C	3	3	0	0	
Gallic acid		hot saturated		20°C	0	0	0	0	
	$C_6\ H_2\ (OH)_3\ COOH$			boiling	-	0	0	0	
Glue	(also acidic)	-		boiling	0	0	0	0	
Glycerine		concentrated		20°C	0	0	0	0	
	$C_3\ H_5\ (OH)_3$			boiling	0	0	0	0	
Humid		-		-	3	3	0	0	
Hydrazine sulphate	$(NH_2)_2\ H_2\ SO_4$	10 %		boiling	-	-	2	2	1+

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Hydrochloric acid	H Cl	0,5%	x	20°C	3	2	1	1	0°+^*
				boiling	3	3	3	3	
Hydrocyanic acid	HCN	-		20°C	-	0	0	0	
Hydrofluoric acid	H_2F_2	40 %		20°C	3	3	3	3	
Hydrogen chloride		-	x	20°C	3	2	1	1	
	H Cl	-	x	50°C	3	2	1	1	
		-	x	100°C	3	3	2	1	
			x	400°C	3	3	3	3	
Hydrogen fluoride	H F	gaseous form		100°C	3	3	1	1	
		dry							
Hydrogen peroxide	$H_2 O_2$	-		20°C	0	0	0	0	
Hydrogen sulphide		<4		20°C	0	0	0	0	
	dry			100°C	0	0	0	0	
	$H_2 S$			<400°C	2	2	0	0	
Hydroxylamine sulphate		10 %		20°C	-	-	0	0	
	$(NH_2 OH)_2 H_2 SO_4$			boiling	-	-	0	0	
Iodine		dry		20°C	0	0	0	0	
		humid	x	20°C	2	2	1	0	
Iodine, tincture of		-	x	20°C	2	2	1	1	0°
Iodoform		vapours		20°C	0	0	0	0	
	CHJ_3			60°C	0	0	0	0	
Iron phosphate	(by the bonderizing process)	-		98°C	1	0	0	0	
Lactic acid		1,5 %		20°C	1	0	0	0	
	CH_3 CHOH COOH			boiling	-	1	0	0	
		10 %		20°C	1	1	0	0	
				boiling	3	3	2	1	0+
		80 %		20°C	1	1	0	0	
				boling	3	2	2	1	0+
		concentrated		20°C	1	1	0	0	
				boiling	3	2	2	1	0+
Lead 3 Pb		molten		400°C	-	-	-	-	
				600°C	-	-	1	-	
Lead acetate = sugar of lead		all		20°C	-	0	0	0	
	Pb $(CH_3 COO)_2$, $3H_2O$	concentrated		boiling	1	0	0	0	
Lead nitrate	Pb (NO3)2	-		20°C	1	0	0	0	
Lemon juice		-		20°C	-	-	0	0	
Linseed oil		-		20°C	0	0	0	0	
	+ 3 % $H_2 SO_4$			200°C	-	-	0	0	
Liqueur		-		-	0	0	0	0	
Lysoform		-		boiling	0	0	0	0	
Lysol		-		boiling	0	0	0	0	
Magnesium carbonate	Mg CO_3	-		20°C	0	0	0	0	
Magnesium chloride		10 %	x	20°C	2	1	0	0	
	Mg Cl_2, 6 H_2O	30 %		20°C	2	1	0	0	
Magnesium sulphate	= Epsom salts	concentrated		20°C	2	1	0	0	
	Mg SO4, 7 H_2O			boiling	-	-	0	0	
Maleic acid	$(CH CO OH)_2$	50 %		100°C	0	0	0	0	
Malic acid		to 50 %		20°C	-	0	0	0	
	$(COOH)_2$ CH_2 CH OH			50°C	0	0	0	0	
				100°C	0	0	0	0	
Manganese-ll-chloride		10 %		boiling	-	-	0	0	
	Mn Cl_2, 4 H_2O	50 %		boiling	-	-	0	0	
Manganese-ll-sulphate	Mn SO4, 7 H_2O	-		20°C	0	0	0	0	
Meat		-		-	-	0	0	0	
Melted fat		-		20°C	0	0	0	0	
Mercuric cyanide	Hg $(CN)_2$	-		-	2	2	0	0	
Mercury Hg		-		20°C	0	0	0	0	
				50°C	0	0	0	0	
Mercury-ll-acetate		cold saturated		20°C	0	0	0	0	
Hg $(CH_3 COO)_2$		hot saturated		boiling	-	0	0	0	
Mercury-ll-chloride		0,1 %	x	20°C	2	1	0	0	
Hg Cl_2 (sublimate)				boiling	3	2	1	0	
Mercury-ll-chloride		0,7 %		20°C	2	2	1	1	0°
		boiling	3	3	2	2	1°		
Mercury-ll-nitrate (Hg $NO_3)_2$, 2 H_2O		-		boiling	0	0	0	0	
Methyl alcohol		all		20°C	0	0	0	0	
	C H_3 O H	concentrated		65°C	0	0	0	0	
Methyl chloride	CH_3 Cl	water-free		boiling	0	0	0	0	
Methylene chloride	CH_2 Cl_2	water-free		boiling	0	0	0	0	
Milk		fresh		to 70°C	-	0	0	0	
		sour		to 70°C	-	1	0	0	

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Mixed acid		50 % H_2SO_4		50°C	3	2	0	0	
	(nitrating acids)	+ 50 %		90°C	3	3	1	1	
		HNO_3		120°C	3	3	2	2	
		75 % H_2SO_4		50 %	3	2	1	0	
		+ 25 %		90°C	3	3	1	1	
		HNO_3		157°C	3	3	3	3	
		20 % H_2SO_4		50°C	3	3	0	0	
		+ 15 %		80°C	3	3	1	0	
		HNO_3							
		70 % H_2SO_4		50°C	3	3	0	0	
		+ 10 %		90°C	3	3	1	0	
		HNO_3		168°C	3	3	3	3	
		30 % H_2SO_4		90°C	3	3	0	0	
		+ 5 %		110°C	3	3	1	0	
		HNO_3							
		15 % H_2SO_4		134°C	3	3	1	1	
		+ 5 %							
		HNO_3							
		2 % H_2SO_4		boiling	3	3	2	0	
		+ 1 %							
		HNO_3							
Monochloroacetic acid	CH_2 Cl COO H	50 %	x	20°C	3	3	3	3	
Mustard		-	x	20°C	2	0	0	0	
Nickel chloride	Ni Cl_2, 6 H_2O	-	x	20°C	-	-	1	1	
Nickel nitrate	Ni $(NO_3)_2$, 6 H_2O	-		20°C	0	-	0	0	
Nickel sulphate		-		20°C	-	-	0	0	
	Ni SO_4, 7 H_2O			boiling					
Nitric acid		7 %		20°C	0	0	0	0	
	H NO_3			boiling	1	0	0	0	
		10 %		20°C	0	0	0	0	
				boiling	1	1	0	0	
		25 %		20°C	0	0	0	0	
				boiling	2	1	0	0	
		37 %		20°C	0	0	0	0	
				boiling	2	1	0	0	
		50 %		20°C	0	0	0	0	
				boiling	2	1	1	1	
		66 %		20°C	0	0	0	0	
				boiling	3	2	0	1	
		99 %		20°C	2	1	1	2	
		(Hoko)		boiling	3	3	2	2	
Nitrous acid	H NO_2	concentrated		20°C	-	-	0	0	
Nitrous acid 60°		-		20°C	0	0	0	0	
Nitrous vitreol content 4 - 5 %		-		75°C	-	-	-	1	1+
Novocaine		-		20°C	0	0	0	0	
Oil	(lubricating oil)	-		20°C	0	0	0	0	
		-		boiling	0	0	0	0	
Oil	(vegetable)	-		20°C	0	0	0	0	
				boiling	0	0	0	0	
Oxalic acid		5 %		20°C and	1	1	0	0	
	$(COOH)_2$, 2 H_2O			boiling	-	3	1	1	
		10 %		20°C	-	1	1	0	
				boiling	-	-	2	2	1+^
		25%		boiling	-	-	2	2	1+^
		50%		boiling	-	-	2	2	1+^
Paraffin		-		20°	0	0	0	0	
				molten mass	0	0	0	0	
P_3-washing powder		-		95°C	0	0	0	0	
Paris Green		-		20°C	0	0	0	0	
	3 CU (As $O_2)_3$, CU (CH_3 $COO)_2$								
Persil		-		20°C and	0	0	0	0	
				boiling					
Petrol		all concentrated		20°C	0	0	0	0	
Petrol ether		-		-	0	0	0	0	
Petroleum		-		20°C	0	0	0	0	
				boiling	0	0	0	0	
Phenol		pure		boiling	2	1	1	0	
	= carbolic acid	+ 10 % H_2O		boiling	3	1	1	0	
	C_6 H_5 OH	crude 90 % Ph		boiling	3	3	1	0	

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Phosphoric acid (pure)	1 %		20°C	-	0	0	0	
$H_3 PO_4$			boiling	1	1	0	0	
	10 %		20°C	2	1	0	0	
			boiling	2	2	0	0	
	45 %		20°C	2	2	0	0	
			boiling	3	2	2	1	1+0*
	60 %		20°C	2	2	0	0	
			boiling	3	3	2	1	1+0*
	70 %		20°C	2	2	0	0	
			boiling	3	3	2	2	1+0*
	80 %		20°C	2	2	1	0	
			boiling	3	3	3	2	1+*
	concentrated		20°C	2	2	1	0	
			boiling	3	3	3	3	
Phosphorous pentoxide $P_2 O_5$	dry or humid		20°C	-	-	1	0	
Photographic developer	-		20°C	1	0	0	0	
Photographic fixer	-	x	20°C	3	3	1	0	
Picric acid $C_6 H_2 (NO_2)_3 OH$	all concentrated		20°C	-	0	0	0	
Potassium acetate $CH_3 COO K$	-		molten	-	-	0	0	
Potassium aluminium sulphate	-		20°C	1	0	0	0	
= alum	10 %		boiling	2	2	1	0	
KAL $(SO_4)_2$, 12 H_2O	hot saturated		20°C	2	2	0	0	
			boiling	3	3	3	2	1+
Potassium bichromate	25 %		20°C	0	0	0	0	
$K_2 Cr_2 O_7$			boiling	3	2	0	0	
Potassium bifluoride KHF_2	cold saturated		20°C	3	2	0	0	
Potassium bisulphate	2 %		90°C	-	-	3	2	0+
K H SO_4	5 %		20°C	-	-	1	0	
			90°C	-	-	3	2	0+^
	15 %		90°C	-	-	3	2	1+
Potassium bisulphite	-		20°C	2	2	0	0	
Ca $H_2 (SO_3)_2$			boiling	3	3	2	0	
= sulphite lye	20 at		200°C	3	3	3	0	
Potassium bitartrate = tartar	hot saturated		cold	-	-	0	0	
K H $C_4 H_4 O_6$			boiling	-	-	2	1	0+
Potassium bromide KBr	-	x	20°C	-	0	0	0	
Potassium chlorate K Cl O_3	hot saturated		boiling	-	0	0	0	
Potassium carbonate	-		20°C	0	0	0	0	
$K_2 CO_3$ = potash			boiling	1	0	0	0	
Potassium chloride	cold saturated	x	20°C	-	-	0	0	
Ca Cl_2, 6 H_2O			boiling	-	-	1	1	0°
Potassium chloride	-	x	20°C	1	0	0	0	
K Cl	hot saturated		boiling	3	1	0	0	0°
Potassium chrome alum = chrome alum	-		20°C	2	2	0	0	0+
KCr $(SO_4)_2$, 12 H_2O			boiling	3	3	3	3	1+
Potassium cyanate K O C N	-		20°C	0	0	0	0	
Potassium cyanide K C N	5 %		20°C	0	0	0	0	
Potassium cyanoferrate (lll)	-		20°C	0	0	0	0	
K_3 [Fe $(CN)_6$]	hot saturated		boiling	0	0	0	0	
Potassium cyanoferrate (ll)	-		20°C and	0	0	0	0	
K_4 [Fe $(CN)_6$], 3 H_2O			boiling					
Potassium hypochlorite Ca $(OCl)_2$, 4 H_2O	cold saturated		to 40°C	-	-	2	1	0°
Potassium hydroxide	-		20°C	0	0	0	0	
Ca $(OH)_2$ = slaked lime			boiling	-	-	0	0	
Potassium hydroxide	20 %		20°C	0	0	0	0	
= caustic potash			boiling	0	0	0	0	
	50 %		20°C	0	0	0	0	
KOH			boiling	2	1	0	0	
	hot saturated		boiling	2	1	0	0	
	fused mass		360°C	3	3	3	3	
Potassium hypochlorite	-	x	20°C	-	-	2	1	0°
K Cl O			150°C	-	-	2	1	0°
Potassium iodide	-	x	20°C	2	1	0	0	
KJ			boiling					
Potassium nitrate	25 %		20°C	0	0	0	0	
= Kalisalpeter			boiling	-	0	0	0	
K NO_3	50 %		20°C	0	0	0	0	
			boiling	-	0	0	0	
	molten mass		550°C	3	0	0	0	
Potassium oxalate	all		20°C	0	0	0	0	
$K_2 C_2 O_4$, H_2O	concentrated		boiling	-	0	0	0	
Potassium permanganate	all		20°C	0	0	0	0	
$KMnO_4$	concentrated		boiling	3	1	0	0	
Potassium sulphate	-		20°C and	-	0	0	0	
$K_2 SO_4$			boiling					

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Pyrogallic acid	= pyrogallol	all		20°C	-	0	0	0	
	$C_6 H_3 (OH)_3$	concentrated							
Quinine sulphate		-		20°C	0	0	0	0	
Salicyclic acid	$HO C_6 H_4 COOH$	-		20°C	-	0	0	0	
Sauerkraut pickle		-	x	-	-	-	2	1	
Silver bromide	Ag Br	-	x	20°C	-	0	0	0	
Silver chloride	Ag Cl	-	x	-	-	3	3	3	
Silver nitrate		10 %		boiling	0	0	0	0	
	$Ag No_3$	fused mass		250°C	3	2	0	0	
Spinning bath	$H_2 SO_4$	up to 10 %		70°C	3	3	2	1	0+^
(viscous bath)	$H_2 SO_4$	ovet 10 %		70°C	3	3	3	3	1+^
Soap		-		20°C	0	0	0	0	
Sodium acetate	$CH_3 COO Na, 3 H_2O$	saturated		boiling	0	0	0	0	
Sodium bicarbonate	$Na H CO_3$	jede		20°C	0	0	0	0	
Sodium bisulphate	$Na H SO_4, H_2O$	10 %		boiling	-	-	1	0	
Sodium bisulphite	$Na H SO_3$	50 %	x	boiling	-	-	0	0	
Sodium bromide	Na Br	20 %	x	80°C	-	-	-	-	0°
Sodium carbonate		10 %		boiling	0	0	0	0	
	$Na_2 CO_3, 10 H_2O$	cold saturated		boiling	0	0	0	0	
		fused mass		900°C	3	3	3	3	
Sodium chlorate		30 %	x	20°C and	-	-	0	0	
	$Na Cl O_3$			boiling					
Sodium chloride		cold saturated	x	20°C	1	0	0	0	
	Na Cl			100°C	2	0	1	0	
	= table salt	hot saturated		100°C	3	2	1	1	0°
Sodium chlorite		5 %		20°C	-	-	2	2	1°
	$Na Cl O_2$			boiling	-	-	3	2	2°
Sodium fluoride	Na F	5 %		20°C	-	-	-	0	
Sodium hydrogenphosphate		-		boiling	-	0	0	0	
	$Na_2 HPO_4, 12 H_2O$								
Sodium hydroxide		25 %		20°C	0	0	0	0	
	= caustic soda			boiling	2	2	1	1	0+
		50 %		boiling	3	2	2	2	1+
	Na O H	fused mass		320°C	3	3	3	3	3+
Sodium hypochlorite	Na Cl O	5 %	x	20°C	3	2	1	1	0°
	= bleach			boiling	3	3	1	1	1°
Sodium nitrate		-		20°C	0	0	0	0	
	$Na NO_3$			boiling	0	0	0	0	
	= sodium salpeter	fused mass		360°C	0	0	0	0	
Sodium nitrite	$Na NO_2$	hot saturated		boiling	-	0	0	0	
Sodium p-toluensulphonchloramine		-		20°C and	-	-	1	0	
= chloramine-T				boiling					
$CH_3 C_6 H_4 SO_2 NCINa, 3 H_2O$									
Sodium perborate	$Na BO_3, 4 H_2O$	cold saturated		20°C	-	0	0	0	
Sodium perchlorate	$Na Cl O_4, 4 H_2O$	10 %		boiling	2	2	0	0	
Sodium peroxyd	$Na_2 O_2$	10 %		20°C	2	1	0	0	
				boiling	3	2	0	0	
	stabilized by 10% sodium silicate	10 %		to 80°C	3	2	0	0	
Sodium phosphate sec.		-		20°C and	0	0	0	0	
	$Na_2 PO_4, 12 H_2O$			boiling					
Sodium phosphate tert.		-		20°C and	0	0	0	0	
	$Na_3 PO_4, 12 H_2O$			boiling					
Sodium salicylate	$HO C_6 H_4 COO Na$	-		20°C	0	0	0	0	
Sodium silicate		-		20°C and	0	0	0	0	
	$Na_2 SiO_3$			boiling					
Sodium sulphate	= Glauber salt	cold saturated		20°C	-	0	0	0	
	$Na_2 SO_4, 10 H_2O$			boiling	1	0	0	0	
Sodium sulphide		25 %		boiling	-	2	0	0	
	$Na_2 S, 9 H_2O$	sat. soln.		100°C	-	-	1	1	1+
Sodium sulphite	$Na_2 SO_3, 7 H_2O$	50 %		boiling	2	2	0	0	
Sodium tetraborate		saturated		20°C	0	0	0	0	
	= borax			boiling	0	0	0	0	
	$Na_2 B_4 O_7, 10 H_2O$	molten			3	3	3	3	
Sodium thiosulphate		25 %		20°C	-	0	0	0	
	$Na_2 S_2 O_3, 5 H_2O$			boiling	-	0	0	0	
Soft soap		-		20°C	0	0	0	0	
Stearic acid		-		20°C	0	0	0	0	
	$C_{17} H_{35} COOH$			130°C	-	-	0	0	
Sugar solution		-		20°C	0	0	0	0	
				boiling	0	0	0	0	

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Corrosive Agent	Concentration	L	Temperature	C	C + F	A2	A4	div.
Sulphur dry	molten		130°C	0	0	0	0	
	simmering		445°C	3	3	2	2	
Sulphur wet	-		20°C	-	1	1	0	
Sulphuric acid	1 %		20°C	3	3	1	0	
$H_2 SO_4$			70°C	3	3	1	0	
			boiling	3	3	1	1	0+*
	2,5 %		20°C	3	3	1	0	
			70°C	3	3	1	0	
			boiling	3	3	2	2	0+*
	5 %		20°C	3	3	1	0	
			70°C	3	3	1	1	0+*
			boiling	3	3	3	2	1+
	7,5 %		20°C	3	3	1	0	
			70°C	3	3	1	1	0*
			boiling	3	3	2	2	1+
	10 %		20°C	3	3	2	1	0+
			70°C	3	3	2	2	1+0*
			boiling	3	3	3	2	1+
	20 %		20°C	3	3	1	1	0+
			70°C	3	3	2	2	1+0*
			boiling	3	3	3	3	1+
	40 %		20°C	3	3	1	1	0+
			70°C	3	3	2	2	1+0*
			boiling	3	3	3	3	2+
	60 %		20°C	3	3	3	2	0+
			70°C	3	3	3	3	1+0*
			boiling	3	3	3	3	
	80 %		20°C	3	3	1	1	0+*
			70°C	3	3	3	2	1+*
			boiling	3	3	3	3	
	98 %		20°C	-	0	0	0	0
	concentrated		70°C	2	2	2	2	1+*
			150°C	3	3	2	2	
			boiling	3	3	3	3	
Sulphurous acid	saturated		20°C	3	2	0	0	
$H_2 S O_3$	4at		135°C	3	2	1	0	
	5 - 8 at		160°C	3	3	2	1	0+
	10 - 20 at		180° -200°C	3	3	2	1	1+
Sulphurous Gas SO_2	-		up to100°C	3	2	0	0	
humid, free of SO_3			>100°C	3	3	1	0	
			>300°C	3	3	1	1	0+
			900°C	3	3	3	2	0+
Superphosphate	-		20°C	-	-	0	0	
$Ca (H_2 PO_4)_2$ + Ca So_4 + 3 % $H_2 SO_4$								
Tannic acid	5 %		20°C	0	0	0	0	
= tannin			boiling	1	0	0	0	
	10 %		20°C	0	0	0	0	
			boiling	1	0	0	0	
	50 %		20°C	0	0	0	0	
			boiling	1	1	0	0	
Tartaric acid	10 %		20°C	1	0	0	0	
COOH $(CHOH)_2$ COOH			boiling	2	2	0	0	
	50 %		20°C	2	1	0	0	
			boiling	3	2	2	2	1+
Thioglycollic acid	-		20°C	-	-	-	1	0+
HS CH_2 COOH			boiling	-	-	-	1	0+
Tin Sn	molten		300°C	2	2	0	0	
			400°C	3	3	1	1	
			600°C	3	3	3	3	
Tin-IV-chloride	-	x	20°C	3	3	3	2	
Sn Cl_4			boiling	3	3	3	3	
Tin-II-chloride	hot saturated	x	50°C	3	2	1	0	
Sn Cl_2, 2 H_2O			boiling	3	3	3	3	
Toluene	-		20°C and	0	0	0	0	
$C_6 H_5 CH_3$			boiling					
Trichloroethylene $C_2 H Cl_3$	-		boiling	0	0	0	0	
Trichloroacetic acid C Cl_3 - COOH	water free	x	20°C	-	-	3	3	
Turpentine, oil of	-		20°C	0	0	0	0	
			and hot					
Urea CO $(NH_2)_2$	-		20°C	0	0	0	0	
Urine	-	x	20°C	-	-	0	0	
			boiling	-	-	0	0	
Varnish = copal varnish	-		-	0	0	0	0	
Vaseline	-		20°C	0	0	0	0	
			hot	0	0	0	0	
Vegetables	-		boiling	-	-	0	0	0

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Corrosive Agent		Concentration	L	Temperature	C 4021 4104	C + F 4016 4510 4057	A2 4301 4306 4541 4305 4540	A4 4401 4404 4436 4571 4435	div. 4449° 4577^ 4506+ 4539*
Vinegar		-		20°C	0	0	0	0	
	= wine vinegar			boiling	2	1	0	0	
Washing powder		-		-	-	0	0	-	
Waste water	(acid-free)	-		to 40°C	1	0	0	0	
Waste water	(with traces of sulphuric acid)	-		to 40°C	2	2	0	0	
Water	tap water	-		20°C	0	0	0	0	
Waterglass (sodium silicate)		-		20°C	0	0	0	0	
				boiling	0	0	0	0	
Water vapour		-		400°C	0	0	0	0	
Water vapour with SO_2				-	2	-	1	0	
Water vapour with CO_2		-		-	2	2	0	0	
Wine	(red wine, white wine)	-		20°C	-	-	0	0	
		-		hot	-	-	0	0	
Xylol		-		20°C	0	0	0	0	
	$C_6H_4(CH_3)_2$			boiling					
Zink Zn		molten		500°C	3	3	3	3	
Zink chloride		-	x	20°C	1	1	0	0	
	$Zn\,Cl_2$			45°C	-	-	2	1	1°
				boiling	3	3	3	2	1°
Zink cyanide dampened with water	$Zn(CN)_2$	-		20°C	1	1	0	0	
Zink sulphate		cold saturated		20°C	-	-	0	0	
	$Zn\,SO_4$, 7 H_2O			boiling	-	-	0	0	
		hot saturated		boiling	2	2	0	0	

Alcohol	=	methyl and ethyl alcohol	Slaked lime	=	calcium hydroxide
Alum	=	potassium aluminium sulphate	Soda	=	sodium carbonate
Ammonium alum	=	aluminium ammonium sulphate	Spirits of wine	=	ethyl alcohol
Antichlor	=	sodium thiosulphate	Sugar of lead	=	lead acetate
Aspirin	=	acetylic acid	Steam	=	water vapour
Bleach	=	sodium hypochloride	Sublimate	=	mercury-II-chloride
Bleach	=	sodium hypochloride and / chlorite	Sulphite lye	=	calcium bisulphite
Bleaching solution	=	chloride of lime	Sulphur (II) chloride	=	sulphur dichloride
Bonderizing solution	=	iron phosphate	Sulphur dioxide	=	sulphurous acid (gas)
Borax	=	sodium tetraborate	Tannic	=	tannic acid
Carbolic acid	=	phenol	Tartar	=	potassium bitartrate
Caustic potash	=	potassium hydroxide	Tetrachloromethane	=	carbon tetrachloride
Caustic soda	=	sodium hydroxide	Trisodium	=	sodium phosphate tert.
Chloramine- T	=	sodium p-toluensulphonchloramine	Wine vinegar	=	vinega
Chloride of lime	=	calcium chloride	Yellow prussiate of potash	=	potassium ferrocyanide (II)
Chloroacetic acid	=	mono- and trichloroacetic acid			
Chrome alum	=	potassium chrome alum			
Cynide of potash	=	potassium cyanide			
Developer	=	photographic developer			
Epsom salts	=	magnesium sulphate			
Ethylene dichloride	=	Dichloroethane			
Fixer	=	photographic fixing agent			
Glacial acetic acid	=	acetic acid			
Glauber salt	=	sodium sulphate			
Hydrochloric acid gas form	=	hydrogen chloride gas			
Industrial air	=	atmosphere			
Ink	=	ferro-gallic ink			
Liquid ammonia	=	Ammonium hydroxyde			
Lubricating oil	=	oil			
Methyl aldehyde	=	formaldehyde			
Nitrating acids	=	mixed acid			
Oleic acid	=	Fatty acid			
Pink salt	=	ammonium hexachlorostannate (IV)			
Potash	=	potassium carbonate			
Precipitating bath	=	spinning bath			
Prussic acid	=	hydrocyanic acid			
Prussiate of potash	=	potassium cyanoferrate (III) (red) potassium cyanoferrate (II) (yellow)			
Pulp	=	fruit pulp			
Quicklime	=	calcium hydroxide			
Red prussiate of potash	=	potassium ferrocyanide (III)			
Refrigerating brine	=	calcium chloride			
Sal-ammoniac	=	Ammonium chloride			
Saltpeter	=	potassium nitrate / sodium nitrate			
Sea-water	=	salt-water			
Silver bromide	=	Silver bromide			

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Special materials
High-performance, corrosion and heat resistant alloys

Consult the steel manufacturer for particular applications!

Alloy	Range of application and special properties
Monel 400 2.4360 K-500 2.4375	Is especially resistant to hydrochloric and hydrofluoric acids in the unaerated condition. It is successfully utilized in the production of salt. The alloy has good resistance to cavitation and erosion in sea water and brackish water at high flow rates. The alloy is highly corrosion resistant to chlorinated solvents, glass etchants, sulphuric and other acids and almost all alkalis. It is not susceptible to stress-corrosion cracking. It can be used in oxidizing atmospheres up to 550°C and a little higher in reducing atmospheres. Usable for formed and forged fasteners.
Titanium 99,8% 3.7025 99,7% 3.7035 99,6% 3.7055 99,5% 3.7065	Alloy used where strength/weight ratio is of prime importance (43 percent lighter than stainless steel). Good fatigue resistance, high corrosion resistance in chemical processing equipment, especially in oxidizing environments. Sea water resistant.
Hastelloy B B-2 2.4617	Especially useful for equipment handling hydrogen chloride gas, aluminium chloride catalysts, hydrochloric acid, sulphuric acid, (in the absence of oxidizing contaminants), acetic and phosphoric acids. The alloy can be used in oxizing atmospheres up to 530°C and in reducing atmospheres or under vacuum at temperatures above 815°C. It is resistant to grain-boundary carbide formation and therefore does not normally require a post-weld heat-treatment. Not recommend for use in strongly oxidizing environments, mineral acids or copper-chloride; see Hastelloy C.
Hastelloy C C-4 2.4610 C-22 2.4602 C-276 2.4819	The most versatile nickel-chromium-molybdenum alloy available today, with improved resistance to both uniform and localized corrosion as well as a variety of mixed industrial chemicals. Also exhibits superior weldability. Outstanding corrosion resistance in chemical processing equipment, especially in strongly oxidizing environments, hot contaminated mineral acids, solvents, chlorine and chlorine-contaminated media (organic and inorganic), dry hypochlorite (chlorine dioxide), formic acid, acetic acid, acetic anhydride, sea water and salt solutions. Outstanding resistance in chemical processes containing Fe +++ and Cu++ chlorides. Even after exposure to temperatures in the range of 650 - 1040°C, the alloy retains high ductility and corrosion resistance. It is resistant to the precipitation of grain boundary carbides and can thus be put into service without the need for a post-weld heat treatment. Some applications: cellophane manufacturing, nuclear fuel reprocessing, chlorine spargers, pesticide production, circuit board etching equipment, complex acid mixtures, heat exchangers, electro galvanizing equipment, SO2 cooling towers, HF furnaces.
Hastelloy G G-30 2.4603	Finds application under both oxidizing and reducing conditions especially in hot phosphoric acid, sulphuric acid, and as a material of construction for gas scrubbers in flue-gas desulphurization units. Very good resistance to pitting and stress corrosion cracking.
Ninomic 75 2.4951 90 2.4969 105 2.4634	A high temperature alloy with good mechanical properties and oxidation resistance up to approximately 1000°C.
Inconel 600 2.4816 625 2.4856 718 2.4668	Oxidation resistance up to 1175°C combined with outstanding general corrosion resistance. Retains high mechanical properties up to 700°C. High fatigue resistance and outstanding creep properties at high temperatures. Good mechanical properties also at low temperatures. This alloy is also used in nuclear reactor components because of its resistance to chloride ion stress corrosion cracking. Weldable without post-weld heat-treatment.
Nilo 36 1.3912 42 1.3917 K 1.3918	An alloy with controlled thermal expansion and an controlled average coefficient of expansion (e.g. less than 1,7 x 10-6/K or between 5,95 and 6,45 1,7 x 10-6/K) in the temperature range 20-100°C.

Brass, Aluminium, Kuprodur (copper)

Mechanical properties according DIN / ISO 8839

Material		Nominal thread diameter mm		Tensile strength R_m N/mm^2	Stress at permanent set limit $R_{p\ 0,2}$ N/mm^2	Percentage elongation after fracture A_5 %
Symbol	Designation	over	to	min.	min.	min.
CU1	E-Cu57/Cu-ETP	–	39	240	160	14
CU2	CUZn37	–	6	440	340	11
		6	39	370	250	19
CU3	CuZn39Pb3	–	6	440	340	11
		6	39	370	250	19
CU4	CuSn6	–	12	470	340	22
		12	39	400	200	33
CU5	CuNi1,5 Si	–	39	590	540	12
CU6	CuZn40MnPb	6	39	440	180	18
CU7	CuAl10Ni5Fe4	12	39	640	270	15
AL1	AIMg3	–	10	270	230	3
		10	20	250	180	4
AL2	AIMg5	–	14	310	205	6
		14	36	280	200	6
AL3	AISi1MgMn	–	6	320	250	7
		6	39	310	260	10
AL4	AlCuMgSi	–	10	420	290	6
		10	39	380	260	10
AL5	AIZnMgCu0,5	–	39	460	380	7
AL6	AIZn5,5MgCu	–	39	510	440	7
TI1	TI 99,8	–	20	290	180	30
TI2	TiAI6V4	–	39	890	820	10

Cold formed bolts and nuts are primarily made of following materials:
- Brass = Ms 63 = Cu Zn 37
- Aluminium = Al Mg 3
- Kuprodur = Cu Ni 1,5 Si

Machined bolts and nuts are made of following materials:
- Brass = Ms 58 = Cu Zn 39 Pb3
- Aluminium = Al Mg Si 1

Tightening torques Ma in (Nm) for screws made of:

∅	M2	M2,5	M3	M3,5	M4	M5	M6	M8	M10
Brass Ms 63 Ms 63	0,14	0,29	0,50	0,79	1,2	2,2	3,9	9	17
Aluminium Al Mg 3	0,10	0,20	0,36	0,57	0,85	1,6	2,8	7	13
Kuprodur Cu Ni 1,5 Si					2,3	4,7	8	19,5	38

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Polyamid 66 (nylon®)

Mechanical properties (dry)	Dry	Humid
Yield strength N/mm^2 (MPa)	85 N/mm^2	60 N/mm^2
Elongation %	30–60%	120–280%
Bending stress max.	130–135 N/mm^2	–
Elasticity module N/mm^2	2600–2900 N/mm^2	1700–2000 N/mm^2
Moisture absorption %	3,4–3,8%	–

Thermal properties (dry)	Dry	Humid
Smelting temperature	250–255 °C	–
Heat resistance briefly, max. Heat resistance continuously	150-170 °C 80–100 °C	–

Chemical properties:

Resistant against:
Acetone, Ammonia 10%, Brandy, Butter, Citric acid 10%, Diesel, Formaldehyde, Fruit juice, Gasoline, Glycerine 90%, hydrogen peroxide, Ink, Mercury, Methanol, Milk acid 10%, Mineral oil, Petroleum, Potassium hydoxide 50%, Potassium nitrate 10%, Soap solution 1%, Sodium carbonate 10%, Sodium chloride (salt), Sodium hydroxide 10%, Vaseline, Vegetable oils, Wax, Wine

Not resistant against:
Acetic acid, Boric acid, Chlorine gas, Chlorine water, Chloroform, Chromium trioxide, Formic acid, Hydrochloric acid, Nitric acid, Ozone, Perchloric acid, Phenol, Phosporic acid, Sulphuric acid, Hot water

Tolerances

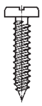
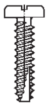
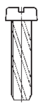
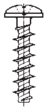
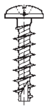
Tolerances for polyamid (nylon ®) fasteners correspond about to those of steel fasteners multiplied by 2.

Tightening torques M_A [Nm] (as guideline only)

Nominal diameter	M3	M4	M5	M6	M8	M10	M12	M16
Screws	0,1	0,2	0,5	1	2	3	4	8
Nuts	0,1	0,3	0,6	1,5	3,0	4	6	12

Fastening in plastics

Following table helps to select the correct type of screws. However, making suitable tests is recommend in any case to determine the two most important parameters: core hole diameter and thread engagement.

Inscription: δ very suitable ϕ limited suitable σ not suitable	Tapping screws  DIN standard	Tapping screws  with cutting edge	Thread cutting screws  DIN 7513 metr. thread	PT screws 	PT screws  with cutting edge
Soft thermoplasics as: CA, CAB, PUR, soft PVC, PTFE, PP, PE	δ	ϕ	σ	δ	ϕ
Hard thermoplastics as: PPO, PC, PMMA, PA, hard PVC, ABS, PS, SB, SAN, POM	ϕ	ϕ	σ	δ	ϕ
Duroplastics as: PF, UF, MF, UP, EP	σ	ϕ	δ	ϕ	δ
Suitable for reassembling:	δ	σ	ϕ	δ	ϕ

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Tightening of fasteners see prescription page T 24 below

Preload F_V and tightening torque M_a for screws and nuts with bearing surfaces according to ISO 4762, 4014, 4017 resp. 4032 / DIN 912, 931, 933 resp. 934

90% of the yield strength is utilized by preload and torque stress

	$m_{ges.} = 0{,}08$						$m_{ges.} = 0{,}10$					
Thread diameter	Preload F_V [N]			Tightening torque M_A [Nm]			Preload F_V [N]			Tightening toruqe M_A [Nm]		
	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.0	12.9
M 4	4 350	6 150	7 400	2,1	2,9	3,5	4 200	5 900	7 100	2,4	3,3	4,0
M 5	7 150	10 100	12 100	4,2	6,0	7,1	6 900	9 700	11 600	4,9	7,0	8,0
M 6	10 100	14 200	17 000	7,0	10	12	9 750	13 700	16 400	8,0	12	14
[M 7]	14 800	20 700	24 900	12	16	20	14 400	20 200	24 200	13	19	23
M 8	18 500	26 100	31 300	17	24	29	17 900	25 100	30 200	20	28	34
[M 9]	24 700	34 700	41 600	25	35	43	23 800	33 400	40 100	29	41	49
M 10 *	29 500	41 400	49 700	34	48	58	28 400	40 000	48 000	40	56	67
M 12 *	43 000	60 500	72 500	60	84	100	41 500	58 500	70 000	69	98	115
M 14 *	59 000	82 500	99 000	95	135	160	56 500	80 000	96 000	110	155	185
M 16	81 000	114 000	137 000	145	205	245	78 500	110 000	132 000	170	240	285
M 18	98 500	138 000	166 000	200	285	340	95 000	134 000	160 000	235	330	395
M 20	127 000	178 000	214 000	285	400	480	122 000	172 000	206 000	330	465	560
M 22 **	158 000	222 000	266 000	380	530	640	152 000	214 000	257 000	445	620	750
M 24	183 000	257 000	308 000	490	690	830	176 000	248 000	298 000	570	800	960
M 27	239 000	337 000	404 000	720	1 000	1 200	232 000	326 000	391 000	840	1 200	1 400
M 30	292 000	410 000	493 000	980	1 400	1 650	282 000	397 000	476 000	1 150	1 600	1 950
M 33	363 000	533 000	612 000	1 330	1 950	2 200	351 000	516 000	593 000	1 560	2 290	2 600
M 36	426 000	620 000	710 000	1 710	2 500	2 900	412 000	605 000	690 000	2 000	2 900	3 400
M 39	510 000	750 000	860 000	2 190	3 200	3 700	490 000	720 000	830 000	2 600	3 800	4 400
M 42	580 000	860 000	980 000	2 700	4 000	4 600	560 000	830 000	950 000	3 200	4 700	5 400
M 8 x 1	20 200	28 400	34 100	18	26	31	19 500	27 000	33 000	22	30	36
M 10 x 1,25 *	31 600	44 400	53 300	36	51	61	30 500	42 900	51 500	42	59	71
M 12 x 1,25 *	48 200	68 000	81 500	64	91	110	46 600	65 500	78 500	76	105	130
M 12 x 1,5 *	45 400	64 000	76 500	62	87	105	43 900	62 000	74 000	72	100	120
M 14 x 1,5 *	65 000	91 500	110 000	100	140	170	63 000	88 500	106 000	120	165	200
M 16 x 1,5	88 000	124 000	148 000	150	215	255	85 000	120 000	144 000	180	250	300
M 18 x 1,5	114 000	161 000	193 000	220	310	370	111 000	156 000	187 000	260	365	435
M 20 x 1,5	144 000	203 000	244 000	305	430	510	140 000	197 000	236 000	380	510	610
M 22 x 1,5 **	178 000	250 000	300 000	405	570	680	172 000	242 000	291 000	480	680	810
M 24 x 2	203 000	286 000	343 000	520	730	880	197 000	277 000	332 000	610	860	1 050
M 27 x 2	264 000	371 000	445 000	760	1 050	1 300	256 000	359 000	431 000	900	1 250	1 500
M 30 x 2	331 000	466 000	559 000	1 050	1 500	1 800	321 000	452 000	542 000	1 250	1 750	2 100
M 33 x 2	407 000	598 000	680 000	1 410	2 080	2 400	395 000	581 000	660 000	1 680	2 470	2 800
M 36 x 3	458 000	670 000	770 000	1 770	2 600	3 000	444 000	650 000	740 000	2 100	3 100	3 500
M 42 x 3	640 000	940 000	1 080 000	2 900	4 200	4 800	620 000	910 000	1 050 000	3 400	5 000	5 700

* Hexagonal items with width across flats according to ISO require about ca. 1,5% lower tightening torque (preload remains the same).

** Hexagonal items with width across flats according to ISO require about ca. 2% higher tightening torque (preload remains the same).

Preload and tightening torque for fastenres of lof property class:

5.8:	Preload	F_v –5.8 [N] = 0,65 x F_v –8.8 [N]
	Tightening torque	M_a –5.8 [Nm] = 0,65 x M_a –8.8 [Nm]
5.6:	Preload	F_v –5.6 [N] = 0,46 x F_v –8.8 [N]
	Tightening torque	M_a –5.6 [Nm] = 0,46 x M_a –8.8 [Nm]

Tightening of fasteners

For good functioning of the fasteners, the preload (clamping force) obtained by tightening is of significance. As a principle, fasteners are to be tightened until their lower yield stress value is reached. However, since tightening causes friction and adds additional stress on the fastener, the effective preload is lower than the yield strength. Suitable tightening torques and the resulting preload are shown in the following charts. Friction, however, has a strong influence on these figures. For normal applications (plain, slightly lubricated), start with friction coefficient $\mathbf{m}_{total}$ = 0,12 for your calculations. In other cases, refer to the following table to find the friction coefficient range.
Values for high-strength structural bolting are found on page A 53,
for stainless steel fasteners see page T 29.

Coefficients of friction in the bearing area (bolt or nut) and in the thread $\mathbf{m}_{total}$

		Nut I tapped threads, plain or phosphated I electroplating (zinc in the thread , 4 mm) I nut face according to ISO 4032 / DIN 934		
		zinc plated	plain	MoS_2 lubricated
Bolt I formed or cut I bearing surface according to ISO 4014, 4017, 4762 DIN 931, 933, 912	plain or phosphated, slightly lubricated		0,12–(0,18)	0,06–(0,12)
	zinc plated, dacrometized	0,12–(0,20)	0,12–(0,18)	0,06–(0,12)
	black or phosphated with PLUS*)		0,14–(0,20)	
	zinc plated with PLUS*)		0,14–(0,20)	
	hot-dip galvanized		0,16–(0,25)	0,08–(0,12)

*) PLUS coating = the thread is coated with an adhesive as locking feature. Addition: m-values only apply to PLUS-coatings and onmiFIT adhesives. For all other adhesives, especially anaerobic adhesives, use m_{total} = 0,20–(0,30) (please consult the manufacturer).

90% of the yield strength is utilized by preload and torque stress

Thread diameter	Preload F_V [N] (μ tot. = 0,125)			Tightening torque M_A [Nm] (μ tot. = 0,125)			Preload F_V [N] (μ tot. = 0,14)			Tightening torque M_A [Nm] (μ tot. = 0,14)		
	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.0	12.9
M 4	4 000	5 650	6 750	2,7	3,8	4,6	3 900	5 450	6 550	2,9	4,1	4,9
M 5	6 550	9 200	11 100	5,5	8,0	9,5	6 350	8 950	10 700	6,0	8,5	10
M 6	9 250	13 000	15 600	9,5	13	16	9 000	12 600	15 100	10	14	17
[M 7]	13 600	19 100	22 900	15	22	26	13 200	18 500	22 200	16	23	28
M 8	17 000	23 900	28 700	23	32	39	16 500	23 200	27 900	25	35	41
[M 9]	22 600	31 900	38 200	34	47	57	22 000	30 900	37 100	36	51	61
M 10 *	27 100	38 000	45 700	46	64	77	26 200	36 900	44 300	49	69	83
M 12 *	39 500	55 500	66 700	80	110	135	38 300	54 000	64 500	86	120	145
M 14 *	54 000	76 000	91 300	125	180	215	52 500	74 000	88 500	135	190	230
M 16	75 000	105 000	126 000	195	275	330	73 000	102 000	123 000	210	295	355
M 18	90 500	127 000	153 000	270	390	455	88 000	124 000	148 000	290	405	485
M 20	117 000	164 000	197 000	385	540	650	114 000	160 000	192 000	410	580	690
M 22 **	145 000	205 000	245 000	510	720	870	141 000	199 000	239 000	550	780	930
M 24	169 000	237 000	284 000	660	930	1 100	164 000	230 000	276 000	710	1 000	1 200
M 27	221 000	311 000	374 000	980	1 400	1 650	215 000	302 000	363 000	1 050	1 500	1 800
M 30	269 000	379 000	454 000	1 350	1 850	2 250	262 000	368 000	442 000	1 450	2 000	2 400
M 33	335 000	493 000	566 000	1 810	2 700	3 100	326 000	479 000	550 000	1 950	2 900	3 300
M 36	394 000	578 000	665 000	2 320	3 400	3 900	382 000	562 000	646 000	2 500	3 700	4 200
M 39	470 000	690 000	790 000	3 000	4 400	5 100	460 000	670 000	770 000	3 200	4 800	5 500
M 42	540 000	790 000	910 000	3 700	5 500	6 300	520 000	770 000	880 000	4 000	5 900	6 800
M 8 x 1	18 600	26 200	31 500	25	35	42	18 100	25 500	30 600	27	38	45
M 10 x 1,25 *	29 100	40 900	49 100	49	68	82	28 300	39 800	47 700	52	73	88
M 12 x 1,25 *	44 600	62 500	75 000	88	125	150	43 300	61 000	73 000	95	135	160
M 12 x 1,5 *	41 900	59 000	70 500	83	115	140	40 700	57 000	68 500	90	125	150
M 14 x 1,5 *	60 500	85 000	102 000	140	195	235	58 500	82 500	99 000	150	210	250
M 16 x 1,5	81 500	114 000	137 000	210	295	350	79 000	111 000	133 000	225	315	380
M 18 x 1,5	106 000	149 000	179 000	305	425	510	103 000	145 000	174 000	325	460	550
M 20 x 1,5	134 000	189 000	226 000	425	600	720	130 000	183 000	220 000	460	640	770
M 22 x 1,5 **	165 000	232 000	279 000	570	800	960	161 000	226 000	271 000	610	880	1 050
M 24 x 2	188 000	265 000	318 000	720	1 000	1 200	183 000	257 000	309 000	780	1 100	1 300
M 27 x 2	245 000	344 000	413 000	1 050	1 500	1 800	238 000	335 000	402 000	1 150	1 600	1 950
M 30 x 2	308 000	433 000	520 000	1 450	2 050	2 500	300 000	422 000	506 000	1 600	2 250	2 700
M 33 x 2	379 000	557 000	640 000	1 990	2 900	3 400	369 000	542 000	623 000	2 150	3 200	3 600
M 36 x 3	425 000	624 000	710 000	2 460	3 600	4 200	413 000	607 000	690 000	2 700	3 900	4 500
M 42 x 3	590 000	870 000	1 000 000	4 000	5 900	6 700	580 000	850 000	980 000	4 300	6 300	7 300

Thread diameter	Preload F_V [N] (μ tot. = 0,16)			Tightening torque M_A [Nm] (μ tot. = 0,16)			Preload F_V [N] (μ tot. = 0,20)			Tightening torque M_A [Nm] (μ tot. = 0,20)		
	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.9	12.9	8.8	10.0	12.9
M 4	3 700	5 200	6 250	3,1	4,4	5,0	3 400	4 800	5 750	3,5	4,9	6
M 5	6 100	8 600	10 300	6,5	9,0	11	5 600	7 900	9 450	7,0	10	12
M 6	8 600	12 100	14 500	11	15	18	7 900	11 100	13 300	12	17	20
[M 7]	12 600	17 800	21 300	18	25	30	11 600	16 300	19 600	20	28	34
M 8	15 800	22 300	26 700	26	37	45	14 500	20 500	24 500	30	40	50
[M 9]	21 100	29 700	35 600	39	55	66	19 400	27 300	32 700	44	62	74
M 10 *	25 200	35 500	42 600	53	75	90	23 400	32 600	39 100	60	84	100
M 12 *	36 800	51 500	62 000	92	130	155	33 900	47 600	57 000	105	145	175
M 14 *	50 500	71 000	85 000	145	205	250	46 300	65 000	78 000	165	230	280
M 16	70 000	98 000	118 000	230	320	385	64 500	90 500	108 000	255	380	435
M 18	84 000	118 000	142 000	310	435	520	77 500	109 000	131 000	350	495	590
M 20	109 000	153 000	184 000	445	630	750	100 000	141 000	169 000	500	710	850
M 22 **	136 000	191 000	229 000	600	840	1 000	125 000	176 000	211 000	680	950	1 150
M 24	157 000	221 000	265 000	770	1 100	1 300	145 000	203 000	244 000	870	1 200	1 450
M 27	207 000	291 000	349 000	1 150	1 600	1 950	190 000	268 000	321 000	1 300	1 800	2 200
M 30	252 000	354 000	425 000	1 550	2 200	2 600	232 000	326 000	391 000	1 750	2 450	2 950
M 33	313 000	460 000	528 000	2 120	3 100	3 600	288 000	424 000	487 000	2 400	3 500	4 100
M 36	368 000	540 000	621 000	2 700	4 000	4 600	338 000	497 000	571 000	3 100	4 500	5 200
M 39	442 000	650 000	740 000	3 500	5 200	5 900	408 000	599 000	680 000	4 000	5 900	6 700
M 42	500 000	740 000	850 000	4 300	6 400	7 300	460 000	680 000	780 000	4 900	7 200	8 300
M 8 x 1	17 400	24 400	29 300	29	41	49	16 000	22 500	27 000	33	46	55
M 10 x 1,25 *	27 200	38 200	45 900	57	80	95	25 000	35 100	42 200	64	90	105
M 12 x 1,25 *	41 600	58 500	70 000	105	145	175	38 400	54 000	64 500	115	165	195
M 12 x 1,5 *	39 100	55 000	66 000	97	135	165	36 000	50 500	60 500	110	155	185
M 14 x 1,5 *	56 500	79 000	95 000	160	225	270	52 000	73 000	87 500	185	255	310
M 16 x 1,5	76 000	107 000	128 000	245	345	410	70 000	98 500	118 000	275	390	465
M 18 x 1,5	99 000	139 000	167 000	355	500	600	91 000	128 000	154 000	405	570	680
M 20 x 1,5	126 000	176 000	212 000	500	700	840	116 000	163 000	195 000	570	800	960
M 22 x 1,5 **	154 000	217 000	261 000	670	940	1 150	143 000	201 000	241 000	760	1 050	1 300
M 24 x 2	176 000	248 000	297 000	850	1 200	1 450	163 000	229 000	275 000	960	1 350	1 600
M 27 x 2	229 000	322 000	387 000	1 250	1 750	2 100	211 000	297 000	357 000	1 400	2 000	2 400
M 30 x 2	288 000	406 000	487 000	1 750	2 450	2 950	266 000	374 000	449 000	2 000	2 800	3 350
M 33 x 2	355 000	522 000	600 000	2 350	3 500	4 000	328 000	481 000	553 000	2 700	4 000	4 500
M 36 x 3	397 000	584 000	670 000	2 900	4 300	4 900	366 000	538 000	618 000	3 300	4 800	5 600
M 42 x 3	550 000	820 000	940 000	4 700	6 900	8 000	510 000	750 000	870 000	5 400	7 900	9 100

Preload F_V and tightening torque M_a for screws and nuts with special torque or bearing surfaces
Values for plain or zinc plated fasteners as supplied.

Serrated screws and nuts

Property class	Clamped material	M 5	M 6	M 8	M 10	M 12	M 14	M 16
		Tightening torque M_A [Nm]						
Screws 8.8 (90) Nuts 8	Steel	9	16	34	58	97	155	215
	Cast iron	7	13	28	49	83	130	195
		Preload F_V [N]						
		6350	9000	16 500	26 200	38 300	52 500	73 000
		Tightening torque M_A [Nm]						
Screws 10.9 (100) Nuts 10	Steel: Rm 500–1000 [N/mm^2]	12	21	44	75	120	185	280
	Cast iron	9,5	16	36	64	105	170	260
		Preload F_V [N]						
		9000	12 600	23 200	37 000	54 000	74 000	102 000

Ribbed screws and nuts

		M 5	M 6	M 8	M 10	M 12	M 14	M 16
		Tightening torque M_A [Nm]						
Screws 10.9 (100) Nuts 10	Steel: Rm , 800 [N/mm^2]	11	19	42	85	130	230	330
	Steel: Rm 800–1100 [N/mm^2]	10	18	37	80	120	215	310
	Cast iron	9	16	35	75	115	200	300
		Preload F_V [N]						
		9000	12 600	23 200	37 000	54 000	74 000	102 000

Thread forming screws

		M 2	M 3	M 4	M 5	M 6	M 8	M 10
Screws according DIN 7500 case hardened	Steel (sufficient sheet metal thickness assumed)	max. forming torque M_F [Nm]						
		0,3	1	2,4	4,7	8	20	39
		Tightening torque M_A [Nm]						
		0,4	1,2	2,8	5,7	10	24	48
		Preload F_V [N]						
		900	2 100	3 900	6 400	9 100	16 800	26 700

Oval head screws with pressed-on washer (K748)

		M 3	M 4	M 5	M 6	M 8	M 10	M 12
Class 5.8	mges 0,125	Tightening torque M_A [Nm]						
		0,8	1,8	3,3	6,1	14	25	51
		Preload F_V [N]						
		1400	2450	3500	5700	9900	14 000	23 500
Class 10.9	mges 0,125	Tightening torque M_A [Nm]						
		1,8	4,2	7,4	14	32	58	115
		Preload F_V [N]						
		3200	5600	8000	13 000	22 500	31 800	53 800

M A R Y L A N D   M E T R I C S
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Pre-Loading of high-strength structural bolts

Complete sets are only to be used. Hot dip galvanized nuts supplied by us are treated and ready for assembly (coated with molykote). An additional lubrication of screws, nuts or washers is not permissible, since it alters the preload values and leads to failures in assembly.
The preload is generally applied by tightening the nut. For this purpose, torque wrenches, impact screwdrivers or similar devices may be used.
Tightening via the bolt head requires a free turning shank, so that no additional frictional resistance is developed.

Torque wrench

When tightening with a torque wrench, the necessary pre-loading force is provided by applicating a measured torque.
The wrench used must be properly adjustable or allow a reliable reading of the required torque.
The maximum discrepancy allowed for adjusting and reading should be +0.1 Ma. Testing is to be done before the torque wrench is used and also during use at least every six months.

Impact screwdriver

When tightening with impact screwdrivers the necessary preload force is provided by impulses. The screwdriver is to be adjusted to the prescribed preload by tests with suitable equipment (e.g. tensometer) on at least three screws intended for use in the assembly.

Angle of rotation

Pre-loading the screws by the angle of rotation method is done by an alignment (“snug”) tightening and then adding a further rotation through the angle φ.

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TECHNICAL INFORMATION and DATA

Method of tightening

Bolt diameter	Necessary preload Pv in the bolt (kN)	Torque wrench: Tightening torque M_a to be applied — Bolt lubricated with MoS_2 (hot dip galvanized) (Nm 2))	Torque wrench: Tightening torque M_a to be applied — Bolt slightly oiled (Nm)	Impact Screwdriver: Preload P_V to be applied 1) (kN)	Angle of rotation method: Necessary alignment torque M_{av} 1) (Nm)
M 12	50	100	120	60	10
M 16	100	250	350	110	50
M 20	160	450	600	175	
M 22	190	650	900	210	100
M 24	220	800	1100	240	
M 27	290	1250	1650	320	200
M 30	350	1650	2200	390	
M 36	510	2850	3800	560	

Angle of rotation method (M 12 to M 36):

Clamping range l_k (mm)	Angle of rotation φ 1)	Rotation U 1)
0–50	180°	1/2
51–100	240°	4/6
101–240	270° 3)	3/4 3)

1) Independent of lubrication of the thread or the surfaces of nut and bolt.

2) For tightening from the head, please ask for data.

3) For bolts M 12–M 22 with clamping range of 171–240 mm, an angle of rotation = 360° or U = 1 is to be applied.

Important: Tightening torques for hot dip galvanized bolts differ from those for plain. See table above.

We offer this only as a process applied to our fastener products, not as a separate item.

Bolt lubrication

MOLYKOTE®

For high-tensile bolted connections, the most important criterion for effectiveness is the preload. Using torque controlled tightening, friction in the thread and under the bearing face directly influences the attained preload.
Bolt lubrication aims to reduce and stabilize friction and minimize the scatter between fastened joints. Additionally, it will improve the ability to loosen the bolts even after long term operation. In view of the many different materials for bolts and nuts and the environmental influences, it is understandable that there can not be a single, multi-purpose lubricant. However, for common use the plain, slightly oiled surface or zinc plating gives sufficient temporary protection against corrosion and a favourable coefficient of friction.

For stainless steel or hot dip galvanized fasteners, for high temperature or critical applications as far as corrosion or preload are concerned, an additional lubrication leads to better performance and higher security of the bolted joints.

- Low coefficient of friction, high preload
- Low variation of friction, equal preload
- Additional protection against corrosion
- Dry fasteners, clean handling
- Assured loosening even after years of operation

Application	Service temperature				
	– 30 °C to + 125 °C	+ 125 °C to + 300 °C	+ 300 °C to + 600 °C	+ 600 °C to + 1100 °C	+ 1100 °C to + 1400 °C
Low coefficient of friction	D G-Rapid plus 1000 7405	G-Rapid plus D 321R	HSC plus 1000	HSC plus	P 37
Low variation of friction	1000 7405	1000 P 37	P 37	P 37	P 37
Protection from cold welding (galling) of austenitic stainless fassteners during assembly	D D 321R				
Protection from seizure of hot dip galvanized bolted connections	G-Rapid plus D 321R D 3484				
Corrosion protection Easy loosening	D HSC plus 1000 7443	HSC plus 1000			
High load carrying capacity	D G-Rapid plus D 321R D 3484	G-Rapid plus D 321R D 3484	HSC plus	HSC plus	P 37

	Paste					AFC Anti-friction coating			
	G-Rapid plus*	HSC plus	1000	P 37	D *	7405 **	D 321R *	7443 **	D 3484 ***
μ-thread	0,10	0,12	0,11	0,13	0,13	0,08	0,09	0,14	0,14
μ-head	0,07	0,010	0,10	0,10	0,08	0,09	0,04	0,07	0,03

* = Preferably for austenitic stainless steels as coefficient of friction is very low
** = Thread phosphated
*** = Preferably for hot dip galvanized

Molykote® coated heavy nuts for high-strength structural bolting and heat-resistant nuts class 5-2 are available on special order.

We offer this only as a process applied to our fastener products, not as a separate item.

Reduced load

Socket cap screws with low heads
For socket cap screws with low heads, with shallow or small sockets, the critical cross section may be underneath the socket and not in the thread.
It is recommended not to use such screws in applications where high loads and full preloading are required.
Property class 10.9 is used to reduce wear in the socket, it is not to get high-strength application fasteners.
Such screws should be tightened by nuts, the socket should be used to prevent rotation of the screws only. In case the screws has to be tightened by the socket,
reduced tightening torques should be used.

Recommended maximum tightening torques $M_{a\ max}$ (Nm)
for low head screws or screws with small sockets.

steel	ISO 7379 12.9	DIN 7984 8.8	DIN 6912 8.8	K 323 10.9	ISO 7380 10.9	DIN 7991 10.9	DIN 913–916 45 H
M 3		1			0,9	1,0	0,6
4		2,3	2,3	1,8	1,7	2	1,5
5	∅ 6 4,6	4	5	5	3,7	5	3,5
6	∅ 8 9,5	7,5	9	6	8	8	6,0
8	∅ 10 22	13,5	19	13	13	16	14
10	∅ 12 45	34	36	22	30	37	26
12	∅ 16 100	52	60		60	65	50
14		80	90			100	55
16	∅ 20 200	110	155		105	110	110
20		210	280			165	210
24		350	440			400	350
stainless steel	–	A2 / A4–70	A2 / A4–70	–	A2 / A4–70	A2 / A4–70	A2 / A4–70
M 3		0,6			0,5	0,5	0,2
4		1,4	1,7		0,8	1,3	0,5
5		2,5	3,5		1,8	2,8	1,5
6		5,5	6,4		4	4,2	2,5
8		10	14		7	8,5	5
10		24	26		15	20	10
12		39	44		33	34	20
14		60	68			52	22
16		85	115		60	58	50
20		160	210			88	80
24		250	330			210	130

The above tightening torques are estimated, taking into consideration head configuration, key size, socket depth and the strength of the screw. They should be double checked by means of testing if used for critical applications.

Screw threads, overview

Screw threads to DIN standards

Name	Designation/ example	Nominal diameter	Standard	Application
M ISO-metric thread (60° thread angle)	M 0.8	0.3 to 0.9 mm	DIN 14, part 1 to part 4	Watches and fine work
	M 30	1 to 68 mm	DIN 13, part 1 ISO 68 261/262 724/965	General engineering (coarse thread)
	M 20 x 1 M 30 x 2 – LH[1])	1 to 1000 mm	DIN 13, part 2 to part 11	General engineering (fine thread)
	DIN 6630 – M 64 x 4	64 and 76 mm	DIN 6630	Packaging; external thread for barrels
	LN 9163 – M 30 x 2 – 4H5H	1.4 to 355 mm	LN 9163	Aviation and aerospace
M ISO-metric thread with interference fit (60° thread angle)	M 10 Sn 4 M 10 Sk 6	3 to 150 mm	DIN 13 part 51 (draft at present)	Tap end of studs — not tight
	M 10 Sn 4 tight	3 to 150 mm		Tap end of studs — tight
M Metric thread with large clearance (60° thread angle)	DIN 2510 – M 36	12 to 180 mm	DIN 2510 part 2	Bolted connections with reduced shank
EG M ISO-metric thread, internal thread for adopting threaded inserts (60° thread angle)	DIN 8140 – EG M 20	2 to 52 mm	DIN 8140 part 2 (draft at present)	Internal thread for adoption of threaded wire inserts
M Metric taper external thread (60° thread angle) (taper 1:16)	DIN 158 – M 30 x 2 keg	6 to 60 mm	DIN 158	Plugs and Grease nipples
	DIN 158 – M 30 x 2 tap short			
S Self forming taper external thread (105° thread angle) (taper 7°30')	S 8 x 1	6 to 10 mm	DIN 71 412 (draft at present)	Taper lubricating nipple (thread similar to DIN 158 but 105° thread angle)
MJ MJ-thread (60° thread angle)	MJ 6 x 1 –	1,6 to 39 mm	DIN ISO 5855	Aviation and aerospace construction
	MJ 6 x 1 – 4H5H		part 1 and part 2	
LN ISO-metric thread for aviation	LN 9163 H 30 x 2	1,4–355 mm	LN 9163 EN 2158	Aviation and aerospace

[1]) LH international designation for left hand thread

Name	Designation/ exemple	Nominal diameter	Standard	Application
G Parallel pipe thread, pressure tight joints are not made on the thread (55° thread angle) Whitworth	G $1^1/_2$ A G $1^1/_2$ B	$^1/_{16}$ to 6	DIN ISO 228	External pipe thread
	G $1^1/_2$		part 1	Internal pipe thread
	DIN 6630 – G $^3/_4$	$^3/_4$, 1, 2	DIN 6630	Packaging; external thread for barrels
Parallel pipe thread, pressure tight joints are not made on the thread (55° thread angle)	$5^1/_2$	$5^1/_2$	DIN 6602	External thread for cistern cars
R Whitworth parallel pipe thread, pressure tight joints are not made on the thread (55° thread angle)	R $^3/_4$	$^1/_8$ to 6	DIN 259 part 1 to part 3[2])	Piping, do not use in new designs
Rp Whitworth parallel pipe thread, pressure tight joints on the thread (55° thread angle)	DIN 2999 – Rp $^1/_2$	$^1/_{16}$ to 6	DIN 2999 part 1	Internal thread for pipes and fittings
	DIN 3858 – Rp $^1/_8$	$^1/_8$ to $1^1/_2$	DIN 3858	Internal thread for pipe unions
R Whitworth taper pipe thread, pressure tight joints on the thread (55° thread angle), (taper 1:16)	DIN 2999 – R $^1/_2$	$^1/_{16}$ to 6	DIN 2999 part 1	External thread for pipes and fittings
	DIN 3858 – R $^1/_8$–1	$^1/_8$ to $1^1/_2$	DIN 3858	External thread for pipe unions
Tr ISO metric trapezoidal thread, single or multiple start (30° thread angle)	Tr 40 x 7	8 to 300 mm	DIN 103 part 1 to part 8 ISO 2901 to 2904	General
	Tr 40 x 14 P7			
Tr Stub metric trapezoidal thread, single or multiple start (30° thread angle)	DIN 380 – Tr 48 x 8		DIN 380 part 1 and part 2	
	DIN 380 – Tr 48 x 14 P7			
Tr Acme trapezoidal thread with clearance, single or multiple start (30° thread angle)	DIN 263 – Tr 48 x 12	48 mm	DIN 263 part 1 and part 2	For rail vehicles
	DIN 263 – Tr 40 x 16 P8	40 mm		
	DIN 6341 – Tr 32 x 1,5	10 to 56 mm	DIN 6341 part 2	For collet chucks
Tr Rounded trapezoidal thread (30° thread angle)	DIN 30 295 – Tr 40 x 5	26 to 80 mm	DIN 30 295 part 1 and part 2	For rail vehicles
KT Trapezoidal thread (20° thread angle)	DIN 6063 – KT 22	10 to 50 mm	DIN 6063 part 2	Preferably for packages made of plastics

[2]) Danger to be mixed up due to identical designation as ISO 7/1. Replaced by DIN ISO 228 part 1 and new designation. See DIN ISO 228 part 1.

Name	Designation/ exemple	Nominal diameter	Standard	Application
S Buttress metric thread, single- or multiple-start (30°/3° thread angle)	S 48 x 8	10 to 640 mm	DIN 513	General
	S 40 x 14 P7		part 1 to part 3	
S Buttress single-start thread (45°/0° thread angle)	DIN 2781 – S 630 x 20	100 to 1250 mm	DIN 2781	For machine tools, hydraulic presses
S Buttress thread, (30°/3° thread angle)	DIN 20 401 – S 25 x 1.5	6 to 40 mm	DIN 20 401 part 1 and part 2	Mining industry
KS Buttress thread (40°/10° thread angle)	DIN 6063 – KS 22	10 to 50 mm	DIN 6063 part 1	Preferably for packages made of plastics
Rd Knuckle parallel thread, single- or multiple-start (30° thread angle)	Rd 40 x $^1/_6$ Rd 40 x $^1/_3$ P$^1/_6$	8 to 200 mm	DIN 405 part 1 and part 2	General
Rd Knuckle parallel thread (30° thread angle)	Rd 40 x 5	10 to 300 mm	DIN 20 400	Mining industry, with large thread overlap
	DIN 15 403 – Rd 80 x 10	50 to 320 mm	DIN 15 403	For lifting hooks
	DIN 7273 – Rd 70	20 to 100 mm	DIN 7273 part 1	For steel sheet items and related joints
Rd Round parallel thread with clearance (steep flank: 15°56' thread angle)	DIN 262 – Rd 59 x 7	34 to 79 mm	DIN 262 part 1 and part 2	For rail vehicles
	DIN 262 – Rd 59 x 7 left			
(flat flank: 30° thread angle)	DIN 264 – Rd 50 x 7	50 mm	DIN 264 part 1 and part 2	
	DIN 264 – Rd 50 x 7 left			
Rd Round parallel thread	DIN 3182 – Rd 40 x $^1/_7$	40, 80 and 110 mm	DIN 3182 part 1	Respirators and gas masks
GL Round parallel thread (30°/60° thread angle)	DIN 168 – GL 25 x 3	8 to 45 mm	DIN 168 part 1	For glass containers
Gf Round taper thread	DIN 4930 – Gf 127	127 mm	DIN 4930 part 2	Tubes for tunneling

Name	Designation/ exemple	Nominal diameter	Standard	Application
E Edison thread	DIN 40 400 – E 27	14 mm 16 mm 18 mm 27 mm 33 mm	DIN 40 400	For d-type fuses (E 14 and E 27 for lamp-sockets)
	DIN 49 612 – E 5	5 mm	DIN 49 612	For lamp-sockets
	DIN 49 610 – E 10	10 mm	DIN 49 610	
	DIN 49 625 – E 40	40 mm	DIN 49 625	
Lamp-socket thread	DIN 49 689 – 28 x 2	28 and 40 mm	DIN 49 689	External thread for lamp-sockets, internal thread for lampshade holders
W Parallel Whitworth thread (55° thread angle)	DIN 49 301 – W $^3/_{16}$	$^3/_{16}$	DIN 49 301	For d-type fuses, screw -in gauge D ll and D lll
Glasg Glasg Thread for glass (35°/50° thread angle)	DIN 40 450 – Glasg 74,5	74,5 mm 84,5 mm 99 mm 123,5 mm 158 mm 188 mm	DIN 40 450	Electric industry: glass fittings, protection glasses
Pg Steel conduit thread (80° thread angle)	DIN 40 430 – Pg 21	7 to 48 mm	DIN 40 430	For electric installations
ST Tapping screw thread (60° thread angle)	DIN 7970 – ST 3,5	1,5 to 9,5 mm	DIN 7970 ISO 1478	For tapping screws
Wood screw thread (60° thread angle)	DIN 7998–4	1,6 to 20 mm	DIN 7998	For wood screws
FG Bicycle screw thread (60° thread angle)	FG 9,5	2 to 34,8 mm	DIN 79 012	For cycles and motor-scooters
Vg Threads for valves (60° thread angle)	DIN 7756 – Vg 12	5 to 12 mm	DIN 7756	Valves for tires
W Taper Whitworth thread (55° thread angle), taper 3:25	DIN 477 – W 28,8 x $^1/_{14}$ tap	19,8 mm, 28,8 mm, 31,3 mm	DIN 477 part 1	Gas cylinders, thread for main nozzle
W Parallel Whitworth thread (55° thread angle)	DIN 477 – W 21,80 x $^1/_{14}$	21,8 mm, 24,32 mm, 25,4 mm		Gas cylinders, thread for side nozzles
	W 80 x $^1/_{11}$	80 mm	DIN 4668	Gas cylinders, thread for neck rings and protection caps
A B C Tripod thread (60° thread angle)	DIN 4503 A $^1/_4$	$^1/_4$–$^3/_8$	DIN 4503 ISO 1222	Connections to photographic equipment

Name	Designation/ exemple	Nominal diameter	Standard	Application
RMS RMS-thread (55° thread angle)	DIN 58 888 – RMS	20,32 mm	DIN 58 888	Objective for microscope
Gg Taper thread (60° thread angle), taper 1 :16	DIN 4941 – Gg 51	44,5 to 88,9 mm	DIN 4941	For drill pipes in water and rock drilling, mining
Gg Taper thread (30°/30° thread angle), taper 1:4	DIN 20 314 –	$3^1/_2$ $4^1/_2$ $5^1/_2$	DIN 20 314	
HA Bone screw thread	DIN 58 810 – HA 4,5	1,5, 2, 2,7, 3,5 and 4,5 mm	DIN 58 810	For surgical implants, external and internal thread
HB Bone screw thread	DIN 58 810 – HB 6,5	4 to 6,5 mm		

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TECHNICAL INFORMATION and DATA

Screws threads to other standards

Name	Identification	Designation/example	Standard	Origin
	UNM	0.80 UNM	ASA B 1.10–1985	USA
Unified threads	UN UNC UNF UNEF UNS	1/4–20 UNC–2A or 0.250–20 UNC–2A	ANSI B 1.1 – 1982 B.S. 1580: Part 1 & 2 1962 CSA B 1.1 – 1949 ISO 263; 725; 5864	USA Great Britain Canada
	UNR UNRC UNRF 1) UNREF UNRS	7/14-20 UNRF–2A or 0.4375–20 UNRF–2A	ANSI B 1.1 – 1982	USA
	UNC UNF 2) UNEF	6(0.138)–32 UNC–2A	B. S. 1580: Part 3: 1965	Great Britain
	UNJ UNJC UNJF UNJEF	0,250–28 UNJF–3A	B. S. 4084: 1978	Great Britain
US thread (old)	NC NF NEF NS 8 N; 12 N; 16 N	12–32 NEF	ANSI B 1.1–1960 replaced by ANSI B 1.1–1982	USA
Withworth threads	BSW BSF	1/4 in.–20 B.S.W.	B.S. 84: 1956	Great Britain
B.A. threads	B.A.	11 B.A.	B.S. 93: 1951	
Parallel pipe threads	NPSC NPSM NPSL	1/8–27 NPSC NPSH	ANSI/ASME B 1.20.1–1983	USA
	Dryseal NPSF Dryseal NPSI	1/8–27 NPSF	ANSI B 1.20.3–1976 (R 1982)	
	G3)	G 1 1/4	B.S. 2779: 1973	Great Britain
	Rp4)	Rp 1/2	B.S. 21:1973	
Taper pipe threads	NPT NPTR	3/8–18 NPT	ANSI/ASME B 1.20.1–1983	USA
	Dryseal NPTF Dryseal PTF-SAE SHORT	1/8–27 NPTF–1	ANSI B 1.20.3–1976 (R 1982)	
	R5)	R 1/2	B.S. 21: 1985	Great Britain
	Rc	Rc 1/2		
Trapezoidal thread	Acme	1 3/4–4 ACME–2G	ANSI B 1.5–1977	USA
			B.S. 1104: 1957	Great Britain
	Stub-Acme	0.500–20 STUB ACME	ANSI B 1.8–1977	USA
Buttress threads	Butt	2.5–8 BUTT–2A	ANSI B 1.9–1973 (R 1985)	
	Buttress	2,0 B.S. Buttress thread 8 tpi medium class	B.S. 1657: 1950	Great Britain
Threads for cycles	BSC	1/4–26. BSC-Med.	B.S. 811: 1950	

1) External thread with rounded root
2) For nominal diameter less than 1/4 inch
3) Replaces old identification BSP.F.
4) Replaces old identification BSP.Pl
5) Replaces old identification BSP.Tr.

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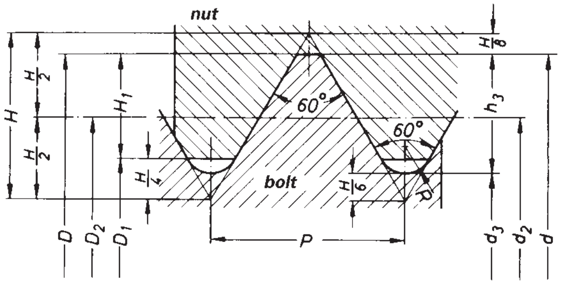
TECHNICAL INFORMATION and DATA

ISO metric screw threads

Basic dimensions



$$H = 0{,}86603\,P$$
$$h_3 = 0{,}61343\,P$$
$$H_1 = 0{,}54127\,P$$
$$R = \frac{H}{6} = 0{,}14434\,P$$
$$d_2 = d - 0{,}64953\,P$$
$$D_1 = d - 2\,H_1$$
$$d_3 = d - 2\,h_3$$

Table 3

Pitch P	Thread height h_3	Thread height H_1	Pitch P	Thread height h_3	Thread height H_1
0,25	0,153	0,135	1,25	0,767	0,677
0,3	0,184	0,162	1,5	0,920	0,812
0,35	0,215	0,189	1,75	1,074	0,947
0,4	0,245	0,217	2	1,227	1,083
0,45	0,276	0,244	2,5	1,534	1,353
0,5	0,307	0,271	3	1,840	1,624
0,6	0,368	0,325	3,5	2,147	1,894
0,7	0,429	0,379	4	2,454	2,165
0,75	0,460	0,406	4,5	2,760	2,436
0,8	0,491	0,433	5	3,067	2,706
1	0,613	0,541	5,5	3,374	2,977
			6	3,681	3,248

Selected sizes

Coarse thread

Nominal diameter 1. choice	Nominal diameter 2. choice	Pitch P	Nominal diameter 1. choice	Nominal diameter 2. choice	Pitch P
1		0,25		18	2,5
1,2		0,25	20		2,5
	1,4	0,3		22	2,5
1,6		0,35	24		3
	1,8	0,35		27	3
2		0,4	30		3,5
2,5		0,45		33	3,5
3		0,5	36		4
	3,5	0,6		39	4
4		0,7	42 1)		4,5
5		0,8		45 1)	4,5
6		1	48 1)		5
	7	1		52 1)	5
8		1,25			
10		1,5			
12		1,75			
	14	2			
16		2			

Fine thread

Nominal diameter 1. choice	Nominal diameter 2. choice	Pitch P	
8		1	
10		1,25	1 1)
12		1,25	1,5 1)
	14	1,5	
16		1,5	
	18	1,5	2 1)
20		1,5	2 1)
	22	1,5	2 1)
24		2	
	27	2	
30		2	
	33	2	
36		3	
	39	3	

1) not in ISO 262

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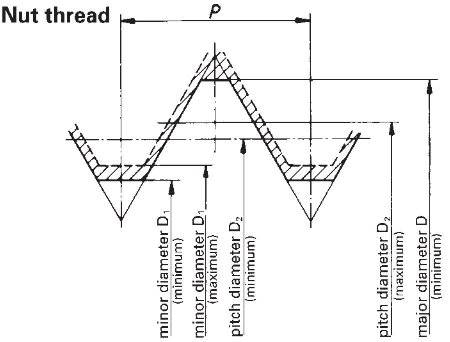
TECHNICAL INFORMATION and DATA



Nut threads with tolerance class 5H resp. 6H (tolerance quality: medium)

Nut threads M 1 to M 1,4 are tolerance class 5H.
Nut threads M 1,6 to M 39 are tolerance class 6H.

Limits of sizes for coarse threads

Thread size	Length of normal thread engagement		Major diameter D	Pitch diameter D_2		Minor diameter D_1	
	from	to	minimum	minimum	maximum	minimum	maximum
M 1	0,6	1,7	1,000	0,838	0,894	0,729	0,785
M 1,2	0,6	1,7	1,200	1,038	1,094	0,929	0,985
M 1,4	0,7	2	1,400	1,205	1,265	1,075	1,142
M 1,6	0,8	2,6	1,600	1,373	1,458	1,221	1,321
M 1,8	0,8	2,6	1,800	1,573	1,658	1,421	1,521
M 2	1	3	2,000	1,740	1,830	1,567	1,679
M 2,5	1,3	3,8	2,500	2,208	2,303	2,013	2,138
M 3	1,5	4,5	3,000	2,675	2,775	2,459	2,599
M 3,5	1,7	5	3,500	3,110	3,222	2,850	3,010
M 4	2	6	4,000	3,545	3,663	3,242	3,422
M 5	2,5	7,5	5,000	4,480	4,605	4,134	4,334
M 6	3	9	6,000	5,350	5,500	4,917	5,153
M 7	3	9	7,000	6,350	6,500	5,917	6,153
M 8	4	12	8,000	7,188	7,348	6,647	6,912
M 10	5	15	10,000	9,026	9,206	8,376	8,676
M 12	6	18	12,000	10,863	11,063	10,106	10,441
M 14	8	24	14,000	12,701	12,913	11,835	12,210
M 16	8	24	16,000	14,701	14,913	13,835	14,210
M 18	10	30	18,000	16,376	16,600	15,294	15,744
M 20	10	30	20,000	18,376	18,600	17,294	17,744
M 22	10	30	22,000	20,376	20,600	19,294	19,744
M 24	12	36	24,000	22,051	22,316	20,752	21,252
M 27	12	36	27,000	25,051	25,316	23,752	24,252
M 30	15	45	30,000	27,727	28,007	26,211	26,771
M 33	15	45	33,000	30,727	31,007	29,211	29,771
M 36	18	53	36,000	33,402	33,702	31,670	32,270
M 39	18	53	39,000	36,402	36,702	34,670	35,270

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TECHNICAL INFORMATION and DATA

Limits of sizes for fine threads

Thread size	Length of normal thread emgagement		Major diameter D	Pitch diameter D_2		Minor diameter D_1	
	from	to	minimum	minimum	maximum	minimum	maximum
M 8 × 1	3	9	8,000	7,350	7,500	6,917	7,153
M 10 × 1	3	9	10,000	9,350	9,500	8,917	9,153
M 10 × 1,25	4	12	10,000	9,188	9,348	8,647	8,912
M 12 × 1,25	4,5	13	12,000	11,188	11,368	10,647	10,912
M 12 × 1,5	5,6	16	12,000	11,026	11,216	10,376	10,676
M 14 × 1,5	5,6	16	14,000	13,026	13,216	12,376	12,676
M 16 × 1,5	5,6	16	16,000	15,026	15,216	14,376	14,676
M 18 × 1,5	5,6	16	18,000	17,026	17,216	16,376	16,676
M 18 × 2	8	24	18,000	16,701	16,913	15,835	16,210
M 20 × 1,5	5,6	16	20,000	19,026	19,216	18,376	18,676
M 20 × 2	8	24	20,000	18,701	18,913	17,835	18,210
M 22 × 1,5	5,6	16	22,000	21,026	21,216	20,376	20,676
M 22 × 2	8	24	22,000	20,701	20,913	19,835	20,210
M 24 × 2	8,5	25	24,000	22,701	22,925	21,835	22,210
M 27 × 2	8,5	25	27,000	25,701	25,925	24,834	25,210
M 30 × 2	8,5	25	30,000	28,701	28,925	27,835	28,210
M 33 × 2	8,5	25	33,000	31,701	31,925	30,835	31,210
M 36 × 3	12	36	36,000	34,051	34,316	32,752	33,252
M 39 × 3	12	36	39,000	37,051	37,316	35,752	36,252

Nut threads with tolerance class 7H (tolerance quality coarse)

Limits of sizes for coarse threads

Thread size	Length of normal thread engagement		Major diameter D	Pitch diameter D_2		Minor diameter D_1	
	from	to	minimum	minimum	maximum	minimum	maximum
M 5	2,5	7,5	5,000	4,480	4,640	4,134	4,384
M 6	3	9	6,000	5,350	5,540	4,917	5,217
M 7	3	9	7,000	6,350	6,540	5,917	6,217
M 8	4	12	8,000	7,188	7,388	6,647	6,982
M 10	5	15	10,000	9,026	9,250	8,376	8,751
M 12	6	18	12,000	10,863	11,113	10,106	10,531
M 14	8	24	14,000	12,701	12,966	11,835	12,310
M 16	8	24	16,000	14,701	14,966	13,835	14,310
M 18	10	30	18,000	16,376	16,656	15,294	15,854
M 20	10	30	20,000	18,376	18,656	17,294	17,854
M 22	10	30	22,000	20,376	20,656	19,294	19,854
M 24	12	36	24,000	22,051	22,386	20,752	21,382
M 27	12	36	27,000	25,051	25,386	23,752	24,382
M 30	15	45	30,000	27,727	28,082	26,211	26,921
M 33	15	45	33,000	30,727	31,082	29,211	29,921
M 36	18	53	36,000	33,402	33,777	31,670	32,420
M 39	18	53	39,000	36,402	36,777	34,670	35,420
M 42	21	63	42,000	39,077	39,477	37,129	37,979
M 45	21	63	45,000	42,077	42,477	40,129	40,979
M 48	24	71	48,000	44,752	45,177	42,587	43,487
M 52	24	71	52,000	48,752	49,177	46,587	47,487

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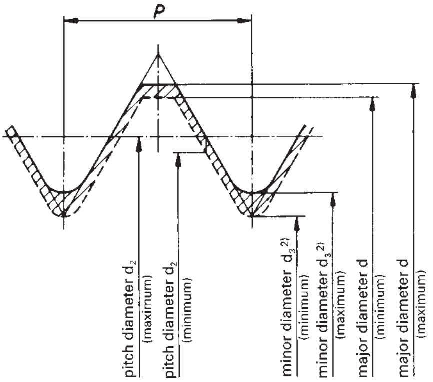
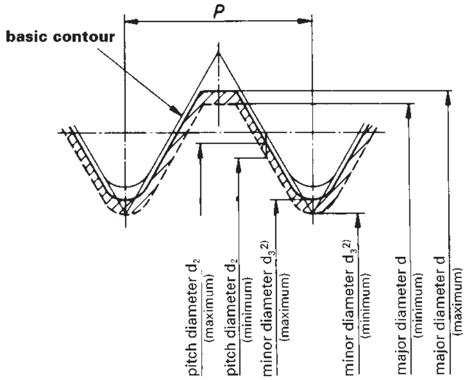
TECHNICAL INFORMATION and DATA

Bolt thread



Bolt thread with deviation h



Bolt thread with deviation g

Bolt thread with tolerance class 6g resp. 6h (tolerance quality: medium)
Bolt thread M 1 to M 1,4 are tolerance class 6h.
Bolt thread M 1,6 to M 39 are tolerance class 6g.

Limits of sizes for coarse threads

Thread size	Length of normal thread engagement		Major diameter d		Pitch diameter d_2		Minor diameter 2) d_1	
	from	to	maximum	minimum	maximum	minimum	maximum	minimum
M 1	0,6	1,7	1,000	0,933	0,838	0,785	0,693	**0,630**
M 1,2	0,6	1,7	1,200	1,133	1,038	0,985	0,893	**0,830**
M 1,4	0,7	2	1,400	1,325	1,205	1,149	1,032	**0,964**
M 1,6	0,8	2,6	1,581	1,496	1,354	1,291	1,151	**1,075**
M 1,8	0,8	2,6	1,781	1,696	1,554	1,491	1,352	**1,275**
M 2	1	3	1,981	1,886	1,721	1,654	1,490	**1,407**
M 2,5	1,3	3,8	2,480	2,380	2,188	2,117	1,928	**1,840**
M 3	1,5	4,5	2,980	2,874	2,655	2,580	2,367	**2,273**
M 3,5	1,7	5	3,479	3,354	3,089	3,004	2,743	**2,635**
M 4	2	6	3,978	3,838	3,523	3,433	3,119	**3,002**
M 5	2,5	7,5	4,976	4,826	4,456	4,361	3,995	**3,869**
M 6	3	9	5,974	5,794	5,324	5,212	4,747	**4,596**
M 7	3	9	6,974	6,794	6,324	6,212	5,747	**5,596**
M 8	4	12	7,972	7,760	7,160	7,042	6,438	**6,272**
M 10	5	15	9,968	9,732	8,994	8,862	8,128	**7,938**
M 12	6	18	11,966	11,701	10,829	10,679	9,819	**9,602**
M 14	8	24	13,962	13,682	12,663	12,503	11,508	**11,271**
M 16	8	24	15,962	15,682	14,663	14,503	13,508	**13,271**
M 18	10	30	17,958	17,623	16,334	16,164	14,891	**14,625**
M 20	10	30	19,958	19,623	18,334	18,164	16,891	**16,625**
M 22	10	30	21,958	21,623	20,334	20,164	18,891	**18,625**
M 24	12	36	23,952	23,577	22,003	21,803	20,271	**19,955**
M 27	12	36	26,952	26,577	25,003	24,803	23,271	**22,955**
M 30	15	45	29,947	29,522	27,674	27,462	25,653	**25,306**
M 33	15	45	32,947	32,522	30,674	30,462	28,653	**28,306**
M 36	18	53	35,940	35,465	33,342	33,118	31,033	**30,655**
M 39	18	53	38,940	38,465	36,342	36,118	34,033	**33,655**

2) maximum calculated as $R = 0{,}144\ P = H/6$, minimum as $R_{min} = 0{,}125\ P < H/7$ (see DIN 13 part 14)

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TECHNICAL INFORMATION and DATA

Limits of sizes for fine threads

Thread size	Length of normal thread engagement		Major diameter d		Pitch diameter d_2		Minor diameter[2)] d_3	
	from	to	maximum	minimum	maximum	minimum	maximum	minimum
M 8 × 1	3	9	7,974	7,794	7,324	7,212	6,747	6,596
M 10 × 1	3	9	9,974	9,794	9,324	9,212	8,747	8,596
M 10 × 1,25	4	12	9,972	9,760	9,160	9,042	8,438	8,272
M 12 × 1,25	4,5	13	11,972	11,760	11,160	11,028	10,438	10,258
M 12 × 1,5	5,6	16	11,968	11,732	10,994	10,854	10,128	9,930
M 14 × 1,5	5,6	16	13,968	13,732	12,994	12,854	12,128	11,930
M 16 × 1,5	5,6	16	15,968	15,732	14,994	14,854	14,128	13,930
M 18 × 1,5	5,6	16	17,968	17,732	16,994	16,854	16,128	15,930
M 18 × 2	8	24	17,962	17,682	16,663	16,503	15,508	15,271
M 20 × 1,5	5,6	16	19,968	19,732	18,994	18,854	18,128	17,930
M 20 × 2	8	24	19,962	19,682	18,663	18,503	17,508	17,271
M 22 × 1,5	5,6	16	21,968	21,732	20,994	20,854	20,128	19,930
M 22 × 2	8	24	21,962	21,682	20,663	20,503	19,508	19,271
M 24 × 2	8,5	25	23,962	23,682	22,663	22,493	21,508	21,261
M 27 × 2	8,5	25	26,962	26,682	25,663	25,483	24,508	24,261
M 30 × 2	8,5	25	29,962	29,682	28,663	28,493	27,508	27,261
M 33 × 2	8,5	25	32,962	32,682	31,663	31,493	30,508	30,261
M 36 × 3	12	36	35,952	35,577	34,003	33,803	32,271	31,955
M 39 × 3	12	36	38,952	38,577	37,003	36,803	35,271	34,955

Bolt thread with tolerance class 8g (tolerance quality: coarse)

Limits of sizes for coarse threads

Thread size	Length of normal thread engagement		Major diameter d		Pitch diameter d_2		Minor diameter[2)] d_3	
	from	to	maximum	minimum	maximum	minimum	maximum	minimum
M 5	2,5	7,5	4,976	4,740	4,456	4,306	3,995	3,814
M 6	3	9	5,974	5,694	5,324	5,144	4,747	4,528
M 7	3	9	6,974	6,694	6,324	6,144	5,747	5,528
M 8	4	12	7,972	7,637	7,160	6,970	6,438	6,200
M 10	5	15	9,968	9,593	8,994	8,782	8,128	7,858
M 12	6	18	11,966	11,541	10,829	10,593	9,819	9,516
M 14	8	24	13,962	13,512	12,663	12,413	11,508	11,181
M 16	8	24	15,962	15,512	14,663	14,413	13,508	13,181
M 18	10	30	17,958	17,428	16,334	16.069	14,891	14,530
M 20	10	30	19,958	19,428	18,334	18,069	16,891	16,530
M 22	10	30	21,958	21,428	20,334	20,069	18,891	18,530
M 24	12	36	23,952	23,352	22,003	21,688	20,271	19,840
M 27	12	36	26,952	26,352	25,003	24,688	23,271	22,840
M 30	15	45	29,947	29,277	27,674	27,339	25,653	25,183
M 33	15	45	32,947	32,277	30,674	30,339	28,653	28,183
M 36	18	53	35,940	35,190	33,342	32,987	31,033	30,524
M 39	18	53	38,940	38,190	36,342	35,987	34,033	33,524
M 42	21	63	41,937	41,137	39,014	38,639	36,416	35,868
M 45	21	63	44,937	44,137	42,014	41,639	39,416	38,868
M 48	24	71	47,929	47,079	44,681	44,281	41,795	41,202
M 52	24	71	51,929	51,079	48,681	48,281	45,795	45,202

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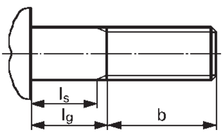
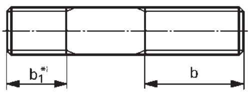
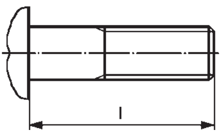
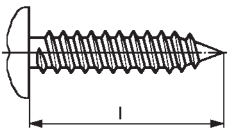
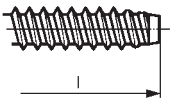
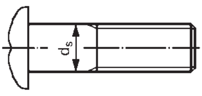
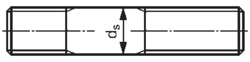
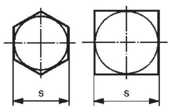
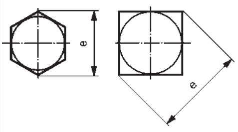
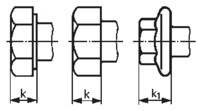
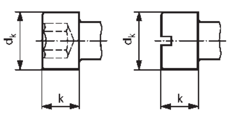
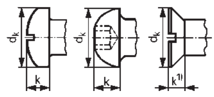
TECHNICAL INFORMATION and DATA

Tolerance for fasteners

Feature	Tolerance for product grades A	B	C	Notes
Internal thread (nuts)	6H	6H	7H	For electroplated coatings and hot dip galvanizing, see relevant product and coating standards.
External thread (screws)	6g	6g	8g	
Thread length 	b^{+2P}_{0}	b^{+2P}_{0}	b^{+2P}_{0}	*P* = pitch of thread Tolerance + 2 *P* only for such bolts where l_s and l_g are not fixed in the product standard.
Stud 	b^{+2P}_{0} b_1 js16	b^{+2P}_{0} b_1 js17	b^{+2P}_{0} b_1 js17	*) Only stud end of studs.
Nominal length 	js 15 js 16 for slotted and cross recessed screws with length . 50 mm	js 17	*l* < 150 : js 17 *l* . 150 : 2 js 17	
Type C 	*l*: # 25 — tolerance: ± 0,8 *l*: . 25 — tolerance: ± 1,3			
Type F 	*l*: # 19 — tolerance: $^{0}_{-0,8}$ *l*: . 19 # 38 — tolerance: $^{0}_{-1,3}$ *l*: . 38 — tolerance: $^{0}_{-1,5}$			
Shank diameter  	h13	h14	± IT 15	The tolerance is not applicable in the areas of the underhead fillet and thread run-out. Allowance for the swelling under the head, see the relevant product standard.

Feature	Tolerance for product grades A	B	C	Notes
Width across flats 	*s* / tole-rance: % 30 — h13 . 30 — h1	*s* / tole-rance: % 18 — h14 . 18 % 60 — h15 . 60 % 180 — h16 . 180 — h17		
Width across corners 	*e* min. ⊥ 1,13 *s* min. *e* min. ⊥ 1,12 *s* min. for flanged bolts and screws and other cold forged heads without trimming operation			
Head height 	js14	js15	*k* / tole-rance: , 10 — js16 ⊥ 10 — js17	1) For flanged hexagon bolts and screws *k* is defined only as a maximum.
Head diameter 	h13 *)	h14 **)	–	*) ± IT 13 for knurled heads **) ± IT 14 for knurled heads
Head height	% M 5 : h13 . M 5 : h14	h14	–	
Head diameter 	h14	h14	–	Tapping screws are product grade B
Head height	% M 5 : h13 . M 5 : h14	h14	–	1) For flat head screws *k* is definied only as a maximum.

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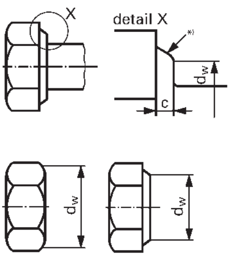
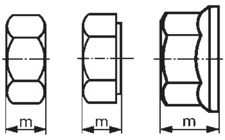
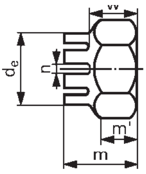
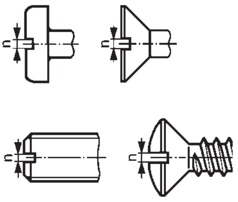
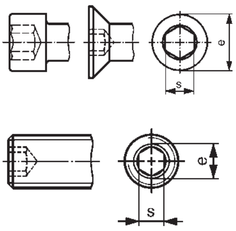
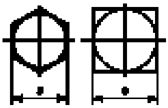
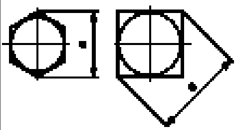
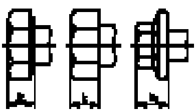
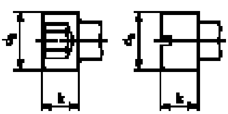
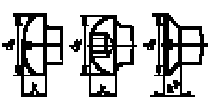
TECHNICAL INFORMATION and DATA

Feature	Tolerance for product grades A	B	C	Notes
Bearing area 	d_w min. = *s* min. – IT 16 for width across flats , 21 mm d_w min. = 0,95 *s* min. for width across flats ⊥ 21 mm d_w max. = *s* actual			Flange bolts see product standards
	thread diameter	*c* max.	*c* min.	
	3 and 4	0,4	0,15	
	5 and 6	0,5	0,15	
	8 to 14	0,6	0,15	
	16 to 36	0,8	0,2	
	over 36	1	0,3	
Height of nuts 	⊥ M 12 : h14 > M 12 ≦ M 18 : h15 > M 18 : h16		h17	Prevailing torque type nuts see product standards
Other features 				
d_e	h14	h15	h16	
m	h14	h15	h17	
n	H14	H14	H15	
w	h14	h14	h15	

Feature	Tolerance for product grades A	B	C	Notes
Slots 	*n* / tolerance*): ≦ 1: + 0,20 / + 0,06 > 1 ≦ 3: + 0,31 / + 0,06 > 3 ≦ 6: + 0,37 / + 0,07	–	–	*) Tolerance field C 13 for *n* ≦ 1, C 14 for *n* > 1
Hexagon sockets 	see table below	–	–	*) Tolerance fields for flat countersunk head screws, button head screws and socket head cap screw of property class 12.9, and socket set screws only. **) For all other products. *e* min. ⊥ 1,14 *s* min. (values see product standards)

s	tolerance *)	tolerance **)
0,7	EF8	EF8
0,9	JS9	JS9
1,3	K9	K9
1,5	D 9	D 10
2	D 9	D 10
2,5	D 10	D 11
3	D 11	D 11
4	E 11	E 11
5	E 11	E 12
6	E 11	E 12
8	E 11	E 12
10	E 11	E 12
12	E 11	E 12
14	E 11	E 12
>14	D 12	D 12

Feature	Tolerance for product grades A	Tolerance for product grades B	Tolerance for product grades C	Notes
Width across flats 	*s* / tolerance ≦ 30 h13 > 30 h14	*s* ≦ 18 > 18 ≦ 60 > 60 ≦ 180 > 180	tolerance h14 h15 h16 h17	
Width across corners 	*e* min. ^ 1,13 *s* min. *e* min. ^ 1,12 *s* min. for flanged bolts and screws and other cold forged heads without trimming operation			
Head height 	js14	js15	*k* / tolerance < 10 js16 ≧ 10 js17	[1]) For flanged hexagon bolts and screws *k* is defined only as a maximum.
Head diameter  Head height	h13 *) ≦ M 5 : h13 > M 5 : h14	h14 **) h14	– –	*) ± IT 13 for knurled heads **) ± IT 14 for knurled heads
Head diameter  Head height	h14 ≦ M 5 : h13 > M 5 : h14	h14 h14	– –	Tapping screws are product grade B [1]) For flat head screws *k* is definied only as a maximum.

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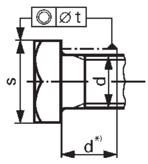
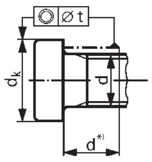
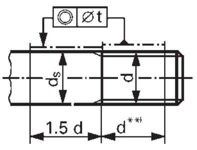
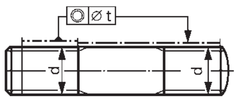
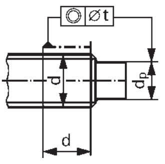
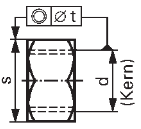
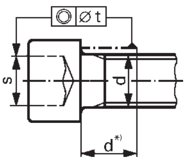
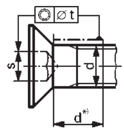
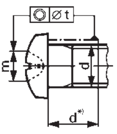
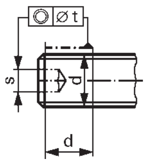
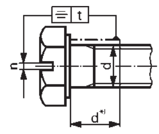
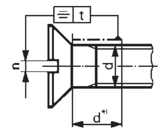
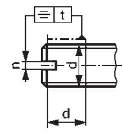
TECHNICAL INFORMATION and DATA

Feature	Tolerance *t* for product grades A	B	C	Tolerance *t* based on dimension	Notes
Coaxiality: head to shank / thread 	2 IT 13	2 IT 14	2 IT 15	*s*	Tapping screws are product grade A *) The datum feature must not be partly shank partly thread. If necessary the datum feature *d* should be displaced at sufficient distance (max. 3*P*) from the head of the screw (to avoid thread run-out X).
	2 IT 13	2 IT 14	2 IT 15	d_k	
Coaxiality: shank to thread 	2 IT 13	2 IT 14	2 IT 15	*d*	*) See above **) Or length of the GO-gange of tolerance class 6h
	2 IT 13	2 IT 14	–	*d*	
Coaxiality: thread end to thread 	2 IT 13	–	–	*d*	
Coaxiality: WAF to minor diameter 	2 IT 13	2 IT 14	2 IT 15	*s*	

Feature	Tolerance *t* for product grades A	B	C	Tolerance *t* based on dimension	Notes
Coaxiality: socket to shank / thread cross recess to shank / thread 	2 IT 13	–	–	*d*	
 	2 IT 13	–	–	*d*	Tapping screws are product grade A
	2 IT 12	–	–	*d*	
Symmetry: slot to shank 	2 IT 12	2 IT 13	2 IT 14	*d*	
	2 IT 12	2 IT 13	2 IT 14	*d*	Tapping screws are product grade A
	2 IT 12	–	–	*d*	

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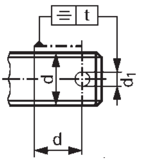
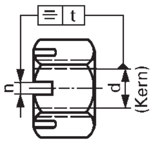
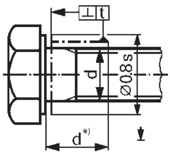
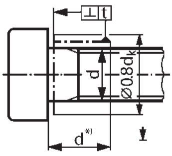
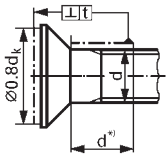
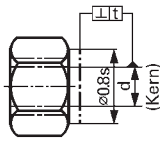
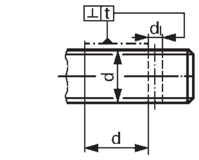
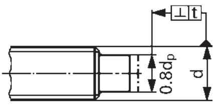
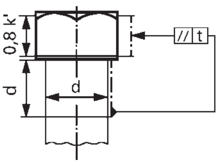
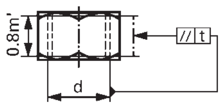
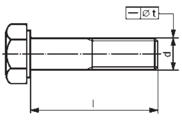
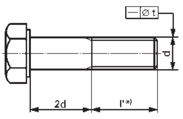
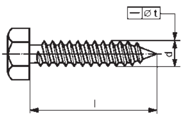
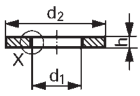
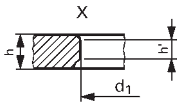
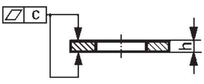
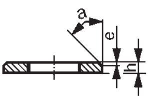
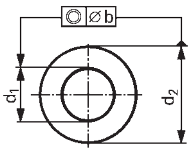
TECHNICAL INFORMATION and DATA

Feature	Tolerance *t* for product grades A	B	C	Tolerance *t* based on dimension	Notes
Symmetry: splint hole to shank 	2 IT 13	2 IT 14	2 IT 15	*d*	
Symmetry: slot to minor diameter 	2 IT 13	2 IT 14	2 IT 15	*d*	

Feature	Tolerance *t* **) for product grades A	B	C	*d*	Notes
Perpendicularity: bearing face to shank / thread	0,05		–	1,6	
				2	
	0,1			2,5	
				3	
				3,5	
				4	
	0,15		0,3	5	
				6	
				7	
	0,18		0,36	8	
	0,24		0,48	10	
	0,27		0,54	12	
	0,31		0,62	14	Measuring circle: 0,8 x width across flats or 0,8 x head diameter
	0,34		0,68	16	
	0,38		0,76	18	*) see page 54
	0,42		0,84	20	**)Tolerance *t* calculated from an angle of 1° for product grades A and B and 2° for product grade C up to *d* = 39 mm and 30° or 1° respectively for sizes over 39 mm (in accordance with common practice).
	0,45		0,90	22	
	0,50		1,00	24	
	0,57		1,14	27	
	0,64		1,28	30	
	0,70		1,40	33	
	0,77		1,54	36	
	0,84		1,68	39	
	0,45		0,90	42	
	0,49		0,98	45	
	0,52		1,04	48	
	0,56		1,12	52	
	0,08			ST 2,2	
	0,16			ST 2,9	
	0,16			ST 3,5	
	0,16			ST 4,2	**)Tolerance for *t* calculated as follows $t < 1{,}2\ d \times \tan 2°$
	0,3			ST 4,8	
	0,3			ST 5,5	
	0,3			ST 6,3	
	0,34			ST 8	
	0,42			ST 9,5	
Perpendicularity:  	Values see above				

Feature	d	Tolerance *t* for product grades A	B	C	Notes
Parallelism 		0,017 × *k′*	0,035 × *k′*		for *k′* and *m′* see product standards
		0,017 × *m′*	0,035 × *m′*		
Straightness 	≤ 8	*t* = 0,002 *l* + 0,05		–	
	> 8	*t* = 0,002 *l* + 0,05		–	
	≤ 8	–		*t* = 2 (0,002 *l′* + 0,05)	*) Straightness tolerance is applicable only for *l′*.
	> 8	–		*t* = 2 (0,0025 *l′* + 0,05)	
		*t* = 0,003 *l* + 0,05			for *l* ≤ 20 *d*

Feature		Tolerances, Product grades: F		A		C	
Clearance hole (punched) Outside diameter (punched)  	*h*	d_1	d_2	d_1	d_2	d_1	d_2
	≤ 4	H12	h13	H13	h14	H14	h16
	>	H13	h14	H14	h15	H15	h16
	h	*h′* 1) min.		*h′* 1) min.		*h′* 2) min.	
	≤ 4	0,5 *h*		0,5 *h*		no requirements	
	>4	0,3 *h*		0,3 *h*			
Thickness 	*h*	h tolerance	*c*1	h tolerance	*c*1	h tolerance	*c*1
Flatness	> 0,5	± 0,04	0,07	± 0,05	0,1	–	no requirements
	> 0,5 ≤ 1	± 0,06	0,1	± 0,1	0,15	± 0,2	
	> 1 ≤ 2,5	± 0,12	0,2	± 0,2	0,2	± 0,3	
	> 2,5 ≤ 4	± 0,16	0,3	± 0,3	0,3	± 0,6	
	> 4 ≤ 6	± 0,2	0,4	± 0,6	0,4	± 1	
	> 6 ≤ 10	± 0,24	0,6	± 1	0,6	± 1,2	
	> 10 ≤ 20	± 0,28	1	± 1,2	1	± 1,6	
	c1: for stainless washers tolerance is 2 x c						
Chamfer 		α = 30° to 45° e_{min} = 0,25 *h* e_{max} = 0,5 *h*				no requirements	
Coaxiality 	d_2	*b*		*b*		*b*	
	≤ 50	2 IT11		2 IT12		2 IT15	
	> 50	2 IT12		2 IT13		2 IT16	

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Standard tolerances and deviations

Nominal dimension	Standard tolerances (acc. DIN 7151)							Tolerance field																
								for shafts (acc. DIN 7160)												for holes (acc. DIN 7161)				
	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16	IT 17	b 13	h 11	h 12	h 13	h 14	h 15	h 16	h 17	js 14	js 15	js 16	js 17	D 12	H 11	H 12	H 13	H 14
to 3	0,06	0,10	0,14	0,25	0,40	0,60	1,00[1]	–	0 – 0,06	0 – 0,10	0 – 0,14	0 – 0,25	0 – 0,40	0 – 0,60	–	±0,125	±0,20	±0,30	±0,50[2]	+ 0,12 + 0,02	+ 0,06 0	+ 0,10 0	+ 0,14 0	+ 0,25 0
over 3 to 6	0,075	0,12	0,18	0,30	0,48	0,75	1,20[1]	– 0,14 – 0,32	0 – 0,075	0 – 0,12	0 – 0,18	0 – 0,30	0 – 0,48	0 – 0,75	–	±0,15	±0,24	±0,375	±0,60[2]	+ 0,15 + 0,03	+ 0,075 0	+ 0,12 0	+ 0,18 0	+ 0,30 0
over 6 to 10	0,09	0,15	0,22	0,36	0,58	0,90	1,50	– 0,15 – 0,37	0 – 0,09	0 – 0,15	0 – 0,22	0 – 0,36	0 – 0,58	0 – 0,90	0 – 1,50	±0,18	±0,29	±0,45	±0,75	+ 0,19 + 0,04	+ 0,09 0	+ 0,15 0	+ 0,22 0	+ 0,36 0
over 10 to 18	0,11	0,18	0,27	0,43	0,70	1,10	1,80	– 0,15 – 0,42	0 – 0,11	0 – 0,18	0 – 0,27	0 – 0,43	0 – 0,70	0 – 1,10	0 – 1,80	±0,215	±0,35	±0,55	±0,90	+ 0,23 + 0,05	+ 0,11 0	+ 0,18 0	+ 0,27 0	+ 0,43 0
over 18 to 30	0,13	0,21	0,33	0,52	0,84	1,30	2,10	– 0,16 – 0,49	0 – 0,13	0 – 0,21	0 – 0,33	0 – 0,52	0 – 0,84	0 – 1,30	0 – 2,10	±0,26	±0,42	±0,65	±1,05	+ 0,275 + 0,065	+ 0,13 0	+ 0,21 0	+ 0,33 0	+ 0,52 0
over 30 to 40	0,16	0,25	0,39	0,62	1,00	1,60	2,50	– 0,17 – 0,56	0 – 0,16	0 – 0,25	0 – 0,39	0 – 0,62	0 – 1,00	0 – 1,60	0 – 2,50	±0,31	±0,50	±0,80	±1,25	+ 0,33 + 0,08	+ 0,16 0	+ 0,25 0	+ 0,39 0	+ 0,62 0
over 40 to 50								– 0,18 – 0,57																
over 50 to 80	0,19	0,30	0,46	0,74	1,20	1,90	3,00	–	0 – 0,19	0 – 0,30	0 – 0,46	0 – 0,74	0 – 1,20	0 – 1,90	0 – 3,00	±0,37	±0,60	±0,95	±1,50	+ 0,40 + 0,10	+ 0,19 0	+ 0,30 0	+ 0,46 0	+ 0,74 0
over 80 to 120	0,22	0,35	0,54	0,87	1,40	2,20	3,50	–	0 – 0,22	0 – 0,35	0 – 0,54	0 – 0,87	0 – 1,40	0 – 2,20	0 – 3,50	±0,435	±0,70	±1,10	±1,75	+ 0,47 + 0,12	+ 0,22 0	+ 0,35 0	+ 0,54 0	+ 0,87 0
over 120 to 180	0,25	0,40	0,63	1,00	1,60	2,50	4,00	–	0 – 0,25	0 – 0,40	0 – 0,63	0 – 1,00	0 – 1,60	0 – 2,50	0 – 4,00	±0,50	±0,80	±1,25	±2,00	+ 0,545 + 0,145	+ 0,25 0	+ 0,40 0	+ 0,63 0	+ 1,00 0
over 180 to 250	0,29	0,46	0,72	1,15	1,85	2,90	4,60	–	0 – 0,29	0 – 0,46	0 – 0,72	0 – 1,15	0 – 1,85	0 – 2,90	0 – 4,60	±0,575	±0,925	±1,45	±2,30	+ 0,63 + 0,17	+ 0,29 0	+ 0,46 0	+ 0,72 0	+ 1,15 0
over 250 to 315	0,32	0,52	0,81	1,30	2,10	3,20	5,20	–	0 – 0,32	0 – 0,52	0 – 0,81	0 – 1,30	0 – 2,10	0 – 3,20	0 – 5,20	±0,65	±1,05	±1,60	±2,60	+ 0,71 + 0,19	+ 0,32 0	+ 0,52 0	+ 0,81 0	+ 1,30 0
over 315 to 400	0,36	0,57	0,89	1,40	2,30	3,60	5,70	–	0 – 0,36	0 – 0,57	0 – 0,89	0 – 1,40	0 – 2,30	0 – 3,60	0 – 5,70	±0,70	±1,15	±1,80	±2,85	+ 0,78 + 0,21	+ 0,36 0	+ 0,57 0	+ 0,89 0	+ 1,40 0
over 400 to 500	0,40	0,63	0,97	1,55	2,50	4,00	6,30	–	0 – 0,40	0 – 0,63	0 – 0,97	0 – 1,55	0 – 2,50	0 – 4,00	0 – 6,30	±0,775	±1,25	±2,00	±3,15	+ 0,86 + 0,23	+ 0,40 0	+ 0,63 0	+ 0,97 0	+ 1,55 0

1) not in DIN 7151
2) not in DIN 7160

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Slots (nominal sizes)

Metric screws				Wood screws			Tapping screws	
∅	DIN 84 85 963 964	DIN 417 427 438 551 553	SN 213328	∅	DIN 95 96 97		∅	DIN 7971 7972 7973
M 1	0,25	0,2		**1,6**	0,4		**2,2**	0,6
M 1,2 (1,4)	0,3	0,2		**2**	0,5		**2,9**	0,8
M 1,6 (1,8)	0,4	0,25		**2,5**	0,6		**3,5**	1
M 2	0,5	0,25		**3**	0,8		**3,9**	1
M 2,5 (2,3)	0,6	0,4		**3,5**	0,8		**4,2**	1,2
M 3	0,8	0,4	0,6	**4**	1		**4,8**	1,2
M 3,5	1	0,5		**4,5**	1		**5,5**	1,6
M 4	1,2	0,6	0,8	**5**	1,2		**6,3**	1,6
M 5	1,2	0,8	1	**5,5**	1,2			
M 6	1,6	1	1,2	**6**	1,6			
M 8	2	1,2		**7**	2			
M 10	2,5	1,6		**8**	2			
M 12	3	2		**10**	2,5			

Cross recesses (nominal sizes)

Metric screws				Wood screws			Tapping screws	
∅	DIN 965 966 7985	SN 213307		∅	DIN 7995 7996 7997	K 525 K 526 K 527	∅	DIN 7981 7982 7983
M 1,6	0	0		**2**	0		**2,2**	1
M 2	1	1		**2,5**	1		**2,9**	1
M 2,5	1	1		**3**	1		**3,5**	2
M 3	1	2		**3,5**	2	2	**3,9**	2
M 3,5	2	2		**4**	2	2	**4,2**	2
M 4	2	2		**4,5**	2	2	**4,8**	2
M 5	2	2		**5**	2	2	**5,5**	3
M 6	3	3		**5,5**	3		**6,3**	3
M 8	4	3		**6**	3	3		
M 10	4			**7**	3			
				8	4			

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TECHNICAL INFORMATION and DATA

Widths across flats, hexagon products

	Hexagon products					Hexagon flanged products		
	DIN	ISO	DIN	ISO	DIN	DIN	DIN – ISO – EN	
∅	558 601 931 933 934 960 961 7990 7968 571	4018 4016 4014 4017 4032 8765 8676	6914 6915 7999 (EN 781) (EN 782) (EN 783) (EN 781)	7412 7414	561	heavy ≤ M10 normal > M10 6921	normal ISO 4162 EN 1662	heavy EN 1665 nuts ISO 4161 EN 1661 EN 1663 EN 1664 DIN 6923 DIN 6926 DIN 6927
M 1,6	3,2							
M 2	4							
M 2,5	5							
M 3	5,5							
M 3,5	6							
M 4	7							
M 5	8					8	7	8
M 6	10				8	10	8	10
M 7	11							
M 8	13				10	13	10	13
M 10	17	16			13	15	13	15 (EN 16)
M 12	19	18	22	21	17	16	15 (EN 16)	18
M 14	22	21				18	18	21
M 16	24		27		19	21	21	24
M 18	27							
M 20	30		32	34	24	27	27	30
M 22	32	34	36					
M 24	36		41		30			
M 27	41		46					
M 30	46		50		36			
M 33	50							
M 36	55		60		46			
M 39	60							
M 42	65				55			
M 45	70							
M 48	75				65			

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TECHNICAL INFORMATION and DATA

Hexagon sockets (widths across flats)

Ø	DIN 912 ISO 4762 DIN 6912	DIN 7984	DIN 7991	DIN 913 914/5/6 ISO 4026 4027/8/9	ISO 7379	ISO 7380	K 323
M 1,4	1,3			0,7			
M 1,6	1,5			0,7			
M 2	1,5			0,9			
M 2,5	2		1,5	1,3			
M 3	2,5	2	2	1,5		2	
M 4	3	2,5	2,5	2		2,5	2
M 5	4	3	3	2,5		3	3
M 6	5	4	4	3	3	4	3
M 8	6	5	5	4	4	5	4
M 10	8	7	6	5	5	6	5
M 12	10	8	8	6	6	8	
M 14	12	10	10	6			
M 16	14	12	10	8	8	10	
M 18	14	12	12	10			
M 20	17	14	12	10	10		
M 22	17	14	14	12			
M 24	19	17	14	12	12		
M 27	19						
M 30	22						
M 33	24						
M 36	27						
M 42	32						
M 48	36						

Hexlobular sockets (TORX®) (nominal sizes)

Metric screws				Wood screws			Tapping screws	
Ø	ISO 7380	ISO 14581 ISO 14583		Ø	K 535 K 537		Ø	ISO 14585 ISO 14586
M 2		T 6		3	T 10		2,9	T 10
M 2,5		T 8		3,5	T 15		3,5	T 15
M 3		T 10		4	T 15		4,2	T 20
M 4	T 20	T 20		4,5	T 25		4,8	T 25
M 5	T 25	T 25		5	T 25		5,5	T 25
M 6	T 30	T 30		6	T 25		6,3	T30
M 8	T 40	T 45		7	T 30			
M 10	T 50	T 50						

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TECHNICAL INFORMATION and DATA

Recommended core hole diameter d (H11) for thread cutting screws DIN 7513/16

Thread nominal diameter	M 2,5	M 3	M 4	M 5	M 6	M8
Core hole diameter tolerance H 11	2,2	2,7	3,6	4,5	5,5	7,4

Recommended core hole diameter d (H11) for thread forming screws DIN 7500 (TAPTITE®)

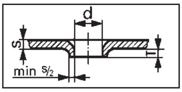
in materials of hardness up to HB 150

Material thickness	Thread, nominal diameter / nut, sheet material	St = steel	Al = aluminium	Cu = brass/copper							
	M 2	M 2,5	M 3	M 3,5	M 4	M 5	M 6	M 8		M 10	
	St, Al, Cu	St, Al, Cu	St, Al, Cu	St, Al, Cu	St, Al, Cu	St, Al, Cu	St, Al, Cu	St	Al, Cu	St	Al	Cu
< 2 mm	1,80	2,25	2,70	3,20	3,60	4,50	5,40	7,25	7,25			
< 3 mm	1,85	2,30	2,75	3,20	3,60[1]	4,50	5,45	7,25	7,25	9,20	9,15	9,15
< 4 mm		2,30	2,75	3,20	3,65	4,55	5,45	7.30	7,30	9,30	9,15	9,15
< 5 mm		2,30	2,75	3,25	3,65	4,60	5,45[1]	7,40	7,30	7,30	9,20	9,25
< 6 mm		2,35	2,75	3,30	3,65[1]	4,60	5,50	7,40	7,30	9,30	9,20	9,25
< 7 mm				3,30	3,70	4,65	5,50[1]	7,50	7,40	9,30	9,20	9,30
< 8 mm				3,30	3,70	4,65	5,55	7,50	7,40	9,40	9,30	9,30
< 10 mm					3,75	4,65	5,55	7,50	7,40	9,40	9,30	9,30
< 12 mm						4,70	5,60	7,50	7,50	9,50	9,40	9,40
< 15 mm								7,55	7,50	9,50	9,40	9,40
> 15 mm								7,60	7,55	9,50	9,50	9,50

1) for steel: drill or punch core hole diameter 0,05 mm larger

in thin sheet metals of steel St 37

Sheet metal thickness	Thread, nominal diameter													
	M 2.5		M 3		M 3.5		M 4		M 5		M 6		M 8	
	d	T	d	T	d	T	d	T	d	T	d	T	d	T
0,5	2,24	1,02	2,71	1,19	3,15	1,35								
0,8	2,26	1,02	2,74	1,19	3,18	1,35	3,59	1,52						
1,0	2,28	1,02	2,77	1,19	3,21	1,35	3,62	1,52	4,53	1,78	5,41			
1,6	2,30	1,02	2,80	1,19	3,24	1,35	3,65	1,55	4,56	1,78	5,44	1,91	7,27	2,11
2,0	2,32	1,09	2,82	1,32	3,28	1,52	3,68	1,78	4,59	2,29	5,47	2,54	7,29	2,95
3,0							3,72	1,91	4,61	2,41	5,49	2,67	7,32	3,18
4,0											5,54		7,37	
5,0													7,45	
6,0													7,53	



Flanging
s = sheet thickness
d = diameter of the hole
T = height of the flange

Thin sheet metals have to be flanged for bolting. By tapping the thread or using self cutting screws, the thin sheet will be weakened, whereas self forming screws create a cold strenghtened, fully loadable thread.

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Application and core hole diameter for tapping screws

The following are some guidelines for the use of tapping screws. The types of screw joint illustrated are given as examples.

Form C (replacing obsolete form B) tapping screws with cone ends (also known as gimlet points) are most commonly used. This is especially the case when several sheets are being joined, where allowance has to be made for misalignment of the holes.

Form F (replacing obsolete form BZ) tapping screws with flat ends are generally only preferred where the screw end lies free and in the case of Form C there would be danger of injury from the point.

For simple screw joints, i.e. those in which the tapping screw cuts its own nut thread, the combined thickness of the metal sheets to be screwed together must be larger than the screw pitch. If the total thickness of the sheet metal is smaller, it is advisable to pierce or extrude the core holes. This allows the necessary tightening to be secured. Otherwise the use of self-locking nuts (also known as spring nuts or speed nuts) is recommended.

Often, however, the pressed-hole screw joints are advantageous – especially in mass production. Using a special tool the pressed-hole is punched, slit, and formed spirally conforming to the thread pitch of the corresponding tapping screw. It can be either punched into the sheet metal to be screwed itself, or also into a special sheet metal – similar to a lock nuts. Pressed-hole screw joints are generally only recommended for low-carbon steel sheets. There are circumstances where heat-treated steels or non-ferrous metals will require a special construction of pressed-holes.

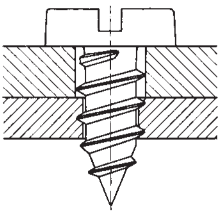

Fig. 1 Simple fastening of metal sheets whose thickness is larger than the screw pitch.

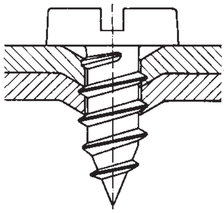

Fig. 2 Fastening with pierced or extruded core hole (for thin sheets)

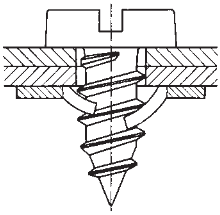

Fig. 3 Fastening with locking nut (speed nut)

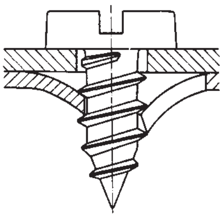

Fig. 4 Pressed-hole fastening joint

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Recommended core hole diameters for tapping screws in metals

Experience with the core hole diameters as set out in the following table has shown that they are also suitable for most kinds of protective coating, e.g. galvanized plating as specified by DIN 267 / part 9 or ISO 4042.
The core hole sizes are given as recommendations which have resulted from the practice by manufacturers and users. It may however be advisable, in certain cases – particularly in mass production – to confirm the core hole diameters by suitable tests.

Tapping screw thread acc. to DIN 7970		Thickness of sheet metal		Core hole diameter[1)] pierced or extruded		Core hole diameter[1)] drilled or punched	
Nominal diameter	No. acc. to ISO	more than	up to	steel, nickel, brass, copper and monel sheets	aluminium sheets	steel, nickel brass, copper and monel sheets	aluminium sheets
2,2	2	-	0,56	-	-	1,6	-
		0,56	0,75	-	-	1,7	1,6
		0,75	0,88	-	-	1,8	1,6
		0,88	1,13	-	-	1,85	1,6
		1,13	1,38	-	-	1,85	1,7
		1,38	1,5	-	-	1,9	1,8
2,9	4	-	0,56	2,2	-	2,2	-
		0,56	0,63	2,5	2,2	2,25	-
		0,63	0,75	2,5	2,2	2,25	2,2
		0,75	0,88	2,5	2,2	2,4	2,2
		0,88	1,25	-	2,2	2,4	2,2
		1,25	1,38	-	-	2,4	2,2
		1,38	1,75	-	-	2,5	2,25
		1,75	2,5	-	-	2,6	2,4
3,5	6	-	0,56	2,8	-	2,6	-
		0,56	0,75	2,8	2,8	2,7	-
		0,75	0,88	2,8	2,8	2,7	2,65
		1	1,25	-	2,8	2,8	2,65
		1,25	1,38	-	-	2,8	2,65
		1,38	1,75	-	-	2,9	2,75
		1,75	2,5	-	-	3	2,85
		2,5	3	-	-	3.2	3
		3	6	-	-	-	3
3,9	7	-	0,5	3	-	2,95	-
		0,5	0,63	3	3	2,95	-
		0,63	0,88	3	3	2,95	2,9
		0,88	1,13	3	3	2,95	2,95
		1,13	1,25	3	3	3	2,95
		1,25	1,38	-	-	3	2,95
		1,38	1,75	-	-	3,2	3
		1,75	2	-	-	3,2	3,5
		2	2,5	-	-	3,5	3,5
		2,5	3,5	-	-	3,6	3,5
4,2	8	-	0,5	3,5	-	-	-
		0,5	0,63	3,5	3,5	3,2	-
		0,63	0,88	3,5	3,5	3,2	2,95
		0,88	1,13	3,5	3,5	3,2	3
		1,13	1,38	3,5	3,5	3,3	3,2
		1,38	2,5	-	-	3,5	3,5
		2,5	3	-	-	3,8	3,7
		3	3,5	-	-	3,9	3,8
		3,5	10	-	-	-	3,9

1) recommended tolerance for the core hole diameter: H 12

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Tapping screw thread acc. to DIN 7970		Thickness of sheet metal		Core hole diameter[1)]			
				pierced or extruded		drilled or punched	
Nominal diameter	No. acc. to ISO	more than	up to	steel, nickel, brass, copper and monel sheets	aluminium sheets	steel, nickel brass, copper and monel sheets	aluminium sheets
4,8	10	-	0,5	4	-	-	-
		0,5	0,75	4	4	3,7	-
		0,75	1,13	4	4	3,7	3,7
		1,13	1,38	4	4	3,9	3,7
		1,38	1,75	-	-	3,9	3,7
		1,75	2,5	-	-	4	3,8
		2,5	3	-	-	4,1	3,8
		3	3,5	-	-	4,3	3,9
		3,5	4	-	-	4,4	3,9
		4	4,75	-	-	4,4	4
		4,75	10	-	-	-	4,2
5,5	12	-	1,13	4,7	-	4,2	-
		1,13	1,38	4,7	-	4,3	4,1
		1,38	1,5	-	-	4,3	4,1
		1,5	1,75	-	-	4,5	4,2
		1,75	2,25	-	-	4,6	4,4
		2,25	3	-	-	4,7	4,6
		3	3,5	-	-	5	4,6
		3,5	4	-	-	5	4,8
		4	4,75	-	-	5,1	4,8
		4,75	10	-	-	-	4,9
6,3	14	-	1,38	5,3	-	4,9	-
		1,38	1,75	-	-	5	5
		1,75	2	-	-	5,2	5
		2	3	-	-	5,3	5,2
		3	4	-	-	5,8	5,3
		4	4,75	-	-	5,9	5,4
		4,75	5	-	-	-	5,6
		5	10	-	-	-	5,8
8	16	-	1,38	-	-	6,4	-
		1,38	1,75	-	-	6,5	6,5
		1,75	2	-	-	6,7	6,5
		2	3	-	-	6,8	6,7
		3	4	-	-	7,2	6,8
		4	4,75	-	-	7,4	6,9
		4,75	5	-	-	-	7
		5	10	-	-	-	7,2

Recommended core hole diameters for tapping screws in plastics

Tapping screw thread acc. to DIN 7970		Core hole diameter	
Nominal diameter	No. acc. to ISO	phenol formaldehyde	cellulose acetate / cellulose nitrate polyacrylate
2,2	2	2	2
2,9	4	2,55	2,4
3,5	6	3,2	3
3,9	7	3,5	3,2
4,2	8	3,8	3,7
4,8	10	4,5	4,3
5,5	12	5	4,8
6,3	14	6	5,6

Electroplated coatings

Electro zinc plating and chromating is the most frequently required coating, since it has proven to be excellent with respect to corrosion resistance and appearance (this process is also called “galvanizing (European terminology only - however in North America, it should not be confused with hot dip galvanizing)” or ”promatizing”, corresponding to zinc-blue-chromated process group B). In vehicle constructions and piping, zinc-plated, yellow-dichromated fasteners are being used more and more because of their higher resistance to corrosion. We keep an extensive range of zinc plated products on stock. Unplated parts that are in stock can normally be electroplated within 1 - 2 weeks.

Coating metal/alloy

Designation symbol	Elements	Symbol
A	Zinc	Zn
B	Cadmium[2])	Cd
C	Copper	Cu
D	Brass	CuZn
E	Nickel	Ni
F	Nickel-chromium[1])	NiCr
G	Copper-nickel	CuNi
H	Copper-nickel-chromium[1])	CuNiCr
J	Tin	Sn
K	Copper-tin (Bronze)	CuSn
L	Silver	Ag
N	Copper-silver	CuAg
P	Zinc-nickel	ZnNi
Q	Zinc-cobalt	ZnCo
R	Zinc-iron	ZnFe

[1]) Thickness of chromium approximately 0,3 μm
[2]) Use of cadmium is restricted or prohibited in certain countries

Chromate treatment and corrosion protection performance

Chromate treatment group		Typical color	Corrosion resistance				
Note: galvanizing as refered to here means **zinc plating**, not hot dip galvanizing.			Increase of corrosion resistance in neutral salt spray test	First appearance of red rust in neutral saltspray test in hours (depending on coating thickness)			
				3 μm	5 μm	8 μm	12μm
-	galvanized only	metallic, silver	100%	-	-	-	-
A	galvanized and clear chromated	metallic, silver	200%	12	24	48	72
B	galvanized and transparent chromated	bright, bluish to bluish iridescent	200%	12	36	72	96
C	galvanized and yellow chromated	yellowish gleaming to yellow-brown, iridescent	350%	24	72	120	144
D	galvanized and olive-drab chromated	olive-drab to olive brown	450%	24	96	144	168
F	galvanized and black	brown-black to black	200%	-	36	72	96

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TECHNICAL INFORMATION and DATA

Coating thickness for parts with external threads

Pitch	Nominal thread diameter1)	General purpose tolerance for screw threads					Special purpose tolerance for screw threads										Tolerance for hot dip galvanizing	
		Tolerance deviation g					Tolerance deviation f					Tolerance deviation e					Tolerance deviation ax	
		Fundamental deviation	Coating thickness max. in the thread				Fundamental deviation	Coating thickness max. in the thread				Fundamental deviation	Coating thickness max. in the thread				Coating thickness max. in the thread	
			2)	3)				2)	3)				2)	3)				2)
			All nominal lengths	Nominal length, l				All Nominal lengths	Nominal length, l				All nominal lengths	Nominal length, l			Fundamental deviation	All nominal lengths
P		A_0		l ≤ 5d	5d < l ≤ 10d	10d < l ≤ 15d	A_0		l ≤ 5d	5d < l ≤ 10d	10d < l ≤ 15d	A_0		l ≤ 5d	5d < l ≤ 10d	10d < l ≤ 15d	A_0	
mm	M	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm
0,25	1; 1,2	– 18	3	3	3	3												
0,3	1,4	– 18	3	3	3	3												
0,35	1,6 (1,8)	– 19	3	3	3	3	– 34	8	8	5	5							
0,4	2	– 19	3	3	3	3	– 34	8	8	5	5							
0,45	2,5 (2,2)	– 20	5	5	3	3	– 35	8	8	5	5							
0,5	3	– 20	5	5	3	3	– 36	8	8	5	5	– 50	12	12	10	8		
0,6	3,5	– 21	5	5	3	3	– 36	8	8	5	5	– 53	12	12	10	8		
0,7	4	– 22	5	5	3	3	– 38	8	8	5	5	– 56	12	12	10	8		
0,75	4,5	– 22	5	5	3	3	– 38	8	8	5	5	– 56	12	12	10	8		
0,8	5	– 24	5	5	3	3	– 38	8	8	5	5	– 60	15	15	12	10		
1	6 (7)	– 26	5	5	3	3	– 40	10	10	8	5	– 60	15	15	12	10	– 290	70
1,25	8	– 20	5	5	5	3	– 42	10	10	8	5	– 63	15	15	12	10	– 295	70
1,5	10	– 32	8	8	5	5	– 45	10	10	8	5	– 67	15	15	12	10	– 300	75
1,75	12	– 34	8	8	5	5	– 48	12	12	8	8	– 71	15	15	12	10	– 310	75
2	16 (14)	– 38	8	8	5	5	– 52	12	12	10	8	– 71	15	15	12	10	– 315	75
2,5	20 (18; 22)	– 42	10	10	8	5	– 58	12	12	10	8	– 80	20	20	15	12	– 315	80
3	24 (27)	– 48	12	12	8	8	– 63	15	15	12	10	– 85	20	20	15	12	– 335	80
3,5	30 (33)	– 53	12	12	10	8	– 70	15	15	12	10	– 90	20	20	15	15	– 345	85
4	36 (39)	– 60	15	15	12	10	– 75	15	15	15	12	– 95	20	20	15	15	– 355	85
4,5	42 (45)	– 63	15	15	12	10	– 80	20	20	15	12	– 100	25	25	20	15		
5	48 (52)	– 71	15	15	12	10	– 85	20	20	15	12	– 106	25	25	20	15		
5,5	56 (60)	– 75	15	15	15	12	– 90	20	20	15	15	– 112	25	25	20	15		
6	64	– 80	20	20	15	12	– 95	20	20	15	15	– 118	25	25	20	15		

1) Information for coarse pitch threads is given for convenience only. The determining characteristic is the thread pitch.
2) Maximum values of nominal coating thickness if local thickness measurement is agreed.
3) Maximum values of nominal coating thickness if batch average thickness measurement is agreed.

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Surface treatment processes
Coatings and Platings

Process	Description
Hot-dip galvanizing	Products are immersed in molten zinc with a temperature of about 440-470°C. Coating thicknesses 40-80my. Dull and rough finish. Spotting may occur within a fairly short time. Very high protection against corrosion. Distant protection even if coating partially is lacking.
Phosphating	Only slight protection against corrosion. Good undercoat for painting. Grey to grey-black appearance. Improved protection against corrosion by subsequent lubricating.
Black oxidizing	Chemical process, bath temperature approx. 140°C. For decorative purposes, only slightly corrosion-resistant.
Burnishing	Similar process as black oxidizing, however, various shades of colour may be obtained: light, medium, dark, or according to customer's sample.
Thermal post-treatment[2]) (baking)	All steel components with high tensile strength (over 1000N/mm^2) may be subject to embrittlement (hydrogen embrittlement) due to absorption of hydrogen during pickling or electrolytic treatment. The beneficial effect of a Thermal post-treatment (below annealing temperature) after electroplating is the removal of hydrogen by effusion and / or the irreversible trapping of hydrogen in the steel. With the present state of technical knowledge this process offers good practical results for fasteners smaller than M14. With increasing coating thickness the difficulty of removing hydrogen increases. Thermal post-treatment follows immediately after the electrolytic treatment.
Dacromet	Excellent, non-electrolytic coating process for high-tensile components. The possibility of hydrogen embrittlement is excluded, if the process is carried out correctly. Resistance to corrosion is roughly the same as for electroplating of the same thickness.
Mechanical (zinc) plating	Chemo-mechanical plating process. The degreased parts are placed in a cladding drum with a special mixture of glass pellets and zinc powder. The glass pellets serve as a carrier for the zinc and help the zinc rise to the surface of the work piece, where it will stick due to cold-welding. By correct processing, hydrogen embrittlement can be excluded.
Polyseal Delta Seal	First, a zinc phosphate layer is applied in an ordinary dipping process. Then, an organic protective coating follows which temper-hardens at about 200°C. Finally, a rust inhibitor is applied. This coating can be ordered in various colors and is an excellent corrosion protection. Main field of application is the automotive industry.
Veralisation	A special process of hard nickel plating. Combines protection against abrasion and corrosion.

[1]) We offer hot dip galvanized hex head screws (ISO 4014/4017, DIN 933/931) in property classes 4.8 and 8.8. The threads are undersized to accept a 6H GO gauge after plating.
A full range of hot-dip galvanized hex structural bolts DIN 7990 and heavy hex bolts for high strength structural bolting DIN 6914 are available from our european stock. Of course, we also offer the matching hot dip galvanized nuts and washers.

[2]) All our products of property classes 10.9, 12.9 and 45H automatically undergo thermal post-treatment after electroplating (also known as baking or stress relieving).

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Electroplated high-tensile steel, electroplated spring steel

Risk of failure due to hydrogen embrittlement

Steel fasteners
- with a hardness of 320 HV and more (property class 10.9 and higher/spring steel) or which have been surface hardened
- which have been chemically and/or electrochemically treated and have therefore absorbed hydrogen
- which are under tensile stress

may be subject to the mechanism of hydrogen embrittlement.

Appropriate precautions (choice of raw material, cleaning in inhibited acid only or by sand-blasting, plating in high cathodic efficient solutions, baking after plating in accordance with ISO 4042) can help to reduce the risk of hydrogen embrittlement.

Based on the technical know-how of our suppliers and our own experience, we supply fasteners of property classes 10.9 and higher, as well as fasteners made of spring steel in electroplated and baked condition.
According to the present state of the art, the risk of hydrogen induced embrittlement is very low, however, it cannot be totally excluded.

All parts can also be supplied dacrometized or mechanically plated. The risk of hydrogen embrittlement is completely eliminated by these processes.

As the user of the fasteners, only you fully know the applications and the pertaining risks. And only you are in a position to establish a cost-effectiveness analysis for the chosen type of plating (low-price electroplating and baking with a calculated risk or high-price special plating without risk) . Be sure to give us the relevant instructions when placing your order.

We also stock certain items and sizes dacrometized or mechanically plated.

Locking of fasteners

When bolted joints are put under dynamic stress, they may become loose unless they are properly secured. A distinction is made between two types of fastener locking.

a) **Securing against loss of clamping load (setting)**
With axially stressed, preloaded screws, setting occurs (i.e. smoothing (= local plastic deformation) of the surfaces in the parting planes, compensation of excessive surface pressure) and leads to a loss of clamping load. A drop in preload increases the dynamic portion of the load in the screw and can cause fatigue failure.

b) **Securing against rotation (unscrewing/loosening)**
If a relative movement between the tightened parts is able to occur as a result of high lateral force (or insufficient preload due to loss of clamping load, faulty assembly, or incorrect dimensioning), it releases the self-locking in the thread and the friction in the head or nut section and the fastener will loosen by itself. This can, in fact, result in a total loosening (falling apart) of the bolted joint.

Precaution against loss of clamping load	**Effects**
Setting partially compensated by tightening	Setting partially compensated during tightening
Increase clamping/diameter ratio, length = 4 x diameter	Greater elasticity, more space for compensation of setting
Reduce surface roughness, clean separating seams, minimize the number of parting planes	Less possibilities for loss through setting (embedding)
Use flange products	Larger bearing surface prevents exceeding the max - imum permissible surface pressure
Use spring elements with sufficient rigidity	Compensation of setting (too soft spring elements have no effect, rather they merely increase the number of separating seams and setting possibilities!)
Re-tighten after initial operating time	Compensates setting

Precaution against unscrewing	**Effects**
Tighten properly, increase preload, use larger dimensions, higher property class	Increased axial forces prevent lateral movements
Increase clamping/diameter ratio (length = 4 x diameter)	Easier bending of the shank. Prevention of relative movement below head or nut
Use shoulder bolts, pin parts together	Prevention of lateral movement (slip) between parts
Increase grip on head and nut surface	Helps prevent relative movement under head or nut
Increase friction in thread	Unscrewing torque increased

Precaution against loosening / (falling apart)	**Effects**
Secure against loss of clamping load and unscrewing	No basis for loosening
Increase friction in thread	Even when clamping force is fully lost, a minimum torque still exists and prevents a complete unscrewing
Limit further rotation through shape locking	Nut cannot be turned beyond the stop.

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Locking elements

Limitations of:

Elements against loss of clamping load		Used with fasteners of property class			
		4.8	5.8	6.8	8.8
Helical spring lock washers	DIN 127 A a) DIN 127 B a)	2	2–3	–	–
High collar spring lock washers	DIN 7980 b)	2	2–3	2–3	–
Double coil spring lock washers (Thackeray washers)		2	2	2–3	–
Curved spring washers	DIN 137 A c)	3	–	–	–
Waved spring washers	DIN 137 B	2	–	–	–
Conical spring washers	SN 212745	2	2	2–3	–
Curved spring lock washers	DIN 128 A	2	2	2–3	–
Waved spring lock washers	DIN 128 B d)	2–3	3	–	–
Conical spring washers	DIN 6796	2	2	2	3
Disc springs	DIN 2093	3	3	2–3	2–3

Elements against rotating		Used with fasteners of property class			
		< 6.8	8.8	10.9	12.9
Prevailing torque nuts with polyamid insert	DIN 982 DIN 985 DIN 986	2–3	3–4	–	–
Prevailing torque nuts all metallic	DIN 980 V/M	2–3	3–4	–	–
Castle nuts	e.g. DIN 935 p. ex. DIN 935	2–3	–	–	–
Tab washers	DIN 93	2–3	–	–	–
Wire as locking means		3	–	–	–
Microencapsulated screws «Precote®»		1	1	1	1
Anaerobic adhesives «OmniFIT»		1	1	1	1
Polyamid patch coated screws and nuts «Kaflok®»		2	3	–	–

Elements against loss of clamping load and against rotating		Used with fasteners of property class			
		< 6.8	8.8	10.9	12.9
Serrated lock washers	DIN 6798 A/J/V/DD	2–3	–	–	–
Ribbed lock washers e.g. «Schnorr®»		2	3	–	–
Toothed lock washers	DIN 6797 A/J	2–3	–	–	–
Hex nuts with toothed lock washers		2–3	–	–	–
Serrated flange screws		–	–	1–2	1–2
Serrated flange nuts		–	–	1–2	1–2

Elements against loosening		Used with fasteners of property class			
		< 6.8	8.8	10.9	12.9
Prevailing torque nuts with polyamid insert	DIN 982 DIN 985 DIN 986	1–2	2	–	–
Prevailing torque nuts all metallic	DIN 980 V/M	1–2	2	–	–
Polyamid patch coated screws and nuts «Kaflok®»		1	1–2	1–2	1–2
Anaerobic adhesives «omniFIT®»		1	1	1	1

1 = excellent 2 = good 3 = acceptable 4 = critical – = ineffective

Note: polyamid = nylon®

a) The use of DIN 128 A is recommended. The standard DIN 127 is withdrawn. Stainless spring lock washers according DIN 127 B may be used based upon the customer's own experience.
b) The standard DIN 7980 is withdrawn.
c) The use of DIN 137 B is recommended. The standard for DIN 137 type A is withdrawn.
d) The use of DIN 128 A is recommended. The standard for DIN 128 type B is withdrawn.

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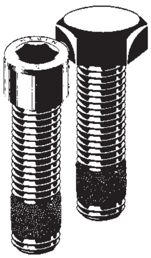
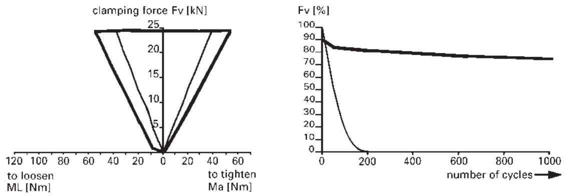
Static and dynamic tests of various locking elements

chart key:
——— regular hex bolts DIN 931-8.8 / hex nuts DIN 934-8 M 10 × 35
——— with locking element

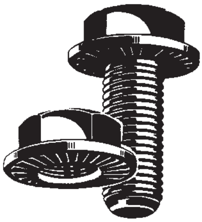
Frequency: 12,5 Hz
Amplitude in idle motion ± 1,0 mm
100% Fv: 25 kN

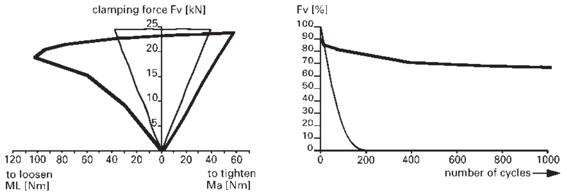




omniFIT®
PRECOTE®

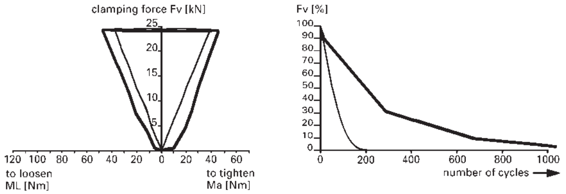
Anaerobic adhesives have excellent locking features after final curing. In the test the loss of preload was less than 15% even after 75000 cycles.





DURLOK®
Serrated screws
and serrated nuts

Serrated or ribbed screws and nuts are very good locking elements. They can be re-used and do not have a limit regarding reasonable temperatures. At sufficient hardness of the connected parts, the loss on preload was less than 20% after 50000 cycles.



Prevailing torque nuts
DIN 980V/ISO 7042

Prevailing torque nuts [with polyamid (nylon®) insert or all metallic] could not prevent complete loosening of the joint. The final preload dropped to 0 after only about 1000 cycles. However, there remained a prevailing torque which prevented the fasteners from falling apart.

Spring lock washers
Toothed lock washers
Tab washers

Spring lock washers, toothed or serrated lock washers, tab washers do not show a locking attribute if used together with fasteners of property class 8.8 or higher. Sometimes loss on preload occurred as fast as on joints with regular hex bolts and nuts without locking elements. In any case after 300 cycles there was no preload left in the joint and the fasteners fall apart.

Securing against loosening

Kaflok®
Nylon-polyamid patch for securing and sealing

Kaflok® is a highly elastic nylon® coating with is sprayed onto a part of the thread and firmly adheres to it. When the thread is engaged, the nylon patch (or ring) generates high pressure against the thread flanks of the mating part. The result is a secured joint which can be loosened at any time again.
Fasteners with a nylon patch do not only secure in a preset position or under preload, but in any position. Therefore Kaflok® is often used with adjusting screws.

Advantages:
- Good locking element against loosening (falling apart)
- No cure time required, load can be applied immediately
- Can be re-used several times
- Secures at any position
- The locking feature is an integrated part of the fastener
- Cost savings in assembly; coated parts can easily be assembled automatically
- No limit to storage time for coated parts
- Kaflok®-ring coated parts have good sealing properties against liquids and gases
- Corresponds to DIN 267 / part 28

Temperature range:	–50 °C to +90 °C (heat resistance briefly: max. +120 °C)
Dimensions - diameter:	M 3 to M 68
length:	5 mm to 200 mm
Chemical resistance against:	alcohol, gasoline, oil, most diluting agents
Colors:	blue (or other colors at our option)
Coefficient of friction in the thread	
for patch coating (=standard)	μ_{thr} = 0,10–0,14
for ring coating	μ_{thr} = 0,12–0,15

Precote® 5

Temperature range:	–50 °C to +150 °C (in air up to +180°C)
Color:	white
Coefficient of friction in the thread	μ_{thr} = 0,12–0,14
(other properties as Kaflok®)	

Vibratite® VC 3

Material:	polyester
Temperature range:	–30 °C to +90° C
Chemical resistance against:	acid, alkaline, caustic solutions
Color:	red
Coefficient of friction in the thread	μ_{thr} = 0,15–0,19

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Securing against loosening

Microencapsulation

Microencapsulation is a bonding pre-coating for threaded parts (M3 and larger). The coating contains two separated microencapsulated components of a modified acrylate system. Varnish functions as carrier for the micro capsules.
When the coated thread is tightened, the micro capsules in the layer are broken and the components are mixed together. The mixture hardens rapidly and fully secures the joint against unscrewing, even at the greatest dynamic lateral forces or vibration.

Microencapsulation is today regarded as one the most effective methods of securing screws in large series.

Advantages:
- The locking feature is an integrated part of the fasteners.
- Major cost savings in assembly; coated parts can easily be assembled automatically.
- Effective sealing of thread (possibility of through-boring instead of blind hole).
- Outstanding results with both low and high tension screw connections.
- Good resistance to chemical influences.
- No damage to surface.
- Coated parts can be stored for up to three years before assembly.
- Corresponds to DIN 267 / part 27

Product	Color code	Torques M_{LB}/M_A	Coefficient of friction in the thread μ thr	Functional strength after h	Temperature range for application
Precote® 30	yellow	< 1	0,14–0,16	3 h	– 60 °C to +120 °C
Precote® 80	red	> 1	0,26–0,28	3 h	– 60 °C to +180 °C
Precote® 85*	blue	> 1,1	0,16–0,18	6 h	– 50 °C to +150 °C
Precote® 100	green	> 1,3	0,12–0,15	6 h	– 50 °C to +120 °C

*** Special = reduced coefficient of friction**
$\mu_{tot.}$ = 0,11 (specially suitable as locking device for high-tensile bolted connections)

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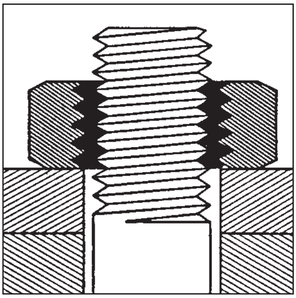
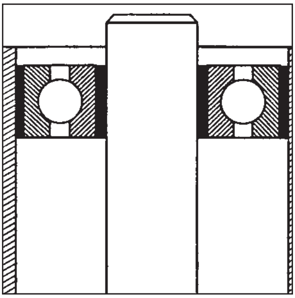
omniFIT® -anaerobic adhesives

omniFIT Diacrylate adhesives are solvent-free, single component anaerobic reactive adhesives. They polymerize when deprived of atmospheric oxygen and under the catalytic effect of metals to a high molecular, networked plastic with strength properties at differing levels.



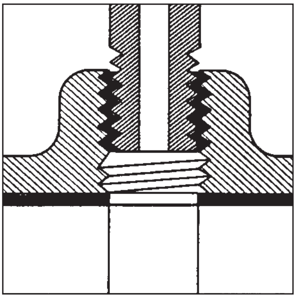
LOCKING
of Threads

Threaded connections of all kinds subjected to transverse and axial loads can be locked against vibration and shock. The locking medium adheres to the surfaces firmly and simultaneously seals the thread gap. It maintains on-torque, prevents loosening and protects against corrosion. As the surface contact is complete, loading is distributed over the whole engaged length, thus preventing material fatique.



RETAINING
of mating Parts

omniFIT can be relied upon to retain mating parts, e.g. pulleys or couplings on shafts, anti-friction bearings or bushes in housings. A change can be made from fixed seating to slip seating with an extended tolerance range. Wedges, adjusting springs, pins and the like can be eliminated. It is suitable for strengthening of press and shrink fittings. It increases static friction by up to 3 times. It prevents fretting corrosion and any need for sealing of the joint space.



SEALING
of Surfaces

For sealing pipe joints and flanges. omniFIT has good resistance to chemicals and is thus suitable as a special sealant. In additional to reliable sealing it is vibration and shock resistant. Hence it is possible, for example, to have any desired angle for connecting pieces. Its high pressure resistance coupled with non-setting and non-flowing properties offer special advantages for sealing flanges and joint faces.

Packing and storage
- bottles of 50 g, 250 g, or 2000 g
- omniFIT seal in tubes of 200 g
- protect from sunlight and keep in dark and cool conditions
- At room temperature the shelf life is 1 year

Precautions
- rated as non toxic
- in our experience, and from a toxicological point of view, there are no problems of using omniFIT
- The characteristic odor makes ventilation advisable
- wash (with soapy water) skin that have been exposed to omniFIT

Processing
- Before omniFIT is applied, surfaces should be cleaned form grease and dust. omniCLEAN, or some other commercial cleaning agent, is suitable for this purpose.
- Where ever possible, omniFIT should be applied to both surfaces to be joined. In the case of threads up to M 16, it is sufficient to apply the adhesive to the bolt thread. However, where blind holes are concerned the bore must be wetted.
- Since the curing reaction starts immediately after the parts are put together (1-3 minutes), they should not be disturbed until initial bond strength is achieved.
- omniFIT products can be applied manually direct from the polyethylene bottles.

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omniFIT® -anaerobic adhesives: varieties

omniFIT 15 yellow (very low strength)

This low strength compound is particularly suitable for adjusting screws which are subject to vibration and connections with very coarse threads which must continue to be dismantled easily. Used with very small screws in eyeglass frames and cable clamps.

omniFIT 50 blue (low strength)

Can be used to lock screws in positions of difficult access which must be removable without much expenditure of strength. For sealing large pipe threads up to 2“. For sealing around sensors, locking and sealing of parts subjects to wear. Use in screwed joints for oil, water and gas.

omniFIT 100 red (medium strength)

Rapid hardening, hence preferred for production line bonding with short sequence times.
Examples of use:
Retaining of sliding bushes, sealing at plugs at cut off points in hydraulic, pneumatic systems. Universal screws locking compounds. For threads up to M 24 and thread engagement till 2 times the diameter.

omniFIT 100 special

Reduced coefficient of friction.
Is specially suitable as locking device for high-tensile bolted connections.

omniFIT 200 green (high strength)

Product line with the shortest curing times. Loosening is possible only if heated. Examples of use: Retaining of shafts and bushes. Reinforcement or replacement of longitudinal and transverse press fits. Screwed joints in frame construction. Preferred screw locking compound in the automotive industry.

omniFIT 230 violet (maximum strength, temperature resistant)

These high stability adhesives can be used for bonds exposed to high temperatures. Of particular importance are the good shear strength properties on smooth surfaces.

omniFIT FD

Specialty products for sealing of surfaces and flanges with different curing and strength properties. Can be used, for example in construction of gear boxes. motors and pumps. In addition, omniFIT FD 20 has DIN-DVGW approval (see also omniFIT seal).

omniFIT seal

For sealing pipe threads, recommended as cure sealant for gas and water supply equipment per DIN-DVGW.

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Product Summary omniFIT®

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Product	Colour code	Strength category	Curing properties	Viscosity [mPa·s]	Gap suited (maximum) [mm]	Shear [N/mm^2] (MPa)	Torques M_{LB}/M_A	M_{LB} [MN]	$M_{LW\,max}$	Functional strength [h]	Final curing time after [h]	Temperature range for application
15 M	yellow	very low strength	rapid hardening	700	0–0,15 (0,25)	4,5	0,9–1,0	5	$< M_{LB}$	< 3	8	−60 °C to + 80 °C
50 M	blue	low strength	rapid hardening	700	0–0,15 (0,25)	11,0	1,0–1,1	12	$< M_{LB}$	< 3	6	−60 °C to + 150 °C
100 M	red	medium strength	rapid hardening	700	0–0,15 (0,25)	20,0	1,1–1,3	17	$< M_{LB}$	< 3	6	
150 M	green	high strength	normal hardening	1100	0–0,02 (0,3)	31,0	> 1,3	28	$> M_{LB}$	< 6	24	
200 LL	green	high strength	rapid hardening	30	ø press fits 0–0,05 (0,1)	30,0	> 1,3	10	$> M_{LB}$	< 3	6	
200 M				700	0–0,15 (0,25)	34,0		28	$> M_{LB}$	< 3	6	
230 L	violet	high strength and temperature resistant	rapid hardening	150	ø press fits 0–0,05 (0,1)	36,0	> 1,3	43	$\perp M_{LB}$	< 3	8	−60 °C to + 200 °C
230 M				700	0–0,15 (0,25)	40,0		47	$\perp M_{LB}$	< 3	8	
220 M	violet	very high strength and temperature resistant	rapid hardening	400	0–0,1 (0,2)	28,0	> 1,3	32	$\perp M_{LB}$	< 3	8	−60 °C to + 220 °C
222 M				700	0–0,15 (0,25)	30,0		35	$\perp M_{LB}$	< 3	8	
FD 10	green	low strength	normal hardening	thixotropic	0,05–0,25 (0,4)	7,0	> 1,1	8	$< M_{LB}$	< 6	24	−60 °C to + 180 °C
FD 20	violet	high strength	rapid hardening	thixotropic		20,0	> 1,3	20	$< M_{LB}$	< 1	6	
FD 30	orange	low strength	rapid hardening	thixotropic		12,0	> 1,1	10	$< M_{LB}$	< 2	6	
seal 50 H	blue	medium strength	rapid hardening	thixotropic	0,05–0,25 (0,4)	20,0	1,1–1,3	20	$\perp M_{LB}$	< 3	8	−60 °C to + 150 °C
seal 54 H	white	medium strength	slow hardening	thixotropic		20,0	1,1–1,3	22	$\perp M_{LB}$	< 12	72	
seal 58 H	blue	high strength	very rapid hardening	thixotropic		30,0	> 1,3	35	$\perp M_{LB}$	< 1	6	−60 °C to + 180 °C

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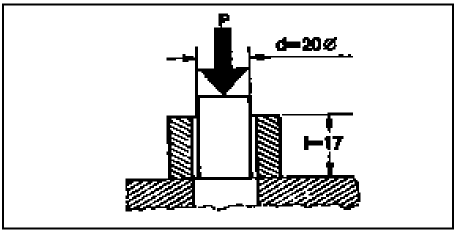
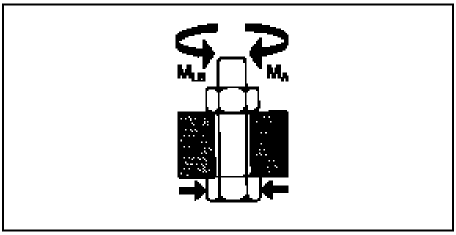
Explanations to the product summary on page T 86





① Viscosity measured with Rotary Viscometer at 20° C in accordance with DIN 54 453.

② Shear Strength T_D per DIN 54452. Material No. 1.0711.07 R_Z = 6 –10 µm

③ Test equipment as Drawing
M_A = Tightening torque
M_{LB} = Breakloose torque
Bolt: M 10 x 35, DIN 933-8.8, black
Nut: M 10, nach DIN 934-8, plain
Clamping sleeve:
hardened steel HCR 58-64
Clearance hole: per DIN 69,
M_A = 50 Nm

④ M_{LB} is defined as the reading obtained at the first relative movement between nut and bolt thread per DIN 54 454 measured without preload.

⑤ M_{LW} max is defined as the maximum reading obtained during one complete turn for screwed connections without preloading. The figures for M_{LB} and M_{LW} max were obtained with black screws M10 x DIN 933-8.8 and nuts M 10 DIN 934-8 plain after 72 hours curing at room temperature.

⑥ The functional strength corresponds to 70% of the final shear strength obtained with test specimens (DIN 54 452).

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CERTIFICATES EN 10204 (formerly DIN 50 049)

a) General
Certificates may be required as proof of quality, as a guarantee or for certifying the origin of the goods. Issuing a certificate can be quite time- and money-consuming, since it may require extensive technical and administrative efforts. The costs of a certificate are openly stated as a separate item on your invoice.

It is always much more complicated and more expensive, sometimes even impossible in the desired form, **to issue a certificate at a later time**. We therefore recommend to clearly indicate requirements for certificates with your request/order.

Besides the costs, a certificate may also have an **influence on the delivery time.** Items in stock do not necessarily have the requested certificates, so that special production or waiting for the next lot may be necessary.

Content and extent of the certificates is generally determined by the customer. In particular, for the frequently requested certificates for material tests **in accordance with EN 10 204 it only is determined:**
- who has to test the product (i.e. plant inspector),
- which products have to be tested (i.e. samples of the delivery lot).

It is not stated:
- what has to be tested,
- how many test runs are to be made.

Lacking given requirements, we assume that the mechanical properties (obtained by the tensile test) and the chemical analysis of one sample product are required. We recommend that the customer give us pertinent information, such as for example on required tests according to the specifications of certain associations (i.e. AD worksheets, SVTI rules, TRD standards) or according to property standards (i.e. DIN, ISO), to clearly specify the contents of the certificate.

b) Documents for material tests in accordance with EN 10 204 (DIN 50 049)

b2) Documents issued by the manufacturing plant*

2.1 **Certificate of compliance**/Werkbescheinigung/Attestation de conformité
Confirmation issued in text form without test results, confirming that the delivery corresponds to the agreement.

2.2 **Test report**/Werkzeugnis/Relevé de contrôle
Confirmation based on results given for products made of the same/similar materials, confirming that the delivery corresponds to the agreement.

2.3 **Specific test report**/Werksprüfzeugnis/Relevé de contrôle spécifique
Confirmation based on results of tests made on the delivery itself, confirming that the delivery corresponds to the agreement.

b3) Documents issued by experts independent of the manufacturing.

3.1 A. **Inspection certificate**/Abnahmeprüfzeugnis/Certificat de réception
Confirmation issued by an officially nominated inspector based on the results of tests made on the delivery itself according to legal rules, confirming that the delivery corresponds to the agreement.

3.1 B. **Inspection certificate**/Abnahmeprüfzeugnis/Certificat de réception
Confirmation issued by the plant inspector based on the results of tests made on the delivery itself according to the requirements of the customer, confirming that the delivery corresponds to the agreement.

3.1 C. **Inspection certificate**/Abnahmeprüfzeugnis/Certificat de réception
Confirmation is by an expert nominated by the customer based on the results of tests made on the delivery itself according to the requirements of the customer, confirming that the delivery corresponds to the agreement.

c) QS certificate
Confirmation that the delivery corresponds to the concluded agreement. Statistical tests or random spot tests are made by us according to the requirements of the customer.

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Maryland Metrics
FASTENER CATALOG INDEX

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Return to Fastener Catalog Master Index Page.

Chapter O

Note: Many of the links above select a group of pages. Use your vertical scroll bar to see all the pages.

You may use our SECURE ORDER FORM or you may use our faxable/mailable ORDER FORMS

Portions of this page are still under construction.

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