TECHNICAL INFORMATION

Contents

All technical specifications and data have been prepared most carefully and accurately using our best knowledge of state-of-the-art technics; however we shall not be held responsible for any legal problems or any other problems arising from the use of this information.

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FOREWORD

Mechanical fasteners - bolts, screws, nuts etc. - are important technical construction parts. There is a clear trend towards: higher mechanical properties, stainless steel materials, corrosion-resistant surface coatings, special fastening systems with adequate assembling tools, fully automatic and robotized feeding and screwing equipment, increasing demand for higher quality and certification.
Mechanical fastening is becoming a more and more advanced field of professional skill and knowledge.

FABORY - a guarantee for quality

It is not suprising that there is an increasing need for the advice of a technical expert and that in some companies, even in the early stages of development and design, the professional fastener engineer becomes involved in a new project so as to realize optimal construction.

FABORY - a guarantee for quality

We feel it as our task to compile the most relevant technical information on fasteners and screw threads in this practical reference guide for design, development, maintenance, purchasing, quality control, technical institutes etc.
All technical information is of a general nature, is mainly based on the German DIN-, the European EN- and the international ISO- standards and is of importance for the construction, calculation and testing of bolted joints.
For specific product information and non-standardized fasteners we refer to the various brochures of our documentation service.
This reference handbook will regularly be kept up-to-date and will be extended to include new topics of general interest, as shown by the queries our Technological Department receives.

FABORY - a guarantee for quality

– the continuous increase of new fasteners and fastening systems
– the regular adaptation of existing standards to the modern level of technics
– the transition from national standards to the international ISO-standards and the European EN-standards do not make it simple for the user of fasteners to get the most recent and relevant information at the right time and to make (the right) use of it. With this new issue of "Fasteners Technology" we aim to meet the urgent need for professional information.

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We appreciate any constructive criticism and comments you may wish to contribute.

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STANDARD

ISO : 898-1
EN : 20898-1
DIN : –

MECHANICAL PROPERTIES

of steel bolts, screws and studs

1 Scope and field of application

The property classes and their mechanical properties apply to bolts, screws and studs, with metric (ISO) thread, with nominal thread diameter $d \leq 39$ mm, made of carbon steel or alloy steel and when tested at room temperature.
They do not apply to set screws and similar (see ISO 898-5) or to specific requirements such as weldability, corrosion resistance (see ISO 3506 on page 15-40-1 and seq), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13 on pages 15-5-3 and 4).
The designation system may be used for sizes (e.g. d > 39 mm), provided that all mechanical requirements of the property classes are met.

2 Designation system of property classes

The property class symbols, indicating the most important mechanical properties, consist of two figures, one on either side of a dot. For example, 10.9. The first figure indicates 1/100 of the nominal tensile strength in N/mm² (See R_m in the table).
So property class 10.9 has a tensile strength of 10 x 100 = 1000 N/mm².
The second figure indicates 10 times the ratio between lower yield stress R_{el} (or proof stress $R_{p0,2}$) and nominal tensile strength R_m (yield stress ratio).
So at property class 10.9 the second figure 9 = 10 x $\frac{900}{1000}$
The multiplication of these two figures will give 1/10 of the yield stress in N/mm², so 10 x 9 = 1/10 x 900 N/mm² .

3 Mechanical properties of bolts, screws and studs

	mechanical property		property class										
			3.6	4.6	4.8	5.6	5.8	6.8	8.8 [1] d<16 mm	8.8 [1] d >16 mm [2]	9.8 [3]	10.9	12.9
1	tensile strength	nom.	300	400		500		600	800	800	900	1000	1200
2	R_m [4] N/mm²	min.	330	400	420	500	520	600	800	830	900	1040	1220
3	Vickers hardness	min.	95	120	130	155	160	190	250	255	290	320	385
	HV F ≥ 98N	max.	250						320	335	360	380	435
4	Brinell hardness	min.	90	114	124	147	152	181	238	242	276	304	366
	HB F = 30 D²	max.	238						304	318	342	361	414
5	Rockwell hardness	min. HRB	52	67	71	79	82	89	-	-	-	-	-
		min. HRC	-	-	-	-	-	-	22	23	28	32	39
	HR	max. HRB	99,5						-	-	-	-	-
		max. HRC	-						32	34	37	39	44
6	Surface hardness HV 0,3	max.	-						5)				
7	Lower yield stress R_{el} [6] N/mm²	nom.	180	240	320	300	400	480	-	-	-	-	-
		min.	190	240	340	300	420	480	-	-	-	-	-
8	Proof stress Rp 0,2 N/mm²	nom.	-						640	640	720	900	1080
		min.	-						640	660	720	940	1100
	Stress under proofing load, Sp	Sp/R_{el} or Sp/Rp 0,2	0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
		N/mm²	180	225	310	280	380	440	580	600	650	830	970
10	Elongation after fracture A in %	min.	25	22	14	20	10	8	12	12	10	9	8
11	Strength under wedge loading		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength shown in 5.2										
12	Impact strength, J	min.	-			25		-	30	30	25	20	15
13	Head soundness		no fracture										
14	Minimum height of non-decarburized thread zone, E		-						$^1/_2H_1$			$^2/_3H_1$	$^3/_4H_1$
	Maximum depth of complete decarburization, G		-						0,015				

1) For class 8.8 in diameter $d \leq 16$ mm there is an increased risk of nut stripping in the case of inadvertent over-tightening inducing a load in excess of proofing load. Reference to ISO 898-2 is recommended.
2) For structural bolting the limit is 12 mm.
3) Applies only to nominal thread diameter $d \leq 16$ mm.
4) Min. tensile properties apply to products of nominal length $l \geq 2,5$ d. Min. hardness applies to products of $l < 2,5$ d and other products, which cannot be tensile-tested (e.g. due to head configuration).
5) 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 class 10.9 max. surface hardness = 390 HV.
6) In cases where the lower yield stress R_{el} cannot be determined, it is permissible to measure the proof stress $R_{p0,2}$.

Guide for properties at elevated temperatures
(No integral part of the standard)

	+20°C	+100°C	+200°C	+250°C	+300°C
Property class	Lower yield stress, R_{el} or proof stress $R_{p0,2}$ N/mm²				
5.6	300	270	230	215	195
8.8	640	590	540	510	480
10.9	940	875	790	745	705
12.9	1100	1020	925	875	825

4 Marking of bolts, screws and studs

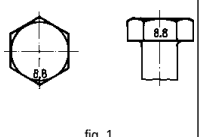


fig. 1

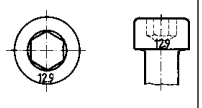
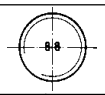


fig. 2

– Marking of all property classes is obligatory for hexagon bolts and screws with nominal diameters $d \geq 5$ mm, preferably on top of the head (fig. 1).
– Marking of property classes ≥ 8.8 is obligatory for hexagon socket head cap screws with nominal diameter $d \geq 5$ mm, preferably on the top of the head (fig. 2).
– When low carbon martensitic steels are used for class 10.9, the symbol 10.9 shall be underlined: 10.9. (See also page 15-10-5).
– Studs shall be marked for property classes ≥ 8.8 and with nominal diameter $d \geq 5$ mm. For studs with interference fit, the marking shall be at the nut end (fig. 3). Alternative identification with symbols (fig. 4) is permissable.
– Left-hand thread shall be marked for nominal diameters $d \geq 5$ mm with the symbol shown in figure 5 either on the top of the head or the point.
Alternative marking, as shown in fig. 6 may be used for hexagon bolts and screws.
– The trade (identification) marking of the manufacturer is mandatory on all products which are marked with property classes.
– For other types of bolts and screws the same marking system shall be used. For special components marking will be as agreed between the interested parties.

fig. 3 

Property class	8.8	9.8	10.9	12.9
identification symbol	O	+	□	Δ

fig. 4
fig. 5

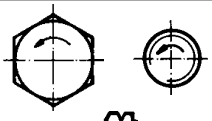
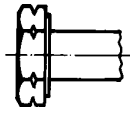



fig. 6


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STANDARD

ISO : 898-7
EN : –
DIN : 267 Part 25

MECHANICAL PROPERTIES

of steel bolts and screws M1 to M10

breaking torques

1. Field of application

This standard incorporates a functional evaluation of the mechanical properties as given in ISO 898 Part 1 by torsion testing to determine the minimum breaking torque before failure has been attained.
These data apply to bolts and screws smaller than size M3 in respect of which no breaking load or proof load values are specified in ISO 898 Part 1 and to short M3 to M10 bolts and screws on which no tensile test can be carried out. This standard does not apply to hexagon socket set screws as specified in DIN 913 en DIN 916, nor to case hardened bolts and screws. Also the property classes 3.6, 6.8 and 9.8 have not been taken into consideration.

2. Minimum breaking torques

Thread size	Thread pitch	Property Class						
		4.6	4.8	5.6	5.8	8.8	10.9	12.9
		Minimum breaking torque, in Nm						
M1	0,25	0,020	0,020	0,024	0,024	0,033	0,040	0,045
M1,2	0,25	0,045	0,046	0,054	0,055	0,075	0,092	0,10
M1,4	0,3	0,070	0,073	0,084	0,087	0,12	0,14	0,16
M1,6	0,35	0,098	0,10	0,12	0,12	0,16	0,20	0,22
M2	0,4	0,22	0,23	0,26	0,27	0,37	0,45	0,50
M2,5	0,45	0,49	0,51	0,59	0,60	0,82	1,0	1,1
M3	0,5	0,92	0,96	1,1	1,1	1,5	1,9	2,1
M3,5	0,6	1,4	1,5	1,7	1,8	2,4	3,0	3,3
M4	0,7	2,1	2,2	2,5	2,6	3,6	4,4	4,9
M5	0,8	4,5	4,7	5,5	5,6	7,6	9,3	10
M6	1	7,6	7,9	9,1	9,4	13	16	17
M7	1	14	14	16	17	23	28	31
M8	1,25	19	20	23	24	33	40	44
M8 x 1	1	23	23	27	28	38	46	52
M10	1,5	39	41	47	49	66	81	90
M10 x 1	1	50	52	60	62	84	103	114
M10 x 1,25	1,25	44	46	53	54	74	90	100

The minimum breaking torque values given in the table shall apply to bolts and screws assigned to thread tolerance classes 6g, 6f or 6e.

The following shall apply for the determination of the minimum breaking torque:

M_B min. = τ_B min. W_p min.
W_p min. = $\frac{\pi}{16} . d_3$ min.^{3}
τ_B min. = X. R_m min.

M_B is the breaking torque;
τ_B is the torsional strength;
W_p is the polar section modulus of torsion;
R_m is the tensile strength;
X is the strength ratio τ_B/R_m

Strength ratio X

Property class	4.6	4.8	5.6	5.8	8.8	10.9	12.9
Strength ratio X	1	0,99	0,96	0,95	0,84	0,79	0,75

STANDARD

DIN : –
ISO : –
ANSI : –

MECHANICAL PROPERTIES

of steel nuts

General explanation

In contrast to the standardisation of the mechanical properties of bolts and screws - in which international agreement has been reached, resulting in one generally accepted ISO-standard 898/1 - this is not yet the case with nuts, causing at present a rather complicated situation during a temporary period of transition.

Relevant studies, experiments and calculations (e.g. Alexander) have shown that due to the higher proof loads of ISO 898/2 (see table 2) and the development of modern tightening techniques based on yield strength, the commonly used nuts with 0,8 D height (e.g. DIN 934) do not provide sufficient assurance that the assembly would resist thread stripping during tightening and that an increase of the nominal 0,8 D nut height is required. (see table 1).
This statement is based on the traditional principle of bolted joints with full loadability, that - when advertently overtorqued - the bolt has to break and no thread stripping may occur.

On the other hand, however, the 0,8 D high nuts are so widely adopted in Europe, that a change-over on a short term could not be realized. This is why, besides the new ISO 898/2 with higher proof loads the existing DIN 267 Part 4 with lower proof loads has to be maintained temporarily for the 0,8 D high nuts. To prevent confusion it has become necessary to add two vertical bars to the code numbers in DIN 267 Part 4 e.g. I8I instead of 8, the latter being the symbol of the higher, so-called “ISO” nuts.

Because ISO 898/2 does not yet give information on nuts without defined proof load values (hardness classes), a new DIN-standard DIN 267 Part 24 had to be issued for the time being.
Thus, at present, there are the following four standards dealing with property classes for nuts:

- DIN 267 Part 4 only for the existing “DIN”-nuts with nominal height ≥ 0,8 D (e.g. DIN 934) (see page 15-5-4)
- ISO 898/2 only for the higher “ISO”-nuts with nominal heights ≥ 0,8 D en ≥ 0,5 D < 0,8 D (see page 15-5-5)
- ISO 898/6 for metric fine threads and only for the higher “ISO”-nuts. (see page 15-5-6)
- DIN 267 Part 24 for nuts defined in hardness classes (see page 15-5-7)

The two DIN-standards will be withdrawn, as soon as ISO 898/2 is completed and generally accepted.

Table 1. Comparison of ISO and DIN widths across flats and nut heights

Nominal size D	Width across flats s		Nut height m								
			ISO Style 1 (ISO 4032)			ISO Style 2 (ISO 4033)			DIN 934		
	ISO	DIN	min. mm	max. mm	m/D	min. mm	max. mm	m/D	min. mm	max. mm	m/D
M5	8		4,4	4,7	0,94	4,8	5,1	1,02	3,7	4	0,8
M6	10		4,9	5,2	0,87	5,4	5,7	0,95	4,7	5	0,83
M7	11		6,14	6,5	0,93	6,84	7,2	1,03	5,2	5,5	0,79
M8	13		6,44	6,8	0,85	7,14	7,5	0,94	6,14	6,5	0,81
M10	16	17	8,04	8,4	0,84	8,94	9,3	0,93	7,64	8	0,8
M12	18	19	10,37	10,8	0,90	11,57	12	1,00	9,64	10	0,83
M14	21	22	12,1	12,8	0,91	13,4	14,1	1,01	10,3	11	0,79
M16	24		14,1	14,8	0,92	15,7	16,4	1,02	12,3	13	0,81
M18	27		15,1	15,8	0,88	16,9	17,6	0,98	14,3	15	0,83
M20	30		16,9	18	0,90	19	20,3	1,02	14,9	16	0,8
M22	34	32	18,1	19,4	0,88	20,5	21,8	0,93	16,9	18	0,82
M24	36		20,2	21,5	0,90	22,6	23,9	1,00	17,7	19	0,79
M27	41		22,5	23,8	0,88	25,4	26,7	0,99	20,7	22	0,81
M30	46		24,3	25,6	0,85	27,3	28,6	0,95	22,7	24	0,8
M33	50		27,4	28,7	0,87	30,9	32,5	0,98	24,7	26	0,79
M36	55		29,4	31	0,86	33,1	34,7	0,96	27,4	29	0,81
M39	60		31,8	33,4	0,86	35,9	37,5	0,96	29,4	31	0,79

Table 2. Comparison of ISO and DIN proof loads.

Nominal size mm		property classes nuts							
		5		8		10		12	
		proofload in N/mm²							
over	up to	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4	ISO 898/2	DIN 267/4
-	4	520	500	800	800	1040	1000	1150	1200
4	7	580	500	810	800	1040	1000	1150	1200
7	10	590	500	830	800	1040	1000	1160	1200
10	16	610	500	840	800	1050	1000	1190	1200
16	39	630	500	920	800	1060	1000	1200	1200

For further details see explanatory notes and annexes in the appropriate standards.

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STANDARD	MECHANICAL PROPERTIES	
DIN : 267 Part 4 (W) ISO : – ANSI : –	**of steel "DIN"-nuts** with proof loads as per DIN 267 Part 4 with coarse and fine thread	info

1 Field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric ISO thread with coarse and fine pitch and thread tolerances 6 G and 4 H to 7 H, with nominal thread diameters up to and including 39 mm, with width across flats or external diameters not less than 1,45 D and heights not less than 0,8 D (including the normal countersunk on the thread), made of carbon steel or low alloy steel and when tested at room temperature.

Furthermore they only apply to the existing so-called "DIN"-nuts, where in the product standards for the mechanical properties reference is made to DIN 267 Part 4, e.g. the hexagon nuts DIN 555 and DIN 934.
IT IS ADVISED THAT FOR NEW DESIGNS THE HIGHER "ISO"-NUTS E.G. ISO 4032 OR ISO 4034 WITH THE HIGHER PROOF LOADS OF ISO 898/2 SHOULD BE USED. DIN 267 PART 4 SHALL BE REPLACED IN THE FUTURE BY ISO 898/2.

This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (See DIN 267 Part 13) or locking (see DIN 267 Part 15).

Nuts made from free-cutting steel shall not be used above + 250°C.
There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H. The use of this standard for nuts above 39 mm is only permitted, when the nuts meet all the requirements.

2 Designation system of property classes

The symbol for property classes consists of a figure that indicates 1/100 of the proof load stress in N/mm^2.
E.g. class 8 has a proof load stress of 8 x 100 = 800 N/mm^2. This proof load stress is equal to the minimum tensile strength of a bolt, which can be loaded up to the minimum yield strength of the bolt when mated with the nut concerned.
Nuts of a higher property class can generally be used in the place of nuts of a lower class.

To make a clear distinction between the "ISO"-nuts with higher proof load stresses, all "DIN"-nuts shall be marked by a vertical bar on either side of the symbol e.g. |**8**|.

3 Mechanical properties of nuts

Mechanical properties			Property class					
			|**4**|*	|**5**|	|**6**|	|**8**|	|**10**|	|**12**|
Proof load stress	Sp	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
Widening			see DIN 267 Part 21					
* Only above M 16								

4 Marking of nuts

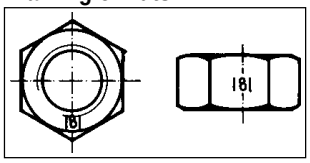


fig. 1

- Hexagon nuts ≥ M 5 shall be marked with the symbol of the property class, a vertical bar on either side of the symbol and the trade (identification) marking of the manufacturer on the bearing surface or side (fig. 1)

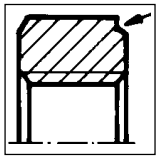


fig. 2

- Hexagon nuts DIN 555 and DIN 934 and castle nuts DIN 935 made from free-cutting steel shall additionally be marked with a groove in one face (fig. 12)

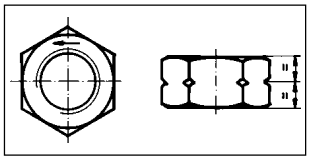


fig. 3

- Left-hand thread shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 3)

FABORY

STANDARD

DIN ISO: 898 Part 2
ISO : 898 Part 2
ANSI : –

MECHANICAL PROPERTIES

of steel "ISO"-nuts

with proof loads as per ISO 898/2 and metric (ISO) thread with coarse pitch

info

1 Scope and field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric ISO thread with coarse pitch and thread tolerance 6 H, with nominal thread diameters up to and including 39 mm, with widths across flats as per ISO 272 and heights ≥ 0,5 D, made of carbon steel or low alloy steel and when tested at room temperature.

Furthermore they only apply to the higher, so-called "ISO"-nuts e.g. ISO 4032 or ISO 4034. This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11)), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15).

Nuts made from free-cutting steel shall not be used above + 250°C .

There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H

2 Designation system of property classes

2.1 Nuts with nominal heights ≥ 0,8 D (full loading capacity)

Property class of nut	mating bolts	
	property class	diameter range
4	3.6 4.6 4.8	> M 16
5	3.6 4.6 4.8	≤ M 16
	5.6 5.8	all
6	6.8	all
8	8.8	all
9	8.8	> M 16 ≤M 39
	9.8	≤M 16
10	10.9	all
12	12.9	≤M 39

The designation of the property classes of these nuts consists of a figure to indicate the maximum appropriate property class of bolts with which they may be mated. A bolt or screw assembled with a nut of the appropriate property class in accordance with the table opposite, is intended to provide an assembly capable of being tightened to the bolt load without thread stripping occuring.

Nuts of a higher property class can generally be used instead of nuts of a lower class.

2.2 Nuts with nominal heights ≥ 0,5 D < 0,8 D (reduced loading capacity)

Property class of nut	Nominal proof load stress N/mm²	Actual proof load stress N/mm²
04	400	380
05	500	500

The designation of the property classes of these nuts consists of a combination of two numbers. The first number is 0, which indicates that the loadability is reduced compared with those described in 2.1.

The second number corresponds with 1/100 of the nominal proof load stress in N/mm².

E.g. class 04 has a nominal proof load stress of 4 x 100 = 400 N/mm².

3 Mechanical properties of nuts with metric (ISO) thread with coarse pitch.

Nominal size (thread diameter) mm		Property class 04					Property class 05					Property class 4					Property class 5					Property class 6				
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC	
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.
-	4	380	188	302	–	30	500	272	353	27,8	36	–	–	–	–	–	520	130	302	–	30	600	150	302	–	30
4	7																580					670				
7	10																590					680				
10	16																610					700				
16	39											510	117	302	–	30	630	146	–	–		720	170	–	–	
39	100	–					–					–					–	128	–			–	142	–	–	

Nominal size (thread diameter) mm		Property class 8					Property class 9					Property class 10					Property class 12								
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV			Rockwell hardness HRC				
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.		max.	min.		max.		
-	4	800	170	302	–	30	900	170	302	–	30	1040	272	353	28	38	1150	295[1]	272[2]	353	31[1]	28[2]	38		
4	7	810	188		–		915	188				1040					1150								
7	10	830					940					1040					1160								
10	16	840					950					1050					1190								
16	39	920	233	353	–	38	920					1060					1200	–			–				
39	100	–	207		–		–	–	–	–	–	–					–	–	–	–	–	–	–		

1) for nuts ISO 4032 (type 1)
2) for nuts ISO 4033 (type 2)

– 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.

– Hardness values for nominal sizes over 39 up to and including 100 mm are to be used for guidance only.

4 Marking of nuts

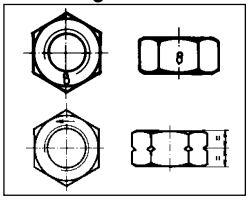


fig. 1 – Hexagon nuts ≥ M 5 and property classes ≥ 8, and classes 05 shall be marked on the side of bearing surface or side with the symbol of the property class and the trade (identification) marking of the manufacturer fig. 1. The alternative marking based on the clock-face system did not find general acceptance.

fig.2 – Left-hand thread ≥ M 6 shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 2).

FABORY

STANDARD

DIN ISO: 898 Part 6
ISO : 898 Part 6
ANSI : –

MECHANICAL PROPERTIES

of steel "ISO"-nuts

with proof loads as per ISO 898/2 and metric (ISO) thread with fine pitch

info

1 Field of application

The property classes and their mechanical properties mentioned below apply to nuts with metric (ISO) thread with fine pitch and thread tolerance 6 H, with nominal thread diameters of up to and including 39 mm, with widths across flats as per ISO 272 and heights ≥ 0,5 D, made of carbon steel or low alloy steel and when tested at room temperature. Furthermore they only apply to the higher, so-called "ISO"-nuts DIN 971 Part 1 and 2 with metric fine pitch. This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15). Nuts made of free-cutting steel shall not be used above + 250°C. There is an increased risk of stripping for assemblies with threads having tolerances wider than 6 g/6 H.

2 Designation system of property classes

2.1 Nuts with nominal heights ≥ 0,8 D (full loading capacity)

Property class of nut	Mating bolts		Nuts	
			Style 1	Style 2
	Property class	Size	Size	
		mm	mm	
6	≤ 6.8	d ≥39	d ≤ 39	–
8	8.8	d ≤ 39	d ≤ 39	d ≤ 16
10	10.9	d ≤ 39	d ≤ 16	d ≤ 39
12	12.9	d ≤ 16	–	d ≤ 16

The designation of the property classes of these nuts consists of a figure to indicate the maximum appropriate property class of bolts with which they may be mated. A bolt or screw assembled with a nut of the appropriate property class in accordance with the table opposite, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occuring.
Nuts of a higher property class can generally be used instead of nuts of a lower class.

2.2 Nuts with nominal heights ≥ 0,5 D ≤ 0,8 D (reduced loading capacity)

Property class of nut	Nominal proof load stress N/mm²	Actual proof load stress N/mm²
04	400	380
05	500	500

The designation of the property classes of these nuts consists of a combination of two numbers. The first number is 0, which indicates that the loadability is reduced compared with those described in 2.1. The second number corresponds with 1/100 of the nominal proof load stress in N/mm². E.g. class 04 has a nominal proof load stress of 4 x100 = 400 N/mm².

3 Mechanical properties of nuts with metric (ISO) thread with fine pitch

Nominal thread diameter d	Property class									
	04					05				
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
8 ≤ d ≤39	380	188	302	not quenched or tempered	thin	500	272	353	quenched and tempered	thin

STANDARD

DIN ISO: 898 Part 6
ISO : 898 Part 6
ANSI : –

MECHANICAL PROPERTIES

of steel "ISO"-nuts

with proofloads as per ISO 898/2 and metric (ISO) thread with fine pitch

Nominal thread diameter d	Property class 6					Property class 8									
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
8 ≤ d ≤ 10	770	188	302	not quenched nor tempered1)	1	955	250	353	quenched and tempered	1	890	195	302	not quenched nor tempered	2
10 < d ≤ 16	780														
16 < d ≤ 33	870	233				1030	295				–	–	–		–
33 < d ≤ 39	930					1090									

1) For thread diameters above 16 mm, nuts may be quenched and tempered at the discretion of the manufacturer.

Nominal thread diameter d	Property class 10					Property class 12									
	Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
mm	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
8 ≤ d ≤ 10	1100	295	353	quenched and tempered	1	1055	250	353	quenched and tempered	2	1200	295	353	quenched and tempered	2
10 < d ≤ 16	1110														
16 < d ≤ 33		–	–	–	–	1080	260				–	–	–	–	–
33 < d ≤ 39	–														

NOTE - Minimum hardness is mandatory for heat-treated nuts too large to be proof-load tested.
For all other nuts minimum hardness is not mandatory but is provided for guidance only

4 Marking of nuts

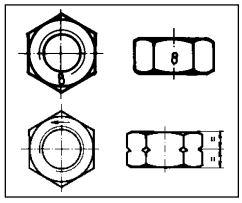


fig. 1 – Hexagon nuts ≥ M5 and property classes ≥ 8 and class 05 shall be marked on the side of bearing surface or side with the symbol of the property class and the trade (identification) marking of the manufacturer (fig. 1). The alternative marking based on the clock-face system did not find general acceptance.

fig. 2 – Left-hand thread ≥ M 6 shall be marked with a left turning arrow on one bearing surface or a groove halfway up the nut height (fig. 2).

FABORY

STANDARD

DIN : 267 Part 24
ISO : –
ANSI : –

MECHANICAL PROPERTIES

of steel nuts

specified in hardness classes

info

1 Field of application

This standard specifies the mechanical properties of nuts which, due to shape or dimensions cannnot be tested by proof loads and cannot be defined on the base of proof load stresses.
They have been classified according to minimum hardness values, from which, however, no conclusions can be drawn with regard to the loadability and the stripping strength of the nuts. The performance properties depend on their style.

This standard does not apply to nuts which have to meet special requirements, such as for weldability, corrosion resistance (see DIN 267 Part 11), ability to withstand temperatures above + 300°C or below - 50°C (see DIN 267 Part 13) or locking ability (see DIN 267 Part 15) nor to nuts which have to withstand specified proof loads in accordance with ISO 898/2, DIN 267 Part 4 and ISO 898/6.
Nuts made from free-cutting steel shall not be used above + 250°C.

2 Designation system of property classes

Property class symbol	11 H	14 H	17 H	22 H
Vickers hardness HV 5 min.	110	140	170	220

The designation of the property classes of these nuts consists of a combination of a number and a letter, see table opposite.
The number indicates 1/10 of the minimum Vickers hardness e.g. 14 x 10 = 140 HV.
The letter H stands for the word “hardness”.

3 Mechanical properties

Mechanical property		Property class 11 H	14H	17 H	22 H
Vickers hardness	min.	110	140	170	220
HV 5	max.	185	215	245	300
Brinell hardness	min.	105	133	162	209
HB 30	max.	176	204	233	285

4 Marking of nuts

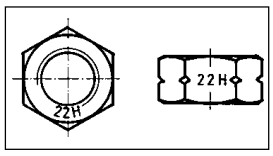


fig 1 – Only property class 22 H nuts shall be marked with the symbol identifying the property class. (fig. 1).

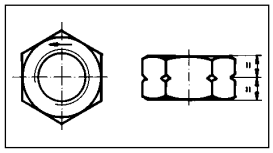


fig. 2 – It is recommended that nuts with left-hand thread be marked with a left turning arrow on one bearing surface or a groove halfway up to the nut height. (fig. 2)

STANDARD
ISO : –
EN : –
DIN : –

MATERIAL PROPERTIES

of steel bolts, screws and nuts

Steels

OVERVIEW AND DEFINITIONS OF STEELS FOR FASTENERS

1. The word steel is understood to mean a deformable iron (Fe)-carbon (C) alloy with a maximum carbon content of 1,5%. So it is not correct to speak, for example, about iron bolts or rivets. The word "iron" should only be used to indicate the chemical element Fe, 100% pure iron and in the combination of the word malleable iron as distinct from malleable steel.

2. Unalloyed, low carbon steel as per DIN 17111 with a C% ≤ 0,22% is used for the lower property classes of bolts, screws and nuts. This steel group is indicated with the letters St followed by a number corresponding with 1/10 of the minimum tensile strength in N/mm². For example, St38 has a tensile strength of 10 x 38 = min. 380 N/mm².
Depending on the steel processing method, (desoxydation method) a distinction is made between:
– **rimmed steel**, indicated with U before St. In this process gases continue to evolve (boiling) as the steel solidifies.
– **killed steel**, indicated with R before St, that gradually changes from a liquid to a solid when silicon or aluminium is added, resulting in a better quality of structure.
Sometimes an extra quality number 1 or 2 is added. Quality number 2 requires maximum phosporus (P) and sulphur (S) content limits whereas quality number 1 does not.
Example: U St 36-2 is a rimmed, low carbon steel with a minimum tensile strength of 360 N/mm² and with a special low P- and S content.
DIN 17111 also includes the so-called **"resulphurized steel"** with an extra, controlled addition of sulphur in the interior section of the material increasing the thread tapping characteristics in the nuts e.g. U 10 S 10. This is a rimmed, low carbon steel of which the first 10 = $\frac{10}{100}$ = 0,1% C and the second 10 = $\frac{10}{100}$ = 0,1% S.

3. Carbon steel as per DIN 1654 **cold heading steels**, DIN 17200 **steels for quenching and tempering** and DIN 17210 **case hardening steels**.
The carbon steels can be divided into 3 types:
– **quality steel**, indicated with the letter C followed by the C% mulitiplied by 100. E.g. C 35 is a quality steel with 0,35% C and a P and S% of max 0,045.
– **high quality steel**, indicated with the letters Ck with a lower P and S content. E.g. Ck 35 is a high quality steel with 0,35% C and a P and S% of max 0,035.
– **cold heading steel**, indicated with the letters Cq having special cold forming characteristics. E.g. Cq 35 is a cold heading steel with 0,35% C and a P and S% of max. 0,035.

4. Alloy steel as per DIN1654 **cold heading steels**, DIN 17200 **steels for quenching and tempering** and DIN 17210 **case hardening steels**.
In this steel group the percentage of elements - which normally only occur as traces or impurities - has been increased and/or other elements have been added to achieve or improve special characteristics, such as higher mechanical properties, better resistance against corrosion, low or high temperatures, etc.
The designation starts with a number indicating 100 x the C-content, followed by the symbols of the relevant alloying elements in sequence of their quantity, starting with the largest, and finally another number(or series of numbers) indicating a certain ratio of the percentage of the alloying element(s).
– 4 for the elements Cr-Co-Mn-Ni-Si-W
– 10 for the elements Al-Cu-Mo-Ti-V
– 100 for the elements C-P-S-N
– 1000 for the element B (boron)
E.g. 36 Cr Ni Mo 4 is a steel alloyed with Cr, Ni and Mo with $\frac{36}{100}$ = 0,36% C and $\frac{4}{4}$ = 1% Cr.
28 B2 is a borium alloyed steel with $\frac{28}{100}$ = 0,28% C and $\frac{2}{1000}$ = 0,002% B.

The most common elements used with fasteners have the following influence:
– **Carbon (C)** is the most important element and influences the mechanical properties considerably. For fasteners the percentage varies up to 0,5% maximum. With increasing C content the strength increases, but the cold formability is reduced. From about 0,3% C the steel can be heat treated.
– **Nickel (Ni)** improves the through-hardening, toughness at low temperatures and the non-magnetic properties. The combination of at least 8% Ni with about 18% Cr results in the important austenitic stainless steel quality A2.
– **Chromium (Cr)** also increases hardenability and strength. A minimum content of about 12,5% is necessary for a steel to be qualified as stainless.
– **Molybdenum (Mo)** increases hardenability and reduces temper brittleness. High temperature strength is improved. When 2 - 3% Mo is added to an alloy with about 18% Cr and about 12% Ni corrosion resistance increases considerably. This quality of austenitic stainless steel is used frequently for fasteners and is designated with A4.
– **Manganese (Mn)** usually occurs like the elements silicon (Si), phosphorus (P) and sulphur (S) only as impurities. By adding Mn, strength, hardenability and wear resistance are increased. However the steel becomes more sensitive to overheating and temper brittleness.
– **Titanium (Ti)** is used as carbide former for stabilisation against intercrystalline corrosion in e.g. stainless steel. The elements Niobium (Nb) and Tantalium (Ta) cause the same effect..
– **Boron (B)** is a relatively new alloying element in fasteners steel. Very small amounts of 0,002-0,003% already improves the through hardening considerably. Because of this, C% can be kept lower, improving the cold workability. The application of boron treated steels has become a very popular alternative in manufacturing cold formed, heat-treated fasteners.

STANDARD

ISO : –
EN : –
DIN : –

MATERIAL PROPERTIES

Of steel bolts, screws and nuts

steels

5. Case hardening steel as per DIN 17210 and DIN 1654 Part 3.
Case hardening steel has a relatively low carbon content and is used to get a very hard, wear resistant surface by adding carbon during the heat treatment. This type of steel is used for tapping screws, thread cutting and self-drilling screws, chipboard screws, etc..

6. Free cutting steel as per DIN 1651.
This special type of steel is characterized by a good metal removal and short chip breaking. This is achieved by increasing the sulphur content to 0,34% max., sometimes with an extra addition of lead. A very popular type for fasteners is 9S20K with C% ≤ 0,13 and 0,18 - 0,25 S, which is machined in the cold-drawn condition.
The manufacturing method of machining on automatic lathes is no longer used very much for commercial fasteners but it is still applied for small quantities or for a product configuration, which is difficult to cold form.
Free cutting steel has restricted properties.

7. High and low temperature steel as per DIN 267 Part 13, DIN 17240, AD-Merkblätter W7 and W10, SEW680.
For technical data of this special group see section 5 of the catalogue (double end studs).

8. Stainless steel as per DIN 267 Part 11, DIN 1654 Part 5, DIN 17440, and ISO 3506.
For technical data see the chapter “stainless steel” in this section.

STANDARD

ISO : –
EN : –
DIN : –

MATERIAL PROPERTIES

of steel bolts, screws and nuts

Heat treatments

OVERVIEW AND DEFINITIONS OF HEAT TREATMENTS FOR FASTENERS

Heat treatment is the thermal change of the metallographic structure of steel by heating and cooling within a certain time to obtain the required properties.

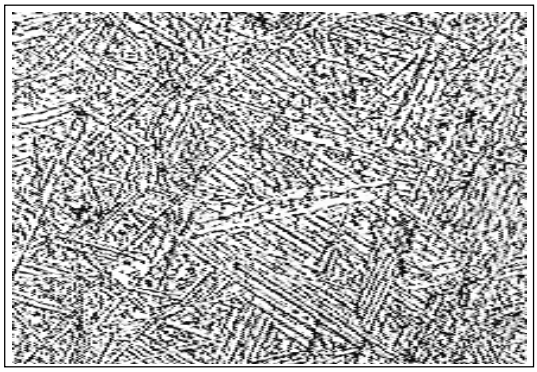
The most common heat treatments in manufacturing fasteners are:

1. Annealing
The steel is held at a temperature of just below 721°C for several hours and is then cooled down slowly to make it soft.
The structure changes from hard, lamellar perlite into soft, globular perlite resulting in an optimal condition of the raw material for cold heading.

2. Normalizing (Recrystallization)
By heating at 800 - 920 °C for not too a long time and then cooling slowly, a coarse and thus brittle grain structure due to, for instance, hot rolling or hot forging, especially of thicker pieces, is brought back again in the original fine grain structure. Through this refining, yield point and impact strength are increased without the tensile strength being reduced too much.

3. Stress-relieving
By cold deformation internal stresses are induced in the material, increasing the tensile strength but decreasing the elongation.
By heating at between 500 and 600°C for a long time and cooling slowly, most of the cold hardening effect disappears. This heat treatment is applied to cold headed bolts and screws of property classes 4.6 and 5.6.

4. Hardening
When steel with a minimum C-content of about 0,3% is heated at a temperature above 800°C (depending on the type of steel) and is quenched in water, oil, air or in a salt bath, the very hard but brittle martensite structure is formed.
The achieved hardness depends on the C% (the higher the carbon, the harder the steel) and the percentage of martensite, which, at a certain critical cooling speed, is formed in the core of the material.
So with thinner bolts from unalloyed carbon steel the critical cooling speed will be reached to the core. However with thicker sizes the heat from the core cannot be transmitted to the outside quickly enough and it will be necessary to add alloying elements like boron, manganese, chromium, nickel and molybdenum, which support the through-hardening i.e. decrease the critical cooling speed.
In general, when a type of steel with such a through-hardening is chosen, about 90% martensite is present in the core after quenching. The choice of cooling medium also influences the cooling speed. Bolts are mainly quenched in oil, because water, which is otherwise more effective, causes too much risk of hardening cracks and warpage.

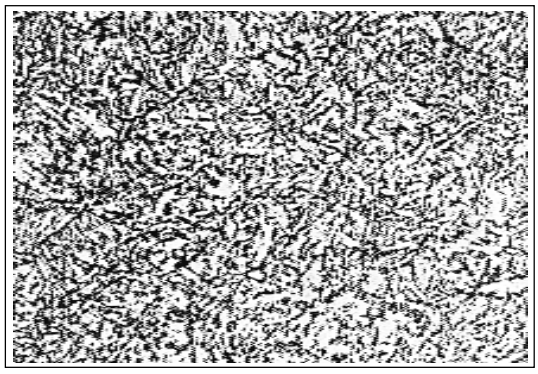


Martensite structure

5. Tempering
With increasing hardness, however, the hardening stresses will rise, and therefore the brittleness of the material will also increase. Mostly a second heat treatment, called tempering, must follow as quickly as possible after quenching. For temperatures of up to 200°C only the brittleness will decrease a little; the hardness will barely decrease. Above 200°C the stresses decrease, the hardness diminishes and the toughness is improved.

6. Quenching and tempering
This is a combined heat treatment of quenching with high-tempering, at between 340° and 650°C immediately following. This is the most important and most commonly practised heat treatment for fasteners. An optimal compromise is reached between a rather high tensile strength, particularly a high yield/tensile strength ratio and sufficient toughness, which is necessary for a fastener carrying all kind of external forces to function effectively. The higher property classes 8.8, 10.9 and 12.9 are, therefore, quenched and tempered.

7. Decarburizing
By heat treating carbon and alloy steels the danger exists that carbon from the outside of the product is removed by the surrounding atmosphere.
The skin then gets a carbon content that is too low; it is not hardenable and will stay soft.
This means that the screw thread under loading could be slid off. To prevent this, the quenching and tempering of fasteners is always done when the furnace is supplied with a protective gas, which keeps the carbon percentage at the level of the steel type.



Structure after quenching and tempering

MATERIAL PROPERTIES

for steel bolts, screws and nuts

Heat treatments

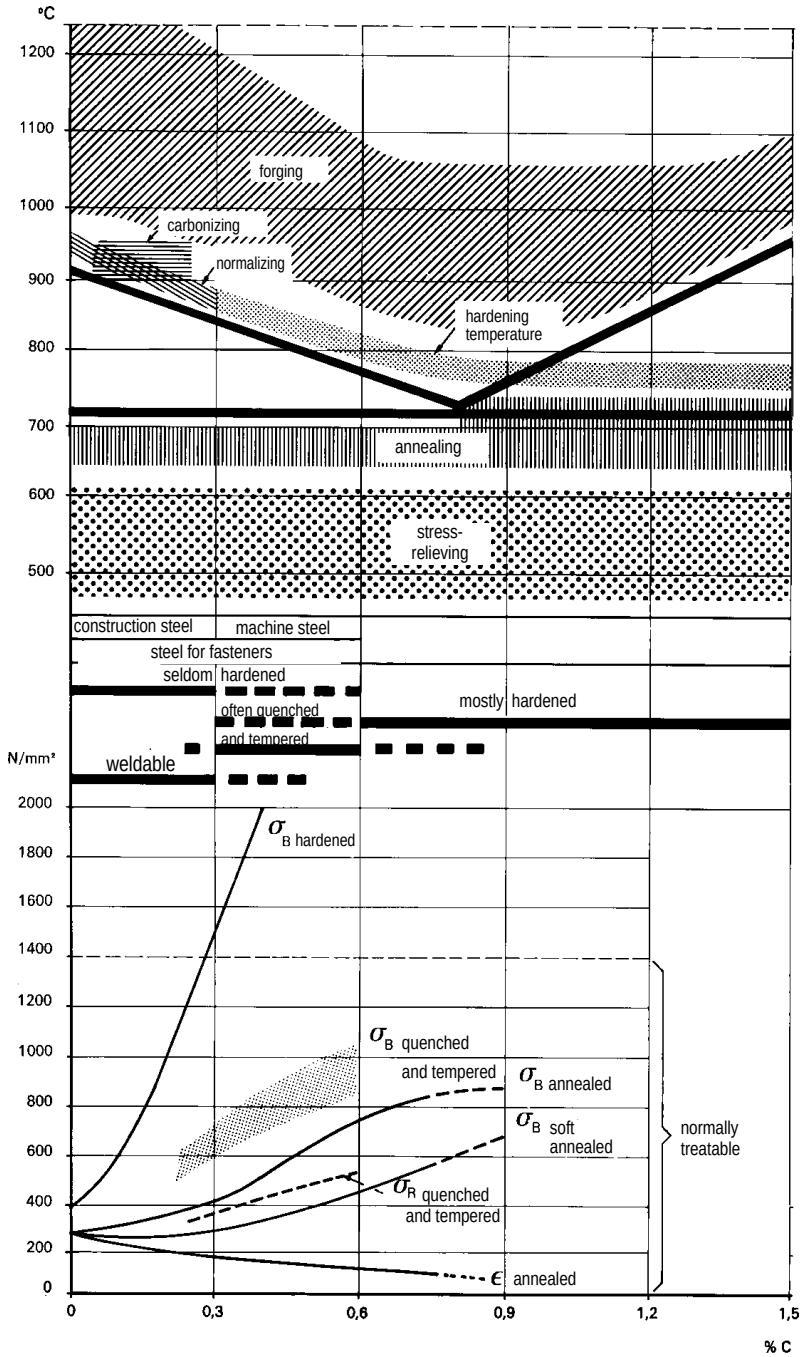
info

8. Case carburizing

This heat treatment is the opposite of decarburizing and is carried out in a carbon emitting gas. On the outside of the product a thin layer with an increased carbon content is built up, through which the skin, after hardening, becomes hard and wear resistant, while the core remains tough. This treatment is applied on fasteners such as tapping screws, thread rolling, thread cutting and self drilling screws and chip board screws. Similar heat treatments are carbonitriding, using carbon and nitrogen, and nitriding, only using nitrogen as an emitting gas.

9. Induction hardening

For special applications a hard, wear resistant layer is formed without the supply of a gas in a high frequency coil with no contact of the workpiece. Mostly only local hardening is executed for the extra protection of weak spots.



Relation between iron-carbon diagram, heat treatment types of steel and mechanical properties

STANDARD

ISO : 898 Part 1
EN : 20898 Part 1
DIN : –

MATERIAL PROPERTIES

of steel bolts, screws and studs

Chemical composition

info

In the table below a specification is given of the steels for the standardized property classes of bolts, screws and studs.
The minimum tempering temperatures are mandatory in all cases.
The chemical composition limits are mandatory only for those fasteners, which are not subject to tensile testing.

Property class	Material and treatment	chemical composition limits (check analysis) %				Tempering temperature °C	Examples of commonly used steels for cold forming	
		C		P	S			
		Min.	max.	max.	max.	min.	Size	Steel designation
3.6 [1])	Carbon steel	–	0,20	0,05	0,06	–	≤ M39	QSt36-2
4.6 [1])		–	0,55	0,05	0,06		≤ M39	QSt36-2, QSt38-2
4.8 [1])							≤ M16	QSt36-2, QSt38-2
5.6		0,15	0,55	0,05	0,06		≤ M39	Cq22
5.8 [1])		–	0,55	0,05	0,06		≤ M39	Cq22, Cq35
6.8 [1])							≤ M39	Cq35, 35B2, Cq45
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	425	≤ M12 ≤ M22 M24 ≤ M39	22B2, 28B2 35B2, Cq35, Cq45 34Cr4, 37Cr4
	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	425	–	–
	Carbon steel, quenched and tempered	0,25	0,55	0,035	0,035			
10.9 [4])	Carbon steel with additives (e.g. Boron or Mn or Cr), quenched and tempered	0,15 [3])	0,35	0,035	0,035	340	≤ M6	35B2, Cq35
10.9 [5])	Carbon steel, quenched and tempered or	0,25	0,55	0,035	0,035	425	M8 ≤ M18 ≤ M39	34Cr4 41Cr4, 34CrMo4, 42CrMo4
	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			
12.9 [5]), [6])	Alloy steel, quenched and tempered [7])	0,20	0,50	0,035	0,035	380	≤M18 ≤ M24 ≤ M39	34CrMo4, 37Cr4, 41Cr4 42CrMo4 34CrNiMo6

[1]) Free cutting steel is allowed for these property classes with the following maximum sulphur, phosphorus and lead contents: sulphur: 0,34%; phosphorus 0,11%; lead 0,35%.
[2]) For nominal diameters above 20 mm the steels specified for property class 10.9 may be necessary in order to achieve sufficient hardenability.
[3]) For plain carbon boron alloyed steel with a carbon content below 0,25% (ladle analysis), the minimum maganese content shall be 0,6% for property class 8.8 and 0,7% for property classes 9.8 and 10.9.
[4]) Products shall be further 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 approximately 90% martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering.
[6]) A metallographically detectable white phosphorus enriched layer is not permitted for property class 12.9 on any surface subjected to tensile stress.
[7]) Alloy steel shall contain one or more of the alloying elements chromium, nickel, molybdenum or vanadium.

FABORY

STANDARD

ISO : –
EN : –
DIN : 267 Part 4 (W)

MATERIAL PROPERTIES

of steel "DIN" nuts

Chemical composition

In the tables below a specification is given of the steels for the standardized property classes of "DIN" nuts e.g. hexagon nuts DIN 555 en DIN 934.

1. NON-CUTTING WORKING

The chemical composition in this table shall also apply to working by chip removal where free-cutting steel is not being used..

Property class	Chemical composition, in % by mass (check analysis) [1]			
	C max.	Mn min.	P max.	S max.
4, 5 and **6**	0,50	–	0,110	0,150
8	0,58	0,30	0,060	0,150
10	0,58	0,30	0,048	0,058
12	0,58	0,45	0,048	0,058

[1]) Chips for the check analysis shall be taken uniformly over the whole cross section.

Thomas steel is not permitted for property classes 8, 10 and 12. "–2" shall be added to the property class code number where Thomas steel shall not be used for manufacturing property classes 5 and 6 nuts.
Nuts assigned to property classes 8 (exceeding size M 16) and 10 shall be hardened and tempered if the proof load values as required on page 15-5-4 cannot be attained in any other way. Hardening and tempering is necessary for all hot forged nuts (exceeding size M 16) with a nominal 0,8D nut height (DIN 934) and for property class 10 nuts for applications at temperatures above + 250°C. The values specified in DIN ISO 898 Part 2 shall apply as the hardness values for hardened and tempered nuts.
Nuts assigned to property class 12 shall be hardened and tempered. If necessary, alloy steels shall be used for manufacturing nuts of property classes 10 and 12.

2. MACHINING FROM FREE-CUTTING STEEL

Property class	Chemical composition, in % (by mass (check analysis) [1]			
	C max.	P max.	Pb max.	S max.
5 AU and **6 AU**	0,50	0,12	0,35	0,34

[1]) Chips for the check analysis shall be taken uniformly over the whole cross section.

Hexagon nuts in accordance with DIN 555, DIN 934 and slotted castle nuts in accordance with DIN 935 assigned to property classes 5 AU and 6 AU shall be specially marked as specified on page 15-5-4, where they are made from free-cutting steel with the chemical composition above.

STANDARD

ISO : 898 Part 2
EN : 20898 Part 2
DIN : –

MATERIAL PROPERTIES

of steel "ISO" nuts

Chemical composition

In the table below a specification is given of the steels for the standardized property classes of "ISO" nuts, e.g. hexagon nuts ISO 4032 and ISO 4034.

Property class		Chemical composition limits (check analysis), %				Examples of commonly used steels for cold forming	
		C max.	Mn min.	P max.	S max.	Size	steel designation
4 [1]), **5** [1]), **6** [1])	–	0,50	–	0,110	0,150	all	QSt36-2
8, **9**	**04** [1])	0,58	0,25	0,060	0,150	≤M16	QSt36-2 Cq 22
10 [2])	**05** [2])	0,58	0,30	0,048	0,058	>M16	Cq 35
12 [2])	–	0,58	0,45	0,048	0,058	all	Cq 35 Cq 45

[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 permissable:
sulphur 0,34%; phosphorus 0,12%; lead 0,35%.

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

Nuts of property classes 05, 8 (Style 1 > M16), 10 and 12 shall be hardened and tempered.

STANDARD

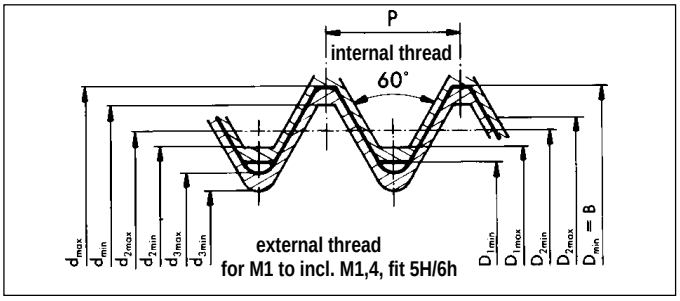
ISO : 965 Part 2
EN : –
DIN : 13 Part 13/20

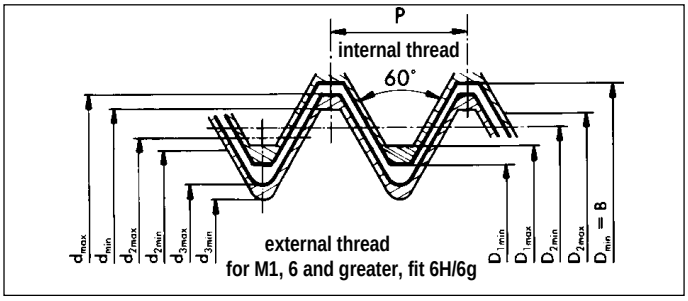
SCREW THREADS

Metric (ISO) screw thread, coarse series -M-

info

Basic profile and limiting profiles





The bold lines indicate the maximum material profiles.
The maximum material profile of the internal thread is the basic profile.

B = basic major diameter
P = pitch

d = major diameter
d_3 = minor diameter
d_2 = pitch diameter
external thread

D = major diameter
D_1 = minor diameter
D_2 = pitch diameter
} internal thread

Limits of sizes for metric screw thread, coarse series, fit 6H/6g[1])

Dimensions in mm

Basic [2] diameter	Pitch	External thread tol. 6g [1] (bolts and screws)						Internal thread tol. 6H [1] (nuts)				Section at minor dia.	Stress area
		major diameter		pitch diameter		minor diameter		pitch diameter		minor diameter		$\pi/4\ d_3^2$	$\pi/4\ \frac{(d_2+d_3)^2}{2}$
$B = D_{min}$	P	d_{max}	d_{min}	d_{2max}	d_{2min}	d_{3max}	d_{3min}	D_{2min}	D_{2max}	D_{1min}	D_{1max}	A_{d3} mm²	A_s mm²
1 [1])	0,25	1,000	0,933	0,838	0,785	0,693	0,630	0,838	0,894	0,729	0,785	0,377	0,460
1,1[1])	0,25	1,100	1,033	0,938	0,885	0,793	0,730	0,938	0,994	0,829	0,885	0,494	0,588
1,2[1])	0,25	1,200	1,133	1,038	0,985	0,893	0,830	1,038	1,094	0,929	0,985	0,626	0,732
1,4[1])	0,3	1,400	1,325	1,205	1,149	1,032	0,964	1,205	1,265	1,075	1,142	0,837	0,983
1,6	0,35	1,581	1,496	1,354	1,291	1,152	1,075	1,373	1,458	1,221	1,321	1,075	1,27
1,8	0,35	1,781	1,696	1,554	1,491	1,352	1,275	1,573	1,658	1,421	1,521	1,474	1,70
2	0,4	1,981	1,886	1,721	1,654	1,490	1,407	1,740	1,830	1,567	1,679	1,788	2,07
2,2	0,45	2,180	2,080	1,888	1,817	1,628	1,540	1,908	2,003	1,713	1,838	2,133	2,48
2,5	0,45	2,480	2,380	2,188	2,117	1,928	1,840	2,208	2,303	2,013	2,138	2,980	3,39
3	0,5	2,980	2,874	2,655	2,580	2,367	2,273	2,675	2,775	2,459	2,599	4,475	5,03
3,5	0,6	3,479	3,354	3,089	3,004	2,743	2,635	3,110	3,222	2,850	3,010	6,000	6,78
4	0,7	3,978	3,838	3,523	3,433	3,119	3,002	3,545	3,663	3,242	3,422	7,749	8,78
4,5	0,75	4,478	4,338	3,991	3,901	3,558	3,439	4,013	4,131	3,688	3,878	10,07	11,3
5	0,8	4,976	4,826	4,456	4,361	3,995	3,869	4,480	4,605	4,134	4,334	12,69	14,2
6	1	5,974	5,794	5,324	5,212	4,747	4,596	5,350	5,500	4,917	5,153	17,89	20,1
7	1	6,974	6,794	6,324	6,212	5,747	5,596	6,350	6,500	5,917	6,153	26,18	28,9
8	1,25	7,972	7,760	7,160	7,042	6,438	6,272	7,188	7,348	6,647	6,912	32,84	36,6
9	1,25	8,972	8,760	8,160	8,042	7,438	7,272	8,188	8,348	7,647	7,912	43,78	48,1
10	1,5	9,968	9,732	8,994	8,862	8,128	7,938	9,026	9,206	8,376	8,676	52,30	58,0
11	1,5	10,968	10,732	9,994	9,862	9,128	8,938	10,026	10,206	9,376	9,676	65,90	72,3
12	1,75	11,966	11,701	10,829	10,679	9,819	9,602	10,863	11,063	10,106	10,441	76,25	84,3
14	2	13,962	13,682	12,663	12,503	11,508	11,271	12,701	12,913	11,835	12,210	104,7	115
16	2	15,962	15,682	14,663	14,503	13,508	13,271	14,701	14,913	13,835	14,210	144,1	157
18	2,5	17,958	17,623	16,334	16,164	14,891	14,625	16,376	16,600	15,294	15,744	175,1	193
20	2,5	19,958	19,623	18,334	18,164	16,891	16,625	18,376	18,600	17,294	17,744	225,2	245
22	2,5	21,958	21,623	20,334	20,164	18,891	18,625	20,376	20,600	19,294	19,744	281,5	303
24	3	23,952	23,577	22,003	21,803	20,271	19,955	22,051	22,316	20,752	21,252	324,3	353
27	3	26,952	26,577	25,003	24,803	23,271	22,955	25,051	25,316	23,752	24,252	427,1	459
30	3,5	29,947	29,522	27,674	27,462	25,653	25,306	27,727	28,007	26,211	26,771	519,0	561
33	3,5	32,947	32,522	30,674	30,462	28,653	28,306	30,727	31,007	29,211	29,771	647,2	694
36	4	35,940	35,465	33,342	33,118	31,033	30,655	33,402	33,702	31,670	32,270	759,3	817
39	4	38,940	38,465	36,342	36,118	34,033	33,655	36,402	36,702	34,670	35,270	913,0	976
42	4,5	41,937	41,437	39,014	38,778	36,416	36,007	39,077	39,392	37,129	37,799	1045	1121
45	4,5	44,937	44,437	42,014	41,778	39,416	39,007	42,077	42,392	40,129	40,799	1224	1306
48	5	47,929	47,399	44,681	44,431	41,795	41,352	44,752	45,087	42,587	43,297	1377	1473
52	5	51,929	51,399	48,681	48,431	45,795	45,352	48,752	49,087	46,587	47,297	1652	1758
56	5,5	55,925	55,365	52,353	52,088	49,177	48,700	52,428	52,783	50,046	50,796	1905	2030
60	5,5	59,925	59,365	56,353	56,088	53,177	52,700	56,428	56,783	54,046	54,796	2227	2362
64	6	63,920	63,320	60,023	59,743	56,559	56,048	60,103	60,478	57,505	58,305	2520	2676
68	6	67,920	67,320	64,023	63,743	60,559	60,048	64,103	64,478	61,505	62,305	2888	3055

– For basic diameters above 68 mm see: metric screw thread, fine series.
– For coated threads the maximum values of d, d_2 and d_3 are equal to the values of the basic profile ($d_{2max} = D_{2min}$ and $d_{3max} = D_1$ min.)
- 1) the values for sizes 1 to incl. 1,4 mm correspond to the fit 5H/6h.
- 2) metric screw thread is designated by the basic diameter, preceded by the profile letter M and followed by the tolerance grade, e.g. 6, and the tolerance position, e.g. g.
Example: M10-6g. If no toleranceclass is indicated the above mentioned fits are valid.

FABORY

STANDARD

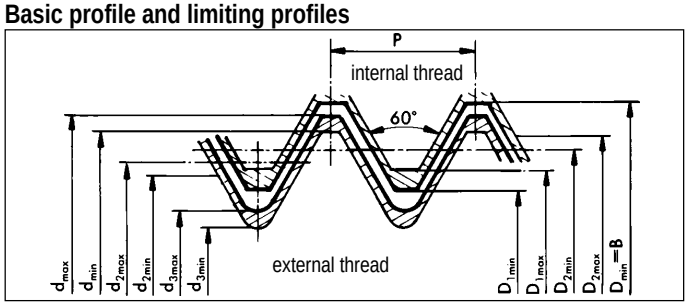
ISO : 965 Part 2
EN : –
DIN : 13 Part 13/21/22/23

SCREW THREADS

Metric (ISO) screw thread, fine series - MF-

info

Basic profile and limiting profiles



The bold lines indicate the maximum material profiles.
The maximum material profile of the internal thread is the basic profile.

B = basic major diameter
P = pitch

d = major diameter
d_2 = pitch diameter
d_3 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for metric screw thread, fine series, fit 6H/6g

Dimensions in mm

Basic[2)] diameter	Pitch	External thread tol. 6g (bolts and screws)						Internal thread tol. 6H (nuts)				Section at minor dia	Stress area
		major diameter		pitch diameter		minor diameter		pitch diameter		minor diameter		$\pi/4\ d_3^{\ 2}$	$\pi/4\ \frac{(d2+d3)2}{2}$
$D_{min}=B$	P	d_{max}	d_{min}	d_{2max}	d_{2min}	d_{3max}	d_{3min}	D_{2min}	D_{2max}	D_{1min}	D_{1max}	A_{d3} mm²	A_s mm²
6	0,75	5,978	5,838	5,491	5,391	5,058	4,929	5,513	5,645	5,188	5,378	20,27	22,0
8	1	7,974	7,794	7,324	7,212	6,747	6,596	7,350	7,500	6,917	7,153	36,03	39,2
10	1	9,974	9,794	9,324	9,212	8,747	8,596	9,350	9,500	8,917	9,153	60,45	64,5
10	1,25	9,972	9,760	9,160	9,042	8,438	8,272	9,188	9,348	8,647	8,912	56,29	61,2
12	1	11,974	11,794	11,324	11,206	10,747	10,590	11,350	11,510	10,917	11,153	91,15	96,1
12	1,25	11,972	11,760	11,160	11,028	10,438	10,258	11,188	11,368	10,647	10,912	86,03	92,1
12	1,5	11,968	11,732	10,994	10,854	10,128	9,930	11,026	11,216	10,376	10,676	81,07	88,1
14	1,5	13,968	13,732	12,994	12,854	12,128	11,930	13,026	13,216	12,376	12,676	116,1	125
16	1,5	15,968	15,732	14,994	14,854	14,128	13,930	15,026	15,216	14,376	14,676	157,5	167
18	1,5	17,968	17,732	16,994	16,854	16,128	15,930	17,026	17,216	16,376	16,676	205,1	216
18	2	17,962	17,682	16,663	16,503	15,508	15,271	16,701	16,913	15,835	16,210	189,8	204
20	1,5	19,968	19,732	18,994	18,854	18,128	17,930	19,026	19,216	18,376	18,676	259,0	272
20	2	19,962	19,682	18,663	18,503	17,508	17,271	18,701	18,913	17,835	18,210	241,8	258
22	1,5	21,968	21,732	20,994	20,854	20,128	19,930	21,026	21,216	20,376	20,676	319,2	333
22	2	21,962	21,682	20,663	20,503	19,508	19,271	20,701	20,913	19,835	20,210	300,1	318
24	1,5	23,968	23,732	22,994	22,844	22,128	21,920	23,026	23,226	22,376	22,676	385,7	401
24	2	23,962	23,682	22,663	22,493	21,508	21,261	22,701	22,925	21,835	22,210	364,6	384
27	1,5	26,968	26,732	25,994	25,844	25,128	24,920	26,026	26,226	25,376	25,676	497,2	514
27	2	26,962	26,682	25,663	25,493	24,508	24,261	25,701	25,925	24,835	25,210	473,2	496
30	1,5	29,968	29,732	28,994	28,844	28,128	27,920	29,026	29,226	28,376	28,676	622,8	642
30	2	29,962	29,682	28,663	28,493	27,508	27,261	28,701	28,925	27,835	28,210	596,0	621
33	1,5	32,968	32,732	31,994	31,844	31,128	30,920	32,026	32,226	31,376	31,676	762,6	784
33	2	32,962	32,682	31,633	31,493	30,508	30,261	31,701	31,925	30,835	31,210	732,8	761
36	1,5	35,968	35,732	34,994	34,844	34,128	33,920	35,026	35,226	34,376	34,676	916,5	940
36	3	35,952	35,577	34,003	33,803	32,271	31,955	34,051	34,316	32,752	33,252	820,4	865
39	1,5	38,968	38,732	37,994	37,844	37,128	36,920	38,026	38,226	37,376	37,676	1085	1110
39	3	38,952	38,577	37,003	36,803	35,271	34,955	37,051	37,316	35,752	36,252	979,7	1028
42	1,5	41,968	41,732	40,994	40,844	40,128	39,920	41,026	41,226	40,376	40,676	1267	1294
42	3	41,952	41,577	40,003	39,803	38,271	37,955	40,051	40,316	38,752	39,252	1153	1206
45	1,5	44,968	44,732	43,994	43,844	43,128	42,920	44,026	44,226	43,376	43,676	1463	1492
45	3	44,952	44,577	43,003	42,803	41,276	40,955	43,051	43,316	41,752	42,252	1341	1398
48	1,5	47,968	47,732	46,994	46,834	46,128	45,910	47,026	47,238	46,376	46,676	1674	1705
48	3	47,952	47,577	46,003	45,791	44,271	43,943	46,051	46,331	44,752	45,252	1543	1604
52	1,5	51,968	51,732	50,994	50,834	50,128	49,910	51,026	51,238	50,376	50,676	1976	2010
52	3	51,952	51,577	50,003	49,791	48,271	47,943	50,051	50,331	48,752	49,252	1834	1900
56	2	55,962	55,682	54,663	54,483	53,508	53,251	54,701	54,937	53,835	54,210	2252	2301
56	4	55,940	55,465	53,342	53,106	51,033	50,643	53,402	53,717	51,670	52,270	2050	2144
60	4	59,940	59,465	57,342	57,106	55,033	54,643	57,402	57,717	55,670	56,270	2384	2485
64	4	63,940	63,465	61,342	61,106	59,033	58,643	61,402	61,717	59,670	60,270	2743	2851
68	4	67,940	67,465	65,342	65,106	63,033	62,643	65,402	65,717	63,670	64,270	3127	3242
72	6	71,920	71,320	68,023	67,743	64,559	64,048	68,103	68,478	65,505	66,305	3287	3463
76	6	75,920	75,320	72,023	71,743	68,559	68,048	72,103	72,478	69,505	70,305	3700	3889
80	6	79,920	79,320	76,023	75,743	72,559	72,048	76,103	76,478	73,505	74,305	4144	4344
90	6	89,920	89,320	86,023	85,743	82,559	82,048	86,103	86,478	83,505	84,305	5364	5590
100	6	99,920	99,320	96,023	95,723	92,559	92,028	96,103	96,503	93,505	94,305	6740	7000
110	6	109,920	109,320	106,023	105,723	102,559	102,028	106,103	106,503	103,505	104,305	8273	8560

– For coated threads the maximum values of d, d_2 and d_3 are equal to the values of the basic profile ($d2_{max}=D_{2min}$ and $d_{3max}=D_{1min}$)
– Metric screw thread, fine series, are designated by the basic diameter, preceded by the profile letter M and followed by the pitch separated by an x-mark and then by the tolerance grade, e.g. 6, and the tolerance position, e.g. H. Example: M10 x 1,25 – 6H. If no tolerance is indicated the fit 6H/6g is valid.

STANDARD

ISO : –
EN : –
DIN : –

SCREW THREADS

Fine versus coarse thread

The general trend for commercial fasteners over the past 20 years has shown a gradual and noticeable shifting in popularity toward coarse threads.
And rightly so, as fine threads cannot be said to be technically superior. Altough fine threads are used in special cases, (such as for adjustment, or for certain engine screws), these cases occur so seldom that fasteners with fine thread are becoming more and more a special product with all the economic disadvantages (higher price, poor availability, double stocking).

The fine screw thread is mainly created for and is still popular in, the automotive industry - and other related industries.

The most important arguments of proponents of fine thread are:
– a higher static tensile strength because of its larger stress area.
– because of the smaller helix angle it offers more resistance to loosening when subjected to vibration.
– better accuracy of adjustment.

In practice however most constructions are not charged statically but dynamically, so fatigue strength is the criterion. Coarse thread exhibits a better fatigue resistance because stress concentration at the root decreases as thread pith increases. The argument of better resistance to loosening has been outdated by the development of mechanical and chemical locking systems, which offer a more effective solution for loss of pre-tension especially during dynamic transversal forces.

Further advantages of coarse thread are:
– less sensitive to damaging and generally easier and quicker assembly
– thicker coatings as a consequence of the larger thread allowances
– less danger of stripping off.

The most important pros and cons can be summarised in the following evaluation table:

Functional properties	**Screw thread**	
	coarse	**fine**
Strength		
– static	-	+
– dynamic	+	-
Locking		
– without locking systems	-	+
– with locking systems	++	++
Insentivity to damaging	+	-
Coating thickness	+	-
Stripping off	+	-
Ease of assembly	+	-
Cost and availibility	+	-

+ means better or more favourable

COARSE THREAD
is recommended for standardized fasteners in general constructions

Note:
For the conversion from the imperial to the metric system in the U.S.A. the Industrial Fasteners Institute has issued the handbook "Metric Fasteners Standards". In this book all threaded fasteners have only the COARSE thread series as standard.
Changing from UNF to metric-fine is not recommended for commercial fasteners.

FABORY

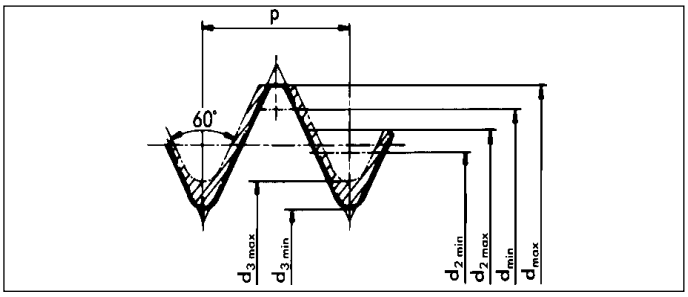
STANDARD
ISO : –
EN : –
DIN : 13 Part 51

SCREW THREADS

Metric (ISO) screw thread with tolerance class Sk6

at the metal end of studs DIN 939

Basic profile and limiting profiles



The bold line indicates the minimum material profile

P = pitch
d = major diameter = basic diameter
d_2 = pitch diameter
d_3 = minor diameter

Limits of sizes for metric screw thread with tolerance class Sk6
Dimensions in mm

Basic diameter d	Pitch P	External thread (studs)					
		major diameter		pitch diameter		minor diameter	
		d_{max}	d_{min}	d_{2max}	d_{2min}	d_{3max}	d_{3min}
6	1	6	5,776	5,406	5,335	4,773	4,663
(7)*	1	7	6,776	6,406	6,335	5,773	5,663
8	1,25	8	7,750	7,244	7,173	6,466	6,343
(9)*	1,25	9	8,750	8,244	8,173	7,466	7,343
10	1,5	10	9,720	9,082	9,011	8,160	8,017
(11)*	1,5	11	10,720	10,082	10,011	9,160	9,017
12	1,75	12	11,600	10,943	10,843	9,853	9,691
14	2	14	13,525	12,781	12,681	11,546	11,369
16	2	16	15,525	14,781	14,681	13,546	13,369
18	2,5	18	17,470	16,456	16,356	14,933	14,731
20	2,5	20	19,470	18,456	18,356	16,933	16,731
22	2,5	22	21,470	20,456	20,356	18,933	18,731
24	3	24	23,400	22,131	22,031	20,319	20,078

Remark:
Tolerance class Sk6 is used for general applications e.g. studs (not sealed connection) and in combination with internal thread, tolerance class fine (4H resp. 4H5H).
These tolerance classes have to do with a transition fit, so a press fit will not always be achieved.
Note:
In the meantime a real press fit of metric screwthread (MFS) has been developed, which is achieved by an oversize on the major diameter.
For the tolerances of this screwthread is referred to DIN 8141 Part 1 and for the corresponding gauges to DIN 8141 Part 2.
These standards can only be used for application in aluminium cast alloys and for sizes M 5 up to and including M 16. Futher development depends on obtained experience.

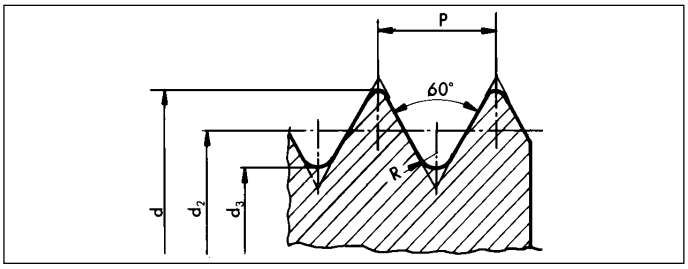
Designation of this screw thread e.g. M12 Sk6.
* Preferably not to be used.

STANDARD
ISO : –
EN : –
DIN : 2510 Part 2

SCREW THREADS

Metric screw thread with large clearance

for double end studs with reduced shank DIN 2510



P = pitch
R = root radius
d = major diameter = basic diameter
d_2 = pitch diameter
d_3 = minor diameter

Basic profile and limits of sizes

Dimensions in mm

Basic diameter d	Pitch P	Root-radius R	External thread (double studs with reduced shank)							
			major diameter		pitch diameter		pitch clearance min.	minor diameter		section at minor dia.
			d_{max}	d_{min}	d_{2max}	d_{2min}		d_{3max}	d_{3min}	
M 12	1,75	0,18	11,823	11,558	10,686	10,536	0,177	9,676	9,400	69
M 16	2	0,20	15,823	15,543	14,524	14,364	0,177	13,369	13,065	133
M 20	2,5	0,25	19,800	19,465	18,176	18,006	0,200	16,733	16,383	210
M 24	3	0,30	23,788	23,413	21,839	21,639	0,212	20,107	19,691	303
M 27	3	0,30	26,788	26,413	24,839	24,639	0,212	23,107	22,691	403
M 30	3,5	0,35	29,775	29,350	27,502	27,290	0,225	25,481	25,017	490

Designation of this screw thread e.g. M 16 DIN 2510

STANDARD

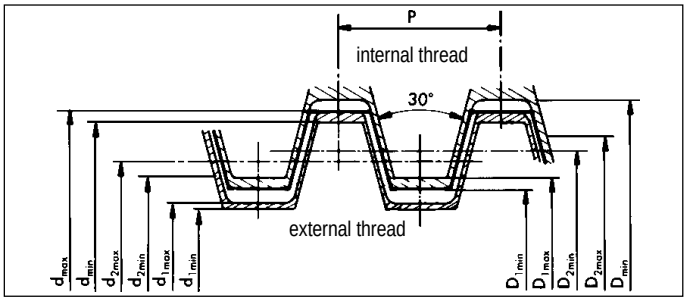
ISO : 2903
EN : –
DIN : 103 Part 5 and 7

SCREW THREADS

Metric (ISO) trapezoidal screw thread -Tr-

for threaded rods and nuts

Basic profile and limiting profiles



The bold lines indicate the maximum material profiles.
The extra thick line is the basic profile.

P = pitch

d = major diameter
d_2 = pitch diameter
d_1 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for trapezoidal thread, medium pitch series, fit 7H/7e

Dimensions in mm

Designation	Pitch P	External thread tol. 7e (threaded rods)						Internal thread tol. 7H (nuts)				
		major diameter		pitch diameter		minor diameter		major diameter	pitch diameter		minor diameter	
		d_{max}	d_{min}	d_{2max}	d_{2min}	d_{1max}	d_{1min}	D_{min}	D_{2min}	D_{2max}	D_{1min}	D_{1max}
Tr 10x2	2	10,000	9,820	8,929	8,739	7,500	7,191	10,500	9,000	9,250	8,000	8,236
Tr 12x3	3	12,000	11,764	10,415	10,191	8,500	8,135	12,500	10,500	10,800	9,000	9,315
Tr 14x3	3	14,000	13,764	12,415	12,191	10,500	10,135	14,500	12,500	12,800	11,000	11,315
Tr 16x4	4	16,000	15,700	13,905	13,640	11,500	11,074	16,500	14,000	14,355	12,000	12,375
Tr 18x4	4	18,000	17,700	15,905	15,640	13,500	13,074	18,500	16,000	16,355	14,000	14,375
Tr 20x4	4	20,000	19,700	17,905	17,640	15,500	15,074	20,500	18,000	18,355	16,000	16,375
Tr 22x5	5	22,000	21,665	19,394	19,114	16,500	16,044	22,500	19,500	19,875	17,000	17,450
Tr 24x5	5	24,000	23,665	21,394	21,094	18,500	18,019	24,500	21,500	21,900	19,000	19,450
Tr 26x5	5	26,000	25,665	23,394	23,094	20,500	20,019	26,500	23,500	23,900	21,000	21,450
Tr 28x5	5	28,000	27,665	25,394	25,094	22,500	22,019	28,500	25,500	25,900	23,000	23,450
Tr 30x6	6	30,000	29,625	26,882	26,547	23,000	22,463	31,000	27,000	27,450	24,000	24,500
Tr 32x6	6	32,000	31,625	28,882	28,547	25,000	24,463	33,000	29,000	29,450	26,000	26,500
Tr 36x6	6	36,000	35,625	32,882	32,547	29,000	28,463	37,000	33,000	33,450	30,000	30,500
Tr 40x7	7	40,000	39,575	36,375	36,020	32,000	31,431	41,000	36,500	36,975	33,000	33,560
Tr 44x7	7	44,000	43,575	40,375	40,020	36,000	35,431	45,000	40,500	40,975	37,000	37,560
Tr 50x8	8	50,000	49,550	45,868	45,468	41,000	40,368	51,000	46,000	46,530	42,000	42,630
Tr 60x9	9	60,000	59,500	55,360	54,935	50,000	49,329	61,000	55,500	56,060	51,000	51,670

This trapezoidal screw thread is recommended for general use and does not apply to special requirements for axial displacement, e.g. lead screws. The diameter/pitch combination “medium” only refers to the choice out of the series coarse, medium or fine and not to the quality of the screw thread or the tolerance class.
This trapezoidal screw thread is designated with the profile letters Tr, followed by the basic diameter and the pitch separated by a X-mark e.g. Tr 20x4.

FABORY

STANDARD

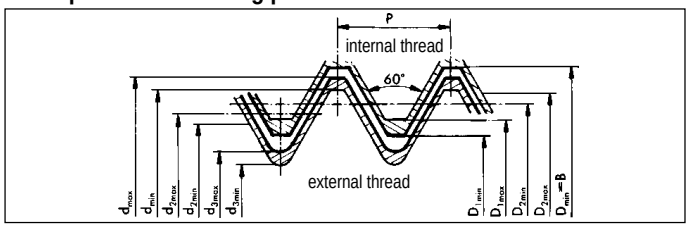
ISO : 5864
EN : –
DIN : –
ANSI : B 1.1

SCREW THREADS

Unified (ISO) screw thread - UNC, UNF and 8UN -

info

Basic profile and limiting profiles



The bold lines indicate the maximum material profiles.
The maximum material profile of the internal thread is the basic profile.

B = basic major diameter
P = pitch
n = number of threads per inch

d = major diameter
d_2 = pitch diameter
d_3 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal diameter

Basic diameter	Number of threads	Pitch	External thread tol. 2A (bolts and screws)						Internal thread tol. 2B (nuts)					Section at minor dia.	Stress area
			major diameter		pitch diameter		minor diameter		major diameter	pitch diameter		minor diameter		$\pi/4\ d_3^2$	$\pi/4\ \frac{(d2+d3)2}{2}$
B inch	n	P	d_{max}	d_{min}	d_{2max}	d_{2min}	d_{3max}	d_{3min}	D_{min}	D_{2min}	D_{2max}	D_{1min}	D_{1max}	A_{d3} mm²	A_s mm²
Limits of sizes for unified screw thread: coarse-UNC, tolerance classes 2A and 2B Dimensions in mm															
1/4	20	1,2700	6,322	6,117	5,496	5,403	4,765	4,580	6,350	5,525	5,646	4,979	5,257	17,4	20,5
5/16	18	1,4111	7,907	7,687	6,990	6,889	6,174	5,972	7,938	7,021	7,155	6,401	6,731	29,3	33,8
3/8	16	1,5875	9,491	9,254	8,460	8,349	7,543	7,318	9,525	8,494	8,638	7,798	8,153	43,7	50
7/16	14	1,8143	11,076	10,816	9,898	9,779	8,851	8,603	11,113	9,934	10,088	9,144	9,550	60,2	68,6
1/2	13	1,9538	12,661	12,386	11,391	11,265	10,264	9,998	12,700	11,430	11,595	10,592	11,023	81,1	91,5
9/16	12	2,1167	14,246	13,958	12,872	12,741	11,650	11,367	14,288	12,914	13,086	11,989	12,446	105	117,4
5/8	11	2,3091	15,834	15,528	14,335	14,197	13,002	12,698	15,875	14,377	14,559	13,386	13,868	130	146
3/4	10	2,5400	19,004	18,677	17,353	17,204	15,887	15,555	19,050	17,399	17,594	16,307	16,840	195	215
7/8	9	2,8222	22,176	21,824	20,342	20,183	18,714	18,352	22,225	20,392	20,599	19,177	19,761	270	298
1	8	3,1750	25,349	24,969	23,286	23,114	21,452	21,052	25,400	23,338	23,561	21,971	22,606	355	391
1 1/8	7	3,6286	28,519	28,103	26,162	25,980	24,066	23,623	28,575	26,218	26,456	24,638	25,349	447	492
1 1/4	7	3,6286	31,694	31,278	29,337	29,150	27,241	26,792	31,750	29,393	29,636	27,813	28,524	574	625
1 3/8	6	4,2333	34,864	34,402	32,113	31,911	29,669	29,162	34,925	32,175	32,438	30,353	31,115	680	745
1 1/2	6	4,2333	38,039	37,577	35,288	35,083	32,844	32,335	38,100	35,350	35,615	33,528	34,290	835	906
1 3/4	5	5,0800	44,381	43,861	41,081	40,856	38,148	37,557	44,450	41,151	41,445	38,964	39,827	1123	1226
2	4 1/2	5,6444	50,726	50,168	47,061	46,820	43,802	43,155	50,800	47,135	47,449	44,679	45,593	1484	1613
2 1/4	4 1/2	5,6444	57,076	56,518	53,411	53,165	50,152	49,500	57,150	53,485	53,804	51,029	51,943	1948	2097
2 1/2	4	6,3500	63,421	62,817	59,296	59,033	55,631	54,910	63,500	59,376	59,717	56,617	57,581	2400	2581
2 3/4	4	6,3500	69,768	69,165	65,643	65,378	61,978	61,255	69,850	65,726	66,073	62,967	63,931	2981	3181
3	4	6,3500	76,118	75,515	71,993	71,722	68,328	67,600	76,200	72,076	72,428	69,317	70,281	3626	3852
Limits of sizes for unified screw thread: fine-UNF, tolerance classes 2A and 2B Dimensions in mm															
1/4	28	0,9071	6,324	6,160	5,735	5,652	5,212	5,063	6,350	5,761	5,869	5,360	5,588	21,0	23,5
5/16	24	1,0583	7,909	7,727	7,221	7,128	6,611	6,442	7,938	7,250	7,371	6,782	7,035	33,8	37,4
3/8	24	1,0583	9,497	9,315	8,808	8,713	8,199	8,027	9,525	8,837	8,961	8,382	8,636	52,2	56,6
7/16	20	1,2700	11,079	10,874	10,253	10,148	9,522	9,325	11,113	10,287	10,424	9,729	10,033	70,3	76,6
1/2	20	1,2700	12,666	12,462	11,841	11,733	11,109	10,910	12,700	11,875	12,016	11,329	11,607	95,9	103
9/16	18	1,4111	14,251	14,031	13,335	13,221	12,519	12,304	14,288	13,371	13,520	12,751	13,081	122	131
5/8	18	1,4111	15,839	15,619	14,922	14,804	14,107	13,887	15,875	14,959	15,110	14,351	14,681	155	165
3/4	16	1,5875	19,011	18,774	17,980	17,854	17,063	16,823	19,050	18,019	18,183	17,323	17,678	226	241
7/8	14	1,8143	22,184	21,923	21,005	20,869	19,959	19,693	22,225	21,047	21,224	20,270	20,675	310	328
1	12	2,1167	25,354	25,065	23,980	23,831	22,758	22,457	25,400	24,026	24,218	23,114	23,571	403	428
1	14	1,8143	25,357	25,095	24,178	24,036	23,123	25,400	24,221	24,407	23,444	23,825	–	420	439
1 1/8	12	2,1167	28,529	28,240	27,155	27,003	25,933	25,629	28,575	27,201	27,398	26,289	26,746	524	552
1 1/4	12	2,1167	31,704	31,415	30,330	30,173	29,108	28,799	31,750	30,376	30,579	29,464	29,921	661	692
1 3/8	12	2,1167	34,876	34,588	33,502	33,343	32,280	31,969	34,925	33,551	33,759	32,639	33,096	813	848
1 1/2	12	2,1167	38,051	37,763	36,677	36,516	35,455	35,141	38,100	36,726	36,936	35,814	36,271	981	1020
Limits of sizes for unified screw thread: 8 UN, tolerance classes 2A and 2B Dimensions in mm							nom.								
1 1/8	8	3,1750	28,521	28,141	26,459	26,284	24,653		28,575	26,513	26,741	25,146	25,781	470	510
1 1/4	8	3,1750	31,697	31,316	29,634	29,456	27,800		31,750	29,688	29,921	28,321	28,956	599	645
1 3/8	8	3,1750	34,869	34,488	32,807	32,624	30,973		34,925	32,863	33,099	31,496	32,131	745	795
1 1/2	8	3,1750	38,044	37,663	35,982	35,796	34,148		38,100	36,038	36,279	34,671	35,306	906	963
1 5/8	8	3,1750	41,219	40,838	39,157	38,969	37,323		41,275	39,213	39,459	37,846	38,481	1084	1148
1 3/4	8	3,1750	44,392	44,011	43,329	42,139	40,495		44,450	42,388	42,636	41,021	41,656	1277	1342
1 7/8	8	3,1750	47,567	47,186	45,564	45,309	43,670		47,625	45,563	45,817	44,196	44,831	1484	1555
2	8	3,1750	50,742	50,361	48,679	48,481	46,845		50,800	48,738	48,994	47,371	48,006	1710	1787

– For coated threads the maximum values of d, d_2 en d_3 are equal to the values of the basic profile ($d_{2max} = D_{2min}$ en $d_{3max} = D_{1min}$).
– Unified screw thread is designated by the basic diameter followed by the number of threads per inch (n), the thread series UNC, UNF or 8 UN and the tolerance class.
e.g.: 3/8 - 24 UNF - 2A.
When no tolerance class is mentioned, the fit 2A/2B is valid.

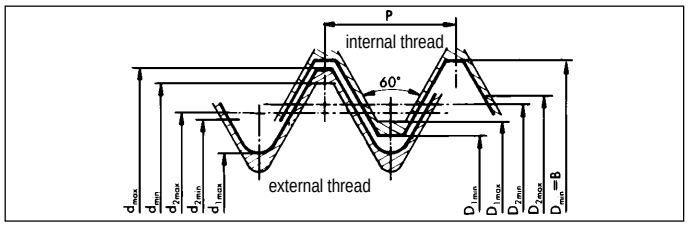
STANDARD

ISO : –
EN : –
DIN : –
USAS : B 1.1

SCREW THREADS

Unified number threads - UNC and UNF -

Basic profile and limiting profiles



The bold lines indicate the maximum material profiles.
The maximum material profile of the internal thread is the basic profile.

B = basic major diameter
P = pitch
n = number of threads per inch

B = major diameter

d = major diameter
d_2 = pitch diameter
d_1 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for UNC en UNF-number thread, tolerance class 2A en 2B

Dimensions in mm

designation	B	n	P	External thread - tol. 2A (screws)					Internal thread - tol. 2B (nuts)			
				major diameter		pitch diameter		minor diameter	pitch diameter		minor diameter	
				d_{max}	d_{min}	d_{2max}	d_{2min}	d_{1max}	D_{2min}	D_{2max}	D_{1min}	D_{1max}
4-40 UNC	2,844	40	0,635	2,824	2,695	2,413	2,350	2,044	2,434	2,517	2,157	2,385
5-40 UNC	3,175	40	0,635	3,154	3,026	2,743	2,678	2,374	2,764	2,847	2,487	2,697
6-32 UNC	3,505	32	0,794	3,484	3,333	2,969	2,899	2,512	2,990	3,083	2,642	2,895
8-32 UNC	4,165	32	0,794	4,142	3,991	3,627	3,554	3,169	3,650	3,746	3,302	3,530
10-24 UNC	4,826	24	1,058	4,800	4,618	4,112	4,029	3,502	4,138	4,246	3,683	3,962
12-24 UNC	5,486	24	1,058	5,461	5,279	4,772	4,687	4,163	4,799	4,909	4,344	4,597
4-48 UNF	2,844	48	0,529	2,827	2,713	2,484	2,424	2,176	2,502	2,580	2,271	2,458
5-44 UNF	3,175	44	0,577	3,157	3,036	2,781	2,718	2,448	2,800	2,880	2,551	2,740
6-40 UNF	3,505	40	0,635	3,484	3,356	3,073	3,008	2,705	3,094	3,180	2,820	3,022
8-36 UNF	4,165	36	0,706	4,145	4,006	3,688	3,617	3,279	3,709	3,799	3,404	3,606
10-32 UNF	4,826	32	0,794	4,803	4,651	4,287	4,212	3,830	4,311	4,409	3,963	4,165
12-28 UNF	5,486	28	0,907	5,461	5,296	4,871	4,791	4,348	4,898	5,003	4,496	4,724

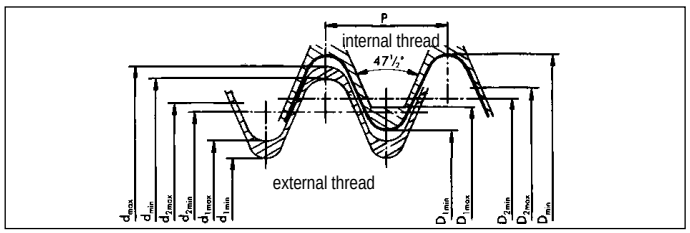
STANDARD

ISO : –
EN : –
DIN : –
BS : 93 (1951)

SCREW THREADS

BA-screw thread

Basic profile and limiting profiles



P = pitch

d = major diameter
d_2 = pitch diameter
d_1 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for BA-screw thread, tolerance class normal

Dimensions in mm

designation	P	External thread (screws)						Internal thread (nuts)				
		major diameter		pitch diameter		minor diameter		major diameter	pitch diameter		minor diameter	
		d_{max}	d_{min}	d_{2max}	d_{2min}	d_{1max}	d_{1min}	D_{min}	D_{2min}	D_{2max}	D_{1min}	D_{1max}
0 BA	1,00	5,975	5,775	5,375	5,250	4,775	4,525	6,000	5,400	5,550	4,800	5,175
1 BA	0,90	5,275	5,095	4,375	4,620	4,195	3,965	5,300	4,760	4,900	4,220	4,560
2 BA	0,81	4,675	4,515	4,190	4,085	3,705	3,495	4,700	4,215	4,340	3,730	4,035
3 BA	0,73	4,075	3,930	3,635	3,535	3,195	3,000	4,100	3,660	3,780	3,220	3,495
4 BA	0,66	3,575	3,445	3,180	3,090	2,785	2,605	3,600	3,205	3,315	2,810	3,060
5 BA	0,59	3,175	3,055	2,820	2,735	2,465	2,295	3,200	2,845	2,945	2,490	2,710
6 BA	0,53	2,775	2,670	2,455	2,375	2,135	1,980	2,800	2,480	2,575	2,160	2,360
7 BA	0,48	2,475	2,380	2,185	2,110	1,895	1,750	2,500	2,210	2,300	1,920	2,100
8 BA	0,43	2,175	2,090	1,915	1,845	1,655	1,520	2,200	1,940	2,020	1,680	1,840

FABORY

WHITWORTH SCREW THREAD IS OUTDATED!

This screw thread is not recommended internationally and for new constructions is advised to use the metric (ISO) or the unified (ISO) screw thread.

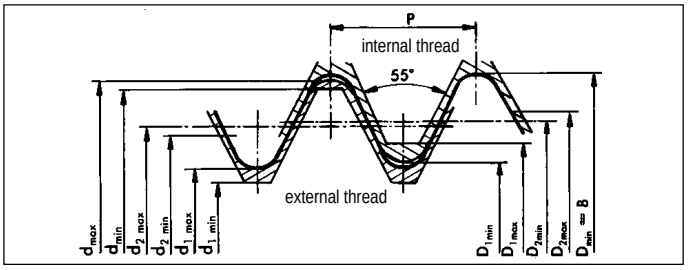
STANDARD

ISO : –
EN : –
DIN : 11 (1930) w
BS : 84 (1956)

SCREW THREADS

Whitworth screw thread - BSW and BSF -

Basic profile and limiting profiles



The bold line indicates the maximum material profile.

B = basic major diameter
P = pitch
n = number of threads per inch

d = major diameter
d_2 = pitch diameter
d_1 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for whitworth screw thread coarse-BSW, medium class

Dimensions in mm

Basic diameter	number of threads	pitch	external thread (bolts and screws)						internal thread (nuts)					Section at minor dia.
			major diameter		pitch diameter		minor diameter		major diameter	pitch diameter		minor diameter		$\pi/4\ d_1^2$
B inch	n	P	d_{max}	d_{min}	$d_{2\,max}$	$d_{2\,min}$	$d_{1\,max}$	$d_{1\,min}$	$D_{min}=B$	$D_{2\,min}$	$D_{2\,max}$	$D_{1\,min}$	$D_{1\,max}$	A_{d1_2} mm²
1/8	40	0,635	3,155	3,035	2,769	2,689	2,362	2,202	3,175	2,769	2,849	2,382	2,622	4,39
5/32	32	0,794	3,949	3,814	3,461	3,371	2,953	2,773	3,969	3,461	3,551	2,973	3,243	6,85
3/16	24	1,058	4,743	4,587	4,084	3,980	3,406	3,198	4,763	4,084	4,188	3,426	3,738	9,10
1/4	20	1,270	6,330	6,000	5,537	5,424	4,724	4,422	6,350	5,537	5,650	4,744	5,224	17,55
5/16	18	1,411	7,918	7,600	7,034	6,915	6,131	5,813	7,938	7,034	7,153	6,151	6,661	29,48
3/8	16	1,588	9,505	9,100	8,509	8,382	7,492	7,154	9,525	8,509	8,636	7,512	8,052	44,06
7/16	14	1,814	11,093	10,700	9,951	9,816	8,789	8,430	11,113	9,951	10,086	8,809	9,379	60,71
1/2	12	2,117	12,675	12,200	11,345	11,199	9,990	9,600	12,700	11,345	11,491	10,015	10,610	78,32
9/16	12	2,117	14,263	13,800	12,933	12,787	11,578	11,188	14,288	12,933	13,079	11,603	12,198	105
5/8	11	2,309	15,846	15,400	14,397	14,244	12,918	12,510	15,876	14,397	14,550	12,948	13,598	131
11/16	11	2,309	17,433	17,000	15,985	15,832	14,507	14,099	17,463	15,985	16,138	14,537	15,187	165
3/4	10	2,540	19,018	18,500	17,424	17,264	15,798	15,371	19,051	17,424	17,584	15,831	16,538	196
7/8	9	2,822	22,190	21,600	20,419	20,250	18,611	18,161	22,226	20,419	20,588	18,647	19,411	272
1	8	3,175	25,361	24,800	23,368	23,189	21,335	20,858	25,401	23,368	23,547	21,375	22,185	358
1 1/8	7	3,629	28,529	27,900	26,253	26,062	23,929	23,419	28,576	26,253	26,444	23,976	24,879	450
1 1/4	7	3,629	31,704	31,000	29,428	29,237	27,104	26,594	31,751	29,428	29,619	27,151	28,054	577
1 1/2	6	4,233	38,048	37,300	35,391	35,184	32,680	32,128	38,101	35,391	35,598	32,733	33,730	839
1 3/4	5	5,080	44,389	43,500	41,199	40,972	37,946	37,341	44,452	41,199	41,426	38,009	39,096	1131
2	4,5	5,645	50,732	49,800	47,187	46,948	43,573	42,936	50,802	47,187	47,426	43,643	44,823	1491
2 1/4	4	6,350	57,072	56,200	53,086	52,833	49,020	48,345	57,152	53,086	53,339	49,100	50,420	1887
2 1/2	4	6,350	63,422	62,500	59,436	59,183	55,370	54,695	63,502	59,436	59,689	55,450	56,770	2408
2 3/4	3,5	7,257	69,763	68,800	65,205	64,934	60,558	59,836	69,853	65,205	65,476	60,648	62,108	2880
3	3,5	7,257	76,113	75,100	71,556	71,285	66,909	66,187	76,203	71,556	71,827	66,999	68,459	3515

Limits of sizes for whitworth screw thread fine-BSF, medium class for external thread and normal class for internal thread

Dimensions in mm

1/4	26	0,977	6,322	6,177	5,697	5,603	5,072	4,879	6,350	5,725	5,867	5,100	5,398	20,45
9/32	26	0,977	7,112	6,962	6,487	6,388	5,862	5,664	7,142	6,518	6,665	5,893	6,190	27,29
5/16	22	1,155	7,907	7,750	7,168	7,064	6,429	6,215	7,938	7,198	7,356	6,459	6,817	32,77
3/8	20	1,270	9,492	9,324	8,679	8,567	7,866	7,640	9,525	8,712	8,880	7,899	8,331	49,03
7/16	18	1,411	11,077	10,897	10,173	10,053	9,268	9,030	11,113	10,208	10,386	9,304	9,764	68,00
1/2	16	1,588	12,662	12,471	11,646	11,519	10,630	10,376	12,700	11,684	11,872	10,668	11,163	89,35
9/16	16	1,588	14,249	14,054	13,233	13,101	12,217	11,958	14,288	13,272	13,467	12,256	12,751	118
5/8	14	1,814	15,834	15,629	14,674	14,536	13,513	13,241	15,875	14,714	14,920	13,553	14,094	144
11/16	14	1,814	17,419	17,209	16,259	16,116	15,098	14,821	17,463	16,302	16,515	15,141	15,682	180
3/4	12	2,117	19,004	18,781	17,648	17,498	16,292	15,994	19,050	17,694	17,917	16,338	16,939	210
7/8	11	2,309	22,225	21,991	20,747	20,589	19,268	18,959	22,225	20,747	20,983	19,268	19,909	292
1	10	2,540	25,400	25,151	23,774	23,607	22,149	21,821	25,400	23,774	24,026	22,149	22,835	385

– After applying a corrosion resistant coating the maximum limits of sizes of the external thread may not exceed the minimum limits of sizes of the internal thread.
– Whitworth screw thread is designated by the basic diameter in inches followed by the number of threads per inch (n), the thread series BSW or BSF and if desired the class of tolerances. Where the latter is not indicated, the above mentioned classes are applicable e.g. 1/4 -20 BSW or 1/2-16 BSF.

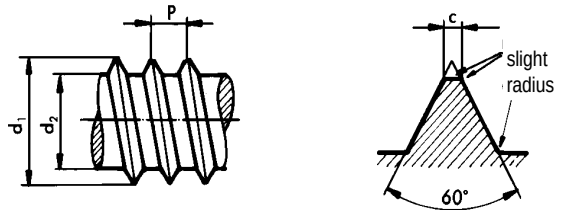
STANDARD
ISO : 1478
EN : 21478
DIN : 7970

SCREW THREADS

Tapping screw thread-ST

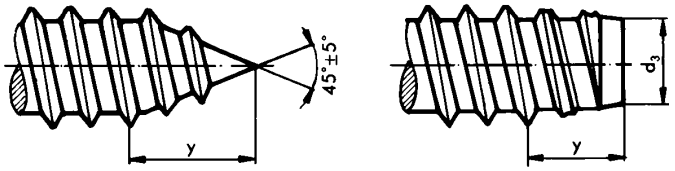
for tapping and self drilling screws

screw thread ST



thread profile

thread ends



type C cone end
(previous ISO-type AB, DIN-type B)

type F flat end
(previous ISO-type B, DIN-type BZ)

Limits of sizes for tapping screw thread

Dimensions in mm

Basic Diameter	ISO Nr.	Pitch P	Major diameter d_{1max}	Major diameter d_{1min}	Minor diameter d_{2max}	Minor diameter d_{2min}	Flat end diameter d_{3max}	Flat end diameter d_{3min}	Crest flattening c_{max}	Point taper length y_{max} Type C	Point taper length y_{max} Type F
ST 2,2	2	0,8	2,24	2,1	1,63	1,52	1,47	1,37	0,1	2	1,6
ST 2,6	3	0,9	2,57	2,43	1,9	1,8	1,73	1,6	0,1	2,3	1,8
ST 2,9	4	1,1	2,9	2,76	2,18	2,08	2,01	1,88	0,1	2,6	2,1
ST 3,3	5	1,3	3,3	3,12	2,39	2,29	2,21	2,08	0,1	3	2,5
ST 3,5	6	1,3	3,53	3,35	2,64	2,51	2,41	2,26	0,1	3,2	2,5
ST 3,9	7	1,3	3,91	3,73	2,92	2,77	2,67	2,51	0,1	3,5	2,7
ST 4,2	8	1,4	4,22	4,04	3,1	2,95	2,84	2,69	0,1	3,7	2,8
ST 4,8	10	1,6	4,8	4,62	3,58	3,43	3,3	3,12	0,15	4,3	3,2
ST 5,5	12	1,8	5,46	5,28	4,17	3,99	3,86	3,68	0,15	5	3,6
ST 6,3	14	1,8	6,25	6,03	4,88	4,7	4,55	4,34	0,15	6	3,6

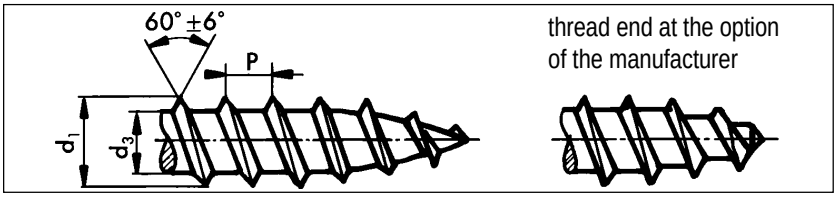
– It has been agreed internationally that tapping screw thread is designated by the basic diameter, preceded by the profile letters ST and that the thread end with cone end is indicated with type C and the thread end with flat end with type F, e.g.: ST 3,5-C.
– For core holes see table elsewhere in this section.

STANDARD
ISO : –
EN : –
DIN : 7998

SCREW THREADS

Wood screw thread

for wood screws



thread end at the option
of the manufacturer

Basic diameter d_1 tol. h15	Pitch P	Pitch tolerance	Minor diameter d_3 tol. h15
1,6	0,7	±0,07	1,1
2	0,9	±0,09	1,4
2,5	1,1	±0,11	1,7
3	1,35	±0,14	2,1
3,5	1,6	±0,16	2,4
4	1,8	±0,18	2,8
4,5	2	±0,2	3,1
5	2,2	±0,22	3,5
(5,5)	2,4	±0,24	3,8
6	2,6	±0,26	4,2
(7)	3,2	±0,32	4,9
8	3,6	±0,36	5,6
10	4,5	±0,45	7
12	5	±0,5	9
16	6	±0,6	12
20	7	±0,7	15

Wood screw thread is designated by the basic diameter e.g. 4 mm: 4

FABORY

STANDARD

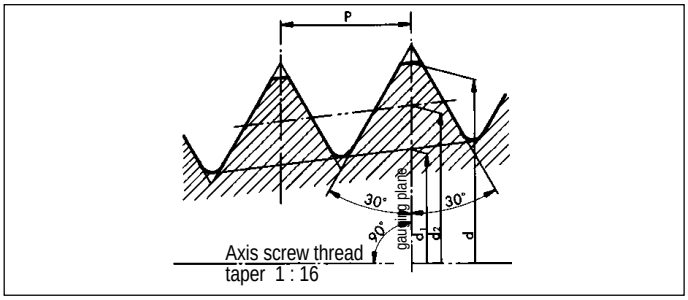
ISO : –
EN : –
DIN : 158

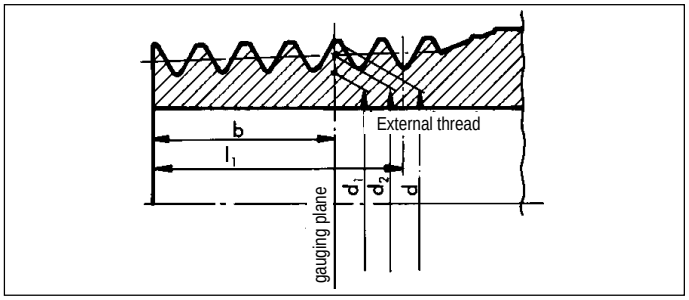
SCREW THREADS

Metric-fine tapered external screw thread

for pipe plugs DIN 906

info





Metric-fine tapered external screw thread is intended to be used for tight joints like pipe plugs, lubricating nipples, etc.
Up to and including M26 no jointing medium is required for oils, other liquids and gases; above an appropriate pressure, tight medium is recommended.
The tapered external thread is normally combined with parallel internal thread according to DIN 158.
The metric-fine tapered external thread is designated by the basic diameter, preceded by the profile letter M and followed by the pitch, separated by an X-mark e.g.: M 20x1,5.

Limits of sizes for tapered external thread, short type

Dimensions in mm

Designation	Pitch P	External thread						gauge length b	useful thread length l_1
		major diameter		pitch diameter		minor diameter			
		d_{max}	d_{min}	d_{2max}	d_{2min}	d_{1max}	d_{1min}		
M 8x1	1	8,093	8,033	7,443	7,383	6,866	6,806	3	4
M 10x1	1	10,093	10,033	9,443	9,383	8,866	8,806	3	4
M 12x1,5	1,5	12,235	12,141	11,261	11,167	10,395	10,301	5,5	7,5
M 14x1,5	1,5	14,235	14,141	13,261	13,167	12,395	12,301	5,5	7,5
M 16x1,5	1,5	16,235	16,141	15,261	15,167	14,395	14,301	5,5	7,5
M 18x1,5	1,5	18,235	18,141	17,261	17,167	16,395	16,301	5,5	7,5
M 20x1,5	1,5	20,235	20,141	19,261	19,167	18,395	18,301	5,5	7,5
M 22x1,5	1,5	22,235	22,141	21,261	21,167	20,395	20,301	5,5	7,5
M 24x1,5	1,5	24,235	24,141	23,261	23,167	22,395	22,301	5,5	7,5
M 30x1,5	1,5	30,235	30,141	29,261	29,167	28,395	28,301	5,5	7,5
M 36x1,5	1,5	36,282	36,156	35,306	35,182	34,442	34,316	6,9	9
M 42x1,5	1,5	42,282	42,156	41,308	41,182	40,442	40,316	6,9	9

STANDARD

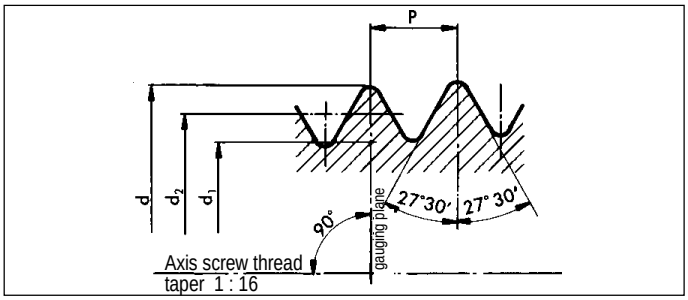
ISO : –
EN : –
DIN : 3858

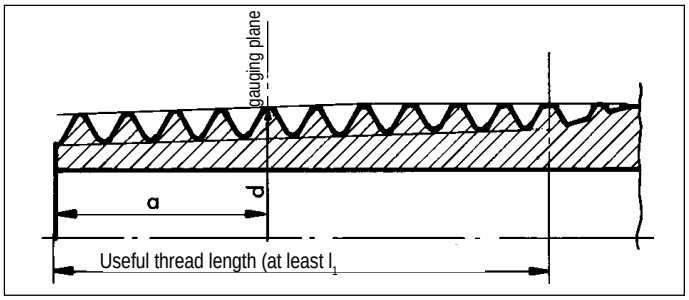
SCREW THREADS

Whitworth tapered external pipe thread-R

for pipe plugs DIN 906

info





Nominal sizes for tapered external thread with tolerance 2 and short type a.

Dimensions in mm

Designation	Number of threads n	Pitch P	External thread				
			major diameter d	pitch diameter d_2	minor diameter d_1	Gauge length a	Useful thread length l_1
$R^1/_8$	28	0,907	9,728	9,147	8,566	3	5,5
$R^1/_4$	19	1,337	13,157	12,301	11,445	4,5	8,2
$R^3/_8$	19	1,337	16,662	15,806	14,950	4,5	8,2
$R^1/_2$	14	1,814	20,955	19,793	18,631	5	10,0
$R^3/_4$	14	1,814	26,441	25,279	24,117	6	11,0
R1	11	2,309	33,249	31,770	30,291	7	13,4
$R1^1/_4$	11	2,309	41,910	40,431	38,952	7,5	13,9
$R1^1/_2$	11	2,309	47,803	46,324	44,845	7,5	13,9

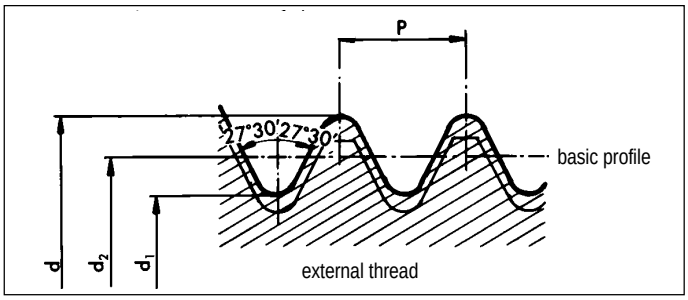
The Whitworth tapered external pipe thread is designated by the profile letter R followed by the nominal diameter in inches e.g.: $R^1/_8$.

STANDARD
ISO : 228 Part 1
EN : –
DIN ISO : 228 part 1

SCREW THREADS

Pipe threads - G, parallel, non pressure-tight

Basic profile and limiting profiles



The bold line indicates the basic profile
P = pitch
n = number of threads per inch

d = major diameter
d_2 = pitch diameter
d_1 = minor diameter
} external thread

D = major diameter
D_2 = pitch diameter
D_1 = minor diameter
} internal thread

Limits of sizes for parallel external pipe threads - G
Dimensions in mm

External thread, class of tolerance A						number of threads	pitch	Internal thread					
Designation	Major diameter		Pitch diameter		minor diameter			Designation	major diameter	pitch diameter		minor diameter	
	d max.	d min.	d_2 max.	d_2 min.	d_1 nom.	n	p		D nom.	D_2 max.	D_2 min.	D_1 max.	D_1 min.
G 1/8 A	9,728	9,514	9,147	9,040	8,566	28	0,907	G 1/8	9,728	9,254	9,147	8,848	8,566
G 1/4 A	13,157	12,907	12,301	12,176	11,445	19	1,337	G 1/4	13,157	12,426	12,301	11,890	11,445
G 3/8 A	16,662	16,412	15,806	15,681	14,950	19	1,337	G 3/8	16,662	15,931	15,806	15,395	14,950
G 1/2 A	20,995	20,671	19,793	19,651	18,631	14	1,814	G 1/2	20,995	19,935	19,793	19,172	18,631
G 5/8 A	22,911	22,627	21,749	21,607	20,587	14	1,814	G 5/8	22,911	21,891	21,749	21,128	20,587
G 3/4 A	26,441	26,157	25,279	25,137	24,117	14	1,814	G 3/4	26,441	25,421	25,279	24,658	24,117
G 7/8 A	30,201	29,917	29,039	28,897	27,877	14	1,814	G 7/8	30,201	29,181	29,039	28,418	27,877
G 1 A	33,249	32,899	31,770	31,590	30,291	11	2,309	G 1	33,249	31,950	31,770	30,931	30,291
G 1 1/8 A	37,897	37,537	36,418	36,238	34,939	11	2,309	G 1 1/8	37,897	36,598	36,418	35,579	34,939
G 1 1/4 A	41,910	41,550	40,431	40,251	38,952	11	2,309	G 1 1/4	41,910	40,611	40,431	39,529	38,952
G 1 1/2 A	47,803	47,443	46,324	46,144	44,845	11	2,309	G 1 1/2	47,803	46,504	46,324	45,485	44,845

Parallel pipe threads - G are intended for the mechanical assembly of the component parts of fittings, cocks and valves, accessories, etc., where pressure-tight joints are not made on the threads.
These threads are designated by the letter G, followed by the nominal size in inches and for external thread followed by the letter A or B of the class of tolerance.
Example: for external thread G 1/2 A and for internal thread G1/2.

STANDARD	BASIC STANDARDS	
ISO : – EN : – DIN : 7975	**Core holes for tapping screws and bolts** with tapping screw thread DIN 7970	info

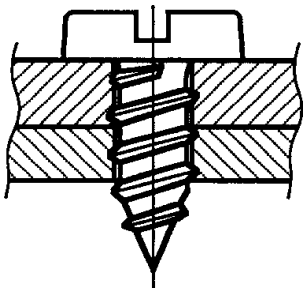
Guidelines for application

- The essential characteristic of tapping screw thread is its capability of forming chipless internal thread in the core hole of the material being joined.
- These core hole data which are theoretically calculated and based on actual tests are valid for fasteners with tapping screw thread to DIN 7970 and only for application in metals with tensile strengths indicated in the tables.
- They cannot be used for plastics. For this application several modifications of tapping screw thread have been developed.
- They are also not applicable in stainless steel. It is not possible to provide any general recommendations per case, tests have to provide the conditions of such joints. The same situation occurs with stainless steel tapping screws.
- Friction coëfficients during screwing-in may be influenced by coatings requiring adaptation of the core holes. The tightening torque is primarily dependent on the friction under the head.
- In sheets with thickness up to 2 mm the holes are usually not drilled but punched. Due to the cold work hardening of the holewall the holes have to be made 0,1 to 0,3 mm larger, depending on material and sheet thickness.
  Ensure that the screw is torqued in the punch direction and not the reverse.
- Tapping screw thread with cone end type C (previously B) is mostly used, especially when with more sheets the pilot point enables the aligning of holes.
- Tapping screw thread with flat end type F (previously BZ) is preferred for use where the running through, sharp point may create problems e.g. injuries.

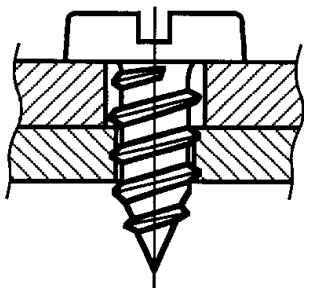
POSSIBILITIES OF APPLICATION

1. Sheet thicknesses not smaller than the pitch of the screw thread.

Simple, most common tapping thread-joints.

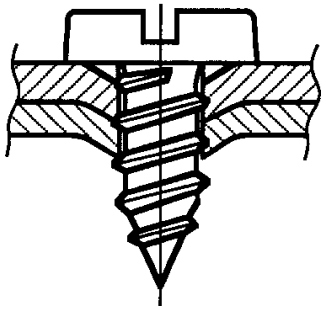


Both sheets are drilled with core hole diameter d_b.

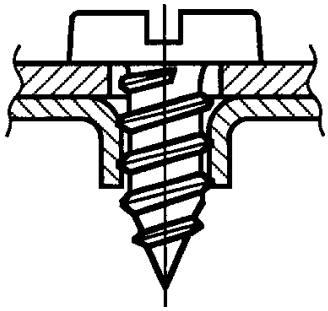


Only the lower sheet is drilled or punched with core hole diameter d_b. The upper sheet has a clearance hole with diameter d_D.

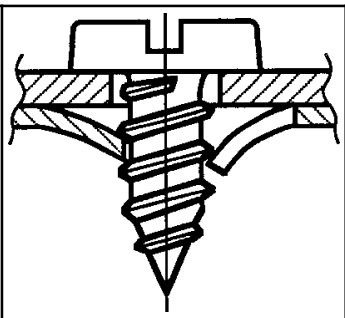
2. Thinner sheet thicknesses



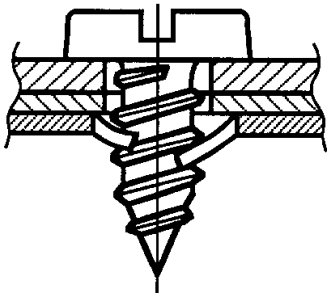
Pierced core hole



Extruded core hole



Presshole-joint (special tool necessary)



Speed nut-joint with clearance holes (for speed nuts see section 12)

For tapping screw thread ST see elsewhere in section 15.
For tapping screws and bolts see sections 6-9-10 and 12.

FABORY

STANDARD	BASIC STANDARDS	
ISO : – EN : – DIN : 7975	**Core holes for tapping screws and bolts** with tapping screw thread DIN 7970	info

GUIDELINES FOR CORE HOLE DIAMETERS d_b [1)]

Core hole diameters for tapping screw thread ST 2,2

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
0,8	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7
0,9	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7
1,0	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,8
1,1	1,7	1,7	1,7	1,7	1,7	1,7	1,7	1,8	1,8
1,2	1,7	1,7	1,7	1,7	1,7	1,7	1,8	1,8	1,8
1,3	1,7	1,7	1,7	1,7	1,7	1,8	1,8	1,8	1,8
1,4	1,7	1,7	1,7	1,7	1,7	1,8	1,8	1,8	1,9
1,5	1,7	1,7	1,7	1,7	1,8	1,8	1,8	1,9	1,9
1,6	1,7	1.7	1,7	1,8	1,8	1,8	1,9	1,9	1,9
1,7	1,7	1,7	1,7	1,8	1,8	1,9	1,9	1,9	1,9
1,8	1,7	1,7	1,8	1,8	1,8	1,9	1,9	1,9	1,9

Core hole diameters for tapping screw thread ST 2,9

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,1	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,3
1,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,3
1,3	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,3	2,3
1,4	2,2	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,4
1,5	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,4	2,4
1,6	2,2	2,2	2,2	2,2	2,3	2,3	2,4	2,4	2,4
1,7	2,2	2,2	2,2	2,2	2,3	2,4	2,4	2,4	2,4
1,8	2,2	2,2	2,2	2,3	2,3	2,4	2,4	2,4	2,5
1,9	2,2	2,2	2,2	2,3	2,4	2,4	2,4	2,5	2,5
2,0	2,2	2,2	2,3	2,3	2,4	2,4	2,5	2,5	2,5
2,2	2,2	2,2	2,3	2,4	2,4	2,5	2,5	2,5	2,5

Core hole diameters for tapping screw thread ST 3,5

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,3	2,6	2,6	2,6	2,6	2,6	2,6	2,7	2,7	2,8
1,4	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,8	2,8
1,5	2,7	2,7	2,7	2,7	2,7	2,7	2,8	2,8	2,9
1,6	2,7	2,7	2,7	2,7	2,7	2,7	2,8	2,9	2,9
1,7	2,7	2,7	2,7	2,7	2,7	2,8	2,8	2,9	2,9
1,8	2,7	2,7	2,7	2,7	2,8	2,8	2,9	2,9	2,9
1,9	2,7	2,7	2,7	2,7	2,8	2,9	2,9	2,9	3,0
2,0	2,7	2,7	2,7	2,8	2,9	2,9	2,9	3,0	3,0
2,2	2,7	2,7	2,8	2,8	2,9	3,0	3,0	3,0	3,0
2,5	2,7	2,7	2,9	2,9	3,0	3,0	3,0	3,1	3,1
2,8	2,7	2,8	2,9	3,0	3,0	3,0	3,1	3,1	3,1

Core hole diameters for tapping screw thread ST 3,9

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,3	2,9	2,9	2,9	2,9	2,9	2,9	3,0	3,0	3,1
1,4	2,9	2,9	2,9	2,9	2,9	3,0	3,1	3,1	3,1
1,5	3,0	3,0	3,0	3,0	3,0	3,0	3,1	3,1	3,2
1,6	3,0	3,0	3,0	3,0	3,0	3,1	3,1	3,2	3,2
1,7	3,0	3,0	3,0	3,0	3,1	3,1	3,2	3,2	3,3
1,8	3,0	3,0	3,0	3,0	3,1	3,2	3,2	3,3	3,3
1,9	3,0	3,0	3,0	3,1	3,2	3,2	3,3	3,3	3,3
2,0	3,0	3,0	3,0	3,1	3,2	3,2	3,3	3,3	3,3
2,2	3,0	3,0	3,1	3,2	3,2	3,3	3,3	3,3	3,4
2,5	3,0	3,0	3,2	3,3	3,3	3,3	3,4	3,4	3,4
2,8	3,0	3,2	3,3	3,3	3,4	3,4	3,4	3,4	3,4
3,0	3,0	3,2	3,3	3,3	3,4	3,4	3,4	3,4	3,5

STANDARD

ISO : –
EN : –
DIN : 7975

BASIC STANDARDS

Core holes for tapping screws and bolts

with tapping screw thread DIN 7970

GUIDELINES FOR CORE HOLE DIAMETERS d_b (CONTINUED) [1)]

Core hole diameters for tapping screw thread ST 4,2

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,4	3,1	3,1	3,1	3,1	3,1	3,1	3,2	3,3	3,4
1,5	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,3	3,4
1,6	3,2	3,2	3,2	3,2	3,2	3,2	3,3	3,4	3,4
1,7	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,4	3,4
1,8	3,2	3,2	3,2	3,2	3,3	3,3	3,4	3,4	3,5
1,9	3,2	3,2	3,2	3,2	3,3	3,4	3,4	3,4	3,5
2,0	3,2	3,2	3,2	3,3	3,4	3,4	3,5	3,5	3,5
2,2	3,2	3,2	3,2	3,3	3,4	3,5	3,5	3,5	3,6
2,5	3,2	3,2	3,4	3,4	3,5	3,5	3,6	3,6	3,6
2,8	3,2	3,3	3,4	3,5	3,6	3,6	3,6	3,6	3,6
3,0	3,2	3,4	3,5	3,5	3,6	3,6	3,6	3,6	3,7
3,5	3,3	3,5	3,6	3,6	3,6	3,7	3,7	3,7	3,7

Core hole diameters for tapping screw thread ST 4,8

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,6	3,6	3,6	3,6	3,6	3,6	3,7	3,8	3,9	3,9
1,7	3,6	3,6	3,6	3,6	3,7	3,8	3,9	3,9	4,0
1,8	3,6	3,6	3,6	3,6	3,8	3,8	3,9	4,0	4,0
1,9	3,6	3,6	3,6	3,7	3,8	3,9	3,9	4,0	4,0
2,0	3,6	3,6	3,6	3,8	3,9	3,9	4,0	4,0	4,1
2,2	3,6	3,6	3,7	3,9	3,9	4,0	4,0	4,1	4,1
2,5	3,6	3,7	3,9	4,0	4,0	4,1	4,1	4,1	4,2
2,8	3,6	3,8	4,0	4,0	4,1	4,1	4,2	4,2	4,2
3,0	3,7	3,9	4,0	4,1	4,1	4,2	4,2	4,2	4,2
3,5	3,8	4,0	4,1	4,2	4,2	4,2	4,2	4,2	4,3
4,0	4,0	4,1	4,2	4,2	4,2	4,2	4,3	4,3	4,3

Core hole diameters for tapping screw thread ST 5,5

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,8	4,2	4,2	4,2	4,2	4,3	4,4	4,5	4,6	4,6
1,9	4,2	4,2	4,2	4,2	4,4	4,5	4,6	4,6	4,7
2,0	4,2	4,2	4,2	4,3	4,4	4,5	4,6	4,6	4,7
2,2	4,2	4,2	4,3	4,4	4,5	4,6	4,7	4,7	4,8
2,5	4,2	4,2	4,4	4,6	4,7	4,7	4,8	4,8	4,8
2,8	4,2	4,4	4,6	4,7	4,7	4,8	4,8	4,8	4,9
3,0	4,2	4,5	4,6	4,7	4,8	4,8	4,8	4,9	4,9
3,5	4,4	4,6	4,7	4,8	4,8	4,9	4,9	4,9	4,9
4,0	4,6	4,7	4,8	4,9	4,9	4,9	4,9	5,0	5,0
4,5	4,7	4,8	4,9	4,9	4,9	4,9	5,0	5,0	5,0

Core hole diameters for tapping screw thread ST 6,3

Sheet thickness s [2)]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
1,8	4,9	4,9	4,9	4,9	5,0	5,2	5,3	5,3	5,4
1,9	4,9	4,9	4,9	5,0	5,1	5,2	5,3	5,4	5,4
2,0	4,9	4,9	4,9	5,1	5,2	5,3	5,4	5,4	5,5
2,2	4,9	4,9	5,0	5,2	5,3	5,4	5,5	5,5	5,6
2,5	4,9	5,0	5,2	5,4	5,4	5,5	5,6	5,6	5,6
2,8	4,9	5,2	5,3	5,5	5,5	5,6	5,6	5,7	5,7
3,0	4,9	5,3	5,4	5,5	5,6	5,6	5,7	5,7	5,7
3,5	5,2	5,4	5,5	5,6	5,7	5,7	5,7	5,7	5,8
4,0	5,3	5,5	5,6	5,7	5,7	5,7	5,8	5,8	5,8
4,5	5,5	5,6	5,7	5,7	5,8	5,8	5,8	5,8	5,8
5,0	5,5	5,7	5,7	5,8	5,8	5,8	5,8	5,8	5,8

FABORY

STANDARD

ISO : –
EN : –
DIN : 7975

BASIC STANDARDS

Core holes for tapping screws and bolts

with tapping screw thread DIN 7970

GUIDELINES FOR CORE HOLE DIAMETERS d_b (CONTINUED) [1]

Core hole diameters for tapping screw thread ST 8

Sheet thickness s [2]	Sheet material Tensile strength R_m N/mm²								
	100	150	200	250	300	350	400	450	500
2,1	6,3	6,3	6,3	6,3	6,5	6,6	6,7	6,8	6,9
2,2	6,3	6,3	6,3	6,5	6,6	6,8	6,8	6,9	7,0
2,5	6,3	6,3	6,5	6,7	6,8	6,9	7,0	7,0	7,1
2,8	6,3	6,4	6,7	6,8	6,9	7,0	7,1	7,1	7,2
3,0	6,3	6,5	6,8	6,9	7,0	7,1	7,1	7,2	7,2
3,5	6,4	6,8	7,0	7,1	7,1	7,2	7,2	7,3	7,3
4,0	6,7	6,9	7,1	7,2	7,2	7,3	7,3	7,3	7,3
4,5	6,8	7,1	7,2	7,2	7,3	7,3	7,3	7,3	7,4
5,0	7,0	7,1	7,2	7,3	7,3	7,3	7,4	7,4	7,4
5,5	7,1	7,2	7,3	7,3	7,3	7,4	7,4	7,4	7,4
6,0	7,1	7,2	7,3	7,3	7,4	7,4	7,4	7,4	7,4
6,5	7,2	7,3	7,3	7,4	7,4	7,4	7,4	7,4	7,4

1) These values of core hole diameters are valid for a simple tapping screw-joint with a clearance hole in the upper sheet and a drilled hole in the lowersheet and for tapping screws without coating.
2) The minimum sheet thickness for every size is equal to the pitch of the tapping screw thread to ensure a sufficiently high tightening torque. The maximum sheet thickness has been chosen in a such a way that the drive-in torque will not exceed 50% of the minimum breaking torque according to DIN 267 Part 12.
   This upper limit is about 0,8 of the nominal diameter e.g. ST 4,2 can used than in a maximum sheet thickness of 0,8 x 4,2 = 3,5 mm.

GUIDELINES FOR THE DIAMETER OF CLEARANCE HOLES

The minimum diameter of clearance holes can be calculated using:

$$d_D = d_1 + {}^1/_3 (d_1 - d_b) \text{ mm}$$

in which: d_D = diameter clearance hole
d_1 = nominal diameter of tapping screw thread
d_b = core hole diameter

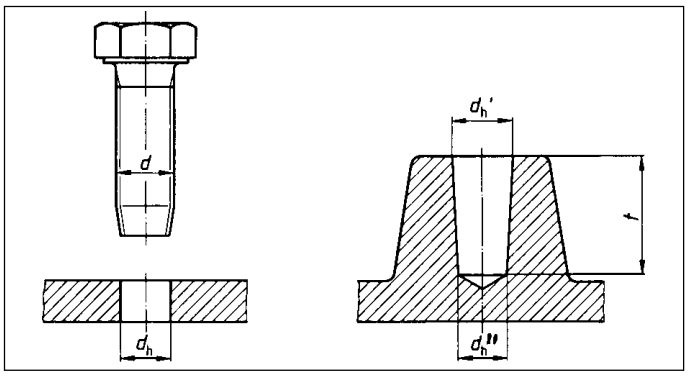
Example:
The minimum diameter of the clearance hole for a tapping screw with ST8 screw thread, material thickness of 4 mm and tensile strength of material being 350N/mm², will be $d_D = 8 + {}^1/_3 (8-7{,}3) = 8{,}23$ mm.

STANDARD

ISO : –
EN : –
DIN : 7500 Part 2

BASIC STANDARDS

Core holes for thread rolling screws in metals (Taptite)



TAPTITE®

For casted holes in Al- and Zn-alloys the core hole diameter is the mean value of d_h' and d_h'' at a hole depth $t \approx 2d$.

GUIDELINES FOR APPLICATION

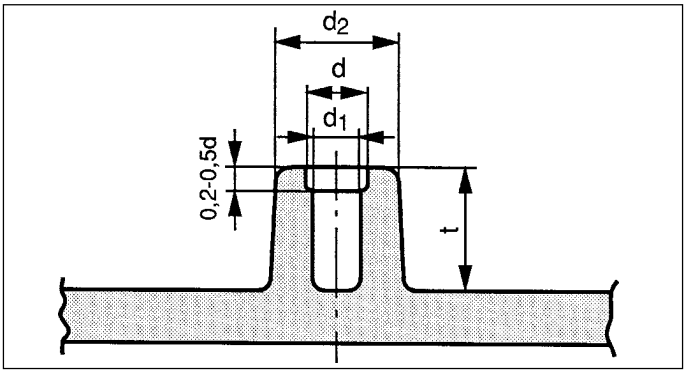
– These core hole diameters are based on actual tests made by manufacturers and users, depending on various materials, material thicknesses or drive-in depths.
These values are for guidance only and, especially, in mass production, it is recommended that one's own tests be carried out in order to achieve an optimal result. The test requirements according to DIN 7500 Part 1 may offer useful assistance.
Manufacturing processes, e.g. punching, which cause cold work hardening of the hole wall, require a somewhat larger hole. The same may be the case with casted holes (harder casting scale).
– Recommended tolerance field for these core holes: H 11 (see elsewhere in this section).
– St=St12 and St37-2 Al=Al99,5F13 and AlMnF10 Cu=E-Cu57F30, E-Cu58F30 and CuZnF38

d	M 2,5			M 3			M 3,5			M 4			M 5			M 6			M 8			M 10		
material thickness or drive-in depth	hole diameter d_h																							
	St	Al	Cu	St	Al	Cu	St	Al	Cu	St	Al	Cu	St	Al	Cu	St	Al	Cu	St	Al	Cu	St	Al	Cu
0,8		2,25																						
0,9		2,25																						
1		2,25			2,7																			
1,2		2,25			2,7			3,15																
1,5		2,25			2,7			3,15			3,6			4,5										
1,6		2,25			2,7			3,2			3,6			4,5										
1,7		2,25			2,7			3,2			3,6			4,5										
1,8		2,25		2,75	2,7			3,2			3,6			4,5										
2		2,25		2,75	2,7			3,2			3,6			4,5			5,4							
2,2		2,25			2,75			3,2			3,6			4,5			5,4			7,25				
2,5		2,25			2,75			3,2		3,65	3,6			4,5			5,4			7,25		9,2		
3		2,3			2,75			3,2		3,65	3,6			4,5			5,45			7,25		9,2	9,15	
3,2		2,3			2,75			3,2		3,65	3,6		4,55	4,5			5,45			7,25		9,2	9,15	
3,5		2,3			2,75			3,2			3,65			4,55			5,45			7,25		9,2	9,15	
4		2,3			2,75			3,2			3,65			4,55		5,5	5,45			7,3		9,3	9,15	
5		2,3			2,75		3,2	3,25		3,7	3,65			4,6		5,5	5,45		7,4	7,3		9,3	9,2	9,25
5,5					2,75		3,2	3,25		3,7	3,65			4,6			5,5		7,4	7,3		9,3	9,2	9,25
6					2,75					3,7	3,65			4,6			5,5		7,4	7,3		9,3	9,2	9,25
6,3											3,7			4,65			5,5		7,4	7,35		9,3	9,2	9,25
6,5											3,7			4,65			5,5		7,4	7,35		9,3	9,2	9,25
7											3,7			4,65		5,55	5,5		7,5	7,4		9,3	9,2	9,3
7,5											3,7			4,65		5,55	5,5		7,5	7,4		9,4	9,3	
8 ≤ 10														4,65			5,55		7,5	7,4		9,4	9,3	
> 10 ≤ 12																				7,5		9,5	9,4	
> 12 ≤ 15																				7,5		9,5	9,4	
> 15 ≤ 20																							9,5	

TAPTITE® is the registered trademark of Research Engineering & Manufacturing Inc.

FABORY

STANDARD	BASIC STANDARDS	
ISO : – EN : – DIN : –	**Core holes for thread rolling screws in plastics (Plastite)**	info



PLASTITE® 45°

The geometry of the boss has in principle to be in conformance with the picture.

GUIDELINES FOR APPLICATION

– These core hole diameters are based on actual tests using various types of plastic.
These values are for guidance only and, especially in mass production, it is recommended that one's own tests be carried out in order to achieve an optimal result.
– The values of the drive-in depth are minimum and if possible, do not go below these values.

Type of plastic	PP, POM, PA6, SAN, PBTP, PE, PTFE			ASA, ABS, SB, PA3OGV, POM3O, PS			PC, PPO, EP, PMMA		
Screw size mm	Core hole Ø d1 mm	Drive-in Ø d2 mm	Drive-in depth t min. mm	Core hole Ø d1 mm	Drive-in Ø d2 mm	Drive-in depth t min. mm	Core hole Ø d1 mm	Drive-in Ø d2 mm	Drive-in depth t min. mm
2 x 1,35	1,45	4	4	1,50	4	3,5	1,60	4,5	4,5
2,5 x 140	1,90	5	5	2,00	5	4,5	2,10	6	5,5
3 x 1,50	2,35	6	6	2,45	6	5,5	2,55	7	6,5
3,5 x 1,65	2,80	7	7	2,90	7	6	3,05	8,5	7,5
4 x 1,75	3,25	8	8	3,40	8	7	3,50	9,5	8,5
5 x 2,20	3,85	10	10	4,05	10	8,5	4,20	12	11
6 x 2,50	4,70	12	12	4,90	12	10,5	5,10	14,5	13
8 x 3,00	6,60	16	16	6,80	16	14	7,00	19,5	17

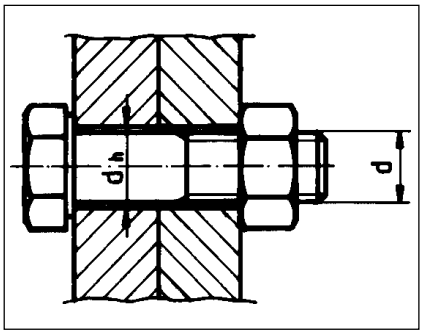
STANDARD

ISO : 273
EN : 20273
DIN : –

BASIC STANDARDS

Clearance holes

for fasteners with screw thread



– As tolerance field for the hole the following is recommended:
fine series : H 12
medium series : H 13
coarse series : H 14
} according to ISO system of limits and fits. See elsewhere in this section

– In cases where it is necessary to avoid interference between the edge of the hole and the underhead fillet of the bolt, chamfering of the hole is recommended.

1. Clearance holes for metric screw thread
Dimensions in mm

thread diameter d	clearance hole d_h series		
	fine	medium	coarse
1	1,1	1,2	1,3
1,2	1,3	1,4	1,5
1,4	1,5	1,6	1,8
1,6	1,7	1,8	2
1,8	2	2,1	2,2
2	2,2	2,4	2,6
2,5	2,7	2,9	3,1
3	3,2	3,4	3,6
3,5	3,7	3,9	4,2
4	4,3	4,5	4,8
4,5	4,8	5	5,3
5	5,3	5,5	5,8
6	6,4	6,6	7
7	7,4	7,6	8
8	8,4	9	10
10	10,5	11	12
12	13	13,5	14,5
14	15	15,5	16,5
16	17	17,5	18,5
18	19	20	21
20	21	22	24
22	23	24	26
24	25	26	28
27	28	30	32
30	31	33	35

thread diameter d	clearance hole d_h series		
	fine	medium	coarse
33	34	36	38
36	37	39	42
39	40	42	45
42	43	45	48
45	46	48	52
48	50	52	56
52	54	56	62
56	58	62	66
60	62	66	70
64	66	70	74
68	70	74	78
72	74	78	82
76	78	82	86
80	82	86	91
85	87	91	96
90	93	96	101
95	98	101	107
100	104	107	112
105	109	112	117
110	114	117	122
115	119	122	127
120	124	127	132
125	129	132	137
130	134	137	144
140	144	147	155
150	155	158	165

2. Clearance holes for unified and Whitworth screw thread
Dimensions in mm, unless given in inches.

thread diameter d	clearance hole d_h series		
	fine	medium	coarse
1/8	3,4	3,6	3,8
5/33	4,3	4,5	4,8
3/16	5,1	5,3	5,6
1/4	6,7	7	7,4
5/16	8,3	8,8	9,5
3/8	10	10,5	11,5
7/16	12	13	14
1/2	13,5	15	16
9/16	15	16	17
5/8	17	18	19
3/4	20	22	23
7/8	23	25	26
1	27	28	30
1 1/8	30	32	34
1 1/4	33	35	37
1 3/8	36	38	40

thread diameter d	clearance hole d_h series		
	fine	medium	coarse
1 1/2	39	41	44
1 3/4	46	48	52
2	53	55	60
2 1/4	60	62	67
2 1/2	66	69	74
2 3/4	72	76	80
3	78	82	86
3 1/4	85	88	95
3 1/2	92	95	103
3 3/4	98	101	110
4	105	108	115
4 1/2	118	121	128
5	130	133	141
5 1/2	144	147	155
6	157	160	168

FABORY

STANDARD

ISO : 4753
EN : –
DIN : 78

BASIC STANDARDS

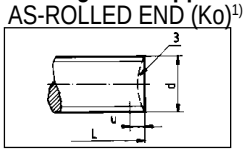
Thread ends and length of projection of bolt ends

for bolts and screws with metric (ISO) screw thread

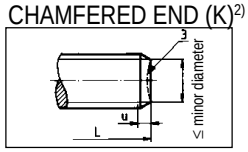
info

1 Thread ends for general applications

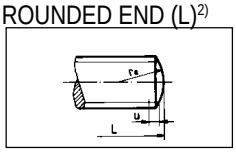
AS-ROLLED END (Ko)[1)]



CHAMFERED END (K)[2)]



ROUNDED END (L)[2)]

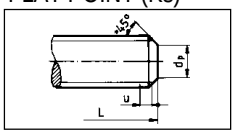


L = nominal length
u = max. 2P (incomplete thread)
$r_e \approx 1{,}4d$

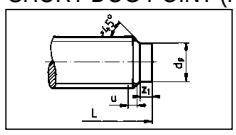
1) This is the normal thread end for screws with rolled thread e.g. slotted screws without a special requirement.
2) The designation K or L is only necessary when a special form is required. Generally the designation of a chamfered end is sufficient.
3) A hollowing due to thread rolling is permissable.

2 Thread ends for special spplications

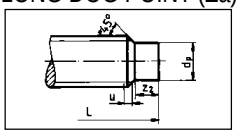
FLAT POINT (Ks)



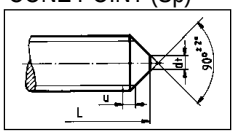
SHORT DOG POINT (Ka)



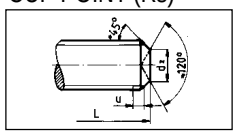
LONG DOG POINT (Za)



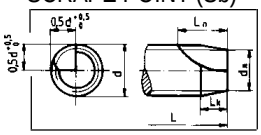
CONE POINT (Sp)



CUP POINT (Rs)



SCRAPE POINT (Sb)

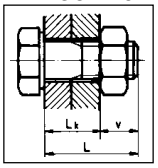


$L_n = d \pm 0{,}5$ mm
$L_k = 0{,}5 \pm 0{,}5$ mm
$dn = d - 1{,}6\ P$

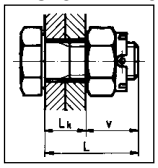
Nominal size d	Pitch P	d_h H13	d_p h13[1)]	d_t[2)] h16	d_z h14	z_1 + IT14	z_2 + IT14	z_3 + IT14	z_4 ≈	z_5 ≈	W min.
1	0,25	-	0,5	-	-	-	0,5	-	-	-	-
1,2	0,25	-	0,6	-	-	-	0,6	-	-	-	-
1,4	0,3	-	0,7	-	0,7	0,35	0,7	-	-	-	-
1,6	0,35	-	0,8	-	0,8	0,4	0,8	-	-	-	-
1,8	0,35	-	0,9	-	0,9	0,45	0,9	-	-	-	-
2	0,4	0,6	1	-	1	0,5	1	0,5	0,25	0,4	0,7
2,2	0,45	0,6	1,2	-	1,1	0,55	1,1	0,55	0,3	0,5	0,8
2,5	0,45	0,6	1,5	-	1,2	0,63	1,25	0,63	0,35	0,6	0,9
3	0,5	0,6	2	-	1,4	0,75	1,5	0,75	0,4	0,8	1,2
3,5	0,6	0,8	2,2	-	1,7	0,88	1,75	0,88	0,45	0,9	1,2
4	0,7	0,8	2,5	-	2	1	2	1	0,5	1	1,5
4,5	0,75	0,8	3	-	2,2	1,12	2,25	1,12	0,55	1,25	1,8
5	0,8	1	3,5	-	2,5	1,25	2,5	1,25	0,6	1,5	2
6	1	1	4	1,5	3	1,5	3	1,5	0,7	1,75	2,5
7	1	1,2	5	2	4	1,75	3,5	1,75	0,8	2,25	2,5
8	1,25	1,6	5,5	2	5	2	4	2	1	2,5	3
10	1,5	2	7	2,5	6	2,5	5	2,5	1	3	3,5
12	1,75	2,5	8,5	3	8	3	6	3	1,25	3,5	4
14	2	3,2	10	4	9	3,5	7	3,5	1,5	4	4,5
16	2	3,2	12	4	10	4	8	4	1,75	4,5	5
18	2,5	4	13	5	12	4,5	9	4,5	2	4,5	6
20	2,5	4	15	5	14	5	10	5	2	5	7
22	2,5	4	17	6	16	5,5	11	5,5	2,5	6	8
24	3	5	18	6	16	6	12	6	2,5	6	9
27	3	5	21	8	-	6,7	13,5	6,7	3	7	10
30	3,5	5	23	8	-	7,5	15	7,5	3	8	11
33	3,5	6,3	26	10	-	8,2	16,5	8,2	3,5	9	12
36	4	6,3	28	10	-	9	18	9	4	10	12
39	4	8	30	12	-	9,7	19,5	9,7	4	11	12
42	4,5	8	32	12	-	10,5	21	10,5	4,5	12	13
45	4,5	8	35	14	-	11,2	22,5	11,2	5	12	14
48	5	8	35	14	-	11,2	22,5	11,2	5	12	14
52	5	8	42	16	-	13	26	13	5	12	16

3 Length of projection of bolt ends V (examples)

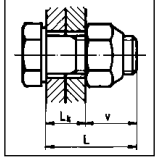
HEXAGON NUT



HEX.SLOTTED NUT



PREV. TORQUE NUT



[1)] In ISO 4753 tolerancefield h14 has been indicated
[2)] up to and including 5 mm the conepoint may be flattened or rounded

- hexagon and slotted (castle) nuts : v = nut height + 2P
- prevailing torque nuts : v = nut height + 3P
- nominal length L = griplength L_k + projection length v.
  The calculated values have to be rounded off to the next larger standardised length.

STANDARD

ISO : 3508-4755
EN : –
DIN : 76

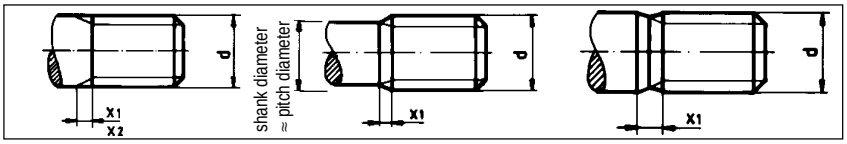
BASIC STANDARDS

Run-out and undercut

for fasteners with metric (ISO) screw thread

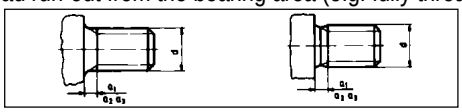
1 External thread

thread run-out



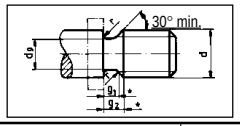
x_1 normal
x_2 short

distance thread run-out from the bearing area (e.g. fully threaded screws)



a_1 normal
a_2 short
a_3 long

thread undercut



type A normal
type B short
* g_1 previously f_1
g_2 previously f_2

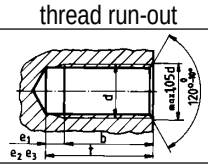
Pitch	Nominal size	Run-out		Distance			Undercut					
P	d	x_1 max.	x_2 max.	a_1 max.	a_2 max.	a_3	d_g	g^1 min. A	g^1 min. B	g^2 max. A	g^2 max. B	r ≈
		norm [1]	short [2]	norm [3]	short [4]	long [5]	h13 [6]	norm [7]	short [8]	norm [7]	short [8]	
0,2	-	0,5	0,25	0,6	0,4	-	d-0,3	0,45	0,25	0,7	0,5	0,1
0,25	1; 1,2	0,6	0,3	0,75	0,5	-	d-0,4	0,55	0,25	0,9	0,6	0,12
0,3	1,4	0,75	0,4	0,9	0,6	-	d-0,5	0,6	0,3	1,05	0,75	0,16
0,35	1,6; 1,7; 1,8	0,9	0,45	1,05	0,7	-	d-0,6	0,7	0,4	1,2	0,9	0,16
0,4	2; 2,3	1	0,5	1,2	0,8	-	d-0,7	0,8	0,5	1,4	1	0,2
0,45	2,2; 2,5; 2,6	1,1	0,6	1,35	0,9	-	d-0,7	1	0,5	1,6	1,1	0,2
0,5	3	1,25	0,7	1,5	1	-	d-0,8	1,1	0,5	1,75	1,25	0,2
0,6	3,5	1,5	0,75	1,8	1,2	-	d-1	1,2	0,6	2,1	1,5	0,4
0,7	4	1,75	0,9	2,1	1,4	-	d-1,1	1,5	0,8	2,45	1,75	0,4
0,75	4,5	1,9	1	2,25	1,5	-	d-1,2	1,6	0,9	2,6	1,9	0,4
0,8	5	2	1	2,4	1,6	3,2	d-1,3	1,7	0,9	2,8	2	0,4
1	6; 7	2,5	1,25	3	2	4	d-1,6	2,1	1,1	3,5	2,5	0,6
1,25	8	3,2	1,6	3,75	2,5	5	d-2	2,7	1,5	4,4	3,2	0,6
1,5	10	3,8	1,9	4,5	3	6	d-2,3	3,2	1,8	5,2	3,8	0,8
1,75	12	4,3	2,2	5,25	3,5	7	d-2,6	3,9	2,1	6,1	4,3	1
2	14; 16	5	2,5	6	4	8	d-3	4,5	2,5	7	5	1
2,5	18; 20; 22	6,3	3,2	7,5	5	10	d-3,6	5,6	3,2	8,7	6,3	1,2
3	24; 27	7,5	3,8	9	6	12	d-4,4	6,7	3,7	10,5	7,5	1,6
3,5	30; 33	9	4,5	10,5	7	14	d-5	7,7	4,7	12	9	1,6
4	36; 39	10	5	12	8	16	d-5,7	9	5	14	10	2
4,5	42; 45	11	5,5	13,5	9	18	d-6,4	10,5	5,5	16	11	2
5	48; 52	12,5	6,3	15	10	20	d-7	11,5	6,5	17,5	12,5	2,5
5,5	56; 60	14	7	16,5	11	22	d-7,7	12,5	7,5	19	14	3,2
6	64; 68	15	7,5	18	12	24	d-8,3	14	8	21	15	3,2
The dimensions are ≈		2,5P	1,25P	3P	2P	4P	-	-	-	3,5P	2,5P	0,5P

1) x_1 always applicable, unless otherwise specified
2) x_2 only to be used when technically necessary
3) a_1 always applicable, unless otherwise specified
4) a_2 for slotted and recessed screws and when technically necessary
5) a_3 only for product class C (previously coarse)
6) tolerance field h 12 up to and including M3
7) undercut type A always applicable, unless otherwise specified
8) undercut type B only to be used when technically necessary

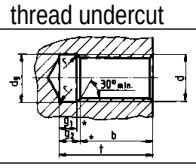
For metric-fine, screw thread run-outs are based on the pitch.

2 Internal thread

thread run-out



thread undercut



e_1 normal
e_2 short
e_3 long
} thread run-out

type C normal
type D short
* g_1 previously f_1
g_2 previously f_2
} thread undercut

Pitch	Nominal size	Thread run-out			Thread undercut					
P	d	e_1	e_2 For guidance	e_3	d_g	g_1 min. C	g_1 min. D	g_2 max. C	g_2 max. D	r ≈
		normal [1]	short [2]	long [3]	H13	norm [4]	short [5]	norm [4]	short [5]	
0,2	-	1,3	0,8	2	d+0,1	0,8	0,5	1,2	0,9	0,1
0,25	1; 1,2	1,5	1	2,4	d+0,1	1	0,6	1,4	1	0,12
0,3	1,4	1,8	1,2	2,9	d+0,1	1,2	0,75	1,6	1,25	0,16
0,35	1,6; 1,7; 1,8	2,1	1,3	3,3	d+0,2	1,4	0,9	1,9	1,4	0,16
0,4	2; 2,3	2,3	1,5	3,7	d+0,2	1,6	1	2,2	1,6	0,2
0,45	2,2; 2,5; 2,6	2,6	1,6	4,1	d+0,2	1,8	1,1	2,4	1,7	0,2
0,5	3	2,8	1,8	4,5	d+0,3	2	1,25	2,7	2	0,2
0,6	3,5	3,4	2,1	5,4	d+0,3	2,4	1,5	3,3	2,4	0,4
0,7	4	3,8	2,4	6,1	d+0,3	2,8	1,75	3,8	2,75	0,4
0,75	4,5	4	2,5	6,4	d+0,3	3	1,9	4	2,9	0,4
0,8	5	4,2	2,7	6,8	d+0,3	3,2	2	4,2	3	0,4
1	6; 7	5,1	3,2	8,2	d+0,5	4	2,5	5,2	3,7	0,6
1,25	8	6,2	3,9	10	d+0,5	5	3,2	6,7	4,9	0,6
1,5	10	7,3	4,6	11,6	d+0,5	6	3,8	7,8	5,6	0,8
1,75	12	8,3	5,2	13,3	d+0,5	7	4,3	9,1	6,4	1
2	14; 16	9,3	5,8	14,8	d+0,5	8	5	10,3	7,3	1
2,5	18; 20; 22	11,2	7	17,9	d+0,5	10	6,3	13	9,3	1,2
3	24; 27	13,1	8,2	21	d+0,5	12	7,5	15,2	10,7	1,6
3,5	30; 33	15,2	9,5	24,3	d+0,5	14	9	17,7	12,7	1,6
4	36; 39	16,8	10,5	26,9	d+0,5	16	10	20	14	2
4,5	42; 45	18,4	11,5	29,4	d+0,5	18	11	23	16	2
5	48; 52	20,8	13	33,3	d+0,5	20	12,5	26	18,5	2,5
5,5	56; 60	22,4	14	35,8	d+0,5	22	14	28	20	3,2
6	64; 68	24	15	38,4	d+0,5	24	15	30	21	3,2
The dimensions are ≈		6,3-4P	4-2,5P	10-6,3P	-	4P	2,5P	-	-	0,5P

1) e_1 always applicable, unless otherwise specified
2) e_2 only to be used when a short run-out is technically necessary
3) e_3 only to be used when a long run-out is technically necessary
4) undercut type C always applicable, unless otherwise specified
5) undercut type D only to be used when technically necessary

For metric-fine, screw thread run-outs are based on the pitch.

FABORY

STANDARD

ISO : 286
EN : –
DIN ISO : 286

BASIC STANDARDS

Tolerance grades and tolerance fields

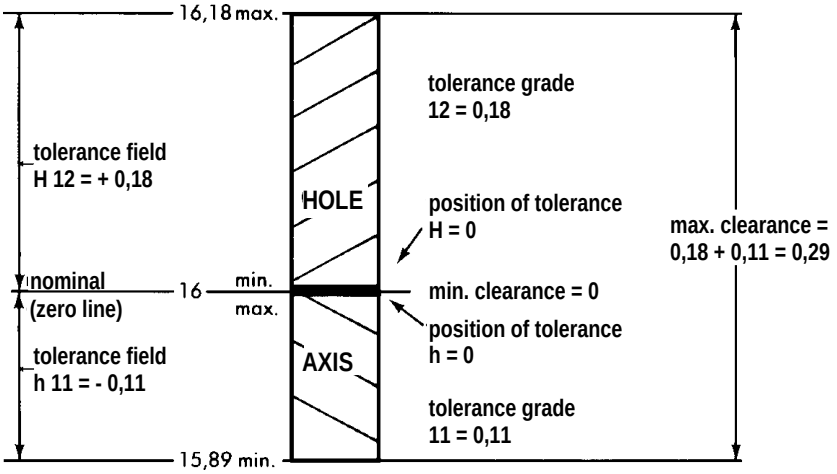
according to ISO system of limits and fits

Tolerance grades and tolerance fields for external and internal dimensions
DIMENSIONS IN mm

NOMINAL DIMENSION	TOLERANCE GRADES							TOLERANCE FIELDS (fundamental deviations)																				
								EXTERNAL DIMENSIONS																	INTERNAL DIMENSIONS				
	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16	IT 17	b 13	h9	h 10	h 11	h 12	h 13	h 14	h15	h 16	h 17	js 14	js 15	js 16	js 17	m 6	D 12	H 11	H 12	H 13	H 14
up to and including 3	0,06	0,10	0,14	0,25	0,40	0,60	1,00[1]	–	0 - 0,025	0 - 0,04	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]	+ 0,009 + 0,002	+ 0,12 + 0,02	+ 0,06 0	+ 0,10 0	+ 0,14 0	+ 0,25 0
above 3 up to and including 6	0,075	0,12	0,18	0,30	0,48	0,75	1,20[1]	- 0,14 - 0,32	0 - 0,03	0 - 0,048	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]	+ 0,012 + 0,004	+ 0,15 + 0,03	+ 0,075 0	+ 0,12 0	+ 0,18 0	+ 0,30 0
above 6 up to and including 10	0,09	0,15	0,22	0,36	0,58	0,90	1,50	- 0,15 - 0,37	0 - 0,036	0 - 0,058	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	+ 0,015 + 0,006	+ 0,19 + 0,04	+ 0,09 + 0	+ 0,15 0	+ 0,22 0	+ 0,36 0
above 10 up to and including 18	0,11	0,18	0,27	0,43	0,70	1,10	1,80	- 0,15 - 0,42	0 0,043	0 - 0,07	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	+ 0,018 + 0,007	+ 0,23 + 0,05	+ 0,11 0	+ 0,18 0	+ 0,27 0	+ 0,43 0
above 18 up to and including 30	0,13	0,21	0,33	0,52	0,84	1,30	2,10	- 0,16 - 0,49	0 0,052	0 - 0,084	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	+ 0,021 + 0,008	+ 0,275 + 0,065	+ 0,13 0	+ 0,21 0	+ 0,33 0	+ 0,52 0
above 30 up to and including 40	0,16	0,25	0,39	0,62	1,00	1,60	2,50	- 0,17 - 0,56	0 - 0,062	0 - 0,10	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	+ 0,025 + 0,009	+ 0,33 + 0,08	+ 0,16 0	+ 0,25 0	+ 0,39 0	+ 0,62 0
above 40 up to and including 50								- 0,18 - 0,57																				
above 50 up to and including 80	0,19	0,30	0,46	0,74	1,20	1,90	3,00	–	0 - 0,074	0 - 0,12	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	+ 0,030 + 0,011	+ 0,40 + 0,10	+ 0,19 0	+ 0,30 0	+ 0,46 0	+0,74 0
above 80 up to and including 120	0,22	0,35	0,54	0,87	1,40	2,20	3,50	–	0 - 0,087	0 - 0,14	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	+ 0,035 + 0,013	+ 0,47 + 0,12	+ 0,22 0	+ 0,35 0	+ 0,54 0	+ 0,87 0
above 120 up to and including 180	0,25	0,40	0,63	1,00	1,60	2,50	4,00	–	0 0,10	0 - 0,16	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	+ 0,040 + 0,015	+ 0,545 + 0,145	+ 0,25 0	+ 0,40 0	+ 0,63 0	+ 1,00 0
above 180 up to and including 250	0,29	0,46	0,72	1,15	1,85	2,90	4,60	–	0 0,115	0 - 0,185	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	+ 0,046 + 0,017	+ 0,63 + 0,17	+ 0,29 0	+ 0,46 0	+ 0,72 0	+ 1,15 0
above 250 up to and including 315	0,32	0,52	0,81	1,30	2,10	3,20	5,20	–	0 0,13	0 - 0,21	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	+ 0,052 + 0,020	+ 0,71 + 0,19	+ 0,32 0	+ 0,52 0	+ 0,81 0	+ 1,30 0
above 315 up to and including 400	0,36	0,57	0,89	1,40	2,30	3,60	5,70	–	0 - 0,14	0 - 0,23	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	+ 0,057 + 0,021	+ 0,78 + 0,21	+ 0,36 0	+ 0,57 0	+ 0,89 0	+ 1,40 0
above 400 up to and including 500	0,40	0,63	0,97	1,55	2,50	4,00	6,30	–	0 - 0,155	0 - 0,25	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	+ 0,063 + 0,023	+ 0,86 + 0,23	+ 0,40 0	+ 0,63 0	+ 0,97 0	+ 1,55 0

- The **NOMINAL DIMENSION** is the dimension expressing the numerical value of an external or internal size. Example: the width across flats s of a M 16 hexagon bolt = 24 mm nominal.
- The **TOLERANCE GRADE** characterises the processing quality. The magnitude of the tolerance of each grade is dependent on the nominal dimension. The designation of the International Tolerance Grades (IT) is given by numerals for the quality, preceded by the letters IT. Example: for tolerance grade IT 13 and a nominal dimension of 24 mm the tolerance between the upper and lower limit = 0,33 mm.
- The **TOLERANCE FIELD** is the graphical representation of the area between the two limits of tolerance of the external or internal dimension. The tolerance field is defined by its position in relation to the zero line and the magnitude of its tolerance grade. The designation is a combination of a letter for the position of the tolerance, followed by a number for the tolerance grade. For external dimensions, small letters and for internal dimensions capitals are used. Example: a shaft with a diameter 10h14 may deviate between maximum 10,0 and minimum 10 - 0,36 = 9,64 mm, a hole with a diameter 51D12 between maximum 51 + 0,40 = 51,4 and minimum 51 + 0,10 = 51,1mm.
- The **FIT** between an internal and external dimension results by joining together the designation of the tolerance field of the internal dimension followed by that of the external dimension separated by a slash. Example: the fit 16H12/h11 expresses that the hole of 16 mm nominal has a tolerance field H12 and may deviate between 16,0 mm minimum and 16 + 0,18 = 16,18 mm maximum and that the shaft of 16 mm nominal and a tolerance field h11 may deviate between 16,0 maximum and 16 - 0,11 = 15,89 mm minimum.
  In fact the fit is characterised by the clearance between shaft and hole and is in this case minimum 0 mm and maximum 0,18 + 0,11 = 0,29 mm.

graphical representation of the fit 16 H 12/h11 with limits of tolerances



As opposed to the designation of shafts and holes, the fit of screw thread is designated by placing the number of the tolerance grade not after but before the letter of the tolerance field e.g. 6H/6g. This is the class of fit "medium", which is most used for commercial fasteners. The fit 6H/6g has always a minimum clearance which can be utilized for applying a corrosion resistant coating without risking that the nut will not match onto the bolt (see also "surface coatings" elsewhere in this section).

STANDARD

ISO : 2306
EN : –
DIN : –
NEN : NPR 3189

BASIC STANDARDS

Drill sizes for tapping of screw thread

GENERAL NOTES

– These drill sizes are guide values for the manufacturing of core holes for tapping of screw thread. Manufacturing can be done by drilling or otherwise.
– The tolerance limits of the screw thread (see "screw thread" elsewhere in this section) may not be exceeded. Depending on material, tools and manufacturing method it may be necessary to deviate from these guide values and to verify these by one's own tests.
– For metric and unified screw thread (ISO-profile) in principle the following formula is valid:
drill size = nominal screw thread size - pitch, if necessary rounded off.

Metric (ISO) screw thread - coarse - M

Screw thread size	Drill size	Screw thread size	Drill size	Screw thread size	Drill size	Screw thread size	Drill size	Screw thread size	Drill size	Screw thread size	Drill size
M1	0,75	M2,2	1,75	M 6	5	M14	12	M30	26,5	M52	47
M1,1	0,85	M2,5	2,05	M 7	6	M16	14	M33	29,5	M56	50,5
M1,2	0,95	M3	2,5	M 8	6,8	M18	15,5	M36	32	M60	54,5
M1,4	1,1	M3,5	2,9	M 9	7,8	M20	17,5	M39	35	M64	58
M1,6	1,25	M4	3,3	M10	8,5	M22	19,5	M42	37,5	M68	62
M1,8	1,45	M4,5	3,7	M11	9,5	M24	21	M45	40,5		
M2	1,6	M5	4,2	M12	10,2	M27	24	M48	43		

Metric (ISO) screw thread - fine - MF

Screw thread size x pitch	Drill size	Screw thread size x pitch	Drill size	Screw thread size x pitch	Drill size	Screw thread size x pitch	Drill size	Screw thread size x pitch	Drill size	Screw thread size x pitch	Drill size
M3 x 0,35	2,65	M 5 x 0,5	4,5	M10 x 1,25	8,8	M14 x 1,5	12,5	M20 x 1,5	18,5	M24 x 1,5	22,5
M3,5x 0,35	3,15	M 6 x 0,75	5,2	M12 x 1	11	M16 x 1,5	14,5	M20 x 2	18	M24 x 2	22
M4 x 0,5	3,5	M 8 x 1	7	M12 x 1,25	10,8	M18 x 1,5	16,5	M22 x 1,5	20,5	M27 x 1,5	25,5
M4,5x 0,5	4	M10 x 1	9	M12 x 1,5	10,5	M18 x 2	16	M22 x 2	20	M27 x 2	25

Unified (ISO) screw thread - coarse - UNC

Screw thread size x threads/inch	Drill size	Screw thread size x threads/ininch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size
1/4 x 20	5,1	7/16 x 14	9,4	5/8 x 11	13,5	1 x 8	22,25	1 3/8 x 6	30,75	2 x 4 1/2	45
5/16 x 18	6,6	1/2 x 13	10,8	3/4 x 10	16,5	1 1/8 x 7	25	1 1/2 x 6	34	2 1/4 x 4 1/2	51,5
3/8 x 16	8	9/16 x 12	12,2	7/8 x 9	19,5	1 1/4 x 7	28	1 3/4 x 5	39,5	2 1/2 x 4	57

Unified (ISO) screw thread fine - UNF

Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size
1/4 x 28	5,5	7/16 x 20	9,9	5/8 x 18	14,5	1 x 12	23,25	1 3/8 x 12	32,75
5/16 x 24	6,9	1/2 x 20	11,5	3/4 x 16	17,5	1 1/8 x 12	26,5	1 1/2 x 12	36
3/8 x 24	8,5	9/16 x 18	12,9	7/8 x 14	20,4	1 1/4 x 12	29,5		

Whitworth parallel external pipe thread - G acc. to DIN ISO 228

Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size	Screw thread size x threads/inch	Drill size
G 1/8 x 28	8,8	G 3/8 x 19	15,25	G 5/8 x 14	21	G 7/8 x 14	28,25	G 1 1/8 x 11	35,3	G 1 1/2 x 11	45
G 1/4 x 19	11,8	G 1/2 x 14	19	G 3/4 x 14	24,5	G 1 x 11	30,75	G 1 1/4 x 11	39,5	G 1 3/4 x 11	51

FABORY

STANDARD

ISO : 272
EN : –
DIN ISO : 272

BASIC STANDARDS

New widths across flats acc. to ISO

Widths across flats
The widths across flats of some hexagon bolts and nuts will change in the future due to the worldwide standardisation ISO.
The introduction will take place gradually and concerns only M10 - M12 - M14 and M22.

Comparison old and new widths across flats

Nominal size		M10	M12	M14	M22
Current width across flats	mm	17	19	22	32
New widths across flats acc. to DIN ISO 272	mm	16	18	21	34

In the following table all hexagon fasteners which will change from the DIN-standards to the new DIN ISO standards have been included.

Comparison of DIN-standards and ISO (DIN ISO) standards

	DIN	ISO and DIN ISO
Hexagon bolts	931 Part 1	4014
	601	4016
	933	4017
	558	4018
Hexagon nuts coarse pitch	934	4032
	555	4034
	439B	4035
Hexagon nuts fine pitch	934	8673
	439B	8675

STANDARD
DIN : 267 Part 9
ISO : 4042
ANSI : –

SURFACE COATINGS

Electroplated coatings

1. Scope and field of application
These technical conditions are in particular related to threaded fasteners (mainly bolts and nuts), but are also applicable to the whole range of mechanical fasteners.

2. Electroplated coatings
An electrolytically applied coating shall be defined as a protective metallic layer being deposited onto the surface of metal articles by immersing these parts in an aqueous solution through which an electrical current is passed.
Note: The use of the nomenclature "galvanizing" for this treatment is not correct.
This information on electroplated coatings corresponds with DIN 267 Part 9 and ISO 4042.

3. Code system
The electroplated coatings of mechanical fasteners are designated by a code consisting of a combination of two capitals and a number.
This system is built up as follows: – a capital for the coating metal (table 1)
– a number for the minimum layer thickness (coating structure) (table 2)
– a capital for the degree of gloss and after-treatment (table 3)

Table 1. **Coating metal**

Code letter	Coating metal	Symbol
A	Zinc	Zn
B	Cadmium	Cd
C	Copper	Cu
D	Brass	CuZn
E	Nickel	Ni
F	Nickel-chrome [1])	NiCr
G	Copper-nickel	CuNi
H	Copper-nickel-chrome [1])	CuNiCr
J	Tin	Sn
K	Copper-tin	CuSn
L	Silver	Ag
N	Copper-silver	CuAg

[1]) Thickness of chrome layer ≈ 0,3 µm

Table 2. **Minimum layer thickness (coating structure)**

Codenumber	Layer thickness (coating structure) in µm 1 coating metal	2 coating metals
0[1])	–	–
1	3	–
2	5	2+ 3
3	8	3+ 5
4	12	4+ 8
5	15	5+10
6	20	8+12
7[2])	25	10+15
8[2])	32	12+20
9[2])	40	16+24

[1]) Code number 0 applies to screw threads below M 1.6, where no specific layer thickness can be specified.
[2]) Does not apply to threaded components.

Table 3. **Degree of gloss and after-treatment**

Codeletter	Degree of gloss	Chromatizing in accordance with DIN 50 941 Process group	Self-colour of chromatizing layer
A	mt (dull) (mat)	none [1])	none
B		B	bluish to bluish iridescent [2])
C		C	yellowish glistening to yellowish-brown,iridescent
D		D	olive green to olive brown
E	bk (bright)	none [1])	none
F		B	bluish to bluish iridescent [2])
G		C	yellowish glistening to yellowish-brown,iridescent
H		D	olive green to olive brown
J	gl (glossy)	none [1])	none
K		B	bluish to bluish iridescent [2])
L		C	yellowish glistening to yellowish-brown,iridescent
M		D	olive green to olive brown
N	hgl (high gloss)	none	–
P	bel (optional)	B, C or D [3]) at manufacturer's discretion	as for process group B, C or D
R	mt (dull) (mat)	F	brownish black to black
S	bk (bright)	F	
T	gl (glossy)	F	

[1]) In the case of Zn and Cd however, process group A
[2]) Only applies to Zn coatings
[3]) Process groups B, C or D in accordance with DIN 50 941 only apply to cadmium and zinc coatings. In the case of other electroplated coatings, "P" in the code symbol signifies "degree of gloss optional".

Ordering code of electroplated coatings for commercial fasteners on stock.

Nominal size		Coating	Zinc-chromatized				Nickel	Copper nickel
		Degree of gloss	Glossy					
		Colour	none	bluish	yellowish	black	–	–
metric	inch							
< 5	< 3/16"		A1J	A1K	A1L	A1T	E1J	G2J
≥ 5 < 10	≥ 3/16" < 3/8"		A2J	A2K	A2L	A2T	E2J	G2J
≥ 10	≥ 3/8"		A3J	A3K	A3L	A3T	E3J	G3J

Example of coding: A3L means zinc-plating (A in table 1) with a minimum layer thickness of 8 µm (3 in table 2) and yellow-chromatized with a glossy degree of gloss (L in table 3).
Example of designation: Hexagon bolt DIN 931 - M16 x 60 - 8.8 - A3L.

FABORY

STANDARD

DIN : 267 Part 9
ISO : 4042
ANSI : –

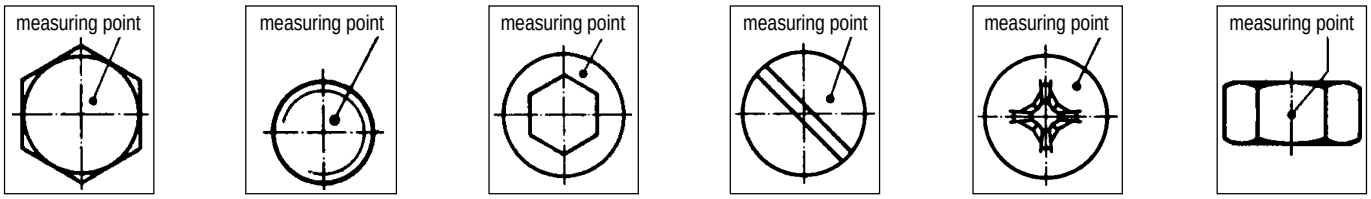
SURFACE COATINGS

Electroplated coatings

info

4. Layer thickness, measuring point and measuring method

The layer thicknesses on the measuring point as indicated in table 2 are minimum values.
Because of the variations in layer thickness on electroplated surfaces on mechanical fasteners, the local layer thickness is measured at a given spot considered significant for the purpose of assessing the protection against corrosion as is indicated in the examples:



The layer thickness can be measured by:
- direct determination in accordance with DIN 50933
- the jet method is accordance with DIN 50951
- the coulometric method in accordance with DIN 50955
- microscopic determination in accordance with DIN 50950

In borderline cases the last method is governing.

5. Screw thread tolerances

The basis for the layer thickness of electroplated coatings is given by the tolerances for ISO-metric screw threads in accordance with DIN 13 resp. ISO-unified screw threads in accordance with ISO 5864 (ANSI B1.1) **prior** to the electroplating, that means tolerance field g resp. 2A for bolts and screws and H resp. 2B for nuts.
The coating must not cause the zero line to be exceeded, so bolts and screws have to meet the go-gauge with tolerance field h resp 3A and a measurable layer thickness can only be applied to nuts on condition that the tolerance field H resp 2B is not being fully utilized down to the zero line.

6. Hydrogen embrittlement

Due to the risk of hydrogen-induced delayed brittle fracture bolts and screws with a tensile strength Rm ≥1000 N/mm or a hardness ≥ 300 HV (F ≥ 98N) have to be baked on 200 ± 10°C as soon as possible but within 4 hours after the coating process.
This is also mandatory for resilient (springy) fasteners with a hardness ≥ 400 HV (F ≥ 98N).

Note: In spite of this special precaution hydrogen embrittlement cannot be excluded for certain with the electrolytical processes in general use today.
Electroplating of bolts and screws of property class 12.9 and higher is strongly advised against.
No responsibility is taken for reduced loadability or the resulting claims from this. This particularly concerns products which are not coated by ourselves.

7. Passivation by chromate treatment

This after-treatment has to be carried out in accordance with DIN 50941 and **after** baking.
The protection against corrosion is considerably increased by chromatizing.
Out of the different colours from bluish (white) to black in table 3, **yellow** passivation is preferred.

In June 1992 a new **national** German standard, DIN ISO 4042-electrolytic surface plating, was published. This standard is identical to the **international** standard ISO 4042 (1st. edition 1989-12-15).

This standard consequently replaces the old **national standard**, DIN 267 Teil 9. This standard has also been replaced in Holland, where the DIN standard is also recognised.

It is generally expected that a **European** EN-standard (identical to ISO 4042) will be introduced, until that time the present standard, DIN 267 Teil 9 will be maintained.

STANDARD	SURFACE COATINGS	
DIN : 267 Part 10 ISO : 1461 ANSI : –	**Hot dip galvanizing**	

1. Scope and field of application

These technical conditions are in particular related to threaded fasteners (mainly bolts and nuts) with M6 up to and including M36 coarse thread and property classes up to and including 10.9 for bolts and 10 for nuts.
The minimum coating thicknesses also apply to other accessories such as washers.

2. Hot dip galvanizing

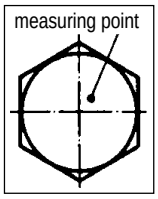
Hot dip galvanizing shall be defined as a protective zinc layer deposited onto the surface of metal articles by immersing these parts in liquid zinc.
Note: This information on hot dip galvinizing corresponds, as regards content, to DIN 267 Part 10.

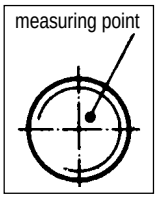
3. Ordering code

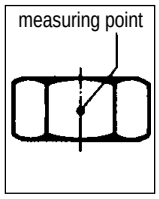
Hot dip galvanized fasteners are designated with t Zn e.g. high strength structural bolt DIN 6914 - M20 x 100 - t Zn

4. Layer thickness, measuring point and measuring method

The **minimum** coating thickness at the measuring point is 40 µm.
The measuring point is a given spot considered significant for the purpose of accessing the protection against corrosion as is indicated in the examples:







The layer thickness can be measured by:
– direct determination in accordance with DIN 50933
– the magnetic measurement in accordance with DIN 50981
When comparing the layer thickness with the mass per unit area 100 µm≙ 700 g/m² may be used.
The thread is tapped in the nuts AFTER hot dip galvanizing.
The bolt thread shall not be recut after galvanizing.

5. Screw thread tolerances

The tolerances of the ISO-metric thread in accordance with DIN 13 and the unified thread according to ISO 5864 (ANSI B1.1) for commercial fasteners are not large enough to permit a coating to the specified minimum thickness.
To ensure that the bolt/nut assembly continues to function properly after hot dip galvanizing without impairing the thread, one of the following methods shall be used:

– standard bolts are hot dip galvanized and become “oversize” thread. These bolts have to be combined with nuts, which have been tapped “oversize” (about 0,3 mm larger) AFTER galvanizing. They do not meet the usual thread fit. These bolts and nuts have to be used as a set. This combination is usually applied and is recommended.
– The bolt thread shall be produced to tolerance position a in accordance with DIN 13 Part 15 BEFORE hot dip galvanizing. The bolts have to be prepared thinner.
  Because the thread profile shall not at any point transgress the zero line it means that the bolts AFTER galvanizing have to meet the go-gauge with tolerance position h.
  These “ISO metric mating” hot dip galvanized bolts have to be combined with nuts, which have been normally tapped AFTER galvanizing and so have to meet the go-gauge with tolerance position H.
  This method satisfies the usual thread fit and can be used with nuts or in tapped holes with standard ISO metric thread

6. Hydrogen embrittlement

Hot dip galvanizing itself does not cause hydrogen embrittlement.
Pre-treatments like pickling have to be processed professionally, because careless treatment may induce hydrogen embrittlement.

7. After-treatment

When in high strength joints a better torque/tension relationship is required, it is neccessary to provide the bolt or nut with an adequate lubricant e.g. molybdenum disulfide Mo S_2.

8. Colour

The colour of the zinc coating may vary from bright to greyish, depending on different circumstances.
The colour however is not an indication of the quality of protection against corrosion and cannot be an argument for rejection, although as bright and glossy an appearance as possible has to be aimed at.

9. Loadability

Generally it can be stated that the mechanical properties of the bolts in accordance with DIN ISO 898/1 and the nuts in accordance with DIN ISO 898/2 resp. DIN 267 Part 4 are not influenced by hot dip galvanizing.
However, taking in account the reduced overlap of the bolt and nut threads, the loadability of the bolt/nut combination is reduced by about 5% for the largest size M36 and gradually increases to 20% for the smallest size M6. For further specific values see DIN 267 Part 10.
Due to the fundamental deviations of the thread tolerances the screw thread of the bolt is allowed to strip off at the minimum ultimate tensile load.

For guidelines concerning the assembly of hot dip galvanized, high tensile bolting in steel structures DIN 6914 see elsewhere in this section.

FABORY

STANDARD

DIN : –
ISO : –
ANSI : –

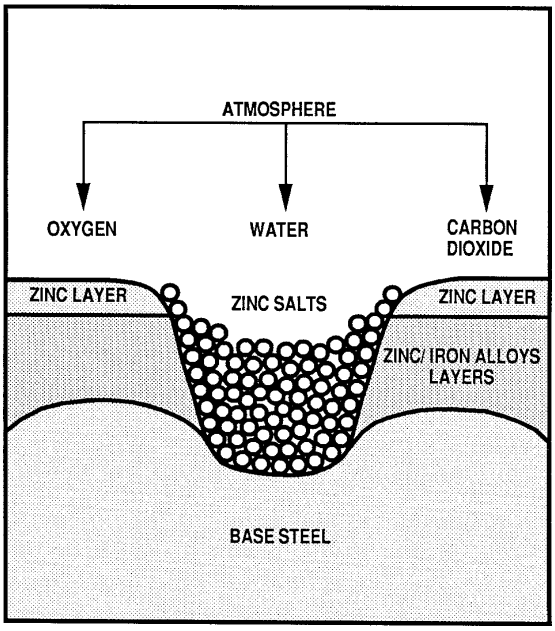
SURFACE COATINGS

Hot dip galvanizing

10. Corrosion protection

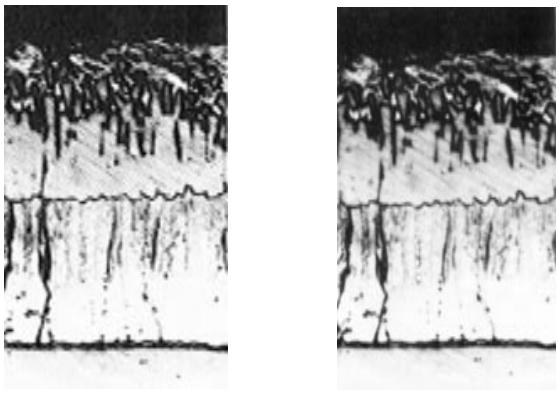
Because zinc is a lesser noble metal than iron (steel), the zinc will corrode first, protecting the steel against rusting until all zinc has dissolved.

Also on spots where the zinc layer has openings with a distance of 1,5 to 2 mm resp. a surface of 10 mm^2, the steel remains protected by an electrochemical process, called “cathodic bridging”. The zinc provides sacrificial protection and the breached coating will be covered by the built-up zinc salts.
A good example of this phenomenon occurs with the screw thread of hot dip galvanized nuts, which are tapped AFTER galvanizing. The zinc layer on the bolt thread completely takes over the protection of the uncoated nut thread.
Another important aspect of cathodic protection is that no under-rusting will occur and the rust-building remains localized to the open spots.



Cathodic protection of hot dip galvanized steel

The hot dipped galvanized zinc layer consists, besides a thick outer layer of pure zinc (the solidification-layer), of 3 alloy layers, of which the iron percentage decreases to the outside. The corrosion resistance of these layers is equal to or better than that of pure zinc, while the resistance against wearing is much higher.

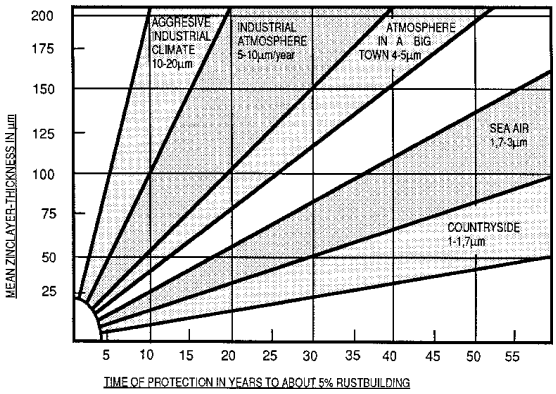


Structure of the zinclayers system of hot dip galvanizing

10.1 Atmospheric corrosion

During atmospheric attack, a layer of corrosion products (zinc-patina) is built up, mainly consisting of zinc carbonate, which is almost insoluble and delays further corrosion. When galvanized steel is kept wet during a longer period and there is insufficient air circulation, a white voluminous zinc corrosion product: “white rust” can be developed which may be less desirable, esthetically, or for painting. White rust building can be suppressed by adequate stocking and packaging or, if necessary, by passivating in chromic acid or oiling.

The time of protection is directly proportional to the thickness of the zinc layer and dependant on the climatical circumstances as is shown in the graph opposite.
Generally the time of protection is from the moment of exposure to the moment the steel surface exhibits rusting not more than 5%.



Influence of the climate on the time of protection of hot dipped galvanized steel

For guidelines concerning the assembly of hot dip galvanized, high tensile bolting in steel structures DIN 6914 see elsewhere in this section.

STANDARD
DIN : –
ISO : –
ANSI : –

SURFACE COATINGS

Hot dip galvanizing

10.2 Contact corrosion

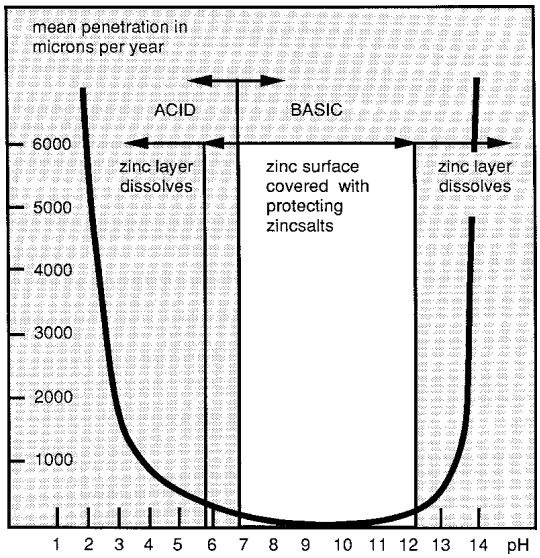
This form of corrosion occurs when two metals are contacted conductively in the presence of a corrosive electrolyte. This is due to the differing electrochemical potentials of the metals concerned, of which the least noble metal will corrode. This process also depends on the relative areas of the contacting metals.
The table opposite gives a practical overview of the reliability of the combination of hot dip galvanized fasteners, of which the area is smaller (second column), and of which the area is larger (third column) than construction area from another material. The assembly of for instance hot dip galvanized bolts in a larger construction of stainless steel will not form a reliable joint.

galvanized steel	reliability of the combination	
contacted with	area zinc smaller than area contacted metal	area zinc larger than area contacted metal
magnesium alloy	good	limited
hot dipped galv. steel	good	good
aluminium alloy	limited	good
cadmium	not	limited
unalloyed steel	limited	limited/not*
malleable steel	limited	limited/not*
alloyed steel	limited	limited/not*
stainless steel	not	good
lead	limited	good
tin	limited	good
copper	not	not
nickel alloy	not	good

* The corrosion speed of uncoated steel contacted with zinc is slow. However a small quantity of rust water will spread over the zinc quickly and cause rust marks, which are unacceptable from an esthetical viewpoint. Therefore this combination will almost always be rejected.

10.3 Chemical corrosion

Zinc is not resistant to strong acids and strong bases (caustics). All in all it can be stated that zinc must not be exposed to solutions with a pH-value of less than 6 and greater than 12,5. The most favourable application range lies between the pH-values 8 and 11.



Resistance of hot dip galvanized steel to chemicals

material	*resistance*	*notes*
concrete (wet)	good	little attack, very good once dry
plastery water	quite good	not permanently resistant
sulphite water	poor	—
phosphor solutions	good	reacts neutrally only
watery extracts of		
oak and beechwood	moderate-poor	permanent influence
ammonia	poor	permanent influence
brine	good	—
calcium chloride solutions	good	—
soap solutions	good	—
detergents in solution	poor-good	depending on composition
weedkillers	good	no free phenols
petrol	good	—
fuel oils	moderate	especially in presence of naphtalene acids, water and/or sulphur compounds
benzene/toluene/xylene	good	only when free of water
solvent- and heavy naphtas	good	only when free of water
methanol and ethanol	poor	during permanent attack
glycerol	good	only when free of water
chloride hydrocarbons	good	only when free of water
organic ester compounds	quite good-good	only when free of water and not reacting as a strong acid
substituted phenols	good	only when free of water
amino compounds	good	only when free of water
liquid glucose	good	—
sulphonates	good	—
synthetic-resin lacquer solutions	good	—
leather, bituminous materials	good	only when free of acid

10.4 Duplex-system

The Duplex-system is a combination of hot dip galvanizing and painting. It may offer a good solution in a very aggressive atmosphere e.g. in the close vicinity of the sea or in an acid environment and/or when maintenance and repairs are practically impossible to carry out, or a special colour is wanted. The time of protection is $1^1/_2$ - $2^1/_2$ times longer than the sum of both separate systems.

For guidelines concerning the assembly of hot dip galvanized, high tensile bolting in steel structure DIN 6914 see elsewhere in this section.

STANDARD	
ISO	: –
EN	: 10204
DIN	: 50049

INSPECTION SPECIFICATIONS

Inspection documents

1. Scope and field of application, normative information and main division.

1.1 The most important commercial fasteners like bolts, screws and nuts shall be marked by indenting or embossing with the designation symbol of the property class (see pages 15-5-1/6, clause 4) and/or the designation symbol of the material (see pages 15-40-3, clause 3, 15-45-2, clause 6 and 15-50-2, clause 7) and with the trade (indentification) marking of the manufacturer. This cheap method of identification and the inspection specifications of DIN 267 Part 5 (see pages 15-30-1/5) usually guarantee a reliable level of quality regarding the requirements of the product specifications.
Critical applications and special fasteners, however sometimes require extra security and a document on material tests (certificate) is required as proof that the delivery is in conformity to the requirements.

1.2 The European standard EN 10204 summarizes and describes various kinds of documents, which can be required in the order of metallic products. Because the German standard DIN 50049 is well-known and is cited in many prescriptions, the contents of EN 10204 has been published as a rivesed edition of DIN 50049, which shall be withdrawn and replaced by DIN EN 10204 after an indefinite period of transition. On the basis of an agreement the future international standard ISO 10474 will be made identical to EN 10204.

1.3 All types of inspection documents can be arranged in two main groups:

1.3.1 Based on non-specific inspection and testing.
Inspection and testing carried out by the manufacturer in accordance with his own procedures to assess whether products made by the same manufacturing process meet the requirements of the order. The products inspected and tested may not necessarily be the products actually supplied.

1.3.2 Based on specific inspection and testing.
Inspection and testing carried out, before delivery, according to the technical requirements of the order, on the products to be supplied or on test units of which the product supplied is part, in order to verify whether these products comply with the requirements of the order.

2. Inspection documents drawn up from inspection and tests carried out by personnel authorized by the maufacturer and who may be involved in the maufacturing department.

2.1 Certificate of compliance with the order "2.1"
Document in which the manufacturer certifies that the products supplied are in compliance with the requirements of the order, without mention of any test results. The certificate of compliance with the order "2.1" is a document drawn up on the basis of non-specific inspection and testing.

2.2 Test report "2.2"
Document in which the manufacturer certifies that the products supplied are in compliance with the requirements of the order and in which he supplies test results based on non-specific inspection and testing.

2.3 Specific test report "2.3"
Document in which the manufacturer certifies that the products supplied are in compliance with the specifications of the order and in which he supplies test results based on specific inspection and testing. The specific test report "2.3" is only used by a manufacturer who does not have an authorized quality control department operating independently of the manufacturing department. If the manufacturer uses an authorized quality control department, operating independently of the manufacturing department he shall supply a "3.1.B" certificate instead of a "2.3" certificate.

3. Inspection documents drawn up for inspection and tests carried out or supervised by authorized personnel independent of the manufacturing department, and based on specific testing.

3.1 Inspection certificate.
Documents issued on the basis of inspection and tests carried out in accordance with the technical specifications of the order or the official regulations and the corresponding technical rules. The tests shall be carried out on the products supplied or the products in the inspection unit, of which the consignment constitutes a part. The inspection unit is set by the product standard, the official regulations and corresponding technical rules or by the order. There are different types:

Inspection certificate "3.1.A"
Is issued and validated by an inspector designated by the official regulations, in accordance with these and the corresponding technical rules.

Inspection certificate "3.1.B"
Is issued by the department independent of the manufacturing department and validated by an authorized representative of the staff independent of the manufacturing department.

Inspection certificate "3.1.C"
Is issued and validated by an authorized representative of the purchaser, in accordance with the specifications of the order.

3.2 Inspection report.
Where the inspection certificate is validated, following special agreement, both by the manufacturer's authorized representative and the purchaser's authorized representative, it is known as the inspection report "3.2".

INSPECTION SPECIFICATIONS

Inspection documents

4. Inspection documents to be supplied by a processor or an intermediary.

When a product is supplied by a processor or an intermediary, they shall submit to the purchaser, without any changes to it, the manufacturer's documentation, as described in this European Standard EN 10204. This documentation from the manufacturer shall be accompanied by suitable means of identification of the product, in order to ensure the traceability between the product and the documentation. If the processor or intermediary has changed the state or dimensions of the product in any way whatever, he shall supply an additional document of compliance for these particular new conditions. This also applies to all special requirements given in the order and not defined in the manufacturer's documentation.

5. Validation of inspection documents.

The inspection documents shall be signed or marked in an appropriate way by the person(s) responsible for the validation of documents. However, if the certificates are prepared by a suitable data processing system the signature may be replaced by an indication of the name and the position of the person responsible for validating the document.

6. Different language versions of inspection documents (informative).

Kind of document	English	German	French	Italian*	Dutch*
2.1	Certificate of compliance with the order	Werks– bescheinigung	Attestation de conformité à la commande	Attestato di conformita all'ordinazione	Fabrieks– verklaring
2.2	Test report	Werkszeugnis	Relevé de contrôle	Attestato di controllo	Fabrieks– contrôlerapport
2.3	Specific test report	Werks– prüfzeugnis	Relevé de contrôle spécifique	Unknown	Fabrieks– beproevingsrapport
3.1.A 3.1.B 3.1.C	Inspection certificate	Abnahme– prüfzeugnis	Certificat de reception	Certificato di collaudo	Afname– beproevingsrapport
3.2	Inspection report	Abnahme– prüfprotokoll	Procès-verbal de réception	Verbale di collaudo	Afname– beproevingsprotokol

* added to EN 10204.

STANDARD

ISO : –
EN : –
DIN : –

INSPECTION SPECIFICATIONS

3.1B-certificate

The 3.1B-certificate is the most common document for fasteners and is mainly required in the petrochemical and tank industry for pipelines, tank installations, pressure vessels, steam equipment and the like. Although the 3.1A and 3.1C certificates generally cause no difficulties - the official authority or the customer himself indicates how and by which experts testing has to be carried out - the 3.1B certificate may quite often be misinterpreted.

1. **The configuration of the 3.1B certificate**
   Supplement 1 to DIN 50049 gives a suggestion of how to achieve optimal uniformity in the documents. It contains all the necessary data and is generally accepted.

2. **Manufacturers, authorized to issue a 3.1B certificate**
   Especially in this matter there is some lack of clarity. The definition of the 3.1B-certificate (see page 15-31-1, point 3) assumes a high degree of organization and quality in the manufacturing company. Guarantee about this can only be obtained on the basis of an official and independent homologation of the manufacturer, which is generally accepted.

   This situation exists in Germany. Most applications of fasteners requiring a 3.1B-certificate fall under the supervision of the German Technische Überwachungsverein (TÜV) and the rules are laid down in the AD-Merkblätter for pressure vessels and the TRD-rules for steam equipment.
   Furthermore the TÜV is generally accepted as an official and independent authority to audit manufacturers on their level of quality, to issue a homologation (Zulassung) and to check the company periodically (Überwachungsvertrag).
   The TÜV yearly publishes a survey (VdTÜV Merkblatt 1253) of all manufacturing companies over the whole world - including manufacturers of fasteners - that have obtained their homologation.
   With 3.1B-certificates of these approved manufacturers no danger occurs that the company and/or the document will not be accepted.

3. **Relation between certificate and product**
   A certificate can only be reliable when it is clearly and unambiguously established that the document and the product concerned belong together. This is not usually the case for smaller, mass-produced articles like bolts and nuts, as yet.
   Nevertheless, some recommendable developments are starting to take place:
   – some manufacturers also indicate the cast number of the certificate on the label of the packing
   – some companies have already made a further move in the ideal direction of marking every product with a symbol corresponding with the symbol of the certificate.

Fabory "a guarantee for quality"

Our products are subjected to a constant quality control. The articles are tested in our modern laboratory.

Profile projector

Tensile testing machine (600kN)

FABORY

STANDARD

ISO : –
EN : –
DIN : 50049 Sub part 1 (1980)

INSPECTION SPECIFICATIONS

Example of the configuration of a 3.1B-certificate

info

Abnahmeprüfzeugnis B / *Inspection certificate B*
DIN 50 049 – 3.1 B

(Firmenkopf)

Nr. / *No.*: 230 Ma
Datum / *Date*: 12.09.1979

(Empfänger)

zu Lieferanzeige / *to Delivery Note:*
Nr. / *No.*: 006480
vom / *of:* 10.09.1979

Zeichen des Herstellerwerkes / *Mark of the Manufacturer:*

Zeichen des Sachverständigen / *Inspector's Stamp:*

Besteller / *Purchaser:*	Bestellung Nr. / *Order No.:*	Datum / *Date:*
Stahlhändler	4557/401/250	08.08.1979

Unsere Auftrags-Nr. / *Our Order-No.:*	Unsere Abteilung / *Our Department:*	Hausruf / *Tel. Ext.:*
gb 60 371	QZP/A	2890

Erzeugnisform / *Product:*	Lieferbedingungen / *Terms of Delivery:*
Blech	DIN 1543

Werkstoff / Lieferzustand *Quality / Condition of Delivery:*	Lieferbedingungen und/oder amtliche Vorschriften / *Terms of Delivery and/or Official Regulations:*
H II normalgeglüht	DIN 17155 Teil 1

Pos. / *Item*	Anzahl / *Quantity*	Abmessungen / *Dimensions* mm	Masse / *Weight* kg	Schmelzen-Nr. / *Cast-No.* Los-Nr. / *Lot-No.*	Erschm. Art / *Melting-furnace*	Chemische Zusammensetzung (Schmelzenanalyse) / *Chem. Composition of Cast* % C	% Si	% Mn	% P	% S	%	%
4	14	12.0x1200x2000	3160	66355	Y	0,14	0,25	0,68	0,014	0,020	-	-
6	8	15.0x1250x2500	2940	65576	Y	0,13	0,22	0,70	0,018	0,023	-	-

Pos. / *Item*	Schmelzen-Nr. / *Cast-No.*	Probe-Nr. / *Test No.*	Probenlage / *Pos. of sample* [1]	Streckgrenze / *Yield stress* N/mm²	Zugfestigkeit / *Tensile strength* N/mm²	Bruchdehnung / *Elongation* % A_5	Kerbschlagarbeit / *Impact Value* (DVM.....-Probe / *Type*) Probenlage / *Pos. of sample* [1]	Joule 1.	2.	3.	Mittel / *Average*	bei / *at* °C	Bemerkungen / *Remarks*
4	66355	943	Kq	293	437	38	Kq	52	55	53	53	+20	
			Fq	312	417	39	Fq	51	54	52	52	"	
	"	948	Kq	298	433	37	Kq	49	51	50	50	"	
			Fq	295	435	38	Fq	55	54	52	54	"	
6	65576	878	Kq	310	447	35	Kq	48	52	50	50	"	
			Fq	304	454	31	Fq	53	50	50	51	"	
	"	911	Kq	339	464	39	Kq	48	51	51	50	"	
			Fq	327	461	38	Fq	54	52	53	53	"	

Faltversuch / *Bending Test:* quer D = 2a < 180°

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellannahme entspricht.

We hereby certify, that the material described above has been tested and complies with the terms of the order contract.

(Firma)

Der Werkssachverständige / *Works inspector*

[1]) A = Anfang / *Beginning*, E = Ende / *End*, F = Fuß / *Bottom*, K = Kopf / *Top*, l = längs / *longitudinal*, q = quer / *transverse*, t = tangential, r = radial, z = senkrecht / *vertical*

STANDARD
ISO : 3506 EN : – DIN ISO : 3506 DIN : 267 Part 11(W)

STAINLESS STEEL

Material properties

Steel grades A1 - A2 - A4

1. Normative information

The German standard DIN 267 Part 11 on corrosion-resistant stainless steel fasteners has been withdrawn due to the mandatory implementation of the European EN-productstandards of hexagon bolts, screws and nuts. These EN-productstandards are indentical with existing international ISO-standards, which refer to appropriate ISO-standards with regard to the specifications and reference standards.
Consequently these ISO-standards are also operative when EN-productstandards are applied.

However, Europe is of the opinion that the existing ISO-standard 3506:1979 does not meet all requirements of the present state of technics.
The European Technical Committee for Standardization CEN/TC 185 "Mechanical Fasteners" therefore decided to wait with the issue of an EN-standard untill ISO 3506, which is now under revision, will be acceptable for Europe.

In spite of this, Germany recommends as an intermediate compromis to use DIN ISO 3506 (unchanged German translation of ISO 3506:1979), when EN-productstandards are applied.
DIN ISO 3506 is also valid for all cases, in which is still referred to DIN 267 Part 11.

2. Scope and field of application

These specifications apply to fasteners (primarily bolts, screws and nuts) made from austenitic grades of corrosion-resistant stainless steels with sizes from 1,6 up to and including 39 mm, metric (ISO) thread and also to nuts with widths across flats or outside diameters ≥ 1,45 d and an effective thread engagement of at least 0,6 d.
This International Standard does not define corrosion or oxidation resistance in particular environments. It does specify grades for fasteners made from corrosion-resistant stainless steels. Some have mechanical properties allowing use at temperatures down to -200°C or up to +800°C in air. Acceptable corrosion and oxidation performances and use at elevated or sub-zero temperatures must be subject of agreement between user and manufacturer appropriate to the proposed service environment.

3. Choice of material

"STAINLESS" steel contains a great number of variants, all with at least 12% chromium (Cr) and mostly also other alloying elements, nickel (Ni) and molybdenum (Mo) being the most important. This extensive field has been divided for fasteners into 3 MATERIAL GROUPS based on their metallurgical structure:

austenitic (A) | martensitic (C) | ferritic (F)

The martensitic and ferritic groups are hardly of any importance to commercial fasteners. They are not available from stock and are only manufactured on order in great quantities.

The austenitic material group - also called chromium-nickel steels - is the most used for fasteners and is further subdivided into 3 steel grades, each with a different resistance to corrosion and a specific field of application.

A1 = a free-cutting quality, having a superior machinability due to a higher phosphorus and sulphur percentage. As a consequence, however, the general corrosion resistance is decreased. This "automatic lathe" stainless steel is seldom used for mass production fasteners.

A2 = the most current steel grade - also called 18/8 (18% Cr, 8% Ni) - with outstanding corrosion resistance under normal atmospheric conditions, in wet surroundings, oxidizing and organic acids, many alkalic and salt solutions.

A4 = the most corrosion resistant steel grade - also called "acid proof" - with an increased nickel percentage and addition of molybdenum. Better resistance to agressive media such as sea climate (chlorides), industrial atmosphere (sulphur dioxide), oxidizing acids and there where pitting may occur.

See corrosion table on page 15-60-4
Unless otherwise specified fasteners from austenitic stainless steel shall be clean and bright. For maximum corrosion resistance passivation is recommended.

4. Chemical composition of austenitic stainless steel A.

The wide limits of percentages of the alloying elements in ISO 3506 allow within every steel grade a great choice out of the special austenitic steel types. The final choice is at the discretion of the manufacturer, depending on the requirements and method of manufacturing. If a special type within the specified grade is wanted, the appropriate German Werkstoffnummer, the American AISI or ISO type number has to be indicated. The most popular types are summarized in the following table.

Stainless steel-		chemical composition in % [1]								Stainless steel types			
Material group	Steel grade	C	Si	Mn	P	S	Cr	Mo [8]	Ni	DIN Werkstoffnr.	AISI types	ISO 683/XIII	Foot notes
Austenitic A	A1	0,12	1,0	2,0	0,20	0,15-0,35	17,0-19,0	0,6	8,0-10,0	1.4305	303	17	[2] [3]
	A2	0,08	1,0	2,0	0,05	0,03	17,0-20,0		8,0-13,0	1.4301	304	11	[3] [4] [6] [7]
										1.4541	321	15	[5]
	A4	0,08	1,0	2,0	0,05	0,03	16,0-18,5	2,0-3,0	10,0-14,0	1.4401	316	20	[3] [4] [6]
										1.4571	316 Ti	21	[5]

1) Maximum values, unless otherwise specified.
2) Sulphur may be replaced by selenium.
3) May contain titanium ≥ 5 X C up to 0,8%.
4) May contain niobium (columbium) and/or tantalum ≥ 10 X C up to 1%.
5) Containing titanium ≥ 5 X C up to 0,8%.
6) May contain copper up to 4%.
7) Molybdenum may also be present at the option of the manufacturer.
8) If for some applications a maximum molybdenum content is essential, this shall be stated at the time the customer orders.

STANDARD
ISO : –
EN : –
DIN ISO : –
DIN : –

STAINLESS STEEL

Material properties

Steel grades A1 - A2 - A4

info

5. Performance under different kinds of corrosion

5.1 Atmospheric (chemical) corrosion

This kind of general corrosion is caused by chemical attack from the atmosphere or aggressive media and is mostly defined as the loss of surface material in µm/year. The attack passes evenly and gradually, mostly visibly and it is checkable. Sudden collapse does not occur, so this type of corrosion is not dangerous.

Generally grade A2 is very satisfactory, but under more aggressive conditions A4 is recommended. See chemical corrosion table on page 15-60-4.

5.2 Contact (galvanic) corrosion

When two metals in the presence of an electrolyte create a difference of electrical potential, a galvanic action occurs which causes the lesser noble metal (anode) to corrode and to sacrifice itself, protecting the nobler metal (kathode). The higher the difference in electrical potentials and the larger the contacting area of the nobler metal relative to that of the lesser noble, the more severely this contact corrosion will attack the anode. Passive austenitic stainless steel is relatively noble, whereas fasteners generally have a comparatively small surface in relation to the construction.

Aluminium performs very well, as practice has proven, because of the formation of an insulating layer of aluminum oxide.

Steel and cast iron have to be covered with a closed protective layer e.g. zinc or lacquer.

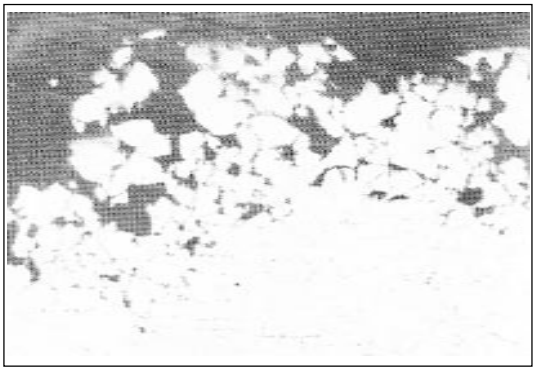
Copper and brass are applicable, when the fasteners are relatively small. Generally this combination can only be advised when an adequate insulation is applied.

Dry wood will not cause problems. In socked condition pitting corrosion may occur on the long run, however the time of resistance is much longer than with plated steel.

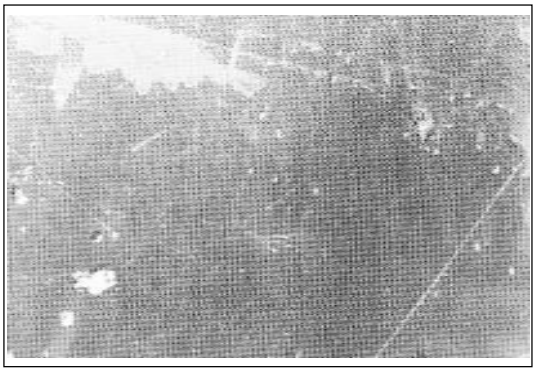
Plastic performs well, although deformation of washers, for example, may cause crevice corrosion.

Asbestos cement and concrete are permissable, given the good experience with, for instance, stainless steel anchors in concrete.

For further information see the contact corrosion table elsewhere in this section. In all cases contact corrosion cannot be avoided, the contact areas have to be insulated with, for example, non-acid fat, insulating lacquers or pastes, plastic bushes or washers, insulating tape.



microstructure of intercrystalline attack



typical phenomenon of pitting corrosion in a chloride solution

5.3 Intercrystalline corrosion

Austenitic stainless steel grades A2 and A4 shall not show chromium carbides between 400° and 800°C causing an attack between the material crystals at the grain boundaries. This is achieved by the choice of the right steel type with, for example, either a lower carbon content, or by addition of stabilizing elements e.g. Titanium (Werkstoffnummer 1.4541 and 1.4571). For fasteners the first method is the most used.

A2 and A4 have to meet the test requirements on intercrystalline corrosion according to ISO 3651.

A1 is not resistant to intercrystalline corrosion due to the higher carbon content and is therefore not suitable for higher temperatures e.g. welding.

5.4 Pitting corrosion

Local pore-like holes may form, growing fast and deep into the material causing the product to be attacked suddenly and severely. This type of corrosion appears especially in halogen (chloride) environments e.g. sea climate and brackish water. A4 offers the best resistance to pitting due to the addition of molybdenum.

5.5 Crevice corrosion

In presence of an aqueous environment corrosion may occur in crevices, for example, of spring washers and under sediments or layers of paint where insufficient air (oxygen) can circulate to restore the passivity of the stainless steel.

5.6 Stress (transcrystalline) corrosion

Cracking across the material crystals may occur when parts are exposed to external or internal stresses in a chloride atmosphere. This corrosion-related phenomenon however will seldom appear with cold headed fasteners.

6. Magnetic properties

Austenitic stainless steel fasteners are normally non-magnetic. The right choice of steel type will limit the permeability (that is the rate of penetration in a magnetic field) to below 1,05 G/Oe.

However after cold working some ability to be magnetized may be evident. In this respect A4 is less sensible than A2 and A1 is the most unfavourable.

Some special applications like for electrotechnical equipment, and in the marine and nuclear industry, require a permeability as close as possible to 1,0. Fasteners on stock are not suitable for these purposes and special non-magnetizable steel types have to be applied in agreement (see Stahl-Eisen-Werkstoffblatt SEW 390, the standard VG 85539 of the Bundesamt für Wehrtechnik and the Grohmannbook "Wissenswertes über Edelstahlschrauben").

7. Temperature range

Heat-resistant up to,+ 400° C according to AD-Merkblatt W2 for pressure vessels and TRD 106 for steam-boilers and oxidation-resistant up to +800° C according to ISO 3506.

Allowing use at very low temperatures: A2 down to -196° C and A4 down to -60° C according to AD-Merkblatt W10 for pressure vessels and DIN 267 Part 13.

STANDARD		
ISO : 3506 EN : – DIN ISO : 3506 DIN : 267 Part 11(W)	**STAINLESS STEEL** **Mechanical properties** Property classes 50 - 70 - 80	info

1. System of designation of property classes

A characteristic property of austenitic stainless steel is that - contrary to the heat treated steels, which are used for the property classes 8.8, 10.9 and 12.9 - this material cannot be hardened and tempered, but can only be strengthened by cold-working, increasing the mechanical properties considerably.

The 3 austenitic steel grades A1, A2 and 4 are divided into 3 property classes 50, 70 and 80 depending on the method of manufacturing and on sizes. The number of the property class corresponds with 1/10 of the tensile strength in N/mm^2, e.g. class 80 has a minimum tensile strength: 80 X 10= 800 N/mm^2.

50 = the soft condition of turned and hot-pressed fasteners. This is seldom used for current fasteners.

70 = the most universal and applied property class for all cold-formed fasteners.This class is the standard class and is delivered when no other class is ordered.

80 = the highest property class, having obtained mechanical values by extra cold deformation to the level of the 8.8 heat-treated steel bolts. Exchange does not require a new strength calculation or adaption of the construction.

2. Mechanical properties

2.1 For sizes above M5

Stainless steel		Property class	For sizes d	Bolts and screws			Nuts
Material group	Steel grade			Tensile strength R_m [3] N/mm^2, min.	0,2%-proof stress $R_{p0,2}$ [3] N/mm^2, min.	Elongation at fracture A_L [4] in mm, min.	Proof load stress S_p N/mm^2
Austenitic	A1, A2 and A4	50	≤M39	500	210	0,6d	500
		70 [1]	≤M20	700	450	0,4d	700
		80 [2]	≤M20	800	600	0,3d	800

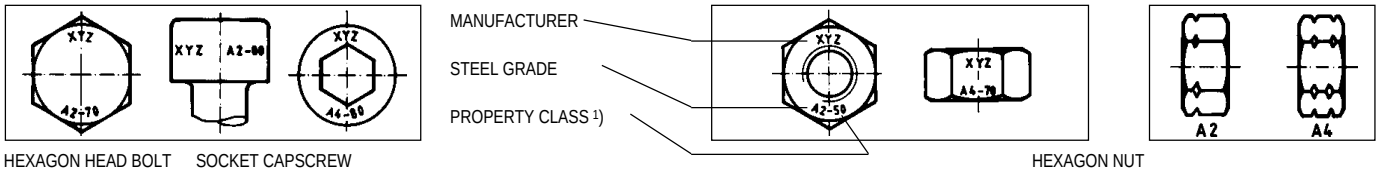
1) These values shall apply only to lengths up to max. 8 x d. In the steel groups A2 and A4 class 70 is the most current.
2) The whole diameter/length-programme of class 80 that we carry on stock possess these properties
3) All values are calculated and reported in terms of the tensile stress area of the thread (see Tables of screw thread elsewhere in this section)
4) The elongation at fracture shall be determined on the actual screw or bolt length ≥3 x d and not on a prepared test piece of gauge length 5 d.

2.2 Breaking torques for sizes up to and including M5

Nominal thread size	Minimum breaking torque Nm		
	Property class 50	Property class 70	Property class 80
M 1,6	0,15	0,2	0,27
M 2	0,3	0,4	0,56
M 2,5	0,6	0,9	1,2
M 3	1,1	1,6	2,1
M 4	2,7	3,8	4,9
M 5	5,5	7,8	10,0

3. Marking: guarantee for quality

Stainless steel hexagon head bolts and nuts, socket cap screws of size M5 and greater and all packaging shall be marked with the manufacturer's identification mark and the steel grade followed by the two digits of the property class or in the case of turned nuts on the alternative way of groove marking, see examples below. Marking of studs and other fasteners shall be agreed on by user and manufacturer.



HEXAGON HEAD BOLT SOCKET CAPSCREW HEXAGON NUT

1) Property class of nuts only for lower strength grades

FABORY

STANDARD

ISO : –
EN : –
DIN ISO : –
DIN : –

STAINLESS STEEL

Guidelines for assembling

General

In many cases corrosion resistance is still the only criterion for the application of stainless steel fasteners. However these articles are being used more and more as mechanical jointing elements, requiring strength and construction reliability. For this purpose it is necessary to gain some understanding of the typical behaviour of stainless steel during assembly and, in particular, of factors related to preload and torque.

1. Maximum admissable surface pressure

For a good connection the admissable surface pressure is of primary importance. It shall not be exceeded after preloading and under the external load between the contact surfaces of bolt head and nut and the clamped material of the construction, otherwise the preload decreases due to plastic deformation and the connection will loosen.

Guide values of the admissable surface pressure of the construction material in N/mm²				
austenitic stainless steel	aluminium alloys	St 37	St 50	cast iron
400*	200	260	420	700

* This value applies to the annealed condition. May rise up to 700 N/mm² depending on the rate of cold deformation.

	Contact surface in mm²																		
nominal size	M3	M4	M5	M6	M8	M10	M10	M12	M12	M14	M14	M16	M18	M20	M22	M22	M24	M27	M30
width across flats in mm	5,5	7	8	10	13	16*	17	18*	19	21*	22	24	27	30	32	34*	36	41	46
hexagon bolts DIN 931/933 hexagon nuts DIN 934	7,54	11,4	13,6	28,0	42,0	72,3	96,1	73,2	94,6	113	141	157	188	244	254	337	356	427	576
socket cap screws DIN 912	11,1	17,6	26,9	34,9	55,8	89,5	–	90,0	–	131	–	181	211	274	342	–	421	464	638

These surfaces can be enlarged by using washers.

* These are the new ISO-widths across flats.

2. Friction coëfficients of stainless steel

The greater ductility of austenitic stainless steel does not only cause higher friction coëfficients u_G on the screw thread and u_K under the head, but also a greater scatter than the normal steels. This means that a lower preload is created at the same torque. A suitable lubricant can diminish the friction, but the scatter remains. Because of the great number of variable factors it is adviseable to establish the friction coëfficients by experiment per application with, for example, a torque-tension tester.

Guide values of friction coëfficients u_G and u_K (according to VDI Richtlinien 2230)							
construction material from	bolt from	nut from	lubricant		elasticity of the connection	friction coëfficient	
			on screw thread	under the head		screw thread u_G	under the head u_K
A2	A2	A2	without	without	very great	**0,26** - 0,50	**0,35** - 0,50
			special lubricant (chloride-parafine base)			**0,12** - 0,23	**0,08** - 0,12
			corrosion-resistant grease			**0,26** - 0,45	**0,25** - 0,35
			without	without	small	**0,23** - 0,35	**0,12** - 0,16
			special lubricant (chloride-parafine base)			**0,10** - 0,16	**0,08** - 0,12
		Al Mg Si	without		very great	**0,32** - 0,43	**0,08** - 0,11
			special lubricant (chloride-parafine base)			**0,28** - 0,35	**0,08** - 0,11

3. Approach of bolt size

For the dimensioning of the bolt size a global comparison can be made with the usual strength classes of the normal steels on the basis of the 0,2% proof stress (see table on page 15-40-3, par. 2.1):

– Class 50 is well over 10% lower than class 4.6, so exchange will not be possible in all cases.
– Class 70 in the sizes up to and including M20 can replace class 8.8 right away when for stainless steel one standardized size greater is taken e.g. M10 A2-70 instead of M8-8.8. Up to 30% higher loads can then be allowed.
  Above M20 up to and including M30 class 70 is only equivalent with class 4.6 and exchange is possible right away.
– Class 80 is 7% lower than class 8.8. Generally exchange will be possible without problems. In critical situations this difference has to be taken into account and especially the surface pressure has to be controlled.

For a more accurate method of calculation see the VDI Richtlinien 2230 “Systematic calculation of high duty bolted joints.”

4. Galling (seizing) of stainless steel

The great ductility means that austenitic stainless steel in general is more susceptible to galling than the normal steels. From many years of experience, however, it has been proven that this genuine problem seldom occurs with bolts, because nowadays they are cold-formed and get a harder cold-worked surface and a smooth, rolled screw thread. Also the positive clearance of iso-metric screw thread contributes favourably against galling.

One condition however, is that the products shall be clean, free of burs, strange metal particles, chips, sand, etc. and that one-sided clamping due to damaging of the screw thread or assembling out of alignment shall be avoided.

Rigid joints are better than elastic ones.

It is advisable to torque as uniformly as possible and at low speed and not to use impact wrenches. It is noted that to induce a certain preload not only are the friction coëfficients important, but also the accuracy of the method of torquing (tightening factor).

The combination of 2 different stainless steel grades, e.g. A2 and A4, is not advantageous as far as galling is concerned. Under special circumstances and for special requirements a suitable lubricant shall be used e.g. chloride-parafine, molykote lacquer, high pressure oil, corrosion-resistant grease.

STANDARD

ISO : –
EN : –
DIN ISO : –
DIN : –

STAINLESS STEEL

Guidelines for assembling

Pre-loads and tightening torques

		Assembly pre-load F_M in kN								Tightening torque M_A in Nm							
Friction coëfficient		0,1	0,12	0,14	0,16	0,18	0,20	0,30	0,40	0,1	0,12	0,14	0,16	0,18	0,20	0,30	0,40
Nom. size	Class																
	50	1,38	1,33	1,27	1,22	1,17	1,12	0,90	0,74	0,8	0,9	1,0	1,1	1,2	1,3	1,5	1,6
M4	70	2,97	2,85	2,73	2,62	2,50	2,40	1,94	1,60	1,7	2,0	2,2	2,3	2,5	2,6	3,0	3,3
	80	3,97	3,80	3,64	3,49	3,34	3,20	2,59	2,13	2,3	2,6	2,9	3,1	3,3	3,5	4,1	4,4
	50	2,26	2,18	2,09	2,00	1,92	1,83	1,49	1,22	1,6	1,8	2,0	2,1	2,2	2,4	2,8	3,2
M5	70	4,85	4,66	4,47	4,29	4,11	3,93	3,19	2,62	3,4	3,8	4,2	4,6	4,9	5,1	6,1	6,6
	80	6,47	6,22	5,96	5,72	5,48	5,24	4,25	3,50	4,6	5,1	5,6	6,1	6,5	6,9	8,0	8,8
	50	3,20	3,07	2,94	2,82	2,70	2,59	2,09	1,73	2,8	3,1	3,5	3,7	4,0	4,1	4,8	5,3
M6	70	6,85	6,57	6,31	6,05	5,79	5,54	4,49	3,70	5,9	6,7	7,4	7,9	8,4	8,8	10,4	11,3
	80	9,13	8,77	8,41	8,06	7,72	7,39	5,98	4,93	8,0	9,1	9,9	10,5	11,2	11,8	13,9	15,0
	50	5,86	5,63	5,40	5,18	4,96	4,75	3,85	3,17	6,8	7,6	8,4	9,0	9,6	10,1	11,9	12,9
M8	70	12,6	12,1	11,6	11,1	10,6	10,2	8,25	6,80	14,5	16,3	17,8	19,3	20,4	21,5	25,5	27,6
	80	16,7	16,1	15,4	14,8	14,2	13,6	11,0	9,1	19,3	21,7	23,8	25,7	27,3	28,7	33,9	36,8
	50	9,32	8,96	8,60	8,27	7,91	7,58	6,14	5,05	13,7	15,4	16,7	18,1	19,3	20,3	24,0	26,2
M10	70	20,0	19,2	18,4	17,7	16,9	16,2	13,1	10,8	30	33	36	39	41	44	51	56
	80	26,6	25,6	24,6	23,6	22,6	21,7	17,5	14,4	39,4	44	47,8	51,6	55,3	58	69	75
	50	13,6	13,1	12,6	12,0	11,6	11,1	9,00	7,38	23,3	26,0	28,9	30,8	32,8	34,8	41,0	44,6
M12	70	29,1	28,1	26,9	25,8	24,8	23,7	19,2	15,8	50	56	62	66	70	74	88	96
	80	38,8	37,4	35,9	34,4	33,0	31,6	25,6	21,1	67	74	82	88	94	100	117	128
	50	18,7	17,9	17,3	16,5	15,8	15,2	12,3	10,1	37,1	41,7	45,6	49	52	56	66	71
M14	70	40,6	38,5	37,0	35,4	34,0	32,6	26,4	21,7	79	89	98	105	112	119	141	152
	80	53,3	51,3	49,3	47,3	45,3	43,3	35,2	29,0	106	119	131	140	150	159	188	204
	50	25,7	24,7	23,8	22,8	21,9	20,9	17,0	14,0	56	63	70	75	81	86	102	110
M16	70	55,0	52,9	50,9	48,9	46,8	44,9	36,4	30,0	121	136	150	162	173	183	218	237
	80	73,3	70,6	67,9	65,2	62,4	59,8	48,6	40,0	161	181	198	217	231	245	291	316
	50	32,2	31,0	29,8	28,5	27,3	26,2	21,2	17,5	81	91	100	108	115	122	144	156
M18	70	69,0	66,4	63,8	61,2	58,6	56,2	45,5	37,5	174	196	213	232	246	260	308	334
	80	92,0	88,5	85,0	81,6	78,1	74,9	60,7	50,1	232	261	285	310	329	346	411	447
	50	41,3	39,8	38,3	36,7	35,2	33,8	27,4	22,6	114	128	142	153	164	173	205	223
M20	70	88,6	85,4	82,0	78,7	75,4	72,4	58,7	48,1	244	274	303	328	351	370	439	479
	80	118	114	109	105	101	96,5	78,3	64,6	325	366	404	438	467	494	586	639
	50	51,6	49,8	47,9	46,0	44,1	42,3	34,3	28,3	154	174	191	208	222	234	279	303
M22	70	61,5	59,3	57,0	54,7	52,5	50,3	40,9	33,7	182	206	227	247	263	279	332	361
	80	148	142	137	131	126	121	98,2	80,9	437	494	545	593	613	670	797	866
	50	59,6	57,4	55,1	52,9	50,7	48,6	39,4	32,6	197	222	243	264	282	298	354	385
M24	70	70,9	68,3	65,6	63,0	60,4	57,9	47,0	38,8	234	264	290	314	336	355	421	458
	80	170	170	157	151	145	139	113	93,1	561	634	696	754	806	852	1010	1099
M27	50	75,6	72,9	70,1	67,3	64,5	61,9	50,2	41,5	275	311	344	377	399	421	503	548
	70	90,0	86,8	83,4	80,1	76,9	73,7	59,8	49,4	328	371	410	444	475	502	599	652
M30	50	91,9	88,6	85,2	81,7	78,4	75,2	61,0	50,3	374	423	467	506	540	571	680	740
	70	104	105	101	97,3	93,3	89,5	72,6	59,9	445	503	556	602	643	680	809	881
M33	50	114	110	106	102	98	94	76	63	506	573	634	688	763	779	929	1013
M36	50	135	130	125	120	115	110	89	74	651	737	814	882	944	998	1189	1296
M39	50	162	156	150	144	138	133	108	89	842	955	1057	1147	1228	1300	1553	1694

These values apply to austenitic stainless steel hexagon bolts and hexagon nuts.
The torques are theoretically calculated values depending on the friction coëfficient chosen and based on a pre-load, utilizing 90% of the minimum 0,2% proof stress during assembly.
This table shall only be used as a guideline. No liability can result from its use.

STANDARD

ISO : 8839
EN : 28839
DIN : 267 Part 18 (W)

COPPER AND COPPER ALLOYS

BRASS AND KUPRODUR

1. Scope and field of application

These specifications apply to mechanical fasteners (mainly bolts, screws and nuts) made from copper and copper alloys with screw thread diameters up to and including 39 mm, with metric (ISO) thread, self tapping and woodscrew thread as indicated in section 10.
Other fasteners, e.g. rivets, may have deviating properties.

The most applied copper alloy is brass, with its most interesting features being: a high electrical conductivity of 15.10^6 S/m and a non-magnetizability of $3 \div 10 \,.\, 10^{-6}\ cm^3 \,.\, g^{-1}$
Therefore brass fasteners are very popular in the electrotechnical industry for switch boxes, transformers, radio and television, antennas, domestic appliances, etc.
Because of its rather respectable corrosion resistance (see the corrosion table elsewhere in this section) this material is also very often used in furniture making and metal work, shipbuilding, the pump and sanitary industry, watchmaking, and the optical and medical equipment industry.
Also the choice can be made by the decorative colour, which can be even further improved by chrome or nickel plating.

2. Materials

For mechanical fasteners a choice can be made out of 7 material types.

Identification symbol	Material symbol		Werkstoff-nummer	Chemical composition in %									according to			Common designations
	new	old		Cu	Zn	Al	Fe	Ni	Pb	Sn	Mn	Si	DIN	ISO	unified numbering system (U.S.A.)	
1) CU 1	Cu-ETPorCu-FRHC	E-Cu	2.0060	≥ 99,90	–	–	–	–	–	–	–	–	1787	1337	C 11000	copper
2) CU 2	Cu Zn 37	Ms63	2.0321	62,0-64,0	rem.	–	–	–	–	–	–	–	17660	426/1	C27400	brass (cold-formed)
3) CU 3	Cu Zn39 Pb3	Ms58	2.0401	57,2-59,0	rem.	–	–	–	2,5-3,5	–	–	–	17660	426/2	C38500	brass (turned)
CU 4	Cu Sn6	Sn Bz6	2.1020	rest	–	–	–	–	–	5,5 7,0	–	–	17662	427	C51900	tin bronze
4) CU 5	Cu Ni1Si	–	2.0853	rest	–	–	–	1,0-1,6	–	–	–	0,4 0,7	17666	1187	–	kuprodur
3) CU6	Cu Zn40 Mn1 Pb	Ms 58 Pb	2.0580	57,0-59,0	rem.	–	–	–	1,0-2,0	–	0,4-1,8		17660	–	C67130	brass (turned)
CU7	Cu Al10 Ni5 Fe4	Cu Al10 Ni	2.0966	rest	–	8,5-11,0	2,0-5,0	4,0 6,0	–	–	–	–	17665	428	C63000	aluminium bronze

1) electrical specific conductivity in mild condition ≥ 57 . 10^6 S/m.
2) homogeneous single phase α–brass. Excellent cold heading quality, difficult to hot forge and to machine.
3) heterogeneous two phase ($\alpha + \beta$) brass. Good machinibility, suitable for hot forging but difficult for cold heading.
4) see next page, clause 7.

It is noted that copper alloys with a content of less than 85% copper and thus also brass, are highly susceptible to stress corrosion, which can occur under tensile stresses particularly in an atmosphere containing ammonia or alkalinitrate.
This selective type of corrosion is also called “season disease” or “dezincification” and can cause unexpected cracking without deformation.
For cold headed products it is frequently necessary to stress relieve on + 250-300 °C.
To obviate any risk, stainless steel will be a technically better alternative.

3. Mechanical properties

Identification symbol	Nominal size		Tensile strength	0,2% Yield limit	Elongation
	above	up to and including	N/mm² min.	N/mm² min.	in % min.
CU 1	–	M39	240	160	14
CU 2	–	M6	440	340	11
	M6	M39	370	250	19
CU 3	–	M6	440	340	11
	M6	M39	370	250	19
CU 4	–	M12	470	340	22
	M12	M39	400	200	33
CU 5	–	M39	590	540	12
CU 6	M6	M39	440	180	18
CU 7	M12	M39	640	270	15

The mechanical properties of brass bolts and screws are comparable with the property class 4.6 of steel fasteners and are in this respect directly interchangeable. However the elongation and impact strength are considerably lower through cold-working causing rupture even under little and short term overloading. Because of this it is advised to use stainless steel instead of brass for dynamic and shocking loads.
Brass can be applied to + 175-200 °C, decreasing the yield limit by about 10%.
Brass cannot be strengthened by heat treatment.

FABORY

STANDARD

ISO : 8839
EN : 28839
DIN : 267 Part 18 (W)

COPPER AND COPPER ALLOYS

BRASS AND KUPRODUR

info

4. Minimum rupture torques in Nm for sizes up to and including M5

Identification Symbol	Nominal size						
	M1,6	M2	M2,5	M3	M3,5	M4	M5
CU 1	0,06	0,12	0,24	0,4	0,7	1	2,1
CU 2	0,10	0,21	0,45	0,8	1,3	1,9	3,8
CU 3	0,10	0,21	0,45	0,8	1,3	1,9	3,8
CU 4	0,11	0,23	0,5	0,9	1,4	2	4,1
CU 5	0,14	0,28	0,6	1,1	1,7	2,5	5,1

The rupture torques have been calculated according to:

$$M_d = \tau . \frac{\pi d_s^3}{16}$$

$$\tau = \frac{R_m}{\sqrt{3}} \qquad d_s = \frac{d_2 + d_3}{2}$$

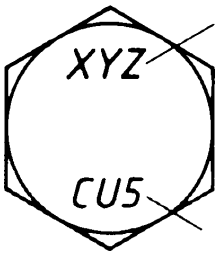
M_d = rupture torque Nm
τ = admissable torsional strength N/mm²
d_s = diameter of the stress cross-section mm
d_2 = nominal effective diameter mm
d_3 = nominal minor diameter mm
R_m = tensile strength N/mm²

5. Tightening torques in Nm for CU 2 (brass Ms 63)

Nominal size	M2	M2,5	M3	M3,5	M4	M5	M6	M8	M10
Tightening torque	0,14	0,29	0,5	0,79	1,2	2,2	3,9	9	17

These values are for reference only.
They should be verified if necessary, on the basis of practical findings.

6. Marking: guarantee for quality



Mark of origin

Material identification symbol

Hexagon head bolts and nuts and socket cap screws made from copper and copper alloys with metric screw thread from M5 upwards must be marked with the material identification symbol and the mark of origin as in the figure. (In this metal group a property class indication, as is usual for steel and stainless steel, does not exist).
The nuts can be marked on one of their end faces or on one of their key flats.
All other fasteners shall generally not be marked, unless it is mutually agreed to do so.

7. Kuprodur (CU 5)

For chemical composition and mechanical properties see the preceding page.
Kuprodur is a copper, nickel, silicon alloy with 98% copper and the following specific features:
– this alloy can be heat-treated, gaining high mechanical properties, which even increase at low temperatures e.g. the elongation and impact strength at -60 °C are about 25% higher.
– temperature-resistant to + 250 °C. Under constant load considerable relaxation with regard to creep has to be taken into account.
– high electrical specific conductivity = 18 . 10^{-6} S/m.
– non-magnetizability = + 0,066 . 10^{-6} cm^3 .g^{-1}.
– not susceptible to stress corrosion and very resistant to many acids, alkalis, sea water and atmospheric influences, comparable with pure copper.
Kuprodur therefore is very often applied in nuclear power plants, and in the water treatment, shipbuilding, low temperature technics, electro-technical and chemical equipment industries.

Pre-loads in N and tightening torques in Nm (with average friction coëfficient = 0,125)

Nominal size	M5	M6	M8	M10	M12	M16
Preload N	5550	7800	14300	22800	33400	63000
Tightening torque Nm	4,7	8	19	39	67	165

These guide values apply to a joint made from copper.

STANDARD

ISO : –
EN : –
DIN : –

SOPRAL ALUMINIUM ALLOYS

1. Scope and field of application

These specifications apply to mechanical fasteners (mainly bolts, screws, nuts and washers) made from aluminium alloys of the manufacturer's trade mark SOPRAL as indicated in section 10.
This information contains manufacturer's data having no relationship with DIN 267 Part 18.
The very extensive field of application may be derived from the following specific features:

- high mechanical properties, SOPRAL P 60 is about comparable with the steel property class 5.8 and the stainless steel property class 50 and about 35% stronger than brass. So it is very suitable in the aluminium structural joints.
- light weight (one-third the weight of steel and stainless steel), which, besides its use in the aircraft and space industry is becoming increasingly important in the vehicle and transport industry, shipbuilding etc.
- adequate corrosion resistance in sea climate among other things, so it has many maritime applications.
- very resistant at extremely low temperatures. The mechanical properties even increase at -196 °C, which is very attractive in the cryogenic industry.
- good thermal conductivity (13 x higher than stainless steel, 4 x higher than steel and 60% of that of copper), so it is applicable in the industry of heat exchangers, air conditioning, radiators, etc.
- the electrical conductivity is, on basis of equal weight, twice that of copper.
  Also through its non-magnetizability, this material is used very frequently in the electrical industry.
- decorative colour which can be varied by anodic coatings.
  Together with a high reflectivity these properties find application in buildings and in the lighting, telecommunication and general decoration industry.
- non-toxic, so it is applicable in installations and equipment in the agriculture and food industry.

2. Materials

In our delivery programme we carry 6 SOPRAL material grades on stock:
SOPRAL P40. This is an aluminium- magnesium- silicon alloy for bolts, screws and nuts for general applications, not requiring very high mechanical properties, but requiring optimal corrosion resistance.
SOPRAL P60. This aluminium- zinc- magnesium alloy for bolts, screws, nuts and spring washers has increased mechanical properties with a well balanced corrosion resistance. This is the favourite grade for load transmitting bolts and nuts in aluminium structural joints.
This type is frequently used in electric power plants and electric transport systems and meet the strict regulations according to the French technical specification No. 15-SE-565 (1983) of the EDF (Electricité de France).
SOPRAL P65, a similar alloy to P60, but somewhat stronger, used exclusively for screws.
SOPRAL A-G3M, an aluminium- magnesium alloy for washers, which in combination with P60 have to be used on the nut side.
SOPRAL A5, pure aluminium with ≥ 99% aluminium, is used for general purpose washers.
2030 (Dural), an aluminium grade for the small nut sizes M3, M4 and M5.

3. Chemical composition

Material Grade	Heat treatment *	Chemical composition in %								corresponding designations				
										Germany		unified numbering system (USA)	France	
		Si	Fe	Cu	Mn	Mg	Cr	Zn	Al	Werkstoff nr.	DIN		new	old
SOPRAL P40	T8	0,3-0,7	0,5	0,1	0,03	0,35-0,8	–	0,1	rem.	3.3207	Al Mg Si 0,5	6101		A-GS
SOPRAL P60	T73	0,4	0,5	1,2-2	0,3	2,1-2,9	–	5,1-6,1	rem.	3.4365	Al Zn Mg Cu 1,5	7075		A-Z5GU
SOPRAL P65	T6													
SOPRAL A-G3M	H26	0,4	0,5	0,1	0,1-0,5	2,6-3,6	0,1	0,2	rem.	3.3535	Al Mg3	5754		A-G3M
SOPRAL A5	–	0,25	0,4	0,05	0,05	0,05	–	0,05	rem.	3.0255	AAL 99,5	1050A		A5
2030 (Dural)	–	–	–	3,5-4,5	–	0,5-1,3	Pb 0,8-1,5		rem.	3.1645	AlCuMgPb	2030		A-U4Pb

* Heat treatment (Temper)
T 6 = solution heat-treated, artificially aged.
T 8 = solution heat-treated, cold-worked and artificially aged.
T 73 = solution heat-treated, tempered at + 108 °C and tempered again at + 177 °C (over-aged), see clause 9.
H26 = 3/4 hardness by cold-working and partially annealing.

4. Mechanical properties[1)]

Material grade	Tensile strength N/mm²	0,2% Yield limit N/mm²	Elongation %	Brinell-[2)] hardness HB	Modulus [3)] of elasticity N/mm²
SOPRAL P40	300-350	260-300	8-10	95-105	67.000
SOPRAL P60	490-560	420-480	11-15	154-169	72.000
SOPRAL P65	550-600	490-530	12-15	160-180	72.000
SOPRAL A-G3M	min. 200	–	–	–	71.000
SOPRAL A5	min. 100	–	–	–	69.000
2030 (Dural)	min. 390	–	–	–	–

1) the mechanical properties may vary according to size.
2) the Brinell hardness is only as a reference and can easily be used to distinguish between two aluminium grades and especially to be able to check whether the heat treatment has been carried out properly.
3) these values are the average of the tensile and compression moduli.

FABORY

STANDARD

ISO : –
EN : –
DIN : –

SOPRAL ALUMINIUM ALLOYS

info

5. Physical properties

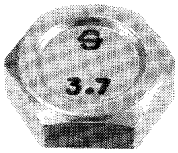
Material grade	Specific weight g/cm³	Electrical resistance at 20 °C Ohm mm²/m	Thermal conductivity at 20 °C th cm²/ms °C	Linear coëfficient of expansion between 20 and 100 °C	Melting range °C
SOPRAL P40	2,7	0,0325	0,44	23×10^{-6}	615 - 655
SOPRAL P60	2,8	0,055	0,29	$27,5 \times 10^{-6}$	475 - 635
SOPRAL P65	2,8	0,61	0,29	$23,5 \times 10^{-6}$	475 - 635

6. Pre-loads and tightening torques

Nominal size			M3	M4	M5	M6	M8	M10	M12	M16	M20	M24	M27
Pre-load in N	SOPRAL P60						8000	14000	21000	40000	62000	100.000	130.000
Tightening torque in Nm	SOPRAL P40	min.	–	0,9	1,6	2,7	7,5	14	28	–	–	–	–
		max.	–	1,1	1,9	3,3	8	17	32	–	–	–	–
	SOPRAL P60	min.	–	–	–	–	8	15	30	65	110	200	300
		max.	–	–	–	–	10	20	40	90	150	280	400
	SOPRAL P65	min.	0,5	1,3	2,5	4,4	11	–	–	–	–	–	–
		max.	0,6	3,16	3	5	12,5	–	–	–	–	–	–

These tightening torques are based on a friction coëfficient of ≈ 0,05.
Torquing on the minimum values with a torque wrench is preferred.
The maximum values shall never be exceeded.
This table serves only as a reference, for which no liability is accepted.

7. Marking



The hexagon bolts -grade SOPRAL P60- are marked on the head with the manufacturer's mark S for SOPRAL and the digit combination 3.7.
The first digit 3 identifies the special heat treatment T 73.
The second digit 7 indicates that grade P60 is made from the aluminium alloy 7075.
These marks are according to the specifications of the EDF (Electricité de France).
All other aluminium fasteners are not marked.

8. Surface treatment and colour

SOPRAL P40 for common use is delivered untreated. The colour is silver-white.
On request these fasteners can be pickled and greased with lanoline for easier assembly and disassembly, or anodized and greased with lanoline for difficult usage conditions, or colour anodized for decoration.
SOPRAL P60 is anodized (thickness of layer: 8-12 microns), bichromated and grease impregnated according to the specifications of the EDF (Electricité de France). In this condition an optimal corrosion resistance and ease of assembling are obtained. In the case of strong dynamic loads is advisable to request P60 without grease impregnation. The colour is yellow.
SOPRAL P65 are supplied colourless anodized. For decoration the screws are chemically brightened and/or colour anodized.

9. Corrosion resistance

Because of the automatic restoration of a thin self-protecting layer of aluminium oxide the SOPRAL grades offer an effective to excellent resistance to attack by the atmosphere, industry and sea water.
In this respect P40 is most favourable.
The majority of chemicals have no effect. However strong bases with a pH > 10, e.g. sodium and potassium, and concentrated acids with a pH < 4, e.g. hydrochloric and sulphuric acid, have to be avoided.
SOPRAL P60 has undergone a special heat treatment T 73 (see clause 3) providing an optimal resistance to intergranular and stress corrosion in agressive environments and making it immune to exfoliation corrosion type.
When aluminium, in the presence of a conducting liquid, comes in contact with another more electropositive metal e.g. steel, stainless steel, copper, it will corrode. On the other hand, when in contact with more electronegative metals, e.g. magnesium, zinc etc., then these will be corroded, thus protecting the aluminium.
To prevent contact corrosion it is advisable to use aluminium fasteners in aluminium constructions.

10. Weldability

You are strictly advised against performing welding on P60 and P65 bolts and nuts; the heat generation during welding has the effect of totally or partially destroying the mechanical properties acquired by the heat treatment.
SOPRAL P40 can be welded using all normal methods.

STANDARD
ISO : –
EN : –
DIN : –

PLASTICS

1. Polyamide PA 6-6 (nylon)

1.1 Scope and field of application

These specifications apply to mechanical fasteners (mainly bolts, screws and nuts) made from **thermoplastic** polyamide PA 6-6 -often called nylon- of the manufacturer's trade mark PLASTIVIS as indicated in section 10.

The field of application extends to nearly all sectors of industry, where low strength is not detrimental, but the following other performance properties may be attractive:

- rust-proof under atmospheric influences, humidity, soft and sea water. No danger of rust or seizing.
- chemical-resistant to usual solvents e.g. acetone, alcohol, petrol, benzol, trichlorethylene and to oil, grease, bases and most diluted acids. Not resistant to concentrated acids. See the chemical corrosion table elsewhere in this section.
- not toxic and so applicable in the food industry.
- electrically and termally insulating.
- not magnetizable, which is important in the electrotechnical industry.
- light in weight, about 7 times lighter than steel and even about $2^1/_2$ times lighter than aluminium, so an ideal material for all applications where light weight plays an important role.
- self-locking against loosening; no rattling joints.
- esthetical performance. The standard colour is natural white. On request other colours can also be manufactured in order to harmonize it with whatever it is used with.
- auto-extinguishable according to the American specification ASTM D 635.

1.2 Mechanical properties

tensile strength	53 N/mm²	acc. to ISO 527
shear strength	54 N/mm²	acc. to ASTM D 732
Shore hardness	7,5 N/mm²	acc. to ISO 868

	M 3	M 4	M 5	M 6	M 8	M 10	M 12
breaking loads in N	200	400	700	1000	2000	2500	4000
tightening torques in Nm	0,13	0,35	0,6	1,27	3,91	6,8	

These are theoretical values determined in the laboratory at 60% relative humidity and 23 °C. The mechanical properties will decrease with increasing temperature and humidity. You are advised to take your own tests, depending on the real circumstances.

1.3 Chemical properties (see table on next page)

1.4 Physical properties

density	1,14 g/cm³	acc. to ISO R1183

humidity absorption cold water	1,3 - 1,4%	acc. to ISO 62
humidity absorption hot water	1,95%	acc. to ISO 62

1.5 Thermal properties

fusion point	255 ° C
normal use temperature	-20 to 100 ° C
peak use temperature	150 ° C

linear expansion coefficient	11 x 10^{-5} per °C	acc. to ASTM D 696
combustability	V 2	acc. to UL 94

1.6 Electrical properties

transversal resistance	10^{11} ohm cm
dielectric rigidity	24,7 kV/mm

conductivity resistance	300 V	

1.7 Tolerances on dimensions

screwthread		
	external thread	internal thread
major diameter	8 e	2 x 7G
minor diameter	2 x 8g	7H
effective diameter	2 x 8g	2 x 7H
pitch	± 5%	

For all other dimensions the tolerances indicated in DIN 267 Part 2 and DIN ISO 4759 have to be doubled.

For more technical data see VDI-Richtlinien 2544 "Fasteners made from thermoplastics".

2. Phenolformaldehyde FS 31 (bakelite)

FS 31 is a heat treatable **duroplastic** on the base of phenolformaldehyde-resin with wood flour as a filler, often also called bakelite.

In the designation FS 31 the letters FS are an abbreviation of the German word "Formstoff", the number 31 identifies the type of fillermaterial, in this case wood flour in the phenoplastic mass.

FS 31 belongs to group 1 of the phenoplastics, used for general applications e.g. the plastic ball knobs, star grips, hand wheels, knurled thumb screws and hand knobs in section 10. Some of the most important properties are:

Density DIN 53479 g/cm³	Tensile strength DIN 53455 N/mm²	Bending strength DIN 53452 N/mm²	Shock resistance DIN 53453 kJ/m²	Impact strength DIN 53457 kJ/m²	Form stability DIN 53458 °C	Temperature range °C	Water absorption DIN 53472 mg	Surface resistance DIN 53482 Ohm	Transversal resistance DIN 53482 Ohm . cm	Disruptive strength DIN 53481 kV/mm
1,4	min. 25	min. 70	min. 6	min. 1,5	min. 125	-40/+ 100	max. 150	10^8	10^{10}	15 - 20

For more technical data see DIN 7708.

FABORY

STANDARD

ISO : –
EN : –
DIN : –

PLASTICS

CHEMICAL PROPERTIES OF PA6-6

1 good
2 moderate (swelling and/or decrease of properties)
3 bad

CHEMICAL AGENT	CONCENTRATION IN %	resistance at		CHEMICAL AGENT	CONCENTRATION IN %	resistance at	
		Temp. 23°C	Temp. 100°C			Temp. 23°C	Temp. 100°C
acetic acid	10	2	3	mineral oils		1	1
acetic acid	30	3	3	monochloric acetic acid	10	3	
acetic acid	90	3	3				
acetone		1		nitric acid	0,1	2	
aluminium chloride	10	1		nitric acid	5	3	3
ammonia gas		2	3	nitric acid	45	1	2
ammonium chloride	35	1	2				
ammonium hydroxide	40	1		oxalic acid	10	2	
aniline		3		ozone		3	
benzene		1		perchlorethylene		1	3
benzene carbon acid	conc.	3		perchloric acid	10	3	
				petrol		1	
calcium chloride	10	1	2	petroleum oil		1	
calcium chloride	saturated	2	3	petrolic ether		1	
chlorine water	normal	2		phenol		3	
chlorine water	10	3		phosphoric acid	0,3	1	
chloroform		3		phosphoric acid	3	2	
chrome alun	10	1		phosphoric acid	10	3	3
citric acid	10	2		potassium hydroxide	10	1	
citric acid	conc.	2		potassium hydroxide	50	2	
copper sulphate	saturated	1		potassium nitrate	10	1	
copper sulphate	0,5	2		potassium permanganate	1	3	
cresol		3		pyridine		1	
cyclohexanol		2		pyrocatechol	norm.	3	
ether		1		resorcinol		3	
ethylacetate		1					
ethylalcohol	96	1		silicone oils		1	
ethylenedichloride		1		soap	norm.	1	
				sodium acetate	5	1	
ferrichloride	2,5	2	3	sodium bisulphate	20	1	2
ferrichloride	5	2		sodium carbonate	saturated	1	
ferrichloride	10	3		sodium chloride	5	1	2
formaldehyde	30	1		sodium dichromate	10	1	
formic acid	2	2		sodium hydroxide	10	1	
formic acid	10	3		sodium hydroxide	50	2	
formic acid	90	3		sodium mono sulphide	2	1	
				sodium silicate	saturated	1	
glycerol, glycol		1	3	sodium sulphate	10	1	
				sulphuric acid	6	3	
hydrochloric acid	2	2	3	sulphuric acid	100	3	
hydrochloric acid	10	3					
hydrogen peroxide	0,5	2		tetrachlor methane		1	
hydrogen peroxide	1	3		toluene		1	
				trichlorethylene		1	2
lactic acid	90	3					
				vegetable oils		1	1
magnesium chloride	10	1					
maleic acid	conc.	3		water		1	2
malonic acid	conc.	3		wine	1	1	
manganic sulphate	10	1					
mercuric chloride	verz.	2		xylene			
mercuric chloride	10	2					
methanol	95	1		zinc chloride	10	2	

FABORY

STANDARD

ISO : 31
EN : –
DIN : 301

TABLES

SI-units and conversion factors

1. The SI-Units system

From 1 January 1978 a law has been constituted that in all member countries of the E.E.C. only officially **recognized** units shall be used. They mainly belong to the "International System of Units, abbreviated SI (**S**ystème **I**nternational d'Unite's).

The object of the SI is that it shall replace **all** other unit systems, which were developed in the past (including the Anglo-Saxon system based on foot and pound) and shall be applied in **all** professional fields and **all over** the world.
The SI offers the possibility of achieving international uniformity with as few units as possible. Besides some so-called "old" units which shall still be accepted for the time being amongst others minute, hour, day, degree Celsius, the designations of the angle: degree, minute and second, litre, ton, bar (for liquid and gas pressure) are, nautical mile, knot and register ton, the introduction of the SI means that a number of familiar units will disappear, including kilogram force (kgf), horsepower(hp), the technical atmospheric pressure (at, also designated by kg/cm^2 or kgf/cm^2), calorie (cal or kilocalorie) and also all Anglo-Saxon units.
In the following tables a selection is given of those units and conversion factors that are commonly used in fastening technics.

			Some new units		
name	Symbol	Unit of:	replaces:	Mutual conversion (rounded off)	
newton	N	force	kgf,kp	1N≈0,1 kgf≈0,1 kp	1 kgf≈1 kp≈10N
joule	J	energy, work, heat	kcal, cal, kgf.m or kgm Btu (British thermal unit)	1J≈1Nm≈0,1 kgf.m 1J≈0,739 cal	1 kgf.m≈10J≈10Nm 1 cal≈4,187J
bar	bar	pressure of liquids and gases	at, kgf/cm^2 or kg/cm^2	1 bar≈1at≈1kgf/cm^2≈kg/cm^2	1 at≈1 bar
kelvin	K	temperature	partly degree °C	Tk≈273,15+$T_{°C}$	$T_{°C}$≈Tk-273,15
			Some old units still remaining		
meter	m	length	–		
second	s	time	–		
kilogram	kg	mass (quantity)	unit weight (weight is force)	1 kg (mass)≈10 N (weight) on earth	
volt	V	electrical voltage	–		
ampere	A	electrical current	–		
watt	W	power (not only electrical)	pk, hp and kcal/h	1 kW≈1,359 pk 1 kW≈1,341 hp 1 kW≈959,845 kcal/h	1 pk≈0,7355 kW 1 hp≈0,7457 kW 1 kcal/h≈0,001163 kW
			Some derived units		
–	N/mm^2	areal force (tension)	kgf/mm^2	1 N/mm^2	1 kgf/mm^2≈10Nmm^2
–	Nm	moment of force	kgfm	1 Nm≈0,1 kgfm	1kgfm≈10 Nm

2. Conversion factors between SI- and Anglo-Saxon units

Length

1 mm	= 0,3937 inches	1 inch	= 25,40 mm
1 m	= 3,2808 feet	1 foot	= 0,3048 m
1 m	= 1,0936 yards	1 yard	= 0,9144 m
1 km	= 0,6214 miles	1 mile	= 1,609 km

Volume

1 mm^3	= 6,10234x10^{-5} $inches^3$	1 $inch^3$	= 1,6387x10^4 mm^3
1 m^3	= 6,10234x10^4 $inches^3$	1 $inch^3$	= 1,6387x10^{-5} m^3
1 m^3	= 35,3147 $feet^3$	1 $foot^3$	= 0,0283 m^3
1 m^3	= 1,3079 $yards^3$	1 $yard^3$	= 0,7645 m^3
1 L	= 0,219 gallons (Brit)	1 gallon(brit)	= 4,566 L
1 L	= 0,264 gallons (USA)	1 gallon (USA)	= 3,7878 L

Energy, work, heat

1 J	= 0,7375 lbf ft	1 lbf ft	= 1,3559 J
1 J	= 2,77x10^{-7} kWh	1 kWh	= 3,6x10^6 J
1 J	= 0,9478x10^{-3} Btu	1 Btu	= 1055,06 J

Area

1 mm^2	= 0,00155 sq. inches	sq. inches	= 645,16 mm^2
1 m^2	= 10,764 sq. feet	sq. feet	= 0,0929 m^2
1 m^2	= 1,196 sq. yards	sq. yards	= 0,836 m^2
1 km^2	= 0,3861 sq. miles	sq. miles	= 2,5889 km^2

Mass

1 gram	= 0,035274 ounces	1 ounce	= 28,349 gram
1 kg	= 2,2046 pounds	1 pound	= 0,4536 kg
1 kg	= 0,0197 CWT	1 CWT	= 50,802 kg
1 ton	= 0,9842 longtons	1 longton	= 1,016 ton

Force

1 N	= 0,2248 lbf	1 lbf	= 4,4482 N
1 kN	= 0,1003 longtonf	1 longtonf	= 9,964 kN

Areal force (tension)

1 N/mm^2	= 145,038 lbf/in^2	1 lbf/in^2	= 0,0069 N/mm^2

Moment of force

1 Nm	= 141,612 ounce-inch	1 ounce-inch	= 0,00706 Nm
1 Nm	= 8,851 pound-inch	1 pound-inch	= 0,113 Nm
1 Nm	= 0,738 pound-foot	1 pound-foot	= 1,3558 Nm

3. Temperature conversion Celsius/Fahrenheit

°C=5/9 (°F-32°) °F=9/5 °C+32°

°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →	°C ←	T ↓	°F →
-28.9	**-20**	-4	43.3	**110**	230	115.6	**240**	464	188	**370**	698	260	**500**	932	332	**630**	1166	404	**760**	1400	477	**890**	1634	549	**1020**	1868	621	**1150**	2102	693	**1280**	2336
-23.3	**-10**	14	48.9	**120**	248	121.1	**250**	482	193	**380**	716	266	**510**	950	338	**640**	1184	410	**770**	1418	482	**900**	1652	554	**1030**	1886	627	**1160**	2120	699	**1290**	2354
-17.8	**0**	32	54.4	**130**	266	127	**260**	500	199	**390**	734	271	**520**	968	343	**650**	1202	416	**780**	1436	488	**910**	1670	560	**1040**	1904	632	**1170**	2138	704	**1300**	2372
-12.2	**10**	50	60.0	**140**	284	132	**270**	518	204	**400**	752	277	**530**	986	349	**660**	1220	421	**790**	1454	493	**920**	1688	566	**1050**	1922	638	**1180**	2156	710	**1310**	2390
-6.7	**20**	68	65.6	**150**	302	138	**280**	536	210	**410**	770	282	**540**	1004	354	**670**	1238	427	**800**	1472	499	**930**	1706	571	**1060**	1940	643	**1190**	2174	716	**1320**	2408
-1.1	**30**	86	71.1	**160**	320	143	**290**	554	216	**420**	788	288	**550**	1022	360	**680**	1256	432	**810**	1490	504	**940**	1724	577	**1070**	1958	649	**1200**	2192	721	**1330**	2426
4.4	**40**	104	76.7	**170**	338	149	**300**	572	221	**430**	806	293	**560**	1040	366	**690**	1274	438	**820**	1508	510	**950**	1742	582	**1080**	1976	654	**1210**	2210	727	**1340**	2444
10.0	**50**	122	82.2	**180**	356	154	**310**	590	227	**440**	824	299	**570**	1058	371	**700**	1292	443	**830**	1526	516	**960**	1760	588	**1090**	1994	660	**1220**	2228	732	**1350**	2462
15.6	**60**	140	87.8	**190**	374	160	**320**	608	232	**450**	842	304	**580**	1076	377	**710**	1310	449	**840**	1544	521	**970**	1778	593	**1100**	2012	666	**1230**	2246	738	**1360**	2480
21.1	**70**	158	93.3	**200**	392	166	**330**	626	238	**460**	860	310	**590**	1094	382	**720**	1328	454	**850**	1562	527	**980**	1796	599	**1110**	2030	671	**1240**	2264	743	**1370**	2498
26.7	**80**	176	98.9	**210**	410	171	**340**	644	243	**470**	878	316	**600**	1112	388	**730**	1346	460	**860**	1580	532	**990**	1814	604	**1120**	2048	677	**1250**	2282	749	**1380**	2516
32.2	**90**	194	104.4	**220**	428	177	**350**	662	249	**480**	896	321	**610**	1130	393	**740**	1364	466	**870**	1598	538	**1000**	1832	610	**1130**	2066	682	**1260**	2300	754	**1390**	2534
37.8	**100**	212	110.0	**230**	446	182	**360**	680	254	**490**	914	327	**620**	1148	399	**750**	1382	471	**880**	1616	543	**1010**	1850	616	**1140**	2084	688	**1270**	2318	760	**1400**	2552

PER DEGREE	
°C °F	°F °C
1= 1.8	1=0.56
2= 3.6	2=1.11
3= 5.4	3=1.67
4= 7.2	4=2.22
5= 9.0	5=2.78
6=10.8	6=3.33
7=12.6	7=3.89
8=14.4	8=4.44
9=16.2	9=5.0

Look up the given temperature in °C or °F in the middle column. The required temperature in °C can be found in the column on the left side and in °F on the right side e.g. in colum T, 200°C corresponds to the right side with 392°F and 200°F to the left side with 99,3°C. Never convert mutually between the column °C and °F. A more accurate result (with a maximum deviation of 0,44° in converting from °F to °C) is achieved by using the values from 1° till 9° on the right side of the table.
Example: 814°C = 810°C + 4°C = 1490°F + 7,2°F = 1497,2°F.

FABORY

STANDARD

ISO : –
EN : –
DIN : 4892

TABLES

Conversion from inch to decimal inch to millimeter

in.	dec. in	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
		Millimeter (mm)											
0	0	0	25,400 0	50,800 0	76,200 0	101,600 0	127,000 0	152,400 0	177,800 0	203,200 0	228,600 0	254,000 0	279,400 0
1/64	0,015 625	0,396 9	25,796 9	51,196 9	76,596 9	101,996 9	127,396 9	152,796 9	178,196 9	203,596 9	228,996 9	254,396 9	279,796 9
1/32	0,031 25	0,793 8	26,193 8	51,593 8	76,993 8	102,393 8	127,793 8	153,193 8	178,593 8	203,993 8	229,393 8	254,793 8	280,193 8
3/64	0,046 875	1,190 6	26,590 6	51,990 6	77,390 6	102,790 6	128,190 6	153,590 6	178,990 6	204,390 6	229,790 6	255,190 6	280,590 6
1/16	0,062 5	1,587 5	26,987 5	52,387 5	77,787 5	103,187 5	128,587 5	153,987 5	179,387 5	204,787 5	230,187 5	255,587 5	280,987 5
5/64	0,078 125	1,984 4	27,384 4	52,784 4	78,184 4	103,584 4	128,984 4	154,384 4	179,784 4	205,184 4	230,584 4	255,984 4	281,384 4
3/32	0,093 75	2,381 2	27,781 2	53,181 2	78,581 2	103,981 2	129,381 2	154,781 2	180,181 2	205,581 2	230,981 2	256,381 2	281,781 2
7/64	0,109 375	2,778 1	28,178 1	53,578 1	78,978 1	104,378 1	129,778 1	155,178 1	180,578 1	205,978 1	231,378 1	256,778 1	282,178 1
1/8	**0,125**	**3,175 0**	**28,575 0**	**53,975 0**	**79,375 0**	**104,775 0**	**130,175 0**	**155,575 0**	**180,975 0**	**206,375 0**	**231,775 0**	**257,175 0**	**282,575 0**
9/64	0,140 625	3,571 9	28,971 9	54,371 9	79,771 9	105,171 9	130,571 9	155,971 9	181,371 9	206,771 9	232,171 9	257,571 9	282,971 9
5/32	0,156 25	3,968 8	29,368 8	54,768 8	80,168 8	105,568 8	130,968 8	156,368 8	181,768 8	207,168 8	232,568 8	257,968 8	283,368 8
11/64	0,171 875	4,365 6	29,765 6	55,165 6	80,565 6	105,965 6	131,365 6	156,765 6	182,165 6	207,565 6	232,965 6	258,365 6	283,765 6
3/16	0,187 5	4,762 5	30,162 5	55,562 5	80,962 5	106,362 5	131,762 5	157,162 5	182,562 5	207,962 5	233,362 5	258,762 5	284,162 5
13/64	0,203 125	5,159 4	30,559 4	55,959 4	81,359 4	106,759 4	132,159 4	157,559 4	182,959 4	208,359 4	233,759 4	259,159 4	284,559 4
7/32	0,218 75	5,556 2	30,956 2	56,356 2	81,756 2	107,156 2	132,556 2	157,956 2	183,356 2	208,756 2	234,156 2	259,556 2	284,956 2
15/64	0,234 375	5,953 1	31,353 1	56,753 1	82,153 1	107,553 1	132,953 1	158,353 1	183,753 1	209,153 1	234,553 1	259,953 1	285,353 1
1/4	**0,25**	**6,350 0**	**31,750 0**	**57,150 0**	**82,550 0**	**107,950 0**	**133,350 0**	**158,750 0**	**184,150 0**	**209,550 0**	**234,950 0**	**260,350 0**	**285,750 0**
17/64	0,265 625	6,746 9	32,146 9	57,546 9	82,946 9	108,346 9	133,746 9	159,146 9	184,546 9	209,946 9	235,346 9	260,746 9	286,146 9
9/32	0,281 25	7,143 8	32,543 8	57,943 8	83,343 8	108,743 8	134,143 8	159,543 8	184,943 8	210,343 8	235,743 8	261,143 8	286,543 8
19/64	0,296 875	7,540 6	32,940 6	58,340 6	83,740 6	109,140 6	134,540 6	159,940 6	185,340 6	210,740 6	236,140 6	261,540 6	286,940 6
5/16	0,312 5	7,937 5	33,337 5	58,737 5	84,137 5	109,537 5	134,937 5	160,337 5	185,737 5	211,137 5	236,537 5	261,937 5	287,337 5
21/64	0,328 125	8,334 4	33,734 4	59,134 4	84,534 4	109,934 4	135,334 4	160,734 4	186,134 4	211,534 4	236,934 4	262,334 4	287,734 4
11/32	0,343 75	8,731 2	34,131 2	59,531 2	84,931 2	110,331 2	135,731 2	161,131 2	186,531 2	211,931 2	237,331 2	262,731 2	288,131 2
23/64	0,359 375	9,128 1	34,528 1	59,928 1	85,328 1	110,728 1	136,128 1	161,528 1	186,928 1	212,328 1	237,728 1	263,128 1	288,528 1
3/8	**0,375**	**9,525 0**	**34,925 0**	**60,325 0**	**85,725 0**	**111,125 0**	**136,525 0**	**161,925 0**	**187,325 0**	**212,725 0**	**238,125 0**	**263,525 0**	**288,925 0**
25/64	0,390 625	9,921 9	35,321 9	60,721 9	86,121 9	111,521 9	136,921 9	162,321 9	187,721 9	213,121 9	238,521 9	263,921 9	289,321 9
13/32	0,406 25	10,318 8	35,718 8	61,118 8	86,518 8	111,918 8	137,318 8	162,718 8	188,118 8	213,518 8	238,918 8	264,318 8	289,718 8
27/64	0,421 875	10,715 6	36,115 6	61,515 6	86,915 6	112,315 6	137,715 6	163,115 6	188,515 6	213,915 6	239,315 6	264,715 6	290,115 6
7/16	0,437 5	11,112 5	36,512 5	61,912 5	87,312 5	112,712 5	138,112 5	163,512 5	188,912 5	214,312 5	239,712 5	265,112 5	290,512 5
29/64	0,453 125	11,509 4	36,909 4	62,309 4	87,709 4	113,109 4	138,509 4	163,909 4	189,309 4	214,709 4	240,109 4	265,509 4	290,909 4
15/32	0,468 75	11,906 2	37,306 2	62,706 2	88,106 2	113,506 2	138,906 2	164,306 2	189,706 2	215,106 2	240,506 2	265,906 2	291,306 2
31/64	0,484 375	12,303 1	37,703 1	63,103 1	88,503 1	113,903 1	139,303 1	164,703 1	190,103 1	215,503 1	240,903 1	266,303 1	291,703 1
1/2	**0,5**	**12,700 0**	**38,100 0**	**63,500 0**	**88,900 0**	**114,300 0**	**139,700 0**	**165,100 0**	**190,500 0**	**215,900 0**	**241,300 0**	**266,700 0**	**292,100 0**
33/64	0,515 625	13,096 9	38,496 9	63,896 9	89,296 9	114,696 9	140,096 9	165,496 9	190,896 9	216,296 9	241,696 9	267,096 9	292,496 9
17/32	0,531 25	13,493 8	38,893 8	64,293 8	89,693 8	115,093 8	140,493 8	165,893 8	191,293 8	216,693 8	242,093 8	267,493 8	292,893 8
35/64	0,546 875	13,890 6	39,290 6	64,690 6	90,090 6	115,490 6	140,890 6	166,290 6	191,690 6	217,090 6	242,490 6	267,890 6	293,290 6
9/16	0,562 5	14,287 5	39,687 5	65,087 5	90,487 5	115,887 5	141,287 5	166,687 5	192,087 5	217,487 5	242,887 5	268,287 5	293,687 5
37/64	0,578 125	14,684 4	40,084 4	65,484 4	90,884 4	116,284 4	141,684 4	167,084 4	192,484 4	217,884 4	243,284 4	268,684 4	294,084 4
19/32	0,593 75	15,081 2	40,481 2	65,881 2	91,281 2	116,681 2	142,081 2	167,481 2	192,881 2	218,281 2	243,681 2	269,081 2	294,481 2
39/64	0,609 375	15,478 1	40,878 1	66,278 1	91,678 1	117,078 1	142,478 1	167,878 1	193,278 1	218,678 1	244,078 1	269,478 1	294,878 1
5/8	**0,625**	**15,875 0**	**41,275 0**	**66,675 0**	**92,075 0**	**117,475 0**	**142,875 0**	**168,275 0**	**193,675 0**	**219,075 0**	**244,475 0**	**269,875 0**	**295,275 0**
41/64	0,640 625	16,271 9	41,671 9	67,071 9	92,471 9	117,871 9	143,271 9	168,671 9	194,071 9	219,471 9	244,871 9	270,271 9	295,671 9
21/32	0,656 25	16,668 8	42,068 8	67,468 8	92,868 8	118,268 8	143,668 8	169,068 8	194,468 8	219,868 8	245,268 8	270,668 8	296,068 8
43/64	0,671 875	17,065 6	42,465 6	67,865 6	93,265 6	118,665 6	144,065 6	169,465 6	194,865 6	220,265 6	245,665 6	271,065 6	296,465 6
11/16	0,687 5	17,462 5	42,862 5	68,262 5	93,662 5	119,062 5	144,462 5	169,862 5	195,262 5	220,662 5	246,062 5	271,462 5	296,862 5
45/64	0,703 125	17,859 4	43,259 4	68,659 4	94,059 4	119,459 4	144,859 4	170,259 4	195,659 4	221,059 4	246,459 4	271,859 4	297,259 4
23/32	0,718 75	18,256 2	43,656 2	69,056 2	94,456 2	119,856 2	145,256 2	170,656 2	196,056 2	221,456 2	246,856 2	272,256 2	297,656 2
47/64	0,734 375	18,653 1	44,053 1	69,453 1	94,853 1	120,253 1	145,653 1	171,053 1	196,453 1	221,853 1	247,253 1	272,653 1	298,053 1
3/4	**0,75**	**19,050 0**	**44,450 0**	**69,850 0**	**95,250 0**	**120,650 0**	**146,050 0**	**171,450 0**	**196,850 0**	**222,250 0**	**247,650 0**	**273,050 0**	**298,450 0**
49/64	0,765 625	19,446 9	44,846 9	70,246 9	95,646 9	121,046 9	146,446 9	171,846 9	197,246 9	222,646 9	248,046 9	273,446 9	298,846 9
25/32	0,781 25	19,843 8	45,243 8	70,643 8	96,043 8	121,443 8	146,843 8	172,243 8	197,643 8	223,043 8	248,443 8	273,843 8	299,243 8
51/64	0,796 875	20,240 6	45,640 6	71,040 6	96,440 6	121,840 6	147,240 6	172,640 6	198,040 6	223,440 6	248,840 6	274,240 6	299,640 6
13/16	0,812 5	20,637 5	46,037 5	71,437 5	96,837 5	122,237 5	147,637 5	173,037 5	198,437 5	223,837 5	249,237 5	274,637 5	300,037 5
53/64	0,828 125	21,034 4	46,434 4	71,834 4	97,234 4	122,634 4	148,034 4	173,434 4	198,834 4	224,234 4	249,634 4	275,034 4	300,434 4
27/32	0,843 75	21,431 2	46,831 2	72,231 2	97,631 2	123,031 2	148,431 2	173,831 2	199,231 2	224,631 2	250,031 2	275,431 2	300,831 2
55/64	0,859 375	21,828 1	47,228 1	72,628 1	98,028 1	123,428 1	148,828 1	174,228 1	199,628 1	225,028 1	250,428 1	275,828 1	301,228 1
7/8	**0,875**	**22,225 0**	**47,625 0**	**73,025 0**	**98,425 0**	**123,825 0**	**149,225 0**	**174,625 0**	**200,025 0**	**225,425 0**	**250,825 0**	**276,225 0**	**301,625 0**
57/64	0,890 625	22,621 9	48,021 9	73,421 9	98,821 9	124,221 9	149,621 9	175,021 9	200,421 9	225,821 9	251,221 9	276,621 9	302,021 9
29/32	0,906 25	23,018 8	48,418 8	73,818 8	99,218 8	124,618 8	150,018 8	175,418 8	200,818 8	226,218 8	251,618 8	277,018 8	302,418 8
59/64	0,921 875	23,415 6	48,815 6	74,215 6	99,615 6	125,015 6	150,415 6	175,815 6	201,215 6	226,615 6	252,015 6	277,415 6	302,815 6
15/16	0,937 5	23,812 5	49,212 5	74,612 5	100,012 5	125,412 5	150,812 5	176,212 5	201,612 5	227,012 5	252,412 5	277,812 5	303,212 5
61/64	0,953 125	24,209 4	49,609 4	75,009 4	100,409 4	125,809 4	151,209 4	176,609 4	202,009 4	227,409 4	252,809 4	278,209 4	303,609 4
31/32	0,968 75	24,606 2	50,006 2	75,406 2	100,806 2	126,206 2	151,606 2	177,006 2	202,406 2	227,806 2	253,206 2	278,606 2	304,006 2
63/64	0,984 375	25,003 1	50,403 1	75,803 1	101,203 1	126,603 1	152,003 1	177,403 1	202,803 1	228,203 1	253,603 1	279,003 1	304,403 1
		12"	13"	14"	15"	16"	17"	18"	19"	20"	21"	22"	23"
in.	dec. in.	Millimeter (mm)											
0	0	304,800 0	330,200 0	355,600 0	381,000 0	406,400 0	431,800 0	457,200 0	482,600 0	508,000 0	533,400 0	558,800 0	584,200 0
1/32	0,031 25	305,593 8	330,993 8	356,393 8	381,793 8	407,193 8	432,593 8	457,993 8	483,393 8	508,793 8	534,193 8	559,593 8	584,993 8
1/16	0,062 5	306,387 5	331,787 5	357,187 5	382,587 5	407,987 5	433,387 5	458,787 5	484,187 5	509,587 5	534,987 5	560,387 5	585,787 5
3/32	0,093 75	307,181 2	332,581 2	357,981 2	383,381 2	408,781 2	434,181 2	459,581 2	484,981 2	510,381 2	535,781 2	561,181 2	586,581 2
1/8	**0,125**	**307,975 0**	**333,375 0**	**358,775 0**	**384,175 0**	**409,575 0**	**434,975 0**	**460,375 0**	**485,775 0**	**511,175 0**	**536,575 0**	**561,975 0**	**587,375 0**
5/32	0,156 25	308,768 8	334,168 8	359,568 8	384,968 8	410,368 8	435,768 8	461,168 8	486,568 8	511,968 8	537,368 8	562,768 8	588,168 8
3/16	0,187 5	309,562 5	334,962 5	360,362 5	385,762 5	411,162 5	436,562 5	461,962 5	487,362 5	512,762 5	538,162 5	563,562 5	588,962 5
7/32	0,218 75	310,356 2	335,756 2	361,156 2	386,556 2	411,956 2	437,356 2	462,756 2	488,156 2	513,556 2	538,956 2	564,356 2	589,756 2
1/4	**0,25**	**311,150 0**	**336,550 0**	**361,950 0**	**387,350 0**	**412,750 0**	**438,150 0**	**463,550 0**	**488,950 0**	**514,350 0**	**539,750 0**	**565,150 0**	**590,550 0**
9/32	0,281 25	311,943 8	337,343 8	362,743 8	388,143 8	413,543 8	438,943 8	464,343 8	489,743 8	515,143 8	540,543 8	565,943 8	591,343 8
5/16	0,312 5	312,737 5	338,137 5	363,537 5	388,937 5	414,337 5	439,737 5	465,137 5	490,537 5	515,937 5	541,337 5	566,737 5	592,137 5
11/32	0,343 75	313,531 2	338,931 2	364,331 2	389,731 2	415,131 2	440,531 2	465,931 2	491,331 2	516,731 2	542,131 2	567,531 2	592,931 2
3/8	**0,375**	**314,325 0**	**339,725 0**	**365,125 0**	**390,525 0**	**415,925 0**	**441,325 0**	**466,725 0**	**492,125 0**	**517,525 0**	**542,925 0**	**568,325 0**	**593,725 0**
13/32	0,406 25	315,118 8	340,518 8	365,918 8	391,318 8	416,718 8	442,118 8	467,518 8	492,918 8	517,318 8	543,718 8	569,118 8	594,518 8
7/16	0,437 5	315,912 5	341,312 5	366,712 5	392,112 5	417,512 5	442,912 5	468,312 5	493,712 5	519,112 5	544,512 5	569,912 5	595,312 5
15/32	0,468 75	316,706 2	342,106 2	367,506 2	392,906 2	418,306 2	443,706 2	469,106 2	494,506 2	519,906 2	545,306 2	570,706 2	596,106 2
1/2	**0,5**	**317,500 0**	**342,900 0**	**368,300 0**	**393,700 0**	**419,100 0**	**444,500 0**	**469,900 0**	**495,300 0**	**520,700 0**	**546,100 0**	**571,500 0**	**596,900 0**
17/32	0,531 25	318,293 8	343,693 8	369,093 8	394,493 8	419,893 8	445,293 8	470,693 8	496,093 8	521,493 8	546,893 8	572,293 8	597,693 8
9/16	0,562 5	319,087 5	344,487 5	369,887 5	395,287 5	420,687 5	446,087 5	471,487 5	496,887 5	522,287 5	547,687 5	573,087 5	598,487 5
19/32	0,593 75	319,881 2	345,281 2	370,681 2	396,081 2	421,481 2	446,881 2	472,281 2	497,681 2	523,081 2	548,481 2	573,881 2	599,281 2
5/8	**0,625**	**320,675 0**	**346,075 0**	**371,475 0**	**396,875 0**	**422,275 0**	**447,675 0**	**473,075 0**	**498,475 0**	**523,875 0**	**549,275 0**	**574,675 0**	**600,075 0**
21/32	0,656 25	321,468 8	346,868 8	372,268 8	397,668 8	423,068 8	448,468 8	473,868 8	499,268 8	524,668 8	550,068 8	575,468 8	600,868 8
11/16	0,687 5	322,262 5	347,662 5	373,062 5	398,462 5	423,862 5	449,262 5	474,662 5	500,062 5	525,462 5	550,862 5	576,262 5	601,662 5
23/32	0,718 75	323,056 2	348,456 2	373,856 2	399,256 2	424,656 2	450,056 2	475,456 2	500,856 2	526,256 2	551,656 2	577,056 2	602,456 2
3/4	**0,75**	**323,850 0**	**349,250 0**	**374,650 0**	**400,050 0**	**425,450 0**	**450,850 0**	**476,250 0**	**501,650 0**	**527,050 0**	**552,450 0**	**577,850 0**	**603,250 0**
25/32	0,781 25	324,643 8	350,043 8	375,443 8	400,843 8	426,243 8	451,643 8	477,043 8	502,443 8	527,843 8	553,243 8	578,643 8	604,043 8
13/16	0,812 5	325,437 5	350,837 5	376,237 5	401,637 5	427,037 5	452,437 5	477,837 5	503,237 5	528,637 5	554,037 5	579,437 5	604,837 5
27/32	0,843 75	326,231 2	351,631 2	377,031 2	402,431 2	427,831 2	453,231 2	478,631 2	504,031 2	529,431 2	554,831 2	580,231 2	605,631 2
7/8	**0,875**	**327,025 0**	**352,425 0**	**377,825 0**	**403,225 0**	**428,625 0**	**454,025 0**	**479,425 0**	**504,825 0**	**530,225 0**	**555,625 0**	**581,025 0**	**606,425 0**
29/32	0,906 25	327,818 8	353,218 8	378,618 8	404,018 8	429,418 8	454,818 8	480,218 8	505,618 8	531,018 8	556,418 8	581,818 8	607,218 8
15/16	0,937 5	328,612 5	354,012 5	379,412 5	404,812 5	430,212 5	455,612 5	481,012 5	506,412 5	531,812 5	557,212 5	582,612 5	608,012 5
31/32	0,968 75	329,406 2	354,806 2	380,206 2	405,606 2	431,006 2	456,406 2	481,806 2	507,206 2	532,606 2	558,006 2	583,406 2	608,806 2

FABORY

STANDARD

ISO : 4964
EN : –
DIN : 50150

TABLES

Conversion of tensile strength, Vickers, Brinell and Rockwell hardnesses

Tensile strength N/mm²	Vickers hardness (F≥98N)	Brinell hardness ($0{,}102 \frac{F}{D^2 \cdot 30} \frac{N}{mm^2}$)	Rockwell hardness							
			HRB	HRF	HRC	HRA	HRD 1)	HR15N	HR30N	HR45N
255	80	76,0								
270	85	80,7	41,0							
285	90	85,5	48,0	82,6						
305	95	90,2	52,0							
320	100	95,0	56,2	87,0						
335	105	99,8								
350	110	105	62,3	90,5						
370	115	109								
385	120	114	66,7	93,6						
400	125	119								
415	130	124	71,2	96,4						
430	135	128								
450	140	133	75,0	99,0						
465	145	138								
480	150	143	78,7	101,4						
495	155	147								
510	160	152	81,7	103,6						
530	165	156								
545	170	162	85,0	105,5						
560	175	166								
575	180	171	87,1	107,2						
595	185	176								
610	190	181	89,5	108,7						
625	195	185								
640	200	190	91,5	110,1						
660	205	195	92,5							
675	210	199	93,5	111,3						
690	215	204	94,0							
705	220	209	95,0	112,4						
720	225	214	96,0							
740	230	219	96,7	113,4						
755	235	223								
770	240	228	98,1	114,3	20,3	60,7	40,3	69,6	41,7	19,9
785	245	233			21,3	61,2	41,1	70,1	42,5	21,1
800	250	238	99,5	115,1	22,2	61,6	41,7	70,6	43,4	22,2
820	255	242			23,1	62,0	42,2	71,1	44,2	23,2
835	260	247	(101)		24,0	62,4	43,1	71,6	45,0	24,3
850	265	252			24,8	62,7	43,7	72,1	45,7	25,2
865	270	257	(102)		25,6	63,1	44,3	72,6	46,4	26,2
880	275	261			26,4	63,5	44,9	73,0	47,2	27,1
900	280	266	(104)		27,1	63,8	45,3	73,4	47,8	27,9
915	285	271			27,8	64,2	46,0	73,8	48,4	28,7
930	290	276	(105)		28,5	64,5	46,5	74,2	49,0	29,5
950	295	280			29,2	64,8	47,1	74,6	49,7	30,4
965	300	285			29,8	65,2	47,5	74,9	50,2	31,1
995	310	295			31,0	65,8	48,4	75,6	51,3	32,5
1030	320	304			32,2	66,4	49,4	76,2	52,3	33,9
1060	330	314			33,3	67,0	50,2	76,8	53,6	35,2
1095	340	323			34,4	67,6	51,1	77,4	54,4	36,5
1125	350	333			35,5	68,1	51,9	78,0	55,4	37,8

Tensile strength N/mm²	Vickers hardness (F≥98N)	Brinell hardness ($0{,}102 \frac{F}{D^2 \cdot 30} \frac{N}{mm^2}$)	Rockwell hardness							
			HRB	HRF	HRC	HRA	HRD 1)	HR15N	HR30N	HR45N
1155	360	342			36,6	68,7	52,8	78,6	56,4	39,1
1190	370	352			37,7	69,2	53,6	79,2	57,4	40,4
1220	380	361			38,8	69,8	54,4	79,8	58,4	41,7
1255	390	371			39,8	70,3	55,3	80,3	59,3	42,9
1290	400	380			40,8	70,8	56,0	80,8	60,2	44,1
1320	410	390			41,8	71,4	56,8	81,4	61,1	45,3
1350	420	399			42,7	71,8	57,5	81,8	61,9	46,4
1385	430	409			43,6	72,3	58,2	82,3	62,7	47,4
1420	440	418			44,5	72,8	58,8	82,8	63,5	48,4
1455	450	428			45,3	73,3	59,4	83,2	64,3	49,4
1485	460	437			46,1	73,6	60,1	83,6	64,9	50,4
1520	470	447			46,9	74,1	60,7	83,9	65,7	51,3
1555	480	(456)			47,7	74,5	61,3	84,3	66,4	52,2
1595	490	(466)			48,4	74,9	61,6	84,7	67,1	53,1
1630	500	(475)			49,1	75,3	62,2	85,0	67,7	53,9
1665	510	(485)			49,8	75,7	62,9	85,4	68,3	54,7
1700	520	(494)			50,5	76,1	63,5	85,7	69,0	55,6
1740	530	(504)			51,1	76,4	63,9	86,0	69,5	56,2
1775	540	(513)			51,7	76,7	64,4	86,3	70,0	57,0
1810	550	(523)			52,3	77,0	64,8	86,6	70,5	57,8
1845	560	(532)			53,0	77,4	65,4	86,9	71,2	58,6
1880	570	(542)			53,6	77,8	65,8	87,2	71,7	59,3
1920	580	(551)			54,1	78,0	66,2	87,5	72,1	59,9
1955	590	(561)			54,7	78,4	66,7	87,8	72,7	60,5
1995	600	(570)			55,2	78,6	67,0	88,0	73,2	61,2
2030	610	(580)			55,7	78,9	67,5	88,2	73,7	61,7
2070	620	(589)			56,3	79,2	67,9	88,5	74,2	62,4
2105	630	(599)			56,8	79,5	68,3	88,8	74,6	63,0
2145	640	(608)			57,3	79,8	68,7	89,0	75,1	63,5
2180	650	(618)			57,8	80,0	69,0	89,2	75,5	64,1
	660				58,3	80,3	69,4	89,5	75,9	64,7
	670				58,8	80,6	69,8	89,7	76,4	65,3
	680				59,2	80,8	70,1	89,8	76,8	65,7
	690				59,7	81,1	70,5	90,1	77,2	66,2
	700				60,1	81,3	70,8	90,3	77,6	66,7
	720				61,0	81,8	71,5	90,7	78,4	67,7
	740				61,8	82,2	72,1	91,0	79,1	68,6
	760				62,5	82,6	72,6	91,2	79,7	69,4
	780				63,3	83,0	73,3	91,5	80,4	70,2
	800				64,0	83,4	73,8	91,8	81,1	71,0
	820				64,7	83,8	74,3	92,1	81,7	71,8
	840				65,3	84,1	74,8	92,3	82,2	72,2
	860				65,9	84,4	75,3	92,5	82,7	73,1
	880				66,4	84,7	75,7	92,7	83,1	73,6
	900				67,0	85,0	76,1	92,9	83,6	74,2
	920				67,5	85,3	76,5	93,0	84,0	74,8
	940				68,0	85,6	76,9	93,2	84,4	75,4

– This conversion table is applicable when the values have been determined as follows:
the tension strength according to DIN 50145, Vickers hardness according to DIN 50133, Brinell hardness according to DIN 50351 and the Rockwell hardness according to DIN 50103 and applies for unalloyed and low alloyed steels. Considerable deviations can usually be expected with alloy and/or cold-worked steel types.
– In principle, every conversion of hardness causes a certain inaccuracy and may only be used when a measuring method cannot be carried out. Conversion may not lead to rejection, unless a certain measuring method has been agreed at the time of ordering.
– A mutual conversion between tensile strength and hardness will cause an even larger deviation and therefore can only be used as an indication value. This can never replace the tensile strength found by tensile testing.

1) The Rockwell hardness HRD is not DIN standardised, but is stated for reference, because this is internationally used e.g. in the American standard ASTM E18.

FABORY

STANDARD

ISO : –
EN : –
DIN : –

TABLES

Contact and chemical corrosion

Contact corrosion table

S = heavy corrosion of the metal given in the horizontal column
G = little or no corrosion of the metal given in the horizontal column
M = moderate corrosion (in very humid atmosphere) of the metal given in the horizontal column

Metal	Surface*	Magnesium alloy	Zinc	Hot dip galv. steel	Aluminium alloy	Cadmium layers	Mild steel	Low alloyed steel	Malleable steel	Chromium steel	Lead	Tin	Copper	Stainless steel
Magnesium-alloy	small		S	S	S	S	S	S	S	S	S	S	S	S
	large		M	M	M	M	S	S	S	S	S	S	S	S
Zinc	small	M		G	S	S	S	S	S	S	S	S	S	S
	large	G		G	G	G	G	G	G	G	G	G	G	G
Hot dip galvanised steel	small	M	G		M	M	S	S	S	S	S	S	S	S
	large	G	G		G	G	G	G	G	G	G	G	G	G
Aluminium alloy	small	M	G	G		G	S		S		S		S	S
	large	G	G	M		G	G	G	M	M	S	S	S	S
Cadmium-layers	small	G	G	G	G		S	S	S	S	S	S	S	S
	large	M	G	M	G		G	G	G	G	G	G	G	G
Mild steel	small	G	G	G	G	G		M	S	S	S	S	S	S
	large	G	G	G	G	G		G	G	G	G	G	G	G
Low alloyed steel	small	G	G	G	G	G	G		G	S	S	S	S	S
	large	G	G	G	G	G	G		G	G	G	G	G	G
Malleable steel	small	G	G	G	G	G	G	M		S	S	S	S	S
	large	G	G	G	G	G	G	G		G	G	G		
Chromium steel	small	G	G	G	G	G	G	G			M	M	S	S
	large	G	G	G	G	G	G	G			G	G		G
Lead	small	G	G	G	G	G	G	G	G	G		G	G	
	large	G	G	G	G	G	G	G	M	G		G		G
Tin	small	G	G	G	G	G	G	G		G		G		
	large	G	G	G	G	G	G	G	G	M		G		
Copper	small	G	G	G	G	G	G	G		M	M	S		
	large	G	G	G	G	G	G	G	G		G	M		G
Stainless steel	small	G	G	G	G	G		G	G		G	G		
	large	G	G	M	G	G	G	G	G	M	M	M	G	

* Relative relationship of the area of this metal surface with respect to the area of the metals given in the adjacent columns.

Chemical corrosion table

CHEMICAL AGENT	Hot dip galv. steel	Stainless steel A2	Stainless steel A4	Brass	Aluminium Sopral	Plastic PA 6.6
Acetates		0-1	0	1-2	0	2-3
Acetone		0	0	0	0	0
Acetylene		0	0	3	0	
Alcohols	3	0	0	0	0-1	0
Alum		2	1	2	0	2
Ammonia gas		0	0	3	0	1
Ammonia	3	0	0	3	1	1
Benzene/Toluene/Xylene	0	0	0	0	0	0
Carbonic acid		0	0	2	0	0
Chlorides						
– sodium-/potassium chloride	0	1	1	2	2-3	0
– Ammonia-/zinc chloride		2	1	2	3	2
– Iron chloride		3	3	3	3	3
Chlorine gas		1	1	1	3	3
Chlorine water		1	1			
Citric acid		1	0	2	1	1
Formic acid		1	0	2	3	3
Glycerol	0	0	0	0-1	0	1
Glycol		0	0	1	1	1
Hydrogen chloride		2-3	2-3	3	3	3
Hydrocarbons	0	0	0	0-1	0	0
– Butane, petrol, tar						
hydrocarbons chlorided						
– Trichlore ethylene	0	0	0	0-1	0	0-1
– Tetrachloride	0	0	0	0-1	0	0-1
Hydrogen sulphide		0-1	0	2	0	1
Lacquers	0	0	0	1	0	1
Nitric acid		1	0-1	3	2	3
– Sodium/Ammonia nitrate	0	0	2-3	0	2	
Oil-fuel/vegetable	1	0	0	0	0	0
Palmatin/stearin acid		1	0	2	0	0
Phosphates	0	1	0	2	2-3	1-2
Phosphoric acid		2-3	0-1	3	2-3	2-3
Resins	2-3	1	1	2-3	0-1	0
Sodium carbonate		0	0	1-2	0	0
Sulphur dioxide dry		0	0	0-1	1	1
Sulphur dioxide wet		1	0	3	2	2
Sulphuric acid	3	3	2-3	3	3	3
– Sodium/Ammonia-sulphate	1	0	0	1	0-1	0
– Nickel/Copper sulphate		0-1	0	2-3	2-3	2-3
Water						
– drinking water		0	0	2	0	0
– acid water	1-2			3	2	1
– salt water	0	1	1	2	1	0

0 = GOOD RESISTANCE
1 = MODERATE RESISTANCE
2 = POOR RESISTANCE
3 = NO RESISTANCE

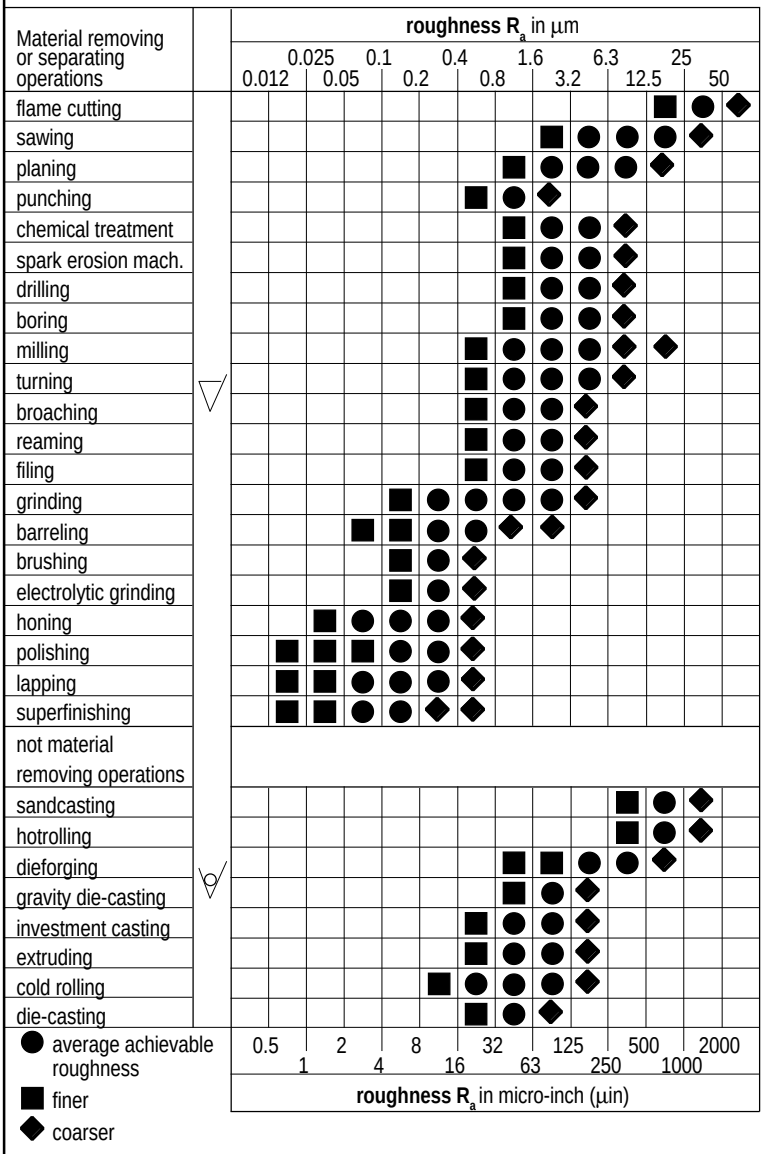
STANDARD

ISO : –
EN : –
DIN : –
NEN : 3638

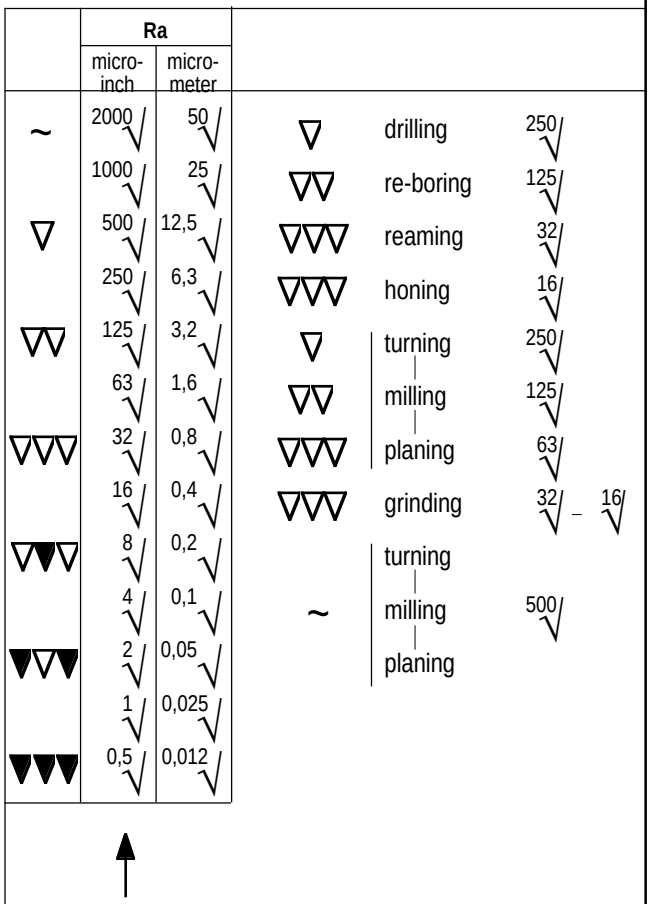
TABLES

Surface roughness

Guidelines for feasible roughness R_a for different processing methods



Comparison of roughness symbols



Roughness values in micro-inches are 40 times the values in micrometers.

These data are only for practical information and to give you an indea of the achievable values of the roughness R_a for different processing methods.
They do not apply to completeness and may not be used as a criterion for acceptance inspection.
They are principally to be used for metal surfaces; other materials may show deviations.

STANDARDIZATION

Introduction

The commonly used commercial fasteners are mainly standardized. The standards offer extensive technical information to the supplier as well as to the user and make a vital link in the mutual commercial trade.
This general introduction aims to give an overall picture to those not familiar with the rather complicated situation of the international and national standardization of fasteners and screw thread.

= ISO =

The *ISO (International Organisation for Standardization)* operates as a worldwide coordinating body. Its aim is to produce order or unity in the divergences of the national standards. The ISO is trying to create an absolute interchangeability of products all over the world by issuing ISO-standards.
Within this organisation the Technical Commitees ISO/TC 1 “Screw Threads” and ISO/TC 2 “Fasteners” - in the latter 28 countries are active and 22 countries passive members - are responsible for these two specialized areas.
In the mean time already more than 100 ISO-standards are published in the English and French language and it may be expected that in the near future this number will increase very rapidly as a consequence of the intensified activities of ISO TC2.
In 1984 for the first time these standards have been collected in the ISO-Standards Handbook 18 “Fasteners and Screw Threads”, and in the French edition Recueil de Normes ISO 18 "Elements de fixation et filetages".

= DIN =

The national German *DIN (Deutsches Institut für Normung)* and the international DIN-ISO standards are very popular, leading standards in Europe. In some countries like the Netherlands, Switzerland and Austria new national standards are no longer issued, the existing ones being gradually withdrawn and in place of these the use of DIN and DIN-ISO standards are recommended.
These countries participate as active members in the DIN-Committees “Mechanische Verbindungselemente FMV” and “Gewinde”, however they maintain their national authority in ISO/TC 1 and ISO/TC 2.
At the moment DIN has published more than 400 standards on fasteners and about 100 standards on screw thread. These have been collected in the following 7 handbooks:
– DIN Handbook 10 • Fasteners 1. Dimensional standards for bolts and screws (also available in English).
– DIN Handbook 43 • Fasteners 2. Standards for bolts, pins, rivets, wedges, adjusting rings, retaining rings.
– DIN Handbook 55 • Fasteners 3. Technical delivery conditions for bolts, screws and nuts.
– DIN Handbook 140 • Fasteners 4. Dimensional standards for nuts and accessories for screwed connections (also available in English).
– DIN Handbook 193 • Fasteners 5. Basic standards.
– DIN Handbook 252 • Fasteners 6. DIN ISO standards. Bolts and nuts. Technical delivery conditions.
– DIN Handbook 45 • Screw thread. Standards.
The adoption of the ISO-standards in the German standardization and their actual application in practice, has not been easy so far. To improve this situation the decision has been taken to adopt ISO standards only when they have been accepted as German standards and the existing DIN standard shall be withdrawn in favour of the DIN-ISO standard after a certain period of transition.

= CEN =

In 1992 the borders between the countries within the E.E.C. shall be removed for the benefit of free trade without restrictions for all products meeting the harmonized European requirements. The common European Standardization Institute *CEN (Comité Europeen de Normalisation)* has meanwhile already started drafting CEN-specifications according to the guidelines of Article 100 of the E.E.C. convention.
For fasteners, a Technical Committee CEN/TC 185 has been formed to make CEN-standards, preferably being identical to the existing ISO-standards. Products, for which no ISO-standard is issued, will get their own new CEN-standard. The first series of CEN (ISO) standards - priority 1 - were to be published as early as 1990.

= INDEX OF STANDARDS =

On the next pages an outline is given of mutually comparative standards. Comparative does not mean that all standards are completely identical. So the degree of correspondance between the DIN and ISO-standards is indicated with a code signifying:
– E The DIN-standard is completely identical to the ISO-standard (Equivalent and related).
– R The ISO-standard has been accepted, but with DIN-modifications (Related but not equivalent).
– N There is no relation at all between the DIN and ISO-standard (Not related).
– ISO/DIS Draft International Standard.
– ISO/R ISO-Recommendation.
In the index “DIN-ISO” for every DIN NR. see to the corresponding section(s) of the catalogue.

FABORY

STANDARD
DIN : 918/202
ISO : –
ANSI : –

STANDARDIZATION

Index DIN - ISO

DIN	DESIGNATION	ISO	1) Correspondance DIN/ISO	SECTION STEEL	STAINLESS STEEL	NON-FERROUS	OTHERS
1	Taper pins	2339	R	8	9	–	–
7	Parallel pins, dowel pins	2338	R	8	9	–	–
11 (withdrawn)	Whitworth screw threads	–	–	–	–	–	15
13 - T- 13	ISO metric screw threads; selected sizes for screws, bolts and nuts from 1 to 52 mm	262	R	–	–	–	15
- T- 20	ISO metric coarse threads from 1 to 68 mm diameter; limits	965/2	R	–	–	–	15
- T- 21 - T- 22 - T- 23	ISO metric fine threads from 1 to 110 mm; limits	965/2	R	–	–	–	15
- T- 51	ISO metric screw threads; bolt thread for transition zone, e.g. tolerance field Sk 6	–	–	–	–	–	15
14 - T- 1/2/3/4	ISO metric screw thread; screw threads below 1 mm diameter	R 1501	R	–	–	–	–
63	Slotted countersunk head screws (with small head)	–	–	–	–	–	–
66	Countersinks for countersunk head screws with com. head style to DIN ISO 7721	–	–	–	–	–	–
74 - T- 1	Countersinks for countersunk head screws	–	–	–	–	–	–
- T- 2	Counterbores for hexagon socket head screws and slotted cheese head screws	–	–	–	–	–	–
- T- 3	Counterbores for hexagon bolts and nuts	–	–	–	–	–	–
76 - T- 1	Run out and undercut for metric ISO threads	3508/4755	R	–	–	–	15
- T- 2	Run out and undercut for Whitworth pipe screw thread	–	–	–	–	–	15
78	Thread ends and length of projection of bolt ends	4753	R	–	–	–	15
84	Slotted cheese head screws	1207	R	6	9	10	–
85	Slotted pan head screws	1580	R	6-14	9	10	–
93	Tab washers with long tab	–	–	7	9	–	–
94	Split pins	1234	R	8	9	10	–
95	Slotted raised countersunk (oval) head wood screws	–	–	–	9	10	–
96	Slotted round head wood screws	–	–	6	9	10	–
97	Slotted countersunk (flat) head wood screws	–	–	6	9	10	–
101	Rivets; technical specifications	R 1051	R	–	–	–	–
103 - T- 5/7	ISO metric trapezoidial screw threads; limits	2903	E	–	–	–	15
124	Round head rivets	R 1051	R	–	–	–	–
125 - T- 1	Washers, product grade A, up to hardness 250 HV, primarily for hexagon bolts and nuts	7089/90	R	7	9	10	–
125 - T- 2	Washers, product grade A, from hardness 300 HV, primarily for hexagon bolts and nuts	7089/90	R	–	–	–	–
126	Washers; product grade C; primarily for hexagon bolts and nuts	7091	R	7	–	–	–
127	Spring lock washers	–	–	7	9	–	–
128	Curved or waved spring lock washers	–	–	7	9	10	–
137	Curved or waved spring washers	–	–	7	9	–	–
158	Metric tapered external screw threads	–	–	–	–	–	15
186	T-head bolts with square neck	–	–	4	9	–	–
188	T-head bolts with double nib	–	–	–	–	–	–
202	Screw threads (general plan)	–	–	–	–	–	15
225*	Symbols and designations of dimensions	225**	E	–	–	–	–
228*	Pipe threads, Whitworth cylindrical	228	E	–	–	–	15
258	Taper pins with thread and constant taper length	8737	R	–	–	–	–
261	T-head bolts	–	–	–	–	–	–
267 - T- 1	General requirements	8992	R	–	–	–	15
- T- 2	Finishes and tolerances	4759/1	R	–	–	–	15
- T- 3	Property classes for bolts and screws	898/1**	–	–	–	–	15
- T- 4	Property classes of nuts (previous classes)	898/2**	R	–	–	–	15
- T- 5	Acceptance inspection	3269	R	–	–	–	15
- T- 6	Finishes and tolerances for product grade F	4759/2	R	–	–	–	–
- T- 9	Electroplated coatings	4042*	R	–	–	–	15
- T- 10	Hot dip galvanized parts	1461	R	–	–	–	15
- T- 11	Corrosion-resistant stainless steel fasteners	3506	R	–	–	–	15
- T- 12	Tapping screws	2702	R	–	–	–	–
- T- 13	Parts for bolted connections for low and high temperature applications	–	–	–	–	–	–
- T- 15	Prevailing torque type nuts	2320	R	–	–	–	–
- T- 18	Parts made of non-ferrous metals	8839**	R	–	–	–	15
- T- 19	Surface discontinuities on bolts screws and studs	6157/1/3**	R	–	–	–	15
- T- 20	Surface discontinuities on nuts } DIN EN 493	DIS 6157/2	R	–	–	–	15
- T- 21	Widening test for nuts } DIN EN 493	DIS 6157/2	R	–	–	–	–

* DIN/ISO standard
** This ISO-standard is also an European EN-standard. The number of the EN-standard is the ISO number increased by 20.000 f.i. ISO 225 = EN 20225.
1) See page 15–65–1 for explanation of the correspondance code.

STANDARD
DIN : 918/202
ISO : –
ANSI : –

STANDARDIZATION

Index DIN - ISO

DIN	DESIGNATION	ISO	1) Correspondance DIN/ISO	SECTION STEEL	STAINLESS STEEL	NON-FERROUS	OTHERS
- T- 24	Property classes of nuts; hardness classes	–	–	–	–	–	15
- T- 25	Torque test for bolts and screws M1 to M10	898/7	R	–	–	–	15
- T- 26	Technical specifications for elements made of spring steel for bolted connections	–	–	–	–	–	–
- T- 27	Steel screws, bolts and studs with an adhesive coating (MK)	–	–	–	–	–	–
- T- 28	Steel screws, bolts and studs with locking coatings (KL)	–	–	–	–	–	–
268	Tangent keys and keyways for alternating shock loads	3117	R	–	–	–	–
271	Tangent keys and keyways for constant loads	3117	R	–	–	–	–
272*	Widths across flats, external	272	E	–	–	–	–
273*	Clearance holes for bolts and screws	273**	E	–	–	–	15
302	Countersunk head rivets	R 1051	R	–	–	–	–
315	Wing nuts	–	–	3-11	–	10-11	–
316	Wing screws	–	–	4	–	10	–
319	Ball knobs	–	–	–	–	10	–
388 - T- 1/2	Hand-wheels of plastic	–	–	–	–	10	–
404	Capstan screws	–	–	–	–	–	–
417	Slotted set screws with long dog point	7435	R	–	–	–	–
427	Slotted headless screws with chamfered end	2342	R	–	–	–	–
431	Pipe nuts with thread according to DIN ISO 228 Part 1	–	–	–	–	–	–
432	External tab washers	–	–	7	–	–	–
433 - T- 1	Washers product grade A, up to hardness 250 HV, primarily for cheese head screws	7092	R	7	9	10	–
- T- 2	Washers, product grade A, from hardness 300 HV, primarily for cheese head screws	7092	R	–	–	–	–
434	Square taper washers for U-sections 8%	–	–	7	9	–	–
435	Square taper washers for I-sections 14%	–	–	7	9	–	–
436	Square washers; especially for wood constructions	–	–	7	9	–	–
438	Slotted set screws with cup point	7436	R	5	9	–	–
439 - T- 1	Hexagon thin nuts; unchamfered; product grade B	4036**	R	–	–	–	–
- T- 2	Hexagon thin nuts; product grade A and B; chamfered	4035/8675**	R	3-11	9	–	–
440	Washers, especially for wood constructions	7094	R	7	9	–	–
443	Sealing push-in caps	–	–	12	–	–	–
444	Eye bolts	–	–	4	9	–	–
462	Internal tab washers for slotted round nuts acc. to DIN 1804	–	–	–	–	–	–
463	Tab washers with long and short tab at right angles	–	–	7	9	–	–
464	Knurled thumb screws, high type	–	–	4	9	10	–
466	Knurled thumb nuts, high type	–	–	3	9	10	–
467	Knurled thumb nuts, thin type,	–	–	3	9	10	–
470	Sealing washers	–	–	12	–	–	–
471	Retaining rings for shafts	–	–	7	9	–	–
472	Retaining rings for bores	–	–	7	9	–	–
475 - T- 1	Widths across flats for bolts, screws, nuts, armatures and fittings	–	–	–	–	–	–
- T- 2	Openings for spanners and sockets	691	–	–	–	–	–
- T- 3	Size pairing of double ended wrenches	1085	–	–	–	–	–
478	Square head bolts with collar	–	–	–	–	–	–
479	Square head bolts with short dog point	–	–	1	–	–	–
480	Square head bolts with collar and short dog point with rounded end	–	–	–	–	–	–
493	Surface discontinuities on nuts	DIS 6157/2	R	–	–	–	–
508	Nuts for T-slots	299	R	–	–	–	–
522	Washers of metallic materials, technical specifications	4759/3	–	–	–	–	–
525	Studs for welding	–	–	–	–	–	–
526	Safety cups for cheese head screws according to DIN 84	–	–	–	–	–	–
529	Masonry bolts	–	–	5	–	–	–
546	Slotted round nuts	–	–	3	–	10	–
547	Round nuts with drilled holes in one face	–	–	–	–	–	–
548	Round nuts with set pin hole in side	–	R	–	–	–	–
551	Slotted set screws with flat point	4766	R	5	9	–	–
553	Slotted set screws with cone point	7434	R	5	9	–	–
555	Hexagon nuts; product grade C	4034**	–	1-3-11	–	10	–
557	Square nuts, product grade C	–	R	3	–	–	–
558	Hexagon head screws; product grade C	4018**	–	1	–	–	–
561	Hexagon head set screws with small hexagon and full dog point	–	–	1	–	–	–
562	Square thin nuts; prodct grade B	–	–	3	9	–	–
564	Hexagon head screws with small hexagon and half dog flat cone point	–		–	–	–	–

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571	Hexagon head wood screws	–	–	1	9	–	–
580	Lifting eye bolts	3266	R	4-11	9	–	–
582	Lifting eye nuts	–	–	4-11	9	–	–
601	Hexagon head bolts, product grade C	4016**	R	1	–	–	–
603	Mushroom head square neck bolts	8677	R	1	9	10	–
604	Flat countersunk nib bolts	–	–	1	–	–	–
605	Flat countersunk square neck bolts	–	–	1	–	–	–
607	Cup head nib bolts	–	–	–	–	–	–
608	Flat countersunk square neck bolts	–	–	–	–	–	–
609	Hexagon fit bolts with long threaded portion	–	–	1	–	–	–
610	Hexagon fit bolts with short threaded portion	–	–	–	–	–	–
649	T-slots for T-head bolts	–	–	–	–	–	–
653	Knurled thumb screws, thin type	–	–	4	–	10	–
660	Round head rivets	R 1051	R	8	9	10	–
661	Countersunk head rivets	R 1051	R	8	9	10	–
662	Mushroom head rivets	R 1051	R	8	–	10	–
674	Flat round head rivets	R 1051	R	–	–	–	–
675	Flat countersunk head rivets	R 1051	R	–	–	–	–
705	Adjusting rings	–	–	7	9	–	–
741 (withdrawn)	Wire rope clips, U-bolts, clamps	–	–	4	–	–	–
787	Bolts and screws for T-slots	299	–	–	–	–	–
792	Cylindrical countersunk screws	–	–	–	–	–	–
797	Special foundation bolts	–	–	–	–	–	–
798	Special foundation nuts	–	–	–	–	–	–
835	Studs, metal end ≈ 2 d	–	–	–	–	–	–
898 - T- 1*	Mechanical properties of fasteners. Part 1: Bolts, screws and studs	898/1**	E	–	–	–	15
- T- 2*	Mechanical properties of fasteners. Part 2: Nuts with specified proof load values	898/2**	E	–	–	–	15
- T- 5*	Mechanical properties of fasteners. Part 5: Set screws and similar threaded fasteners	898/5	E	–	–	–	15
- T- 6*	Mechanical properties of fasteners. Part 6: Nuts with specified proof load values, fine pitch thread	898/6	E	–	–	–	15
899	Hand operated wrenches and sockets	1711	R	–	–	–	–
906	Hexagon socket pipe plugs, conical thread	–	–	2	–	–	–
907	Core plugs, cylindrical thread	–	–	–	–	–	–
908	Hexagon socket screw plugs, cylindrical thread	–	–	2	–	–	–
909	Hexagon head screw plugs, conical thread	–	–	–	–	–	–
910 - T- 1	Hexagon head screw plugs, heavy type, cylindrical thread	–	–	2	9	–	–
- T- 2	Hexagon head pipe plugs with vent	–	–	–	–	–	–
911	Hexagon socket screw keys	2936	–	2	–	–	–
912	Hexagon socket head cap screws	4762	R	2-14	9	10-11	–
913	Hexagon socket set screws with flat point	4026	R	2	9	–	–
914	Hexagon socket set screws with cone point	4027	R	2	9	–	–
915	Hexagon socket set screws with dog point	4028	R	2	9	–	–
916	Hexagon socket set screws with cup point	4029	R	2	9	–	–
917	Hexagon cap nuts	–	–	3	9	10	–
918	Terminology and nomenclature, definitions, abbreviations	–	–	–	–	–	15
-Beiblatt 1	Figures and names	1891*	R	–	–	–	–
-Beiblatt 2	ISO- and DIN standards survey	–	–	–	–	–	–
920	Slotted pan head screws with small head	–	–	–	–	–	–
921	Slotted pan head screws with large head	–	–	–	–	–	–
922	Slotted pan head screws with small head and full dog point	–	–	–	–	–	–
923	Slotted pan head screws with shoulder	–	–	–	–	–	–
924	Slotted raised countersunk head screws with dog point	–	–	–	–	–	–
925	Slotted countersunk head screws with full dog point	–	–	–	–	–	–
926	Slotted set screws with dog point	–	–	–	–	–	–
927	Slotted shoulder screws	–	–	–	–	–	–
928	Square weld nuts	–	–	3	9	–	–
929	Hexagon weld nuts	–	–	3	9	–	–
931 T1/T2	Hexagon head bolts, product grades A and B	4014**	R	1-11	9	10-11	–
931 Beiblatt 1	Hexagon head bolts with shank, weights	–	–	–	–	–	–
933	Hexagon head screws, product grades A and B	4017**	R	1-11	9	10-11	–
934	Hexagon nuts, metric coarse and fine pitch thread, product grades A and B	4032**	R	1-3-11	9	10-11	–
935 - T- 1	Hexagon slotted and castle nuts, product grades A and B	–	–	3-11	9	–	–
- T- 3	Hexagon slotted nuts, product grade C	–	–	–	–	–	–

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936	Hexagon thin nuts	–	–	–	–	–	–
937	Hexagon thin slotted and castle nuts (old type)	–	–	–	–	–	–
938	Studs, metal end ≈ 1d	–	–	5	9	–	–
939	Studs, metal end ≈ 1,25d	–	–	5-11	9	–	–
940	Studs, metal end ≈ 2,5d	–	–	–	–	–	–
946	Determination of coefficients of friction	–	–	–	–	–	–
950	Handwheels, offset arm type, hole of hub round	–	–	–	–	10	–
960	Hexagon head bolts, metric fine pitch, product grades A and B	8765**	R	1	–	–	–
961	Hexagon head screws, metric fine pitch, product grades A and B	8676**	R	1	–	–	–
962	Bolts, screws, studs, nuts, designations, types and finishes	7378/8991	R	–	–	–	–
963	Slotted countersunk (flat) head screws	2009	R	6-14	9	10	–
964	Slotted raised countersunk head screws	2010	R	6	9	10	–
965	Cross recessed countersunk (flat) head screws	7046	R	6	9	–	–
966	Cross recessed raised countersunk head screws	7047	R	6	9	10	–
971 - T-1	Hexagon nuts, style 1, metric fine pitch thread, property classes 6 and 8	8673**	R	–	–	–	–
- T-2	Hexagon nuts, style 2, metric fine pitch thread, property classes 10 and 12	8674**	R	–	–	–	–
974 - T-1	Diameters of counterbores for hexagon socket head cap screws and screws with cheese- or panhead	–	–	–	–	–	–
- T-2	Diameters of counterbores for hexagon bolts, screws and nuts	–	–	–	–	–	–
975	Threaded rods	–	–	5-11	9	10-11	–
976	Threaded pins	–	–	5	9	–	–
979	Hexagon thin slotted and castle nuts, product grades A and B	–	–	3	–	–	–
980	Prevailing torque type hexagon nuts, all-metal nuts	7042	–	3	9	–	–
981	Rolling bearings accessories; locknuts	–	–	–	–	–	–
982	Prevailing torque type hexagon nuts with non-metallic insert, high type	–	–	3	9	–	–
983	Retaining rings with lugs for shafts	–	–	–	–	–	–
984	Retaining rings with lugs for bores	–	–	–	–	–	–
985	Prevailing torque type hexagon nuts with non-metallic insert; low type	–	–	3	9	–	–
986	Prevailing torque type hexagon domed cap nuts with non metallic insert	–	–	3	9	–	–
987	Self-locking plate nuts	–	–	–	–	–	–
988	Shim rings and supporting rings	–	–	7	–	–	–
1142	Wire rope grips	–	–	–	–	–	–
1433	Pins without head, type m	–	–	–	–	–	–
1434	Pins with small head, type m	–	–	–	–	–	–
1435	Pins with small head, type mg	–	–	–	–	–	–
1436	Pins with large head, type mg	–	–	–	–	–	–
1440	Washers, type medium for clevis pins	8738	R	7	–	–	–
1441	Washers, type coarse for clevis pins	–	–	–	–	–	–
1443	Clevis pins without head (ISO)	2340	–	–	–	–	–
1444	Clevis pins with head (ISO)	2341	R	–	–	–	–
1445	Clevis pins with head and threaded portion	–	–	–	–	–	–
1469	Grooved pins, half length grooved with gorge	–	–	–	–	–	–
1470	Grooved pins full length parallel grooved with pilot	8739	R	8	–	–	–
1471	Grooved pins full length taper grooved	8744	R	8	–	–	–
1472	Grooved pins half length taper grooved	8745	R	8	–	–	–
1473	Grooved pins full length parallel grooved with chamfer	8740	R	8	–	–	–
1474	Grooved pins half length reverse grooved	8741	R	8	–	–	–
1475	Grooved pins third length centre groved	8742/43	R	8	–	–	–
1476	Round head grooved pins	8746	R	8	–	–	–
1477	Countersunk head grooved pins	8747	R	–	–	–	–
1478	Turnbuckles made from tubes or bars	–	–	–	–	–	–
1479	Turnbuckels made from hexagon bars	–	–	–	–	–	–
1479*	Hexagon head tapping screws	1479	E	–	–	–	–
1480	Turnbuckels, forged (open type)	–	–	4	–	–	–
1481	Spring type straight pins slotted heavy type	8752	R	8	9	–	–
1481*	Slotted pan head tapping screws	1481	E	–	–	–	–
1482*	Slotted countersunk (flat) head tapping screws (common head style)	1482	E	–	–	–	–
1483*	Slotted raised countersunk (oval) head tapping screws (commen head style)	1483	E	–	–	–	–
1580*	Slotted pan head screws, product grade A	1580	E	–	–	–	–
1587	Hexagon domed cap nuts	–	–	3	9	10	–
1651	Free cutting steels	683/9	R	–	–	–	15
1654 - T-1	Cold heading and cold extruding steels	4954	R	–	–	–	15
- T-2	Cold heading and cold extruding steels for killed unalloyed steels not intended for heat treatment	–	–	–	–	–	15
- T-3	Cold heading and cold extruding steels for case hardening steels	–	–	–	–	–	15
- T-4	Cold heading and cold extruding steels for quenching and tempering	–	–	–	–	–	15
- T-5	Cold heading and cold extruding steels for stainless steels	–	–	–	–	–	15

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1804	Slotted round nuts for hook spanner	–	–	3	–	–	–
1816	Round nuts with set pin holes inside	–	–	–	–	–	–
1891*	Terminology and nomenclature	1891	E	–	–	–	–
2009*	Slotted countersunk head screws (common style), product grade A	2009	E	–	–	–	–
2010*	Slotted raised countersunk head screws (common style) product grade A	2010	E	–	–	–	–
2082 - T-1	Nuts for milling machine arbors	839/2	R	–	–	–	–
2092	Disc springs; calculation	–	–	–	–	–	–
2093	Disc springs; dimensions and quality specifications	–	–	7	9	–	–
2095	Compression springs	–	–	12	–	–	–
2097	Tension springs	–	–	12	–	–	–
2244	Screw threads, terms and definitions	1504	R	–	–	–	–
2507	Bolts and nuts for piping work	–	–	–	–	–	–
2509	Double end studs	–	–	–	–	–	–
2510 - T-1 3/8	Bolted connections with reduced shank	–	–	5	–	–	–
2510 - T-2	Metric thread with large clearance	–	–	–	–	–	15
2510 - T-3	Bolted connections with reduced shank; bolts	–	–	–	–	–	–
3017	Hose-clamps	–	–	–	–	–	–
3126	Drive ends for screwdriver bits	1173	R	14	–	–	–
3127	Screwdriver bits for slotted head screws	2380	R	14	–	–	–
3800 - T-1*	Axial load fatigue testing	–	–	–	–	–	–
3858	Whitworth pipe threads	–	–	–	–	–	15
4000	Tabular layouts of article charisteristics	–	–	–	–	–	–
4014*	Hexagon bolts, product grades A and B	4014**	E	–	–	–	–
4016*	Hexagon bolts, product grade C	4016**	E	–	–	–	–
4017*	Hexagon head screws, product grades A and B	4017**	E	–	–	–	–
4018*	Hexagon head screws, product grade C	4018**	E	–	–	–	–
4032*	Hexagon nuts, style 1, product grades A and B	4032**	E	–	–	–	–
4034*	Hexagon nuts, style 1, product grade C	4034**	E	–	–	–	–
4035*	Hexagon thin nuts, product grades A and B (chamfered)	4035**	E	–	–	–	–
4036*	Hexagon thin nuts, product grade B (unchamfered)	4036**	R	–	–	–	–
4626	Center bolts for laminated leaf springs	–	–	12	–	–	–
4759*	Tolerances for fasteners	4759	E	–	–	–	–
5903	Fish bolts	–	–	–	–	–	–
5914	Baseplate screws with rectangular head	–	–	–	–	–	–
5917	Coupling screws	–	–	–	–	–	–
6303	Knurled nuts	–	–	–	–	–	–
6319	Spherical washers; conical seats	–	–	4	–	–	–
6325	Parallel pins, hardened; tolerance zone m 6	8734	R	8	–	–	–
6330	Thick hexagon nuts	–	–	4	9	–	–
6331	Thick hexagon nuts 1,5 d, with collar	–	–	4	9	–	–
6332	Grub screws with thrust point	–	–	–	–	–	–
6336	Star grips	–	–	–	–	10	–
6340	Washers for clamping devices	–	–	–	–	–	–
6378	Clip bolts	–	–	–	–	–	–
6379	Studs for T-nuts	–	–	4	–	–	–
6791	Semi-tubular pan head rivets	R 1051	R	–	–	–	–
6792	Semi-tubular countersunk head rivets	R 1051	R	–	–	–	–
6796	Conical spring washers	–	–	–	–	–	–
6797	Toothed lock washers	–	–	7	9	–	–
6798	Serrated lock washers	–	–	7	9	10	–
6799	Retaining washers for shafts	–	–	7	9	–	–
6880	Bright key steel	–	–	8	9	–	–
6881	Saddle keys	–	–	–	–	–	–
6883	Taper keys	2492	R	–	–	–	–
6884	Gib-head parallel keys	2492	R	–	–	–	–
6885 - T-1	Parallel keys	R 773	R	8	9	–	–
6886	Taper keys	R 774	R	–	–	–	–
6887	Taper keys with gip head	R 774	R	8	–	–	–
6888	Woodruff keys	3912	R	8	–	–	–
6889	Gib-head saddle keys	–	–	–	–	–	–
6900	Screw and washer assemblies	–	–	6	–	–	–
6901	Tapping screw assemblies	–	–	–	–	–	–

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6902	Washers for screw assemblies	–	–	–	–	–	–
6903	Washers for tapping screw assemblies	–	–	–	–	–	–
6904	Curved spring washers for screw assemblies	–	–	–	–	–	–
6905	Spring washers for screw assemblies	–	–	–	–	–	–
6906	Lock washers for screw assemblies	–	–	–	–	–	–
6907	Serrated lock washers for screw assemblies	–	–	–	–	–	–
6908	Conical spring washers for screw assemblies	–	–	–	–	–	–
6911	Hexagon socket screw keys with pilot	–	–	2	–	–	–
6912	Hexagon socket head cap screws with centre hole and low head	–	–	2	9	–	–
6913	Spring lock washers with safety rings	–	–	–	–	–	–
6914	Hexagon bolts with large widths across flats for high tensile structural bolting	7412	R	1	–	–	–
6915	Hexagon nuts with large widths across flats for high tensile structural bolting	7414	R	1	–	–	–
6916	Round washers for high-tensile structural bolting	7416	R	1	–	–	–
6917	Square taper washers for I-sections for high-tensile structural bolting	–	–	1	–	–	–
6918	Square washers for U-sections for high-tensile structural bolting	–	–	1	–	–	–
6921	Hexagon flange bolts	DIS 8102/04	R	1	–	–	–
6922	Hexagon flange bolts with reduced shank	DIS 8100/14	R	–	–	–	–
6923	Hexagon flange nuts	4161	R	3	9	–	–
6924	Prevailing torque type hexagon nuts, non-metallic insert	7040	R	–	–	–	–
6925	Prevailing torque type hexagon nuts; all metal nuts	7042	R	–	–	–	–
6926	Prevailing torque type hexagon flange nuts; non-metallic insert	7043	R	–	–	–	–
6927	Prevailing torque type hexagon flange nuts; all metal nuts	7044	R	–	–	–	–
6928	Hexagon washer head tapping screws	7053	–	–	–	–	–
7045*	Cross recessed pan head screws, product grade A	7045	E	–	–	–	–
7046*	Cross recessed countersunk flat head screws (common head style), product grade A	7046	E	–	–	–	–
7047*	Cross recessed raised countersunk head screws (common head style), product grade A	7047	E	–	–	–	–
7049*	Cross recessed pan head tapping screws	7049	E	–	–	–	–
7050*	Cross recessed countersunk (flat) head tapping screws (common head style)	7050	E	–	–	–	–
7051*	Cross recensed raised countersunk (oval) head tapping screws	7051	E	–	–	–	–
7160	ISO-Deviations for shafts	286	–	–	–	–	15
7161	ISO-Deviations for holes	286	–	–	–	–	15
7274	Steel canisters	–	–	–	–	–	–
7331	Compression rivets	–	–	–	–	–	–
7337	Blind rivets; with break mandrel	–	–	8	–	–	–
7338	Rivets for break and clutch linings	–	–	–	–	–	–
7339	Tubular rivets (one piece)	–	–	–	–	–	–
7340	Tubular rivets cut from the tube	–	–	–	–	–	–
7341	Rivet pins	R 1051	R	–	–	–	–
7343	Spirol pins; medium duty	8750/51	R	8	9	–	–
7344	Spirol pins; heavy duty	8748	R	8	–	–	–
7346	Spring type straight pins; slotted; slight type	–	–	–	–	–	–
7349	Washers for bolts with heavy type spring pins	–	–	7	9	–	–
7426	Hexagon insert bits for hexagon socket screws	1173	R	14	–	–	–
7500	Thread rolling screws and bolts	–	–	6	–	–	15
7504	Self drilling screws and bolts	–	–	6	6	6	–
7513	Thread cutting screws; hexagon screws and slotted head screws	–	–	6	–	–	–
7516	Thread cutting screws; cross recessed head screws	–	–	6	–	–	–
7603	Sealing rings for pipe unions and screw plugs	–	–	–	–	10	–
7604	Hexagon head screw plugs light type cylindrical thread	–	–	–	–	–	–
7708	Plastics; moulding materials;	–	–	–	–	–	15
7721*	Countersunk head screws, head configuration and gauging	7721**	E	–	–	–	–
7952	Sheet metal anchorage with threads	–	–	–	–	–	–
7962	Cross recesses for screws	4757	R	–	–	–	–
7964	Bolts and screws with coarse thread and reduced shank	–	–	–	–	–	–
7965	Screwed inserts	–	–	3	–	–	–
7967	Self locking counter nuts	–	–	3	9	–	–
7968	Hexagon fit bolts	–	–	–	–	–	–
7969	Slotted countersunk head bolts for steel structures	–	–	–	–	–	–
7970	Tapping screw thread	1478	R	–	–	–	15
7971	Slotted pan head tapping screws	1481	R	6-14	9-14	10	–
7972	Slotted countersunk head tapping screws	1482	R	6	9	–	–
7973	Slotted raised countersunk head tapping screws	1483	R	6	9	–	–
7975	Core hole diameters for tapping screws	–	–	–	–	–	15
7976	Hexagon head tapping screws	1479	R	6	–	–	–
7977	Taper pins with thread ends and constant point lengths	8737	R	8	–	–	–
7978	Taper pins with internal thread	8736	R	8	–	–	–

* DIN/ISO standard

** This ISO-standard is also an European EN-standard. The number of the EN-standard is the ISO number increased by 20.000 f.i. ISO 225 = EN 20225.

1) See page 15–65–1 for explanation of the correspondance code.

FABORY

STANDARD

DIN : 918/202
ISO : –
ANSI : –

STANDARDIZATION

Index DIN - ISO

DIN	DESIGNATION	ISO	1) Correspondance DIN/ISO	SECTION STEEL	STAINLESS STEEL	NON-FERROUS	OTHERS
7979	Parallel pins with internal thread	8733/35	R	8	–	–	–
7980	Spring lock washers for screws with cylindrical heads	–	–	7	9	–	–
7981	Cross recessed pan head tapping screws	7049	R	6	9	10	–
7982	Cross recessed countersunk head tapping screws	7050	R	6	9	–	–
7983	Cross recessed raised countersunk head tapping screws	7051	R	6	9	–	–
7984	Hexagon socket head cap screws with low head	–	–	2	9	–	–
7985	Cross recessed raised cheese head screws	7045	R	6	9	–	–
7988	Cross recessed raised countersunk (oval) head screws	–	–	–	–	–	–
7989	Washers for steel constructions	–	–	7	–	–	–
7990	Hexagon bolts and nuts for steel structures	–	–	1	–	–	–
7991	Hexagon socket countersunk head screws	–	–	2	9	–	–
7992	Tee-head bolts with large heads	–	–	–	–	–	–
7993	Snap rings	–	–	–	–	–	–
7995	Cross recessed raised countersunk head wood screws	–	–	–	–	–	–
7996	Cross recessed round head wood screws	–	–	6	–	–	–
7997	Cross recessed countersunk head wood screws	–	–	–	–	–	–
7998	Threads for wood screws	–	–	–	–	–	–
7999	High tensile strength hexagon fit bolts with large width across flats for structural bolting	–	–	–	–	–	–
8140	Wire thread inserts	–	–	–	14	–	–
8673*	Hexagon nuts, style 1, fine pitch product grades A and B	8673**	E	–	–	–	–
8674*	Hexagon nuts, style 2, fine pitch, product grades A and B	8674**	E	–	–	–	–
8675*	Hexagon thin nuts, fine pitch, product grades A and B	8675**	E	–	–	–	–
8676*	Hexagon head screws, fine pitch, product grades A and B	8676**	E	–	–	–	–
8748*	Spring type straight slotted pins, coiled, heavy duty	8748	E	8	–	–	–
8749*	Pins and grooved pins, shear test	8749	E	–	9	–	–
8750*	Spring type straight pins, coiled standard duty	8750	E	–	–	–	–
8765*	Hexagon head bolts, fine pitch, product grades A and B	8765**	E	–	–	–	–
9021	Washers with outside diameter ≈ x 3 nominal thread diameter	7093	R	7	9	10	–
9045	Snap rings	–	–	–	–	–	–
9841	Hexagon socket head shoulder screw	7379	R	–	–	–	–
11014	Countersunk double-nip bolts	–	–	–	–	–	–
11023	Linch pins	–	–	–	–	–	–
11024	Spring cotter of a bolt	–	–	8	–	–	–
15237	Seating screws and cupped washers for the attachment of components to belts	–	–	–	9	–	–
16903	Inserts nuts for plastic mouldings	–	–	–	–	–	–
21346	Square head bolts for shaft guides	–	–	–	–	–	–
22424	Triangle head bolts	–	–	–	–	–	–
22425	Triangle nuts	–	–	–	–	–	–
24536	Graphical symbols for stone bolts and hammer head bolts	–	–	–	–	–	–
25192	Hammer head bolts	–	–	–	–	–	–
25193	Mushroom head anchor screws	–	–	–	–	–	–
25195	Countersunk bolts with double nip	–	–	–	–	–	–
25197	Cap bolts	–	–	–	–	–	–
25200	Screws, bolts and nuts for rail vehicles	–	–	–	–	–	–
28129	Lifting nut; for covers	–	–	–	–	–	–
30386	Hexagonal nuts; rounded acme thread	–	–	–	–	–	–
30387	Shouldered nuts; metric fine thread rounded acme thread	–	–	–	–	–	–
30389	Hexagon and castle nuts with knuckle thread	–	–	–	–	–	–
43699 (withdrawn)	Contact spring lock washers	–	–	7	–	–	–
50049***	Documents on materials testing	–	–	–	–	–	15
50049 BBL1	Suggestions for the configuration of documents	–	–	–	–	–	15
50150	Hardness conversion tables	4964	R	–	–	–	15
50914	Testing the resistance of stainless steels to intergranular corrosion	3651	R	–	–	–	15
71412	Lubricating nippels; cone type	3799	R	12	12	–	–
71752	Fork joints; yokes	–	–	4	–	–	–
71802	Ball stud and tie rod sockets with spring lock	–	–	4	–	–	–
74361 - T-2	Conical spring washers for wheel bolts	–	–	12	–	–	–
82101	Shackles	–	–	4	9	–	–

* DIN/ISO standard

** This ISO-standard is also an European EN-standard. The number of the EN-standard is the ISO number increased by 20.000 f.i. ISO 225 = EN 20225.

*** This DIN standard is equal to the European standard EN 10204

1) See page 15–65–1 for explanation of the correspondance code.

STANDARD

DIN : 918
ISO : –
ANSI : –

STANDARDIZATION

Index ISO - DIN - ANSI

ISO	DIN	1) correspondance ISO/DIN	ANSI
225**	225*	E	–
228**	228*	E	–
262	13 - Teil 13	R	–
272	272*	E	–
273**	273*	E	–
286	7160	R	–
299	787	–	B 5.1
299	508	–	–
638/9	1651	R	–
691	475 - Teil 2	R	–
R 773	6885 - Teil 1	R	–
R 774	6886/6887	R	–
839/2	2082 - Teil 1	R	–
885	–	–	–
887	–	–	–
888	–	–	–
898/1**	898 - Teil 1*	E	–
898/2**	898 - Teil 2*	E	–
898/5	898 - Teil 5*	E	–
898/6	898 - Teil 6*	E	–
898/7	267 Teil 25	R	–
965/2	13 - Teil 20 to 23	R	B 1.13 M
1085	475 - Teil 3	R	–
1173	3126	R	–
1207	84	R	B 18.6.7 M
1234	94	R	–
1461	267 - Teil 10	R	–
1478	7970	R	B 18.6.5 M
1479	1479*	E	B 18.6.5 M
1481	1481*	E	B 18.6.5 M
1482	1482*	E	B 18.6.5 M
1483	1483*	E	B 18.6.5 M
R 1501	14 - Teil 1 to 4	R	–
1504	2244	R	–
1580	1580*	E	B 18.6.7 M
1711	899	R	–
1891	1891*	E	B 18.12
2009	2009*	E	B 18.6.7 M
2010	2010*	E	B 18.6.7 M
2320	267 - Teil 15	R	B 18.16.1 M
2338	7	R	–
2339	1	R	–
2340	1443	R	–
2341	1444	R	–
2342	427	R	–
2380	3127	R	–
2491	6885 - Teil 3	R	–
2492	6883/84	R	–
2702	267 - Teil 12	R	–
2770	–	–	–
2903	103 - Teil 5 and 7	E	–
2936	911	–	B 18.3.2 M
3117	268	R	–
3117	271	R	–
3266	580	R	–
3269	267 - Teil 5	R	–
3506	267 - Teil 11	R	–
3508	76 - Teil 1	R	–
3651	50914	R	–
3799	71412	R	–

ISO	DIN	1) correspondance ISO/DIN	ANSI
3800/1	Teil 1 - 3800*	E	–
3912	6888	R	–
4014**	4014*	E	B 18.2.3.1 M
4015**	–	–	B 18.2.3.2 M
4016**	4016*	E	B 18.2.3.5 M
4017**	4017*	E	B 18.2.3.1 M
4018**	4018*	E	B 18.2.3.5 M
4026	913	R	B 18.3.6 M
4027	914	R	B 18.3.6 M
4028	915	R	B 18.3.6 M
4029	916	R	B 18.3.6 M
4032**	4032*	E/R	B 18.2.4.1 M
4033**	–	–	B 18.2.4.2 M
4034**	4034*	E	–
4035**	4035*	E	B 18.2.4.5 M
4036**	4036*	E	–
4042	267 - Teil 9	R	–
4154	–	–	–
DIS 4155	–	–	–
4161	6923	R	B 18.2.4.4 M
4162	–	–	–
4166	–	–	–
4753	78	R	–
4755	76 - Teil 1	R	–
4757	7962	R	–
4759/1	4759 - Teil 1*	E	–
4759/2	267 - Teil 6	R	–
4759/3	522	R	–
4762	912	R	B 18.3.1 M
4766	551	R	–
4775	–	–	–
4954	1654	R	–
4964	50150	R	–
5864	–	–	B 1.1
6157/1**	267 - Teil 19	R	–
DIS 6157/2	DIN EN 493	R	–
6157/3**	267 - Teil 19	R	B 18.16.3 M
7040	6924	R	B 18.16.3 M
7041	–	–	B 18.16.3 M
7042	6925	R	–
7043	6926	R	B 18.16.3 M
7044	6927	R	B 18.16.3 M
7045	7045*	R	B 18.16.7 M
7046	7046*	R	–
7047	7047*	R	–
7049	7049*	R	–
7050	7050*	R	–
7051	7051*	R	–
7053	6928	R	–
7089	125 A	R	B 18.22 M
7090	125 B	R	–
7091	126	R	B 18.22 M
7092	433	R	–
7093	9021	R	–
7094	440	R	–
7378	962	R	–
7379	9841	R	B 18.3.3 M
7380	–	R	B 18.3.4 M
7411	–	R	B 14.3.4 M
7412	6914	R	B 18.2.3.7 M

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1) See page 15-65-1 for an explanation of the code letters.

STANDARD

DIN : 918
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STANDARDIZATION

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ISO	DIN	1) correspondance ISO/DIN	ANSI
7413	–	–	–
7414	6915	R	–
7415	–	–	–
7416	6916	R	–
7417	–	–	–
7434	553	R	–
7435	417	R	–
7436	438	R	–
7719	–	–	B 18.16.3 M
7720	–	–	B 18.16.3 M
7721**	7721*	E	–
DIS 8102	6921/22	R	B 18.2.3.4 M
DIS 8104	6921/22	R	–
8673**	8673*	E	–
8674**	8674*	E	–
8675**	8675*	E	–
8676**	8676*/961	E/R	–
8677	603	R	–
8733	7979	R	–
8734	6325	R	–
8735	7979	R	–
8736	7978	R	–
8737	7977	R	–
8738	1440	R	–
8739	1470	R	–
8740	1473	R	–
8741	1474	R	–
8742	1475	R	–
8743	1475	R	–
8744	1471	R	–
8745	1472	R	–
8746	1476	R	–
8747	1477	R	–
8748	8748*	E	–
8749	8749*	E	–
8750	8750*	E	–
8751	7343	R	–
8752	1481	R	–
8765**	8765*/960	E/R	–
8839**	267 - Teil 18	R	–
8991	962	R	–
8992	267 - Teil1	R	–
10509	–	–	–

ISO	DIN	1) correspondance ISO/DIN	ANSI

* DIN/ISO standard
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1) See page 15-65-1 for an explanation of the code letters.

PROFESSIONAL LITERATURE

on fasteners technology

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- **Worldwide**
  ISO Standards Handbook 18. Fasteners and screw threads.
  Recueil de normes ISO 18 • Elements de fixation et filetages.

- **Germany**
  DIN - Taschenbuch 10*. Mechanische Verbindungselemente 1, Schrauben, Massnormen
  DIN - Taschenbuch 43. Mechanische Verbindungselemente 2, Bolzen, Stifte, Niete, Keile, Stell- und Sicherungsringe.
  DIN - Taschenbuch 55. Mechanische Verbindungselemente 3, Technische Lieferbedingungen, Schrauben und Muttern.
  DIN - Taschenbuch 140*. Mechanische Verbindungselemente 4, Muttern, Zubehörteile, Massnormen.
  DIN - Taschenbuch 193. Mechanische Verbindungselemente 5, Grundnormen.
  DIN - Taschenbuch 252. Mechanische Verbindungselemente 6, DIN ISO Normen-Schrauben, Muttern. Technische Lieferbedingungen.
  DIN - Taschenbuch 41. Schraubwerkzeuge.
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  DIN - Taschenbuch 197. Längenprüftechnik 2. Lehren.
  DIN - Umschlüsselungs - Handbuch für US-Gewindenormen. Beuth-Verlag.
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  TRD - Taschenbuch. Technische Regeln für Dampfkessel.
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- **United States of America**
  ASTM - Standards. Volume 15.08 Fasteners.
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  SAE - Handbook. Volume 2. Parts and Components.

- **Great Britain**
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