UDC 621.882.2.082.8 : 621.993 : 620.1

November 1982

Drilling screws

with self-tapping screw thread in accordance with DIN 7970
Dimensions Requirements Testing

DIN 7504

Bohrschrauben mit Blechschrauben-Gewinde nach DIN 7970; Masse, Anforderungen, Prüfung

As it is current practice in standards published by the International Organization for Standardization (ISO), the comma has been used throughout as a decimal marker.

Dimensions in mm

1 Field of application

This standard deals with heat treated screws with a self-tapping screw thread in accordance with DIN 7970 (at present at the stage of draft), which are designed with a drilling tip which drills the core hole for the screw of its own accord during assembly, and which then form the mating screw thread of their own accord, either in a non-cutting or in a cutting operation, with the aid of the threaded portion of the screw adjoining the drilling tip. The existing DIN Standards on self-tapping screws specify the styles of the head of the screws covered by this standard, with the exception of hexagon flange head screws, the dimensions of which are featured in this standard. DIN 267 Part 1 specifies the general requirements, and the principles outlined in DIN 267 Part 5 (at present at the stage of draft) apply to acceptance testing.

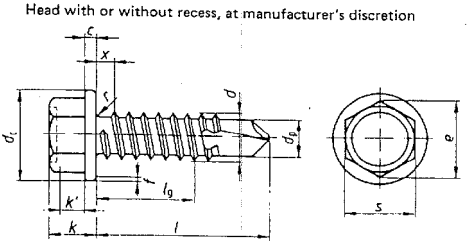
The purpose of this standard is to ensure that the screws are able to drill their core hole and form their mating screw thread without becoming distorted or fracturing in the process, provided that no overstressing has occurred. Consequently the following characteristics are regarded as representing the most important aspects for the assessment of the mechanical and operational characteristics of a drilling screw:

- skin hardness
- suitability in respect of core hole drilling and forming of the mating screw thread
- torsional strength.

When manufacturing drilling screws in accordance with this standard, the patent rights aspect must be examined.

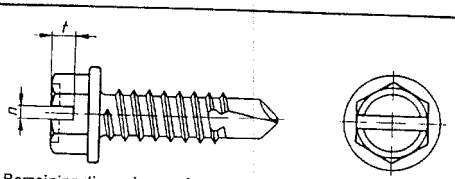
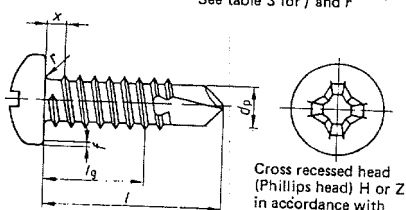
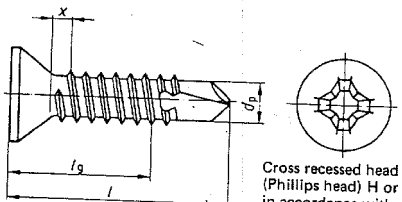
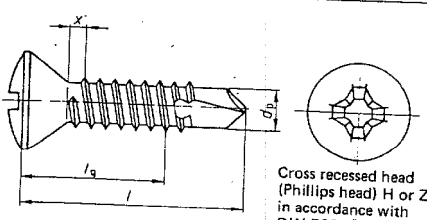
2 Dimensions, designation

Table 1. **Types and designations**

Type	Figure	Remaining dimensions in accordance with	Example of designation
K	Head with or without recess, at manufacturer's discretion 	Table 3	Drilling screw DIN 7504— ST 4,2 X 13 — K

Continued on pages 2 to 8

Table 1. (continued)

Type	Figure	Remaining dimensions in accordance with	Example of designation
L	 Remaining dimensions as for type K	Table 3	Drilling screw DIN 7504 – ST 4,2 X 13 – L
N	See table 3 for *f* and *r*  Cross recessed head (Phillips head) H or Z in accordance with DIN 7962 *)	DIN 7981 *)	Drilling screw DIN 7504 – ST 4,2 X 13 – N – H
P	 Cross recessed head (Phillips head) H or Z in accordance with DIN 7962 *)	DIN 7982 *)	Drilling screw DIN 7504 – ST 4,2 X 13 – P – H
Q	 Cross recessed head (Phillips head) H or Z in accordance with DIN 7962 *)	DIN 7983 *)	Drilling screw DIN 7504 – ST 4,2 X 13 – Q – H

x max. = *P*

*) At present at the stage of draft

Note: The letters A to J and M have not been used to designate the types, in order to avoid the possibility of confusion with conventional designations for self-tapping screws and metric screws.

Tabular layout of article characteristics DIN 4000 – 2 – 1 applies to screws in accordance with this standard

Table 2. **Drilling range and screw lengths**

Screw thread d			ST 2,9	ST 3,5	(ST 3,9)	ST 4,2	ST 4,8	ST 5,5	ST 6,3
Drilling range (sheet or plate thickness) [1]		from	0,7	0,7	0,7	1,75	1,75	1,75	2
		to	1,9	2,25	2,4	3	4,4	5,25	6
d_p [2]		max.	2,3	2,8	3,1	3,6	4,1	4,8	5,8
Nominal length	l min.	l max.	l_g min.						
9,5	8,75	10,25	3,25 [3]	2,85 [3]					
13	12,1	13,9	6,6	6,2	5,8	4,3	4,7 [3]		
16	15,1	16,9	9,6	9,2	8,8	7,3	5,8	5 [3]	
19	18	20	12,5	12,1	11,7	10,3	8,7	8	7
22	21	23		15,1	14,7	13,3	11,7	11	10
25	24	26		18,1	17,7	16,3	14,7	14	13
32	30,75	33,25			24,5	23	21,5	21	20
38	36,75	39,25			30,5	29	27,5	27	26
45	43,75	46,25					34,5	34	33
50	48,75	51,25					39,5	39	38

[1] In order to determine the nominal length l it may be necessary to add an air gap (if present) to the individual sheet or plate thicknesses.

[2] The diameter d_p is dependent on the technical process and it presupposes operational capability in accordance with table 5.

[3] These lengths are not applicable to countersunk head screws.

Table 3. **Head dimensions of type K and L screws**

Screw thread d			ST 3,5	(ST 3,9)	ST 4,2	ST 4,8	ST 5,5	ST 6,3
c		min.	0,6	0,6	0,9	0,9	1	1
d_c		max.	8,3	8,3	8,8	10,5	11	13,2
		min.	7,6	7,6	8,2	9,8	10	12,2
f [1]		≈	0,4	0,4	0,4	0,5	0,5	0,5
e		min.	5,96	5,96	7,59	8,71	8,71	10,95
k		max.	3,45	3,45	4,25	4,45	5,45	6,45
		min.	3,2	3,2	4	4,15	5,15	6,15
k' [2]		min.	1,55	1,55	1,9	2	2,7	3,3
n	Nominal dimension		1	1	1,2	1,2	1,6	1,6
		min.	1,06	1,06	1,26	1,26	1,66	1,66
		max.	1,2	1,2	1,51	1,51	1,91	1,91
r		max.	0,5	0,5	0,6	0,7	0,8	0,9
s	max. = nominal dimension s		5,5	5,5	7	8	8	10
		min.	5,32	5,32	6,78	7,78	7,78	9,78
t		min.	1	1	1,2	1,4	1,6	1,8
		max.	1,4	1,4	1,6	1,8	2	2,2

[1] Chamfer necessary for manufacturing reasons

[2] Minimum depth required to ensure proper grip by the wrench; the dimension e_{min} must be present within this range.

The ST 3,9 screw thread featured in brackets in the above table should be avoided wherever possible.

3 Requirements

3.1 Design and dimensional accuracy

DIN ISO 4759 Part 1, product class A, and DIN 267 Part 2 (at present at the stage of draft) shall apply to the design and dimensional accuracy of drilling screws (previously design m).

3.2 Material

Case hardening steel in accordance with DIN 17 210 or heat treatable steel in accordance with DIN 17 200 shall be used as the material for drilling screws, at manufacturer's discretion. Other steels of equivalent quality are authorized.

Other materials require prior mutual agreement.

DIN 267 Part 9 shall apply to surface protection by electroplating.

3.3 Screw thread and drilling tip

DIN 7970 (at present at the stage of draft) shall apply to the screw thread of drilling screws.

Table 2 shall apply to the drilling tip and to the load bearing portion of the screw thread.

3.4 Metallurgical properties

3.4.1 Surface hardness

The surface hardness of drilling screws must be 560 HV 0,3 at least after heat treatment.

3.4.2 Depth of case hardening

The values given in table 4 shall apply to the depth of case hardening Eht.

Table 4. **Depth of case hardening**

Screw thread d	Depth of case hardening	
	min.	max.
ST 2,9 and ST 3,5	0,05	0,18
ST 3,9 to ST 5,5	0,10	0,23
ST 6,3	0,15	0,28

3.4.3 Core hardness

The core hardness must be situated between 240 and 425 HV 0,3 after heat treatment.

3.4.4 Microstructure

The structure of drilling screws shall not exhibit any ferrite streaks between the surface zone and the core after heat treatment.

3.5 Mechanical properties

3.5.1 Suitability in respect of core hole drilling

The tip of the drilling screw shall be shaped in such a way that it is capable of drilling the necessary core hole for the forming of the mating screw thread. Subclause 4.2.1 shall apply to the testing of this characteristic.

3.5.2 Suitability in respect of forming of the mating screw thread

During the forming of the mating screw thread by screwing into a steel test sheet in accordance with subclause 4.2.1, the screw thread of drilling screws must not become distorted, i.e. it must remain true to size after the test.

3.5.3 Capacity to withstand torsional stresses

The capacity of drilling screws to withstand torsional stresses must be sufficiently great for the torque at fracture to attain at least the minimum values specified in table 7 during a test.

4 Testing

4.1 Test methods relating to metallurgical properties

4.1.1 Testing of surface hardness

The surface hardness shall be tested in accordance with Vickers as specified in DIN 50 133 Part 2. The indentation shall be applied on as flat a portion of the screw as possible, preferably on the head of the screw.

4.1.2 Measuring the depth of case hardening

The depth of case hardening can be measured microscopically on a longitudinal micro-section at the centre of the thread flank.

In the case of drilling screws with nominal diameters up to 3,9 mm, the microscopic measurement can be carried out at the core diameter.

DIN 50 190 Part 1 shall apply to the determination of the depth of case hardening.

4.1.3 Testing of the core hardness

The core hardness shall be tested on a transverse micro-section in accordance with Vickers as specified in DIN 50 133 Part 2.

4.1.4 Examination of the structure

The structure of the material microstructure shall be examined by metallography.

4.2 Test methods relating to mechanical properties

4.2.1 Drilling and screwing in test

The screw to be tested shall be either bright and oiled, phosphate coated and oiled, or galvanized with a coating thickness of 8 µm max. It shall be capable of drilling through a steel test sheet exhibiting the thicknesses specified in table 5. The material of the test sheet shall exhibit a carbon content not exceeding 0,23 % max., and its hardness shall be situated between 110 and 125 HV.

Figure 1 illustrates a suitable testing appliance as an example. Axial forces specified in table 5 shall be applied for the drilling and screwing in test. Table 5 shall also apply to the drilling speed.

The drilling process shall be deemed to have been completed when the core hole has been drilled.

4.2.2 Inspection of the drilled hole

Subject to mutual agreement, an inspection of the drilled hole may also be carried out. For this purpose, test sheets with thicknesses in accordance with table 6 shall be used. Subclause 4.2.1 shall apply to the material and hardness of the test sheet. The test sheet shall be centered with a light punch mark at the spot to be drilled. After the test sheet has been drilled through, the maximum size of the drilled hole shall not exceed the values specified in table 6.

Figure 2 illustrates a suitable testing arrangement as an addition to the appliance illustrated in figure 1. The inside diameter of the bush shall be approx. 0,25 mm larger than the outside diameter of the screw thread. The length of the bush shall be selected in such a way that the drilling tip protrudes out of the bush.

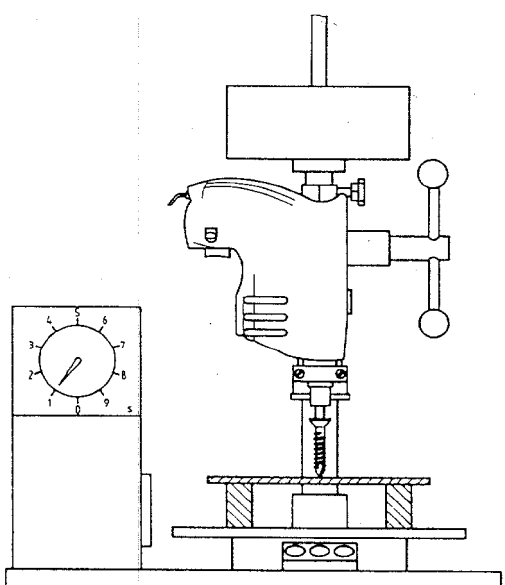


Figure 1. Testing appliance for the drilling and screwing in test

Table 5. **Test data for the drilling and screwing in test**

Screw thread *d*	Thickness of test sheet [1] mm	Axial force N	Test duration *s* max.	Rotational speed of screw under load min. $^{-1}$
ST 2,9	0,7 + 0,7 = 1,4	150	3	1800 to 2500
ST 3,5	1 + 1 = 2	150	4	1800 to 2500
ST 3,9	1 + 1 = 2	150	4,5	1800 to 2500
ST 4,2	1,5 + 1,5 = 3	250	5	1800 to 2500
ST 4,8	2 + 2 = 4	250	7	1800 to 2500
ST 5,5	2 + 3 = 5	350	11	1000 to 1800
ST 6,3	2 + 3 = 5	350	13	1000 to 1800

[1] The thickness of the test sheet can be achieved by placing two steel sheets on top of one another. These values apply to the acceptance test only, and are not comparable to the drilling ranges of table 2.

The axial forces specified in table 5 can also be regarded as guideline values for the application (assembly) of drilling screws. If these values are substantially exceeded, the drilling tips may be partially destroyed by fracture or burning up.

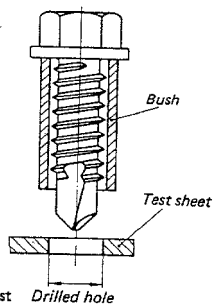


Figure 2. Test arrangement for the drilling test

Table 6. **Test data for the drilled hole**

Screw thread *d*	Sheet thickness mm	Hole diameter mm max.
ST 2,9	1	2,4
ST 3,5	1	2,9
ST 3,9	1	3,2
ST 4,2	2	3,7
ST 4,8	2	4,2
ST 5,5	2	4,9
ST 6,3	2	5,9

4.2.3 Torsional test

The drilling screw to be tested shall be clamped in a slitted clamping device with female screw thread, or in an equivalent testing device in such a way that the clamped portion of the drilling screw is not damaged.

Figure 3 illustrates an example of testing appliance. After clamping, at least two turns of the screw thread must protrude above the clamping device, and at least two turns of the screw thread (without the drilling tip) must be firmly clamped in the device or testing appliance. In the case of short drilling screws, the screw head shall not rest on the face of the clamping device, and the complete screw thread shall be firmly clamped.

The drilling screw shall be tightened until fracture occurs, and the minimum rupture torques in accordance with table 7 shall be attained.

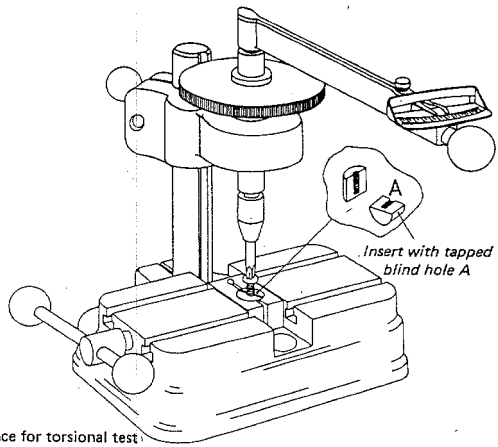


Figure 3. Testing appliance for torsional test

Table 7. **Minimum rupture torques**

Screw thread d	Rupture torque N · m min.
ST 2,9	1,5
ST 3,5	2,8
ST 3,9	3,4
ST 4,2	4,5
ST 4,8	6,5
ST 5,5	10
ST 6,3	14

4.3 Acceptance test

The random sampling schedule in accordance with table 8 applies to the screwing-in test in the case of acceptance testing.

Table 8. **Random sampling schedule**

Batch size		Number of specimens
from	to	
–	15 000	12
15 001	50 000	18
50 001	–	25

In the case of the drilling test in accordance with subclause 4.2.1, all the specimens must exhibit values situated below the specified limits. Should one specimen exhibit a value situated above the maximum limit value, a repeat test with double the number of specimens must be carried out. In this repeat test, only one limit value on one single specimen at the very most may be exceeded. If the limit value is exceeded in more than one case, the batch shall be deemed as not complying with the standard.

Standards referred to

DIN 267 Part 1	Fasteners; technical delivery conditions, general requirements
DIN 267 Part 2	(at present at the stage of draft) Fasteners; technical delivery conditions, finish and dimensional accuracy
DIN 267 Part 5	(at present at the stage of draft) Fasteners; technical delivery conditions, acceptance test
DIN 267 Part 9	Fasteners; technical delivery conditions, components with electroplated coatings
DIN 4000 Part 2	Tabular layouts of article characteristics for bolts and nuts
DIN 7962	(at present at the stage of draft) Cross recessed heads for screws; ISO 4757 modified
DIN 7970	(at present at the stage of draft) Thread and screw ends for self-tapping screws, ISO 1478 modified
DIN 7981	(at present at the stage of draft) Cross recessed oval head self-tapping screws
DIN 7982	(at present at the stage of draft) Cross recessed countersunk head self-tapping screws
DIN 7983	(at present at the stage of draft) Cross recessed countersunk oval head self-tapping screws
DIN 17 200	Quenched and tempered steels; quality specifications
DIN 17 210	Case hardening steels; quality specifications
DIN 50 133 Part 2	Testing of metallic materials; Vickers hardness testing, test load range 1,96 to 49 N (0,2 to 5 kp) (minimum load range)
DIN 50 190 Part 1	Hardness penetration depth of heat treated components: determination of depth of case hardening
DIN ISO 4759 Part 1	Fasteners; tolerances for bolts, screws and nuts with screw thread diameters from 1,6 to 150 mm, product grades A, B and C

Explanatory notes

In conjunction with the standardization of thread grooving screws with ISO metric screw thread (see DIN 7500), the request was also expresssed for the standardization of drilling screws with self-tapping screw thread in accordance with DIN 7970, in view of their increasing importance. In March 1981, draft Standard DIN 7504 on this subject was therefore published; its layout was modelled very closely on the layout of DIN 7500, and it specified various types of drilling screws. This draft standard led after revision to the publication of this standard.

The field of application outlines the purpose of the standard and describes the required characteristics of drilling screws, the testing of which is specified in detail in the "Requirements" clause. The most commonly used types of drilling screws are covered in this standard, and reference to the corresponding standards on self-tapping screws is made in respect of the dimensions of the screw heads. Because hexagon head self-tapping screws with collar and without drilling tip are not yet standardized, the head dimensions of these drilling screws have been featured in DIN 7504.

This standard takes into consideration the forthcoming revised editions of DIN 7970 (self-tapping screw threads) and DIN 7962 (cross recessed heads), in respect of which draft standards are in existence at this time. These draft standards are based on international standards (ISO 1478 and ISO 4757) at present in course of preparation, and they have adopted the international symbols for self-tapping screw threads, screw ends and cross recessed heads used in these international standards, viz.:

ST... for self-tapping screw threads,

C for self-tapping screw ends with coned point,

F for self-tapping screw ends with dog point,

H for so-called Phillips heads, and

Z for so-called Pozidriv heads.

These symbols are destined for use in all the standards concerned, and they have already been used in draft standards (see for examples the drafts of DIN 7981, DIN 7982 and DIN 7983).

Because of existing patent rights, the drilling tip has not been sized in detail in the standard. Its operational capability is ensured by virtue of the specified mechanical properties of the drilling screws. The length of the drilling tip is limited by the dimension l_g. This dimension specifies the minimum length of the fully formed out portion of screw thread, and provides information on the available clamping length in function of the nominal length l.

International Patent Classification

F 16 B 25/00