Self-drilling tapping screws
Dimensions, requirements and testing

DIN 7504

ICS 21.060.10

Supersedes February 1992 edition.

Descriptors: Self-drilling tapping screws, tapping screws, fasteners.

Bohrschrauben mit Blechschrauben-Gewinde; Maße, Anforderungen, Prüfung

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

Foreword

This standard has been prepared by the *Normenausschuß Mechanische Verbindungselemente* (Fasteners Standards Committee).

Amendments

The following amendments have been made to the February 1992 edition.

a) Types N, P and Q screws are no longer included.

b) The standard has been editorially revised.

Previous editions

DIN 7504: 1982-11, 1992-02.

1 Scope and field of application

This standard specifies dimensions, requirements and test methods for heat-treated self-drilling tapping screws ('tapping screws', for short). These screws have a drill point with which they form a pilot hole during assembly, followed by a threaded section with which they form their mating thread, either in a forming or in a cutting operation. See the relevant DIN Standards and ISO Standards for head styles and threads of self-drilling screws.

The specifications of this standard are intended to ensure that tapping screws are capable of performing the above functions without their own thread fracturing or becoming deformed. To that end, requirements have been specified for surface hardness, drilling and thread forming capability and torsional strength.

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 962
Designation system for fasteners

DIN 4000-2
Tabular layouts of article characteristics for bolts, screws and nuts

DIN 6928
Hexagon washer head tapping screws

DIN 17 210
Case hardening steel; technical delivery conditions

DIN 50 133
Vickers hardness testing of metallic materials; HV 0,2 to HV 100

DIN EN 10 083-1
Quenched and tempered steels; technical delivery conditions for special steels

DIN EN 10 083-2
Quenched and tempered steels; technical delivery conditions for unalloyed quality steels

DIN EN ISO 2702
Heat-treated steel tapping screws; mechanical properties (ISO 2702 : 1992)

ISO 3269 : 1988
Fasteners; acceptance inspection

ISO 4042 : 1989
Threaded components; electroplated coatings

ISO 7049 : 1983
Cross recessed pan head tapping screws

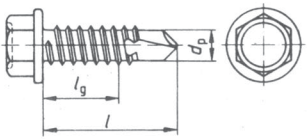
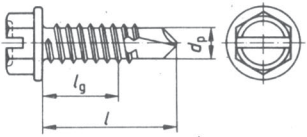
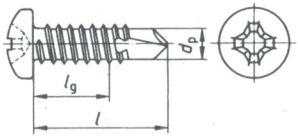
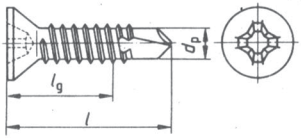
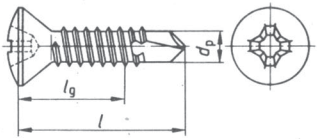
ISO 7050 : 1983
Cross recessed countersunk (flat) head tapping screws (common head style)

ISO 7051 : 1983
Cross recessed raised countersunk (oval) head tapping screws

Continued on pages 2 to 6.

2 Dimensions and designations

Table 1: Screw types and designations

Type	Illustration	Other dimensions as in	Example of designation
K		DIN 6928	Screw DIN 7504 – ST4,2 × 13 – K
L		DIN 6928; slot dimensions as in DIN 962	Screw DIN 7504 – ST4,2 × 13 – L
M (N)	 Type H or Z cross recess	ISO 7049	Screw DIN 7504 – ST4,2 × 13 – M – H
O (P)	 Type H or Z cross recess	ISO 7050	Screw DIN 7504 – ST4,2 × 13 – O – H
R (Q)	 Type H or Z cross recess	ISO 7051	Screw DIN 7504 – ST4,2 × 13 – R – H

The DIN 4000 – 2 – 1 tabular layout of article characteristics shall apply to screws as covered in this standard.

Table 2: Drilling depth and grip length

Dimensions in mm

Thread size		ST2,9	ST3,5	(ST3,9)	ST4,2	ST4,8	ST5,5	ST6,3
Drilling depth (sheet/plate thickness) [1]	From	0,7	0,7	0,7	1,75	1,75	1,75	2,0
	To	1,9	2,25	2,4	3,0	4,4	5,25	6,0
d_p [2] (maximum)		2,3	2,8	3,1	3,6	4,1	4,8	5,8
Nominal size	l Minimum / Maximum	Minimum grip length, l_g						
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	3,7 [3]		
16	15,1 / 16,9	9,6	9,2	8,8	7,3	5,8	5 [3]	
19	18,0 / 20,0	12,5	12,1	11,7	10,3	8,7	8	7
22	21,0 / 23,0		15,1	14,7	13,3	11,7	11	10
25	24,0 / 26,0		18,1	17,7	16,3	14,7	14	13
32	30,75 / 33,25			24,5	23,0	21,5	21	20
38	36,75 / 39,25			30,5	29,0	27,5	27	26
45	43,75 / 46,25					34,5	34	33
50	48,75 / 51,25					39,5	39	38

Thread size ST3,9 (given in brackets) should not be used.

[1] When determining the nominal length, l, it may be necessary to add the width of any air gap between sheets/plates.

[2] The drill point design shall be at the manufacturer's discretion, subject to the d_p values not being exceeded and the requirements specified in subclause 4.6.1 in conjunction with table 4 being complied with.

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

4 Technical delivery conditions

4.1 Design

Tapping screws shall be designed in accordance with the relevant product standards (cf. table 1).

4.2 Material

Tapping screws shall be made either of case hardening steel as specified in DIN 17 210 or steel for quenching and tempering as specified in DIN EN 10 083-1 and DIN 10 083-2 (at the manufacturer's discretion), use of steel grades of equivalent quality being permitted.

4.3 Screw thread and drill point

The thread of tapping screws shall comply with the specifications of the standards on tapping screws, except for the drill point diameter, d_p, and the grip length, l_g, for which the specifications of table 2 shall apply.

4.4 Surface finish

ISO 4042 shall apply with regard to electroplating.

4.5 Metallurgical properties

4.5.1 Surface hardness

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

4.5.2 Case depth

The case depth of screws shall comply with the values specified in table 3.

Table 3: Case depth

Dimensions in mm

Thread size	Case depth (Eht 450)	
	Minimum	Maximum
ST2,9 and **ST3,5**	0,05	0,18
ST3,9 to **ST5,5**	0,10	0,23
ST6,3	0,15	0,28

4.5.3 Core hardness

The core hardness of screws shall, after heat treatment, be between 270 HV 5 and 425 HV 5.

4.5.4 Microstructure

The microstructure of screws shall, after heat treatment, show no band of free ferrite between core and case.

4.6 Mechanical properties

4.6.1 Drilling capability

The point of tapping screws shall be designed so as to permit the pilot hole to be properly drilled in the test specified in subclause 5.2.1.

4.6.2 Thread forming capability

In the test described in subclause 5.2.1, tapping screws shall be capable of forming a mating thread without their own thread becoming deformed.

4.6.3 Torsional strength

The torsional strength of screws shall be such that, when tested in accordance with subclause 5.2.3, the torque necessary to cause failure (breaking torque) is equal to or greater than the values specified in table 6.

5 Testing

5.1 Metallurgical properties

5.1.1 Determination of surface hardness

The surface hardness shall be determined in accordance with DIN 50 133, the impression being made on a flat section of the screw, preferably on the screw head.

5.1.2 Determination of case depth

The case depth may be determined by examining a microsection made at the thread flank mid-point (i. e. between crest and root) with a microscope.

In the case of screws with a nominal diameter of 3,9 mm or less, the measurement may be made in the root of the thread.

Determination of the case depth shall be in accordance with DIN EN ISO 2702.

5.1.3 Determination of core hardness

The core hardness shall be determined in accordance with DIN 50 133 using a transverse microsection.

5.1.4 Examination of microstructure

The microstructure of the screw material shall be examined metallographically.

5.2 Mechanical properties

5.2.1 Drive test

The drive test shall be carried out using the test assembly shown in figure 1 by way of example.

The screw to be tested shall be either bright and oiled, phosphated and oiled, or galvanized to a maximum coating thickness of 8 µm. It shall be capable of being driven through an assembly of two steel test plates of a thickness complying with the values given in table 4. The material of the test plates shall have a carbon content not exceeding 0,23 %, their hardness being between 110 and 125 HV. The axial forces to be applied and the drilling speed shall be as specified in table 4.

The test shall be deemed to be concluded when the pilot hole has been drilled.

5.2.2 Alternative test

By agreement, an alternative test may be carried out. For this purpose, test plates made of the material and having the hardness specified in subclause 5.2.1, and with a thickness complying with the values given in table 5, shall be

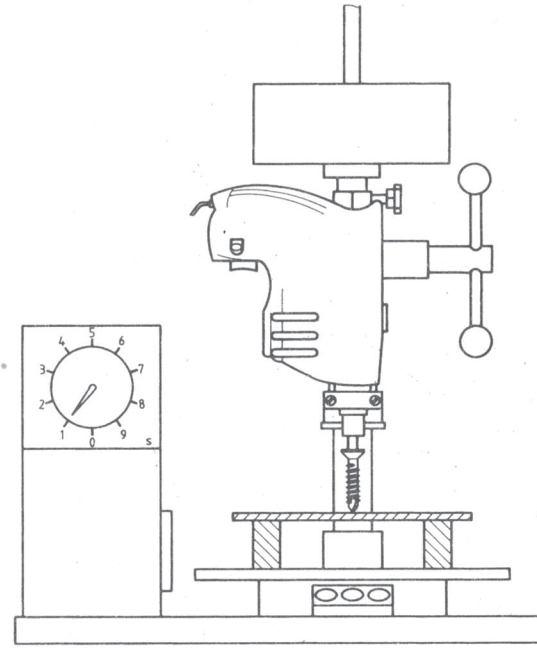


Figure 1: Test assembly for drive test

Table 4: Drive test parameters

Thread size	Thickness of test plates[1], in mm	Axial force, in N	Maximum test duration, in s	Drilling speed of screw under load, in min^{-1}
ST2,9	0,7 + 0,7 = 1,4	150	3	1 800 to 2 500
ST3,5	1 + 1 = 2	150	4	1 800 to 2 500
ST3,9	1 + 1 = 2	150	4,5	1 800 to 2 500
ST4,2	1,5 + 1,5 = 3	250	5	1 800 to 2 500
ST4,8	2 + 2 = 4	250	7	1 800 to 2 500
ST5,5	2 + 3 = 5	350	11	1 000 to 1 800
ST6,3	2 + 3 = 5	350	13	1 000 to 1 800

[1]) The overall test plate thickness may be achieved by placing two single plates on top of each other. The values specified here apply to acceptance testing only and should not be confused with the required drilling depth specified in table 2.

used. Prior to drilling, the test plate shall be marked with a centred punch. After drilling, the maximum size of the hole shall not exceed the values specified in table 5.

Figure 2 shows a suitable arrangement to complement the assembly shown in figure 1. The inside diameter of the bush shall be larger by about 0,25 mm than the thread major diameter, its length being selected so that the drill point projects beyond the bush.

The axial forces specified in table 5 may be regarded as guideline values for the assembly of tapping screws in practice; if these values are markedly exceeded, the drill point may be destroyed by breakage or overheating.

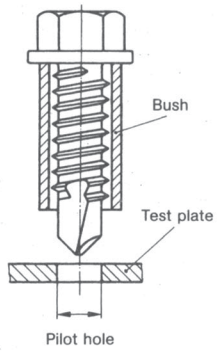


Figure 2: Alternative drill test

Table 5: Alternative drive test parameters

Dimensions in mm

Thread size	Plate thickness	Maximum hole diameter
ST2,9	1	2,4
ST3,5	1	2,9
ST3,9	1	3,2
ST4,2	2	3,7
ST4,8	2	4,2
ST5,5	2	4,9
ST6,3	2	5,9

5.2.3 Torsional strength test

The shank of the screw shall be clamped in a split threaded die, as shown in figure 3 by way of example, or in an equivalent device so that the clamped portion of the screw is not damaged. At least two full-form threads shall project above the clamping device, and at least two full-form threads (without drill point) shall be held in the clamping device. In the case of short screws, the complete thread shall be held in the die, the screw head not resting on the device.

The screw shall be tightened until fracture occurs, and the minimum breaking torques shall be established.

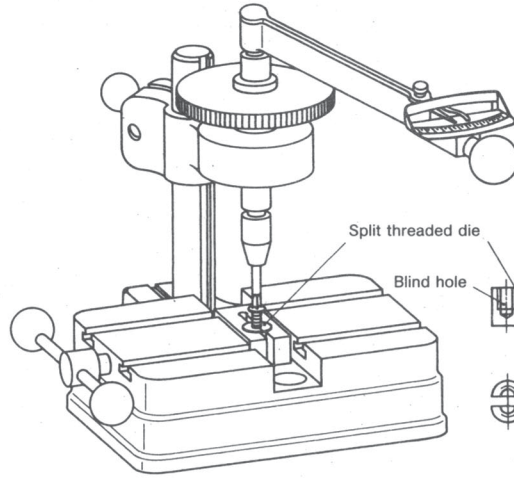


Figure 3: Torsional strength test apparatus

Table 6: Minimum breaking torques

Thread size	Minimum breaking torque, in Nm
ST2,9	1,5
ST3,5	2,8
ST3,9	3,4
ST4,2	4,5
ST4,8	6,5
ST5,5	10
ST6,3	14

5.3 Acceptance inspection

ISO 3269 shall apply with regard to acceptance inspection.

For the drive test, the sampling plan given in table 7 shall apply.

Table 7: Sampling plan

Lot size		Number of samples
From	to	
–	15 000	12
15 001	50 000	18
50 001	–	25

In the drive test described in subclause 5.2.1, the time it takes to drill the hole shall be less than the test duration specified in table 4. If a specimen exceeds these values, a repeat test with double the number of specimens shall be carried out. In this test, not more than one specimen may exceed the values specified. Otherwise, the whole lot shall be deemed as not complying with this standard.