Table 3 Test Plate Thicknesses and Hole Sizes for Drive, Clamp Load and Proof Torque Tests

Nominal Screw Size and Threads per Inch	Thickness, in		Hole Dia, in
	Max	Min	
No. 2-56	0.1270	0.1230	0.075
3-48	0.1270	0.1230	0.087
4-40	0.1270	0.1230	0.098
5-40	0.1270	0.1230	0.110
6-32	0.1270	0.1230	0.120
8-32	0.1905	0.1845	0.147
10-24	0.1905	0.1845	0.166
1/4-20	0.2540	0.2460	0.219
5/16-18	0.3175	0.3075	0.277
3/8-16	0.3800	0.3700	0.339
7/16-14	0.4425	0.4325	0.394
1/2-13	0.5050	0.4950	0.456

***NOTE:** Values shown in Table 3 are intended for specification purposes and for acceptability of screws to the requirements of the specification. These values are not valid for use in design or assembly unless all conditions of the application are identical with those specified for the inspection tests.*

3.9 Hydrogen Embrittlement Test. Screws shall be threaded into a tapped hole or free running nut (para. 3.12) having thickness of at least 1.5 times the nominal screw size and tightened with a torque equal to the hydrogen embrittlement torque specified in Table 2 for the applicable screw size and finish. Spacers should be used for screws with unthreaded shanks and may be used with other lengths providing full thread engagement is maintained within the test nut or tapped hole. The assembly shall remain in this tightened state for 24 hours. The original hydrogen embrittlement torque shall then be reapplied, following which the screw shall be removed by the application of removal torque. Nuts may be hardened to permit reusability.

3.10 Torque Wrenches. Torque wrenches used in all tests shall be accurate within plus or minus 2 percent of the maximum of the specified torque range of the wrench.

Alternatively, a torque sensing power device of equivalent accuracy may be used.

3.11 Test Plate. Test plates shall be low carbon cold rolled steel having a hardness of Rockwell B 70-85. Test plate thicknesses and hole sizes are given in Table 3. Test holes shall be drilled or punched and redrilled, or reamed, to within plus or minus 0.001 in. of the hole sizes specified in Table 3.

3.12 Under Head Bearing Test Surface. The surface condition of plain commercially available flat washers, free running nuts, and cold rolled steel is normally suitable for tests specified in paragraphs 3.6, 3.7, and 3.9. For referee purposes, however, the surface shall conform to 20-30 μin. (AA roughness range).

4. Inspection.

4.1 Inspection Procedure.

(Refer to complete standard.)

IFI Notes:

1. ***SAE J78 is a standard developed through the procedures of the Society of Automotive Engineers. J78 is under the jurisdiction of Division 29 of the SAE Iron and Steel Technical Committee. J78 was originally published in 1972, revised in 1973, and then reaffirmed and reissued, without technical change, in 1979.***
2. ***J78 covers the dimensional, mechanical and performance requirements for steel self-drilling tapping screws. In this presentation those requirements relating to quality assurance and inspection have been omitted. For the omitted information, refer to the complete J78.***
3. ***For a discussion of self-drilling screws, refer to page H-1.***
4. ***SAE J78-1979 is reprinted with the permission of its publisher, Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001, U.S.A.***

1. Scope.

1.1 General. This standard covers the dimensional and general specifications, including performance requirements, for carbon steel self-drilling tapping screws suitable for use in general applications.

It is the objective of this standard to insure that carbon steel self-drilling tapping screws, by meeting the mechanical and performance requirements specified, shall drill a hole and form or cut mating threads in materials into which they are driven without deforming their own thread and without breaking during assembly.

An Appendix is included to provide a recommended technique for measuring the case depth on the screws.

(NOTE: IFI recommends that the performance requirements covered in this standard apply only to the combination of laboratory conditions described in the testing procedures. If other conditions are met in an actual service application (such as different materials, thicknesses, etc.), drilling speed, drill load, starting torque, failure torque, and driving time values may require adjustment.)

1.2 Screw Types and Application. The two types of self-drilling tapping screws covered by this standard are designated and described as follows:

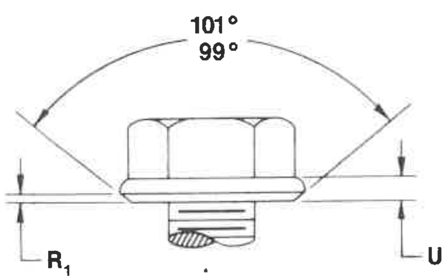
1.2.1 *Type BSD* — Type BSD screws shall have spaced threads with drill points of varying configuration, designated Style 2 and Style 3, designed to accommodate different panel thickness conditions as delineated in Table 5.

1.2.2 *Type CSD* — Type CSD screws shall have threads of machine screw diameter-pitch combinations approximating Unified Form with drill points of varying configuration, designated Style 2 and Style 3, designed to accommodate different panel thickness conditions as delineated in Table 5. Type CSD screws are not subject to thread gaging but shall meet dimensions specified in this standard. They are intended for application where the use of a machine screw pitch thread is preferred over the spaced thread.

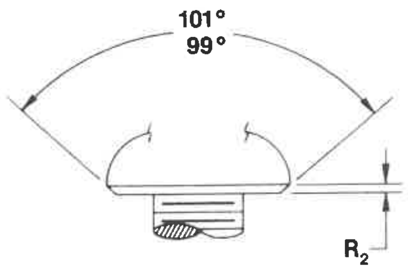
1.3 Head Types. The head types applicable to self-drilling tapping screws covered by this standard shall include those specified in ANSI/ASME B18.6.4, page H-11, except for slotted head and hex (nonwasher) head designs which are not recommended for self-drilling screws.

2. Dimensional Requirements.

SELF-DRILLING TAPPING SCREWS



HEX WASHER HEAD



RECESSED HEADS

Table 1 Head Chamfer Dimensions for Milled Point Self-Drilling Tapping Screws

Nominal Screw Size	U Washer Thickness Max	U Washer Thickness Min	R_1 Chamfer Height Hex Washer Heads Ref	R_2 Chamfer Height Recessed Heads Ref
4	0.030	0.020	0.015	0.015
6	0.040	0.025	0.015	0.015
8	0.050	0.035	0.020	0.015
10	0.050	0.035	0.020	0.020
12	0.050	0.035	0.020	0.020
1/4	0.060	0.040	0.025	0.020

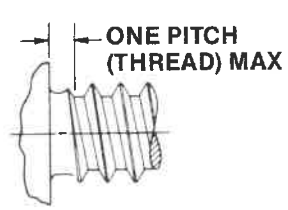


FIG. 1

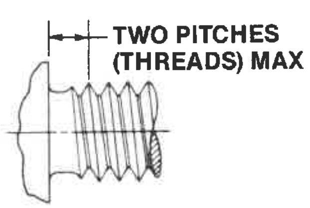


FIG. 2

2.1 General Dimensions. Dimensions and general specifications applicable to heads, body, and screw length for Type BSD and Type CSD screws shall conform to those specified for Type B and Type C tapping screws, respectively, as specified in ANSI/ASME B18.6.4, except as specified in paragraphs 2.2 - 2.4.

2.2 Heads. The underside on all noncountersunk styles of heads on milled point self-drilling screws may be chamfered at the periphery of head in accordance with the dimensions specified in Table 1.

2.3 Eccentricity. Eccentricity is defined as one-half of the full or total indicator reading.

2.3.1 *Eccentricity of Hex and Hex Washer Heads* — Hex and hex washer heads shall not be eccentric with the axis of screw by an amount equal to more than 4 percent of the basic screw diameter.

2.3.2 *Eccentricity of Recess* — The recess in recessed head screws shall not be eccentric with the axis of screw by an amount equal to more than 4 percent of the basic screw diameter.

2.4 Length of Thread.

2.4.1 *Type BSD Screws* — For screws of nominal lengths equal to or shorter than 1.50 in., the full form threads shall extend close to the head such that the specified minor diameter limits are maintained to within one pitch (thread), or closer if practicable, of the underside of the head. See Fig. 1. For screws of nominal lengths longer than 1.50 in., the length of full form thread shall be as specified by the purchaser.

2.4.2 *Type CSD Screws* — For screws of nominal lengths equal to or shorter than 1.50 in., the full form threads shall extend close to the head such that the specified major diameter limits are maintained to within two pitches (threads), or closer if practicable, of the underside of the head. See Fig. 2. For screws of nominal lengths longer than 1.50 in., the length of full form thread shall be as specified by the purchaser.

SELF-DRILLING TAPPING SCREWS

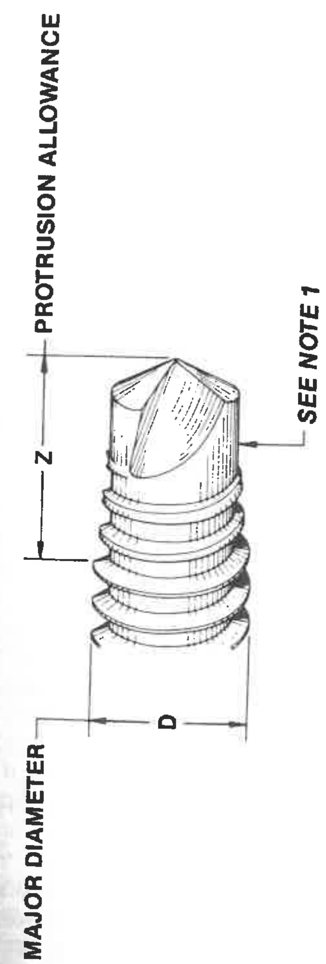


Table 2 Dimensions of Threads and Points for Types BSD and CSD Self-Drilling Tapping Screws

Nominal Size or Basic Screw Diameter	Type BSD Threads Per Inch	Type BSD D Major Diameter Max	Type BSD D Major Diameter Min	Type BSD d Minor Diameter Max	Type BSD d Minor Diameter Min	Type BSD Z Protrusion Allowance (Ref) Style 2 Point	Type BSD Z Protrusion Allowance (Ref) Style 3 Point	Type CSD Threads Per Inch	Type CSD D Major Diameter Max	Type CSD D Major Diameter Min	Type CSD Z Protrusion Allowance (Ref) Style 2 Point	Type CSD Z Protrusion Allowance (Ref) Style 3 Point
4 0.1120	24	0.114	0.110	0.086	0.082	0.163	—	40	0.1120	0.1072	0.130	—
6 0.1380	20	0.139	0.135	0.104	0.099	0.190	0.220	32	0.1380	0.1326	0.152	0.172
8 0.1640	18	0.166	0.161	0.122	0.116	0.211	0.251	32	0.1640	0.1586	0.162	0.202
10 0.1900	16	0.189	0.183	0.141	0.135	0.235	0.300	24	0.1900	0.1834	0.193	0.258
12 0.2160	14	0.215	0.209	0.164	0.157	0.283	0.353	24	0.2160	0.2094	0.223	0.293
1/4 0.2500	14	0.246	0.240	0.192	0.185	0.318	0.393	20	0.2500	0.2428	0.275	0.350
See Note 2						3					3	

Nominal Size or Basic Screw Diameter	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 2 Points Formed 90 deg Heads	Style 2 Formed Csk Heads	Style 2 Milled 90 deg Heads	Style 2 Milled Csk Heads	Style 3 Points Formed 90 deg Heads	Style 3 Formed Csk Heads	Style 3 Milled 90 deg Heads	Style 3 Milled Csk Heads
4 0.1120	5/16	3/8	3/8	7/16	—	—	—	—
6 0.1380	5/16	3/8	3/8	7/16	3/8	7/16	7/16	1/2
8 0.1640	3/8	7/16	7/16	1/2	7/16	1/2	1/2	9/16
10 0.1900	7/16	1/2	15/32	19/32	1/2	9/16	9/16	21/32
12 0.2160	1/2	5/8	17/32	21/32	1/2	5/8	21/32	25/32
1/4 0.2500	1/2	5/8	17/32	11/16	1/2	5/8	11/16	27/32

NOTES:

1. Drill portion of points may be milled and/or cold formed and details of point taper and flute design shall be optional with the manufacturer, provided the screws meet the performance requirements specified in this standard and are capable of drilling the maximum panel thicknesses shown in Table 5 prior to thread pickup.
2. Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.
3. Protrusion allowance Z is the distance, measured parallel to the axis of screw, from the extreme end of the point to the first full form thread beyond the point and encompasses the length of drill point and the tapered incomplete threads. It is intended for use in calculating the maximum effective design grip length Y on the screw in accordance with the following:

$$Y = L\,min - Z$$

2.5 Threads and Points. The threads and points applicable to screws covered by this standard are generally described under paragraph 1.2. They shall conform to the dimensions specified in Table 2.

3. Material and Process Requirements.

3.1 Material and Chemistry. Screws shall be made from cold heading quality, killed steel wire conforming to the following chemical composition:

Analysis[a]	Composition Limits, % by weight[b]			
	Carbon		Manganese	
	Max	Min	Max	Min
Ladle	0.25	0.15	1.65	0.70
Check	0.27	0.13	1.71	0.64

[a] Ladle analyses are shown for informational purposes. Check analyses are mandatory and refer to individual determinations on uncarburized or core portions of screws.

[b] ***IFI recommends that boron in the range of 0.0005–0.003 be permitted.***

3.2 Heat Treatment. Screws shall be heat treated in a carbonitriding or gas carburizing system. Cyaniding systems may be approved by the purchaser when it is shown that a continuous flow (no batch) quenching process which consistently produces uniform case and core hardnesses is employed.

3.2.1 *Tempering Temperature* — Minimum tempering temperature shall be 625°F.

When cyaniding systems are approved, the minimum tempering temperature shall be 450°F.

3.2.2 *Case Depth* — Screws shall have a case depth conforming to the tabulation below:

Nominal Screw Size	Case Depth, in.	
	Max	Min
4 and 6	0.007	0.002
8 thru 12	0.009	0.004
1/4	0.011	0.005

Case depth shall be measured at a midpoint between crest and root on the thread flank. A recommended technique for measuring case depth is given in the Appendix A.

3.2.3 *Case Hardness* — Screws shall have a case hardness equivalent to Rockwell C 52-58. For routine quality control purposes (where case depth and geometry of screw permit), case hardness may be measured on end, shank, or head using Rockwell 15 N. As an alternate, or where this method is not applicable, a microhardness instrument with a Knoop or diamond pyramid indenter and a 500 g load may be used. In such cases, measurements shall be made on the thread profile of a properly prepared longitudinal metallographic specimen.

3.2.4 *Core Hardness* — Screws shall have a core hardness equivalent to Rockwell C 32-40, when measured at mid-radius of a transverse section through the screw taken at a distance sufficiently behind the point of the screw to be through the full minor diameter.

(IFI Note: When case hardening screws in a gas carbonitriding furnace, it is difficult to develop a case hardness of RC 52 min on screws tempered to a core hardness of RC 40 max. IFI recommends that in such circumstances a case hardness range of RC 48 to 58 be permitted.)

3.3 Ductility. Heads of screws shall not separate completely from the shank when a permanent deformation of 5 deg is induced between the plane of the under head bearing surface and a plane normal to the axis of the screw, when tested in accordance with paragraph 3.3.1.

3.3.1 *Ductility Test* — The sample screw shall be inserted into a drilled hole in a hardened wedge block, or other suitable device, and an axial compressive (or impact) load applied against the top of the screw head. Loading shall be continued until the plane of the under head bearing surface is bent permanently through 5 deg with respect to a plane normal to the axis of the screw.

3.4 Finish. Unless otherwise specified, screws shall be supplied with a natural (as processed) finish, unplated or uncoated. Where corrosion preventative or decorative finishes are required, screws shall be plated or coated as specified by the user. However, where steel screws are plated or coated and subject to hydrogen embrittlement, they shall be suitably treated subsequent to the plating or coating operation to obviate such embrittlement. Cadmium or zinc electroplated screws shall be subjected to the hydrogen embrittlement test in paragraph 3.4.1.

3.4.1 *Hydrogen Embrittlement Test* — Cadmium and zinc electroplated screws shall drill their own hole and form a thread in a steel test plate with a thickness equal to the maximum specified for the applicable screw type and size in Table 5. The head of the screw shall be seated against one or more ANSI/ASME B18.22.1 Type B Plain Washers, Narrow Series, page L-4, (size corresponding to screw size and minimum stack thickness corresponding to maximum unthreaded length under the head), or an equivalent spacer, and tightened with a torque equal to the hydrogen embrittlement torque specified in Table 3. The assembly shall remain in this tightened state for 24 hours. The original hydrogen embrittlement torque shall then be reapplied, following which the screw shall be removed by the application of removal torque. There shall be no evidence of failure of the screws.

3.4.2 In cases where screws are plated or coated following delivery to the purchaser (or where plating or coating of screws is otherwise under the control of the purchaser), the screw producer shall not be responsible for failures of screws to meet mechanical or performance requirements due to plating or coating. In such cases, additional screws from the same lot shall be stripped of plating or coating, baked, lubricated with machine oil, and retested in the natural finish.

Table 3 Mechanical and Performance Requirements for Types BSD and CSD Self-Drilling Tapping Screws

Nominal Screw Size	Minimum Torsional Strength, lb-in		Hydrogen Embrittlement Test Torque, lb-in	
			Cadmium Plated Screws	Zinc Plated Screws
	Type BSD	Type CSD	Types BSD and CSD	Types BSD and CSD
4	14	14	10.5	12
6	24	24	18	20
8	42	48	36	41
10	61	65	49	55
12	92	100	72	85
1/4	150	156	114	132

4. Performance Requirements and Tests.

4.1 Torsional Strength. Screws shall not fail with the application of a torque less than the torsional strength torque specified in Table 3, when tested in accordance with paragraph 4.1.1.

4.1.1 *Torsional Strength Test* — The sample screw shall be securely clamped by suitable means (see Fig. 3, page H-20) such that the threads in the clamped length are not damaged, and that at least two full threads project above the clamping device, and that at least two full threads exclusive of point, flutes, or thread cutting slot, are held within the clamping device. By means of a suitably calibrated torque measuring device, torque shall be applied to the screw until failure of the screw occurs. The torque required to cause failure shall be recorded as the torsional strength torque.

4.2 Drill-Drive Test. Sample screws shall be selected at random from the lot and shall be used to drill holes and form or cut mating threads in a test plate. The time in seconds

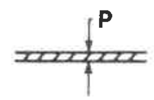


FIG. 5A — SINGLE PANEL

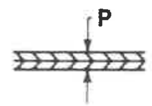


FIG. 5B — DOUBLE PANEL

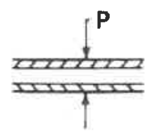


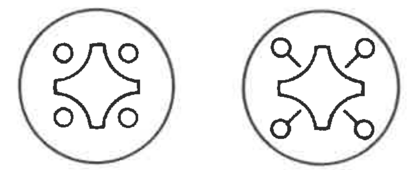
FIG. 5C — SPACED PANEL

FIG. 5 — TYPICAL PANEL CONFIGURATIONS

Table 5 Self-Drilling Tapping Screw Selection Chart

Screw Type	Point Style	Nominal Screw Size	P[a] Recommended Panel Thickness, in.
BSD and CSD	2	4	0.080 Max
		6	0.090 Max
		8	0.100 Max
		10	0.110 Max
		12	0.140 Max
		1/4	0.175 Max
	3	6	0.090-0.110
		8	0.100-0.140
		10	0.110-0.175
		12	0.110-0.210
		1/4	0.110-0.210

[a] If the panel to be drilled is comprised of two or more layers (see Figs. 5B and 5C), the gap between the layers (which might consist of a sealing strip, airspace caused by warpage, etc., or just the separation caused by the pressure exerted by the driver) must be considered in determining the point style for the particular fastener. Using a self-drilling tapping screw as covered in this standard in a multilayer application with an excessive gap could result in point breakage since the tapping in one layer begins before completion of the drilling of the other layers and since the advancement of the screw in the tapping operation is much faster than in the drilling operation.



TYPE 1 TYPE 1A

ROUND DEPRESSIONS TO BE LOCATED AS SHOWN

RECESS TYPES

MARKS MAY BE RAISED OR DEPRESSED AT MANUFACTURERS OPTION

HEX AND HEX WASHER TYPES

FIG. 6

The photomicrographs given in Appendix A illustrate comparisons between the structure of case and core produced by the method recommended therein and a regular quenched and tempered structure. Case depths were measured on each of three screws after carbonitriding and microhardness traverses were run. The same parts were then water-quenched from 1430 F (775 C) and case depths were again measured. Results of each method appear under the photographs.

5.1 Optional Head Marking. For the purpose of identifying self-drilling tapping screws in assembled components, the consumer, at his option, may specify identifying head markings. Heads of self-drilling tapping screws, when specified by the consumer, shall be marked as shown in Fig. 6.

APPENDIX A

Introduction.

The accurate measurement of case depth of fasteners which have been carburized or carbonitrided is often affected by conflicting results obtained by different laboratories. The conventional microscopic method relies on the ability of the technician to distinguish the line of demarcation between the case and the core, and with annealed or tempered structures this line is often not very sharply defined. Consequently, it is common for different people to come up with varying results on the same sample. The following recommended technique, however, greatly reduces the element of visual interpretation inherent in microscopic examination.

Samples are prepared by grinding to approximately one-half diameter on a longitudinal plane. They are heated for 7 minutes at 1430°F (775°C) and water quenched. Further grinding on 240 and 600 grit papers, followed by a 30 second etch in 2½ nital, rinse in methanol, and dry in an air blast, results in a structure as seen in the accompanying photomicrographs. The austenizing temperature of 1430°F (775°C) is sufficient to completely transform and harden the hyper-eutectoid case whereas the core will not harden. The polishing, while not up to full metallographic standards, is sufficient to clearly reveal the structure when etched. It is not necessary to mount the specimens in bakelite or lucite, which is a time-saving factor.

The following is a guide for Case Depth Measurement.

A. Standard Method.

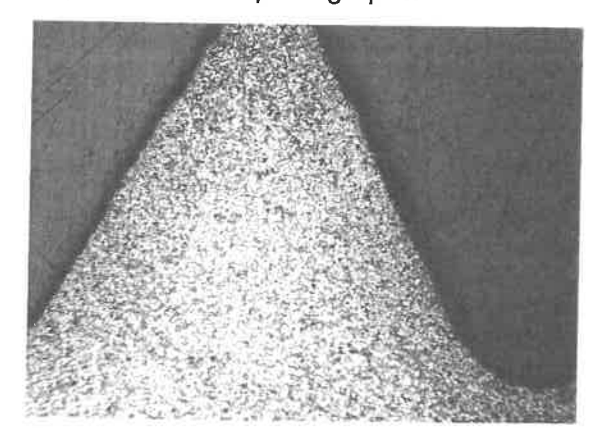
1. Prepare and quench samples as described in preceding paragraph.
2. Measure total case at thread flank, midpoint between crest and root. The depth of the case is taken as the line of demarcation between the hardened hypereutectoid zone and the unhardened core. Recommended magnification 100X.
3. Take readings on four separate threads and average results to obtain case depth of the screw. (The average figure rather than the minimum depth found at any one point should be used as the criterion for case depth, as a single low reading represents only a very small proportion of the total area involved.)

B. Referee Method.

1. Take sample representing the conventional heat treatment of the part and mount and polish for microscopic examination.
2. Measure case with Tukon or equivalent micro-hardness instrument. Start at surface at midpoint of screw flank between root and crest, measure hardness at 0.001 in. increments. Case depth will be perpendicular distance from surface to a point of Rc 45 minimum.

(IFI Notes: Because indentations spaced at 0.001 in. risk adjacent measurements being taken on cold worked material, IFI suggests that hardness reading increments spaced at 0.002 in. are more practical. When 0.001 in. increments are required a lighter than 500 gm load is recommended. Because the specified min core hardness of tapping screws is RC 40, a case depth at which the hardness is RC 45 is considered the effective case depth. Total case depth is where no effect of carbon enrichment is measureable and is a value of questionable importance when related to screw performance.)

The accompanying photomicrographs illustrate comparisons between the structure of case and core produced by the method recommended herein and a regular quenched and tempered structure. Case depths were measured on each of three screws after carbonitriding and micro-hardness traverses were run. The same parts were then water-quenched from 1430°F (775°C) and case depths were again measured. Results of each method appear under the photographs.



Structure of Case & Core After Anneal at 1600°F (870°C) for 7 minutes — Magnification of 100X, Nital Etch.