IFI
535
1982

METRIC SOCKET COUNTERSUNK HEAD CAP SCREWS

IFI NOTE:

IFI-535 covers hexagon socket countersunk head cap screws in nominal thread diameters M3 through M20. IFI-535 is an interim standard which is now being considered by ASME Standards Committee B18 as the basis of an American National Standard. When this standard is published it will probably be designated ANSI/ASME B18.3.5. At that time IFI will withdraw IFI-535 and support the new American National Standard.

1. GENERAL

1.1 Scope

1.1.1 This standard contains the complete dimensional, mechanical and performance requirements for Metric Series Hexagon Socket Countersunk Head Cap Screws of nominal sizes from 3 mm to 20 mm.

Socket countersunk head cap screws are designed and recommended for applications where a flush seating socket head screw is desired. Wrenchability is limited by the socket size and key engagement. Because of the head configuration, this product is not recommended where maximum fatigue resistance is required.

1.2 Interchangeability

Socket countersunk head cap screws, manufactured to this standard are intended for structural use. Because of dimensional differences, they are not interchangeable with those now manufactured in metric standard countries. The screws covered in this standard have higher heads which are needed to develop the full strength of the material.

1.3 Dimensions

All dimensions in this standard are given in millimeters (mm) and apply before plating unless otherwise stated.

1.4 Options

Options, where specified, shall be at the discretion of the manufacturer unless otherwise agreed upon by manufacturer and purchaser.

1.5 Responsibility for Modification

The manufacturer shall not be held responsible for malfunctions of product determined to be due to plating or other modifications when such plating or modification is not accomplished under his control or direction.

1.6 Terminology

For definitions of terms relating to fasteners or component features thereof used in this standard, refer to American National Standard, Glossary of Terms for Mechanical Fasteners, ANSI B18.12, page J—5.

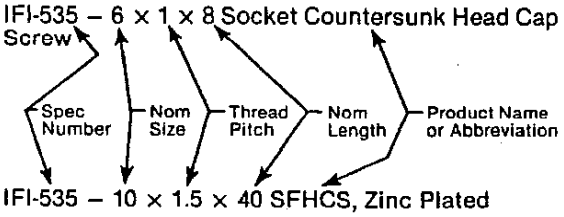
1.7 Designation

Metric socket countersunk head cap screws conforming to this standard shall be designated by the following data in the sequence shown:

a. Specification (IFI-535) number followed by a dash.
b. Nominal size of screw.
c. Thread pitch, preceded by "×". For the coarse pitch series listed in Table 1, the thread pitch may be omitted.
d. Nominal screw length, preceded by "×".
e. Name of product. Where so desired, the product name may be abbreviated "SFHCS".
f. Material and property class. For alloy steel screws the material and property class shall be omitted.
g. Protective finish, if required.

Examples:

IFI-535 – 6 × 1 × 8 Socket Countersunk Head Cap Screw



IFI-535 – 10 × 1.5 × 40 SFHCS, Zinc Plated

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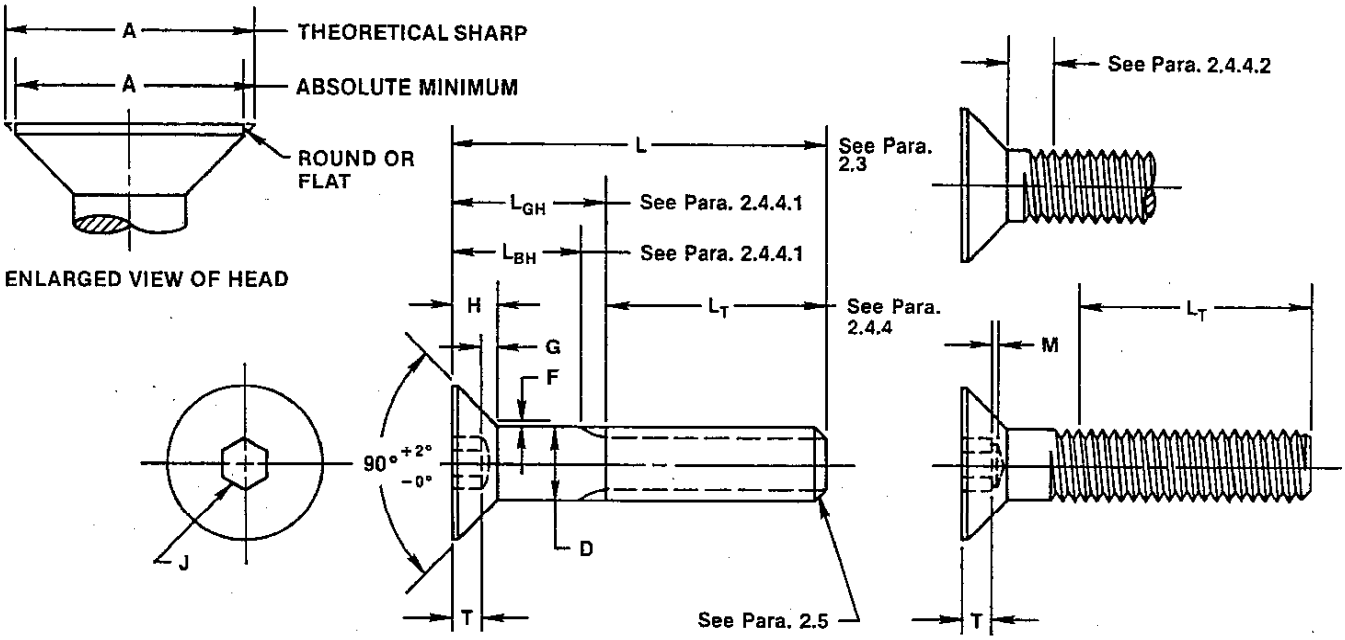

Table 1 Dimensions of Hexagon Socket Countersunk Head Cap Screws

Nom Screw Dia and Thread Pitch	D		A		H		J	T	G	F	M
	Body Dia		Head Diameter		Head Height		Hexagon Socket Size	Key Engagement	Wall Thickness	Fillet Extension Above D Max	Drill Allowance
	Max	Min	Theoretical Sharp Max	Abs. Min	Reference	Flushness Tolerance	Nom	Min	Min	Max	Max
M3 × 0.5	3.00	2.86	6.72	5.35	1.86	0.30	2.0	1.1	0.25	0.25	0.3
M4 × 0.7	4.00	3.82	8.96	7.80	2.48	0.30	2.5	1.5	0.45	0.35	0.4
M5 × 0.8	5.00	4.82	11.20	9.75	3.10	0.35	3.0	1.9	0.66	0.40	0.5
M6 × 1	6.00	5.82	13.44	11.70	3.72	0.35	4.0	2.2	0.70	0.50	0.6
M8 × 1.25	8.00	7.78	17.92	15.65	4.96	0.40	5.0	3.0	1.16	0.60	0.8
M10 × 1.5	10.00	9.78	22.40	19.50	6.20	0.50	6.0	3.6	1.62	0.80	0.9
M12 × 1.75	12.00	11.73	26.88	23.40	7.44	0.60	8.0	4.3	1.80	0.90	1.2
M14 × 2	14.00	13.73	30.24	26.18	8.12	0.70	10.0	4.7	1.62	1.00	1.5
M16 × 2	16.00	15.73	33.60	23.76	8.80	0.80	10.0	4.8	2.20	1.00	1.5
M20 × 2.5	20.00	19.67	40.32	34.60	10.16	1.00	12.0	5.6	2.20	1.20	1.5
See Para.			2.1.1		2.1.2	2.1.3	2.2.1	2.2.2	2.2.7	2.1.4	

2. DIMENSIONAL CHARACTERISTICS

The following requirements supplement the dimensional data presented in Tables 1 and 2 and shall apply to the respective features of screws.

2.1 Heads

2.1.1 Head Diameter. The maximum sharp values under Column A are theoretical values as it is not practical to make the edges of the head sharp. The maximum sharp value represents the exact diameter of a hole countersunk to exactly 90 deg. in which a screw having maximum head size will just fit flush.

2.1.2 Head Height. The tabulated values for head height are given for reference only and are calculated to the maximum formulation.

2.1.3 Flushness Tolerance. The flush-

ness tolerance is the distance the top surface of a screw having the minimum head size will be below the flush condition in a hole countersunk exactly 90 deg to the maximum sharp dimension listed in Column A.

2.1.4 Fillet. A fillet between the conical bearing surface of the head and the shank (body) of the screw is allowable above the maximum tabulated value for D within the value listed for F.

2.2 Sockets

2.2.1 Socket Size. Sockets shall be of the nominal size "J" specified in Table 1 for the respective screw size and shall conform with the dimensions given in Table 2 (see Table 2 of ANSI B18.3.1M, page G—3), as determined by gaging in accordance with Paragraph 2.2.3.

2.2.2 Key Engagement. The key engagement depth shall conform with the minimum values specified for "T" in Table 1, as determined by gaging in accordance with Paragraph 2.2.3.

2.2.3 Socket Gaging. Acceptability of sockets shall be determined by the use of the hexagon socket gages specified in Table 3 (see Table 4 of ANSI B18.3.1M, page G—5). The hexagon sockets shall allow the GO member of the gage to enter freely to the minimum key engagement depth. The NOT GO gage member shall be permitted to enter only to a depth equivalent to 7.5 percent of the nominal socket size.

For determining the acceptability of sockets in plated products after plating, a GO gage identical in design and tolerances to that shown in Table 3, except having a minimum width across flats dimension equal to the nominal socket size, shall be employed.

2.2.4 Edge of Socket. The edge at junction of the socket with the top of head may be broken (rounded or chamfered) as depicted in Fig. 3 providing the depth of chamfer or rounding does not violate the NOT GO gage penetration limit specified in 2.2.3.

2.2.5 Broached Sockets. For hexagon broached sockets which are at or near the maximum limit of size, the overcut resulting

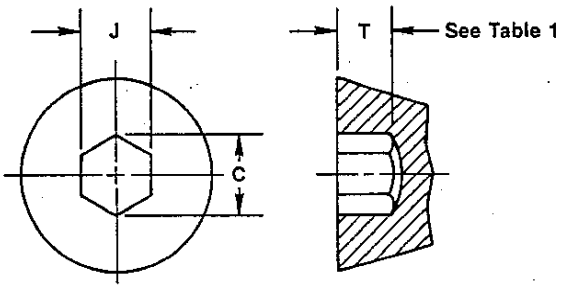

FIG. 1 FORGED HEXAGON SOCKET

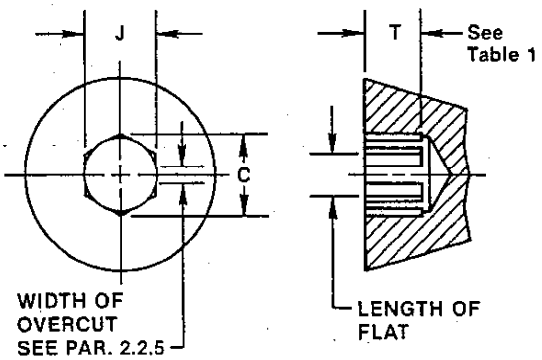

FIG. 2 BROACHED HEXAGON SOCKET

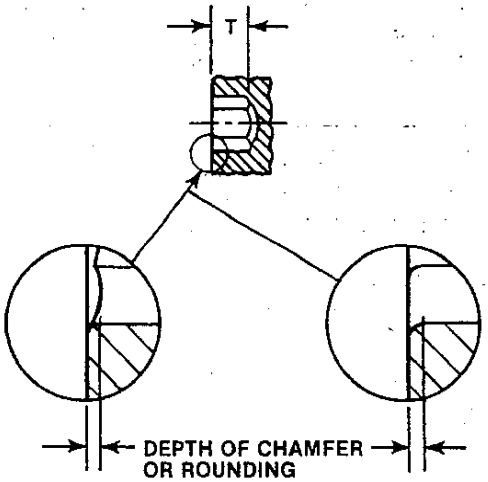

FIG. 3 SOCKET EDGE DETAIL

from drilling shall not exceed 20 percent of the length of any flat of the socket. See Fig. 2.

2.2.6 Socket True Position. The axis of the socket shall be located at true position relative to the axis of the screw within a tolerance zone having a diameter equal to 3 per-

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Table 1A Body and Grip Lengths

Nominal Diameter	M3		M4		M5		M6		M8		M10		M12		M14		M16		M20	
Nominal Length	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}
35	17.0	14.5	15.0	11.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
40	22.0	19.5	20.0	16.5	18.0	14.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
45	27.0	24.5	25.0	21.5	23.0	19.0	21.0	16.0	—	—	—	—	—	—	—	—	—	—	—	—
50	32.0	29.5	30.0	26.5	28.0	24.0	26.0	21.0	22.0	15.7	—	—	—	—	—	—	—	—	—	—
55	37.0	34.5	35.0	31.5	33.0	29.0	31.0	26.0	27.0	20.7	—	—	—	—	—	—	—	—	—	—
60	—	—	40.0	36.5	38.0	34.0	36.0	31.0	32.0	25.7	28.0	20.5	—	—	—	—	—	—	—	—
65	—	—	45.0	41.5	43.0	39.0	41.0	36.0	37.0	30.7	33.0	25.5	29.0	20.2	—	—	—	—	—	—
70	—	—	50.0	46.5	48.0	44.0	46.0	41.0	42.0	35.7	38.0	30.5	34.0	25.2	30.0	20.0	—	—	—	—
80	—	—	60.0	56.5	58.0	54.0	56.0	51.0	52.0	45.7	48.0	40.5	44.0	35.2	40.0	30.0	36.0	26.0	—	—
90	—	—	—	—	68.0	64.0	66.0	61.0	62.0	55.7	58.0	50.5	54.0	45.2	50.0	40.0	46.0	36.0	—	—
100	—	—	—	—	78.0	74.0	76.0	71.0	72.0	65.7	68.0	60.5	64.0	55.2	60.0	50.0	56.0	46.0	—	—
110	—	—	—	—	—	—	86.0	81.0	82.0	75.7	78.0	70.5	74.0	65.2	70.0	60.0	66.0	56.0	58.0	45.5
120	—	—	—	—	—	—	96.0	91.0	92.0	85.7	88.0	80.5	84.0	75.2	80.0	70.0	76.0	66.0	68.0	55.5
130	—	—	—	—	—	—	—	—	102.0	95.7	98.0	90.5	94.0	85.2	90.0	80.0	86.0	76.0	78.0	65.5
140	—	—	—	—	—	—	—	—	112.0	105.7	108.0	100.5	104.0	95.2	100.0	90.0	96.0	86.0	88.0	75.5
150	—	—	—	—	—	—	—	—	122.0	115.7	118.0	110.5	114.0	105.2	110.0	100.0	106.0	96.0	98.0	85.5

NOTES

(1) Screws of diameter/length combinations above upper heavy line shall be threaded full length, see 2.4.4.2.

(2) For screw sizes and/or lengths not tabulated, see 2.4.4.3.

cent of the basic screw diameter or 0.26 mm, whichever is greater, for nominal screw sizes up to and including 12 mm, and equal to 6 percent of the basic screw diameter for sizes larger than 12 mm; regardless of feature size.

2.2.7 Wall Thickness. The minimum wall thickness "G" specified in Table 1 shall be controlled using the gaging shown in Appendix III.

2.3 Length

2.3.1 Measurement. The length of socket countersunk head cap screws shall be measured, parallel to the axis of screw, from the plane of the top surface of the head to the extreme end of the shank.

2.3.2 Tolerance On Length. The tolerance on length shall be bilateral as tabulated below:

Nominal Screw Length	Tolerance on Length, mm
Up to 16mm, incl.	±0.3
Over 16 to 60mm, incl.	±0.5
Over 60 to 150mm, incl.	±0.8

2.3.3 Standard Lengths. The standard lengths for socket countersunk head cap screws shall be as follows: 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 80, 90, 100, 110, 120, 130, 140, and 150 mm.

2.4 Threads

2.4.1 Thread Series and Form. Unless otherwise specified, threads shall be the metric coarse series in accordance with American National Standard, Metric Screw Threads—M Profile, ANSI B1.13M, page A—8, or International Standard, General Purpose Metric Screw Threads—Selected Sizes for Screws, Bolts and Nuts, ISO 262-1973. The thread form shall conform to International Standard, General Purpose Metric Screw Threads—Basic Profile, ISO 68-1973.

2.4.2 Thread Tolerance Class. Threads shall be ISO Tolerance Class 4g6g. For plated screws the allowance "g" may be consumed by the thickness of plating so that the maximum limit of size after plating shall be Tolerance Class 4h6h. Thread limits shall be

in accordance with ANSI B1.13M. See Appendix VI of ANSI B18.3.1M, page G—14, wherein the limiting dimensions applicable to threads up to 4 mm in size before and after plating are given for reference purposes. The allowable "g" shown therein for those sizes has been increased over that specified in B1.13M. However, because the minimum limits are unchanged, the screws will be totally interchangeable.

2.4.3 Thread Gaging. Gaging shall be in conformance with System 22 of ANSI B1.3M, page A—35.

2.4.4 Thread Length, L_T. The length of thread is controlled by the grip length L_{GH} specified in Table 1A.

2.4.4.1 Grip Length, L_{GH}. The tabulated L_{GH} values are maximum and represent the minimum design grip length, including the reference head height, of the screw. They shall be measured from the top of the head to the face of a GO thread ring gage, having the thread countersink and/or counterbore removed, which has been assembled by hand as far as the thread will permit. The tabulated L_{BH} values are minimum and represent the minimum body length, including the reference head height of the screw. They are equal to L_{GH} minus 5 times the pitch of the thread for the respective screw size.

Screws having nominal lengths falling between those for which L_{GH} and L_{BH} values are tabulated in Table 1A shall have L_{GH} and L_{BH} dimensions conforming with those of the next shorter tabulated nominal length for the respective screw size.

2.4.4.2 Thread to Head. For screws of nominal lengths above the heavy line in Table 1A, the thread length shall govern the grip and body lengths. On these screws, the complete (full form) threads measured with a thread ring gage, having the thread chamfer and/or counterbore removed, shall extend to within two pitches (threads) of the intersection of the conical portion of the head with the body diameter.

2.4.4.3 Non-Tabulated Lengths. For screws of nominal lengths longer than those for which L_{GH} and L_{BH} values are tabulated in Table 1A, the maximum grip gaging length L_{GH} and body length L_{BH} of the screws shall be determined as follows:

$$L_{GH} = L - L_T$$

$$L_{BH} = L - L_{TT}$$

Where: L = Nominal length

L_T = Minimum thread length from Table 4

L_{TT} = Maximum total thread length from Table 4

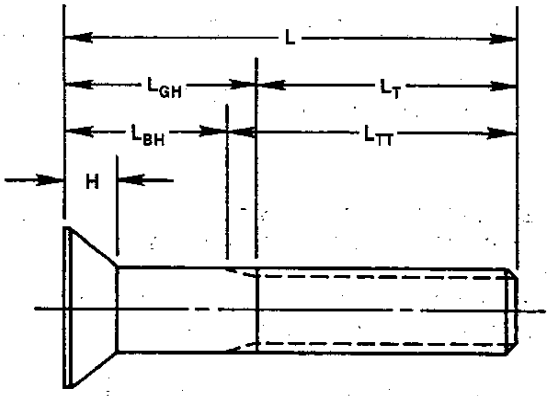

TABLE 4. Thread Lengths for Lengths Not Tabulated in Table 1A

Nominal Screw Diameter	L_T Minimum Thread Length	L_{TT} Maximum Total Thread Length
M3	18.0	23.5
M4	20.0	25.5
M5	22.0	31.0
M6	24.0	35.0
M8	28.0	42.3
M10	32.0	49.5
M12	36.0	56.8
M14	40.0	64.0
M16	44.0	70.0
M20	52.0	84.5

2.5 Point

The end on screws of 5 mm nominal size and larger and of nominal lengths equivalent to 0.75 times the basic screw diameter or longer shall be chamfered. The chamfer shall extend slightly below the root of the thread and the edge between the flat and chamfer may be slightly rounded. The included angle of the point shall be approximately 90 deg. Chamfering on screw sizes up to and including 4 mm and of larger sizes having lengths shorter than 0.75 times the basic screw diameter shall be optional.

2.6 Concentricity.

Concentricity of the thread with the body shall be within 0.13 mm per mm of body length (unthreaded portion) full (total) indicator reading, taken directly under the head when the screw is held by the full threads closest to the head of the screw and shall not exceed 0.65 mm.

2.7 Surface Roughness.

For alloy steel screws of nominal lengths equal to or less than 8 times the basic screw diameter, the surface roughness on the screws before plating shall not exceed 1.6 micrometers AA on the fillet and head bearing surfaces, nor exceed 0.8 micrometer AA on the threads.

For longer lengths the surface roughness of the screws prior to plating shall not exceed 3.2 micrometers AA on the body, fillet and head bearing surfaces.

Normally, it shall be sufficient to ascertain that these surfaces on screws have the equivalent of a smooth machined finish by visual comparison with known surface standards. However, where it is practical and deemed necessary to measure those surfaces with commercially available equipment, roughness measurements shall be taken axially on the body and fillet surfaces, and circumferentially on the bearing surface.

3. MATERIAL, PROCESSING AND MECHANICAL PROPERTIES

3.1 Material and Processing

Socket countersunk head cap screws shall be fabricated from an alloy steel. Material, manufacturing processes, heat treatment, surface discontinuities, decarburization and carburization in threads, test methods and inspection shall conform to requirements given in ASTM A574M, page G—45.

3.2 Mechanical Properties

3.2.1 Hardness. Alloy steel screws shall have a hardness of Rockwell C39 to 44 for nominal sizes up to and including 12 mm, and Rockwell C37 to 44 for sizes larger than 12 mm.

3.2.2 Tensile Strength. Screws having a nominal length equal to or exceeding two times the basic screw diameter shall withstand without failure, the static tensile load listed in Table 5 when tested in accordance with Paragraph 3.4.1 of ASTM F606, page B—61. Screws of shorter nominal lengths shall not be subject to tensile testing but accepted on the basis of meeting the hardness requirements in Paragraph 3.2.1 and the "G" minimum wall thickness per Paragraph 2.2.7.

Table 5 Tensile Strength Requirements

Nom Screw Dia and Thread Pitch	Tensile Strength, min kN
M3 × 0.5	5.2
M4 × 0.7	9.1
M5 × 0.8	14.7
M6 × 1	20.8
M8 × 1.25	37.9
M10 × 1.5	60.0
M12 × 1.75	87.2
M14 × 2	120
M16 × 2	162
M20 × 2.5	253

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APPENDIX I

FORMULAS FOR DIMENSIONS

Body Diameter (D) — Table 1

D (Max) = Basic or Nominal Size — See table for values

D (Min) = D (Max) — IT13 Tolerance from ISO System of Limits & Fits, page J—29.

Head Diameter (A) — Table 1

A (Max) =

A (Min) =

Head Height (H) — Table 1

H (Ref) =

Flushness Tolerance =

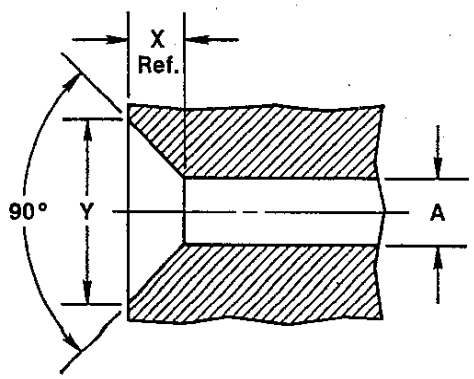
Key Engagement (T) — Table 1

T (Min) =

G (Min) =

APPENDIX II

DRILL AND COUNTERSINK SIZES FOR METRIC COUNTERSUNK SOCKET HEAD CAP SCREWS



D	A	X	Y
Nominal Screw Size	Nominal Drill Size	Countersink Depth (Ref)	Countersink Diameter Min
M3	3.5	1.61	6.72
M4	4.6	2.18	8.96
M5	6.0	2.60	11.20
M6	7.0	3.22	13.44
M8	9.0	4.46	17.92
M10	11.5	5.45	22.40
M12	13.5	6.69	26.88
M14	16.0	7.12	30.24
M16	18.0	7.80	33.60
M20	22.4	8.96	40.32

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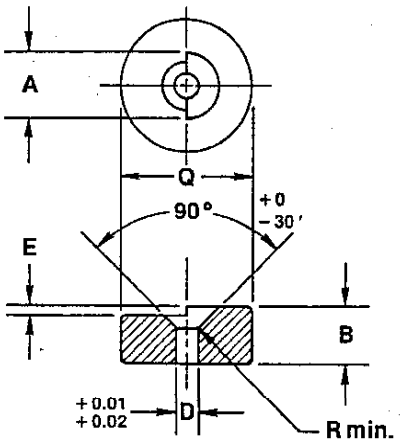
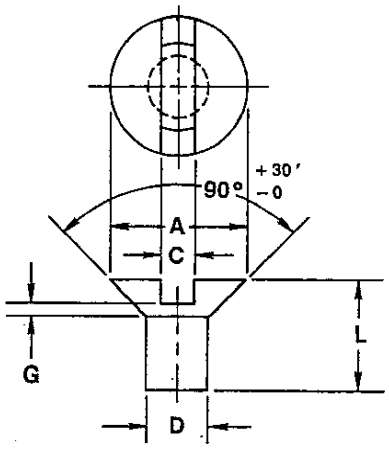
APPENDIX III

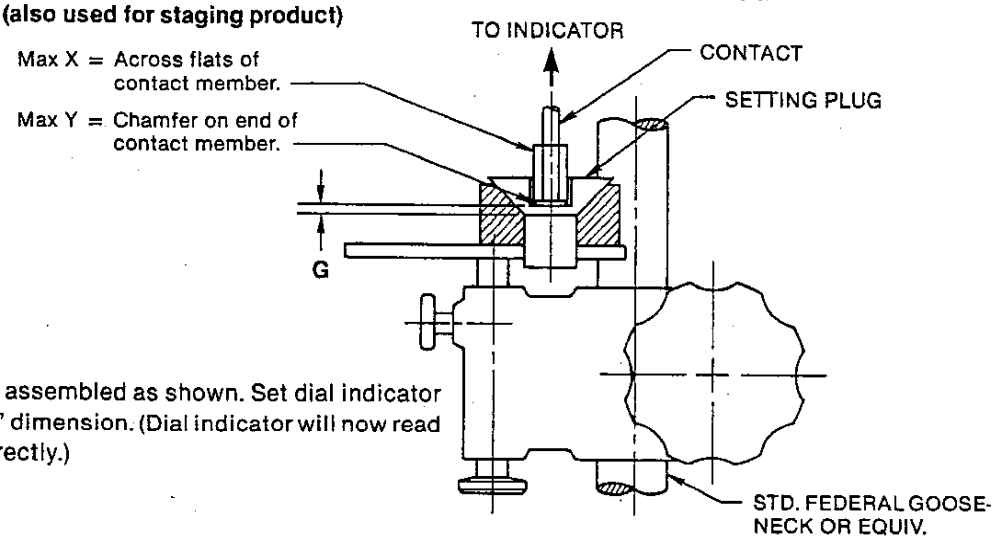
SUGGESTED GAGE FOR STAGING COUNTERSUNK SOCKET HEAD CAP SCREW TO CHECK MIN WALL THICKNESS "G"



FLUSHNESS GAGE
(also used for staging product)



SETTING PLUG



With Gage assembled as shown. Set dial indicator to read "G" dimension. (Dial indicator will now read hex wall directly.)

D	A	G	C	E	L (Ref)	Q (Ref)	B (Ref)	R	X	Y
3	6.72	0.25	2.4	0.30	20	24	6	2	2.0	0.1
4	8.96	0.45	2.9	0.30	20	24	10	2	2.5	0.1
5	11.20	0.66	3.5	0.35	24	24	12	3	3.0	0.2
6	13.44	0.70	4.7	0.35	24	30	12	3	4.0	0.2
8	17.92	1.16	5.8	0.40	36	30	16	3	5.0	0.2
10	22.40	1.62	7.0	0.50	36	35	16	3	6.0	0.2
12	26.88	1.80	9.3	0.60	36	40	20	4	8.0	0.2
14	30.24	1.62	11.6	0.70	36	45	22	4	10.0	0.2
16	33.60	2.20	11.6	0.80	36	50	24	4	10.0	0.2
20	40.32	2.20	13.8	1.00	36	60	28	4	12.0	0.2

Note — All dimensions are max, with gage makers tolerance except as noted.