

METRIC FASTENERS

A number of American National Standards covering metric bolts, screws, nuts, and washers have been established in cooperation with the Department of Defense in such a way that they could be used by the Government for procurement purposes. Extensive information concerning these metric fasteners is given in the following text and tables, but for additional manufacturing and acceptance specifications reference should be made to the respective Standards which may be obtained by nongovernmental agencies from the American National Standards Institute, 11 West 42nd Street, New York, N.Y. 10036. These Standards are:

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Manufacturers should be consulted concerning which items and sizes are in stock production.

Comparison with ISO Standards.—American National Standards for metric bolts, screws and nuts have been coordinated to the extent possible with the comparable ISO Standards or proposed Standards. The dimensional differences between the ANSI and the comparable ISO Standards or proposed Standards are few, relatively minor, and none will affect the functional interchangeability of bolts, screws, and nuts manufactured to the requirements of either.

Where no comparable ISO Standard had been developed, as was the case when the ANSI Standards for Metric Heavy Hex Screws, Metric Heavy Hex Bolts, and Metric Hex Lag Screws were adopted, nominal diameters, thread pitches, body diameters, widths across flats, head heights, thread lengths, thread dimensions, and nominal lengths are in accord with ISO Standards for related hex head screws and bolts. At the time of ANSI adoption (1982) there was no ISO Standard for round head square neck bolts.

The following functional characteristics of hex head screws and bolts are in agreement between the respective ANSI Standard and the comparable ISO Standard or proposed Standard: diameters and thread pitches, body diameters, widths across flats (see exception below), bearing surface diameters (except for metric hex bolts), flange diameters (for metric hex flange screws), head heights, thread lengths, thread dimensions, and nominal lengths.

Table 1. American National Standard Metric Hex Cap Screws
ANSI/ASME B18.2.3.1M-1979 (R1995)

PROPERTY CLASS AND MANUFACTURER'S IDENTIFICATION TO APPEAR ON TOP OF HEAD

Nominal Screw Dia., D , and Thread Pitch	Body Dia., D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height, K_1	Washer Face Thick., C		Washer Face Dia., D_w
	Max	Min	Max	Min	Max	Min	Max	Min		Min	Max		Min
M5 × 0.8	5.00	4.82	8.00	7.78	9.24	8.79	3.65	3.35	2.4	0.5	0.2	7.0
M6 × 1	6.00	5.82	10.00	9.78	11.55	11.05	4.15	3.85	2.8	0.5	0.2	8.9
M8 × 1.25	8.00	7.78	13.00	12.73	15.01	14.38	5.50	5.10	3.7	0.6	0.3	11.6
*M10 × 1.5	10.00	9.78	15.00	14.73	17.32	16.64	6.63	6.17	4.5	0.6	0.3	13.6
M10 × 1.5	10.00	9.78	16.00	15.73	18.48	17.77	6.63	6.17	4.5	0.6	0.3	14.6
M12 × 1.75	12.00	11.73	18.00	17.73	20.78	20.03	7.76	7.24	5.2	0.6	0.3	16.6
M14 × 2	14.00	13.73	21.00	20.67	24.25	23.35	9.09	8.51	6.2	0.6	0.3	19.6
M16 × 2	16.00	15.73	24.00	23.67	27.71	26.75	10.32	9.68	7.0	0.8	0.4	22.5
M20 × 2.5	20.00	19.67	30.00	29.16	34.64	32.95	12.88	12.12	8.8	0.8	0.4	27.7
M24 × 3	24.00	23.67	36.00	35.00	41.57	39.55	15.44	14.56	10.5	0.8	0.4	33.2
M30 × 3.5	30.00	29.67	46.00	45.00	53.12	50.85	19.48	17.92	13.1	0.8	0.4	42.7
M36 × 4	36.00	35.61	55.00	53.80	63.51	60.79	23.38	21.62	15.8	0.8	0.4	51.1
M42 × 4.5	42.00	41.38	65.00	62.90	75.06	71.71	26.97	25.03	18.2	1.0	0.5	59.8
M48 × 5	48.00	47.38	75.00	72.60	86.60	82.76	31.07	28.93	21.0	1.0	0.5	69.0
M56 × 5.5	56.00	55.26	85.00	82.20	98.15	93.71	36.20	33.80	24.5	1.0	0.5	78.1
M64 × 6	64.00	63.26	95.00	91.80	109.70	104.65	41.32	38.68	28.0	1.0	0.5	87.2
M72 × 6	72.00	71.26	105.00	101.40	121.24	115.60	46.45	43.55	31.5	1.2	0.6	96.3
M80 × 6	80.00	79.26	115.00	111.00	132.72	126.54	51.58	48.42	35.0	1.2	0.6	105.4
M90 × 6	90.00	89.13	130.00	125.50	150.11	143.07	57.74	54.26	39.2	1.2	0.6	119.2
M100 × 6	100.00	99.13	145.00	140.00	167.43	159.60	63.90	60.10	43.4	1.2	0.6	133.0

* This size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 hex cap screws with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

Basic thread lengths, B , are the same as given in Table 12.

Transition thread length, X , includes the length of incomplete threads and tolerances on grip gaging length and body length. It is intended for calculation purposes.

For additional manufacturing and acceptance specifications, reference should be made to the ANSI/ASME B18.2.3.1M-1979 (R1995).

Table 2. American National Standard Metric Formed Hex Screws
ANSI/ASME B18.2.3.2M-1979 (R1995)

PROPERTY CLASS AND MANUFACTURER'S IDENTIFICATION TO APPEAR ON TOP OF HEAD

OPTIONAL POINT CONSTRUCTION

OPTIONAL HEAD DESIGN

Nominal Screw Dia., D , and Thread Pitch	Body Dia., D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height, K_1	Washer Face Thick., C		Washer Face Dia., D_w
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Max	Min	Max
M5 × 0.8	5.00	4.82	8.00	7.64	9.24	8.56	3.65	3.35	2.4	0.5	0.2	6.9
M6 × 1	6.00	5.82	10.00	9.64	11.55	10.80	4.15	3.85	2.0	0.5	0.2	8.9
M8 × 1.25	8.00	7.78	13.00	12.57	15.01	14.08	5.50	5.10	3.7	0.6	0.3	11.6
^a M10 × 1.5	10.00	9.78	15.00	14.57	17.32	16.32	6.63	6.17	4.5	0.6	0.3	13.6
M10 × 1.5	10.00	9.78	16.00	15.57	18.48	17.43	6.63	6.17	4.5	0.6	0.3	14.6
M12 × 1.75	12.00	11.73	18.00	17.57	20.78	19.68	7.76	7.24	5.2	0.6	0.3	16.6
M14 × 2	14.00	13.73	21.00	20.16	24.25	22.58	9.09	8.51	6.2	0.6	0.3	19.6
M16 × 2	16.00	15.73	24.00	23.16	27.71	25.94	10.32	9.68	7.0	0.8	0.4	22.5
M20 × 2.5	20.00	19.67	30.00	29.16	34.64	32.66	12.88	12.12	8.8	0.8	0.4	27.7
M24 × 3	24.00	23.67	36.00	35.00	41.57	39.20	15.44	14.56	10.5	0.8	0.4	33.2

^aThis size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 formed hex screws with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

†Basic thread lengths, B , are the same as given in Table 12.

‡Transition thread length, X , includes the length of incomplete threads and tolerances on the grip gaging length and body length. It is intended for calculation purposes.

For additional manufacturing and acceptance specifications, reference should be made to the Standard.

Socket head cap screws ANSI B18.3.1M-1986 are functionally interchangeable with screws which conform to ISO R861-1968 or ISO 4762-1977. However, the thread lengths specified in the ANSI Standard are equal to or longer than required by either ISO Standard. Consequently the grip lengths also vary on screws where the North American thread length practice differs. Minor variations in head diameter, head height, key engagement and wall thickness are due to diverse tolerancing practice and will be found documented in the ANSI Standard.

One exception with respect to width across flats for metric hex cap screws, formed hex screws, and hex bolts is the M10 size. These are currently being produced in the United States with a width across flats of 15 mm. This size, however, is not an ISO Standard. Unless these M10 screws and bolts with 15 mm width across flats are specifically ordered, the M10 size with 16 mm across flats will be furnished.

Table 3. American National Standard Metric Heavy Hex Screws
ANSI B18.2.3.3M-1979 (R1995)

PROPERTY CLASS AND MANUFACTURER'S IDENTIFICATION TO APPEAR ON TOP OF HEAD

Nominal Screw Dia., D , and Thread Pitch	Body Diameter, D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height, K_1	Washer Face Thickness, C		Washer Face Dia., D_w
	Max	Min	Max	Min	Max	Min	Max	Min		Max	Min	
M12 × 1.75	12.00	11.73	21.00	20.67	24.25	23.35	7.76	7.24	5.2	0.6	0.3	19.6
M14 × 2	14.00	13.73	24.00	23.67	27.71	26.75	9.09	8.51	6.2	0.6	0.3	22.5
M16 × 2	16.00	15.73	27.00	26.67	31.18	30.14	10.32	9.68	7.0	0.8	0.4	25.3
M20 × 2.5	20.00	19.67	34.00	33.00	39.26	37.29	12.88	12.12	8.8	0.8	0.4	31.4
M24 × 3	24.00	23.67	41.00	40.00	47.34	45.20	15.44	14.56	10.5	0.8	0.4	38.0
M30 × 3.5	30.00	29.67	50.00	49.00	57.74	55.37	19.48	17.92	13.1	0.8	0.4	46.6
M36 × 4	36.00	35.61	60.00	58.80	69.28	66.44	23.38	21.72	15.8	0.8	0.4	55.9

All dimensions are in millimeters.

Basic thread lengths, B , are the same as given in Table 12.

Transition thread length, X , includes the length of incomplete threads and tolerances on grip gaging length and body length. It is intended for calculation purposes.

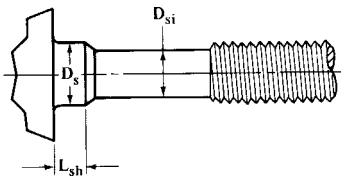
For additional manufacturing and acceptance specifications, reference should be made to the Standard.

ANSI letter symbols designating dimensional characteristics are in accord with those used in ISO Standards except capitals have been used for data processing convenience instead of the lower case letters used in the ISO Standards.

Metric Screw and Bolt Diameters.—Metric screws and bolts are furnished with full diameter body within the limits shown in the respective dimensional tables, or are threaded to the head (see *Metric Screw and Bolt Thread Lengths*) unless the purchaser specifies "reduced body diameter." Metric formed hex screws (Table 4), hex flange screws (Table 4), hex bolts (Table 4), heavy hex bolts (Table 4), hex lag screws (Table 5), heavy hex flange screws (Table 6), and round head square neck bolts (Table 8) may be obtained with reduced diameter body, if so specified; however, formed hex screws, hex flange screws, heavy hex flange screws, hex bolts, or heavy hex bolts with nominal lengths shorter than $4D$, where D is the nominal diameter, are not recommended. Metric formed hex screws, hex flange screws, heavy hex flange screws, and hex lag screws with reduced body diameter will be furnished with a shoulder under the head. For metric hex bolts and heavy hex bolts this is optional with the manufacturer.

For bolts and lag screws there may be a reasonable swell, fin, or die seam on the body adjacent to the head not exceeding the nominal bolt diameter by: 0.50 mm for M5, 0.65 mm for M6, 0.75 mm for M8 through M14, 1.25 mm for M16, 1.50 mm for M20 through M30, 2.30 mm for M36 through M48, 3.00 mm for M56 through M72, and 4.80 mm for M80 through M100.

Table 4. American National Standard Metric Hex Screws and Bolts — Reduced Body Diameters

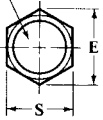
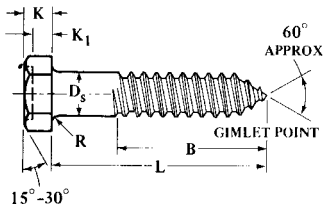
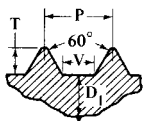
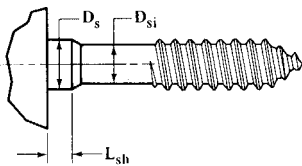


Nominal Dia., D_s , and Thread Pitch	Shoulder Diameter, ^a D_s		Body Diameter, D_{si}		Shoulder Length, ^a L_{sh}		Nominal Dia., D_s , and Thread Pitch	Shoulder Diameter, ^a D_s		Body Diameter, D_{si}		Shoulder Length, ^a L_{sh}	
	Max	Min	Max	Min	Max	Min		Max	Min	Max	Min	Max	Min
Metric Formed Hex Screws (ANSI B18.2.3.2M–1979, R1989)													
M5 × 0.8	5.00	4.82	4.46	4.36	3.5	2.5	M14 × 2	14.00	13.73	12.77	12.50	8.0	7.0
M6 × 1	6.00	5.82	5.39	5.21	4.0	3.0	M16 × 2	16.00	15.73	14.77	14.50	9.0	8.0
M8 × 1.25	8.00	7.78	7.26	7.04	5.0	4.0	M20 × 2.5	20.00	19.67	18.49	18.16	11.0	10.0
M10 × 1.5	10.00	9.78	9.08	8.86	6.0	5.0	M24 × 3	24.00	23.67	22.13	21.80	13.0	12.0
M12 × 1.75	12.00	11.73	10.95	10.68	7.0	6.0	...	...	...	...	...	...	...
Metric Hex Flange Screws (ANSI B18.2.3.4M–1984)													
M5 × 0.8	5.00	4.82	4.46	4.36	3.5	2.5	M12 × 1.75	12.00	11.73	10.95	10.68	7.0	6.0
M6 × 1	6.00	5.82	5.39	5.21	4.0	3.0	M14 × 2	14.00	13.73	12.77	12.50	8.0	7.0
M8 × 1.25	8.00	7.78	7.26	7.04	5.0	4.0	M16 × 2	16.00	15.73	14.77	14.50	9.0	8.0
M10 × 1.5	10.00	9.78	9.08	8.86	6.0	5.0	...	...	...	...	...	...	...
Metric Hex Bolts (ANSI B18.2.3.5M–1979, R1989)													
M5 × 0.8	5.48	4.52	4.46	4.36	3.5	2.5	M14 × 2	14.70	13.30	12.77	12.50	8.0	7.0
M6 × 1	6.48	5.52	5.39	5.21	4.0	3.0	M16 × 2	16.70	15.30	14.77	14.50	9.0	8.0
M8 × 1.25	8.58	7.42	7.26	7.04	5.0	4.0	M20 × 2.5	20.84	19.16	18.49	18.16	11.0	10.0
M10 × 1.5	10.58	9.42	9.08	8.86	6.0	5.0	M24 × 3	24.84	23.16	22.13	21.80	13.0	12.0
M12 × 1.75	12.70	11.30	10.95	10.68	7.0	6.0	...	...	...	...	...	...	...
Metric Heavy Hex Bolts (ANSI B18.2.3.6M–1979, R1989)													
M12 × 1.75	12.70	11.30	10.95	10.68	7.0	6.0	M20 × 2.5	20.84	19.16	18.49	18.16	11.0	10.0
M14 × 2	14.70	13.30	12.77	12.50	8.0	7.0	M24 × 3	24.84	23.16	22.13	21.80	13.0	12.0
M16 × 2	16.70	15.30	14.77	14.50	9.0	8.0	...	...	...	...	...	...	...
Metric Heavy Hex Flange Screws (ANSI B18.2.3.9M–1984)													
M10 × 1.5	10.00	9.78	9.08	8.86	6.0	5.0	M16 × 2	16.00	15.73	14.77	14.50	9.0	8.0
M12 × 1.75	12.00	11.73	10.95	10.68	7.0	6.0	M20 × 2.5	20.00	19.67	18.49	18.16	11.0	10.0
M14 × 2	14.00	13.73	12.77	12.50	8.0	7.0	...	...	...	...	...	...	...

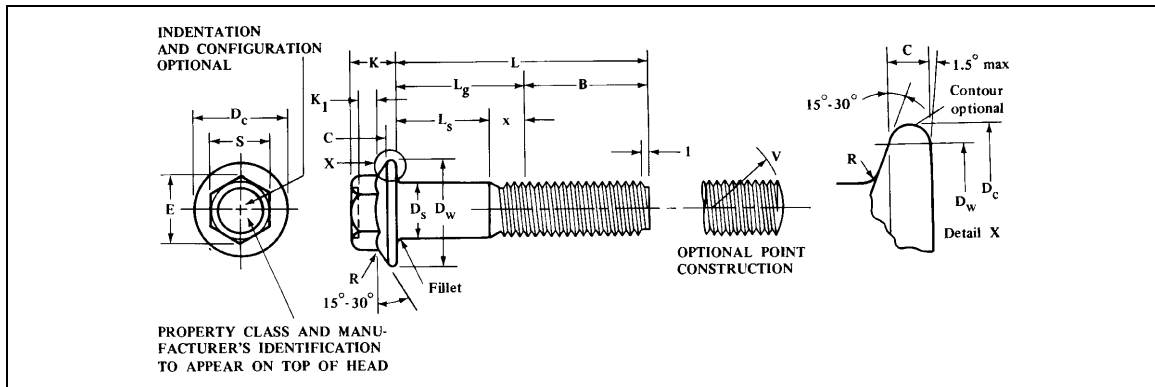
^a Shoulder is mandatory for formed hex screws, hex flange screws, and heavy hex flange screws. Shoulder is optional for hex bolts and heavy hex bolts.

All dimensions are in millimeters.

Table 5. American National Standard Metric Hex Lag Screws
ANSI B18.2.3.8M-1981, R1991

INDENTATION AND CONFIGURATION OPTIONAL									
									
		15°-30°					DETAIL OF THREAD		
Nominal Screw Dia., D	Body Diameter, D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height, K_1
	Max	Min	Max	Min	Max	Min	Max	Min	Min
5	5.48	4.52	8.00	7.64	9.24	8.63	3.9	3.1	2.4
6	6.48	5.52	10.00	9.64	11.55	10.89	4.4	3.6	2.8
8	8.58	7.42	13.00	12.57	15.01	14.20	5.7	4.9	3.7
10	10.58	9.42	16.00	15.57	18.48	17.59	6.9	5.9	4.5
12	12.70	11.30	18.00	17.57	20.78	19.85	8.0	7.0	5.2
16	16.70	15.30	24.00	23.16	27.71	26.17	10.8	9.3	7.0
20	20.84	19.16	30.00	29.16	34.64	32.95	13.4	11.6	8.8
24	24.84	23.16	36.00	35.00	41.57	39.55	15.9	14.1	10.5
Nominal Screw Dia., D	Thread Dimensions				Nominal Screw Dia., D	Thread Dimensions			
	Thread Pitch, P	Flat at Root, V	Depth of Thread, T	Root Dia., D_1		Thread Pitch, P	Flat at Root, V	Depth of Thread, T	Root Dia., D_1
5	2.3	1.0	0.9	3.2	12	4.2	1.8	1.6	8.7
6	2.5	1.1	1.0	4.0	16	5.1	2.2	2.0	12.0
8	2.8	1.2	1.1	5.8	20	5.6	2.4	2.2	15.6
10	3.6	1.6	1.4	7.2	24	7.3	3.1	2.8	18.1
REDUCED BODY DIAMETER									
									
Nominal Screw Dia., D	Shoulder Diameter, D_s		Shoulder Length, L_{sh}		Nominal Screw Dia., D	Shoulder Diameter, D_s		Shoulder Length, L_{sh}	
	Max	Min	Max	Min		Max	Min	Max	Min
5	5.48	4.52	3.5	2.5	12	12.70	11.30	7.0	6.0
6	6.48	5.52	4.0	3.0	16	16.70	15.30	9.0	8.0
8	8.58	7.42	5.0	4.0	20	20.84	19.16	11.0	10.0
10	10.58	9.42	6.0	5.0	24	24.84	23.16	13.0	12.0

All dimensions are in millimeters. Reduced body diameter, D_{si} , is the blank diameter before rolling. Shoulder is mandatory when body diameter is reduced.

Table 6. American National Standard Metric Heavy Hex Flange Screws ANSI/ASME B18.2.3.9M-1984


Nominal Screw Dia., D , and Thread Pitch	Body Dia., D_s		Width Across Flats, S		Width Across Corners, E		Flange Dia., D_c	Bearing Circle Dia., D_w	Flange Edge Thickness, C	Head Height, K	Wrenching Height K_1	Fillet Radius, R
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Max	Min	Max
M10 \times 1.5	10.00	9.78	15.00	14.57	17.32	16.32	22.3	19.6	1.5	8.6	3.70	0.6
M12 \times 1.75	12.00	11.73	18.00	17.57	20.78	19.68	26.6	23.8	1.8	10.4	4.60	0.7
M14 \times 2	14.00	13.73	21.00	20.48	24.25	22.94	30.5	27.6	2.1	12.4	5.50	0.9
M16 \times 2	16.00	15.73	24.00	23.16	27.71	25.94	35.0	31.9	2.4	14.1	6.20	1.0
M20 \times 2.5	20.00	19.67	30.00	29.16	34.64	32.66	43.0	39.9	3.0	17.7	7.90	1.2

All dimensions are in millimeters. Basic thread lengths, B , are as given in Table 12. Transition thread length, x , includes the length of incomplete threads and tolerances on grip gaging length and body length. It is intended for calculation purposes. For additional manufacturing and acceptance specifications, reference should be made to ANSI/ASME B18.2.3.9M-1984 standard.

Table 7. American National Standard Metric Hex Flange Screws
ANSI/ASME B18.2.3.4M-1984

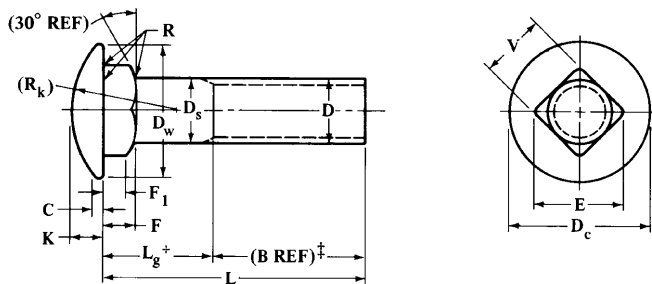
Nominal Screw Dia., D , and Thread Pitch	Body Dia., D_s		Width Across Flats, S		Width Across Corners, E		Flange Dia., D_c	Bearing Circle Dia., D_w	Flange Edge Thickness, C	Head Height, K	Wrenching Height, K_1	Fillet Radius, R
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Max	Min	Max
M5 × 0.8	5.00	4.82	7.00	6.64	8.08	7.44	11.4	9.4	1.0	5.6	2.30	0.3
M6 × 1	6.00	5.82	8.00	7.64	9.24	8.56	13.6	11.6	1.1	6.8	2.90	0.4
M8 × 1.25	8.00	7.78	10.00	9.64	11.55	10.80	17.0	14.9	1.2	8.5	3.80	0.5
M10 × 1.5	10.00	9.78	13.00	12.57	15.01	14.08	20.8	18.7	1.5	9.7	4.30	0.6
M12 × 1.75	12.00	11.73	15.00	14.57	17.32	16.32	24.7	22.0	1.8	11.9	5.40	0.7
M14 × 2	14.00	13.73	18.00	17.57	20.78	19.68	28.6	25.9	2.1	12.9	5.60	0.8
M16 × 2	16.00	15.73	21.00	20.48	24.25	22.94	32.8	30.1	2.4	15.1	6.70	1.0

All dimensions are in millimeters. Basic thread lengths, B , are the same as given in Table 12. Transition thread length, x , includes the length of incomplete threads and tolerances on grip gaging length and body length. This dimension is intended for calculation purposes only. For additional manufacturing and acceptance specifications, reference should be made to ANSI/ASME B18.2.3.4M-1984 standard.

Table 8. American National Standard Metric Round Head Square Neck Bolts
Reduced Body Diameters ANSI/ASME B18.5.2.2M-1982 (R1993)

Nominal Bolt Dia., D and Thread Pitch	Diameter of Reduced Body D_r		Nominal Bolt Dia., D and Thread Pitch	Diameter of Reduced Body D_r	
	Max	Min		Max	Min
M5 × 0.8	5.00	4.36	M14 × 2	14.00	12.50
M6 × 1	6.00	5.21	M16 × 2	16.00	14.50
M8 × 1.25	8.00	7.04	M20 × 2.5	20.00	18.16
M10 × 1.5	10.00	8.86	M24 × 3	24.00	21.80
M12 × 1.75	12.00	10.68	...	...	...

All dimensions are in millimeters.

Table 9. American National Standard Metric Round Head Square Neck Bolts ANSI B18.2.3.7M-1979 (R1989)


Nominal Bolt Dia., <i>D</i> and Thread Pitch	Diameter of Full Body, <i>D_s</i>		Head Radius, (<i>R_k</i>)	Head height, <i>K</i>		Head Edge Thickness, <i>C</i>		Head Dia., <i>D_c</i>	Bearing Surface Dia., <i>D_w</i>	Square Depth, <i>F</i>		Square Corner Depth, <i>F₁</i>	Square Width Across Flats, <i>V</i>		Square Width Across Corners, <i>E</i>	
	Max	Min		Ref.	Max	Min	Max			Min	Max		Min	Max	Min	Max	Min	Max	Min
M5 × 0.8	5.48	4.52	8.8	3.1	2.5	1.8	1.0	11.8	9.8	3.1	2.5	1.6	5.48	4.88	7.75	6.34
M6 × 1	6.48	5.52	10.7	3.6	3.0	1.9	1.1	14.2	12.2	3.6	3.0	1.9	6.48	5.88	9.16	7.64
M8 × 1.25	8.58	7.42	12.5	4.8	4.0	2.2	1.2	18.0	15.8	4.8	4.0	2.5	8.58	7.85	12.13	10.20
M10 × 1.5	10.58	9.42	15.5	5.8	5.0	2.5	1.5	22.3	19.6	5.8	5.0	3.2	10.58	9.85	14.96	12.80
M12 × 1.75	12.70	11.30	19.0	6.8	6.0	2.8	1.8	26.6	23.8	6.8	6.0	3.8	12.70	11.82	17.96	15.37
M14 × 2	14.70	13.30	21.9	7.9	7.0	3.3	2.1	30.5	27.6	7.9	7.0	4.4	14.70	13.82	20.79	17.97
M16 × 2	16.70	15.30	25.5	8.9	8.0	3.6	2.4	35.0	31.9	8.9	8.0	5.0	16.70	15.82	23.62	20.57
M20 × 2.5	20.84	19.16	31.9	10.9	10.0	4.2	3.0	43.0	39.9	10.9	10.0	6.3	20.84	19.79	29.47	25.73
M24 × 3	24.84	23.16	37.9	13.1	12.0	5.1	3.6	51.0	47.6	13.1	12.0	7.6	24.84	23.79	35.13	30.93

All dimensions are in millimeters.

† L_g is the grip gaging length which controls the length of thread *B*.

‡*B* is the basic thread length and is a reference dimension (see Table 13).

For additional manufacturing and acceptance specifications, see ANSI/ASME B18.5.2.2M-1982, R1993.

Table 10. ANSI Heavy Hex Bolts ANSI B18.2.3.6M-1979 (R1989)

PROPERTY CLASS AND MANUFACTURER'S IDENTIFICATION TO APPEAR ON TOP OF HEAD

Nominal Dia., <i>D</i> and Thread Pitch	Body Diameter, <i>D_s</i>		Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Head Height, <i>K</i>		Wrenching Height, <i>K₁</i>	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
M12 × 1.75	12.70	11.30	21.00	20.16	24.25	22.78	7.95	7.24	5.2	
M14 × 2	14.70	13.30	24.00	23.16	27.71	26.17	9.25	8.51	6.2	
M16 × 2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.68	7.0	
M20 × 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	12.12	8.8	
M24 × 3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.56	10.5	
M30 × 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.92	13.1	
M36 × 4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.72	15.8	

All dimensions are in millimeters. *Basic thread lengths, *B*, are the same as given in Table 12. For additional manufacturing and acceptance specifications, reference should be made to the ANSI B18.2.3.6M-1979, R1989 standard.

Table 11. ANSI Metric Heavy Hex Structural Bolts ANSI B18.2.3.7M-1979 (R1989)

PROPERTY CLASS AND MANUFACTURER'S IDENTIFICATION TO APPEAR ON TOP OF HEAD

Dia. <i>D</i> , and Thread Pitch	Body Diameter, <i>D_s</i>		Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Head Height, <i>K</i>		Wrenching Height, <i>K₁</i>	Washer Face Dia., <i>D_w</i>	Washer Face Thickness, <i>C</i>		Thread Length, <i>B</i> ^a		Transition Thread Length, <i>X</i> ^b
	Max	Min	Max	Min	Max	Min	Max	Min			Max	Min	Lengths ≤ 100	Lengths > 100		Basic	Max
	M16 × 2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	6.5	24.9	0.8	0.4	31	38	6.0
M20 × 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	11.60	8.1	31.4	0.8	0.4	36	43	7.5
M22 × 2.5	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	9.2	33.3	0.8	0.4	38	45	7.5
M24 × 3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	9.9	38.0	0.8	0.4	41	48	9.0
M27 × 3	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	11.3	42.8	0.8	0.4	44	51	9.0
M30 × 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	12.4	46.5	0.8	0.4	49	56	10.5
M36 × 4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.45	15.0	55.9	0.8	0.4	56	63	12.0

^a Basic thread length, *B*, is a reference dimension.

^b Transition thread length, *X*, includes the length of incomplete threads and tolerances on grip gaging length and body length. It is intended for calculation purposes.

All dimensions are in millimeters.

For additional manufacturing and acceptance specifications, reference should be made to the ANSI B18.2.3.7M-1979 (R1995) standard.

Table 12. American National Standard Metric Hex Bolts
ANSI/ASME B18.2.3.5M-1989

Nominal Bolt Dia., D and Thread Pitch	Body Diameter, D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height, K_1	For Bolt Lengths		
	Max	Min	Max	Min	Max	Min	Max	Min		Basic Thread Length, ^a B		
									Min	125 mm ∇	125 and 200 mm ∧	200 mm ∧
M5 × 0.8	5.48	4.52	8.00	7.64	9.24	8.63	3.58	3.35	2.4	16	22	35
M6 × 1	6.19	5.52	10.00	9.64	11.55	10.89	4.38	3.55	2.8	18	24	37
M8 × 1.25	8.58	7.42	13.00	12.57	15.01	14.20	5.68	5.10	3.7	22	28	41
^b M10 × 1.5	10.58	9.42	15.00	14.57	17.32	16.46	6.85	6.17	4.5	26	32	45
M10 × 1.5	10.58	9.42	16.00	15.57	18.48	17.59	6.85	6.17	4.5	26	32	45
M12 × 1.75	12.70	11.30	18.00	17.57	20.78	19.85	7.95	7.24	5.2	30	36	49
M14 × 2	14.70	13.30	21.00	20.16	24.25	22.78	9.25	8.51	6.2	34	40	53
M16 × 2	16.70	15.30	24.00	23.16	27.71	26.17	10.75	9.68	7.0	38	44	57
M20 × 2.5	20.84	19.16	30.00	29.16	34.64	32.95	13.40	12.12	8.8	46	52	65
M24 × 3	24.84	23.16	36.00	35.00	41.57	39.55	15.90	14.56	10.5	54	60	73
M30 × 3.5	30.84	29.16	46.00	45.00	53.12	50.55	19.75	17.92	13.1	66	72	85
M36 × 4	37.00	35.00	55.00	53.80	63.51	60.79	23.55	21.72	15.8	78	84	97
M42 × 4.5	43.00	41.00	65.00	62.90	75.06	71.71	27.05	25.03	18.2	90	96	109
M48 × 5	49.00	47.00	75.00	72.60	86.60	82.76	31.07	28.93	21.0	102	108	121
M56 × 5.5	57.20	54.80	85.00	82.20	98.15	93.71	36.20	33.80	24.5	...	124	137
M64 × 6	65.52	62.80	95.00	91.80	109.70	104.65	41.32	38.68	28.0	...	140	153
M72 × 6	73.84	70.80	105.00	101.40	121.24	115.60	46.45	43.55	31.5	...	156	169
M80 × 6	82.16	78.80	115.00	111.00	132.79	126.54	51.58	48.42	35.0	...	172	185
M90 × 6	92.48	88.60	130.00	125.50	150.11	143.07	57.74	54.26	39.2	...	192	205
M100 × 6	102.80	98.60	145.00	140.00	167.43	159.60	63.90	60.10	43.4	...	212	225

^a Basic thread length, B , is a reference dimension.

^b This size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 hex bolts with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

For additional manufacturing and acceptance specifications, reference should be made to the ANSI B18.2.3.5M-1979 (R1995) standard.

Materials and Mechanical Properties.—Unless otherwise specified, steel metric screws and bolts, with the exception of heavy hex structural bolts, hex lag screws, and socket head cap screws, conform to the requirements specified in SAE J1199 or ASTM F568. Steel heavy hex structural bolts conform to ASTM A325M or ASTM A490M. Alloy steel socket head cap screws conform to ASTM 574M, property class 12.9, where the numeral 12 represents approximately one-hundredth of the minimum tensile strength in megapascals and the decimal .9 approximates the ratio of the minimum yield stress to the minimum tensile stress. This is in accord with ISO designation practice. Screws and bolts

of other materials, and all materials for hex lag bolts, have properties as agreed upon by the purchaser and the manufacturer.

Except for socket head cap screws, metric screws and bolts are furnished with a natural (as processed) finish, unplated or uncoated unless otherwise specified.

Alloy steel socket head cap screws are furnished with an oiled black oxide coating (thermal or chemical) unless a protective plating or coating is specified by the purchaser.

Metric Screw and Bolt Designation.—Metric screws and bolts with the exception of socket head cap screws are designated by the following data, preferably in the sequence shown: product name, nominal diameter and thread pitch (except for hex lag screws), nominal length, steel property class or material identification, and protective coating, if required.

Example: Hex cap screw, M10 × 1.5 × 50, class 9.8, zinc plated

Heavy hex structural bolt, M24 × 3 × 80, ASTM A490M

Hex lag screw, 6 × 35, silicon bronze.

Socket head cap screws (metric series) are designated by the following data in the order shown: ANSI Standard number, nominal size, thread pitch, nominal screw length, name of product (may be abbreviated SHCS), material and property class (alloy steel screws are supplied to property class 12.9 as specified in ASTM A574M: corrosion-resistant steel screws are specified to the property class and material requirements in ASTM F837M), and protective finish, if required.

Example: B18.3.1M—6 × 1 × 20 Hexagon Socket Head Cap Screw, Alloy Steel

B18.3.1M—10 × 1.5 × 40 SHCS, Alloy Steel Zinc Plated.

Metric Screw and Bolt Thread Lengths.—The length of thread on metric screws and bolts (except for metric lag screws) is controlled by the grip gaging length, L_g max. This is the distance measured parallel to the axis of the screw or bolt, from under the head bearing surface to the face of a noncounterbored or noncountersunk standard GO thread ring gage assembled by hand as far as the thread will permit. The maximum grip gaging length, as calculated and rounded to one decimal place, is equal to the nominal screw length, L , minus the basic thread length, B , or in the case of socket head cap screws, minus the minimum thread length L_T . B and L_T are reference dimensions intended for calculation purposes only and will be found in Tables 12 and 14, respectively.

Table 13. Basic Thread Lengths for Metric Round Head Square Neck Bolts
ANSI/ASME B18.5.2.2M-1982, R1993

Nom. Bolt Dia., D and Thread Pitch	Bolt Length, L			Nom. Bolt Dia., D and Thread Pitch	Bolt Length, L		
	≤ 125	> 125 and ≤ 200	> 200		≤ 125	> 125 and ≤ 200	> 200
	Basic Thread Length, B				Basic Thread length, B		
M5 × 0.8	16	22	35	M14 × 2	34	40	53
M6 × 1	18	24	37	M16 × 2	38	44	57
M8 × 1.25	22	28	41	M20 × 2.5	46	52	65
M10 × 1.5	26	32	45	M24 × 3	54	60	73
M12 × 1.75	30	36	49	...	...	...	...

All dimensions are in millimeters

Basic thread length B is a reference dimension intended for calculation purposes only.

Table 14. Socket Head Cap Screws (Metric Series)—Length of Complete Thread
ANSI/ASME B18.3.1M-1986

Nominal Size	Length of Complete Thread, L_T	Nominal Size	Length of Complete Thread, L_T	Nominal Size	Length of Complete Thread, L_T
M1.6	15.2	M6	24.0	M20	52.0
M2	16.0	M8	28.0	M24	60.0
M2.5	17.0	M10	32.0	M30	72.0
M3	18.0	M12	36.0	M36	84.0
M4	20.0	M14	40.0	M42	96.0
M5	22.0	M16	44.0	M48	108.0

Grip length, L_G equals screw length, L , minus L_T . Total length of thread L_{TT} equals L_T plus 5 times the pitch of the coarse thread for the respective screw size. Body length L_B equals L minus L_{TT} .

The minimum thread length for hex lag screws is equal to one-half the nominal screw length plus 12 mm, or 150 mm, whichever is shorter. Screws too short for this formula to apply are threaded as close to the head as practicable.

Metric Screw and Bolt Diameter-Length Combinations.—For a given diameter, the recommended range of lengths of metric cap screws, formed hex screws, heavy hex screws, hex flange screws, and heavy hex flange screws can be found in Table 16, for heavy hex structural bolts in Table 17, for hex lag screws in Table 15, for round head square neck bolts in Table 18, and for socket head cap screws in Table 19. No recommendations for diameter-length combinations are given in the Standards for hex bolts and heavy hex bolts.

Hex bolts in sizes M5 through M24 and heavy hex bolts in sizes M12 through M24 are standard only in lengths longer than 150 mm or $10D$, whichever is shorter. When shorter lengths of these sizes are ordered, hex cap screws are normally supplied in place of hex bolts and heavy hex screws in place of heavy hex bolts. Hex bolts in sizes M30 and larger and heavy hex bolts in sizes M30 and M36 are standard in all lengths; however, at manufacturer's option, hex cap screws may be substituted for hex bolts and heavy hex screws for heavy hex bolts for any diameter-length combination.

Table 15. Recommended Diameter-Length Combinations for Metric Hex Lag Screws
ANSI B18.2.3.8M-1981 (R1999)

Nominal Length, L	Nominal Screw Diameter								Nominal Length, L	Nominal Screw Diameter				
	5	6	8	10	12	16	20	24		10	12	16	20	24
8	X	...	...	...	...	...	...	...	90	X	X	X	X	X
10	X	X	...	...	...	...	...	...	100	X	X	X	X	X
12	X	X	X	...	...	...	...	...	110	...	X	X	X	X
14	X	X	X	...	...	...	...	...	120	...	X	X	X	X
16	X	X	X	X	...	...	...	...	130	...	...	X	X	X
20	X	X	X	X	X	...	...	...	140	...	...	X	X	X
25	X	X	X	X	X	X	...	...	150	...	...	X	X	X
30	X	X	X	X	X	X	X	...	160	...	...	X	X	X
35	X	X	X	X	X	X	X	X	180	...	...	...	X	X
40	X	X	X	X	X	X	X	X	200	...	...	...	X	X
45	X	X	X	X	X	X	X	X	220	...	...	...	...	X
50	X	X	X	X	X	X	X	X	240	...	...	...	...	X
60	...	X	X	X	X	X	X	X	260	...	...	...	...	X
70	...	...	X	X	X	X	X	X	280	...	...	...	...	X
80	...	...	X	X	X	X	X	X	300	...	...	...	...	X

All dimensions are in millimeters.

Recommended diameter-length combinations are indicated by the symbol X.

Table 16. Rec'd Diameter-Length Combinations for Metric Hex Cap Screws, Formed Hex and Heavy Hex Screws, Hex Flange and Heavy Hex Flange Screws

Nominal Length ^a	Diameter—Pitch										
	M5 ×0.8	M6 ×1	M8 ×1.25	M10 ×1.5	M12 ×1.75	M14 ×2	M16 ×2	M20 ×2.5	M24 ×3	M30 ×3.5	M36 ×4
8	X	...	...	...	...	...	...	...	...	...	...
10	X	X	...	...	...	...	...	...	...	...	...
12	X	X	X	...	...	...	...	...	...	...	...
14	X	X	X	X ^b	...	...	...	...	...	...	...
16	X	X	X	X	X ^b	X ^b	...	...	...	...	...
20	X	X	X	X	X	X	...	...	...	...	...
25	X	X	X	X	X	X	X	...	...	...	...
30	X	X	X	X	X	X	X	X	...	...	...
35	X	X	X	X	X	X	X	X	X	...	...
40	X	X	X	X	X	X	X	X	X	X	...
45	X	X	X	X	X	X	X	X	X	X	...
50	X	X	X	X	X	X	X	X	X	X	X
(55)	...	X	X	X	X	X	X	X	X	X	X
60	...	X	X	X	X	X	X	X	X	X	X
(65)	...	...	X	X	X	X	X	X	X	X	X
70	...	...	X	X	X	X	X	X	X	X	X
(75)	...	...	X	X	X	X	X	X	X	X	X
80	...	...	X	X	X	X	X	X	X	X	X
(85)	...	...	...	X	X	X	X	X	X	X	X
90	...	...	...	X	X	X	X	X	X	X	X
100	...	...	...	X	X	X	X	X	X	X	X
110	...	...	...	...	X	X	X	X	X	X	X
120	...	...	...	...	X	X	X	X	X	X	X
130	...	...	...	...	...	X	X	X	X	X	X
140	...	...	...	...	...	X	X	X	X	X	X
150	...	...	...	...	...	...	X	X	X	X	X
160	...	...	...	...	...	...	X	X	X	X	X
(170)	...	...	...	...	...	...	...	X	X	X	X
180	...	...	...	...	...	...	...	X	X	X	X
(190)	...	...	...	...	...	...	...	X	X	X	X
200	...	...	...	...	...	...	...	X	X	X	X
220	...	...	...	...	...	...	...	...	X	X	X
240	...	...	...	...	...	...	...	...	X	X	X
260	...	...	...	...	...	...	...	...	...	X	X
280	...	...	...	...	...	...	...	...	...	X	X
300	...	...	...	...	...	...	...	...	...	X	X

^a Lengths in parentheses are not recommended. Recommended lengths of formed hex screws, hex flange screws, and heavy hex flange screws do not extend above 150 mm. Recommended lengths of heavy hex screws do not extend below 20 mm. Standard sizes for government use. Recommended diameter-length combinations are indicated by the symbol X. Screws with lengths above heavy cross lines are threaded full length.

^b Does not apply to hex flange screws and heavy hex flange screws.

All dimensions are in millimeters.

For available diameters of each type of screw, see respective dimensional table.

Table 17. Recommended Diameter-Length Combinations for Metric Heavy Hex Structural Bolts

Nominal Length, <i>L</i>	Nominal Diameter and Thread Pitch						
	M16 × 2	M20 × 2.5	M22 × 2.5	M24 × 3	M27 × 3	M30 × 3.5	M36 × 4
45	X	...	...	...	...	...	...
50	X	X	...	...	...	...	...
55	X	X	X	...	...	...	...
60	X	X	X	X	...	...	...
65	X	X	X	X	X	...	...
70	X	X	X	X	X	X	...
75	X	X	X	X	X	X	...
80	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X
90	X	X	X	X	X	X	X
95	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X
110	X	X	X	X	X	X	X
120	X	X	X	X	X	X	X
130	X	X	X	X	X	X	X
140	X	X	X	X	X	X	X
150	X	X	X	X	X	X	X
160	X	X	X	X	X	X	X
170	X	X	X	X	X	X	X
180	X	X	X	X	X	X	X
190	X	X	X	X	X	X	X
200	X	X	X	X	X	X	X
210	X	X	X	X	X	X	X
220	X	X	X	X	X	X	X
230	X	X	X	X	X	X	X
240	X	X	X	X	X	X	X
250	X	X	X	X	X	X	X
260	X	X	X	X	X	X	X
270	X	X	X	X	X	X	X
280	X	X	X	X	X	X	X
290	X	X	X	X	X	X	X
300	X	X	X	X	X	X	X

All dimensions are in millimeters.

Recommended diameter-length combinations are indicated by the symbol X.

Bolts with lengths above the heavy cross lines are threaded full length.

Table 18. Recommended Diameter-Length Combinations for Metric Round Head Square Neck Bolts

Nominal Length, ^a <i>L</i>	Nominal Diameter and Thread Pitch								
	M5 × 0.8	M6 × 1	M8 × 1.25	M10 × 1.5	M12 × 1.75	M14 × 2	M16 × 2	M20 × 2.5	M24 × 3
10	X	...	...	...	...	...	...	...	...
12	X	X	...	...	...	...	...	...	...
(14)	X	X	...	...	...	...	...	...	...
16	X	X	X	...	...	...	...	...	...
20	X	X	X	X	...	...	...	...	...
25	X	X	X	X	X	...	...	...	...
30	X	X	X	X	X	X	X	...	...
35	X	X	X	X	X	X	X	...	...
40	X	X	X	X	X	X	X	X	...
45	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X
(55)	...	X	X	X	X	X	X	X	X
60	...	X	X	X	X	X	X	X	X
(65)	...	...	X	X	X	X	X	X	X
70	...	...	X	X	X	X	X	X	X
(75)	...	...	X	X	X	X	X	X	X
80	...	...	X	X	X	X	X	X	X
(85)	...	...	...	X	X	X	X	X	X

Table 18. (Continued) Recommended Diameter-Length Combinations for Metric Round Head Square Neck Bolts

Nominal Length, ^a <i>L</i>	Nominal Diameter and Thread Pitch								
	M5 × 0.8	M6 × 1	M8 × 1.25	M10 × 1.5	M12 × 1.75	M14 × 2	M16 × 2	M20 × 2.5	M24 × 3
90	X	X	X	X	X	X
100	X	X	X	X	X	X
110	X	X	X	X	X
120	X	X	X	X	X
130	X	X	X	X
140	X	X	X	X
150	X	X	X
160	X	X	X
(170)	X	X
180	X	X
(190)	X	X
200	X	X
220	X
240	X

^a Bolts with lengths above the heavy cross lines are threaded full length. Lengths in () are not recommended.

All dimensions are in millimeters. Recommended diameter-length combinations are indicated by the symbol X. Standard sizes for government use.

Table 19. Diameter-Length Combinations for Socket Head Cap Screws (Metric Series)

Nominal Length, <i>L</i>	Nominal Size													
	M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	M14	M16	M20	M24
20	X	X												
25	X	X	X	X										
30	X	X	X	X	X									
35	...	X	X	X	X	X	X							
40	...	X	X	X	X	X	X							
45	X	X	X	X	X	X						
50	X	X	X	X	X	X	X					
55	X	X	X	X	X	X					
60	X	X	X	X	X	X	X				
65	X	X	X	X	X	X	X	X			
70	X	X	X	X	X	X	X	X		
80	X	X	X	X	X	X	X	X	X	
90	X	X	X	X	X	X	X	X	
100	X	X	X	X	X	X	X	X	X
110	X	X	X	X	X	X	X	X
120	X	X	X	X	X	X	X	X
130	X	X	X	X	X	X	X
140	X	X	X	X	X	X	X
150	X	X	X	X	X	X	X
160	X	X	X	X	X	X	X
180	X	X	X	X	X	X
200	X	X	X	X	X	X
220	X	X	X	X	X
240	X	X	X	X	X
260	X	X	X	X
300	X	X	X

All dimensions are in millimeters. Screws with lengths above heavy cross lines are threaded full length. Diameter-length combinations are indicated by the symbol X. Standard sizes for government use. In addition to the lengths shown, the following lengths are standard: 3, 4, 5, 6, 8, 10, 12, and 16 mm. No diameter-length combinations are given in the Standard for these lengths. Screws larger than M24 with lengths equal to or shorter than L_{TT} (see Table 14 footnote) are threaded full length.

Metric Screw and Bolt Clearance Holes.—Clearance holes for screws and bolts with the exception of hex lag screws, socket head cap screws, and round head square neck bolts are given in Table 20. Clearance holes for round head square neck bolts are given in Table 8 and drill and counterbore sizes for socket head cap screws are given in Table 21.

Table 20. Recommended Clearance Holes for Metric Hex Screws and Bolts

Nominal Dia., D and Thread Pitch	Clearance Hole Dia., Basic, D_h			Nominal Dia., D and Thread Pitch	Clearance Hole Dia., Basic, D_h		
	Close	Normal, Preferred	Loose		Close	Normal, Preferred	Loose
M5 × 0.8	5.3	5.5	5.8	M30 × 3.5	31.0	33.0	35.0
M6 × 1	6.4	6.6	7.0	M36 × 4	37.0	39.0	42.0
M8 × 1.25	8.4	9.0	10.0	M42 × 4.5	43.0	45.0	48.0
M10 × 1.5	10.5	11.0	12.0	M48 × 5	50.0	52.0	56.0
M12 × 1.75	13.0	13.5	14.5	M56 × 5.5	58.0	62.0	66.0
M14 × 2	15.0	15.5	16.5	M64 × 6	66.0	70.0	74.0
M16 × 2	17.0	17.5	18.5	M72 × 6	74.0	78.0	82.0
M20 × 2.5	21.0	22.0	24.0	M80 × 6	82.0	86.0	91.0
M22 × 2.5 ^a	23.0	24.0	26.0	M90 × 6	93.0	96.0	101.0
M24 × 3	25.0	26.0	28.0	M100 × 6	104.0	107.0	112.0
M27 × 3 ^a	28.0	30.0	32.0	...	...	...	...

^a Applies only to heavy hex structural bolts.

All dimensions are in millimeters.

Does not apply to hex lag screws, hex socket head cap screws, or round head square neck bolts.

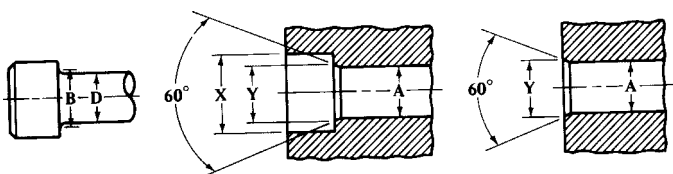
Normal Clearance: This is preferred for general purpose applications and should be specified unless special design considerations dictate the need for either a close or loose clearance hole.

Close Clearance: This should be specified only where conditions such as critical alignment of assembled parts, wall thickness or other limitations necessitate use of a minimum hole. When close clearance holes are specified, special provision (e.g. countersinking) must be made at the screw or bolt entry side to permit proper seating of the screw or bolt head.

Loose Clearance: This should be specified only for applications where maximum adjustment capability between components being assembled is necessary.

Recommended Tolerances: The clearance hole diameters given in this table are minimum size. Recommended tolerances are: for screw or bolt diameter M5, +0.2 mm; for M6 through M16, +0.3 mm; for M20 through M42, +0.4 mm; for M48 through M72, +0.5 mm; and for M80 through M100, +0.6 mm.

Table 21. Drill and Counterbore Sizes for Metric Socket Head Cap Screws



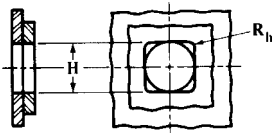
Nominal Size or Basic Screw Diameter	Nominal Drill Size, A		Counterbore Diameter, X	Countersink Diameter, ^a Y
	Close Fit ^b	Normal Fit ^c		
M1.6	1.80	1.95	3.50	2.0
M2	2.20	2.40	4.40	2.6
M2.5	2.70	3.00	5.40	3.1
M3	3.40	3.70	6.50	3.6
M4	4.40	4.80	8.25	4.7
M5	5.40	5.80	9.75	5.7
M6	6.40	6.80	11.25	6.8
M8	8.40	8.80	14.25	9.2
M10	10.50	10.80	17.25	11.2
M12	12.50	12.80	19.25	14.2
M14	14.50	14.75	22.25	16.2
M16	16.50	16.75	25.50	18.2
M20	20.50	20.75	31.50	22.4
M24	24.50	24.75	37.50	26.4
M30	30.75	31.75	47.50	33.4
M36	37.00	37.50	56.50	39.4
M42	43.00	44.00	66.00	45.6
M48	49.00	50.00	75.00	52.6

^a *Countersink*: It is considered good practice to countersink or break the edges of holes which are smaller than B Max. (see Table 23) in parts having a hardness which approaches, equals, or exceeds the screw hardness. If such holes are not countersunk, the heads of screws may not seat properly or the sharp edges on holes may deform the fillets on screws, thereby making them susceptible to fatigue in applications involving dynamic loading. The countersink or corner relief, however, should not be larger than is necessary to ensure that the fillet on the screw is cleared. Normally, the diameter of countersink does not have to exceed B Max. Countersinks or corner reliefs in excess of this diameter reduce the effective bearing area and introduce the possibility of embedment where the parts to be fastened are softer than the screws or of brinelling or flaring the heads of the screws where the parts to be fastened are harder than the screws.

^b *Close Fit*: The close fit is normally limited to holes for those lengths of screws which are threaded to the head in assemblies where only one screw is to be used or where two or more screws are to be used and the mating holes are to be produced either at assembly or by matched and coordinated tooling.

^c *Normal Fit*: The normal fit is intended for screws of relatively long length or for assemblies involving two or more screws where the mating holes are to be produced by conventional tolerancing methods. It provides for the maximum allowable eccentricity of the longest standard screws and for certain variations in the parts to be fastened, such as: deviations in hole straightness, angularity between the axis of the tapped hole and that of the hole for shank, differences in center distances of the mating holes, etc.

All dimensions are in millimeters.

Table 22. Recommended Clearance Holes for Metric Round Head Square Neck Bolts


Nom. Bolt Dia., D and Thd. Pitch	Clearance			Corner Radius R_h	Nom. Bolt Dia., D and Thd. Pitch	Clearance			Corner Radius R_h
	Close ^a	Normal ^b	Loose ^c			Close ^a	Normal ^b	Loose ^c	
	Minimum Hole Diameter or Square Width, H					Minimum Hole Diameter or Square Width, H			
M5 × 0.8	5.5	...	5.8	0.2	M14 × 2	15.0	15.5	16.5	0.6
M6 × 1	6.6	...	7.0	0.3	M16 × 2	17.0	17.5	18.5	0.6
M8 × 1.25	...	9.0	10.0	0.4	M20 × 2.5	21.0	22.0	24.0	0.8
M10 × 1.5	...	11.0	12.0	0.4	M24 × 3	25.0	26.0	28.0	1.0
M12 × 1.75	13.0	13.5	14.5	0.6	...	...	...	...	...

^a *Close Clearance*: Close clearance should be specified only for square holes in very thin and/or soft material, or for slots, or where conditions such as critical alignment of assembled parts, wall thickness, or other limitations necessitate use of a minimal hole. Allowable swell or fins on the bolt body and/or fins on the corners of the square neck may interfere with close clearance round or square holes.

^b *Normal Clearance*: Normal clearance hole sizes are preferred for general purpose applications and should be specified unless special design considerations dictate the need for either a close or loose clearance hole.

^c *Loose Clearance*: Loose clearance hole sizes should be specified only for applications where maximum adjustment capability between components being assembled is necessary. Loose clearance square hole or slots may not prevent bolt turning during wrenching.

All dimensions are in millimeters.

Metric Screw and Bolt Thread Series.—Unless otherwise specified, metric screws and bolts, except for hex lag screws, are furnished with metric coarse threads conforming to the dimensions for general purpose threads given in ANSI B1.13M (see *Metric Screw and Bolt Diameter-Length Combinations* Metric Screw Threads in Index). Except for socket head cap screws, the tolerance class is 6g, which applies to plain finish (unplated or uncoated) screws or bolts and to plated or coated screws or bolts before plating or coating. For screws with additive finish, the 6g diameters may be exceeded by the amount of the allowance, i.e. the basic diameters apply to the screws or bolts after plating or coating. For socket head cap screws, the tolerance class is 4g6g, but for plated screws, the allowance g may be consumed by the thickness of plating so that the maximum limit of size after plating is tolerance class 4h6h. Thread limits are in accordance with ANSI B1.13M. Metric hex lag screws have a special thread which is covered in Table 5.

Metric Screw and Bolt Identification Symbols.—Screws and bolts are identified on the top of the head by property class symbols and manufacturer's identification symbol.

Table 23. American National Standard Socket Head Cap Screws—Metric Series
ANSI/ASME B18.3.1M-1986

Nom. Size and Thread Pitch	Body Diameter, D		Head Diameter A		Head Height H		Chamfer or Radius S	Hexagon Socket Size ^a J	Spline Socket Size ^a M	Key Engagement T	Transition Dia. B^a
	Max	Min	Max	Min	Max	Min					
M1.6 × 0.35	1.60	1.46	3.00	2.87	1.60	1.52	0.16	1.5	1.829	0.80	2.0
M2 × 0.4	2.00	1.86	3.80	3.65	2.00	1.91	0.20	1.5	1.829	1.00	2.6
M2.5 × 0.45	2.50	2.36	4.50	4.33	2.50	2.40	0.25	2.0	2.438	1.25	3.1
M3 × 0.5	3.00	2.86	5.50	5.32	3.00	2.89	0.30	2.5	2.819	1.50	3.6
M4 × 0.7	4.00	3.82	7.00	6.80	4.00	3.88	0.40	3.0	3.378	2.00	4.7
M5 × 0.8	5.00	4.82	8.50	8.27	5.00	4.86	0.50	4.0	4.648	2.50	5.7
M6 × 1	6.00	5.82	10.00	9.74	6.00	5.85	0.60	5.0	5.486	3.00	6.8
M8 × 1.25	8.00	7.78	13.00	12.70	8.00	7.83	0.80	6.0	7.391	4.00	9.2
M10 × 1.5	10.00	9.78	16.00	15.67	10.00	9.81	1.00	8.0	...	5.00	11.2
M12 × 1.75	12.00	11.73	18.00	17.63	12.00	11.79	1.20	10.0	...	6.00	14.2
M14 × 2 ^b	14.00	13.73	21.00	20.60	14.00	13.77	1.40	12.0	...	7.00	16.2
M16 × 2	16.00	15.73	24.00	23.58	16.00	15.76	1.60	14.0	...	8.00	18.2
M20 × 2.5	20.00	19.67	30.00	29.53	20.00	19.73	2.00	17.0	...	10.00	22.4
M24 × 3	24.00	23.67	36.00	35.48	24.00	23.70	2.40	19.0	...	12.00	26.4
M30 × 3.5	30.00	29.67	45.00	44.42	30.00	29.67	3.00	22.0	...	15.00	33.4
M36 × 4	36.00	35.61	54.00	53.37	36.00	35.64	3.60	27.0	...	18.00	39.4
M42 × 4.5	42.00	41.61	63.00	62.31	42.00	41.61	4.20	32.0	...	21.00	45.6
M48 × 5	48.00	47.61	72.00	71.27	48.00	47.58	4.80	36.0	...	24.00	52.6

^a See also Table 25.

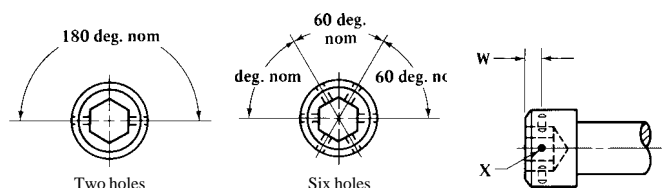
^b The M14 × 2 size is not recommended for use in new designs.

All dimensions are in millimeters

L_G is grip length and L_B is body length (see Table 14).

For length of complete thread, see Table 14.

For additional manufacturing and acceptance specifications, see ANSI/ASME B18.3.1M-1986.

Table 24. Drilled Head Dimensions for Metric Hex Socket Head Cap Screws


Nominal Size or Basic Screw Diameter	Hole Center Location, W		Drilled Hole Diameter, X		Hole Alignment Check Plug Diameter
	Max	Min	Max	Min	Basic
M3	1.20	0.80	0.95	0.80	0.75
M4	1.60	1.20	1.35	1.20	0.90
M5	2.00	1.50	1.35	1.20	0.90
M6	2.30	1.80	1.35	1.20	0.90
M8	2.70	2.20	1.35	1.20	0.90
M10	3.30	2.80	1.65	1.50	1.40
M12	4.00	3.50	1.65	1.50	1.40
M16	5.00	4.50	1.65	1.50	1.40
M20	6.30	5.80	2.15	2.00	1.80
M24	7.30	6.80	2.15	2.00	1.80
M30	9.00	8.50	2.15	2.00	1.80
M36	10.50	10.00	2.15	2.00	1.80

All dimensions are in millimeters.

Drilled head metric hexagon socket head cap screws normally are not available in screw sizes smaller than M3 nor larger than M36. The M3 and M4 nominal screw sizes have two drilled holes spaced 180 degrees apart. Nominal screw sizes M5 and larger have six drilled holes spaced 60 degrees apart unless the purchaser specifies two drilled holes. The positioning of holes on opposite sides of the socket should be such that the hole alignment check plug will pass completely through the head without any deflection. When so specified by the purchaser, the edges of holes on the outside surface of the head will be chamfered 45 degrees to a depth of 0.30 to 0.50 mm.

Table 25. American National Standard Hexagon and Spline Sockets for Socket Head Cap Screws—Metric Series ANSI/ASME B18.3.1M-1986

Nominal Hexagon Socket Size		Socket Width Across Flats, J		Socket Width Across Corners, C		Nominal Hexagon Socket Size		Socket Width Across Flats, J		Socket Width Across Corners, C	
Metric Hexagon Sockets											
	Max	Min	Min		Max	Min		Max	Min	Min	
1.5	1.545	1.520	1.73	12	12.146	12.032	13.80				
2	2.045	2.020	2.30	14	14.159	14.032	16.09				
2.5	2.560	2.520	2.87	17	17.216	17.050	19.56				
3	3.071	3.020	3.44	19	19.243	19.065	21.87				
4	4.084	4.020	4.58	22	22.319	22.065	25.31				
5	5.084	5.020	5.72	24	24.319	24.065	27.60				
6	6.095	6.020	6.86	27	27.319	27.065	31.04				
8	8.115	8.025	9.15	32	32.461	32.080	36.80				
10	10.127	10.025	11.50	36	36.461	36.080	41.38				
Metric Spline Sockets ^a											
Nominal Spline Socket Size	Socket Major Diameter, M		Socket Minor Diameter, N		Width of Tooth, P						
	Max	Min	Max	Min	Max	Min					
1.829	1.8796	1.8542	1.6256	1.6002	0.4064	0.3810					
2.438	2.4892	2.4638	2.0828	2.0320	0.5588	0.5334					
2.819	2.9210	2.8702	2.4892	2.4384	0.6350	0.5842					
3.378	3.4798	3.4290	2.9972	2.9464	0.7620	0.7112					
4.648	4.7752	4.7244	4.1402	4.0894	0.9906	0.9398					
5.486	5.6134	5.5626	4.8260	4.7752	1.2700	1.2192					
7.391	7.5692	7.5184	6.4516	6.4008	1.7272	2.6764					

^a The tabulated dimensions represent direct metric conversions of the equivalent inch size spline sockets shown in American National Standard Socket Cap, Shoulder and Set Screws — Inch Series ANSI B18.3. Therefore, the spline keys and bits shown therein are applicable for wrenching the corresponding size metric spline sockets.

Metric Nuts

The American National Standards covering metric nuts have been established in cooperation with the Department of Defense in such a way that they could be used by the Government for procurement purposes. Extensive information concerning these nuts is given in the following text and tables, but for more complete manufacturing and acceptance specifications, reference should be made to the respective Standards, which may be obtained by non-governmental agencies from the American National Standards Institute, 11 West

42nd Street, New York, N.Y. 10036. Manufacturers should be consulted concerning items and sizes which are in stock production.

Comparison with ISO Standards.—American National Standards for metric nuts have been coordinated to the extent possible with comparable ISO Standards or proposed Standards, thus: ANSI B18.2.4.1M Metric Hex Nuts, Style 1 with ISO 4032; B18.2.4.2M Metric Hex Nuts, Style 2 with ISO 4033; B18.2.4.4M Metric Hex Flange Nuts with ISO 4161; B18.2.4.5M Metric Hex Jam Nuts with ISO 4035; and B18.2.4.3M Metric Slotted Hex Nuts, B18.2.4.6M Metric Heavy Hex Nuts in sizes M12 through M36, and B18.16.3M Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts with comparable draft ISO Standards. The dimensional differences between each ANSI Standard and the comparable ISO Standard or draft Standard are very few, relatively minor, and none will affect the interchangeability of nuts manufactured to the requirements of either.

At its meeting in Varna, May 1977, ISO/TC2 studied several technical reports analyzing design considerations influencing determination of the best series of widths across flats for hex bolts, screws, and nuts. A primary technical objective was to achieve a logical ratio between under head (nut) bearing surface area (which determines the magnitude of compressive stress on the bolted members) and the tensile stress area of the screw thread (which governs the clamping force that can be developed by tightening the fastener). The series of widths across flats in the ANSI Standards agree with those which were selected by ISO/TC2 to be ISO Standards.

One exception for width across flats of metric hex nuts, styles 1 and 2, metric slotted hex nuts, metric hex jam nuts, and prevailing-torque metric hex nuts is the M10 size. These nuts in M10 size are currently being produced in the United States with a width across flats of 15 mm. This width, however, is not an ISO Standard. Unless these M10 nuts with width across flats of 15 mm are specifically ordered, the M10 size with 16 mm width across flats will be furnished.

In ANSI Standards for metric nuts, letter symbols designating dimensional characteristics are in accord with those used in ISO Standards, except capitals have been used for data processing convenience instead of lower case letters used in ISO Standards.

Metric Nut Tops and Bearing Surfaces.—Metric hex nuts, styles 1 and 2, slotted hex nuts, and hex jam nuts are double chamfered in sizes M16 and smaller and in sizes M20 and larger may either be double chamfered or have a washer-faced bearing surface and a chamfered top at the option of the manufacturer. Metric heavy hex nuts are optional either way in all sizes. Metric hex flange nuts have a flange bearing surface and a chamfered top and prevailing-torque type metric hex nuts have a chamfered bearing surface. Prevailing-torque type metric hex flange nuts have a flange bearing surface. All types of metric nuts have the tapped hole countersunk on the bearing face and metric slotted hex nuts, hex flange nuts, and prevailing-torque type hex nuts and hex flange nuts may be countersunk on the top face.

Materials and Mechanical Properties.—Nonheat-treated carbon steel metric hex nuts, style 1 and slotted hex nuts conform to material and property class requirements specified for property class 5 nuts; hex nuts, style 2 and hex flange nuts to property class 9 nuts; hex jam nuts to property class 04 nuts, and nonheat-treated carbon and alloy steel heavy hex nuts to property classes 5, 9, 8S, or 8S3 nuts; all as covered in ASTM A563M. Carbon steel metric hex nuts, style 1 and slotted hex nuts that have specified heat treatment conform to material and property class requirements specified for property class 10 nuts; hex nuts, style 2 to property class 12 nuts; hex jam nuts to property class 05 nuts; hex flange nuts to property classes 10 and 12 nuts; and carbon or alloy steel heavy hex nuts to property classes 10S, 10S3, or 12 nuts, all as covered in ASTM A563M. Carbon steel prevailing-torque type hex nuts and hex flange nuts conform to mechanical and property class requirements as given in ANSI B18.16.1M.

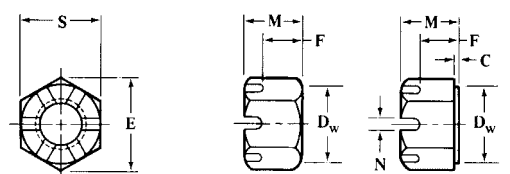
Table 26. American National Standard Metric Hex Nuts, Styles 1 and 2
ANSI/ASME B18.2.4.1M and B18.2.4.2M-1979 (R1995)

Nominal Nut Dia. and Thread Pitch	Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Thickness, <i>M</i>		Bearing Face Dia., <i>D_w</i>	Washer Face Thickness, <i>C</i>	
	Max	Min	Max	Min	Max	Min	Min	Max	Min
Metric Hex Nuts — Style 1									
M1.6 × 0.35	3.20	3.02	3.70	3.41	1.30	1.05	2.3	...	...
M2 × 0.4	4.00	3.82	4.62	4.32	1.60	1.35	3.1	...	...
M2.5 × 0.45	5.00	4.82	5.77	5.45	2.00	1.75	4.1	...	...
M3 × 0.5	5.50	5.32	6.35	6.01	2.40	2.15	4.6	...	...
M3.5 × 0.6	6.00	5.82	6.93	6.58	2.80	2.55	5.1	...	...
M4 × 0.7	7.00	6.78	8.08	7.66	3.20	2.90	6.0	...	...
M5 × 0.8	8.00	7.78	9.24	8.79	4.70	4.40	7.0	...	...
M6 × 1	10.00	9.78	11.55	11.05	5.20	4.90	8.9	...	...
M8 × 1.25	13.00	12.73	15.01	14.38	6.80	6.44	11.6	...	...
^a M10 × 1.5	15.00	14.73	17.32	16.64	9.1	8.7	13.6	0.6	0.3
M10 × 1.5	16.00	15.73	18.48	17.77	8.40	8.04	14.6	...	...
M12 × 1.75	18.00	17.73	20.78	20.03	10.80	10.37	16.6	...	...
M14 × 2	21.00	20.67	24.25	23.36	12.80	12.10	19.4	...	...
M16 × 2	24.00	23.67	27.71	26.75	14.80	14.10	22.4	...	...
M20 × 2.5	30.00	29.16	34.64	32.95	18.00	16.90	27.9	0.8	0.4
M24 × 3	36.00	35.00	41.57	39.55	21.50	20.20	32.5	0.8	0.4
M30 × 3.5	46.00	45.00	53.12	50.85	25.60	24.30	42.5	0.8	0.4
M36 × 4	55.00	53.80	63.51	60.79	31.00	29.40	50.8	0.8	0.4
Metric Hex Nuts — Style 2									
M3 × 0.5	5.50	5.32	6.35	6.01	2.90	2.65	4.6	...	...
M3.5 × 0.6	6.00	5.82	6.93	6.58	3.30	3.00	5.1	...	...
M4 × 0.7	7.00	6.78	8.08	7.66	3.80	3.50	5.9	...	...
M5 × 0.8	8.00	7.78	9.24	8.79	5.10	4.80	6.9	...	...
M6 × 1	10.00	9.78	11.55	11.05	5.70	5.40	8.9	...	...
M8 × 1.25	13.00	12.73	15.01	14.38	7.50	7.14	11.6	...	...
^a M10 × 1.5	15.00	14.73	17.32	16.64	10.0	9.6	13.6	0.6	0.3
M10 × 1.5	16.00	15.73	18.48	17.77	9.30	8.94	14.6	...	...
M12 × 1.75	18.00	17.73	20.78	20.03	12.00	11.57	16.6	...	...
M14 × 2	21.00	20.67	24.25	23.35	14.10	13.40	19.6	...	...
M16 × 2	24.00	23.67	27.71	26.75	16.40	15.70	22.5	...	...
M20 × 2.5	30.00	29.16	34.64	32.95	20.30	19.00	27.7	0.8	0.4
M24 × 3	36.00	35.00	41.57	39.55	23.90	22.60	33.2	0.8	0.4
M30 × 3.5	46.00	45.00	53.12	50.85	28.60	27.30	42.7	0.8	0.4
M36 × 4	55.00	53.80	63.51	60.79	34.70	33.10	51.1	0.8	0.4

^a This size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 hex nuts with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

Table 27. American National Standard Metric Slotted Hex Nuts
ANSI B18.2.4M-1982 (R1999)



Nominal Nut Dia. and Thread Pitch	Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Thickness, <i>M</i>		Bearing Face Dia., <i>D_w</i>	Unslotted Thickness, <i>F</i>		Width of Slot, <i>N</i>		Washer Face Thickness <i>C</i>	
	Max	Min	Max	Min	Max	Min	Min	Max	Min	Max	Min	Max	Min
M5 × 0.8	8.00	7.78	9.24	8.79	5.10	4.80	6.9	3.2	2.9	2.0	1.4	...	...
M6 × 1	10.00	9.78	11.55	11.05	5.70	5.40	8.9	3.5	3.2	2.4	1.8	...	...
M8 × 1.25	13.00	12.73	15.01	14.38	7.50	7.14	11.6	4.4	4.1	2.9	2.3	...	...
^a M10 × 1.5	15.00	14.73	17.32	16.64	10.0	9.6	13.6	5.7	5.4	3.4	2.8	0.6	0.3
M10 × 1.5	16.00	15.73	18.48	17.77	9.30	8.94	14.6	5.2	4.9	3.4	2.8	...	...
M12 × 1.75	18.00	17.73	20.78	20.03	12.00	11.57	16.6	7.3	6.9	4.0	3.2	...	...
M14 × 2	21.00	20.67	24.25	23.35	14.10	13.40	19.6	8.6	8.0	4.3	3.5	...	...
M16 × 2	24.00	23.67	27.71	26.75	16.40	15.70	22.5	9.9	9.3	5.3	4.5	...	...
M20 × 2.5	30.00	29.16	34.64	32.95	20.30	19.00	27.7	13.3	12.2	5.7	4.5	0.8	0.4
M24 × 3	36.00	35.00	41.57	39.55	23.90	22.60	33.2	15.4	14.3	6.7	5.5	0.8	0.4
M30 × 3.5	46.00	45.00	53.12	50.85	28.60	27.30	42.7	18.1	16.8	8.5	7.0	0.8	0.4
M36 × 4	55.00	53.80	63.51	60.79	34.70	33.10	51.1	23.7	22.4	8.5	7.0	0.8	0.4

^aThis size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 slotted hex nuts with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

Metric nuts of other materials, such as stainless steel, brass, bronze, and aluminum alloys, have properties as agreed upon by the manufacturer and purchaser. Properties of nuts of several grades of non-ferrous materials are covered in ASTM F467M.

Unless otherwise specified, metric nuts are furnished with a natural (unprocessed) finish, unplated or uncoated.

Metric Nut Thread Series.—Metric nuts have metric coarse threads with class 6H tolerances in accordance with ANSI B1.13M (see *Metric Screw and Bolt Diameter-Length Combinations* Metric Screw Threads in index). For prevailing-torque type metric nuts this condition applies before introduction of the prevailing torque feature. Nuts intended for use with externally threaded fasteners which are plated or coated with a plating or coating thickness (e.g., hot dip galvanized) requiring overlapping of the nut thread to permit assembly, have over-tapped threads in conformance with requirements specified in ASTM A563M.

Table 28. American National Standard Metric Hex Flange Nuts
ANSI B18.2.4M-1982 (R1999)

Nominal Nut Dia. and Thread Pitch	Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Flange Dia., <i>D_c</i>	Bearing Circle Dia., <i>D_w</i>	Flange Edge Thickness, <i>C</i>	Thickness, <i>M</i>		Flange Top Fillet Radius, <i>R</i>
	Max	Min	Max	Min				Max	Min	
M5 × 0.8	8.00	7.78	9.24	8.79	11.8	9.8	1.0	5.00	4.70	0.3
M6 × 1	10.00	9.78	11.55	11.05	14.2	12.2	1.1	6.00	5.70	0.4
M8 × 1.25	13.00	12.73	15.01	14.38	17.9	15.8	1.2	8.00	7.60	0.5
M10 × 1.5	15.00	14.73	17.32	16.64	21.8	19.6	1.5	10.00	9.60	0.6
M12 × 1.75	18.00	17.73	20.78	20.03	26.0	23.8	1.8	12.00	11.60	0.7
M14 × 2	21.00	20.67	24.25	23.35	29.9	27.6	2.1	14.00	13.30	0.9
M16 × 2	24.00	23.67	27.71	26.75	34.5	31.9	2.4	16.00	15.30	1.0
M20 × 2.5	30.00	29.16	34.64	32.95	42.8	39.9	3.0	20.00	18.90	1.2

All dimensions are in millimeters.

Types of Metric Prevailing-Torque Type Nuts.—There are three basic designs for prevailing-torque type nuts:

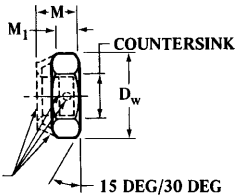
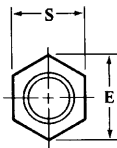
1) All-metal, one-piece construction nuts which derive their prevailing-torque characteristics from controlled distortion of the nut thread and/or body.

2) Metal nuts which derive their prevailing-torque characteristics from addition or fusion of a nonmetallic insert, plug, or patch in their threads.

3) Top insert, two-piece construction nuts which derive their prevailing-torque characteristics from an insert, usually a full ring of non-metallic material, located and retained in the nut at its top surface.

The first two designs are designated in Tables 29 and 30 as “all-metal” type and the third design as “top-insert” type.

Table 29. American National Standard Prevailing-Torque Metric Hex Nuts — Property Classes 5, 9, and 10
ANSI/AMSE B18.16.3M-1998



NOTE: SIZE, SHAPE AND LOCATION OF THE PREVAILING-TORQUE ELEMENT OPTIONAL

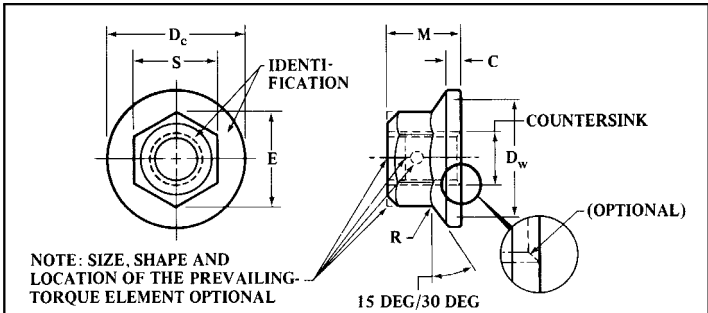
Nominal Nut Dia. and Thread Pitch	Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		Property Classes 5 and 10 Nuts				Property Class 9 Nuts				Property Class		Bearing Face Dia., <i>D_w</i>
					All Metal ^a Type		Top Insert Type		All Metal Type		Top Insert Type		5 and 10 Nuts	9 Nuts	
	Thickness, <i>M</i>												Wrenching Height, <i>M₁</i>		
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Min	Min	
M3 × 0.5	5.50	5.32	6.35	6.01	3.10	2.65	4.50	3.90	3.10	2.65	4.50	3.90	1.4	1.4	4.6
M3.5 × 0.6	6.00	5.82	6.93	6.58	3.50	3.00	5.00	4.30	3.50	3.00	5.00	4.30	1.7	1.7	5.1
M4 × 0.7	7.00	6.78	8.08	7.66	4.00	3.50	6.00	5.30	4.00	3.50	6.00	5.30	1.9	1.9	5.9
M5 × 0.8	8.00	7.78	9.24	8.79	5.30	4.80	6.80	6.00	5.30	4.80	7.20	6.40	2.7	2.7	6.9
M6 × 1	10.00	9.78	11.55	11.05	5.90	5.40	8.00	7.20	6.70	5.40	8.50	7.70	3.0	3.0	8.9
M8 × 1.25	13.00	12.73	15.01	14.38	7.10	6.44	9.50	8.50	8.00	7.14	10.20	9.20	3.7	4.3	11.6
^b M10 × 1.5	15.00	14.73	17.32	16.64	9.70	8.70	12.50	11.50	11.20	9.60	13.50	12.50	5.6	6.2	13.6
M10 × 1.5	16.00	15.73	18.48	17.77	9.00	8.04	11.90	10.90	10.50	8.94	12.80	11.80	4.8	5.6	14.6
M12 × 1.75	18.00	17.73	20.78	20.03	11.60	10.37	14.90	13.90	13.30	11.57	16.10	15.10	6.7	7.7	16.6
M14 × 2	21.00	20.67	24.25	23.35	13.20	12.10	17.00	15.80	15.40	13.40	18.30	17.10	7.8	8.9	19.6
M16 × 2	24.00	23.67	27.71	26.75	15.20	14.10	19.10	17.90	17.90	15.70	20.70	19.50	9.1	10.5	22.5
M20 × 2.5	30.00	29.16	34.64	32.95	19.00	16.90	22.80	21.50	21.80	19.00	25.10	23.80	10.9	12.7	27.7
M24 × 3	36.00	35.00	41.57	39.55	23.00	20.20	27.10	25.60	26.40	22.60	29.50	28.00	13.0	15.1	33.2
M30 × 3.5	46.00	45.00	53.12	50.85	26.90	24.30	32.60	30.60	31.80	27.30	35.60	33.60	15.7	18.2	42.7
M36 × 4	55.00	53.80	63.51	60.79	32.50	29.40	38.90	36.90	38.50	33.10	42.60	40.60	19.0	22.1	51.1

^a Also includes metal nuts with non-metallic inserts, plugs, or patches in their threads.

^b This size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 slotted hex nuts with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

Table 30. American National Standard Prevailing-Torque Metric Hex Flange Nuts
ANSI B18.16.3M-1998



Nominal Dia. and Thread Pitch	Width Across Flats, <i>S</i>		Width Across Corners, <i>E</i>		All Metal Type ^a		Top Insert Type		Flange Dia., <i>D_c</i>	Bearing Circle Dia., <i>D_v</i>	Flange Edge Thickness, <i>C</i>	Flange Top Fillet Radius, <i>R</i>
					Thickness, <i>M</i> (All Nut Property Classes)							
					Max	Min	Max	Min				
M6 × 1	10.00	9.78	11.55	11.05	7.30	5.70	8.80	8.00	14.2	12.2	1.1	0.4
M8 × 1.25	13.00	12.73	15.01	14.38	9.40	7.60	10.70	9.70	17.9	15.8	1.2	0.5
M10 × 1.5	15.00	14.73	17.32	16.64	11.40	9.60	13.50	12.50	21.8	19.6	1.5	0.6
M12 × 1.75	18.00	17.73	20.78	20.03	13.80	11.60	16.10	15.10	26.0	23.8	1.8	0.7
M14 × 2	21.00	20.67	24.25	23.35	15.90	13.30	18.20	17.00	29.9	27.6	2.1	0.9
M16 × 2	24.00	23.67	27.71	26.75	18.30	15.30	20.30	19.10	34.5	31.9	2.4	1.0
M20 × 2.5	30.00	29.16	34.64	32.95	22.40	18.90	24.80	23.50	42.8	39.9	3.0	1.2

^a Also includes metal nuts with nonmetallic inserts, plugs, or patches in their threads.

All dimensions are in millimeters.

Metric Nut Identification Symbols.—Carbon steel hex nuts, styles 1 and 2, hex flange nuts, and carbon and alloy steel heavy hex nuts are marked to identify the property class and manufacturer in accordance with requirements specified in ASTM A563M. The aforementioned nuts when made of other materials, as well as slotted hex nuts and hex jam nuts, are marked to identify the property class and manufacturer as agreed upon by manufacturer and purchaser. Carbon steel prevailing-torque type hex nuts and hex flange nuts are marked to identify property class and manufacturer as specified in ANSI B18.16.1M. Prevailing-torque type nuts of other materials are identified as agreed upon by the manufacturer and purchaser.

Metric Nut Designation.—Metric nuts are designated by the following data, preferably in the sequence shown: product name, nominal diameter and thread pitch, steel property class or material identification, and protective coating, if required. (Note: It is common practice in ISO Standards to omit thread pitch from the product designation when the nut threads are the metric coarse thread series, e.g., M10 stands for M10 × 1.5).

- Example: Hex nut, style 1, M10 × 1.5, ASTM A563M class 10, zinc plated
- Heavy hex nut, M20 × 2.5, silicon bronze, ASTM F467, grade 651
- Slotted hex nut, M20, ASTM A563M class 10.

Table 31. American National Standard Metric Hex Jam Nuts and Heavy Hex Nuts
ANSI B18.2.4.5M and B18.2.4.6M-1979 (R1998)

Nominal Nut Dia. and Thread Pitch	Width Across Flats, S		Width Across Corners, E		Thickness, M		Bearing Face Dia., D_w	Washer Face Thickness, C	
	Max	Min	Max	Min	Max	Min	Min	Max	Min
Metric Hex Jam Nuts									
M5 × 0.8	8.00	7.78	9.24	8.79	2.70	2.45	6.9	...	...
M6 × 1	10.00	9.78	11.55	11.05	3.20	2.90	8.9	...	...
M8 × 1.25	13.00	12.73	15.01	14.38	4.00	3.70	11.6	...	...
^a M10 × 1.5	15.00	14.73	17.32	16.64	5.00	4.70	13.6	...	...
M10 × 1.5	16.00	15.73	18.48	17.77	5.00	4.70	14.6	...	...
M12 × 1.75	18.00	17.73	20.78	20.03	6.00	5.70	16.6	...	...
M14 × 2	21.00	20.67	24.25	23.35	7.00	6.42	19.6	...	...
M16 × 2	24.00	23.67	27.71	26.75	8.00	7.42	22.5	...	...
M20 × 2.5	30.00	29.16	34.64	32.95	10.00	9.10	27.7	0.8	0.4
M24 × 3	36.00	35.00	41.57	39.55	12.00	10.90	33.2	0.8	0.4
M30 × 3.5	46.00	45.00	53.12	50.85	15.00	13.90	42.7	0.8	0.4
M36 × 4	55.00	53.80	63.51	60.79	18.00	16.90	51.1	0.8	0.4
Metric Heavy Hex Nuts									
M12 × 1.75	21.00	20.16	24.25	22.78	12.3	11.9	19.2	0.8	0.4
M14 × 2	24.00	23.16	27.71	26.17	14.3	13.6	22.0	0.8	0.4
M16 × 2	27.00	26.16	31.18	29.56	17.1	16.4	24.9	0.8	0.4
M20 × 2.5	34.00	33.00	39.26	37.29	20.7	19.4	31.4	0.8	0.4
M22 × 2.5	36.00	35.00	41.57	39.55	23.6	22.3	33.3	0.8	0.4
M24 × 3	41.00	40.00	47.34	45.20	24.2	22.9	38.0	0.8	0.4
M27 × 3	46.00	45.00	53.12	50.85	27.6	26.3	42.8	0.8	0.4
M30 × 3.5	50.00	49.00	57.74	55.37	30.7	29.1	46.6	0.8	0.4
M36 × 4	60.00	58.80	69.28	66.44	36.6	35.0	55.9	0.8	0.4
M42 × 4.5	70.00	67.90	80.83	77.41	42.0	40.4	64.5	1.0	0.5
M48 × 5	80.00	77.60	92.38	88.46	48.0	46.4	73.7	1.0	0.5
M56 × 5.5	90.00	87.20	103.92	99.41	56.0	54.1	82.8	1.0	0.5
M64 × 6	100.00	96.80	115.47	110.35	64.0	62.1	92.0	1.0	0.5
M72 × 6	110.00	106.40	127.02	121.30	72.0	70.1	101.1	1.2	0.6
M80 × 6	120.00	116.00	138.56	132.24	80.0	78.1	110.2	1.2	0.6
M90 × 6	135.00	130.50	155.88	148.77	90.0	87.8	124.0	1.2	0.6
M100 × 6	150.00	145.00	173.21	165.30	100.0	97.8	137.8	1.2	0.6

^a This size with width across flats of 15 mm is not standard. Unless specifically ordered, M10 hex jam nuts with 16 mm width across flats will be furnished.

All dimensions are in millimeters.

Metric Washers

Metric Plain Washers.—American National Standard ANSI B18.22M-1981 (R1990) covers general specifications and dimensions for flat, round-hole washers, both soft (as fabricated) and hardened, intended for use in general-purpose applications. Dimensions are given in the following table. Manufacturers should be consulted for current information on stock sizes.

Comparison with ISO Standards.—The washers covered by this ANSI Standard are nominally similar to those covered in various ISO documents. Outside diameters were selected, where possible, from ISO/TC2/WG6/N47 “General Plan for Plain Washers for Metric Bolts, Screws, and Nuts.” The thicknesses given in the ANSI Standard are similar to the nominal ISO thicknesses, however the tolerances differ. Inside diameters also differ.

ISO metric washers are currently covered in ISO 887, “Plain Washers for Metric Bolts, Screws, and Nuts – General Plan.”

Types of Metric Plain Washers.—Soft (as fabricated) washers are generally available in nominal sizes 1.6 mm through 36 mm in a variety of materials. They are normally used in low-strength applications to distribute bearing load, to provide a uniform bearing surface, and to prevent marring of the work surface.

Hardened steel washers are normally available in sizes 6 mm through 36 mm in the narrow and regular series. They are intended primarily for use in high-strength joints to minimize embedment, to provide a uniform bearing surface, and to bridge large clearance holes and slots.

Metric Plain Washer Materials and Finish.—Soft (as fabricated) washers are made of nonhardened steel unless otherwise specified by the purchaser. Hardened washers are made of through-hardened steel tempered to a hardness of 38 to 45 Rockwell C.

Unless otherwise specified, washers are furnished with a natural (as fabricated) finish, unplated or uncoated with a light film of oil or rust inhibitor.

Metric Plain Washer Designation.—When specifying metric plain washers, the designation should include the following data in the sequence shown: description, nominal size, series, material type, and finish, if required.

Example: Plain washer, 6 mm, narrow, soft, steel, zinc plated

Plain washer, 10 mm, regular, hardened steel.

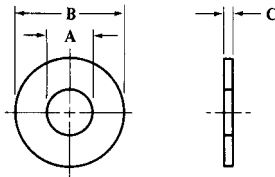


Table 32. American National Standard Metric Plain Washers
ANSI B18.22M-1981, R1990

Nominal Washer Size ^a	Washer Series	Inside Diameter, <i>A</i>		Outside Diameter, <i>B</i>		Thickness, <i>C</i>	
		Max	Min	Max	Min	Max	Min
1.6	Narrow	2.09	1.95	4.00	3.70	0.70	0.50
	Regular	2.09	1.95	5.00	4.70	0.70	0.50
	Wide	2.09	1.95	6.00	5.70	0.90	0.60
2	Narrow	2.64	2.50	5.00	4.70	0.90	0.60
	Regular	2.64	2.50	6.00	5.70	0.90	0.60
	Wide	2.64	2.50	8.00	7.64	0.90	0.60

**Table 32. (Continued) American National Standard Metric Plain Washers
ANSI B18.22M-1981, R1990**

Nominal Washer Size ^a	Washer Series	Inside Diameter, <i>A</i>		Outside Diameter, <i>B</i>		Thickness, <i>C</i>	
		Max	Min	Max	Min	Max	Min
2.5	Narrow	3.14	3.00	6.00	5.70	0.90	0.60
	Regular	3.14	3.00	8.00	7.64	0.90	0.60
	Wide	3.14	3.00	10.00	9.64	1.20	0.80
3	Narrow	3.68	3.50	7.00	6.64	0.90	0.60
	Regular	3.68	3.50	10.00	9.64	1.20	0.80
	Wide	3.68	3.50	12.00	11.57	1.40	1.00
3.5	Narrow	4.18	4.00	9.00	8.64	1.20	0.80
	Regular	4.18	4.00	10.00	9.64	1.40	1.00
	Wide	4.18	4.00	15.00	14.57	1.75	1.20
4	Narrow	4.88	4.70	10.00	9.64	1.20	0.80
	Regular	4.88	4.70	12.00	11.57	1.40	1.00
	Wide	4.88	4.70	16.00	15.57	2.30	1.60
5	Narrow	5.78	5.50	11.00	10.57	1.40	1.00
	Regular	5.78	5.50	15.00	14.57	1.75	1.20
	Wide	5.78	5.50	20.00	19.48	2.30	1.60
6	Narrow	6.87	6.65	13.00	12.57	1.75	1.20
	Regular	6.87	6.65	18.80	18.37	1.75	1.20
	Wide	6.87	6.65	25.40	24.88	2.30	1.60
8	Narrow	9.12	8.90	18.80 ^b	18.37 ^b	2.30	1.60
	Regular	9.12	8.90	25.40 ^b	24.48 ^b	2.30	1.60
	Wide	9.12	8.90	32.00	31.38	2.80	2.00
10	Narrow	11.12	10.85	20.00	19.48	2.30	1.60
	Regular	11.12	10.85	28.00	27.48	2.80	2.00
	Wide	11.12	10.85	39.00	38.38	3.50	2.50
12	Narrow	13.57	13.30	25.40	24.88	2.80	2.00
	Regular	13.57	13.30	34.00	33.38	3.50	2.50
	Wide	13.57	13.30	44.00	43.38	3.50	2.50
14	Narrow	15.52	15.25	28.00	27.48	2.80	2.00
	Regular	15.52	15.25	39.00	38.38	3.50	2.50
	Wide	15.52	15.25	50.00	49.38	4.00	3.00
16	Narrow	17.52	17.25	32.00	31.38	3.50	2.50
	Regular	17.52	17.25	44.00	43.38	4.00	3.00
	Wide	17.52	17.25	56.00	54.80	4.60	3.50
20	Narrow	22.32	21.80	39.00	38.38	4.00	3.00
	Regular	22.32	21.80	50.00	49.38	4.60	3.50
	Wide	22.32	21.80	66.00	64.80	5.10	4.00
24	Narrow	26.12	25.60	44.00	43.38	4.60	3.50
	Regular	26.12	25.60	56.00	54.80	5.10	4.00
	Wide	26.12	25.60	72.00	70.80	5.60	4.50
30	Narrow	33.02	32.40	56.00	54.80	5.10	4.00
	Regular	33.02	32.40	72.00	70.80	5.60	4.50
	Wide	33.02	32.40	90.00	88.60	6.40	5.00
36	Narrow	38.92	38.30	66.00	64.80	5.60	4.50
	Regular	38.92	38.30	90.00	88.60	6.40	5.00
	Wide	38.92	38.30	110.00	108.60	8.50	7.00

^a Nominal washer sizes are intended for use with comparable screw and bolt sizes.

^b The 18.80/18.37 and 25.40/24.48 mm outside diameters avoid washers which could be used in coin-operated devices.

All dimensions are in millimeters.