

Chapter 16

Nuts, bolts, screws and washers

ISO metric precision hexagon bolts, screws and nuts are covered by BS 3643 and ISO 272. The standard includes washer faced hexagon head bolts and full bearing head bolts. In both cases there is a small radius under the bolthead which would not normally be shown on drawings, due to its size, but is included here for completeness of the text. With an M36 bolt, the radius is only 1.7 mm. Bolts may be chamfered at 45° at the end of the shank, or radiused. The rounded end has a radius of approximately one and one quarter times the shank diameter and can also be used if required to draw the rolled thread end. The washer face under the head is also very thin and for a M36 bolt is only 0.5 mm.

Figure 16.1(a) shows the bolt proportions and Table 16.1 the dimensions for bolts in common use. Dimensions of suitable nuts are also given and illustrated in Fig. 16.1(b).

Included in Table 16.1 and shown in Fig. 16.1(c)

are typical washers to suit the above bolts and nuts and these are covered by BS 4320. Standard washers are available in two different thicknesses, in steel or brass, and are normally plain, but may be chamfered.

Table 16.1 gives dimensions of commonly used bolts, nuts and washers so that these can be used easily on assembly drawings. For some dimensions maximum and minimum values appear in the standards and we have taken an average figure rounded up to the nearest 0.5 mm and this will be found satisfactory for normal drawing purposes. Reference should be made to the relevant standards quoted for exact dimensions if required in design and manufacture.

Drawing nuts and bolts

It is often necessary to draw nuts and bolts and a quick easy method is required to produce a satisfactory result.

Table 16.1

Nominal size thread diameter	Thread pitch	Minor diameter of thread	Width across corners	Width across flats	Diameter of washer face	Height of bolt head	Thickness of normal nut	Thickness of thin nut	Washer inside diameter	Washer outside diameter	Washer thickness Form A	Washer thickness Form B
D			A/C	A/F	Df	H	T	t				
M1.6	0.35	1.1	3.5	3.0		1.0	1.25		1.7	4.0	0.3	
M2	0.4	1.4	4.5	4.0		1.5	1.5		2.2	5.0	0.3	
M2.5	0.45	1.9	5.5	5.0		1.75	2.0		2.7	6.5	0.5	
M3	0.5	2.3	6.0	5.5	5.0	2.0	2.25		3.2	7.0	0.5	
M4	0.7	3.0	8.0	7.0	6.5	2.75	3.0		4.3	9.0	0.8	
M5	0.8	3.9	9.0	8.0	7.5	3.5	4.0		5.3	10.0	1.0	
M6	1.0	4.7	11.5	10.0	9.0	4.0	5.0		6.4	12.5	1.6	0.8
M8	1.25	6.4	15.0	13.0	12.0	5.5	6.5	5.0	8.4	17	1.6	1.0
M10	1.5	8.1	19.5	17.0	16.0	7.0	8.0	6.0	10.5	21	2.0	1.25
M12	1.75	9.7	21.5	19.0	18.0	8.0	10.0	7.0	13.0	24	2.5	1.6
M16	2.0	13.5	27.0	24.0	23.0	10.0	13.0	8.0	17.0	30	3.0	2.0
M20	2.5	16.7	34.0	30.0	29.0	13.0	16.0	9.0	21.0	37	3.0	2.0
M24	3.0	20.0	41.5	36.0	34.5	15.0	19.0	10.0	25.0	44	4.0	2.5
M30	3.5	25.5	52.0	46.0	44.5	19.0	24.0	12.0	31.0	56	4.0	2.5
M36	4.0	31.0	62.5	55.0	53.5	23.0	29.0	14.0	37.0	66	5.0	3.0

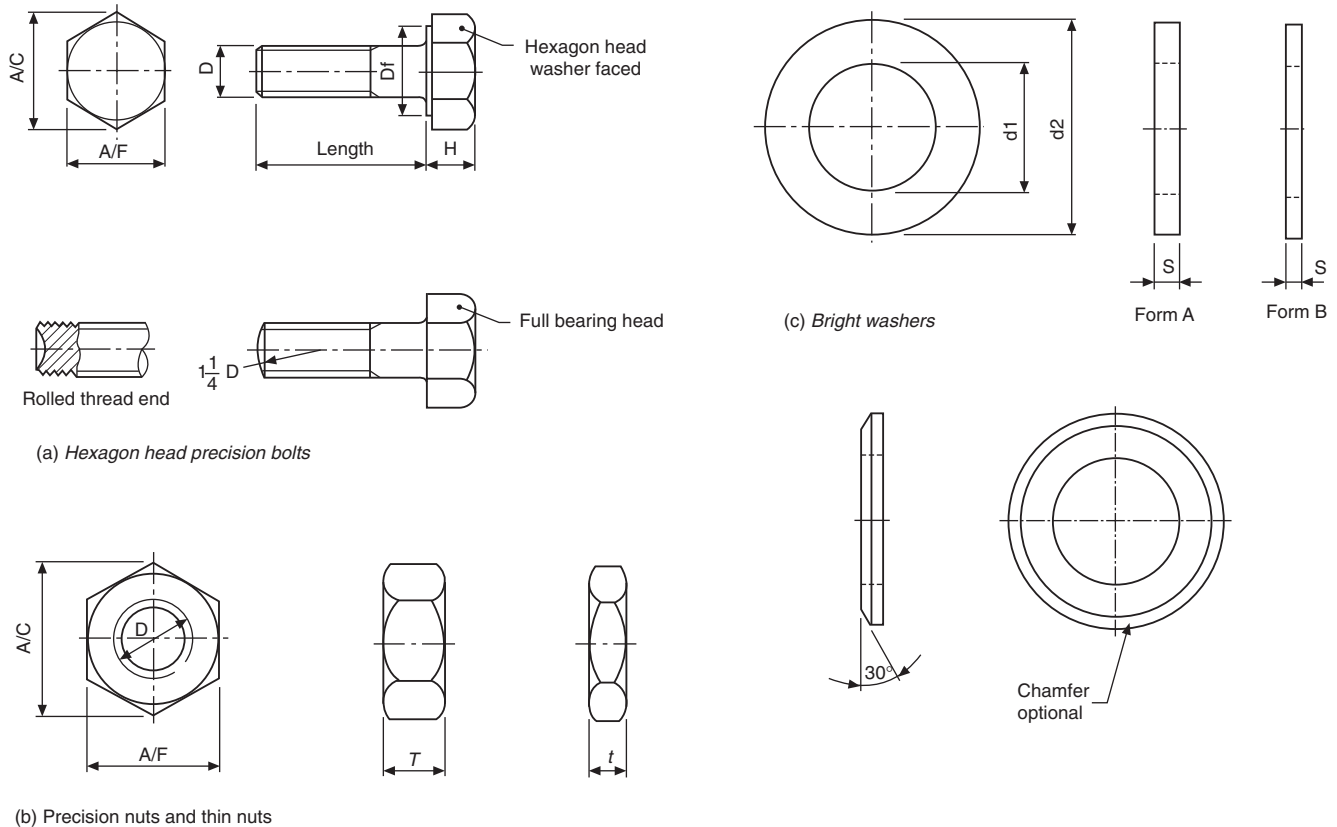


Fig. 16.1 Proportions of bolts, nuts and washers. A/C means across corners. A/F means across flats.

Nuts and bolts are not normally drawn on detail drawings unless they are of a special type. They are shown on assembly drawings and, provided they are standard stock sizes, are called up in parts lists and schedules. A description of the head, the thread and the length being generally sufficient. Templates are available for drawing nuts and bolts and can be recommended for their time saving advantages.

It is conventional drawing practice to show, as first choice, nuts and bolts in the across corners position if a single view only is illustrated since this is instantly recognizable.

Approximate construction for nuts and bolts (Figs 16.2 and 16.3)

Stage 1

- 1 Draw a circle in the plan position, $2D$ in diameter, where D is equal to the thread size. In this example let us assume that the thread size is M20.
- 2 Draw a hexagon inside the 40 mm diameter circle and inside the hexagon draw another circle tangential to the hexagon on the six sides. This circle is the projection of the chamfer which can be seen on the front elevation.

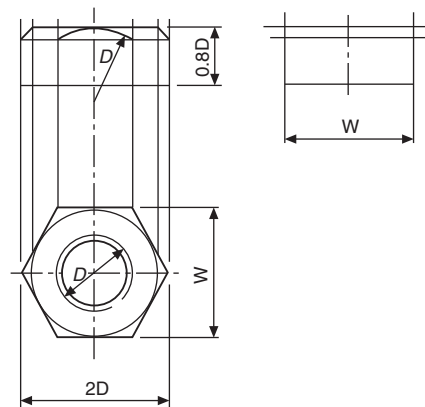
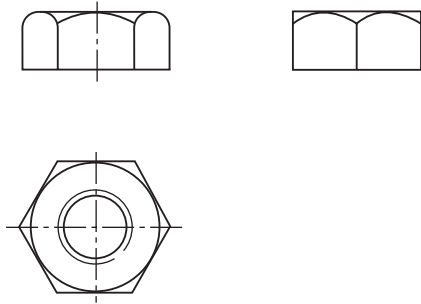


Fig. 16.2 Stage 1

- 3 the nut thickness is $0.8D$. Project the four corners of the hexagon to the front elevation.
- 4 Project three corners of the hexagon in the end elevation and note, that the width of the end elevation is given by dimension W .
- 5 Line in the projected diameter of the chamfer circle and the base in the front elevation.
- 6 As an approximation, draw a radius to show the chamfer on the front elevation. The radius should equal the thread size D .
- 7 Add the female convention to the plan view.

**Fig. 16.3** Stage 2**Stage 2**

- 1 The projection of the curve on the chamfered faces of the hexagon that lie at an angle would produce ellipses in the front elevation. In their place we usually show small circular arcs, their radii can be found by trial, but are approximately $0.25D$.
- 2 The end elevation of the nut has square corners and the projection of the corner which coincides with the centre line terminates at the bottom of the chamfer curve.
- 3 Complete the view by drawing circular arcs on the two chamfered faces. Find by trial, the radius of an arc which will touch the top of the nut and the projection lines from the corner in the front elevation.

Reference to Fig. 16.1a and b will show that the constructions in Fig. 16.2 and Fig. 16.3 can be used for the bolthead and locknut where proportions for thickness can be approximated to $0.7D$ and $0.5D$.

For exact dimensions however, please refer to Table 16.1.

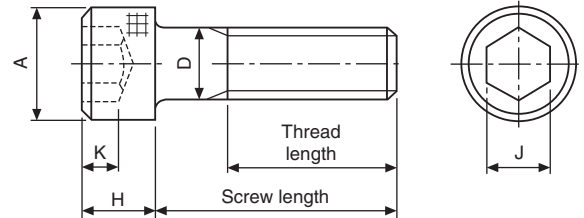
Socket head screws manufactured to BS EN ISO 4762 and BS 3643-2

It is often required to draw these screws and although the head type and the length are generally quoted in parts lists it is necessary to know the proportions of the head. Dimensions follow for each of the most commonly used screws.

Before specifying screws it is advisable to consult a manufacturers list for availability. In the interest of standardization and economy, designers are urged to use stock lengths wherever possible and standard lengths of screws include the following; 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, and 200 mm. If lengths over 200 mm are required, then increments of 20 mm are the preferred ISO lengths. It should be understood that not all diameters of screw are available in the above lengths. For example, the range of lengths for an M3 screw lies between 5 and 35 mm, for an M10 screw between 12 and 100 mm for one particular type of head. The same range will also not cover different types of head, hence the necessity to check stock lists.

ISO metric socket cap screws Dimensions in Table 16.2

These screws are distinguished by square knurling on the heads. Generally, the lengths of standard screws increase in increments of 5 mm and 10 mm, but the exact range should be checked from the manufacturers catalogue.

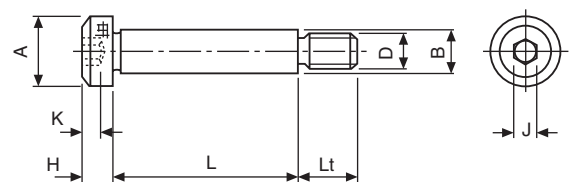
**Fig. 16.4** ISO metric hexagon socket shoulder screws. Dimensions in Table 16.3**Table 16.2**

Nominal size D	M3	M4	M5	M6	M8	M10	M12	M16	M20
Head diameter A	5.5	7	8.5	10	13	16	18	24	30
Head depth H	3	4	5	6	8	10	12	16	20
Key engagement K	1.3	2	2.7	3.3	4.3	5.5	6.6	8.8	10.7
Socket size J	2.5	3	4	5	6	8	10	14	17

ISO metric hexagon socket shoulder screws Dimensions in Table 16.3

Table 16.3

Nominal shoulder diameter B	6	8	10	12	16
Head diameter A	10	13	16	18	24
Head height H	4.5	5.5	7	8	10
Socket size J	3	4	5	6	8
Screw thread diameter D	M5	M6	M8	M10	M12
Nominal thread length Lt	9.75	11.25	13.25	16.4	18.4
Key engagement K	2.45	3.3	4.15	4.92	6.62

**Fig. 16.5** ISO metric hexagon socket button head screws. Dimensions in Table 16.4