

Specification for

Hexagon socket screws and wrench keys —

Inch series

UDC 666.71/.72:691.421

Confirmed
January 2012

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices Technical Committee	Engineering Equipment Users' Association*
Association of Consulting Engineers	Gas Council*
Association of Hydraulic Equipment Manufacturers Ltd.*	Institution of Civil Engineers
Association of Mining Electrical and Mechanical Engineers	Institution of Gas Engineers*
British Compressed Air Society	Institution of Heating and Ventilating Engineers
British Electrical and Allied Manufacturers' Association*	Institution of Mechanical Engineers
British Gear Manufacturers' Association	Institution of Mechanical Engineers (Automobile Division)
British Internal Combustion Engine Manufacturers' Association	Institution of Plant Engineers
British Mechanical Engineering Confederation	Institution of Production Engineers*
British Pump Manufacturers' Association	Locomotive and Allied Manufacturers' Association of Great Britain*
British Steel Industry*	London Transport Executive
Crown Agents for Oversea Governments and Administrations	Machine Tool Trades Association*
Department of Employment (H.M. Factory Inspectorate)	Ministry of Defence
Department of the Environment*	Ministry of Defence, Army Department
Department of Trade and Industry	National Coal Board*
Department of Trade and Industry — National Engineering Laboratory	National Physical Laboratory (Department of Trade and Industry)
Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales*	Process Plant Association
	Royal Institute of British Architects
	Telecommunications Engineering Manufacturing Association
	Water-tube Boilermakers' Association

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Black Bolt and Nut Association of Great Britain	Institute of Iron and Steel Wire Manufacturers
British Bolt Nut Screw and Rivet Federation	Ministry of Aviation, Supply Department
British Constructional Steelwork Association	Ministry of Defence, Navy Department
British Railways Board	Precision Bolt and Nut Institute
Constructional Steel Research and Development Organization	Rolled Thread Screw Association
Council of British Manufacturers of Petroleum Equipment	Scientific Instrument Manufacturers Association of Great Britain
Electronic Engineering Association	Society of Motor Manufacturers and Traders
Fasteners and Turned Parts Institute	Socket Screw Manufacturers Association
	Washer Manufacturers Association of Great Britain

This British Standard, having been approved by the Mechanical Engineering Industry Standards Committee, was published under the authority of the Executive Board on 15 June 1973

© BSI 10-1999

First published June 1954
First revision June 1973

The following BSI references relate to the work on this standard:
Committee references MEE/60/3 and MEE/60
Draft for comment 68/23846

ISBN 0 580 07139 1

Amendments issued since publication

Amd. No.	Date of issue	Comments
4127	November 1983	Indicated by a sideline in the margin

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	iii
1 General	1
1.1 Scope	1
2 Hexagon socket screws	1
2.1 Materials	1
2.2 Finish	1
2.3 Dimensions	1
2.4 Head diameter	1
2.5 Length of socket screws	1
2.6 Tolerance on length	1
2.7 Ends of socket screws	2
2.8 Screw threads	2
2.9 Radius under head	2
2.10 Length of thread	2
2.11 Concentricity and straightness	3
2.12 Dimensions of hexagon sockets	4
3 Hexagon wrench keys and bits	21
3.1 Material	21
3.2 Finish	21
3.3 Dimensions	21
3.4 Ends of keys	21
3.5 Torque test	21
3.6 Application	21
Appendix A Mechanical properties of finished alloy steel hexagon socket screws and wrench keys	24
Appendix B Dimensioning of countersunk head screws	26
Appendix C Terminal length increments for socket screws	27
Figure 1 — Alternative types of cup point and socket permissible with hexagon socket set screws with ISO inch (Unified), BA, BSW and BSF and G(BSPF) threads	15
Table 1 — Option 1 for thread length and grip lengths of cap screws having UNC, UNF, BSW, BSF and BA threads	5
Table 2A — Dimensions of hexagon socket head cap screws, ISO inch (Unified) threads	8
Table 2B — Dimensions of hexagon socket head cap screws, BSW and BSF threads	9
Table 2C — Dimensions of hexagon socket head cap screws, BA threads	10
Table 3 — Dimensions of hexagon socket countersunk head screws with ISO inch (Unified) threads	11
Table 4 — Dimensions of hexagon socket button head screws with ISO inch (Unified) threads	12
Table 5 — Hexagon socket head shoulder screws (stripper bolts) with ISO inch (Unified) and BSW/BSF threads	13
Table 6A — Dimensions of hexagon socket set screws with ISO inch (Unified) threads	16
Table 6B — Dimensions of hexagon socket set screws with BSW and BSF threads	17

	Page
Table 6C — Dimensions of hexagon socket set screws with BA threads	18
Table 6D — Dimensions of hexagon socket set screws with G(BSPF) threads	19
Table 7 — Dimensions of hexagon sockets	20
Table 8 — Dimensions of hexagon wrench keys	22
Table 9 — Applicability of hexagon wrench keys to various socket screw types and sizes	23
Publications referred to	Inside back cover

Foreword

The first issue of BS 2470, in 1954, included hexagon socket screws with Unified threads in sizes $\frac{1}{4}$ in and over, the general dimensions of which were the same as the American specification then current. Since then the American specification has been revised, the two most important changes being the increase of the head diameter of cap screws and the adoption of new thread length formulae which results in shorter thread lengths on long length cap screws. In this revision the head diameters of cap screws are unchanged because of the need to maintain interchangeability with screws to the 1954 edition since holes counterbored for the smaller head would not accommodate the revised American head diameters.

The minimum thread lengths resulting from the revised United States thread length formula have been adopted for the optional thread lengths now shown together with most of the minor changes in the American specification, including changes in certain tolerances to bring them in line with current manufacturing practices. Other changes are the inclusion of the Unified numbered series and the 80° countersunk and button heads with Unified threads.

Hexagon socket screws with the obsolescent BSW, BSF and BA threads are retained in this revision although at some time they will become obsolete in view of the current recommendation that first preference should be given to ISO metric screw threads.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 28, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General

1.1 Scope

This British Standard specifies requirements for hexagon socket screws with ISO Inch (Unified) BSW, BSF, G(BSPF) and BA threads and to wrench keys for use with them.

Section 2 gives dimensions, tolerances and general requirements for cap screws, countersunk head screws, button head screws, shoulder screws (stripper bolts) and set screws. Section 3 gives dimensions, tolerances and requirements for wrench keys. Appendices relate to mechanical properties, nominal length increments and the method of dimensioning countersunk head screws.

NOTE The titles of British Standards referred to in this standard are listed on the inside back cover.

2 Hexagon socket screws

2.1 Materials

Steel hexagon socket screws shall be manufactured from high grade alloy steel, hardened, quenched in oil and tempered to give the mechanical properties specified in Appendix A.

NOTE Hexagon socket screws in any material other than that specified are subject to agreement between the manufacturer and the purchaser.

2.2 Finish

Hexagon socket screws shall be cleanly finished and free from defects. High grade alloy steel hexagon socket screws shall have a blue-black heat treatment, or chemical black oxide finish with the exception of the shoulder or body of socket head shoulder screws, which shall have a bright ground finish.

Where hexagon socket screws are required to be plated, the type and thickness of coating shall be specified by the purchaser in his enquiry and order. BS 3382 specifies requirements for electroplated coatings on threaded components.

2.3 Dimensions

Hexagon socket screws, plated or plain finish, shall conform to the dimensions and tolerances given in Table 2 to Table 6 and 2.4 to 2.9.

2.4 Head diameter

2.4.1 Cap and shoulder screws. Heads may be plain or knurled at the option of the manufacturer unless otherwise specified. For knurled screws the diameter measured over the top of the knurl shall not exceed the maximum specified in Table 2A, Table 2B, Table 2C and Table 5 and the diameter of the head before knurling or the unknurled section of head shall be not less than the minimum specified in Table 2A, Table 2B, Table 2C and Table 5.

2.4.2 80° Countersunk head screws. The maximum sharp values given for 82°/80° countersunk heads in Table 3 are theoretical values only as it is not practicable to make the edge of the head sharp (see Appendix B).

2.5 Length of socket screws

2.5.1 Cap screws and button head screws. The length shall be the distance from the underside of the head to the extreme end of the shank, including the chamfer.

2.5.2 Countersunk head screws. The length shall be the distance from the top of the head to the extreme end of the shank, including the chamfer.

2.5.3 Shoulder screws. The length shall be the distance from the underside of the head to the end of the shoulder or body, excluding the threaded end.

2.5.4 Set screws. The length, for all types of point, shall be the length overall, including the chamfer at the socket end and the point. Unless otherwise specified cup point screws shall be supplied.

NOTE For details of nominal length increments see Appendix C.

2.6 Tolerance on length

The permissible tolerance on length shall be as follows:

1) *Cap screws, countersunk head screws and button head screws*

Length	Tolerance
in	in
Up to and including 1	± 0.016
Over 1 up to and including 6	± 0.031
Over 6	± 0.062

2) *Shoulder screws (length of shoulder)*

± 0.005 in

3) *Set screws*

Length	Tolerance
in	in
Up to and including $\frac{5}{8}$	± 0.010
Over $\frac{5}{8}$ up to and including 2	± 0.020
Over 2 up to and including 6	± 0.031
Over 6	± 0.062

2.7 Ends of socket screws

2.7.1 Cap screws, countersunk head screws, button head screws and shoulder screws. The end shall be flat or slightly concave and chamfered. The flat shall be normal to the axis of the screw and the included angle of the chamfer shall be approximately 90°. The chamfer shall extend slightly below the root of the thread and the edge between the flat and the chamfer may be slightly rounded. Chamfering of sizes up to and including No. 8 UNC/F or 3 BA shall be optional.

2.7.2 Set screws

2.7.2.1 Set screws may be supplied with any type of point specified in Table 6, as required by the purchaser. Unless otherwise specified cup point shall be supplied.

2.7.2.2 The face of the socket ends of the screws shall be chamfered at 30°/45° to slightly below the root diameter of the thread except that screws equal to or shorter than those shown in columns 5 to 7 of Table 6 shall be chamfered at the option of the manufacturer.

2.7.2.3 The chamfer at the point end of the flat and cup point set screws shall be 45°/50°, except that screws equal to or shorter than those shown in column 5 of Table 6 shall be chamfered at 30°/50°. The point angles specified shall apply only to those portions of the angles which lie below the root diameter of the thread.

2.8 Screw threads

2.8.1 ISO inch (Unified) threads. UNC and UNF screw threads shall conform to the limits and tolerances for Class 2A, or Class 3A, as specified in BS 1580.

2.8.2 BA screw threads. BA screw threads shall conform to the limits and tolerances for normal or close class, as specified in BS 93.

2.8.3 BSW and BSF screw threads. BSW and BSF screw threads shall conform to the limits and tolerances for medium or close class, as specified in BS 84.

2.8.4 G(BSPF) screw threads. G(BSPF) screw threads shall conform to the limits and tolerances for Class A threads of BSP sizes as specified in BS 2779¹⁾.

2.9 Radius under head

2.9.1 Cap and button head screws. The radius under the heads of the screws shall run smoothly into the face of the head and shank without any step or discontinuity.

NOTE A true radius is not essential provided that the curve is smooth and lies wholly within the maximum radius determined from the maximum transitional diameter and the minimum radius specified.

2.9.2 Countersunk head screws. The radius under the head of the screws shall run smoothly into the conical bearing surface of the head and the shank without any step or discontinuity.

2.10 Length of thread

2.10.1 General. The length of thread T shown in Table 2 shall be the distance from the extreme end of the screw, including any chamfer, to the leading face of a ring gauge, without chamfer, which has been screwed as far as possible onto the screw by hand. The thread length does not include the runout threads.

The runout threads shall not exceed $2\frac{1}{2}$ pitches.

2.10.2 Cap screws. To accommodate different manufacturing techniques two alternative thread lengths are permitted at the option of the manufacturer. Both will give the minimum thread length T specified in Table 2 which is equivalent to twice the nominal diameter plus $\frac{1}{2}$ in.

The thread length T shall be controlled by the grip length G .

The grip length G is the distance from the underside of the head to the leading face of a ring gauge, without chamfer, which has been screwed as far as possible onto the screw by hand. The grip length includes the runout threads.

The tolerance on grip length shall be + 0 – 2.5 pitches.

2.10.2.1 Option 1. The following are the requirements for thread lengths and grip lengths given in Table 1.

1) Screws of sizes between the heavy lines in Table 1 shall be threaded to within a distance from the underside of the head equal to the grip length G shown in Table 1.

Sizes between the heavy lines in Table 1 for which no grip length is shown shall be threaded to have the grip length of the next size shorter shown in Table 1.

¹⁾ in course of revision.

2) Sizes shorter than those shown between the heavy lines in Table 1 shall be threaded to within $2\frac{1}{2}$ pitches of the head for diameters up to and including $\frac{5}{8}$ inch and as close to the head as is practical for diameters $\frac{3}{4}$ in to 1 in inclusive.

3) Sizes longer than those shown between the heavy lines in Table 1 shall have a grip length G calculated by subtracting the minimum thread length T shown in Table 2, from the nominal screw length L shown in Table 1 (i.e. $G = L - T$).

2.10.2.2 Option 2. The following are the requirements for thread lengths and grip lengths given in Table 2.

1) Screws shall be threaded to within a distance from the underside of the head equal to grip length G calculated by subtracting the minimum thread length T shown in Table 2, from the nominal screw length L (i.e. $G = L - T$).

2) Screws too short for the minimum thread length shall be threaded to within 2.5 pitches from the underside of the head for diameters up to and including $\frac{5}{8}$ in and as close to the head as practical for diameters $\frac{3}{4}$ in to 1 in inclusive.

2.10.3 Countersunk-head screws. The minimum length of thread shall be as specified in Table 3, with a tolerance of $-\frac{0}{+1}$ diameter. Screws that are too short for the length of thread specified shall be threaded to permit a screw ring gauge to be screwed by hand to within a distance from the underside of the head not exceeding 2.5 times the pitch.

2.10.4 Button head screws. The minimum length of thread shall be as specified in Table 4. There is no maximum limit specified. Screws that are too short for the length of thread stated shall be threaded to permit a screw ring gauge to be screwed by hand to within a distance from the underside of the head not exceeding 2.5 times the pitch.

2.10.5 Shoulder screws. The length of thread shall be as specified in Table 5 and shall include an undercut to permit the face of the shoulder to screw down flush on to the face of the component.

2.11 Concentricity and straightness

2.11.1 Cap screws

2.11.1.1 The head shall be concentric to the axis of the shank within 1 % of the basic screw diameter (2 % full indicator movement) or 0.006 in full indicator movement, whichever is the greater.

2.11.1.2 The socket shall be concentric to the axis of the shank within 1.5 % of the basic screw diameter (3 % full indicator movement) or 0.005 in full indicator movement, whichever is the greater, for sizes up to $\frac{1}{2}$ in, and 3 % (6 % full indicator movement) for sizes over $\frac{1}{2}$ in.

2.11.1.3 Cap screws shall be straight within 0.006 in per inch of length for nominal diameters up to and including $\frac{1}{2}$ in and within 0.005 in per inch of length for nominal diameters over $\frac{1}{2}$ in.

2.11.2 Countersunk head screws

2.11.2.1 The conical surface of the head shall be concentric to the axis of the shank within 1 % of the basic screw diameter (2 % full indicator movement) or 0.006 in full indicator movement, whichever is the greater.

2.11.2.2 The socket shall be concentric to the axis of the shank within $1\frac{1}{2}$ % of the basic screw diameter (3 % full indicator movement) or 0.005 in full indicator movement, whichever is the greater, for sizes up to $\frac{1}{2}$ in and 3 % (6 % full indicator movement) for sizes over $\frac{1}{2}$ in.

2.11.2.3 The screws shall be straight within 0.006 in per inch of length for nominal diameters up to and including $\frac{1}{2}$ in and within 0.005 in per inch of length for nominal diameters over $\frac{1}{2}$ in.

2.11.3 Button head screws

2.11.3.1 The head shall be concentric to the axis of the shank within 3 % of the maximum head diameter or 0.004 in (0.008 in full indicator movement), whichever is the greater.

2.11.3.2 The socket shall be concentric to the axis of the shank within $1\frac{1}{2}$ % of the basic screw diameter (3 % full indicator movement) or 0.005 in full indicator movement, whichever is the greater, for sizes up to $\frac{1}{2}$ in and 3 % (6 % full indicator movement) for sizes over $\frac{1}{2}$ in.

2.11.3.3 The screws shall be straight within 0.006 in per inch length for nominal diameters up to and including $\frac{1}{2}$ in and within 0.005 in per inch length for nominal diameters over $\frac{1}{2}$ in.

2.11.4 Shoulder screws

2.11.4.1 The head shall be concentric with the shoulder within 1 % (2 % full indicator movement) of the nominal diameter D , as shown in Table 2, or 0.003 in (0.006 in full indicator movement), whichever is the greater.

2.11.4.2 Effective diameter and shoulder shall be concentric to within 0.004 in full indicator movement when checked at a distance of 0.188 in from the shoulder at the threaded end.

2.11.4.3 Concentricity, parallelism, straightness and squareness of shoulder to thread shall be within 0.005 in full indicator movement per inch of shoulder length, with a maximum of 0.025 in when firmly seated against the shoulder in a threaded bush, and checked on the shoulder at a distance $2F$ (see Table 5) from the underside of the head. The threads of the bush shall be basic size, and the bush O.D. and ends shall be concentric and square with the axis.

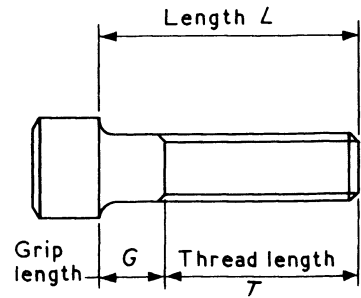
2.11.5 Set screws. The permissible eccentricity of the dog point axis, with respect to the axis of the thread, shall not exceed 3 % of the basic diameter of the screw, and in no case shall be greater than 0.005 in for sizes up to and including $\frac{3}{4}$ in. For sizes over $\frac{3}{4}$ in it shall not be greater than 0.010 in. (Full indicator movement shall not exceed twice the permissible eccentricity.)

2.12 Dimensions of hexagon sockets

For convenience, only the nominal size of the hexagon socket is given in Table 2 to Table 6. The limits of size across the flats of the sockets shall be as given in Table 7.

Table 1 — Option 1 for thread length and grip lengths of cap screws having UNC, UNF, BSW, BSF and BA threads

See 2.10.2 for explanation and further details.



Length L	Nominal size									Length L
					6 BA	5 BA	4 BA	3 BA	2 BA	
	0 UNC/F	1 UNC/F	2 UNC/F	3 UNC/F	4 UNC/F	5 UNC/F	6 UNC/F	8 UNC/F	$\frac{3}{16}$ BSWF 10 UNC/F	
	Maximum grip length G									
Below $\frac{3}{4}$										Below $\frac{3}{4}$
$\frac{3}{4}$										$\frac{3}{4}$
$\frac{7}{8}$	0.250	0.250	0.250							$\frac{7}{8}$
1	0.500				0.250	0.250				1
$1\frac{1}{4}$	0.750	0.625	0.625	0.625			0.500	0.375	0.375	$1\frac{1}{4}$
$1\frac{1}{2}$		0.875	0.875	0.875	0.750	0.750				$1\frac{1}{2}$
$1\frac{3}{4}$			1.125	1.125			1.000	0.875	0.875	$1\frac{3}{4}$
2				1.375	1.250	1.250				2
$2\frac{1}{4}$							1.500	1.375	1.375	$2\frac{1}{4}$
$2\frac{1}{2}$							1.750			$2\frac{1}{2}$
$2\frac{3}{4}$							2.000	1.875	1.875	$2\frac{3}{4}$
3										3
$3\frac{1}{4}$								2.375	2.375	$3\frac{1}{4}$
$3\frac{1}{2}$										$3\frac{1}{2}$
$3\frac{3}{4}$									2.875	$3\frac{3}{4}$
4										4
Over 4										Over 4