BS A 401-420:2015

BSI Standards Publication

AEROSPACE SERIES

Specification for screws, pan and 100° countersunk head, hexalobular drive recess (unified threads below ¼ inch) in various materials

bsi.

...making excellence a habit.™

Publishing and copyright information

Published by BSI Standards Limited 2015

ISBN 978 0 580 82769 3

ICS 49.030.20

The following BSI references relate to the work on this document:
Committee reference ACE/12
Draft for comment 15/30281806DC

Publication history

First published October 2015

Amendments issued since publication

Date	Text affected

Contents

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.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2015. It was prepared by Technical Committee ACE/12, *Aerospace fasteners and fastening systems*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

This British Standard has been introduced to give a hexalobular drive recess alternative to the traditional slot used in screws in the BSI range A 204, A 206, A 208 and A 217 to A 221 (a quick reference guide is provided in Annex A). This is intended to alleviate the risks of screw driver blade slippage in the vicinity of electronic printed circuit board copper track work and associated wiring.

The method of manufacturing choices are more controlled than those of the slotted BS A 204, etc. range, especially for the austenitic corrosion resistant (CRES) steel option, so to better maintain its strength characteristics, e.g. by cold heading and cold rolling threads. This new standard's title omits the term "machine" as in "machine screw" to reflect this.

This standard also expands the choices by introducing stronger alloy steel, martensitic CRES steel and high temperature/high expansion steel options.

The historic thread size of 2-64 UNF has been maintained. However, very few mating female threaded fasteners such as nuts and helical wire thread inserts, are available commercially; most are 2-56 UNC. Thread size 2-56 UNC has therefore been included as a thread size option.

This standard does not incorporate a mating range of plain hexagon nuts to match the new range of material choices listed above.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

Hazard warnings

CAUTION. Screws conforming to BS A 401 and BS A 411 have cadmium as a plating material, which has been restricted and/or banned in many countries owing to environmental and health concerns. Users should consult local officials if they have questions concerning the use of cadmium-plated parts.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies the dimensions, materials, protective finishes and part numbers for 100° countersunk head and pan head screws with unified threads for non-structural general aerospace use.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASD-STAN TR 3775, *Aerospace series – Bolts and pins – materials*

BS 1134, *Assessment of surface texture – Guidance and general information*

BS 1473, *Specification for wrought aluminium and aluminium alloys for general engineering purposes – rivet, bolt and screw stock*

BS 1580-3*, Unified screw threads – Screw threads with diameters below ¼ in – Part 3: Requirements*

BS 1872, *Specification for electroplated coatings of tin*

BS 6338, *Specification for chromate conversion coatings on electroplated zinc and cadmium coatings*

BS A 100, *Specification for general requirements for bolts and free running nuts of tensile strength not exceeding 1 249 MPa*

BS L 102, *Specification for bars and extruded sections of aluminium-copper-magnesium-silicon-manganese alloy (solution treated and aged at room temperature) (not exceeding 200 mm diameter or minor sectional dimension) (Cu 4.4, Mg 0.5, Si 0.7, Mn 0.8)*

BS L 168, *Specification for bars and extruded sections of aluminium-copper-magnesium-silicon-manganese alloy (solution treated and artificially aged) (not exceeding 200 mm diameter or minor sectional dimension) (Cu 4.4, Mg 0.5, Si 0.7, Mn 0.8)*

BS S 80, *High chromium-nickel corrosion resisting steel forging stock, bars, forgings and parts (880 to 1 080 MPa: limiting ruling section 100 mm)*

BS S 129, *Specification for 18/9 chromium-nickel corrosion-resisting steel (titanium stabilized) billets, bars, forgings and parts (540 MPa: limiting ruling section 150 mm)*

BS S 130, *Specification for 18/9 chromium-nickel corrosion-resisting steel (niobium stabilized) billets, bars, forgings and parts (540 MPa: limiting ruling section 150 mm)*

BS S 142, *Specification for 1% chromium-molybdenum steel billets, bars, forgings and parts (900–1 100 MPa: limiting ruling section 40 mm)*

BS S 147, *Specification for 0.5% nickel-chromium-molybdenum steel bars for the manufacture of forged bolts and forged nuts*

BS S 148, *Specification for low nickel-chromium steel (bar for the manufacture of forged bolts only)*

BS S 154, *Specification – 2½% nickel-chromium-molybdenum steel billets, bars, forgings and parts (880–1 080 MPa: limiting ruling section 150 mm)*

BS S 158, *Specification for 1% chromium-molybdenum steel bars for the manufacture of forged bolts and forged nuts*

BS EN 755-2, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Mechanical properties*

BS EN 2100, *Aluminium alloy AL-P2014A-T4511 – Extruded bars and sections a or D ≤ 200 mm*

BS EN 2133, *Aerospace series – Cadmium plating of steels with specified tensile strength ≤1 450 MPa, copper, copper alloys and nickel alloy*

BS EN 2284, *Specification for sulfuric acid anodizing of aluminium and wrought aluminium alloys*

BS EN 2398, *Aerospace series – Heat resisting steel FE-PA2601 (X6NiCrTiMoV26-15) – Rm ≥ 900 MPa – Bars for machined bolts – D ≤ 25 mm*

BS EN 2399, *Aerospace series – Heat resisting steel FE-PA2601 (X4NiCrTiMoV26-15) – Rm ≥ 900 MPa – Bars for forged bolts – D ≤ 25 mm*

BS EN 2516, *Passivation of corrosion resisting steels and decontamination of nickel based alloys*

BS EN 3911, *Aerospace series – Six lobe recess – Geometrical definition*

BS EN 4826, *Aerospace series – Zinc-nickel (12-16% Ni) plating of steels with specified tensile strength ≤ 1 450 MPa, copper alloys, nickel alloys and aluminium alloys for parts and fasteners*

BS EN 12163, *Copper and copper alloys – Rod for general purposes*

BS EN 12164, *Copper and copper alloys – Rod for free machining purposes*

BS EN 12166, *Copper and copper alloys – Wire for general purposes*

BS EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel – Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread*

SAE AMS 03-19, *Electro-deposition of cadmium*

SAE AMS 03-25, *Sulfuric acid anodizing of aluminium and aluminium alloys*

SAE AMS 2417, *Aerospace material specification, plating, zinc-nickel alloy*

3 General

The screws shall conform to the relevant requirements of BS A 100 in respect of manufacture, screw threads, identification and marking.

NOTE Unless otherwise stated, the measurement and scientific values shown are expressed in imperial British units with metric SI conversions in parentheses ( ) as needs be.

4 Quality assurance procedure

A quality assurance procedure shall be carried out in accordance with BS A 100, with the exception of samples for dimensional and non-destructive inspection which shall be taken from each batch in accordance with the levels given in Table 1 of this standard.

Table 1 **Sampling plan**

Acceptable quality level (AQL)	Inspection level 11	Inspection level S-1
1%	Thread size	Underhead radius Drive recess dimensions
2.5%	Burrs and plating (visual)	Head concentricity Drive recess form and position
4%	Nominal length Other dimensions	Head height (pan only) Head protrusion (dimension *P*) (countersunk only)

5 Material and manufacture

5.1 The screws shall be manufactured from the materials listed in Table 2.

5.2 The screws shall be manufactured by one of the following methods to suit the material type and shall meet the final mechanical properties as listed after any post manufacture heat treatment.

a) Machined from bright drawn bars. Not applicable to pan head screws made from the materials listed in b) below.

b) Cold headed from wire or bright drawn bars. This is the minimum requirement for pan head screws made from aluminium, brass, austenitic CRES steel and low alloy steel.

c) Hot forged and machined to suit. Applicable to any suitable material listed.

6 Protective finish

The screws shall be coated with the protective treatment for the appropriate material as specified in Table 2.

7 Freedom from defects

The screws shall be free from harmful defects, such as thread rolling laps between the nominal effective diameter and the minor diameter or any cracks.

NOTE Screws may be rejected at any time for faults in or revealed by manufacture, even if they have been made from material passed previously for chemical composition and mechanical properties.

8 Dimensions

With the exception of the thread, the screws shall conform to the dimensions and tolerances given in this standard, prior to applying any protective finish.

NOTE 1 Unless otherwise stated, the values given are in inches. For a guide to the thread sizes converted to decimal inch and metric mm, refer to Annex B.

NOTE 2 The dimensions and tolerances can be found in Figure 1 to Figure 7 inclusive and their associated tables, Table 3 to Table 9 inclusive.

NOTE 3 Any dry film lubricant applied as specified in Table 2 might take parts oversize on all features including the thread; this is acceptable.

9 Head of screws

Screw heads shall be concentric with the shank within the dimensional limits shown in Figure 5 and Figure 6.

Drive recesses shall be within the dimensional limits shown in Figure 1 and Figure 2 and shall be positioned central to the head's outside diameter. The recesses shall be clean and free from burrs upon visual inspection.

Table 2 **British Standard identifier, material and finish of screws *(1 of 3)***

British Standard identifier	Type of head	Material description/specification [A]	Mechanical properties		Protective finish [D]
			Tensile strength [C] tons/inch² (MPa) min	0.2% proof stress tons/inch² (MPa) min	
A401	100° Countersunk	Carbon-manganese (mild) steel in accordance with BS EN ISO 898-1, Property class 4.6	25 (385)	Not stated in material spec	Cadmium coated and passivated [E] in accordance with SAE AMS 03-19 and BS 6338, Class 2c or BS EN 2133, coating Class-C
A411	Pan				
A402	100° Countersunk				Zinc-nickel coated and passivated in accordance with BS EN 4826, A3/B3 [F] or SAE AMS 2417 Type-2 Grade-B In addition, a friction control lubricant [G] with a Coefficient of Friction of 0.08μ to 0.14μ shall be applied
A412	Pan				
A403	100° Countersunk	Alloy steel in accordance with BS S 142, BS S 147, BS S 148, BS S 154 or BS S 158 or as listed in ASD-STAN TR 3775 Table-1 Strength Class 900 [B]	58 (895)	45 (695)	Zinc-nickel coated and passivated in accordance with BS EN 4826, A3/B3 [F] or SAE AMS 2417 Type-2 Grade-B In addition, a friction control lubricant [G] with a Coefficient of Friction of 0.08μ to 0.14μ shall be applied
A413	Pan				
A404	100° Countersunk	Corrosion resisting steel (austenitic) in accordance with BS S 129 or BS S 130	35 (540)	13.5 (210)	None
A414	Pan				
A405	100° Countersunk	Corrosion resisting steel (martensitic) in accordance with BS S 80	57 (880)	47 (725)	Passivate in accordance with BS EN 2516, coating Class-C2 [H]
A415	Pan				

Table 2 **British Standard identifier, material and finish of screws *(2 of 3)***

British Standard identifier	Type of head	Material description/specification [A)]	Mechanical properties		Protective finish [D)]
			Tensile strength [C)] tons/inch² (MPa) min	0.2% proof stress tons/inch² (MPa) min	
A406	100° Countersunk	Corrosion resisting steel A286 (heat resisting, high expansion) in accordance with BS EN 2398 or BS EN 2399 or as listed in ASD-STAN TR 3775 Table-3 Strength Class 900 [B)]	58 (895)	38 (585)	Passivate in accordance with BS EN 2516, coating Class-C2 [I)]
A416	Pan				
A407	100° Countersunk	Aluminium alloy in accordance with: BS 1473 -2014A-TF or 5056A-H4 (AlCu4SiMg) BS EN 755-2 -2014A-T4 or T6 (AlCu4SiMg) BS L 102, BS EN 2100 BS L 168 -T6	20 (310)	15 (230)	Sulphuric acid anodized in accordance with SAE AMS 03-25 or BS EN 2284, BC Dyed green and sealed in pure water
A417	Pan				
A408	100° Countersunk	Brass in accordance with: BS EN 12163 -CW508L-R370 or R460 (CuZn37) -CW712R-R340 (CuZn36Sn1Pb) BS EN 12164 -CW614N-R500 (CuZn39Pb) BS EN 12166 -CW508L-R460 or R700 (CuZn37) -CW614N-R500 (CuZn39Pb3) -CW712R-R400 (CuZn36Sn1Pb)	22 (340)	10 (155)	Tin coated in accordance with BS 1872, classification ≤No.4 UN - Cu/Cu/Sn/4/m or Cu/Ni/Sn/4/m >No.4 UN - Cu/Cu/Sn/5/m or Cu/Ni/Sn/5/m
A418	Pan				

Table 2 **British Standard identifier, material and finish of screws *(3 of 3)***

A) See Table 6 and Table 7 for limitations of material type to head form and screw thread size.

B) Screws made from the alternative material specs chosen from ASD-STAN TR 3775 shall conform to the mechanical properties shown in this table after their final heat treatment.

C) Tensile strength shown in tons/in^2 maintained for quick reference comparison to slotted screw range A204 to A221.

D) If not stated here, and where protective finish specs state a choice, the plating thickness option most suitable for threaded parts shall apply.

E) Cadmium coating is only offered on screws A401 and A411 as they can be considered as replacements [but only at Original Equipment Manufacturer (OEM) Design Authority's request] for slotted screws A204 and A217. The zinc-nickel is offered as a cadmium replacement in the industry drive to remove use of cadmium.

F) Zinc-nickel coating thickness Class-A for basic shank diameter ≤.138 inch (3.5 mm) and Class-B for larger diameters.

G) Manufacturers might wish to choose a lubricant from the recommendations listed in Technical Report ASD-STAN TR 4070.

H) Passivation Class-C2 has been chosen for martensitic CRES steel so to avoid the environmental issues associated with hexavalent chrome in the usually selected Class-C4 process.

I) Passivation Class-C2 has been chosen for heat resisting steel so to avoid the environmental issues associated with hexavalent chrome in the usually selected Class-C1 process.

10 Hexalobular drive recess

10.1 General

The recess profile and lead-in counterbore shall conform to BS EN 3911.

NOTE At time of publication, the recess design, known by the trade name Torx [1] is currently held by Acument Global Technologies. Any technical queries about the recess design, gauging or to gain a licence to manufacture these screws or driver tools, should be directed to this company.

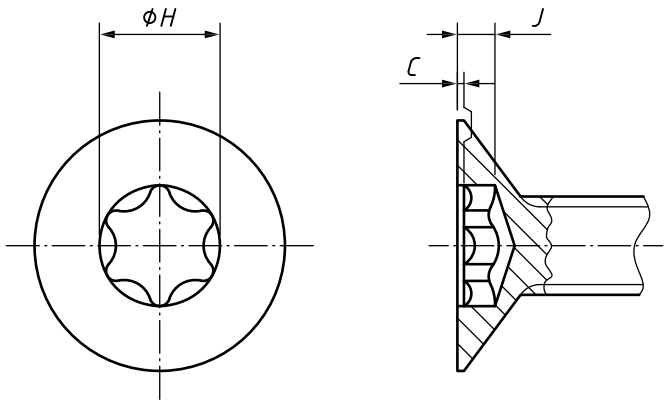
The depth of drive recess (dimension J) shall be measured from the top of the head to the shoulder point where the parallel sides stop using an appropriate gauge.

10.2 100° Countersunk head screws

The recesses suitable for countersunk head screws shall be as shown in Figure 1 and the dimensions shall be as given in Table 3.

NOTE For clarity, the unified thread identifier feature has been omitted.

Figure 1 **Hexalobular recess in 100° countersunk heads**



Key

øH	Counterbore diameter
C	Counterbore depth
J	Recess depth

[1] Torx is a trade mark owned by Acument Intellectual Properties, LLC and is the trade name of a product supplied by Acument Intellectual Properties, LLC. This information is given for the convenience of users of this standard and does not constitute an endorsement by BSI of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table 3 **Dimensions of hexalobular recesses for 100° countersunk heads**

1	2	3	4	5	6
Nominal size of screw	**Recess code** [A]	**Counterbore diameter**	**Counterbore depth**	**Recess depth**	**Fallaway** [B] **penetration of no-go gauge**
		øH	***C***	***J***	(not shown)
		ref	max	–	max
No. 0-80 UNF	06	.069	.005	.017 .014	.014
No. 2-56 UNC No. 2-64 UNF	07	.081	.005	.025 .022	.016
No. 4-40 UNC	08	.094	.005	.030 .024	.019
No. 6-32 UNC	10	.111	.005	.048 .035	.022
No. 8-32 UNC	15	.132	.005	.058 .045	.026
No. 10-32 UNF	20	.155	.010	.071 .055	.031

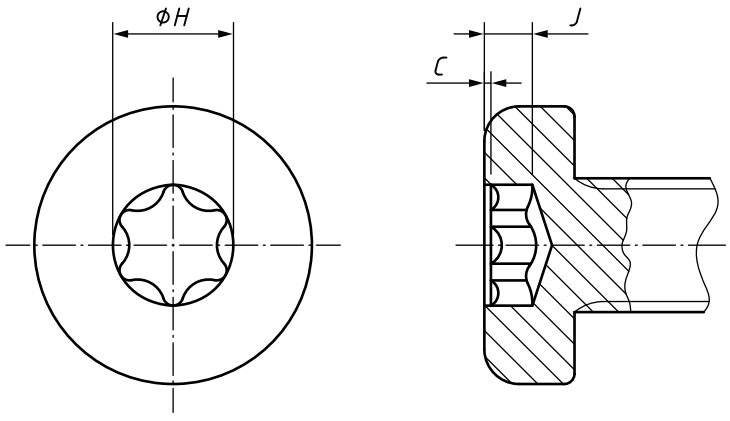
[A] For inspection gauges, refer to BS EN ISO 10664, except for Recess code 07, for which refer to AIA NAS1800.
[B] Fallaway is the initial entry distortion caused by the punch/heading tool that creates the recess. The fallaway might be greater than net recess sizes but is limited to the depth stated.

10.3 Pan head screws

The recesses suitable for pan head screws shall be as shown in Figure 2 and the dimensions shall be as given in Table 4.

NOTE For clarity, the unified thread identifier feature has been omitted.

Figure 2 **Hexalobular recess in pan heads**



Key
øH Counterbore diameter
C Counterbore depth
J Recess depth

Table 4 **Dimensions of hexalobular recesses for pan heads**

1	2	3	4	5	6
Nominal size of screw	**Recess code** [A]	**Counterbore diameter**	**Counterbore depth**	**Recess depth**	**Fallaway** [B] **penetration of no-go gauge**
		øH	***C***	***J***	(not shown)
		ref	max	–	max
No. 0-80 UNF	05	.058	.005	.025 .019	.009
No. 2-56 UNC No. 2-64 UNF	07	.081	.005	.035 .029	.016
No. 4-40 UNC	09	.101	.005	.045 .039	.020
No. 6-32 UNC	15	.132	.005	.050 .044	.026
No. 8-32 UNC	20	.155	.010	.065 .054	.031
No. 10-32 UNF	25	.178	.010	.065 .054	.036

[A] For inspection gauges, refer to BS EN ISO 10664, except for Recess code 07, for which refer to AIA NAS1800.
[B] Fallaway is the initial entry distortion caused by the punch/heading tool that creates the recess. The fallaway might be greater than net recess sizes but is limited to the depth stated.

11 Unified thread identifier

11.1 General

*COMMENTARY ON **11.1***

The purpose of the identifying features was historically to differentiate unified threaded fasteners from other similar inch series thread systems such as BSF and BA. Subsequently, it also aids differentiating from metric threads, especially the closely matched M5x0,8 to No. 10-32 UNF.

The identifying features generally conform to the recommendations in reference sheet SAE ITC RS440 (sheet 2).

Screws of size No. 4-40 UNC and larger shall be configured in accordance with one of the two options specified in **11.2** and **11.3**.

11.2 Annular groove on head (option 1)

*COMMENTARY ON **11.2***

Traditionally, in slotted screws, the head had the option of a shallow spotface, but as the hexalobular recess has as part of its design a shallow lead-in counterbore, the two features interfere with each other; hence an annular groove design has been substituted.

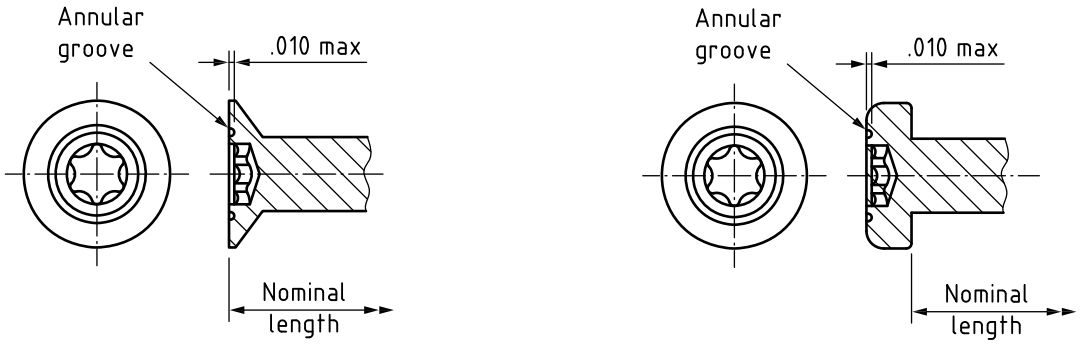
The groove shall be of half-round profile to the depth shown in Figure 3.

The inside diameter (ID) of the groove shall not conjoin with the lead-in counterbore of the hexalobular recess but shall leave at least a .020 inch clear land between the two features.

The outside diameter (OD) of the groove shall be on the flat end faces of the screw heads (i.e. shall not overlap into the pan head's outer edge rad) and shall not obscure any head identification markings.

This feature shall be the preferred option and shall be produced by default unless option 2 is requested by the purchaser.

Figure 3 **Unified thread identifier option 1 (annular groove)**



a) 100° Countersunk head **b) Pan head**

11.3 Plain cylindrical extension (option 2)

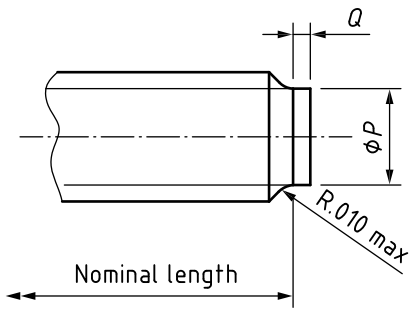
*COMMENTARY ON **11.3***

This option extends the screw length longer than its stated length. If supplied unrequested, this might result in bottoming out issues in blind holes, etc.

Screws shall only be supplied with a plain cylindrical extension if specifically requested by a purchaser.

This option shall be configured as shown in Figure 4 and the dimensions shall be as given in Table 5.

Figure 4 **Unified thread identifier option 2 (plain cylindrical extension)**



Key

Q Protrusion

øP Diameter

Table 5 **Unified thread identifier option 2**

Nominal size of screw	Plain cylindrical extension	
	Diameter	Protrusion
	øP	***Q***
No. 4-40 UNC	.050	.030
	.035	.020
No. 6-32 UNC	.065	.030
	.045	.020
No. 8-32 UNC	.085	.040
	.065	.030
No. 10-32 UNF	.105	.040
	.085	.030

12 Length of screws

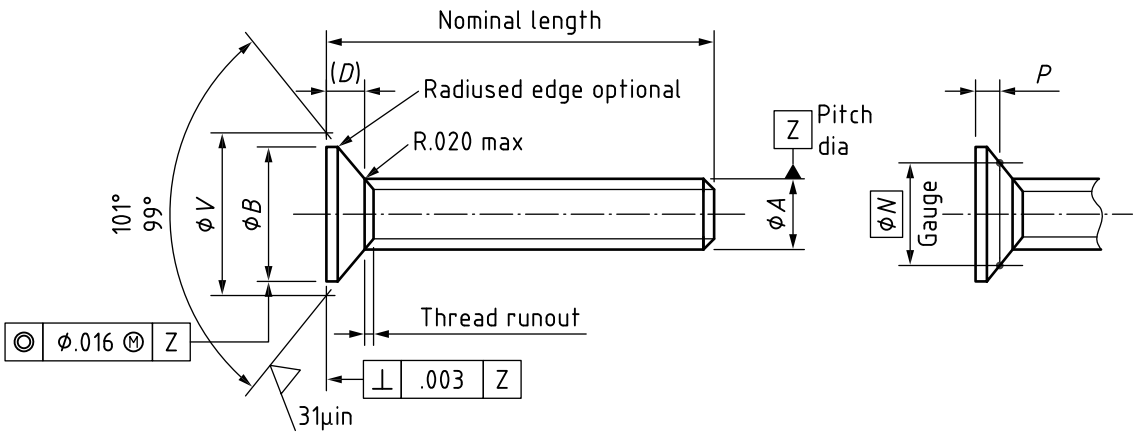
*COMMENTARY ON **CLAUSE 12***

The range of lengths for each given thread diameter, with length code are shown in Table 9.

12.1 100° Countersunk head screws

The nominal length of countersunk head screws shall be the distance from the upper surface of the head to the end of the shank, including any chamfer or radius, but excluding the plain cylindrical extension of the shank which may be used as an identification of the unified thread (see Figure 5 and Table 6).

Figure 5 **Dimensions of countersunk head screws**



Key

See Table 6.

Table 6 **Dimensions of countersunk head screws**

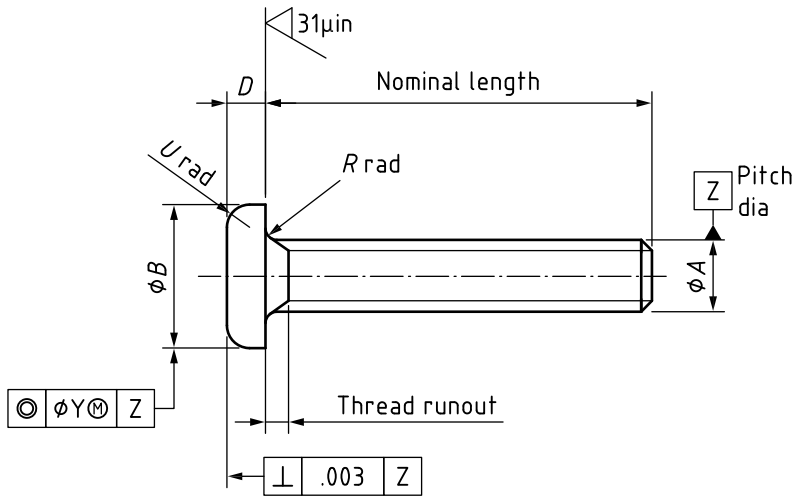
1	2	3	4	5	6	7	8	9
Nominal size of screw	**Basic shank diameter**	**Thread runout**	**Diameter of head**		**Head depth**	**Head protrusion gauging**		**Flushness tolerance for *P***
	øA	**2-pitches**	***øV*** [A]	***øB*** [A]	***D* ref** [A]	***øN*** [A]	***P*** [A]	***(F)*** [A]
	ref	max	ref	–	max	basic	nom	–
No. 0-80 UNF [B]	.060	.025	.121	.110 .102	.026	.0744	.0196	±.002
No. 2-56 UNC [B]	.086	.036	.174	.158	.038	.1209	.0223	±.0025
No. 2-64 UNF [B]		.031		.148				
No. 4-40 UNC	.112	.050	.227	.206 .191	.049	.174	.0222	±.003
No. 6-32 UNC	.138	.063	.281	.255 .238	.061	.2208	.0253	±.0035
No. 8-32 UNC	.164	.063	.334	.303 .285	.073	.2669	.0282	±.004
No. 10-32 UNF	.190	.063	.387	.351 .333	.084	.3145	.0304	±.004

[A] The countersunk head is described in Annex C, with recommended methods of measuring it in Annex D.
[B] Theses thread sizes are not available in any corrosion resisting steel option (except austenitic) or aluminium alloy.

12.2 Pan head screws

The nominal length of pan head screws shall be the distance from the underside of the head to the end of the shank, including any chamfer or radius, but excluding the plain cylindrical extension of the shank which may be used as an identification of the unified thread (see Figure 6 and Table 7).

Figure 6 **Dimensions of pan head screws**



Key

See Table 7.

Table 7 **Dimensions of pan head screws**

1	2	3	4	5	6	7	8
Nominal size of screw	**Basic shank diameter**	**Thread runout**	**Diameter of head**	**Thickness of head**	**Radius of head**	**Radius under head**	**Head OD concentricity tolerance**
	øA	**2-pitches**	***øB***	***D***	***U***	***R***	***Y***
	ref	max	–	–	nom	–	–
No. 0-80 UNF [A)]	.060	.025	.116 .104	.039 .031	.020	.006 max	.0025
No. 2-56 UNC [A)]	.086	.036	.167	.053	.035	.010	.003
No. 2-64 UNF [A)]		.031	.155	.045		max	
No. 4-40 UNC	.112	.050	.219 .205	.068 .058	.042	.015 .005	.004
No. 6-32 UNC	.138	.063	.270 .256	.082 .072	.046	.015 .005	.005
No. 8-32 UNC	.164	.063	.322 .306	.096 .085	.052	.020 .010	.0055
No. 10-32 UNF	.190	.063	.373 .357	.110 .099	.061	.020 .010	.007

[A)] These thread sizes are not available in any corrosion resisting steel option (except austenitic) or aluminium alloy.

12.3 Tolerance on length

The permissible tolerance on the nominal length of screws shall be in accordance with Table 8.

Table 8 **Tolerance on length**

Nominal length	Tolerance
Up to and including ½	0 –.020
Over ½	0 –.031 (1/32)

13 Screw threads

All screw threads in all sizes and all materials listed shall be rolled after any final heat-treatment (to achieve full material strength), but prior to applying any protective finish.

The screw threads shall have the thread form and pitches specified in BS 1580-3 and shall conform to Class 2A limits.

The screw threads shall have a surface finish of or better than 31µin (0,8µm) in accordance with BS 1134.

NOTE Any dry film lubricant when specified in Table 2, may be applied over the whole screw, not just the threads.

14 Ends of screws

14.1 As rolled thread ends

*COMMENTARY ON **14.1***

*When screws are made with rolled threads, the lead formed at the end of the screw by the thread-rolling operation can be regarded as providing the necessary chamfer to the end and no other machining operation is necessary, unless the purchaser has specified that the ends are to be machined finished as described in **14.2**.*

The manufacturer may supply rolled thread screws with cleaned-up machine cut ends independent of a purchaser's order request.

When a thread is rolled, the first few turns (thread pitches) might not be the full thread form height. These are termed the Lead threads and act as a lead-in chamfer. The first turn of the roller also tends to throw the metal out the end face slightly, giving distortion. The original screw blank end face is termed the Low point and the thrown out distortion is deemed the High point. This is all permitted within the limitations shown in Figure 7a).

The nominal length shall be measured to the high point described above [see Figure 7a)].

14.2 Machine cut ends

The ends of screws at the option of the manufacturer or the purchaser shall be finished either with:

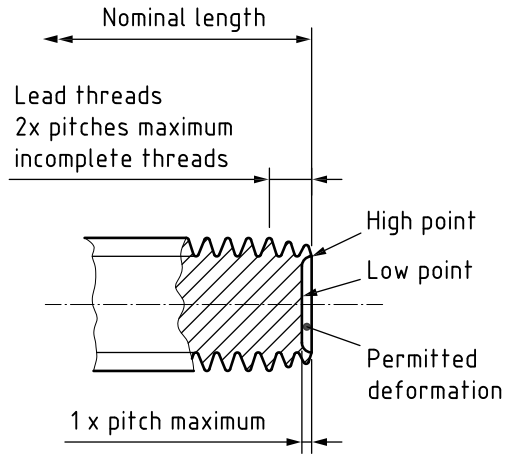
a) a chamfer with a 90° included angle to a depth slightly exceeding the depth of thread [see Figure 7b)]; or

b) a convex radius approximately equal to 1¼ times the nominal diameter of the shank [see Figure 7c)].

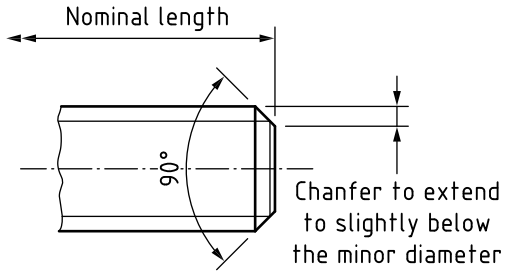
NOTE 1 For convenience, only one type of end is illustrated in the full views of each screw type, see Figure 5 and Figure 6. The alternative types of end permissible are shown in Figure 7.

NOTE 2 Screws may also have the additional unified thread identification option plain cylindrical extension (see Figure 4).

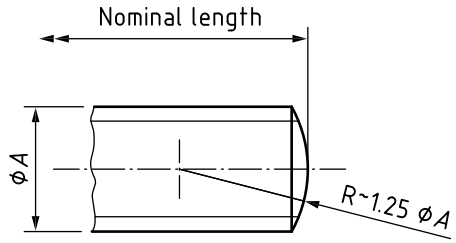
Figure 7 **Types of end permissible on screws**



a) Rolled thread end (approx. form as rolled)



b) Cut chamfered end



c) Cut radiused end

15 Length of thread

15.1 100° Countersunk head screws

Countersunk head screws shall be threaded as far as possible up to the head. The length of unthreaded shank under the head (thread runout) shall not exceed 2 × thread pitch and shall be taken to be the distance from the leading face of a standard nut or ring gauge without countersink, which has been screwed on as far as possible by hand (without undue force) to the intersection point of the basic major diameter and the countersunk portion of the head (see Figure 5).

15.2 Pan head screws

Pan head screws shall be threaded to leave a length of unthreaded shank under the head (thread runout) not exceeding 2 × thread pitch. The length of unthreaded shank shall be taken to be the distance from the leading face of a standard nut or ring gauge without countersink, which has been screwed on as far as possible by hand (without undue force) to the underside of the head (see Figure 6).

16 Designation

The screws shall be designated with part numbers for ordering purposes by the relevant British Standard identifier (see Table 2) suffixed with the appropriate thread size and length code (see Table 9).

NOTE For example, a 100° countersunk head with default option 1 unified thread identifier, in aluminium alloy, ½ inch long No. 6-32 UNC screw is A407B16.

Any requirement for the option 2 unified thread identifier feature over the default option 1 (see Clause **11**), shall be obtained if specifically requested by the purchaser by adding a suffix "E" (for extension) to the part no. designation e.g. A407B16E.

Table 9 **Nominal length and part number codes**

Length (inches)		Nominal size of screw						
		No. 0-80 UNF	No. 2-56 UNC	No. 2-64 UNF	No. 4-40 UNC	No. 6-32 UNC	No. 8-32 UNC	No. 10-32 UNF
3/32	(.09375)	Y3	–	–	–	–	–	–
1/8	(.125)	Y4	ZC4	Z4	A4 [A)]	B4 [A)]	–	–
5/32	(.15625)	Y5	ZC5	Z5	–	–	–	–
3/16	(.1875)	Y6	ZC6	Z6	A6	B6 [A)]	C6 [A)]	D6 [A)]
7/32	(.21875)	Y7	ZC7	Z7	–	–	–	–
1/4	(.250)	Y8	ZC8	Z8	A8	B8	C8	D8
5/16	(.3125)	Y10	ZC10	Z10	A10	B10	C10	D10
3/8	(.375)	Y12	ZC12	Z12	A12	B12	C12	D12
7/16	(.4375)	–	ZC14	Z14	A14	B14	C14	D14
1/2	(.500)	–	ZC16	Z16	A16	B16	C16	D16
9/16	(.5625)	–	ZC18	Z18	A18	B18	–	–
5/8	(.625)	–	ZC20	Z20	A20	B20	C20	D20
3/4	(.750)	–	ZC24	Z24	A24	B24	C24	D24
7/8	(.875)	–	ZC28	Z28	A28	B28	C28	D28
1	(1.000)	–	ZC32	Z32	A32	B32	C32	D32
1 1/8	(1.125)	–	–	–	A36	B36	C36	D36
1 1/4	(1.250)	–	–	–	A40	B40	C40	D40
1 3/8	(1.375)	–	–	–	A44	B44	C44	D44
1 1/2	(1.500)	–	–	–	A48	B48	C48	D48

[A)] Only applicable to pan head screws because nominal length is not possible (too short) for countersunk head screws.

17 Identification and marking

17.1 Each package or box of screws shall have the complete BS part number designation (e.g. A401B16) and batch identification number or code clearly shown on each label. The unified thread symbol of three contiguous circles **OOO** shall also be clearly marked.

17.2 No. 8-32 UNC screws shall have the manufacturer's identification symbol applied to the upper surface of the head.

17.3 No. 10-32 UNF screws shall have the numerical digits of the basic BS identifier (e.g. "401" from BS A 401) and the manufacturer's identification symbol applied to the upper surface of the head.

17.4 All screws manufactured from high temperature/high expansion CRES steel shall be marked with an "X" applied to the upper surface of the head.

17.5 The method of marking the screw heads shall be selected from one of the following:

a) Using controlled pressure die stamping using a character marking die of a rounded tip form. The depth of impression shall be kept to a minimum consistent with legibility and not greater than .010 inch deep.

b) Integrally produced by the forging/heading tool with characters of a rounded tip form. The depth of impression shall be kept to a minimum consistent with legibility and not greater than .010 inch deep.

c) i) Microprocessor "controlled dot peen" with a spherical indenting stylus of .005 inch diameter.

ii) An indentation depth of .001 inch to .002 inch for steels with a hardness less than 54 HRC.

iii) An indentation depth of not greater than .003 inch for aluminium and brass.

17.6 All markings shall be applied to the screws prior to applying any required protective finish.

17.7 Screws of No. 4-40 UNC nominal size and larger shall be identified as having unified threads (see Clause **11**).

17.8 Aluminium screws shall be identified by colour dyeing of the anodize finish (see the protective finish column in Table 2).

Annex A (informative)

Screw equivalency quick reference guide

Table A.1 guides the designer who intends to update equipment designs to select the nearest new recess equivalent.

Table A.1 **Recess screw comparison to slotted screw equivalent**

This standard recess screw part no.	Slotted screw spec no.	Remarks
A401-A420	**A204-A221**	
A401	A204	Equivalent
A411	A217	Equivalent
A402	A204	Similar but using zinc-nickel plating with a dry film lubricant as an alternative to cadmium plating
A412	A217	Similar but using zinc-nickel plating with a dry film lubricant as an alternative to cadmium plating
A403	N/A	New material version
A413	N/A	New material version
A404	A206	Equivalent
A414	A218	Equivalent
A405	N/A	New material version
A415	N/A	New material version
A406	N/A	New material version
A416	N/A	New material version
A407	A208	Equivalent but only has sulphuric acid anodize option. Chromic acid now omitted.
A417	A219	Equivalent but only has sulphuric acid anodize option. Chromic acid now omitted.
A408	A220	Equivalent
A418	A221	Equivalent

NOTE Table A.1 is included for a designer's reference use only. It is not the intention for the recess screws to be alternative parts to the slotted screws used in existing designs without the express permission of the original equipment's Design Authority.

Annex B (informative)

Conversion tables

Table B.1 is a quick reference size comparison list.

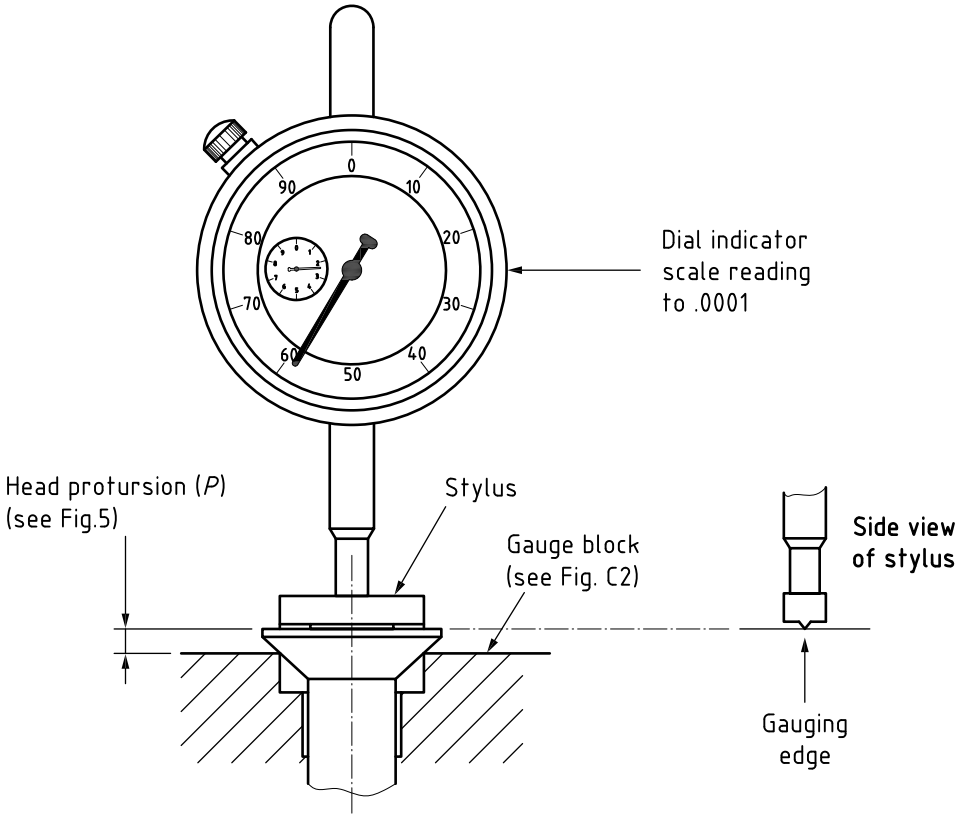
Table B.1 **Shank gauge and inch decimal to millimetre equivalents of basic diameters of screws**

Screw sizes (shank gauge)	**Basic diameters** inch	**Equivalents** mm
No. 0	.060	1,52
No. 2	.086	2,18
No. 4	.112	2,84
No. 6	.138	3,51
No. 8	.164	4,17
No.10	.190	4,83

Annex C (informative) Measuring inspection criteria for countersunk heads

C.1 Figure C.1 shows the typical equipment needed to measure screw head protrusion in the simple gauge block.

Figure C.1 **Method of measuring head protrusion of countersunk head screws**



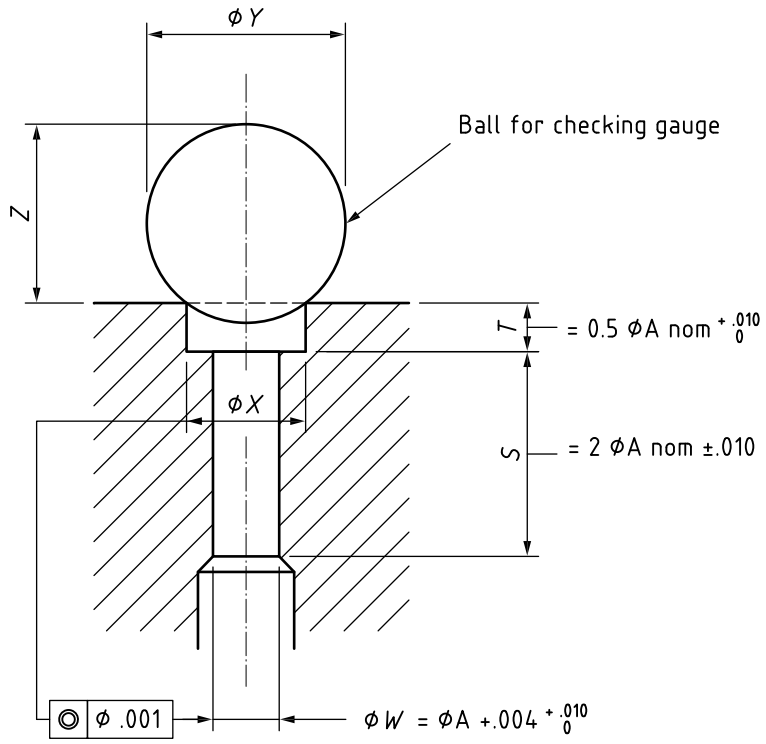
NOTE 1 Figure C.1 is based upon BS A 273:1978, Figure 1.

NOTE 2 The gauging practice described in BS A 273:1978 should be followed, but with the deviations as described in this British Standard to suit the smaller diameter of the thread sizes and to allow the use of the standard gauge blocks described in AIA NAS9800 Rev.3 Table II Fastener Type B. BS A 273 and AIA NAS9800 differ in that BS A 273 has a very small land around the rim of the counterbore which makes the screw head gauge diameter øN (see Figure D.1) slightly larger than the gauge block's counterbore diameter øX (see Figure C.2), whereas AIA NAS9800 has both diameters the same size. This British Standard adopts the AIA NAS9800 method.

NOTE 3 Gauging edge of stylus and top surface of gauge block should be parallel within .0001. Indicator should be perpendicular to the gauge block.

C.2 Figure C.2 shows the form and sizing of the gauge block to enable its manufacture and also shows how to check for any subsequent wear around the ball seating rim. See Table C.1 for its sizes.

Figure C.2 **Typical gauge block for 100° countersunk head screws**



Key

T	Depth of counterbore	ø*W*	Diameter of guide
S	Length of guide	ø*X*	Counterbore diameter
ø*Y*	Ball diameter	*Z*	Ball protrusion

NOTE 1 Figure C.2 is based upon BS A 273:1978, Figure 2. Gauge blocks configured to AIA NAS9800 Rev.3 Fig.2 may be used.

NOTE 2 The values stated in Table C.1 below are taken from those shown (≥.112 shank diameter) in AIA NAS9800 Rev.3 Table II Fastener Type B and its Notes 1 and 2. Values for shank diameters .060 and .086 have been calculated using the formulas shown.

Table C.1 **Dimensions of gauge block for 100° countersunk head screws**

1	2		3	4
Basic shank diameter	**Ball diameter**		**Counterbore diameter**	**Ball protrusion**
øA	***øY*** [A)]		***øX*** [B)]	***Z*** [C)]
ref	+.000025 0		+.0002 0	0 –.002
.060	.12500	(1/8)	.0744	.1127
.086	.18750	(3/16)	.1209	.1654
.112	.28125	(9/32)	.1740	.2511
.138	.34375	(11/32)	.2208	.3036
.164	.40625	(13/32)	.2669	.3563
.190	.50000	(1/2)	.3145	.4444

A) Ball diameter ø*Y* is derived from formula ø*X* × 1.5557 and then selecting the nearest standard ball size within ±.015 inch of the calculated value.

B) Counterbore ø*X* is the same size as ø*N* basic gauge diameter of screw head found listed in Table 6.

C) Ball protrusion *Z* is derived from formula:

$$Z = R + \sqrt{R^2 - (\text{ø}X/2)^2}$$

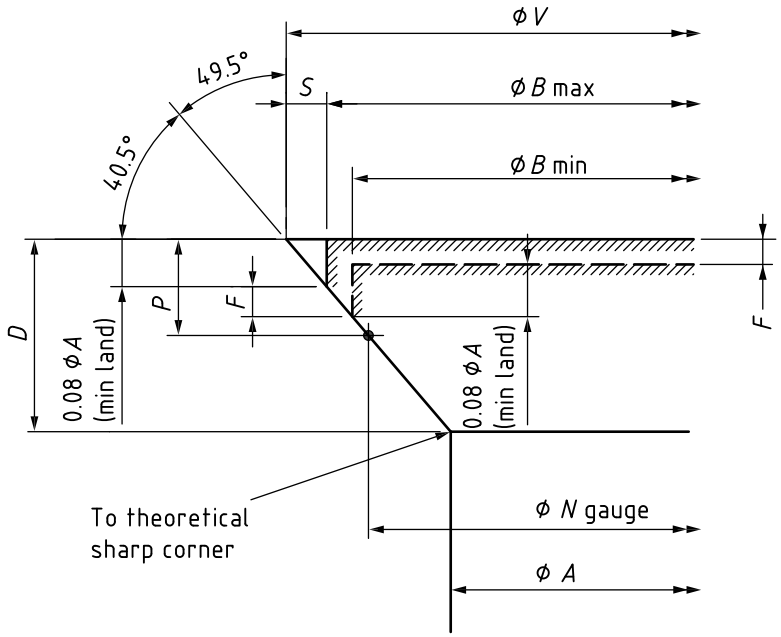
where: *R* is ø*Y*/2.

Annex D (informative)

Derivation of design of the countersunk head

D.1 Figure D.1 shows the nature of how countersunk heads are derived for use of this British Standard. It is in line with modern inspection methods.

Figure D.1 **Formulae for dimensions for countersunk head screws**



Key
Refer to descriptions below.

For design reference, the countersink head is derived from these formulas:

ø*V* nom	is 2.048 ø*A* – 0.0019
ø*B* min	is 1.82 ø*A* – 0.013
ø*B* max	is ø*V* nom – 2*S*
ø*N* gauge	is 1.79 ø*A* – 0.033
F	is 0.5 (ø*B* max – ø*B* min) × tan 40.5°
D max	is 0.5 (ø*V* nom – ø*A*) ÷ tan 49.5°

Where:

ø*A*	is shank nominal diameter.
ø*V*	is theoretical head diameter to sharp edge.
ø*B*	is actual head diameter as produced with ø*V*'s sharp edge removed.
S	is removed land width between ø*V* nominal and ø*B* maximum.
D	is head height, now represented in Table 6 as a reference size because height should now be inspected using the head protrusion *P* gauging method.
F	is flushness range, represented in Table 6 as a tolerance of the head protrusion *P* to suit new head gauging method. Its values

have been taken directly from BS 3A 204 [2)] where it is stated as Flushness tolerance *F* max e.g. .004 max for screw size No. 0-80 UNF is now ±.002.

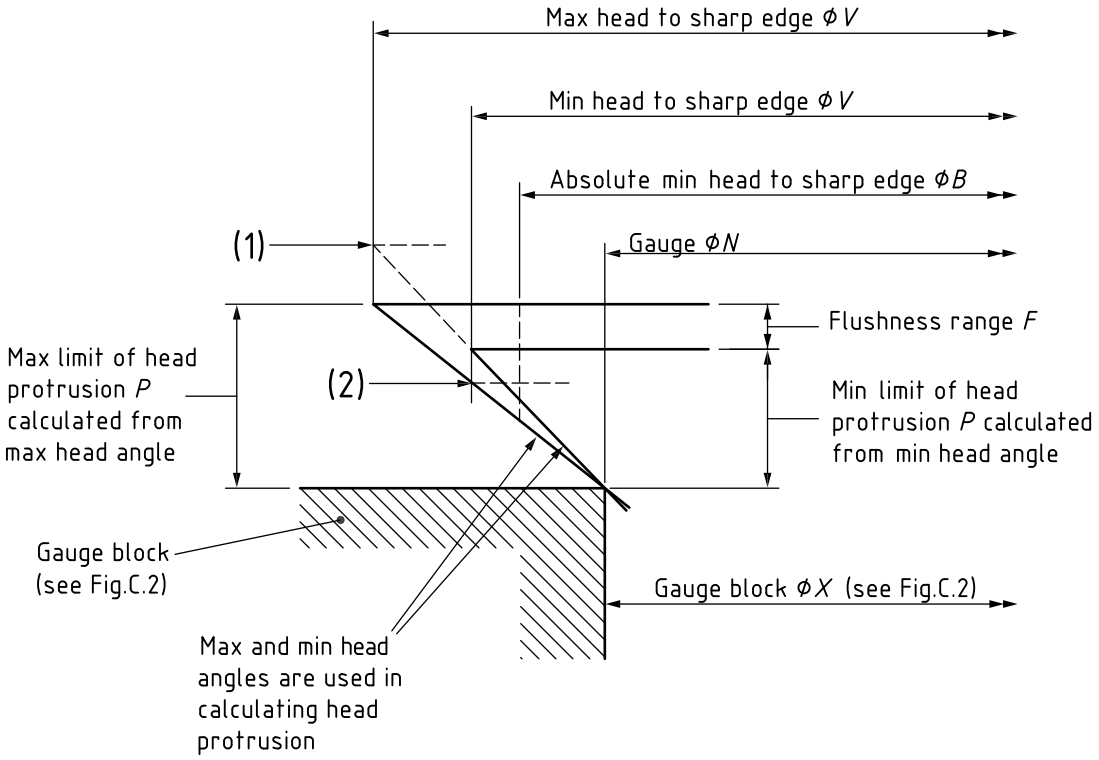
øN is gauge diameter to allow the use of standard gauge blocks configured to AIA NAS9800 Rev.3 Fig.2 (see Figure D.2), then the sizes stated in AIA NAS9800 Rev.3 Table II Fastener Type B for said specifications *øA* have been used directly. For the two non-stated sizes, i.e. for .060 inch and .086 inch shank diameters, *øN* has been calculated using the formula listed above which originates from ASME B18.6.3:2013, Appendix-C (Formulas for Dimensions) Table C-3 (100° Flat Countersunk Head Screws) gaging diameters G = 1.79D – 0.033.

P is head protrusion. The head heights (*D*) of British and US outline 100° countersunk head screws are not the same, so dimension *P* differs from one to the other. *P* is normally positioned approximately 1/2*D* from the screw's top face on US screws (see AIA NAS9800 Rev.3, **5.1.6**) and 1/3*D* on British screws (see BS A 273:1978, **3.5**). Due to this specification using the British head outline, but adopting the US head gauging sizes, then *P* has had to be specially calculated based upon the known gauge diameter *øN* of the US specification. *P* nominal was calculated simply by drawing the basic geometry in CAD using *øV*ref, *øN* basic and nominal countersink angle (100°), then measuring the distance *P*.

[2)] BS 3A 204 was under review at the time of this publication.

D.2 Figure D.2 shows the head's outer face flushness and is an aid to designers to help ensure the screw heads seat as expected in their design of mounting holes.

Figure D.2 **Absolute max and min head conditions of countersunk head screws**



NOTE 1 Figure D.2 is based upon BS A 273:1978, Figure 3.

NOTE 2 The limits on head protrusion do not permit the extreme limits on diameter to sharp edge and on head angle show at points (1) and (2) to occur in one and the same head. This is because the application of these countersunk heads demand a high degree of flushness.

(1) Indicates the maximum head protrusion obtainable with the minimum head angle.

(2) Indicates the minimum head protrusion obtainable with the maximum head angle.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS A 204 – BS A 221, *Specifications for machine screws and nuts (Unified threads) below ¼ inch for aeronautical purposes*

BS A 273:1978, *Specification for gauging practice for 100° countersunk head fasteners for flushness control*

BS EN ISO 10664, *Hexalobular internal driving feature for bolts and screws*

Industry standards publications

SAE ITC RS440, Sheet 2, *Identification of unified nuts, bolts & screws*

ASD-STAN TR 4070, *Molybdenum disulphide coatings – List of commercial products*

AIA NAS1800, *Recess, six lobe drive, internal, dimensions for recess and gages*

AIA NAS9800 Rev.3, *Head protrusion gaging, 100° flush head fasteners, gage block, gage diameter and stylus*

ASME B18.6.3:2013, *Machine screws, tapping screws and metallic drive screws (Inch series)*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™