

BRITISH STANDARD A.101:1969+A3:2012

**AEROSPACE SERIES
METRIC AND INCH UNITS**

**GENERAL REQUIREMENTS
FOR
TITANIUM BOLTS**

BRITISH STANDARDS INSTITUTION

BRITISH STANDARD : AEROSPACE SERIES
SPECIFICATION FOR
GENERAL REQUIREMENTS FOR
TITANIUM BOLTS

FOREWORD

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 June 1969. Amendment No.3 came into effect on 30 September 2012. It was prepared by Technical Committee ACE/12, *Aerospace fasteners and fastenings*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS A 101:1969+A3:2012 supersedes BS A 101:1969, incorporating Amendments Nos. 1 and 2, which is withdrawn.

Information about this document

The start and finish of text introduced or altered by Amendment No.3:2012 is indicated in the text by tags $\boxed{A3}$ and $\boxed{A3}$. Minor editorial changes are not tagged. Changes from Amendments Nos.1 and 2 are not shown.

This British Standard is intended for use in conjunction with those 'A' series British Standard Aerospace specifications in which conformity to this standard is a specific requirement.

It may also be applicable to other aerospace threaded fasteners if required by the relevant specification, drawing, contract or order, and is a companion to British Standard A.100, 'General requirements for bolts and nuts of tensile strength not exceeding 125 hbar (180 000 lbf/in²)'.

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.

The standard makes reference to the following specifications:

British Standard:

British Standard A.4. Test pieces and test methods for metallic materials for aircraft.

British Standard TA.28. Titanium-aluminium-vanadium forging stock.

$\boxed{A3}$ BS 350. Conversion factors for units $\boxed{A3}$.

BS 1134. Centre-line-average height method for the assessment of surface texture.

$\boxed{A3}$ BS 6001-1. Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.

Quality management systems - Requirements for aviation, space and defense organizations.

BS EN ISO 3452-4. Non-destructive testing – Penetrant testing – Part 4: Equipment.

BS EN ISO 7083. Technical drawings – Symbols for geometrical tolerancing – Proportions and dimensions.

BS ISO 80000-1. Quantities and units – Part 1: General $\boxed{A3}$.

BS ISO 80000-1: BS EN ISO 9000:2005. Quality management systems - Fundamentals and vocabulary.

$\boxed{A3}$ References deleted. $\boxed{A3}$

$\boxed{A3}$ Footnotes deleted. $\boxed{A3}$

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SPECIFICATION

1. GENERAL

1.1 SCOPE

This British Standard specifies the general requirements for metric and inch aerospace bolts manufactured from titanium alloys.

The requirements related to nominal size are presented in individual tables for use as appropriate to the relevant bolt specification. The values tabulated for metric and inch bolts have a proportional relationship and are not direct conversions.

NOTE. Information concerning SI (metric) units is given in BS 350, and  BS ISO 80000-1 .

1.2 MATERIAL

1.2.1 The bolts shall be manufactured from the material specified in the relevant bolt specification.

1.2.2 Bolts may be rejected at any time for faults in or revealed by manufacture although they have been made from material which previously complied with the relevant material specification.

1.3 MANUFACTURE

1.3.1 The heads of bolts shall be formed by hot forging before heat treatment. Driving recesses and the lightening hole of the double hexagon design may be machined or forged.

1.3.1.1 The heating equipment for hot forging shall be approved by the Inspecting Authority and shall be of a type which ensures a consistent temperature throughout the batch of that part of the material being worked. This temperature shall be automatically controlled.

1.3.2 The forged blanks shall be heat-treated in accordance with the material specification to produce the properties required by the relevant bolt specification and this specification (2.7). No blank shall be subjected to the specified heat treatment more than three times.

1.3.3 The headed and heat-treated blanks shall have the shank and bearing surface of the head wet ground. The amount of metal removed shall be as little as is practicable, consistent with the production of a clean smooth surface, the maintenance of optimum grain flow around the underhead radii as specified in 2.6.2.1 and the removal of surface contamination as specified in 2.6.2.4.

1.3.4 Threads shall be formed by a single rolling process after final heat treatment.

1.3.5 For sizes No. 10 and above, and M5 and above, the head to shank fillet shall be rolled after final heat treatment. The fillet radius, after rolling, shall conform to that specified in the relevant bolt specification. The fillet area may be distorted as shown in Appendix F. There shall be no machining of the fillet radius after rolling.

1.3.6 All processes of manufacture shall be to the satisfaction of the Inspecting Authority.

1.4 DIMENSIONS

All bolts shall conform to the dimensions and tolerances specified in this standard and the relevant bolt specification. The dimensions shall be controlled in accordance with 2.3.

1.5 RUN-OUT OF SCREW THREADS

The bolts shall have a thread run-out conforming to the requirements given in Appendix G.

1.6 SURFACE TREATMENT

The bolts shall be surface treated in accordance with the relevant bolt specification.

1.7 IDENTIFICATION MARKING

1.7.1 Bolts shall have the manufacturer's identification applied to the upper face of the head.

1.7.2 Bolts of No. 10 or M5 and larger shall have the complete part number (e.g. A000-3-D) applied to the upper face of the head.

1.7.3 Each individual package of bolts shall have the complete part number, batch identification and inspection stamp clearly shown on the label.

1.7.4 The method of marking shall be by raised or depressed characters. The depressed characters shall be not greater than 0.25 mm (0.010 in) in depth and shall be of rounded root form.

1.8 PACKAGING

The bolts shall be packed so as to prevent damage during handling, transportation and storage. Bolts of one batch and part number shall be packed in unit packages. An assortment of unit packages may be in larger packages.

2. INSPECTION PROCEDURE

2.1 GENERAL

 **2.1.1 Quality assurance authority.** The quality assurance system selected shall satisfy the requirements of the quality assurance authority.

NOTE 1. The appropriate quality assurance system for the manufacture of aerospace products is given in BS EN ISO 9000:2005 with BS EN 9100.

NOTE 2. Manufacturers and users are advised that in respect of Civil Aviation Authority (CAA) certification, this is no longer appropriate for the manufacture of standard parts (fasteners).

Manufacturers and users should therefore check with their local CAA office for eligibility. 

2.1.2 Inspection. Inspection shall satisfy the requirements of the appropriate authority by use of the sample procedures specified in 2.2.2 on the finished products, except that by agreement with the local Inspecting Authority properly controlled and recorded interstage inspection may be substituted.

2.1.3 Materials and surface treatments. The manufacturer shall provide evidence to the Inspecting Authority that all materials and surface treatments comply with the relevant specifications, and shall also show that the identity of all materials has been maintained throughout all stages of bolt manufacture.

2.1.4 Records. The manufacturer shall establish a batch record chart (or card) to the satisfaction of the Inspecting Authority. The record shall show the batch quantity and the serial numbers of certificates covering approval of all materials. The results of all inspections and tests made in

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accordance with this standard shall be recorded and correlated with the batch numbers, and the batch record chart (or card) shall show the serial numbers of those records to the satisfaction of the Inspecting Authority.

2.2 ACCEPTANCE OF PRODUCTION BATCHES

2.2.1 Definition of batch. A batch shall consist of finished bolts which are of the same type and diameter, fabricated by the same process from material of the same cast, heat-treated as one lot and processed and produced as one continuous run, free from any interruptions or changes such as, in the opinion of the Inspecting Authority, might be expected to result in a significant variation in the quality of the finished product.

2.2.2 Sampling. Except where 100% inspection is specified, random samples shall be taken from each batch in accordance with 2.2.3 for dimensional and non-destructive inspection, and with Appendices A and D for destructive inspection.

2.2.3 Samples for dimensional and non-destructive inspection. Samples for dimensional and non-destructive inspection shall be taken from each batch in accordance with BS 6001-1, at inspection levels shown in Table 1. The acceptance or rejection shall depend upon the acceptable quality levels (AQL's) applied to the characteristics given in Table 1.

TABLE 1. INSPECTION LEVELS

AQL	Inspection level II	Inspection level S-I
0.065	Penetrant flaw detection	
1.0	Shank diameter Thread size	Plain shank length Underhead radius Squareness Driving geometry Thread run-out
2.5	Protrusion (countersunk heads) Surface texture (visual) Burrs and plating (visual) Identification (visual)	Straightness of shank Concentricity
4.0	Overall length Thread chamfer Other dimensional characteristics	Head height (protruding heads)

2.3 CONTROL OF DIMENSIONS

2.3.1 All dimensions shall be controlled by a system of gauging approved by the Inspecting Authority. The type and quality of all gauges, projection apparatus (including diagrams) and inspecting techniques shall also be to the satisfaction of the Inspecting Authority. In case of dispute fixed limit gauges or optical projection (as appropriate) shall be used for checking dimensions of screw threads.

2.3.2 Each gauge and projection diagram shall be marked with its reference number (serial number) and, in the case of non-adjustable gauges, the gauging dimensions.

Each gauge shall further be certified initially, and thereafter the standard of accuracy of each gauge shall be maintained by regular certification either at an approved gauge test house or, if agreed with the Inspecting Authority, at the manufacturer's own test room. The accuracy of each projection diagram shall be to the satisfaction of the Inspecting Authority.

2.3.3 A record card shall be prepared and maintained, to the satisfaction of the Inspecting Authority, for each gauge, showing the initial dimensions of each gauging element, the frequency of the maintenance checks and the gauge dimensions resulting therefrom.

2.4 SURFACE TEXTURE

The surface texture, determined visually, shall be as specified in Table 2. In cases of dispute measurement shall be made in accordance with BS 1134.

TABLE 2. SURFACE TEXTURE

Feature	Roughness height rating maximum (CLA to BS 1134)	
	µin	µm
Head to shank fillet, thread root, thread sides, and thread run out	16	0.4
Shank and bearing surface of head	32	0.8
Others	125	3.2

2.5 GEOMETRIC TOLERANCES

The tolerances of the bolt's geometric features shall comply with Fig. 1.

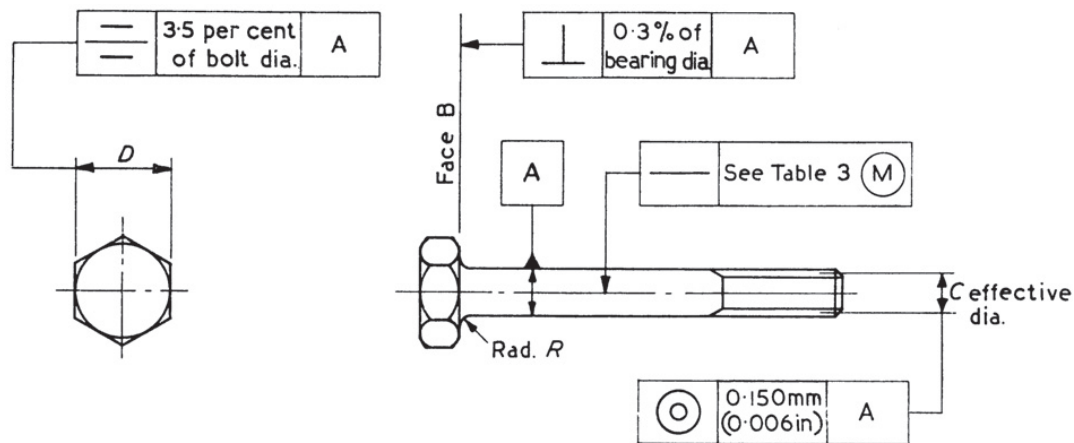


Fig. 1a. Hexagonal head

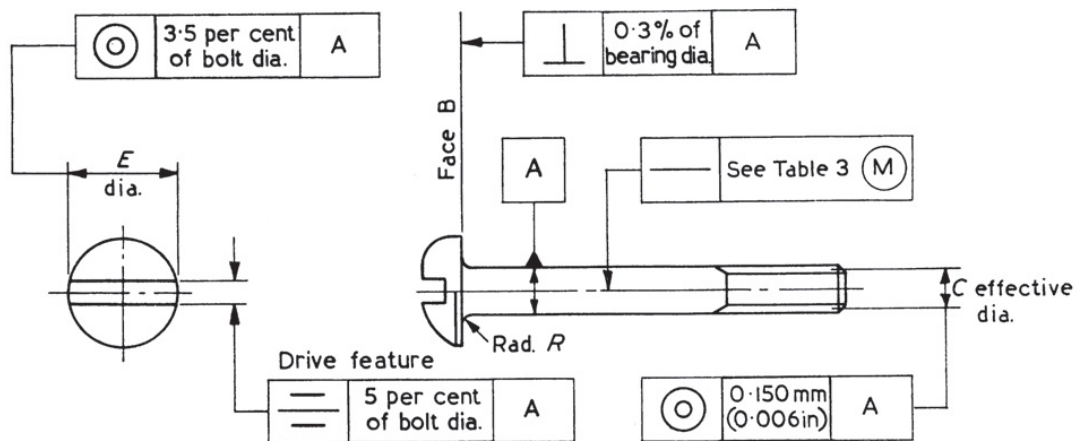


Fig. 1b. Pan head and mushroom head

NOTE 1. Fillet rad. R to blend smoothly with face and shank, subject to the requirements of Appendix F.

NOTE 2. Geometrical tolerances are presented in accordance with BS EN ISO 7083.

NOTE 3. Third angle projection.

Fig. 1 Geometrical tolerances

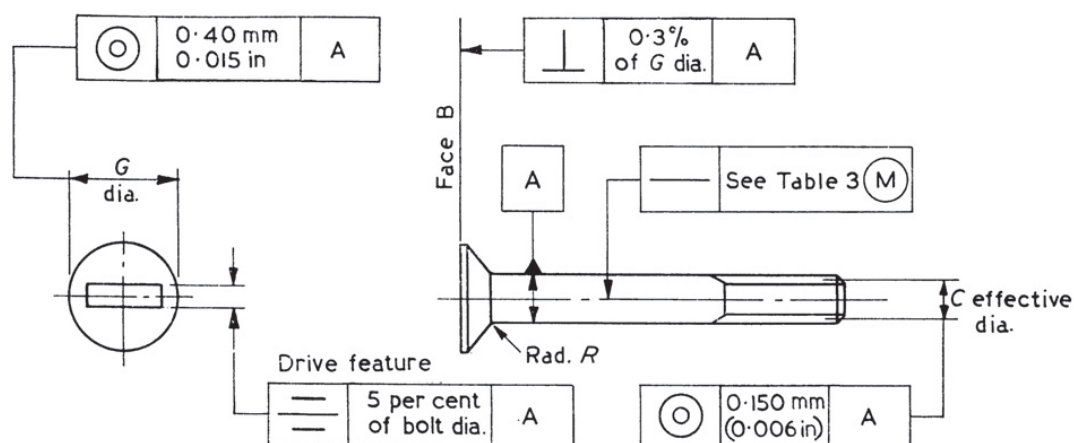


Fig. 1c. Countersunk head

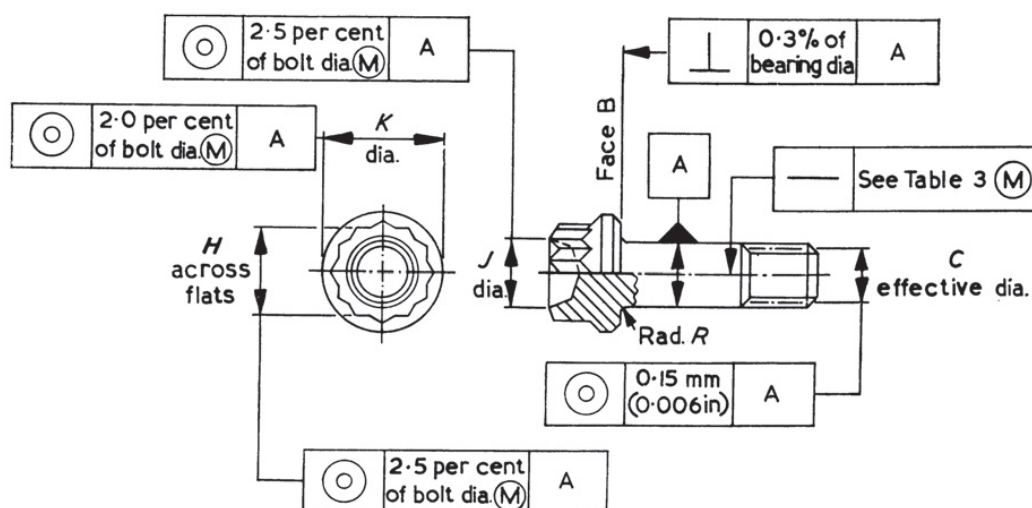


Fig. 1*d*. Double hexagon head

NOTE 1. Fillet rad. R to blend smoothly with face and shank, subject to the requirements of Appendix F.

NOTE 2. Geometrical tolerances are presented in accordance with $\boxed{A_3}$ BS EN ISO 7083 $\boxed{A_3}$.

NOTE 3. Third angle projection.

Fig. 1 Geometrical tolerances (cont'd)