

Specification for

Electrical connectors of assessed quality for d.c. and low frequency application: generic data, methods of test and capability approval procedures

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- Society of British Aerospace Companies Limited*
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Foreword

This revised British Standard, which supersedes BS 9520:1974, has been prepared under the direction of the Electronic Components Standards Committee, and is the generic specification for the low-frequency electrical connectors in the system of standards for electronic components of assessed quality. The revision is necessary in the light of changes in test requirements for low-frequency electrical connectors for electronic equipment. It also includes additional tests for airframe-fit connectors.

It consists of two sections, the first of which prescribes mandatory requirements relating to terminology and definitions, test procedures, inspection procedure and general data. This section shall be used for inspection purposes as and when required by the detail specification.

The second section prescribes general rules necessary for the preparation of detail specifications. This section also covers inspection requirements and certified test records.

This standard calls for the use of substances and/or test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or the user from statutory obligations relating to health and safety at any stage of manufacture or use.

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 viii, pages 1 to 82 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.

Section 1. Principles and mandatory procedures

1.1 General matters

1.1.1 Scope

This British Standard is applicable to connectors intended primarily for use on telecommunication and allied electronic equipment. It gives appropriate terminology and definitions, specifies requirements for general data and test procedures and includes rules for the preparation of detail specifications. Inspection requirements are also specified and reference is made to the preparation and issue of certified test records. Capability approval procedures are included in section 3.

This standard is to be read in conjunction with the relevant standards in the BS 9000 series. All general details and definitions in these standards that are appropriate to this specification apply, unless otherwise stated herein.

1.1.2 Related documents

This British Standard makes reference to the following documents:

- BS 308, *Engineering drawing practice*.
- BS 410, *Specification for test sieves*.
- BS 646, *Cartridge fuse-links (rated at up to 5 amperes) for a.c. and d.c. service*.
- BS 969, *Plain limit gauges. Limits and tolerances*.
- BS 2011, (IEC 68) *Basic environmental testing procedures*¹⁾.
- BS 2045, (ISO/R 3) *Preferred numbers*.
- BS 3763, (ISO/R 1000) *The International System of units (SI)*.
- BS 3939, (IEC 117) *Graphical symbols for electrical power, telecommunications and electronics diagrams*.
- BS 4727, *Glossary of electrotechnical, power, telecommunications, electronics, lighting and colour terms*.
- BS 5310, *Hand crimping tools for the termination of electrical cables and wires for low frequency and radio frequency applications*.
- BS 5775, *Specification for quantities, units and symbols*.
- BS 6001, *Sampling procedures and tables for inspection by attributes*.
- BS 9000, *General requirements for electronic components of assessed quality*.

BS 9521, *Removable contacts of assessed quality for electrical connectors as defined by BS 9520: generic data, methods of test and rules for the preparation of detail specifications*.

BS 3G 100, *General requirements for equipment in aircraft*.

BS G 178, *Crimped joints for aircraft electrical cables and wires*.

BS G 192, *Efglas type electrical cables with copper conductors for aircraft*.

BS G 195, *Minyvin type electrical cables for aircraft*.

BS G 199, *Tables relating pressure to altitudes, airspeeds and Mach numbers for use in aeronautical instrument design and calibration*.

BS G 202, *Design and performance requirements for aircraft electrical plugs and sockets for d.c. and low frequency a.c. applications*.

BS G 210, *PTFE insulated equipment wires (with silver plated copper conductors)*.

BS G 212, *General requirements for aircraft electrical cables*.

BS SP 20, *Panel type airfilter elements for use with internal combustion engines and compressors on aircraft*.

IEC 130-1, *Connectors for frequencies below 3 MHz — Part 1: General requirements and measuring methods*.

IEC 352, *Solderless wrapped connections. General requirements. Test methods and practical guidance*.

NOTE When reference to an IEC Publication or ISO Recommendation is given in parentheses the British Standard is identical in technical content with the IEC Publication or ISO Recommendation except where deviation(s) are indicated in the British Standard.

1.1.3 Terminology

For the purposes of this British Standard the general electrical and telecommunication terms and definitions given in the appropriate Part of BS 4727 apply. In addition the following specific terms and their definitions are applicable to the family of components covered by this generic specification.

The basic terms are interrelated and are used in the order of precedence shown below.

Family. See 5.2 of BS 9000-1:1981.

Type. A basic shape, e.g. circular, rectangular, printed wiring, telephone jack.

Pattern. A design covered by an individual detail specification.

Range. The shell sizes and contact arrangements within a pattern.

¹⁾ Additional tests are included in BS 2011 pending submission to and decision by the appropriate Technical Committee of the International Electrotechnical Commission.

Style. Configurations within a range, e.g. fixed, free, coupler, adaptor, mounting arrangement, etc.

Variant. An individual connector, within a style, having a feature or features different from the standard connector.

Specimen. An individual connector in a sample.

Specific terms and definitions are arranged in groups under the following headings:

- General terms
- Connector accessory terms
- Connector terms
- Contact and termination terms
- Mounting terms
- Tool terms

Preferred terms have been given definitions but non-preferred terms have only a cross reference back to the preferred term.

1.1.3.1 General terms

1.1.3.1.1 characteristic

a quality or feature peculiar to, or inherent in, the design of a connector, e.g. its shape, weight, force required to engage and separate, contact arrangement, contact retention force

1.1.3.1.2 operating temperature, maximum

the maximum internal temperature of connector (comprising ambient temperature plus temperature rise due to load and cable characteristics)

1.1.3.1.3 rating

a limiting value placed on a particular function of the connector at stated conditions

1.1.3.1.4 service life

the period of time for which the connector, accessory, etc. is expected to perform satisfactorily

1.1.3.1.5 voltage, breakdown

the point at which the current increase diverges from linear with linear increase of applied voltage

1.1.3.1.6 voltage proof

a test voltage equivalent to the work voltage multiplied by the safety factor

1.1.3.1.7 working voltage

maximum voltage at which a connector is rated to operate at the stated operating conditions

1.1.3.2 Connector accessory terms

1.1.3.2.1 adaptor

an intermediate device to provide for attachments such as special accessories, special mounting means or special interconnecting means

1.1.3.2.2 accessory

any additional item that does not form part of the basic connector and contact

1.1.3.2.3 boot

a flexible or resilient housing forming an extension to the connector body to protect and support the cable termination; it may be heat shrinkable, and may also be used as a potting form

1.1.3.2.4 cable clamp

a device or accessory attached to the connector body or to a cable outlet to support the cable or wire, provide strain relief, and absorb mechanical stress that would otherwise be transmitted by the cable to the connector terminations

1.1.3.2.5 cable outlet

an accessory consisting of a rigid housing for attachment to the connector body; it may incorporate provision for a cable clamp or seal, or for terminating screens, and may provide shielding against electrical interference

1.1.3.2.6 cable packing sleeve

an accessory for use on all undersize wire to ensure that a seal is achieved

1.1.3.2.7 cover, connector

an accessory to cover the mating end of a connector for mechanical, and/or environmental, protection

1.1.3.2.8 ferrule

an accessory in the form of a short tube to provide cable support or termination for a cable screen

1.1.3.2.9 filler plug

an accessory used to fill unused contact or grommet cavities in a connector

1.1.3.2.10 grommet

an accessory used to support the wires or cable; it may also prevent the ingress of moisture or contaminants

1.1.3.2.11**grommet follower**

an accessory used to contain the grommet

1.1.3.2.12**grommet nut**

an accessory used to retain the grommet and follower

1.1.3.2.13**hood**

see cable outlet (1.1.3.2.5)

1.1.3.2.14**potting mould**

an accessory used as a mould into which potting compound is injected

1.1.3.2.15**outlet nut**

an accessory that secures the cable outlet to the body of the connector

1.1.3.2.16**shield, connector**

see cable outlet (1.1.3.2.5)

1.1.3.2.17**shroud**

an accessory that provides physical protection to otherwise exposed contacts

1.1.3.2.18**strain relief clamp**

see cable clamp (1.1.3.2.4)

1.1.3.2.19**union nut**

an accessory used to retain cable glands or seals on a cable outlet

1.1.3.3 Connector terms**1.1.3.3.1****airframe fit connector**

a connector that forms a termination with airframe wiring

1.1.3.3.2**adaptor connector**

a component to permit electrical connection(s) between two or more connectors where direct connection is mechanically impossible

1.1.3.3.3**barrier seal**

a seal provided between shell and insert, and insert and contacts

1.1.3.3.4**connector**

a device that terminates conductors for the purpose of providing connection and disconnection to a suitable mating component

1.1.3.3.5**connector, board-mounted two-part**

a connector for printed boards. Connection is made between two connectors, either or both of which are mounted on a printed board

1.1.3.3.6**connector body**

the basic part of a connector, e.g. the housing (shell) and insert less contacts, to which accessories may be attached

1.1.3.3.7**connector, butting**

a connector having contacts designed for end face contact only, in which electrical continuity is achieved and maintained by axial force

1.1.3.3.8**connector, circular**

a connector that is basically cylindrical and has a mating face with a basically circular periphery

1.1.3.3.9**connector compatibility**

the requirement that connectors made to a common detail specification by various manufacturers are intermateable, intermountable and interchangeable with each other

1.1.3.3.10**connector, coupler, free**

a connector that mates with a free connector in a cable-to-cable application

1.1.3.3.11**connector, edge socket**

a connector that accepts the edge of a printed board and makes contact directly with printed contact pads

1.1.3.3.12**connector engaging and separating force**

the force required to engage fully or to separate a pair of mating components including the effect of a coupling, locking or similar device

1.1.3.3.13**connector, environment resistant**

a connector provided with means for protection against moisture, temperature or contaminants

1.1.3.3.14**connector, fixed**

a connector for attachment to a rigid surface

1.1.3.3.15**connector, float mount**

a fixed connector with mounting means permitting movement to facilitate alignment with mating connector

1.1.3.3.16**connector, free**

a connector for attachment to a free end of a wire or cable

1.1.3.3.17**connector, hermaphroditic**

a connector that mates with an identical connector

1.1.3.3.18**connector, hermetic**

a connector having hermetic seals between contacts and insert and insert and housing (shell)

1.1.3.3.19**connector, hybrid**

a connector having provision for alternative contact types in discrete positions

1.1.3.3.20**connector, insert**

see insert (1.1.3.3.39)

1.1.3.3.21**connector, moulded body**

a connector that does not have an external shell

1.1.3.3.22**connector, printed board**

see connector, board-mounted two-part (1.1.3.3.5), connector, edge socket (1.1.3.3.11)

1.1.3.3.23**connector, quick disconnect**

see coupling, bayonet (1.1.3.3.31) coupling, push-pull (1.1.3.3.32) and coupling, twist-pull (1.1.3.3.35)

1.1.3.3.24**connector, rack and panel**

one of two mating fixed connectors intended to provide a connection between a unit and its mounting rack and having an alignment device to ensure correct mating; it normally has no coupling device and is mated by the movement between the unit, rack and printed board

1.1.3.3.25**connector, receptacle**

see connector, fixed (1.1.3.3.14)

1.1.3.3.26**connector, rectangular**

a connector that is basically rectangular and has a basically rectangular mating face

1.1.3.3.27**connector, scoop-proof**

a connector incorporating features preventing its contacts, either male or female, from being touched by the front of the mating connector

1.1.3.3.28**connector, single-hole mounting**

a connector mounted through a single hole in a panel, having a shoulder and captivating device

1.1.3.3.29**connector, umbilical**

a connector, used to connect a cable to a vehicle, that is separated automatically before or during the initial movement of the vehicle

1.1.3.3.30**connector, unitor**

a connector that does not have a coupling device as part of its construction and depends for mating and unmating upon either the apparatus to which it is fitted or hand operation. *See also* connector rack and panel 1.1.3.3.24

1.1.3.3.31**coupling, bayonet**

a quick-coupling device for mating connectors that utilizes projections riding in ramps and providing jacking and locking features with limited rotation

1.1.3.3.32**coupling, push-pull**

a quick-coupling device with locking and unlocking features for mating or unmating connectors by axial operation of the coupling ring

1.1.3.3.33**coupling ring**

a rotatable or axially operated device, having a hand grip and normally fitted to a free connector, used in coupling and uncoupling mating connectors

1.1.3.3.34**coupling, threaded**

a means of coupling and uncoupling mating connectors by threads in a coupling ring engaged with threads on a fixed shell

1.1.3.3.35**coupling, twist-pull**

a quick-coupling device with locking and unlocking features for securing mating connectors by rotation of the coupling ring, and releasing by axial operation of the coupling ring (e.g. lanyard release, lever release)

1.1.3.3.36**environmentally sealed**

see connector, environment resistant (1.1.3.3.13)

1.1.3.3.37**guide pin**

a pin or rod, extending beyond the mating face of a connector, designed to guide the coupling or assembly of the connector to ensure proper mating of the contacts

1.1.3.3.38**housing (shell)**

the part of a connector into which the insert and contacts are assembled

1.1.3.3.39**insert**

an insulating element designed to support and position contacts in a connector

1.1.3.3.40**insert arrangement**

see contact arrangement (1.1.3.4.5)

1.1.3.3.41**interface**

the insert surfaces of a pair of connectors that face each other when mated

1.1.3.3.42**interfacial seal**

a seal provided at the interface to prevent the ingress of moisture or contaminants when connectors are mated

1.1.3.3.43**jack screw**

a captive screw used to couple and uncouple mating connectors; it may also provide a polarization facility

1.1.3.3.44**jack, socket connector**

a connector to mate with a jack plug

1.1.3.3.45**jack, plug connector**

a free connector consisting of two or more contacts on a common shank

1.1.3.3.46**key**

a projection that engages with a keyway to provide guidance and alignment

1.1.3.3.47**keyway**

a slot or groove in which a key engages

1.1.3.3.48**orientation**

the angular position of an insert within a circular shell constituting the whole or part of a connector polarization system; identification of the orientation is from a specified datum point on the interface to a specified datum on the shell, such as a major key or keyway

1.1.3.3.49**polarization**

the provision of features to ensure the correct alignment of connectors during mating and to prevent accidental mating of similar connectors

1.1.3.3.50**polarizing pin, key or keyway**

a device or feature incorporated in a connector to accomplish polarization

1.1.3.3.51**potting**

the sealing of the cable end of a connector with a fluid compound that sets to exclude air, moisture and contaminants

1.1.3.3.52**receptacle**

see connector, fixed (1.1.3.3.14)

1.1.3.3.53**shell, connector**

see housing (shell) (1.1.3.3.38)

1.1.3.4 Contact and termination terms

(*see also* BS 9521)

1.1.3.4.1**barrel**

the section of the contact that accommodates the conductor (normally applies to crimped contacts)

1.1.3.4.2**bucket**

see solder bucket (1.1.3.4.33)

1.1.3.4.3**conductor pull-off force**

the tensile force necessary to separate a conductor from a contact or terminal

1.1.3.4.4**contact**

the conductive element in a connector that mates with a corresponding element in another connector to transfer electrical energy

1.1.3.4.5**contact arrangement**

the combination of the spacing, positioning and number of contact locations in a connector

1.1.3.4.6**contact, concentric**

a set of coaxial contacts providing two independent circuits through a single mechanical assembly

1.1.3.4.7**contact, crimp**

a contact having a conductor barrel designed to be mechanically formed around a conductor in order to make a mechanical and an electrical connection to the conductor

1.1.3.4.8**contact engaging and separating force**

the force needed fully to engage or separate a mating pair of contacts

1.1.3.4.9**contact, female**

a contact having an engagement end that will accept entry of a male contact

1.1.3.4.10**contact float**

the permitted free movement of a contact in its insert or insulator

1.1.3.4.11**contact, hermaphroditic**

a contact that mates with another contact of the same design

1.1.3.4.12**contact, inspection hole**

a hole provided in the crimp barrel to permit visual inspection to ensure that the conductor has been inserted to the proper depth before and after crimping

1.1.3.4.13**contact, male**

a contact having an engagement end that makes contact by insertion into the female contact

1.1.3.4.14**contact, plug pin**

see contact, male (1.1.3.4.13)

1.1.3.4.15**contact, resilient**

a contact having split or spring sides

1.1.3.4.16**contact resistance**

the electrical resistance of a pair of mated contacts, the resistance being measured in milli-ohms or in millivolt drop at a specified current at stated points on the cables

1.1.3.4.17**contact, restricted entry**

see restricted entry (1.1.3.4.31)

1.1.3.4.18**contact retainer**

a device, either on the contact or in the insert, to retain the contact in the insert

1.1.3.4.19**contact retention force**

the axial load in either direction that a contact can withstand without being displaced from its intended position within an insert

1.1.3.4.20**contact size number**

an assigned number used to denote the size of the contact, related either to the engagement or wire accommodation end or to both ends

1.1.3.4.21**contact socket**

see contact, female (1.1.3.4.9)

1.1.3.4.22**contact, solder**

a contact incorporating a means of attaching a conductor with solder

1.1.3.4.23**contact, staked**

a contact for individual mounting to a printed wiring board, normally driven through the board and soldered to the printed wiring track

1.1.3.4.24**contact, thermocouple**

a contact employed in thermocouple applications, materials often used being iron, constantan, copper, chromel and alumel

1.1.3.4.25**contact wipe**

the distance of travel by one contact with respect to another during their engagement or separation

1.1.3.4.26**contact, wire wrap**

a contact designed to accept a solderless wrap joint

1.1.3.4.27**crimp**

the mechanical formation of a contact barrel around a conductor to make an electrical connection

1.1.3.4.28**crimp, indent**

joint wherein the forming of the crimp results in a number of local indentations

1.1.3.4.29**crimp, perimeter**

joint wherein the forming of the crimp results in a symmetrical shape, e.g. to a square or a hexagon

1.1.3.4.30**post, wire wrap**

a terminal to accept a solderless wrapped joint

1.1.3.4.31**restricted entry**

a female contact or insert design that prevents the insertion of an oversize male contact or test prod

1.1.3.4.32**socket contact**

see contact, female (1.1.3.4.9)

1.1.3.4.33**solder bucket**

the section of a contact that accommodates the conductor for soldering

1.1.3.4.34**solder eye**

a hole in a terminal or contact termination through which a wire can be inserted prior to being soldered

1.1.3.4.35**solderless connection**

a joint between conductors achieved by mechanical pressure without the use of solder or any method requiring heat, e.g. crimp joint, wrap, joint

1.1.3.4.36**solderless wrap joint**

a joint achieved solely by wrapping a wire conductor around a post having sharp corners

1.1.3.4.37**wire wrap**

see solderless wrap joint (1.1.3.4.36)

1.1.3.5 Mounting terms**1.1.3.5.1****front mounted**

the mounting of a connector with its mounting flange on the outside of the panel, chassis, etc

1.1.3.5.2**mounting flange**

a projection from a connector for the purpose of attaching the connector to a panel, chassis, etc

1.1.3.5.3**mounting jam nut**

see connector, single-hole mounting (1.1.3.3.28)

1.1.3.5.4**mounting, single-hole**

see connector, single-hole mounting (1.1.3.3.28)

1.1.3.5.5**panel cut-out**

a hole, or number of holes, cut in a panel for the purpose of mounting connectors

1.1.3.5.6**panel seal**

a seal provided between a connector and panel

1.1.3.5.7**rear mounted**

the mounting of a connector with its mounting flange on the inside of the panel, chassis, etc

1.1.3.6 Tool terms**1.1.3.6.1****crimping tool**

mechanism used in crimping

1.1.3.6.2**extraction tool**

a device for removing removable contacts from a connector

1.1.3.6.3**insertion tool**

a device used to insert contacts into a connector

1.1.3.6.4**removal tool**

see extraction tool (1.1.3.6.2)

1.1.3.6.5**sizing gauge**

a gauge simulating a maximum size male contact or a minimum size female contact

1.1.4 Letter symbols, signs and abbreviations

The letter symbols, signs and abbreviations employed in all standards and documents applicable to electronic components covered by this specification shall be in conformity with BS 5775 or shall be derived in accordance with the principles of that standard.

1.1.5 Graphical symbols

The graphical symbols employed in all standards and documents applicable to electronic components covered by this specification shall be in conformity with BS 3939 or shall be derived in accordance with the principles of that standard.

1.1.6 Marking of the component and package

As far as practicable the following particulars shall be legibly and durably marked on each connector in the following order of importance;

- a) the manufacturer's factory identification code;
- b) the date code (see clause 22 of BS 9000-1:1981);
- c) the individual reference number.

The above and following particulars shall be marked on the packaging²⁾ of the connector:

- d) BSI number of the detail specification;
- e) any additional marking as required in the relevant detail specification.

1.1.7 Eligibility for approval

The primary stage of manufacture is defined as the first process subsequent to the manufacture of finished piece parts and sub-assemblies.

A sub-assembly is defined as the permanent assembly of two or more piece parts.

The subsequent process of surface finishing if applicable, may be sub-contracted under the terms of 3.2 of BS 9000-5:1989.

²⁾ Where a transparent package is used the information may be marked on a label that can be read without opening the package.

Eligibility for approval is to be granted only to manufacturers approved in accordance with BS 9000 and BS 9520.

For the purposes of this standard all processes subsequent to the manufacture of finished piece parts and sub-assemblies shall be subjected to direct surveillance by the chief inspector/quality manager.

1.1.8 Structurally similar components

In the case of connectors with common design features it will usually be possible, for qualification sampling inspection and test purposes, to regard them as structurally similar in this respect. This will permit a reduction in the number of specimens but may be subject to the requirement that any inspection or test sequence shall include at least one specimen of each component which that sequence is intended to cover. In such cases the manufacturer shall state the ground on which structural similarity is claimed.

1.1.9 Delayed delivery

Connectors held for a period exceeding 36 months, or for the period stated in the detail specification, following acceptance inspection shall be re-examined for group A inspection, excluding subgroup A5.

1.1.10 Supplementary procedures for qualification approval

The requirements of section 2 of BS 9000-1:1981 shall apply except as prescribed in the detail specification.

1.1.10.1 Procedure in the event of failure at group C or group D inspection. See 20.11 of BS 9000-1:1981.

1.1.10.2 Release before completion of group B tests. When the conditions for reduced inspection described in BS 6001 have been satisfied for all applicable group B tests, the manufacturer is permitted to release components before the completion of such tests.

1.1.11 Certified test records

Certified test records (CTRs) shall be prepared by the manufacturer for full assessment level connectors. They are not required for the basic assessment level. Certified test records shall be printed in the form shown in Appendix C to BS 9000-1:1981.

When the relevant detail specification requires that attributes information shall be recorded, the total number of rejected connectors shall be recorded without reference to the parameter for which the rejection was made. Certified test records are not required for the capability approval procedures (see section 3).

1.1.12 Standard ratings and characteristics

1.1.12.1 General. Ratings and characteristics should wherever possible be taken from the preferred lists given in 1.1.12.2 to 1.1.12.5. If additional items are included in a detail specification the values and conditions under which they apply shall be stated. Any interdependence or ratings and characteristics and any limiting conditions of use shall be stated.

1.1.12.2 Electrical ratings

a) *Standard current ratings.* The current ratings should be selected from the R 10 series of BS 2045.

b) *Standard voltage ratings.* The values of the voltages are d.c. or a.c. peak:

30, 50, 120, 250, 350, 500, 700, 1 000, 1 600, 2 500, 4 000, 6 300, 10 000, 16 000 and 25 000 V.

1.1.12.3 Environmental ratings

a) *Preferred environmental categories.*

Connectors are grouped into the following preferred classifications according to their ability to withstand extremes of temperature and humidity. This system of climatic classification is fully described in BS 2011:

65/260/56

65/200/56

65/155/56

55/155/56

55/125/56

55/085/56

25/085/21

10/070/04

b) *Preferred severities for environmental tests.*

These should be selected from the following list:

- | | |
|-----------------|--|
| 1) Bump | Test Eb (BS 2011-2.1Eb),
390 m/s ² (40g _n);
4 000 ± 10 bumps. |
| 2) Vibration | Test Fc (BS 2011-2.1Fc),
Procedure A frequency
range 10 Hz to 500 Hz
or 10 Hz to 2 000 Hz. Vibration
amplitude 0.75 mm
or 98 m/s ² (10g _n), duration 6 h
or 30 h continuous monitoring. |
| 3) Acceleration | Test Ga (BS 2011-2.1Ga),
98 m/s ² (10g _n), 196 m/s ²
(20g _n), 490 m/s ² (50g _n),
980 m/s ² (100g _n). |

4) Shock Test Ea (BS 2011-2.1Ea),
294 m/s² (30g_n), 490 m/s²
(50g_n), 981 m/s² (100g_n).

5) Low air pressure Test M (BS 2011-2.1M).
44 mbar or 300 mbar.

c) *Preferred proof voltage ratings*

Connector rating	Proof voltage
≤ 1 kV	3 <i>E</i>
> 1 kV	1.5 <i>E</i> (with a minimum of 3 kV)

where *E* is the working voltage (d.c. or a.c. peak)

1.1.12.4 Endurance ratings

a) *Mechanical*. The number of operations should be selected from the following:

10, 50, 250, 300, 500, 1 000 or 1 500

b) *High temperature*. The temperature level shall preferably be selected from the following:

70, 85, 125, 155, 200, 260, or 350 °C

c) *Duration*. The duration shall preferably be selected from the following:

16, 50, 250, 500, 1 000 or 2 000 h

1.1.12.5 Electrical characteristics

a) *Standard minimum values of insulation resistance*. These shall preferably be selected from the following:

10, 30, 50, 100, 500, 1 000, 5 000, 10 000,
50 000 or 100 000 MΩ

b) *Standard maximum values of resistance for contacts and shells*. These shall preferably be selected from the following:

2, 5, 10, 15, 25 or 200 mΩ

c) *Limits of change in resistance*. These shall preferably be selected from the following:

2,5 or 10 mΩ

1.1.13 Unchecked parameters

The manufacturer may quote parameters additional to those given in the detail specification, and may include suitable checks on these in his quality conformance (QC) procedures. These parameters, however, will not be checked by the National Supervising Inspectorate (NSI) and cannot be guaranteed by the authority.

1.2 Test procedures

1.2.1 Measurement conditions

1.2.1.1 General conditions. Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in clause 5 of BS 2011-1.1:1980.

For the subsequent recovery periods, specimens shall remain mated or unmated as they were during the conditioning cycle(s). Where measurements are to be completed within a specified period specimens measured early and failing to meet the requirements may be measured again before the expiry of the period.

NOTE To avoid damage to contacting surfaces of contacts the use of sharp probes should be avoided.

Where tests are specified for individual contacts they shall be applied to all contacts of specimens having up to and including six contacts. For specimens having seven or more contacts a minimum of six test contacts shall be selected in accordance with the details, if any, given in the relevant test clause. When the specimen includes more than one size of contact those selected shall include specimens of each size, approximately in proportion to the total number of each size. Tests involving successive measurements shall be made on the same contacts throughout the series. This directive does not apply to the tests for fireproofness in which every contact shall be included.

Where an approved mating component is specified for engagement with the component under test, the dimensions of the mating component shall conform to the requirements of the appropriate drawings. When testing edge socket connectors for printed circuit boards a mating set shall consist of a connector and board (or gauge).

Unless otherwise specified, tests on connectors shall be performed with all contacts fitted.

Before commencing tests on connectors the manufacturer shall show that the combinations of crimp barrel, conductor and crimping tool to be used for the tests conform to BS G 178 or to the appropriate specified standard.

Where cable is used for test purposes this should preferably have PTFE extruded insulation, in order that the true performance of the connector can be measured without possible weaknesses of the cable lowering connector performance.

1.2.1.2 Airframe connectors: wiring of specimens, classes S, H and N only (for classes K and U see detail specification). A proportion of the contacts in each specimen shall be wired with special leads (measurement leads) intended to facilitate the accurate determination of contact resistance. Such leads shall be prepared in strict accordance with the requirements of **M.1.1** to **M.1.10**, using the type and size of cable given in **M.2**.

The specimens shall be divided into three approximately equal groups (A, B, C) which, after the requisite contacts have been wired with measurements leads, shall be wired as follows:

Group A. All remaining contacts shall be wired with cable as near as possible to the largest diameter and gauge that can be accommodated, respectively, by the grommet seals and by the contact buckets.

Group B. All remaining contacts shall be wired with cable as near as possible to the minimum diameter and wire gauge that can be accommodated, respectively, by the grommet seals and by the contact buckets.

Group C. Approximately 25 % of the contacts shall be unwired and their grommet aperture shall be sealed with filler plugs. The remaining contacts shall be wired as for group A.

The cables to be used are specified in Appendix M. Requirements shall be adhered to strictly, unless prior sanction is obtained from the NSI for the use of different cables and/or measurement leads. In such a case, care should be exercised to ensure that the type(s) of cables selected have a smooth, exterior finish. The type(s) shall be declared by the manufacturer of the connectors.

Where there are more than six contacts of the same rating contained in the connector the number tested shall not be less than six. These shall be selected from these having the least nominal spacing between each other, or the least nominal spacing between the contacts and the metal housing.

Not less than 500 mm of the appropriate type of cable shall be used for each contact. During “conditioning” the test circuit connections to the measurement leads shall be made outside any chamber(s) used so as to avoid the risk that the characteristics of the leads might impair the environmental resistance of the connector.

1.2.1.3 Order of tests. The tests specified in **1.2.2** to **1.2.6** have been listed under the headings of electrical, mechanical, environmental and endurance for convenience of reference. It is not intended that they shall be applied in the order listed, but as shown in **2.2** and the relevant detail specification.

1.2.2 Visual examination

The specimens shall be examined visually, using a device having a magnification of two to four diameters, for:

- a) workmanship and finish, which shall be satisfactory;
- b) marking, which shall be in accordance with the requirements of **1.1.6**;
- c) permanence of marking (not easily removed by rubbing with fingers);
- d) mechanical damage, movement or displacement of parts such as would impair operation.

1.2.3 Dimensioning and gauging procedures

1.2.3.1 Dimensions, outline. Dimensions shall be checked and shall comply with the outline drawings in the detail specification.

1.2.3.2 Dimensions, detail and materials. The piece parts prescribed in the detail specification shall be checked and shall comply with the relevant manufacturing drawings. Measured dimension shall be recorded.

1.2.3.3 Gauging procedure

1.2.3.3.1 Mechanical compatibility gauging. Where compatibility gauges are prescribed on the control drawings the relevant specimens shall accept the gauges.

1.2.3.3.2 Mechanical compatibility compliance. The specimens shall be checked for compliance with the control drawings (by gauge or projection method). However, when approved piece-part gauges and assembly jigs are used in production, and it has been demonstrated on the “D” tests that compatibility gauging (**1.2.3.3.1**) is satisfactory and by agreement with the NSI, this test may be omitted.

1.2.3.3.3 Polarizing gauging. The specific gauge or the appropriate approved mating specimen shall be used. The polarizing feature shall engage and ensure correct mating.

1.2.3.3.4 Orientation gauging. This test is applicable only to ranges of connectors that include orientation variants. Attempts shall be made to mate the specimens in all combination of different orientations using the appropriate force or torque, or by hand as prescribed in the detail specification. It shall not be possible to start the coupling device or mate the specimen, except where mating is intended.

1.2.4 Electrical test procedures

1.2.4.1 Mounting. Where mounting is specified for electrical tests, unless otherwise specified in the detail specification, a metal plate shall be used. The dimensions of the plate shall be such that the contour of the specimens is exceeded. The thickness and panel cut-out shall be within the limits specified for fixed connectors.

1.2.4.2 Contact resistance. Contacts shall be selected in accordance with the requirements of 1.2.1. Measurements shall be carried out with d.c. or a.c. The measuring apparatus shall be such as to ensure an accuracy of $\pm 10\%$. For a.c. measurements, the frequency shall not exceed 2 kHz. In the case of dispute the d.c. measurement shall govern. The contact resistance shall normally be derived from the voltage drop measured between the points intended for connection of the wiring to the contacts or as specified in the relevant detail specification. The contact shall neither be made nor broken while measuring voltage is applied.

When required by the detail specification, leads as shown in Appendix M shall be used (mandatory for airframe-fit).

Where the termination end of the contact is not directly accessible the conductor resistance of the cable or wire used shall be measured and taken into consideration in arriving at the contact resistance³⁾.

When measured with d.c. one measuring cycle consists of:

- switching the controlled current in one direction;
- measurement of the voltage drop;
- switching the controlled current in the opposite direction;
- measurement of the voltage drop;
- switching off.

The results will then be determined by averaging the two measurements.

NOTE 1 Unless otherwise specified, the made contact(s) shall not be disturbed between the end of the preceding test and the application of the voltage in this test, nor between successive cycles.

When measuring with a.c. one measuring cycle consists of:

- switching on the controlled current;
- measurement of the voltage drop;
- switching off.

Where more than one cycle is required by the detail specification they shall be carried out in immediate succession.

NOTE 2 For printed wiring board connectors see the detail specification for details of the contact resistance gauge and contact (a pair consists of contact and gauge).

For contacts designed for use in the microvolt range, modifications of the measuring method and/or special requirements may be specified in the detail specification.

a) *Light current.* Contact resistance shall be measured with an r.m.s. alternating or direct current not exceeding 50 mA. During the measurements the open circuit e.m.f. of the source shall not exceed 20 mV d.c. or a.c. peak.

The contact resistance shall be not greater than that specified for each mating pair of contacts.

b) *Rated current.* On individual contacts the contact resistance shall be measured with the rated r.m.s. alternating or direct current specified in the detail specification. During the measurements the open circuit e.m.f. of the source shall not exceed 2.5 V d.c. or a.c. peak. The contact resistance shall be not greater than that specified for each mating pair of contacts.

When this contact resistance test is prescribed the following details shall be given in the detail specification:

- 1) the points on each of the two mating terminations at which the voltage drop shall be measured;
- 2) for mated pairs, the number of contacts to be measured and the number of measuring cycles, if more than one;
- 3) maximum value of current and maximum e.m.f. of the source;
- 4) maximum limit of contact resistance;
- 5) any necessary gauges.

1.2.4.3 Housing (shell) electrical continuity.

Connectors having metallic housing intended to provide electrical continuity when mated shall be tested as follows.

a) Measurements shall be made on mated connectors using equipment as prescribed for a) of 1.2.4.2 (contact resistance, light current).

³⁾ Ambient temperature variations should be considered.

- b) Connectors shall be fitted with braid or housing (shell) connecting wire in accordance with manufacturer's instructions.
- c) For free connectors the measuring equipment shall be connected to the braid or shell connecting wire as close to the cable entry as possible.
- d) The resistance shall be measured:
 - 1) between the measuring points in c) of mated free connectors;
 - 2) between the measuring point in c) of the free connector and the mounting plate adjacent to the fixed connector;
 - 3) between the mounting panels, if both connectors are fixed.
- e) The resistance shall not be greater than that prescribed in the detail specification.
- f) The original finish on the metallic housing shall remain intact, i.e. unbroken.

1.2.4.4 Insulation resistance. Connectors shall be mounted in accordance with 1.2.4.1.

The insulation resistance shall be measured with a d.c. voltage of either 100 ± 20 V or 500 ± 50 V using method A or B that follow, as required in the detail specification.

The insulation resistance shall be measured after an electrification time of 1 min, or earlier if a stable reading is achieved. In case of dispute the reading taken at the 1 min period shall govern.

NOTE On connectors having closely spaced contacts the wires or cable cores may be held away from each other to avoid possible spurious readings.

For printed board edge connectors the insulating test board or gauge shall be cleaned or removed prior to measurement.

Method A. The contacts to be tested shall be selected in accordance with the requirements of 1.2.1 and connected to suitable insulated wire. The insulation resistance shall be measured on unmated connectors using the specified test voltage applied for 1 min in turn between each contact being tested and all others connected together and to the shell and/or mounting plate.

The insulation resistance shall be not less than that specified in the detail specification.

Method B. All contacts shall be tested. Alternate contacts shall be connected together to form two groups.

The insulation resistance shall be measured on unmated connectors using the specified test voltage applied for 1 min between:

- a) the first group of contacts and the second group connected to the shell/mounting plate;
- b) the second group of contacts and the first group connected to the shell/mounting plate.

The insulation resistance shall be not less than that specified in the detail specification.

When this insulation resistance test is prescribed the following details shall be given in the detail specification:

- 1) value of the test voltage;
- 2) test method (A or B);
- 3) minimum value of the insulation resistance.

1.2.4.5 Voltage proof. The voltage prescribed in the detail specification shall normally be applied to mated connectors as prescribed below. Additionally the detail specification may require tests to be done on unmated connectors.

Connectors shall be mounted as specified in 1.2.4.

The connector shall be subjected to the d.c. or a.c. peak voltage applied at a rate not exceeding 500 V per second using method A or B that follow, as specified in the detail specification. Where an alternating current is used it shall have a frequency of 40 Hz to 65 Hz and be approximately sinusoidal in wave form.

Method A. Contacts shall be selected in accordance with the requirements of 1.2.1. The connector shall be subjected to the proof voltage as specified in the detail specification. The period of electrification shall be 1 min, or as otherwise specified. The voltage shall be applied between each contact in turn and the shell and/or mounting plate, all other contacts being connected together and to the shell and/or mounting plate. When using this method for acceptance testing the period of electrification shall be 5 s.

There shall be no breakdown or flashover. Leakage current, where specified, shall be not greater than the maximum specified.

Method B. All contacts shall be tested. Alternate contacts shall be connected together to form two groups.

The connector shall be subjected to the proof voltage as specified in the detail specification. The period of electrification shall be 1 min, or as otherwise specified. The voltage shall be applied between:

- a) the first group of contacts and the second group connected to the shell/mounting plate;
- b) the second group of contacts and the first group connected to the shell/mounting plate.

There shall be no breakdown or flashover. Leakage current, where specified, shall not be exceeded.

NOTE For safety it is recommended that the power dissipated should be limited to 1 W.

When this voltage proof test is prescribed the following details shall be given in the detail specification:

- 1) value or proof voltage;
- 2) whether mated or unmated connectors⁴⁾;
- 3) test method (A or B);
- 4) period of electrification, if different from 1 min.

1.2.4.6 Current overload. Connectors shall be mated for this test. Select one contact pair fitted with measurement leads in each mated pair of connectors.

The following initial measurements shall then be made:

- a) *Insulation resistance as in 1.2.4.4, method A* (500 + 50 V). The initial value shall be in accordance with the detail specification.
- b) *Contact resistance as in a) of 1.2.4.2.* The initial value shall be in accordance with the detail specification.

A direct current as specified in the following table shall then be applied for duration of 0.35 s (+ 0.05 s, – 0 s), at the end of which the connectors and cables shall be allowed to return to ambient temperature (between 15 °C and 35 °C).

Contact size	Current
	A
22	100
20	180
16	380
12	900

This procedure shall be repeated eight times, and at the conclusion of the ninth cycle the following final measurements shall be made:

- a) *Insulation resistance as in 1.2.4.4, method A* (500 + 50 V). The after-conditioning value shall be in accordance with the detail specification.
- b) *Contact resistance as in a) of 1.2.4.2.* The after-conditioning value shall be in accordance with the detail specification.

For recommended connector test rig see Appendix N. See also **20.5** of BS 9000-1:1981.

1.2.4.7 Shielding effectiveness. In preparation.

1.2.4.8 Current switching. A total of six mated contact pairs selected at random shall be tested. The free connector shall be board mounted with the three parallel resistive and capacitive loads connected as shown in Appendix S. The fixed mating connector is board/panel mounted and wired as applicable. The load current for each load is supplied via a pair of contacts using 3 m of 0.4 mm twisted pair as supply leads.

The connector shall be subjected to the specified number of switching operations at the prescribed rate and speed for each of the specified current ratings in sequence.

1.2.5 Mechanical test procedures

1.2.5.1 General. For test involving shock or vibration conditions fixed connectors shall be mounted in their normal manner on to plates or jigs of such strength or rigidity that the specimens will experience the full force of the test conditions.

Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as defined in clause **5** of BS 2011-1.1:1980.

1.2.5.2 Mass. The mass of the specimen shall be measured and shall be within the limits stated in the detail specification. The heaviest specimen in each connector style or size only need be measured.

1.2.5.3 Engaging and separating force, connector. Fixed connectors shall be mounted in the normal manner, or alternatively the normal method of mounting may be simulated.

Mating pairs (or the connector and the specified gauge) shall be fully engaged and separated in the normal manner. The force for engaging and separating shall be measured and shall be within the limits specified. Where the force limit is not specified, engaging and separating shall be achieved by hand or by special tools as prescribed in the detail specification.

1.2.5.4 Contact retention (in insert). This test is applicable to unwired contacts unsupported by accessories. Not more than two contacts in the connector shall be tested, unless otherwise specified. The test contacts shall be as widely separated as possible, with one in or near the centre of the connector.

The force as specified shall be applied for at least 10 s along the axes of the contacts being tested in both directions consecutively. The force shall be increased steadily, at a rate of approximately 4.5 N/s up to the specified value. There shall be no permanent displacement of the contact in relation to its insert, unless otherwise specified, and no damage or loosening of parts.

⁴⁾ Where unmated connectors are prescribed, only those having protruding contact elements need be tested.

When this contact retention test is prescribed the following details shall be given in the detail specification:

- a) number of contacts to be tested (if more than two);
- b) maximum axial displacement.

1.2.5.5 Insert retention in housing (shell) axial.

Cable fittings and accessories shall not be fitted.

WARNING. Where the force is applied by air pressure there is the danger of contacts and/or inserts being ejected at high velocity.

An axial force (or pressure) as specified shall be applied to the insert in both directions consecutively. The force (or pressure) shall be increased steadily up to the specified value, and maintained for 1 min. The connector shall be visually examined; there shall be no damage, movement or displacement of the insert from its original position in the shell.

1.2.5.6 Insert retention in housing (shell) torsional.

This test is applicable only to removable-type contact connectors. Cable fittings and accessories shall not be fitted.

With the shell of connector securely clamped, a torque as specified shall be applied to the insert by a suitable test fixture. The torque shall be applied steadily at a rate of approximately 0.50 N m/s, up to the specified value. There shall be no rotation of the insert such as to cause permanent displacement of the insert from its original position in the shell.

The connector shall be visually examined; there shall be no damage, movement or displacement of parts such as would impair operation.

When this insert retention in housing (shell) torsional test is prescribed the following detail shall be given in the detail specification:

torque value.

1.2.5.7 Mechanical impact (free connectors only).

A length of the prescribed cable or wiring equal to the specified drop height plus 600 mm shall be assembled in the normal manner to the connector. The free end of the cable shall be secured at the drop height. The connector shall be held with the cable fully extended horizontally and allowed to fall freely from the drop height on to a steel plate of 6 mm minimum thickness on a concrete floor. The number of impacts shall be as specified. The drop height shall be 2 m unless otherwise specified. The connectors shall then be subjected to the following tests:

- a) *Visual examination.* The connector shall be visually examined. There shall be no damage to contacts, loosening of parts or other mechanical damage such as would impair operation.

- b) *Engaging and separating.* The connector shall be engaged and separated with a mating connector in the normal manner. Engagement and separation shall be achieved by hand or by special tools as specified.

When this impact test is prescribed the following details shall be given in the detail specification:

- 1) number of impacts;
- 2) drop height if other than 2 m.

1.2.5.8 Cable clamping (for connectors with cable fixing devices)

1.2.5.8.1 General. A suitable length of the specified cable(s) shall be attached to the connector in the normal way except that conductors shall not be joined to the contacts. All cables shall be clamped together and tested as a bunch and every effort should be made to ensure that the load is uniformly distributed over the bunch at the point where the load is applied. The tests specified in 1.2.5.8.2 to 1.2.5.8.5 shall be carried out.

1.2.5.8.2 Resistance to cable rotation. The free end of the cable(s) shall be deflected at an angle of 45° to 50° to the axis of the entry of the connector and rotated. The number of rotations shall be as specified in the detail specification. During the test the cable shall not rotate about its axis.

The specimen shall be visually examined at the junction of the cable and the clamping device. There shall be no damage such as would impair operation.

1.2.5.8.3 Resistance to cable pull tensile. The specified tensile force shall be applied to the free end of the cable parallel to the axis of the cable and cable entry.

The cable shall not be permanently displaced by more than the amount specified in the detail specification. The specimen shall be visually examined at the junction of the cable and the clamping device. There shall be no damage such as would impair operation.

1.2.5.8.4 Resistance to cable bend. The connector shall be clamped and a force applied at right angles to the cable entry axis. The magnitude of the force and the point at which it is applied shall be as prescribed in the detail specification.

The force shall then be removed and the cable brought back to the original position. These operations are considered to be one bend. The number of bends shall be as specified in the detail specification.

The cable shall not be permanently displaced by more than the amount specified in the detail specification. The specimen shall be visually examined; there shall be no damage such as would impair operation.

1.2.5.8.5 Resistance to cable torsion. The connector shall be fixed and a torque shall be applied to the cable. The test shall be repeated with the torque in the opposite sense. The detail specification shall prescribe the torque and the point of application, which shall be expressed as the distance from the cable entry. Dependent upon cable type, the torque figure in the detail specification shall be attained or cable failure shall occur without slip or rotation within the cable. The cable clamping device shall not have moved in relation to the connector body.

The specimen shall be visually examined at the junction of the cable and the clamping device after each application of the torque. There shall be no damage such as would impair operation.

1.2.5.9 Contact holding force (for resilient contacts only). Contacts shall be selected in accordance with the requirements of 1.2.5.4. The contacts shall be sized using the specified sizing gauge and for the number of operations as prescribed in the detail specification. The specimens shall be held with the mating face on the underside so that when the holding gauge is inserted the weight of the gauge shall act vertically downwards in the direction of separation. The specified gauge for contact holding force shall be fully engaged with each contact in turn.

Each contact shall retain the gauge.

1.2.5.10 Probe damage (applicable only to connectors having female contacts). Contacts shall be selected in accordance with the requirements of 1.2.5.4. The test tool and appropriate test prods shall be as specified in the detail specification. The test tool shall be set for the specified bending moment.

The test tool shall have its prod inserted into the contact to the depth specified in the relevant detail specification. The connector shall be held with the axis of the test tool in a horizontal plane. With the test tool in position and remaining unsupported the connector shall be rotated in one direction through 360° about the axis of the contact in 10 s to 15 s. Where more than one test prod is specified the test shall be repeated using each prod in turn.

The same contacts shall then be subjected to the contact holding force test specified in 1.2.5.9, excluding the application of the sizing gauge. Each contact shall retain the gauge.

1.2.5.11 Insert ageing (for removable contact types only). The contacts shall be subjected to the contact retention test described in 1.2.5.4.

The contacts shall be inserted and withdrawn the specified number of times using the tools prescribed in the detail specification. The time interval between the insertions and withdrawals where required shall be as prescribed in the detail specification. Replacement contacts may be used where prescribed in the detail specification. The contacts shall then be resubjected to the contact retention tests of 1.2.5.4.

1.2.5.12 Compass safe distance. Connectors and accessories shall be tested as mated pairs with all contacts fitted but unwired. Specimens shall be subjected to the procedure of BS 3G 100-2.2.

When this compass safe distance test is prescribed the following detail shall be given in the detail specification:

the compass safe distance if other than 125 mm.

1.2.5.13 Static load transverse (fixed connectors only). The connector shall be mounted as specified in 1.2.4.1. A steady force shall be applied to the outer shell of the connector (through an adaptor if necessary) in a direction parallel to the mounting plane. The value of the force and its point of application shall be specified by the relevant detail specification.

There shall be no damage or loosening of parts such as would impair operation.

1.2.5.14 Moulding strength test. Method of test for moulding strength as in Appendix F.

1.2.5.15 Coupling pin strength. This test shall be applied to assembled coupling pins. The housing (shell) of the connector shall be clamped securely and a force as specified in the detail specification applied to the smaller end along the major axis of the coupling pin. The force shall be applied steadily at the rate specified in the detail specification using a suitably shaped test pin.

The specimen shall then be visually examined and there shall be no displacement or loosening of the coupling pin.

1.2.5.16 Grounding contact spring holding force. The specified sizing gauge shall be applied three times to the grounding springs in the connector. The connector is held with the mating face lowermost so that the weight of the gauge acts vertically downwards in the direction of separation. The specified holding force gauge shall be fully engaged with the grounding springs.

The grounding spring shall retain the gauge.

1.2.5.17 Contact dislodgement by cable

nutration (contact walk-out). Replace one contact in each connector with contacts crimped to stranded steel wire of an appropriate size. Mount the unmated specimen in a test fixture as shown in appendix J and suspend a mass of 1.36 kg freely from the steel wire. Rotate the fixture through 360° 100 times at a maximum rate of 20 cycles per minute.

NOTE Only three specimen connectors for each contact size and style need be tested.

On completion, contacts that were subjected to this test shall be replaced by unwired contacts and filler plugs and their cavities shall be exempted from any subsequent testing.

During this test contacts shall not become dislodged from their normal position.

1.2.5.18 Contact gauge location and retention within insert. Applicable test gauges as shown in the relevant detail specification shall be inserted in three random/selected cavities of each connector under test, such that each cavity size is tested.

The remaining cavities shall have wired contacts inserted. The gauge shall be inserted, as if a contact were being inserted, an axial load of 8 N shall be applied to the gauge and the location of the gauge with respect to a rigid surface of the connector shall be measured. The axial load specified in the following table shall be applied to the test gauge in the direction tending to extract the gauge from the connector.

Contact size	Minimum contact retention force N
22	54
20	90
16	112
12	135

The load shall be applied at a rate of approximately 4 N/s, until the specified load has been reached. The displacement of the gauge relative to the connector shall be measured whilst under load after the load has been applied for 10 s minimum.

The relative movement shall not exceed 0.38 mm.

1.2.5.19 Strength of insertion/extraction tools. Support an insertion or extraction tool in a vertical position such that a compressive load may be applied to the tool, the nose of the tool to rest on a rigid level surface. The loads are to be applied in accordance with the following table and the rate of loading should not exceed approximately 1 kg/s.

Tool		Load kg	Load N
22	Insertion	0.5	5
	Extraction	2.0	20
20	Insertion	3.0	29
	Extraction	4.3	42
16	Insertion	3.5	34
	Extraction	12.00	118
12	Insertion	15.00	147
	Extraction	24.00	235

There shall be no permanent deformation, splitting or cracking of the tool.

1.2.5.20 Coupled strength (connectors with locking devices). This test is primarily intended for insulation displacement connectors and cables, to simulate accidental mechanical loads tending to pull the connectors apart and to check electrical continuity under these conditions.

Connectors shall be fully mated with locking devices engaged in the normal manner. A load equal to the maximum withdrawal force plus 60 N shall be applied along the axis of the cable for a period of 10 s. After removal of the load the specimens shall be visually examined.

The specimens shall again be fully mated in the normal manner and a load of 1 N per way shall be applied along the axis of the cable. Whilst in this condition the contact resistance shall be measured.

1.2.5.21 Accessory thread strength. This test is applied to mated connectors. Fixed styles shall be mounted in the normal manner or the normal method of mounting shall be simulated using a rigid panel. A maximum of three panels of each size shall be tested.

Fit specimens of suitable cable accessories and attach a torque spanner as shown in Appendix K. Apply the specified torque to the free mating connector and maintain it for at least 1 min. Repeat the procedure for the fixed connector. Disengage the mating pairs and visually examine the specimens. There shall be no breakage or other damage such as would impair performance.

1.2.5.22 External bending moment. Specimens for this test are to include mated connectors and also free styles mated with stowage housings (shells). A maximum of three specimens only of each shell size shall be tested. Fixed connectors and stowage housings (shells) shall be mounted in the normal manner or the normal method of mounting shall be simulated. A bending moment as specified shall be applied as shown in Appendix L and maintained for at least 1 min.

Disengage the mated pair and visually examine the connectors. There shall be no breakage or other damage such as would impair performance.

1.2.5.23 Insert grommet bonding. The following test shall be applied to one assembly at the commencement of each batch and one other assembly at the conclusion of the same batch. This test shall be carried out under standard atmospheric conditions for testing as specified in clause 5 of BS 2011-1.1:1980.

Select an insert assembly or an insert assembly in its housing (shell) having the largest number of contact cavities for the particular batch. Insert and extract the relevant size wired contact using the prescribed insertion/extraction tool ten times into each of seven contact cavities, using one contact cavity nearest the centre of the insert face, three contact cavities in the mid-centre spaced approximately 120° apart, and three contact cavities on the periphery approximately 120° apart.

Where there are seven contact cavities or less, all contact cavities shall have contacts inserted and extracted. Apply the voltage proof test as in 1.2.2.4 of this standard using the proof voltage prescribed in the relevant connector detail specification. There shall be no failure.

1.2.5.24 Cable flexing. This test is primarily intended for insulation displacement connectors fitted with ribbon or individual cable(s) and cable clamp devices where these are normally supplied.

a) *Ribbon cable.* The ribbon cable shall be flexed along a line at right angles to the connectors to + 90°, back to – 90° and then returned to the normal direction of cable entry. The cable shall be under a constant tension of 0.1 N per way along the axis of the cable.

This shall constitute one cycle. The specimen shall be subjected to 10 cycles.

b) *Individual conductor cables.* For cables having individual conductors the cable shall be flexed in two directions at right angles mutually perpendicular to the cable entry to + 90°, back to – 90° and then returned to the normal direction of cable entry. The cable shall be under a constant tension of 0.1 N per way along the axis of the cable.

This shall constitute one cycle. The specimen shall be subjected to 10 cycles, 5 cycles in each of the two directions.

The above procedure is for conditioning only and is not a complete test method in its own right but forms part of a sequence of tests in a subgroup.

When this cable flexing test is prescribed the following details shall be given in the detail specification;

initial and final tests and the requirements.

1.2.5.25 Male contact protection. Specimens for this test are to include fixed and free connector styles with male contacts fitted. Where applicable, fixed styles shall also include stowage housings (shells). Fixed items shall be mounted normally, or alternatively the normal method of mounting shall be simulated.

The leading edge of the housing (shell) of the connector fitted with female contacts shall be scooped within the frontal opening formed by the housing (shell) of the mating connector fitted with male contacts. The loading edge of both housings (shells) shall remain in contact with each other throughout the test. The fixed or free connector shall not allow the housing (shell) of the mating connector to touch the male contacts.

1.2.5.26 Male contact stability. Three widely spaced male contacts selected at random shall each be replaced in turn by the test gauge or a suitably modified contact as prescribed in the detail specification.

With the test gauge fully inserted and retained, apply the force prescribed in the detail specification for the particular contact size perpendicularly to the gauge at the point shown on the gauge outline drawing (see Appendix O). Establish a measurement datum taken at the engaging end of the gauge.

Reapply the same force in the diametrically opposite direction and measure the total displacement from the datum to the secondary position of the engaging end of the gauge.

The total displacement shall not exceed the amount given in the detail specification.

When this test is prescribed the following details shall be given in the detail specification:

- a) dimensions of test gauges or modified contacts;
- b) test load;
- c) point of load application;
- d) permitted total displacement.

1.2.5.27 Engaging and separating (for twist-pull coupling connectors having lanyard or lever release). Fixed connectors shall be mounted in the normal manner, or alternatively the normal method of mounting may be simulated. Mating pairs shall be fully engaged and the engaging forces shall be measured. These shall be within the limits specified in the detail specification.

With each specimen fully engaged, a tensile force shall be applied to the lanyard or lever along the axis of the mated pair at a constant rate of approximately 5 cm/min until separation occurs. The forces for separation shall be measured and shall be within the limits specified in the detail specification.

A separating force of 5 N is then applied vertically downwards. The maximum displacement under load between the specimen and the mounting plate shall not exceed 0.5 mm.

After separation, the specimens shall be visually examined and there shall be no sign of damage to the connector mouldings or the locking guides.

1.2.5.28 Locking integrity. See Appendix Q.

1.2.5.29 Torsional overload (locking devices). Fixed connectors shall be mounted on a rigid metal plate. The specimen connector pair under test shall be fully mated with the locking devices engaged normally. A maximum overload torque as specified below shall then be applied to the male quarter-turn locking guides or jack screws, as appropriate, for a period of 10 ± 1 s.

	N m
Quarter-turn locking guides	0.2
Jack screws: 2.5 M thread	0.3
1.6 M thread	0.1

There shall be no sign of damage to the connector moulding, locking guides or jack screws such as would impair operation.

1.2.5.30 Misuse of contact insertion/extraction tool. Subject separate groups of five contact cavities to the following procedure. Should a tool become damaged during any of the tests it shall be replaced. Failure of a tool does not constitute a test failure:

a) Insert the extraction tool and apply a force as prescribed in the detail specification. With the force maintained, rotate the tool through 180° . Remove the tool together with the contact.

Reinsert the contact and repeat the above procedure three times on each of the five contact cavities selected. There shall be no damage to the contacts, the insert and the contact retention system.

b) Remove the contact. Reinsert with the insertion tool and apply a force as prescribed in the detail specification. With the force maintained, rotate the tool through 180° . Remove the tool.

Repeat this procedure three times on each of the five contact cavities selected. There shall be no damage to the contacts, the insert and the contact retention system.

c) Remove the contact. Reinsert the contact with the insertion tool and apply a force as prescribed in the detail specification. This procedure shall be carried out once only on each of the five contact cavities selected, and a new tool shall be used for each cavity. There shall be no damage to the contacts, the insert and the contact retention system.

1.2.5.31 Termination torsion. See Appendix S and subclause 1.2.1.1.

1.2.5.32 Guide key retention. See Appendix T.

1.2.5.33 Locking (safety) wire pull out. A suitable length of locking wire of, e.g. nickel copper or nickel chrome alloy, shall be threaded through a safety wire hole in each connector and secured.

NOTE It is suggested that a 0.51 mm diameter wire be used.

A load of 133 N (30 lbf) minimum shall then be applied perpendicular to the axis of the hole. One hole in each component shall be tested.

The locking wire shall not pull out.

1.2.6 Environmental test procedure

1.2.6.1 General. Where tests impose shock or vibration conditions fixed specimens shall be mounted in their normal manner or to plates or jigs of such strength or rigidity that the specimens will experience the true force of the test conditions. Unless otherwise specified, the basic environmental test methods of BS 2011 shall apply and all tests shall be carried out under standard atmosphere conditions for testing as defined in BS 2011. Where specified, connectors shall be mounted in particular attitudes, the attitudes being recorded.

In tests where connectors are subjected to environmental conditions in test chambers, e.g. dry heat, cold, damp heat, low pressure, mould growth, etc. the disposition of the connectors in the test chamber shall be such as to permit free circulation of air so that the connectors do not shield each other from the environment.

NOTE 1.2.6.2, 1.2.6.3, 1.2.6.4 and 1.2.6.5 not applicable to connector, couplers, free (see 1.1.3.3.10).

1.2.6.2 Bump. Unless otherwise specified the connectors shall be mounted on a test jig. A typical test jig is shown in Appendix B. Connectors shall be tested as mated pairs and in a manner such that all mechanical features such as panel mounting arrangements and locking retaining devices are fully utilized.

Unless otherwise specified each connector shall be wired with the appropriate cable or wiring, which shall be secured as illustrated in Appendix B. The connectors shall be subjected to the procedure of test Eb of BS 2011-2.1Eb:1977 using the preferred degree of severity.

During the last two hundred bumps, continuous monitoring of electrical continuity shall be carried out on all contacts and screen, where fitted, connected in series. There shall be no intermittency of current as shown by a change of circuit resistance of $10\,000\ \Omega$ of duration greater than $10\ \mu\text{s}$, unless otherwise prescribed in the detail specification.

When this bump test is prescribed, the following details shall be given in the detail specification:

- a) method of mounting;
- b) axes and direction;
- c) any deviations from preferred conditions.

1.2.6.3 *Vibration*

1.2.6.3.1 *Vibration: general.* The connectors shall be mounted as specified in 1.2.6.2 and shall be subjected to procedure A of test Fc of BS 2011-2.1Fc:1977 using the appropriate degree of severity and at the temperature specified in the relevant detail specification.

During initial resonance search and the last two frequency sweeps continuous monitoring of electrical continuity shall be carried out on all contacts and screen, where fitted, connected in series. There shall be no intermittency of current as shown by a change of circuit resistance of $10\,000\ \Omega$ of duration greater than $10\ \mu\text{s}$, unless otherwise specified in the detail specification.

When this vibration test is prescribed the following details shall be given in the detail specification:

- a) temperature;
- b) method of mounting;
- c) axes and direction;
- d) frequency range;
- e) vibration amplitude;
- f) any deviation from preferred conditions.

1.2.6.3.2 *Vibration: airframe applications*

1.2.6.3.2.1 *Specimens: selection and wiring arrangement.* Specimens for these tests shall include mated pairs and unmated but capped fixed connectors. Fixed connectors shall be secured to the test fixture on the vibration table by their normal mounting arrangement. The test fixture shall be as rigid and symmetrical as possible. The wires from wired specimens shall be secured to the table at points not less than 200 mm from where they emerge from the connectors. The measurement leads of all, or of six engaged contacts, whichever is the lesser, shall be connected in series. The contacts selected shall be the centre contact and others extending radially as widely as possible. A means shall be provided for continuously monitoring the resistance of each series chain by applying 1 A d.c. from an open circuit source not exceeding 2.5 V through the measurement lead screens connected in series, and by measuring the potential across the chain of contacts via the inner conductors connected in series.

NOTE A recommended method of measurement is by the use of a storage oscilloscope connected to the inner conductors. Where more than one chain is being tested the chains may be connected to form one single series chain. In order to simplify detection, the current flowing through the series screen circuit may be increased subject to the open circuit voltage not exceeding 2.5 V and the current not exceeding 5 A.

1.2.6.3.2.2 *Sinusoidal excitation test procedure*

1.2.6.3.2.2.1 Subject the specimens to the following vibration resonance search test.

- a) The vibration table shall be capable of producing a linear vibration of continuously variable frequency and, if possible, amplitude over the range of frequencies and amplitudes specified for the test. Alternatively, a stepped control of amplitude may be used, provided that at all frequencies the amplitude used is greater than that specified in the appropriate curve (see Appendix H). No harmonic shall have an amplitude greater than $0.25/n^2$ of the fundamental, where n is the order of the harmonic.
- b) The specimens shall be vibrated successively in two mutually perpendicular directions.
- c) The specimens shall be checked for resonance over the frequency and amplitude ranges given in Figure 15.