BRITISH STANDARD

BS 7727:1994
Incorporating Amendment No. 1

CONFIRMED
DECEMBER 2007

Code of practice for

Installation and inspection of pre-insulated compression terminals and connectors for cables with copper conductors up to 6 mm^2

ICS 29.120.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cables and Insulation Standards Policy Committee (CIL/-) to Technical Committee CIL/20, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Manufacturers of Domestic Electrical Appliances
BECCAMA (BEAMA Electrical Cable Connector and Accessories Manufacturers' Association)
British Approvals Service for Cables
British Cable Makers' Confederation
British Plastics Federation
British Steel Industry
Department of Trade and Industry (Consumer Safety Unit, CA Division)
Electricity Association
Engineering Equipment and Materials Users' Association
Institution of Electrical Engineers
London Regional Transport

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Electrical Contractors' Association
Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
ERA Technology Ltd.
Institution of Lighting Engineers
London Underground Ltd.
Transmission and Distribution Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 May 1994

The following BSI references relate to the work on this standard:
Committee reference CIL/20
Draft for comment 93/207110 DC

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Amendments issued since publication

Amd. No.	Date	Comments
16445	29 September 2006	See foreword. Also deletion of AWG values from title and Clause **1**

Contents

Foreword

This British Standard has been prepared under the direction of the Cables and Insulation Standards Policy Committee.

BS 7727 is intended to give guidance to manufacturers and contractors who use compression terminals and connectors of the pre-insulated type to enable cables to be terminated using good engineering practice and to provide quality control guidance for the compression tooling.

A similar code of practice for uninsulated connectors is [A1] BS 7609 [A1].

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

The start and finish of text introduced or altered by Amendment No. 1:2006 is indicated in the text by tags [A1] [A1]. Minor editorial changes are not tagged.

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.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

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

1 Scope

This British Standard recommends methods and procedures applicable to installation and inspection of pre-insulated terminals and connectors for use on copper conductors of insulated cables conforming to [A1⟩ BS EN 60228:2005, up to 6 mm^2 cross-sectional area ⟨A1], using hand application tooling.

This standard does not apply to installations which are required to comply with BS 5G 178-1:1993 and BS 4G 178-2:1986.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back hover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1
pre-insulated compression joint

an electrical connection made by compressively forming the insulated barrel of a terminal or connector around one or more conductors

3.2
terminal lug

a connector comprising a palm and a barrel, for connecting a conductor to an equipment terminal

3.3
splice

a device used to permanently connect conductors to each other

NOTE This is also known as a through connector or a closed end connector (see **A.2**)

3.4
disconnect connector

a device used to connect a conductor to another conductor or equipment terminal fitted with a similar connector having mating parts of opposite gender. Such connection or disconnection may only be suitable for a limited number of operations

3.5
barrel

part of a connector designed to accommodate the conductor

3.6
palm

part of a terminal lug formed flat to make a bolted connection to an equipment terminal

3.7
insulation sleeve

cylindrical insulation sleeve surrounding the compression barrel and through which the compressed connection is made. The insulation may be extended to protect the mating part of a connector

3.8
insulation grip sleeve

an optional metal sleeve interposed between the compression barrel and insulation for the purpose of providing a positive retention of the wire insulation within the insulation compression area

3.9
compression sleeve

a metal sleeve often used to improve compression properties of the spring material when using mating disconnect devices

NOTE Such a sleeve may also be extended to provide retention of wire insulation.

4 Marking

Each compression connector and its packaging should be clearly marked with the supplier's identification (Figure 1). Reference should be made to the manufacturer's literature in order to establish wire size ranges which are identified by insulation colour and sometimes also by marking upon the palm.

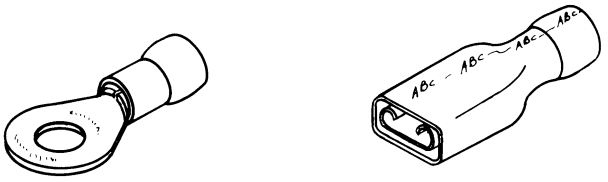


Figure 1 — Example of identification marking

5 Selection of styles

There are various styles of terminals and connectors available; some of these are described in Annex A . If there is any doubt about correct selection, advice should be sought from the supplier or manufacturer.

Insulation entry diameter should be checked to ensure that the selected wire insulation can be accommodated. Flared and straight entry variants are available (Figure 2).

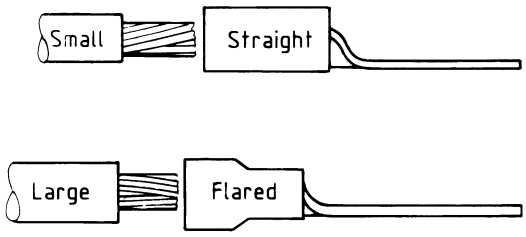


Figure 2 — Examples of styles

6 Compression tools

Advice should be sought from the terminal supplier or manufacturer, if there is any doubt about the correct selection of the tool, cavity in a multicavity tool, or where applicable, dies. Compression tools (Figure 3) should have full closure mechanisms and be designed to compress both the conductor and insulation areas simultaneously, forming the insulation sleeve closely around the wire insulation (see clause **10**).

Locators are available for various terminal types and, as they facilitate precise location during compression, they promote consistently good results. The use of locators is recommended particularly on connectors without brazed seams. The use of simple tools capable only of compressing the conductor and insulation areas in two separate operations, and without locators or full closure mechanisms, is likely to give rise to inconsistent results and is not recommended for production equipment.

Tools should be regularly maintained, tested and where required, certified. Further information on maintenance, testing and certification is given in Annex B .

7 Current rating

Current ratings are dependent upon the conductors in use, the environment and the permitted temperature rise. Correctly designed copper compression terminals and splices, correctly applied to annealed high-conductivity copper conductors will have at least as high current ratings as those conductors. However, with disconnect connectors, which are made from copper alloy, the current ratings are governed by different criteria and advice should be sought from the supplier or manufacturer. For flat blade push-on male/female connectors BS 5057:1992 provides current/temperature ratings.

8 Preparation

Cable should be cut to length and stripped squarely and cleanly without damage to conductors or insulation (Figure 4). There should be no missing conductor strands. Stripped length should allow for protrusion of conductor witness (Figure 5) of approximately 1 mm from the barrel end when fully inserted. Where a conductor stop is provided, the conductor should reach it without there being any inclusion of insulation within the barrel. Care should be taken to ensure that the conductor surface is kept clean. If the conductor surface is tarnished or otherwise contaminated, it may be cleaned, taking care not to damage any strands. Otherwise, it should be shortened sufficiently to reveal clean strands. Chemical cleansing, with substances which may react with the material or plating of either the conductor or the terminal, should not be used.

If the compression tool is fitted with a locator (Figure 6) it should be appropriate to the style of terminal being compressed. If fitted with an insulation thickness adjustment (Figure 7), this should be set according to the tool manufacturer's instructions.

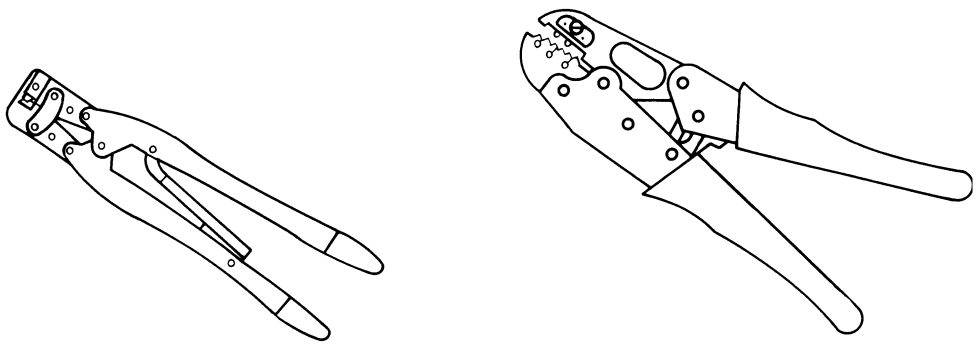


Figure 3 — Examples of compression tools

Figure 4 — Example of correct and incorrect stripping of insulation

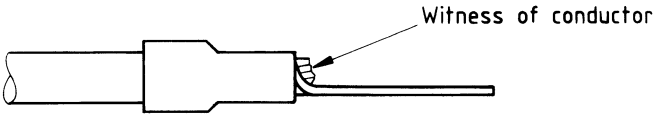


Figure 5 — Example of correct bare conductor protrusion

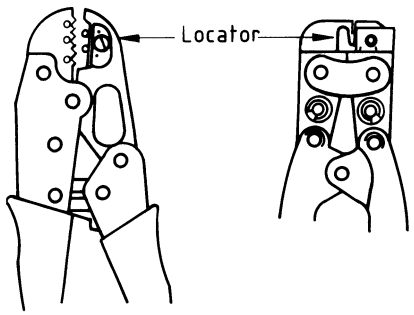
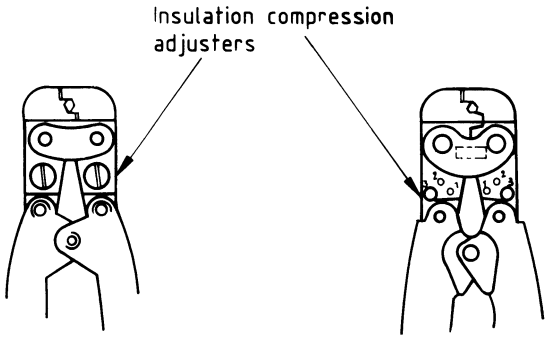


Figure 6 — Example of a tool with a locator fitted



Example of a tool with insulation thickness adjustment

Figure 7 — Example of a tool with insulation thickness adjustment

9 Compression

The connector should be inserted into the tool die-space (Figure 8); if a locator is present it should be used. If a locator is not present, the compression barrel should be inserted in the correct plane as shown in Figure 8. The connector should then be retained by means of a light partial closure of the handles. Continued light pressure of the full closure mechanism will then retain the terminal in place while inserting the wire. Care should be taken to fully insert the wire ensuring that the conductor strands abut the locator/conductor stop. Care should be taken to ensure thin wires do not pass the stop and enter the conductor barrel.

The handles should then be closed until the full closure device permits them to be opened, releasing the compressed connector.

10 Inspection

Figure 9 shows correct compression features and Figure 10 shows common faults.

The compressed connector should be inspected to check the following.

a) The correct connector has been used for the conductor size (see clause **4**).

b) Compression die identifier markings show that the correct dies have been used for the connector size.

c) Correct positioning of compressed areas, ensuring that the conductor compression is central to the conductor barrel length and in the correct plane.

d) Approximately 1 mm of conductor shows at the barrel end or that, if a wire stop is present, the conductor abuts it.

e) The wire insulation is fully inserted into the entry of the insulation sleeve and is adequately secured or supported, depending upon the connector construction.

f) There is no apparent damage to conductors or insulation and that no stray strands of conductor are visible.

NOTE When inspecting fully insulated connectors, the use of an illuminated torch style magnifier can be helpful.

Quality control procedures should include the periodic sampling of completed work for tensile testing and voltage drop testing as required by the appropriate user standard. When installing assembled and compressed connectors and terminals, care should be taken to avoid undue stress caused by tension in the connected wiring on the weight of heavy cableforms. Where significant vibration or movement of wiring is likely to occur, the connection should be protected by securing the wiring in a suitable manner.

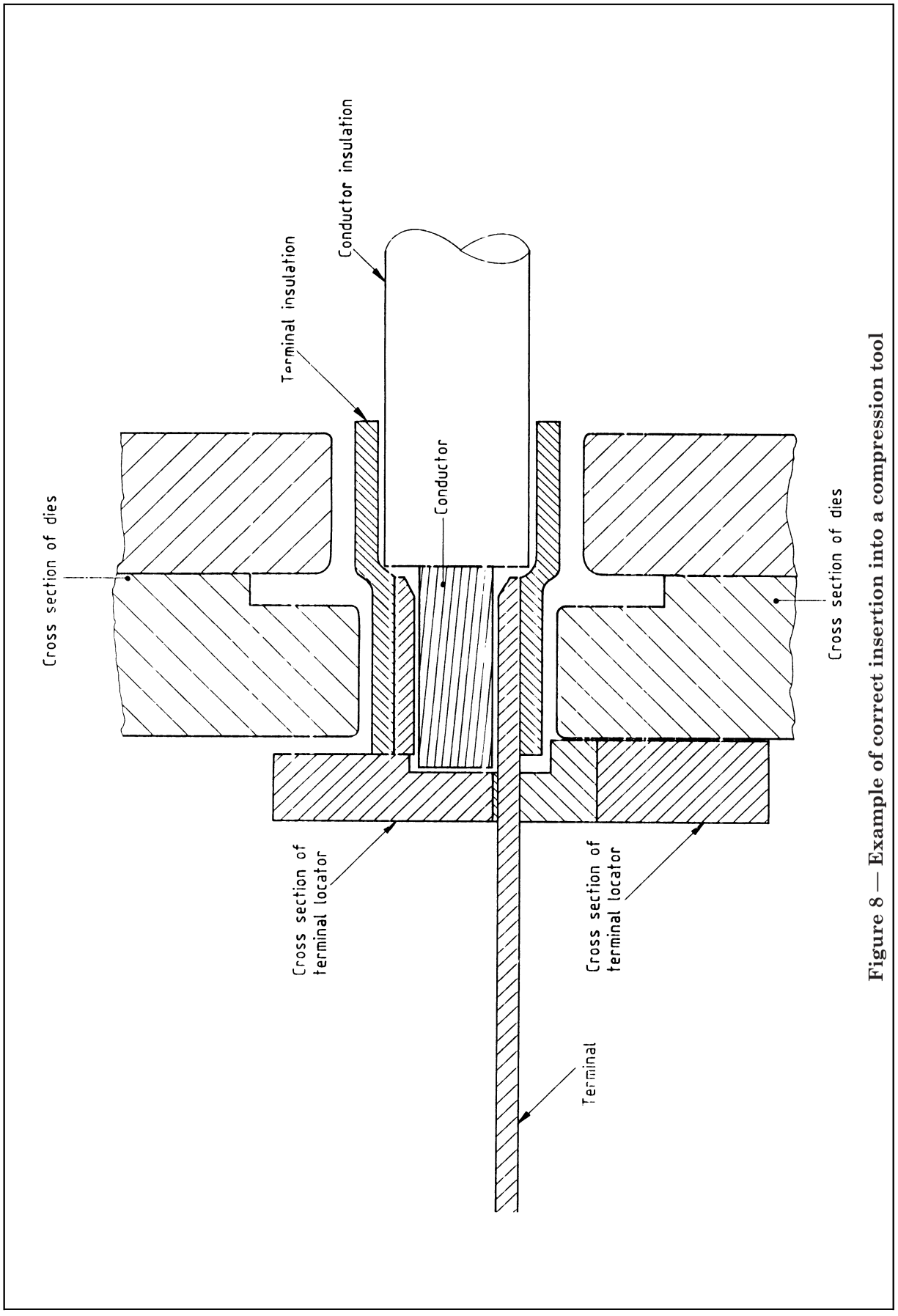


Figure 8 — Example of correct insertion into a compression tool

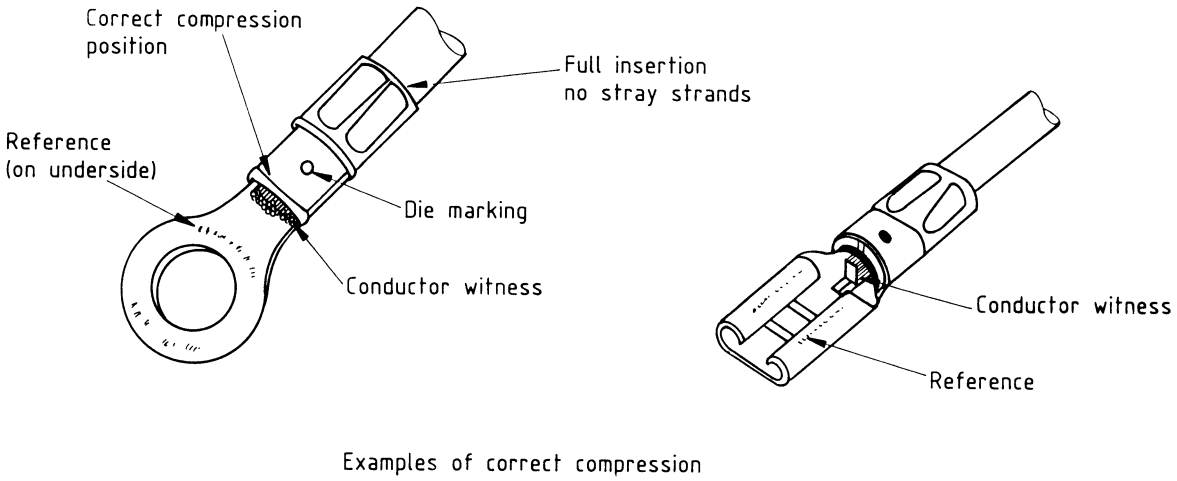


Figure 9 — Examples of correct compression

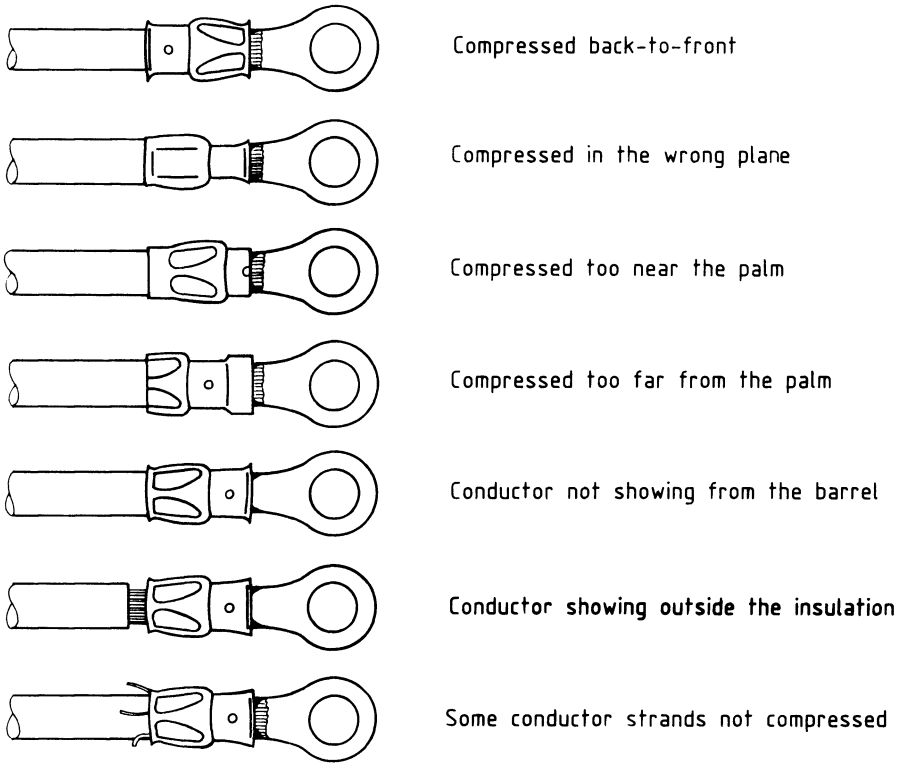


Figure 10 — Examples of common faults

Annex A (informative) Construction of pre-insulated terminals, splices and connectors

A.1 Pre-insulated copper compression terminals (see Figure A.1**)**

The compression area is a cylindrical barrel formed from tightly butted sheet copper, the seam of which may be brazed. One end of the barrel is integral with a connecting palm which is usually a flat ring, blade or spade/fork shape suitable for connecting to an equipment terminal. Optionally, the palm may be cranked and/or hook ended, or formed into a circular or rectangular section pin for pinch screw clamping. The product is normally annealed followed by electroplating for protection.

A tubular insulating sleeve is fitted around the barrel, usually flush with the junction of barrel and palm, extending past the opposite end of the barrel to provide cable insulation support. The insulation may be parallel or have a flared wire entry portion; it may also be formed so as to present a wire entry funnel for easy application. Various insulation materials are available and should be selected with the following in mind:

— operating temperature;

— exposure to certain fluids;

— environmental requirements concerning products of combustion.

PVC is commonly used; it has excellent insulation and mechanical properties and is little affected by moisture. Other insulation materials include nylon, polycarbonate, PEEK, PVF and PTFE. These materials offer a range of properties including higher temperature ratings. The supplier should be consulted when any of the following are important considerations:

— susceptibility to deterioration from oil and grease;

— temperature and flammability ratings;

— products of combustion.

It is essential that nylon insulated products are not exposed to high or low humidity prior to use.

In addition to the insulating sleeve, there may be a metal sleeve interposed between the insulating sleeve and the barrel, extending for most of the length of the insulating sleeve. This optional metal sleeve provides a positive retention grip for the cable insulation and may also be formed to provide a wire entry funnel.

Insulation sleeving is normally coloured to indicate the applicable conductor size range.

A.2 Pre-insulated splices (see Figure A.2)

A lap or parallel splice has a short barrel of sufficient size to connect the sum of the conductors to be joined. The barrel has insulation protruding at both ends allowing wires to be inserted from opposite directions, overlapping in the compression area. Installation is made with single or multiple compression depending on the manufacturer's recommendation.

A closed end splice has a similar barrel, but the insulation is formed or moulded to allow wire entry from one end only. Installation is made with a single compression of the conductor only.

A through or butt splice has a longer barrel with two compression areas separated by an indent which acts as a conductor stop. The insulation sleeve extends beyond both ends and allows for the wires to be joined to be inserted from opposite directions. Two separate compression operations are required.

The copper barrels of these types are frequently made from tubular copper, but can be from rolled sheet with tightly butted seams, which may be brazed.

A.3 Pre-insulated disconnect connectors (see Figure A.3)

Mating connectors are usually flat male and female connections with male tab dimensions of 2.8, 4.8, 6.3 and 9.5 mm wide and thickness of 0.5, 0.8 and 1.2 mm (see BS 5057:1992). Cylindrical bullet male and female connectors are usually of 3, 4, 4.6 or 5 mm diameter.

Because of the necessity to maintain contact pressure of the mating connectors, these are normally made from a suitable grade of brass or phosphor-bronze and the material thickness is often approximately half that of similar sized copper terminals. To allow for the differing characteristics and thickness of these components, it is usual to supplement the compression barrel with a copper sleeve interposed between the barrel and the insulation sleeve. This sleeve may be extended to provide cable insulation grip.

The insulation sleeve of mating connectors is often extended to cover and insulate the mating parts.

The process of compressing mating connectors using the above style of composite construction is more critical than with copper barrelled terminals. It is essential that this is done with the greatest care and in accordance with the manufacturer's instructions to ensure correct wire strip length, insertion and positioning within the compression dies. The use of a suitable location device on the compression tool is strongly recommended.

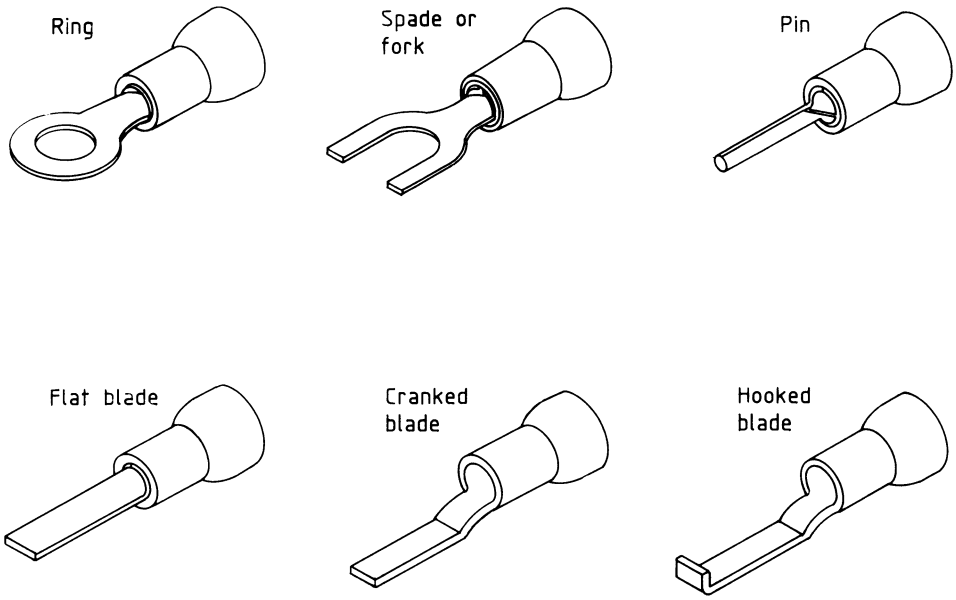


Figure A.1 — Examples of pre-insulated compression terminal

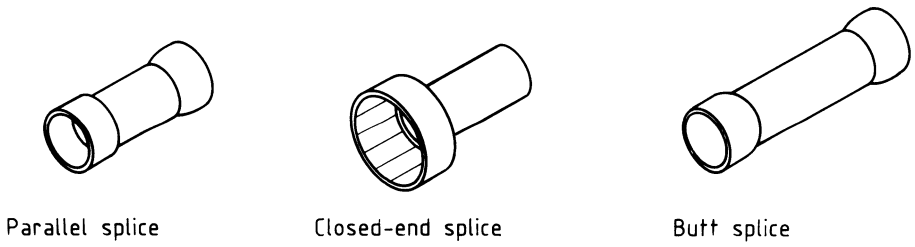


Figure A.2 — Examples of pre-insulated splices

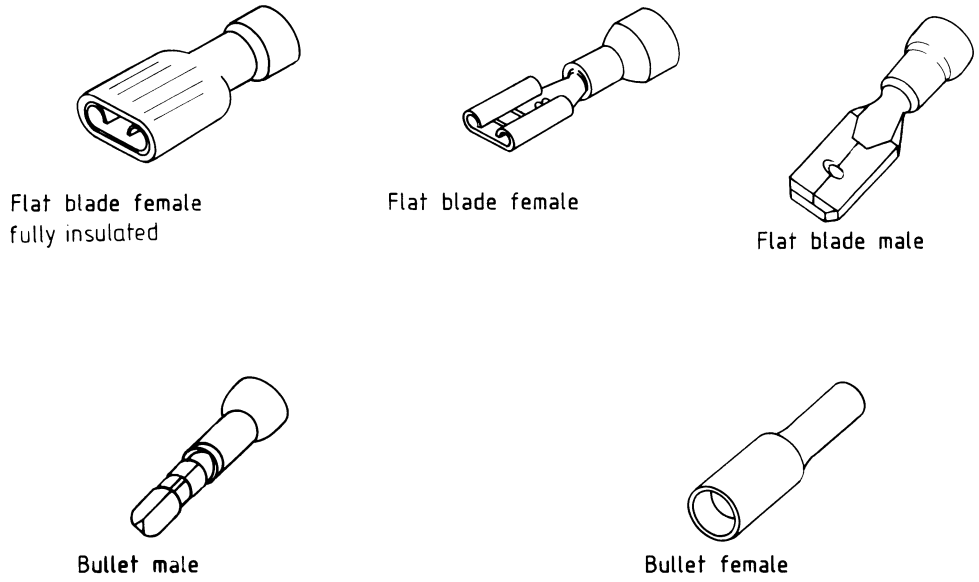


Figure A.3 — Examples of pre-insulated disconnect connectors

Annex B (informative) Maintenance, testing and certification of tooling

B.1 General

All tooling used in the application of cable connectors should be kept in a good state of repair and adjustment. Tools and associated parts should be serial numbered for identification and records of repairs, performance and certification kept on file by the user company or department. The manufacturer's repair and maintenance instructions should be observed in conjunction with the following recommendations, using only the original manufacturer's replacement parts.

At suitable intervals of up to 12 months maximum, depending upon tool types, usage and manufacturer's recommendations, the tools should be submitted to a suitably qualified maintenance, test and inspection authority. Such an authority should operate a quality system assessed and registered to ▮A1⟩ BS EN ISO 9000, MOD or UKAS ⟨A1▮ accreditation where the scope of the approval includes all the appropriate activities listed in this annex.

The authority should maintain records of tool history indexed by serial numbers which are engraved on tools by the authority. These records should show details of each submission including tensile test figures and any comments. When a tool is received for maintenance, the records should be consulted. If, for example, an important previous comment appears to have been ignored it can then be restated with greater emphasis.

When submitting tooling for maintenance, test and certification, it should be accompanied by specimens of work performed by the normal operator immediately before submission. The specimens should be prepared for tensile testing in the manner required by the maintenance, test and inspection authority. The authority should be consulted regarding any use of the tooling which falls outside the normal specifications or operating standards so that due allowance can be made for the user's requirements.

B.2 Examination of initial specimens

Upon receipt by the authority, initial specimens should be examined in accordance with clause **10** or another recognized standard and tensile tested. If the test results are below the required level, or examination shows other faults, the user should be notified. If a fault is sufficiently serious to cast doubt upon the quality of work performed by the tooling in question, the user should be notified by telephone or fax as soon as possible. Details of faults should be entered on the certificate in the comments section.

Tools and accompanying dies should be examined carefully for missing parts, damage and excessive wear. Interchangeable dies should be checked for correctness of fit. All pins, linkages and joints should operate smoothly without excessive play. Any faulty parts should be replaced and the tools cleaned and lubricated.

The full closure mechanism (ratchet) should be tested for correct operation and release point. If necessary, it should be adjusted or replaced.

With the tool in the closed position, die compression cavities should be checked with the aid of "go/no-go" gauges. If out of tolerance, the dies or tool should be scrapped unless there is provision for adjustment, in which case the adjustment should be made prior to retesting. It should be noted that gauging of dies is not a definitive test of tooling efficiency. It is possible for the tool to give gauge measurements in tolerance but fail to achieve sufficient pressure to close the dies when compressing a connector, because of excessive wear in the mechanism.

B.3 Preparation and testing of compressed specimens

Three specimens should be prepared for each die using the appropriate minimum wire size and should be tested in accordance with the tensile test requirements of the reference standard e.g. [A1] BS EN 61238-1:2003 [A1] or BS 5057:1992. If a specimen fails to meet these requirements, the tool should be adjusted as necessary and retested to ensure compliance.

Details of the above operations should be entered on the Tool History Record, the reference number of which will be found engraved on the tool and its dies unless this is the first presentation for maintenance, test and certification. In this case the next available number should be engraved on the tool and its dies, and a new record opened.

B.4 Certificate

The inspection and test certificate should show the following:

a) user (customer) name, address, contact name and order number;

b) date, certificate serial number, tool history reference number, user's tool reference number (if any), the tool manufacturer and part number;

c) style of tool with completed check-list of operations;

d) details of any special requirements, non-typical applications, etc;

e) details of tensile test, showing the reference standard, the standard acceptance level and the results; manufacturer and part number of terminals, manufacturer and details of cables;

f) comments to the user;

g) authorized signature on behalf of the maintenance, test and certification authority;

h) quality system status of inspection and certification authority.

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

[A1] BS EN 60228:2005, *Conductors of insulated cables.* [A1]

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

[A1] BS 5057:1992, *Specification for flat, quick-connect terminations.* [A1]

BS 7609:1992, *Code of practice for installation and inspection of uninsulated compression and mechanical connectors for power cables with copper or aluminium conductors.*

BS 5G 178, *Crimped joints for aircraft electric cables and wires.*

BS 5G 178-1:1993, *Specification for design requirements (including tests) for components and tools.*

BS 4G 178-2:1986, *Specification for control of crimping (including user control tests).*

[A1] BS EN 61238-1:2003, *Compression and mechanical connectors for power cables for rated voltages up to 36 kV (U_m = 42 kV) — Part 1: Test methods and requirements.*

BS EN ISO 9000:2005, *Quality management systems — Fundamentals and vocabulary.* [A1]

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