

Sectional specification for capability approval of manufacturers of double-sided flexible printed wiring boards of assessed quality with through hole connections and with or without rigidizing component materials

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Foreword

This revision of BS 9765, which has been prepared under the direction of the Electronic Components Standards Committee, is one of a series dealing with printed wiring boards of assessed quality. This standard supersedes BS 9765:1978, which is withdrawn.

The generic standard, BS 9760, defines the test methods applicable to all types of printed wiring board and capability approval procedures and rules. The specific tests and requirements applicable to different types of printed wiring board are contained in a series of sectional specifications comprising BS 9761 to BS 9766. These specifications deal both with requirements for capability approval and with those for quality conformance inspection. This particular sectional specification deals with double-sided flexible printed wiring boards with through hole connections and with or without rigidizing component materials and includes tests for capability approval using composite test patterns (CTPs) for which information is given in Appendix A to Appendix D.

A flexible printed wiring board comprises a conductor pattern supported on a flexible insulating substrate. It is usual to apply a cover layer over the conductor pattern to give an encapsulated system. The cover layer is provided with apertures (holes, slots, etc.) to give access to the termination areas of the conductor pattern. Double-sided flexible printed wiring boards may have the two sides electrically connected by means of an appropriate method of through hole connection.

To obtain approval for a flexi-rigid printed wiring board, capability approval should first be obtained for flexible wiring boards (see section 2). This includes tests using the CTPs. Flexi-rigid combinations should then comply with the additional requirements and tests for the extension of capability and for capability approval as specified in section 3.

WARNING. Some of the test procedures given in this standard require the use of substances that may be injurious to health unless adequate safety precautions are taken. The standard 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.

For ease of reference, the test item numbering used in BS 9765:1978 has been retained, except for the introduction of the new tests numbered 24 to 26.

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

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 35 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. General

1.1 Scope

This British Standard specifies requirements for the capability approval of manufacturers of double-sided flexible printed wiring boards with through hole connections and with or without rigidizing component materials. The method of through hole connection shall be either plated through holes (PTHs) or suitable interconnection devices such as eyelets.

This standard includes tests, selected from those described in BS 9760, for use in capability approval and in conjunction with detail specifications.

It applies only to the following types of rigidizing components in combination with flexible printed wiring boards complying with section 2 of this standard and to the following adhesive systems.

- a) Rigidizing components:
 - 1) clad or unclad rigid base material;
 - 2) clad or unclad flexible base material;
 - 3) rigid printed wiring board;
 - 4) other flexible printed wiring board.
- b) Adhesive systems:
 - 1) liquid adhesive;
 - 2) cast film adhesive;
 - 3) bonding sheet material;
 - 4) double-sided adhesive tape.

NOTE 1 Liquid adhesives and cast film adhesives do not on their own provide adequate insulation between bonded rigidizing and flexible printed wiring board components having overlying conductive patterns on both parts. An additional insulating layer, e.g. a cover layer is required between these overlying patterns.

This standard also provides guidance on the preparation of customer detail specifications.

NOTE 2 Section 2 specifies requirements and tests for flexible printed wiring boards. Additional requirements and tests for the extension of the assessment to flexible printed wiring boards containing rigidizing components (flexi-rigid printed wiring boards) are specified in section 3.

NOTE 3 This standard is not applicable to:

- a) flexible ribbon wiring;
- b) combinations involving:
 - 1) through hole connections between the flexible printed wiring board and the rigidizing components;
 - 2) flexible tails bonded and connected by plated through holes to inner layers of multilayer printed wiring boards;
 - 3) mechanical attachment methods such as soldering, riveting, eyeletting, and pinning.

These combinations are considered to be assembly operations which may be performed by the printed wiring board manufacturer or by the customer and they are not therefore covered by this standard. The assessment and release of such features should be by separate local agreement between the manufacturer and the customer.

1.2 Related documents

This British Standard makes reference to the following publications.

BS 2011, *Basic environmental testing procedures — Part 2.1Ca: Test Ca. Damp heat, steady state.*

BS 4584, *Metal-clad base materials for printed wiring boards — Part 2: Epoxide woven glass fabric copper-clad laminated sheet, general purpose grade: EP-GC-Cu-2 — Part 3: Epoxide woven glass fabric copper-clad laminated sheet, flame retardant grade: EP-GC-Cu-3 — Part 9: Flexible copper-clad polyester (PETP) film: PETP-F-Cu-9 — Part 10: Flexible copper-clad polyimide film: PI-F-Cu-10.*

BS 6096, *Marking inks and solder resist coating materials for printed circuits.*

BS 9000, *General requirements for a system for electronic components of assessed quality — Part 1: Specification of basic rules and procedures.*

BS 9760, *Specification for printed circuits of assessed quality: generic data and methods of test: capability approval procedure and rules.*

BS 9761, *Sectional specification for capability approval of manufacturers of multilayer rigid printed wiring boards of assessed quality with plated through holes.*

BS 9762, *Sectional specification for capability approval of manufacturers of double-sided rigid printed wiring boards of assessed quality with plated through holes.*

BS 9763, *Sectional specification for capability approval of manufacturers of single- or double-sided printed wiring boards of assessed quality without plated through holes.*

BS 9764, *Sectional specification for capability approval of manufacturers of single- or double-sided flexible printed wiring boards of assessed quality without plated through holes and with or without rigidizing component materials.*

BS 9766, *Specification for printed circuits of assessed quality: sectional specification for multilayer flexi-rigid printed circuits with through hole connections.*

PD 9002, *BS 9000, BS CECC and IECQ qualified products list.*

1.3 Base materials

The base materials used shall either comply with BS 4584 or shall be other suitable materials for which an approved manufacturer or user specification is available (see **2.3.4** of BS 9760:1977).

NOTE A list of typical properties of materials is given in Appendix J.

1.4 Customer detail specification

A customer detail specification (see section 3 of BS 9760:1977) is required for the purchase of printed wiring boards covered by capability approval.

NOTE A suitable form for a customer detail specification is shown in Appendix G.

1.5 Inspection

Printed wiring boards shall not be released until the following has been done:

- a) capability approval has been obtained by complying with Table 2 of this standard or where appropriate (see **1.3**) the requirements defined by the manufacturer's capability manual, and with section 2 of BS 9760:1977;
- b) a customer detail specification has been prepared and agreed (see section 3 of BS 9760:1977);
- c) production quality conformance inspection in accordance with Table 4 of this standard has been carried out.

Section 2. Capability approval and quality conformance inspection of flexible printed wiring boards

2.1 Description of capability: limits of approval

2.1.1 The description of the capability shall comply with **2.2** of BS 9760:1977.

NOTE Capability should be chosen so that it encompasses all printed wiring boards that require release in accordance with BS 9760.

2.1.2 The manufacturer shall describe his capability in terms of active board size (excluding borders), minimum conductor width and spacing, minimum diameter of plated through hole (PTH), if applicable, aspect ratio (board/hole), finishes and additional features.

2.1.3 The minimum level of capability permitted shall be as follows:

active board size	270 mm × 200 mm
conductor width and spacing	0.4 mm
one form of through hole connection	
one type of conductor finish	

2.1.4 The abstract of approval, for inclusion in PD 9002, shall be in tabular form.

NOTE An example is given in Appendix H.

2.2 Demonstration of capability

2.2.1 General

The manufacturer shall demonstrate the boundary limits of the claimed capability in accordance with **2.1**.

2.2.2 Size

2.2.2.1 *Minimum size for capability approval.* The minimum pattern for capability approval shall be one complete composite test pattern (CTP) as shown in Appendix A.

2.2.2.2 *Maximum size for capability approval.* Capability for printed wiring boards larger than the CTP shall be demonstrated by printing the CTPs in groups, as shown in Appendix D, or by multiple printing of the group pattern shown in Appendix B.

2.2.3 Minimum conductor width and spacing

Two sizes of conductor width and spacing are shown in specimen F in Appendix C. The manufacturer shall declare which width is being offered for approval. Where the manufacturer wishes to declare a finer width and spacing than shown in specimen F of this standard, he shall provide a specially designed specimen F to demonstrate his capabilities.

2.2.4 Method of through hole connection

The method of through hole connection demonstrated shall be one of the following:

- a) eyelets or similar appropriate devices only; or
- b) PTHs only; or
- c) PTHs and eyelets, subject to **2.3.2**; in this case, PTHs shall be the principal method for approval.

2.2.5 Finishes

2.2.5.1 *Different finishes.* All different finishes (organic and inorganic) whether for surface and/or edge contacts shall be assessed separately (see **2.3.3.2**).

NOTE With the agreement of the National Supervising Inspectorate (NSI), test results for a finish which have been obtained during tests establishing approval to one specification in the BS 9760 series of sectional specifications may be transferred for use in establishing approval to another specification in the series, in lieu of further testing.

2.2.5.2 *Edge connector finish thickness.* The thickness of finishes required for the minimum level of capability shall be as given in Table 2.

NOTE Thinner coatings may be used to demonstrate additional capability.

2.2.6 Additional features

For additional features, suitable specimens shall be provided as specified in **2.3.3** of BS 9760:1977.

2.3 Capability CTP allocation

2.3.1 Programme of capability assessment

The programme of capability assessment shall comply with **2.3** of BS 9760:1977.

2.3.2 Standard patterns

The standard patterns shown in Appendix A to Appendix D shall be used for demonstrating standard capability.

The quantities of patterns to be supplied for capability assessment shall be as follows for each family of materials, e.g. polyester, polyimide, fluorinated ethylene propylene (FEP):

- a) for single size CTP: six boards = six CTPs (three separate production lots);

At least five of these CTPs shall have the same method of through hole connection.

NOTE The sixth CTP may be used for demonstration of an alternative method of through hole connection [see **2.2.4 c**) and Table 1].

- b) for double size CTP: three boards = six CTPs (three separate production lots);

At least five of these CTPs shall have the same method of through hole connection.

NOTE The sixth CTP may be used for demonstration of an alternative method of through hole connection [see 2.2.4 c) and Table 1].

c) for quadruple size CTP: two boards = eight CTPs (two separate production lots); at least six of these CTPs shall have the same method of through hole connection.

NOTE The remaining two CTPs may be used for demonstration of an alternative method of through hole connection [see 2.2.4 c) and Table 1].

d) for sizes other than those given in a) to c), the CTP layout shall be by agreement with the NSI; a minimum of six CTPs and at least two complete boards shall be provided.

Each of the boards in a) to d) shall have the same finish.

Capability for finishes, combinations of substrate and cover layer and methods of through holes connection other than those originally demonstrated shall be demonstrated with additional test patterns. Either CTPs or production boards shall be used for these test patterns. The capability tests to be applied to these alternatives shall be selected from Table 3 and shall be the subject of agreement between the manufacturer and the NSI.

2.3.3 Test specimen allocation

2.3.3.1 General. The specimens for each test shall be selected from as many complete boards and CTPs as possible.

Tests for items 1 to 8 of Table 3 shall be carried out on the complete boards before any subdivision into CTPs.

The CTPs shall be allocated for test items 9 to 22 of Table 3. The lots from each CTP shall be kept separate and identified as being from CTP 1, 2 or 3. The remaining CTPs shall be used to provide specimens for test item 23, and for test items 19 and 20, if necessary. The capability approval specimens shall be tested in accordance with the schedule given in Table 3. The allocation of test specimens for the tests in Table 3 shall be as given in Table 2. Where the performance requirements of Table 3 are not appropriate for any particular material or method of making flexible printed wiring boards the manufacturer shall specify the test limits, as specified in 2.3.1 of BS 9760:1977.

NOTE The requirements given in Table 3 are the minimum acceptable values.

2.3.3.2 Additional finishes. Additional finishes shall be tested using one CTP for each finish in accordance with A.2. Capability approval and production tests shall be selected where possible from Table 3 and shall be the subject of agreement between the manufacturer and the NSI.

Solder resists and marking inks shall be considered to be additional finishes.

NOTE Solder and marking inks are tested using specimens described in Appendix G of BS 9763:1988 to minimize costs. Requirements and methods of test for suitable solder resist materials and marking inks are given in BS 6096.

Table 1 — CTP allocation

Approval size (see 2.3)	Allocation
Single size CTP	Three* CTPs shall be used to provide specimens for test items 9 to 22 of Table 3 Two* CTPs shall be divided into cover layer and non-cover layer parts. The cover layer parts shall be used for test item 23 of Table 3. The non-cover layer parts shall provide additional specimens where necessary for test items 19 and 20 of Table 3 NOTE The remaining CTP may be used as a reserve in case of accidental damage before testing and may also be used to demonstrate eyelet through hole connections where both PTHs and eyelets are being demonstrated (see 2.3.2)
Double size CTP	Three* CTPs, one from each board, shall be used to provide specimens for test items 9 to 22 of Table 3 Of the other three CTPs, two* shall be divided into cover layer and non-cover layer parts. The cover layer parts shall be used for test item 23 of Table 3 NOTE The remaining CTP may be used as a reserve in case of accidental damage before testing and may also be used to demonstrate eyelet through hole connections where both PTHs and eyelets are being demonstrated (see 2.3.2)
Quadruple size CTP	Three* CTPs, one from board 1 and two from board 2, shall be used to provide specimens for test items 9 to 22 of Table 3 Two* CTPs, one from board 1 and one from board 2, shall be divided into cover layer and non-cover layer parts. The cover layer parts shall be used for test item 23 of Table 3 NOTE One* CTP may be used as a reserve in case of accidental damage before testing. The remaining two CTPs may be used to demonstrate eyelet through hole connections where both PTHs and eyelets are being demonstrated (see 2.3.2)

In each size group, CTPs marked “” are all to have the same method of through hole connection (see 2.3.2).

Table 2 — Allocation of CTP specimens (see 2.3)

Specimen identity	Total quantity required for testing	Tests applied and allocation (see Table 3)	
Complete board	See 2.3.2	Items 1 to 8	All boards before subdivision
CTP cover layer only	2 CTPs (see Table 1)	Item 23	2 specimens
From three subdivided CTPs ^a :			
A	12	Item 20 Item 19	3 for wetting 3 for dewetting 3 for wetting 3 for dewetting } All separate lots Each lot shall comprise a mixture of cover layer and non-cover layer parts
B	12 ^b	Item 20 Item 19	3 for wetting 3 for dewetting 3 for wetting 3 for dewetting } All separate lots
C	9	Item 9(a) Item 17	3 specimens and 3 for reserve 3 specimens
D	6	Item 15 Item 18	3 specimens 3 specimens } Separate lots
E	3	Item 16	3 specimens
G	3	Item 11	3 specimens
J	3	Item 10	3 specimens
K	9	Item 13 Item 21 Item 9(b) ^c	All specimens All specimens 3 specimens
X	3	Item 14	3 specimens
Y	6	Item 22 Item 12	3 specimens 3 specimens } Separate lots

^a Where three specimens are required, each is to be taken from a different CTP. Where six specimens are required, two are to be taken from each CTP.

^b Additional specimens are available from the two CTPs for test item 23.

^c This test follows the tests in items 13 and 21 of Table 3.

2.3.3.3 Other features. A suitable number of specimens shall be provided and subjected to the relevant tests as specified in 2.3.3 of BS 9760:1977. Landless PTHs shall be regarded as additional features and shall be assessed in accordance with 1.2.3.8 of BS 9760:1977.

2.4.2 Acceptance level 1

accept	no failures
reject	one failure

2.4.3 Acceptance level 2

accept	one failure
reject	two failures

2.4 Capability approval acceptance levels

2.4.1 General

The level of assessment for each parameter shall be as given in Table 3, based on one of the levels given in 2.4.2 to 2.4.4.

2.4.4 Acceptance level 3

In the event of one failure in the first set of three specimens (one from each CTP), a further three specimens (one from each CTP) shall be tested. In the event of two failures in the first set of three specimens, the lot shall be rejected. This is summarized as follows:

first set of three specimens

accept	no failures
retest	one failure
reject	two failures

second set of three specimens

accept	no failures
reject	one failure

2.5 Capability approval report

The capability approval report shall comply with 2.5 of BS 9760:1977.

The capability approval report shall state clearly the range of the manufacturer’s approval as described in 2.1 of this standard and also 2.2 of BS 9760:1977.

2.6 Abstract of description of capability

The abstract of description of capability shall comply with 2.4 of BS 9760:1977.

NOTE Appendix H gives an example of a format for an abstract of description of capability for inclusion in PD 9002.

2.7 Quality conformance inspection

2.7.1 General

The requirements for quality conformance during manufacture shall be as given in Table 4.

Subgroups A0, A2 and B1 shall be applied to production boards only. Other tests shall be applied either to production boards or to special test circuits.

Production boards subjected to destructive tests marked “(D)” shall not be accepted for release (see 20.2 of BS 9000-1:1981).

2.7.2 Certified test records

Certified test records shall be prepared giving attributes information as specified in subgroups A5, B8 and C6 in Table 4.

Table 3 — Schedule of tests for capability approval for double-sided flexible printed wiring boards with through hole connections^a

Item no.	Inspection characteristics	Clause reference in section 1 of BS 9760:1977	Test pattern (see Appendix A to Appendix D)	Acceptance level (see 2.4)	Requirements	Remarks ^b
1	Visual inspection	1.2.2	Complete board	1	Pattern, marking, identification, material and finishes shall comply with the CTP	All boards before subdivision
2(a)	Appearance	1.2.2	Complete board	1	The board shall be inspected for general appearance and workmanship. There shall be no apparent defects apart from those permitted by this standard The surface of the conductors, including metallic finishes, shall be of uniform appearance, free from cracks, burns, pits, nodules and blisters	All boards before subdivision
2(b)	Edge finish	1.2.2	Complete board	1	Edges shall be clean cut. There shall be no tears or nicks Outside corners shall have a radius not exceeding 2.5 mm Inside corners shall have a radius of not less than 1 mm or anti-tear holes of not less than 2 mm diameter	All boards before subdivision
2(c)	PTHs	1.2.2	Complete board	1	The plating in the hole shall be clean and free from inclusions. There shall be no apparent failure of the plating within the holes. There shall be no voids	All boards before subdivision
2(d)	Eyelets	1.2.2	Specimens A and E	1	All eyelets shall be firmly secured in accordance with the eyelet manufacturer's instructions. There shall be no damage to contacting copper NOTE Flanges may be soldered down	All boards before subdivision
2(e)	Bonding of conductor to base	1.2.2	Complete pattern	1	There shall be no separation of the conductor pattern from the base by apparent blisters and wrinkles other than those permitted in relevant material standards	All boards before subdivision

^a For ease of reference, the main numbering used for test items in BS 9765:1978 has been retained in this standard, except for the introduction of the new tests numbered 24 to 26.

^b CTP and specimen allocation is specified in Table 1 and Table 2.