
British Standard

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

Spécification intermédiaire pour l'agrément de savoir-faire des fabricants de cartes imprimées rigides multicouches de qualité assurée avec trous métallisés

Rahmenspezifikation für die Anerkennung der Fähigkeit für Hersteller von gütebestätigten starren Mehrlagenleiterplatten mit metallisierten Löchern

Foreword

This revision of BS 9761, which has been prepared under the direction of the Electronic Component Standards Committee is one of a series of specifications dealing with printed wiring boards of assessed quality. This standard supersedes BS 9761 : 1977, which is withdrawn.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 boards 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 multilayer rigid printed wiring boards with plated through holes (PTHs) and includes tests for capability approval using composite test patterns (CTPs) for which information is given in appendices A to N.

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 in relation to health and safety at any stage of manufacture or use.

For ease of reference, the test item numbering used in BS 9761 : 1977 has been retained, except for the introduction of the new tests numbered 32 to 38.

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

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Corrections

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Table 2. Schedule of tests for capability approval for multilayer boards with PTHs

In the inspection characteristics column for item no. 14, in line 3, delete 'II' and the associated footnote.

In the inspection characteristics column for item no. 15, in line 2, delete 'II' and in the requirements column, delete the existing text and substitute the following.

'There shall be no cracking of the platings, inner foils or their interfaces'

In the inspection characteristics column for item no. 19, delete 'Resistance of interconnections' and substitute the following.

'Change of resistance of plated through holes (thermal cycling)'

In the clause reference in section one of BS 9760 : 1977 column for item no. 19, in line 1, delete '1.2.4.3 and '.

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Table 3. Quality conformance inspection: multilayer printed wiring boards with PTHs

In the requirements column for Subgroup B3 (D), delete the existing text and substitute 'As specified in item 14 of table 2' against '1.2.6.4.3' and 'As specified in item 15 of table 2' against '1.2.6.4.2'.

Under Subgroup C3 (D), delete the entire entry for 'Solvent resistance'.

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Section one. General

1.1 Scope

This British Standard specifies requirements for the capability approval of manufacturers of multilayer rigid printed wiring boards with plated through holes (PTHs). It also includes requirements for quality conformance inspection.

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

The standard also includes guidance on the preparation of customer detail specifications.

NOTE. There are no requirements for eyelets, rivets, turrets, etc. 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 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 9765	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
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).

The test requirements given in table 2 are applicable to epoxide glass base materials except where otherwise stated. For base materials other than epoxide glass, the printed wiring board manufacturer shall define the test requirements for table 2 in his capability manual. This test information shall also be available to the customer.

1.4 Customer detail specification

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

NOTE. A suitable form for a customer detail specification for multilayer rigid printed wiring boards with PTH is shown in appendix Q.

1.5 Inspection

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

- 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 two of BS 9760 : 1977;
- a customer detail specification has been prepared and agreed (see section three of BS 9760 : 1977);
- production quality conformance inspection in accordance with table 3 of this standard has been carried out.

Section two. Capability approval

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), number of layers, minimum conductor width and spacing, minimum diameter of plated through hole (PTH), aspect ratio (board/hole), finishes and additional features.

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

active board size	200 mm x 165 mm
conductor width and spacing	0.4 mm
aspect ratio (board/hole)	2:1
minimum diameter of PTH	0.7 mm
minimum number of layers	8

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

NOTE. An example is given in appendix P.

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 M.

2.2.3 Minimum conductor width and spacing

Two sizes of conductor width and spacing are shown in specimen F in appendix G.

NOTE. These sizes are repeated on internal layers (V layers) of specimen K in appendix G and specimen B in appendix D.

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 Diameter of PTH

The diameter of the PTH shall be within the limits listed in appendix H.

NOTE. Smaller diameter PTHs may be used to demonstrate an additional capability.

2.2.5 Number of layers

The minimum number of layers shall be eight arranged as shown for the CTP in appendix N.

NOTE. Capability for more than eight layers may be demonstrated using the pattern construction for the CTP shown in appendix N. The number of layers for approval should be based on the maximum experienced in production.

2.2.6 Finishes

2.2.6.1 Different finishes. All different finishes (organic and inorganic) whether for surface and/or edge contacts shall be assessed separately (see 2.3.3.3).

NOTE. With the agreement of the National Supervising Inspectorate (NSI), 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.

2.2.6.2 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.

2.2.7 Additional features

2.2.7.1 Surface bonded heat sinks or other metallic layers.

The test specimens used shall be either boards with the test pattern shown in appendix H of BS 9762 : 1988 or suitable production boards, if an equivalent level of assessment is achieved.

Each type of heat sink and its surface finish (e.g. nickel plated copper, anodized aluminium) shall be assessed separately, in accordance with table 2.

NOTE 1. Aspects such as shape and the method used to manufacture the heat sink are not assessed. The assessment is restricted to the mechanical and electrical integrity of the bonding and to any degradation of the printed wiring board. Thermal design aspects of the heat sink are not assessed.

NOTE 2. Test results establishing approval for heat sinks on double-sided boards can normally be used to establish approval for multilayer boards.

2.2.7.2 Landless or landed PTHs. These PTHs shall be assessed on specimen H without surface pads as described in 1.2.3.8 of BS 9760 : 1977 using the relevant tests of table 2.

2.2.7.3 Other features. Suitable specimens shall be provided for other features 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 appendices A to K and appendix M shall be used for demonstrating standard capability. Hole dimensions shall be as specified in appendix L.

The quantities of patterns to be supplied for capability assessment shall be as follows:

- (a) for single size CTP: eight boards = eight CTPs (four separate production lots);
- (b) for double size CTP: four boards = eight CTPs (four separate production lots);
- (c) for quadruple size CTP: two boards = eight CTPs (two separate production lots);
- (d) for sizes other than those given in (a) to (c), the CTP layout shall be by agreement with the NSI; a minimum of eight CTPs and at least two complete boards shall be provided.

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

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 9 and 32 to 34 of table 2 shall be carried out on the complete boards before any subdivision into CTPs. The tests for items 10 and 34 shall be made on the complete CTP before subdivision into specimens.

A total of six CTPs shall be allocated for test items 11 to 26 of table 2 as shown in table 1. The lots from each CTP shall be kept separate and identified. The capability approval specimens shall be tested in accordance with the schedule given in table 2. Where the performance requirements of table 2 are not applicable, the manufacturer shall specify the test limits, as specified in 2.3.1 of BS 9760 : 1977.

The remaining two CTPs shall be used for two purposes as follows:

- (a) as reserve specimens in case of accidental damage before testing (in any subdivision, note the requirement for specimens for item 27 of table 2);
- (b) to provide specimens for the thermal shock test (item 27 of table 2).

Table 1. Allocation of CTP specimens			
Specimen identity	Total quantity required for testing	Tests applied and allocation (see table 2)	
A	18	Item 22(b) Item 23(b)	3 for wetting 6 for dewetting 3 for wetting 6 for dewetting
B	18	Item 22(a) Item 23(a)	3 for wetting 6 for dewetting 3 for wetting 6 for dewetting
C1	6	Item 20	All specimens
C2	6	Item 25	All specimens
C3	6	Item 11(a)* Item 15	3 specimens 3 specimens
D	3	Item 26	3 specimens
E	3	Item 14	3 specimens
F	6	Examined on all complete CTPs	
G	3	Item 12	3 specimens
H	6	Item 13	All specimens
J	3	Item 17	3 specimens
K	6	Item 4 Item 9 Item 24 Item 25 Item 11(b)†	All specimens All specimens All specimens All specimens All specimens
L	3	Item 19	3 specimens
M	6	Item 18	All specimens
N	6	Examined on all complete CTPs	
Reserve boards	2 CTPs	Item 27	12 split CTP
*This test follows the tests in items 24 and 25 of table 2. †This test is destructive if method A of 1.2.3.7 of BS 9760 : 1977 is used in the test for plating thickness.			

2.3.3.2 Test for thermal shock (see item 27 of table 2). For the thermal shock test, one of the two reserve CTPs shall be divided as follows:

- (a) specimens C1, C2, C3, B, A, F, G, E, M and H shall be contained in the same part of the CTP; and
- (b) specimens L, D, N and J shall be contained in the same part of the CTP.

Each part of the CTP shall be submitted to the thermal shock test (see item 27 of table 2).

2.3.3.3 Additional finishes. Additional finishes shall be tested using one CTP for each finish in accordance with A.2. Capability approval tests and production tests shall be selected where possible from table 2 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 resists and marking inks are tested using specimens described in appendix G of BS 9762 : 1988 or, to minimize costs, appendix G of BS 9763 : 1988. Requirements and methods of test for suitable solder resist materials and marking inks are given in BS 6096.

2.3.3.4 Additional features

2.3.3.4.2 Other features. A suitable number of specimens pattern shown in appendix H of BS 9762, or three production boards shall be provided for each type of heat sink and shall be subjected to the tests described in items 32 to 37 of table 2.

2.3.4.2 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.

2.4 Capability approval acceptance levels

2.4.1 General

The level of assessment for each parameter shall be as given in table 2, based on one of the levels given in 2.4.2 or 2.4.3.

2.4.2 Acceptance level 1

accept	no failures
reject	one failure

2.4.3 Acceptance level 2

accept	one failure
reject	two failures

2.5 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 P gives an example of a format for an abstract of description of capability for inclusion in PD 9002.

Section three. Quality conformance inspection

3.1 General

The requirements for quality conformance during manufacture shall be as given in table 3.

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 : Part 1 : 1981).

3.2 Certified test records

Certified test records shall be prepared giving attributes information as specified in subgroups A5, B8 and C6 in table 3.

Table 2. Schedule of tests for capability approval for multilayer boards with PTHs*

Item no.	Inspection characteristics	Clause reference in section one of BS 9760 : 1977	Test pattern (see appendices A to K)	Acceptance level (see 2.4)	Requirements	Remarks
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	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 and base material, shall be of uniform appearance, free from cracks, burns, pits, nodules and blisters. There shall be no fine line cracks or breaks in the conductors. PTHs shall appear clean and free from inclusions of any sort that may affect component insertion or solderability. There shall be no apparent failure of the plating within the hole but voids are permissible, provided that their sum total does not exceed one-quarter of the hole circumference and provided that the effective length of plating through the board is not reduced by more than one-quarter at any point. Visual estimation of the void hold dimensions is sufficient. In any one board, holes with plating voids shall not exceed 10 % of the total number of PTHs	All boards before subdivision
3	Conductor widths and defects	1.2.3.3	Complete board	1	(a) 0.4 mm conductors. Except in cases of local defects, the conductor width shall not depart from the design width (0.4 mm) by more than 10 %. In any event, the effective width of the conductor, resulting from its width being less than the design width in the presence of hole or edge defects, shall be not less than 75 % of the design width (b) 0.25 mm conductors. Inclusive of local defects, the conductor width shall not depart from the design width (0.25 mm) by more than 0.08 mm	All boards before subdivision

*For ease of reference, the test item numbering used in BS 9761 : 1977 has been retained, except for the introduction of the new tests numbered 32 to 38. Where a test is not applicable to this standard, it is marked 'Not applicable'.

Table 2 (continued)

Table 2 (continued)										
Item no.	Inspection characteristics	Clause reference in section one of BS 9760 : 1977	Test pattern (see appendices A to K)	Acceptance level (see 2.4)	Requirements	Remarks				
					(c) Conductors below 0.25 mm. Inclusive of local defects, the conductor width shall not depart from the design width by more than the manufacturer's claimed tolerance (d) All conductors. The number of holes in conductors shall not exceed one per 650 mm² of board area. Indentations in conductors, other than those in edge contacts, shall not be a reason for the rejection of the printed wiring board					
4	Edge connector defects	1.2.3.5	Specimen K	2	The plated surface of edge contacts shall be smooth and free from defects in the contact zone likely to cause a reduction in either the electrical or mechanical properties of the connectors NOTE. Examples of such defects are pin holes, deep scratches, roughness or pitting The number of imperfections permitted in the contact zone on each conductor shall be as follows: <table> <tr> <td>indentations</td> <td>1</td> </tr> <tr> <td>bumps</td> <td>1</td> </tr> </table>	indentations	1	bumps	1	All boards before subdivision
indentations	1									
bumps	1									
5	Conductor spacing	1.2.3.4	Specimen F	2	The spacing between adjacent conductors shall be not less than 75 % of the design spacing. Any conductive particles between these conductors shall not reduce the leakage path length by more than 20 %	All boards before subdivision				
6	Holes/ registration	1.2.3.6	Specimen N	1	The hole dimensions shall comply with the diameters as listed in appendix L Permissible misalignment of hole and land: outer surface layers <i>Holes not plated through.</i> The width of metal at any point around the hole shall be not less than 0.15 mm <i>PTHs.</i> The width of metal at any point around the hole shall be not less than 0.08 mm Permissible misalignment of hole and land: inner surface layers The hole shall not break out of the land	All boards before subdivision				