

System of quality assessment

Sectional specification —

**Flexible multilayer printed boards with
through-connections**

ICS 31.180

Committees responsible for this British Standard

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- Association of Contract Engineers Manufacturers
- Federation of the Electronics Industry
- GAMBICA
- Ministry of Defence
- National Supervising Inspectorate
- Printed Circuit Interconnection Federation
- Surface Mounting and Related Technologies (Smart Group) Ltd.

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Foreword

This British Standard has been prepared by Technical Committee EPL/501, Electronic assembly technology.

The BS 123000:2001 series of British Standards is based on draft proposals to revise the EN 123000 series dated 1992 and 1997. These were circulated and voted on in CENELEC, but the CENELEC Technical Board decided not to approve them for publication. Following repeated attempts by the British National Committee to get them published, the Technical Board agreed to grant derogation from standstill to the British National Committee to publish national standards on the basis of the prEN 123000 series (Technical Board decision D106/092).

These standards are published to complement the BS EN 123000 series, which remains current. They will be withdrawn only if they are replaced by revised EN standards. They have been published because they are considered to be an improvement upon the EN series, for the following reasons.

- a) Requirements for modern materials and surface finishes required by the electronics industry have been incorporated.
- b) Reference is made to ANSI/IPC A-600F for many of the inspection criteria. This has been undertaken in response to industry requests.
- c) References to obsolete CECC regulatory documents have been replaced.
- d) Tests and requirements that are no longer considered relevant have been removed.
- e) The UK electronics industry requires standards that are subject to ongoing revision, in order to take account of new European Eco-Directives.

This British Standard is a sectional specification. It should be read in conjunction with the generic specification, BS 123000, and any associated capability detail specification.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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 and ii, pages 1 to 29 and a back cover.

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1 Scope

This British Standard specifies characteristics to be assessed and test methods to be used for capability approval testing and for quality conformity inspection (lot-by-lot and periodic inspection). It is applicable for all flexible multilayer printed boards with through-connections, irrespective of their method of manufacture, when they are ready for the mounting of components.

This British Standard is a sectional specification intended for use with the IECQ system of quality assessment for electronic components.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 4727-1:Group 11 (IEC 60194), *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms — Part 1: Terms common to power, telecommunications and electronics — Group 11: Printed circuits.*

BS 6001-1:1999 (ISO 2859-1:1999), *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.*

BS 6221-2:1991 (IEC 60326-2:1990), *Printed wiring boards — Part 2: Methods of test.*

BS 6221-3 (IEC 60326-3), *Printed wiring boards — Guide for the design and use of printed wiring boards.*

BS 123000:2001, *System of quality assessment — Generic specification — Printed boards.*

3 Terms and definitions

For the purposes of this British Standard the terms and definitions given in BS 4727-1:Group 11 and BS 123000 together with the following apply.

3.1

relevant specification

product specification for an actual batch of printed boards, i.e. a customer detail specification as well as a capability detail specification applied to a specific material, surface finish etc., as applicable

4 General requirements

The following specifications for flexible multilayer printed boards with through-connections shall be prepared, unless a suitable capability detail specification already exists, using this British Standard as a basis:

- a) capability detail specifications for general use or applying to specific applications;
- b) customer detail specifications, which shall be prepared in accordance with BS 123000:2001, 7.2.

NOTE 1 BS 123800-003 is an example of a capability detail specification for flexible multilayer printed boards with through-connections.

NOTE 2 A capability detail specification is prepared either by an international or national body or by a manufacturer (see also BS CECC 00111-4). A customer detail specification should preferably be written by the customer and allocated a number within the customer's own system. Further details are given in BS 123000 and BS CECC 00114-3.

5 Capability approval

5.1 Basic capability

Testing shall be carried out on the composite test pattern given in clause 9.

5.2 Additional capability

BS 123000:2001, 5.3.3 shall apply.

NOTE For multiple arrangements see also clause 9.

5.3 Maintenance of capability approval

BS 123000:2001, 5.6 shall apply.

6 Relevant specification

The relevant specification shall contain all the information necessary to define the printed board clearly and completely. Care shall be taken to avoid unnecessary proscriptions. Tolerances shall be stated as necessary. Nominal values without tolerances, or simple maximum or minimum values, shall be given where these are sufficient. Where tolerances are necessary for certain areas or parts of the printed board only, they shall be applied and restricted to those areas or parts.

If there are several possibilities of presentation, of tolerance classes etc., the selections given in BS 6221-3 shall be applied as practical.

In the case of discrepancy between the customer detail specification and other pertinent specifications (e.g. generic specification, sectional specification or capability detail specification), the customer detail specification shall prevail.

7 Capability test programme

For initial demonstration and subsequent re-demonstration, the capability approval test programme shall be in accordance with the relevant capability detail specification. Demonstration of additional capability shall be in accordance with BS 123000:2001, **5.3.3**.

NOTE For composite test pattern specimens, see clause **9** and Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16. Examples of multiple arrangements of test patterns are shown in Figure 17. Examples of soldered holes are shown in Figure 18, methods of reinforcing lands in Figure 19, examples relating to access holes in Figure 20, and examples of delamination in Figure 21.

There shall be no more than three failures throughout the entire sequence of tests.

8 Quality conformity inspection

8.1 General

Quality conformity inspection shall be conducted on samples which are either taken from the production batch, or which are representative of the production batch (i.e. manufactured using the same processes, having the same features, and concurrent with the released batch).

8.2 Sampling plans

The sampling plans of BS 6001-1, as referenced in Table 1, Table 2 and Table 3, shall be used. In all cases there shall be no defects.

NOTE 1 Unless otherwise specified, production boards and/or specially designed test patterns may be used for carrying out tests for the lot-by-lot and periodic inspection.

NOTE 2 Where specially designed test patterns are used, they may be included in the panel. They may be based upon the appropriate pattern of the composite test pattern as detailed in clause **9**.

8.3 Inspection groups

Inspection level C shall be used, unless another inspection level is specified in the customer detail specification. Other inspection levels shall be in accordance with Table 1 and Table 2.

Printed boards shall be aggregated into inspection lots in accordance with BS 123000:2001, **6.1**.

NOTE For definition of the inspection groups, see BS 123000:2001, **6.3**.

Quality conformity inspection shall be carried out in accordance with Table 1, Table 2 and Table 3.

Table 1 — Group A quality conformity inspection

Inspection group	Characteristics	Test no. ^a	Assessment level A		Assessment level B		Assessment level C		Assessment level D	
			IL ^b	AQL ^c	IL	AQL	IL	AQL	IL	AQL
Sub-group A1	Visual inspection									
	Conformity	1	S2	2.5 %			100 %			
	Identification	1	S2	2.5 %			100 %			
	Appearance	1a	S2	2.5 %			100 %			
	Workmanship	1a	S2	2.5 %			100 %			
	Board edges	1a	S2	2.5 %			100 %			
	Eyelets	1a	S2	2.5 %			100 %			
	Bonding, conductor to substrate	1a	S2	2.5 %			100 %			
	Bonding, coverlayer to substrate and pattern	1a	S2	2.5 %			100 %			
	Conductor defects	1b	S2	2.5 %	See BS 123000:2001, 7.2.5		100 %		See BS 123000:2001, 7.2.5	
	Particles between conductors	1b, 1c	S2	2.5 %			100 %			
Sub-group A2	Dimensional examination									
	Board dimensions	2	S1	4.0 %			S4	2.5 %		
	Holes	2	S1	4.0 %			S4	2.5 %		
	Access holes	2	S1	4.0 %			S4	2.5 %		
	Slots, notches	2	S1	4.0 %			S4	2.5 %		
	Conductor width	2	S1	4.0 %			S4	2.5 %		
	Conductor spacing	2	S1	4.0 %			S4	2.5 %		
	Misalignment of hole and land	2	S1	4.0 %			S4	2.5 %		
	Positional tolerance of hole centres	2	S1	4.0 %			S4	2.5 %		
Sub-group A3	Spare group for additional group A tests									
NOTE This listing may be subject to continuing review, as required by the publication and revision of new capability detail specifications.										
^a As specified in BS 6221-2:1991. ^b Inspection level (defined in BS 6001-1:1999, Table 1). ^c Acceptability quality level.										

Table 2 — Group B quality conformity inspection

Inspection group	Characteristics	Test no. ^a	Assessment level A		Assessment level B		Assessment level C		Assessment level D	
			IL ^b	AQL ^c	IL	AQL	IL	AQL	IL	AQL
Sub-group B1	Dimensional interchangeability Not applicable				See BS 123000:2001, 7.2.5				See BS 123000:2001, 7.2.5	
Sub-group B2	Solderability	14a	S2	2.5 %			S3	2.5 %		
Sub-group B3	Shock tests Not applicable									
Sub-group B4	Mechanical tests Peel strength, conductor to base material	10c	—	—			S2	2.5 %		
	Pull-off strength, lands with plain holes (if applicable)	11a	—	—			S2	2.5 %		
Sub-group B5	Surface finish tests (if applicable) Adhesion of plating	13a	S1	2.5 %			S2	2.5 %		
	Thickness of plating, contact areas	13f	—	—			S2	2.5 %		
Sub-group B6	Spare group for additional group B tests									
NOTE This listing may be subject to continuing review, as required by the publication and revision of new capability detail specifications.										
^a As specified in BS 6221-2:1991. ^b Inspection level (defined in BS 6001-1:1999, Table 1). ^c Acceptable quality level.										

Table 3 — Group C quality conformity inspection

Inspection group	Characteristics	Test no. ^a	Assessment level A		Assessment level B		Assessment level C		Assessment level D	
			No. ^b	Defects ^c	No.	Defects	No.	Defects	No.	Defects
Sub-group C1	Tests in 3-month intervals									
	Insulation resistance before and after damp heat	6a	—	—	See BS 123000:2001, 7.2.5		3	1	See BS 123000:2001, 7.2.5	
	Change in resistance of plated-through holes	3c	—	—		6	1			
Sub-group C2	Tests in 12-month intervals									
	Not applicable									
Sub-group C3	Spare group for additional intervals									
NOTE This listing may be subject to continuing review, as required by the publication and revision of new capability detail specifications.										
^a As specified in BS 6221-2:1991. ^b Number of specimens to be tested. ^c Maximum permissible number of defects.										

9 Test patterns and test boards

9.1 General

A test pattern shall consist of:

- a) a part of a conductive pattern on a production board (and used in the application of the printed board); or
- b) a special test pattern particularly designed and prepared for the purpose of testing only.

A test pattern shall be located:

- 1) on a test coupon (a portion of a printed board or a panel detached prior to using the printed board); or
- 2) on a separate test board.

9.2 Capability approval testing

Basic capability shall be assessed using the composite test pattern given in 9.2 and the six-layer structure given in 9.3.

Where additional capability claims are greater than the minimum number of layers, the six-layer board with additional layers shall be used. All additional layers shall have the structure specified in 9.4 and shall bear the same conductive pattern as shown in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16.

Where additional capability claims are for a larger board size (active area) than that of a test board bearing one composite test pattern (160 mm × 320 mm), multiple arrangements as given in 9.5 shall be used.

NOTE See also BS 123000:2001, 5.3.

9.3 Composite test pattern

The composite test pattern shall be used for testing capability (see BS 123000:2001, 5.3).

NOTE 1 Using the single test specimens of the composite test pattern shown in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16, the tests shown in Table 4 can be made.

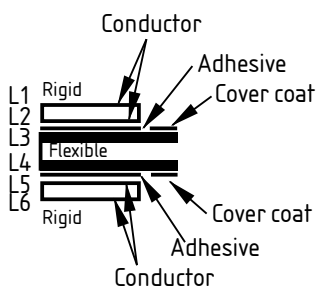
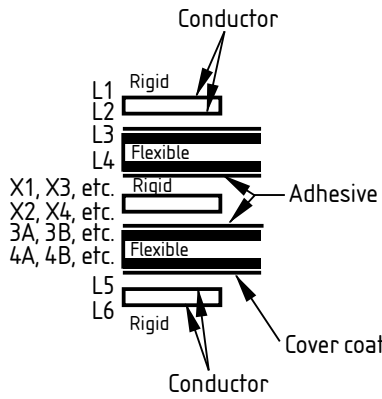
Table 4 — Test specimen details

Specimen	Test	Coverlayer access hole diameter mm	Nominal hole diameter mm	Nominal land diameter mm
A	Solderability of plated-through holes	2.0	0.8	1.8
B	Pull-out strength, landless plated-through holes	—	1.0	—
C	Pull-out strength, plain holes	2.2	0.8	2.0
D	Change of resistance of plated-through holes and interconnections	2.0	0.8	1.8
E	Insulation resistance (all layers)	2.0	0.8	1.8
F	Conductor definition	—	—	—
G	Peel strength and delamination	—	—	—
H	Solderability of conductors, plating finishes	—	—	—
J	Insulation resistance (surface layers)	2.0	0.8	1.8
K	Plating finishes, contact areas (optional)	—	—	—
L	Flexural fatigue/current proof conductors	2.0	0.8	1.8
M	Insulation resistance (between layers)	2.0	0.8	1.8
N	Registration and CAF coupon (Cathodic Anodic Filament)	2.2	1.0	2.0

9.4 Structure of a typical board

The structure of a typical test board shall be as shown in Table 5.

Table 5 — Structure of a typical test board

Characteristic	Requirement	
	Test board with six layers	Test board with more than six layers
Structure	 NOTE L3 and L4 are the only layers used in the flexible section of the composite test pattern.	
Total board thickness	(1.15 ± 0.2) mm	
Laminate: — nominal thickness — conductive foil	Not less than 25 μm 35 μm copper, both sides	To be specified in the relevant specification
Insulation: — thickness — number of adhesive sheets	25 μm min. dielectric material 1 each 25 μm min. thickness	
Holes	All plated-through except for coupon C	
Surface finish	To be specified in the relevant specification	
The patterns shall be correctly oriented according to the method of construction. Sufficient space shall be provided outside the pattern area to accommodate a registration system.		

9.5 Multiple arrangements of the composite test pattern

Where additional capability claims are for larger board sizes (active area) than that of a single composite test pattern (160 mm $\times$ 320 mm) and if the manufacturer wishes to demonstrate the additional capability by using the composite test pattern, adequate multiple arrangements of the composite test pattern shall be used. The multiple arrangements shall be such that each corner of the active area is occupied by a composite test pattern. Unoccupied areas between the composite test patterns shall not exceed the dimensions of the composite test pattern.

NOTE Examples of multiple arrangements are shown in Figure 17.