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BSI Standards Publication

Solderless connections

Part 5: Press-in connections — General requirements, test methods and practical guidance

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National foreword

This British Standard is the UK implementation of EN 60352-5:2012. It is identical to IEC 60352-5:2012, incorporating corrigendum September 2014. It supersedes BS EN 60352-5:2008, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/48, Electromechanical components and mechanical structures for electronic equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

Solderless connections - Part 5: Press-in connections - General requirements, test methods and practical guidance

(IEC 60352-5:2012)

Connexions sans soudure -
Partie 5: Connexions insérées à force -
Exigences générales, méthodes d'essai et guide pratique
(CEI 60352-5:2012)

Lötfreie Verbindungen -
Teil 5: Einpressverbindungen -
Allgemeine Anforderungen, Prüfverfahren und Anwendungshinweise
(IEC 60352-5:2012)

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European Committee for Electrotechnical Standardization
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Foreword

The text of document 48B/2276/FDIS, future edition 4 of IEC 60352-5, prepared by SC 48B, "Connectors", of IEC TC 48, "Electromechanical components and mechanical structures for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60352-5:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-12-28
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-03-28

This document supersedes EN 60352-5:2008

EN 60352-5:2012 includes the following significant technical changes with respect to EN 60352-5:2008:

a) Enhancement of Annex A and further application remarks are added.

b) Editorial changes throughout the standard to prevent the document from being misunderstood as specification for establishing press-in connection in total.

c) Deletion of all tables with hole dimensions. Historically the hole dimensions were constrained because of the dimensions of the wire wrap and clip connections posts. Since these connection technologies are no longer commonly used, the design requirements are no longer practical.

d) Inclusion of additional figures and one table in 4.4.4 to define tolerance ranges for holes in test-boards and to illustrate them.

e) Inclusion of a requirement for the thickness of the test-board in 4.4.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60352-5:2012 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-581	2008	International Electrotechnical Vocabulary - Part 581: Electromechanical components for electronic equipment	-	-
IEC 60068-1 + corr. October + A1	1988 1988 1992	Environmental testing - Part 1: General and guidance	EN 60068-1[1)]	1994
IEC 60352-1 + corr. October	1997 1998	Solderless connections - Part 1: Wrapped connections - General requirements, test methods and practical guidance	EN 60352-1	1997
IEC 60512	Series	Connectors for electronic equipment - Tests and measurements	EN 60512	Series
IEC 60512-1-100	-	Connectors for electronic equipment - Tests and measurements - Part 1-100: General - Applicable publications	EN 60512-1-100	-
IEC 61188-5-1	-	Printed boards and printed board assemblies - Design and use - Part 5-1: Attachment (land/joint) considerations - Generic requirements	EN 61188-5-1	-
IEC 61249	Series	Materials for printed boards and other interconnecting structures	EN 61249	Series
IEC 62326-4	1996	Printed boards - Part 4: Rigid multilayer printed boards with interlayer connections - Sectional specification	EN 62326-4	1997

[1)] EN 60068-1 includes A1 to IEC 60068-1 + corr. October.

CONTENTS

INTRODUCTION

This part of IEC 60352 includes requirements, tests and practical guidance information.

Two test schedules are provided.

a) The qualification test schedule applies to individual press-in connections (press-in zone).

   They are tested to the specification provided by the manufacturer of the press-in termination (see 4.6) taking into account the requirements of Clause 4.

   The qualification is independent of the application of the press-in zone in a component.

b) The application test schedule applies to press-in connections which are part of a component and are already qualified to the qualification test schedule.

   Test sequences focus on the performance of the press-in connection which is affected by the implementation in a component.

As the manufacturer of the press-in termination has to provide the main part of the information needed for qualification, the word "manufacturer" is used throughout this standard for simplicity.

IEC Guide 109 advocates the need to minimise the impact of a product on the natural environment throughout the product life cycle.

SOLDERLESS CONNECTIONS –

Part 5: Press-in connections – General requirements, test methods and practical guidance

1 Scope and object

This part of IEC 60352 is applicable to solderless press-in connections for use in telecommunication equipment and in electronic devices employing similar techniques.

The press-in connection consists of a termination having a suitable press-in zone which is inserted into a plated-through hole of a double-sided or multilayer printed board.

Information on materials and data from industrial experience is included in addition to the test procedures to provide electrically stable connections under prescribed environmental conditions.

The object of this part of IEC 60352 is to determine the suitability of press-in connections under mechanical, electrical and atmospheric conditions as specified by the manufacturer of the press-in termination and to provide a means of comparing test results when the tools used to make the connections are of different designs or manufacture.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(581):2008, *International Electrotechnical Vocabulary (IEV) – Part 581: Electromechanical components for electronic equipment*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 60352-1:1997, *Solderless connections – Part 1: Wrapped connections – General requirements, test methods and practical guidance*

IEC 60512 (all parts), *Connectors for electronic equipment – Tests and measurements*

IEC 60512-1-100, *Connectors for electronic equipment – Tests and measurements – Part 1-100: General – Applicable publications*

IEC 61188-5-1: *Printed boards and printed board assemblies – Design and use – Part 5-1: Attachment (land/joint) considerations – Generic requirements*

IEC 61249 (all parts), *Materials for printed boards and other interconnecting structures*

IEC 62326-4:1996, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050(581) and IEC 60512-1 as well as the following apply.

3.1
press-in connection
solderless connection made by inserting a press-in termination into a plated-through hole of a printed board

[IEC 60050-581: 2008, 581-03-46]

3.2
press-in termination (press-in post)
termination having a specially shaped zone suitable to provide for a solderless press-in connection

[IEC 60050-581: 2008, 581-03-39]

3.2.1
solid press-in termination
press-in termination having a solid press-in zone which behaves primarily rigid and induces a elastoplastic deflection of the through hole

[IEC 60050-581: 2008, 581-03-40]

3.2.2
compliant press-in termination
press-in termination having a compliant press-in zone which causes a limited elastoplastic deflection of the through hole and a elastoplastic deformation of the press-in zone

[IEC 60050-581: 2008, 581-03-41, modified]

3.3
press-in zone
specially shaped section of a press-in termination which is suitable to provide for the press-in connection

[IEC 60050-581: 2008, 581-03-52]

3.4
termination insertion tool
device used to insert press-in terminations or components equipped with press-in terminations into a printed board

[IEC 60050-581: 2008, 581-05-22]

3.5
termination removal tool
device for removing a press-in termination from a printed board

[IEC 60050-581: 2008, 581-05-23]

3.6
set of parts
one press-in termination and a test-board with one or more plated-through holes. The press-in termination is not mounted in the printed board

3.7
specimen
printed board, or a part of a printed board, with a mounted press-in termination, with or without a component housing

3.8
manufacturer
manufacturer of the press-in termination, who performs the tests according to this standard using a test board

4 Requirements

4.1 General

The connections shall be processed in a careful and workmanlike manner, in accordance with best practice.

4.2 Tools

4.2.1 General

Tools shall be used and inspected according to the instructions and dimensions provided by the manufacturer.

The tools shall be capable of making uniformly reliable connections.

The tools shall be so designed that they do not damage the press-in termination or the printed board when correctly operated.

4.2.2 Tools evaluation

Tools are evaluated for performance by testing the connections made by them and carrying out tests according to 4.5 and 5.1.2. They shall meet the requirements of 4.6d) and 5.2.1.3.

4.3 Press-in terminations

4.3.1 Materials

Material used in the press-in zone shall be specified by the manufacturer.

For information on materials, see A.4.3.

4.3.2 Dimensions of the press-in zone

The performance of a press-in connection depends on the dimensions of the specially shaped press-in zone and the materials used for the press-in termination together with the dimensions and materials of the plated-through hole in the printed board.

4.3.3 Dimensions of the plated through hole

The minimum thickness of copper plating of the printed circuit board shall be 25 μm. The shape and dimensions including the tolerances of the plated through hole shall be specified by the manufacturer.

4.3.4 Surface finishes

The press-in zone of the press-in termination shall be either unplated or plated. The surface finish shall be specified by the manufacturer.

The surface shall be free of detrimental contamination or corrosion.

4.4 Test boards

4.4.1 General

For test purposes test boards according to IEC 61188-5-1 and IEC 62326-4 or to a specification given by the manufacturer shall be used.

Four layer printed circuit test boards shall be used for testing unless otherwise specified in the component specification or in the manufacturer's specification.

4.4.2 Materials

The manufacturer shall specify the types of base material for which the press-in zone is designed.

Examples of base materials may be found in IEC 61249.

4.4.3 Thickness of test boards

The thickness of the test-board shall be that for which the press-in connection is designed. When a press-in connection is designed to be used with different board thicknesses, the test board selected shall be of the thinnest nominal thickness for which the press-in connection is intended to be used.

NOTE If a press-in connection is designed for board sizes of 1,6 mm to 2,4 mm, a test board with a nominal thickness of 1,6 mm (within tolerance range) is used.

4.4.4 Plated-through hole

The minimum and the maximum plated hole diameter the press-in connection is intended for shall be defined by the manufacturer. The tolerance range is then the range between the minimum and the maximum plated hole diameter.

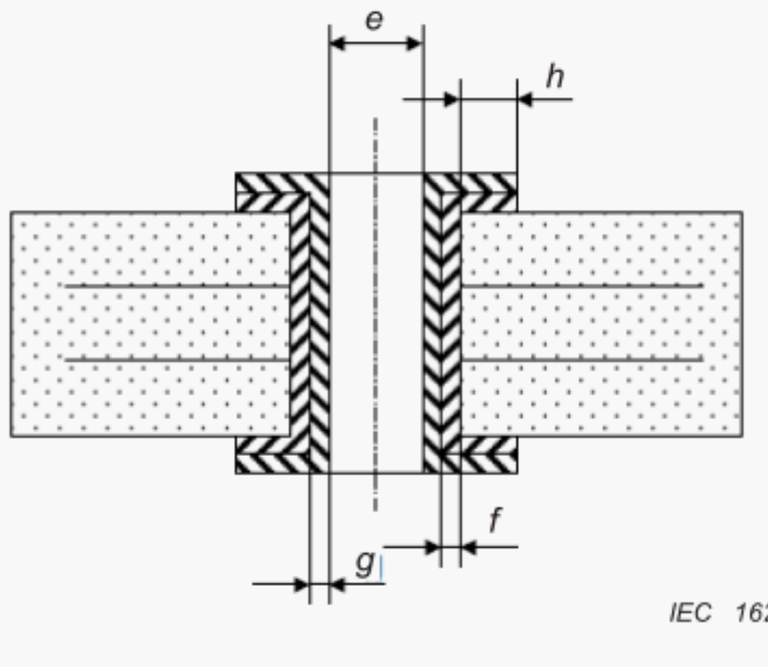


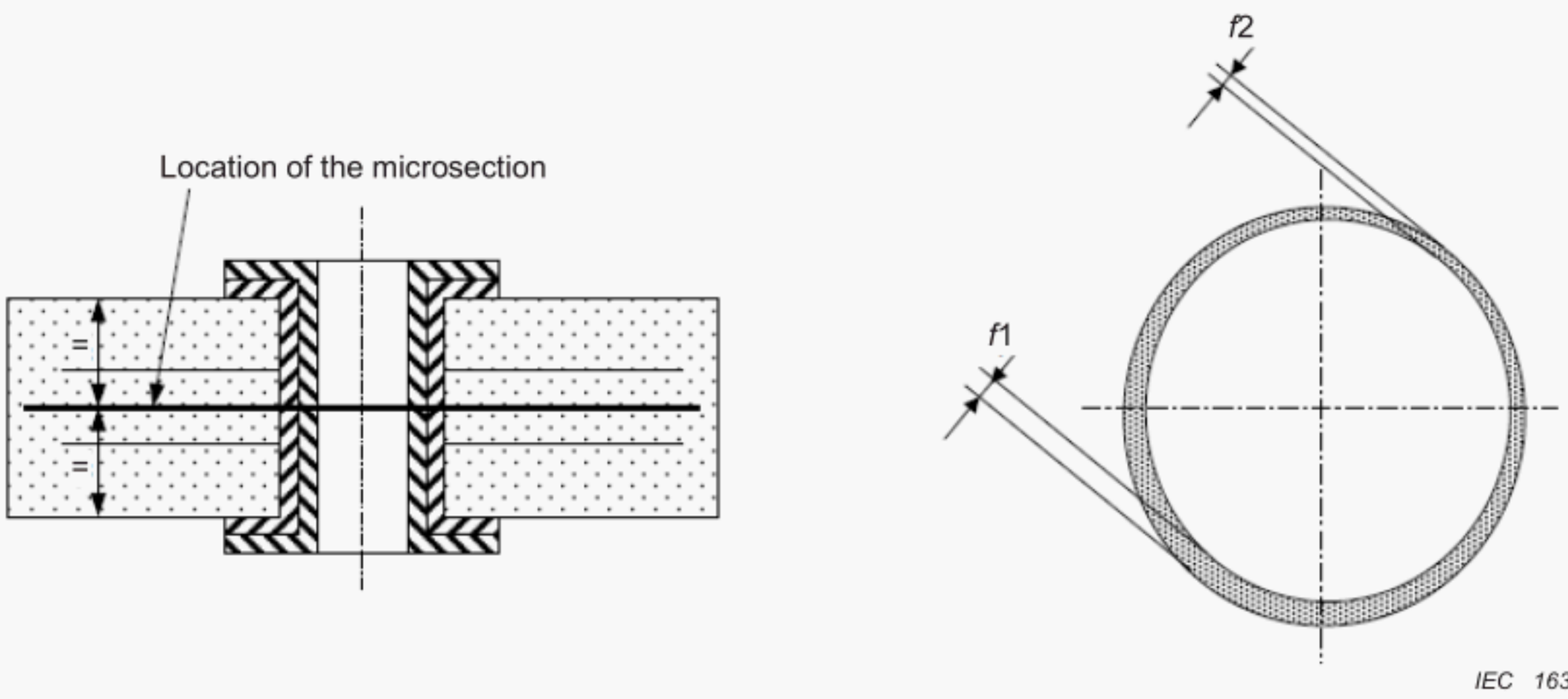
Figure 1 – Plated-through hole

The plated-through holes shall fulfil the requirements according to Table 1, where the item definition follows Figure 1.

Table 1 – Plated-through hole requirements for test boards

Item according to Figure 1	Description	Requirement
e	Min. hole tolerance range (range a)	lower 30 % of the tolerance range
	Max. hole tolerance range (range b)	upper 30 % of the tolerance range
f	copper thickness of the tube	min. 25 µm, max. 35 µm
g	final plating	for information see A.4.3
h	pad width	min. 0,15 mm

The thickness of the copper tube shall be measured by a transversal microsection through the hole according to Figure 2. The values of *f*1 and *f*2 shall be in the required range of f according to Table 1.



Key

*f*1 maximal measured value of the copper thickness

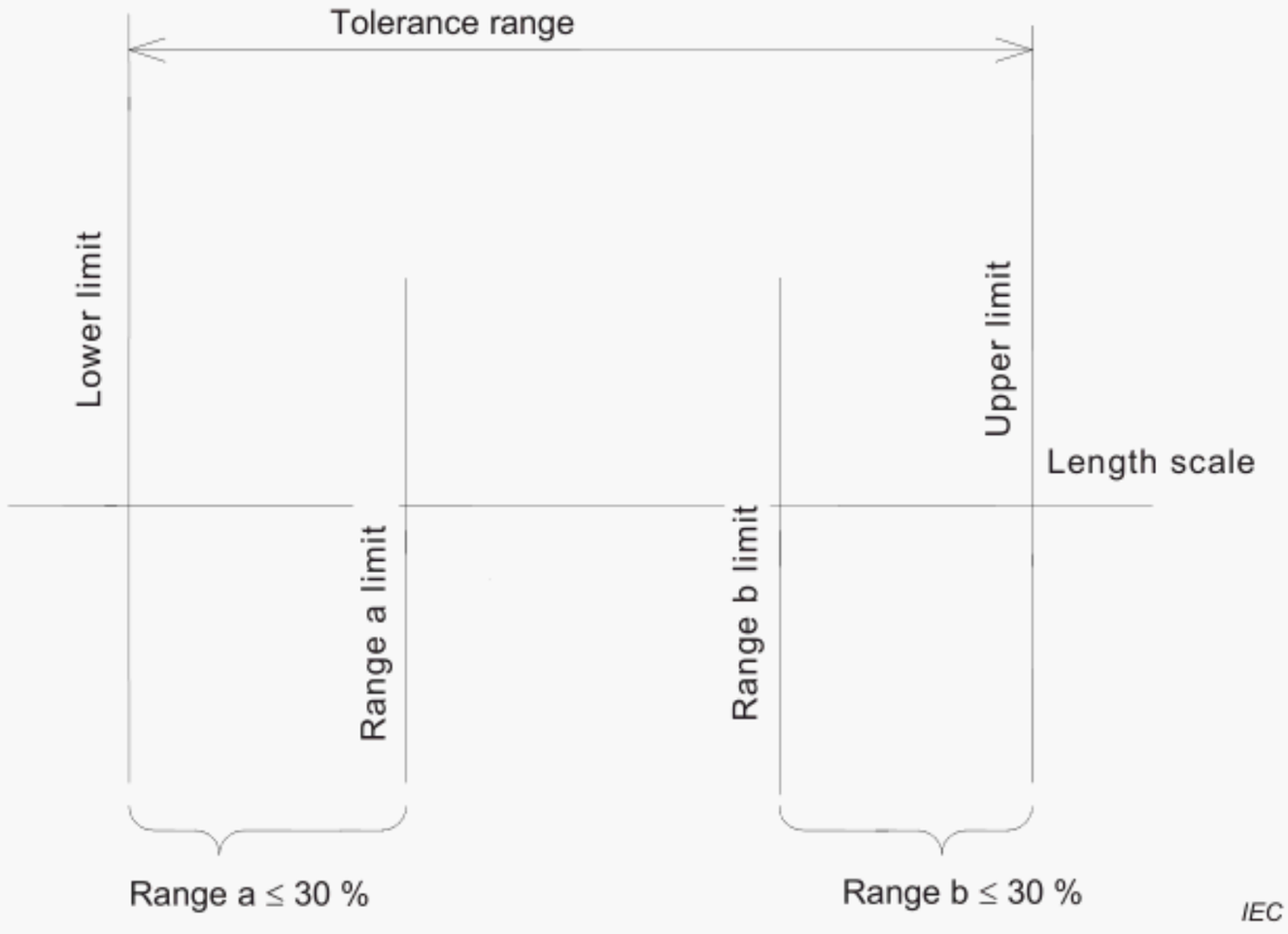
*f*2 minimal measured value of the copper thickness

Figure 2 – Location and example of the transversal microsection for measuring the copper thickness

NOTE It is important that all holes of a test board have the same thickness of copper plating. The difference of diameters has therefore to be made via different diameters of the drill tools respective holes in injection moulded boards. It is recommended to manufacture test boards having both minimal and maximal holes on it, because then it can be excluded that the holes have different thicknesses of the copper plating under ordinary manufacturing conditions.

The plated hole tolerance range is the difference between the minimum and the maximum diameter of the plated hole. For testing of the quality of the termination itself, it is necessary to perform tests of the contact close to the maximal hole and close to the minimal hole as well. Measure the holes in the test board and identify which hole diameters are within range a and also the hole diameters within range b of Figure 3.

The hole diameter ranging is shown in Figure 3.



Dimensions in millimetres

NOTE not to scale

Figure 3 – Example of hole ranges

Further plating requirements shall be specified by the manufacturer.

4.5 Press-in connections

a) The combination of press-in termination, printed board and termination insertion tool shall be compatible and specified by the manufacturer.

b) The press-in termination shall be correctly mounted in the plated-through hole of the printed board as specified in the specification of the manufacturer.

c) The press-in operation may result in deformation of the plated-through hole. The limits of deformation shall be according to 5.2.2.5.

d) The press-in termination shall not be damaged (e.g. cracked or bent).

e) There shall be no deformation of the printed conductor and/or the plating of the plated-through hole caused by the termination insertion tool or device.

f) There shall be no lands fractured or lifted.

g) There shall be no delamination, blistering or cracking of layers.

h) After the press-in operation, no detrimental plating particle chips shall be visible.

i) At the opposite side of the press-in direction, no plating of the plated-through hole shall be loosened.

4.6 Manufacturer´s specification

The following information shall be supplied by the manufacturer of the press-in zone and/or the component:

a) Printed board and hole information
   - printed board material;
   - maximum number of conductive layers;
   - printed board minimum and maximum thickness;
   - printed board plating materials;
   - finished plated-through hole dimensions, including tolerances;

- hole dimension prior to plating.

b) Press-in zone information
   - material of the press-in termination;
   - plating.

c) Information on the application
   - straight or right angle termination;
   - rear plug up;
   - wrapped connection;
   - individual press-in termination;
   - connector with pre-assembled press-in terminations.

d) Instructions and tools for the press-in operation
   - tools to be used;
   - number of replacements with a new press-in termination.

e) Forces
   - maximum press-in force per termination;
   - minimum push-out force per termination after tests.

f) Any other significant information.

5 Tests

5.1 General remarks

5.1.1 General

As explained in the introduction, there are two test schedules which shall be applied according to the following conditions.

a) Press-in connections, according to the requirements in Clause 4 and the requirements in the manufacturer's specification, shall be tested in accordance with the qualification test schedule in 5.3.2.

   This test schedule is intended to be applied on individual press-in terminations without component housing.

b) Press-in connections which are part of a component and already qualified to the qualification test schedule shall be tested in accordance with the application test schedule in 5.3.4.

   This test schedule is intended to be applied on complete components consisting of multiple press-in terminations mounted in a component housing.

The application test schedule shall be implemented in the detail standard of the component in such a way that the duplication of tests may be avoided.

Therefore, the test phases in test group D (see 5.3.4.1) may be inserted in any test group of the component specification, as long as the sequence, conditioning and environment comply with the requirements of this standard.

5.1.2 Standard conditions for testing

5.1.2.1 General

Unless otherwise specified, all tests shall be carried out under standard conditions for testing as specified in IEC 60512-1.

The ambient temperature and the relative humidity at which the measurements are made shall be stated in the test report.

In case of dispute about test results, the test shall be repeated at one of the referee conditions of IEC 60068-1.

5.1.2.2 Preconditioning

Unless otherwise specified, the connections shall be preconditioned under standard conditions for testing in accordance with the requirements of IEC 60512-1 for a minimum period of 24 h.

5.1.2.3 Recovery

Unless otherwise specified, the specimens shall be allowed to recover under standard conditions for testing for a period of a minimum of 2 h after conditioning.

5.1.3 Mounting of specimens

For the qualification test schedule, the sets of parts consist of press-in terminations and a test board with plated-through holes. When mounting is required in a test, the parts shall be mounted using the mounting method described in the manufacturer's specification.

For the application test schedule, complete components shall be pressed on a printed board, using the normal mounting method, unless otherwise specified in the component specification or in the manufacturer's specification.

NOTE For the definitions of sets of parts and specimen, see 3.6 and 3.7.

5.2 Test and measuring methods

NOTE As far as test methods are described in this subclause, it is intended that the description be replaced by a reference to IEC 60512 as soon as the relevant test method is included in IEC 60512.

5.2.1 General examination

5.2.1.1 Visual examination of parts and specimens

The test shall be carried out in accordance with IEC 60512, test 1a. Magnification shall be five times, and all parts and specimens shall be examined to ensure that the applicable requirements of 4.5 have been met.

5.2.1.2 Examination of dimensions

The test shall be carried out in accordance with IEC 60512, test 1b. All parts shall be examined to ensure that the applicable requirements of 4.3 to 4.6 have been met.

5.2.1.3 Inspection of tools

The tools shall be inspected and controlled according to the manufacturer's instructions and specifications to be sure that the applicable requirements of 4.2 and 4.6 have been met.

5.2.2 Mechanical tests

5.2.2.1 Bending

This test is only applicable to press-in terminations having a free post length of ≥10 mm protruding from the board.

The object of this test is to assess the ability of a press-in connection to withstand the mechanical stress caused by an unintentional bending of the free length of the termination and following adjustment.

The test specimen shall consist of a printed board or a part of a printed board, with an inserted press-in termination having a free post length of ≥ 10 mm for bending.

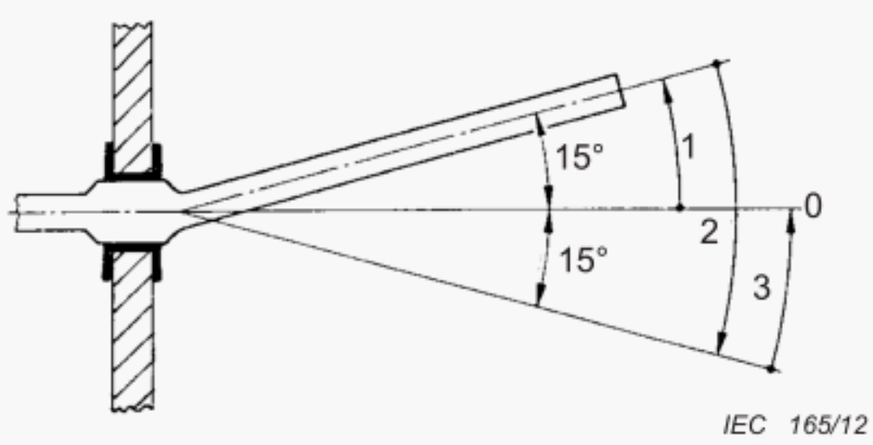


Figure 4 – Test arrangement, bending

The free end of one press-in termination shall be bent in one direction and the free end of a second press-in termination shall be bent in the perpendicular direction. Bending over distances 1, 2 and 3 shall be considered to be one cycle as shown in Figure 4.

Test severity: One cycle shall be carried out unless otherwise specified by the manufacturer.

5.2.2.2 Press-in force

The upper limit of the press-in force shall be specified by the manufacturer.

The recommended speed for application of the press-in force during measurement shall be 25 mm/min to 50 mm/min unless otherwise specified by the manufacturer.

5.2.2.3 Push-out force

This test is only applicable in the qualification test schedule.

The object of this test is to check the minimum value and assess the ability of a press-in connection to withstand the mechanical stress caused by a force acting along the longitudinal axis of the press-in termination.

The test specimen shall consist of a test-board with a press-in termination inserted as shown in Figure 5.

After the press-in operation and before carrying out the push-out test, the test specimens shall be allowed to recover for a period of at least 24 h.

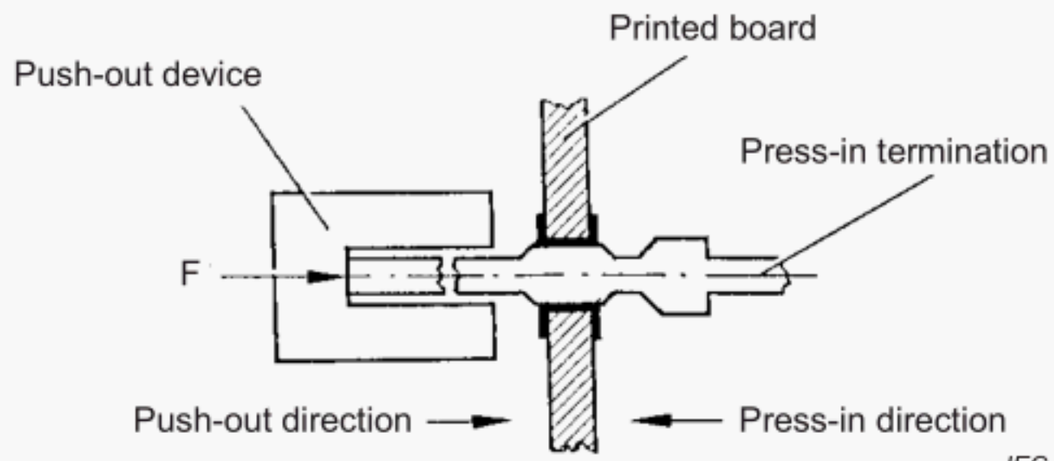


Figure 5 – Test arrangement – push-out force

A force *F* shall be applied to the press-in termination against the press-in direction.

A suitable device shall be used, for example a tensile testing machine. The head of the tensile testing machine shall travel steadily at a speed < 12 mm/min.

The specimen shall be tested until the press-in termination moves in the plated-through hole of the printed board. The ultimate load shall be measured.

Where, for technical reasons, when carrying out the push-out test, the push-out operation cannot be applied, a pull-out operation may be applied.

For information on additional mechanical stresses acting on the press-in termination due to the application of the press-in connection, see A.6.1.

5.2.2.4 Vibration

This test is only applicable in the application test schedule.

The test shall be carried out in accordance with IEC 60512, test 6d.

The test specimens shall be firmly held on a vibration table.

A suitable test arrangement for testing press-in connections shall be defined in the component specification.

Preferred severities are given in Table 2.

Contact disturbance shall be monitored during vibration test in accordance with IEC 60512, test 2e.

Requirement: No contact disturbance exceeding 1 μs unless otherwise specified in the applicable detail standard of the component.

Table 2 – Vibration, preferred test severities

Range of frequency	10 Hz to 55 Hz	10 Hz to 500 Hz	10 Hz to 2 000 Hz
Full duration	2 h $^{+5}_{0}$ min	6 h $^{+5}_{0}$ min	6 h $^{+5}_{0}$ min
Displacement amplitude below the cross-over frequency	0,35 mm	0,35 mm	1,5 mm
Acceleration amplitude above the cross-over frequency	–	50 m/s^2	200 m/s^2
Directions	Three axes	Three axes	Three axes
Number of sweep cycles per direction	8	10	8

Unless otherwise specified in the relevant component detail standard, the 10 Hz to 500 Hz range shall be carried out.

5.2.2.5 Microsectioning

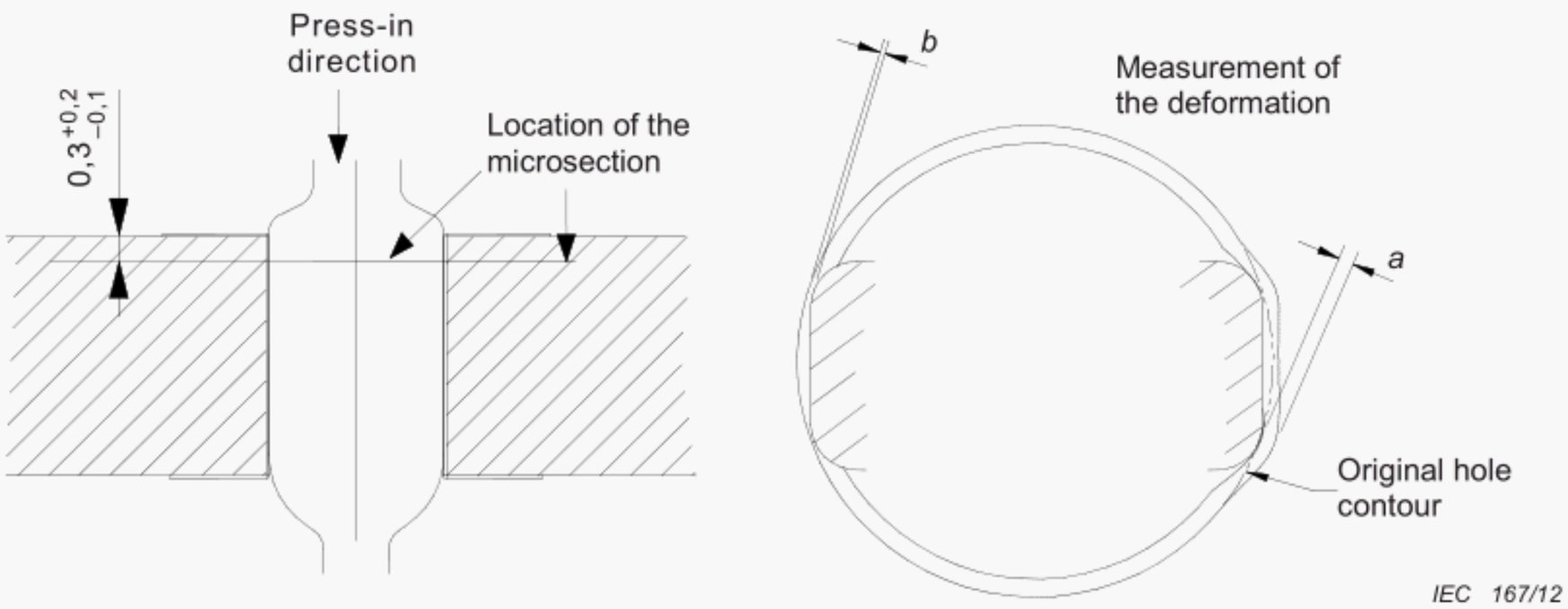
5.2.2.5.1 General

The test shall be carried out in accordance with IEC 61188-5-1.

5.2.2.5.2 Transverse sectioning

The deformation "*a*" of the drilled hole contour in the plated-through hole shall be smaller than 70 μm.

The minimum remaining thickness "*b*" of the plating shall be more than 8 μm. There shall be no cracks in the plating of the through hole. See Figure 6. Compliance is checked by inspection and measurement.



Dimensions in millimetres

Figure 6 – Transverse section of a press-in connection

5.2.2.5.3 Longitudinal sectioning

The deformation "*c*" of the connected pattern to the plated-through hole shall be not more than 50 μm (see Figure 7).

Neither the plating of the plated-through hole nor the conductor may have cracks ("*d*"). For double-sided printed boards, these requirements are applicable to the outer layers.

Compliance is checked by inspection, measurement and visual examination according to 5.2.1.1. The measurement shall be recorded.

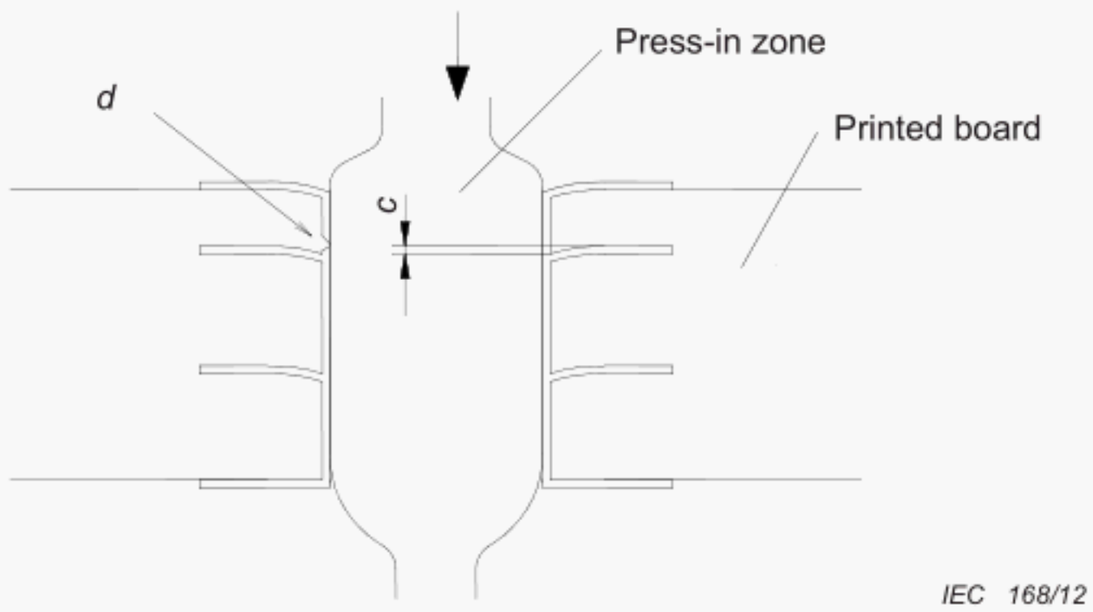


Figure 7 – Longitudinal section of a press-in connection

The area of contact between the press-in zone and the hole shall be appropriate to carry the specified current.

5.2.2.6 Replacement (repairing)

The manufacturer shall specify if replacement is allowed and, if so, the number of replacements allowed. The test of the ability of a press-in zone to withstand replacement and its possibility to show equal performance is made by having a part of the press-in zone replaced.

Replacement is always carried out with new press-in terminations, using the tools specified by the manufacturer. All requirements are identical to those applicable to the first press-in cycle. The repaired sets of parts shall be inspected. No loose parts of metal or cracks in the board layer or conductors shall be visible.

If the component allows the replacement of the press-in termination, the operation and the tools shall be specified by the manufacturer of the component or a detail standard.

5.2.3 Electrical tests

5.2.3.1 Contact resistance

The contact resistance test shall be carried out in accordance with IEC 60512, test 2a. Care shall be taken regarding the resolution of the micro-voltmeter as well as corrections for thermo-electrical voltage. The measuring points should be made as close as possible to minimize the bulk resistance.

Figure 8 shows an example of the test arrangement.

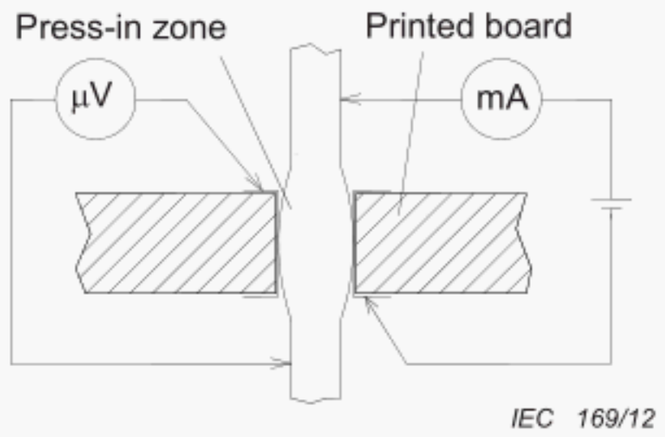


Figure 8 – Test arrangement for contact resistance

Requirements after mechanical, electrical or climatic conditioning:

a) Qualification test schedule: The maximum change of contact resistance shall be less than 0,5 mΩ for each test phase.

b) Application test schedule: The maximum change of contact resistance shall be specified in the component detail standard, if any, or in the manufacturer's specification.

If necessary, when direct measurement of press-in connection is not possible, an overall measurement of contact resistance shall be specified and the requirement for the press-in connection shall be included in the value required for the component.

5.2.4 Climatic tests

5.2.4.1 General

The detail standard of the component, if any, or the manufacturer's specification shall prescribe the upper category temperature (UCT) and the lower category temperature (LCT) which shall be used in the following tests.

When the printed board associated with this component has a different temperature category, the climatic test shall be carried out with the temperature category either of the component, or the printed board, whichever is the less severe.

5.2.4.2 Rapid change of temperature

The test shall be carried out in accordance with IEC 60512, test 11d. Unless otherwise specified by the manufacturer of the component or a detail standard, the following details shall apply:

– low temperature	T_A	–40 °C (LCT)
– high temperature	T_B	85 °C (UCT)
– duration of exposure	t_1	30 min
– number of cycles		10

5.2.4.3 Climatic sequence

The test shall be carried out in accordance with IEC 60512, test 11a. Unless otherwise specified by the manufacturer of the component or a detail standard, the following details shall apply:

– dry heat, test temperature	85 °C (UCT)
– cold, test temperature	–40 °C (LCT)
– damp heat, cyclic, remaining cycles	5

5.2.4.4 Dry heat

The test shall be carried out in accordance with IEC 60512, test 11i. Unless otherwise specified by the manufacturer of the component or a detail standard, the following details shall apply:

– test temperature 85 °C (UCT)
– test duration 1 000 h

5.3 Test schedules

5.3.1 General

If the press-in zone shall be qualified for more than one type of printed board (see 4.4.2), there shall be one complete set of specimens for each type.

Samples shall be subjected to usual manufacturing processes and the plated-through hole dimensions shall be within the tolerance range as shown in 4.4.4 and Table 1.

Prior to any testing, the test-boards shall be measured and holes shall be listed or marked with the appropriate range to which they belong.

It is important that the press-in operation is carried out correctly with production tools. The equipment and tools used shall be recorded in the test report.

5.3.2 Qualification test schedule

5.3.2.1 Test group A

Sets of parts for test group A shall be a minimum of six. If replacement is applicable additional press-in terminations have to be provided. All holes shall be with diameter in the lower 30 % of the tolerance range (range a) (see 4.4.4).

Table 3 – Qualification test schedule – Test group A

Test phase	Test		Measurement to be performed		Requirement
	Title	Subclause	Title	Test No. of IEC 60512	Subclause
AP1	Mounting	5.3.2.1	Press-in force		5.2.2.2
AP2 if applicable	Replacement	5.2.2.6			
AP3			Visual examination (and evaluation of tools)	1a	4.5
AP4	Microsectioning	5.2.2.5			
AP4.1 Three specimens	Transverse sectioning	5.2.2.5.2			5.2.2.5.2
AP4.2 Three specimens	Longitudinal sectioning	5.2.2.5.3			5.2.2.5.3

5.3.2.2 Test group B

Sets of parts for test group B shall be a minimum of 14. If replacement is applicable additional press-in terminations have to be provided. A minimum of seven holes shall be in range a and a minimum of seven holes shall be with diameter in the upper 30 % of the tolerance range (range b) (see 4.4.4).

If a press-in zone is specified to be replaceable, the push-out force shall be measured after the number of replacements specified.

Table 4 – Qualification test schedule – Test group B

Test phase	Test		Measurement to be performed		Requirement
	Title	Subclause	Title	Test No. of IEC 60512	Subclause
BP1	Mounting	5.3.2.2	Press-in force		5.2.2.2
BP2 if applicable	Bending[a)]	5.2.2.1			
BP3			Push-out force		5.2.2.3
BP4 if applicable	Replacement	5.2.2.6			
BP5 if applicable		5.2.2.3	Push-out force		5.2.2.3
[a)] This test should be done on the seven sets of parts with holes in range b, if applicable.					

5.3.2.3 Test group C

Sets of parts for test group C shall be a minimum of 200. A minimum of 40 of the press-in terminations shall be mounted in holes of range a, and a minimum of 40 shall be in range b (see 4.4.4).

If replacement is applicable, a minimum of 40 of the specimens shall be mounted in holes which, prior to the test, have been used according to the specified number of replacements allowed, 20 shall be in holes of range a, and 20 shall be in holes of range b (see 4.4.4). New press-in terminals shall be used in each replacement. All specimens shall be subjected to IEC 60512, test 1a. See the requirements in 4.5.

Table 5 – Qualification test schedule – Test group C

Test phase	Test		Measurement to be performed		Requirement
	Title	Subclause	Title	Test No. of IEC 60512	Subclause
CP1	Mounting	5.3.2.2			
CP2 if applicable	Replacement	5.2.2.6			
CP3			Contact resistance – millivolt level method	2a	5.2.3.1
CP4	Rapid change of temperature	5.2.4.2		11d	
CP5	Climatic sequence	5.2.4.3		11a	
CP6	Dry heat	5.2.4.4		11i	
CP7	No required tests and measurements				
CP8			Contact resistance – millivolt level method	2a	5.2.3.1
CP9		5.2.2.3	Push-out force		5.2.2.3[a)], minimum push-out force per termination according to 4.6 e)
[a)] The test for push-out force has to be performed on 14 of the 200 terminations, 7 of them out of range a and 7 of them out of range b.					

5.3.3 Flow chart

For quick orientation, the qualification test schedule described in 5.3.2 is shown as a flow chart in Figure 9:

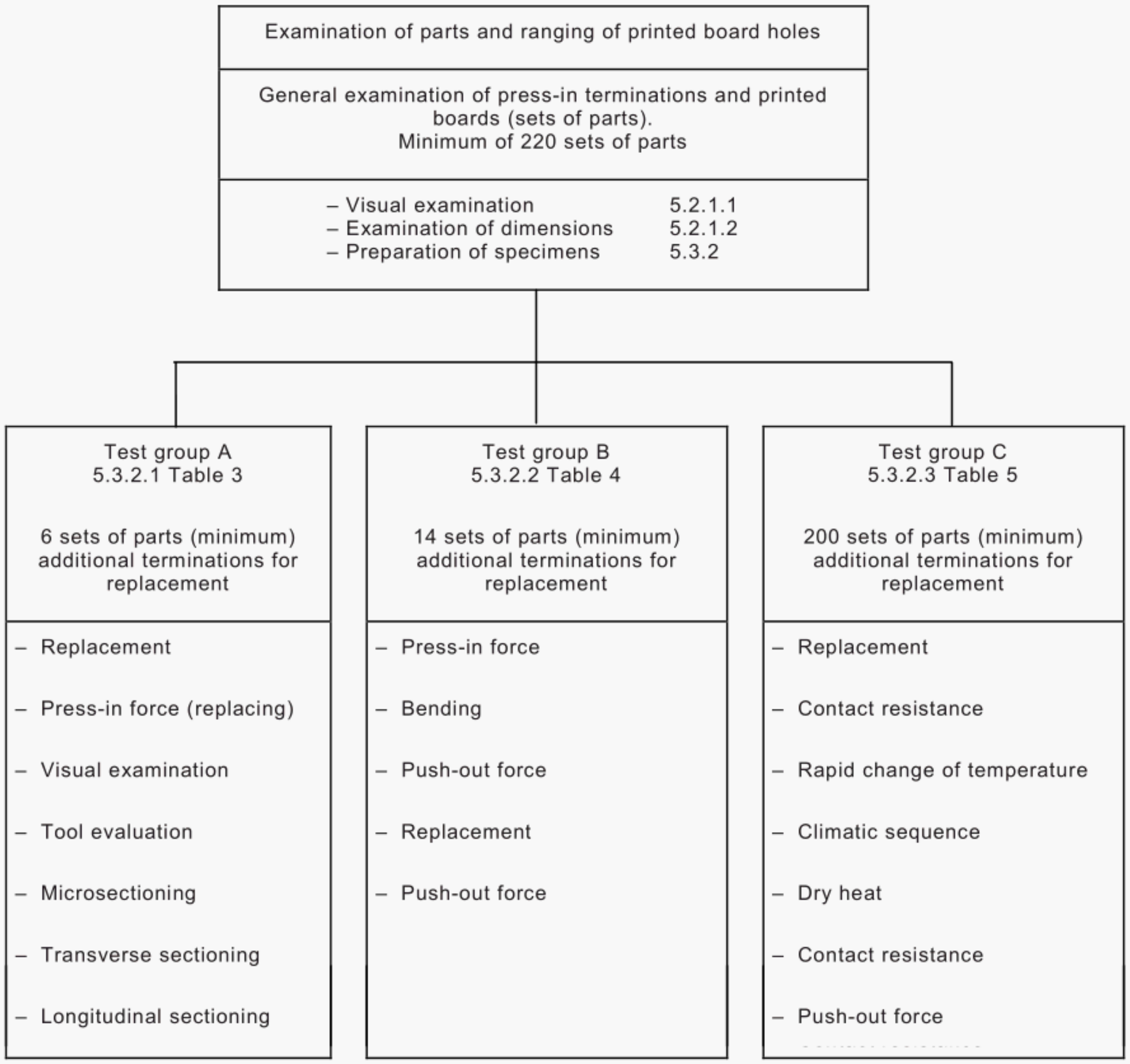


Figure 9 – Qualification test schedule

5.3.4 Application test schedule

5.3.4.1 General

The purpose of the application test schedule is to be implemented in a component specification. Only press-in zones approved by the qualification test are allowed for this test. The test references in each table refer to methods detailed in the IEC 60512 family of test methods. IEC 60512-1-100 can be used to point the reader to the correct test method document. For example, test 1a, visual examination, is now IEC 60512-1-1.

5.3.4.2 Test group D

Where this test schedule is applicable (see 5.1), six components shall be pressed into the printed board(s) of the application with the tools specified by the manufacturer, and according to the manufacturer's recommendation. If the total number of terminations is less than 40, the number of components shall be increased.

A press-in termination mounted in the component and pressed into the printed board is called a specimen.

All specimens shall be subjected to the following tests.

Table 6 – Application test schedule – Test group D

Test phase	Test		Measurement to be performed		Requirement
	Title	Subclause	Title	Test No. of IEC 60512	Subclause
DP1			Contact resistance – millivolt level method	2a	[a]
DP2	Vibration	5.2.2.4	Contact disturbance	6d and 2e	5.2.2.4
DP3	Rapid change of temperature	5.2.4.2		11d	
DP4	Dry heat	5.2.4.4		11i	
DP5			Contact resistance – millivolt level method	2a	[a]
DP6 Eight specimens	Microsectioning	5.2.2.5			
DP6.1 Four specimens	Transverse sectioning	5.2.2.5.2			5.2.2.5.2
DP6.2 Four specimens	Longitudinal sectioning	5.2.2.5.3			5.2.2.5.3

[a] According to the component specification.

5.4 Test report

5.4.1 Qualification test report

5.4.1.1 General

A test report of the qualification test shall be written by the test house.

5.4.1.2 Input information

The test report shall contain the following input information, mainly based on the specification and the recommendations of the manufacturer:

– types of printed boards to qualify against;
– hole dimensions including tolerances, according to the manufacturer's specification;
– surface treatment (preflux, lubricant, etc.) of the plated-through hole;
– number of replacements allowed;
– mounting and replacing tool descriptions and dimensions;
– maximum press-in force;
– minimum push-out force after tests;

– additional information necessary for the user and the test house;
– any deviation from the standard.

5.4.1.3 Output information

The test report shall contain the following output information:

– test house, test date and test operator(s);
– equipment and tools used for the test;
– details of the tests required in the IEC 60512 series;
– all results from the measurements, compliance or non-compliance noted;
– summary/judgement. If approved with some non-compliance, this shall be justified.

5.4.2 Application test report

5.4.2.1 Input information

The test report shall contain the following input information:

– qualification test report;
– appropriate connector detail standard;
– additional information necessary for the user and test house;
– any deviation from the standard.

5.4.2.2 Output information

The test report shall contain the following output information:

– test house, test date and test operator(s);
– equipment and tools used for the test;
– all results from the measurements, compliance or non-compliance noted;
– summary/judgement. If approved with some non-compliance, this shall be justified.

If the application test is a part of a complete connector qualification test, the above-listed output information may be a part of the full test report.

Annex A
(informative)

Practical guidance

A.1 General

While the normative part of this standard describes requirements and tests, the intention of the practical guidance is to provide helpful information in regard to the usage of press-in connections.

A.2 Current-carrying capacity

In general, the total area of contact between the press-in zone of the press-in termination and the metal plating of the plated-through hole in a printed board of a press-in connection made in accordance with this standard should result in a larger cross-section than that of the minimum press-in termination cross-section. Therefore, the current-carrying capacity of the press-in connection will be at least equal to that of the press-in termination. The limiting factor will normally be the conductors in the printed board.

A.3 Tool information

A.3.1 Termination insertion tool

Generally, a termination insertion tool is required to insert the termination into the printed board. The tool shall be able to apply the insertion force on those parts of the termination which are designed and intended for this purpose. The tool should also provide for a correct insertion depth of the termination in the printed board. Care should be taken that functional surfaces of the termination are spared and also that the printed board remains undamaged by the insertion tool.

Different kinds of termination insertion tools are used, such as

a) single-termination insertion tools, mostly power operated with an automatic positioning device. These tools are especially used in those cases where a large number of terminations should be inserted in a free pattern;

b) comb insertion tools: they are used in those cases where terminations in a fixed pattern should be inserted; for example in a row with a constant pitch;

c) assembly insertion tools: in some cases, the terminations are part of a pre-assembled product, for example a connector. Then, a specially designed tool should be used. This tool applies the force directly on the terminations or pushes on another part of the pre-assembled product which should be strong enough to pass the force onto the termination.

A.3.2 Support block

During insertion of the terminations, the printed board should be supported by a device specially designed for that purpose. It should support the printed board as close as possible to the hole in which the termination is inserted and it should be large enough to carry the printed board to prevent bow.

The block can be made of metal, for example steel or aluminium, or of plastic material and it should be of sufficient strength to withstand the insertion forces. Care should be taken at all times to avoid damage to the printed board. In addition, the height of the support block should be such that the total length of the inserted termination can be accepted.

A.3.3 Termination removal tool

When a press-in termination is to be removed, a specially designed tool should be used. Such a tool pushes out the termination opposite to the direction in which it is inserted.

Care should be taken that the printed board is properly supported and that it is not damaged. In case of repairing the press-in termination should not be used a second time and should be replaced by a new one.

The insertion of a single repair termination should be carried out by a specially designed tool.

During insertion of a repair termination, care should be taken that the termination is inserted in the proper direction, to the correct depth and without damaging the printed board.

A.4 Press-in termination information

A.4.1 General

Two types of press-in terminations are in use:

a) solid press-in terminations;

b) compliant press-in terminations.

In the case of solid press-in terminations, the force necessary to establish a good mechanical and electrical stability should be generated by the deformation of the plated-through hole of the printed board.

In the case of compliant press-in terminations, it is mainly the press-in zone which undergoes plastic deformation as its residual elasticity generates the necessary force, while the deformation of the plated-through hole does not occur or is much less than in the case of a solid press-in termination.

It should be noted that performance may vary within and between the two types of terminations. Care should be taken to ensure that the termination is suitable for its intended application.

Press-in connections with wrap posts are subjected to torsional forces during the wrapping process. Therefore, the torsional strength of a press-in connection having a press-in termination with a wrap post should be in accordance with IEC 60352-1.

A.4.2 Design features

The design of a press-in termination and its press-in zone should be such that:

– all surfaces of the press-in termination which come into contact with the plated-through hole are made to minimize damage to the metal plating of the plated-through hole and to ensure that a good contact function is established;

– the press-in zones are provided with a lead-in;

– the press-in termination is provided with means, for example a shoulder or a suitable surface, by which the press-in force can be applied.

For the shape of the press-in zone, a wide variety of designs can be used.

The press-in termination should be so designed that a press-in connection is achieved by inserting the press-in zone to a predetermined depth in a specified plated-through hole in the board.

A.4.3 Materials and surface finishes

The press-in terminations will often be an integral part of a contact element and therefore of the same copper-based alloy. The choice of material will depend upon the size and function of the part but should equally be suited to the requirements of a good, stable electrical connection.

All materials are subject to stress relaxation depending on time, temperature and stress.

The termination material and design should be such that the force maintaining the connection will not decrease with time to a degree where the connection suffers an unacceptable increase in resistance.

The surface finish of the press-in zone, and its compatibility with the finish of the plated-through hole in the printed board shall be specified by the manufacturer. See also A.6.4.

A.4.4 Press-in terminations with connector contact elements

A.4.4.1 General

Press-in terminations are often provided with connector contact elements. Usually, there is a contact blade or spring, at the front end of the termination suitable for insertion/withdrawal of a printed board and/or a contact blade at the rear end of the termination suitable for insertion/withdrawal of a free connector.

These contact elements should be in accordance with the relevant connector specifications.

A.4.4.2 Axial strength of press-in connections with connector contact elements

Press-in connections with connector contact elements are subjected to axial forces during insertion and withdrawal of printed board assemblies and/or free connectors.

For information on external axial forces, see A.6.1.

A.4.4.3 True position

Where press-in terminations are intended to be parts of a multipole connector, the connector requirements regarding dimensions and tolerances on position and level of the contacts should be met, particularly with regard to printed board bending and level of contact tips (normal/ premating).

A.5 Printed board information

A.5.1 General

Printed boards should be compatible with press-in technology with respect to materials, design and dimensions.

Press-in terminations make use of the strength in the printed board to employ contact force. If a press-in zone is designed to be used for printed boards thinner than 1,5 mm, special care should be taken to avoid unintentional bending/bowing of the board.

A.5.2 Plated-through hole

To obtain a stable press-in connection, the press-in termination and the plated-through hole in the printed board shall be compatible.

Essential parameters, which are of great importance for the reliability of a press-in connection, are

a) the press-in termination regarding
   - design;
   - material characteristics;
   - dimensions;
   - characteristics of surface (finish, roughness, etc.);
b) the plated-through hole regarding
   - diameter of drilled hole and finished hole;
   - true position tolerance of hole pattern of printed board;
   - plating thickness, surface treatments and pre-processing;
   - characteristics of the plating material(s) (for example ductility, adhesion);
   - thickness of the printed board;
   - number of layers in a multilayer board;
   - characteristics of the base material of the printed board.

Minimum thickness of copper plating is given in 4.3.3. In general, plated-through holes are surrounded by lands which enhance the mechanical stability of the plated-through hole. Plated-through holes without lands may be susceptible to damage, for example displacing the copper tube.

For further information, see IEC 61188-5-1.

NOTE Actual used surface treatments and platings are: chemical tin (min. 0,8 μm Sn), tin plated (hot air levelling, HAL) (max. 15 μm Sn), chemical silver (0,1 – 0,3 μm Ag), chemical gold over nickel (0,05 – 0,12 μm Au over 3 – 7 μm Ni) and organic solderable preservative (OSP).

A.6 Connection information

A.6.1 General

In practice, press-in connections are subjected to different application conditions regarding the mechanical stresses acting on the press-in termination. Structural measures should ensure that such mechanical stresses are clearly less than the smallest push-out force of the press-in connection.

A.6.2 Repair of press-in connections

During its lifetime, a mounted electrical component with a press-in connection may fail. In such cases, it may be economic to replace it.

To remove a termination, it should be carefully extracted with a suitable tool. Care should be taken that the termination is not bent and the printed board is not damaged.

An example of a suitable tool is shown in Figure A.1.

Reinsertion of the previously inserted termination in the hole is not recommended. However, it is permissible to insert a new termination into the previously used hole, provided that the hole and the termination are capable of meeting the requirements specified by the manufacturer.

Repair procedures for a component with replaceable individual press-in zones should be specified by the manufacturer. But generally, a plated-through hole should not be re-used more than three times.

A solid press-in connection should not be replaced because of the permanent deformation of the plated-through hole of the printed board.

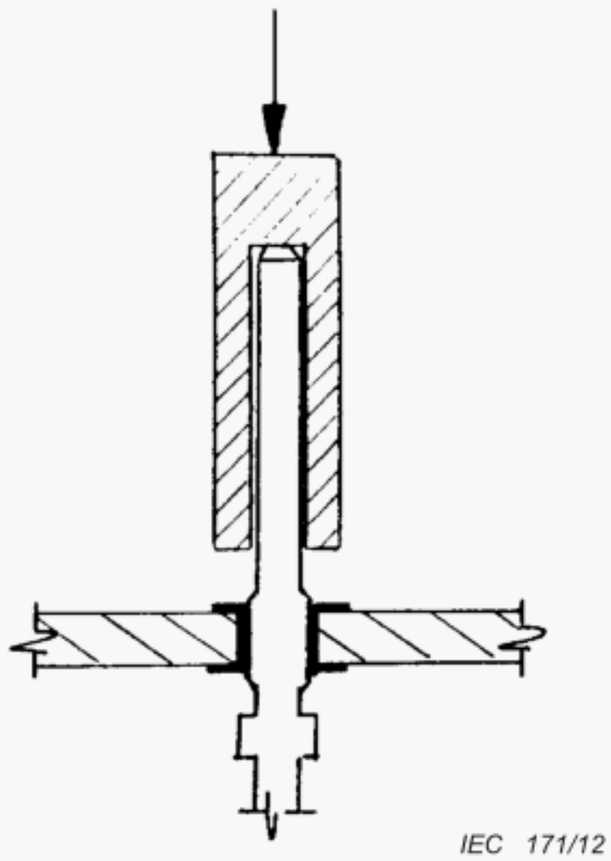


Figure A.1 – Example of a termination removal tool

A.6.3 Combination of press-in connections and soldered connections

It is not recommended to solder other components on a printed board already fitted with press-in terminations. If this is necessary, precautions should be taken to minimize the effect of the temperature on the press-in connections.

A.6.4 Bimetallic electrolytic corrosion effects

To avoid bimetallic electrolytic corrosion effects, care should be taken, when selecting the materials, that those chosen for press-in termination, surface and plating materials for the plated-through hole in the printed board are as close as practicable in the electrogalvanic series of metals.

A.6.5 Dimensioning of the hole

For the quality of a press-in connection the correct composition of the hole is essential:

– the choice of a suitable drill
– the copper plating and the
– additional plating (finish)

Additional plating is commonly added on the inside of the drilled hole to improve the quality sum up for the diameter of the finished plated-through hole. The type of additional plating material and the used plating process influence the tolerance stack.

The copper plating should be uniformly distributed about the full drill-depth. The composition is shown in a conceptual drawing in Figure A.2.

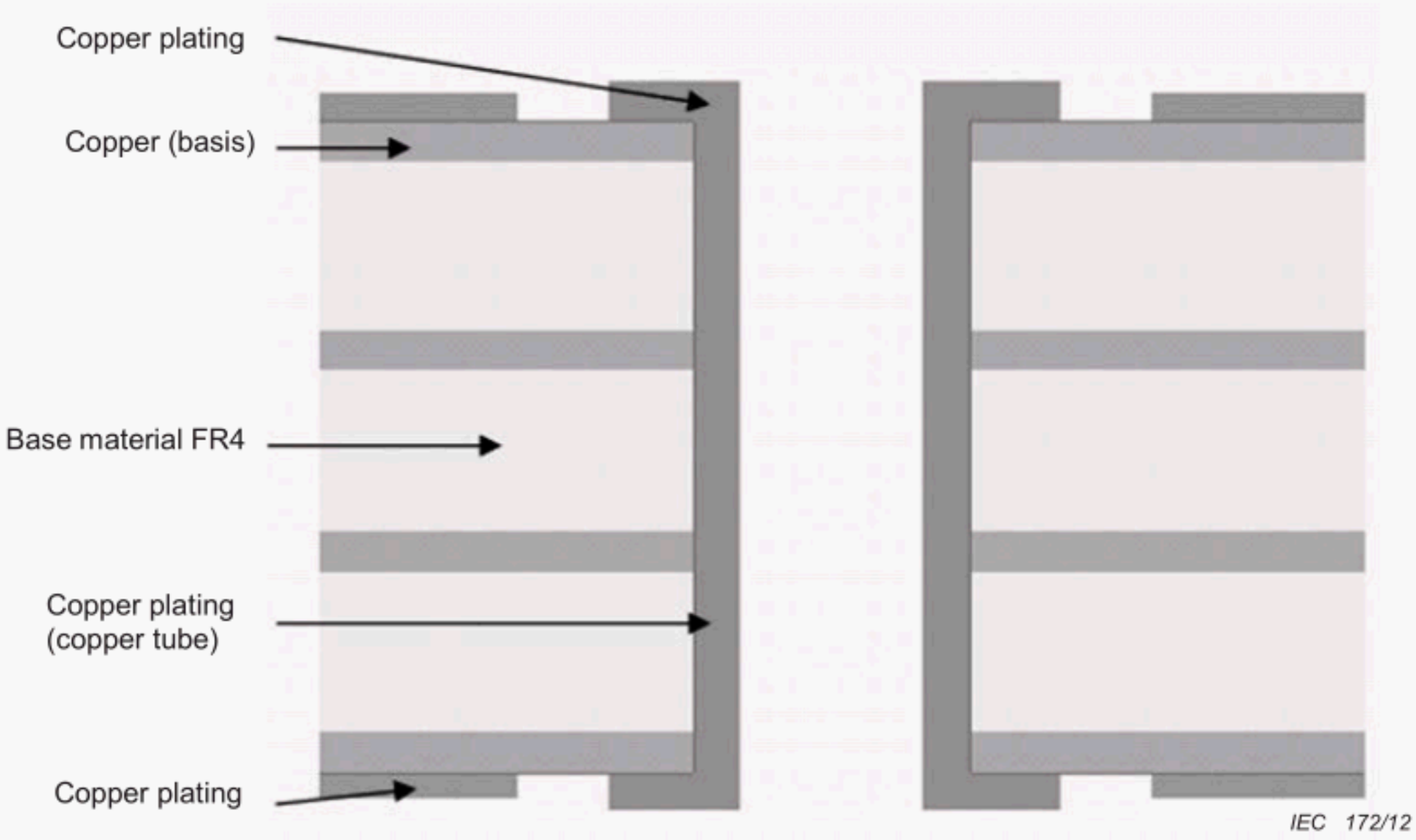


Figure A.2 – Conceptual composition of a four-layer printed circuit-board

Due to inaccuracies in manufacturing of through-holes and the galvanic process of copper plating (e.g. too little movement of electrolyte) there may be the possibility of having higher thicknesses of copper in the ends of the hole than in the middle zone. If this effect, called the galvanic-rim-effect, is too strong, this results in the following disadvantages:

– During testing a smaller end-diameter than the effective diameter of the press-in-connection is measured.
– The press-in zone of the contact will be deformed during the insert-process more than necessary.
– The press-in forces will be higher.

Because these disadvantages sum up to the galvanic-rim-effect, the manufacturer has to control the processes to limit the hole tolerances. It is recommended to make cut images to inspect.

A.6.6 Manufacturing of the hole, example with drilling for FR4

For the quality of a press-in connection the correct composition of the hole is essential. The diameter shall be according to the given tolerances. Additionally the copper plating should be at least 25 μm thick (see 4.4.4) and should not differ within a specific application. Therefore user and manufacturer of the printed board should specify the diameter of the finished plated-through hole, the diameter of the drilling-tool and the thickness of the plating.

When using a base material according to IEC 61249-2-4 the typical dimensioning of the hole is described in Table A.1 for a nominal diameter of 1,00 mm.

Table A.1 – Example for dimensioning the hole

Recommended diameter of the finished hole after plating and finish	1,05 mm
Thickness of finish (example Sn)	0,002 mm
Copper tube (to guarantee a thickness at least of 25μm)	0,06 mm
Addend for using resin/glassfibre matrix FR4 (taking into account additional reflow of resin, drill out-of-round, surface roughness, etc.)	0,03 mm
Optimal diameter of the drilling tool	**1,142 mm**
Diameter of the next available standard-drill-tool	1,15 mm
Resulting diameter of the finished plated-through hole (approx.)	**1,06 mm**

For other hole diameters the conditions are comparable, if the galvanic process and the plating facilities are similar. Therefore this may serve as good example.

A.6.7 Manufacturing of the hole with materials other than FR4

If other materials and manufacturing processes than those defined in IEC 61249-2-4 (FR4) are used, the required drill diameters may differ from the values as described in Table A.1.

For example, if the printed boards are manufactured via 3D-MID the hole will not be drilled, but formed during the injection process instead. The mould diameter results directly from the finished hole diameter plus two times the plating thickness.

Bibliography

IEC Guide 109:2003, *Environmental aspects – Inclusion in electrotechnical product standards*

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