

# INTERNATIONAL STANDARD

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

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INTERNATIONAL  
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International Standard IEC 60352-5 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This fifth edition cancels and replaces the fourth edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant changes with respect to the previous edition:

- a) revising the scope by removing the wording "... telecommunication equipment and in electronic devices employing similar techniques" and replacing it by "... electrical and electronic equipment and components" in the first paragraph;
- b) adding terms and definitions for 'board', 'hole' and 'metal board' to recognize that press-in terminations are being used in many non-printed board materials;

- c) editorial changes to clarify the difference between the two test schedules for qualification and application;
- d) modification of upper limit of copper thickness of the plated-through-hole to reflect actual market trends and manufacturing practices;
- e) removal of bending test, as this test is very specific for applications of press-in technology no longer common;
- f) adding graphs to document the press-in and push-out force, since this is common testing practice and provides further insight into mechanical performance of the contact zone;
- g) reducing the number of test specimens required, since in previous testing scheme a lot of test samples were discarded;
- h) new wording in 4.5 for cracked and bent terminations;
- i) added Figure 7b to show V and A connection locations when the press-in termination does not protrude through the bottom side of the board.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
48B/2810/FDIS	48B/2822/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60352 series, published under the general title *Solderless connections*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

## INTRODUCTION

This part of IEC 60352 includes requirements and relevant tests (normative) as well as a practical guidance in Annex A (informative) for press-in connections.

Two test schedules are provided.

- a) The qualification test schedule applies to individual press-in connections to demonstrate the suitability of the press-in zone.

These press-in connections 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.

The requirements and tests apply to all elements involved in the manufacturing of a press-in connection:

- the press-in termination, which may be part of a component (e.g. a multi-pole connector);
- the board, printed board or MID (moulded interconnect device) - (plated-through holes dimensions) for which the termination is suitable;
- the tool(s) required to produce the press-in connection.

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 document for simplicity to indicate the manufacturer of the press-in termination. The manufacturers of the other items playing a role in the qualification of press-in connections are specified, if needed, as the board manufacturer or the tool(s) manufacturer.

The practical guidance in Annex A (informative) serves as a guide for the workmanship required in 4.1. Attention is drawn to the fact that some industries (e.g. automotive, aircraft and aerospace, nuclear, military) may have specific workmanship standards and/or quality requirements, which are outside the scope of this document.

IEC Guide 109 advocates the need to minimize 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

This part of IEC 60352 is applicable to solderless press-in connections for use in electrical and electronic equipment and components.

The press-in connection consists of a termination having a suitable press-in zone which is inserted into a hole of a board.

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

The object of this document 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 are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60512-1, *Connectors for electrical and electronic equipment – Tests and measurements – Part 1: Generic specification*

IEC 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60512-1-2, *Connectors for electronic equipment – Tests and measurements – Part 1-2: General examination – Test 1b: Examination of dimension and mass*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-2-5, *Connectors for electronic equipment – Tests and measurements – Part 2-5: Electrical continuity and contact resistance tests – Test 2e: Contact disturbance*

IEC 60512-6-4, *Connectors for electronic equipment – Tests and measurements – Part 6-4: Dynamic stress tests – Test 6d: Vibration (sinusoidal)*

IEC 60512-11-1, *Connectors for electrical and electronic equipment – Tests and measurements – Part 11-1: Climatic tests – Test 11a – Climatic sequence*

IEC 60512-11-4, *Connectors for electronic equipment – Tests and measurements – Part 11-4: Climatic tests – Test 11d: Rapid change of temperature*

IEC 60512-11-9, *Connectors for electronic equipment – Tests and measurements – Part 11-9: Climatic tests – Test 11i: Dry heat*

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

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

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>.

#### 3.1

##### **board**

printed board or MID (moulded interconnect device) with plated-through holes or metal board with holes

#### 3.2

##### **hole**

finished plated-through hole in a printed board or MID

Note 1 to entry: Finished hole in a metal board may be plated or unplated.

#### 3.3

##### **metal board**

board consisting of solid, electrically conductive base material, which may have an electrically insulative coating applied

#### 3.4

##### **moulded interconnect device**

##### **MID**

injection moulded thermoplastic substrate which incorporates a conductive circuit pattern and integrates mechanical and electrical functions

#### 3.5

##### **press-in connection**

solderless connection made by inserting a press-in termination into a hole of a board

[SOURCE: IEC 60050-581:2008, 581-23-38, modified – deleted the words "plated-through" and "printed".]

#### 3.6

##### **press-in termination**

##### **press-in post**

termination having a specially shaped zone suitable to provide for a solderless press-in connection

[SOURCE: IEC 60050-581:2008, 581-23-31, modified – the word "section" is replaced by "zone" and the word "solderless" is added.]

### 3.7

#### **solid press-in termination**

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

[SOURCE: IEC 60050-581:2008, 581-23-32, modified – added wording "which behaves primarily rigidly and induces a deflection of the through hole".]

### 3.8

#### **compliant press-in termination**

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

[SOURCE: IEC 60050-581:2008, 581-23-33, modified – added wording "which causes a limited deflection of the through hole and a deformation of the press-in zone".]

### 3.9

#### **press-in zone**

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

[SOURCE: IEC 60050-581:2008, 581-23-43]

### 3.10

#### **termination insertion tool**

device used to insert press-in terminations or components equipped with press-in terminations into a board

[SOURCE: IEC 60050-581:2008, 581-24-29, modified – deleted the word "printed".]

### 3.11

#### **termination removal tool**

device for removing a press-in termination from a board

[SOURCE: IEC 60050-581:2008, 581-24-30, modified – deleted the word "printed".]

### 3.12

#### **set of parts**

one press-in termination and a test board with one or more holes

Note 1 to entry: The press-in termination is not mounted in the board.

### 3.13

#### **specimen**

board, or a part of a board, with a mounted press-in termination, with or without component parts

### 3.14

#### **manufacturer**

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

## 4 Requirements

### 4.1 General

The connections shall be processed in a careful and workmanlike manner in accordance with good current practice.

Annex A (informative) provides practical guidance and may constitute a benchmark for the assessment of workmanship.

NOTE Some industry sectors (e.g. automotive, aerospace, marine, nuclear, military) use workmanship standards which may be considered upon agreement between manufacturer and user.

The manufacturer shall provide instructions for the assembly of the connections.

### 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, i.e. press-in connections complying with the requirements of this document.

The tools shall be so designed that they do not damage the press-in termination or the 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 or MID or dimensions of the hole in the metal board.

#### 4.3.3 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.

Press-in terminations intended to be suitable for use in printed boards shall use four layer printed boards for testing unless otherwise specified in the detail product specification or in the manufacturer's specification.

For press-in zones for soldered printed boards, the test boards shall be prepared according to manufacturer's instructions.

Press-in terminations intended to be suitable for use in metal boards or MID shall use metal boards or MIDs with hole dimensions in accordance with the manufacturer's specifications.

##### 4.4.2 Materials

The manufacturer shall specify the board material for which the press-in zone is designed.

Examples of printed board base materials may be found in the IEC 61249 series.

##### 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 termination 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 termination is intended to be used.

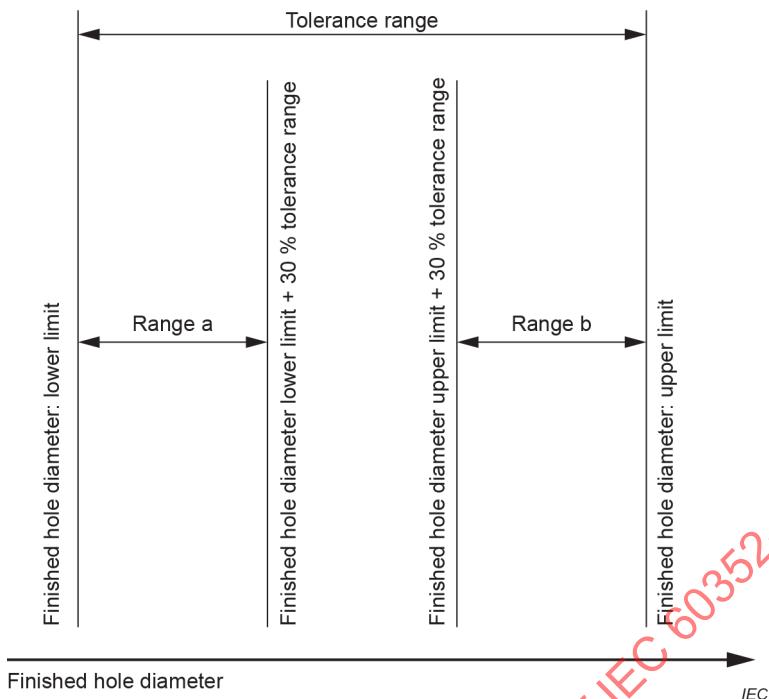
**NOTE** If a press-in termination is designed for board sizes of 1,6 mm to 2,4 mm, a test board with a nominal thickness of 1,6 mm (within tolerance range) is used.

##### 4.4.4 Hole

The minimum and the maximum finished hole diameter the press-in termination is intended for shall be defined by the manufacturer. The difference between the minimum and the maximum diameter of the finished hole is the tolerance range.

For testing of the quality of the press-in termination itself, it is necessary to perform tests of the press-in zone close to the minimum finished hole and close to the maximum finished 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 1.

At a tolerance range less than 0,06 mm (60  $\mu\text{m}$ ), the hole diameter shall be within the tolerance range. Then it is not necessary to identify maximal and minimal holes.



NOTE Not to scale.

**Figure 1 – Guide for hole ranges in a test board**

#### 4.4.5 Plated-through hole

For boards that include plated-through holes, the minimum and the maximum finished plated-through hole diameter that the press-in termination is intended for shall be defined by the manufacturer.

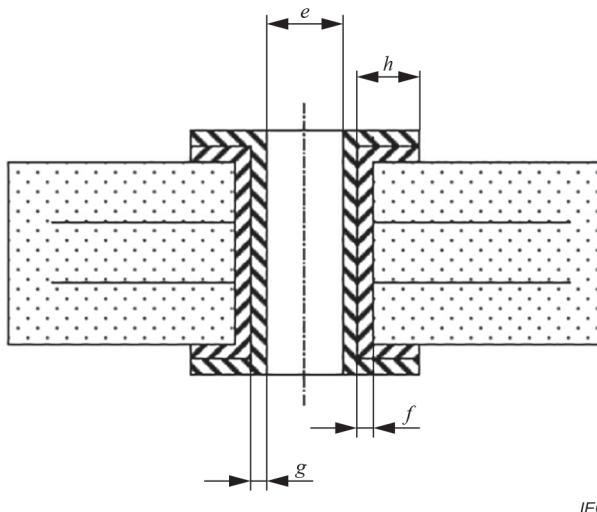
The plated-through holes shall fulfil the requirements in Table 1, where the item definition follows Figure 2.

**Table 1 – Plated-through hole requirements for test printed boards**

Item according to Figure 2	Description	Requirement
e	Range of test holes (Figure 1)	range a: lower 30 % of the tolerance range
		range b: upper 30 % of the tolerance range
f	copper thickness of the tube	25 µm min., 50 µm max. <sup>a</sup>
g	final plating	for information see A.4.3
h	pad width	0,15 mm min.

<sup>a</sup> Unless otherwise specified by the manufacturer.

It is important that all plated-through holes in a printed test board meet the requirements of Table 1. The difference of finished hole diameters range a and range b has therefore to be made via different diameters of the drill tools respective holes in MID. It is recommended to manufacture test boards having both range a and range b holes. This is in line with practical conditions and ensures that all holes meet the requirements of Table 1.

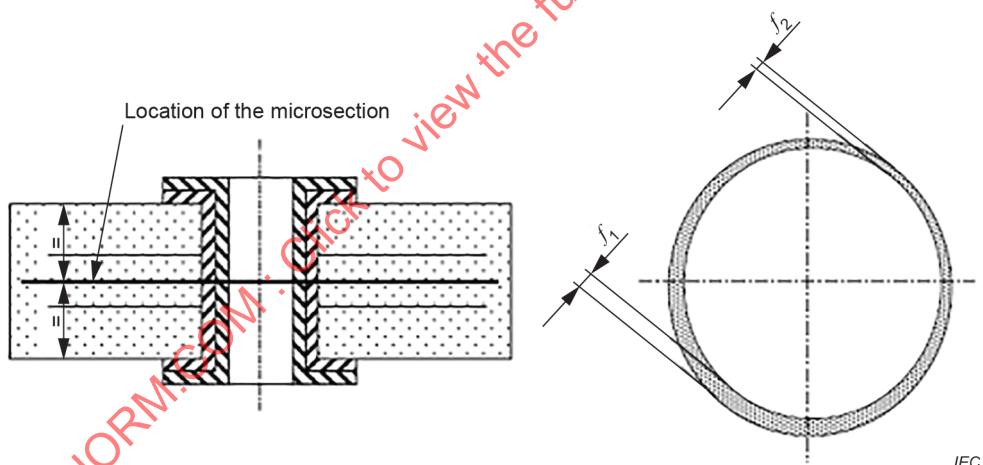


See Table 1 for symbol definitions.

**Figure 2 – Plated-through hole**

Further plating requirements shall be specified by the manufacturer. See A.5.2.

The thickness of the copper tube shall be measured by a transversal microsection through the hole according to Figure 3. 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 3 – Location and example of the transversal microsection for measuring the copper thickness**

#### 4.5 Press-in connections

- a) The combination of press-in termination, board and termination insertion tool shall be compatible and specified by the manufacturer.
- b) The press-in termination shall be correctly mounted in the hole of the board as specified in the manufacturer's specification.
- c) After the press-in operation, no detrimental plating particle chips shall be visible.
- d) At the opposite side of the press-in direction, no plating of the plated-through hole shall be loosened.

- e) No unintentional cracks or fractures shall be visible on the press-in termination after the press-in operation. Predesigned breaking locations described in the manufacturer's specification are permitted.
- f) The press-in operation may result in deformation of the plated-through hole plating layer(s). The limits of deformation shall be according to 5.2.2.4.
- g) 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.
- h) There shall be no lands fractured or lifted.
- i) There shall be no delamination, blistering or cracking of layers.

Examination of the press-in terminations and boards in terms of the above criteria shall be between 5 $\times$  and 200 $\times$  magnification.

#### **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;
  - fitness for soldered or unsoldered printed boards.
- b) Metal board and hole information:
  - board material;
  - board minimum and maximum thickness;
  - board plating materials (if appropriate);
  - finished hole dimensions, including tolerances.
- c) Press-in termination information:
  - material of the press-in termination;
  - plating.
- d) Information on the application:
  - straight or right angle termination;
  - rear plug up;
  - wrapped connection;
  - individual press-in termination;
  - connector or application with pre-assembled press-in terminations.
- e) Instructions and tools for the press-in operation:
  - tools to be used;
  - number of replacements with a new press-in termination;
  - offset location and tolerance.
- f) Forces:
  - maximum press-in force per termination;
  - minimum push-out force per termination after tests.
- g) 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 other parts.

- b) Press-in connections which are part of a component or application 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 for components with a number of press-in terminations. The application test schedule may be implemented in the detail product specification in such a way that the duplication of tests is avoided.

#### 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 set of parts consists of press-in terminations and a test board with holes. Metal boards may or may not have plated holes according to the manufacturer's specifications. 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, metal board or MID as appropriate, using the normal mounting method, unless otherwise specified in the detail product specification or in the manufacturer's specification.

NOTE For the definitions of "set of parts" and "specimen", see 3.12 and 3.13, respectively.

## 5.2 Test and measuring methods

### 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 60512-1-1 Test 1a. Magnification shall be between 5 times and 200 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 60512-1-2 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 Press-in force

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

The maximum force  $F$  shall be measured and the force-deflection graph documented.

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.

### 5.2.2.2 Push-out force

This test is only applicable in the qualification test schedule.

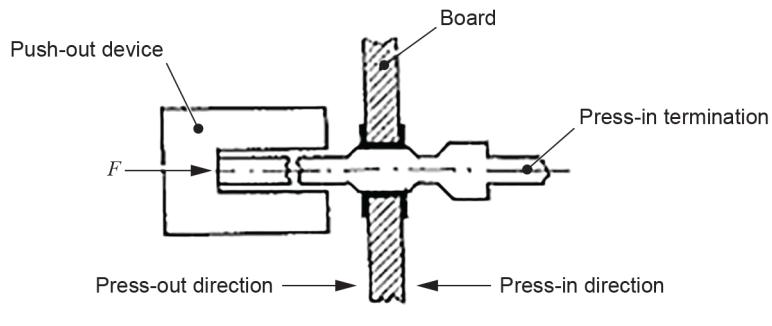
The object of this test is to ensure a minimum holding force of a press-in connection against the press-in direction.

If a push-out operation is not applicable, a pull-out operation may be performed.

The lower limit of the push-out force shall be specified by the manufacturer.

The specimen shall consist of a test board with a press-in termination inserted as shown in Figure 4.

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



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**Figure 4 – Test arrangement – push-out force**

A force  $F$  shall be applied to the press-in termination against the press-in direction. The maximum force  $F_{\max}$  shall be recorded and the force-deflection graph documented.

The specimen shall be tested until the press-in termination moves in the hole of the board as far as possible.

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

If the manufacturer defines the geometry of the push-out device, it shall be used for this test. If not then the test laboratory may create a suitable geometry. The push-out device shall be documented.

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.

#### 5.2.2.3 Vibration

This test is only applicable in the application test schedule.

The test shall be carried out in accordance with IEC 60512-6-4 Test 6d.

The specimens shall be firmly held on a vibration table.

A suitable test arrangement for testing press-in connections shall be defined by the manufacturer or shall be included in the detail product specification.

When direct measurement of press-in connection is not possible, an overall measurement of contact resistance shall be specified. The total resistance specified for the application shall not be exceeded.

Preferred severities are given in Table 2.

**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
<b>Full duration</b>	$120^{+5}_0$ min	$360^{+5}_0$ min	$360^{+5}_0$ min
<b>Displacement amplitude below the cross-over frequency</b>	0,35 mm	0,35 mm	1,5 mm
<b>Acceleration amplitude above the cross-over frequency</b>	–	$50 \text{ m/s}^2$	$200 \text{ m/s}^2$
<b>Directions</b>	Three axes	Three axes	Three axes
<b>Number of sweep cycles per direction</b>	8	10	8

Unless otherwise specified by the manufacturer or in the relevant detail product specification, the 10 Hz to 500 Hz range shall be carried out.

#### 5.2.2.4 Microsectioning for plated-through holes

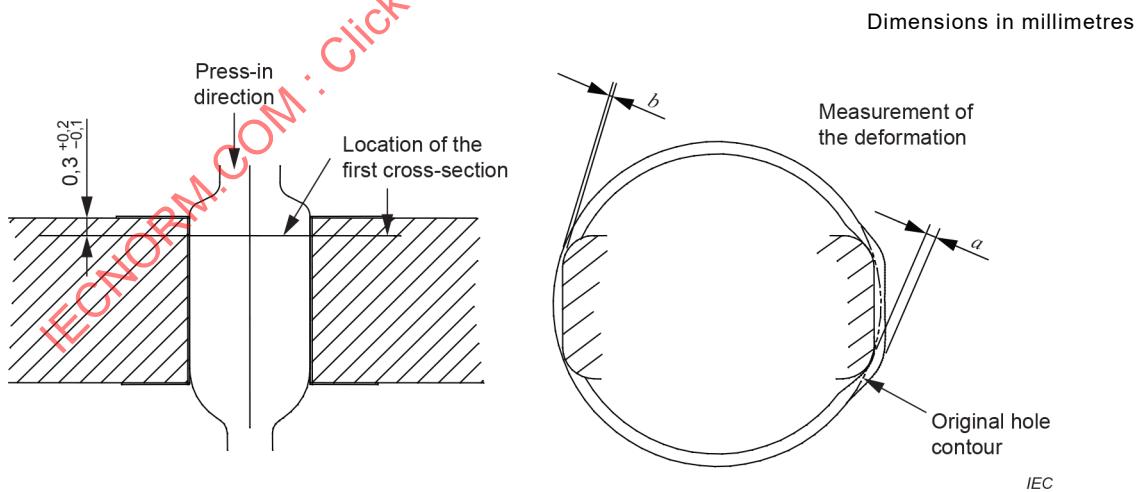
##### 5.2.2.4.1 General

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

For metal boards, microsectioning is not required.

##### 5.2.2.4.2 Transverse sectioning

A first cross-section shall be made approximately 0,3 mm below the top of the board. The deformation "a" of the drilled hole contour in the plated-through hole shall be smaller than 70  $\mu\text{m}$ . The minimum remaining thickness "b" of the plating shall be more than 8  $\mu\text{m}$ . There shall be no cracks in the plating of the plated-through hole. See Figure 5. Compliance is checked by inspection and measurement.

**Figure 5 – Transverse section of a press-in connection**

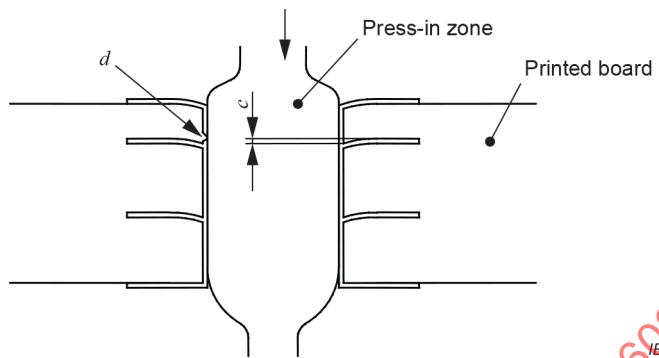
A second cross-section shall be made approximately in the middle of the press-in contact zone and the hole. This area is determined from the longitudinal section and documented. Together with the longitudinal section, the gas-tight contact area may be estimated.

##### 5.2.2.4.3 Longitudinal sectioning

The sectioning needs to go accurately through the biggest deformation of the hole. The exact location shall be determined from the first cross-section.

The deformation "c" of the connected pattern to the plated-through hole shall be not more than 50 µm (see Figure 6).

Neither the plating of the plated-through hole nor the conductor shall 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 results shall be recorded.



**Figure 6 – Longitudinal section of a press-in connection**

#### 5.2.2.5 Replacement (repairing)

The manufacturer shall specify if replacement is allowed and, if so, the number of replacements allowed.

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 or application allows the replacement of the press-in termination, the operation and the tools shall be specified by the manufacturer of the component or the detail product specification.

#### 5.2.3 Contact resistance measurements

The contact resistance test shall be carried out in accordance with IEC 60512-2-1 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 contact terminal material resistance or bulk resistance.

Figure 7 shows two examples of the test arrangement.

Figure 7a shows the V and A connection points that should be made when the press-in termination protrudes through the board. Figure 7b shows the V and A connection points that should be made when the press-in termination does not protrude through the board. The V and A connections in Figure 7b will provide a less accurate measurement of the termination and board interface resistance as the resistance value will include some bulk resistance. This bulk resistance value should be measured or calculated and subtracted from the total resistance measured to arrive at the termination and board interface resistance value. When measuring smaller press-fit terminations, caution needs to be taken not to induce any motion to the termination. Hand probing is not recommended.

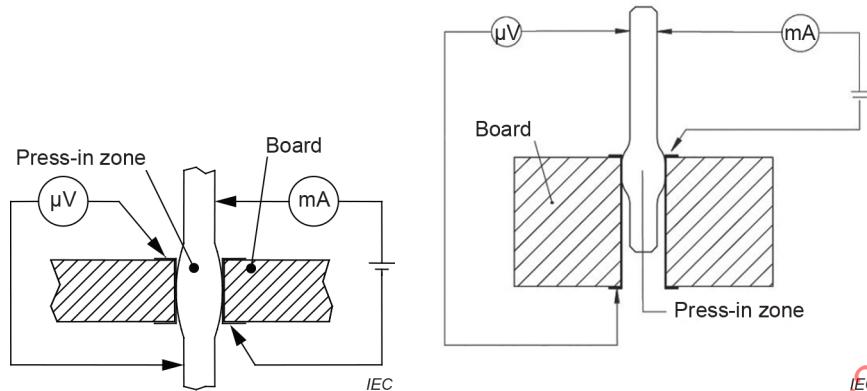


Figure 7a

Figure 7b

Figure 7 – Test arrangement for contact resistance

Requirements before mechanical, electrical or climatic conditioning:

The first measurement of the contact resistance shall be made no earlier than 2 h after making the press-in connection.

The measured value of the first measurement is the reference value for the following measurements.

Requirements after mechanical, electrical or climatic conditioning:

- a) Qualification test schedule: The maximum change of contact resistance shall be less than 0,5 mΩ or the value specified in the detail product specification.
- b) Application test schedule: The maximum change of contact resistance shall be specified in the detail product specification, if any, or in the manufacturer's specification. When direct measurement of press-in connection is not possible, an overall measurement of contact resistance shall be specified. The total resistance specified for the application shall not be exceeded.

## 5.2.4 Climatic tests

### 5.2.4.1 General

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

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

#### 5.2.4.2 Rapid change of temperature

The test shall be carried out in accordance with IEC 60512-11-4 Test 11d. Unless otherwise specified by the manufacturer's specification or a detail product specification, the following details shall apply:

- low temperature  $T_A$   $-40^{\circ}\text{C}$  (LCT)
- high temperature  $T_B$   $85^{\circ}\text{C}$  (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 60512-11-1 Test 11a. Unless otherwise specified by the manufacturer's specification or a detail product specification, the following details shall apply:

- dry heat, test temperature  $85^{\circ}\text{C}$  (UCT)
- cold, test temperature  $-40^{\circ}\text{C}$  (LCT)
- damp heat, cyclic, remaining cycles 5

#### 5.2.4.4 Dry heat

The test shall be carried out in accordance with IEC 60512-11-9 Test 11i. Unless otherwise specified by the manufacturer's specification or a detail product specification, the following details shall apply:

- test temperature  $85^{\circ}\text{C}$  (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 board (see 4.4.2), there shall be one complete set of press-in terminations for each type.

Samples shall be subjected to usual manufacturing processes and the 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 AP

Specimens for test group AP shall be a minimum of 18. Each half of the holes shall have diameter in the tolerance range a or b.

If replacement is applicable, additional press-in terminations needs to be provided according to the number of replacements. See Table 3.

**Table 3 – Qualification test schedule – Test group AP**

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test no.	Severity or condition of test	Title	IEC 60512 Test no.	Requirement
AP1	Mounting		5.2.2.1	Press-in force		Specified by manufacturer
AP2 if applicable	Replacement		5.2.2.5			
AP3	Visual examination		5.2.1.1	Visual examination (and evaluation of tools)	1a	4.5
AP4 if applicable	Microsectioning		5.2.2.4			
AP4.1	Transverse sectioning	Three specimens per tolerance range and sectioning	5.2.2.4.2			5.2.2.4.2
AP4.2	Longitudinal sectioning	Three specimens per tolerance range	5.2.2.4.3			5.2.2.4.3

**5.3.2.2 Test group BP**

Specimens for test group BP shall be a minimum of 14. Each half of the holes shall have diameter in the tolerance range a or b. If replacement is applicable, additional press-in terminations needs to be provided according to the number of replacements.

If a press-in zone is specified to be replaceable, the push-out force shall be measured after the number of replacements specified. See Table 4.

**Table 4 – Qualification test schedule – Test group BP**

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test no.	Severity or condition of test	Title	IEC 60512 Test no.	Requirement
BP1	Mounting		5.2.2.1	Press-in force		Specified by manufacturer
BP2			5.2.2.2	Push-out force		Specified by manufacturer
BP3 if applicable	Replacement <sup>a</sup>		5.2.2.5			
BP4 if applicable			5.2.2.2	Push-out force		Specified by manufacturer

<sup>a</sup> This test should be done on the seven sets of parts with holes in range b, if applicable.

**5.3.2.3 Test group CP**

Specimens for test group CP shall be a minimum of 80. Each half of the holes shall have diameter in the tolerance range a or b.

If replacement is applicable, a minimum of 40 of the press-in terminations shall be mounted in holes which, prior to the test, have been used according to the specified number of replacements allowed. Each half shall be mounted in holes which have diameter in the tolerance range a or b. New press-in terminals shall be used in each replacement. The required number of press-in terminations is in addition to the minimum of 80 defined above.

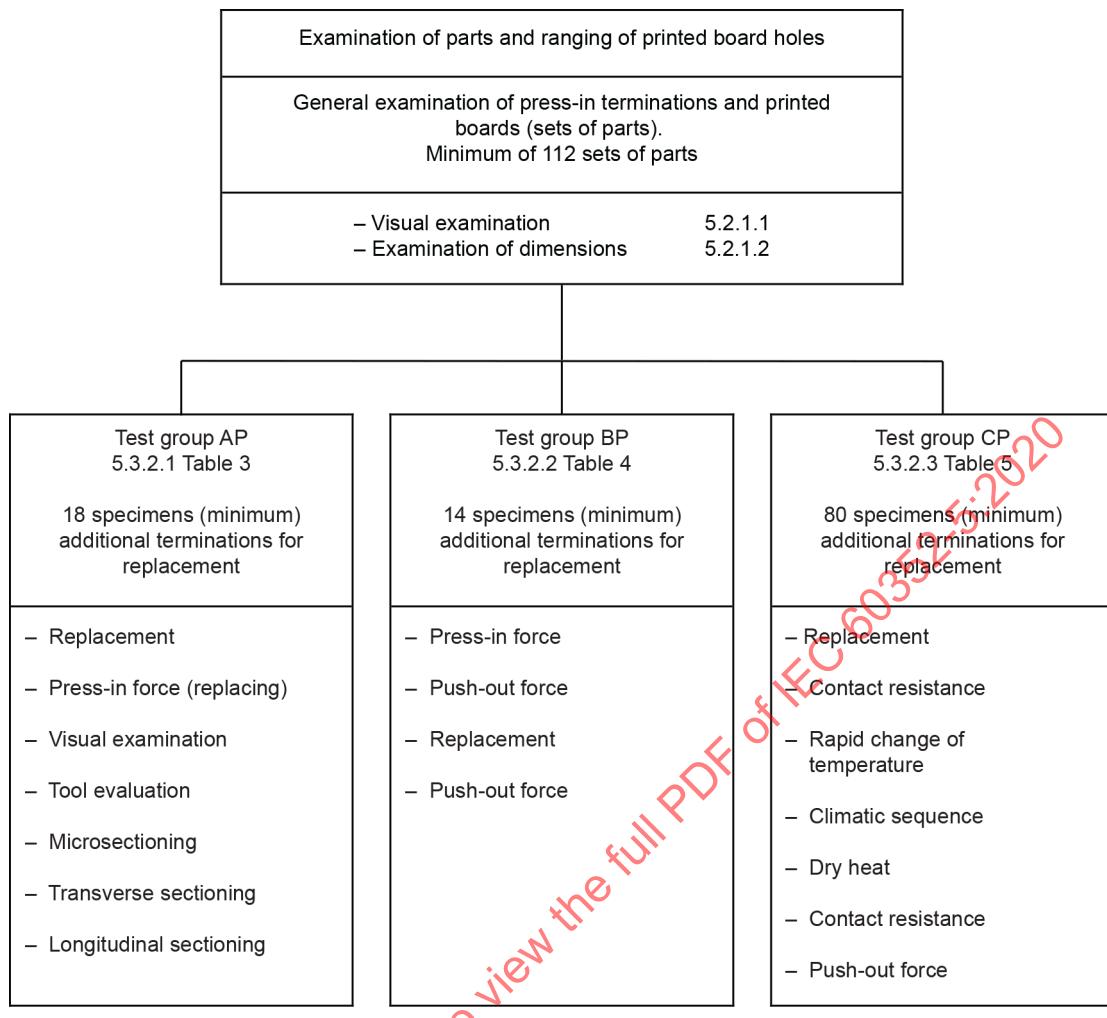
All specimens shall be subjected to IEC 60512-1-1. See the requirements in 4.5. See Table 5.

**Table 5 – Qualification test schedule – Test group CP**

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test no.	Severity or condition of test	Title	IEC 60512 Test no.	Requirement
CP1	Mounting		5.2.2.1			Specified by manufacturer
CP2 if applicable	Replacement		5.2.2.5			
CP3				Contact resistance – millivolt level method	2a	5.2.3 reference value
CP4	Rapid change of temperature	11d	5.2.4.2 -40 °C (LCT) 85 °C (UCT) 30 min 10 cycles			
CP5	Climatic sequence	11a	5.2.4.3 dry heat: 85 °C (UCT) cold: -40 °C (LCT) damp heat: 5 remaining cycles			
CP6	Dry heat	11i	5.2.4.4 dry heat: 85 °C (UCT)			
CP7			5.2.3	Contact resistance – millivolt level method	2a	maximum change of contact resistance: 0,5 mΩ
CP8			5.2.2.2	Push-out force		Specified by manufacturer

### 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 8:



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**Figure 8 – 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 detail product specification. Only press-in zones approved by the qualification test are allowed for this test.

##### 5.3.4.2 Test group DP

Where this test schedule is applicable (see 5.1.1), six components shall be pressed into the 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 component with press-in terminations pressed into the board is called a specimen.

All specimens shall be subjected to the following tests. See Table 6.

**Table 6 – Application test schedule – Test group DP**

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test no.	Severity or condition of test	Title	IEC 60512 Test no.	Requirement
DP1			5.2.3	Contact resistance – millivolt level method	2a	according to detail product specification or manufacturer's specification reference value
DP2	Vibration	6d	5.2.2.3	Contact disturbance	2e	according to detail product specification or manufacturer's specification
DP3	Rapid change of temperature	11d	5.2.4.2 -40 °C (LCT) 85 °C (UCT) 30 min 10 cycles			
DP4	Dry heat	11i	5.2.4.4 85 °C (UCT) 1 000 h			
DP5			5.2.3	Contact resistance – millivolt level method	2a	according to detail product specification or manufacturer's specification
DP6 if applicable	Microsectioning		5.2.2.4			
DP6.1 Four specimens	Transverse sectioning		5.2.2.4.2			5.2.2.4.2
DP6.2 Four specimens	Longitudinal sectioning		5.2.2.4.3			5.2.2.4.3

## 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 laboratory.

#### 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 boards to qualify against;
- hole dimensions including tolerances, according to the manufacturer's specification;
- surface treatment (preflux, lubricant, etc.) of the hole, if any is applied;
- 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 laboratory;
- any deviation from this document.

#### **5.4.1.3 Output information**

The test report shall contain the following output information:

- test laboratory name and address, test dates and test operator(s);
- equipment and tools used for the test;
- details of the tests performed;
- all results from the measurements, compliance or non-compliance noted;
- summary/judgement.

### **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 detail product specification;
- additional information necessary for the user and test house;
- any deviation from this document.

#### **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.

## Annex A (informative)

### Practical guidance

#### A.1 General

While the normative part of this document 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

Generally, for the current-carrying capacity of a press-in connection, the overall resistance of the press-in termination and the leads of the PCB or MID is predominant.

On a gas-tight connection the pure transition resistance between the press-in zone and the finished hole is very small because the effective length is very short and the contact areas are very dense and intense.

#### A.3 Tool information

##### A.3.1 Termination insertion tool

Generally, a termination insertion tool is required to insert the termination into the 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 board. Care should be taken that functional surfaces of the termination are spared and also that the board remains undamaged by the insertion tool.

Different kinds of termination insertion tools are used, such as the following:

- 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 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 support the 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 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 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 board.

## A.4 Information to press-in termination and press-in connections

### 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. The required small dimensional tolerances need to be observed, so that there will be no damage to the printed board and plated-through hole.

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 hole does not occur or is much less than in the case of a solid press-in termination.

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; metal boards are less susceptible to damage during insertion of the press-in termination.
- the press-in zones are provided with a lead-in geometry;
- 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.