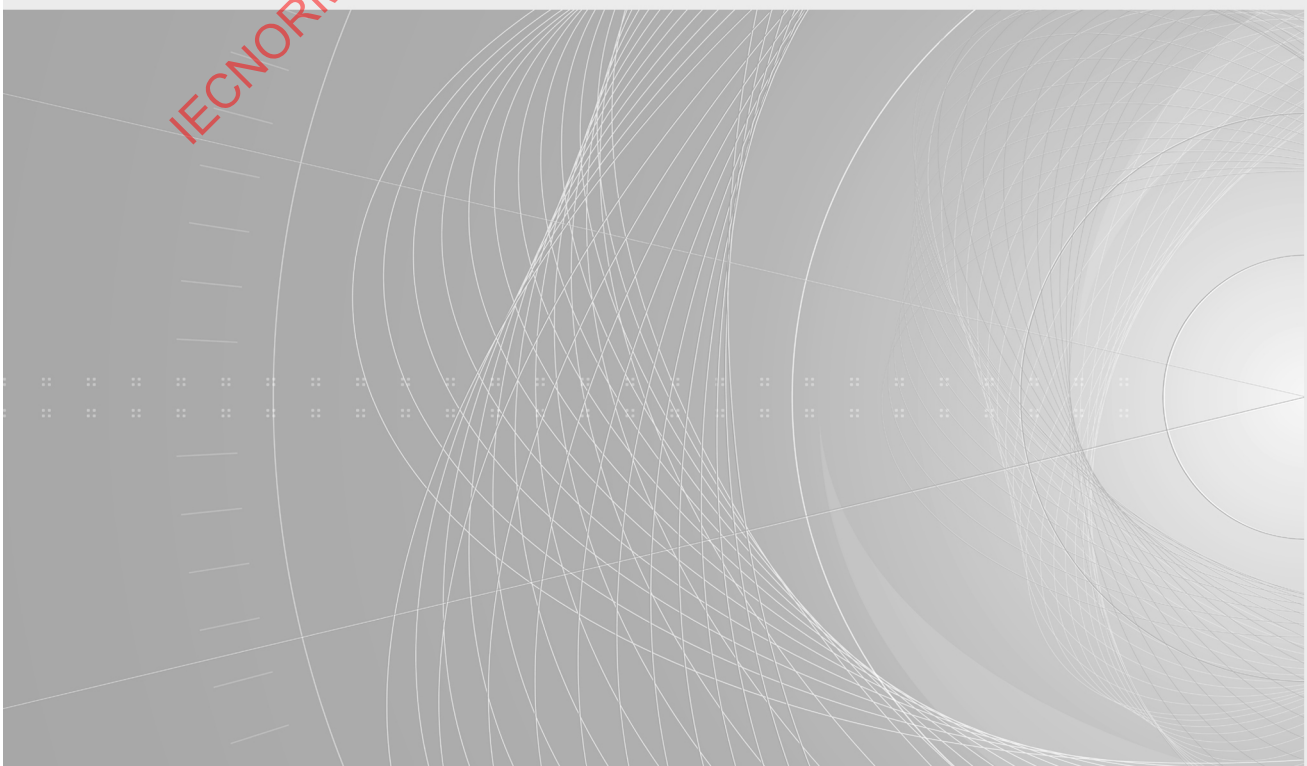
IEC 61191-4

Edition 2.0 2017-07

INTERNATIONAL STANDARD

Printed board assemblies –
Part 4: Sectional specification – Requirements for terminal soldered assemblies



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FOREWORD

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International Standard IEC 61191-4 has been prepared by IEC technical committee 91: Electronics assembly technology.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

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

- The requirements have been updated to be compliant with the acceptance criteria in IPC-A-610F.

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

CDV	Report on voting
91/1399/CDV	91/1434/RVC

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 61191 series, published under the general title *Printed board assemblies*, 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

PRINTED BOARD ASSEMBLIES –

Part 4: Sectional specification – Requirements for terminal soldered assemblies

1 Scope

This part of IEC 61191 prescribes requirements for terminal soldered assemblies. The requirements pertain to those assemblies that are entirely terminal/wire interconnecting structures or to the terminal/wire portions of those assemblies that include other related technologies (i.e. surface mounting, through-hole mounting, chip mounting).

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 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 61191-1:2013, *Printed board assemblies – Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194 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

4 General requirements

Requirements of IEC 61191-1 are a mandatory part of this specification.

Workmanship shall meet the requirements of IPC-A-610 in accordance with the classification requirements of this document.

5 General terminal and part mounting requirements

5.1 General

The requirements of 5.2 are applicable to terminals and part mounting in all types of assemblies.

5.2 Wire and cable preparation

5.2.1 General

Sufficient insulation cover shall be stripped from the wire or leads to provide for insulation clearances as specified. Chemical stripping agents shall be used for solid wire only and shall be neutralized or removed prior to soldering. In stripping insulation, care should be taken to avoid nicking or otherwise damaging the wire or the remaining insulation. For level A or B assemblies, the number of nicked or broken strands in a single wire shall not exceed the limits given in Table 1. For wires used at a potential of 6 kV or greater, or for level C assemblies, there shall be no broken strands. The number of nicked strands shall be in accordance with Table 1. Insulation discolouration resulting from thermal stripping is permissible.

Table 1 – Nicked or broken strand limits

Number of strands	Maximum allowable scraped, nicked or broken strands		
	Level A and B	Level C not tinned	Level C pretinned
1 (solid)	No damage in excess of 10 % conductor diameter		
2 to 6	0	0	0
7 to 15	1	0	1
16 to 25	3	0	2
26 to 40	4	3	3
41 to 60	5	4	4
61 to 120	6	5	5
121 or more	6 % of strands	5 % of strands	5 % of strands

5.2.2 Tinning of stranded wire

Portions of stranded wire to be soldered shall be tinned prior to mounting. The solder shall wet the stranded wire and penetrate to the inner strands of the wire. Wicking of solder under the insulation shall be minimized.

5.3 Terminal installation

5.3.1 General

The detailed requirements for installation of solder terminals are defined in 5.3.2 to 5.3.8.

5.3.2 Terminal mounting (mechanical)

Terminals not connected to printed wiring or ground planes shall be of the rolled flange configuration (see Figure 1). A printed foil land may be used as a seating surface for a rolled flange provided that the land is isolated and not connected to active printed wiring or ground plane.

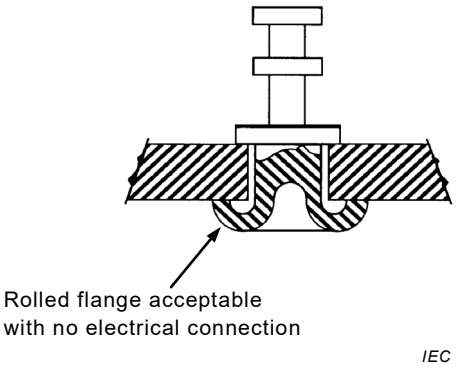


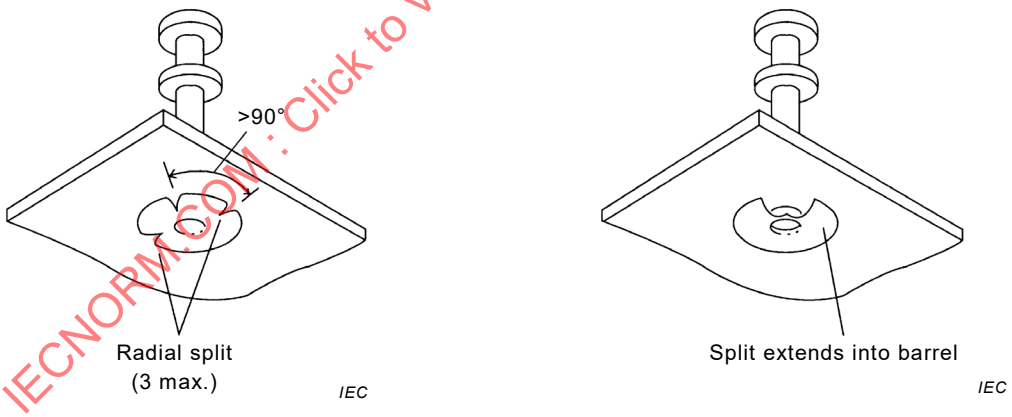
Figure 1 – Rolled flange terminal

5.3.3 Terminal shank discontinuities

The shank of the terminal shall not be perforated, split, cracked, and there shall not be discontinuity to the extent that oils, flux, inks, or other substances used for processing the printed board can be entrapped. Circumferential cracks or splits in the shank are not acceptable regardless of the extent.

5.3.4 Flange discontinuities

The rolled flange shall not be split, cracked or otherwise discontinuous to the extent that flux, oils, inks, or other liquid substances used for processing the printed board can be entrapped within the mounting hole. After rolling, the rolled area shall be free of circumferential splits or cracks, but may have a maximum of three radial splits or cracks provided that the splits or cracks are separated by at least 90° and do not extend into the barrel of the terminal (see Figure 2).

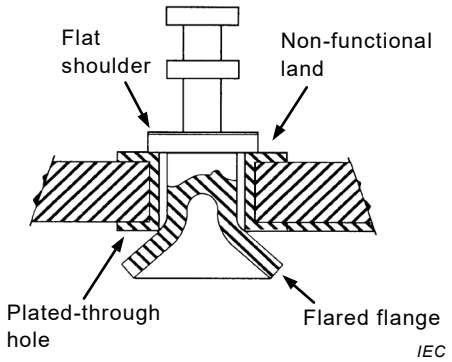


a) Acceptable **b) Not acceptable**

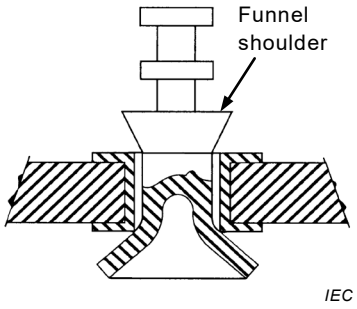
Figure 2 – Rolled flange discontinuities

5.3.5 Terminal mounting (electrical)

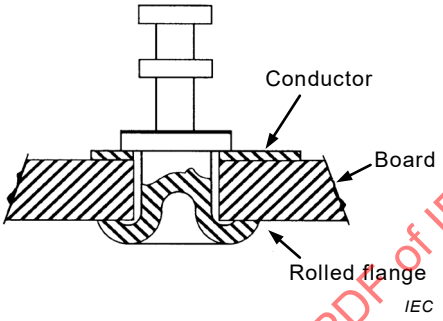
Flared flange terminals shall be mounted in non-interfacial plated through-holes provided the mounting is in conjunction with a land or ground plane on the flared side as shown in Figure 3a. They shall not be flared to the base material of the printed board. Funnel shoulder terminals shall not be used (see Figure 3b). Terminals may be mounted in non-plated through-holes with active circuitry on the top-side (or primary side) and a rolled flange on the backside of the board (see Figure 3c).



a) Acceptable



b) Not acceptable



c) Acceptable

Figure 3 – Flared flange terminals

5.3.6 Flange angles

Flared flanges shall be formed to include an angle of between 35° and 120° and shall extend between 0,4 mm and 1,5 mm beyond the surface of the land provided minimum electrical spacing requirements are maintained (see Figure 4), and the flare diameter does not exceed the diameter of the land.

Dimensions in millimetres

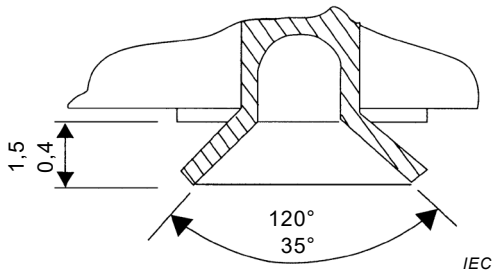


Figure 4 – Flared angles

5.3.7 Shank discontinuities

After installation, the shank of the terminal shall meet the requirements of 5.3.3.

5.3.8 Flared flange discontinuities

The flared flange of a terminal shall not be perforated, split, cracked, or otherwise discontinuous to the extent that flux, oils, inks or other substances used for processing the printed board can be entrapped. After flaring, the flange shall conform to 5.3.4.

5.4 Mounting to terminals

5.4.1 General

The detailed requirements for the mounting of components and wires to terminals installed in printed boards, terminal boards or chassis members are defined in 5.4.2 to 5.4.11.

5.4.2 Wire and lead wrap-around

Leads and wires should be mechanically secured to their terminals before soldering. Such mechanical securing should prevent motion between the parts of the connection during the soldering operation. Leads and wires shall be wrapped around turret and straight pin terminals for a minimum of 180° and may overlap provided there is sufficient room on the turret (see Figure 5).

The last wire on a straight pin terminal shall be at least one wire diameter from the top to allow for an adequate solder fillet. Adequate service loops should be provided to allow for field maintenance.

For wires with a diameter of less than 0,25 mm, a minimum of one turn and a maximum of three turns shall be used. Exception is made in the case of those small parts used for terminating wires where such mechanical securing would be impracticable, such as connector solder cups, slotted terminal posts and heat shrinkable solder devices. Wires and leads shall contact the post for at least 180° and shall not be wrapped on each other.

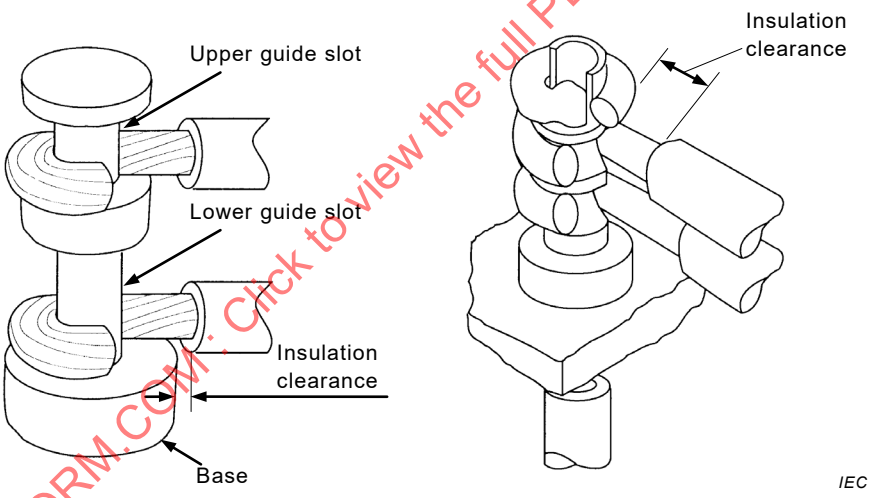


Figure 5 – Wire and lead wrap around

5.4.3 Side route connection

If mechanically secured in accordance with 5.4.2 a 90° minimum wrap is acceptable (see Figure 6d). Lead and wire ends may extend beyond the base of terminals provided the minimum electrical spacing is maintained. When practicable, except for bus wires, wires shall be placed in ascending order with the largest on the bottom.

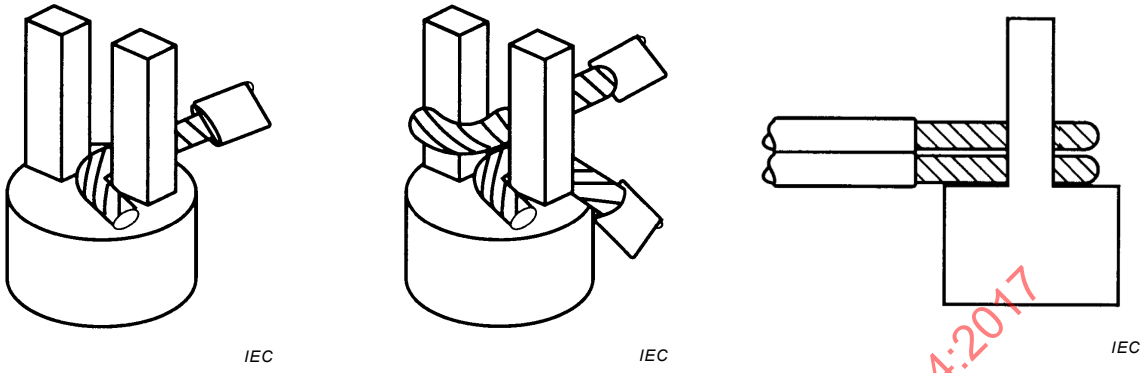
The wire or component lead shall be dressed through the slot and wrapped to either post of the terminal (see Figure 6a) ensuring positive contact of the wire with at least one corner of the post (see Figure 6d). The wire or lead shall also be in firm contact with the base of the terminal or the previously installed wire (see Figure 6c).

The attachments shall be maintained so that:

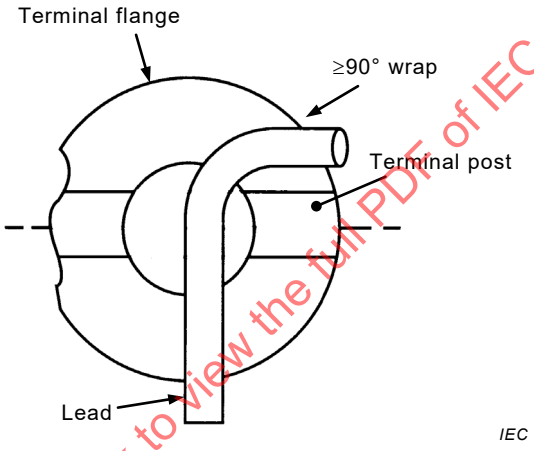
a) there is no overlapping of wraps and wires;

b) spacing between wires, and spacing between the wires and the terminal board or panel is a minimum consistent with the thickness of the wire insulation;

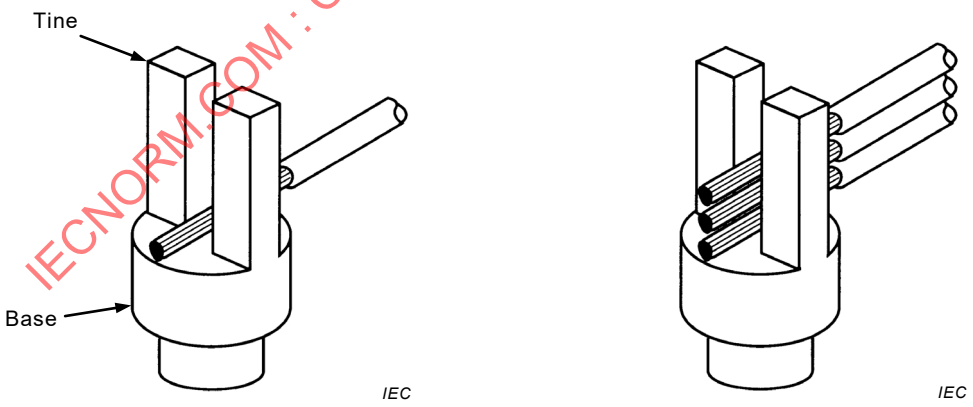
c) the wraps are dressed in alternate rotations (see Figure 6b).



a) Single wire wrap **b) Multiple wire wrap** **c) Stacked wires**



d) Minimum wrap



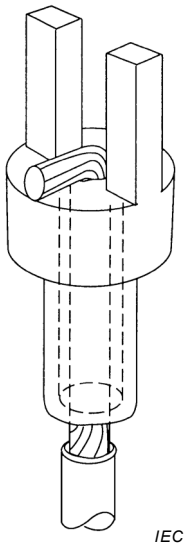
e) Not acceptable **f) Not acceptable**

Figure 6 – Side route connections and wrap on bifurcated terminal

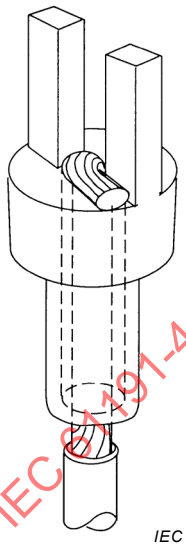
5.4.4 Top and bottom route connection

The wire shall be wrapped on the terminal base or post to ensure positive contact of the wire or, if mechanically secured in accordance with 5.4.2, with a minimum bend of 90° (see Figure 7a and 7b). The wire lead shall also be in contact with the base of the terminal or the previously installed wire. When more than one wire shall be attached, they shall be inserted at the same time, but shall be wrapped separately around alternate posts.

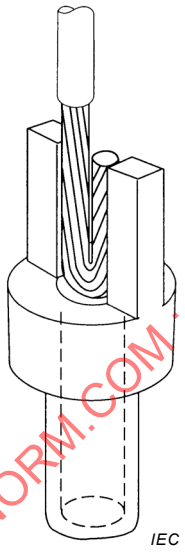
The wire shall feed straight into the terminal between the tines when top routed wires to bifurcated terminals are required by the design. The space between the tines shall be filled by having the wire bent double or by using a separate filler wire, where space between the tines permits it (see Figures 7c and 7d).



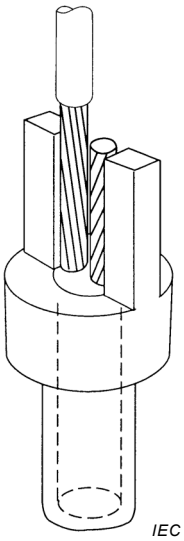
a) Bottom route connection



b) Bottom route connection



c) Top route connection



d) Top route connection

Figure 7 – Top and bottom route terminal connection

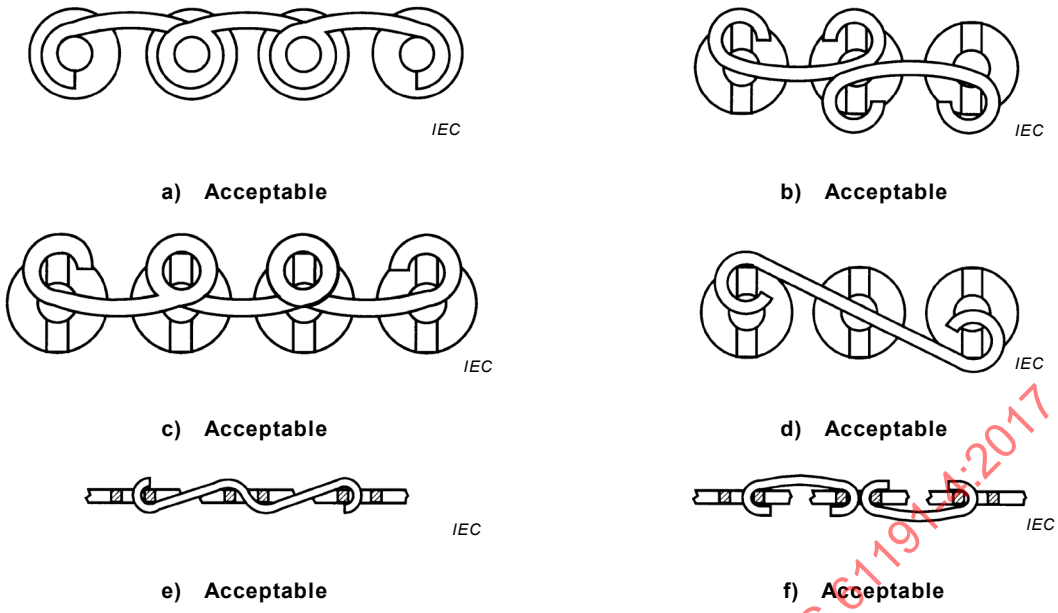
5.4.5 Continuous runs

If three or more terminals should be connected, a continuous solid bus wire may be run from terminal to terminal (see Figure 8) provided that:

a) the connections to the first and last terminal meet the requirements of 5.4.2;

b) a curvature is included in the unwrapped wire portion of the jumper to provide relief of tension from environmental loading;

c) in the case of pierced or perforated terminals, the wire shall contact at least two non-adjacent contact surfaces of each intermediate terminal (see Figure 8e).



a) Acceptable

b) Acceptable

c) Acceptable

d) Acceptable

e) Acceptable

f) Acceptable

Figure 8 – Continuous run wire wraps

5.4.6 Service loops

Lead wires shall be dressed in the proper position with a slight loop or gradual bend as shown in Figure 9. The bend shall be sufficient to allow field repair. After soldering, wires shall meet the insulation clearance requirements of 5.4.7.

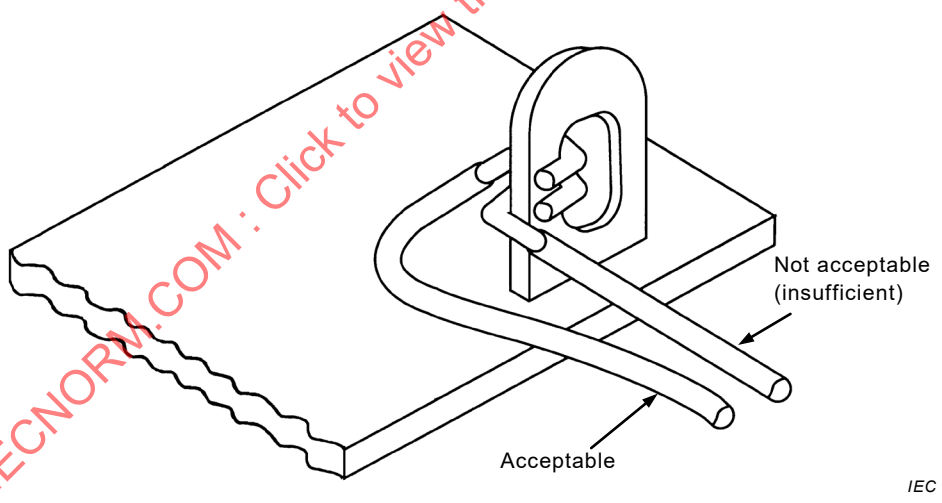


Figure 9 – Service loop for lead wiring

5.4.7 Insulation clearance

The clearance (c) between the end of wire insulation and the solder of the connection shall be as follows (see Figure 10):

a) minimum clearance: the insulation may be in contact with the solder joint but not be covered by solder. The contour of the wires shall not be obscured at the termination of the insulation;

b) maximum clearance: clearance shall be less than two wire diameters including insulation or 1,5 mm whichever is larger, but shall not permit shorting between adjacent conductors.

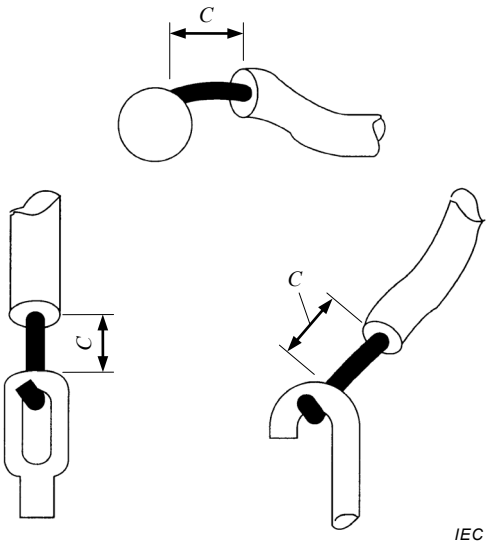


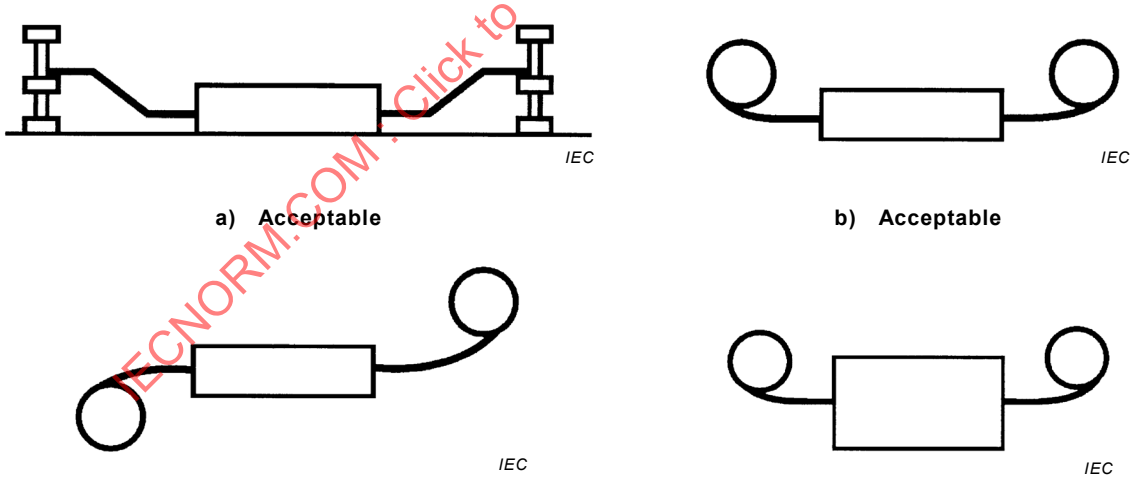
Figure 10 – Insulation clearance measurement (*c*)

5.4.8 Orientation of wire wrap

Lead wires may be wrapped clockwise or anticlockwise (consistent with the direction of potential stress application), but shall continue the curvature of the dress of the lead wires and shall not interfere with the wrapping of other wires on the terminal.

5.4.9 Stress relief

Component leads and wires connected to terminals should have stress relief (see Figure 11). Components shall not be rigidly connected between non-bondable terminals.



a) Acceptable **b) Acceptable**

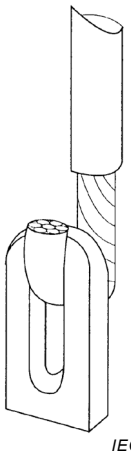
c) Acceptable **d) Acceptable**

Figure 11 – Stress relief examples

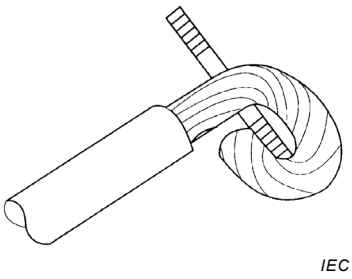
5.4.10 Pierced or perforated terminals

For wiring to a single terminal, the wire(s) shall pass through the eye and be wrapped around the terminal (see Figure 12). When a continuous run is used, the wire shall be attached to the end terminals (first and last) in the same manner that wires are attached to single terminals. The jumper wire shall contact at least two non-adjacent contact surfaces of each intermediate terminal (see Figure 8e).

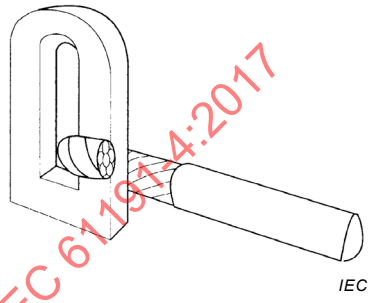
For user-approved designs that incorporate staking/bonding of wires, the wire(s) attached to pierced terminals shall contact at least two (adjacent or nonadjacent) surfaces of the terminal. The wire winding shall be a minimum of 1/4 turn to a maximum of 3/4 turn. The lead and wire ends may extend beyond the terminal a maximum of one (1) lead diameter (see Figures 12d and 12e).



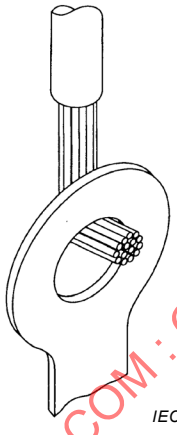
a) Acceptable wrap around



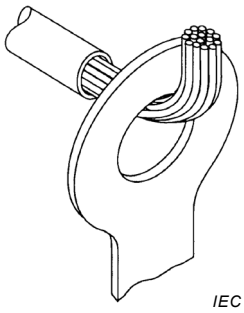
b) Acceptable wrap around



c) Acceptable wrap around



d) Acceptable wire extension



e) Acceptable wire extension

Figure 12 – Pierced or perforated terminal wire wrap

5.4.11 Cup and hollow cylindrical terminal soldering

5.4.11.1 General

Wires shall be soldered into solder cup terminals in a manner which ensures complete solder fill of the cup and precludes entrapment of flux.

5.4.11.2 Soldering of wires and leads to solder cups

No more than three wires shall be installed in the cup. In no instance shall the lay of the strands of any wire be disturbed, nor shall strands be moved. The wire or wires shall be inserted for the full depth of the cup and a fillet shall be formed along the surfaces of contact. Solder shall wet the entire inside of the cup and shall fill at least 75 % of the mouth of the cup. Solder shall be visible in the inspection hole and may rise slightly above it. Solder may overfill the cup. Any solder on the outside of the cup should be in the form of a thin film.

6 Acceptance requirements

6.1 General

The use of the materials, processes and products described and specified in IEC 61191-1 results in soldered interconnections that are better than the minimum terminal soldering acceptance requirements in Clause 6. Processes and their control should be capable of producing products meeting or exceeding the acceptance criteria for a level C product.

6.2 Control and corrective actions

The detailed requirements for acceptance, corrective action limits, control limit determination, and general assembly criteria described in IEC 61191-1 are a mandatory part of this document. In addition, the requirements of 6.3 shall be met for all soldered terminals and interconnecting acceptability.

6.3 Terminal soldering

6.3.1 General

Terminals mounted in plated through-holes should provide evidence of good wetting to both the terminal flange and land or ground plane (see Table 2).

Table 2 – Plated through-holes with terminals, minimum acceptance conditions[1)]

Criteria		Level A	Level B	Level C
A	Circumferential fillet and wetting-solder source side	270°	270°	330°
B	Percentage of original land area covered with wetted solder-solder source side	75 %[2)]	75 %[2)]	75 %[2)]

[1)] Wetted solder refers to solder applied by the solder process.

[2)] A total maximum of 25 % depression, including both solder source and destination sides, is permitted.

6.3.2 Wire-terminal attachment

For flat and cylindrical terminals, the solder quantity shall be adjusted so that the wire or terminal outline is discernible through the solder hole in solder. The hole in the solder tab does not need to be filled with solder.

6.4 Part marking and reference designations

Part markings and reference designations shall be legible and components should be mounted in such a manner that markings are visible.

7 Rework of unsatisfactory soldered connections

Rework of unsatisfactory solder connections shall not be performed until the discrepancies have been documented. This data shall be used to provide an indication as to possible causes and to determine if corrective action is required (see IEC 61191-1). When rework is performed, each rework connection shall be inspected to the requirements of 6.3 (see Table 3 for list of defects).

Table 3 – Defects for terminal attachment and soldering defects

No.	Defects
1	Defects identified in Table 2 of IEC 61191-1:2013
2	Damage to wire in excess of that allowed in Table 1
3	Charred wiring insulation or components
4	Inadequate stress relief on leaded components and wires
NOTE Solder in the stress relief bend does not constitute elimination of stress relief.	