BS EN 61191-2:2013

BSI Standards Publication

Printed board assemblies

Part 2: Sectional specification — Requirements for surface mount soldered assemblies

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 61191-2:2013. It is identical to IEC 61191-2:2013. It supersedes BS EN 61191-2:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/501, Electronic assembly technology & Printed Electronics.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2013

Published by BSI Standards Limited 2013

ISBN 978 0 580 77064 7

ICS 31.190; 31.240

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2013.

Amendments issued since publication

Amd. No.	Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61191-2

October 2013

ICS 31.190; 31.240

Supersedes EN 61191-2:1998

English version

Printed board assemblies - Part 2: Sectional specification - Requirements for surface mount soldered assemblies

(IEC 61191-2:2013)

Ensembles de cartes imprimées - Partie 2: Spécification intermédiaire - Exigences relatives à l'assemblage par brasage pour montage en surface (CEI 61191-2:2013)

Elektronikaufbauten auf Leiterplatten - Teil 2: Rahmenspezifikation - Anforderungen an gelötete Baugruppen in Oberflächenmontage (IEC 61191-2:2013)

This European Standard was approved by CENELEC on 2013-07-10. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

© 2013 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Ref. No. EN 61191-2:2013 E

Foreword

The text of document 91/1091/FDIS, future edition 2 of IEC 61191-2, prepared by IEC/TC 91 "Electronics assembly technology " was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61191-2:2013.

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)	2014-04-10
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-07-10

This document supersedes EN 61191-2:1998.

EN 61191-2:2013 includes the following significant technical changes with respect to EN 61191-2:1998:

– IPC-A-610 on workmanship has been included as a normative reference;

– some of the terminology used in the document has been updated;

– references to EN standards have been corrected;

– the use of lead-free solder paste and plating are addressed.

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 61191-2:2013 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 61191-1	2013	Printed board assemblies Part 1: Generic specification - Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies	EN 61191-1	2013
IPC-A-610E	2010	Acceptability of Electronic Assemblies	-	-

CONTENTS

PRINTED BOARD ASSEMBLIES –

Part 2: Sectional specification – Requirements for surface mount soldered assemblies

1 Scope

This part of IEC 61191 gives the requirements for surface mount solder connections. The requirements pertain to those assemblies that are totally surface mounted or to the surface mounted portions of those assemblies that include other related technologies (e.g. through-hole, chip mounting, terminal mounting, etc.).

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

IPC-A-610E:2010, *Acceptability of Electronic Assemblies*

3 Conventions

Unless otherwise specified by the user, the word "shall" signifies that the requirement is mandatory. Deviations from any "shall" requirement requires written acceptance by the user, e.g. via assembly drawing, specification or contract provision.

The word “should” is used to indicate a recommendation or guidance statement. The word “may” indicates an optional situation. Both “should” and “may” express non-mandatory situations. “Will” is used to express a declaration of purpose.

4 General requirements

Clause 4 of IEC 61191-1:2013 is a mandatory part of this standard.

Workmanship of surface mount assemblies shall meet the requirements of IPC-A-610E in accordance with the classification requirements of this standard.

5 Classification

This standard recognizes that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in producibility, complexity, functional performance requirements, and verification (inspection/test) frequency. These are the following:

Level A: General electronic products

Level B: Dedicated service electronic products

Level C: High performance electronic products

The user of the assemblies is responsible for determining the level to which his product belongs. It should be recognized that there may be overlaps of equipment between levels. The contract shall specify the level required and indicate any exceptions or additional requirements to the parameters, where appropriate (see 4.3 of IEC 61191-1:2013).

6 Surface mounting of components

6.1 General

This clause covers assembly of components that are placed on the surface to be manually or machine soldered and includes components designed for surface mounting as well as through-hole components that have been adapted for surface mounting technology.

6.2 Alignment requirements

Sufficient process control at all stages of design and assembly shall be in place to enable the post-soldering alignments and solder joint fillet controls specified in 7.3 to be achieved.

Relevant factors affecting the requirements include land and conductor design, component proximities, component and land solderability, solder paste/adhesive quantity and alignment and component placement accuracy.

6.3 Process control

If suitable process controls are not in place to ensure compliance with 6.2 and the intent of Annex A, the detailed requirements of Annex A shall be mandatory.

6.4 Surface mounted component requirements

The leads of lead surface mounted components shall be formed to their final configuration prior to mounting. Leads shall be formed in such a manner that the lead-to-body seal is not damaged or degraded and that they may be soldered into place by subsequent processes which do not result in residual stresses decreasing reliability. When the leads of dual-in-line packages, flatpacks, and other multilead devices become misaligned during processing or handling, they may be straightened to ensure parallelism and alignment prior to mounting, while maintaining the lead-to-body seal integrity.

6.5 Flatpack lead forming

6.5.1 General

Leads on opposite sides of surface mounted flatpacks shall be formed such that the non-parallelism between the base surface of the component and the surface of the printed board (i.e. component cant) is minimal. Component cant is permissible provided the final configuration does not exceed the maximum spacing limit of 2,0 mm (see Figure 1).

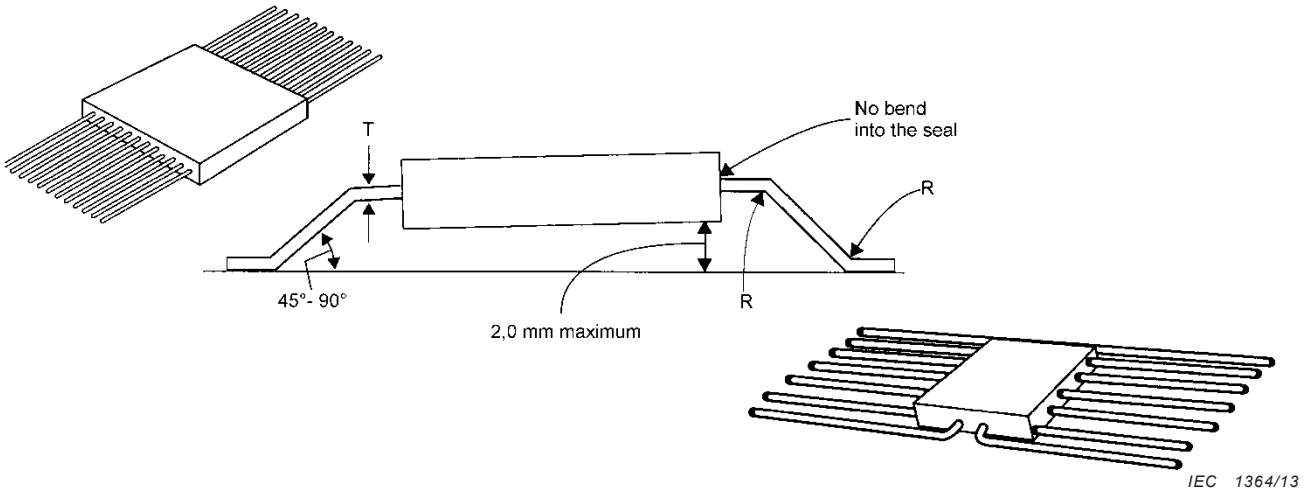


Figure 1 – Lead formation for surface mounted device

6.5.2 Surface mounted device lead bends

Leads shall be supported during forming to protect the lead-to-body seal. Bends shall not extend into the seal (see Figure 1). The lead-bend radius (*R*) shall be >1 *T* (*T* = nominal lead thickness). The angle of that part of the lead between the upper and lower bends in relation to the mounting land shall be 45° minimum and 90° maximum.

6.5.3 Surface mounted device lead deformation

Lead deformation (unintentional bending) may be allowed when

a) no evidence of a short circuit or potential short circuit exists,

b) lead-to-body seal or weld is not damaged by the deformation,

c) does not violate minimum electrical spacing requirement,

d) top of lead does not extend beyond the top of body; preformed stress loops may extend above the top of the body; however, stand-off height limit shall not be exceeded,

e) toe curl, if present on bends, shall not exceed two times the thickness of the lead (2 *T*),

f) coplanarity limits are not exceeded.

6.5.4 Flattened leads

Components with axial leads of round cross-section may be flattened (coined) for positive seating in surface mounting. If flattening is used, the flattened thickness shall be not less than 40 % of the original diameter. Flattened areas of leads shall be excluded from the 10 % deformation requirement in 6.5.3 of IEC 61191-1:2013.

Flattened leads on opposite sides of a surface mount part shall be formed such that the non-parallelism between the base surface of the component and the surface of the printed board (e.g., component cant) is minimal.

6.5.5 Dual-in-line packages (DIPs)

Dual-in-line packages may be surface mounted provided the leads are configured to meet the mounting requirements for surface mounted loaded parts. The lead preparation operation shall be performed using die forming/cutting systems. Hand forming and trimming of leads are prohibited.

6.5.6 Parts not configured for surface mounting

Flatpacks of the through-hole configuration, transistors, metal power packages, and other non-axial lead components shall not be surface mounted unless the leads are formed to meet the surface mounted device lead forming requirements. Such applications shall be agreed on between user and manufacturer.

6.6 Small devices with two terminations

6.6.1 General

The detailed requirements for mounting of small devices with two lead terminations are defined in the following subclauses.

6.6.2 Stack mounting

When part stacking is permitted by the assembly drawing, parts shall not bridge spacing between other parts or components such as terminals or other chip components.

6.6.3 Devices with external deposited elements

Components with electrical elements deposited on an external surface (such as chip resistors) shall be mounted with that surface facing away from the printed board or substrate.

6.7 Lead component body positioning

6.7.1 General

Parts mounted over protected surfaces and insulated parts that are positioned over circuitry or parts mounted over surfaces without exposed circuitry may be flush mounted (i.e. no stand-off height). Parts mounted over exposed circuitry shall have their leads formed to provide a minimum of 0,25 mm between the bottom of the component body and the exposed circuitry. The maximum clearance between the bottom of the leaded component body and the printed wiring surface shall not exceed 2,0 mm.

6.7.2 Axial-leaded components

The body of a surface mounted axial-leaded component should be spaced from the surface of the printed board at a maximum of 2,0 mm unless the component is mechanically attached to the substrate by adhesive or other means. Leads on opposite sides of surface mounted axial-leaded components shall be formed such that component cant (non-parallelism between the base surface of the mounted component and the surface of the printed board) is minimal and in no instance shall body cant result in non-conformance with maximum spacing limits.

6.7.3 Other components

TO-can devices, tall profile components (i.e. over 15 mm), transformers, and metal power packages may be surface mounted provided the parts are bonded or otherwise secured to the board in a manner which enables the part to withstand the end-item shock, vibration and environmental stresses.

6.8 Parts configured for butt lead mounting

Components designed for through hole (pin-in-hole) applications and modified for butt joint attachment, or stiff leaded dual-in-line packages may be butt mounted on level A and B products. Butt mounting is not permitted on level C products unless the component is designed for surface mounting.

6.9 Non-conductive adhesive coverage limits

Non-conductive adhesive materials, when used for component mounting, shall not flow onto, or obscure, areas to be soldered or into vias or plated-through holes.

7 Acceptance requirements

7.1 General

Materials, processes, and procedures described and specified in IEC 61191-1 provide for soldered interconnections that are better than the minimum surface mount acceptance requirements in this clause. Processes and their control should be capable of producing product meeting or exceeding the acceptance criteria for defined product levels.

7.2 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 standard. In addition, the following subclause shall be met for all surface mount assembly and for connection acceptability.

7.3 Surface soldering of leads and terminations

7.3.1 General

Solder joints or terminations on components designed for surface mounting shall exhibit solder joints that meet the general descriptions of Clause 10 of IEC 61191-1:2013 with the specific measurements defined in 7.3.3 through 7.3.12 of this standard. Some surface mounted components will self-align during reflow soldering but a degree of misalignment is permitted to the extent specified. However, minimum design conductor spacing shall not be violated.

In the following paragraphs, certain joint features are unspecified in size and the only requirement is that a properly wetted fillet to both lead/termination and lands be visible. Geometric dimensions not called out with any requirements are considered non-critical to the performance of the interconnection.

Surface mounted joints formed to connector, socket, and other leads or terminations without mechanical support, subject to stress from insertion and withdrawal of components or printed boards shall meet the requirements of level C.

7.3.2 Solder fillet height and heel fillets

7.3.2.1 General

The height *F* of solder fillets, including heel fillets, as required in the following subclauses shall be judged by the distance the applied solder has risen up the joined surface. Figure 2 illustrates this measurement for joints of equal height but having different solder volume. In 7.3.3 to 7.3.12, for some lead configurations, the minimum acceptable fillet height criteria is referenced to the lead thickness *T*, or one half the thickness (0,5 *T*). When referenced to *T*, the height of the heel fillet to a formed lead shall be measured at the lowest point of the inside bend radius of the lead, as indicated by point A of Figure 2b (e.g. level C in Figures 3 to 5). When referenced to 0,5 *T*, the fillet may be 0,5 *T* lower (e.g. level B in Figures 3 to 5).

NOTE Subclause 7.3.3 provides an organization that combines the requirement paragraph, the appropriate Figure and a dimensional table that describes the specific details.

7.3.2.2 Solder connection contours

A mounting technique shall be used to compensate for the coefficient of thermal expansion (CTE) mismatch of the part and board. This mounting technique shall be limited to part leads, specialized mounting devices, and normal solder connections. The use of specialized stand-offs mounted between the part and the land is permissible. Leadless components shall not be soldered into place utilizing redundant interconnect wiring between the component castellation and the land. When CTE mismatch compensation is provided, bottom only terminations and leadless chip carriers (see 7.3.8 and 7.3.9) are not required to have 0,2 mm solder thickness.

Designs which utilize special solder connection contours as part of a CTE mismatch compensation system shall be identified on the approval assembly drawing. The mounting technique shall be capable of performing with a solder connection which meets the requirements of this standard.

7.3.2.3 Surface mount device lead heel position

The heel of a leaded component shall not overhang the land.

NOTE The heel begins where the lead starts to curve at the lead bend.

7.3.2.4 Break-away tie bars

Components (e.g. connectors and flexible circuits) which incorporate break-away tie bars in their design may be installed or soldered in place prior to removal of the tie bar. Exposed basis metal resulting from tie bar removal is permissible.

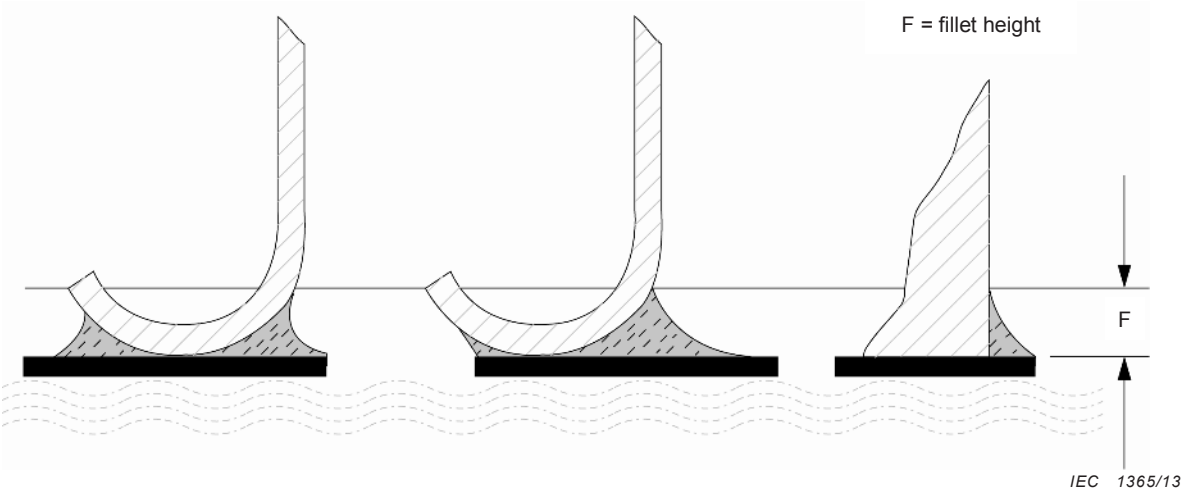


Figure 2a – Fillet height

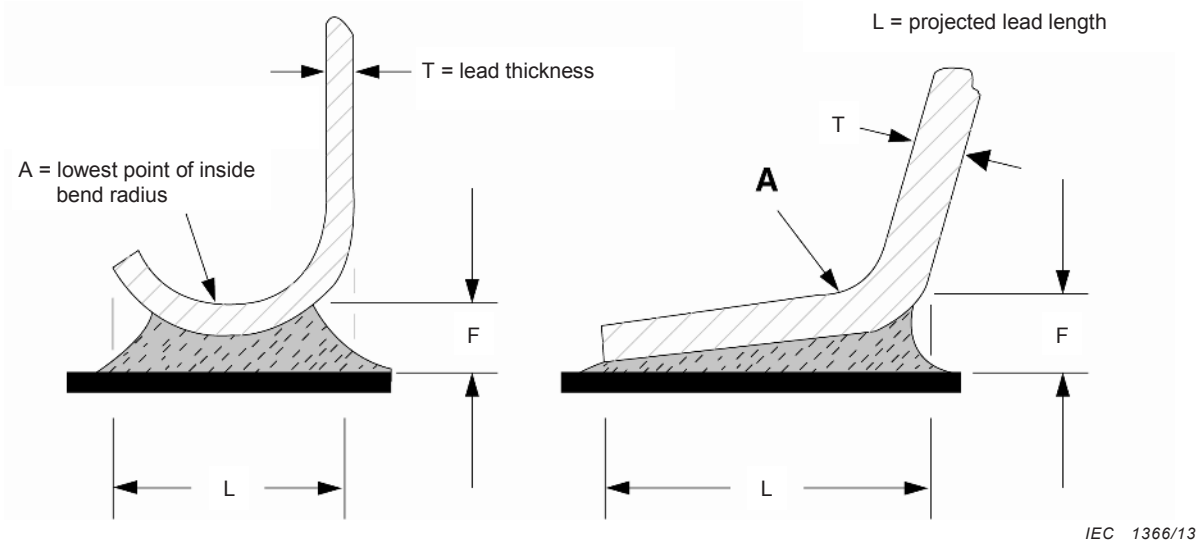
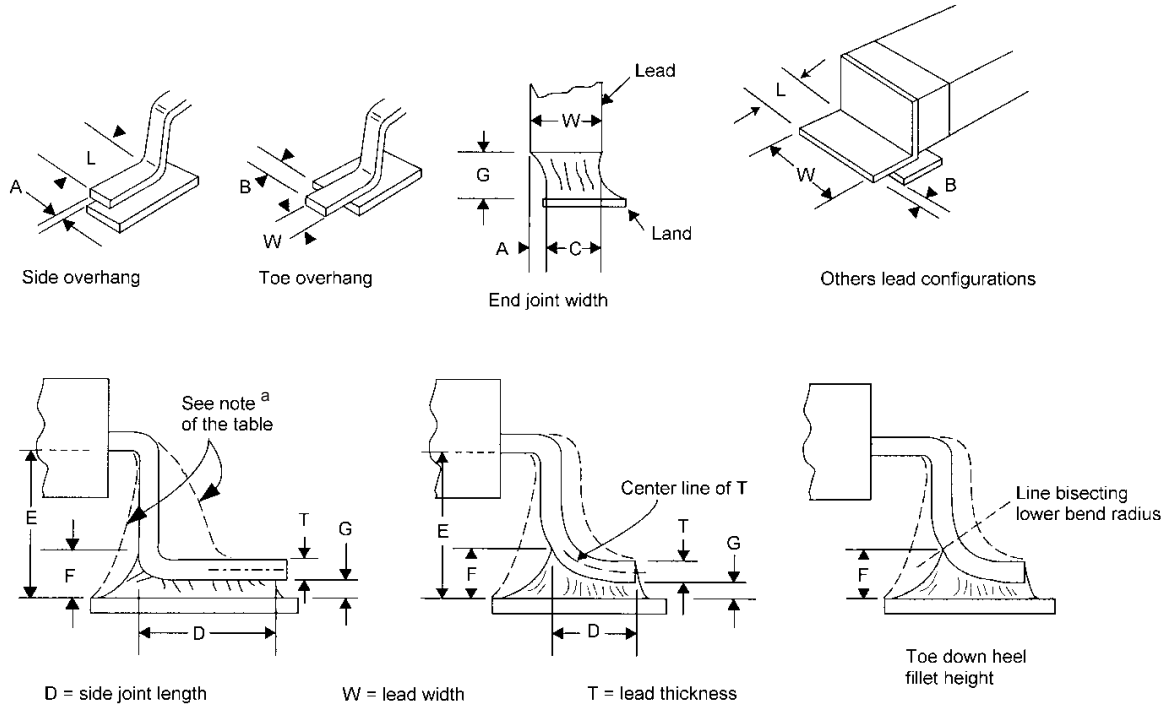


Figure 2b – Fillet height referenced to lead thickness

Figure 2 – Fillet height

7.3.3 Flat ribbon L and gull-wing leads

Solder joints between substrate lands and flat ribbon leads formed into L, and gull wing shape component leads of either stiff or flexible materials shall meet the alignment and solder fillet requirements of Figure 3 for each product level.



IEC 1367/13

Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang	*A*	1/2 *W* or 0,5 [d] whichever is less; 1/3 *W* below 0,5 mm pitch devices	1/2 W or 0,5 [d] whichever is less; 1/3 W below 0,5 mm pitch devices	1/4 W or 0,5 [d] whichever is less
Maximum toe overhang	*B*	1/2 *W* [d]	Not permitted	Not permitted
Minimum end joint width [c]	*C*	*W – A*	*W – A*	*W – A*
Minimum side joint length [b, c]	*D*	1/2 *L*	2/3 *L*	3/4 *L*
Maximum heel fillet height	*E*	e a	a	a
Minimum heel fillet height	*F*	e	*G* + 1/2 *T*	*G* + *T*
Minimum solder thickness	*G*	e	e	e
For lead frames made of Fe-Ni alloy 42 the next higher level should be chosen.				

[a] Solder fillets for levels A and B may extend through the top bend.

[b] Leads not having wettable sides or ends by design (such as leads stamped or sheared from prepared stock) are not required to have side or end fillets, but side overhang is not permitted (all levels).

[c] Devices with *W* greater than *D* shall be exempted from the side joint requirements of this table.

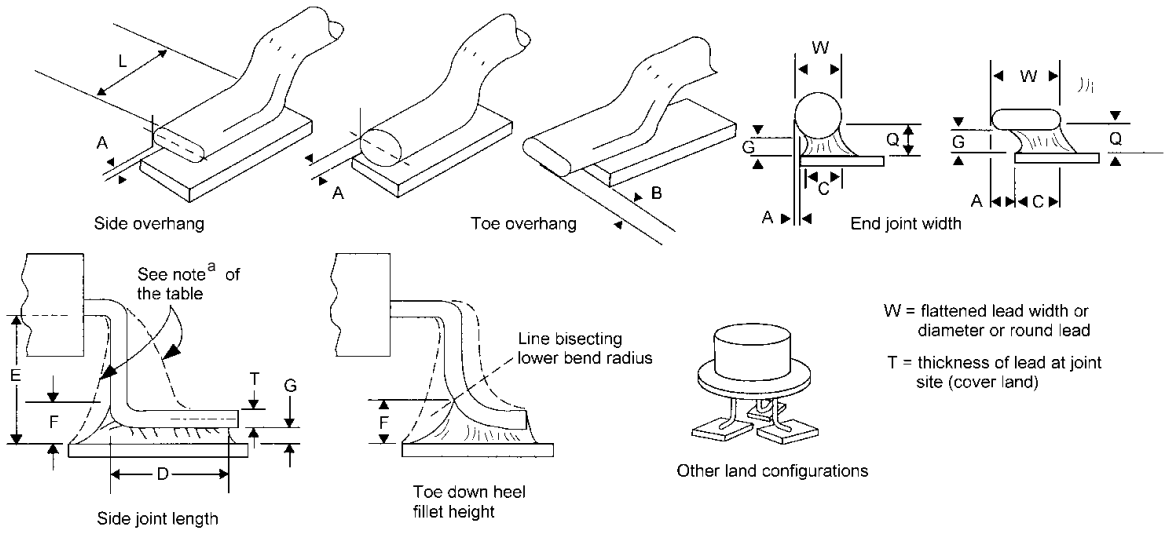
[d] Shall not violate minimum design conductor spacing.

[e] Properly wetted fillet evident.

Figure 3 – Flat ribbon L and gull-wing leads

7.3.4 Round or flattened (coined) leads

Joints formed to round or flattened (coined) leads shall meet the dimensional and fillet requirements of Figure 4 for each product level.



IEC 1368/13

Dimensions in millimetres

Feature	Dimension	Level [a]	Level B [b]	Level C
Maximum side overhang	*A*	1/3 *W*	1/3 *W*	1/4 *W*
Maximum toe overhang	*B*	[b]	[b]	[b]
Minimum end joint width	*C*	[c]	[c]	*W* – *A*
Minimum side joint length	*D*	1/2 *L*	2/3 *L*	3/4 *L*
Maximum heel fillet height	*E*	[a]	[a]	[a]
Minimum heel fillet height	*F*	[c]	*G* + 1/2 *T*	*G* + *T*
Minimum solder thickness	*G*	[c]	[c]	[c]
Minimum side joint height	*Q*	[c]	*G* + 1/2 *T* or *G* + 0,5 whichever is less	*G* + 1/2 T or *G* + 0,5 whichever is less

[a] Solder fillet for levels A and B may extend through the top bend. Solder should not extend under the body of low profile surface mount components whose leads are made of Fe-Ni alloy 42 or similar metals.

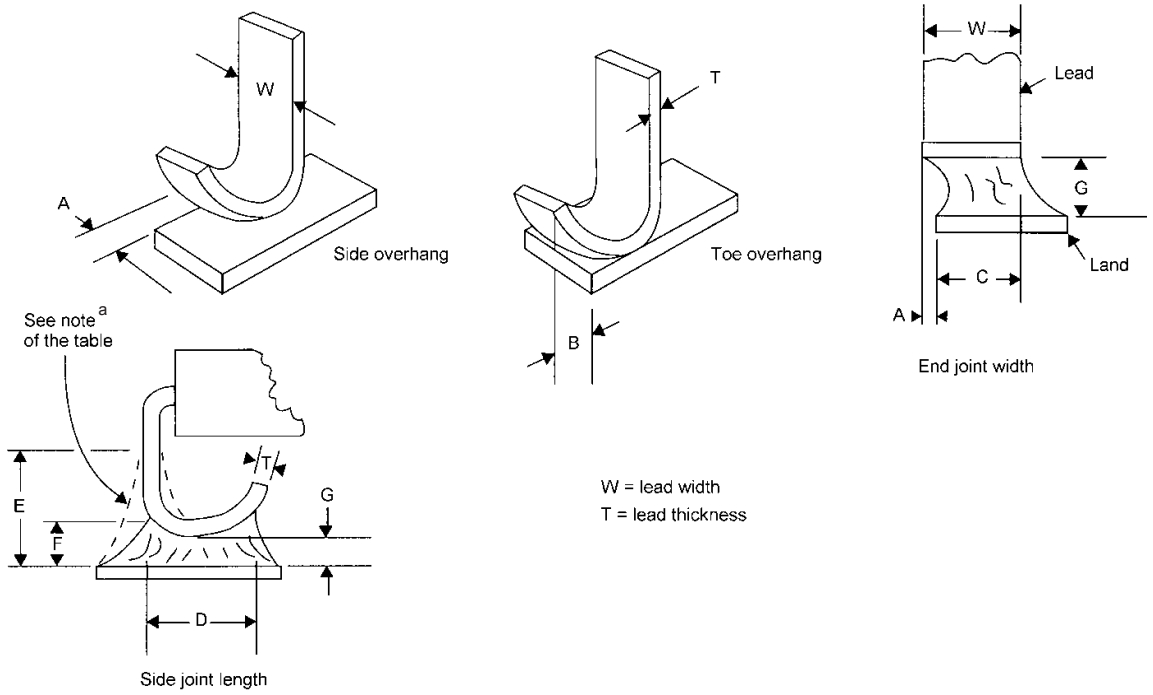
[b] Shall not violate minimum design conductor spacing.

[c] Properly wetted fillet evident.

Figure 4 – Round or flattened (coined) lead joint

7.3.5 J leads

Joints formed to leads having a J shape at the joint site shall meet the dimensional and fillet requirements of Figure 5 for each product level.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang [f]	*A*	1/2 *W*	1/2 *W*	1/4 *W*
Maximum toe overhang	*B*	c f	a f	a f
Minimum end joint width	*C*	d	*W* – *A*	*W* – *A*
Minimum side joint length [e]	*D*	d	1 1/2 *W*	1 1/2 *W*
Maximum fillet height	*E*	a	a	a
Minimum fillet height	*F*	b, d	$G + 1/2\ T^2$	$G + T^2$
Minimum solder thickness	*G*	d	d	d

[a] Maximum solder fillet should not touch package body.

[b] Maximum height to bend radius shall not exceed 2 *T*. Fillets shall be furnished on both toe and heel area of J-lead.

[c] Unspecified parameter.

[d] Properly wetted fillet evident.

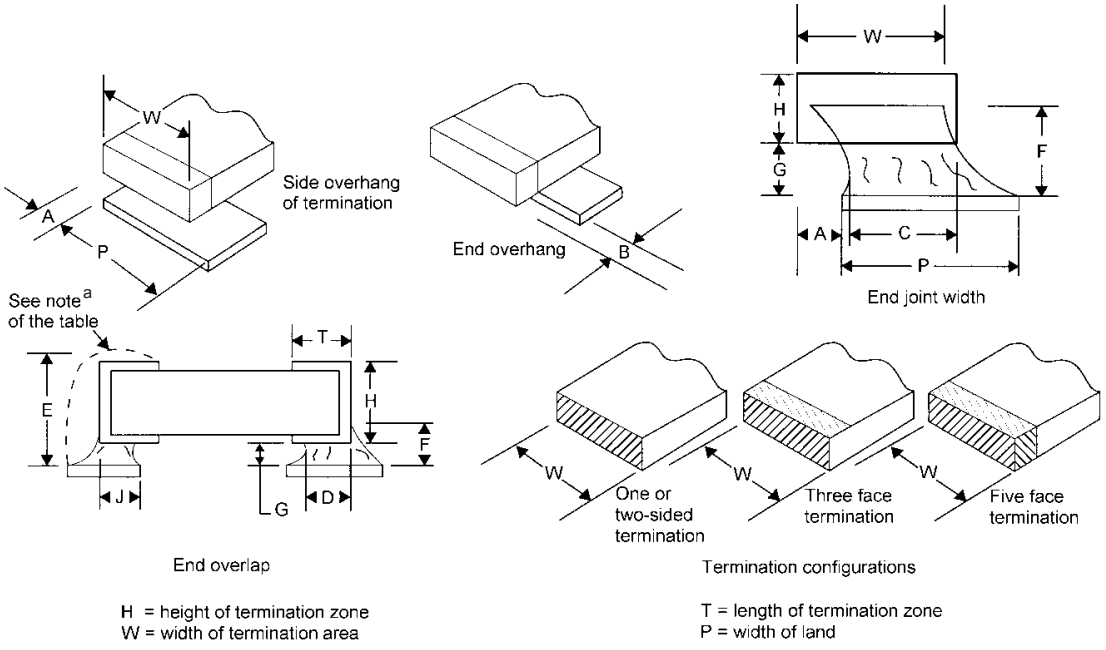
[e] Leads not having wettable sides by design (such as leads stamped from pre-plated stock) are not required to have side fillets.

[f] Shall not violate minimum design conductor spacing.

Figure 5 – J lead joint

7.3.6 Rectangular or square end components

Solder joints to components having terminations of a square or rectangular configuration shall meet the dimensional and solder fillet requirements of Figure 6 for each product level.



IEC 1370/13

Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang [e]	*A*	1/2 *W* or 1,5 whichever is less	1/3 W or 1,5 whichever is less	1/4 *W* or 1,5 whichever is less
End overhang	*B*	Not permitted	Not permitted	Not permitted
Minimum end joint width	*C*	1/2 *W*	1/2 *W*	3/4 *W*
Minimum side joint length [c]	*D*	[d]	1/2 *T*	3/4 *T*
Maximum fillet height [a]	*E*	[a]	[a]	[a]
Minimum fillet height	*F*	[d]	*G* + 1/4 *H* or *G* + 0,5 whichever is less	*G* + 1/4 *H* or *G* + 0,5 whichever is less
Minimum solder thickness [b]	*G*	[d]	[d]	0,2 [b]
Minimum end overlap [c]	*J*	2/3 *T*	2/3 *T*	3/4 *T*

[a] The maximum fillet may overhang the land or extend onto the top of the end cap metallization; however, the solder shall not extend further onto the component body.

[b] Unless satisfactory cleaning can be demonstrated with reduced clearance. *G* is not specified when cleaning is not required.

[c] Not required for one face only termination type components.

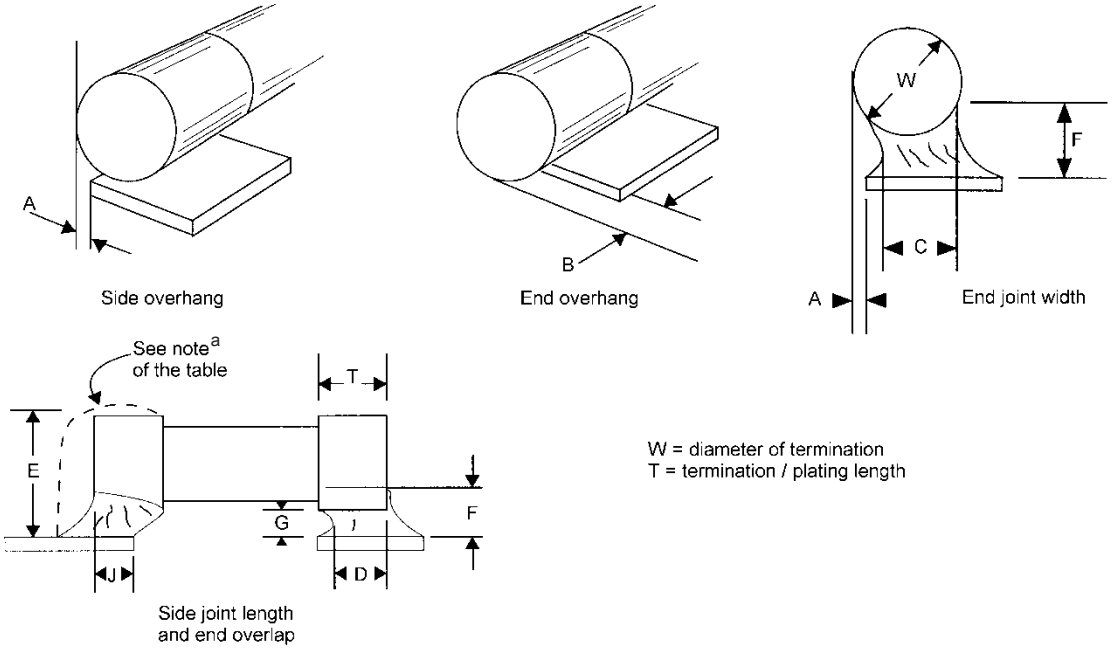
[d] Properly wetted fillet evident.

[e] Shall not violate minimum design conductor spacing.

Figure 6 – Rectangular or square end components

7.3.7 Cylindrical end cap terminations

Solder joints to components having cylindrical end cap terminations (e.g. MELFs) shall meet the dimensional and solder fillet requirements of Figure 7 for each product level.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang [c]	*A*	1/3 *W*	1/3 *W*	1/4 *W*
End overhang	*B*	Not permitted	Not permitted	Not permitted
Minimum end joint width	*C*	[b]	1/2 *W*	1/2 *W*
Minimum side joint length	*D*	[b]	1/2 *T*	3/4 *T*
Maximum fillet height (end and side)	*E*	[a]	[b]	a)
Minimum fillet height (end and side)	*F*	[b]	[b]	G + 1/4 *W* or *G* + 1,0 whichever is less
Minimum solder thickness	*G*	[b]	[b]	b)
Minimum end overlap	*J*	2/3 *T*	2/3 *T*	*T*

[a] The maximum fillet may overhang the land or extend onto the top of the end-cap metallization; however, the solder shall not extend further onto the component body.

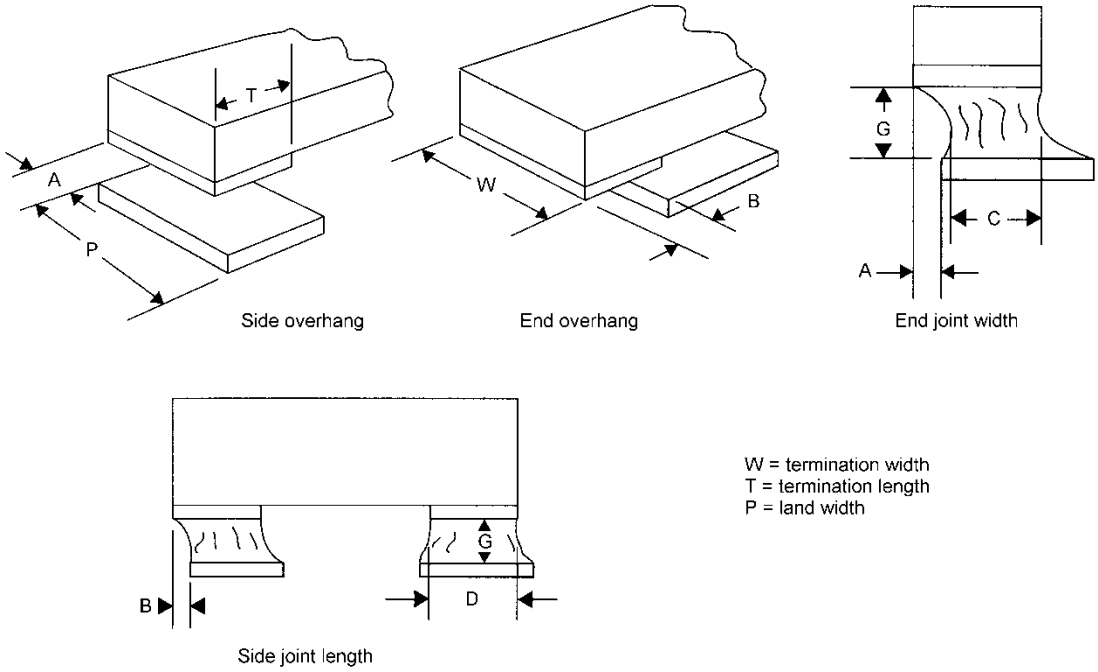
[b] Properly wetted fillet evident.

[c] Shall not violate minimum design conductor spacing.

Figure 7 – Cylindrical end-cap terminations

7.3.8 Bottom only terminations

Discrete chip components, leadless chip carriers, and other devices having metallized terminations on the bottom side only shall meet the dimensional and solder fillet requirements of Figure 8 for each product level.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang	*A*	[a] [d]	[a] [d]	[a] [d]
End overhang	*B*	Not permitted	Not permitted	Not permitted
Minimum end joint width	*C*	1/2 *W*	1/2 *W*	3/4 *W*
Minimum side joint length	*D*	[a]	[a]	[a]
Maximum fillet height	*E*	[a]	[a]	[a]
Minimum fillet height	*F*	[a]	[a]	[a]
Minimum solder thickness [c]	*G*	[b]	[b]	0,2[c]

[a] Unspecified parameter.

[b] Properly wetted fillet evident.

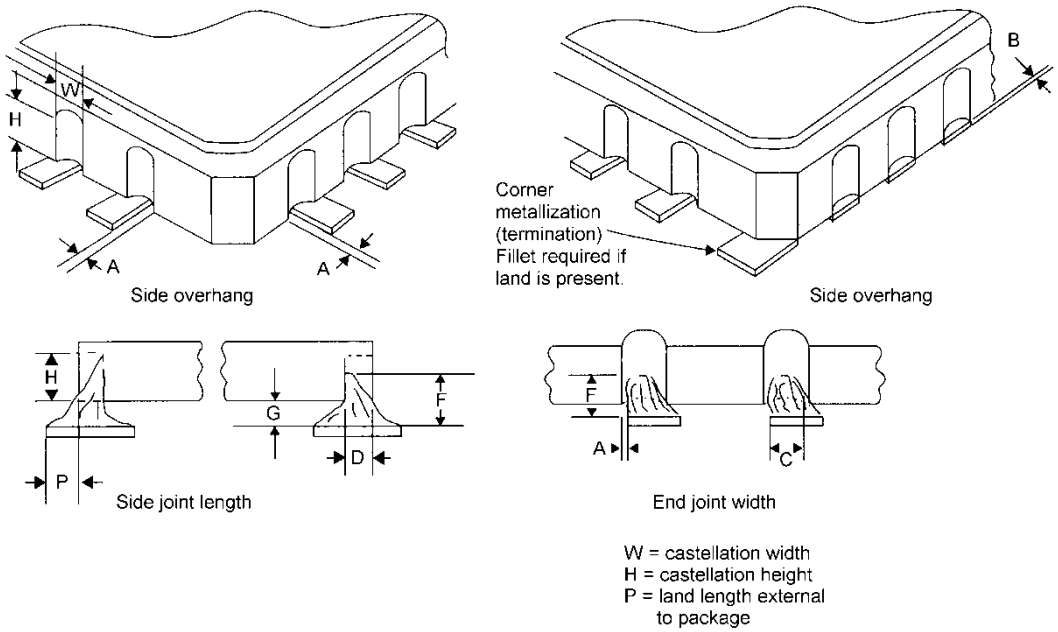
[c] Unless satisfactory cleaning can be demonstrated with reduced clearance. *G* is not specified when cleaning is not required.

[d] Shall not violate minimum design conductor spacing.

Figure 8 – Bottom only terminations

7.3.9 Leadless chip carriers with castellated terminations

Joints formed to castellated terminations of leadless chip carriers shall meet the dimensional and solder fillet requirements of Figure 9 for each product level.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang [d]	*A*	1/2 *W*	1/2 *W*	1/4 *W*
End overhang	*B*	Not permitted	Not permitted	Not permitted
Minimum end joint width	*C*	1/2 *W*	1/2 *W*	3/4 *W*
Minimum side joint length [a]	*D*	[c]	1/2 *F* or *P* whichever is less	1/2 *F* or *P* whichever is less
Maximum fillet height	*E*	Not applicable	Not applicable	Not applicable
Minimum fillet height	*F*	[c]	*G* + 1/4 *H*	*G* + 1/2 *H*
Minimum solder thickness	*G*	[c]	[c]	0,2 [b]

[a] Length *D* is dependent upon fillet height *F*, and is referenced to end of package.

[b] Unless satisfactory cleaning can be demonstrated with reduced clearance. *G* is not specified when cleaning is not required.

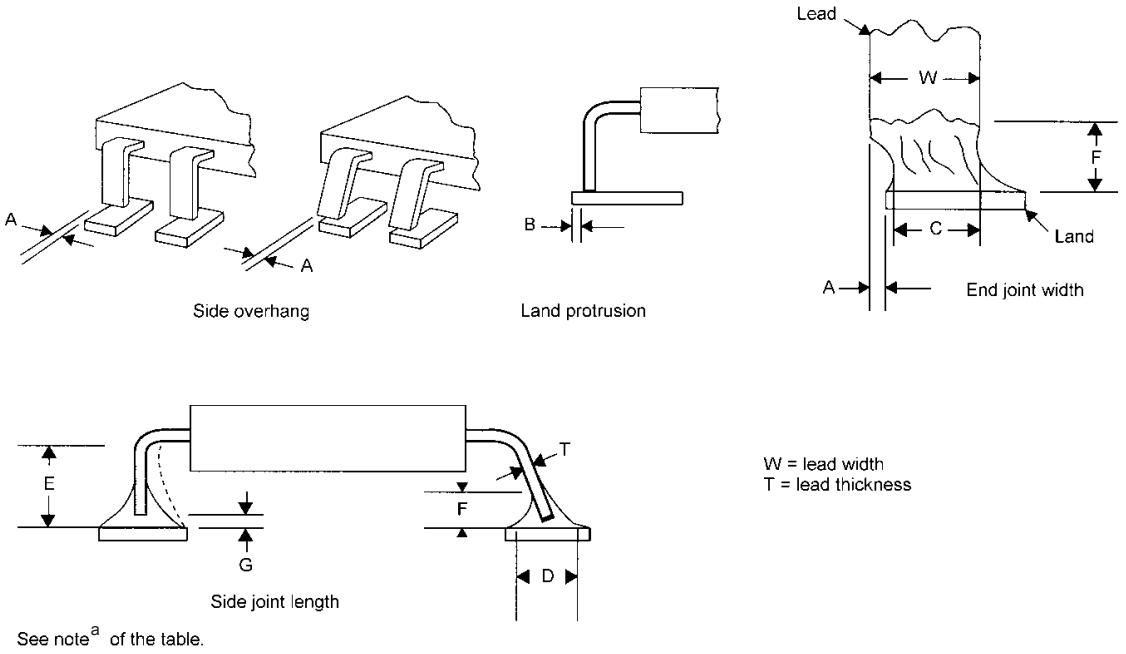
[c] Properly wetted fillet evident.

[d] Shall not violate minimum design conductor spacing.

Figure 9 – Leadless chip carriers with castellated terminations

7.3.10 Butt joints

Joints formed to leads positioned perpendicular to a circuit land in a butt configuration shall meet the dimensional and solder fillet requirements of Figure 10 for each product level. For level A and B products, leads not having wettable sides by design (such as leads stamped or sheared from preplated stock) are not required to have side fillets; however the design should permit easy inspection of wetting to the wettable surfaces.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C [b]
Maximum side overhang [e]	*A*	1/4 *W*	Not permitted	Not permitted
Minimum land protrusion	*B*	*T* or 0,5 whichever is greater	*T* or 0,5 whichever is greater	*T* or 0,5 whichever is greater
Minimum end joint width	*C*	3/4 *W*	3/4 *W*	3/4 *W*
Minimum side joint length [a]	*D*	[c]	[c]	[c]
Maximum fillet height	*E*	[a]	[a]	[a]
Minimum fillet height	*F*	0,5	0,5	*G* + 1,5 *W* or *G* + 0,5 whichever is greater
Maximum solder thickness	*G*	0,1[d]	0,1[d]	0,1[d]

[a] Maximum fillet may extend into the bend radius. Solder shall not extend under the body of low profile surface mount components whose leads are made of Fe-Ni alloy 42 or similar metals.

[b] To be permitted for level C product, parts shall have been defined for butt joint SMT mounting.

[c] Unspecified parameter.

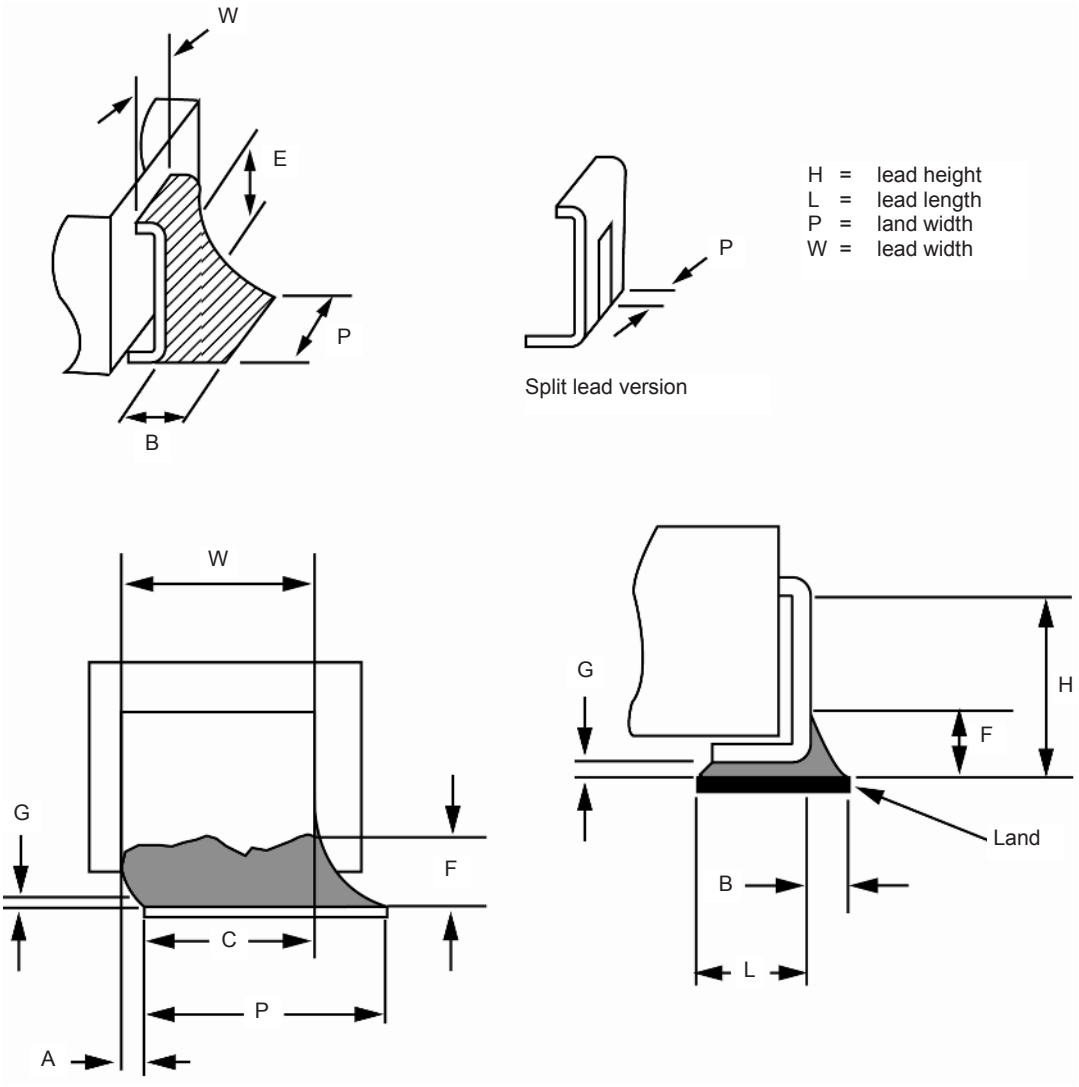
[d] Properly wetted fillet evident.

[e] Shall not violate minimum design conductor spacing.

Figure 10 – Butt joints

7.3.11 Inward L-shaped ribbon leads

Solder joints to components having inward L-shaped ribbon lead terminations shall meet the dimensional and solder fillet requirement of Figure 11.



Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Maximum side overhang [b]	*A*	1/2 *W*	1/2 *W*	1/4 *W* or 1/4 *P* whichever is less
Minimum land protrusion	*B*	[a]	[a]	1/2 *H* or 0,5 whichever is less
Minimum end joint width	*C*	1/2 *W*	1/2 *W*	3/4 *W* or 3/4 *P* whichever is less
Maximum fillet height	*E*	*H*	*H*	*H*
Minimum fillet height	*F*	*G* + 1/4 *H* or *G* + 0,5 whichever is less	*G* + 1/4 *H* or *G* + 0,5 whichever is less	*G* + 1/4 *H* or *G* + 0,5 whichever is less
Minimum solder thickness	*G*	No limit if all other requirements met	No limit if all other requirements met	No limit if all other requirements met

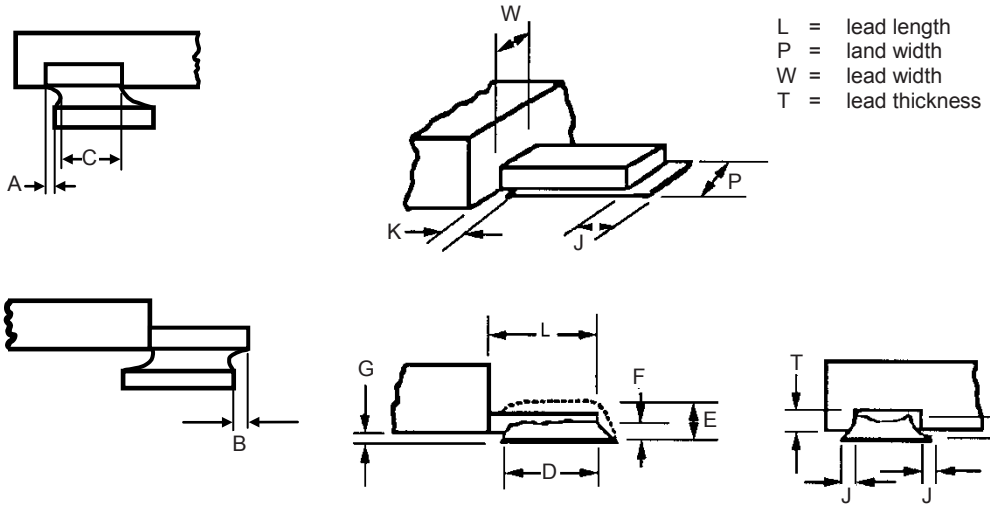
[a] Identified parameter.

[b] Shall not violate minimum design conductor spacing.

Figure 11 – Inward L-shaped ribbon leads

7.3.12 Flat lug leads

Solder joints to power dissipating components with flat lug leads terminations shall meet the dimensional requirements of Figure 12 for each product level.



IEC 1376/13

Dimensions in millimetres

Feature	Dimension	Level A	Level B	Level C
Side overhang	*A*	Not permitted	Not permitted	Not permitted
Toe overhang	*B*	Not permitted	Not permitted	Not permitted
Minimum end joint width	*C*	1/2 *W*	1/2 *W*	*W*
Minimum side joint length	*D*	*L* – *K* [a]	*L* – *K* [a]	*L* – *K* [a]
Maximum fillet height	*E*	[b]	[b]	*G* + *T* + 1,0
Minimum fillet height	*F*	[b]	[b]	*G* + *T*
Maximum solder thickness	*G*	[b]	[b]	0,2
Maximum land protrusion	*J*	[b]	[b]	*T*
Maximum gap	*K*	[b]	2 *T*	*T*

[a] Where the lug is intended to be soldered beneath the component body and the land is designed for this purpose, the lead shall show evidence of wetting in the gap *K*.

[b] Unspecified parameter.

Figure 12 – Flat lug leads

7.4 General post-soldering requirements applicable to all surface-mounted assemblies

7.4.1 Dewetting

Non-conforming, defect level A, B, C: dewetting at any termination if it reduces the wetted area of any termination or land by more than 5 % of the maximum.

7.4.2 Leaching

Non-conforming, defect level A, B, C: leaching at any termination if it causes more than 5 % of the visible part of any termination wetted area to become unwetted.

7.4.3 Pits, voids, blowholes, and cavities

Non-conforming, defect level A, B, C: when the wetted areas or wetted perimeters of a solder joint are reduced below the specified minimum for the relevant joint type.

7.4.4 Solder wicking

Non-conforming, defect level A, B, C: wicking prevents the specified minimum wetting requirements for the relevant joint type from being met, or it causes excessive stiffness in a lead.

7.4.5 Solder webs and skins

Non-conforming, defect level A, B, C: any solder web or skin present.

7.4.6 Bridging

Non-conforming, defect level A, B, C: any unwanted bridging joining normally isolated conducting surfaces.

Non-conforming, defect level B, C: where excess solder causes a large rigid connection between two or more component terminations that are intended to be electrically connected but physically apart, this may also be non-conforming. Defect due to stress risks from CTE mismatch.

7.4.7 Degradation of marking

Non-conforming, defect level A, B, C: loss of identity data or parametric value marking through degradation of characters or colours on components, parts, printed boards.

7.4.8 Solder spikes

Acceptable, level A, B, C: spikes that have rounded tips or are less than 0,5 mm high and appear in circuits that operate below 250 V a.c. or d.c.

Non-conforming, defect level A, B, C: any spike that violates minimum design spacing.

7.4.9 Disturbed joint

Acceptable, level A, B, C: a joint with surface roughness (grainy or dull finish).

Non-conforming, defect level A, B, C: any joint exhibiting a crack, fillet lifting, or a surface exhibiting visible contamination.

7.4.10 Component damage

Non-conforming, defect level A, B, C: any damage to a component, part, or board that may

a) cause loss of functionality, reduction in reliability, or

b) result in failures to meet relevant IEC or user's specifications, or

c) it may be a rejection criterion for quality inspections.

7.4.11 Open circuit, non-wetting

Non-conforming, defect level A, B, C: any solder joint where solder was available but there has been failure to wet any surface specified as being part of the minimum joint, for example due to solder balling, poor solderability, surface tension effect (tombstoning).

7.4.12 Component tilting

Acceptable, level A, B, C: a component or part that exhibits tilt in any direction, but meets the relevant specified requirements for all its soldered joints.

Non-conforming, defect level A, B, C: any component or part whose tilt causes it to fail to meet the specified minimum requirements.

7.4.13 Non-conducting adhesive encroachment

Acceptable, level A, B, C: adhesive encroachment into a solder joint that does not prevent it from meeting the relevant specified minimum wetting and alignment requirements.

Non-conforming, defect level A, B, C: adhesive encroachment into a solder joint that will cause it to fail to meet the relevant specified minimum requirements for the joint or prevent reliable rework.

7.4.14 Open circuit, no solder available (skip)

Non-conforming, defect level A, B, C: any failure to make a solder joint due to local non-availability of solder prior to or during soldering, for example arising from a stencil defect, shadowing, solder balling.

7.4.15 Component on edge

Acceptable, level A, B, C: provided component body length is less than 3,2 mm, width is less than 1,6 mm and thickness greater than 1,0 mm and all solder joint and alignment requirements for the relevant level are met.

8 Rework and repair

Rework shall only be undertaken with prior permission of the user. The maximum number of rework actions on an individual board or unit shall be agreed on with the user.

All rework activities on a product shall be recorded in the manufacturer's quality system. This data shall be used for continual improvement and corrective action by the supplier.

When rework is performed, each reworked or reflowed connection shall be inspected to the requirements of 7.3. See Table 1 for re-workable defects.

Table 1 – Surface mounted solder joint defects

No.	Defects
1	Defects identified in Table 2 of IEC 61191-1:2013.
2	Flat, ribbon L, or gull-wing lead solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.3.
3	Round or flattened (coined) lead solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.4.
4	J lead solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.5.
5	Rectangular or square end component solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.6.
6	Cylindrical end cap termination (MELF) solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.7.
7	Bottom only termination solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.8.
8	Leadless chip carrier with castellated termination solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.9.
9	Butt joint solder connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.10.
10	Inward L-shaped lead connections that do not meet the requirements of 7.3, 7.3.2 or 7.3.11.
11	Flat lug leads on power dissipating components that do not meet the requirements of 7.3, 7.3.2 or 7.3.12.

Annex A
(normative)

Placement requirements for surface mounted devices

A.1 General

The following placement requirements for surface mount devices shall be imposed only if process controls are not sufficiently in place to ensure compliance with 6.3.

A.2 Component positioning

Misregistration of components shall not reduce the spacing to adjacent printed wiring or other metallized elements by more than the minimum electrical spacing.

A.3 Small devices incorporating two terminations

A.3.1 Metallization coverage over the land (side-to-side)

At least 75 % of the component metallization width on each end of the component shall overlap the land area. If land metallization width is less than 75 % of the component metallization, the component metallization shall cover the entire width of the land (see Figure 6).

A.3.2 Metallization coverage over the land (end)

At least 2/3 of the length of the end metallization shall overlap the land area. Minimum conductor spacing shall be maintained (see Figure 6).

A.4 Mounting of cylindrical end cap devices (MELFs)

MELF devices shall be mounted such that the side overhang does not exceed 25 % of the diameter of the metallized face (end cap). At least 2/3 of the thickness of the metallized face (end cap) shall be on the land (see Figure 7). Use of lands with cut-outs (e.g. U-shaped lands) to aid in component positioning is permissible provided that an adequate solder fillet is formed.

A.5 Registration of castellated chip carriers

At least 3/4 of the cross-section of each metallized castellation of a leadless chip carrier shall be over the land to which the chip carrier is registered (see Figure 9).

A.6 Surface mounted device lead and land contact

Minimum contact length (D) shall be equal to 3/4 of the foot length (L) for flat ribbon leads, J leads, round leads and flattened round leads. Refer to Figures 3 to 5.

A.7 Surface mounted device lead side overhang

Leads may have side overhang, provided the overhang does not exceed 25 % of the lead width or 0,5 mm, whichever is less, and minimum conductor spacing is maintained.

A.8 Surface mounted device lead toe overhang

Toe ends of leads of surface mounted devices may overhang the land, provided the minimum electrical spacing and contact length is maintained.

A.9 Surface mounted device lead height off land (prior to soldering)

Round or flattened leads may be raised off the land surface a maximum of one-half the original lead diameter. Flat or ribbon leads may be raised off the land surface a maximum of two times the lead thickness or 0,5 mm, whichever is less. Toe up or toe down on flat and round leads shall be permissible provided that separation between leads and termination area does not exceed 2 *T* and 1/2 *D* limits, respectively.

A.10 Positioning of J lead devices

J lead devices shall be mounted so that the side overhang is less than 25 % of the lead width. The part shall be positioned so that a minimum solder fillet of two lead widths can be formed.

A.11 Positioning gull-wing lead devices

It is preferred that leads be seated such that the full length of the foot is within the land area (no overhang).

A.12 External connections to packaging and interconnect structures

Where packaging and interconnect structures (P&I) are used to provide controlled thermal expansion, they shall not be connected to external system elements (i.e. chassis or heat sinks) that will degrade the thermal expansion control below design limits.

_____

This page deliberately left blank

This page deliberately left blank

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

All the data, software and documentation set out in all British Standards and other BSI publications are the property of and copyrighted by BSI, or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI. Details and advice can be obtained from the Copyright & Licensing Department.

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™