6 THROUGH-HOLE MOUNTING AND TERMINATIONS

6.1 Through-Hole Terminations - General Axial Leaded components, when mounted horizontal to the board surface, should be approximately centered between the mounting holes. The entire length of the component body should be in contact with the board surface. The maximum space between the component body and the board **shall [N1N2P3]** not exceed 0.7 mm [0.028 in]. Components that are required to be mounted off the board **shall [D1D2D3]** be elevated at least 1.5 mm [0.059 in]. Components mounted in unsupported holes and required to be elevated **shall [D1D2D3]** be provided with lead forms at the board surface, or other mechanical support.

Axial leaded components mounted vertically in unsupported holes **shall [D1D2D3]** be mounted with lead forms or other mechanical support.

Axial lead components mounted vertically in supported holes **shall [D1D2D3]** have component height and clearance (from the board to the body or weld bead) requirements in accordance with the user determined dimension and **shall not [D1D2D3]** impact form, fit or function.

6.1.1 Lead Forming Part and component leads should be preformed to the final configuration excluding the final clinch or retention bend before assembly or installation. The lead forming process **shall not [D1D2D3]** damage lead seals, welds, or connections internal to components.

Leads **shall [A1P2D3]** extend at least one lead diameter or thickness but not less than 0.8 mm [0.031 in] from the body or weld before the start of the bend radius (see Figure 6-1).

The lead bend radius **shall [A1P2D3]** be in accordance with Table 6-1.

Note: Measurement is made from the end of the part. (The end of the part is defined to include any coating, solder seal, solder or weld bead, or any other extension.)

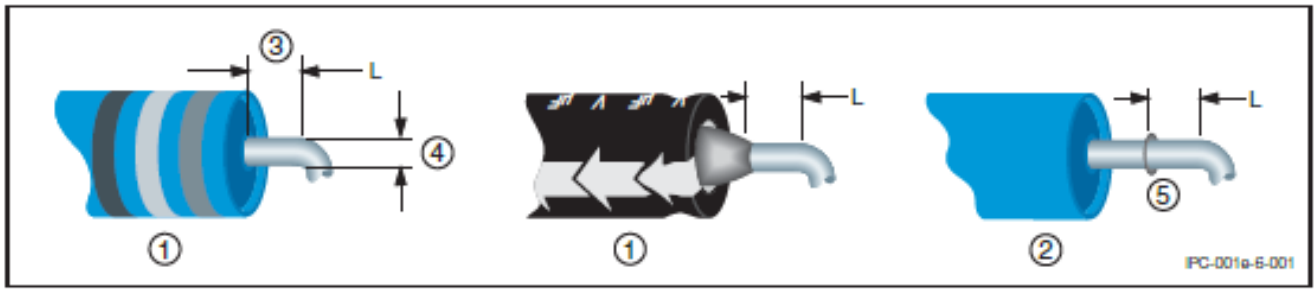

Figure 6-1 Lead Bends

1. Standard bend
2. Welded bend
3. Straight for 1 diameter/lead thickness, but not less than 0.8 mm [0.031 in]
4. Diameter/Thickness
5. Weld

Table 6-1 Lead Bend Radius

Lead Diameter	Minimum Bend Radius (R)
<0.8 mm [0.031 in]	1 diameter/thickness
0.8 to 1.2 mm [0.031 to 0.047 in]	1.5 diameters/thickness
>1.2 mm [0.047 in]	2 diameters/thickness

6.1.2 Lead Deformation Limits Leads **shall not [D1D2D3]** have nicks or deformation exceeding 10% of the diameter, width, or thickness of the lead except as allowed for flattened leads (see 7.1.4).

6.1.3 Termination Requirements Component leads in supported holes may be terminated using a straight through, partially clinched, or clinched configuration. The clinch should be sufficient to provide mechanical restraint during the soldering process. The orientation of the clinch relative to any conductor is optional. DIP leads should have at least two diagonally opposing leads partially bent outward.

Lead Terminations in unsupported holes **shall [N1N2D3]** be clinched a minimum of 45°.

If a lead or wire is clinched, the lead **shall [N1N2D3]** be wetted in the clinched area. The outline of the lead should be discernible in the solder connection.

Tempered leads **shall not [D1D2D3]** be terminated with a (full) clinched configuration.

Lead protrusion **shall not [D1D2D3]** violate minimum electrical clearance requirements. Lead protrusion **shall [D1D2D3]** be in accordance with Table 6-2 for supported holes or Table 6-3 for unsupported holes.

Connector leads, relay leads, tempered leads and leads greater than 1.3 mm [0.051 in] diameter are exempt from the maximum length requirement provided that they do not violate minimum electrical spacing.

Table 6-2 Protrusion of Leads in Supported Holes

	Class 1	Class 2	Class 3
(L) min.	End is discernible in solder[1]		
(L) max.	No danger of shorts	2.5 mm [0.0984 in]	1.5 mm [0.0591 in]

Note 1: For boards greater than 2.3 mm [0.0906 in] thick, with components having preestablished lead lengths, e.g., DIPs, sockets, connectors, as a minimum need to have the component or lead shoulder flush to the board surface, but the lead end may not be discernible in the subsequent solder connection.

Table 6-3 Protrusion of Leads in Unsupported Holes

	Class 1	Class 2	Class 3
(L) min.	End is discernible in solder		Sufficient to clinch
(L) max[1]	No danger of shorts		

Note 1: Lead protrusion should not exceed 2.5 mm [0.0984 in] if there is a possibility of violation of minimum electrical spacing, damage to soldered connections due to lead deflection or penetration of static protective packaging during subsequent handling or operating environments.

6.1.4 Lead Trimming Leads may be trimmed after soldering provided the cutters do not damage the component or solder connection due to physical shock. Tempered leads **shall not [N1D2D3]** be trimmed unless specified on the drawings.

When lead cutting is performed after soldering, the solder terminations **shall [N1D2D3]** either be reflowed or visually inspected at 10X to ensure that the original solder connection has not been damaged (e.g., fractured) or deformed. Lead trimming after soldering that cuts into solder fillets **shall [N1N2D3]** be reflowed (Figure 6-2). If the solder connection is reflowed this is considered part of the soldering process and not rework. This requirement does not apply to components that are designed such that a portion of the lead is intended to be removed after soldering (e.g., break-away tie bars).

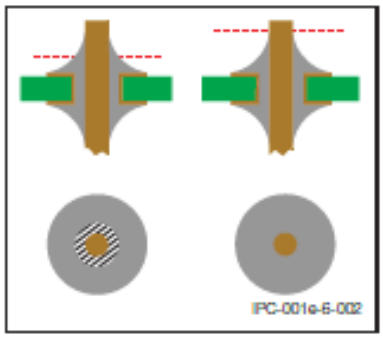

Figure 6-2 Lead Trimming

6.1.5 Interfacial Connections PTHs without leads used for interfacial connections need not be filled with solder.

6.1.6 Coating Meniscus In Solder For Class 1 and 2 as an exception to Tables 6-4 or 6-5, as appropriate for supported or unsupported holes, on the solder destination side the meniscus may be covered by solder but on the solder source side there **shall [D1D2D3]** be 360° visible solder wetting and no visible coating meniscus in the solder connection. Solder connections **shall [N1N2D3]** meet the requirements of Tables 6-4 or 6-5, as appropriate.

6.2 Supported Holes

6.2.1 Solder Application Solder **shall [N1D2D3]** only be applied to one side of a PTH except for intrusive soldering. Heat may be simultaneously applied to both sides of the PTH.

6.2.2 Through-Hole Component Lead Soldering When soldering component leads into PTH connections, the goal of the process is to accomplish 100% fill of the PTH with solder and good wetting to the lands, lead, and barrel top and bottom. The solder connection **shall [D1D2D3]** meet the requirements of Table 6-4, regardless of the soldering process, e.g., hand soldering, wave soldering, intrusive soldering, etc.

As an exception to the Class 2 fill requirements in Table 6-4, the minimum permissible vertical fill of a PTH is 50% or 1.19 mm [0.047 in], whichever is less, provided the following conditions are met:

a. The PTH is connected to thermal or conductor layers that act as thermal heat sinks.

b. The component lead is discernible in the lead termination side.

c. The solder fillet on the lead termination side is wetted 360° of the PTH barrel and 360° of the lead.

d. Surrounding PTHs meet requirements of Table 6-4.

Note: Less than 100% solder fill may not be acceptable in some applications, e.g., thermal shock, electrical performance. The user is responsible for identifying these situations to the manufacturer.

Table 6-4 Supported Holes with Component Leads, Minimum Acceptable Conditions[1]

	Criteria	Class 1	Class 2	Class 3
A	Vertical fill of solder. Notes 2,3 and Figure 6-3	Not specified	75%	
B	Circumferential wetting of lead and barrel on solder destination side.	Not specified	180°	270°
C	Percentage of original land area covered with wetted solder on solder destination side.	0		
D	Circumferential fillet and wetting of lead and barrel on solder source side.	270°		330°
E	Percentage of original land area covered with wetted solder on solder source side. Note 1	75%		

Note 1: Wetted solder refers to solder applied by any solder process including intrusive soldering. For intrusive soldering there may not be an external fillet between the lead and the land.
Note 2: The 25% unfilled height includes the sum of both source and destination side depressions.
Note 3: Class 2 may have less than 75% vertical fill as noted in 6.2.2.

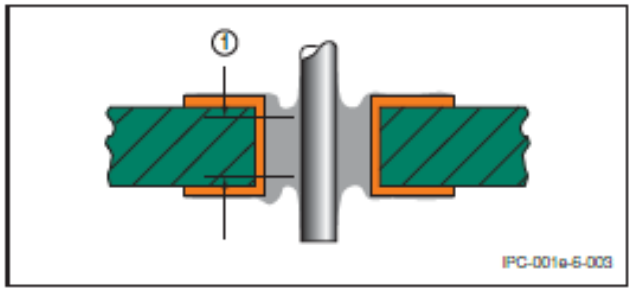

Figure 6-3 Vertical Fill Example
1. Vertical fill

6.3 Unsupported Holes

6.3.1 Lead Termination Requirements for Unsupported Holes Lead protrusion for unsupported holes **shall [D1D2D3]** meet the requirements of Table 6-3. Solder **shall [D1D2D3]** meet the requirements of Table 6-5.

Table 6-5 Unsupported Holes with Component Leads, Minimum Acceptable Conditions[1,4]

Criteria	Class 1	Class 2	Class 3
A. Fillet wetted to lead and land	270°		330°, Note 2
B. Percentage of land area covered with wetted solder. Note 3	75%		

Note 1: Double sided boards with functional lands on both sides need to comply to A and B on both sides.
Note 2: For Class 3, lead is wetted in the clinched area.
Note 3: Solder is not required to cap or cover the hole.
Note 4: Wetted solder refers to solder applied by the solder process.