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MILITARY STANDARD

PART AND COMPONENT MOUNTING FOR HIGH QUALITY/HIGH RELIABILITY SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES

AMSC N/A

SOLD

DEPARTMENT OF DEFENSE
WASHINGTON, DC 20301

Part and Component Mounting for High Quality/High Reliability Soldered Electrical and Electronic Assemblies

DOD-STD-2000-2A

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this standard should be addressed to: Commanding Officer, Naval Air Engineering Center, Code 9313, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this standard or by letter.

FOREWORD

1. Electrical and electronic assemblies used in military applications are continuously becoming more diverse, complex and sophisticated yet smaller, lighter, denser in internal packaging, sturdier with respect to environment, and more reliable with respect to both function and service life. Such changes in technological posture mandate both definition and standardization of component mounting techniques in military electrical and electronic equipment.

2. This standard provides for communication between designers, fabricating personnel, and inspectors. The uniformity of component mounting criteria applies to manual or automated procedures. This standard is intended for use by any of the many organizations engaged in the production of military electronic equipment. Criteria of this standard are not directed to end item products per se but are instead directed to part and component mounting essential to the said end item products and should be implemented in conjunction with appropriate documents.

3. This standard addresses those components normally defined as standard and miniature, and provides technical criteria essential to electrical connections and wiring within equipment fabricated by or for the Department of Defense.

4. It is recognized that mounting criteria other than specified herein exist or may exist in the future but it is intended that the requirements of this standard be extrapolated to such noncovered criteria insofar as practicable.

5. DOD-STD-2000-1, DOD-STD-2000-2 and DOD-STD-2000-3 are standards concerning the requirements for High Quality/High Reliability soldered electrical and electronic connections. They are intended to be invoked only for this level of "Quality." The three documents are also intended to be used as a set. The requirements in each consider and complement the others.

6. These three documents are not to be confused with DOD-STD-2000-4 General Purpose Soldering Requirements for Electrical and Electronic Equipment. DOD-STD-2000-4 covers general purpose soldering only, and will be invoked independently in situations which do not require soldering at the level covered by DOD-STD-2000-1, DOD-STD-2000-2 and DOD-STD-2000-3.

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1. SCOPE

1.1 Applicability. This standard prescribes mounting criteria for electrical and electronic components and wiring used in guided missiles, aircraft, satellites, shipboard weapon systems, ammunition and weapon systems, ground vehicle equipment, and program critical ground support equipment. Soldering processes and procedures, and criteria for obtaining high quality/high reliability electrical and electronic solder connections are covered in DOD-STD-2000-1 and DOD-STD-2000-3, respectively.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation, form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-M-38510	Microcircuit, General Specification for
MIL-P-50884	Printed-Wiring, Flexible and Rigid-Flex
MIL-R-55342	Resistor, Fixed, Film, Chip, Established Reliability, General Specification for
MIL-C-55365/4	Capacitor, Chip, Fixed, Tantalum, Established Reliability, Style CWR06

STANDARDS

MILITARY

MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-1389	Design Requirements for Standard Electronic Modules
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically-Initiated Explosive Devices) (Metric)
DOD-STD-2000-1	Soldering Technology, High Quality/High Reliability
DOD-STD-2000-3	Criteria for High Quality/High Reliability Soldering Technology

STANDARDS (Continued)

MILITARY (Continued)

MIL-STD-2118	Flexible and Rigid-Flex Printed-Wiring for Electronic Equipment
MS-21266	Grommet, Plastic, Edging

HANDBOOKS

MILITARY

DOD-HDBK-263	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Metric

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer).

2.2 Other publications. The following document(s) form a part of this standard to the extent specified herein. The issues of the documents which are indicated as DOD adopted shall be the issue in the DODISS and the supplement thereto, if applicable.

ANSI/IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 North Lincoln Avenue, Lincolnwood, IL 60646.)

3. DEFINITIONS

3.1 Terms and definitions. The definitions applicable to this standard shall be in accordance with ANSI/IPC-T-50.

4. GENERAL REQUIREMENTS

4.1 Conflict. In the event of any conflict between the requirements of this standard and the applicable assembly drawing(s), differences shall be referred to the Government Contracting Officer or his designated technical activity and a request for deviation with supporting data shall be submitted for approval prior to proceeding. Upon such approval, the provisions shall be officially documented (by notice of revision or equivalent) on the assembly drawing(s) which shall then govern.

4.2 Design.

4.2.1 Design requirements information. The following paragraphs provide design information on the subjects indicated. Where differences exist between this standard and documents referenced herein, the requirements of this standard takes precedence.

4.1	Drawing requirements
4.2.1.1	Rigid printed wiring boards
4.2.1.2	Reference to rigid flex printed wiring
4.5	Hybrid microelectronic modules and assemblies
4.7.1	Obscuring of termination
4.7.2	Moisture traps
4.7.3	Vibration
4.7.4	Insulation of metal case components
4.7.5	Perpendicular mounting
4.10	Interference spacing
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4.12	Part piggybacking
4.14	Jumper wires
4.16	Eyelets
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5.1.1.4	Use of unsupported holes
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5.1.1.12.6	Foil pad as seating for rolled flanges
5.1.1.13.7	Terminals and plated-through holes
5.1.1.13.8	Terminals and plated-through holes with rolled flange

4.2.1.1 Rigid printed wiring boards. Rigid printed wiring boards used in conjunction with this standard shall provide conductors, terminal areas, conductor patterns, plated-through holes in accordance with MIL-STD-275, and detailed supplementary requirements specified herein. Minimum spacing between conductive patterns of printed wiring boards shall be in accordance with

conductor spacing requirements of tables I and II if the printed wiring board is not, or is not intended to be conformally coated or encapsulated. The use of uncoated printed wiring boards requires approval of Government Contracting Officer.

TABLE I. Conductor spacing (uncoated printed wiring boards) (sea level to 10,000 feet).

Voltage between conductors DC or AC peak (volts)	Minimum spacing
0-150	0.025 inch (0.64 mm)
151-300	0.050 inch (1.3 mm)
301-500	0.100 inch (2.54 mm)
Greater than 500	0.0002 inch (0.0051 mm) per volt

TABLE II. Conductor spacing (uncoated printed wiring boards) (over 10,000 feet).

Voltage between conductors DC or AC peak (volts)	Minimum spacing
0-50	0.025 inch (0.64 mm)
51-100	0.060 inch (1.5 mm)
101-170	0.125 inch (3.2 mm)
171-250	0.250 inch (6.4 mm)
251-500	0.500 inch (12.7 mm)
Greater than 500	0.001 inch (0.03 mm) per volt

4.2.1.2 Flexible and rigid flex printed wiring. Flexible and rigid flex printed wiring shall be in accordance with MIL-P-50884 and MIL-STD-2118. Part mounting for flexible and rigid flex printed wiring assemblies shall be in accordance with MIL-STD-2118 and detailed supplementary requirements specified herein.

4.3 Solder processes and processing. Solder processes, processing and processing materials shall be in accordance with DOD-STD-2000-1.

4.4 Soldered connections. Soldered electrical connections shall be in accordance with DOD-STD-2000-3.

4.5 Hybrid microelectronic modules and assemblies. Component mounting and attachment within hybrid microelectronic modules and assemblies shall be in accordance with MIL-M-38510. Attachment of completed hybrid microelectronic modules to printed wiring or other interconnecting substrates shall be in accordance with the detailed requirements specified herein.

4.6 Electrostatic discharge. Components shall be mounted utilizing electrostatic control criteria and procedures defined in DOD-STD-2000-1.

4.7 Component positioning. Parts and components shall be positioned in compliance with the individual drawings and mounted in accordance with the requirements specified herein.

4.7.1 Components shall be mounted so that terminations of other components are not obscured.

4.7.2 Parts and components shall be mounted such that the formation of moisture traps is precluded.

4.7.3 Components shall be mounted in such a manner so as to withstand all vibration and mechanical shock requirements specified for the end product.

4.7.4 Metal cased components which are not otherwise insulated but are mounted over printed conductor wiring shall be insulated from adjacent wiring circuitry and conductor elements. If the addition of insulation is required for conformance with this requirement, an engineering change notice or request for deviation shall be initiated. Insulation material shall be compatible with the circuit and printed wiring board material.

4.7.5 Axial-leaded components shall be mounted parallel to the board surface. Perpendicular mounting shall be used only with prior approval of the Government Contracting Officer. Under no circumstance shall planar mounting for perpendicular axial leaded components be used.

4.8 Visibility of markings. Components shall be mounted insofar as practicable in such a manner that markings pertaining to value, part type, etc., are visible. For parts marked in such a way that some of the marking will be hidden regardless of the orientation of the part, the following shall be the order of precedence for which markings shall be visible.

a. Polarity.

b. Part value.

c. Part type (manufacturer's or DOD part number as applicable for that type part).

d. Traceability code (if applicable).

4.9 Part markings and reference designations. Part markings and reference designations shall be legible with letters and numerals unbroken, clearly defined and unsmeared.

4.10 Interference spacing. Parts and components shall be mounted such that they do not overhang the edge of a printed wiring board, terminal panel, or chassis member. The minimum spacing for conductive items (components, uninsulated leadwires, metal-cased components, terminals, standoffs, lockwashers and other like items) shall be 0.060 inch (1.58 mm) from edge of printed wiring board, terminal panel, or chassis member.

4.11 Part clearance spacing. Any portion of a bare lead, metallic component body, terminal, or like item shall be spaced at least 0.060 inch (1.58 mm) from one to another except as permitted by MIL-STD-275 or otherwise specified herein.

4.12 Piggybacking. There shall be no piggybacking of parts or components.

4.13 Lead forming.

4.13.1 Lead malforming limits. Whether formed manually or by machine or die, part and component leads shall not be mounted if the part or component lead evidence nicks or deformation exceeding 10% of the diameter of the lead. Basis metal shall not be exposed.

4.13.2 Tempered leads. Tempered leads (sometimes referred to as pins) and untempered leads 0.050 inch (1.3 mm) or greater in diameter or thickness shall not be bent nor formed for mounting purposes inasmuch as body seals and connections internal to the component may be damaged. Neither shall tempered leads be cut with diagonal cutters or other tools which impart shock to connections internal to the component. Untempered leads that are smaller than 0.050 inch (1.3 mm) in diameter shall be clinched when installed in unsupported holes.

4.14 Jumper wires. Jumper wires included as a part of the initial design shall conform to the mounting requirements for axial-leaded components. Jumper wire modifications (haywires) require the approval of the Government Contracting Officer.

4.15 Insulation clearance. Clearance between the solder of the connection and the end of either separable or fixed insulation on the wire in the connection shall be as follows:

a. Minimum clearance. There shall be visible clearance between the insulation and solder connection. The insulation shall not abut the solder nor shall it be embedded in or surrounded by the solder. Neither shall the insulation be melted, charred, seared, nor diminished in diameter.

b. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch (1.58 mm), whichever is larger, but shall not be such to permit shorting between adjacent conductors.

c. High voltage clearance. The insulation clearance for high voltage wires (thick walled insulation) shall be 1/8 $\pm$ 1/16 inch (3.2 $\pm$ 1.58 mm).

4.16 Eyelets. Eyelets are unacceptable for electrical connections.

4.17 Resins and other adhesives. When resins and other adhesives are used, they shall be compatible with the printed wiring board, components, processes and process solvents, solutions and materials.

5. DETAIL REQUIREMENTS

5.1 Mounting of parts and components. Whether accomplished manually or automatically, parts and components shall be mounted to printed wiring boards, to terminal boards, and to terminals as specified herein.

5.1.1 Parts and components mounted to printed wiring boards. Axial and nonaxial-leaded components shall be mounted on only one side of a printed wiring assembly if the leads are dressed through holes. Planar mounted components may be mounted on either or both sides of a printed wiring assembly. Components to be mounted shall be designed for and capable of withstanding soldering temperatures incident to the particular process to be used for fabrication of the assembly. When design restrictions mandate mounting components incapable of withstanding soldering temperatures incident to the particular process, such components shall be mounted and hand-soldered to the assembly as a separate operation or shall be processed using a localized reflow technology approved by the Government Contracting Officer prior to use (see Specialized Technologies, DOD-STD-2000-1).

5.1.1.1 Hole obstruction. Parts and components shall be mounted such that they do not obstruct solder flow onto the topside termination areas of interfacial, quasi-interfacial, or interlayer plated-through holes (see figure 1).

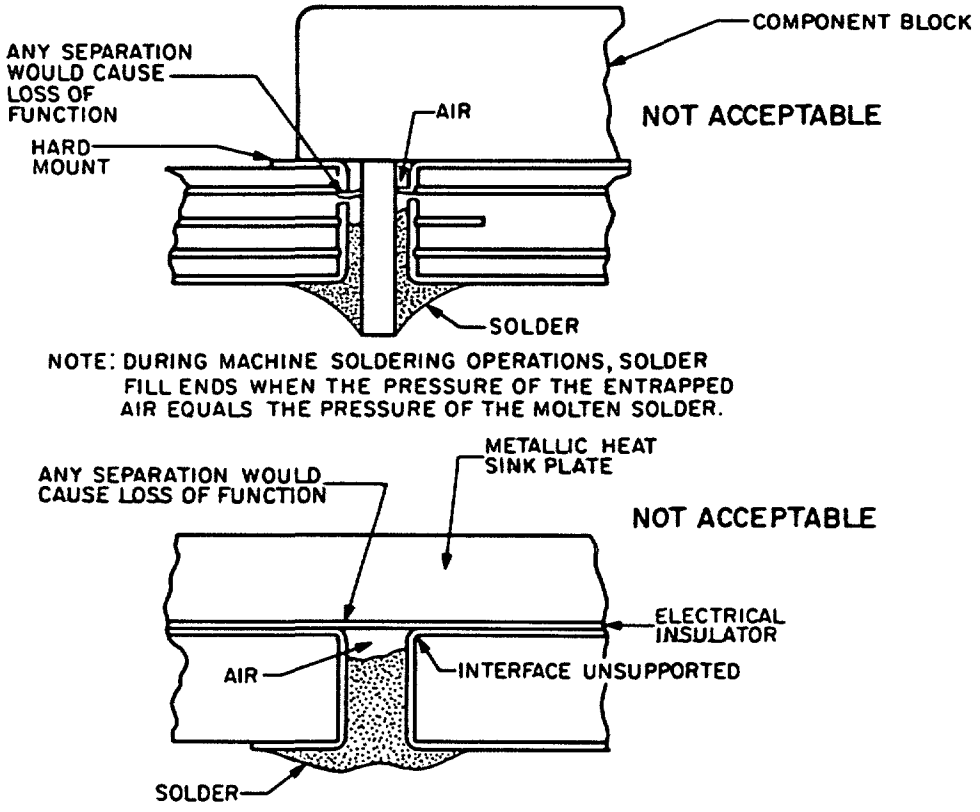


FIGURE 1. Blocked plated-through holes (see 5.1.1.1).

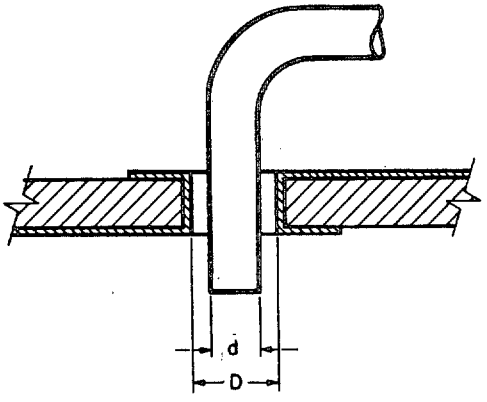
5.1.1.2 Lead-to-hole relationship. No more than one item, whether wire or component lead, shall be inserted in any one hole.

5.1.1.2.1 Round leads-maximum clearance. With all tolerances taken into consideration, the maximum diameter of the finished plated-through hole shall be less than 0.028 inches (0.7 mm) larger than the minimum diameter of the inserted round finished tinned lead (see figure 2A).

5.1.1.2.2. Round leads-minimum clearance. With all tolerances taken into consideration, the minimum diameter of the finished plated-through hole shall be greater than 0.010 inch (0.25 mm) larger than the maximum diameter of the inserted round finished tinned lead (see figure 2A).

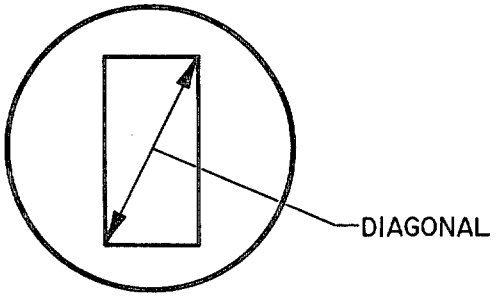
5.1.1.2.3 Rectangular (ribbon) leads-maximum clearance. With all tolerances taken into consideration, the maximum diameter of the finished plated-through hole shall be less than 0.028 inch (0.7 mm) larger than the minimum diagonal of the inserted rectangular finished tinned lead (see figure 2B).

5.1.1.2.4 Rectangular (ribbon) leads-minimum clearance. With all tolerances taken into consideration, the minimum diameter of the finished plated-through hole shall be greater than 0.006 inch (0.15 mm) larger than the maximum diagonal of the inserted rectangular finished tinned lead (see figure 2B).



A

D MAX EQUAL TO OR LESS THAN d min plus 0.028 INCH (0.7 mm)
D MIN EQUAL TO OR GREATER THAN d max plus 0.010 INCH (0.25 mm)



B

FIGURE 2. Lead-to-hole relationships (see 5.1.1.2).

5.1.1.3 Lead preforming. Part and component leads shall be preformed to the final configuration excluding the final clinch or retention bend before assembly or installation.

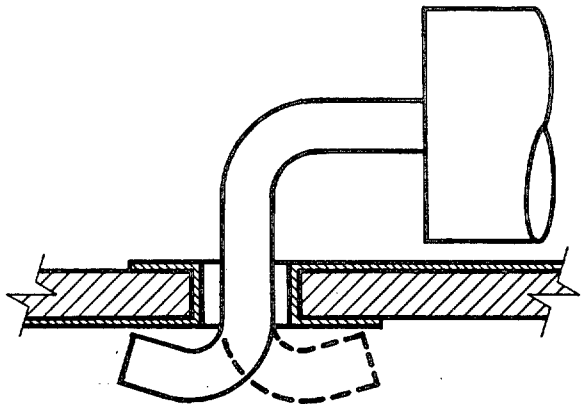
5.1.1.4 Part and component lead terminations. Part and component leads shall be of the clinched, partial clinch or straight-through configuration and shall be terminated in accordance with 5.1.1.4.1. Except for terminal mounting (see 5.1.1.12 and 5.1.1.13), holes that are not plated-through and connection configurations that incorporate offset lands utilized in conjunction with holes that are not plated-through shall be used for part and component lead termination only with prior approval of the Government Contracting Officer. If unsupported holes are authorized, part and component leads shall be of the full clinched configuration and shall be terminated in accordance with 5.1.1.4.2 including 5.1.1.4.2.1.

5.1.1.4.1 Leads in plated-through holes in printed wiring boards shall be of the full clinch configuration (Type I; see figure 3A) unless otherwise approved by the Government Contracting Officer. When automatic insertion equipment provides repeatable clinches within the 15-45 degree clinch angle, partial clinch (Type II; see figure 3B) is acceptable. Type I is not applicable for leads of dual in-line packages (DIPs) or pins of other type modules. Type II is not applicable for tempered pins or for leads over 0.050 inch (1.3 mm) in diameter.

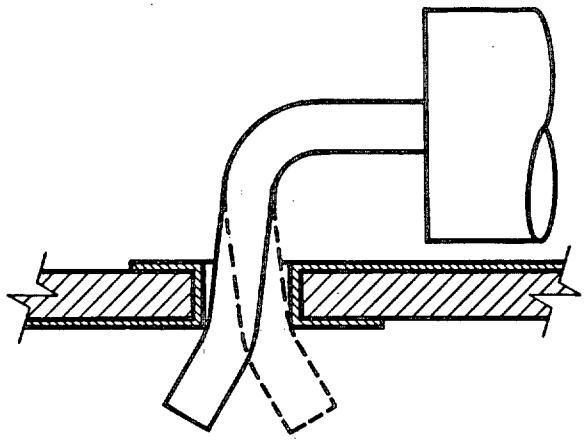
5.1.1.4.2 Clinched lead terminations. The length of the clinched portion of wires and component leads shall be no less than one-half the largest dimension (usually the diameter) of the terminal area or 1/32 inch (0.79 mm), whichever is greater, and no more than the diameter (or length) of the termination area (see figure 4A). The lead length shall be determined prior to soldering (actual measurement is not required except for referee purposes). Lead overhang no greater than 0.032 inch (0.81 mm) is permissible provided that clearance to adjacent conductive elements is no less than 0.015 inch (0.38 mm). When manually clinched, the clinched portion of the wire of lead should be directed along a conductor trace connected to the termination area. When automatically clinched, the orientation of the clinch relative to any trace is optional. The leads on opposite ends or sides of a component shall be directed in opposite directions (see figure 4B). Manually formed clinches for nonaxial leaded components shall be directed radially from the center of the component when the termination area array on the printed wiring board is patterned for such radial orientation.

5.1.1.4.2.1 Fully clinched (Type I). Clinched leads (Type I) shall be bent between 75 and 90 degrees from a vertical line perpendicular to the board (see figure 4C).

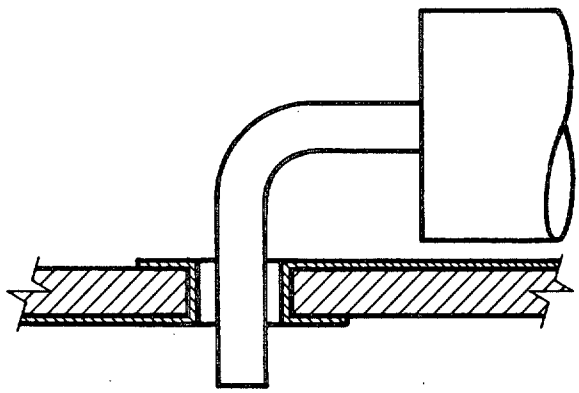
5.1.1.4.2.2 Partially clinched (Type II). Partially clinched leads (Type II) shall be bent between 15 degrees to 45 degrees as measured from a vertical line perpendicular to the board (see figure 4C). Lead length (E) shall be 0.040 ± 0.020 inch (1.0 ± 0.5 mm) as measured from the conductor surface for the plated-through hole (see figure 5). Type II lead termination shall not be used for manually inserted components except on diagonally opposite corner pins of Dual-In Line Packages (DIPs).



A. TYPE I CLINCH CONFIGURATION
(CLINCH FORMED IN EITHER DIRECTION)



B. TYPE II PARTIAL CLINCH
(CLINCH FORMED IN EITHER DIRECTION)



C. TYPE III STRAIGHT-THROUGH CONFIGURATION

FIGURE 3. Plated-through hole lead termination (see 5.1.1.4.1).

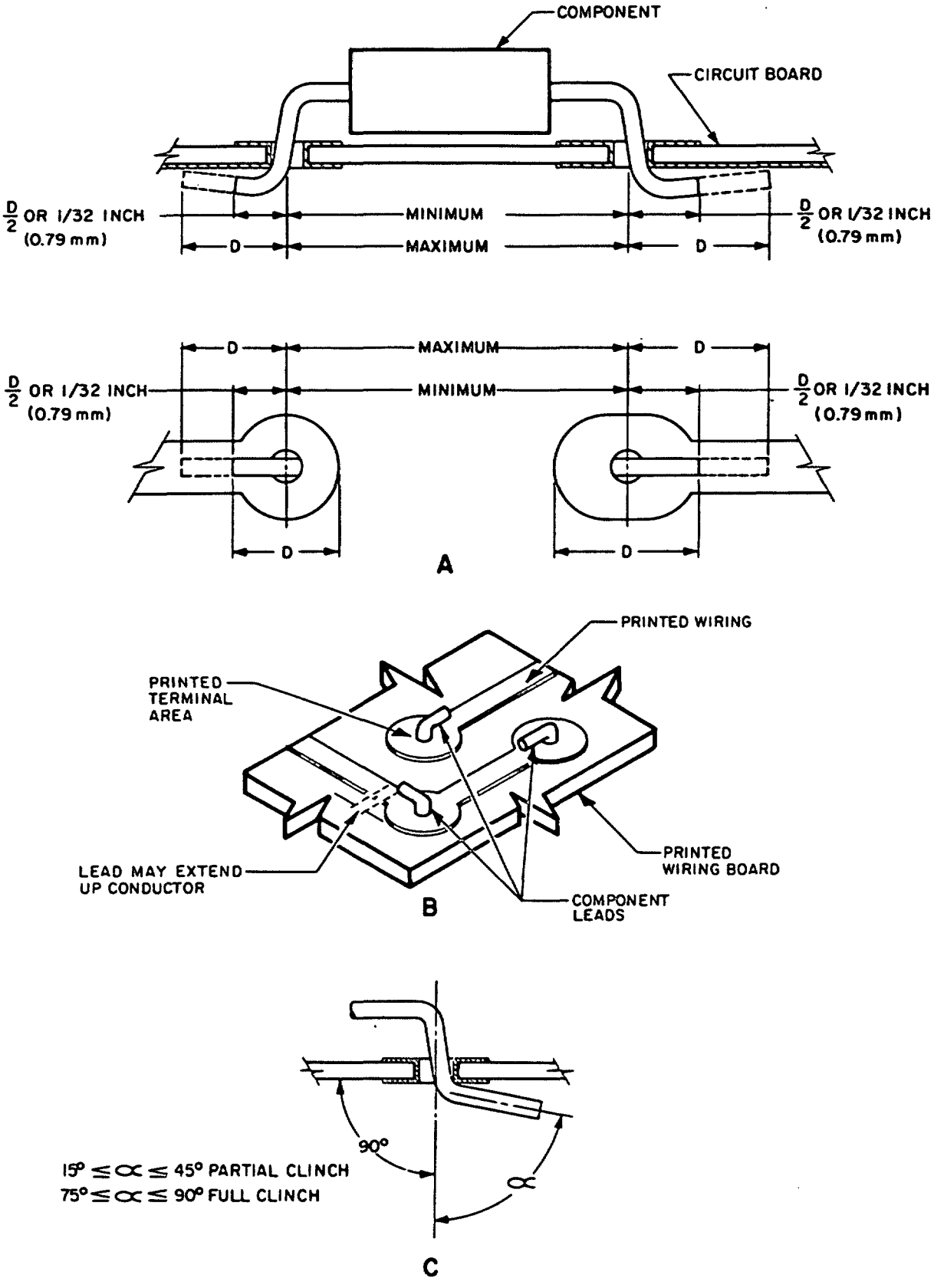


FIGURE 4. Lead termination (clinched leads) (see 5.1.1.4.2).

5.1.1.4.3 Straight-through lead termination (Type III). Component leads terminated straight-through shall extend from the exit surface of the printed wiring board, a minimum of 0.020 inch (0.5 mm) and a maximum of 0.060 inch (1.5 mm) (dimension E, figure 5) for boards thicker than 0.030 inch (0.76 mm) (dimension TB). On boards 0.030 (0.76 mm) or thinner the lead extension shall be 0.030 (0.76 mm) minimum and 0.060 (1.5 mm) maximum. Printed wiring assembly designs which necessitate different lead extension requirements are considered unique mounting requirements and require prior approval of the Government Contracting Officer. Dimension E is the distance from the conductor surface, to the end of the projecting lead. The minimum lead length shall be determined prior to soldering. Actual measurement is not required except for referee purposes.

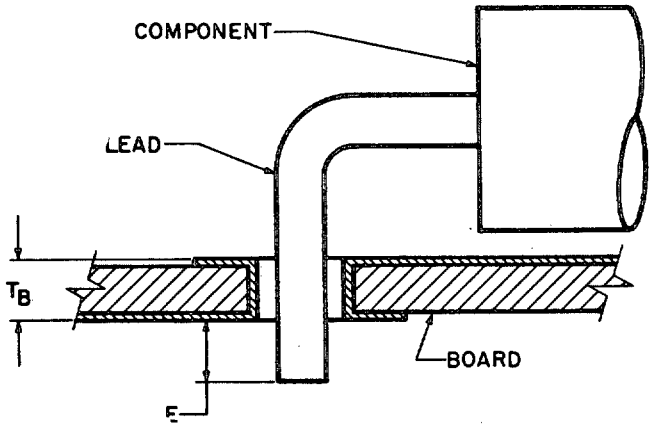


FIGURE 5. Straight-through lead extension (see 5.1.1.4.3).

5.1.1.5 Wiring to printed wiring boards. Interconnect wiring connected directly (not via connectors) to printed boards or printed board assemblies shall be installed in plated-through holes or on turret terminals. Bare tinned wire with added insulating sleeving shall not be used. Wires shall be installed on turret terminals if the wires are subject to removal for normal maintenance action. Insulated solid or stranded wire shall be installed in accordance with DOD-STD-2000-1 as applicable to plated-through holes and to terminals in accordance with 5.1.3.1 thru 5.1.3.8. Insulated solid or stranded wire installed in plated-through holes in printed boards with base material thickness of 0.020 inch (0.5 mm) or less shall be clinched to the solder side. Mounting of solid conductors of flat ribbon cable or flexible printed wiring in plated-through holes constitutes a unique mounting design (see Specialized Technology DOD-STD-2000-1). Routing and cabling requirements shall be specified on the assembly drawing.

5.1.1.6 Lead straightness. Leads shall not be bent at the body of the component or between the body of a component and any lead weld and shall extend straight from the body seal and lead weld for at least twice the lead diameter or thickness. For lead diameters of 0.015 inch (0.38 mm) or less, the straight extension shall be 0.030 inch (0.76 mm) (see figure 6).

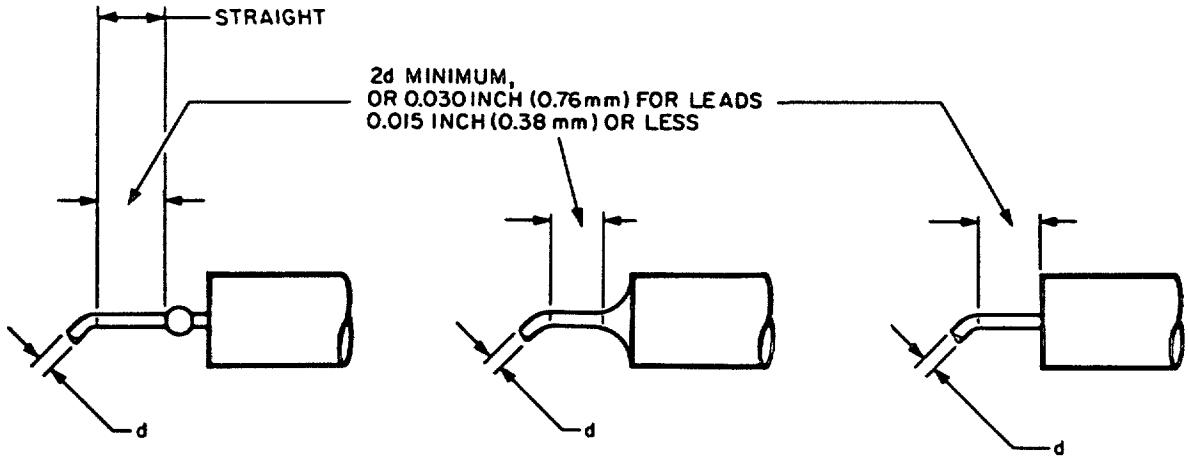


FIGURE 6. Lead straightness (see 5.1.1.6).

5.1.1.7 Axial-leaded components. Axial-leaded components shall be mounted parallel to the board surface (see 4.7.5).

5.1.1.7.1 Physical support. Dependent upon weight and heat generation characteristics, components shall be mounted for support as follows:

5.1.1.7.1.1 Except for planar and authorized perpendicular mounted components (see 4.7.5), components weighing less than 1/4 ounce (7.08g) per lead, which dissipate less than 1 watt and are not clamped or otherwise supported, shall be mounted parallel to the board surface with the spacing between the component body and board a maximum of 0.010 inch (0.25 mm).

5.1.1.7.1.2 All components weighing 1/4 ounce (7.08g) per lead or more shall be supported in a clamp or other device (including embedment) such that the soldered connections are not solely relied upon for mechanical strength (see figure 7).

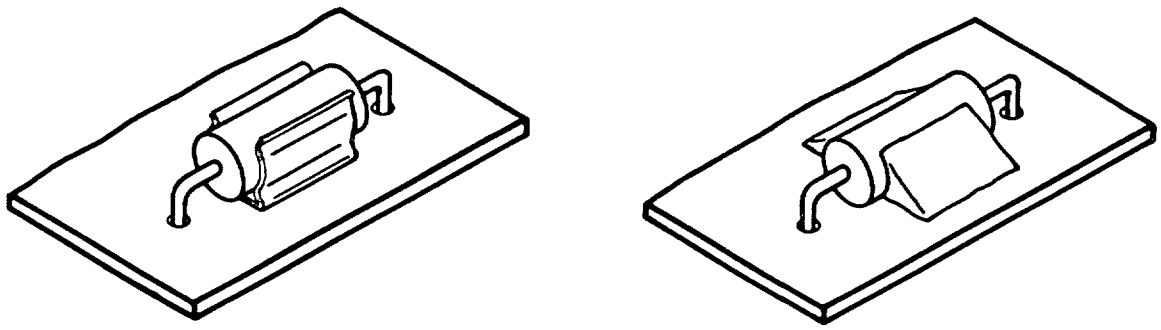


FIGURE 7. Supporting clamp and embedment (see 5.1.1.7.1.2).

5.1.1.7.2 Heat dissipation. Components that dissipate one watt or more during actual circuit operation shall be mounted with a clamp, thermal ground plane, or separately manufactured heat sinking element (see figure 8 for examples) of a size and configuration adequate to dissipate the heat to the extent that the maximum allowable operating temperature of the printed wiring board is not exceeded. Any heat dissipation technique or device shall permit appropriate cleaning to remove contaminants from the assembly. Conductive materials used to transfer heat between parts and heat sink shall be compatible with assembly and cleaning processes.

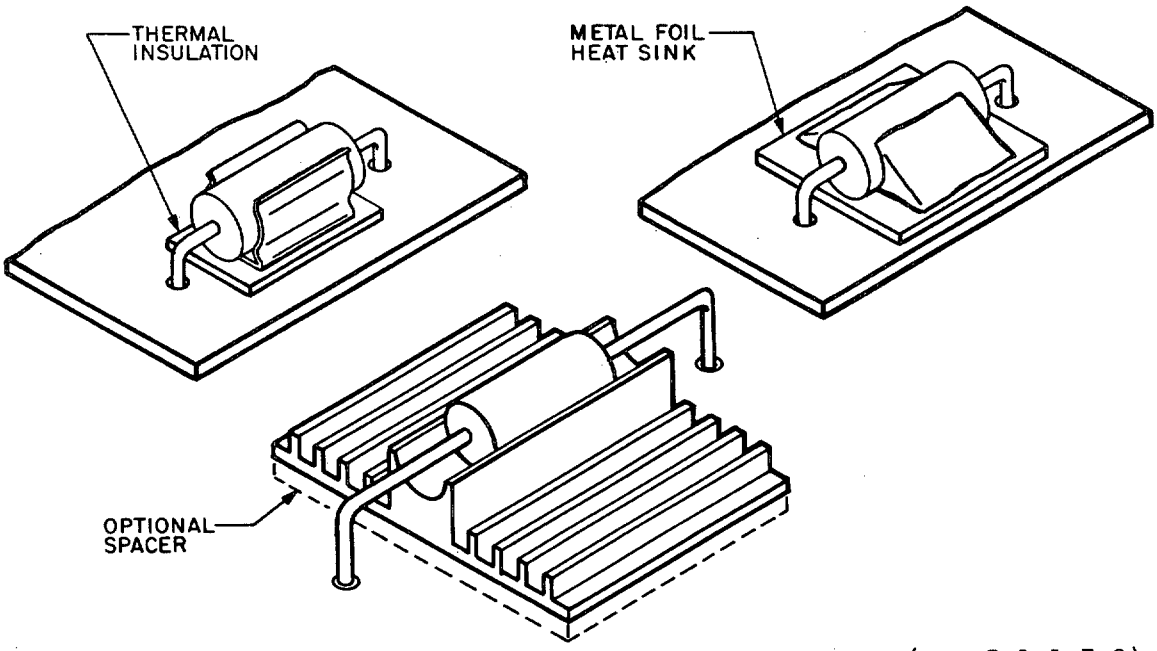


FIGURE 8. Typical heat sinked axial-leaded components (see 5.1.1.7.2).

5.1.1.7.3 Cross conductor mounting. When bodies of components are mounted across more than one conductor on a printed wiring assembly, the board surface shall be protected from moisture traps. A conformal coating material applied prior to component assembly as shown in figure 9 shall be used for such protection unless the board is coated with a prepreg material or permanent solder mask. The conformal coating shall be selected in accordance with DOD-STD-2000-1 and shall be compatible with the printed wiring board and parts mounted thereon. This requirement is applicable to components with or without insulating sleeving (see MIL-STD-275).

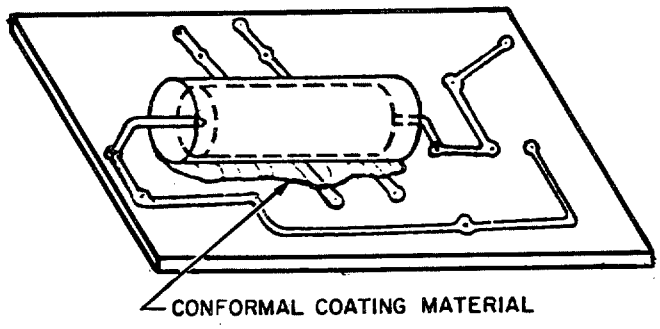


FIGURE 9. Cross conductor mounting (see 5.1.1.7.3).

5.1.1.7.4 Body centering. Except as otherwise specified herein, the bodies (including end seals and welds) of horizontally mounted, axial leaded components should be approximately centered in the span between mounting holes, as shown in figure 10.

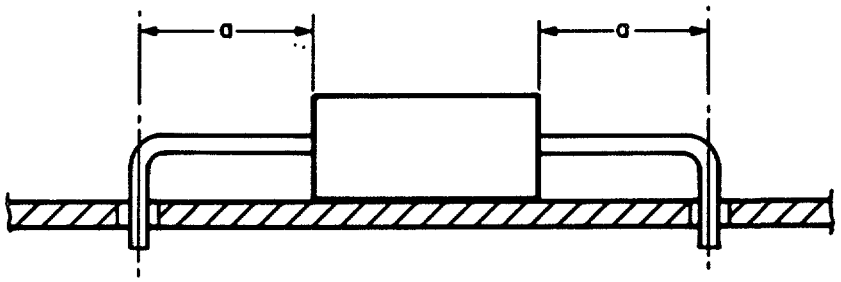


FIGURE 10. Body centering (see 5.1.1.7.4).

5.1.1.7.5 Maximum combined lead length. Unless exception is specified on the the government approved assembly drawings, the combined length of the straight lead extension from the part body (labeled x or y in figure 11) of components mounted horizontally shall not exceed one inch (2.54 cm).

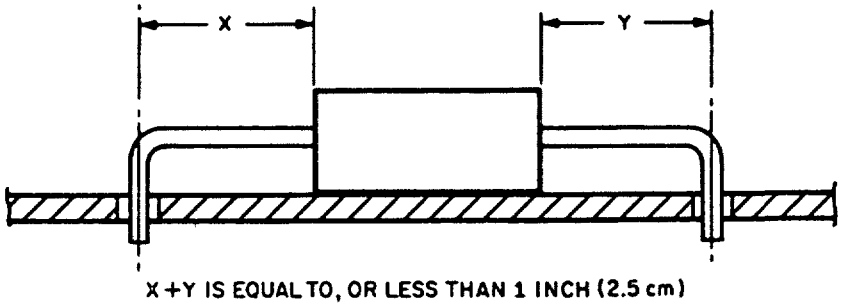


FIGURE 11. Maximum combined length of leads (see 5.1.1.7.5).

5.1.1.7.6 Stress relief provisions. The leads of components mounted horizontally with bodies in direct contact with the printed board or printed wiring thereon shall be mounted to assure that stress relief is not reduced or negated by solder fill in the lead bends. Lead straightness shall remain as specified in 5.1.1.6. The radius (r) (see figure 12) of each relief bend shall be at least 0.030 inch (0.76 mm) but not less than the diameter of the lead. Components shall be mounted in one of the following configurations:

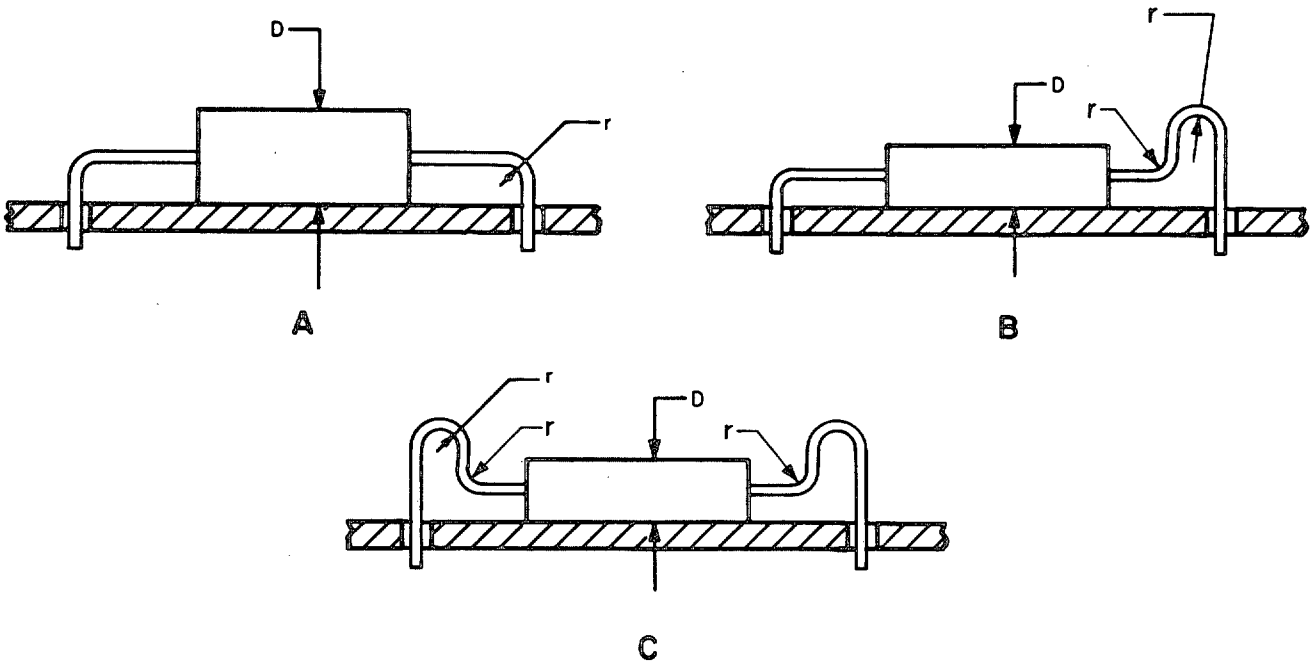
a. in a conventional manner utilizing 90 degree lead bends directly to the mounting hole (see figure 12A),

b. with camel hump bends (see figures 12B and 12C),

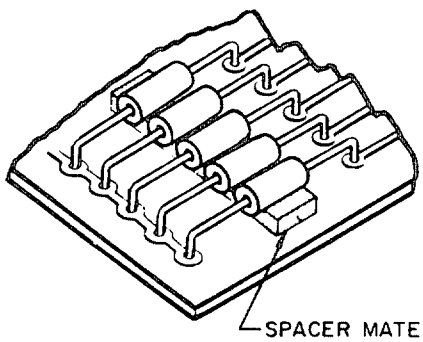
c. with spacer material attached to the printed wiring board under the component body and using conventional 90 degree lead bends (figure 12D), or

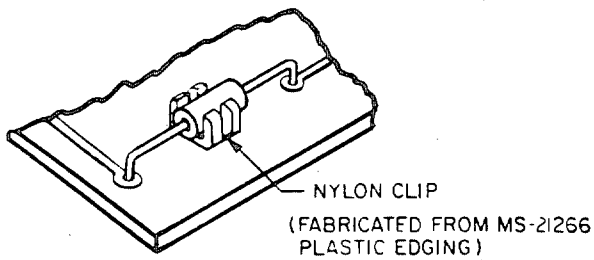
d. with a fabricated nylon clip fabricated from MS21266 plastic edging under the component body and leads formed with a conventional 90 degree lead bends (see figure 12E).

When D $\geq$ 0.125 inch (3.2 mm) (see figure 12) the configuration of (A), below, may be utilized. When D $\leq$ 0.125 inch (3.2 mm), the configuration (B), (C), (D), (E) or (F) shall be utilized.



Typical optional method





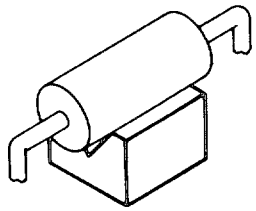


FIGURE 12. Stress relief provisions (see 5.1.1.7.6).

5.1.1.8 Leadless components. End capped chip resistors of the MIL-R-55342 configuration, end capped chip capacitors of the MIL-C-55365/4 configuration, and similar leadless end capped discrete components utilized in miniature and standard assemblies shall be mounted in accordance with 5.1.1.8.1 thru 5.1.1.8.6.

5.1.1.8.1 Chip devices shall be mounted only to printed wiring or printed circuitry; the devices shall not be stacked nor shall they bridge spacing between other parts or components such as terminals or other properly mounted chip devices (see figure 13).

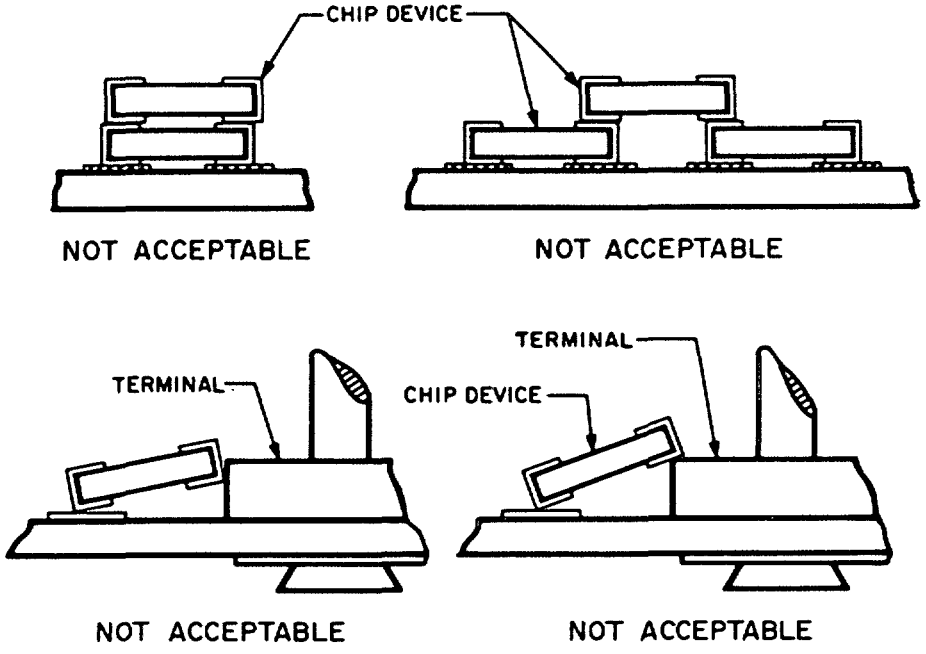


FIGURE 13. Improper mounting of chip devices (see 5.1.1.8.1).

5.1.1.8.2 The device shall be positioned such that the device shall not overhang the terminal area more than 10 percent of the device width (W) (see figure 14). It is preferred that the device be positioned with no overhang. The minimum conductor spacing shall be maintained.

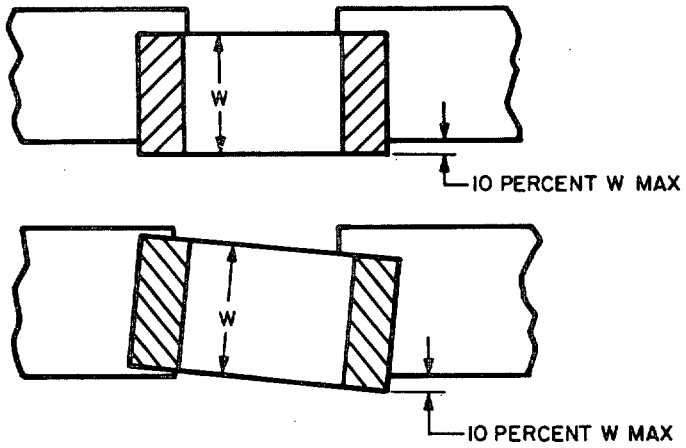


FIGURE 14. Acceptable chip overhang (see 5.1.1.8.2).

5.1.1.8.3 The end cap of the chip device shall extend onto the terminal area a minimum of 0.005 inch (0.13 mm) (see figure 15).

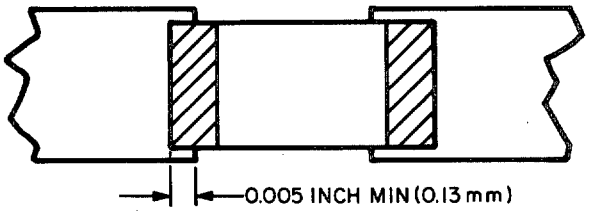


FIGURE 15. Minimum lap of chip on terminal area (see 5.1.1.8.3).

5.1.1.8.4 Mispositioning of chip devices shall not reduce the specified minimum spacing to adjacent printed wiring (see tables I and II) or other metallized elements.

5.1.1.8.5 The device shall be mounted flat and parallel with the surface of the printed board wiring within 10 degrees (see figure 16).

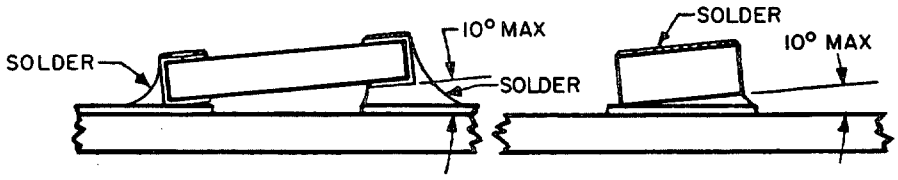


FIGURE 16. Maximum chip canting (see 5.1.1.8.5).

5.1.1.8.6 The space between the body of the soldered-in-place chip device and the terminal areas shall not exceed 0.015 inch (0.38 mm) (see figure 17).

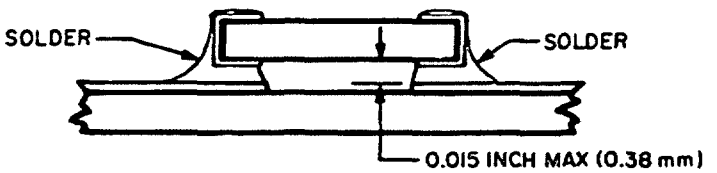
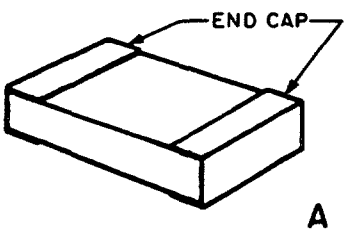


FIGURE 17. Maximum chip elevation (see 5.1.1.8.6).

5.1.1.8.7 In addition to the requirements of paragraphs 5.1.1.8.1 through 5.1.1.8.6, leadless chip components of end cap configuration, as illustrated in figure 18A, shall be mounted only if the components are in accordance with 5.1.1.8.8 through 5.1.1.8.15. Leadless chip components of the reflow configuration, as illustrated in figure 18B, shall be mounted only if the components are in accordance with 5.1.1.8.8 through 5.1.1.8.15. If the vertical (V) dimension of reflow configuration chips is greater than the thickness (T) dimension (see figure 18B), the reflow configuration chips should not be used in assemblies subject to high vibration or shock loads, especially in airborne or missile systems.

5.1.1.8.7.1 If the chip component is secured to the printed wiring board utilizing an adhesive bonding resin, the area or resin coverage shall be limited to 25 percent of the bonded surface of the chip after mounting.

END CAP CONFIGURATION



REFLOW CONFIGURATION

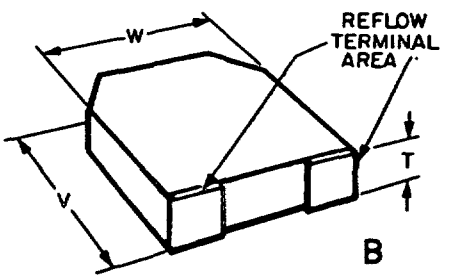


FIGURE 18. Leadless chip components (see 5.1.1.8.7 and 5.1.1.8.8).

5.1.1.8.8 There shall be no discontinuities in the metallized terminal areas of leadless components of the reflow configuration (see figure 18B).

5.1.1.8.9 Discontinuities in the metallized end caps shall not reduce the effective width (W) by more than 20 percent nor the area by more than 30 percent (see figure 19).

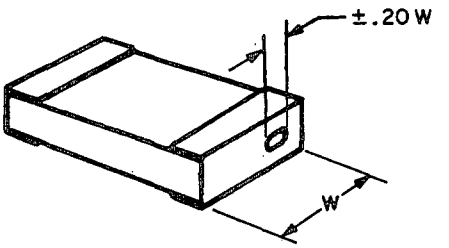


FIGURE 19. End cap discontinuities (see 5.1.1.8.9).

5.1.1.8.10 The body of the component shall not be cracked, scored, chipped, broken, or otherwise damaged.

5.1.1.8.11 Components with electrical elements deposited on an external surface (such as chip resistors) shall be mounted with that surface facing away from the printed wiring board or substrates (see figure 20).

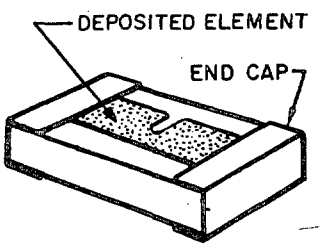


FIGURE 20. Chip resistor (see 5.1.1.8.11).

5.1.1.8.12 Solder shall cover and blend smoothly to the complete substrate land or printed board terminal area and shall fillet to and blend smoothly with the metallized end cap as shown in figure 21A. It is preferred that solder cover the complete metallized area of the end cap as shown in figure 21B, but coverage to three quarters the thickness (T) of the component (including metallization) shall be acceptable provided there are no pits, voids or other discontinuity in the solder fillet.

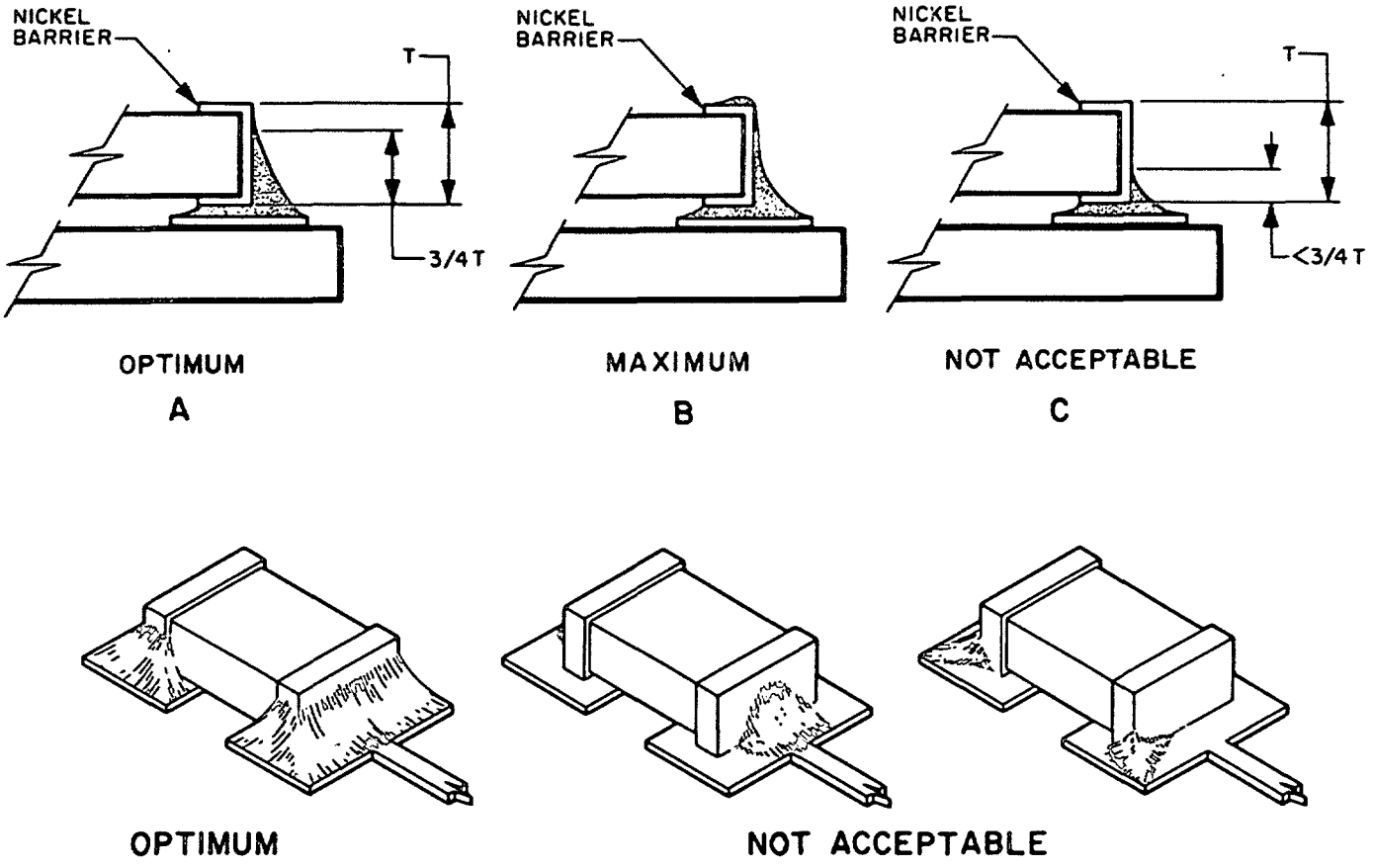


FIGURE 21. Solder filleting (see 5.1.1.8.12).

5.1.1.8.13 There shall be no discernible discontinuities in the solder coverage of terminal areas of components of the reflow configuration. Solder shall not encase any nonmetallized portion of the body of a component of the reflow configuration.

5.1.1.8.14 The appearance of the solder joint surface shall be smooth, nonporous, and noncrystalline and shall have a finish which may vary from satin to bright. There shall be no discontinuities exceeding that permitted under 5.1.1.8.9 nor hairline fractures, cracks, or dewetting.

5.1.1.8.15 There shall be no visible evidence of contamination of the solder such as flux residue, grease, foreign material or discoloration.

5.1.1.9 Nonaxial-lead components with leads extending from a single surface. Nonaxial-leaded components shall be:

a. Mounted with the surface from which the leads egress (hereinafter referred to as the BASE SURFACE or BASE) parallel to the surface of the printed board within the spacing tolerances specified herein.

b. Side mounted.

c. Leads shall extend straight from the base a minimum of twice the lead diameter but not less than .030 inch (0.76 mm) except where the leads have been formed during component manufacture.

5.1.1.9.1 Standard components. Mounting of standard components shall be in accordance with 5.1.1.9.1.1 thru 5.1.1.9.1.7 except as specified in 5.1.1.9.2 thru 5.1.1.9.6.

5.1.1.9.1.1 Components shall be mounted freestanding (i.e., with the base surface separated from the surface of the board with no support other than the component leads) only if the weight of the component is 1/8 ounce (3.5 grams) per lead or less. When components are mounted freestanding, the spacing between the surface of the component and the surface of the board shall be a minimum of 0.050 inch (1.3 mm) and a maximum of 0.100 inch (2.54 mm). The base surface shall parallel the surface of the printed wiring board within 10 degrees and in no instance shall nonparallelism result in nonconformance with the minimum or maximum spacing limit.

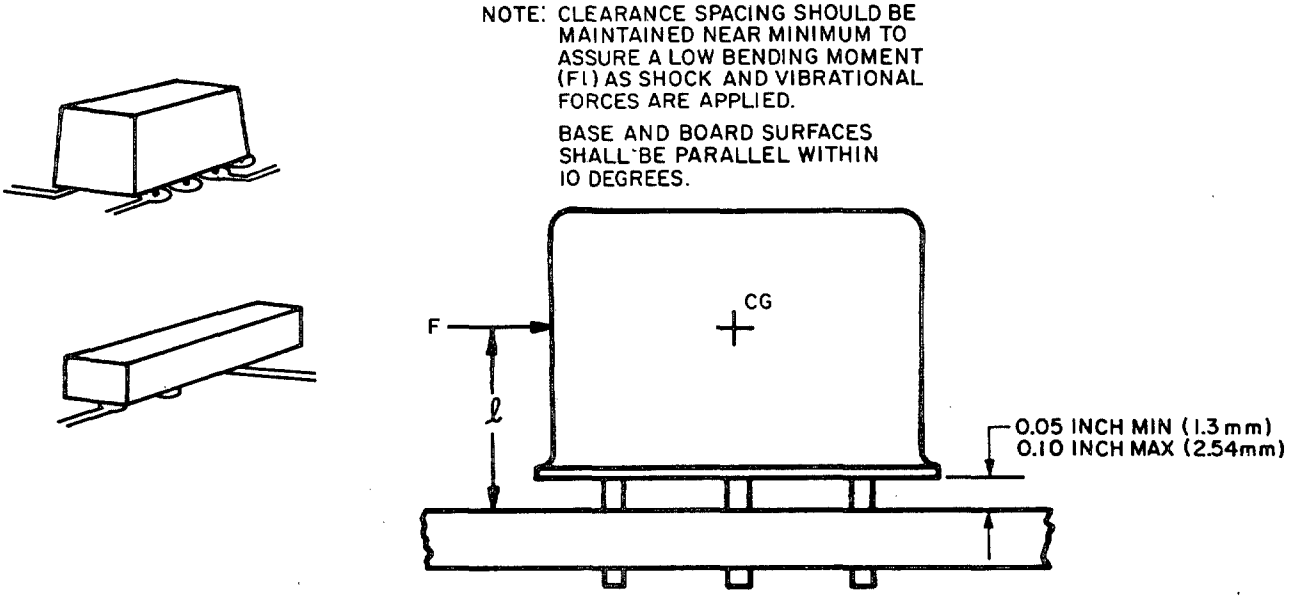


FIGURE 22. Mounting of freestanding nonaxial-leaded components (see 5.1.1.9.1.1).

5.1.1.9.1.2 Components weighing more than 1/8 ounce (3.5 g) per lead shall be mounted with the base surface paralleling the surface of the board. The component shall be supported on:

a. Resilient feet or standoffs integral to the component body (figures 23A and 23B),

b. Resilient or specially configured nonresilient footed standoff devices (figure 23C), or

c. Separate resilient nonfooted standoffs which do not block plated-through holes nor conceal connections on the component side of the board.

5.1.1.9.1.3 When a component with resilient integral feet or resilient integral standoff is mounted to a printed wiring board, the component shall be seated with each foot in contact with the surface of the board. For this requirement, a button standoff as shown in figure 23B shall be deemed a foot and the mating surface of each button shall be flat on the board (or circuitry thereon). Footed standoffs, as illustrated in figures 23C and 23D, shall have a minimum foot height of 0.010 inch (0.25 mm).

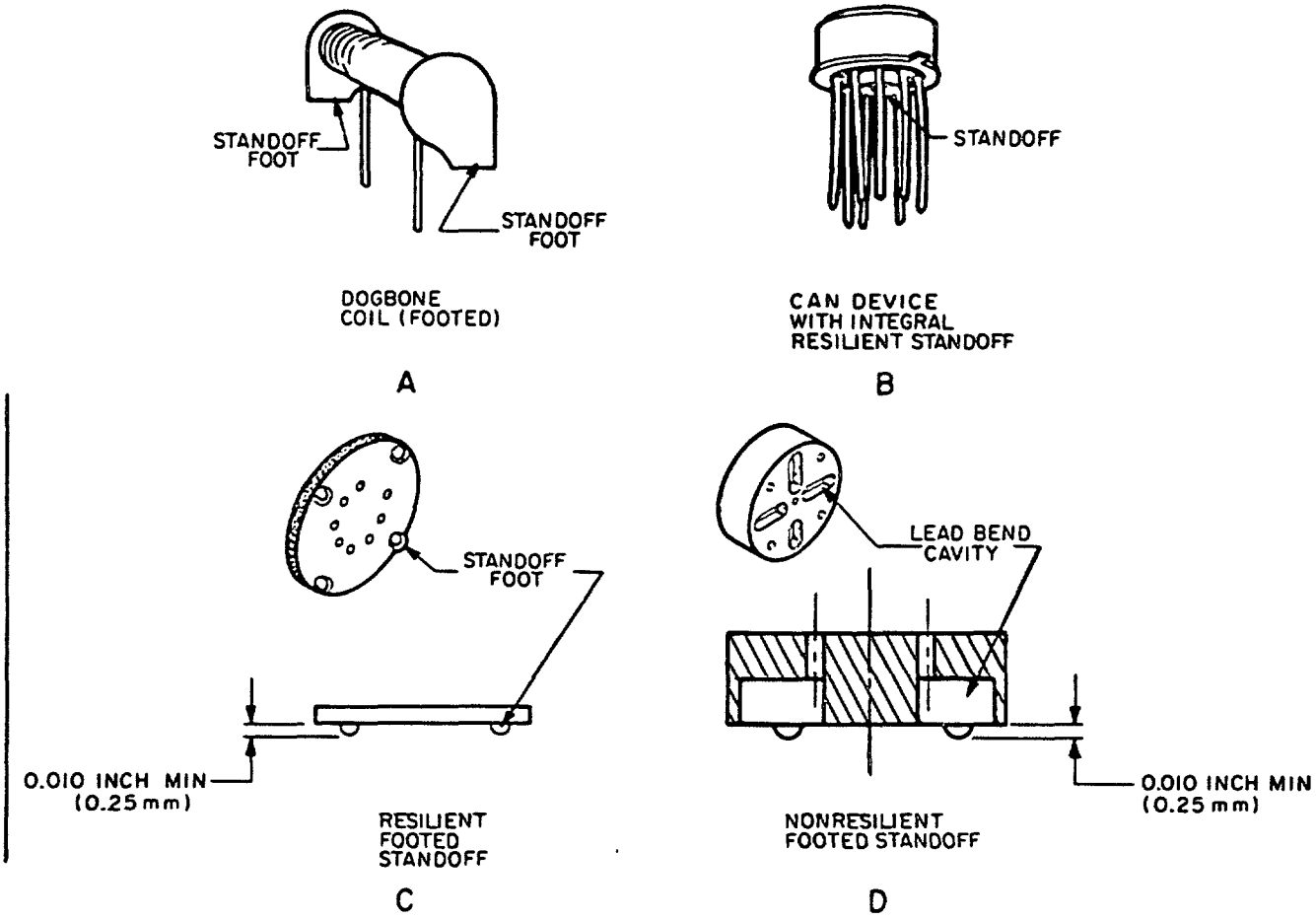
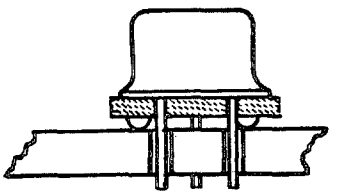


FIGURE 23. Typical standoff devices (see 5.1.1.9.1.2 and 5.1.1.9.1.3).

5.1.1.9.1.4 When a separate resilient footed standoff device or separate resilient nonfooted standoff is utilized and the component is mounted with the base surface paralleling the board surface, mounting shall be such that the component base is seated in contact with and flat to the footed or nonfooted standoff and such that the feet of the footed standoff maintain full contact with the board surface. No resilient standoff shall be inverted, tilted, canted, nor seated with any foot (or base surface) not in contact with the board or circuitry thereon. Neither shall the component be tilted, canted, or separated from the mating surface of the resilient standoff device. Standoffs shall be snug fit restrained from lateral movement but not force fit depressed such that resiliency is negated between the board and the component.

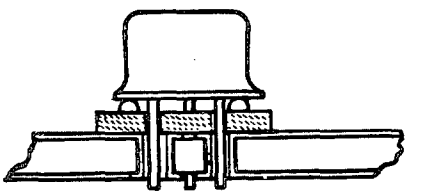


ACCEPTABLE

COMPONENT SEATED FLAT TO STANDOFF.

FEET IN CONTACT WITH BOARD.

A

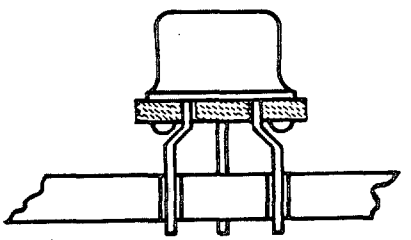


NOT ACCEPTABLE

STANDOFF INVERTED.

STANDOFF BLOCKS PLATED-THROUGH HOLE.

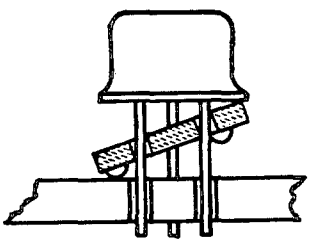
B



NOT ACCEPTABLE

STANDOFF NOT IN CONTACT WITH BOARD.

C



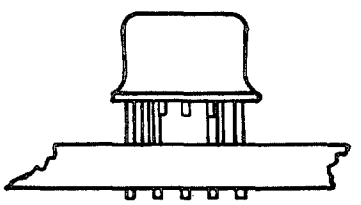
NOT ACCEPTABLE

STANDOFF TILTED.

COMPONENT NOT SEATED FLAT TO STANDOFF.

FEET DO NOT CONTACT BOARD.

D

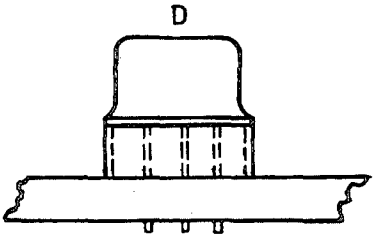


ACCEPTABLE

COMPONENT SEATED FLAT TO STANDOFF OF RESILIENT MATERIAL.

BASE OF STANDOFF FLAT ON BOARD.

E



NOT ACCEPTABLE

ALTHOUGH OF RESILIENT MATERIAL, STANDOFF CONCEALS CONNECTION ON COMPONENT SIDE OF BOARD.

F

FIGURE 24. Parallel mounting on nonaxial-leaded components utilizing resilient standoffs (see 5.1.1.9.1.4).

5.1.1.9.1.5 When a specially configured nonresilient footed standoff device is utilized in conjunction with a component mounted with the base surface parallel to the surface of the board, the base surface shall be in full contact with the device and each foot of the device shall be in full contact with the printed board. That portion of the lead in the lead bend cavity (see figure 23D) shall be formed to coincide with an angular line extending from the lead insertion hole in the standoff device to the lead attachment hole in the printed board (see figure 25A).

NOTE: Although other lead bends could conceivably be more easily accomplished, bends to any configuration other than the one illustrated in figure 25A would permit loss of component seating when vibrational and shock forces are applied perpendicular to the surface of the printed wiring board.

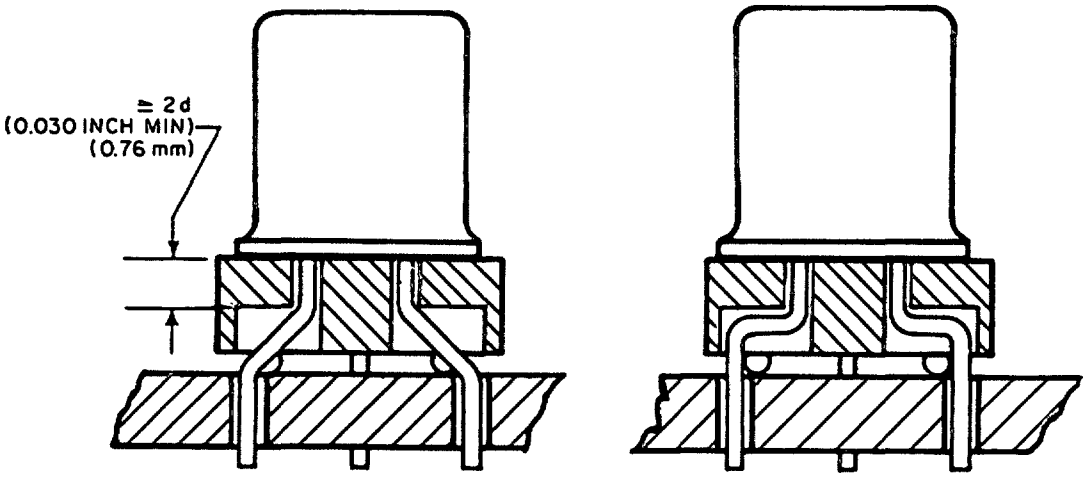


FIGURE 25. Parallel mounting of nonaxial-leaded components utilizing nonresilient standoffs (see 5.1.1.9.1.5).

5.1.1.9.1.6 When approved in advance by the Government Contracting Officer a component may be side-mounted as shown in figure 26, and the side surface of the body (or at least one point of any irregularly configured component such as certain pocketbook capacitors) shall be in full contact with the printed board and the body shall be bonded or otherwise retained to the board to preclude hammering when vibrational and shock forces are applied.

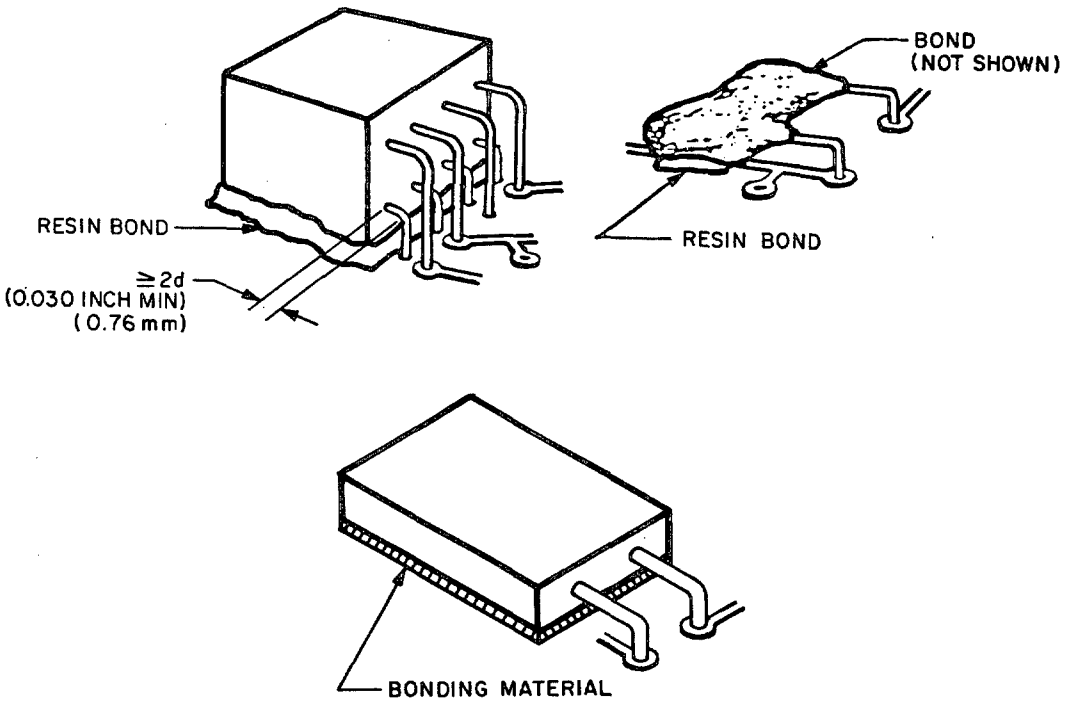


FIGURE 26. Side-mounted, nonaxial-leaded components (see 5.1.1.9.1.6).

5.1.1.9.1.7 When approved in advance by the Government Contracting Officer a component may be side-mounted or end mounted, and leads thereof shall be formed to a radius (r) at least 0.030 inch (0.76 mm) but no less than the diameter (d) of the lead (see figure 27). The maximum radius of any stress relief bend shall be 3d. When leads are formed as shown by phantom lines in figure 27, the span (X) shall not exceed 0.25 inch (6.4 mm). The lead rise (Z) from the base surface of an end mounted component shall not exceed 0.25 inch (6.4 mm). Side-mounted or reverse end-mounted components (figure 27) shall have one side or the reverse end in full contact with the board surface and resin bonded to it.

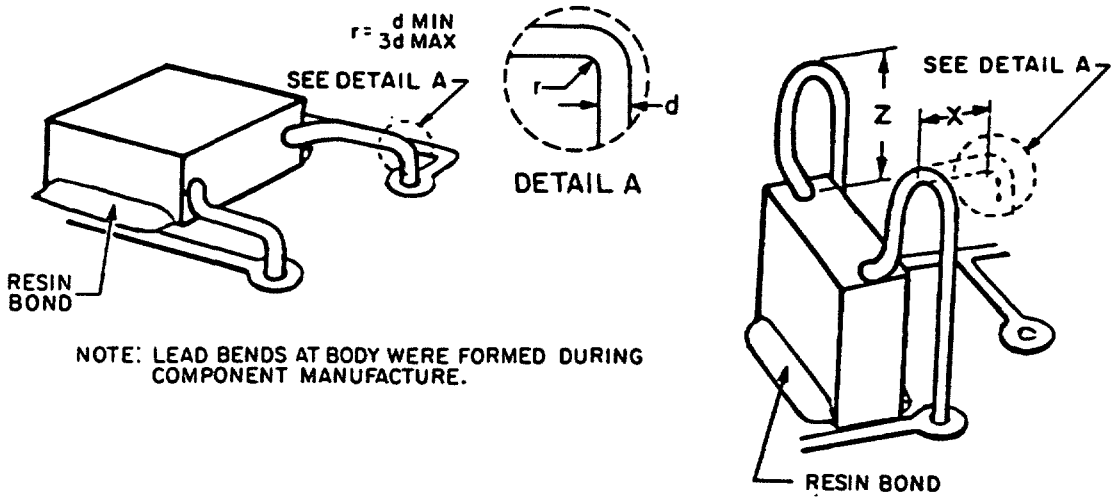


FIGURE 27. Radii for stress relief bends (see 5.1.1.9.1.7).

5.1.1.9.1.8 Any nonaxial-leaded component with coating meniscus on one or more leads shall be mounted such that the meniscus is no closer than 0.010 inch (0.25 mm) from the terminal area on the component surface of the board. Trimming of the meniscus is prohibited. This requirement takes precedence over requirements of 5.1.1.9.1.1 (see figure 28).

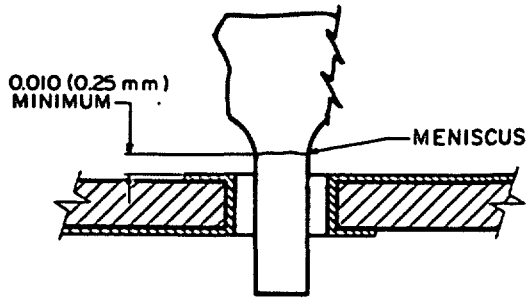


FIGURE 28. Meniscus clearance (see 5.1.1.9.1.8).

5.1.1.9.2 Dual lead components. Dual lead components of configurations A through E of figure 29 shall, as an exception to 5.1.1.9.1.1, be mounted freestanding with the larger sides perpendicular to the board surface ±15 degrees as shown in figure 30 when:

a. Angularity is required for clearance in the next higher assembly.

b. That edge of the body nearest the surface of the board parallels the board surface within 10° and is no less than 0.040 inch (1.0 mm) and no more than 0.090 inch (2.3 mm) from the surface. Components of configurations F through J of figure 29 are not included under the above angularity exception.

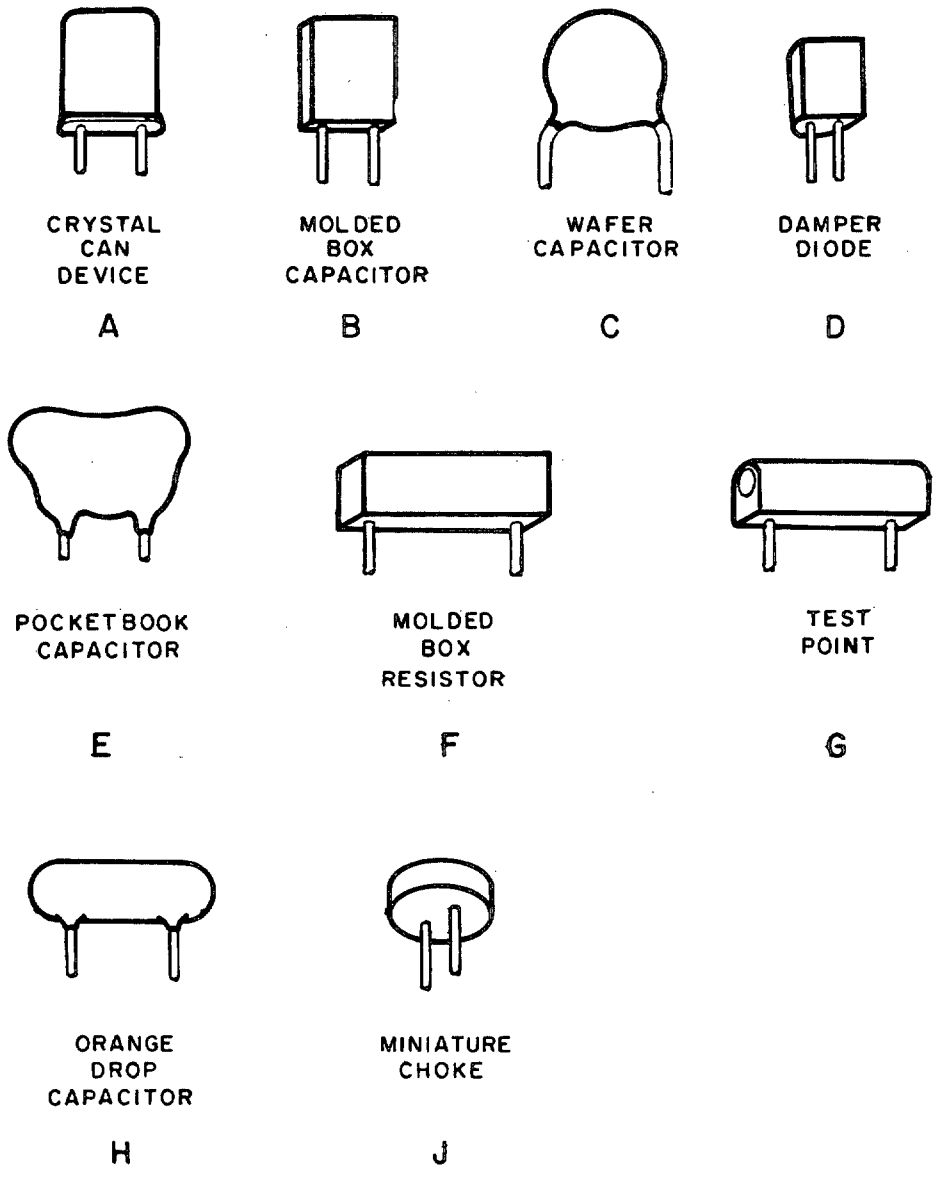


FIGURE 29. Typical configuration of components with dual nonaxial-leads (see 5.1.1.9.2).

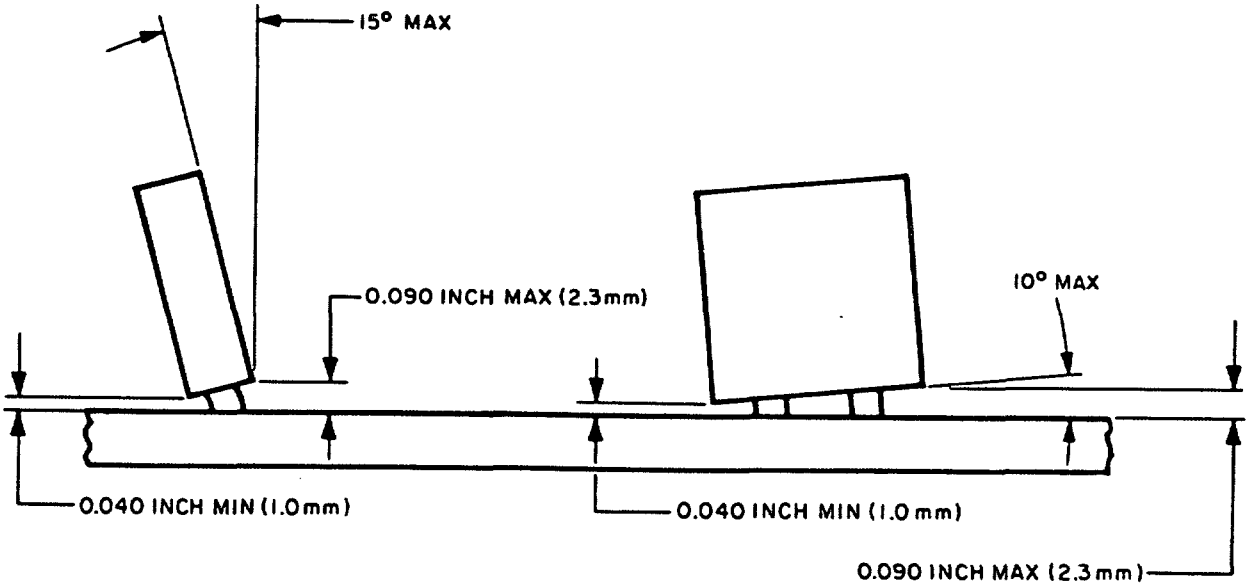


FIGURE 30. Mounting of components with dual nonaxial-leads (see 5.1.1.9.2).

5.1.1.9.3 Metal power packages. As an exception to 5.1.1.9, components of the metal power package configuration (see figure 31) shall not be mounted freestanding. Such components shall be mounted in accordance with paragraph 5.1.1.9.3.1, or, if the leads are neither tempered nor greater than 0.050 inch (1.3 mm) in diameter, and stress relief is provided in accordance with 5.1.1.9.1.5 or 5.1.1.9.1.7, they may be side-mounted, through-board mounted, or mounted on nonresilient standoffs. The leads of all components of the metal power package configuration shall be stress relieved in accordance with 5.1.1.9, utilizing the stress relief method corresponding to the mounting technique. The standoffs, heat sink frames and resilient spacers on which metal power packages are mounted shall be of a configuration which facilitates cleaning.

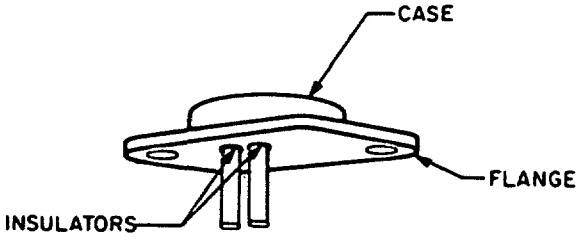


FIGURE 31. Metal power package transistor (see 5.1.1.9.3).

5.1.1.9.3.1 Metal power packages mounted on resilient standoffs. (See figure 32.)

5.1.1.9.3.1.1 Lead holes shall not be plated-through if the component body is mounted in contact with the board or circuitry thereon. This requirement takes precedence over 5.1.1.4.

5.1.1.9.3.1.2 The component body shall be spaced a minimum of 0.020 inch (0.5 mm) above the board surface if lead holes are interfacial or interlayer connections (to permit solder flow to and onto the component terminal areas).

5.1.1.9.3.1.3 Leads may be tempered or exceed 0.050 inch (1.3 mm) provided they are not clinched against the printed wiring terminal area.

5.1.1.9.3.1.4 A washer shall be inserted between each screw head and the terminal area.

5.1.1.9.3.1.5 A washer shall be inserted between each screw head and the board material.

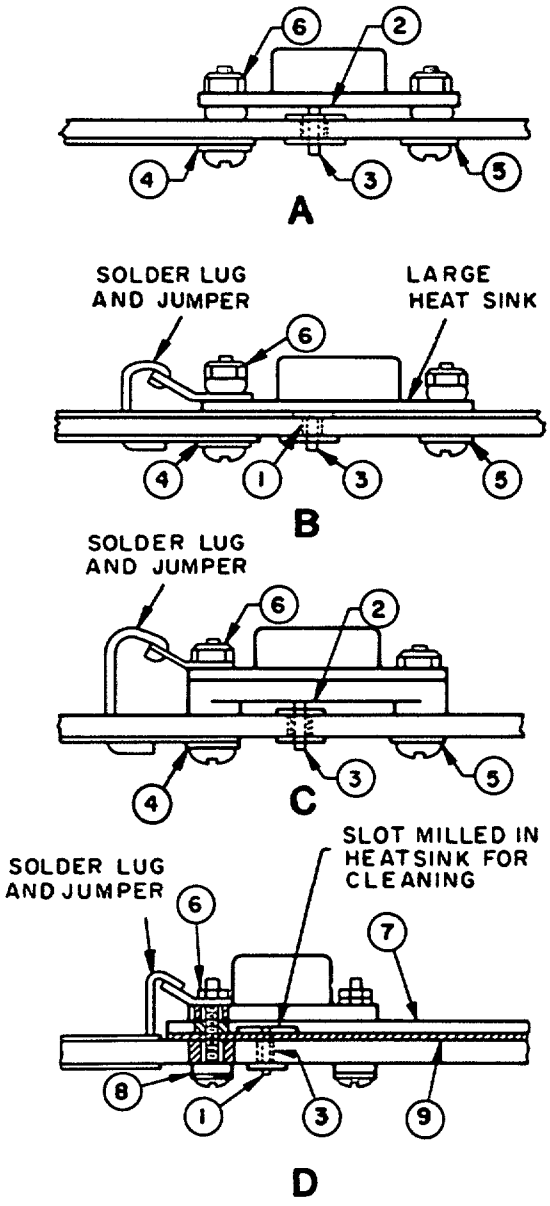
5.1.1.9.3.1.6 Nuts shall be lock type or shall be retained by locking devices.

5.1.1.9.3.1.7 The heat sink or device mounting flange must be provided with threads to match mounting screw for solder lug.

5.1.1.9.3.1.8 A resilient material shall be incorporated to provide stress relief. It shall either be mounted between the metal power package and the board or be a stressed member in the mounting/hold down hardware (see figure 32D).

5.1.1.9.3.1.9 Where the metal power package or heat sinks are mounted over circuitry, insulating material shall be placed between the metal power package or heat sink and the board.

5.1.1.9.3.1.10 The top side of plated-through holes shall not be obscured and shall allow solder flow onto the component side of the board.



1. Lead holes shall not be plated-through if the component body is mounted in contact with the board or circuitry thereto (see 5.1.1.9.3.1.1).
2. Component body spaced a minimum of 0.020 inch (0.5 mm) above the board surface (see 5.1.1.9.3.1.2).
3. Unclinched tempered lead, or lead exceeding 0.050 inch (1.3 mm) in diameter (see 5.1.1.9.3.1.3).
4. Washer inserted between screw head and the terminal area (to preclude terminal area damage) (see 5.1.1.9.3.1.4).
5. Washer inserted between screw head and the board material (to preclude board damage).
6. Lock type nut or nut retained by locking device.
7. Heat sink or mounting flange provided threaded to match mounting screw.
8. Resilient material providing stress relief (either mounted between the metal power package and the board or as a stressed member).
9. Insulating material between metal power package or heat sinks mounted over circuitry.

FIGURE 32. Mounting of metal power packages (see 5.1.1.9.3.1).

5.1.1.9.3.2 Metal power packages mounted on nonresilient standoffs. The leads of metal power packages mounted on nonresilient standoffs shall be either straight-through in plated-through holes, or clinched in an unsupported hole. The leads shall be untempered or less than 0.050 inch (1.3 mm) in diameter. The leads shall be stress relieved in accordance with 5.1.1.9.1.5. The mounting hardware (screws, nuts, washers, etc.) shall be mounted in accordance with 5.1.1.9.3.1.4 through 5.1.1.9.3.1.7. The insulation and hole clearance requirements of 5.1.1.9.3.1.9 and 5.1.1.9.3.1.10 shall also apply (see figure 33).

5.1.1.9.3.3 Heat sinking of metal power packages. Heat sinking frames may be utilized in conjunction with components encased in metal power packages provided mounting is otherwise in accordance with requirements of 5.1.1.9. When heat sinking frames of the type identified as A, B or C of figure 33 are utilized, the preferred method for providing stress relief for solder connections is the inclusion of a resilient spacer between the base of the heat sink and the surface of the printed wiring board. Spacer thickness shall be commensurate with the thickness of the frame and the thickness of the flange of the metal power package but not less than 0.020 inch (0.5 mm) (see figure 33).

NOTE: Heat dissipation characteristics of end-mounted, side-mounted, and through-board mounted components shall be carefully considered for each particular application inasmuch as excess heat can cause damage to printed boards (see 5.1.1.7.1.1) and insufficient dissipation can damage the component internally.

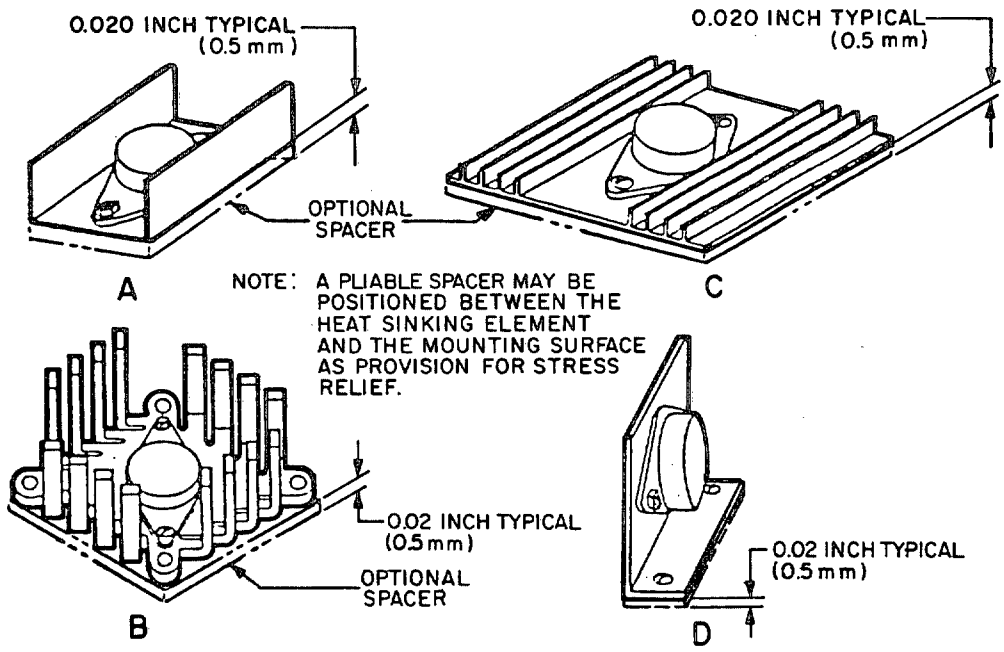


FIGURE 33. Heat sinked metal power packages (see 5.1.1.9.3).

5.1.1.9.4 In-line connectors. As an exception to 5.1.1.9, in-line printed wiring board connectors such as shown in figure 34 may be mounted in full contact with the printed wiring board provided that the connector is designed such that there are both stress relief provisions internal to the connector body and cavities (either visible or hidden) which preclude blocking of plated-through holes (see figure 35).

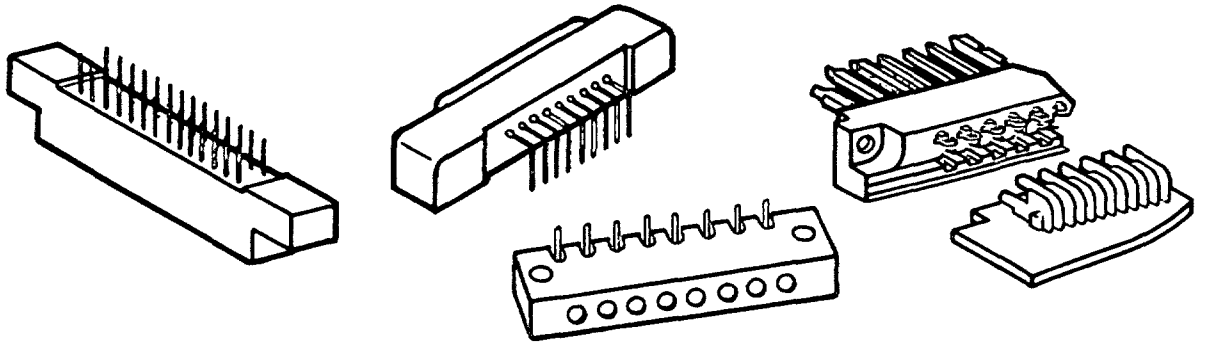


FIGURE 34. In-line printed wiring board connectors (see 5.1.1.9.4).

5.1.1.9.4.1 When internal provision for stress relief and hidden cavities used to facilitate solder flow precludes visual conformance with specified criteria, acceptability of hidden connections shall be based on:

a. Validation that the connector design does include internal provision for stress relief and cavities which permit solder flow.

b. Satisfactory functional characteristics during or after exposure to specified environmental conditions.

c. This is an exception to 4.4.

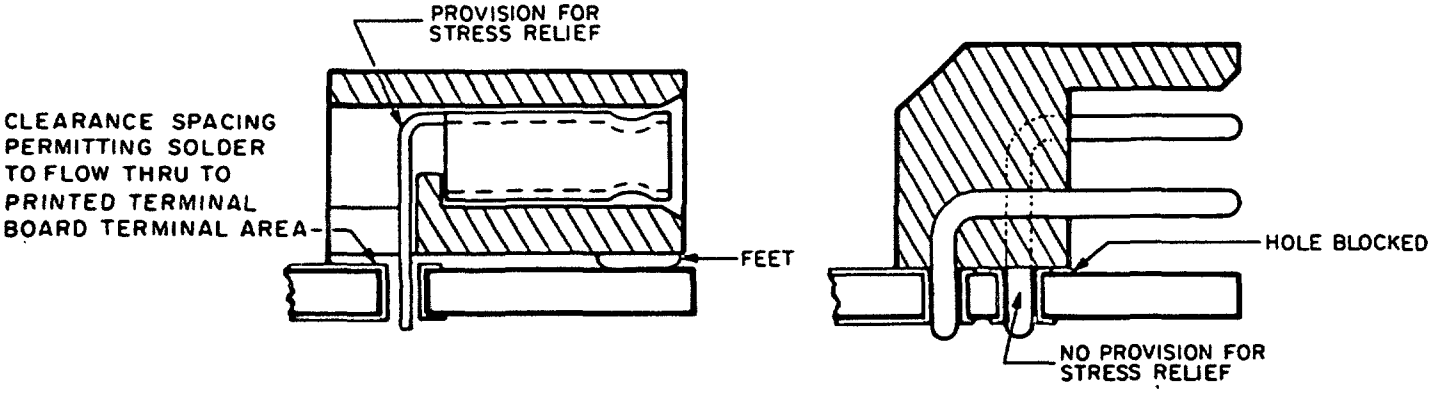


FIGURE 35. Internal connector lead configurations (see 5.1.1.9.4.1).

5.1.1.9.5 Potentiometers. As an exception to 5.1.1.9.1.1, potentiometers and other adjustment devices weighing less than 1/8 ounce (3.5 grams) per lead shall, unless the diameter of each lead is 0.040 inch (1.0 mm) or greater, be mounted in accordance with 5.1.1.9.1.2 or 5.1.1.9.1.3.

5.1.1.9.6 Tall profile components. As an exception to 5.1.1.9.1.1, tall profile transformers and other devices with center of gravity in the upper half of the component body (see figure 25) shall be mounted in accordance with or 5.1.1.9.1.2 or 5.1.1.9.1.3 regardless of lead diameter or weight per lead ratios.

5.1.1.10 Nonaxial-leaded components with leads extending from more than a single surface. Flatpacks, dual in-line packaged (DIP) components, and other devices configured with leads extended from two or more sidewalls (see figure 36) shall be mounted with all leads seated on terminal areas or in through holes. Leads shall not be truncated (see figure 37). Components of the flatpack configuration shall be mounted in accordance with 5.1.1.10.1 and those of the DIP configuration shall be mounted in accordance with 5.1.1.10.5.

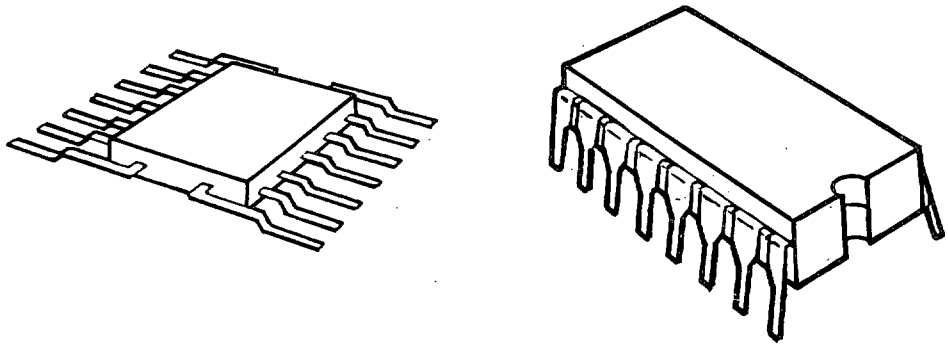


FIGURE 36. Flatpacks and DIPs (see 5.1.1.10).

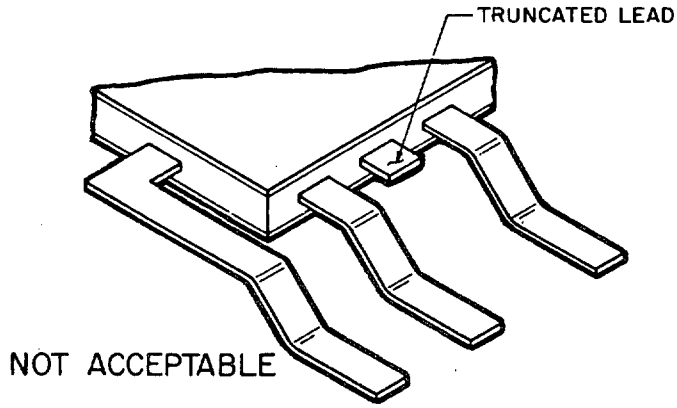


FIGURE 37. Truncated flatpack leads (see 5.1.1.10).

5.1.1.10.1 Flatpacks. Whether planar mounted or mounted with leads inserted in through holes, flatpacks utilized in conjunction with printed wiring assemblies shall be mounted in accordance with 5.1.1.10.1.1.

5.1.1.10.1.1 Body seating. Flatpacks shall be mounted with the body seated in accordance with 5.1.1.10.1.2 thru 5.1.1.10.1.6.

5.1.1.10.1.2 Any component with a body of nonconductive material shall be mounted with the body seated in contact with the surface of the printed board or circuitry thereof unless:

a. The body covers more than one printed conductor on the board and the board is not (or is not to be) conformally coated.

b. The terminal area pattern for the device is such that the portion of the terminal area abutting any plated through hole used for interfacial or interlayer connection is partially or totally beneath the body (see figure 38).

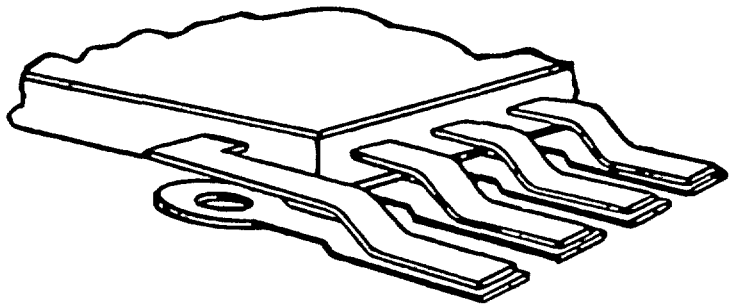


FIGURE 38. Flatpack seated on printed pattern combined with interfacial hole (see 5.1.1.10.1.2).

5.1.1.10.1.3 Any component with a body of conductive material shall be seated on the printed board only if there is no printed conductor beneath the body.

5.1.1.10.1.4 If there are one or more conductors beneath a conductive body or if a body is nonconductive but covers more than one printed conductor on a board and the board is not (or is not to be) conformally coated, the body shall be:

a. Mounted flat on electrical insulation that is firmly affixed (either by pressure or adhesive) to the printed board such that the moisture traps are precluded.

b. Spaced from the board a minimum of 0.015 inch (0.38 mm).

5.1.1.10.1.5 If the terminal area pattern for the flatpack is such that any interlayer portion of the area surrounding a plated-through hole used for interfacial or interlayer connection underlies either a conductive or non-conductive body, the body shall be spaced a minimum of 0.015 inch (0.38 mm) above the surface of the terminal area to permit solder flow through the hole onto the terminal area.

5.1.1.10.1.6 Maximum spacing between the component body and the surface of the terminal area shall be 0.025 inch (0.64 mm).

5.1.1.10.1.7 Leads on opposite sides of planar mounted flat packs (see figure 39) shall be formed such that component cant (non-parallelism between the base surface of the mounted component and the surface of the printed wiring board) is minimal and in no instance shall body cant result in non-conformance with the minimum and maximum spacing limits 0.015 inch (0.38 mm) and 0.025 inch (0.64 mm), respectively) as specified in 5.1.1.10.1.5 and 5.1.1.10.1.6.

5.1.1.10.2 Lead configuration. Leads of flatpacks of the plug-in configuration (leads egressing from the base surface as shown in figure 39) shall be configured for mounting in accordance with 5.1.1.9.1.1 and the component shall be mounted in accordance with the requirements thereof. Whether of the ribbon, flatted or square configuration, the leads of flatpacks of the normal and butterfly configuration (leads egressing from two or more sidewalls as shown in figure 40) shall be configured as shown in figure 41 if the component is planar mounted and as shown in figure 42 if mounted with leads dressed through the board.

FIGURE 39. Flatpacks of the plug-in configuration (see 5.1.1.10.2)

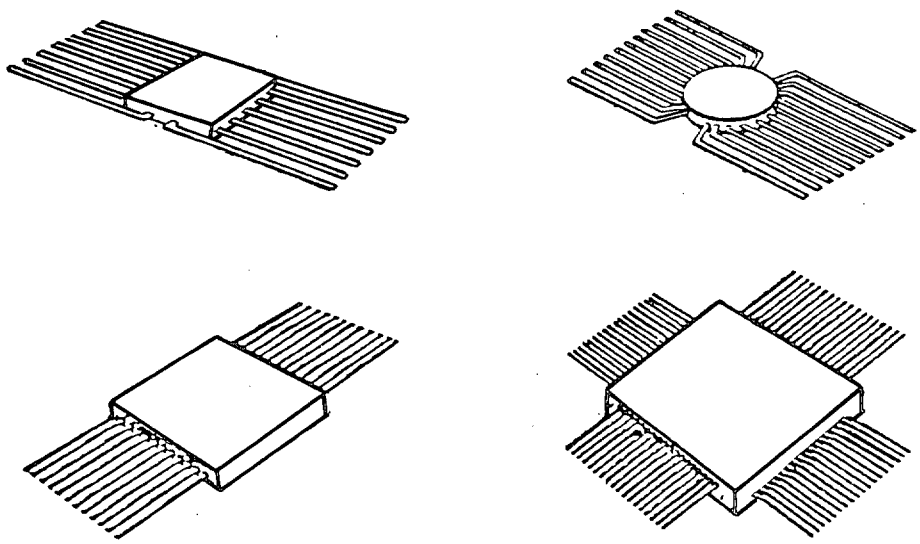


FIGURE 40. Normal and butterfly flatpacks (see 5.1.1.10.2).

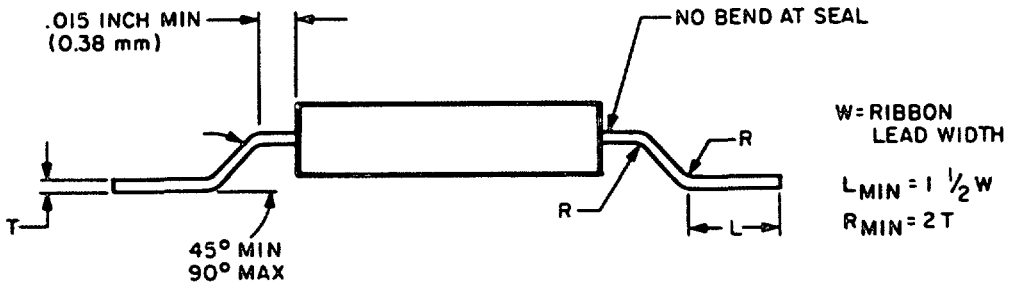


FIGURE 41. Configuration of ribbon leads for planar mounted flatpacks (see 5.1.1.10.2).

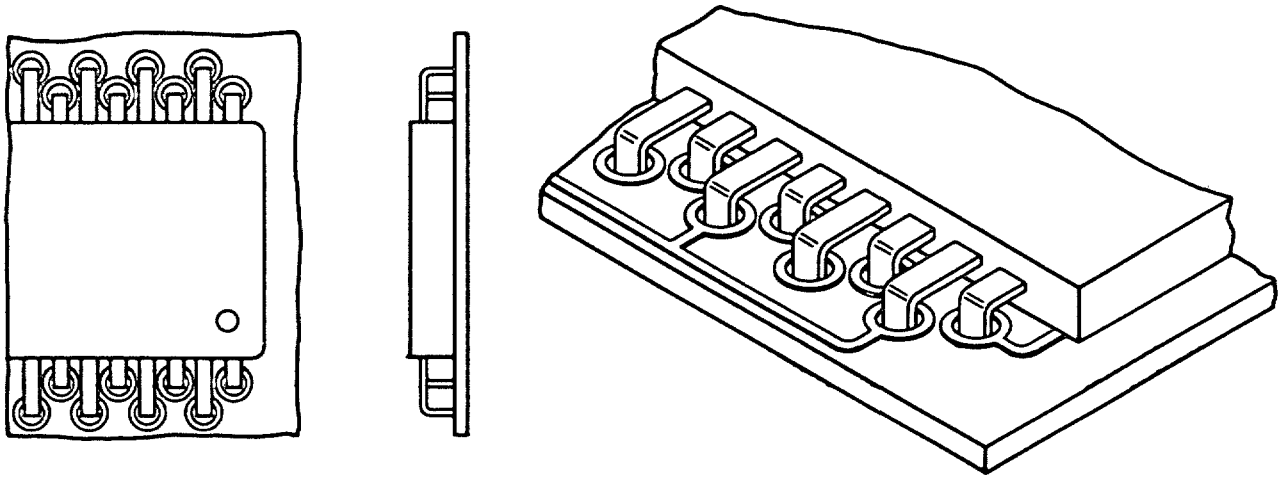


FIGURE 42. Configuration of ribbon leads for through-hole mounted flatpacks (see 5.1.1.10.2).

5.1.1.10.3 Lead seating for planar mounted flatpacks. Leads shall be seated such that the heel to terminal area relationship shall conform to figure 43. Leads shall be seated such that there is no side overhang. Toe overhang (see figures 44 and 45) is acceptable provided that the requirements of 5.1.1.10.3.1 through 5.1.1.10.3.6 are met.

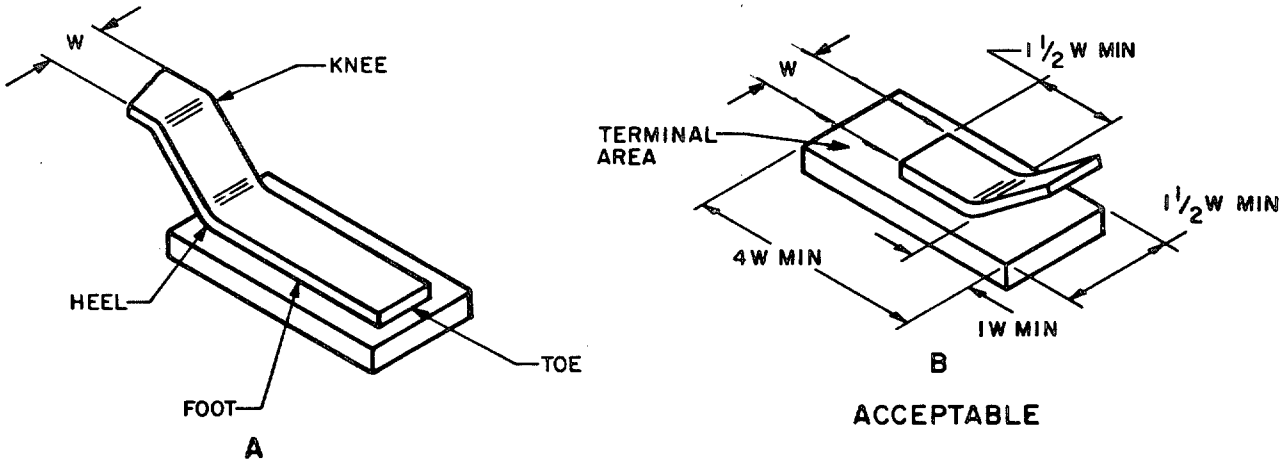


FIGURE 43. Heel mounting requirements for ribbon leads (see 5.1.1.10.3).

5.1.1.10.3.1 The length of lead contact shall be a minimum of 150 percent of the width (see figures 44 and 45).

5.1.1.10.3.2 Toe overhang is permissible provided that it does not exceed 25 percent of the width or diameter of the lead and the spacing to adjacent conductive elements remains greater than the minimums specified in paragraphs 4.2.1.1 and 4.2.1.2 (see figure 44).

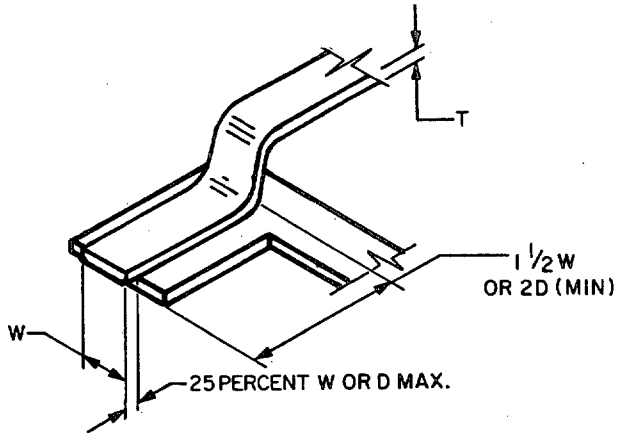


FIGURE 44. Toe overhang limits for ribbon leads (see 5.1.1.10.3 and 5.1.1.10.3.2).

5.1.1.10.3.3 Toe curl shall not exceed twice the lead thickness (2T) (see figure 45).

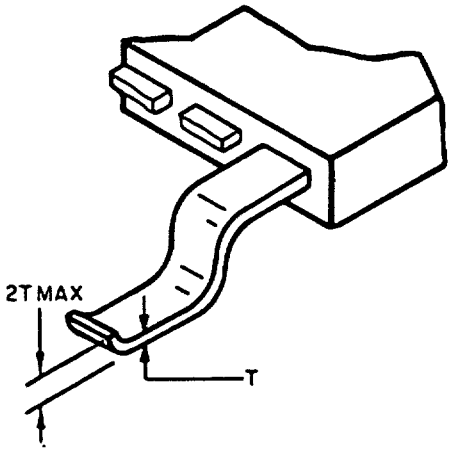


FIGURE 45. Toe curl limits for ribbon leads (see 5.1.1.10.3 and 5.1.1.10.3.3).

5.1.1.10.3.4 It is preferred that leads be seated in contact with the terminal area for the full length of the foot. Separation between the foot of such leads and the surface of the terminal associated area shall not exceed twice the lead thickness (2T) (see figure 46).

5.1.1.10.3.5 Leads shall be formed such that they will contact the termination area upon mounting without the need to impart stress on the lead to accomplish soldering.

5.1.1.10.3.6 Leads shall be formed such that foot twist is minimal and in no instance shall foot twist result in non-conformance with the 2T maximum spacing requirement of 5.1.1.10.3.4.

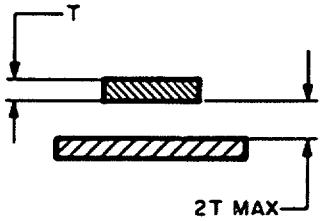


FIGURE 46. Permissible separation between lead and terminal area (see 5.1.1.10.3.4).

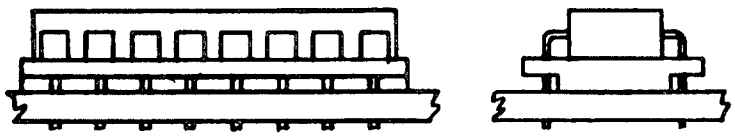
5.1.1.10.4 Lead dressed for through-board mounting. Whether of a round, square or ribbon cross section, leads shall be dressed to and through the printed wiring board such that canting, bending, bowing, twisting, or other deformation does not cause clearance spacings to be reduced beyond the minimum specified (see 4.2.1.1). Canting, bowing and bending of leads in any direction shall not exceed 25 percent of the lead width (or diameter) nor shall leads be twisted more than 15 degrees.

5.1.1.10.5 Dual in-line packages. A dual in-line package (DIP) utilized in conjunction with printed wiring assemblies shall be mounted in accordance with 5.1.1.10.5.1 thru 5.1.1.10.5.8.

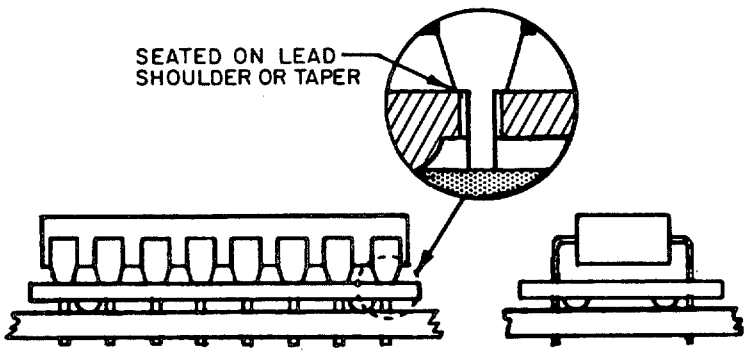
5.1.1.10.5.1 The base of the device shall be spaced from the surface of the printed wiring board a minimum of 0.010 inch (0.25 mm) and a maximum of 0.040 inch (1.1 mm).

5.1.1.10.5.2 The base of the device shall parallel the surface of the printed wiring board within 0.010 inch per inch (0.010 mm per mm).

5.1.1.10.5.3 When a separate resilient footed standoff device or separate resilient nonfooted standoff is utilized in conjunction with a dual inline package, mounting shall be in accordance with 5.1.1.9.1.4. No standoff shall be inverted, tilted, canted, nor seated with any foot (or base surface) not in contact with the board or circuitry thereon. Neither shall the component be tilted, canted, or separated from the mating surface of the standoff device. Standoffs shall be snug fit between the board and the component (see figure 47).



A



B

FIGURE 47. DIP mounting utilizing resilient footed and nonfooted standoffs (see 5.1.1.10.5.3).

5.1.1.10.5.4 DIP devices shall not be mounted in sockets or other plug-in devices which rely upon contact pressure for part retention. Leads of the DIP device shall be soldered in place.

5.1.1.10.5.5 DIPs mounted directly to heat sink frames shall have special stress relief provisions included.

NOTE: The inclusion of a pliable spacer material between the heat sink frame and the printed wiring board (see figure 48A, 48B and 48C) is an acceptable method for assuring stress relief provided the resilient added material is of sufficient thickness (0.020 inch (0.5 mm) typical) to compensate for forces imposed during temperature change.

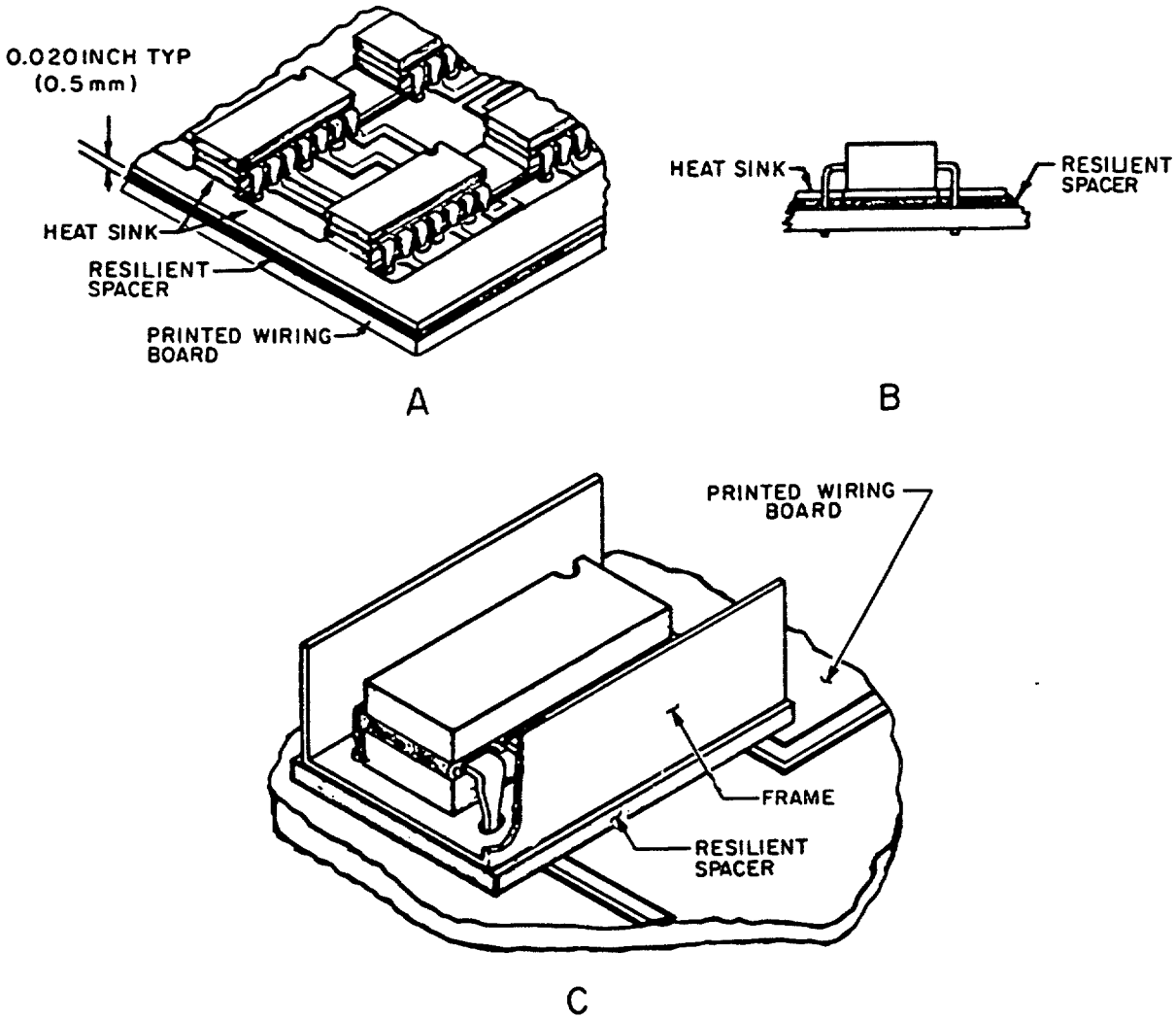


FIGURE 48. Resilient spacer to heat sink frame (see 5.1.1.10.5.5).

5.1.1.10.5.6 The body of a DIP device shall not be formed from epoxy, other resin, or plastic. CERDIPs and ceramic bodied DIPs with side brazed leads are acceptable provided they are proven reliable for intended environmental use (see figure 49A and 49B).

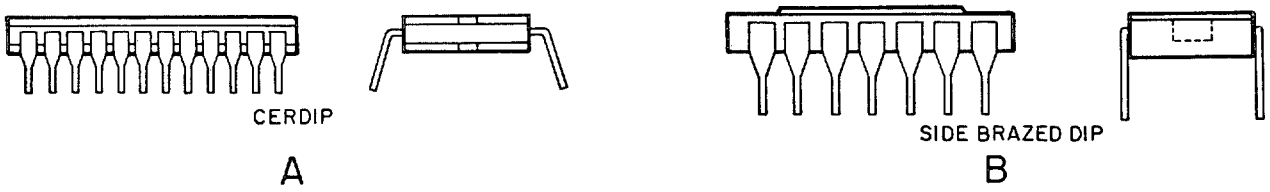


FIGURE 49. Typical ceramic dual in-line package devices (see 5.1.1.10.5.6).

5.1.1.10.5.7 Leads on DIPs may be bent, rather than clinched, toward the termination area to retain parts during soldering operations but such bent leads shall conform to all requirements applicable to unclinched straight-through leads (see figure 50). Bends shall be limited to 30 degrees maximum outward from the axis of the hole and to a maximum of 4 leads per component, not more than 2 leads on one side. When DIP leads are bent, they shall be bent outward (away from the center of the part body). This is an exception to 5.1.1.4.

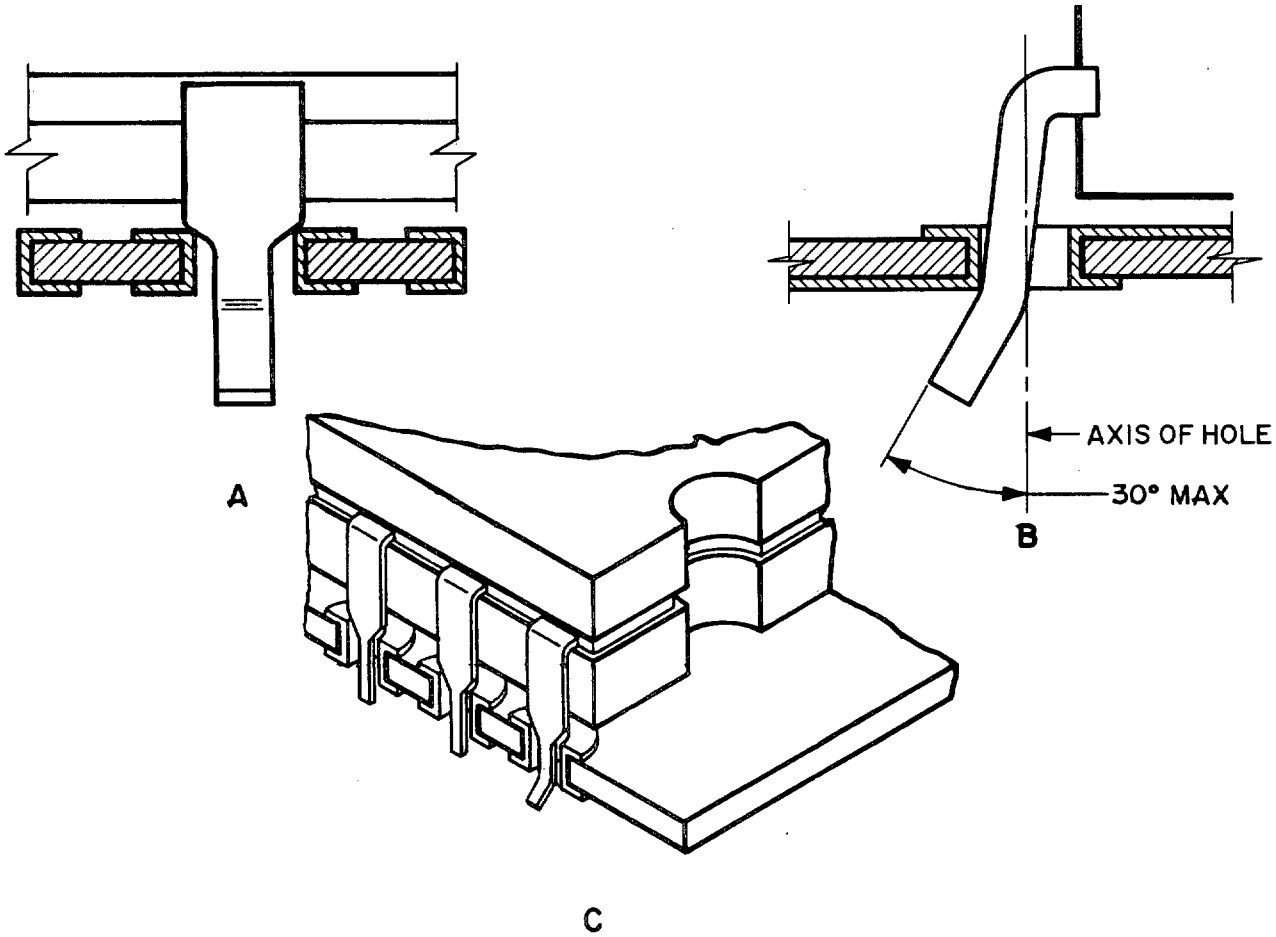


FIGURE 50. Lead bends for multileaded components (see 5.1.1.10.5.7).

5.1.1.10.5.8 Bowing and bending of leads shall be limited to 25 percent of the lead width and twisting of leads shall be limited to 15 degrees.

5.1.1.10.5.9 The lead-to-body seals of mounted devices shall be undamaged. Body chipouts that extend to or into the glass seal and chipouts that expose a normally encased area of a lead, are unacceptable. Hairline cracks in either the seal or the body are not acceptable (see figure 51).

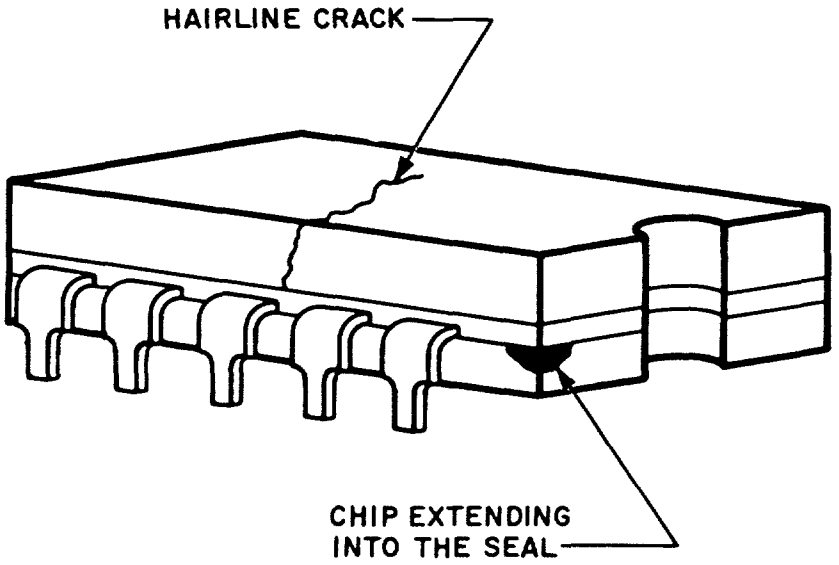


FIGURE 51. Not acceptable body and seal conditions (see 5.1.1.10.5.9).

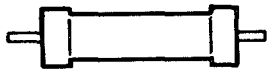
5.1.1.11 Planar mounted components. Except as specified in 5.1.1.11.1 and 5.1.1.11.2, components shall be planar mounted only when prior approval is obtained from the Government Contracting Officer.

5.1.1.11.1 Flatpacks of the plug-in configuration, dual in-line packages, transistors, metal power packages, and other nonaxial-leaded components shall not be planar mounted.

5.1.1.11.2 Miniature axial-leaded components. Miniature axial-leaded components shall be planar mounted in accordance with 5.1.1.11.2.1 thru 5.1.1.11.2.6.

5.1.1.11.2.1 Planar mounting of axial-leaded component shall be utilized only if the component is miniature weighing less than .050 ounces (1.4 grams) and is mounted parallel to the board surface. Table III lists the weight and body diameter of typical axial-leaded resistors.

TABLE III. Approximate weight of typical resistors.

Power Rating (Watts)	Physical Configuration	Body Dia.		Weight	
		Inches	mm	Ounces	Grams
5		0.30	7.6	0.143	4.05
2		0.31	7.9	0.101	2.86
1		0.28	7.1	0.052	1.49
1/2		0.14	3.6	0.022	0.62
1/4		0.10	2.5	0.011	0.31
1/4		0.09	2.3	0.010	0.28
1/8		0.06	1.5	0.003	0.08

NOTE: The size and weight of components vary by type of component, material, construction, manufacturer and other like considerations. Accordingly, the characteristics of a component to be planar lead mounted should be ascertained on an individual piece basis.

5.1.1.11.2.2 Components with axial-leads of rectangular cross section shall be mounted in accordance with 5.1.1.10.3.

5.1.1.11.2.3 Components with axial-leads of round cross section shall be utilized for planar mounting only if the leads are coined or flatted for positive seating. For flatted round leads with an original diameter (D) of 0.025 inch (0.64 mm) or greater, the flatted thickness (T) shall be 60 ± 10 percent of the original diameter. For leads with an original diameter less than 0.025 inch (0.64 mm), the flatted thickness shall be 50 ± 5 percent of the original diameter (see figure 52). Actual measurement of the flatted thickness is not required except for referee purposes. Flatted areas of leads coined for planar mounting shall be excluded from the 10 percent deformation requirement.

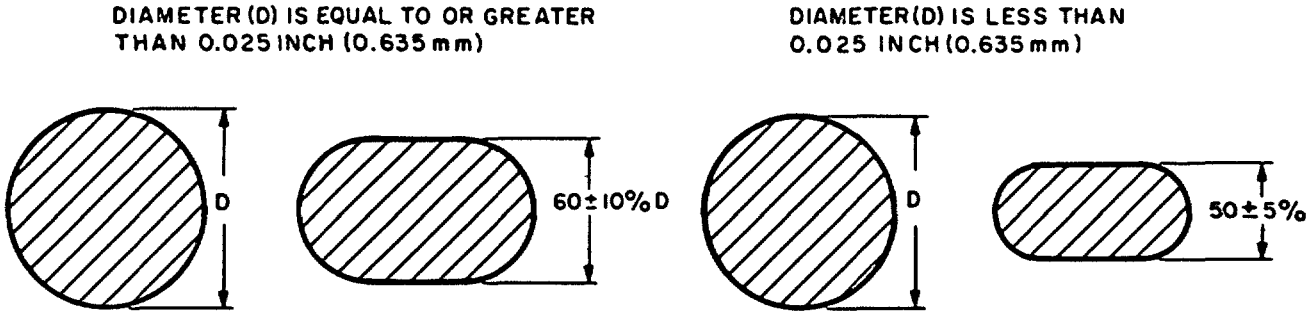


FIGURE 52. Flatted round leads (see 5.1.1.11.2.3).

5.1.1.11.2.4 The body of a planar mounted axial-leaded component shall be spaced a minimum of 0.015 inch (0.38 mm) from the surface of the printed wiring board and a maximum of 0.025 inch (0.64 mm) (see figure 53). Leads on opposite sides of planar mounted axial-leaded components shall be formed such that component cant (nonparallelism between the base surface of the mounted component and the surface of the printed wiring board) is minimal and in no instance shall body cant result in nonconformance with the minimum and maximum spacing limits (0.015 inch (0.38 mm) and 0.025 inch (0.64 mm), respectively).

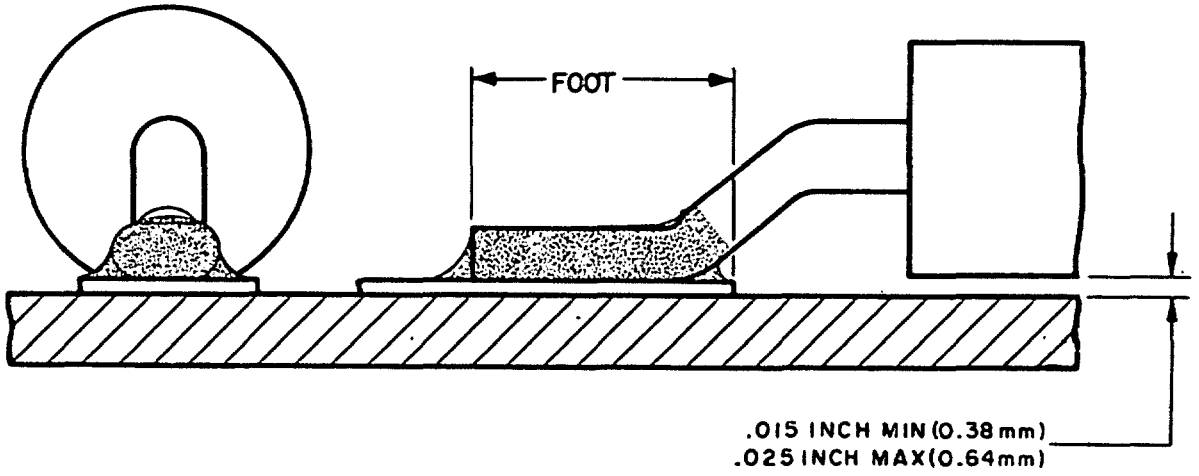


FIGURE 53. Coined or flattened lead (see 5.1.1.11.2.4 and 5.1.1.11.2.5).

5.1.1.11.2.5 Flatted round leads shall be seated with the heel to terminal area relationship in accordance with figure 53. Leads shall be seated with no side overhang. Toe overhang is acceptable provided that the flatted lead in contact with the terminal area is a minimum of 150 percent of the unflatted lead diameter and the overhang does not reduce spacing to adjacent parts to less than specified in 4.2.1.1 and 4.2.1.2.

5.1.1.11.2.6 It is preferred that leads be seated in contact with the terminal area for the full length of the foot. Separation between the foot of such leads and the surface of the terminal area shall be limited to 15 degrees from the surface of the board (see figure 54).

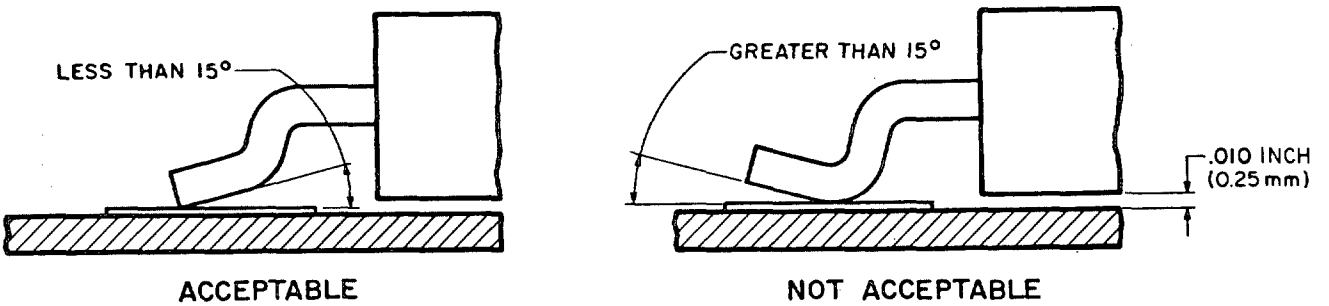


FIGURE 54. Formed lead alignment (see 5.1.1.11.2.6).

5.1.1.12 Terminals used for mechanical mounting. Terminals not connected to printed wiring or printed ground planes shall be of the rolled flange configuration (see figure 55). Rolled flange terminals shall be in accordance with 5.1.1.12.1 thru 5.1.1.12.1.5.

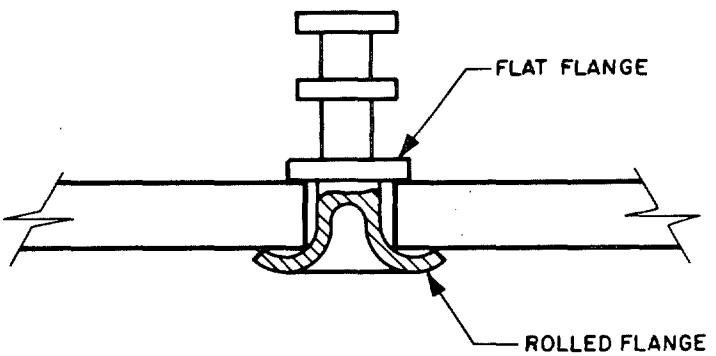


FIGURE 55. Rolled flange terminals (see 5.1.1.12).

5.1.1.12.1 The terminal shall be set such that it can neither be rotated nor moved axially under normal finger force and such that there is no cracking, chipping, or delamination of the base material of the printed board or terminal board.

5.1.1.12.2 The shank of the terminal shall not be perforated nor split, cracked, or otherwise discontinuous to the extent that oils, flux, inks, or other liquid substances utilized for processing the printed board are or can be entrapped within the mounting hole. Circumferential cracks or splits in the shank are not acceptable regardless of extent.

5.1.1.12.3 The lip of the rolled flange shall contact the base laminate for the full periphery of the flange.

5.1.1.12.4 The rolled flange shall not be split, cracked, or otherwise discontinuous to the extent that flux, oils, inks, or other liquid substances utilized 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 degrees and do not extend beyond the rolled area of the terminal (see figure 56).

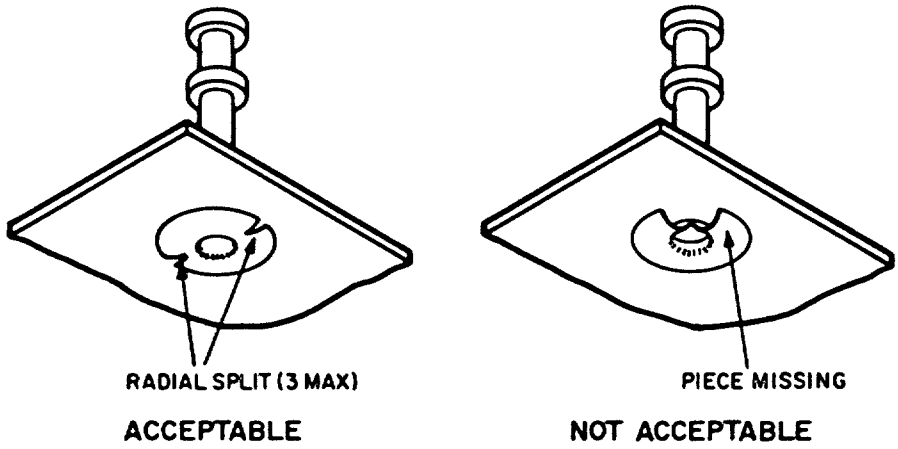


FIGURE 56. Rolled flange requirement (see 5.1.1.12.4).

5.1.1.12.5 Washers or discs may be utilized under the rolled flanges provided that:

a. There are no deviations from other requirements of this paragraph.

b. The washer or discs are not utilized for connection to electrical circuitry either by pressure or direct wiring.

5.1.1.12.6 A printed foil pad may be utilized as a seating surface for a rolled flange provided that the pad is isolated and not connected to active printed wiring or ground plane.

NOTE: When a rolled flange is used in conjunction with an electrically nonactive pad, solder is neither necessary nor particularly desirable.

5.1.1.13 Terminals used for electrical mounting. For printed boards or printed board assemblies, terminals shall be of the funnel flange configuration shown in figure 57. Whether utilized in printed boards or printed board assemblies, funnel flange terminals shall be mounted in accordance with 5.1.1.13.1 thru 5.1.1.13.8.

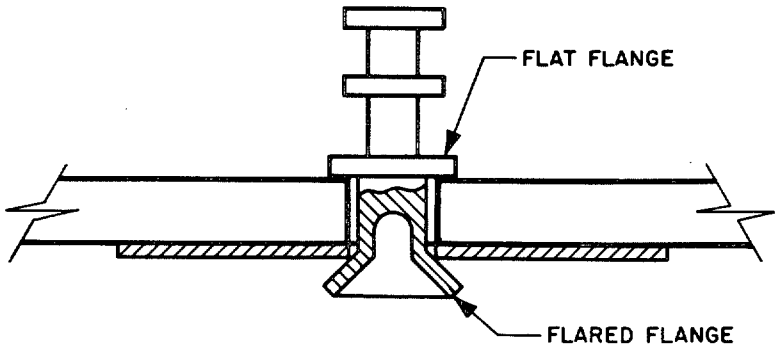


FIGURE 57. Standoff termination (see 5.1.1.13).

5.1.1.13.1 The terminal shall be perpendicular to the printed board within 5 degrees.

5.1.1.13.2 Flat body flanges (see figure 58) shall be seated to the base material of the printed board and not on ground planes or terminal areas. If it is specified that the flange be soldered and the flared flange on the solder side of the board is soldered, the connection to the body flange shall be completed utilizing a high temperature solder and the flared flange connection shall be completed utilizing a lower temperature solder.

5.1.1.13.3 Funnel flanges shall be utilized only in conjunction with terminal areas (isolated or active) or ground planes; they shall not be flared to the base material of the printed board.

5.1.1.13.4 The terminal shall be set such that it is free to rotate but not free to move axially under normal finger force. The terminal area shall not be lifted or otherwise damaged nor shall the printed board be cracked, chipped, delaminated or measled.

5.1.1.13.5 Funnel flanges shall be formed to an included angle between 55 and 120 degrees and shall extend between 0.015 inch (0.38 mm) and 0.030 inch (0.76 mm) beyond the surface of the terminal area (see figure 58A). The maximum flare diameter shall not be greater than 80 percent of the diameter of the terminal area (see figure 58B).

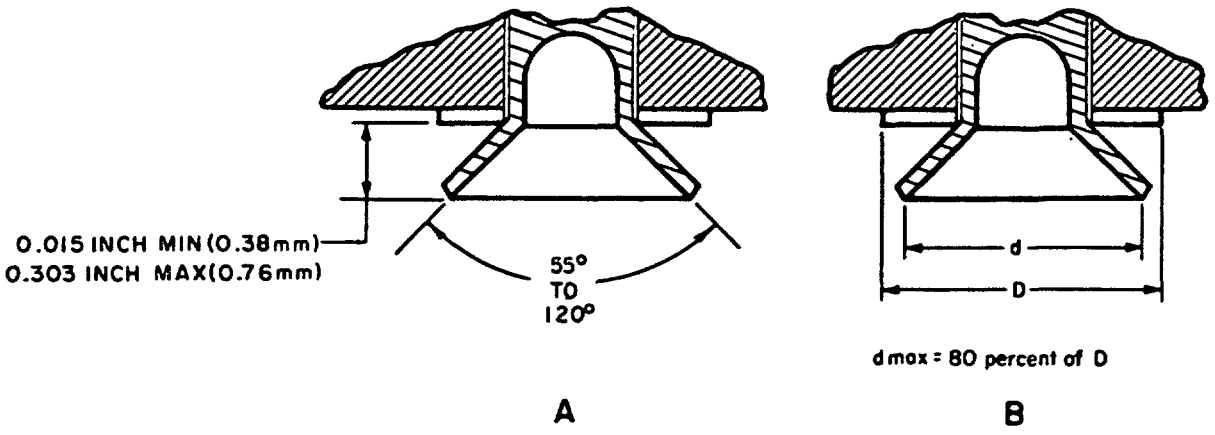


FIGURE 58. Flare and extension of funnel flanges (see 5.1.1.13.5).

5.1.1.13.6 The flared flange of a terminal shall not be perforated or split, cracked, or otherwise discontinuous to the extent that oils, flux, inks, or other liquid substances utilized for processing the printed board may be entrapped within the mounting hole. After flaring, the flange 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 degrees and do not extend beyond the flared area of the terminal.

5.1.1.13.7 Terminals shall only be mounted in unsupported holes. If it is essential that a terminal be utilized for interfacial connection, a dual hole configuration incorporating a supported plated-through hole shall be combined with an unsupported hole interconnected by a terminal area on the solder side of the printed wiring board (see figure 59). Terminals shall not be utilized in unsupported holes to provide interfacial connections (see figure 60).

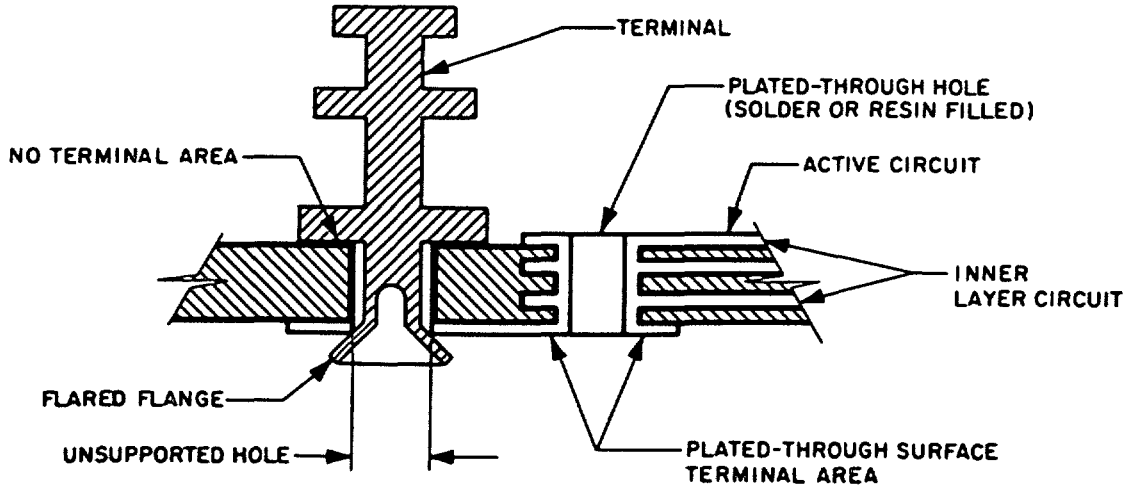
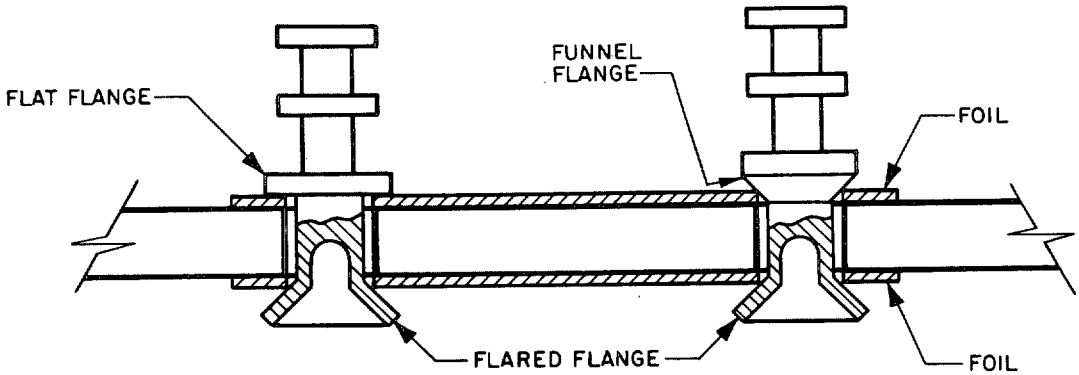


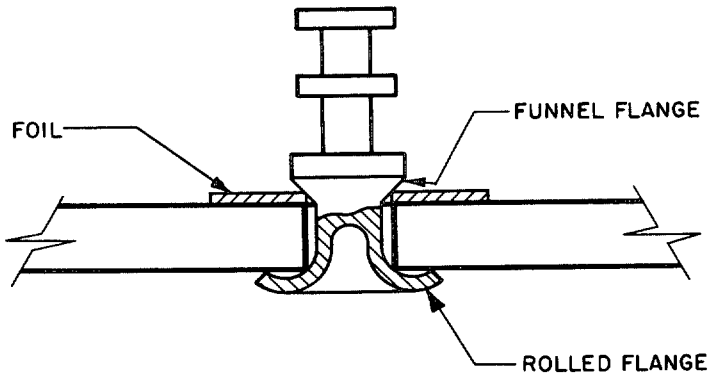
FIGURE 59. Dual hole configuration for interfacial and interlayer terminal mountings (see 5.1.1.13.7).



NOT ACCEPTABLE

FIGURE 60. Standoff terminal interfacial connection (see 5.1.1.13.7).

5.1.1.13.8 Terminals with a rolled flange on the solder side and a funnel flange on the component side shall not be used (see figure 61).



NOT ACCEPTABLE

FIGURE 61. Funnel and rolled flange terminal (see 5.1.1.13.8).

5.1.2 Terminal board mountings. Terminals shall be mounted to terminal boards in accordance with 5.1.1.12 and 5.1.1.13.

5.1.3 Mounting to terminals. Whether terminals are mounted to printed boards, terminal boards or chassis members, components and wires shall be mounted in accordance with 5.1.3.1 through 5.1.3.8.

5.1.3.1 Lead wires shall be dressed in the proper position with a slight loop or gradual bend as shown in figure 62. The bend shall be sufficient to preclude tension on the connection when such is finished and to permit one field repair.

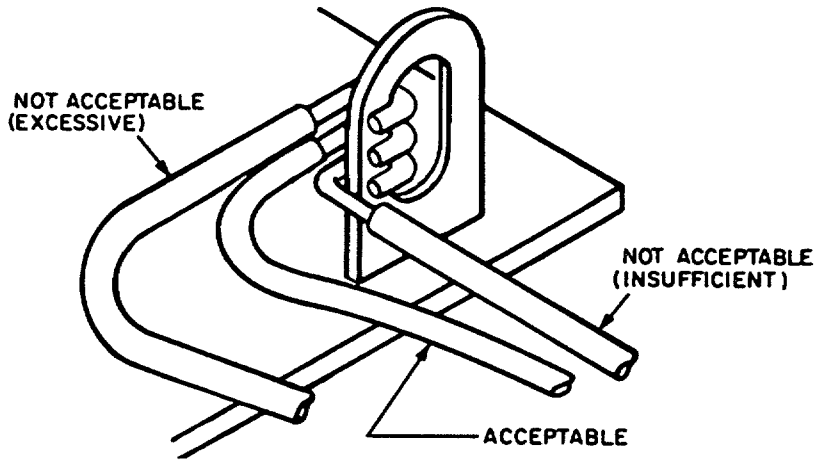


FIGURE 62. Stress relief for lead wiring (see 5.1.3.1).

5.1.3.2 Lead wires may be wrapped clockwise or counterclockwise but shall continue the curvature of the dress of the lead wires (see figure 63) and shall not interfere with the wrapping of other wires on the terminal.

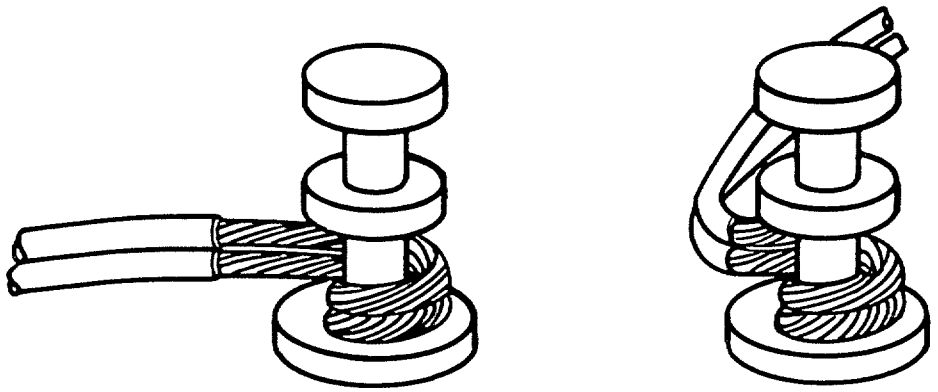
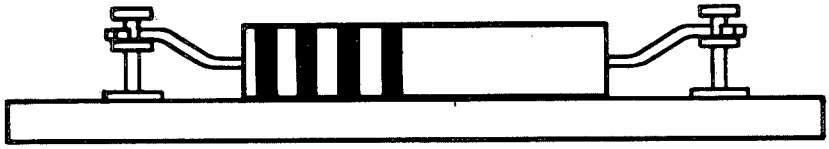


FIGURE 63. Lead dress (see 5.1.3.2).

5.1.3.3 There shall be no more than three attachments to any terminal other than turret or bifurcated terminals and there shall be no more than three attachments to any terminal section of turret and bifurcated terminals.

5.1.3.4 Unless mounted with the component body seated to a printed board, terminal board, or chassis with stress bends as shown in figure 64A, components shall be mounted such that the body is displaced with respect to the terminal to which they are attached as shown in figures 64B, 64C and 64D.



A
VERTICAL PLANE

COMPONENT DIAMETER TO 3/16"
1/2 W RESISTOR (TYP)

B
HORIZONTAL PLANE

COMPONENT DIAMETER
3/16" TO 1/4"
1W RESISTOR (TYP)

C
HORIZONTAL PLANE

COMPONENT DIAMETER 1/4" AND GREATER
2W RESISTOR (TYP)

D

HORIZONTAL PLANE

FIGURE 64. Expansion radii (see 5.1.3.4).

5.1.3.5 Turret terminals.

5.1.3.5.1 Lead wrap. Leads or wires shall be maintained in contact with the post for the full curvature of the wrap which shall extend not less than 180 degrees (1/2 turn) and no more than 270 degrees (3/4 turn) (see figure 65) around the post. There shall be no more than three conductors for each section. The first wire shall be attached to the base and vertical post in the lower section or the shoulder and vertical post in the upper section. Additional wires shall be attached as close as possible to the preceding wire consistent with the insulation thickness. When practicable, except for bus wire, conductors shall be placed in ascending order so that the largest wires are on the bottom. The side route shall be used on all solid post turret type terminals.

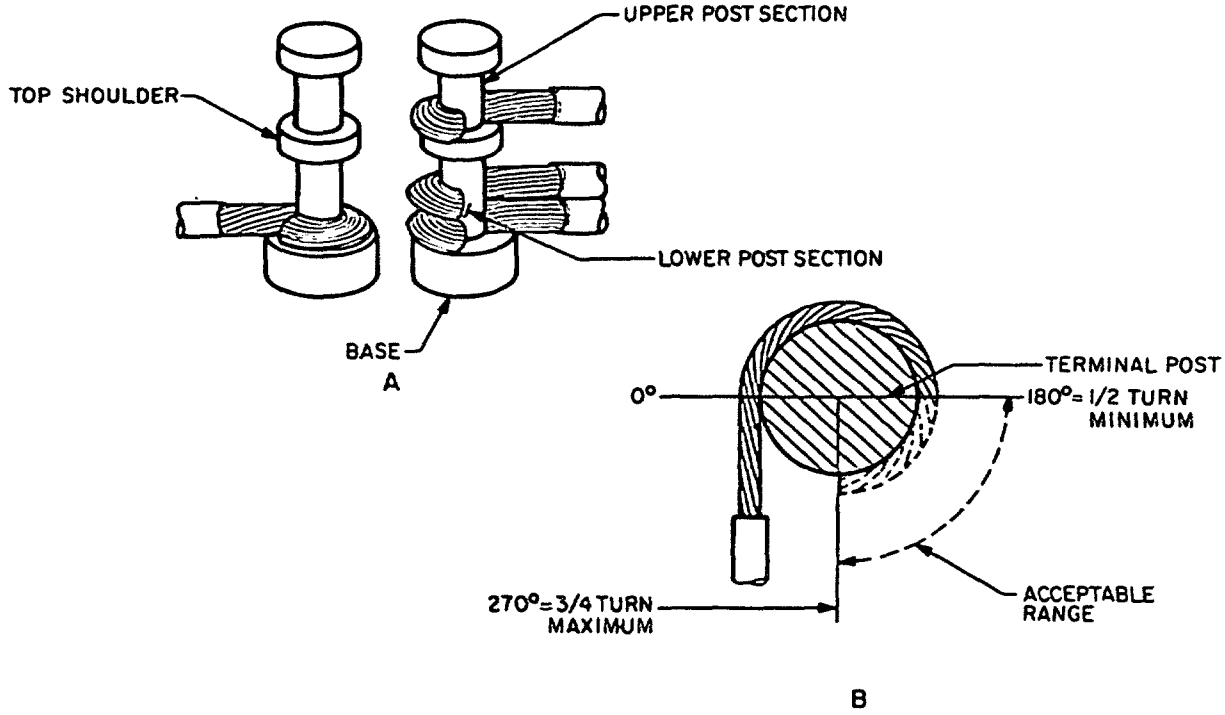


FIGURE 65. Turret terminal wire wrap (see 5.1.3.5.1).

5.1.3.5.2 Continuous run wrapping. If three or more terminals in a row are to be connected, a solid bus wire jumper may be continued from terminal to terminal as shown in figure 66 provided the first and last terminals of the series conform to the 180 to 270 degree requirement.

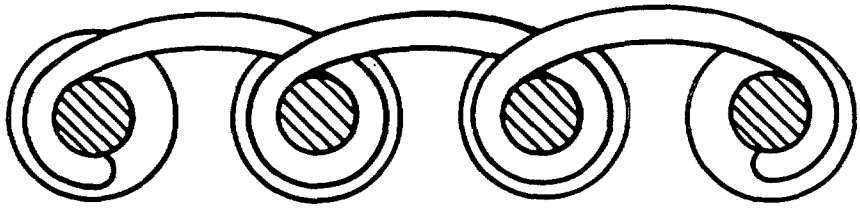


FIGURE 66. Continuous run wrapping, turret terminals (see 5.1.3.5.2).

5.1.3.6 Bifurcated terminals. The order of preferred terminations of bifurcated terminals shall be as follows:

5.1.3.6.1 Side route connection. The wire or component lead shall be dressed through the slot and wrapped to either post of the terminal (see figure 67A). The wire or lead shall be wrapped to the terminal post a minimum of 180 degrees and a maximum of 270 degrees (1/2 to 3/4 turn). The wire or lead shall be wrapped on the terminal post to assure positive contact of the wire with at least two corners of the post (see figure 67D). The wire or lead shall also be in firm contact with the base of the terminal or the previously installed wire (see figure 67B). The number of attachments shall be limited to three per terminal post and shall be maintained such that:

a. There is no overlapping of wraps and wires.

b. Spacing between wires and between wires and terminal board or panel is a minimum consistent with the thickness of the wire insulation.

c. The wraps are dressed in alternate directions (see figure 67C).

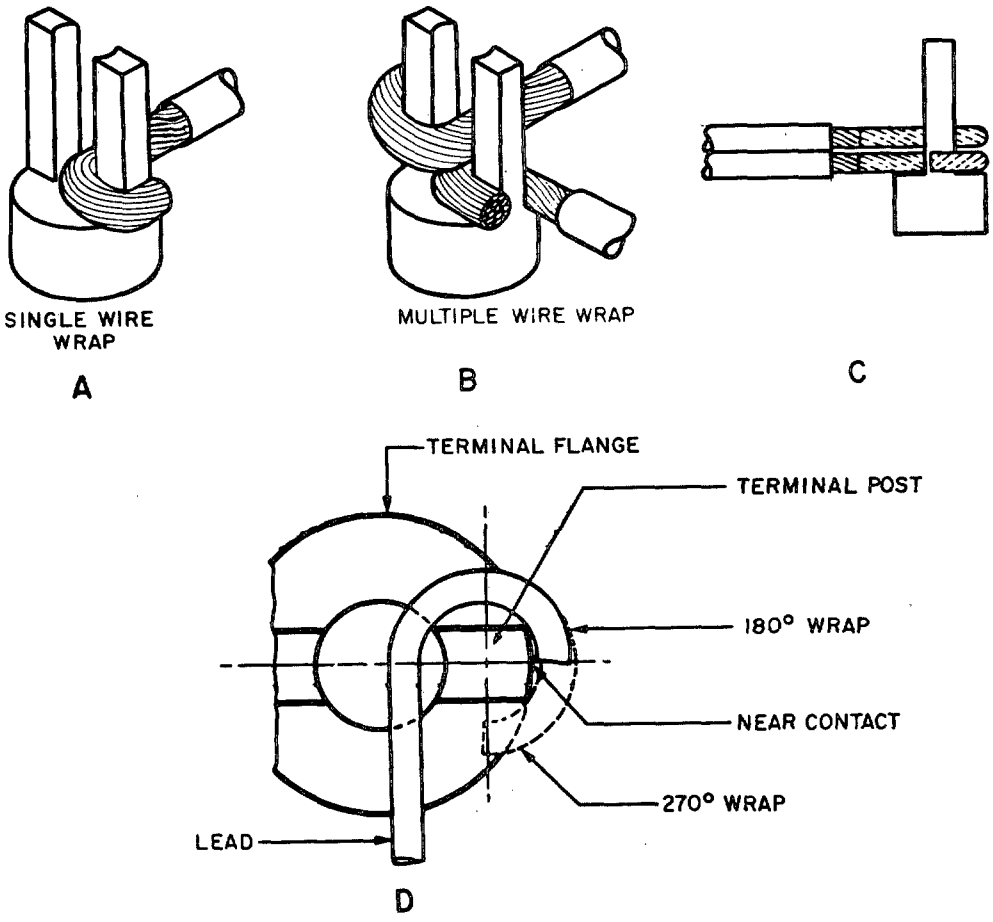


FIGURE 67. Side route connections and wrap on bifurcated terminal (see 5.1.3.6.1).

5.1.3.6.2 Bottom route connection. The wire shall be inserted through the terminal base and wrapped to either post a minimum of 180 degrees and a maximum of 270 degrees (1/2 to 3/4 turn) (see figure 68). The wire shall be wrapped on the terminal post to assure positive contact of the wire with at least two corners of the post. The wire lead shall also be in firm contact with the base of the terminal or the previously installed wire. When more than one wire is to be attached, they shall be inserted at the same time but shall be wrapped separately around alternate posts.

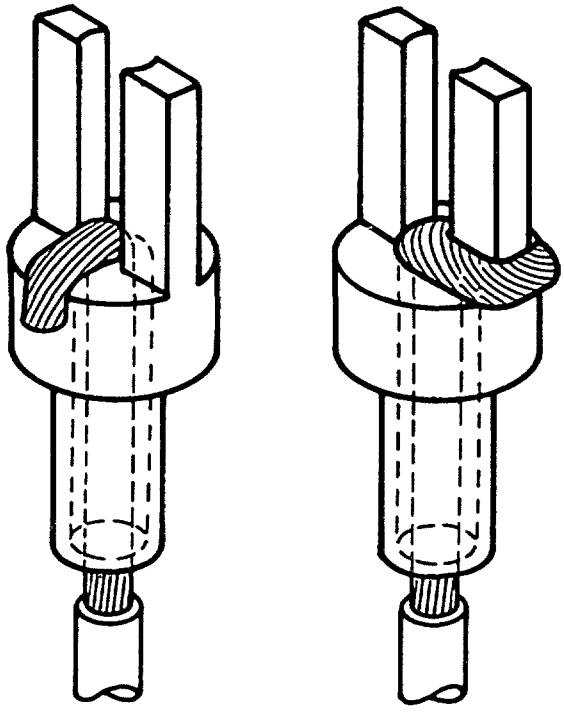


FIGURE 68. Bottom route terminal connection (see 5.1.3.6.2).

5.1.3.6.3 Continuous run connections. When a series of terminals are mounted in a row with the post pairs parallel with all others and the terminals are to be connected each to the other, such interconnection shall be made in accordance with figures 69, 70 or 71.

5.1.3.6.4 Individual solid jumper wires shall be wrapped between corresponding posts of adjacent terminals in the row (see figure 69). Individual wraps shall be in accordance with 5.1.3.6.1.

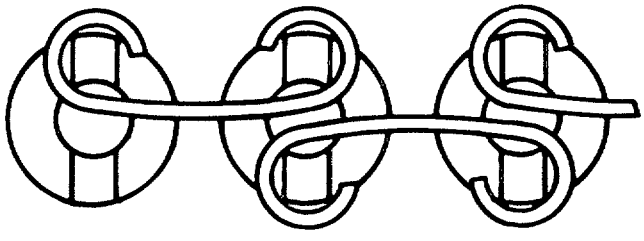


FIGURE 69. Individual wrap, bifurcated terminals (see 5.1.3.6.4).

5.1.3.6.5 A solid jumper wire shall be wrapped to one post of the initial terminal in the row and continued from terminal to terminal with 360 degree wrapping (see figure 70) at the post corresponding with the first until the last terminal is wrapped. The first and last wraps shall be in accordance with 5.1.3.6.1.

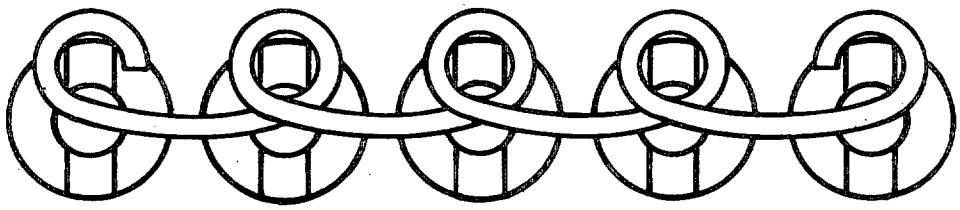


FIGURE 70. Continuous run wrapping, bifurcated terminals (see 5.1.3.6.5).

5.1.3.6.6 A solid jumper wire shall be wrapped to one post of the initial terminal in the row, dressed through the slot of each subsequent terminal without wraps, and wrapped to that post of the last terminal which corresponds with the post of the initial terminal wrapped. The first and last wraps shall be in accordance with 5.1.3.6.1. The unwrapped portion of the jumper shall include a curvature for relief of tension caused by thermal expansion and contraction (see figure 71).

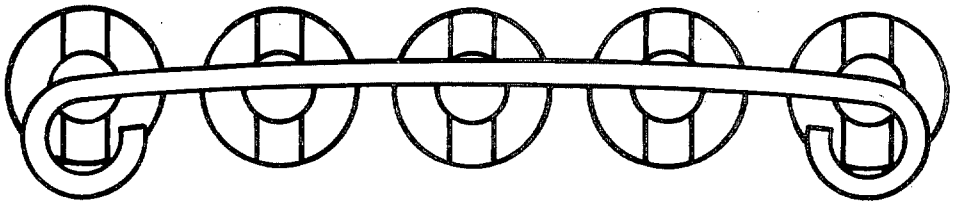


FIGURE 71. Continuous run wrapping, bifurcated terminals, alternate procedure (see 5.1.3.6.6).

5.1.3.7 Hook terminals. The bend to attach wires and leads to hook terminals shall be 180 to 270 degrees (1/2 to 3/4 turn). The maximum wire fill shall not exceed the end of the hooks (see figure 72). There shall be no more than three conductors for each terminal. For size 30 or smaller wire, a maximum terminal wrap of 3 turns may be used. Wires shall be wrapped directly to the terminal and not on prior wrapped wires.

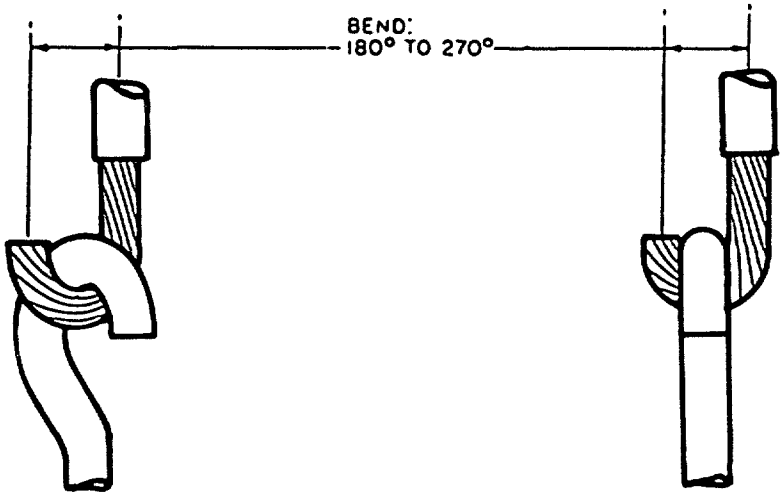


FIGURE 72. Hook terminal connections (see 5.1.3.7).

5.1.3.8 Pierced or perforated terminals. For wiring to a single terminal, the wire shall pass through the eye and be wrapped around the terminal 180 to 270 degrees (1/2 to 3/4 turn), as applicable (see figure 73). If wires are to be attached to a group of terminals such as on transformers, certain relays, and rotary switches, the wires shall be neatly arranged around the terminals in such a manner that they do not cross one another. When a continuous run is more practicable than would be the application of individual jumpers, intermediate terminals of a series to be connected with each other shall be joined with a solid jumper wire threaded through the openings (see figure 74). 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 nonadjacent contact surfaces of each intermediate terminal.

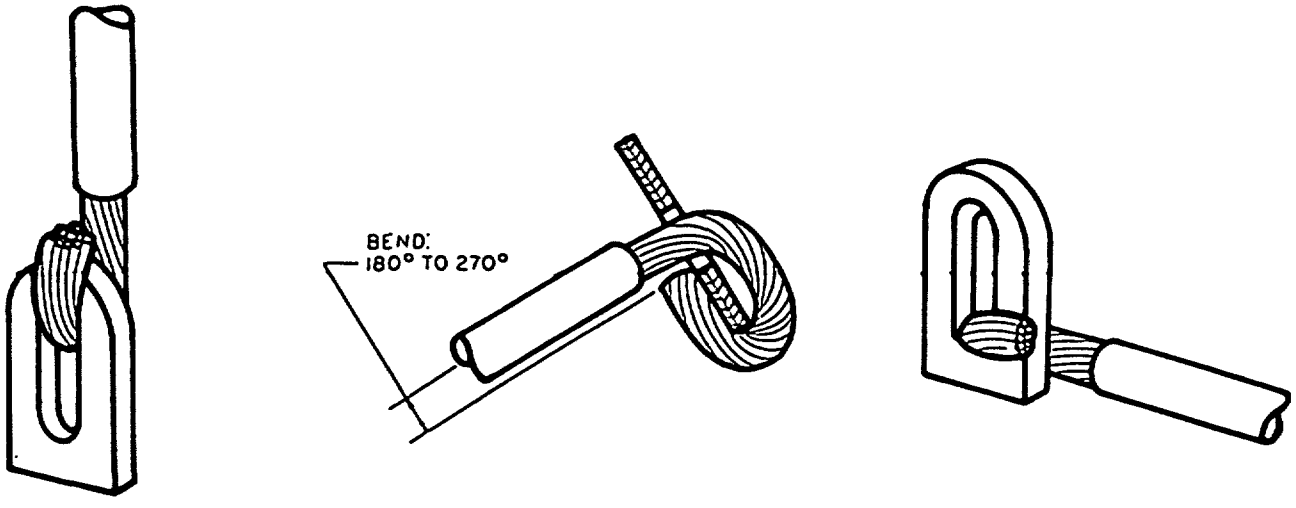


FIGURE 73. Pierced or perforated terminal wire wrap (see 5.1.3.8).

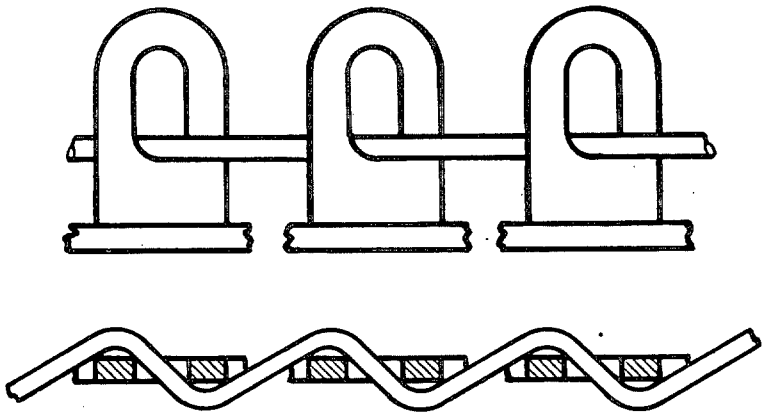


FIGURE 74. Continuous run weaving, pierced or perforated terminals (see 5.1.3.8).

6. NOTES

6.1 Supersession note. This standard is one of a series of documents for High Quality/High Reliability soldering. The series consists of DOD-STD-2000-1 Soldering Technology, High Quality/High Reliability; DOD-STD-2000-2 Part and Component Mounting for High Quality/High Reliability Soldered Electrical and Electronic Assemblies; DOD-STD-2000-3 Criteria for High Quality/High Reliability Soldering Technology. As a set, this series is intended to supersede the documents listed below. The listed documents will remain in effect until they are cancelled by separate notice.

MIL-S-45743	Soldering, Manual Type, High Reliability, Electrical and Electronic Equipment
MIL-P-46843	Printed Wiring Assemblies
MIL-S-46844	Solder Bath Soldering of Printed Wiring Assemblies
MIL-S-46860	Soldering of Metallic Ribbon Lead Materials to Solder Coated Conductors, Process for Reflow
MIL-S-50826(AR)	Soft Soldered Electrical Connections for Special Weapons Items Including Other Related Electronic Devices
MIL-S-50827(AR)	Soft Soldered Electrical Connections for Conventional Weapons Items Including Other Related Electronic Devices
MIL-STD-252(CR)	Classification of Visual and Mechanical Defects for Equipment, Electronic, Wired and Other Devices

MIL-STD-1460(AR)	Soldering of Electrical Connections and Printed Wiring Assemblies, Procedures for
QWS-10.00B	Acceptance Criteria for Solder Connections and Wiring in Electronic Equipment
WS-4554	Wave Soldering of Printed Wiring Assemblies, Automatic Machine Type
WS-6536	Process Specification Procedures and Requirements for Preparation and Soldering of Electrical Connections
WS-14146	Preparation, Soldering and Inspection of Electrical Connections

6.2 Changes from previous issue. The margins of this standard are marked with vertical lines to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

6.3 Subject term (key word) listing.

Component, leadless
Component, axial-leaded
Component, nonaxial-leaded
Component, metal mounting cased
Design requirements
Lead configuration
Lead termination
Printed board assembly
Printed circuit board
Printed wiring board
Printed wiring board, rigid
Printed wiring flexible and rigid flex
Terminal,electrical

6.4 Use of metric units. English units (inches, pounds, Fahrenheit) are the primary units used by the United States Industry for manufacturing electronic assemblies. In this document, measurements are provided in English units followed by the metric equivalent. The conversions from English to metric are made in accordance with FED-STD-376. The metric equivalents provided in this document are rounded to sensible values. Direct conversions which are mathematically correct but reflect unreasonable degrees of precision in metric units have been avoided (i.e., 5.002 mm is considered unreasonable; this should be rounded to 5.0 mm). In the event of conflict, the primary English measurement shall take precedence.

Custodian:
Air Force - 20
Army - MI
Navy - AS
NSA - NS

Review activities:
AF - 11, 15, 17, 19, 84, 99
Army - AR, CR, ER, MR
Navy - EC, OS
DLA - ES, DH

User activities:
Army - AV
Navy - MC
DLA - DH

Preparing Activity:
Navy - AS
(Project No. SOLD-0023)

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INDEX OF REFERENCED DOCUMENTS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
DOD-STD-2000-2A	Part & Componet Mtg. For High Qual/High Rel. Soldered Elec. & Elex. Assy.

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.