Subject: Hand Soldering, Electrical

APPROVED BY Manager, Hardware Engineering

STATUS Maintenance Revision

PURPOSE Presents the requirements which must be met for a reliable electrical connection between two or more metals employing solder as the bonding agent.

NOTE

This instruction does not cover dip soldering, wave soldering, induction soldering, resistance soldering, or ultrasonic soldering methods.

L-3 Communications Corporation, Link Simulation & Training Division (hereafter referred to as Link) personnel shall follow the requirements of this instruction when soldering electrical connections.

AFFECTED FUNCTIONS Hardware Engineering
Manufacturing

REFERENCES

LMS 11-4	Stripping of Wire
O-T-236	Tetrachloroethylene (Perchloroethylene), Technical
QQ-S-571	Solder; Tin Alloy, Tin-Lead Alloy, and Lead Alloy
TT-I-735	Isopropyl Alcohol
O-E-760	Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents
MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
MIL-T-81533	Trichloroethane, 1,1,1 (Methyl Chloroform), Inhibited, Vapor Degreasing

1. REQUIREMENTS

1.1 Soldering irons.

a. Temperature and types. Soldering irons shall be temperature controlled and shall be capable of maintaining the measured idling tip temperature within ±10°F (±5.5°C). Uncontrolled (constant output) soldering irons

may be used when approved by the procuring activity. Resistance between the tip of the hot soldering iron and the workstation ground shall not exceed 5.0 ohms. The potential difference between the workstation ground and the tip of the hot soldering iron shall not exceed 2 millivolts RMS. Three-wire cords and tip grounding shall be used. The soldering iron shall be of such design as to provide zero voltage switching. Soldering guns of the transformer type shall not be used.

b. Soldering iron tip. All soldering iron tips should be plated. The following precautions shall be taken:

(1) Tips shall be secure against heating elements when inserted into the iron.

(2) Tips shall be thoroughly clean (free of dirt, scale, oxide, pits, etc.) and tinned as often as necessary to produce a satisfactory solder joint.

(3) To utilize the tip to its maximum capability, it is necessary to check the tip frequently for (1) and (2), above, depending on the volume of soldering performed.

(4) A cellulose sponge, moistened with water, shall be used to wipe tips off periodically to maintain a bright, shiny appearance. If not acceptable after wiping on a damp sponge, tip should be replaced.

1.2 Solder pots. The solder pots used for tinning of areas to be soldered shall be temperature controlled. Solder pots or baths shall be set at a preselected temperature within the range of 475°F to 525°F (245°C to 275°C). The temperature shall be maintained within ±10°F (±5.5°C) of the preselected temperature.

1.3 Wire strippers. See **LMS 11-4**, Stripping of Wire.

1.4 Component lead cleaning tools. A typical component lead cleaning tool is shown in Figure 1. This tool is constructed of 1/2-inch (1.27-cm) tinned copper shielding braid-mounted on a spring type holder. Knives, emery cloth, sandpaper, and other abrasives shall not be used.

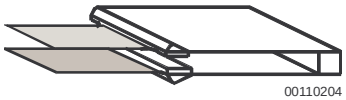


Figure 1 Lead Cleaning Tool

1.5 Thermal shunts (heat sinks). Thermal shunts or heat sinks, when specified on the drawing, operation record, or by the Industrial Engineering Department, shall be used to protect heat-sensitive components such as semiconductors, meter movements, precision resistors, etc., from damage due to heat while soldering. Thermal shunts shall be held in place by suitable means, such as friction or spring tension, which will prevent damage to the surface and insulation of the wire and to the component being soldered. See Figure 2 for typical thermal shunts.

1.6 Soldering aids.

a. Soldering aids are available with forked ends, spade ends, and brush ends. (See Figure 3.)

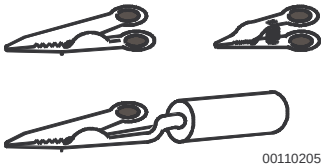


Figure 2 Thermal Shunts

Figure 3 Soldering Aid

b. Soldering aids shall be used for various minor assembly and rework operations, e.g., reaming and cleaning lug holes, unwinding and removal of wires from terminals, guiding wires and parts into position for soldering, cleaning connections before soldering, brushing out wire cuttings and splattered solder, etc.

1.7 Wire bending tools. Wire bending tools (jigs, pliers, etc.) shall have smooth bending surfaces and shall be used to bend part leads without nicking, ringing, or other damage to the extent that the bare base metal of the lead is showing.

1.8 Materials.

a. Solder.

(1) Hand Soldering. Mildly activated rosin core, wire-type solder conforming to Federal Specification QQ-S-571, Composition Sn60, Sn62, or Sn63 shall be used for most electrical work.

(2) Dip Tinning. Solder used in the dip–tinning process shall be solid metal alloy composed of 60 percent tin and 40 percent lead, or 63 percent tin and 37 percent lead, conforming to Federal Specification QQ-S-571, Composition Sn60 or Sn63.

b. Flux (dip tinning).

Flux. Rosin fluxes conforming to types R or RMA of MIL-F-14256 shall be used for making electrical and electronic connections. For fluxing purposes, a soldered joint which functions as both a mechanical and an electrical connection (for example, in grounding applications through a chassis) shall be considered an electrical connection.

c. Flux thinner. Rosin flux should be thinned, when necessary, with compatible thinner, but the manufacturer's specific gravity must be maintained.

d. Flux solvents and cleaners.

(1) Isopropyl Alcohol.

(2) Freon.

(3) Chlorothene DV.

(4) Solvent MX-4 (John B. Moore Corporation).

CAUTION: Solvents should be used in a well-ventilated room, and direct inhalation of the vapors or contact with the skin should be avoided.

1.9 Wire preparation.

a. All insulated wire leads will be stripped by the appropriate method (see Manufacturing Standard **LMS 11-4**, Stripping of Wire) and tinned. The solder shall penetrate to the inner strands of the wire and shall wet the tinned portion of the wire. Solid/stranded wire that is pretinned requires no further tinning. Untinned/stranded wire will be twisted firmly, prior to tinning, in the same direction as the normal lay of the strands to prevent bird-caging. (See paragraph 1.14i).

b. Cleaning of conductors and terminals. Conductor surfaces to be soldered shall be clean prior to soldering. Cleaning may be as follows:

(1) Grease and oil shall be removed from conductors and terminals by applying a noncorrosive solvent such as:

(a) 1, 1, 1-trichloroethane conforming to MIL-T-81533; or

(b) ethyl alcohol conforming to O-E-760, type III, or isopropyl alcohol conforming to TT-I-735; or

(c) tetrachloroethylene conforming to O-T-236.

(2) Oxides and varnishes shall be removed by methods which do not damage leads or parts, and which do not cause contamination or hinder solder wetting.

(3) Sand blasting shall not be used.

(4) Dust or other loose material shall be removed.

c. Wicking. Capillary flow in the form of wicking under the insulation of stranded wire soldered to a terminal area is permissible, provided that the insulation is of a type which can withstand soldering temperatures, the application does not require that the wicked portion of wire be flexible, and the criteria for wicking is not otherwise specified for the particular application on applicable drawings

1.10 Insulation clearance.

a. Stripping Insulation. Sufficient insulation shall be stripped from the wire of leads to provide for insulation clearances as specified in paragraph 1.10b. In stripping insulation, care should be taken to avoid nicking or otherwise damaging the wire or the remaining insulation. Wires or wire strands shall not be broken, severed, or birdcaged. Wires and strands shall be inspected at 4X magnification. Nicks, cuts, scrapes, stretching, or other observable damage which exceeds 10 percent of the original wire cross-sectional area is unacceptable. Discoloration of the wires or strands that shows evidence of overheating is undesirable.

NOTE: The cross-sectional area of a stranded wire is the sum of the cross-sectional areas of the individual strands.

b. 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:

(1) Minimum Clearance. The insulation may abut the solder. It shall not, however, be embedded in or surrounded by the solder. The insulation shall not be melted, charred, seared, or diminished in diameter.

(2) Maximum Clearance. The maximum clearance shall be two wire diameters (including insulation) or 1/16 inch (1.6 mm), whichever is larger, but shall not be such that it permits shorting between adjacent conductors.

(3) High–voltage clearance. The insulation clearance for high–voltage wires (greater than 6 kV) shall be 1/8 inch, ±1/16 inch (3.2 ±1.6 mm), unless otherwise specified in the assembly drawing.

1.11 Wire terminations.

a. General.

(1) The preferred method for jumper wiring shall be individually routed jumpers. Jumpers may be run continuously (wrapped around a terminal and continued to the next terminal).

(2) All hookup wire shall have sufficient slack to prevent mechanical strain at the soldered connection and to allow for replacement on terminals at least two times.

(3) Where practicable, when more than one wire is terminated, the heaviest gauge wire shall be placed at the bottom of the terminal with the remaining wires arranged in order toward the top.

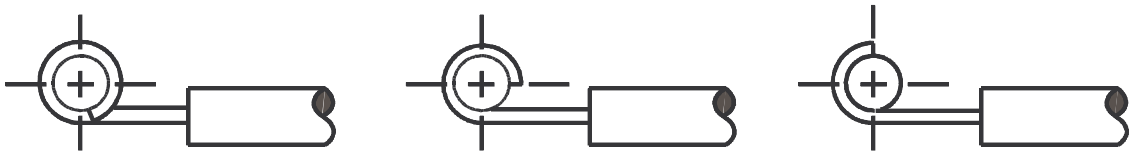
(4) Where practicable, when a wire and a part lead are terminated, the wire shall be placed below the part lead on the terminal post.

CAUTION

Under no circumstances shall conductors be modified to facilitate attachment to undersize terminals, nor shall terminal of any type be modified to accommodate oversize conductors. Should this condition exist, Engineering shall be required to give direction.

(5) Wire and lead wraparound. Leads and wires shall be mechanically secured to their terminals before soldering. Such mechanical securing shall prevent motion between the parts of a joint during the soldering operation. Leads and wires shall be wrapped around terminals for a minimum of 180 degrees and not more than 350 degrees in a single layer only. (See Figure 4.) For AWG 30 or smaller wire, a maximum of 3 turns may be used. Exception is made in the case of those small parts used for terminating conductors and to which such mechanical securing would be impracticable, such as connector solder cups, slotted terminal posts, heat shrinkable solder devices, etc. Lead extension shall be restricted to the limits required by design to

prevent equipment malfunction. In no case shall wires be wrapped on each other.



A. 350 DEGREES WRAP B. 270 DEGREES WRAP C. 180 DEGREES WRAP

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Figure 4 Wire And Lead Wraparound

(6) When terminating multiwire conductors in connectors which use a screw to develop a compression-type termination, do not tin the wires.

(7) Number of wires per terminal. The number of wires terminated in an individual terminal shall not be greater than three. Multisection turret, bifurcated, or multihole lug terminals shall have not more than three wires per section, tong, or hole.

b. Turret terminals.

(1) General lead and wire wraparound. Component leads and wires shall be mechanically secured to their terminals before soldering with sufficient securing to prevent motion between the parts of a joint during the soldering operation. The wire shall be in contact with the terminal or post for the full curvature of the wrap. Solder shall form visible fillets with that portion of wire or lead in contact with terminal. The solder shall not obscure the contour of the wire. For slotted terminals, solder may completely fill the slot. When soldering the second section on double-ended terminals, care should be taken to insure that the joint on the first section is not compromised.

(a) When three or more terminals in a row are to be electrically common, a solid bus wire may be wrapped around the middle terminals 360 degrees while the end

terminals are wrapped the amount specified above. (See part B of Figure 5.)

(b) On multiple connections to a solder terminal, all wires located within a section of the terminal should be wrapped in the same direction. (See part A of Figure 5.)

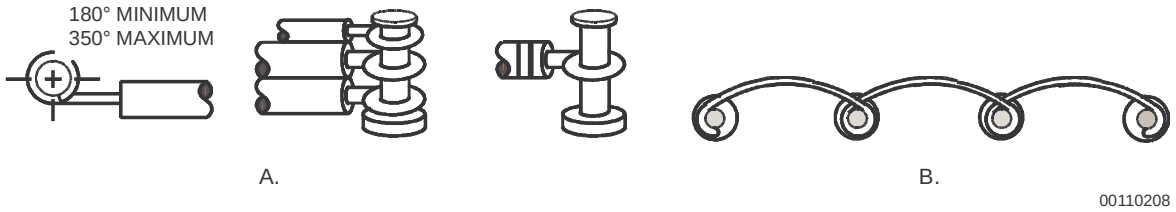


Figure 5 Lead Wrap Methods

(2) Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall not exceed the limits specified in paragraph 1.10b. (See Figure 6.)

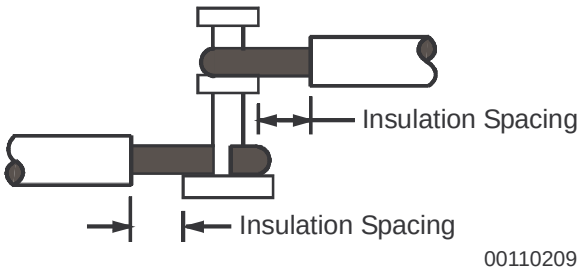


Figure 6 Insulation Clearance

(3) Lead Bends. Lead bends shall not extend to the part body or weld. The radius of bends shall be one lead thickness, one lead diameter, or one lead diameter prior to coining. (See Figure 7).

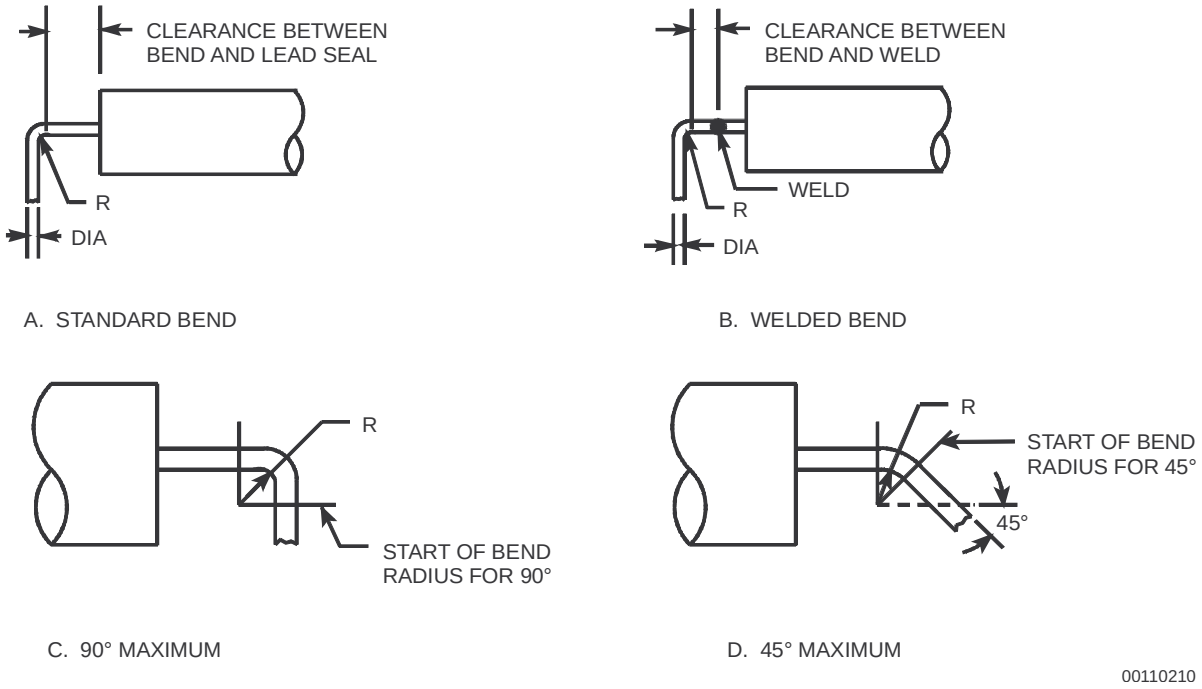
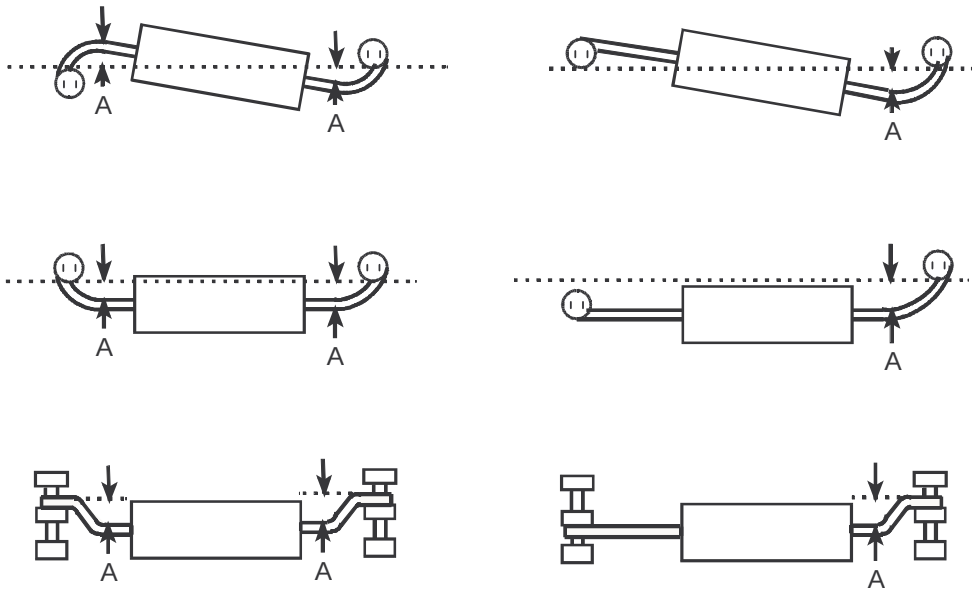


Figure 7 Lead Bends

(4) Stress relief. Axial or opposed lead devices with leads terminating at a connection point shall have a minimum lead-connection-to-body offset of at least 2 lead diameters or thickness, but not less than .030 inch (0.75 mm). Where the component body will not be secured to the mounting surface by bonding, coating, or other means, the lead(s) on only one of the opposing sides of the component needs be so configured. Typical examples of stress relief are included in Figure 8.



Device with bodies either secured or unsecured to mounting surface.

Alternate method for devices with bodies unsecured to the mounting surface.

Measurement "A" is equal to or greater than two times lead diameter or thickness but not less than .030 inches (0.75 mm).

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Figure 8 Typical Stress Relief Bends

c. Hook terminals.

(1) Wire leads terminated in a hook terminal shall be wrapped 180 to 270 degrees around the hook and crimped tight as shown in Figure 9. The maximum wire fill shall not exceed the end of the hook.

(2) Multiple terminations. A maximum of three leads shall be terminated in the hook terminal. The terminations shall be made as stated in paragraph 1.11c(1). Various methods of termination are shown in Figure 10.

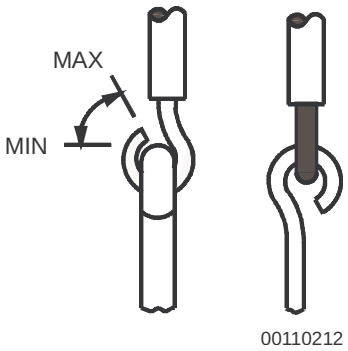

Figure 9 Hook Terminations

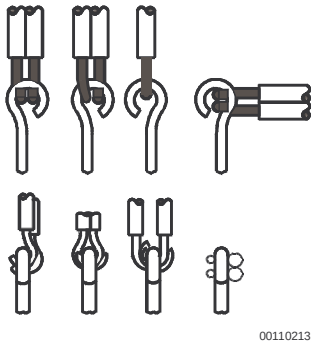

Figure 10 Hook Terminations

(3) Insulation spacing. The distance between the hooked contact and the insulation on the wire shall not exceed the limits specified in paragraph 1.10b. (See Figure 11.)

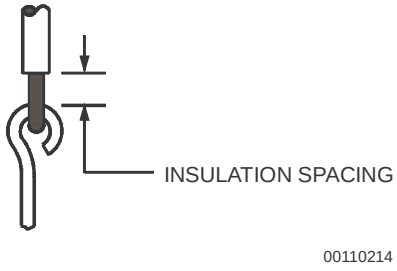

Figure 11 Insulation Spacing

d. Pierced or perforated terminals.

(1) Wire leads shall be wrapped around the terminal eye 180 degrees and crimped tight enough to retain the connection. (See Figure 12.) The wire should be cut off flush with the terminal; however, a 1/32–inch (0.8–mm) maximum pigtail is permissible. 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.

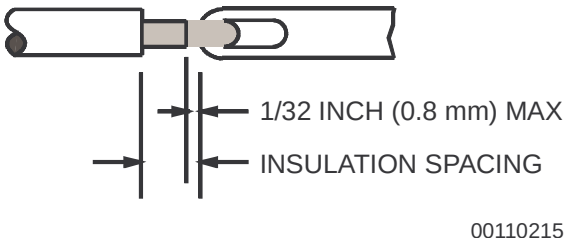

Figure 12 Lug Terminals

(2) Multiple termination. A maximum of three leads is acceptable on terminal strip eyelets, provided the connection method conforms to paragraph 1.11d(1).

(3) Insulation spacing. The distance between the pigtail extension and the insulation (Figure 12) shall not exceed the limits specified in paragraph 1.10b.

(4) Application. The standard set forth for the eyelet terminations shall also be applicable to the following connections: relays, barrier strip adapter terminals, blue ribbon connectors, tube sockets, and wafer switches.

(5) In those instances where the connecting wire(s) is of too large a diameter to enter the eye of the lug terminal (or there is no eye in the terminal), it shall be permissible to wrap the wire(s) around the terminal, approximately 180 degrees, crimp tight, and solder. (See Figure 13.) The number of wires terminated in this manner, on one terminal, shall be limited to the number that can be wrapped on the terminal itself and still maintain a neat appearance. In no case shall a wire be wrapped over another wire. (This condition generally exists only on small miniaturized components).

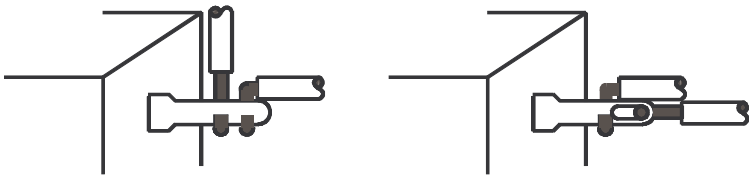

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Figure 13 Multiwire Terminations

e. Solder cup terminals.

(1) No more than three wires shall be installed in the cup, and in no instance shall the lay of the strands of any wire be disturbed, nor shall strands be removed. The wire or wires shall be inserted for the full depth of the cup and a fillet shall be formed along the surfaces of contact. Solder shall wet the entire inside of the cup. Solder shall follow the contour of the cup and shall fill at least 75 percent of the mouth of the cup. Solder may overfill the cup. Any solder on the outside of the cup shall be in the form of a thin film. (See Figure 14).

1. SOLDER ALMOST FILLS CUP AND FOLLOWS THE CONTOUR OF THE CUP ENTRY.
2. WETTING BETWEEN LEAD OR WIRE AND CUP IS VISIBLE.
3. ANY SOLDER ON THE OUTSIDE SURFACE OF THE SOLDER CUP IN THE FORM OF A THIN FILM.

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Figure 14 Wire And Lead Soldering to Solder Cups

(2) Insulation spacing. The distance between the solder cup and the conductor insulation shall not exceed the dimensions specified in paragraph 1.10b. (See Figure 15.)

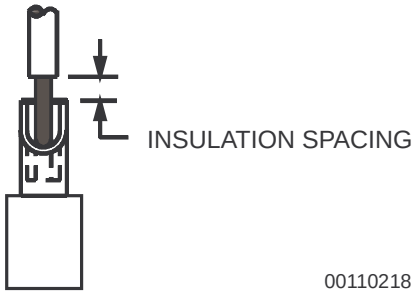

Figure 15 Insulation Spacing

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

(1) Side–route connection. The wire or component lead shall be dressed through the slot and wrapped to either post of the terminal (see part A of Figure 16) and shall be in contact with the flat surfaces of two nonadjacent sides. (See part B of Figure 16). The wire or lead shall also be in firm contact with the base of the terminal or the previously installed wire. (See part C of Figure 16). 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 spacing between the wires and the terminal board or panel is a minimum consistent with the thickness of the wire insulation.

(c) The wraps are dressed in alternate directions. (See part D of Figure 16.)

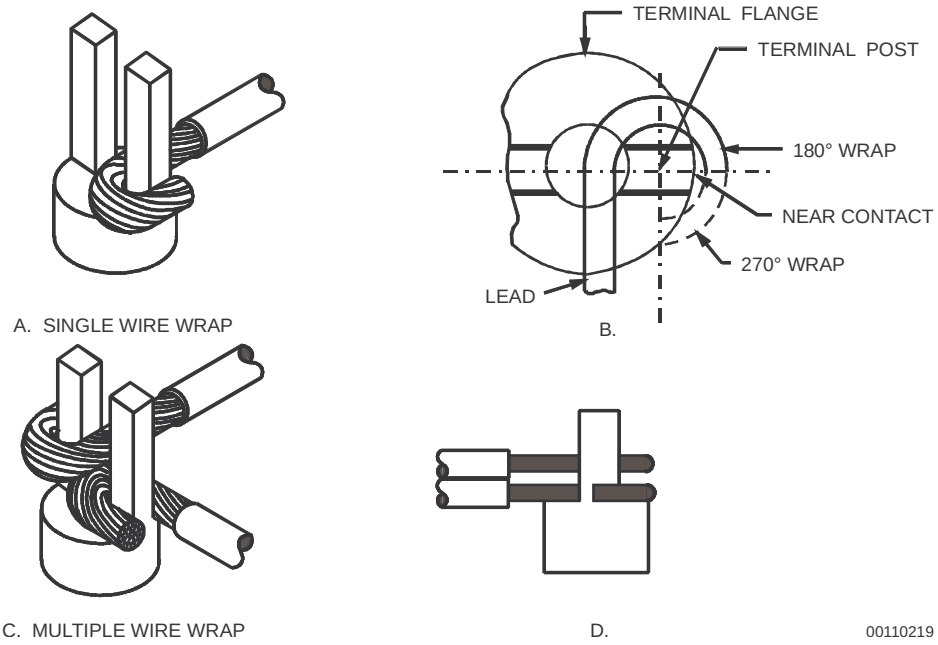

Figure 16 Side Route Connections and Wrap on Bifurcated Terminal

(2) Bottom–route connection. The wire shall be wrapped on the terminal post and shall be in contact with the flat surfaces of two nonadjacent sides. 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. (See Figure 17.)

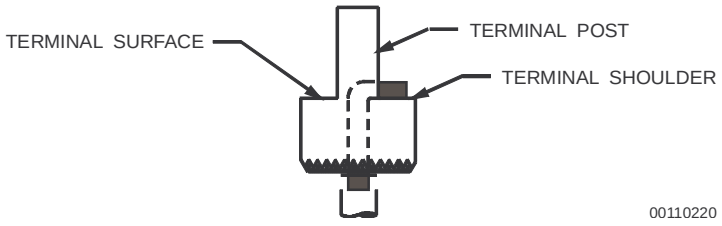

Figure 17 Bifurcated Terminations, Bottom Entry

(3) Side entry for shoulderless termination.

(a) The wire shall lie flush along the bottom interior surface of the terminal with maximum allowable rise of the wire being limited to the wire diameter. (See Figure 18.)

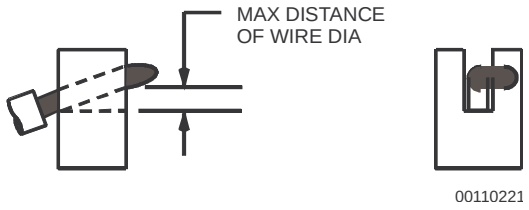

Figure 18 Bifurcated Terminations, Side Entry

(b) All 25-gauge wire and wires of larger diameters shall be mounted with a 30– to 90–degree wrap and lie flat against the terminal surface. (See Figure 19.)

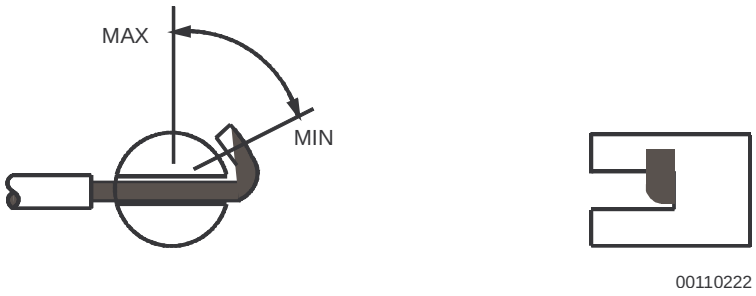

Figure 19 Bifurcated Terminations

(c) All 26-gauge wire and wires of smaller diameters shall be wrapped 90 to 180 degrees and shall lie flat against the surface of the terminal. (See Figure 20.)

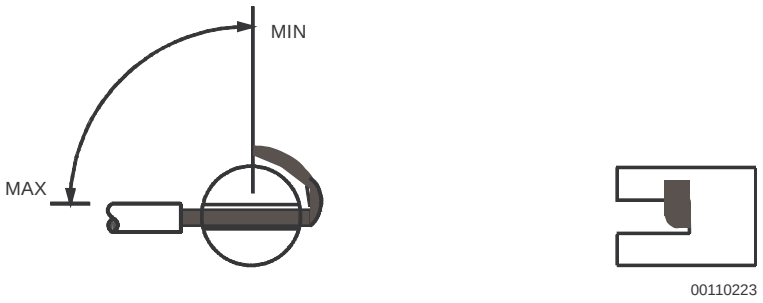

Figure 20 Bifurcated Terminations

(d) Wire of approximately the same diameter as the distance between the terminal posts shall not extend or be indented greater than 1/32 inch (0.8 mm). (See Figure 21.)

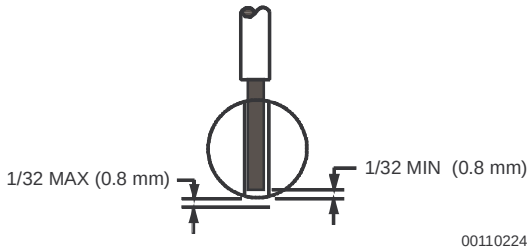

Figure 21 Wire Placement

(4) Top entry. If the diameter of the wire is of sufficient size to fill the gap between the posts with a minimum amount of solder, a filler need not be used. However, if the aforementioned criteria cannot be met, then a filler wire shall be required. (See Figure 22.) Wire may be bent back to form a filler wire, or separate filler wire may be used. The filler wire shall be flush with the top of the terminal post or a maximum of 1/16 inch (1.6 mm) above to 1/8 inch (3.2 mm) below the surface of the terminal post.

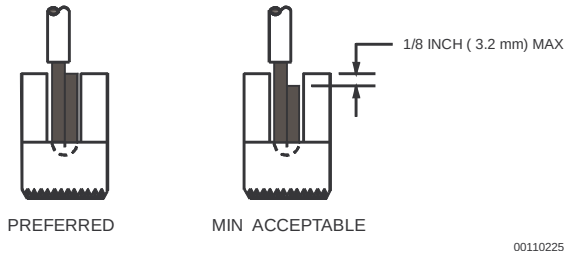

Figure 22 Filler Wire

(5) Lead extension. Wire leads shall not extend beyond the terminal surface more than 1/32 inch (0.8 mm). The leads shall cover not less than 1/2 the terminal or surface. (See Figure 23.)

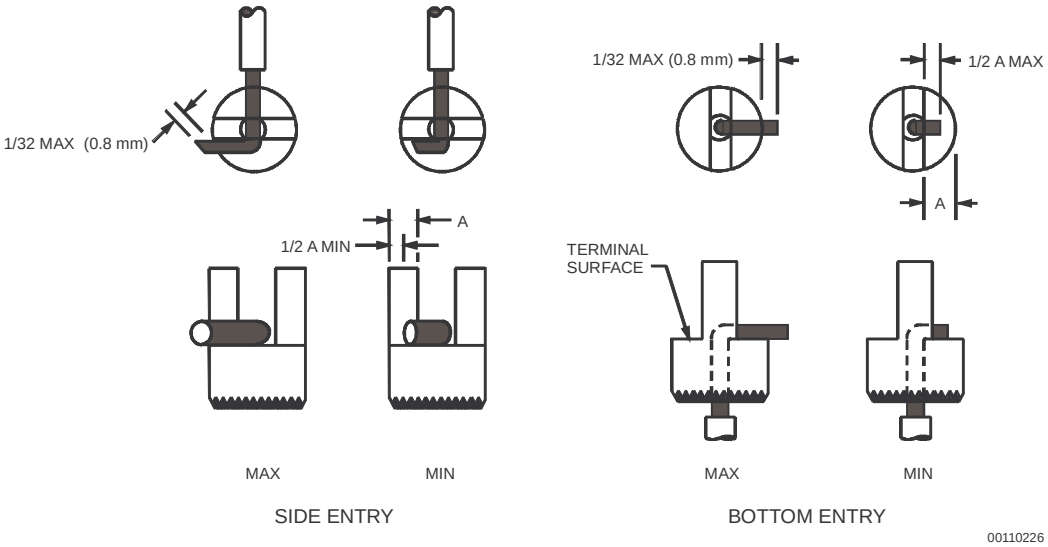

Figure 23 Lead Extension

(6) Multiple terminations. Entry of two or more wires shall wrap around the post in an alternate manner as shown in Figure 24. The maximum number of wires terminated in a single turret shall be limited by the minimum spacing requirement of one wire diameter (Dimension A minimum equals smallest wire diameter) from the top of the terminal using the smallest wire termination as a guide. However, in no case shall there be more

than three terminations to a terminal. Wire–wraps shall be parallel to the terminal's bottom surface.

Figure 24 Multiple Wire Terminations

(7) Insulation spacing. The distance between the terminal and conductor insulation shall not exceed the limits specified in paragraph 1.10b. (See Figure 25.)

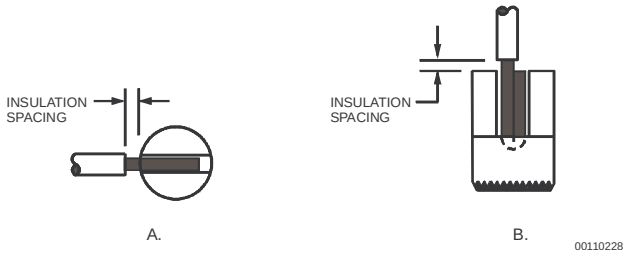

Figure 25 Insulation Spacing

1.12 Hand Soldering.

a. Precleaning. Cleanliness of part leads and printed wiring surfaces shall be sufficient to insure solderability.

b. Applying flux. When used, liquid flux shall be applied in a thin, even coat to those surfaces being joined prior to application of heat. Cored solder wire shall be placed in such a position that the flux can flow and cover the joint as the solder melts. Flux shall be so applied that no damage will occur to surrounding parts and materials.

c. Applying heat. The areas to be joined shall be heated to cause melting of the solder and wetting of the surfaces. Excessive time (slow heating)

and excessive temperature shall be avoided to prevent unreliable joints and damage to parts. Heat sinks shall be used for the protection of parts, as required. Parts, wire insulation, or printed wiring boards which have been charred, melted, or burned shall be replaced. When heat has caused part materials to discolor, further evaluation shall be performed to ascertain whether the essential properties have been adversely affected; if so, the item shall be replaced.

d. Applying solder. The areas to be joined shall be at the correct temperature, then the solder shall be applied to the joint and not to the soldering iron; however, a very small quantity of solder may be applied at the place where the iron tip touches the joint to improve heat transfer. When the solder-preform method is used, the solder may be applied to the joint prior to heating.

e. Cooling. No liquid shall be used to cool a soldered connection. The connection shall be cooled in air at room temperature only. Heat sinks may be used to expedite cooling. The connection shall not be subjected to movement or stress at any time during the cooling and solidification of the solder.

f. Resoldering. Care should be taken to avoid the need for resoldering. When resoldering is required, the quality standards for the resoldered connection shall be the same as for the original connection. A cold solder or disturbed joint will require only reheating and reflowing of the solder.

g. Flux residue removal. Flux residues shall be removed within one hour after soldering by applying appropriate noncorrosive solvents. Mechanical means such as agitation, brushing, etc. may be used in conjunction with the solvents. The cleaning solvents and methods used shall have no damaging effect on the parts, connections, and materials being cleaned. Ultrasonic cleaning may damage certain parts, particularly transistors, and should generally be avoided.

h. Specific hand-soldering applications.

(1) Hook terminals. The quantity of solder on a hooked joint shall be limited such that the outline of the terminal and the wire are clearly defined. (See Figure 26.)

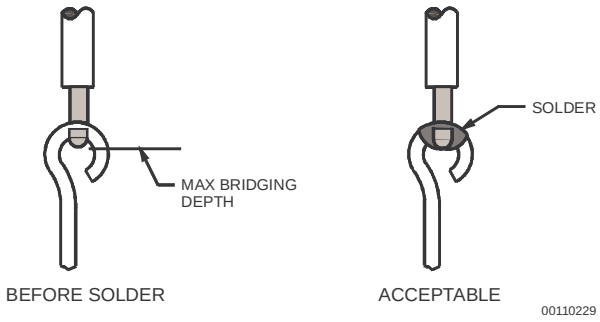

Figure 26 Hook Terminations

(2) Cup terminals. The solder shall cover the wire sufficiently to insure an adequate connection with a good fillet visible. The amount of solder may slightly exceed the optimum, as shown in Figure 27.

1. SOLDER ALMOST FILLS CUP AND FOLLOWS THE CONTOUR OF THE CUP ENTRY.
2. WETTING BETWEEN LEAD OR WIRE AND CUP IS VISIBLE.
3. ANY SOLDER ON THE OUTSIDE SURFACE OF THE SOLDER CUP IN THE FORM OF A THIN FILM.

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Figure 27 Acceptable Cup Termination

(a) Figure 28 illustrates two unacceptable cup-type terminations. Unacceptability is based on excess or insufficient solder, wire insulation in the solder cup, and/or foreign material in the joint.

(b) All strands must be in cup.

(c) The tinned effect occurring at the point where the soldering iron tip contacts the base of the cup is normal provided there are no peaks, globules, or excessive solder buildup to the extent that the possibility of shorting to adjacent terminals exists.

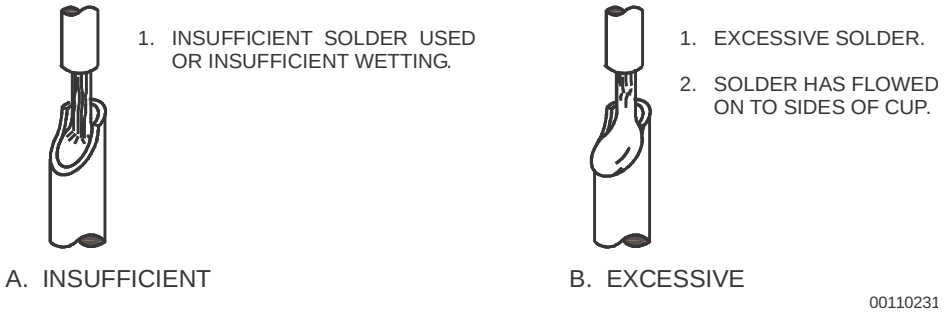

Figure 28 Unacceptable Cup Terminations

(3) Pierced-terminal connections. A sufficient quantity of solder shall cover the wire and eyelet with the outline of each discernible. Generally the terminal hole is not filled with solder. It is permissible, however, for the hole to be filled with solder where the component lead or wire practically fills the hole or when added strength is desired for some of the smaller, thin–gauge terminals. (See Figure 29.)

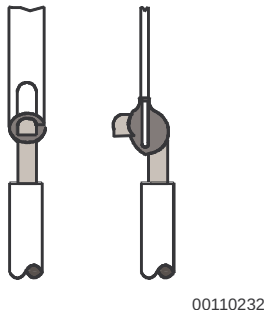

Figure 29 Multiwire Terminations

1.13 The ideal soldered electrical connection. The ideal soldered electrical connection shall include all of the following characteristics:

a. Clean with a shiny, bright, and smooth appearance.

b. Free from porosity.

c. Good fillet between conductor and terminal.

d. Good adherence of conductor to terminal.

e. Sufficient solder to allow for the contour of the wire or lead to be visible after soldering. (Exception: for solder cups, the contour of the wire or lead is visible from the insulation to the point of entry into the cup.)

f. Wire strands or leads at the connection intact and not damaged beyond the permissible limits specified in this document and **LMS 11-4** Stripping of Wire.

g. The conductor shall not be exposed through charred, frayed, split, or pinched insulation.

1.14 Unacceptable solder joints - causes and corrections.

a. Cold joint. A cold joint is an unwetted joint which has a beaded convex appearance. The solder does not positively bond the surfaces and/or blend to the contours of the parts; this occurs because of insufficient heating of the parts being joined due to the following:

(1) Poor contact (low thermal conductivity) between the hot iron and the joint.

(2) Soldering iron too cold.

(3) Dirt or oxide film on parts being joined.

(4) Too rapid a dissipation of heat due to large conductors or terminals.

b. A cold soldered joint shall be disassembled and cleaned, refluxed, then resoldered.

c. Rosin joint. In a rosin joint, flux remains visible between the solder and mating surfaces. It is similar in appearance to a cold joint. A rosin joint occurs when using an insufficiently hot iron or one that is too small. It is also caused by using excessive flux. A rosin joint shall be disassembled, cleaned, and resoldered. (See Figure 30.)

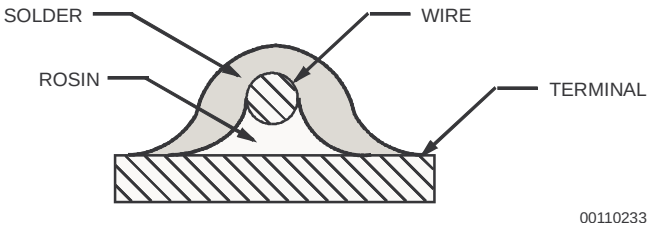

Figure 30 Typical Rosin Joint

d. Disturbed or fractured solder joint. A disturbed or fractured joint has an irregular, crystallized appearance and frequently shows cracks and cleavage-like lines. This is the result of a poor mechanical connection in which the parts have moved before the solder has solidified. A disturbed solder joint shall be cleaned, refluxed, and resoldered.

e. Excessive solder joint. When more solder is used than is necessary for a good reliable joint, a buildup of solder obscures the contours of the parts and/or shows globules, drips, tails, etc. These joints are usually caused by using excessive solder and/or a pitted tip. Remove excess solder with a clean hot iron.

f. Insufficient solder joint. An insufficient solder joint is characterized by exposed wire at the point of the mechanical connection. These solder joints are usually caused by insufficient solder applied to the joint. Such joints, when conducting a current, have high resistance and undesirable heat. An insufficient solder joint shall be cleaned, refluxed, and resoldered.

g. Dewetting. This condition is found when the solder appears to wet the metal by forming a silvery coat or film over the joint. This film will not accept solder flow and will form droplets, producing an unreliable joint. The film has a crystalline appearance. Dewetting is a result of soldering an unclean joint. The connection shall be disassembled, cleaned, and resoldered.

h. Gas holes, pin holes, voids. Caused by flux gases entrapped within the solder joint. Apply a hot iron to the joint to correct.

i. Disturbed lay of wire. Figure 31 depicts acceptable wire lay. The wire shall lie in the normal direction in a tight compact wrap. This criteria shall apply to all types of connections. Extreme wire strand separation (birdcaging) shall be unacceptable. When any one gap between strands exceeds the diameter of one strand (if all strands are nearly parallel), or if it is possible to see through the strands, the joint shall be rejected.

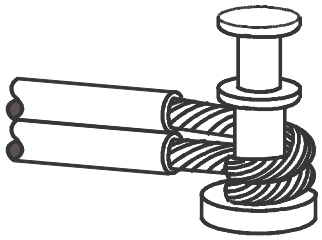

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Figure 31 Acceptable Wire Lay

j. Touchup. Manual soldering as specified herein is permitted, if necessary, to remove solder projections, icicles, and bridges of solder or to add solder to the part connection area. The quality standards for touchup shall be the same as for the original work.

(1) Preparation and cleanliness of parts and wires.

(2) Proper attachment of wires and leads.

(3) Materials - fluxes, solders, and cleaning solvents.

(4) Application of fluxes and solders.

(5) Temperature control.

k. Additional soldering procedures.

Postsoldering cleaning. Terminations made with devices having premeasured amounts of solder and type R or RMA flux encapsulated in a preformed, transparent, heat–shrinkable, self-sealing insulating material do not require flux removal.

2. Quality Assurance Provisions

2.1 Inspection of product. Inspection shall be conducted to assure that all soldered joints meet the requirements of this specification, drawings, and related documents. All parts shall be visually inspected after the soldering operation for presence of excess solder, excess flux (see paragraph 1.12g), loose wire strands, protruding material, foreign particles, underheating or overheating of the soldered joint, or damage to other portions of the assembly or wire insulation.

2.2 The Quality Assurance Organization shall be responsible for assuring that the workmanship meets the minimum requirements specified herein.

2.3 Operators performing soldering tasks shall be trained to perform to this instruction.

2.4 Work area. The work area must be kept clean at all times with a minimum of free dust, oil, and corrosive fumes. Benches and equipment must be uncluttered and kept clean at all times. Bench or tabletop shall be clean and free of grease, oil, chips, solder particles, and wire clippings. Do not use wiping cloths or felt pads as a bench covering.

a. Hand tools such as cutters, crimpers, pliers, etc., are to be free of wax, oil, and other contaminates.

b. All equipment in direct contact with the parts during assembly, such as hoppers, raceways of eyeleters, anvils, and feed wheels of insertion equipment, must be cleaned periodically.

c. No air hoses shall be used in cleaning or drying processes unless the air provided is adequately filtered.

2.5 Personal. Clean, sensible, and safe apparel shall be worn by personnel at all times. Personal cleanliness is extremely important. Washing of hands must be followed by thoroughly drying with paper toweling to absorb any acid-forming moisture from the skin. Hand creams must be approved. Smoking, food stuffs, and beverages shall not be allowed in work area.

3. Preparation For Delivery (Not Applicable)