

INCH-POUND

MIL-DTL-28748D
w/AMENDMENT 1
11 April 2012
SUPERSEDING
MIL-DTL-28748D
11 June 2001

DETAIL SPECIFICATION
CONNECTOR, PLUG AND RECEPTACLE,
RECTANGULAR, RACK AND PANEL
SOLDER TYPE AND CRIMP TYPE CONTACTS
GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers rectangular, rack and panel, electrical connectors, with nonremovable solder type contacts, and removable crimp type contacts, intended for use in electronic and electrical equipment (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 and 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements cited in sections 3, 4 and 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Comments, suggestions, or questions on this document should be addressed to: DLA Land and Maritime, ATTN: VAI, P.O. Box 3990, Columbus, OH 43218-3990 or email: RectangularConnector@dsc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.daps.dla.mil>.

MIL-DTL-28748D
w/AMENDMENT 1

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys.
- MIL-DTL-22520 - Crimping Tools, Wire Termination, General Specification For.
- MIL-I-81969/18 - Installing and Removal Tools, Connector Electrical Contact, Type I, Class I, Composition C.
- MIL-I-81969/20 - Installing and Removal Tools, Connector Electrical Contact, Type I, Class I, Composition A.

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-202 - Test Method for Electronic and Electrical Component Parts.
- MIL-STD-889 - Dissimilar Metals.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Copies of these documents are available online at <https://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of documents which are cited in the solicitation. (see 6.2).

ASME INTERNATIONAL

- ASME B46.1 - Surface Texture (Surface Roughness, Waviness and Lay).

(Copies of these documents are available online at <http://www.asme.org> or from the ASME International, Three Park Avenue, New York, NY 10016-5990.)

ASTM INTERNATIONAL

- ASTM A342/A342M - Standard Test Methods for Permeability of Feebly Magnetic Materials.
- ASTM A276 - Steel Bars and Shapes, Stainless.
- ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars.
- ASTM B16/B16M - Free-Cutting Brass Rod, Bar and Shapes for use in Screw Machines.
- ASTM B36/B36M - Plate, Brass, Sheet, Strip, and Rolled Bar.
- ASTM B121/B121M - Plate, Leaded Brass, Sheet, Strip, and Rolled Bar.
- ASTM B122/B122M - Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar.
- ASTM B139/B139M - Rod, Phosphor Bronze, Bar, and Shapes.
- ASTM B194 - Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
- ASTM B196/B196M - Rod and Bar, Copper-Beryllium Alloy.
- ASTM B197/B197M - Wire, Copper-Beryllium Alloy.
- ASTM B633 - Zinc on Iron and Steel, Electrodeposited Coatings Of.
- ASTM B488 - Gold for Engineering Uses, Electrodeposited Coatings Of.
- ASTM D5948 - Compounds, Molding, Thermosetting.
- ASTM D4067 - Materials, Molding and Extrusion, Reinforced and Filled Poly (Phenylene Sulfide) (PPS) Injection, using ASTM Methods.

(Copies of these documents are available online at <http://www.astm.org> or from the ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

MIL-DTL-28748D
w/AMENDMENT 1

ELECTRONIC COMPONENT INDUSTRY ASSOCIATION (ECIA)

- EIA-364-11 - Connectors , Electrical, Resistance to Solvents, Test Procedure For.
- EIA-364-20 - Connectors, Sockets, and Coaxial Contacts, Electrical, Withstanding Voltage Test Procedure For.
- EIA/ECA-364-21 - Insulation Resistance Test Procedure For Electrical Connectors, Sockets, and Coaxial Contacts.
- EIA-364-23 - Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets.
- EIA-364-25 - Probe Damage Test Procedure for Electrical Connectors.
- EIA/ECA-364-26 - Electrical Connectors, Contacts and Sockets, Salt Spray Test Procedure For.
- EIA-364-27 - Connectors, Electrical, Mechanical Shock (Specified Pulse) Test Procedure For.
- EIA-364-28 - Connectors and Sockets, Electrical, Vibration, Test Procedure For.
- EIA-364-31 - Connectors and Sockets, Electrical, Humidity Test, Procedure For.
- EIA-364-32 - Connectors and Sockets, Electrical, Thermal Shock (Temperature Cycling) Test Procedure For.
- EIA-364-56 - Connectors, Electrical, Soldering Heat Test Procedure For, Resistance To.

(Copies of these documents are available online at <http://www.eciaonline.org> or from the Electronic Component Industry Association, 1111 Alderman Drive, Suite 400, Alpharetta, GA 30005-4175.)

TECHAMERICA

- EIA-557 - Statistical Process Control Systems.

(Copies of these documents are available online at <http://www.techamerica.org> or from the TechAmerica, 601 Pennsylvania Avenue, NW, North Building, Suite 600, Washington, DC 20004.)

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

- J-STD-004 - Requirements for Soldering Fluxes.
- J-STD-006 - Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications.

(Copies of these documents are available online at <http://www.ipc.org> or from the IPC - Association Connecting Electronics Industries, 3000 Lakeside Drive, Suite 309 S, Bannockburn, IL 60015-1249.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO-10012-1 - Equipment, Quality Assurance Requirements for Measuring.

(Copies of these documents are available online at <http://www.iso.ch> or from the International Organization for Standardization American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.)

NCSL INTERNATIONAL

- NCSL Z540.3 - Calibration of Measuring and Test Equipment, Requirements For.

(Copies of these documents are available online at <http://www.ncsli.org> or from NCSL International, 2995 Wilderness Place, Suite 107 Boulder, Colorado 80301-5404)

MIL-DTL-28748D
w/AMENDMENT 1

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AS22759	- Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy.
SAE AS39029	- Contacts, Electrical Connector, General Specification.
SAE AS39029/34	- Contacts, Electrical Connector, Pin, Crimp Removal, (MIL-DTL-28748/3 and MIL-DTL-28748/35 Connectors).
SAE AS39029/35	- Contacts, Electrical Connector, Socket, Crimp Removal, (MIL-DTL-28748/4 and MIL-DTL-29748/14 Connectors).
SAE AS39029/36	- Contacts, Electrical Connector, Pin, Crimp Removal, (MIL-DTL-28748/9 Connectors).
SAE AS39029/37	- Contacts, Electrical Connector, Socket, Crimp Removal, (MIL-DTL-8748/10 Connectors).
SAE AMS2700	- Passivation Treatments for Corrosion-Resist Steel.
SAE AMS4016	- Aluminum Alloy, Sheet and Plate 2.5Mg-0.25Cr (5052-H32) Strain Hardened, Quarter-Hard, and Stabilized.
SAE AMS-QQ-N-290	- Nickel Plating (Electrodeposited).
SAE AMS-QQ-P-416	- Plating, Cadmium (Electrodeposited).
SAE AMS-P-81728	- Plating, Tin-Lead (Electrodeposited).

(Copies of these documents are available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Quality.

3.2.1 Qualification. Connectors furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.5 and 6.3).

3.3 Materials. Example reference materials are identified herein. However, when an example reference material is not identified, a material shall be used which will enable the connectors and accessories to meet the performance requirements of this specification. Acceptance or approval of a constituent material shall not be construed as a guaranty of acceptance of the finished product.

MIL-DTL-28748D
w/AMENDMENT 1

3.3.1 Reference materials, plating, and processes. The identified reference material, plating, and processes have been established to provide assurances that connectors manufactured to this specification will properly interface to similar industry standard or government specified connector systems without problems of electrochemical contamination of critical electrical or mechanical interfaces or generation of incompatible mechanical interface surface wear products. The manufacturer of connectors supplied to this specification are allowed to use alternate recognized industry standard materials, plating, and processes from those identified in 3.3 of this specification. Alternate materials, plating and processes used must be coordinated with the qualifying activity as part of the qualification process. Use of alternates to those referenced guidance items by the supplier must not result in inferior short or long term performance or reliability of supplied connectors as compared with connectors manufactured using the referenced materials, plating, or processes. Short or long term failures or reliability problems due to use of these alternates shall be the responsibility of the supplier.

3.3.2 Nonmagnetic materials. All parts shall be made from materials which are classified as nonmagnetic.

3.3.3 Metals and finishes. All exposed metal parts, other than electrical contacts, shall be manufactured with a corrosion-resistant material or finished to resist corrosion. Noncorrosion-resisting metal parts shall be cadmium plated in accordance with SAE AMS-QQ-P-416, type II, class 1 or class 2, or zinc plated in accordance with ASTM B633, type II, SC 3 or SC 4, except that a preliminary plating of other metal is permissible. Aluminum alloy parts shall be anodized in accordance with MIL-A-8625, type I or II. Corrosion resistance steel parts shall be passivated in accordance with SAE AMS2700. Unless otherwise specified (see 3.3.1), all finishes shall be conductive, except anodized parts.

3.3.3.1 Dissimilar metals. When dissimilar metals (as defined in MIL-STD-889) are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. The use of dissimilar metals which, in contact, tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum and aluminum alloy) is not acceptable (see 3.3).

3.3.3.2 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle cost.

3.3.3.3 Pure tin. The use of pure tin is prohibited. Tin content used in connector materials shall not exceed 97 percent, and an alloy material shall be chosen to inhibit the growth of tin whiskers (see 6.4)

3.3.4 Insert material. Insert material shall be diallyl phthalate conforming to ASTM D5948, type SDG-F, GDI-30F, GII-30F, or SIG-F, or thermoplastic polyphenylene sulfide compound conforming to ASTM D4067, type GST-40F (see 3.3.1).

3.3.5 Solder type contacts. Solder type contacts shall of the nonremovable type (see 3.4.2.2). Materials shall be in accordance with ASTM B36/B36M, ASTM B121/B121M, ASTM B16/B16M, ASTM B122/B122M (C72500), ASTM B139/B139M, ASTM B194, ASTM B196/B196M, or ASTM B197/B197M. Crimp type contacts shall conform to SAE AS39029. Manufacturers who are using crimp type contacts which are qualified, do not have to measure finish thickness specified in 4.7.19.1 and 4.7.19.2, or to perform the industrial gas test specified in 4.7.20.

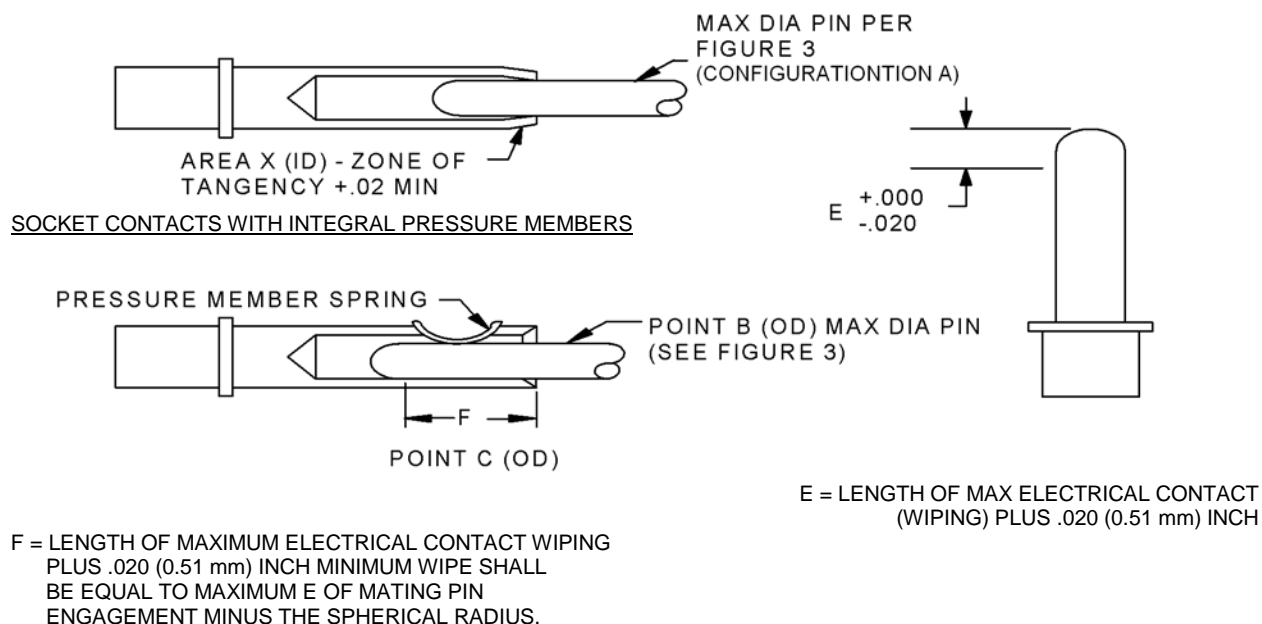
3.3.5.1 Contact retaining clip. The contact retaining clip shall be of a material which will assure compliance with the contact retention requirements (see 3.5.4). Plastic contact retaining clips shall not be used.

MIL-DTL-28748D
w/AMENDMENT 13.3.5.2 Contact finish (solder type).

3.3.5.2.1 Overall finish (solder type). All parts of the contact shall be gold-plated in accordance with ASTM B488, type 2, code C, $1.25\ \mu\text{m}$ for the socket spring and $0.50\ \mu\text{m}$ for the socket sleeve. Finish for pin and socket contacts shall be over a nickel underplate, .000030 to .000150 inch thick ($1.27\ \mu\text{m}$ to $3.01\ \mu\text{m}$) in accordance with SAE AMS-QQ-N-290. Silver shall not be used as an underplate.

3.3.5.2.2 Localized finish.

3.3.5.2.2.1 Contact mating area. The contact mating area shall be overall in accordance with ASTM B488 type 2, code C, $1.27\ \mu\text{m}$, over a nickel underplate .000050 to .000150 inch thick, ($1.27\ \mu\text{m}$ to $3.81\ \mu\text{m}$) in accordance with SAE AMS-QQ-N-290. The contact mating area is as specified on [figure 1](#).

SOCKET CONTACTS WITH SEPARATE PRESSURE MEMBERSFIGURE 1. Areas of application of localized finish.

3.3.5.2.2.2 Terminations. Terminations shall be gold in accordance with ASTM B488, type 2, code C, $1.27\ \mu\text{m}$, class 1, over a nickel underplate in accordance with SAE AMS-QQ-N-290, class 2, .000050 to .000150 ($1.27\ \mu\text{m}$ to $3.81\ \mu\text{m}$) inch thick or tin-lead in accordance with SAE AMS-P-81728, .0001 inch minimum thickness ($2.54\ \mu\text{m}$).

3.3.5.2.2.3 Nonfunctional areas (crimp and solder contacts). Any portion of the contact other than the contact mating area or termination area shall have a nickel plating in accordance with SAE AMS-QQ-N-290, .000050 to .000150 inch thick ($1.27\ \mu\text{m}$ to $3.81\ \mu\text{m}$).

3.3.6 Protective shells, connector shields and accessories. Unless otherwise specified, protective shells, connector shields, and other accessories shall be made of a high grade aluminum alloy conforming to SAE AMS4016, temper H-32 or corrosion-resistant steel conforming to ASTM A276, ASTM A582/A582M, series 300 (nonmagnetic), 420 or other material satisfactory to the Government. There shall be no assembly of protective shells, connector shields or other accessories made of different materials than specified herein.

MIL-DTL-28748D
w/AMENDMENT 1

3.3.7 Connector assembly. No parts of the connector assembly shall be permanently displaced from their original, normal fitted position at completion of the specified test (see 3.1).

3.4 Connector interface and physical construction. Connectors shall be of the interface and physical construction specified (see 3.1). The removable contact connector is intended to permit individual insertion and removal of the contacts with the insertion and removal tools specified in 3.4.6. Wire conductors shall be attached to the contacts by crimping with the crimp tools specified in table II for removable contacts and soldered for nonremovable contacts.

3.4.1 Insert interface. Inserts shall be of one-piece construction and shall be such that they will not crack, chip, or break in normal service or assembly. Inserts glued or bonded together shall not be used. The insert dimensions shall be as specified (see 3.1). The insert hole configuration for the removable contacts shall conform to the dimensions shown on figure 2. Removable contacts, when assembled, shall be recessed a minimum of 0.010 inch (0.25 mm) below the rear face of the insert.

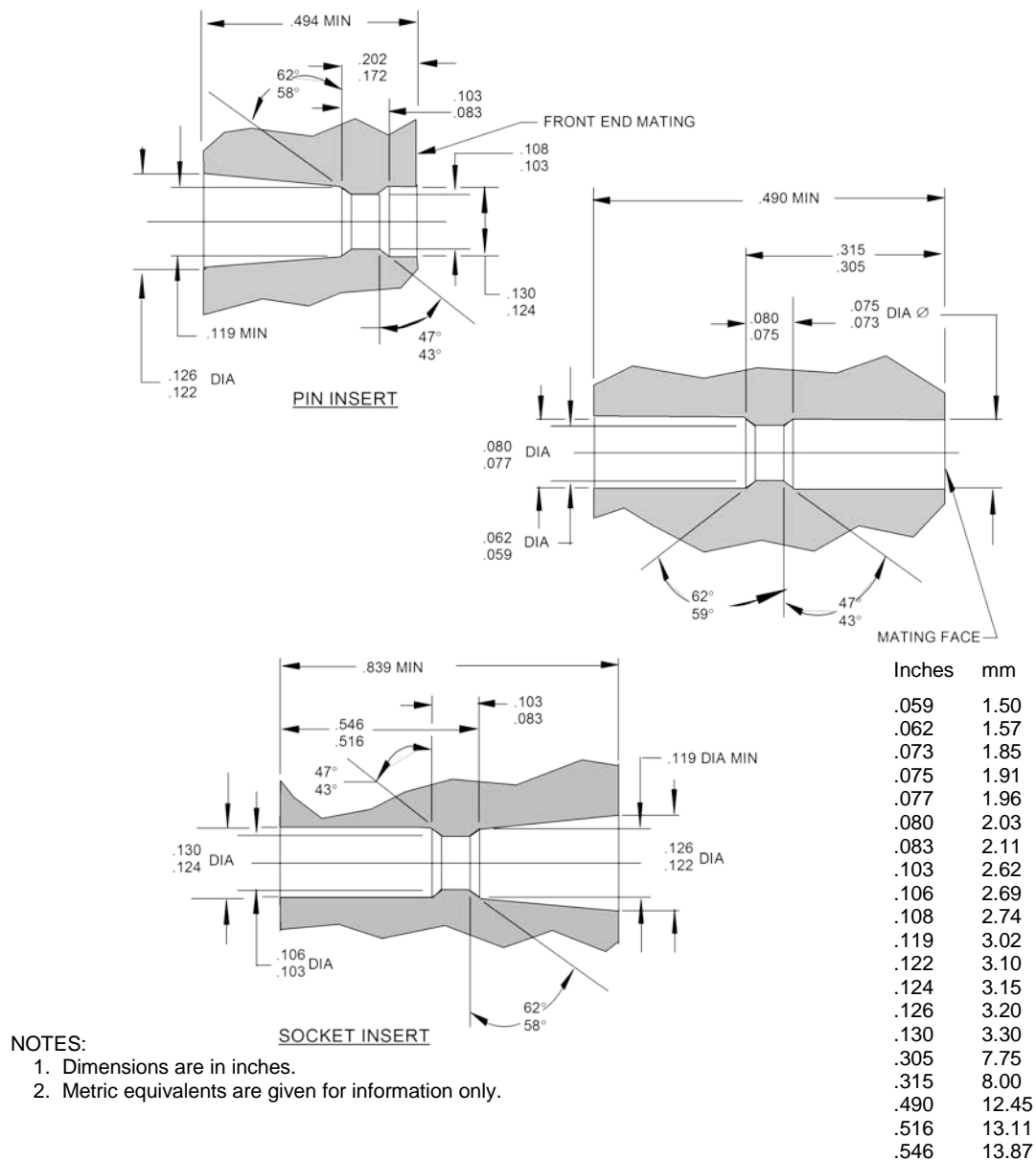


FIGURE 2. Insert hole configuration.

MIL-DTL-28748D
w/AMENDMENT 1

3.4.2 Contacts.

3.4.2.1 Removable contacts. Removable contacts shall be qualified to SAE AS39029. For shipments to the original equipment manufacturers (OEM), or other suppliers, crimp contact connectors may be supplied without contacts (see 3.6 and 6.2).

3.4.2.1.1 Pin contacts. Pin contacts shall be in accordance with SAE AS39029/34 and SAE AS39029/36.

3.4.2.1.2 Socket contacts. Sockets contacts shall be in accordance with SAE AS39029/35 and SAE AS39029/37.

3.4.2.1.3 Contact retaining clip. The contact retaining clip is furnished as part of the contact, assembled in the location shown on SAE AS39029/34, SAE AS39029/35, SAE AS39029/36, and SAE AS39029/37. The design of the clip shall be designed to allow the contacts of being inserted and removed by the tools shown on MIL-I-81969/18 and MIL-I-81969/20.

3.4.2.2 Nonremovable contacts. Nonremovable contact dimensions shall be as shown on [figure 3](#) and shall meet the applicable requirements of this specification.

3.4.2.2.1 Contact pin. The contact pin shall be of the round pin type with a 60-degree included angle (conical tip configuration), allowing for a flat end not in excess of .015 inch (0.38 mm) in diameter for size 20 or larger and .008 inch (0.20 mm) for smaller.

3.4.2.2.2 Socket contact. The socket contact shall have a circular cross-section and shall be machined. The entering end of the socket contact shall be rounded or chamfered to allow for directing and centering of the entering pin. The socket contact shall provide the spring action for maintaining the contact pressure between the pin and socket. The contact shall be of the closed entry design to exclude the entrance of a pin .005 inch (0.13 mm) larger than the allowable maximum diameter of the mating pin.

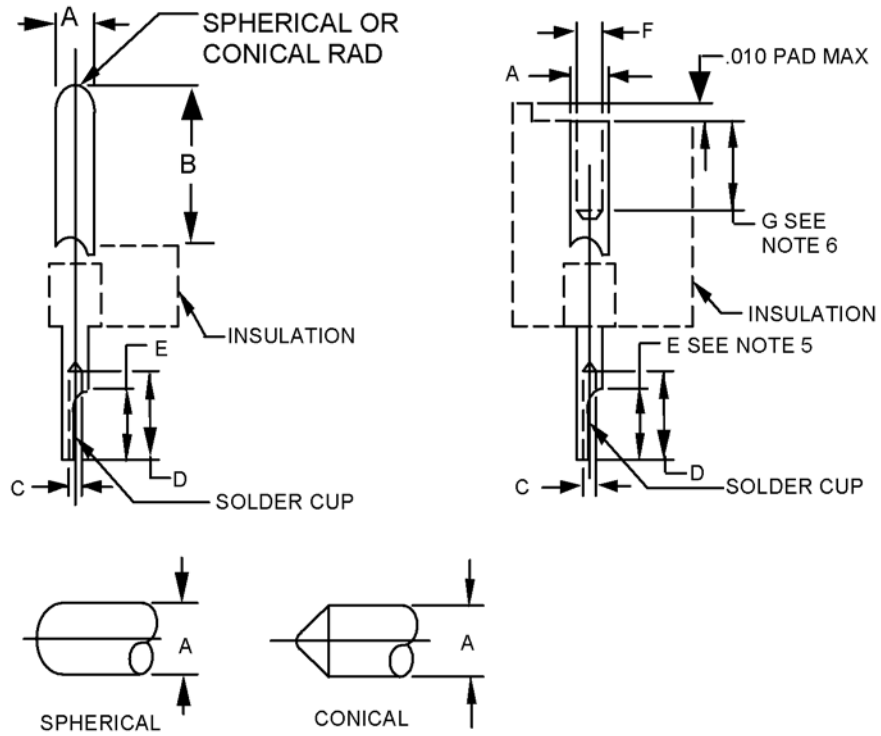
3.4.2.2.3 Tinning solder cups. Where pretinned solder cups are required, the interior surface of solder cups shall be completely tinned over 100 percent of the full circle portion and for at least 50 percent of the remainder of the solder well area with solder conforming to composition Sn60 of J-STD-004. Only fluxes meeting J-STD-006, shall be used, any excess of which shall be removed. Solder cup terminals shall be so constructed that liquid solder cannot leak through to the front of the socket and prevent insertion of the pin contact. No excess solder shall be on the exterior of the solder cup.

3.4.2.3 Electrical characteristics. Contacts shall have the electrical characteristics as specified in [table 1](#).

TABLE I. Current rating.

Contact	Wire size (AWG)	Amperes (max)
Solder		
16	16	13
20	20	7.5
22	22	5.0
Crimp		
16-16	16	13
16-16	18	10
16-16	20	7.5
16-20	20	7.5
16-20	22	5.0
16-20	24	3.0
20-20	20	7.5
20-20	22	5.0
20-20	24	3.0

MIL-DTL-28748D
w/AMENDMENT 1



Dimensions				
Contact size	A dia (mm)	B ±.015 (0.38 mm)	C min dia (mm)	D min (mm)
22	.030 ±.0005 (0.76 ±.01)	.145 (3.68)	.034 (0.86)	.065 (1.65)
20	.040 ±.001 (1.02 ±.03)	.203 (5.16)	.043 (1.09)	.115 (2.92)
16	.0625 ±.001 (1.58 ±.03)	.223 (5.66)	.069 (1.75)	.115 (2.92)

Configuration A - Pin

FIGURE 3. Contact assembly dimensions for nonremovable contacts.

MIL-DTL-28748D
w/AMENDMENT 1

Dimensions					
Contact size	A dia (mm)	C min dia (mm)	D min (mm)	F min dia (mm)	G min (mm)
22	.066 (1.68) .055 (1.40)	.034 (0.86)	.065 (1.65)	.032 (0.81)	.170 (4.31)
20	.072 (1.83) .064 (1.63)	.043 (1.09)	.115 (2.92)	.0415 (1.054)	.290 (7.37)
16	.106 (2.69) .099 (2.51)	.069 (1.75)	.115 (2.92)	.064 (1.63)	.290 (7.37)

Configuration B - Socket

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Wall thickness shall be .005 min (0.13 mm) at any point.
4. Dimensions are for finished parts after plating.
5. E is 50-75% of D.
6. Minimum bore depth of socket from connector mating surface.

FIGURE 3. Contact assembly dimensions for nonremovable contacts - Continued.

3.4.2.4 Contact identification and arrangement. The contact identification and arrangement shall be as specified (see 3.1). Letters or numerals shall be raised and clearly legible or shall appear in legible contrasting colors. Letters or numerals shall be arranged to avoid confusion between contacts. All letters or numerals shall appear on the front and rear faces of each insert. Lettering of the socket insert shall correspond with that of the mating pin insert.

3.4.3 Polarization. Polarization of the plug with its receptacle shall be accomplished by mechanical means such as the shells, protective shell, bosses, guide pins, guide sockets, or jackscrews. Jackscrews and center jackscrew types shall conform as specified in the specification sheets, as applicable. Guidepins shall conform as specified in the specification sheets. Where jackscrews and jack sockets are required, lubrication is optional.

3.4.4 Mating. Unless otherwise specified, connector plugs and receptacles shall be capable of being mated and unmated by hand without the aid of special tools (see 3.1).

3.4.5 Protective shell. The protective shell design shall be in accordance with the applicable military standard listed on the supplement to this specification (see 3.1).

3.4.6 Insertion and removal tools. Insertion and removal tools are used for easy assembly and disassembly of pin and socket contact and permitted connectors to meet the performance requirements of this specification. Installing tools shall be in accordance with MIL-I-81969/18, and removal tools shall be in accordance with MIL-I-81969/20.

MIL-DTL-28748D
w/AMENDMENT 1

3.4.7 Crimping tools. Crimping tools are specified in [table II](#).

TABLE II. Crimping tools

Contacts	Applicable tool	
	Basic tool	Positioner
SAE AS39029/34 SAE AS39029/35 SAE AS39029/36 SAE AS39029/37	M22520/1-01 M22520/1-01 M22520/1-01 M22520/1-01	M22520/1-03 M22520/1-03 M22520/1-03 M22520/1-03
SAE AS39029/34 SAE AS39029/35	M22520/2-01 M22520/2-01	Buchanan 614412, Daniels K187 or equivalent Buchanan 615695, Daniels K280 or equivalent

3.4.8 Operating temperature. The connectors shall be suitable for operation throughout a temperature range of -55°C to +125°C.

3.4.9 Assembly. For shipments to the OEM or suppliers, connectors may be shipped unassembled. For shipments directly to the Government, all connectors shall be assembled except for the removable contacts.

3.5 Performance. Connectors shall be designed to meet the performance requirements specified herein.

3.5.1 Magnetic permeability. The relative permeability of the connector assembly or shield shall be less than 2.0 μ (see [4.7.3](#)).

3.5.2 Insulation resistance. When the connectors are tested as specified in [4.7.4](#), the insulation resistance shall be not less than 5,000 megohms.

3.5.3 Dielectric withstanding voltage. When tested as specified in [4.7.5](#), connectors shall withstand the test voltage as specified in [table III](#) without flashover.

TABLE III. Test voltages for dielectric withstanding voltage requirement.

Contact size	Test voltage, 60 Hz rms (sea level)	
	Initial volts	After conditioning volts
Solder		
22	1,000	500
20	1,200	600
16	1,000	500
Crimp		
22-22	1,000	500
16-20	2,000	1,000
16-16	2,000	1,000

3.5.4 Contact retention. When tested as specified in [4.7.6](#), individual contacts shall withstand an axial load as shown in [table IV](#) without damage to the contact, insert, or contact retaining clip, if applicable.

MIL-DTL-28748D
w/AMENDMENT 1TABLE IV. Contact retention.

Mating end size	Pounds
22	6
20	10
16	20

3.5.5 Contact insertion and removal forces (removable contacts only). When tested as specified in 4.7.7, the axial forces required to insert and remove removable contacts shall not exceed 15 lbf (67 N).

3.5.6 Temperature cycling. When the connectors are tested as specified in 4.7.8, there shall be no evidence of physical damage. Following temperature cycling, the dielectric withstanding voltage shall meet the requirements of 3.5.3.

3.5.7 Humidity. When the connectors are tested as specified in 4.7.9, the insulation resistance shall be not less than 100 megohms and the dielectric withstanding voltage shall meet the requirements of 3.5.3.

3.5.8 Vibration. When the complete connector assembly, wired with the appropriate size wire, is tested as specified in 4.7.10, there shall be no cracking, breaking, or loosening of parts. There shall be no loss of electrical continuity of any contact circuits of more than 1 microsecond with 100 milliamperes minimum flowing in each contact circuit. After vibration test, the connector assembly shall show no signs of loosening, fracture, or other deterioration (see 3.3.7).

3.5.9 Shock (specified pulse). When tested as specified in 4.7.11, there shall be no evidence of failure of metallic or dielectric materials, nor shall the mated portions of the connector become disengaged. There shall be no loss of electrical continuity of any of the contact circuits of more than 1 microsecond with 100 milliamperes minimum flowing in each contact circuit.

3.5.10 Insertion and withdrawal force (connector assembly). When tested as specified in 4.7.12, the force required to engage or separate any pair of mated connectors (plug and receptacle) shall not exceed 1 pound times the number of contacts specified on the applicable specification sheet or military standard (see 3.1).

3.5.11 Durability. When connector assemblies are tested as specified in 4.7.13, there shall be no evidence of electrical or mechanical damage that impairs the normal operation of the connector.

3.5.12 Contact resistance. When contacts in the mated condition are tested as specified in 4.7.14, the contact resistance shall be as specified in table V.

TABLE V. Contact resistance.

Contact size	Test current amperes (max)	Initial volts (max)	After conditioning volts (max)
22	5.0	.060	.070
20	7.5	.055	.065
16	13.0	.050	.060

3.5.13 Salt spray (corrosion).

3.5.13.1 Connectors. When connectors are tested as specified in 4.7.15, there shall not be sufficient corrosion to interfere with mating or unmating the connectors. Following the salt spray test, the dielectric withstanding voltage shall meet the requirements of the conditioning values specified in table III. Contact resistance shall not exceed the requirements in table V.

MIL-DTL-28748D
w/AMENDMENT 1

3.5.13.2 Nonremovable contacts. When nonremovable contacts are tested as specified in 4.7.15, any corrosive products resulting therefrom shall not cause exposure of base metal on the sets of pin and socket contacts.

3.5.14 Low level circuit (for nonremovable contacts). When tested as specified in 4.7.16, the values of contact resistance shall not exceed the potential drop in table VI.

TABLE VI. Low level circuit.

Wire size awg	Initial contact resistance (max)(ohms) ^{1/}	Initial potential drop (max) (volts)	After conditioning resistance (max)(ohms) ^{1/}	After conditioning voltage (max) (volts)
16	5 mΩ	5 μV	60 mΩ	6 μV
20	9 mΩ	9 μV	11 mΩ	11 μV
22	15 mΩ	15 μV	17 mΩ	17 μV

^{1/} Test current shall be .001 amperes.

3.5.15 Resistance to test probe damage (for nonremovable contacts). When tested as specified in 4.7.17, socket contacts shall withstand the bending moment and depth of test probe insertion without evidence of visible damage. In addition, socket contacts shall meet the requirements of 3.5.16.

3.5.16 Contact separating forces (nonremovable contacts). When socket contacts are tested as specified in 4.7.18, the forces required to withdraw the pins shall be in accordance with table VII.

TABLE VII. Contact separating forces. ^{1/}

Contact size	Maximum force ounces (Newton)	Minimum force ounces (Newton)
22	9.0 (2.50)	0.5 (0.14)
20	16.0 (4.45)	0.75 (0.21)
16	20.0 (5.56)	2.0 (0.56)

^{1/} Metric equivalents are given for information only.

3.5.17 Industrial gas. When tested as specified in 4.7.20, unmated contacts shall withstand industrial gas conditioning for 100 hours and show no evidence of damage that would interfere with the mechanical or electrical performance.

3.5.18 Solderability. Solderable, nonremovable contact terminations shall withstand the test specified in 4.7.21, unless solder cup terminations are specified. For solder cup terminations, individual contacts may be removed from the insulator or an alternate method using a hand iron may be used on the contacts in an assembled (non-removed) configuration.

3.5.19 Resistance to soldering heat. When tested in accordance with 4.7.22, the connectors shall be visually inspected and shall show no evidence of distortion or physical damage and shall meet the contact retention requirements of 3.5.4 and dimensional requirements of 3.3.5.

3.5.20 Resistance to solvents. When tested in accordance with 4.7.23, the connectors shall be visually inspected and shall show no evidence of cracking, crazing, discoloration, distortion or bleeding out of any foreign matter from the material. Pitting shall not be allowed. The marking and color coding shall be legible.

MIL-DTL-28748D
w/AMENDMENT 1

3.5.21 Contact pin strength. Contact pin strength shall be tested in accordance with 4.7.24, with the forces specified in table VIII. The force shall not produce a permanent set in excess of .005 inch (0.13 mm).

TABLE VIII. Contact pin strength. 1/

Mating end (contact size)	Moment lb-in. (Newton)
16	2.00 (8.90)
20	.53 (2.36)
22	.22 (0.98)

1/ Metric equivalents are given for information only.

3.6 Marking. Connectors and shields are to be marked in accordance with method I of MIL-STD-1285, and are to include the Part or Identifying Number (PIN)(see 3.1), the manufacturer's name or code symbol, and date code. For shipments of connectors with crimp removable contacts, shipped separately, to the OEM or other contractors, the complete military PIN of the connector with contacts to be loaded, shall be marked on the connector (see 3.4.2.1 and 6.2). For shipments of connectors without contacts to the OEM's or other contractors, the connector shall be marked with the complete military PIN of the connector "without contacts" (1L designation). For field replacement purposes, the contact types used shall be specified in the OEM's technical data.

3.7 Workmanship. Connectors, contacts, shields, jackscrews, and guide pins shall be processed in such a manner as to be uniform in quality and shall be free from defects that will affect life, serviceability or appearance. There shall be no evidence of poor molding, fabricating, cracking of insulator after molding or improperly assembled contacts, peeling or chipping of the plating or finish, nicks and burrs of metal parts surfaces, and no post molding warpage of connectors. The contacts shall be free from such burrs or sharp corners that would damage the plating of mating connectors.

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (see 4.4.4).
- c. Quality conformance inspection (see 4.5).

4.2 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.2.1 Verification testing. The following identified tests and test methods assure socket integrity within typical operating conditions and applications. Alternate commercial industry standard test methods are allowed, however when an alternate method is used, the alternate method must be coordinated with the qualifying activity prior to performance of the test. The test methods described herein are proven methods and shall be the referee method in cases of dispute.

4.2.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy qualify and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment (i.e. NCSL Z540.3, ISO 10012-1, or comparable standards) shall be required.

MIL-DTL-28748D
w/AMENDMENT 1

4.2.3 Responsibility for compliance. All items shall meet all requirements of sections 3 and 4. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2.4 Assembly distributor. Assembly distributors must be listed on, or approved for listing on, the applicable qualified products list. The qualified connector manufacturer shall certify that the assembly distributor is approved for the distribution of the manufacturer's parts. The assembly distributor shall use only piece parts supplied by the qualified connector manufacturer. No testing other than visual examination is required of certified piece parts obtained from the qualified connector manufacturer, except when there is cause for rejection. All assemblies produced at the assembly distributor's plant shall be subjected to examination of product to assure that the assembly process conforms with that established at the qualified manufacturing plant. Quality control requirements, including Government inspection surveillance, shall be the same as required for the qualified connector manufacturer.

4.2.5 Statistical process control (SPC). A SPC program shall be established and maintained in accordance with EIA-557. Evidence of such compliance shall be verified by the qualifying activity as a prerequisite for qualification and retention of qualification.

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials, as specified in 3.3 and on the specification sheets (see 3.1), used in fabricating the connectors, are in accordance with the applicable referenced specifications or performance requirements prior to such fabrication (see 3.5, 4.7.2, and 6.2).

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production. Use of alternate materials, plating, and processes shall be identified for inclusion in the product test documentation (see 3.3.1).

4.4.1 Preparation of samples.

4.4.1.1 Contacts. Preparation of samples; SAE AS39029/34, SAE AS39029/35, SAE AS39029/36, and SAE AS39029/37 contacts shall be wired using wire conforming to SAE AS22759.

4.4.1.2 Shields (if applicable). Shields shall be assembled.

4.4.1.3 Connectors. Completely assembled plugs or receptacles, complete with guide pins, jackscrews, back-up plates, contacts, and shields (if applicable) shall be subjected to qualification inspection as follows.

4.4.1.3.1 Connectors with nonremovable or removable contacts. The completely assembled plugs and receptacles (six each for crimp terminations and eight for non-removable contacts), with the insert arrangement of the largest size connector in accordance with the applicable military specification sheet, and two each completely assembled plugs and receptacles for all other connector sizes for which qualification is desired shall be submitted.

4.4.1.3.2 Nonremovable contacts. Forty sets of pin and socket contacts shall be subjected to qualification inspection.

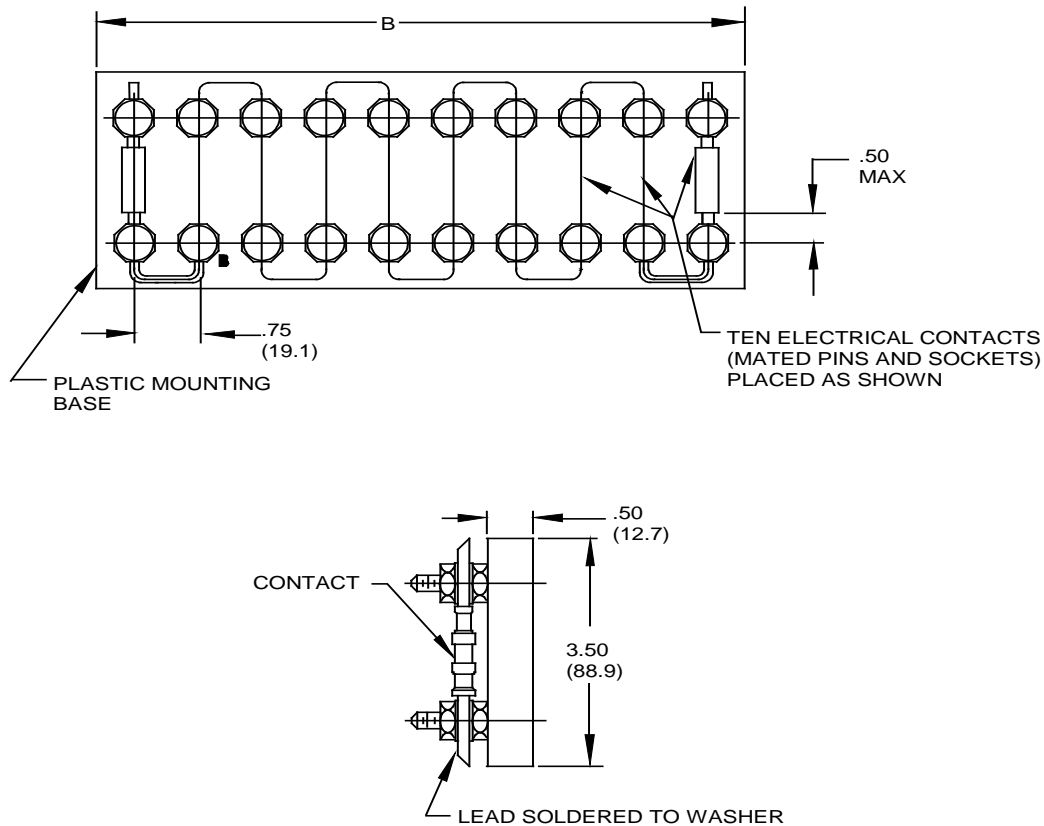
4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in tables IX and X, as applicable, in the order shown.

MIL-DTL-28748D
w/AMENDMENT 1

4.4.2.1 Connectors. The six mating connector assemblies (for crimp contact terminations) or eight mating connector assemblies (for nonremovable contacts), shall be divided equally into three groups (for crimp terminations) or four groups (for nonremovable contacts) of two units each for groups I, II, III, and V (group V is for solder terminations only) tests in [table IX](#). Any two additional mating connector assemblies shall be designated as group IV sample units in [table IX](#).

4.4.2.2 Nonremovable contacts. The sample shall be divided equally into two groups of 20 units each for groups I and II in [table IX](#) and subjected to the inspection for their particular group. For salt spray test, 10 sets of contacts shall be unwired and unmated and 10 sets shall be mounted as shown on [figure 4](#).

4.4.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Metric equivalents are in parenthesis.

FIGURE 4. Test fixture for salt spray test.

MIL-DTL-28748D
w/AMENDMENT 1TABLE IX. Qualification inspection - connectors.

Number of sample units	Requirement paragraph	Test method paragraph	Number of sample units to be inspected					Condition
			Groups					
			I	II	III	IV	V	
			2	2	2	2	2	
Examination of product	3.3, 3.4, 3.5, 3.6, and 3.7	4.7.2	X	X	X	X	X	All Connectors
Permeability	3.5.1	4.7.3	X	X	X	X	X	Mated or unmated
Insulation resistance	3.5.2	4.7.4	X	X	X	X	X	Mated
Dielectric withstanding voltage	3.5.3	4.7.5	X	X	X	X	X	Unmated
Contact retention	3.5.4	4.7.6		X			X 1/	Unmated
Contact insertion and removal forces	3.5.5	4.7.7	X					Unmated
Temperature cycling	3.5.6	4.7.8	X					Mated
Dielectric withstanding voltage	3.5.3	4.7.5	X					Unmated
Humidity	3.5.7	4.7.9		X		X		Unmated
Insulation resistance	3.5.2	4.7.4		X		X		Unmated
Dielectric withstanding voltage	3.5.3	4.7.5		X		X		Unmated
Vibration	3.5.8	4.7.10	X			X 2/		Mated
Shock (specified pulse)	3.5.9	4.7.11	X			X 2/		Mated
Insertion and withdrawal force (connector assembly)	3.5.10	4.7.12	X					Mated or unmated
Durability	3.5.11	4.7.13	X					Mated or unmated
Contact resistance	3.5.12	4.7.14	X					Mated
Salt spray (corrosion)	3.5.13	4.7.15			X			Unmated
Dielectric withstanding voltage	3.5.3	4.7.5			X			Mated
Solderability	3.5.18	4.7.21					X 3/	Unmated
Resistance to soldering heat	3.5.19	4.7.22					X 3/	Unmated
Resistance to solvents	3.5.20	4.7.23	X				X	Unmated

1/ This inspection is to be performed after "solderability" and "resistance to soldering heat".

2/ Need not be monitored for electrical continuity during test.

3/ Applicable for solder type termination connectors only.

MIL-DTL-28748D
w/AMENDMENT 1TABLE X. Qualification inspection - nonremovable contacts.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected
<u>Group I</u>			
Examination of product	3.7	4.7.2	20 ^{1/}
Salt spray (corrosion)	3.5.13.2	4.7.15	
Examination of product	3.7	4.7.2	
Low level circuit	3.5.14	4.7.16	
<u>Group II</u>			
Examination of product	3.7	4.7.2	20
Resistance to test probe damage	3.5.15	4.7.17	
Contact separating forces	3.5.16	4.7.18	
Contact pin strength	3.5.21	4.7.24	
Industrial gas	3.5.17	4.7.20	

^{1/} For salt spray test, 10 sets of contacts shall be unwired and unmated, and 10 sets shall be specified on [figure 4](#).

4.4.4 Verification of qualification. To retain qualification, the contractor shall verify in coordination with the qualifying activity the capability of manufacturing products, which meet the performance requirements of this specification. Refer to the qualifying activity at any time that the inspection data indicates failure of the qualified product to meet the performance requirements of this specification.

4.5 Quality conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A.

4.5.1.1 Inspection lot. An inspection lot shall consist of all the connectors of the same PIN, produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.1.1 Sample size, contact measurements. A total of 13 contact positions shall be measured per sample in each subgroup. For connectors with 13 or less contacts, all positions shall be measured. This shall apply to the requirements as specified in [4.7.2](#), [4.7.5](#), [4.7.14](#), and [4.7.16](#).

4.5.1.2 Group A inspection. Group A inspection shall consist of the examination and tests specified in [table XI](#), in the order shown.

TABLE XI. Group A inspection.

Inspection	Requirement paragraph	Test paragraph
Examination of product	3.3, 3.4, 3.6, and 3.7	4.7.2
Dielectric withstanding voltage	3.5.3	4.7.5
Contact separating force (contacts)	3.5.16	4.7.18

4.5.1.2.1 Sampling plan. Statistical sampling and inspection for the samples submitted for group A inspection shall be on a lot by lot basis with sample sizes as listed in . Any occurrence of a failure shall be considered as failure of the lot.

MIL-DTL-28748D
w/AMENDMENT 1TABLE XII. Lot and sample size.

Lot size	Sample size
1 to 50	5
51 to 90	7
91 to 150	11
151 to 280	13
281 to 500	16
501 to 1200	19
1201 to 3200	23
3201 to 10000	29
10001 to	35

4.5.1.2.2 Rejected lots. If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using the sample size of the next higher lot size specified in [table XII](#) and shall not thereafter be tendered for acceptance unless the former rejection or requirement of correction is disclosed. Such lots shall be clearly identified as reinspected lots.

4.5.1.2.3 Disposition of sample units. Sample units which have passed all the group A inspections may be delivered on the contract if the lot is accepted and the sample units are still within the specification tolerances.

4.5.1.3 Group B inspection. Group B inspection shall be performed every 6 months on sample units, which have passed group A inspections. Group B inspections shall consist of the examinations and tests specified in [table XIII](#), in the order shown, and the sample shall be selected from inspection lots that have passed group A inspection. Connector series may be combined for lot purposes during group B inspection and shall be in proportion to the number of connectors produced in each series.

TABLE XIII. Group B inspection.

Inspection	Requirement paragraph	Test paragraph
Examination of product	3.3 , 3.4 , 3.5 , 3.6 , and 3.7	4.7.2
Permeability	3.5.1	4.7.3
Insulation resistance	3.5.2	4.7.4
Contact retention	3.5.4	4.7.6
Insertion and withdrawal force (connector assembly)	3.5.10	4.7.12

4.5.1.3.1 Sampling plan. Four sample pairs containing the largest number of contact positions with a full complement of contacts (not including the variation in terminal types) available at time of inspection should be selected at random from items produced every 6 months. Where crimp type contacts are specified, that type shall be used in group B samples.

4.5.1.3.2 Failures. If one or more sample units fail to pass group B inspection, the sample shall be considered to have failed.

4.5.1.3.3 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.5.1.3.4 Disposition of sample units. Sample units, which have passed group B inspection, may be delivered on a contract or purchase order if the lot is accepted.

MIL-DTL-28748D
w/AMENDMENT 1

4.6 Group C inspection (periodic). Periodic inspection shall consist of a 12-month inspection and a 36-month requalification. Delivery of products, which have passed groups A and B inspections, shall not be delayed pending results of these periodic inspections. Upon passing this inspection two consecutive times, the supplier may select sample connectors every 36 months. If production of a particular PIN is not current, the periodic inspection tests shall take place at the time production is resumed. The testing shall revert to the original schedule, which is applied to a newly qualified product.

4.6.1 Group C inspection. Group C inspection shall consist of the examinations and tests specified in [table XIV](#), in the order shown. Group C inspection shall be made on sample units selected from inspection lots, which have passed the groups A and B inspection.

4.6.1.1 Sampling plan. Six mated pairs of the smallest, medium (exact middle or next higher), and largest insert for every design type. Forty sets of nonremovable pin and socket contacts shall be selected from current production after 200,000 connectors of each PIN have been produced or once every 36 months, whichever occurs first.

All sample units are to contain a proper mix of hardware for which the manufacturer has approval of sample units of each PIN of connector. The six sets of connectors shall be divided into three groups and two pairs each shall be subjected to groups I, II, and III tests in [table XIV](#). The 40 sets of nonremovable pin and socket contacts shall be divided into two groups for the tests of groups IV and V in [table XIV](#). A design type is defined as a style represented per military specification sheet. Therefore, a company qualified to two slash sheets would test six mated pairs or 12 mated pairs if qualified to four slash sheets, etc.

4.6.1.2 Noncompliance. If a sample fails to pass group C inspection, the contractor shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection, which the original sample failed, at the option of the Government). Group A and B inspections may be reinstated; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action shall be made available to the cognizant inspection activity and to the qualifying activity.

4.6.1.3 Defectives. Any failures of the samples tested in [table XIV](#), the entire lot is considered to have failed.

MIL-DTL-28748D
w/AMENDMENT 1TABLE XIV. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected
Connector			
<u>Group I</u>			
Temperature cycling	3.5.6	4.7.8	
Dielectric withstanding voltage	3.5.3	4.7.5	
Vibration	3.5.8	4.7.10	
Shock (specified pulse)	3.5.9	4.7.11	2 sets
Humidity	3.5.7	4.7.9	
Insulation resistance	3.5.2	4.7.4	
Dielectric withstanding voltage	3.5.3	4.7.5	
<u>Group II</u>			
Durability	3.5.11	4.7.13	2 sets
Contact resistance	3.5.12	4.7.14	
<u>Group III</u>			
Salt spray (corrosion)	3.5.13	4.7.15	2 sets
Dielectric withstanding voltage	3.5.3	4.7.5	
Contacts			
<u>Group IV</u>			
Contact pin strength	3.5.21	4.7.24	20 sets
Resistance to test probe damage	3.5.15	4.7.17	
<u>Group V</u>			
Salt spray (corrosion)	3.5.13	4.7.15	
Solderability	3.5.18	4.7.21	
Examination of product	3.7	4.7.2	20 sets
Low level circuit	3.5.14	4.7.16	

4.6.1.4 Disposition of sample units. Sample units, which have been subjected to group C inspection, shall not be delivered on the contract or purchase order.

4.7 Methods of inspection.

4.7.1 Test methods. The following identified tests and test methods assure connector integrity within typical operating conditions and applications. Alternate commercial industry standard methods are allowed, however when an alternate method is used, the qualifying activity must be notified prior to performance of the test. The test methods described herein are proven methods and shall be the referee method in cases of dispute.

4.7.2 Visual and mechanical examination. Connectors and associated fittings shall be examined to verify that the design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3.3, 3.4, 3.5, 3.6, and 3.7).

MIL-DTL-28748D
w/AMENDMENT 1

4.7.3 Permeability (see [3.5.1](#)). The permeability of all parts of each connector assembly shall be measured with an indicator conforming to ASTM A342/A342M.

4.7.4 Insulation resistance (see [3.5.2](#) and [figure 5](#)). Unmated connector assemblies shall be tested in accordance with test procedure EIA/ECA-364-21. The following detail shall apply: Duration of application of test voltage shall be one minute minimum.

4.7.5 Dielectric withstanding voltage (see [3.5.3](#) and [figure 5](#)). Unmated connector assemblies shall be tested in accordance with test procedure EIA-364-20. The following details shall apply:

- a. Nature of potential: AC.
- b. Magnitude of test voltage: See [table III](#).
- c. Points of application of test voltage: Between contacts alternately connected and between contacts and body.

4.7.6 Contact retention (see [3.5.4](#)).

4.7.6.1 Nonremovable contacts. Axial loads shall be applied to individual contacts in unmated connectors. The load shall be applied uniformly at a rate of one pound per second in one direction and then the other direction.

4.7.6.2 Removable contacts (see [3.5.5](#)). The contact shall be inserted and withdrawn 10 times from the same hole. The axial loads shall be applied to individual contacts in unmated connectors. The load shall be applied uniformly (in the normal removal direction) at a rate of one pound per second. The axial load must be maintained a minimum of 30 seconds. The maximum axial displacement is .015 inch (0.38 mm) after seating of the contact.

4.7.7 Contact insertion and removal forces (see [3.5.5](#)). Contacts shall be inserted and removed from the corresponding connector inserts nine times by means of tools conforming to MIL-I-81969/18 and MIL-I-81969/20. The procedures and instrumentation shall be capable of measuring the force applied parallel to the axis of the contacts. Measurements shall be taken on the first and ninth cycles.

4.7.8 Temperature cycling (see [3.5.6](#)). Mated connectors shall be tested in accordance with test procedure EIA-364-32. The following details and exception shall apply:

- a. Test condition A, except the high temperature shall be $125^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- b. Measurements after cycling: Following the temperature cycling test, dielectric withstanding voltage shall be tested as specified in [4.7.5](#).

MIL-DTL-28748D
w/AMENDMENT 1

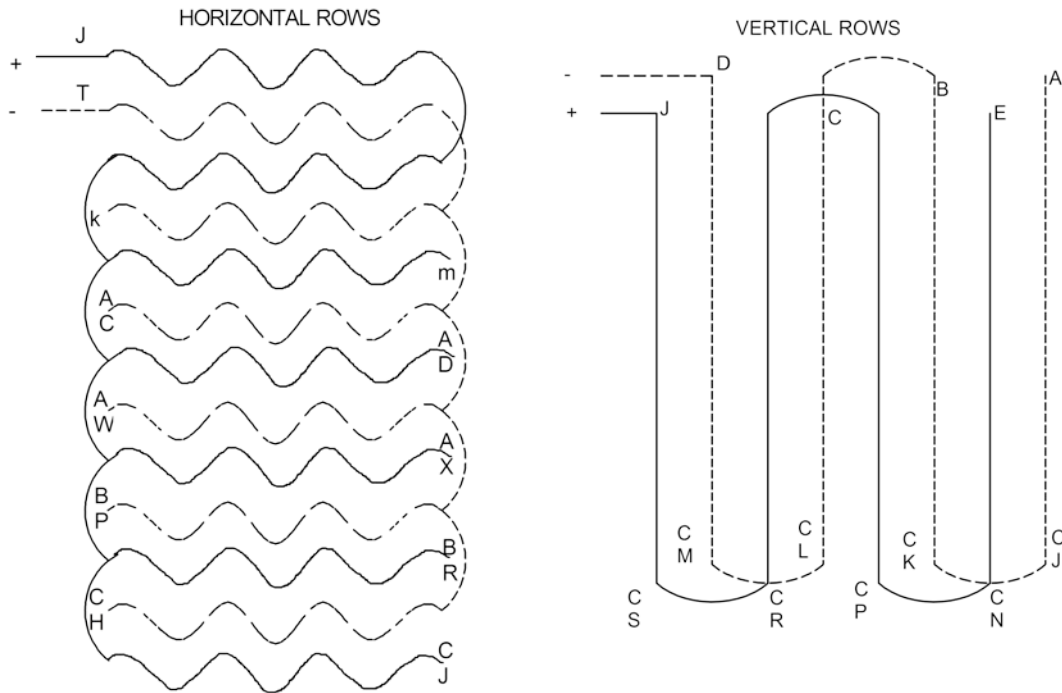
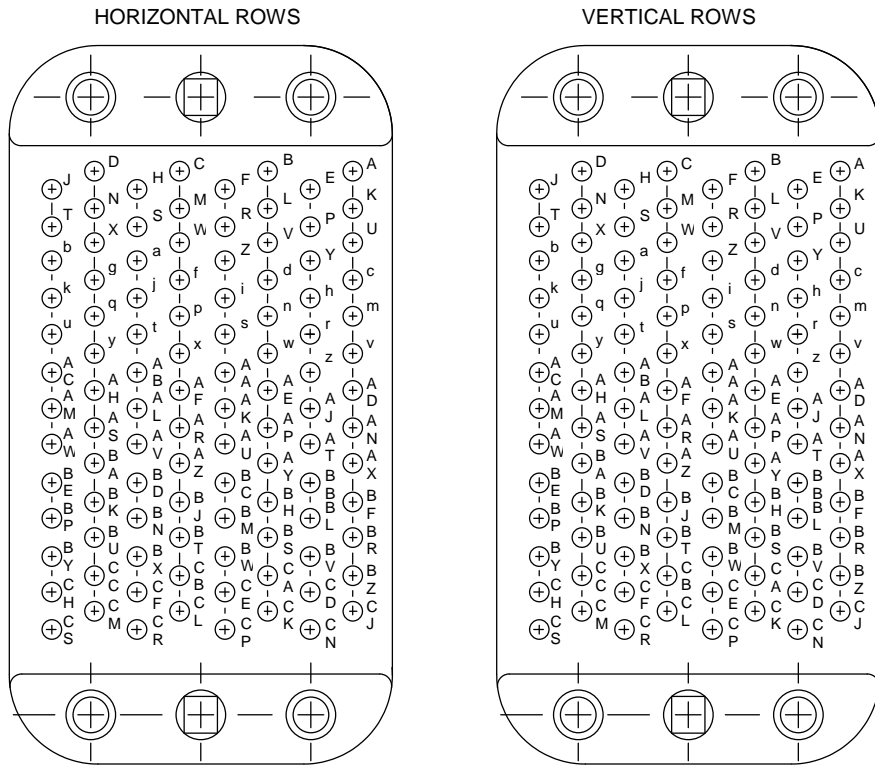


FIGURE 5. Wiring diagram, either horizontal or vertical method for insulation resistance dielectric high potential and moisture resistance tests.

MIL-DTL-28748D
w/AMENDMENT 1

4.7.9 Humidity (see [3.5.7](#) and [figure 4](#)). Unmated plugs and receptacles shall be tested in accordance with method IV, of test procedure EIA-364-31, except steps 7A and 7B are not required. The following details shall apply:

a. Initial measurements: No measurements are required after initial conditioning, nor voltage applied to connectors during exposure.

b. Final measurement: After completion of step 6 of the final cycle, but no sooner than 1-1/2 hours and not later than 3 hours while the sample is still in the chamber, insulation resistance shall be measured as specified in [4.7.4](#). Following the insulation resistance test, dielectric withstanding voltage shall be tested as specified in [4.7.5](#), except the magnitude of test voltage shall be in accordance with [table III](#) for a period of 5 minutes, applied between all contacts and the shell.

4.7.10 Vibration (see [3.5.8](#)). Complete mated connectors shall be tested in accordance with, test condition II of test procedure EIA-364-28.

a. At the conclusion of this test, the connector assembly shall be visually examined for loosening, fracture, or other deterioration (see [3.3.7](#)).

4.7.11 Shock (specified pulse) (see [3.5.9](#)). Complete mated connectors shall be tested in accordance with test procedure EIA-364-27. The following details shall apply:

a. Mounting method: In accordance with the mounting fixture in test method of test procedure EIA-364-28.

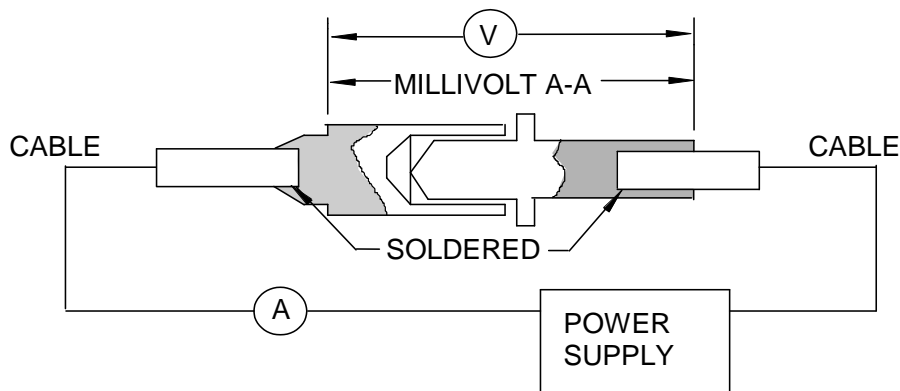
b. Test condition I.

c. Measurements: Contacts shall be monitored for electrical continuity during test and connectors shall be examined for evidence of failure of metallic or dielectric materials and engagement of the mated portions after test.

4.7.12 Insertion and withdrawal force (connector assembly) (see [3.5.10](#)). Each connector, with full complement of contacts, shall be mated and unmated. The insertion and withdrawal forces, applied gradually, shall be measured after three cycles.

4.7.13 Durability (see [3.5.11](#)). The complete connector assemblies shall be subjected to 500 cycles of insertion and withdrawal at a rate not to exceed 500 cycles per hour. Tests shall be conducted using normal engaging hardware. The insertions and withdrawals shall be accomplished in a manner similar to that which the connectors shall be subjected in service.

4.7.14 Contact resistance (see [table V](#)). The potential drop across each mated pair of pin and socket contacts shall be measured at rated current as shown in [table V](#). Potential drop readings shall be taken across the two points as shown on [figure 6 \(A-A\)](#). Measurements shall be taken after the temperature of the wire has stabilized and readings shall comply with the initial test values shown in [table V](#).

MIL-DTL-28748D
w/AMENDMENT 1FIGURE 6. Voltage drop test wiring diagram.

4.7.15 Salt spray (corrosion) (see 3.5.13). The unmated plugs and receptacles, nonremovable contacts (unwired and unmated), and nonremovable contacts mounted in accordance with figure 4 shall be tested in accordance with test procedure EIA/ECA-364-26. The following details shall apply:

a. Test condition B.

b. Measurements after exposure: Immediately after exposure, the exterior surfaces of the connectors and of the individual sets of pin and socket contacts shall be washed with tap water and the connectors and the individual sets of pin and socket contacts shall be dried for 12 hours maximum in a circulating air oven at a temperature of $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($100^{\circ}\text{F} \pm 5^{\circ}\text{F}$). Following the salt spray test, the unmated plugs and receptacles shall be subjected to the dielectric withstanding voltage test specified in 4.7.5, except the magnitude of test voltage shall be in accordance with the "after conditioning" values in table III.

4.7.16 Low level circuit (see 3.5.14). Nonremovable contacts shall be tested in accordance with test procedure EIA-364-23.

4.7.17 Resistance to test probe damage (nonremovable contacts) (see 3.5.15). Non-removable contacts shall be tested in accordance with test procedure EIA-364-25, and with the bending moment in table XV applied. The contact shall be suitably supported to prevent bending, but the support shall not reinforce the pressure member. The test probe shall consist of a hardened steel pin having a diameter equal to the nominal dimension of the mating pin contact and a spherical radius tip. The test probe shall be free and unsupported, and the socket contact shall be maintained in a horizontal position. For each specified depth, the contact shall be rotated one complete revolution at a uniform rate.

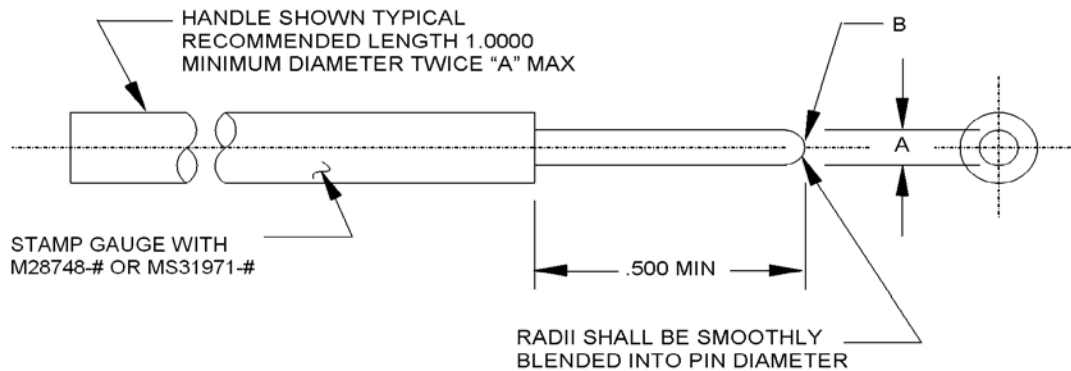
TABLE XV. Bending moment for test probe damage test. 1/

Contact size	Bend moment inch-pounds (kg)
16	2.0 (0.91)
20	0.5 (0.23)
22	0.125 (0.057)

1/ Metric equivalents are given for information only.

MIL-DTL-28748D
w/AMENDMENT 1

4.7.18 **Contact separating forces (nonremovable contacts)** (see 3.5.16). Provisions shall be made for mounting socket contacts in a suitable position for applying gradually increasing loads during withdrawal of the minimum diameter hardened test pins. The depth of engagement shall be equal to the maximum length of the pin for the mating connector. Polished test pins as specified on figure 7 with a maximum diameter, as shown on figure 7 table, shall be inserted into and withdrawn from each socket contact three times prior to measurement. Following this procedure, polished test pins as specified on figure 7 with a minimum diameter, as specified on figure 7 table, shall be inserted into each socket contact. Withdrawal forces, applied gradually, shall then be measured.



Test pins for measuring contact separating forces.

Contact size and dash number	A (mm)		B
	Minimum diameter +.0001 (0.003) -.0000	Maximum diameter +.0000 -.0001 (0.003)	Max flat (mm)
16X1	0.0615 (1.56)		.015 (0.38)
16Y1	---	0.0635 (1.61)	.015 (0.38)
20X1	0.0390 (0.99)		.007 (0.18)
20Y1	---	0.0410 (1.04)	.007 (0.18)
22X1	0.0295 (0.75)		.007 (0.18)
22Y1	---	0.0305 (0.77)	.007 (0.18)

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Material: Gauge pin for contact sizes 22 and 20, tool steel or tungsten carbide, and for contact size 16, tungsten carbide.
4. Finish: 6 to 10 microinches root mean square determined in accordance with ASME B46.1.
5. No plating.
6. These gauges are intended for use with electric connector socket contacts referenced in this document and in SAE AS39029.

FIGURE 7. Test pin.

MIL-DTL-28748D
w/AMENDMENT 1

4.7.19 Finish thickness. Finish thickness of the plating and strikes shall be determined by any method which will give results within ± 0.10 percent of the true thickness.

4.7.19.1 Overall finish. Plating thickness shall be measured on the external surfaces of the contact body.

4.7.19.2 Localized finish (see 4.7.19.2). Finished thickness shall be .00005 inch (0.00127 mm) minimum thickness of deposited gold. Measurements shall be made at point B or C (see figure 1) as applicable. However, the plating on non-significant surfaces, nonfunctional surfaces shall be sufficient thickness to ensure plating continuity and uniform appearance.

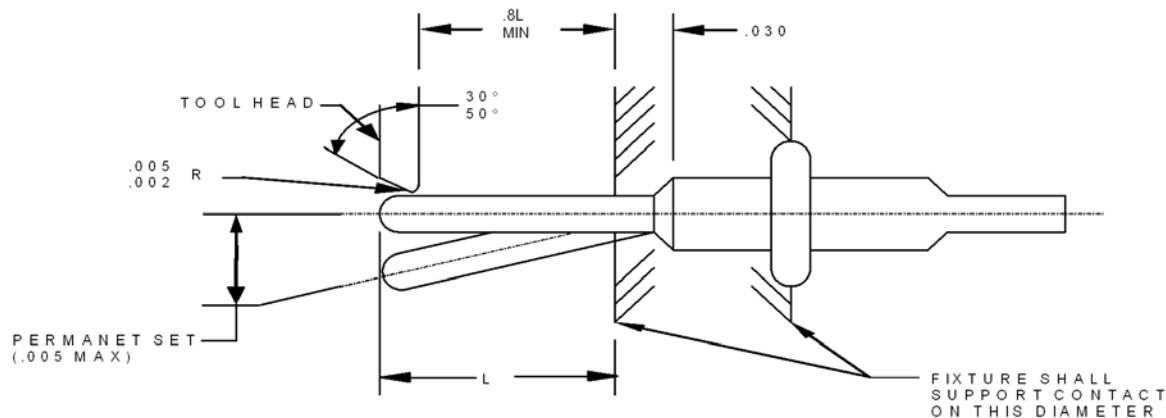
4.7.20 Industrial gas (see 3.5.17). Unmated contacts shall be placed on a noncorrosive rack in a closed plastic or glass chamber (volume 2 cubic feet maximum) which contains a 10 percent solution of sulphurated potash NF in distilled water. Contacts shall not be immersed in the solution but shall be exposed to the sulfide vapor for 100 hours.

4.7.21 Solderability (see 3.5.18). Solder type contacts shall be tested in accordance with method 208 of MIL-STD-202.

4.7.22 Resistance to soldering heat (see 3.5.19). All connectors with solder terminations shall be tested in accordance with test procedure EIA-364-56. The connectors shall be tested in accordance with procedure 1, unless otherwise specified (see 3.1).

4.7.23 Resistance to solvents (see 3.5.20). Connectors shall be tested in accordance with test procedure EIA-364-11. The solvents shall be class 1. The connectors tested shall be fully assembled by normal assembly operations.

4.7.24 Contact pin strength (see 3.5.21). Nonremovable contacts shall be mounted in a suitable fixture and a force (see table VIII) shall be applied to the end of the pin as shown on figure 8. The maximum rate of travel of the tool head of the testing machine shall not exceed 1 inch per minute. The maximum loading time shall not exceed 1 minute. The permanent set shall be the difference between the initial and the final position of the extreme pin tip, immediately after load removal and shall not exceed the limits specified in 3.5.21.



Inches	mm
.002	0.051
.005	0.127
.030	0.762
.8	20.32

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.

FIGURE 8. Contact strength.

MIL-DTL-28748D
w/AMENDMENT 1

5. Packaging.

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Connectors and contacts covered by this specification are intended for use in airborne, ground support, and shipboard electrical and electronic equipment.

6.1.1 Insert material. The connectors covered by this specification are composed of an insert made of a suitable insulation material into which are fixed either pins or sockets, with which electrical connections can be made. The specification also covers inserts, so that the units may be purchased separately as required.

6.2. Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable specification sheet and the complete PIN (see 3.1).
- c. Level of preservation, packaging, packing and marking required (see section 5).
- d. Quantity of units per package, if other than one.
- e. Whether contacts are included (see 3.4.2.1 and 3.6).
- f. Insert material required (see 3.3.4).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 28748 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus (DSCC-VQ), Document Control Unit, Columbus, OH 43218-3990 or email vqchief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.daps.dla.mil>.

MIL-DTL-28748D
w/AMENDMENT 1

6.4 Tin whisker growth. The use of alloys with tin content greater than 97 percent may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after, and can develop under typical operation conditions on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead have shown to inhibit the growth of tin whiskers.

6.5 Definitions.

6.5.1 Connector assembly. A complete connector assembly consists of a mated plug and receptacle.

6.5.2 Receptacle. A connector receptacle is that portion of the connector assembly which is normally "fixed", that is rigidly attached to a supporting surface. It will be provided with pin or socket contacts.

6.5.3 Plug. A connector plug is that portion of the connector assembly which is normally "removable". The plug will be provided with pin or socket contacts.

6.6 Interchangeability. All complete connectors, including their complement of pin or socket contacts, having the same PIN will be completely interchangeable with each other with respect to installation (physical) and performance (function) as specified herein. Suitable evidence, such as dimensional data, may be required by the Government in order to assure that complete connector assemblies will be interchangeable and meet the requirements of this specification.

6.6.1 Removable contacts. All pins and sockets will be capable of being assembled in the molded inserts and be completely interchangeable with each other with respect to installation (physical) and performance (function) as specified herein (see 3.1). Tools will be capable of properly inserting and removing the pin and socket contacts from the molded inserts. Suitable evidence such as dimensional data, may be required by the Government in order to assure that pins and sockets will be interchangeable and meet the requirements of this specification.

6.6.2 Plugs and receptacles. Plugs and receptacles of a given size and design manufactured by one source to the requirements of this specification, will be capable of mating with associated plugs and receptacles manufactured to the requirements of this specification by other sources.

6.7 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals and additional information is available on their website <http://www.epa.gov/osw/hazard/wastemin/priority.htm>. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

6.8 Subject (key word) listing.

Assembly distributor
Beryllium
Pin strength
Copper
Diallyl phthalate
Lead
Localized finish
Nickel
Polyphenylene sulfide
Shells
Shields
Tin

MIL-DTL-28748D
w/AMENDMENT 1

6.9 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. 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.

CONCLUDING MATERIAL

Custodians:

Army - CR

Navy - EC

Air Force - 85

DLA - CC

Preparing activity:

DLA - CC

(Project 5935-2010-158)

Review activities:

Army - AR, AT, AV, CR4, MI

Navy - AS, MC, OS, SH

Air Force - 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.daps.dla.mil>.