INCH-POUND

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12 February 2008
SUPERSEDING
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DETAIL SPECIFICATION

# CABLES, SPECIAL PURPOSE, ELECTRICAL, ALUMINUM FOIL SHIELDED PAIRS, TRIPLETS, OR QUADS GENERAL SPECIFICATION FOR

Inactive for new design after 12 February 2008

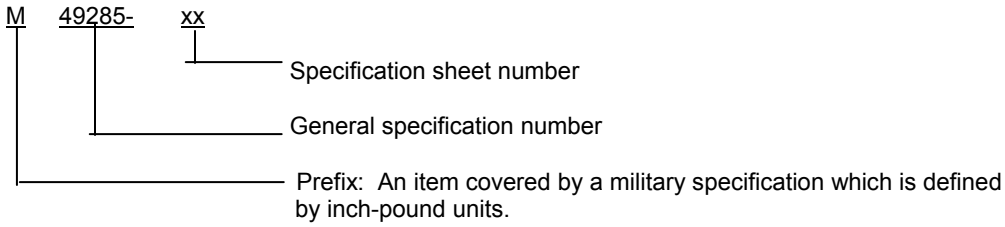
This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This document covers cables composed of polyester-backed aluminum foil shielded pair, triplet, and quad configurations.

1.2 Classification. Cables will be as specified herein (see 1.2.1 and 6.2).

1.2.1 Part or Identifying Number (PIN). PINs to be used for special purpose cables acquired to this specification are created as follows:




## 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 of documents 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.

FEDERAL SPECIFICATION

| | | |
|---|---|---|
| L-P-390 | - | Plastic, Molding and Extrusion Material, Polyethylene and Copolymers (Low, Medium, and High Density). |

Comments, suggestions or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: DSCC-VAI, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to WireCable@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

FEDERAL STANDARDS

| | | |
|---|---|---|
| FED-STD-228 | - | Cable and Wire, Insulated; Methods of Testing. |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-I-631 | - | Insulation, Electrical, Synthetic Resin Composition, Nonrigid. |
| MIL-DTL-12000 | - | Cable, Cord, and Wire, Electric, Packaging of. |
| MIL-PRF-39012 | - | Connectors, Coaxial, Radio Frequency, General Specification for. |

(See supplement 1 for list of associated specifications.)

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-104 | - | Limit for Electrical Insulation Color. |
| MIL-STD-130 | - | Identification Marking of U. S. Military Property. |

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil/ 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 these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

| | | |
|---|---|---|
| ASTM A818 | - | Wire, Steel, Carbon, Coppered. |
| ASTM B173 | - | Concentric Stranded Members, for Electrical Conductors. |
| ASTM B174 | - | Copper Conductors, Bunch-Stranded for Electrical Conductors. |
| ASTM B286 | - | Copper Conductors For Use in Hookup Wire for Electronic Equipment. |
| ASTM D470 | - | Wire and Cable, Crosslinked Insulations and Jackets for. |
| ASTM D2240 | - | Rubber Property - Durometer Hardness. |
| ASTM D4101 | - | Propylene Plastic Injection and Extrusion Materials. |

(Copies of these documents are available online at www.astm.org or from ASTM INTERNATIONAL, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

Munsell Color Chart .

(Copies of this document are available online at www.gretamacbeth.com or from Gretag-Macbeth, LLC, 79 T. W Alexander Drive, 4401 Building, Suite 250, Research Triangle Park, NC 27709.)

UNDERWRITER LABORATORIES (UL)

UL 1581 - Wire, Electrical, Cables, and Flexible Cords.

(Copies are available from www.ul.com or from Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

2.4 Order of precedence. 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.

3.1.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.3.

3.2 Materials. Materials shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the cables to meet the performance requirements of this document.

3.2.1 Conductor material. Solid and stranded conductors are to be in accordance with ASTM B286, ASTM B173, or ASTM B174, except that the direction of the lay may be right or left. Drain wire is to be in accordance with ASTM B286, Except that the direction of the lay may be right or left. Individual item construction and wire gauge will be specified in 3.1.

3.2.2 Conductor insulation. Polyvinyl chloride, polyethylene, and polypropylene materials used in the cable shall be in accordance with the following.

3.2.2.1 Insulated conductor. Conductors shall be insulated with polyvinyl chloride, polyethylene, or polypropylene as specified in 3.1. The insulation of the conductors shall be color coded as specified in table II.

3.2.2.2 Polyvinyl chloride. When specified (see 3.1), the insulation shall be polyvinyl chloride or its copolymer PVC, polyvinyl acetate, conforming to the requirements of the UL 1581 and the applicable specification sheet.

3.2.2.3 Polyethylene. Polyethylene shall conform to L-P-390, type II, class L, grade 3.

3.2.2.4 Polypropylene. Polypropylene shall conform to ASTM D4101.

3.2.3 Binders, separators, and fillers. Unless otherwise specified (see 3.1), the materials shall be in accordance with 3.2.3.1 through 3.2.3.5, and shall be nonconductive. The materials may be utilized as processing aids and identification markers in constructing the cable.

3.2.3.1 Polyester tape. Tape shall conform to type G of MIL-I-631.

3.2.3.2 Paper tape. Tape shall conform to grade A, class I as specified in table I.

3.2.3.3 Polypropylene tape. Tape shall conform to ASTM D4101.

TABLE I. Physical and electrical requirements for grade A paper tape.

| | Thickness tolerance (± mil) | Apparent density (min. grams/cm$^3$) | Tensile strength (min. lbs/in.) | | Conducting paths (max. number/ft$^2$) | Dielectric strength (min., volts/mil) |
|---|---|---|---|---|---|---|
| | Grade A | Grade A | Machine direction Grade A | Cross direction Grade A | Grade A | Grade A |
| | | | | | | |
| 0.20 | 0.02 | 1.00 | 1.5 | 1.0 | 9 | 1250 |
| 0.25 | 0.02 | 1.00 | 2.5 | 1.0 | 7 | 1200 |
| 0.3 | 0.02 | 1.00 | 3.5 | 1.5 | 7 | 1000 |
| 0.35 | 0.03 | 1.00 | 4.0 | 1.8 | 6 | 950 |
| 0.4 | 0.03 | 1.00 | 4.5 | 2.0 | 5 | 850 |
| 0.45 | 0.03 | 1.00 | 5.0 | 2.5 | 4 | 750 |
| 0.5 | 0.03 | 1.00 | 6.0 | 3.0 | 4 | 700 |
| 0.55 | 0.03 | 1.00 | 7.0 | 3.5 | 3 | 650 |
| 0.6 | 0.03 | 1.00 | 8.0 | 4.0 | 2 | 600 |
| 0.75 | 0.04 | 1.00 | 9.0 | 5.0 | 2 | 500 |
| 1.0 | 0.05 | 1.00 | 14.0 | 8.0 | 2 | 400 |
| 1.5 | 0.07 | 1.00 | 19.0 | 10.0 | 1 | 400 |
| 1.7 | 0.08 | 1.00 | 21.0 | 11.0 | 1 | 400 |
| 2.0 | 0.10 | 1.00 | 24.5 | 13.0 | 1 | 400 |
| 2.5 | 0.12 | 1.00 | 29.0 | 15.0 | 1 | 375 |
| 3.0 | 0.15 | 1.00 | 34.0 | 18.0 | 1 | 350 |
| 4.0 | 0.20 | 1.00 | 40.0 | 22.0 | 1 | 300 |
| 5.0 | 0.25 | 1.00 | 55.0 | 26.0 | 1 | 250 |
| 6.0 | 0.30 | 1.00 | 65.0 | 31.0 | 1 | 225 |
| 10.0 | 1.0 | 1.00 | 100.0 | 50.0 | 1 | 200 |
| 15.0 | 1.5 | 1.00 | 150.0 | 65.0 | 1 | 175 |
| 20.0 | 2.0 | 1.00 | 200.0 | 80.0 | 1 | 150 |
| 30.0 | 3.0 | 1.00 | 250.0 | 100 | 1 | 125 |

TABLE II. Color coding.

| Pair number | Color coded | Pair number | Color coded |
|---|---|---|---|
| 1 | Black paired with Red | 19 | White paired with Blue |
| 2 | Black paired with White | 20 | White paired with Yellow |
| 3 | Black paired with Green | 21 | White paired with Brown |
| 4 | Black paired with Blue | 22 | White paired with Orange |
| 5 | Black paired with Yellow | 23 | Blue paired with Yellow |
| 6 | Black paired with Brown | 24 | Blue paired with Brown |
| 7 | Black paired with Orange | 25 | Blue paired with Orange |
| 8 | Red paired with White | 26 | Brown paired with Yellow |
| 9 | Red paired with Green | 27 | Brown paired with Orange |
| 10 | Red paired with Blue | 28 | Orange paired with Yellow |
| 11 | Red paired with Yellow | 29 | Purple paired with Orange |
| 12 | Red paired with Brown | 30 | Purple paired with Red |
| 13 | Red paired with Orange | 31 | Purple paired with White |
| 14 | Green paired with White | 32 | Purple paired with Dark Green |
| 15 | Green paired with Blue | 33 | Purple paired with Light Blue |
| 16 | Green paired with Yellow | 34 | Purple paired with Yellow |
| 17 | Green paired with Brown | 35 | Purple paired with Brown |
| 18 | Green paired with Orange | 36 | Purple paired with Black |
| | | 37 | Gray paired with White |

3.2.3.4 Fibrous fillers. Fibrous fillers shall consist of either cotton, jute, synthetic fibers, or glass fibers. The material selected shall be appropriate for the type of cable in which it is used and shall have been treated for flame or moisture resistance, or a combination of both, as necessary, to enable the cable to meet the requirements for the particular type of construction.

3.2.3.5 Nonfibrous fillers. Nonfibrous fillers shall consist of elastomeric material which is readily removable from insulation of conductors and insulating tapes over shields without the aid of solvents, cleaners, or tools. The acceptability of the material shall be determined by the cable filler removability test (see 3.4.16). Fillers shall show no signs of deterioration from aging stability for cold bend tests.

3.2.4 Jacket. The jacket material shall be as specified (see 3.1). The material may be extruded over cable pairs or over the barrier tape. Unless otherwise specified (see 3.1), coloring shall be gray (slate).

3.2.5 Shields. A shield with a minimum aluminum foil thickness of .00031 inch (0.0079 mm) shall be bonded to a polyester tape with a minimum thickness of .00045 inch (0.0114 mm). If desired, an additional insulating polyester tape may be spirally wrapped over the shield. The color code of the shield shall be specified in accordance with item description in 3.1. Shielded electrical requirements are specified in 3.1. The unfolded foil shield width shall be consistent and shall vary not more than .030 inch (0.76 mm) throughout the manufactured lots.

3.3 Design and construction. The pairs, triplets, or quads shall be twisted with lays chosen to meet the applicable crosstalk requirements. The cable shall be assembled from the twisted pairs, triplets, or quads to form a substantially cylindrical core and jacketed overall. Cable length (see 3.1.1) shall be as specified in the contract or acquisition document (see 6.2d).

3.3.1 Cable components.

3.3.1.1 Insulated copper conductors. The insulated copper conductors shall be in accordance with the military specification sheets (see 3.1) and the requirements stated herein.

3.3.1.2 Copper coated steel conductors. Copper coated steel conductors shall conform to ASTM A818.

3.3.1.3 Drain wire. Drain wires shall be uninsulated stranded or solid, tin-plated conductors. Each strand shall be free from lumps, kinks, splits, scrapes, and corrosion. Splices made in conductors may be either brazed, using a silver alloy solder and a nonacid flux, or welded. Splices shall be butted and shall be free from lumps and sharp projections and also as specified in 3.2.1. In no case shall all strands of a multiple stranded conductor be spliced at one point along the conductor length. The tensile strength of any section of a conductor splice which was brazed or welded shall be not less than 85 percent of the tensile strength of adjacent sections without a splice. The lay of the drain wire shall be applied with the same lay as the conductors and shall have a common axis. The conductors shall maintain their relative position throughout the length of the cable. The individual drain wire configuration shall be as specified in 3.1.

3.3.1.4 Shields. (see 3.1 and 3.2.5).

3.3.1.5 Jacket. The jacket shall be as specified in 3.2.4.

3.3.1.5.1 Polyvinyl chloride (Jacket material only). The polyvinyl chloride shall be as specified in 3.2.2.2.

3.3.1.5.2 Polyethylene (Jacket material). The polyethylene shall conform to L-P-390, type III, class L, grade 3.

3.3.1.5.3 Crosslinked polyolefin. The crosslinked polyolefin shall meet the applicable requirements of the individual specification sheet (see 3.1) and as specified herein.

3.3.2 Twisting of pairs, triplets, or quads. The shielded pairs, triplets, or quads, shall consist of two, three, or four insulated wires and one drain wire. The pair lay length shall be selected in order to meet the applicable crosstalk requirements (see 3.4.6).

3.3.2.1 Cabling. The method by which a group of pairs, triplets, or quads is assembled shall be such that pairs, triplets, or quads are adjacent throughout the cable. Adjacent pairs, triplets, or quads shall exhibit the same configuration from one cabled end to the other end in any cable length. The pair, triplet, or quad configuration identification by shield color code and cable lay length shall be specified for each item in the corresponding specification sheets (see 3.1).

3.3.3 Patching. There shall be no patching on the insulation or the jacket material.

3.3.4 Cable put-up. Unless otherwise specified in the acquisition document (see 6.2), cable shall be put-upon spools/reels.

3.4 Performance.

3.4.1 Color conformance. The jacket and insulation color shall correspond to class 1 of MIL-STD-104 (see 4.4.2).

3.4.2 Durometer hardness. The cable jacket material shall have a "Shore A" hardness as specified in 3.1 (see 4.4.3).

3.4.3 Tensile strength. The cable jacket shall have a minimum tensile strength as specified in 3.1 (see 4.4.4).

3.4.4 Elongation. The cable jacket shall have a minimum elongation as specified in 3.1 (see 4.4.5).

3.4.5 Jacket thickness and outside cable diameter. The jacket thickness and outside cable diameter shall be as specified in 3.1. The minimum spot thickness of the jacket shall be not less than 70 percent of the specified thickness and the average thickness of any cross section of the jacket shall be not less than 90 percent of the specified thickness (see 4.4.6).

3.4.6 Crosstalk. The crosstalk between two adjacent shielded pairs of the cable shall be as specified in 3.1. Crosstalk testing is not required on single pair cables (see 4.4.7).

3.4.7 Shield continuity and insulation resistance. The resistance between the shield and its drain wire shall be less than 1 ohm. Unless otherwise specified (see 3.1), the resistance between all other components shall be greater than 200 megohms per thousand feet at 500 V dc (see 4.4.8).

3.4.8 Copper conductor resistance. The direct current, dc resistance, shall be as specified in table III. Test sample readings shall be ohms per 1,000 feet length (see 4.4.9).

TABLE III. DC resistances.

| A<br>wire table<br>AWG | B<br>Limit, ohms/1,000 feet<br>68°F (20°C) |
|---|---|
| 16 | 5.4 maximum |
| 18 | 7.3 maximum |
| 20 | 11.7 maximum |
| 22 | 18.5 maximum |
| 24 | 29.7 maximum |

3.4.9 Aging stability. There shall be no evidence of cracks or flaws in either the insulation material, the jacket, or the fillers (see 4.4.10).

3.4.10 Dielectric withstanding voltage. In each length of completed cable, the insulation between conductors, between conductors and shield, and between adjacent shields shall withstand the dc potential for three seconds as follows (see 4.4.11):

| | DC volts, minimum |
|---|---|
| Between conductors | 3,600 |
| Between conductors and shield | 1,800 |
| Between shields and two adjacent pairs | 600 |

3.4.11 Cold bend. There shall be no evidence of cracks or flaws in either the insulation, jacket material, or fillers. The markings shall be legible (see 4.4.12).

3.4.12 Dielectric reeling. The cable shall meet the dielectric withstanding voltage test of 3.4.10 between the shields after repeated unreeling in accordance with 4.4.13. Any failure within the cable shall be cause for rejection.

3.4.13 Shield coverage. There shall be no breaks in the shield covering (see 3.4.14).

3.4.14 Flex test. The cable shall be tested in accordance with 4.4.15. Following the flex test, the cable shall meet the crosstalk requirements as specified in 3.4.6.

3.4.15 Shield integrity test. Each shield when tested shall meet the requirements as specified in 3.1 (see 4.4.16.)

3.4.16 Cable filler removability. The filler material shall be flexible and shall be removable from any part with which it is in contact, through the use of fingers only. It shall not adhere to the fingers, to the insulation, or to tape or other covering over shields. The presence of occasional particles or slivers of filler residue will be acceptable, providing that these can be removed by light brushing with the fingers. Filler material which leaves residue that is removable only by vigorous wiping or through the use of solvents will not be acceptable (see 4.4.17).

3.4.17 Flammability. The cable shall meet the requirements as specified in 3.1 (see 4.4.18).

3.5 Cable identification. Unless otherwise specified (see 3.1), cables shall be marked with the military part number (see 1.2.1 and 3.1), manufacturer's code symbol and name, and any applicable UL printing requirements associated with the UL style called out in the specification sheet. Printing shall be located on the outside of the jacket in accordance with the basic requirements of MIL-STD-130. The marking shall be done in such a manner as not to deform or otherwise damage the jacket or outer covering. The first 25 feet of the cable sample unit shall be examined for the marking requirements. The marking shall be visible and legible from the outside of the cable. The marking shall be legible after the aging stability and cold bend tests. Marking is to appear throughout the entire length of the cable and is not to exceed 24 inches in marking interval.

3.6 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 costs.

3.7 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of cable components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.6).

3.8 Workmanship. Cable shall be processed in such a manner as to be free from all defects which could affect proper functioning in service. The exterior surfaces shall be smooth, uniform, and free from splinters and other defects visible to the naked eye.

4. VERIFICATION

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

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

(1) Conformance inspection on individual conductors.

(2) Conformance.

4.2 First article inspection. Unless otherwise specified (see 6.3), first article samples shall be fabricated and tested by the manufacturer with tools and methods that, as far as practicable, are the same as those which will be used for quantity production of the product. The manufacture of the cable for a Government contract, prior to approval of the first article sample, shall be at the manufacturer's risk. First article inspection shall be performed on suitable length of cable. Certification of compliance for the basic material may be obtained from the supplier of the material providing that such certification contains actual tests, examination, or other verifiable quality data. Unless otherwise specified (see 6.2), first article inspection test reports shall be forwarded to the acquiring activity for approval.

4.2.1 Samples. Three first article samples shall be subjected to the tests specified in table IV. No failures shall be permitted.

4.3 Conformance inspection. Conformance inspection shall consist of the tests specified in 4.3.1 and 4.3.2.

4.3.1 Conformance inspection on individual conductors. The insulated conductor shall be inspected prior to cabling. Both solid and stranded insulated conductors shall be inspected to, and in accordance with 3.3.1.1.

4.3.2 Conformance inspection on completed cables. Conformance inspection on completed cables shall be in accordance with groups A and B tests (see 4.3.3 and 4.3.4.)

4.3.2.1 Inspection lot. All cables of the same number of pairs, triplets, or quads, offered for delivery at one time shall be considered a lot for purposes of sampling and inspection. Quantities of cables which might be delivered against two or more contracts may be combined into one lot for purposes of sampling if produced at the same time.

4.3.2.2 Unit of product. The unit of product for determining lot size shall be the number of spool/reels of cables having the same number of pairs, triplets, or quads, and the same approximate manufactured length.

4.3.2.2.1 Sample. The sample shall consist of that number of units of product required by the sampling plan for the lot size specified in 4.3.2.1.

4.3.2.2.2 Specimen. A specimen is a length of completed cable from one unit of product.

4.3.3 Group A inspection. Group A inspection shall consist of the examination and tests shown in table V.

4.3.3.1 Sampling for group A, subgroup 1. The tests specified in table V, subgroup 1, shall be performed on every length of finished cable. If any sample fails in any test, the entire length of cable shall be rejected. Samples on the adjacent reels shall be subjected to the same test in which failure occurred.

4.3.3.2 Sampling for group A, subgroup 2. Unless otherwise specified, samples shall be selected in table VI for group subgroup 2 inspection in table V. Within each specimen of the sample, the insulated conductors shall be selected in table VII.

4.3.3.3 Sampling for measurement of colors. In each specimen (see 4.3.3.2), pairs shall be selected at random in table VII. The number of pairs on one end of the cable so examined shall be the same as specified in 4.3.3.2.

4.3.4 Group B inspection. Group B inspection shall consist of the test shown in table VIII. Specimens shall be specified in table IX. For the crosstalk test, the number of pairs within the specimen shall be specified in table X and the test results shall be computed in table IX to determine acceptance.

4.3.5 Rejected lots. If an inspection lot is rejected, the supplier may withdraw the lot, rework it to correct the defects or screen out the defective units; such lots shall be clearly identified as reinspected lots. Rejected lots shall be inspected using tightened inspections; the sample size shall be the sample shown in table VI and table IX for the next larger lot size for the applicable test.

4.3.6 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with MIL-DTL-12000.

TABLE IV. First article inspection.

| Inspection | Requirement paragraph | Test paragraph |
|---|---|---|
| Visual and dimensional examination | 3.2, 3.3, 3.5, and 3.6 | 4.4.1 |
| Color conformance | 3.4.1 | 4.4.2 |
| Durometer hardness | 3.4.2 | 4.4.3 |
| Tensile strength | 3.4.3 | 4.4.4 |
| Elongation | 3.4.4 | 4.4.5 |
| Jacket thickness and outside cable diameter | 3.4.5 | 4.4.6 |
| Crosstalk | 3.4.6 | 4.4.7 |
| Shield continuity and insulation resistance | 3.4.7 | 4.4.8 |
| Conductor resistance | 3.4.8 | 4.4.9 |
| Aging stability | 3.4.9 | 4.4.10 |
| Dielectric withstanding voltage | 3.4.10 | 4.4.11 |
| Cold bend | 3.4.11 | 4.4.12 |
| Dielectric reeling | 3.4.12 | 4.4.13 |
| Shield coverage | 3.4.13 | 4.4.14 |
| Flex test | 3.4.14 | 4.4.15 |
| Shield integrity test | 3.4.15 | 4.4.16 |
| Cable filler removability test | 3.4.16 | 4.4.17 |
| Flammability | 3.4.17 | 4.4.18 |

4.4 Methods of inspection.

4.4.1 Visual and dimensional examination. A 10-feet length of cable cut from the end of the specimen shall be examined to verify that the materials, design and construction, the cable identification, and workmanship are in accordance with the applicable requirements (see 3.2, 3.3, 3.5, and 3.6). The cable shall be examined for jacket imperfections on all of the surface which is visible without unwinding the cable from the reel.

4.4.2 Color conformance. The insulation and jacket color shall be in accordance with the Munsell Color Chart for class 1 of MIL-STD-104 and shall match the preferred limits, unless otherwise approved by the contracting officer. If any pair is found not having color as specified, every pair in that specific length shall be compared with the Munsell color card. Also, the spools/reels of cable preceding and following shall be examined to determine the extent of incorrect coloring (see 3.4.1).

4.4.3 Durometer hardness. The cable jacket shall be tested in accordance with ASTM D2240 on a shore durometer, type A (see 3.4.2).

4.4.4 Tensile strength. The cable jacket shall be tested in accordance with method 3021 of FED-STD-228 or ASTM D470 (see 3.4.3).

4.4.5 Elongation. The cable jacket shall be tested in accordance with method 3031 of FED-STD-228 or ASTM D470 (see 3.4.4).

TABLE V. Group A inspection.

| Inspection | Requirement paragraph | Test paragraph |
|---|---|---|
| Subgroup I | | |
| Visual and dimensional examination | 3.2, 3.3, 3.5, and 3.6 | 4.4.1 |
| Cable filler removability | 3.4.16 | 4.4.17 |
| Subgroup II | | |
| Color conformance | 3.4.1 | 4.4.2 |
| Durometer hardness | 3.4.2 | 4.4.3 |
| Tensile strength | 3.4.3 | 4.4.4 |
| Elongation | 3.4.4 | 4.4.5 |
| Jacket thickness and outside cable diameter | 3.4.5 | 4.4.6 |
| Shield continuity and insulation resistance | 3.4.7 | 4.4.8 |
| Conductor resistance | 3.4.8 | 4.4.9 |
| Dielectric withstanding voltage | 3.4.10 | 4.4.11 |
| Dielectric reeling | 3.4.12 | 4.4.13 |
| Shield coverage | 3.4.13 | 4.4.14 |
| Cable identification permanency and durability | 3.5 | |

TABLE VI. Sampling for group A, subgroup 2 inspection.

| Lot size, number of units (reels) of cable | Sample units to be inspected |
|---|---|
| 1 to 13 | 2 |
| 14 to 25 | 3 |
| 26 to 62 | 4 |
| 63 to 160 | 7 |
| 161 to 410 | 10 |

TABLE VII. Sampling for group A, subgroup 2.

| Pairs in cable | Pairs to be tested |
|---|---|
| 3 | 3 |
| 6 | 6 |
| 9 | 7 |
| 11 | 7 |
| 15, 16 | 8 |
| 19 | 9 |
| 26 | 10 |
| 27 | 10 |
| 52 | 15 |
| 104 | 20 |

TABLE VIII. Group B inspection.

| Inspection | Requirement paragraph | Test paragraph |
|---|---|---|
| Crosstalk | 3.4.6 | 4.4.7 |
| Flex test | 3.4.14 | 4.4.15 |
| Shield integrity | 3.4.15 | 4.4.16 |

TABLE IX. Sampling for group B inspection.

| Lot size, number of units (spools/reels) of cable |
|---|
| 1 to 17 |
| 18 to 35 |
| 36 to 70 |
| 71 to 140 |
| 141 to 280 |
| 281 to 560 |
| 561 to 1,120 |
| 1,121 to 2,240 |

TABLE X. Pair sampling per specimen. 1/2/

| Number of pairs in specimen | Number of random pair combinations of crosstalk required |
|---|---|
| 104 | 20 |
| 52 | 15 |
| 27 | 10 |
| 19, 26 | 10 |
| 15, 16 | 8 |
| 11 | 6 |
| 9 | 5 |
| 6 | 3 |
| 3 | 2 |
| 2 | 1 |

1/ A failure is defined as a pair faulted to one or more adjacent pairs.

2/ A failure is also defined as a measurement not meeting the criteria as specified in 3.4.6.

4.4.6 Jacket thickness and outside cable diameter. The jacket thickness and outside cable diameter shall be measured with a micrometer caliper graduated to read in mils or .001 inch (0.03 mm) and having flat surfaces on both the anvil and end of the spindle, each approximately .25 inch (6.4 mm) in diameter. The surfaces of anvil and spindle shall be parallel to within .0001 inch (0.003 mm) (see 3.4.5).

4.4.6.1 Cables with filler. The jacket thickness and outside cable diameter shall be measured in accordance with method 1331 of FED-STD-228.

4.4.6.2 Cables without filler. A 2-foot length of cable shall be cut from the end of the specimen. The cable diameter shall be measured at two positions 12 inches apart along the sample length and three measurements 120º apart around each position. The diameters shall be summed and then divided by 6 to obtain the average diameter. The jacket shall then be cut lengthwise in two places 180 degrees apart to obtain two equal sections. Three measurements of thickness shall be made on each piece 6 inches apart. The average thickness is the sum of these thicknesses divided by 6.

4.4.7 Crosstalk. Crosstalk shall be measured by applying a known signal voltage to a shielded pair. The voltage induced into an adjacent pair is then measured (see 3.4.6). Specimens shall be 150 feet in length. Cables shall be tested as follows:

a. Crosstalk test: This test determines the balanced mode crosstalk between adjacent individual pairs within the cable. A known signal voltage shall be fed into a shielded pair and the voltage induced onto an adjacent pair is determined to be the crosstalk of the cable pair.

b. For the purposes of this specification, crosstalk is defined as the difference (in dB) between the input level of the disturbing pair and the output level of a directly adjacent disturbed pair. The relationship between levels is to be relative to an impedance matched circuit: Where signal source, receiver, and cable pairs are all properly terminated (both ends). The termination impedance shall be 50 ohms for all cables except those having expanded polyethylene dielectrics. These pair's termination impedance shall be 100 Ω (nominal).

c. The applied signal level in the excited pair shall be -12 dBm. This level shall be maintained throughout the test.

d. The cable specimen shall be tested while coiled on a reel. Both ends of the test sample must be made available.

e. All shields of the cable under test shall be insulated from each other at the far end and shall be connected to the ground plane at the generator end.

f. Equipment required: The equipment shall be capable of making measurements over the frequency ranges and amplitude levels required. The equipment shall be sensitive enough to allow the detection of changes four times less in magnitude than those called for in 3.4.6.

g. Both near end and far end crosstalk measurements are to be made. The results shall be as specified in 3.4.6.

4.4.8 Shield continuity and insulation resistance. Resistance between drain wire and shield, between conductors in pair, between each conductor and its shield, and between shields shall be measured with a suitable instrument having not less than 1 percent accuracy (see 3.4.7).

4.4.9 Conductor resistance. The resistance of each conductor shall be measured in accordance with method 6021 of FED-STD-228 (see 3.4.8).

4.4.10 Aging stability. Unless otherwise specified (see 3.1.1), the cable shall meet the aging stability test. Specimens of the cable shall be duplicates of those specified in 4.4.12.1. The specimens shall be suspended in a test oven at the test temperature, without touching one another, or the walls of the oven. Heated air at atmospheric pressure shall be circulated so as to maintain a uniform temperature of 98°C ±2°C in the oven. The specimens shall

be conditioned for a period of 7 days. After this conditioning period, the specimens shall be removed from the oven and conditioned at room temperature for a minimum of 4 hours (see 3.4.9).

4.4.11 Dielectric withstanding voltage. The cable shall be subjected to a dielectric withstanding test to determine conformance with 3.4.10. Points of application are as follows:

a. Conductor to conductor.

b. Conductor to shield/drain wire.

c. Between shields/drain wire of adjacent pairs.

4.4.12 Cold bend (see 3.4.11).

4.4.12.1 Specimens. For cables with an overall diameter of less than .500 inch (12.70 mm), the tests shall be conducted on three specimens of cable; the length of each specimen shall be at least 150 times the diameter. For .500 inch (12.70 mm) and larger diameter cables, the tests shall be conducted on two specimens of cable; the length of each specimen shall be at least 120 times the diameter of the cable.

4.4.12.2 Procedure. One end of the test specimen shall be clamped circumferentially at two points, approximately 45 degrees apart, to a mandrel whose diameter is 10 times that of the test specimen. The specimen shall be wrapped around the mandrel for one full turn. The mounted specimen shall then be conditioned for 20 hours at a temperature of -20°C ±2°C. During this conditioning period, the specimens shall be kept reasonably straight. After this conditioning, but while the specimens are still in the cold chamber at the conditioning temperature, the specimens shall be wrapped for three close turns (two close turns for cables having a diameter of .500 inch (12.70 mm) or greater) around the mandrel at a uniform rate of 15 ±3 revolutions per minute, preferably by means of an electrically-driven motor. The cable shall be guided by a free moving sheave or transversing device in intimate contact with the cable at the initial point of bend. The cable shall then be removed from the cold chamber and visually examined except at clamping points. The specimen shall then be tested in accordance with 4.4.11.

4.4.13 Dielectric reeling. Unless otherwise specified in 3.1, one sample from each lot (approximately 500 feet) of finished cable shall be rewound from one reel to another for a total of five times. There shall be sufficient tension to cause the cable to remain in full contact with the reels. The dielectric withstanding voltage test between all shields/drain wires of adjacent pairs shall then be performed in accordance with 4.4.11, from each drain wire/shield in turn to all other drain wires/shields (see 3.4.12).

4.4.14 Shield coverage. A foil shielded pair of sufficient length shall be coiled around a mandrel. The mandrel shall be three times the diameter of the shielded pair. The sample must remain in full contact with the mandrel (see 3.4.13).

4.4.15 Flex test. The cable shall be laid on a flat surface with two feet of the cable extending over the edge. Bend the sample over the edge 90º, straighten and repeat 20 times. Rotate the sample 45 degrees and repeat the flexing another 25 minutes. The bend radius is to be 10 times the cable diameter (see 3.4.14). The same sample as used in 4.4.7 shall be used in this test.

4.4.15.1 Crosstalk. Repeat the crosstalk test as specified in 4.4.7. Results shall meet the crosstalk requirements stated in 3.4.6.

4.4.16 Shield integrity test (see 3.4.15).

NOTE: See appendix A for description of the test fixture.

4.4.16.1 Sample preparation.

4.4.16.1.1 Jacket removal. Unless otherwise specified in the individual specification sheet, single and dual pair cables shall be tested with their jackets in place. Multipair cables shall have the jackets removed. Carefully score not quite through the jacket and tear the jacket away, being careful not to cut or disturb the configuration of the shield.

Remove a 38-inch long sample pair from the cable under test, again being careful not to disturb the configuration. Nothing other than the plastic holder included with the test fixture shall be used to preserve the physical arrangement of the shield structure during the test, except at the ends of the sample where a small piece of tape may be used to prevent unwinding of the shield at the termination.

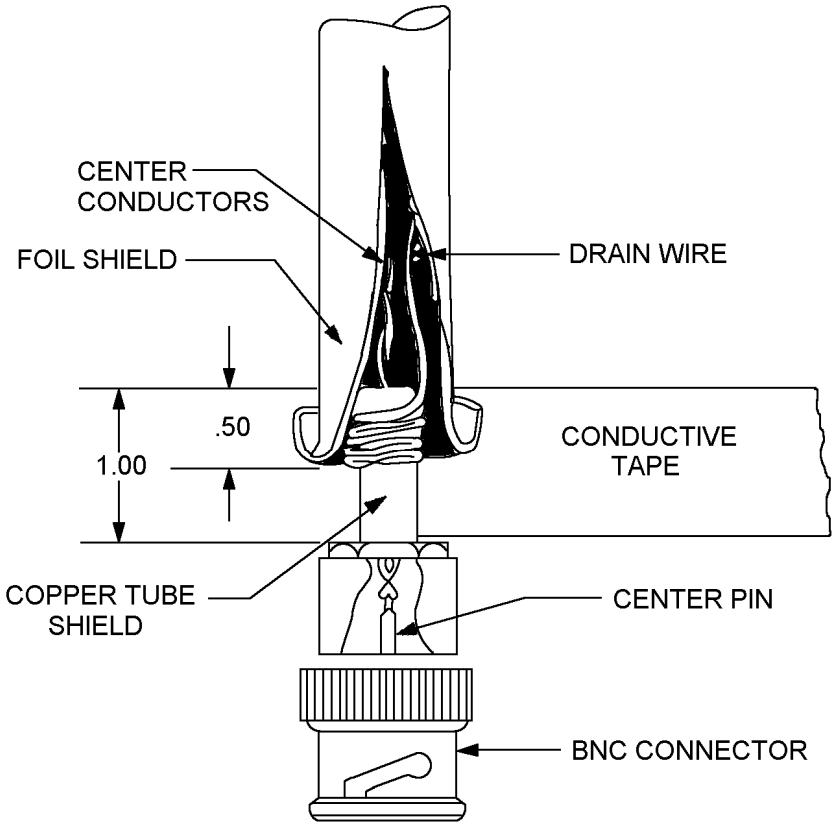
4.4.16.1.2 Sample assembly. The sample assembly is to be 36 inches long over the mating faces of the modified BNC connectors (see figure 1). The BNC connectors are type M-39012/16 in accordance with MIL-PRF-39012. The three washers normally used in the connectors are discarded. A 1.25 inch (31.8 mm) length of 0.187" OD copper tubing is soldered into the retaining nut with 1 inch (25.4 mm) extruding outward. All flux must be removed from the threads of the retaining nut and connector body following this and any subsequent soldering operations, as anything preventing good metal to metal contact in the threaded joint may result in a false indication of failure.

Approximately 1.5 inches (38.1 mm) of shield is to be carefully unwrapped from each end of the sample (one end will probably have to be slit longitudinally) and folded back. Both insulated conductors are to be end stripped and soldered together into the BNC connector center pin. Any exposed conductor at the base of the pin is to be covered with a small piece of electrical tape to prevent shorting to the connector shell or copper tube. The pin and conductors are then inserted through the copper tube and the pin is seated in the connector.

Samples having inward facing foil shall have the drain wire wrapped around the copper tube and soldered to it. One half inch of the shield foil shall be folder to face outward (see figure 1) and the assembly shall be wrapped with .003 inch (0.08 mm) copper foil tape (which may have conductive pressure-sensitive adhesive). The tape shall extend from just beyond the connector retaining nut past any opening in the shield. It shall be pressed firmly around the copper tube, the exposed folded back portion of the shield foil and the shield beyond any disturbed area. The copper foil shall be soldered to the copper tube and all seams or cracks in the copper foil shall be soldered shut. Care must be taken to avoid melting insulation on the conductors. Connectors shall be attached to both ends of the sample in the above manner and the assembly shall be tested for shorts between the center pin and shell using an ohmmeter or other low voltage method.

A shielded 50Ω coaxial load having a BNC connector shall be attached to one end of the sample. The sample shall be placed in the plastic support tube and suitable insulation shall be placed over the coaxial load so it will not short to the inner tube of the fixture. Care shall be taken not to disturb the shield configuration while inserting the sample into the support tube. Samples having outward facing shields shall be treated in the same manner except that .500 inch (12.7 mm) of the shield shall be folded inward for intimate contact with the copper tube.

Other methods of sample assembly are acceptable provided they achieve the same goals. Any RF leakage at the sample ends will contribute to sample failure.




NOTES:
1. BNC is standard type with .187 inch (4.75 mm) copper tubing soldered into the retaining nut, 1.25 inches (31.8 mm) of tubing should be used.
2. The BNC connector is modified to include a copper tube to shield connections.

FIGURE 1. Connector installation.

4.4.16.1.3 Sample installation. Attach the specimen to the BNC feed through inside the cover plate. Guide the specimen into the inner tube of the fixture, close the fixture, and tightly secure the flanges. Wing nuts may be used instead of hex nuts for convenience.

4.4.17 Cable filler removability test. This test is applicable to the non-fibrous filler material used to fill voids or act as the cable core.

4.4.17.1 Specimens. A specimen shall consist of a length of completed cable approximately 10 feet long.

4.4.17.2 Procedure. All overall cable parts such as the jacket or binder tapes shall be removed from one end of the specimen so as to expose the pairs and filler material for a distance of about three feet. Without the use of tools, the filler shall be separated from the conductors or shielded pairs for their exposed length.

4.4.18 Flammability. The cable shall be tested in accordance with UL 1581.

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. These cables are intended to be used as audio, control, data, and instrumentation cables in protective buildings and shelters. Use may include flexing, requirements include low dielectric constant. Temperature range is -20°C to +80°C.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. PIN (see 1.2.1).

c. Title, number and date of corresponding specification sheet (see 3.1).

d. Number of first article samples, if other than specified in 4.2.1.

e. Cable length if different from 3.1.1 (see 3.3).

f. Packaging, preservation, and packing if other than in section 5.

6.3 First article. Invitations for bids should provide that the Government reserves the right to waive the requirement for first article samples as to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending acquisition.

6.4 Environmental pollution prevention measures. Environmental pollution prevention measures are contained in the packaging material specifications referenced herein. Refer to material specifications or preparing activity for recommended disposability methods.

6.5 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. Environmentally Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm. Further information is available at the following EPA site: http://www.epa.gov/epaoswer/hazwaste/minimize/. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see section 3).

6.6 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating 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, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to ASTM-B545, Standard Specification for Electrodeposited Coatings of Tin.

6.7 Cross reference (see table XI).

TABLE XI. Cross reference.

| Former purchase description designator | Current basic cable specification designator |
|---|---|
| CR-CS-0099-000 Rev. B | MIL-C-49285 |
| CR-CS-0099-001 Rev. C | MIL-C-49285/1 |
| CR-CS-0099-002 | MIL-C-49285/2 |
| CR-CS-0099-003 Rev. D | MIL-C-49285/3 |
| CR-CS-0099-004 | MIL-C-49285/4 |
| CR-CS-0099-005 | MIL-C-49285/5 |
| CR-CS-0099-006 | MIL-C-49285/6 |
| CR-CS-0099-007 Rev. A | MIL-C-49285/7 |
| CR-CS-0099-008 | MIL-C-49285/8 |
| CR-CS-0099-009 | MIL-C-49285/9 |
| CR-CS-0099-010 | MIL-C-49285/10 |
| CR-CS-0099-011 | MIL-C-49285/11 |
| CR-CS-0099-012 | MIL-C-49285/12 |
| CR-CS-0099-014 | MIL-C-49285/14 |
| CR-CS-0099-015 | MIL-C-49285/15 |
| CR-CS-0099-016 | MIL-C-49285/16 |
| CR-CS-0099-017 | MIL-C-49285/17 |
| CR-CS-0099-018 | MIL-C-49285/18 |
| CR-CS-0099-019 | MIL-C-49285/19 |
| CR-CS-0099-020 | MIL-C-49285/20 |
| CR-CS-0099-021 | MIL-C-49285/21 |
| CR-CS-0099-022 Rev. C | MIL-C-49285/22 |
| CR-CS-0099-023 | MIL-C-49285/23 |
| CR-CS-0099-024 | MIL-C-49285/24 |
| CR-CS-0099-025 | MIL-C-49285/25 |
| CR-CS-0099-026 | MIL-C-49285/26 |
| CR-CS-0099-028 | MIL-C-49285/28 |
| CR-CS-0099-030 | MIL-C-49285/30 |
| CR-CS-0099-031 | MIL-C-49285/31 |
| CR-CS-0099-032 | MIL-C-49285/32 |
| CR-CS-0099-035 | MIL-C-49285/35 |
| CR-CS-0099-038 | MIL-C-49285/38 |

6.8 Subject term (keyword) listing.

Crosstalk
Drain wire

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

# SHIELD INTEGRITY TEST FIXTURE ASSEMBLY DESCRIPTION

## A.1 SCOPE

A.1.1 Scope. This appendix details the assembly description for the shield integrity test fixture. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance only.

## A.2 CONSTRUCTION

A.2.1 Assembly description. A cutaway drawing of the fixture is shown on figure A-1. The outer conductor is the outer conductor of a 3.125 inch (79.38 mm) 50-ohm rigid coaxial transmission line with a flange on each end. The length over the flanges is 60 inches.

The inner conductor is the inner conductor of a 3.125 inches (79.38 mm) 50-ohm rigid coaxial transmission line, specified to be without centering pegs, not pierced. The overall length should be such that a .125 inch (3.18 mm) gap will exist between the end of the conductor and the inner surface of the end plate when the other end of the conductor is properly mated with the connector on the 3.125 inches (79.38 mm) to N adapter and this adapter is bolted to the outer conductor flange.

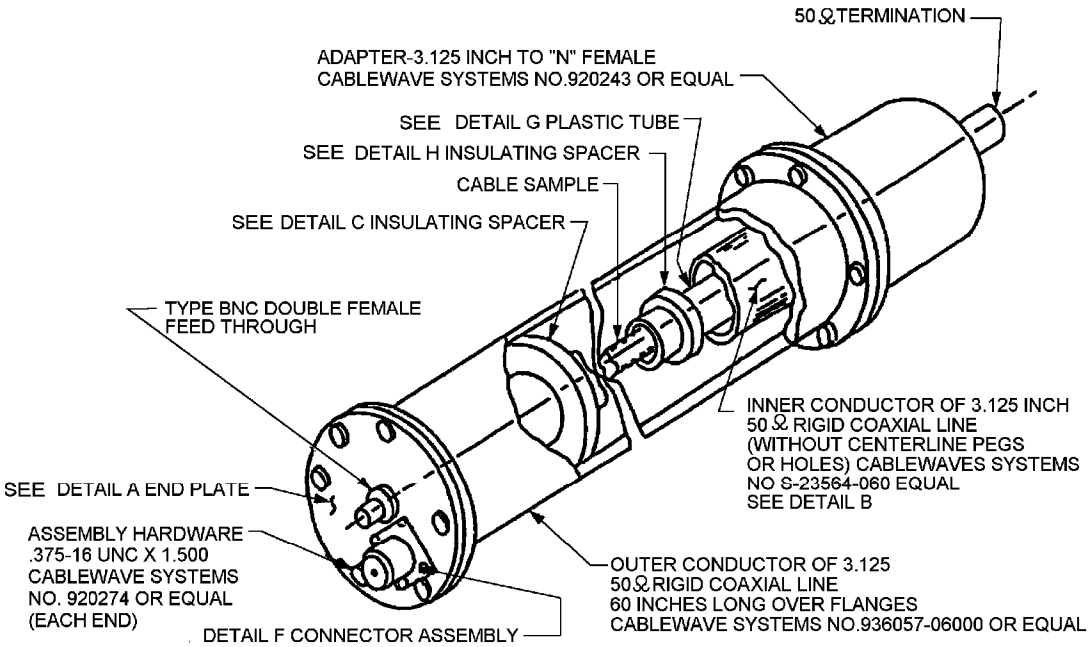
The inner conductor has a female banana jack in a rectangular mounting block brazed to its outer surface near the end next to the end plate (see figure A-2, detail B). This mates with the center pin of the off-center connector in the end plate.

The inner conductor is supported near the end plate by means of a 3.125 inches (79.38 mm) connector insulator which has been modified by enlarging the center hole to form a press fit over the inner conductor and turning down the outside diameter to form a slip fit inside the outer conductor (see figure A-2, detail C).

The end plate (see figure A-2, detail A) is made from a 3.125 inch (79.38 mm) blank end plate having a .125 inch (3.18 mm) thick center portion. A type BNC double female feed-through connector (UG`-492A/U) is installed in the center of the end plate. A modified UG-58/U type N panel receptacle connector (see figure A-2, detail D, E, and F) is installed off center in the end plate with the flange on the outside surface of the end plate (see figure A-2, details A and F) to mate with the banana jack on the inner conductor.

The sample is to be prepared and terminated as specified in 4.4.16.1.

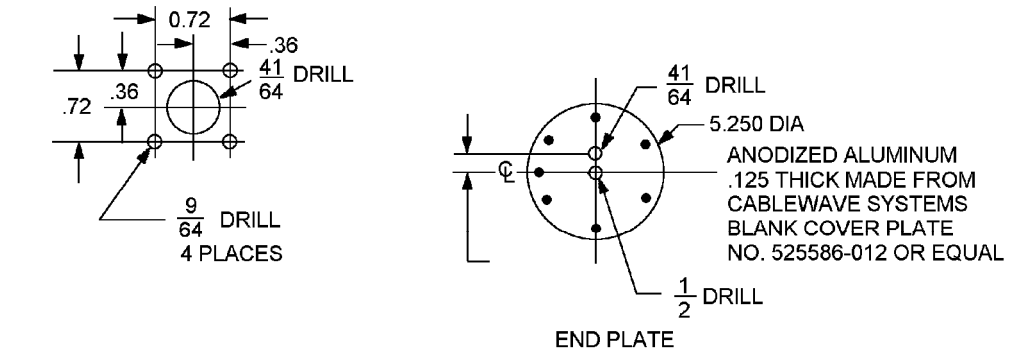
To assist in centering the sample being tested within the inner conductor tube, a polyethylene or acrylic plastic tube having an inside diameter slightly larger than the diameter of the sample and having a lengthwise slot slightly wider than the diameter of the sample shall be used (see figure A-2, detail G). This plastic tube shall be centered by means of "C" shaped nylon washers which form a slip fit inside the inner conductor and a snug fit on the plastic tube (see figure A-2, detail H).



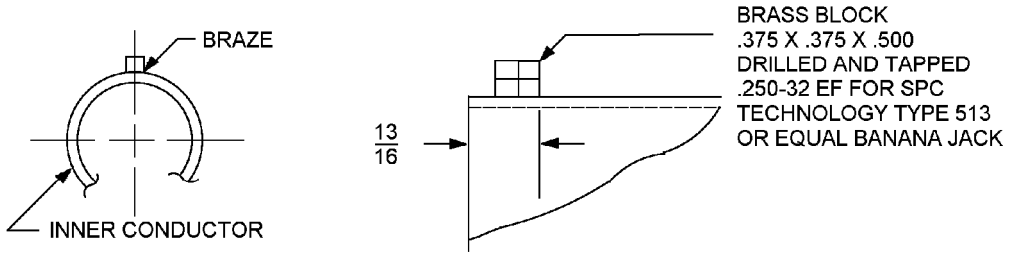

INNER TUBE SPACED .123 INCH FROM END PLATE BY SHORTENING END AWAY FROM ADAPTOR.

CABLE SAMPLE IS 36 INCHES OVER FACES OF MALE BNC CONNECTORS-TERMINATED IN SPECIFIED SHIELDED LOAD.

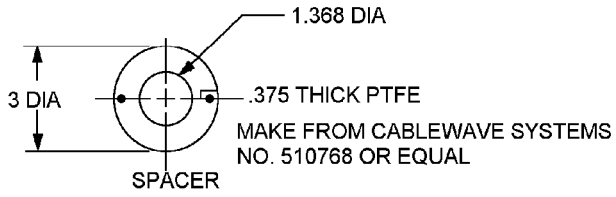
FIGURE A-1. Shield integrity test fixture.




DETAIL A

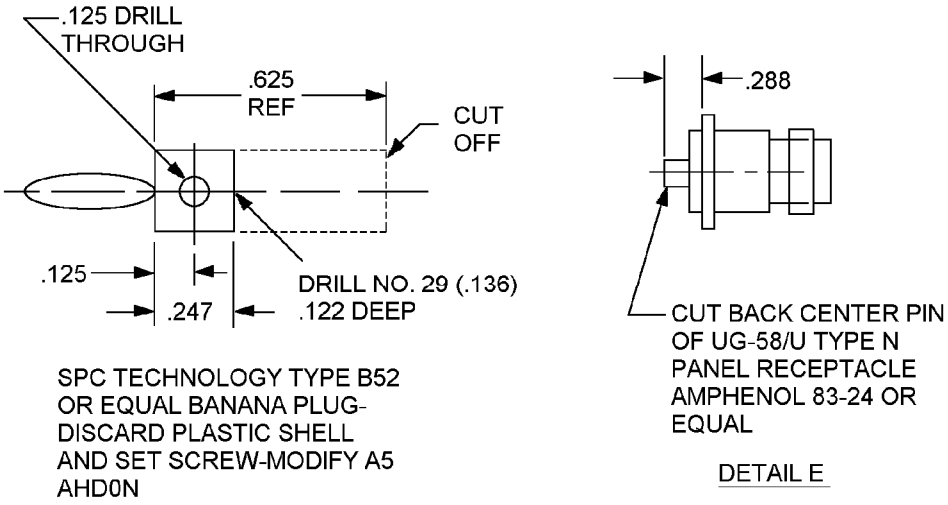


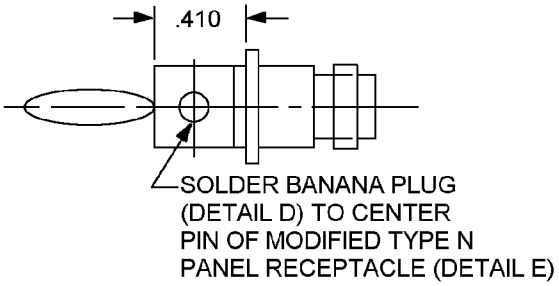

DETAIL B

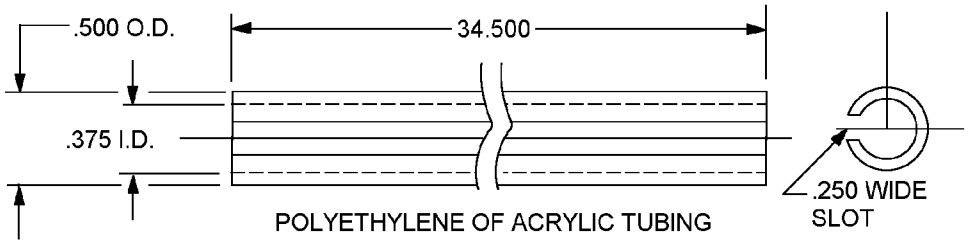



DETAIL C

FIGURE A-2. Shield integrity assembly components.

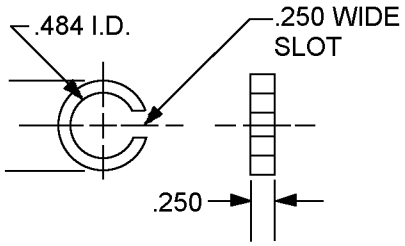



DETAIL G

FIGURE A-2. Shield integrity assembly components - Continued.




NYLON-3 REQUIRED

NO SCALE

DETAIL H

| Inches | mm | Inches | mm |
|---|---|---|---|
| .123 | 3.12 | .484 | 12.29 |
| .125 | 3.18 | .500 | 12.70 |
| .136 | 3.45 | 1.218 | 30.93 |
| .250 | 6.35 | 1.500 | 38.10 |
| .288 | 7.15 | 3.125 | 79.38 |
| .375 | 9.53 | 34.500 | 876.30 |
| .410 | 10.41 | | |

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

FIGURE A-2. Shield integrity assembly components - Continued.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - SH
Air Force - 11
DLA - CC

Review activity:
Army - MI

Preparing activity:
DLA - CC

(Project 6145-2007-037)

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