INCH-POUND

MIL-DTL-22931D
15 April 2013
SUPERSEDING
MIL-DTL-22931C
21 November 2003

DETAIL SPECIFICATION

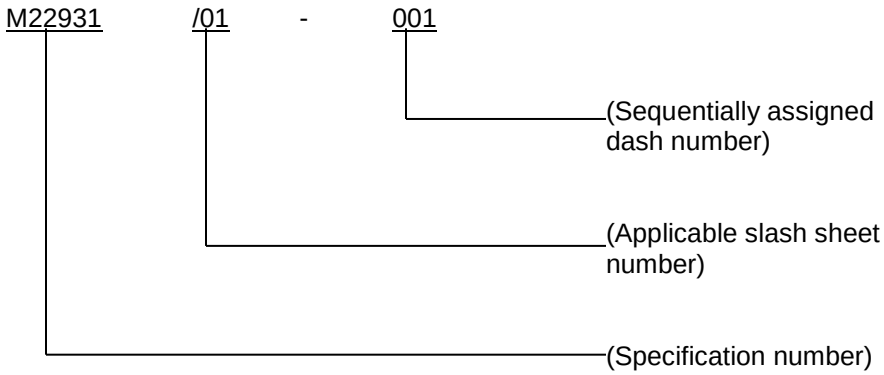
CABLES, RADIO FREQUENCY, SEMIRIGID, COAXIAL, SEMI-AIR-DIELECTRIC,
GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers semi-air-dielectric, coaxial, semirigid radio frequency cables with smooth, corrugated, or braided outer conductors with outside diameters ranging from .500 to 3.125 inches, with an impedance of 50 or 75 ohms (see 3.1). The operating temperature ranges are -55°C to +80°C or -55°C to +200°C, as specified (see 3.1), and the storage temperature capability is -65°C.

1.2 Part or Identifying Number (PIN). The PIN consists of the letter "M" followed by the specification number, the associated slash sheet number and the sequentially assigned dash number.



Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, Columbus, ATTN: VAI, P.O. Box 3990 East Broad Street, Columbus, Ohio 43216-5000 or email to RFConnector@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.dla.mil.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 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 documents cited in sections 3, 4, or 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 STANDARD

FED-STD-228 – Cable and Wire, Insulated, Method of Testing.

COMMERCIAL ITEM DISCRIPTION

A-A-59551 - Wire, Electrical, Copper (Un-insulated).

DEPARTMENT OF DEFENSE SPECIFICATION

MIL-R-39016/32 - Relays, Electromagnetic, DPDT, Low Level to 2 Amperes (Latching).

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130 - Identification Marking of U. S. Military Property.
MIL-STD-202 - Test Methods for Electronics and Electrical Component Parts.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(See supplement 1 for list of specification sheets.)

(Copies of these documents are available online at https://assist.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 B152/B152M - Copper Sheet, Strip, Plate, and Rolled Bar.
ASTM B188 - Standard Specification for Seamless Copper Bus Pipe and Tube.
ASTM B209 - Standard Specification for Aluminum-Alloy Sheet and Plate.
ASTM B210 - Standard Specification for Aluminum-Alloy Drawn Seamless Tubes.
ASTM B221 - Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Shapes, and Tubes.
ASTM B234 - Standard Specification for Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers.

ASTM D150 - Loss Characteristics (AC) and Permittivity (Dielectric Constant) of Solid Electrical Insulation.
ASTM D648 - Plastics, Deflection Temperature of, Under Flexural Load in the Edgewise Position.
ASTM D1248 - Polyethylene Plastics Extrusion Materials for Wire and Cable.

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

NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCSL)

NCSL-Z540.3 - Calibration Laboratories and Measuring and Test Equipment.

(Copies are available online at http://www.ncsli.org/ or from National Conference of Standards Laboratories [NCSL], 2995 Wilderness Place Suite 107, Boulder, Colorado 80301-5405.)

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 sheets. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Materials. The materials used in the construction of the cable shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the cable to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.2.1 Inner conductor. The inner conductor shall be solid or tubular as specified (see 3.1) and shall be in accordance with 3.2.1.1, 3.2.1.2, or 3.2.1.3.

3.2.1.1 Solid. Solid conductors shall be wire conforming to A-A-59551.

3.2.1.2 Tubular. Tubular conductors shall conform to the requirements of ASTM B188.

3.2.1.3 Tubular, with seam or weld. Tubular conductors, with seam or weld, shall be manufactured from copper strip that conforms to ASTM B152/B152M.

3.2.1.4 Joints. There shall be no joints in solid conductors made subsequent to the last drawing operation. Joints in the inner conductors shall be brazed or silver soldered using a nonacid flux, so that the diameter shall not be increased and there shall be no lumps or sharp projections.

3.2.2 Dielectrics. The dielectrics used in the construction of cables shall be as specified for each specified application (see 3.1), and shall be in accordance with 3.2.2.1, 3.2.2.2 or 3.2.2.3.

3.2.2.1 Polyethylene. Polyethylene shall be in accordance with ASTM D1248.

3.2.2.2 Polystyrene. Polystyrene tapes shall be made from biaxially oriented sheets of pure polystyrene, free from colorants or lubricants. In addition, the polystyrene shall have a minimum heat distortion temperature of 92°C, measured in accordance with ASTM D648; a dielectric constant of 2.5 at 1 x 10^6 hertz (Hz); and a dissipation factor of 0.0003 maximum at 1 x 10^6 Hz, both measured in accordance with ASTM D150.

3.2.2.3 TFE fluorocarbon. TFE fluorocarbon shall be polytetrafluoroethylene. The dielectric constant and dissipation factor (tangent of loss angle) shall not exceed 2.1 and 0.0003, respectively, when measured in accordance with ASTM D150.

3.2.2.4 Polypropylene. Polypropylene shall be acceptable, provided the manufacturer certifies the loss factor does not exceed 0.0012.

3.2.3 Outer conductors. The outer conductor (or shield) of the cable shall be braided, smooth, or corrugated metal tube, as specified (see 3.1), and shall be in accordance with 3.2.3.1 to 3.2.3.2.2. The conductor may be formed in any manner, provided the requirements of this specification are met.

3.2.3.1 Braid. The individual strands of the braid shall conform to A-A-59551.

3.2.3.2 Tubes and strips.

3.2.3.2.1 Aluminum. Aluminum tubes shall conform to the requirements of ASTM B210, ASTM B234 or ASTM B221, as applicable. Aluminum strips may be used to form tubes provided they meet the requirements of ASTM B209.

3.2.3.2.2 Copper. Copper tubes shall conform to the requirements of ASTM B188. Copper strips shall conform to the requirements of ASTM B152/B152M.

3.2.4 Jacket (when applicable). The jacket shall consist of a continuous sheet of polyethylene conforming to type I or II, class C of ASTM D1248.

3.2.4.1 Thickness. The minimum wall thickness of the jacket at any point shall be as specified (see 3.1).

3.3 Dimensions. The dimensions of the cables shall be as specified (see 3.1).

3.4 Electrical performance.

3.4.1 Continuity. When cables are tested as specified in 4.5.2, each conductor in each reel of cable shall be continuous.

3.4.2 Voltage withstand. When cables are tested as specified in 4.5.3, the completed cable shall withstand the potential specified (see 3.1) without breakdown.

3.4.3 Insulation defects, spark (when applicable, see 3.1). When cables with jackets are tested as specified in 4.5.4, the jacket shall be continuous without cracks, breaks or holes.

3.4.4 Insulation resistance. When cables are tested as specified in 4.5.5, the insulation resistance per 1,000 feet shall be not less than 100,000 megohms.

3.4.5 Attenuation. When cables are tested as specified in 4.5.6, the attenuation shall be as specified (see 3.1).

3.4.6 Velocity. When cables are tested as specified in 4.5.7, the velocity shall be as specified (see 3.1).

3.4.7 Capacitance. When cables are tested as specified in 4.5.8, the capacitance shall be as specified (see 3.1).

3.4.8 Impedance. When cables are tested as specified in 4.5.9, the impedance shall be as specified (see 3.1).

3.4.9 Voltage standing wave ratio (VSWR). When cables are tested in accordance with 4.5.10, the VSWR of the sample unit shall not exceed the value specified (see 3.1) as the initial VSWR. The connectors shall be included as part of the cable, and shall comply with the requirements specified herein.

3.5 Environmental.

3.5.1 Pressure tightness (when applicable, see 3.1). When tested as specified in 4.5.11, cables with smooth or corrugated outer conductors shall be capable of retaining the internal pressure specified (see 3.1), with a pressure drop of not more than 1 pound per square inch gage (psig) over a period of 24 hours.

3.5.2 Cold bend (when applicable, see 3.1). When specified, jacketed cable shall be tested as specified in 4.5.12, and there shall be no evidence of cracking or splitting of the cable jacket.

3.5.3 Bending (when applicable, see 3.1). When specified, finished cables shall be tested in accordance with 4.5.13. Following the test, the cable shall meet the requirements of 3.4.9 and 3.5.2. When the alternate procedure is used, there shall be no evidence of kinking, wrinkling or cracking.

3.5.4 Temperature cycling (when applicable, see 3.1). When specified, cables shall be tested as specified in 4.5.14. There shall be no evidence of mechanical damage, and the capacitance and VSWR shall be as specified (see 3.1).

3.5.5 Thermal shock (when applicable, see 3.1). When specified, cables shall be tested as specified in 4.5.15. There shall be no flaring of any layer, and unless otherwise specified (see 3.1), the measurements following exposure shall not vary from the original measurement by more than the following:

Core	- .125 inch (3.18 mm)
Insulating layer	- .375 inch (9.53 mm)
Outer conductor	- .125 inch (3.18 mm)
Outer jacket	- .750 inch (19.05 mm)

3.5.6 Vibration, high frequency (when applicable, see 3.1). When specified, cables shall be tested as specified in 4.5.16. There shall be no conductor discontinuity nor evidence of damage.

3.5.7 Shock (when applicable, see 3.1). When specified, cables shall be tested as specified in 4.5.17. There shall be no conductor discontinuity nor evidence of damage.

3.6 Marking. The cables shall be marked in accordance with MIL-STD-130 with the complete PIN, the manufacturer's code symbol, and the manufacturer's name, at least every 2 feet. The manufacturer's code symbol shall be in accordance with MIL-STD-1285. Marking shall not permanently indent, deform, or otherwise damage the jacket or outer conductor.

3.7 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.

3.8 Workmanship. Cables shall be processed in such a manner as to be uniform in quality and shall be free from any burrs, die marks, chatter marks, foreign material, and other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

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

a. Materials inspection (see 4.2).
b. Conformance inspection (see 4.4).

4.2 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table I, used in fabricating the cables, are in accordance with the applicable referenced specification or requirements prior to such fabrication.

TABLE I. Materials inspection.

Material	Requirement paragraph	Applicable specification
Wire and braid	3.2.1.1, 3.2.3.1	A-A-59551
Copper	3.2.1.3, 3.2.3.2.2	ASTM B152, ASTM B188
Polyethylene	3.2.2.1, 3.2.4	ASTM D1248, L-P-390
Polystyrene	3.2.2.2	ASTM D150, D648
TFE fluorocarbon	3.2.2.3	ASTM D150
Aluminum	3.2.3.2.1	ASTM B209, B210, B221, B234

4.3 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.

4.4 Conformance inspection.

4.4.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections. Except as specified in 4.4.2.1.5, delivery of products which have passed groups A and B inspections shall not be delayed pending results of the group C inspection.

4.4.1.1 Inspection lot. An inspection lot shall consist of all cable covered by a single specification sheet, produced under essentially the same conditions, and offered for inspection at the same time.

4.4.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table II, in the order shown.

TABLE II. Group A inspection.

Examination or test	Requirement paragraph	Test paragraph	Sampling plan
Subgroup I			
Visual and mechanical	3.1, 3.3, 3.6 and 3.7	4.5.1	See 4.4.1.2.1
Subgroup 2			
Continuity	3.4.1	4.5.2	100%
Voltage withstand	3.4.2	4.5.3	inspection
Insulation defects, spark (when applicable)	3.4.3	4.5.4	required
Insulation resistance	3.4.4	4.5.5	
Pressure tighteners (when applicable)	3.5.1	4.5.11	

4.4.1.2.1 Sampling plan. Statistical sampling and inspection for subgroup 1 shall be in accordance with table III, except that the number of sample units shall be not more than two times the number of reels in the inspection lot. No more than two sample units shall be selected from each reel of cable. When two sample units are required from one reel, they shall be cut from each end of the reel. For subgroup 2, each reel in the inspection lot shall be tested.

TABLE III. Sampling plan for group A and B inspections.

Inspection lot size Cable length (feet)	Sample units	Accept on (No. of failures)
0 to 16,000	5	
16,001 to 26,000	8	
26,001 to 64,000	13	
64,001 to 160,000	20	0
160,001 to 440,000	32	
440,001 to 2,200,000	50	
2,200,001 and over	80	

4.4.1.2.2 Sample unit. For subgroup 1, a sample unit is a piece of cable three feet in length and cut from the reel of cable. For subgroup 2, the complete length of cable on each reel shall be tested.

4.4.1.2.3 Defective unit. A defective unit is any sample unit failing any test in any test group. The reel of cable from which the sample unit was taken will be considered defective.

4.4.1.2.4 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for re-inspection. Such lots shall be separate from new lots, and shall be clearly identified as re-inspected lots.

4.4.1.2.5 Disposition of sample units. Sample units, and the reels of cable from which the sample units were taken which failed one or more of the inspections shall not be delivered on the contract or order. However, insulation defects, spark failures may be repaired or the cable cut at this point (see 4.5.4), and shipped.

4.4.1.3 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table IV, in the order shown, and shall be made on reels of cable which have been subjected to and have passed the group A inspection.

4.4.1.3.1 Sampling plan. The sampling plan shall be in accordance with table III.

TABLE IV. Group B inspection.

Test	Requirement paragraph	Test paragraph
Attenuation 1/	3.4.5	4.5.6
Velocity	3.4.6	4.5.7
Capacitance	3.4.7	4.5.8
Impedance	3.4.8	4.5.9
VSWR	3.4.9	4.5.10

1/ At all specified frequencies.

4.4.1.3.2 Sample unit. A sample unit is a piece of cable cut from the reel of cable and the length specified for the applicable test method.

4.4.1.3.3 Defective unit. A defective unit is any sample unit failing any test or inspection of table IV. The reel of cable from which the sample unit was taken will be considered defective.

4.4.1.3.4 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for re-inspection. Such lots shall be separate from new lots, and shall be clearly identified as re-inspected lots.

4.4.1.3.5 Disposition of sample units. Sample units and the reels of cable from which the sample units were taken may be delivered on the contract or order; if the sample units have passed all the group B inspection and the lot is accepted.

4.4.1.4 Periodic inspection. Periodic inspection shall consist of group C inspection.

4.4.1.4.1 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table V, 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.

TABLE V. Group C inspection.

Test	Requirement paragraph	Test paragraph
Cold bend (when applicable)	3.5.2	4.5.12
Bending (when applicable)	3.5.3	4.5.13
Temperature cycling (when applicable)	3.5.4	4.5.14
Thermal shock (when applicable)	3.5.5	4.5.15
Vibration, high frequency (when applicable)	3.5.6	4.5.16
Shock (when applicable)	3.5.7	4.5.17

4.4.1.4.2 Sampling plan. Sample units shall be selected from each 6-months' production of cable covered by a single specification sheet, in accordance with table VI, except that the number of sample units shall be not more than two times the number of reels in the inspection lot. No more than two sample units shall be selected from each reel of cable. When two sample units are required from one reel, they shall be cut from each end of the reel. The sample units shall be selected from different production runs throughout the 6-month period. No failures shall be permitted for group C inspection.

TABLE VI. Sampling plan for group C inspection.

Lot size Cable length (six months production)	Sample units
0 to 16,000	0
16,001 to 26,000	1
26,001 to 64,000	2
64,001 to 160,000	3
160,001 to 440,000	4
440,001 to 2,200,000	5
2,200,001 and over	8

4.4.1.4.3 Sample unit. A sample unit is a piece of cable cut from the reel of cable of the length specified for the applicable test method.

4.4.1.4.4 Defective unit. A defective unit is any sample unit failing any test or inspection of table V. The reel of cable from which the sample unit was taken will be considered defective.

4.4.1.4.5 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or purchase order. The reel from which the sample unit was taken may be shipped, if the sample unit was not defective, and the lot is accepted.

4.4.1.4.6 Noncompliance. If a sample fails to pass group C inspection, the supplier 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 materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until 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 re-instituted; however, final acceptance shall be withheld until the group C re-inspection has shown that the corrective action as successful. In the event of failure after re-inspection, information concerning the failure and corrective action taken shall be furnished to the contracting officer.

4.4.2 Inspection of preparation for delivery. Sample packages or packs and the inspection of the preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

4.4.3 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with NCSL Z540-3 or equivalent.

4.5 Methods of examination and test.

4.5.1 Visual and mechanical examination. The cable shall be examined to verify that the design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3, 3.6, and 3.7). A micrometer caliper or an instrument of equal accuracy shall be used to determine the proper dimensions.

4.5.2 Continuity (see 3.4.1). A direct current (dc) potential of 6 volts maximum shall be applied, through an appropriate indicator, to the inner and outer conductors of the reel of cable. The voltage may be applied to the conductors individually or in series.

4.5.3 Voltage withstand (see 3.4.2). The cables shall be tested in accordance with method 6111 of FED-STD-228, except that the cable shall not be immersed in water but shall be tested dry and the use of direct current (dc) voltage is acceptable. The following details shall apply:

a. The test shall be performed on completed cable only.
b. The test voltage shall be as specified (see 3.1).
c. The potential shall be applied to the inner conductor with the outer conductor grounded.

4.5.4 Insulation defects, spark (when applicable, see 3.4.3). Jacketed cables shall be tested in accordance with method 6211 of FED-STD-228. The following details shall apply:

a. The test voltage shall be a 60 Hz root-mean-square (rms) voltage as specified in table VII.
b. The potential shall be applied between the outer conductor and the outer surface of the jacket. A puncture of the jacket by the applied voltage shall constitute a point of failure. The cable may be cut at this point, or it may be repaired to the satisfaction of the Government.

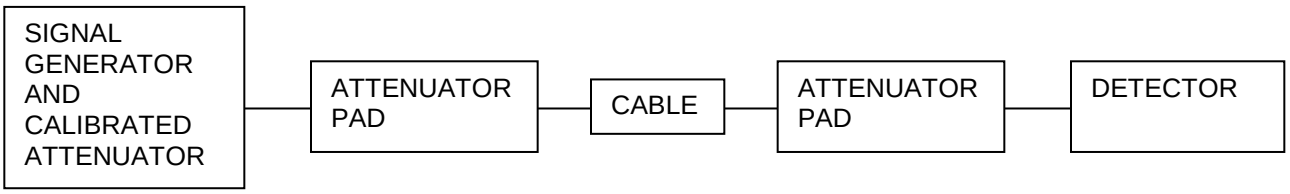
TABLE VII. Voltage for spark test.

Jacket thickness (minimum) (inch)	Voltage (rms)
0.035 (0.89 mm)	7,000
0.060 (1.52 mm)	9,000
0.065 (1.65 mm)	10,000

4.5.5 Insulation resistance (see 3.4.4). The cable shall be tested in accordance method 6031 of FED-STD-228, except that the cable shall not be immersed in water but shall be tested dry. The following details shall apply:

a. The test shall be performed on completed cable only.
b. The test voltage shall be not less than 200 volts.
c. The potential shall be applied to the inner conductor with the outer conductor grounded.

4.5.6 Attenuation (see 3.4.5). The attenuation, expressed in decibels (dB) per 100 feet, shall be measured at a sufficiently low-power level that the resulting temperature rise will be negligible. An acceptable method for measuring attenuation is as follows:



In the block diagram, a suitable length of cable with an attenuation greater than the measuring accuracy of the equipment is inserted between the connectors. The signal generator and calibrated attenuator are adjusted to produce a reasonable indication at the detector, when the detector is tuned. The detector reading is noted, and the calibrated attenuator output level is recorded. The cable under test is when withdrawn and the circuit completed with the connectors (or a very short length of cable). With the detector tuned, the calibrated attenuator is readjusted to reproduce the original reading at the detector and the attenuator output level is again recorded. Attenuation is then computed as follows:

$$A = \frac{100}{L} \text{ (Difference in calibrated attenuator reading in dB)}$$

Where:

A = Attenuation in dB per 100 feet.
L = Length of cable under test (in feet).

For measurement at frequencies of 400 megahertz (MHz), or less, the characteristic impedance of the attenuator pads and connectors shall preferably be the same as that of the cable under test. For measurement at frequencies of 1 GHz or above, the attenuator pads, connectors, and the test cable shall be matched to the same characteristic impedance. Both pads shall be high enough in attenuation value to minimize the error caused by the mismatch of the signal generator and detector. For the majority of measurements, it is recommended that the attenuation of each pad be approximately 10 dB. Tuning stubs may be used in the circuit for impedance matching purposes. Any other method approved by the procuring activity may be used in lieu of that described herein. When the attenuation of the cable under test is less than 1 dB at the test frequency, the attenuation may be measured by the short circuit method.

4.5.7 Velocity (see 3.4.6). The velocity of propagation is determined in terms of the percentage of velocity of wave propagation along the cable to the velocity of an electromagnetic wave in free space. The velocity of propagation in the cable shall be found by resonating a length of cable at a frequency between 10 and 200 MHz with one end short-circuited or open-circuited or by equivalent method subject to the approval of the procuring activity. The same sample may be used for velocity and capacitance measurements.

$$\text{Percent velocity} = \frac{\text{Fr. x length (ft)}}{2.46\ N}$$

Where:

Fr. = Resonant frequency in MHz
N = Number of quarter wavelengths in the cable

4.5.8 Capacitance (see 3.4.7). The capacitance of the cable shall be measured to three significant figures, at any one frequency between 1 kilohertz (kHz) and 1 MHz reported in picofarads (pf) per foot. An electrically short piece, that is less than 1/40 of a wavelength of cable, shall be used for this test.

4.5.9 Impedance (see 3.4.8). The characteristic impedance of cable shall be determined by calculation from the capacitance and the velocity propagation measurements using the following formula:

$$Zo = \frac{101{,}600}{\text{Velocity of propagation (\%)} * \text{Capacitance (pf/ft)}}$$

Velocity propagation and capacitance values shall be determined as specified in 4.5.7 and 4.5.8.

4.5.10 VSWR (see 3.4.9). The VSWR of a minimum length of 100 feet of cable shall be measured over the specified frequency range (see 3.1) using a swept frequency technique with capability of measuring a VSWR of 1.04 or less. The measurement system may be in the form of directional coupler(s), hybrid, or reflection coefficient bridge and shall have a directivity of at least 35 dB.

4.5.11 Pressure tightness (when applicable, see 3.5.1). The entire length of finished cable with smooth or corrugated outer conductor shall be pressurized with an internal pressure of 30 psig and the pressure drop shall be measured after a 24-hour period.

4.5.12 Cold bend (when applicable, see 3.5.2). Cables with jackets shall be tested in accordance with 4.5.12.1 or 4.5.12.2, as applicable.

4.5.12.1 Cables (1.625 inches (41.28 mm) nominal diameter or smaller). A section of finished cable, whose length shall be sufficient to make one revolution around a mandrel with a diameter as specified (see 3.1), shall be placed in a chamber and subjected to a temperature of -30°C ± 2°C for at least 12 hours. After this period, the cable shall be removed and immediately subjected to a 180° band around the mandrel specified. The cable shall be examined for visual evidence of cracking and breaks in the jacket.

4.5.12.1 Cables (larger than 1.625 inches (41.28 mm) nominal diameter). A section of finished cable, whose length shall be sufficient to make one-half revolution around a mandrel with a diameter as specified (see 3.1), shall be placed in a chamber and subjected to a temperature of -30°C ± 2°C for at least 12 hours. After this period, the cable shall be removed and immediately subjected at a 180° bend around the mandrel specified. The cable shall be examined for evidence of cracking and breaks in the jacket.

4.5.13 Bending (when applicable, see 3.5.3). Finished cables shall be tested in accordance with 4.5.13.1. When applicable, the alternate procedure, 4.5.13.2 may be used.

4.5.13.1 Procedure. The length of cable shall be sufficient to provide three complete coils around the mandrel specified (see 3.1). One end of the test cable shall be clamped circumferentially at any two points, approximately 45° apart, to the mandrel. The specimen shall then be coiled and uncoiled (the mandrel shall be rotated a minimum of 720°) give times. Although no special tools shall be used during the bending of the cable, a mechanism may be provided to guide the cable on the mandrel. The cable shall then be coiled and uncoiled at a rate between 1 and 5 revolutions per minute (rpm). After the fifth cycle, the sample shall be tested as specified in 4.5.10 and 4.5.12. VSWR may be measured on the sample while coiled.

4.5.13.2 Alternate procedure (for use with cables larger than 1.625 inches (41.28 mm) nominal diameter). The length of cable shall be sufficient to form 180° on the mandrel specified (see 3.1). The test cable shall then be subjected to 10 reverse bends of 180° each on the mandrel. After the fifth cycle, the sample shall be cut open and examined to verify that there is no kinking, wrinkling or cracking.

4.5.14 Temperature cycling (when applicable, see 3.5.4). Cables shall be tested in accordance with 4.5.14.1 or 4.5.14.2, as applicable.

4.5.14.1 Cables 1.625 inches (41.28 mm) nominal diameter and smaller). A length of cable with connectors properly attached, sufficient to make one complete 360° turn, shall be coiled on a mandrel of a diameter equal to the diameter specified (see 3.1). The mandrel with cable firmly attached shall be placed in a chamber and subjected to the temperature cycling specified in table VIII. After the cycling has been completed, the cable shall be tested as specified in 4.5.8 and 4.5.10.

4.5.14.2 Cables (larger than 1.625 inches (41.28 mm) nominal diameter). A length of cable with connectors properly attached, sufficient to make one-half revolution around a mandrel with a diameter as specified (see 3.1), shall be subjected to the temperature cycling specified in table VIII. After the cycling has been completed, the cable shall be tested as specified in 4.5.8 and 4.5.10.

TABLE VIII. Temperature cycling.

Step	-55°C to +80°C (°C)	-55°C to +200°C (°C)	Time (hours)
1	-55 ± 2	-55 ± 2	4 – 8
2	25 +10 -5	25 +10 –5	4 – 24
3	80 ± 2	200 ± 5	4 – 8
4	25 +10 -5	25 +10 –5	4 - 24

4.5.15 Thermal shock (when applicable, see 3.5.5). A piece of cable, 5 feet long shall be prepared by carefully removing 1 inch of insulation from each end. (For purpose of this test, insulation is defined as all layers of non-conducting material covering the electrical conductor, e.g., primary insulation, all tapes, and braids of the jacket). The specimen shall be formed into a loose coil not less than 1 foot in diameter and shall be laid on a screen for handling throughout the test (see 3.1). A razor blade, or equivalent, held perpendicular to the axis of the specimen shall be used to cut the insulation for the removal operation. The length of exposed conductor at each end of the specimen shall be measured to the nearest .125 inch (3.18 mm) or as specified (see 3.1). The test cable shall be placed for 30 minutes in a preheated air-circulating oven at the temperature specified (see 3.1). It shall then be removed from the oven and within 2 minutes placed in a chamber maintained at -55°C ± 2°C. The specimen shall be exposed to this temperature for 30 minutes. It shall be removed and stored for a minimum of 30 minutes at room temperature, 20° to 25°C. At the conclusion of this cycle, the distance from the end of each layer of insulation to the end of the conductor shall be measured to the nearest .125 inch (3.18 mm) (see 3.1). This thermal shock and the measurements shall be repeated for an additional three cycles (a total of four cycles). Cables shall be examined for flaring of any layer, and checked for measurement variations.

4.5.16 Vibration, high frequency (when applicable, see 3.5.6). Cables shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

a. Mounting of specimen – Secure one end of an appropriate length of cable (supported by three or less rigid clamps on each end) to a vibrating means while the other end is supported by a rigidly stationary surface. A foot of free cable length shall exist between the supporting surfaces. Each end shall describe a 180° nominal bend.
b. Test-condition letter – B, except 10-55 Hz.
c. Measurements – Short circuits shall be continually monitored throughout test with a detector applied by a latching relay, conforming to MIL-R-39016/32.

Cables shall be examined for damage.

4.5.17 Shock (when applicable, see 3.5.7). Cables shall be tested in accordance with method 202 of MIL-STD-202. The following details shall apply:

a. Mounting method and accessories – Three or less cable straps to provide as rigid support as possible.
b. Acceleration requirements – 15g.
c. Number of blows – 18 shocks, 3 in each of 3 mutually perpendicular directions.
d. Measurements after shock – Cables shall be examined for discontinuity and damage.

5. PACKAGING

5.1 Packaging requirements. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD 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 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 which may be helpful, but is not mandatory.)

6.1 Intended use. Cables covered by this specification are intended for use with military communication equipment and include two or more general installation classes: airborne, shipboard, and ground.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
c. Packaging requirements (see 5.1).

6.2.1 Indirect shipment. The preservation, packaging, packing, and marking requirements specified in section 5 apply only to direct purchases by or direct shipment to the Government and are not intended to apply contracts or orders between the supplier and prime contractor.

6.3 Connectors. Users are cautioned that connectors vary between cable type and the proper connector must be obtained for the cable type actually procured.

6.4 Cross reference. Cross reference information to former classification will be found on the individual specification sheets (see 3.1).

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. 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).

6.6 Subject term (keyword) listing:

Copper
Voltage standing wave ratio (VSWR)

6.7 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.

CONCLUDING MATERIAL

Custodians:
Army – CR
Navy – EC
Air Force – 85
DLA - CC

Preparing activity:
DLA – CC

(Project 6145-2013-016)

Review activities:
Army – AR, AT, AV, CR4, MI
Navy – AS, MC, OS
Air Force – 19

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 information above using the ASSIST Online database at https://assist.dla.mil.