INCH-POUND

MIL-DTL-3933K
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SUPERSEDING
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DETAIL SPECIFICATION

ATTENUATORS, FIXED, SPACE LEVEL, NON-SPACE LEVEL 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 the general requirements for radio and microwave frequency fixed attenuators, including chip, coaxial, leaded, and relay header attenuators (see 6.1). This specification provides three device level designators; a space level (T) part number is intended for space application, (S) screened and (N) non-screened part numbering are intended for all other applications (see 1.4).

1.2 Classification. Attenuators are of the following classes, specified in 6.2 and appendix B, table B-I though B-IV: Classification system categorizes attenuators having the same functional use but different requirements for performance.

Class I	-	For performance characteristic, see appendix B table B-I.
Class II	-	For performance characteristic, see appendix B table B-II.
Class III	-	For performance characteristic, see appendix B table B-III.
Class IV	-	For performance characteristic, see appendix B table B-IV.

1.3 Device substitutions. A device of higher classification type may be substituted for the same basic device of a lower classification type. Classification types, in descending order, are as follows: class I, class II, class III, and class IV. A device of higher designator level may be substituted for the same basic PIN devices of a lower designator level. Designator level, in descending order, are as follows: “T”, “S” and “N”. Any part(s) being used for substitution with procuring activity approval may retain its original marking, or the PIN may be remarked. Lot records should maintain traceability of any remarking.

1.4 Part or Identifying Number (PIN). The military PIN consists of the letter “M” followed by the basic number of the specification sheet, an assigned dash (see 3.1), and the letter N, S or T; where N indicates non-screened, S indicates screened items and T indicates space level. PINs without N, S, or T are considered non-screened items.

M 3933/14-	01	N	S	or	T
Military designator and specification sheet number	Dash number designated	Non-screened	Screened		Space level

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

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 and 4 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 (see 6.2).

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-3890	-	Lines, Radio Frequency Transmission (Coaxial, Air Dielectric) General Specification For.
MIL-H-28719	-	Header, Hermetically Sealed.
MIL-PRF-39012	-	Connectors, Coaxial, Radio Frequency, General Specification For.
MIL-DTL-55302	-	Connectors, Printed Circuit Subassembly and Accessories.
MIL-DTL-45204	-	Gold Plating, Electrodeposited.

(See supplement 1 for list of associated specification sheets.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130	-	Identification Marking of US Military Property.
MIL-STD-202	-	Electronic and Electrical Component Parts.
MIL-STD-790	-	Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications.
MIL-STD-883	-	Test Method Standard, Microcircuits.
MIL-STD-889	-	Dissimilar Metals.
MIL-STD-1276	-	Leads for Electronic Component Parts.

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

2.2.2 Other Government documents, drawing, and publications. The following other Government documents, drawings, and publications 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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA 1124	-	Outgassing Data for Selecting Spacecraft Materials.

(Hard copies of this document are no longer available from the NASA Goddard Materials Branch or the Document Automation and Production Service Detachment Office (DAPS). This information is only available at http://outgassing.nasa.gov.)

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 (see 6.2).

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.)

ASTM INTERNATIONAL

ASTM-A582/A582M	-	Free-Machining Stainless Steel Bars.
ASTM-B16/B16M	-	Free Cutting Brass Rod, Bar and Shapes, For Use in Screw Machines.
ASTM-B36/B36M	-	Brass Plate, Sheet, Strip, and Rolled Bar.
ASTM-B121/B121M	-	Leaded Brass Plate, Sheet, Strip, and Rolled Bar.
ASTM-B124/B124M	-	Copper and Copper Alloy Forging Rod, Bar, and Shapes.
ASTM-B194	-	Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
ASTM-B196/B196M	-	Copper-Beryllium Alloy Rod and Bar.
ASTM-B197/B197M	-	Copper-Beryllium Alloy Wire.
ASTM-B488	-	Electrodeposited Coating of Gold for Engineering uses.
ASTM-B700	-	Electrodeposited Coatings of Silver for Engineering.
ASTM-E595	-	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment .

(Copies are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA557	-	Statistical Process Control Systems.

(Copies are available online at http://www.eia.org or from Electronic Industries Alliance, Corporate Engineering Department, 2500 Wilson Boulevard, Arlington, VA 22201.)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE287	-	IEEE Standard for Precision Coaxial Connectors.

(Copies are available online at http://www.ieee.org or from IEEE Service Center, 445 Hoes Lane, P. O. Box 1331, Piscataway, NJ 08855-1331.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO10012	-	Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment.

(Copies are available online at http://iso.org or http://www.iso.org/iso/home.htm or from American National Standards Institute, 13th Floor, 11 West 42nd Street, New York, NY 10036-0350.)

SAE INTERNATIONAL (SAE)

SAE-AMS2422	-	Plating, Gold.
SAE-AMS4375	-	Sheet and Plate, Magnesium Alloy (3.0 Al - 1.0 Zn - 0.20 Mn) (AZ31B-0) Annealed and Re-crystallized.
SAE-AMS4376	-	Plate, Magnesium Alloy (3.0 Al - 1.0 Zn - 0.20 Mn (AZ31B-H26)), Cold Rolled and Partially Annealed.
SAE-AMS4377	-	Sheet and Plate, Magnesium Alloy (3.0 Al - 1.0 Zn - 0.20 Mn) (AZ31B-H24), Cold Rolled, Partially Annealed.
SAE-AMS2404	-	Nickel, Electroless, Plating.
SAE-AMS QQ-N-29	-	Nickel Plating (Electrodeposited).

(Copies are available online at http://www.sae.org. or from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

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

3.2 Qualification. Attenuators furnished under this specification shall be products qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5, 6.3 and appendix C).

3.2.1 Qualified Product List (QPL) system. The manufacturer shall establish and maintain a QPL system for parts covered by this specification. Requirements for this system are specified in MIL-STD-790 (all product levels, see 4.1). In addition, the manufacturer shall either establish a Statistical Process Control (SPC) system that meets requirements of 3.2.2 below, or employ Statistical Quality Control (SQC) techniques as described in 3.2.3 below.

3.2.2 SPC system. As part of the overall MIL-STD-790 QPL system, the manufacturer shall establish a SPC system that meets the requirements of EIA557 (see 4.1).

3.2.3 SQC techniques. As an alternative to establishing an SPC system, the manufacturer may, with qualifying activity approval (see 6.3), employ various SQC techniques (such as trend charts, Pareto charts, run charts, check charts, histograms, and flow charts).

3.3 Material. The material shall be as specified herein and in the applicable specification sheets. When a definite material is not specified, a material shall be used which will enable the attenuator 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. In addition, for space level only, materials used in the manufacturing of the attenuator shall meet the outgassing requirement (see 3.3.8).

3.3.1 Brass. Brass shall conform to ASTM-B16/B16M, ASTM-B36/B36M, ASTM-B121/B121M, or ASTM-B124/B124M.

3.3.2 Copper alloy. Copper alloy used in the fabrication of coaxial-type attenuators shall conform to the material requirements specified in MIL-DTL-3890.

3.3.3 Copper-beryllium. When specified, copper-beryllium alloy shall conform to ASTM-B194, ASTM-B196/B196M, or ASTM-B197/B197M.

3.3.4 Magnesium alloy. Magnesium alloy shall be composition AZ31B, condition H24, conforming to SAE-AMS4375, SAE-AMS4376, and SAE-AMS4377. When specified (see 3.1 and 6.2), magnesium attenuators shall be supplied. Magnesium shall not be used for space application unless coated with an approved finish to prevent corrosion. Maximum sustained tensile stresses for magnesium shall be limited to less than 50 percent of yield strength.

3.3.5 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals (see MIL-STD-889) shall not be used in intimate contact with each other. Dissimilar metals are defined as metal specimens that are in contact or otherwise electrically connected to each other in a conductive solution that generate an electric current.

3.3.6 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of radio and microwave frequency fixed attenuator components and of solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum 3 percent lead, by mass (see 6.7).

3.3.7 Gold plating (space level only). Connector center contacts shall meet the requirements in 3.4.3.2 herein. All other copper, copper beryllium, or brass surfaces shall be gold plated to a minimum gold thickness of 50 micro inches in accordance with MIL-DTL-45204, Type II Grade C over 100 micro inches minimum of electrodeposited nickel in accordance with SAE-AMS QQ-N-290 or over 100 micro inches minimum of electroless nickel in accordance with SAE-AMS2404. Electroless nickel shall not be used on any components that are required to flex. A baking test accordance with MIL-DTL-45204 shall be performed on 2 percent or two samples from each plating lot, whichever is greater. For applications where the component is required to flex, in addition to the baking test, a bend test in accordance with MIL-DTL-45204 shall be performed on 2 percent or two samples from each plating lot, whichever is greater. A cutting test in accordance with MIL-DTL-45204 may be substituted when the bend test is not feasible.

3.3.8 Outgassing (space level only). When examined as specified in 4.7.16, the number of samples (see Table II or Table V) shall meet the following requirements:

a. Total Mass Loss (TML) shall not exceed 1 percent.

b. Volatile Condensable Material (VCM) shall not exceed 0.1 percent.

3.3.8.1 Outgassing test data (see 2.2.2). Data listed in NASA Publication 1124 may be used in lieu of actual test data for applicable materials. The material shall be assessed prior to use. The actual material shall be exactly the same manufacturers, constituent material, manufacturing processes/procedures, and manufacturing equipment/plants, as the one that is listed.

3.4 Design and construction. Attenuators shall be of the design, construction, and physical dimensions specified (see 3.1). Attenuators shall be of the lightest practicable weight consistent with the strength required for sturdiness, safety, and reliability.

3.4.1 Operating frequency range. The frequency range shall be as specified (see 3.1).

3.4.2 Nominal impedance. The nominal impedance for attenuators shall be as specified (see 3.1).

3.4.3 Connectors.

3.4.3.1 Connector bodies. Unless otherwise specified (see 3.1) the connector material shall conform to the requirements in paragraph 3.3. The material and gauging for receptacle socket contact (female) and for pin contact (male) connectors shall conform to the requirements of MIL-PRF-39012. Male connectors shall meet the coupling proof torque, contact push, contact retention and rotational contact retention requirements. Female connectors shall meet requirements for engaging/disengaging forces, contact retention and rotational contact retention. When specified (see 3.1), precision connectors shall be in accordance with IEEE287.

3.4.3.2 Connector center contacts. Unless otherwise specified, the male center contact pins shall be made of corrosion resisting steel, type 302 or 304 (see 6.5), type 303 in accordance with ASTMA582/A582M or beryllium copper, conforming to ASTM-B194, ASTM-B196/B196M, or ASTMB197/B197M. Beryllium copper parts shall be plated with 99 percent gold in accordance with SAE-AMS2422, ASTM-B488, or MIL-DTL-45204, over 100 micro inches minimum of nickel plate. Stainless steel parts shall be silver plated in accordance with ASTM-B700, type II, grade A, or gold plated with 99 percent gold in accordance with SAE-AMS2422, ASTM-B488, or MIL-DTL-45204. The female center contact pins shall be made of beryllium copper, conforming to ASTM-B194, ASTM-B196/B196M, ASTM-B197/B197M and when specified (see 3.1), gold plated in accordance with SAE-AMS2422, ASTM-B488, or MIL-DTL-45204 with 99 percent gold minimum, Knoop hardness 130-300, inclusive, 50 micro inches (0.0013 mm) minimum gold thickness over 100 micro inches minimum of nickel plate. Nickel is used only when specifications cannot be met using alternate material means (see appendix C). For gold plated contacts, a baking test shall be performed in accordance with MIL-DTL-45204 on 2 percent or two samples from each plating lot, whichever is greater.

3.4.3.3 Printed circuit connectors. Printed circuit connectors for a specific attenuator shall conform to MIL-DTL-55302.

3.4.4 Leads. Unless otherwise specified, lead connections for a specific attenuator shall be a chemical composition conforming to MIL-STD-1276 and shall be solderable.

3.4.5 Socket pins. Socket pins for a specific attenuator shall conform to MIL-H-28719 as applicable.

3.4.6 Weight. The weight for attenuators shall be as specified (see 3.1).

3.4.7 External finish. The external finish of attenuators shall be as specified (see 3.1).

3.4.8 Temperature range. Operating/non-operating temperature range shall be as specified (see 3.1).

3.4.9 Resistor cards.

3.4.9.1 Resistive elements. Resistive elements shall either be protected against degradation or shall be made of materials that are not susceptible to moisture or corrosion. Unpassivated Nichrome elements are prohibited.

3.4.9.2 Passivation of resistive element. Passivation of the attenuator element shall maintain its physical, electrical, and mechanical properties over the specified humidity, temperature, and frequency range. The properties of low-out-gassing passivation used for space level attenuators shall be subjected to the testing and verification procedures of ASTM-E595.

3.4.10 Breakaway torque (coaxial body style with threaded connectors: S and T level devices only). Attenuators shall be tested as specified in 4.7.17. The connector junction in the connector body shall not be moved by a torque less than specified in 4.7.17. The torque stripe (see 3.6.4) shall be examined as evidence the attenuator joint has not moved.

3.5 Performance.

3.5.1 Screening (see 4.7.2). All screened attenuators produced to this specification shall be screened in accordance with Table III in the order shown. After screening, the attenuator shall be subjected to and pass group A inspection (see 4.6.1.5). Screening requirements shall consist of 3.5.1.1 through 3.5.1.7.

3.5.1.1 Thermal shock. Screen attenuators in accordance with 4.7.2.1.

3.5.1.2 Pre-conditioning electrical. Screen attenuators in accordance with 4.7.2.2.

3.5.1.3 Conditioning. Screen attenuators in accordance with 4.7.2.3.

3.5.1.4 Post-conditioning electrical. Screen attenuators in accordance with 4.7.2.4. Attenuators shall pass the delta limit criteria of 4.7.2.4.

3.5.1.5 Monitored thermal cycling (space level only). Monitored thermal cycling shall be in accordance with 4.7.2.5 and shall satisfy all detail criteria listed in 4.7.2.5.

3.5.1.6 Peak power. Peak power shall be in accordance with 4.7.11.7.

3.5.1.7 Radiographic. Screen attenuators in accordance with 4.7.2.6. Results shall satisfy all detail criteria listed in 4.7.2.6. Space level attenuators shall be screened in accordance with 4.7.2.6 and 4.7.2.6.1.

3.5.2 Coaxial connector wear resistance. When attenuators with coaxial connectors are tested as specified in 4.7.3, there shall be no damage to the connectors that will cause electrical failure. During and after cycling, neither lubrication nor removal of excess material shall be permitted. After this test, attenuators shall meet the requirements of 3.5.3 and 3.5.4.

3.5.3 Voltage standing wave ratio (VSWR) (at either end). When attenuators are tested as specified in 4.7.4, the VSWR at room temperature shall not exceed the value specified.

3.5.4 Attenuation. When attenuators are tested as specified in 4.7.5, the attenuation at room temperature shall be as specified. The deviation from nominal value shall not exceed the applicable value in the specification sheet (see 3.1).

3.5.5 Electromagnetic interference (RF leakage) (for coaxial attenuators). When attenuators are tested as specified in 4.7.6, the RF leakage from the attenuator shall be at least 65 dB below the incoming signal level.

3.5.6 Coaxial connector repeatability. After attenuators are tested as specified in 4.7.7, the variation of attenuation shall not exceed the applicable value in the specification sheet (see 3.1).

3.5.7 Solderability (as applicable). When attenuators with solderable connections are tested as specified in 4.7.8, there shall be no evidence of pinholes and blistering.

3.5.8 Terminal strength/lead integrity (as applicable). When attenuators with terminals or leads are tested as specified in 4.7.9, there shall be no evidence of a broken terminal or lead, elongation greater than one-half of the thread pitch, or breakage, loosening, or relative motion between the terminals and the attenuator body when viewed through a magnification of at least 10X. Any of these shall be a failure.

3.5.9 Resistance to solvents. When attenuators are tested as specified in 4.7.10, there shall be no evidence of illegible marking, mechanical damage, or deterioration of material or finishes to the extent that they can be readily identified from a distance of at least six inches with normal room lighting and without the aid of magnification or with a viewer having a magnification no greater than 3X.

3.5.10 Stability of attenuation. When attenuators are tested as specified in 4.7.11, the attenuation change after temperature change, thermal shock, vibration, shock, moisture resistance, salt spray or peak power shall not exceed the applicable value specified in the specification sheet (see 3.1). After the salt spray test, there shall be no evidence of corrosion or pitting.

3.5.11 Sensitivity of attenuation. When computed as specified in 4.7.12, the sensitivity of attenuation of attenuators with frequency, with power, and with temperature shall not exceed the maximum sensitivity of attenuation specified in the appropriate specification sheet.

3.5.12 Life test. When attenuators are tested as specified in 4.7.13, the attenuation change shall not exceed the value that was measured for temperature stability under 3.5.4.

3.5.13 Force to engage/disengage. When attenuators are tested as specified in 4.7.14, the torque necessary to completely couple or uncouple the connectors shall not exceed that specified in the applicable specification sheet of MIL-PRF-39012 (see 3.1).

3.5.14 Coupling proof torque. When attenuators are tested as specified in 4.7.15, the coupling mechanism shall not be dislodged and the connector interface dimensions shall remain as specified in the applicable specification sheet of MIL-PRF-39012 (see 3.1).

3.6 Marking. Attenuators shall be marked in accordance with MIL-STD-130, with the class (see 1.2), military PIN (see 1.4), manufacturer's source code or logo, attenuation in dB, frequency range, average power rating, date code, and serialization. When available marking space is less than .15 square inches (97 square millimeters), the following criteria may be deleted from marking in the following order, but only as space restrictions require: average power rating, frequency range, class, and attenuation. Marking characters shall be at least .031 inch (0.79 mm) high. The marking shall be placed on the attenuator using a method providing legible and permanent marking for the life of the attenuator. The marking location is optional. Marking locations indicated in individual slash sheets are suggested locations. When practicable, a location shall be picked that will be least likely to be covered in attenuator installation. The marking shall remain legible after Group A and screening (when applicable). If indelible ink is used to mark space level attenuators, it shall meet the outgassing requirements of 3.3.8.

Class III	-	Class (I, II, III or IV)
M3933/25-01S	-	Military PIN
12345	-	Manufacturer's source code or logo
1133	-	Date code
XXXX	-	Serialization

3.6.2 Date code. Attenuators shall be marked by a unique code to identify the period during which they were assembled. The first two numbers in the code shall be two digits of the number of the year, and the third and fourth number shall be two digits indicating the calendar week of the year. When the number of the week is a single digit, it shall be proceeded by a zero reading from left to right or from top to bottom, the code number shall designate the year and week, in that order. The date code shall not be altered or removed from the attenuator.

3.6.3 Serialization. Each attenuator shall be marked with a unique serial number assigned consecutively within the inspection lot allowing traceability of the attenuator. Space level devices shall contain lot traceability on all parts from the time the lot is assembled to the time it is accepted.

3.6.4 Torque stripe (S and T level devices only). A torque stripe shall be applied over the joint where threaded sub-assemblies meet the attenuator body. When a torque stripe is not visible at all times, it shall be visible if failure analysis to be performed on the attenuator.

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. Attenuators shall be processed in such a manner as to be uniform in quality and shall be free from sharp edges and burrs, except where sharp edges are required for mechanical or electrical reasons.

4. VERIFICATION

4.1 Test equipment, inspection facilities, QPL, and SPC/SQC systems. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the contractor. Establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with NCSL-Z540.3 or ISO10012. Establishment and maintenance of a QPL system shall be in accordance with MIL-STD-790. Establishment and maintenance of a Statistical Process Control (SPC) system, as appropriate and determined by the manufacturer, shall be in accordance with EIA557 (see 3.2.1 and 3.2.2). With qualifying activity approval (see 6.3), various Statistical Quality Control (SQC) techniques (such as trend charts, Pareto charts, run charts, check sheets, histograms and flow charts) may be used in lieu of an SPC system.

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

a. Material inspection (see 4.3).

b. Qualification inspection (see 4.5).

c. Conformance inspection (see 4.6.1).

d. Periodic inspection (see 4.6.2 and 4.6.3).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table I and 4.3.1, used in fabricating the attenuator, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

TABLE I. Materials inspection.

Material	Requirement paragraph	Applicable specification
Brass	3.3.1	ASTM-B16/B16M, ASTM-B36/B36M, ASTM-B121/B121M, ASTM-B124/B124M
Copper alloy	3.3.2	MIL-DTL-3890
Copper-beryllium	3.3.3	ASTM-B194, ASTM-B196/B196M, ASTM-B197/B197M
Magnesium alloy	3.3.4	SAE-AMS4375, SAE-AMS4376, SAE-AMS4377

4.3.1 Resistor card inspection (space level only). Each resistor card shall be visually inspected from each inspection lot in accordance with appendix D of this specification.

4.4 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.

4.4.1 Test method variation. Variation from the specified test methods used to verify the electrical parameters is allowed provided that it is demonstrated to the preparing activity or their agent that such variations in no way relax the requirements of this specification and that they are approved before testing is performed. For proposed test variations, a test method comparative error analysis shall be made available for checking by the preparing activity or their agent.

4.5 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. The procedures for qualification inspection and qualification for each group are defined under appendix A.

4.5.1 Sample. The number of sample units to be submitted for qualification inspection shall be as specified in table II and A 3.1.1 to this specification.

4.5.2 Failures. One or more failures shall be cause for refusal to grant qualification approval. A failure shall be anything that does not meet the requirements of the specification.

4.5.3 Extension of qualification. Qualification obtained for each group shall constitute qualification for all attenuators with characteristics for that group (see table A-II). Each space level attenuator style shall be qualified separately, unless group qualification is applicable (see table A-I). Appendix C establishes qualification inspection requirements for radio and microwave frequency surface mount chip attenuators for use in established reliability electronic applications.

4.5.4 Disposition of qualification sample units. Sample units which have been subjected to qualification testing shall not be delivered on any contract or purchase order. The Government reserves the right to retain the sample units or to require the contractor to furnish the sample units with the qualification inspection report.

TABLE II. Qualification inspection.

Inspection	Requirement	Test method	Device level and number of samples (reject quantity)		
			N	S	T
Certification requirements					ASTM-E595
Outgassing	3.3.8	4.7.16	------	----	3 (0)
Material	3.3	4.3	Required	Required	Required
Group I			All sample units		
			N=11	S=22	T=45
Screened in accordance with table III	3.5.1	4.7.2	---	Required	Required
Visual and mechanical examination	3.1, 3.3, 3.4, 3.6, 3.8	4.7.1	Required	Required	Required
Coaxial connector wear resistance: 1/	3.5.2	4.7.3			
VSWR	3.5.3	4.7.4	Required	Required	Required
Attenuation	3.5.4	4.7.5			
Life test: 1,000 hours	3.5.12	4.7.13	2 (0)	5 (0)	10 (0)
Group II					
Stability of attenuation	3.5.10				
With temperature change		4.7.11.1			
After thermal shock		4.7.11.2	3 (0)	5(0)	10 (0)
After vibration		4.7.11.3			
After shock		4.7.11.4			
After moisture resistance		4.7.11.5			
After salt atmosphere		4.7.11.6			
After peak power		4.7.11.7			
Extended monitored thermal cycling 100 cycles (space level only)	3.5.1.5	4.7.2.5	------	------	5 (0)
Sensitivity of attenuation	3.5.11	4.7.12			
After change in frequency					
After change in input power					
After change in temperature			3 (0)	5 (0)	5 (0)
Resistance to solvents	3.5.9	4.7.10			
Monitored (space level only)					
Vibration, 3 axes	----	4.7.18			
Shock, 6 directions	-----	4.7.19			
Visual and mechanical examination	3.1, 3.3, 3.4, 3.6, 3.8	4.7.1			
Breakaway torque	3.4.10	4.7.17	-------	2 (0)	4 (0)
Group III	3.5.5				
Electromagnetic interference RF leakage 1/	3.5.6	4.7.6			
Coaxial connector repeatability:	3.5.4	4.7.7			
Attenuation 1/	3.5.7	4.7.5			
Solderability 2/	3.5.8	4.7.8			
Terminal strength/lead integrity 3/	----	4.7.9			
Endpoints:	3.5.13	----			
Force to engage/disengage	3.5.14	4.7.14			
Coupling proof torque	3.5.4	4.7.15	3 (0)	5 (0)	11 (0)
Attenuation	--	4.7.5			
DC Resistance	---	4.7.2.2.1			
VSWR	3.5.3	4.7.4			
Monitored (space level only)		----			
thermal cycling	3.5.1.5,	4.7.2.5,			
vibration	----	4.7.18			
Visual and mechanical examination	3.1, 3.3, 3.4,3.6, 3.8	4.7.1			

1/ Coaxial types of attenuator.
2/ Attenuators with solderable leads or terminal.
3/ Attenuators with leads or terminal.

4.5.5 Retention of qualification. To retain qualification, the manufacturer shall forward a report at 12 month intervals for space level (see table V) and 24 month intervals for non-space level (see table VI) to the qualifying activity (see 6.3). For continued retention of QPL status for the space level (T) attenuators, the manufacturer shall certify the maintenance of the test capability and lot control system necessary for testing space level (T) attenuators. The manufacturer's system shall address the elements described in MIL-STD-790 and shall be maintained such that the qualifying activity can verify and validate those elements. The qualifying activity shall establish the initial reporting date. The following requirements shall be met:

a. A summary of the results of the tests performed for inspection of product for delivery (group A), indicating as a minimum the number of attenuators that have passed and the number that have failed. The results of the tests of all reworked attenuators shall be identified and accounted for.

b. Periodic group B inspection requirements are met for space level only (see table V).

c. Periodic group C inspection requirements are met for non space level only (see table VI). A summary of the results of tests performed for periodic inspection (group C), including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 24 month period. If the summary of test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action shall be taken to remove the failing product from the qualified products list.

d. Design of attenuator has not been modified.

Failure to submit the report within 60 days after the end of each 12 month period for space level and 24 month period for non space level shall result in loss of qualification for the product. In addition to the periodic submission of inspection data, the manufacturer shall immediately notify the qualifying activity at any time during the12 month period for space level and 24 month period non space level that the inspection data indicates failure of the qualified product to meet the requirements of this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the manufacturer still has the capabilities and facilities necessary to produce the attenuators. If during the two consecutive reporting periods there has been no production, the manufacturers may be required, at the discretion of the qualifying activity, to submit his qualified products to testing in accordance with the qualification inspection requirements and the reason for no production.

4.6 Conformance inspection.

4.6.1 General. Conformance inspection shall consist of group A inspection, and screening (when applicable). Group B inspection (see table V) and Group C (see table VI) inspection shall be performed under periodic inspection. Appendix C establishes requirements for conformance inspection of radio and microwave frequency surface mount chip attenuators for use in established reliability electronic applications.

4.6.1.1 Inspection of product for delivery.

4.6.1.1.1 Non-space level attenuator. The manufacturer's inspection system shall be used for preparation for delivery. Inspection of product for delivery shall consist of screening (when applicable), and group A inspection.

4.6.1.1.2 Space level attenuator. Inspection of product for delivery shall consist of screening (table III) and group A inspections, and shall be performed on a production lot basis. Test deletion or reduction, which may be granted for non-space level product, is not allowed for space level product.

4.6.1.2 Inspection lot. An inspection lot shall consist of all attenuators with the same PIN (attenuation value/dB) produced under essentially the same conditions, and offered for inspection at one time. Space level lots shall be kept separate from non-space level lots. Inspection lot formation shall be one week for space level and one month for non space level devices.

4.6.1.3 Production lot. A production lot shall consist of a style of attenuators manufactured during the same period from the same lot materials, under the same specifications and procedures. These attenuators shall be produced using the same processes and process equipment. The manufacturer's documentation shall define the qualified production system through all significant manufacturing operations, including final assembly. Space level lots shall be kept separate from non-space level lots.

4.6.1.4 Screening. Screening shall consist of the examination and tests specified in table III in the order shown. Attenuators shall pass screening before being subjected to group A inspection.

TABLE III. Screening.

Inspection	Requirement paragraph	Test method paragraph	PDA (Percent Defect Allowable)	
			S	T
Thermal shock	3.5.1.1	4.7.2.1	-----	----
Monitored thermal cycling 2/ Parts and assembly verification 2/	3.5.1.5	4.7.2.5 4.7.2.5.1	---	5% or 2 whichever is greater
Pre-conditioning electrical: DC resistance VSWR Attenuation	3.5.1.2 ----- 3.5.3 3.5.4	4.7.2.2 4.7.2.2.1 4.7.2.2.2, 4.7.4 4.7.2.2.3, 4.7.5	-----	------
Conditioning	3.5.1.3	4.7.2.3	10% or 1 whichever is greater	5% or 1 whichever is greater
Post-conditioning electrical: DC resistance VSWR 1/ Attenuation 1/	3.5.1.4 ------- 3.5.3 3.5.4	4.7.2.4 4.7.2.2.1 4.7.2.2.2, 4.7.4 4.7.2.2.3, 4.7.5	10% or 1 whichever is greater	5% or 1 whichever is greater
Stability of attenuation: 3/ After peak power	3.5.1.6	4.7.11.7	10% or 1 whichever is greater	5% or 1 whichever is greater
Radiographic inspection	3.5.1.7	4.7.2.6	---	-----

1/ These tests will satisfy VSWR and attenuation conformance inspection in Group A prior to stability of attenuation: after peak power.
2/ Space level only.
3/ Screening and group A after Peak Power measurements may be performed concurrently.

4.6.1.5 Group A inspection. Group A inspection shall consist of the examination and tests specified in table IV, in the order shown.

TABLE IV. Group A inspection. 1/

Inspection	Requirement	Test method
Visual and mechanical examination	3.1, 3.3, 3.4, 3.6, and 3.8	4.7.1
VSWR	3.5.3	4.7.4
Attenuation	3.5.4	4.7.5
Stability of attenuation: After peak power	3.5.10	4.7.11.7

1/ Post-conditioning (screening) and group A VSWR and attenuation measurements may be performed concurrently.

4.6.1.6 Hundred-percent inspection. All screened and space level attenuators shall be subjected to screening and group A inspection. All non-screened attenuators shall be subjected to group A inspection. Defective units shall be individually rejected. The rejection criteria for space level device shall be zero except for screening. The PDA requirements shall be met (see table III) in order for the lot to be accepted after screening.

4.6.1.7 Rejected items. If an inspection item is rejected, the manufacturer may rework to correct the defect and resubmit for re-inspection. Such items shall be separate from new items and shall be clearly identified as re-inspected items. Space level parts shall not be reworked after formal testing has begun except for marking.

4.6.1.8 Test data. Data shall be taken and recorded for screened and space level devices and sent to the procuring activity only when it is specified in the acquisition document (see 6.2). Manner of performing measurements and data sheets shall be included and shipped in the same container as the attenuator. No classified information shall appear on data sheet.

4.6.2 Periodic group B inspection (Space level only)

4.6.2.1 Group B inspection. Group B inspection shall consist of the inspections specified in table V in the order shown and shall be performed on samples from lots which have been subjected to and have passed screening and group A inspection. Group B inspection shall be performed on inspection lot formation.

TABLE V. Group B inspection (space level only)

Inspection	Requirement	Test method	Number of samples
Life test : 1000 hours	3.5.12	4.7.13	10 (0)
Extended monitored thermal cycling 100 cycles	3.5.1.5	4.7.2.5	10 (0)
Breakaway torque	3.4.10	4.7.17	5 (0)
Monitored Vibration, 3 axes Shock, 6 directions	------ ------	4.7.18 4.7.19	10 (0)
Moisture resistance	------	4.7.11.5	5 (0)
Resistance to Solvents	3.5.9	4.7.10	5 (0)

4.6.2.2 Sampling plan. A minimum of 45 sample units shall be required for group B inspection selected every 12 months. Sample units shall be divided according to table V and subjected only to inspection indicated for the particular inspection.

4.6.2.3 Failures. If one or more sample units fail to pass group B inspection, the sample shall be considered to have failed. Failures during group B shall be reported to the procuring activity and to the qualifying activity. The procuring activity shall determine the action to be taken, depending on the nature of the failure mode. Sample units that failed group B inspection shall not bear part numbers according to this specification.

4.6.2.4 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on contract.

4.6.3 Periodic group C inspection (Non space level only).

4.6.3.1 Periodic Group C inspection. Group C inspection shall consist of the inspections, specified in table VI in the order shown. As depicted in table VI, samples shall be tested at temperature extremes (see 3.1) in accordance with requirements for stability of attenuation with temperature change or sensitivity of attenuation after change in temperature (see Table VI). Temperature extreme tests inclusion in table VI represents each sample's requirement to endure temperature extreme testing. Group C inspection shall be made on sample units selected from inspection lots which have passed screening and group A inspection.

4.6.3.2 Sampling plan. The number of sample units shall be selected every 24 months and shall be defined in table VI. A minimum sample consisting of 11 for non screened and 22 for screened devices shall be required and divided into groups according to table VI. The units shall then be subjected only to the inspections indicated for their particular group. The first inspection shall be 24 months after the date of notification of qualification.

4.6.3.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on contract.

4.6.3.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and cognizant inspection activity of such failure and shall take corrective action on the material 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 and processes, and which are considered subject to the same failure. Acceptance and shipment 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 inspections, or the inspection which the original sample failed) at the option of the qualifying activity (see 6.3). Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group C inspection has shown that corrective action was successful. In the event of failure after inspection, information concerning the failure and the corrective action taken shall be furnished to the cognizant inspection activity and to the qualifying activity (see 6.3).

TABLE VI. Group C inspection.

Inspection	Requirement	Test method	Device level and number of samples	
			N	S
Group I				
Stability of attenuation	3.5.10	4.7.11		
With temperature change		4.7.11.1		
After thermal shock		4.7.11.2		
After vibration		4.7.11.3		
After shock		4.7.11.4		
After moisture resistance		4.7.11.5		
After salt atmosphere		4.7.11.6	6 (0)	8 (0)
After peak power		4.7.11.7		
Sensitivity of attenuation	3.5.11	4.7.12		
After change in frequency				
After change in input power				
After change in temperature				
Resistance to solvents	3.5.9	4.7.10		
Visual and mechanical examination	3.1, 3.3, 3.4, 3.6, 3.8	4.7.1		
Group II				
Life test: 1,000 hours	3.5.12	4.7.13	2 (0)	5 (0)
Breakaway torque	3.4.10	4.7.17	----	2 (0)
Group III				
Sensitivity of attenuation	3.5.11	4.7.12		
After change in temperature	3.5.2	4.7.7		
Coaxial connector wear resistance: 1/	3.5.3	4.7.4		
VSWR	3.5.4	4.7.5		
Attenuation	3.5.6	4.7.7		
Coaxial connector repeatability: 1/	3.5.4	4.7.5		
Attenuation	3.5.7	4.7.8		
Solderability 2/	3.5.8	4.7.9		
Terminal strength/lead integrity 3/	3.5.5	4.7.6	3 (0)	7 (0)
Electromagnetic interference/RF leakage 1/		4.7.14		
Endpoints:	3.5.13			
Force to engage/disengage	3.5.14	4.7.15		
Coupling proof torque	3.5.4	4.7.5		
Attenuation				
DC resistance	------	4.7.2.2.1		
VSWR	3.5.3	4.7.4		
Visual and mechanical examination	3.1, 3.3, 3.4, 3.6, 3.8	4.7.1		

1/ Coaxial types of attenuators.
2/ Attenuators with solderable leads or terminals.
3/ Attenuators with leads or terminals.

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination (see 3.1, 3.3, 3.4, 3.6, and 3.8). Attenuators shall be examined to verify that the design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements.

4.7.1.1 Pre-assembly 100 percent visual inspection (space level only). All components used in the construction of attenuators shall be examined via 10X minimum to 30X maximum visual inspection. Components must be visually clean and free of contamination, residue, defects such as cracks, deformities, chips, and visible burrs. Inspected components with abnormal conditions shall not be used for manufacturing.

4.7.2 Screening (see 3.5.1). Attenuators shall be screened as specified in 4.7.2.1 through 4.7.2.6.

4.7.2.1 Thermal shock (see 3.5.1.1). With the connections uncovered, attenuators shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: When applicable, attenuators may be mounted on a heat sink.

b. Test condition: B, except temperature extremes shall be those specified (see 3.1) and number of cycles shall be ten (10). Place attenuators in the cold chamber for one-half hour. Attenuators shall be so positioned that they are exposed to freely circulating chamber air. Remove attenuators from the cold chamber and place in the hot chamber for one-half hour. Transfer shall take place within five (5) minutes of removal from the cold chamber, one cycle consisting of room temperature to cold, to room temperature to hot, and back to room temperature.

4.7.2.2 Pre-conditioning electrical (see 3.5.1.2). Before the conditioning is performed, the parameters listed in Table III as pre-conditioning shall be measured at 25°C ± 5°C and the data recorded for all attenuators. Method of measurements shall be as specified in 4.7.2.2.1 through 4.7.2.2.3.

4.7.2.2.1 DC resistance (as applicable). The DC resistance center conductor to center conductor and center conductor to case or ground (as applicable) for each side shall be measured using equipment capable of measuring one hundredth of an ohm.

4.7.2.2.2 VSWR. The VSWR shall be measured as specified in 4.7.4 at a low power level.

4.7.2.2.3 Attenuation. The attenuation (insertion loss) between ends shall be measured as specified in 4.7.5, with the exception that the signal source frequency shall be 50 MHz minimum.

4.7.2.3 Conditioning (see 3.5.1.3). Each end (input or output) of the attenuator shall be subjected to a direct current power level equal to the derated average power specified (see 3.1) at a temperature of +75°C ± 5°C for a period of 48 hours minimum (for a total of 96 hours minimum). Space level attenuators conditioning shall be at rated temperature and dc power (adjusting temperature/power as necessary to avoid overstress) for a period of 120 hours minimum at each end (for a total of 240 hours minimum). (Direct current power level is equal to the applied voltage times current). During the conditioning test, the attenuator shall be terminated in a resistive load equal to the rated nominal impedance ± 5 percent tolerance (see 3.4.2) specified in the specification sheet (see 3.1). Test shall meet the PDA requirements specified in table III for lot acceptance.

4.7.2.4 Post-conditioning electrical (see 3.5.1.4). After the conditioning, the same parameters specified in 4.7.2.2 shall be re-measured and the parametric change (delta) shall be determined. Attenuators that exceed one or more of the following delta limits shall be considered to have failed.

a. DC resistance - - - - - - ± 2 percent or 0.25 ohms, whichever is greater.

b. VSWR - - - - - - - - - - - ± 0.1.

c. Attenuation - - - - - - - - ± 0.1 dB for 0 to 4 dB range.
± 0.1 dB for attenuators in the 4.5 dB to 9 dB range.
± 0.2 dB for 9.5 dB and higher value attenuators.

d. Test shall meet the PDA requirements specified in table III for lot acceptances.

4.7.2.5 Monitored thermal cycling (space level only see 3.5.1.5). Attenuators shall be subjected to monitored thermal cycling in accordance with MIL-STD-202, method 304, with DC resistance to be continuously monitored at a minimum sample rate of 4 measurements per minute. The following details and exceptions apply:

a. Test temperatures range shall be -55°C to + 100°C.

b. Temperature ramp rate shall be 5°(C/min) to 8° (C/min) degrees C per minute or allowable by the chamber.

c. Dwell time at temperature extremes shall be 15 minutes minimum.

d. Number of cycles shall be 15.

e. Units exhibiting DC resistance measurements exceeding +/-10 percent or 0.25 ohms, from the initial measurement, shall be rejected and removed from the lot.

f. Test shall meet the PDA requirements specified in table III for lot acceptances.

4.7.2.5.1 Parts and Assembly Verification test (PAV) (space level only). Attenuation measurements immediately following Monitored Thermal Cycle (MTC) shall include Parts and Assembly Verification (PAV) test. Rigidly mount the attenuator under test and separate from the vector network analyzer (VNA) such that the body of the attenuator is completely exposed. Connect both ends of the attenuator under test to the VNA. Monitor the attenuation and VSWR response over the part's rated frequency spectrum, while continuously tapping the attenuator body for a minimum of 10 seconds alternating 180 degrees during tapping. The tapping instrument shall be non-metallic, such as Nylatron or equivalent, 20-22 grams in weight, and tapping distance shall be 1-3 inches. The tool shall not harm the attenuator under test. The RF response shall not exceed tolerances specified in section 3.1 and must remain uniform and stable during sweeps. Any intermittent change in the RF response observed on the analyzer shall be cause for rejection.

4.7.2.6 Radiographic (see 3.5.1.7). Unless otherwise specified by the procuring activity, the attenuators shall be examined in accordance with method 209 of MIL-STD-202, the following details shall apply:

a. A three-dimensional image quality indicator, constructed of, and containing materials which are compatible with the attenuators being x-rayed, shall be available for simultaneous exposure with the attenuator. The image quality indicator shall utilize slots, wires, and particles of sizes down to and including major dimensions equal to or less than .001 inch.

b. Two views shall be required, at 90° to each other, and both perpendicular to the major (long) axis of the attenuator.

c. The radiographs shall be examined under variable lighting conditions and magnification of 1X to 7X for the defects specified in MIL-STD-202, method 209. For space level applications the radiographs shall be examined under variable lighting conditions and magnification of 4X minimum to 10X maximum and shall meet the examination and acceptance criteria of 4.7.2.6.1.

d. X-ray rejects must be removed from lot and disposed of, in accordance with 4.6.1.6 and 4.6.1.7.

e. Serialization of attenuators is required and must be correlated to the film views. One film copy is required to be shipped with the attenuators. The manufacturer is not required to retain film copies. One copy of a report is required for each lot shipped indicating the number of attenuators radiographically inspected, the number found acceptable, and the number rejected.

4.7.2.6.1 Radiographic (space level only). Examination and acceptance criteria for radiographic inspection of coaxial attenuators devices shall meet the design and construction requirements of the specification. Devices that deviate significantly from the specified construction shall be rejected. Any device for which the radiograph reveals any of the following defects shall be rejected:

a. Extraneous or foreign matter.

b. Extra attenuator components including but not limited to (depending on construction): springs, plungers, nails, grounding clips, substrate, or bellows.

c. Missing internal components.

d. Damaged internal components or components that deviate significantly from the specified size or outline.

e. Flaking on any plated surface.

f. Cracks, splits, or chips in the substrate.

g. Gross misalignment, improper placement, or improper positioning of internal components.

h. Springs with coils that overlap or are intertwined.

i. Springs with end coils that overlap with the plunger.

j. Gaps between internal components that are electrically significant, for example, between the connector pin or socket to the spring and/or plunger, between the plunger or nail (depending on construction) and both sides of the substrate.

4.7.3 Coaxial connector wear resistance (see 3.5.2). The connectors shall be subjected to 500 cycles of connection and disconnection. A cycle shall consist of a firm connection made to both connectors of the attenuator with the coupling means tightened (for threaded connector types) or mated (for non-threaded connector types) and the connector then completely disconnected and removed from the circuit. Threaded connector types shall be tightened to the following minimum torque:

a. SMA: 10 inch-pounds minimum.

b. TNC: 6 inch-pounds minimum.

c. Type N: 10 inch-pounds minimum.

4.7.4 VSWR (at either end) (see 3.5.3). The VSWR of attenuators shall be measured at each end and at the specified frequency (see 3.1).

4.7.4.1 Procedure. VSWR of attenuators shall be measured using a system as shown in FIGURE 1 or equivalent. Tuners and pads shall be used, when necessary, to reduce residual VSWR of the system to a level that will assure accurate results before connecting the assembly under test. The overall accuracy of VSWR measurements shall be such that the absolute VSWR = (measured VSWR) +0.08 (maximum specified VSWR). VSWR (S11, S22) may be measured simultaneously with attenuation (S21), using an automatic network analyzer. Multiple, accurate data points over the entire frequency range can be obtained with specified accuracy (see 3.1). Unless otherwise specified in the specification sheet, test requirements shall be made by sweeping the network/spectrum analyzer (in steps) over that portion of the attenuator's operating frequency range falling between 10 MHz and 42 GHz (see 3.1) or falling within the complete frequency range of the analyzer.

4.7.5 Attenuation (see 3.5.4). The attenuation of attenuators shall be measured. An automatic network analyzer may be used. The attenuation (S21) and VSWR (S11, S22) can be measured simultaneously with multiple, accurate data points over the entire frequency range, with the accuracy therein specified over the frequency range specified (see 3.1). Unless otherwise specified in the specification sheet, test requirements shall be made by sweeping the network/spectrum analyzer (in steps) over that portion of the attenuator's operating frequency range falling between 10 MHz and 42 GHz (see 3.1) or falling within the complete frequency range of the analyzer.

4.7.6 Electromagnetic interference (when specified) (see 3.1) (RF leakage) (see 3.5.5). The swept frequency measurement shall be made covering the total frequency range in steps not exceeding an octave band (the appropriate stub antenna shall be tuned to a quarter wave at mid-octave).

a. Place a fixed amount of RF power in a transmission line in series with a variable attenuator and spectrum analyzer.

b. Place specified value of attenuation (see 3.1) in the line and note the difference in readings on the spectrum analyzer.

c. Reset the attenuator to zero and place a $\lambda/4$ (at mid-band) at one end of the flexible coaxial cable and connected to the spectrum analyzer.

d. Place the test attenuator in a transmission line properly terminated and "SNIFF" the part with the $\lambda/4$ stub. The $\lambda/4$ stub shall come as close to the part as possible without touching. Particular attention shall be given to connectors, fastening devices, and flange interfaces.

e. Any attenuation in excess of the value specified in 4.7.6b shall be cause for rejecting the part.

4.7.7 Connector repeatability (see 3.5.6). Attenuators shall be tested for connector repeatability using a network analyzer, a system as shown in FIGURE 2, or equivalent. The following details shall apply:

a. Test at specified test frequencies or at three frequencies, one from each third of the rated frequency range.

b. Perform 10 complete connects and disconnects, both ends separately. Threaded connector types shall be tightened to the following minimum torque:

i. SMA: 10 inch-pounds minimum.

ii. TNC: 6 inch-pounds minimum.

iii. Type N: 10 inch-pounds minimum

c. Rotate attenuator through a full 360° with each mating at approximately 36° increments.

d. Cleaning of connectors or reshaping of contacts is not permitted during test sequence.

e. Side thrust shall not be permitted during test.

4.7.8 Solderability (see 3.5.7). The terminals of the attenuator shall be tested in accordance with method 208 of MIL-STD-202.

4.7.9 Terminal strength/lead integrity (see 3.5.8). Attenuators shall be tested as specified in 4.7.9.1 or 4.7.9.2.

4.7.9.1 Terminal strength. Attenuators with terminals shall be tested in accordance with method 211 of MIL-STD-202, test condition A, applied force 1.5 pounds.

4.7.9.2 Lead integrity. Attenuators with leads shall be tested in accordance with method 211 of MIL-STD-202, test condition C. The applied force shall be 8 ounces ± 0.5 ounces. For leads with a section modulus equal to or less than that of a lead with a cross-section of 0.006 X 0.20, the force shall be 3 ounces ± 0.3 ounces.

4.7.10 Resistance to solvents (see 3.5.9). Attenuators shall be tested in accordance with method 215 of MIL-STD-202. All portions of the attenuator shall be brushed.

4.7.11 Stability of attenuation (see 3.5.10). Attenuators shall be subjected to the tests as specified in 4.7.11.1 to 4.7.11.7 inclusive. At the conclusion of each of these tests, the attenuators shall be examined for evidence of mechanical damage.

4.7.11.1 With temperature change. The change in attenuation with temperature change shall be determined by measuring the attenuation of the attenuators (see 4.7.5 and FIGURE 5) at 23°C ± 2°C with a maximum power input of 10 milliwatts (mW), and at both extremes of the operating temperature range specified (see 3.1). Source and load impedance as seen from the junction of both thermal isolators shall be reflection-less. When the dB is greater than 0.1 dB from reference to the extreme operating temperature, FIGURE 5 is a recommended test setup.

4.7.11.2 After thermal shock. Attenuators shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

a. Test condition: B, -65°C to +100°C.

b. Measurements before and after thermal shock: Attenuation shall be measured (see 4.7.5 and FIGURE 6), at the inspection conditions specified in 4.4, with minimum input power and at full-rated input power (see 3.1).

4.7.11.3 After vibration. Attenuators shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition: D, unless otherwise specified (see 3.1).

b. Method of mounting: Attenuators shall be attached to the vibration table by clamps. Unless otherwise specified, a clamp shall be placed around the center of each attenuator, and no part of the attenuator shall touch any object other than the clamp.

c. Duration of vibration: One hour in each of three mutually perpendicular directions (total 3 hours).

d. Measurements after vibration: Attenuation shall be measured as specified in 4.7.5.

4.7.11.4 After shock. Attenuators shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

a. Test condition: I, unless otherwise specified (see 3.1).

b. Measurement after shock: Attenuation shall be measured as specified in 4.7.5.

4.7.11.5 After moisture resistance. Attenuators shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Initial measurements: Not applicable.

b. Polarization and load: Not applicable.

c. Sub-cycle step 7b: Not applicable.

d. Final measurement: Attenuation shall be measured as specified in 4.7.5. MIL-STD-202 method 106 requirements for final measurements “after drying period” shall apply (see Table VI).

TABLE VI. Accuracy for attenuation measurements.

Attenuation value, dB	Attenuator	Figure	Accuracy of attenuation measurements
Up to 50, incl.	Class III attenuators (specification sheets MIL-DTL-3933/10, /18, /19, /30, 31 and /32).	3	0.2 dB max for 0 to 10 dB values 0.2 dB/10dB max for values greater than 10dB
Up to 50, incl.	Class IV attenuators (specification sheets MIL-DTL-3933/14, /16, /17, /23, /24, /25 and /29).	4	0.2 dB max for 0 to 10 dB values 0.2 dB/10dB max for values greater than 10dB

4.7.11.6 After salt atmosphere. Attenuators shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

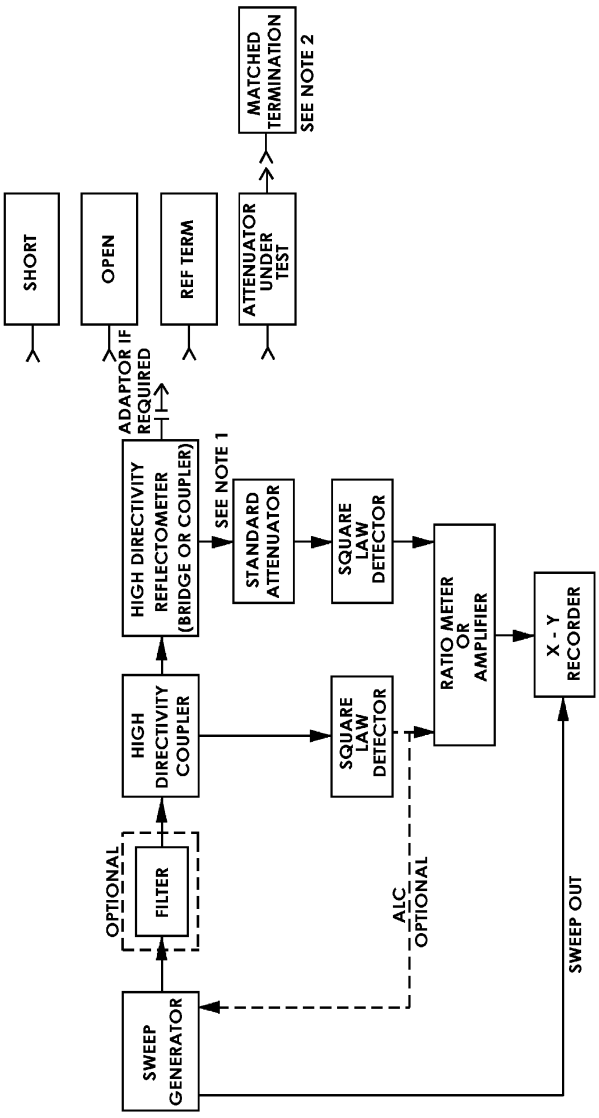
a. Special detail: During the test, connectors shall be mated to capped dummy connectors.

b. Test condition: Non-space level: B, space level: A.

c. Examinations after exposure: Attenuators shall be examined for evidence of corrosion or pitting.

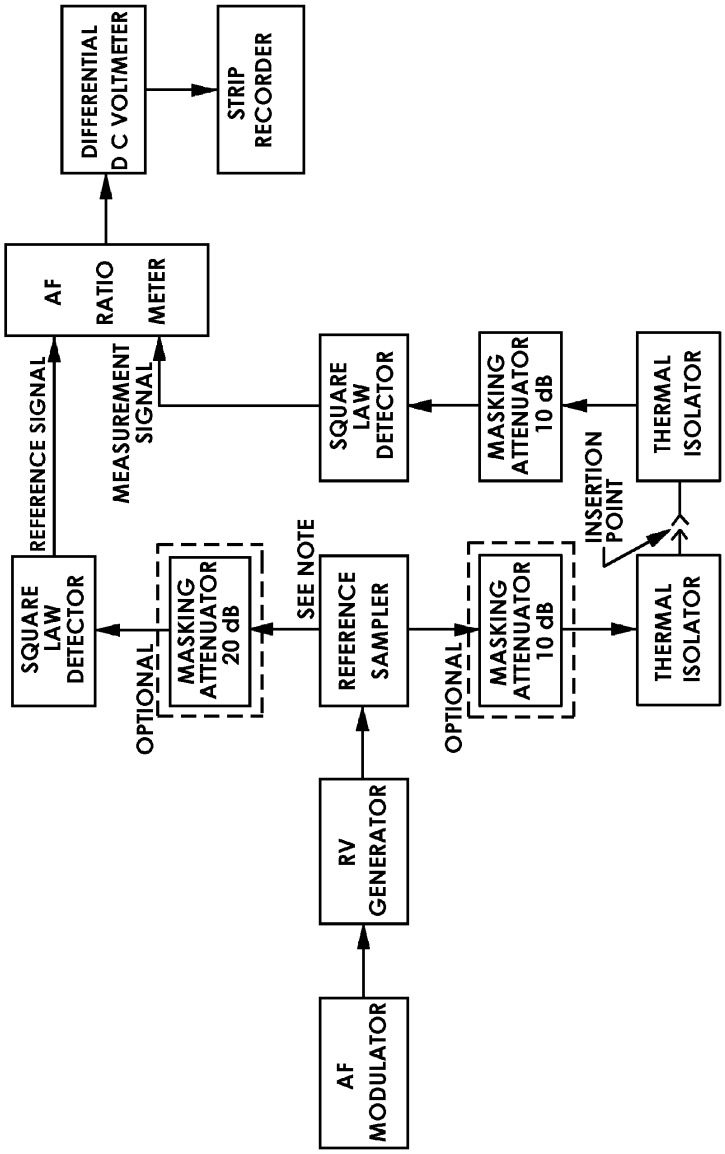
d. Measurements after salt spray: Attenuation shall be measured as specified in 4.7.5 after the attenuator has been cleaned of any salt accumulation.

4.7.11.7 After peak power. Attenuators shall be supported in still air and free space at the standard inspection conditions specified in 4.4. The specified peak power shall be applied for 1.00 ± .01 hour at each end (see 3.1). After the attenuator has cooled to standard inspection conditions (see 4.4), attenuation shall be measured as specified in 4.7.5. Test shall meet the PDA requirements specified in table III for lot acceptances.



NOTES:
1. Use with crystal type detectors.
2. May be omitted for attenuators with a nominal attenuation of 20 dB or greater.
3. Equivalent swept slotted line system may be used instead.

FIGURE 1. VSWR test setup (or equivalent)



NOTE: High directivity coupler or matched signal splitter.

FIGURE 2. Test setup for connector repeatability (or equivalent).

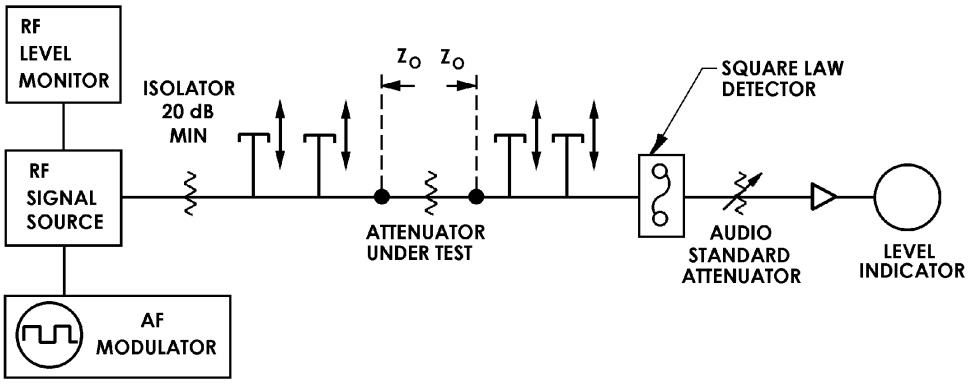
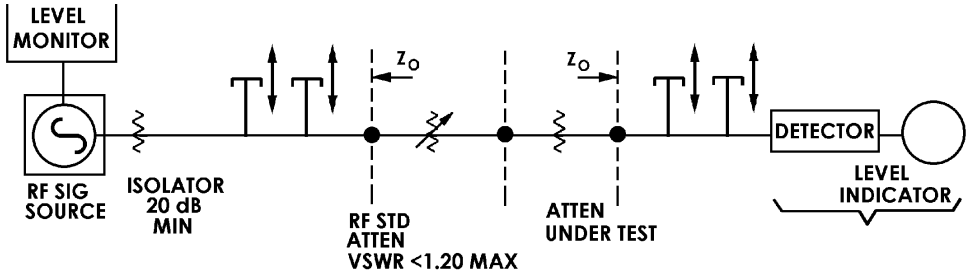


FIGURE 3. Test setup for attenuation measurements for attenuators up to 50 dB, incl., by RF-substitution method, or equivalent.



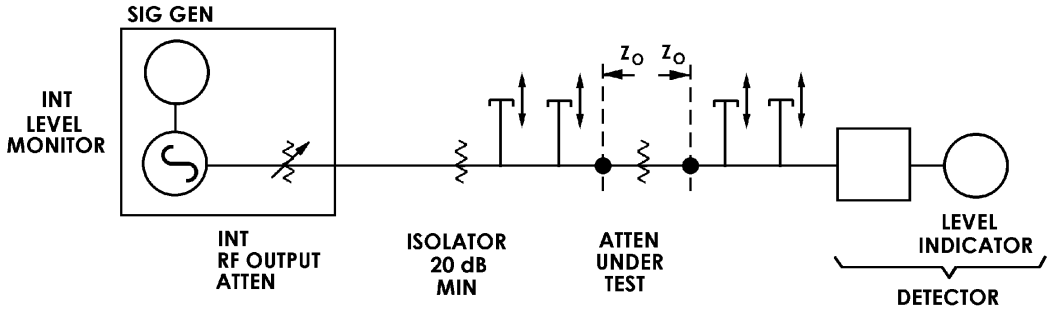


FIGURE 4. Test setup for attenuation measurements for attenuators up to 50 dB, inclusive, by signal-generator method, or equivalent.

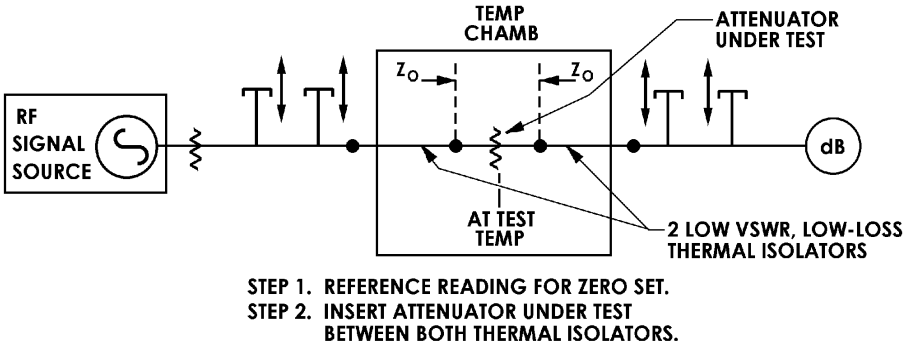


FIGURE 5. Modification of test setup for attenuation measurement at extreme temperature, or equivalent.

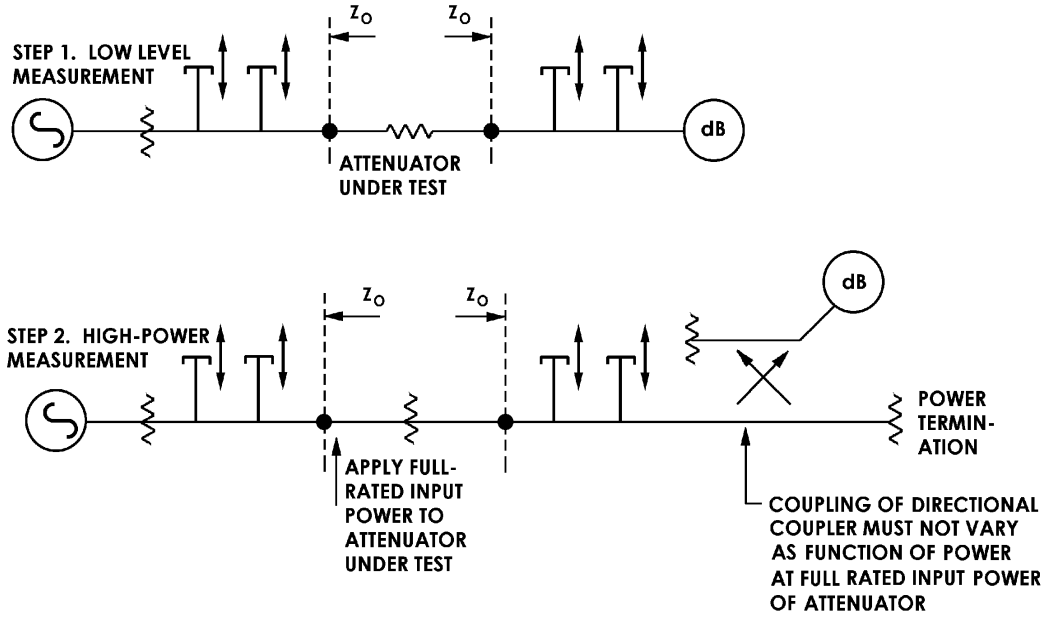


FIGURE 6. Modification of test setup for attenuation measurement at high power, or equivalent.

4.7.12 Sensitivity of attenuation (see 3.5.11). Sensitivity of attenuation of attenuators shall be determined by measuring attenuation as specified in 4.7.5 at each extreme of the frequency range (see 3.1), at full input power (see 3.1) and any reference power, and at each extreme of the temperature range (see 3.1). Sensitivity of attenuation shall be computed in accordance with the following formulas:

$$\text{Frequency sensitivity} = \frac{\Delta dB}{dB}\frac{1}{\Delta f}$$

$$\text{Power sensitivity} = \frac{\Delta dB}{dB}\frac{1}{\Delta p}$$

$$\text{Temperature sensitivity} = \frac{\Delta dB}{dB}\frac{1}{\Delta t}$$

$$= \frac{\Delta dB}{\Delta t} \text{ for secondary standard over 20 dB}$$

Where:

ΔdB = Change in attenuation at either extreme of the operating frequency, at full input power, or at either extreme of the operating temperature (see 3.1).

dB = Attenuation at reference frequency, reference power, or reference temperature.

Δf = Change in frequency from reference to extreme, in GHz.

Δp = Change in power from reference to full input, in watts.

Δt = Change in temperature from reference to extreme, in °C.

4.7.13 Life test (see 3.5.12). Attenuators shall be tested in the same manner as specified in 4.7.2.3 and 4.7.2.4, except the time shall be 1,000 hours (500 hours for each end).

4.7.14 Force to engage/disengage (see 3.5.13). Attenuator connectors shall pass the force to engage/disengage requirements of MIL-PRF-39012.

4.7.15 Coupling proof torque (see 3.5.14). Attenuator connectors shall pass the coupling proof torque requirements of MIL-PRF-39012.

4.7.16 Outgassing (space level only see 3.3.8). The attenuator organic material shall be tested in accordance with ASTM E595.

4.7.17 Breakaway torque (S and T level devices only see 3.4.10). Attenuators shall be measured for breakaway torque by applying a counter-clockwise torque to the female connector with the attenuator body firmly secured. Connector junctions in the connector body shall not be moved by a torque less than the following torque applied to a fully assembled attenuator:

a. For S level devices

i. All style types: 10 inch-pounds.

b. For T level devices

i. SMA style: 14 inch-pounds.

ii. TNC style: 10 inch-pounds.

iii. Type N: 14 inch-pounds.

4.7.18 Monitored vibration (space level only). Attenuators shall be subjected to monitored vibration in accordance with method 204 of MIL-STD-202 (see 4.7.11.3) and with DC resistance to be continuously monitored. The following details and exceptions shall apply:

a. Units exhibiting DC resistance measurements exceeding +/-10 percent or 0.25 ohms, from the initial measurement, shall be rejected and removed from the lot.

4.7.19 Monitored shock(space level only). Attenuators shall be subjected to monitored shock in accordance with method 214 of MIL-STD-202 (see 4.7.11.4) and with DC resistance to be continuously monitored. The following details and exceptions shall apply:

a. Units exhibiting DC resistance measurements exceeding +/-10 percent or 0.25 ohms, from the initial measurement, shall be rejected and removed from the lot.

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. Attenuators covered by this specification are intended for use in military equipment systems and space systems in the radio and microwave frequency region (see 1.1).

6.1.1 Derating guidelines. Unless otherwise specified in the specification sheet (see 3.1), design applications should derate RF input power by 1.5 dB (in dB_m) or x 0.70 (in watts).

6.2 Acquisition requirements. For attenuators covered by specification sheets (see 3.1). Acquisition documents should specify the following:

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

b. Title, number, and date of the applicable specification sheet (see 3.1 and 1.4).

c. Packaging requirements (see 5.1).

d. If special or additional identification marking is required.

e. Magnesium alloy, only when specified (see 3.1). Use of Magnesium alloy is not recommended for space level applications (See 3.3.4).

f. PIN (see 1.4).

g. Data delivery requirements (see 4.6.1.8).

h. Class of attenuator specified (see 1.2 and appendix B).

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 3933 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 DLA Land and Maritime, Code VQE, P.O. Box 3990, Columbus, OH 43218-3990 (mail to: vqe.chief@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.

6.3.1 Provisions governing qualification. Copies of "Provisions Governing Qualification" SD-6 may be obtained upon application to Defense Automation and Production Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.4 Subject term (keyword) listing.

Connectors	Qualification	VSWR
Electrical	Radio	Monitored thermal cycling
Interference, electromagnetic	Screening	PDA
Leads	Sensitivity	
Microwave	Stability	

6.5 Corrosion resistant steel bars, wire, shapes and forgings. Experience has shown that requirements for corrosion resistant steel are satisfied by material conforming with SAE-AMS-QQ-S-763, "Steel Bars, Wire, Shapes, and Forgings; Corrosion Resistant" (inactive).

6.6 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 at http://www.epa.gov/osw/hazard/wastemin/priority.htm. Included in the 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).

6.7 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 (see 3.3.6). For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

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

APPENDIX A

PROCEDURES FOR QUALIFICATION INSPECTION AND GROUP QUALIFICATION BY CHARACTERISTICS

A.1. SCOPE

A.1.1 Scope. This appendix covers the procedure for qualification inspection of attenuators covered by this specification and employs a “group qualification”. Previous revision of this specification appendix employed a Group qualification approach that identified for all attenuator types, the entirety of ways in which each attenuator type could be qualified by previous qualification of other attenuators with more rigorous requirements characteristics. A simplified approach is adopted herein to enable the same matrix of group qualification possibilities, without reiterating the entire list of attenuator characteristics combinations available to accomplish group qualification. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2. APPLICABLE DOCUMENTS (This is not applicable to this appendix.)

A.3. SUBMISSION

A.3.1 Product levels. The procedure for submitting samples to qualify non-space level (N and S) is predicated upon meeting the inspections specified under table II on number of non-space level samples in A.3.1.1. The procedure for submitting samples to qualify space level (T) is predicated upon meeting the inspections specified under table II on number of space level samples in A.3.1.1. Each space level attenuator style shall be qualified separately, unless group qualification is applicable (see Table A-I). Qualification to the space level (T), the manufacturer shall also meet the additional requirements for outgassing, monitored thermal cycling and conditioning for space level attenuators (see 4.7.2.3) as well as being approved by the qualifying activity on the capability to conduct tests and examinations for space level product (production lot formation) using MIL-STD-790 program. After qualification has been granted, no changes shall be made in materials, design, or construction without approval of the qualifying activity.

A.3.1.1 Sample size. The number of samples of the same specification sheet (see 3.1) and PIN that shall be subjected to qualification inspection shall be defined in table II. Non space level, a minimum of 11 sample units for non-screened and 22 for screened units shall be required for qualification inspection. Space level, a minimum of 45 sample units shall be required for qualification inspection. The sample units shall be divided according to table II.

A.3.1.2 Inspection routine. The sample shall be subjected to the qualification inspection specified in table II, in the order shown. All units shall be subjected to the inspection of group I including space level units. The sample units shall then be subjected only to the inspections indicated for their particular group.

A.3.1.3 Certification of material (space level only). When submitting samples (see table II) for qualification, the manufacturer shall submit certification that the materials used in the components are in accordance with the applicable specification requirements.

APPENDIX A

A.4. REQUIREMENTS

A.4.1 Group qualification. Group qualification is herein interpreted as “characteristic qualification”. Attenuators with subordinate characteristics, that have all been qualified by previous qualification of the same or more rigorous dominant characteristics in earlier qualified attenuators, are considered qualified, with no additional testing. The extent of qualification for space level attenuators require qualification by attenuator style covering each subordinate characteristic listed in Table A-I. Group qualification by characteristics requires previous qualification of dominant characteristics covering each subordinate characteristic listed in Table A-II. Qualification requires qualifying an attenuator characteristic listed under each characteristic category for an attenuator type. Acceptance of group qualification by characteristics is at the discretion of the qualifying activity: DLA Land and Maritime, Code -VQE, P.O. Box 3990, Columbus, OH 43218-3990 (mail to: vqe.chief@dla.mil).

A.4.2. Extent of qualification (space level only). The extent of qualification between styles shall be as specified in Table A-I.

Table A-I. Extension of qualification. (space level only)

Attenuator style by slash sheet 1/	**Will qualify style**	
Space level	Space level, Screened or Non-screened	
/10 (SERIES N)	/10 , /18	
/17 (TNC)	/17	
/19 (BNC)	/19	
/23 (TO-5 CONFIGURATION)	/23	
/25 (SMA)	/25, /24, /16, /14	
/29 (SURFACE MOUNT)	/29	
/31 (3.5 mm)	/31	
/32 (SMK)	/32, /30	
Characteristic category		
Average power	Low Medium	Low Medium, Low
Attenuation	20 dB and 1 dB 30 dB 40 dB 60 dB	20 dB to 0 dB 30 dB to 0 dB 40 dB to 0 dB 60 dB to 0 dB

1/ A maximum frequency shall be selected from the slash sheet that includes the frequency range covered by the attenuator style.

A.4.3 List of dominant attenuator qualification characteristics(non-space level only). The list of dominant attenuator qualification characteristics, listed by attenuator type, and associated lists of subordinate attenuator characteristics intended for group qualification by characteristics, is as follows:

TABLE A-II. Characteristics for group qualification.

Attenuator type	**Coaxial**	
Characteristic category	Previous qualifying attenuator characteristic (dominant) values	Attenuator characteristics (subordinate) qualified by group qualification
Screening	Screened Non-screened	Screened or Non-screened Non-screened
Frequency range (GHz)	DC-42 DC-28 DC-26.5 DC-18 DC-12	DC- 42, DC-28, DC- 26.5, DC-18, DC-12, DC-8, DC-2 DC-28, DC- 26.5, DC-18, DC-12, DC-8, DC-2 DC-26.5, DC-18 DC-12, DC-8, DC-2 DC-18, DC-12, DC-8, DC-2 DC-12, DC-8, DC-2
Average power	Low Medium High	Low Medium, Low High, Medium, Low
Attenuation	20 dB and 1 dB 40 dB 60 dB	20 dB to 0 dB 40 dB to 0 dB 60 dB to 0 dB
Attenuator type	**Stripline, terminal, or lead**	
Characteristic category	Previous qualifying attenuator characteristic (dominant)	Attenuator characteristics (subordinate) qualified by group qualification
Screening	Screened Non-screened	Screened or non-screened Non-screened
Frequency range (GHz)	DC-12 DC-8 DC-4 DC-1	DC-12, DC-8, DC-4, DC-1 DC-8, DC-4, DC-1 DC-4, DC-1 DC-1
Average power	Low Medium	Low Medium
Attenuation	20 dB and 1 dB	20 dB to 1 dB

APPENDIX B

BOILERPLATE TABLES DEFINING ATTENUATOR CLASSES

(PERFORMANCE LEVELS FOR USE IN SPECIFICATION SHEETS)

B.1. SCOPE

B.1.1 Scope. Appendix B includes separate boiler plate tables for definition of attenuator class (see 1.2). These tables are to be used as guidelines in specification sheets. Classification system categorizes attenuators having the same functional use but different requirements for performance. Tables below define attenuator tolerances to be used in each specification sheet for each classification (such as performance level) that users desire. Ideally, a specification sheet could have as many classifications as the market desires; therefore, the classification must be marked (see 3.6) on the attenuator to distinguish it from other performance levels. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

B.2. APPLICABLE DOCUMENTS (This is not applicable to this appendix.)

B.3. REQUIREMENTS

B.3.1 Tables defining attenuator classes in specification sheets. If a user wishes an attenuator for fit and function, but is dissatisfied with the performance level and wishes to order a tighter or looser attenuator tolerance, then add the new class tolerance to the specification sheet. This way all classes of attenuators are available for all specification sheets. When higher sensitivity and stability are desired, simply order a class II instead of a class III or a class IV.

APPENDIX B

TABLE B-I. Class I attenuator performance levels.

Characteristic	Class I
VSWR (at either end, max) DC to 18 GHz DC over 18 GHz Others, F in GHz	 1.05 1.15 1.03+ 0.005F
Deviation of attenuation from that specified at reference frequency (basic test) (see 3.1), max: Up to 10 dB, inclusive Over 10 dB	 0.02 dB 0.002 dB/dB
Change in attenuation after temperature change or thermal shock, max: Up to 10 dB, inclusive Over 10 dB	 0.002 dB 0.0005 dB/dB
Change in attenuation after vibration or shock, max: Up to 10 dB, inclusive Over 10 dB	 0.02 dB 0.002 dB/dB
Change in attenuation after moisture resistance, max: Up to 10 dB, inclusive Over 10 dB	 0.02 dB 0.002 dB/dB
Change in attenuation after salt atmosphere, max: Up to 10 dB, inclusive Over 10 dB	 0.02 dB 0.002 dB/dB
Change in attenuation after peak power, max: Up to 10 dB, inclusive Over 10 dB	 0.002 dB 0.0005 dB/dB
Frequency sensitivity, max:	0.005 dB/dB/GHz
Power sensitivity for full input power, max:	0 dB/dB/Watt
Temperature sensitivity of attenuation, max:	10^{-6} dB/dB/°C
Connector repeatability max: Variation in attenuation	 0.002 dB
Concentricity of coaxial connectors	2 percent of inner diameter of outer conductor or 3 mils, whichever is greater

APPENDIX B

TABLE B-II. Class II attenuator performance levels - Continued.

Characteristic	Class II
VSWR (at either end, max) DC to 18 GHz DC over 18 GHz Others, F in GHz	 1.15 1.30 1.10+ 0.015F
Deviation of attenuation from that specified at reference frequency (basic test) (see 3.1), max: Up to 10 dB, inclusive Over 10 dB	 0.1 dB 0.01 dB/dB
Change in attenuation after temperature change or thermal shock, max: Up to 10 dB, inclusive Over 10 dB	 0.01 dB 0.001 dB/dB
Change in attenuation after vibration or shock, max: Up to 10 dB, inclusive Over 10 dB	 0.05 dB 0.005dB/dB
Change in attenuation after moisture resistance, max: Up to 10 dB, inclusive Over 10 dB	 0.1 dB 0.01 dB/dB
Change in attenuation after salt atmosphere, max: Up to 10 dB, inclusive Over 10 dB	 0.1 dB 0.01 dB/dB
Change in attenuation after peak power, max: Up to 10 dB, inclusive Over 10 dB	 0.01 dB 0.01 dB/dB
Frequency sensitivity, max:	0.02 dB/dB/GHz
Power sensitivity for full input power, max:	0.001 dB/dB/Watt
Temperature sensitivity of attenuation, max:	0.0001 dB/dB/°C
Connector repeatability max: variation in attenuation	 0.01 dB
Concentricity of coaxial connectors	2 percent of inner diameter of outer conductor or 3 mils, whichever is greater

APPENDIX B

TABLE B-III. Class III attenuator performance levels - Continued.

Characteristic	Class III
VSWR (at either end, max) DC to 18 GHz DC over 18 GHz Others, F in GHz	 1.35 1.50 1.30+ 0.02F
Deviation of attenuation from that specified at reference frequency (basic test) (see 3.1), max: Up to 10 dB, inclusive Over 10 dB	 0.2 dB 0.02 dB/dB
Change in attenuation after temperature change or on thermal shock, max: Up to 10 dB, inclusive Over 10 dB	 0.05 dB 0.005 dB/dB
Change in attenuation after vibration or shock, max: Up to 10 dB, inclusive Over 10 dB	 0.1 dB 0.01 dB/dB
Change in attenuation after moisture resistance, max: Up to 10 dB, inclusive Over 10 dB	 0.2 dB 0.02 dB/dB
Change in attenuation after salt atmosphere, max: Up to 10 dB, inclusive Over 10 dB	 0.2 dB 0.02 dB/dB
Change in attenuation after peak power, max: Up to 10 dB, inclusive Over 10 dB	 0.05 dB 0.005 dB/dB
Frequency sensitivity, max:	0.1 dB/dB/GHz
Power sensitivity for full input power, max:	0.005 dB/dB/Watt or 0.004 dB/dB/Watt
Temperature sensitivity of attenuation, max:	0.0004 dB/dB/°C
Connector repeatability max: Variation in attenuation	 0.02 dB
Concentricity of coaxial connectors	4 percent or 5 mils

APPENDIX B

TABLE B-IV. Class IV attenuator performance levels - Continued.

Characteristic	Class IV
VSWR (at either end, max) DC to 18 GHz DC over 18 GHz Others, F in GHz	 1.50 1.75 1.50+ 0.03F
Deviation of attenuation from that specified at reference frequency (basic test) (see 3.1), max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Change in attenuation after temperature change or thermal shock, max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Change in attenuation after vibration or shock, max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Change in attenuation after moisture resistance, max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Change in attenuation after salt atmosphere, max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Change in attenuation after peak power, max: Up to 10 dB, inclusive Over 10 dB	 0.5 dB 0.05 dB/dB
Frequency sensitivity, max:	0.4 dB/dB/GHz
Power sensitivity for full input power, max:	0.005 dB/dB/Watt
Temperature sensitivity of attenuation, max:	0.0006 dB/dB/°C
Connector repeatability max: Variation in attenuation	 0.04 dB
Concentricity of coaxial connectors	4 percent or 5 mils

APPENDIX C

SURFACE MOUNT CHIP ATTENUATORS QUALIFICATION AND CONFORMANCE INSPECTION

C.1. SCOPE

C.1.1 Scope. The purpose of this appendix is to establish standards for qualification and conformance inspection of radio and microwave frequency surface mount chip attenuators for use in established reliability electronic applications. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

C.1.2 Classification. Two device levels of surface mount chip attenuators have been designated as (T) space level part number for use in space applications, and (S) military level for use in standard military applications.

C.2. APPLICABLE DOCUMENTS

C.2.1 General. The documents listed in this section are specified in sections C.3 or C.4 of this appendix. This section does not include documents cited in other sections of this appendix 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 C.3 or C.4 of this appendix, whether or not they are listed.

C.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-3933/29	-	Attenuators, Fixed, Space Level, Non Space Level, Chip, (Surface Mount), 0-20 dB, Frequency Range: DC To 18 GHz. Class IV.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	-	Electronic and Electrical Component Parts.
MIL-STD-883	-	Microcircuits, Test Method Standard.

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

C.2.3 Non-Government publications. The following documents form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

APPENDIX C

ASTM INTERNATIONAL

ASTM-E595	-	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

(Copies of this document are available online at http://www.astm.org and from ASTM INTERNATIONAL, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

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

C.3 REQUIREMENTS

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

C.3.2 General.

C.3.2.1 Element evaluation. Chip attenuators from each inspection lot shall be evaluated in accordance with table C-I for qualification, table C-II for conformance inspection and table C-III for periodic inspection. Element characteristics required to assure device performance and assembly process capability shall be identified within the element acquisition document.

C.3.2.2 Sequence of testing. Subgroups within a group of tests may be performed in any sequence, but individual tests within a subgroup shall be performed in the sequence indicated.

C.3.2.3 Device level designator. (S) and (T) element evaluation requirements are identified in the appropriate column of table C-I.

C.3.2.4 Sample selection. Samples shall be randomly selected from inspection lots. The sample size columns in the evaluation tables give the minimum quantities to be evaluated with applicable accept number enclosed in parenthesis.

C.3.2.5 Test sample preparation. When assembly is required to perform electrical tests, test samples should be assembled such that the assembly methods and conditions the element will see during normal assembly will be simulated.

C.3.3 Critical interface requirements. The critical interfaces and physical dimensions of the attenuator chip shall be in accordance with the requirements of MIL-DTL-3933 and the specification sheet. A completed drawing of the attenuator chip showing dimensions, bond pad locations, and metallization descriptions and metal layer composition shall be made available to the preparing activity and to the qualifying activity prior to qualification. A unique critical interface identifier as part of the PIN (Y_1Y_2; see MIL-DTL-3933/29 and C.3.6 herein) shall be assigned to the specification sheet drawing based on any of the following differences:

a. Bond pad and backside metal [Y_1 as (A) for aluminum, (C) for copper, (G) for gold or (N) for nickel]. Nickel shall be used only when no other material provides specified requirements.

b. Body style [Y_2 as (P) for open bond pads, (L) for welded leads already attached or (W) for wrap around leads].

C.3.3.1 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally, for any chip attenuator metallization. Tin content of chip attenuator components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see C.6.2).

C.3.4 Qualification. Chip attenuators furnished under this specification shall be products which are qualified for listing on the applicable qualified products list, qualified to the requirements specified herein and in accordance with the applicable specification sheets.

C.3.5 Passivation of attenuator element. When used, polyimide passivation of the attenuator element shall maintain its physical, electrical and mechanical properties over the specified humidity, temperature and frequency range. The properties of low-out-gassing polyimide passivation used for space level (T) chip attenuators shall be subjected to the testing and verification procedures of ASTM-E595.

C.3.6 Part Identifying Number (PIN) (see MIL-DTL-3933/29). The military PIN consists of the letter “M” followed by the basic number of the specification sheet, an assigned dash (see C.3.1), a “suffix letter” (X) (assigned by QPL-3933) denoting the chip manufacturer, the device level classification (T) or (S) (see C.1.2) and a unique critical interface identifier (Y_1Y_2) (see C.3.2) assigned based on the metal finish on the bond pads or backside and the body style (see C.3.2).

C.3.7 Marking. The dB value of the attenuation shall be laser marked on the attenuator chip. Also, the chip shall be laser marked with the PIN “suffix number”, indicating the chip manufacturer (assigned by QPL-3933).

C.4 VERIFICATION

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

a. Material inspection (see C.4.1.1).

b. Qualification inspection (see C.4.2).

c. Conformance inspection group A (see C.4.3).

d. Periodic inspection group B (see C.4.3.3)

C.4.1.1 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials used in fabricating the attenuator, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

C.4.2 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units (see C.4.2.1) produced with equipment and procedures normally used in production. Qualification obtained for each group (see appendix A) shall constitute qualification for all chip attenuators with characteristics for that group.

C.4.2.1 Sampling plan. A minimum of 83 sample units for S level and 158 sample units for T level devices shall be required for qualification inspection. The sample shall be subjected to the qualification inspection specified in table C-I, in the order shown. All units shall be subjected to the inspection of group I. The samples units shall then be divided and subjected only to the inspection indicated for their particular group.

C.4.2.2 Failures. One or more failures shall be cause for refusal to grant qualification approval. A failure shall be anything that does not meet the requirements of the specification.

C.4.2.3 Disposition of qualification sample units. Sample units which have been subjected to qualification testing shall not be delivered on any contract or purchase order. The Government reserves the right to retain the sample units or to require the contractor to furnish the sample units with the qualification inspection report.

APPENDIX C

TABLE C-I. Qualification inspection surface mount chip attenuator evaluation requirements

Inspection	Reference paragraph	Test method	Device level and number of samples	
			S	T
Group I				
Visual and mechanical	C 4.3.6.1	MIL-STD-883 TM 2032	100 percent	
Element electrical		--	100 percent	
Thermal shock	4.7.2.1	MIL-STD-202 TM 107 condition B	----	100 percent
Element electrical		--	----	100 percent
Conditioning	4.7.2.3	--	100 percent	
Stability of attenuation	4.7.11	--	---	100 percent
Post element electrical	4.7.2.4	--	----	100 percent
Solderability	4.7.8	MIL-STD-202 TM 208 condition B	3 (0)	3 (0)
Group II				
Stability of attenuation with temperature	4.7.11		11 (0)	22 (0)
After thermal shock	4.7.2.1	MIL-STD-202 TM 107 Condition B		
After vibration	4.7.11.3	MIL-STD-202 TM 204 condition D		
After shock	4.7.11.4	MIL-STD-202 TM 213 condition I		
After Moisture resistance	4.7.11.5	MIL-STD-202 TM 106		
After peak power	4.7.12	---		
Sensitivity of attenuation After change in frequency After change in input power After change in temperature	4.7.12	---	11 (0)	23 (0)
Visual and mechanical	C 4.3.6.1	MIL-STD-883 TM 2032	22(0)	45 (0)
Group III				
Life test: 1,000 hours	C.4.3.6.4	----	22 (0)	45 (0)
Post element electrical	4.7.2.4	----	2 (0)	5 (0)
Mechanical strength	C.4.3.6.2	MIL-STD-883 TM 2019	2 (0)	5 (0)
Wire bond strength 1/	C.4.3.6.3	MIL-STD-883 TM 2011	10 (0)	10 (0)

1/ Qualifying activity to specify wire size and bond type.

APPENDIX C

C.4.3 Conformance inspection.

C.4.3.1 General. Conformance inspection shall consist of group A and group B inspections. Group B inspection shall be performed under periodic inspection.

C.4.3.1.1 Inspection lot. An inspection lot shall consist of one device type with the same PIN produced under essentially the same conditions from the same production line and offered for inspection at one time.

C.4.3.2 Group A inspection. Group A inspection shall be conducted as shown in Table C-II on all chip attenuators in the inspection lot. Chip attenuators that fail the 100 percent inspections of group A shall be removed from the inspection lot.

TABLE C-II. Surface mount chip attenuator evaluation requirements (Group A).

Inspection	Reference paragraph	Test method	Device level and number of samples	
			S	T
Visual and mechanical	C 4.3.6.1	MIL-STD-883 TM 2032	100 percent	
Element electrical	C.4.3.6.2	--	100 percent	
Thermal shock	4.7.2.1	MIL-STD-202 TM 107 condition B	----	100 percent
Element electrical	C.4.3.6.2	--	----	100 percent
Conditioning	4.7.2.3	--	100 percent	
Stability of attenuation	4.7.11	--	---	100 percent
Post element electrical	4.7.2.4	--	----	100 percent
Solderability	4.7.8	MIL-STD-202 TM 208 condition B	3 (0)	3 (0)

C.4.3.2.1 Accept on zero defects. This specification uses accept on zero defect sampling plan. No defective units shall be delivered or accepted, from the 100 percent inspections of group A. (T) chip attenuators whose lots experience in excess of 5 percent defective units during group A inspection shall be rejected in entirety. (S) chip attenuators whose lots experience in excess of 10 percent defective units during group A inspection shall be rejected in entirety.

C.4.3.3 Periodic Group B inspection. Group B inspection shall consist of the inspections specified in table C-III in the order shown. Group B inspection shall be performed on samples from lots which have been subjected to and have passed group A inspection.

C.4.3.3.1 Sampling plan. Number of samples shall be selected according to table C-III and shall be performed every 24 months on inspection lot basis. The samples units shall then be subjected only to the inspection indicated for their particular subgroup.

C.4.3.3.2 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on contract.

APPENDIX C

TABLE C-III. Surface mount chip attenuator evaluation requirements (Group B).

Inspection	Reference paragraph	Test method	Device level and number of samples	
			S	T
Subgroup I				
Stability of attenuation with temperature	4.7.11		100 percent	
After thermal shock	4.7.2.1	MIL-STD-202 TM 107 condition B	11 (0)	22 (0)
After vibration	4.7.11.3	MIL-STD-202 TM 204 condition D		
After shock	4.7.11.4	MIL-STD-202 TM 213 condition I		
After Moisture resistance				
After peak power	4.7.12	---		
Sensitivity of attenuation After change in frequency After change in input power After change in temperature	4.7.12	--------	11 (0)	23 (0)
Visual and mechanical	C 4.3.6.1	MIL-STD-883 TM 2032	22(0)	45 (0)
Subgroup II				
Life test: 1000 hours	C.4.3.6.5	----	22 (0)	45 (0)
Post element electrical	4.7.2.4	----	22 (0)	45 (0)
Mechanical strength	C.4.3.6.3	MIL-STD-883 TM 2019	3 (0)	5 (0)
Wire bond strength 1/	C.4.3.6.4	MIL-STD-883 TM 2011	22 (0)	45 (0)

1/ Procuring Activity to specify wire bond size and bond type.

C.4.3.4 Nonconformance. Devices which fail any test criteria in group A shall be identified and controlled until removal from the inspection lot. If a sample fails to pass group B inspection, the manufacturer shall perform an analysis of the failure and take corrective action on the material or process that caused the failure. Group B inspection shall be repeated on additional samples for the subgroup(s) that failed. If the resubmitted sample fails the inspection which the original sample failed, acceptance and shipment of the product (and similar products), shall be discontinued. Corrective action shall cover all products accepted since the last successful completion of group B inspection. After corrective action has been taken and is acceptable to the government, group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B inspection, (subgroups I and II), has passed and show that the corrective action is successful.

APPENDIX C

C.4.3.5 Rejected lots. Inspection lots that fail group A requirements shall be rejected. Inspection lots that fail resubmission for group B inspection shall be rejected. Rejected inspection lots shall not be delivered to the government on contracts for qualified products.

C.4.3.6 Methods of examination and test.

C.4.3.6.1 100 percent visual inspection. Each surface mount chip attenuator shall be visually inspected to ensure conformance with the class K requirements of Method 2032 from MIL-STD-883 for space level (T) devices and class H requirements of Method 2032 from MIL-STD-883 for military level (S) devices.

C.4.3.6.2 Element electrical. Each element shall be electrically tested at +25°C as specified in the element acquisition documents.

C.4.3.6.3 Mechanical strength. Mechanical strength shall be performed in accordance with MIL-STD-883, test method 2019. For chip attenuators that are attached to the substrate at the end terminations, the area used to determine the force applied shall be the total area of the mounting surface of the end terminations.

C.4.3.6.4 Wire bond strength. Wire bond strength testing shall be performed in accordance with MIL-STD-883 test method 2011 to elements which are wire bonded during the device assembly operation. The sample will include at least 45 bond wires minimum for space level and 22 bond wires minimum for military level. If bimetallic bonds are to be used on the die pad, then a 300°C bake for at least 1 hour in air or an inset atmosphere shall precede the bond pull.

C.4.3.6.5 Life test. Space level (T) and military level (S) chip attenuators shall be tested for a minimum of 1000 hours at rated temperature and dc power adjusted to avoid overstress.

C.5 PACKAGING

C.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.

C.6 NOTES

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

C.6.1 Intended use. The radio and microwave frequency surface mount chip attenuators described in appendix C are intended for use in established reliability electronic applications for use in space and for use in standard military equipment and environments.

C.6.2 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 (see C.3.2.1). For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

APPENDIX C

C.6.3 Terms, definitions.

C.6.3.1 Element. A constituent of a device that contributes directly to its operation (e.g., chip resistor, capacitor, diode, transistor, integrated circuit, surface acoustic wave (SAW), substrate, package, etc., incorporated into a device), is an element of the device.

C.6.3.2. Passivation. The silicon oxide, nitride or other insulating material that is grown or deposited on the die prior to metallization.

APPENDIX D

VISUAL RESISTOR CARD INSPECTION
(Space Level Only)

D.1 SCOPE

D.1.1 Scope. This appendix details the procedure for visual inspection of conductors, metallization, scratches, voids, corrosion, substrate defects, etc., of chip resistors covered by this specification. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

D.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

D.3 INSPECTION

D.3.1 Conductor metallization defects (thick or thin film). Any resistor which exhibits the following defects in the active circuit metallization shall not be acceptable. The active circuit metallization is all metal or any other material used for interconnection except metallized scribe lines, unused bonding pads, and identification marking.

D.3.1.1 Conductor metallization scratches (thick or thin film). A scratch is defined as any tearing defect that disturbs the original surface of the metallization.

a. Any scratch in metallization through which the underlying resistor material also appears to be scratched.

b. Any scratch in the interconnecting metallization which exposes resistive material, substrate, or oxide anywhere along its length and reduces the width of the connecting strip to less than 50 percent of its original width.

D.3.1.2 Conductor metallization voids (thick or thin film). A void is defined as any region in the interconnecting metallization where the underlying resistive material or substrate is visible which is not caused by a scratch. Any void in the interconnecting metallization which leaves less than 50 percent of the original width undisturbed (see figure D-1).

D.3.1.3 Conductor metallization nonadherence (thick or thin film). Conductor metallization nonadherence is defined as any evidence of metallization lifting, peeling, or blistering (see figure D-1).

D.3.1.4 Conductor metallization bridging (thin film) (see figure D-1). Conductor metallization bridging defects are defined as follows:

a. Bridged metallization defect that reduces the distance between any two metallization areas to less than 50 percent or 0.3 mils, whichever is greater.

b. Bridging between metallization and resistor pattern not intended by design that reduces the distance between the two to less than 0.1 mils.

D.3.1.5 Conductor metallization missing (thick or thin film). Conductor metallization defects are defined as more than 5 percent of the metallization area missing from the bonding pad (see figure D-1).

D.3.1.6 Conductor metallization corrosion (thick and thin film). Metallization corrosion is defined as any evidence of localized heavy stains, metallization corrosion, discoloration or mottled metallization (see figure D-1).

D.3.1.7 Excessive metallization (thick and thin film). A buildup or protrusions of termination material shall not exceed .003 inches (0.08 mm) above the average thickness of the termination's surface (see figure D-1).

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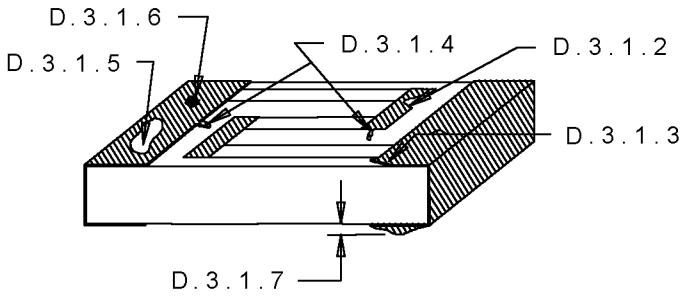

FIGURE D-1. Conductor metallization defects.

D.3.2 Resistor defects (thick and thin film). Any resistor which exhibits the following defects in the active area shall not be acceptable. The active area of a resistor is that part of a resistor pattern which remains in series connection between resistor terminals and is not shorted by metallization. For resistor patterns using laser trimmed “rungs”, any anomaly in a non-active area at least two rungs beyond the last properly trimmed rung are acceptable.

D.3.2.1 Resistor scratches (thick or thin film) (see figure D-2 and figure D-3). Resistor scratches are defined as any scratch within the active resistor area one mil or longer. A scratch must be indicated by either disturbance of the surface resistor or extraneous, shiny material remaining from the instrument causing the scratch.

D.3.2.2 Resistor voids (thick and/or thin film) (see figure D-2 and figure D-3).

a. For block patterns, a void or neckdown in the active resistor area which reduces the width of the area by more than 10 percent of the original area (see figure D-2).

b. For thin film serpentine and link patterns a void or neckdown in the active resistor area which reduces the width of the area by more than 50 percent of the original area (see figure D-3).

D.3.2.3 Resistor nonadherence (thick and thin film). Resistor nonadherence is defined as any evidence of resistor film lifting, peeling, or blistering (see figure D-2 and figure D-3).

D.3.2.4 Resistor cracks (thick and thin film). Any chip out or crack in the resistor area.

D.3.2.5 Resistor material corrosion (thick and /or thin film). Resistor material corrosion is defined as follows:

a. Any evidence of localized heavy stains or corrosion of resistor material in the active resistor area (see figure D-2 and figure D-3).

b. For thin film, discoloration of the resistor film due to thermal stabilization is not a cause for rejection.

D.3.2.6 Resistor bridging defects (thin film). Resistor bridging defects are defined as follows (see figure D-3):

a. Resistor bridging caused by photolithographic defect that forms a conductive bridge across two or more adjacent active resistance areas where width of bridge path is less than one half the smallest line width in the pattern.

b. Partial bridging defect that reduces the distance between adjacent active resistance areas to less than 50 percent of the design separation.

APPENDIX D

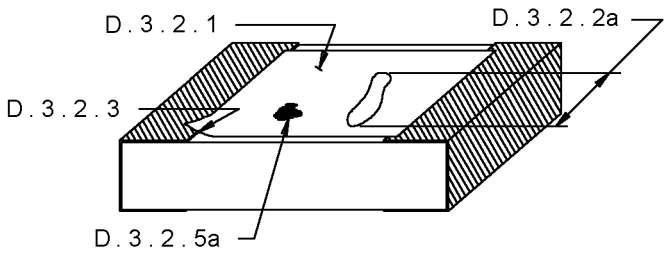

FIGURE D-2. Resistor voids.

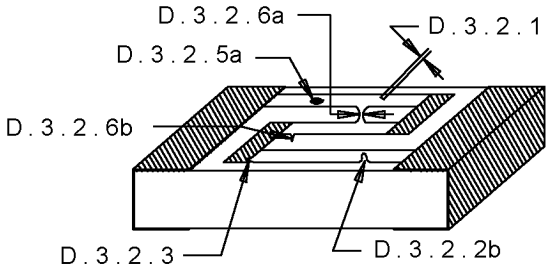

FIGURE D-3. Resistors defects.

D.3.2.7 Resistor trim faults (thick or thin film). After trimming any resistor which exhibits the following defects in the active area shall not be acceptable (see figure D-4 and figure D-5).

Applies to thin film:

a. The narrowest remaining width after trimming must be equal to or greater than 50 percent of the width of the narrowest line within the same resistor pattern (see figure D-5).

b. For a resistor pattern with links designed for incremental trim where edge of cut touches the active resistor area (see figure D-5).

c. Discoloration of resistors in and around laser kerfs is not cause for rejection.

Applies to thick and thin film:

d. Uncut resistor material remaining after trimming due to "skipping" (see figure D-4 and figure D-5).

e. Voids, cracking, or similar damage caused to the underlying material by trimming where such damage touches active interconnects, resistor area, or both.

f. Any unintentional "scorching" of resistor areas by direct laser beam or spurious reflections caused by optics of the system.

g. For a cut in the resistor pattern which reduces a link or ladder width by more than 50 percent of original width. Links cut 100 percent are acceptable (see figure D-5).

D.3.3 Substrate defects (thick and/or thin film). Any resistor which exhibits a substrate defect is cause for rejection and defined as follows (see figure D-4 and figure D-5):

a. Any crack in that exceeds 3.0 mil in length or comes closer than 1.0 mil to an active resistor or bonding pad area on the substrate (see figure D-4 and figure D-5).

b. Any crack in a substrate that exceeds 1.0 mil in length and points towards the active resistor area (see figure D-4 and figure D-5).

c. A substrate, when scribed and broken, is left with an attached portion of an adjacent substrate which contains metallization or resistor material (see figure D-4 and figure D-5).

d. Any crack not originating at a substrate edge is cause for rejection (see figure D-4 and figure D-5).

D.3.4 Foreign material (thick and/or thin film). Material is considered attached when it cannot be removed with a soft bristled brush or a nominal gas blow (of 20 psig) of dry nitrogen or air. Attached foreign material which reduces the separation between metallization areas to be less than 0.1 mil or is greater than 5 percent of the surface area on which it occurs is cause for rejection.

D.3.5 Heavy metal marks (thick and thin film). Metal marks are defined as termination material on the surface of the substrate or passivation. Heavy metal marks are defined as dots of solder that are continuous and do not allow the substrate/passivation to be seen between the individual dots of metal when viewed at 30X. Light metal marks are defined as dots of metal when viewed at 30X. Light metal marking can be accepted.

a. Reject for any heavy metal marks greater than 10 mils in any direction.

b. Reject for 5 or more heavy metal marks larger than 3 mils but less than 10 mils in any direction on a surface of a resistor chip.

D.3.6 Coating defects (thick and thin film). Protective coating is applied over the resistor element for mechanical and environmental protection.

a. Reject for coating damage which exposes the underlying resistor element.

b. Reject for any visible cracks in the coating.

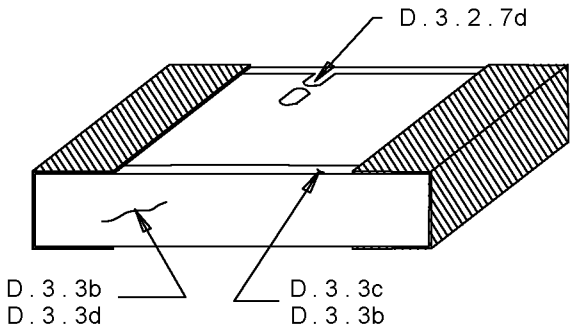

FIGURE D-4. Cracks, chip outs, or voids.

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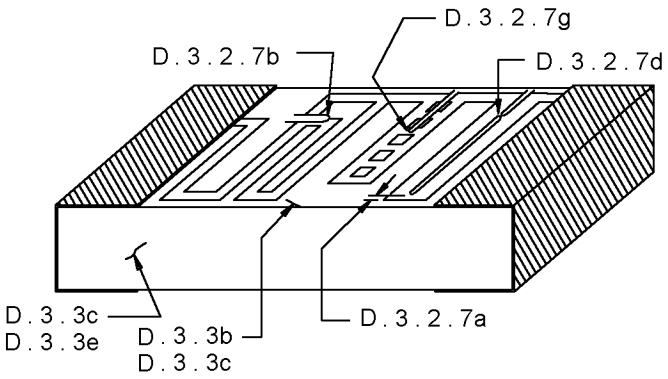

FIGURE D-5. Resistor trim faults and substrate defects.

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

Review activities:
Army - MI
Navy - AS, MC, SH
Air Force - 71, 99

Preparing activity:
DLA - CC

(Project 5985-2010-002)

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/.