

INCH-POUND

MIL-DTL-28837B
 26 March 2004
 SUPERSEDING
 MIL-DTL-28837A
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DETAIL SPECIFICATION

MIXER STAGES, RADIO FREQUENCY
 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 mixer stages, radio frequency for use in military systems (see 6.1).

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 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-DTL-85	-	Waveguides, Rigid, Rectangular, General Specification for.
MIL-DTL-3922	-	Flanges, Waveguide, General Purpose, General Specification for.
MIL-C-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-F-14072	-	Finishes for Ground Based Electronic Equipment.
MIL-P-24691/3	-	Pipe and Tube, Corrosion-Resistant, Stainless Steel, Seamless or Welded.
MIL-H-28719	-	Header, Hermetically Sealed.
MIL-PRF-39012	-	Connectors, Coaxial, Radio Frequency, General Specification for.
MIL-C-55302	-	Connectors, Printed Circuit Subassembly and Accessories.

Comments suggestions or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: VAT, P. O. Box 3990, Columbus, OH 43216-5000, or emailed to ([mailto: TubesFiberOptic@dla.mil](mailto:TubesFiberOptic@dla.mil)). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

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STANDARDS

FEDERAL

FED-STD-H28 - Screw-Thread Standards for Federal Services.

DEPARTMENT OF DEFENSE

MIL-STD-129 - Military Marking.
 MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
 MIL-STD-889 - Dissimilar Metals.
 MIL-STD-1276 - Leads for Electronic Component Parts.
 MIL-STD-1285 - Marking of Electrical and Electronic Parts.
 MIL-STD-2073-1 - Standard Practice for Military Packaging.

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

2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z540.1 - Calibration Laboratories and Measuring and Test Equipment.

(Application for copies should be addressed to American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036.)

ASTM INTERNATIONAL

ASTM-A240/A240M - Heat-Resisting Chromium and Chromium-Nickel, Stainless Steel Plate, Sheet, and Strip for Pressure Vessels (DoD adopted).
 ASTM-A666 - Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar (DoD Adopted).
 ASTM-A693 - Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip (DoD adopted).
 ASTM-B16/B16M - Free-Cutting Brass Rod, Bar and Shapes, for Use in Screw Machines (DoD adopted).
 ASTM-B26/B26M - Aluminum-Alloy Sand Castings (DoD adopted).
 ASTM-B36/B36M - Brass Plate, Sheet, Strip, and Rolled Bar (DoD adopted).
 ASTM-B85 - Aluminum-Alloy Die Castings (DoD adopted).
 ASTM-B108 - Aluminum-Alloy Permanent Mold Castings (DoD adopted).
 ASTM-B121/B121M - Leaded Brass Plate, Sheet, Strip, and Rolled Bar (DoD adopted).
 ASTM-B124/B124M - Copper and Copper Alloy Forging Rod, Bar, and Shapes (DoD adopted).
 ASTM-B194 - Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar (DoD adopted).
 ASTM-B209 - Aluminum and Aluminum-Alloy, Sheet and Plate (DoD adopted).
 ASTM-B221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (DoD adopted).
 ASTM-B241/B241M - Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube (DoD adopted).
 ASTM-B308/B308M - Aluminum-Alloy 6061-T6 Standard Structural Shapes (DoD adopted).
 ASTM-B339 - Pig Tin (DoD adopted).
 ASTM-488 - Electrodeposited Coatings of Gold for Engineering Uses (DoD adopted).
 ASTM-B545 - Electrodeposited Coatings of Tin (DoD adopted).
 ASTM-B700 - Electrodeposited Coatings of Silver for Engineering Use.

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ASTM-D5948 - Molding Compounds, Thermosetting (DoD adopted).

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

SAE INTERNATIONAL

SAE-AMS2422	-	Plating, Gold.
SAE-AMS4290	-	Aluminum Alloy, Die Castings 9.5 Si - 0.50 Mg (360.0-F) As Cast (UNS A03600).
SAE-AMS4291	-	Aluminum Alloy, Die Castings 8.5 Si - 3.5 Cu (A380.0) As Cast (UNS D13800).
SAE-AMS5511	-	Steel, Corrosion-Resistant, Sheet, Strip, and Plate 19 Cr - 9.5 Ni (304L) Solution Heat Treated (DoD adopted).
SAE-AMS-C-26074	-	Coatings, Electroless Nickel, Requirements for (DoD adopted).
SAE-AMS-I-23011	-	Iron Nickel Alloys for Sealing to Glasses and Ceramics (DoD adopted).
SAE-AMS-QQ-A-200	-	Aluminum Alloy, Bar, Rod, Shapes, Structural Shapes, Tube, and Wire, Extruded, General Specification for (DoD adopted).
SAE-AMS-QQ-A-250	-	Aluminum and Aluminum-Alloy, Plate and Sheet (DoD adopted).
SAE-AMS-QQ-N-290	-	Nickel Plating (Electrodeposited) (DoD adopted).
SAE-AMS-QQ-S-763	-	Steel Bars, Wire, Shapes, and Forgings; Corrosion Resistant (DoD adopted).
SAE-J452	-	Chemical Compositions, Mechanized and Physical Properties of SAE, Aluminum Casting Alloys, General Information.

(Copies of these documents are available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, 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 mixer 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. Mixers covered by specification sheets furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for the opening of bids (see 4.5 and 6.3).

3.3 Material. The material shall be as specified. When a definite material is not specified, a material shall be used which will enable the mixers 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. Unless otherwise specified (see 3.1), the material shall be selected from the following materials.

- a. Aluminum alloy plates and sheet shall conform to the composition 6061 of ASTM-B209 and SAE-AMS-QQ-A-250; extruded aluminum alloy shall conform to composition 6063 of ASTM-B241/B241M, or composition 6061 of ASTM-B221.
- b. Corrosion-resisting steel plates, sheets, and stays shall conform to ASTM-A240/A240M, ASTM-A-666, and ASTM-A693 and SAE-AMS5511. Corrosion-resisting forging shall conform to SAE-AMS-QQ-S-763, and corrosion-resisting steel pipe shall conform to MIL-P-24691/3.
- c. Copper alloy sheet shall conform to ASTM-B36/B36M and ASTM-B121/B121M.
- d. Aluminum alloy shall conform to alloy A360 of ASTM-B85, ASTM-B26/B26M, ASTM-B108, SAE-J452, SAE-AMS4290, and SAE-AMS4291, alloy 356-T6 of ASTM-B108 or alloy D712.0-F of ASTM-B26/B26M.

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- e. Brass shall conform to alloy 360 of ASTM-B121/B121M, ASTM-B36/B36M, ASTM-B16/B16M, and ASTM-B124/B124M.
- f. Beryllium copper shall conform to ASTM-B194.
- g. Pure tin shall be prohibited internally and externally.

3.3.1 Dissimilar metal. Unless suitably protected against electrolytic corrosion, dissimilar metal as defined in MIL-STD-889 shall not be in intimate contact.

3.3.2 Plastic. Plastic shall conform to ASTM-D5948.

3.3.3 Fungus. Material used in the construction of mixers shall be fungus inert.

3.3.4 Headers. Headers shall conform to MIL-H-28719.

3.4 Design and construction. Mixers shall be of design, construction, and physical dimensions specified (see 3.1).

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

3.4.2 Nominal impedance. Unless otherwise specified (see 3.1), the nominal impedance looking into the local oscillator and RF ports of Transverse-Electro-Magnetic (TEM) mixers shall be 50 ohms.

3.4.3 Input level. The input level for mixers shall be as specified (see 3.1).

3.4.4 Threaded parts. All screw threads used in construction of mixers shall be in accordance with FED-STD-H28.

3.4.5 Mounting. Mixers shall be mounted in any position.

3.4.6 RF connections.

3.4.6.1 Coaxial connectors. Coaxial connectors for a specific mixer shall conform to MIL-PRF-39012 as applicable (see 3.1).

3.4.6.2 Waveguide flanges. Unless otherwise specified (see 3.1), all flanges used on mixers shall mate electrically and mechanically with flanges covered by MIL-DTL-3922 or (see 6.8).

3.4.6.3 Printed circuit connectors. Printed circuit connections for a specific mixer shall conform to MIL-C-55302 as applicable (see 3.1).

3.4.6.4 Leads. Lead connections for a specific mixer shall be a chemical composition conforming to MIL-STD-1276 or SAE-AMS-I-23011 and unless otherwise specified (see 3.1), shall be solderable.

3.4.6.5 Socket pins. Unless otherwise specified (see 3.1), socket pins for a specific mixer shall be in accordance with header specification MIL-H-28719.

3.4.6.6 Receptacles. Receptacle connections for a specific mixer shall be as specified (see 3.1).

3.4.6.7 Connection caps. All waveguide and coaxial connections shall be sealed with push-on plastic caps to prevent both damage and the entrance of moisture and foreign material during storage.

3.4.7 Waveguide. Waveguides used in the manufacturing of the mixers shall conform to MIL-DTL-85 or (see 6.9), as applicable (see 3.1).

3.4.8 Finish. Unless otherwise specified (see 3.1), the finish shall be as specified in 3.4.8.1 through 3.4.8.3.

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3.4.8.1 RF mating surfaces. Mating surfaces shall be finished in gold, nickel or silver conforming to SAE-AMS2422, ASTM-B488, SAE-AMS-C-26074, SAE-AMS-QQ-N-290, and ASTM-B700. Nickel shall be used only if no other surface finish can meet the performance requirements.

3.4.8.2 External surfaces. All external surfaces excepting RF mating surfaces shall be finished in accordance with MIL-F-14072.

3.4.8.3 Aluminum alloys. Aluminum alloy surfaces shall be chemically treated in accordance with MIL-C-5541; however, electrical mating surfaces shall be conductive.

3.4.8.4 Tin whiskers. Pure tin shall not be used to coat any surface, internally or externally. Tin based coatings shall be alloyed with a minimum of 3 percent of a second metal, which has been shown to inhibit the growth of tin whiskers (see 6.10). Use of tin alloys is acceptable as approved by the qualifying activity.

3.4.9 Weight. The weight shall be as specified (see 3.1).

3.4.10 Temperature range. The temperature range shall be as specified (see 3.1).

3.4.11 Life. Unless otherwise specified (see 3.1), the manufacturer shall submit to qualification activity evidence that mixers are designed to operate for 1 year and degradation for this period shall not exceed specified limits (see 3.1). This evidence on each mixer for which qualification is requested shall be a certificate to the qualifying activity and a written guaranty shall be furnished to the acquiring activity on each awarded contract. Any acquired mixer that fails to meet this life requirement shall be replaced by the manufacturer at no cost to the Government.

3.5 Preconditioning (screened only). All screened mixers shall be preconditioned as specified in 4.7.2 and shall subsequently meet the electrical requirements specified (see 3.1).

3.6 Burn-in (screened only). All screened mixers shall be burned in as specified in 4.7.3, and shall subsequently meet the electrical requirements specified (see 3.1).

3.7 Electrical characteristics. When mixers are tested as specified in 4.7.4, the applicable electrical characteristics and tolerances shall be as specified (see 3.1).

3.8 Thermal shock. When mixers are tested as specified in 4.7.5, there shall be no physical damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.9 Vibration. When mixers are tested as specified in 4.7.6, there shall be no evidence of damage and no vibration induced amplitude modulation beyond the limits specified (see 3.1).

3.10 Shock. When mixers are tested as specified in 4.7.7, there shall be no evidence of damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.11 Seal. After mixers are tested as specified in 4.7.8, they shall meet electrical requirements specified (see 3.1).

3.12 Barometric pressure (when specified, see 3.1). When mixers are tested as specified in 4.7.9, there shall be no evidence of damage. During the test, electrical characteristics, as applicable, shall be as specified (see 3.1).

3.13 Solderability (as applicable). When mixers with solderable connections are tested as specified in 4.7.10, the terminals shall meet the criteria specified herein.

3.14 Resistance to solvents. When mixers are tested as specified in 4.7.11, there shall be no evidence of illegible marking, mechanical damage, or deterioration of material or finishes.

3.15 Resistance to soldering heat (as applicable). When mixers with solderable terminals are tested as specified in 4.7.12, there shall be no damage to the mixers or to the terminal insulators that will cause electrical failure, or hermetically sealed mixers to leak. Chipping of terminal insulators above shall not be cause for failure unless the chipping extends to the outer periphery. After the test, mixers shall meet the conversion loss and seal requirements.

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3.16 Temperature extreme. When mixers are tested as specified in 4.7.13, there shall be no evidence of damage. During this test, the mixers shall meet the conversion loss and isolation requirements.

3.17 Terminal strength. When mixers are tested as specified in 4.7.14, the terminal strength shall be no less than the value specified.

3.18 Moisture resistance. When mixers are tested as specified in 4.7.15, there shall be no evidence of damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.19 Salt spray (when specified) (see 3.1). When mixers are tested as specified in 4.7.16, there shall be no evidence of warping, cracking, peeling, excessive corrosion, or in case of plated metals, corrosion that has passed through the plating and exposed the base metal. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.20 Marking. Mixers shall be marked in accordance with MIL-STD-1285 with the PIN and the manufacturer's source code. Marking characters shall be approximately .125 inch (3.18 mm) in height. The marking shall be placed on the identification plate, using a method that will provide legible and permanent marking for the life of the mixer. The manufacturer's name or trademark may also be included in the marking provided such is not expressly forbidden in the contract. When space does not permit use of an identification plate, marking may be directly on a flat or circular cylindrical surface of the body. Letter size may be reduced to accommodate the following:

Preferred	M28837/ 1-01S ZZZZZ	PIN
		Manufacturer's source code
Permissible	M 28837/ 1-01S ZZZZZ	

3.20.1 Serialization. When the contract requires that mixers be serialized, each mixer shall be marked with a unique serial number assigned consecutively within the inspection lot, allowing traceability of the mixer.

3.21 Workmanship. Mixers shall be manufactured and processed in such a manner as to be uniform in quality, and the shell of the mixer shall be free from tool marks, burrs, deep scratches, and other defects that will affect life, serviceability, or appearance.

3.22 Radiographic inspection (space level component screening only). Components intended for space environment application shall be subjected to and pass radiographic inspection (100% screening) in accordance with 4.7.17.

3.23 Acceleration (space level component screening only). Components intended for space environment application shall be subjected to and pass acceleration requirement (100% screening) in accordance with 4.7.18.

4. VERIFICATION

4.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantities to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ANSI Z540.1.

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

- a. Materials inspection (see 4.3).
- b. Qualification inspection (see 4.5).
- c. Conformance inspection (see 4.6).

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

TABLE I. Materials inspection.

Material	Requirement paragraph	Applicable specification(s)
Aluminum -----	3.3	ASTM-B26/B26M, ASTM-B85, ASTM-B108, ASTM-B209, ASTM-B221, ASTM-B241/B241M, ASTM-B308/B308M, SAE-AMS4290, SAE-AMS4291, SAE-AMS-QQ-A-200, SAE-AMS-QQ-A-250, SAE-J452
Nickel-Iron Alloy -----	3.3	SAE-AMS-I-23011
Brass -----	3.3	ASTM-B16/B16M, ASTM-B36/B36M, ASTM-B121/B121M, ASTM-B124/B124M
Copper -----	3.3	ASTM-B36/B36M, ASTM-B121/B121M, ASTM-B194
Steel -----	3.3	ASTM-A240/240M, ASTM-A666, ASTM-A693, SAE-AMS5511, MIL-P-24691/3
Plastics -----	3.3.2	ASTM-D5948
Finish -----	3.4.8	SAE-AMS-C-26074, ASTM-B700, SAE-AMS2422, ASTM-B488, SAE-AMS-QQ-N-290

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.

4.5 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.

4.5.1 Sample size. Four mixers of each PIN, for which qualification is sought, shall be subjected to qualification inspection.

4.5.2 Inspection routine. The sample shall be subjected to the inspections specified in table II, in the order shown. All sample units shall be subjected to the inspection of group I. The sample shall then be divided into two subgroups and subjected to the inspection for their particular subgroup.

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

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 supplier to furnish the sample units with the qualification inspection report.

4.5.5 Retention of qualification. To retain qualification, the contractor shall forward a report at 24-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- 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 lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.

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- b. The results of tests performed for periodic inspection (group B), including the number and mode of failures. The test report shall include results of all periodic inspection tests performed and completed during the 24-month period. If the test results indicate nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 24-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 24-month period 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 company still has the capabilities and facilities necessary to produce the item. If during 24-month reporting periods, there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit the products to testing in accordance with the qualification inspection requirements.

TABLE II. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph
<u>Group I (4 sample units)</u>		
Visual and mechanical-----	3.1, 3.3 through 3.4.8.3, 3.20 and 3.21	4.7.1
Preconditioning <u>1/</u> -----	3.5	4.7.2
Burn-in <u>1/</u> -----	3.6	4.7.3
Electrical characteristics <u>2/</u> -----	3.7	4.7.4
Conversion loss-----	---	4.7.4.1
Noise figure-----	---	4.7.4.2
Isolation -----	---	4.7.4.3
Conversion compression -----	---	4.7.4.4
Conversion desensitization-----	---	4.7.4.5
Intermodulation -----	---	4.7.4.6
Insertion loss -----	---	4.7.4.7
VSWR -----	---	4.7.4.8
RF leakage -----	---	4.7.4.9
<u>Group II</u>		
<u>Subgroup I (2 sample units)</u>		
Thermal shock-----	3.8	4.7.9
Vibration -----	3.9	4.7.6.1 and 4.7.6.2
Shock-----	3.10	4.7.7
Seal -----	3.11	4.7.8
Barometric pressure <u>3/</u> -----	3.12	4.7.9
Electrical characteristics <u>2/</u> -----	3.7	4.7.4
<u>Group III (2 sample units)</u>		
Solderability <u>2/</u> -----	3.13	4.7.10
Resistance to solvent <u>2/</u> -----	3.14	4.7.11
Resistance to soldering heat <u>2/</u> -----	3.15	4.7.12
Temperature extreme-----	3.16	4.7.13
Terminal strength <u>2/</u> -----	3.17	4.7.14
Moisture resistance-----	3.18	4.7.15
Salt spray <u>3/</u> -----	3.19	4.7.16
Electrical characteristics <u>2/</u> -----	3.7	4.7.4

1/ Screened only.

2/ As applicable (see 3.1).

3/ When specified (see 3.1).

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4.5.6 Extension of qualification. Qualification of a screened mixer in a given package style may be extended to the nonscreened version.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of the product for delivery shall consist of group A inspection.

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

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table III in the order shown. Subgroup 1 shall consist of screened and unscreened items. Subgroup 2 shall consist of only screened items.

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph
<u>Subgroup 1 (screened and unscreened samples)</u>		
Visual and mechanical examination -----	3.1, 3.3 through 3.4.8.3, inclusive, 3.20 and 3.21	4.7.1
Seal -----	3.11	4.7.8
Electrical characteristics <u>1/</u> -----	3.7	4.7.4
Conversion loss-----	---	4.7.4.1
Noise figure-----	---	4.7.4.2
Isolation -----	---	4.7.4.3
Conversion compression -----	---	4.7.4.4
Conversion desensitization-----	---	4.7.4.5
Intermodulation -----	---	4.7.4.6
Insertion loss -----	---	4.7.4.7
VSWR -----	---	4.7.4.8
RF leakage -----	---	4.7.4.9
<u>Subgroup 2 (screened samples only)</u>		
Thermal shock-----	3.8	4.7.5
Vibration -----	3.9	4.7.6.1
Seal -----	3.11	4.7.8
Electrical characteristics <u>1/</u> -----	3.7	4.7.4
Radiographic inspection <u>2/</u> -----	3.22	4.7.17
Acceleration <u>2/</u> -----	3.23	4.7.18

1/ As applicable (see 3.1).

2/ Additional screening requirement for Space level components.

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be performed on an inspection lot basis with a random sample of mixers selected in accordance with table IV. Acceptance levels shall be based upon the zero defective sampling plan. No failures shall be permitted.

TABLE IV. Group A sampling plan.

Lot size	Sample size	"space flight" mixers
1 - 13	100 percent	100 percent
14 - 150	13	100 percent
151 - 280	20	100 percent
281 - 500	29	100 percent
501 - 1,200	34	100 percent
1,201 - 3,200	42	100 percent
3,201 - 10,000	50	100 percent
10,001 - 35,000	60	100 percent
35,001 - 150,000	74	100 percent
150,001 - 500,000	90	100 percent
500,001 and over	102	100 percent

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4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection, defined as double original sample size with acceptance on zero failures. If tightened inspection fails, the rejected lot shall not be re-inspected, re-screened, or reworked. All rework shall be performed prior to re-inspection. Resubmitted lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.2 Periodic inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance (see 6.3.1) with the applicable requirements, delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections. Frequency of periodic inspection is defined by qualifying activity to be every 24 months, consistent with period of qualification validation.

4.6.2.1 Group B inspection. Group B inspection shall consist of the inspections specified in table V, in the order shown. Group B inspection shall be made on sample units selected from inspection lots which have passed the group A inspection (see 6.3.1). Group B inspection may cover a family of structurally similar mixer stages built on the same header in accordance with MIL-H-28719.

TABLE V. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
<u>Subgroup 1 (2 sample units)</u>		
Thermal shock-----	3.8	4.7.5
Vibration -----	3.9	4.7.6
Shock-----	3.10	4.7.7
Seal-----	3.11	4.7.8
Barometric pressure <u>1/</u> -----	3.12	4.7.9
Electrical characteristics <u>2/</u> -----	3.7	4.7.4
<u>Subgroup 2 (2 sample units)</u>		
Solderability <u>2/</u> -----	3.13	4.7.10
Resistance to solvent <u>2/</u> -----	3.14	4.7.11
Resistance to soldering heat <u>2/</u> -----	3.15	4.7.12
Temperature extreme-----	3.16	4.7.13
Terminal strength <u>2/</u> -----	3.17	4.7.14
Moisture resistance-----	3.18	4.7.15
Salt spray <u>1/</u> -----	3.19	4.7.16
Electrical characteristics <u>2/</u> -----	3.7	4.7.4

1/ When specified (see 3.1).

2/ As applicable (see 3.1).

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Mixers shall be examined to verify that the material, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.4.8.3, inclusive, 3.20, and 3.21).

4.7.2 Preconditioning (screened only) (see 3.5). Unless otherwise specified, all screened mixers shall be preconditioned by subjecting them to the maximum operating temperature (see 3.1), for a 24 hour period. Subsequently each mixer shall meet the requirements of table III in the order shown.

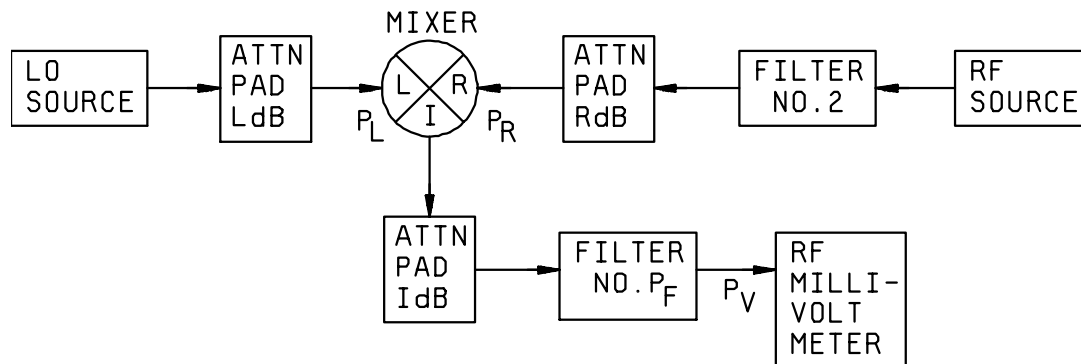
4.7.3 Burn-in (screened only) (see 3.6). All screened mixers shall be tested by applying a 30 mA dc, unless otherwise specified (see 3.1) to the IF port for 48 hours in each polarity. Each mixer shall meet the requirements of table III in the order shown.

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4.7.4 Electrical characteristics (see 3.7). The electrical characteristics shall be determined by the tests specified herein, as applicable (see 3.1). Electrical tests included herein do not embrace all of the electrical tests that may be requested. Unless otherwise specified (see 3.1), LO input level shall be +7 dBm. "Equivalent" test setups may be used provided they are industry accepted as equal to or better than the setups shown in figures 1 through 9.

4.7.4.1 Conversion loss (SSB). The conversion loss of mixers shall be measured at the low end and high end of the specified frequency range (see 3.1).

Procedure (see figure 1). The RF input level shall be -10 dBm and the LO input shall be as specified (see 3.1 and 4.7.4). When the -10 dBm input is such to cause a given mixer to operate in its nonlinear range, the RF input level shall be adjusted so the mixer shall operate in its linear range. The characteristic of the crystal filter number 1 shall be such that it will reject all responses other than the desired or specified intermediate frequency (IF). The characteristic of the filter number 2 shall be such that it will attenuate all harmonics of the RF source by at least 30 dB.



$$\text{Conversion loss} = (P_R - I_{dB} - P_f - P_V) \text{ dB}$$

FIGURE 1. Conversion loss test setup.

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4.7.4.2 SSB noise figure. The SSB noise figure (NF) of mixers shall be measured as follows:

The NF shall be measured with thermal noise with specified LO frequency and available power. Unless otherwise specified, the IF shall be the difference between LO and (nominal) RF. Mixer port terminations shall be 1.2:1 VSWR or less at the L port for LO, at the R port for RF, and at the I port for each LO + RF and LO - RF. Measurement accuracy of NF shall be ± 0.4 dB.

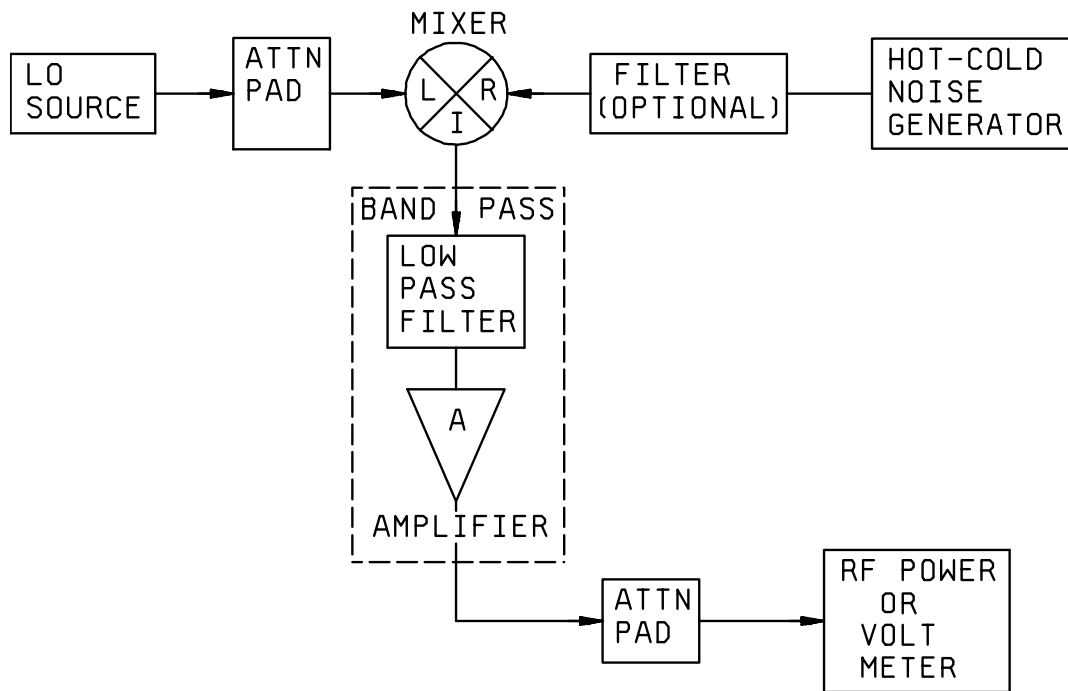
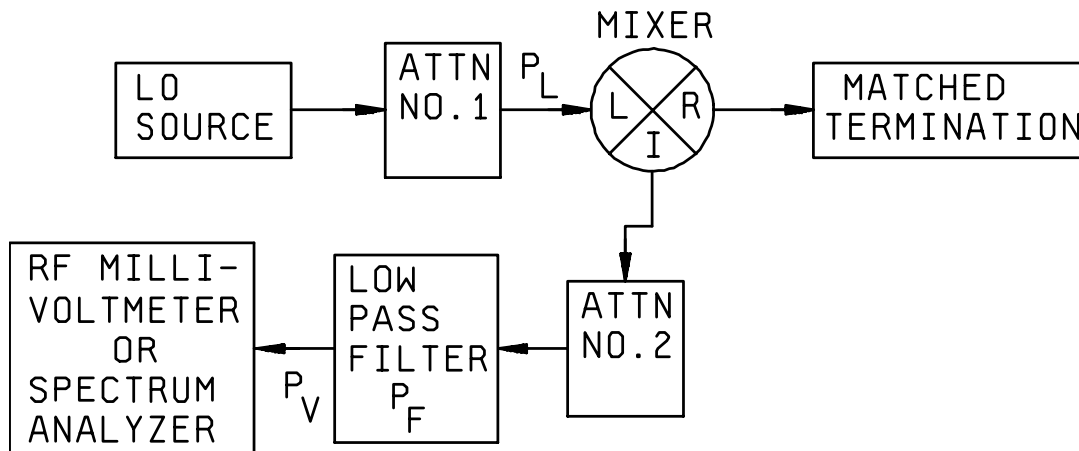


FIGURE 2. Noise figure test setup.

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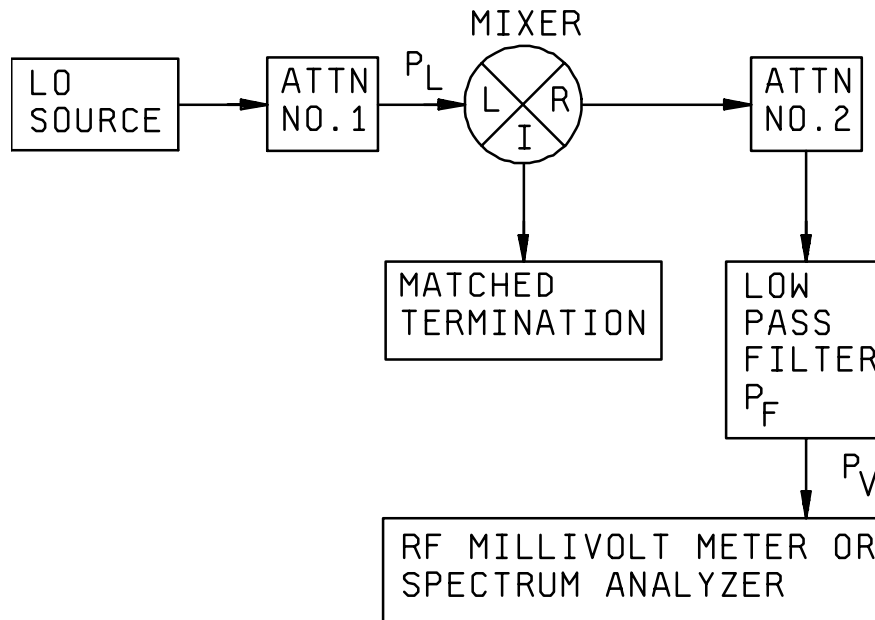
4.7.4.3 Isolation. The isolation between the LO to IF, LO to RF, and RF to IF ports shall be measured at the low end, center, and high end of the specified frequency (see 3.1) using the test setup in figures 3, 4, and 5. The input power shall be as specified (see 3.1). An acceptable alternate test method is the sweep frequency technique. The low pass filters shall attenuate all harmonics at least 30 dB and have negligible insertion loss over the specified frequency (see 3.1).



$$\text{LO to IF isolation} = (P_L - P_V - \text{ATTN. \#2} - P_F) \text{ dB}$$

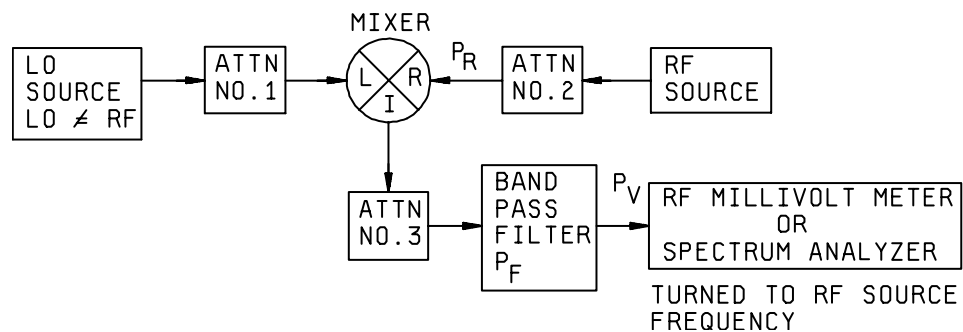
FIGURE 3. LO to IF isolation test setup.

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$$\text{LO to RF isolation} = (P_L - P_V - \text{ATTN. \#2} - P_F) \text{ dB}$$

FIGURE 4. LO to RF isolation test setup.



$$\text{RF to IF isolation} = (P_R - P_V - \text{ATTN. \#3} - P_F) \text{ dB}$$

FIGURE 5. RF to IF isolation test setup.

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4.7.4.4 Conversion compression. The conversion compression shall be determined by measuring the RF power required to increase the conversion loss by 1 dB.

Procedure. Using the test setup of figure 1 and the procedures of 4.7.4.1, determine a conversion loss at some convenient LO and RF frequencies within the specified range, adjusting the available RF power to the level specified for 1 dB compression maximum. Increase attenuation in ATTN R by nominally 10 dB and decrease ATTN I by the same actual value. Re-measure conversion loss. Change of 1 dB or less shall be acceptable.

NOTE: Minimum value of ATTN R and ATTN I shall neither be less than 10 dB.

4.7.4.5 Conversion desensitization. The conversion desensitization shall be determined by measuring the RF power required to increase the conversion loss by 1 dB.

Procedure. Using the test setup in figure 1 and the procedures in 4.7.4.1, determine a conversion loss at some convenient LO and RF frequencies within the specified frequency range (see 3.1). Introduce a second RF frequency and increase its power until the conversion loss increases by 1 dB. This second RF signal power shall be as specified (see 3.1).

4.7.4.6 Intermodulation. The intermodulation products of the mixer shall be tested as specified in 4.7.4.6.1 or 4.7.4.6.2.

4.7.4.6.1 Two-tone third-order intermodulation. The two-tone third-order intermodulation (LO-(2RF1-RF2)) and (LO-(2RF2-RF1)) shall be measured using the test setup of figure 6. The following details shall apply:

a. Measuring system.

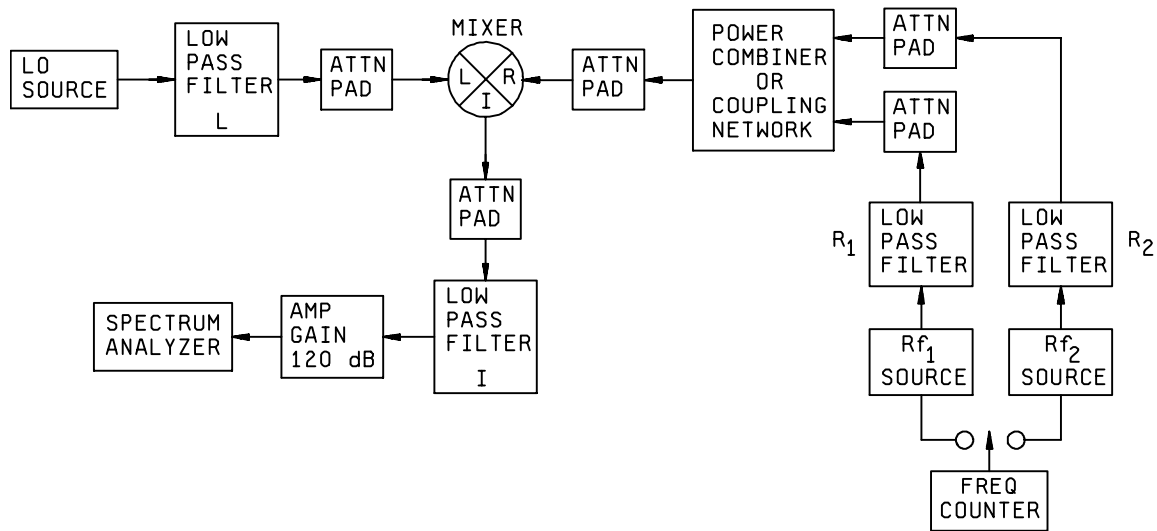
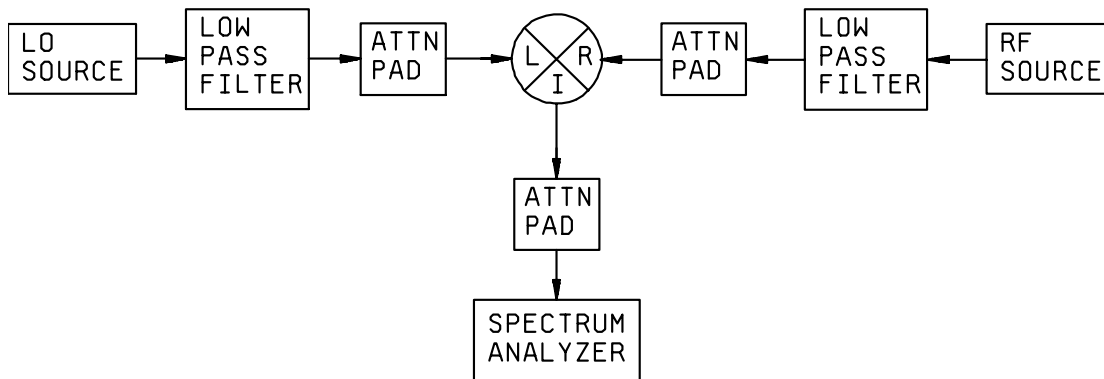
- (1) The measuring system dynamic range shall exceed the allowable intermodulation by at least 10 dB.
- (2) The measuring system shall have flat amplitude response across the frequency range of the third-order intermodulation frequencies.
- (3) Sufficient attenuation shall be provided to prevent overload of the spectrum analyzer.
- (4) The power combiner hybrid network shall provide isolation of 20 dB minimum.

b. Procedures.

- (1) Adjust ATTN RF1, ATTN RF2, and ATTN R to provide available power of RF1 and RF2 each equal to (LO available power - 20 dB) at the R port.
- (2) Adjust spectrum analyzer sensitivity and ATTN I for LO-RF1 and LO-RF2 to indicate 0 dB relative. Measure relative level of third-order intermodulation.
- (3) Increase ATTN I by 10 dB. If the levels of the four frequencies of step (2) each decrease 10 dB, the determination of step 2 is valid.

4.7.4.6.2 Harmonic intermodulation. The harmonic intermodulation product shall be measured using the test setup in figure 7. With the specified LO and RF powers (see 3.1) applied at some convenient LO and RF frequencies within the specified range, the harmonics power level in reference to the IF output shall be measured.

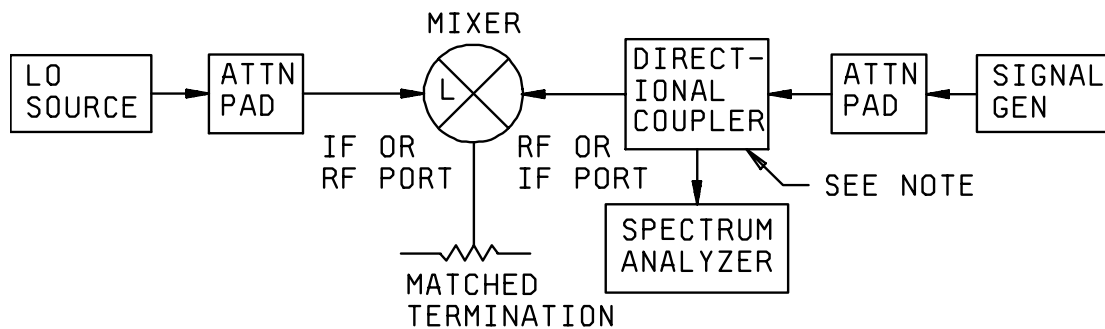
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FIGURE 6. Two-tone, third-order intermodulation test setup.FIGURE 7. Harmonics intermodulation product test setup.

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4.7.4.7 Insertion loss. The insertion loss, both reflected and dissipated using the test setup in figure 4 shall be measured from the LO port to the RF port with a dc current driven into the IF port at the specified level (see 3.1). The measurement shall be made at the low end, center, and high end or by a sweep frequency method over the specified frequency range (see 3.1).

4.7.4.8 VSWR. The VSWR at the RF and IF ports shall be measured using the test setup in figure 8. With the mixer removed from the test setup, establish a reference level on the spectrum analyzer at the center of the specified frequency range (see 3.1) by putting a short on the end of the directional coupler. Connect the RF port of the mixer to the output of the directional coupler. Apply the specified signal (see 3.1) to the LO port. Measure the reflected power on the spectrum analyzer. Repeat this procedure for the low end and high end of the specified frequency range (see 3.1). Repeat the procedure at the IF port using the specified IF frequency.

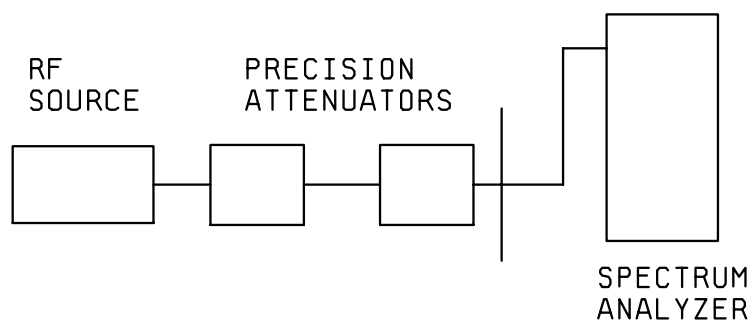


NOTE: The directivity of the directional coupler shall be such as to permit measurement of the VSWR with the appropriate accuracy.

FIGURE 8. VSWR test setup.

4.7.4.9 RF leakage. The RF leakage shall be measured using test set up on figure 9. The test equipment used to monitor and detect RF leakage shall be calibrated at the center frequency with an input power of 100 mwcw. The radiated signal strength (see figure 9) shall be measured by placing the antenna horn as close as possible to the mixer under test without making physical contact. The horn shall be oriented to any direction. The mixer shall be operated at the calibration power level.

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Test setup for calibration for RF leakage detector.

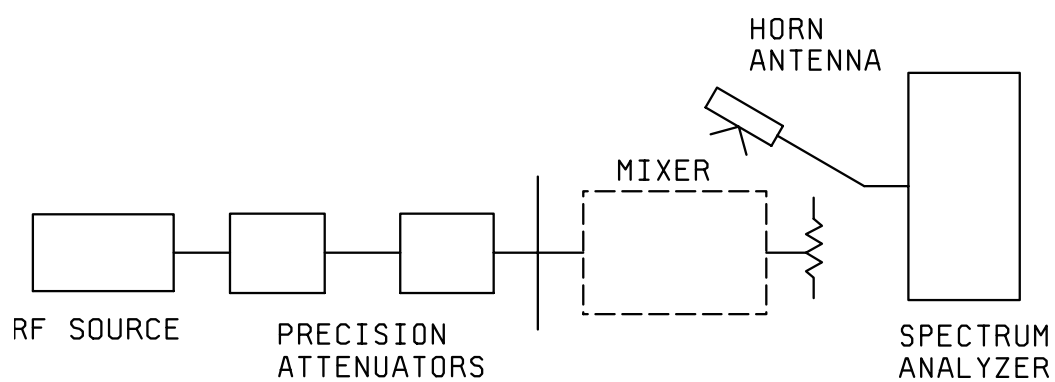


FIGURE 9. RF leakage test setup.

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4.7.5 Thermal shock (see 3.9). Mixers shall be tested in accordance with method 107 of MIL-STD-202. The following detail shall apply:

Test condition letter: B, unless otherwise specified (see 3.1).

4.7.6 Vibration (see 3.10). Unless otherwise specified (see 3.1), mixers shall be tested as specified in 4.8.6.1.

4.7.6.1 High frequency. Mixers shall be tested in accordance with method 204 of MIL-STD-202. The following detail shall apply:

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

4.7.6.2 Random nature. Mixers shall be tested in accordance with method 214 of MIL-STD-202. The following detail shall apply:

Test condition: IIF and 15 minutes duration, unless otherwise specified (see 3.1).

4.7.7 Shock (see 3.10). Mixers shall be tested in accordance with method 213 of MIL-STD-202. The following shall apply:

Test condition letter: A, unless otherwise specified (see 3.1).

4.7.8 Seal (see 3.11). Mixers shall be tested as specified in 4.7.8.1, 4.7.8.2, or 4.7.8.3, as applicable (see 3.1).

4.7.8.1 Hermetic seal. Hermetically sealed mixers shall be tested in accordance with method 112 of MIL-STD-202. The following details shall apply:

- a. Test condition letter: C, unless otherwise specified.
- b. Procedure: IIIA or IIIC.
- c. Degree of leakage rate sensitivity:

(1) 10^{-6} atm cm³/s for mixers whose volume is greater than 2 cubic inches.

(2) 10^{-8} atm cm³/s for mixers whose volume is 2 cubic inches or less.

4.7.8.2 O-ring seal, solder seal, or encapsulated seal. O-ring sealed, solder sealed, or encapsulated sealed mixers shall be tested in accordance with method 104 of MIL-STD-202. The following detail shall apply:

Test condition letter: B.

4.7.8.3 Dust-cover seal. When specified (see 3.1), dust cover sealed mixers shall be tested in accordance with method 103 of MIL-STD-202. The following detail shall apply:

Test condition letter: B.

4.7.9 Barometric pressure (when specified (see 3.1) (see 3.12)). Mixers shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: Normal mounting means.
- b. Test condition letter: C, unless otherwise specified (see 3.1).
- c. Measurements after test. Electrical characteristics, as applicable (see 3.1).

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4.7.10 Solderability (as applicable) (see 3.13). The terminals of the mixers shall be tested in accordance with method 208 of MIL-STD-202. The following detail shall apply:

Number of terminals: All.

4.7.11 Resistance to solvents (see 3.14). Mixers shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- a. Portion of the mixer to be brushed: The marked portion of the mixer.
- b. Number of mixers to be tested: All.

4.7.12 Resistance to soldering heat (as applicable) (see 3.15). All mixers shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

- a. The use of heat sinks: Not applicable.
- b. Terminations not to be tested: Not applicable.
- c. Special preparation: Not applicable.
- d. Immersion in flux: Not applicable.
- e. Depth of immersion in molten solder: $.060 \pm .020$ (1.52 ± 0.51 mm) of header.
- f. Test condition letter: B.
- g. Cooling time: Stabilize to $+25^{\circ}\text{C} \pm 1^{\circ}\text{C}$.
- h. Examinations and measurements before and after the test: Conversion loss and seal tests.

4.7.13 Temperature extreme (see 3.16). The mixer shall be tested at both the specified high temperature and low temperature ranges (see 3.1).

4.7.14 Terminal strength (as applicable) (see 3.17). The terminals of the mixers shall be tested in accordance with method 211 of MIL-STD-202. The following details shall apply:

- a. Test condition letter: A.
- b. Applied force: .5 pound.

4.7.15 Moisture resistance (see 3.18). Mixers shall be tested in accordance with method 106 of MIL-STD-202.

4.7.16 Salt spray (when specified, see 3.1 and 3.19). Mixers shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- a. Mounting: Normal mounting means.
- b. Test condition letter: B.
- c. Measurements after the test: Conversion loss and isolation.

4.7.17 Radiographic inspection (space level component screening only). Mixers intended for space environment application shall be examined in accordance with MIL-STD-202, method 209 (see 3.22). The following shall apply:

- a. A known "good" comparison reference mixer shall be available for simultaneous exposure with the device under test.

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- b. Two views shall be required, at 90° to each other, both perpendicular to the major (long) axis of the mixer.
- c. Radiographs shall be examined under variable lighting conditions and magnification 1X to 7X for defects specified in paragraph 4 of MIL-STD-202, method 209.
- d. Mixers x-rayed and found acceptable shall be identified with a blue dot, readily visible, not interfering with other markings.
- e. Serialization of mixers is required and must be correlatable to film views. One film copy is required shipped with the mixers. A report is required for each lot indicating the number of mixers inspected, the number found acceptable, and the number rejected.

4.7.18 Acceleration (space level component screening only). Mixers intended for space environment application shall be tested in accordance with MIL-STD-202, method 212 (see 3.23), with following details applied:

- a. Mounting - Normal mounting means.
- b. Test condition - B. The maximum acceleration test level shall correspond with levels experienced during space environment applications (not less than 5, 000 g). Direction(s) of application shall correspond with direction(s) of maximum susceptibility of internal mixer subcomponent flexure.
- c. Measurements - Electrical functionality (see 4.7.4) shall be verified (as accepted by the qualifying activity) before and after exposure to acceleration.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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. Mixers covered by this specification are intended for use in military systems as balanced mixers, phase detectors, balanced modulators, amplitude modulators, pulse modulators, and current controlled attenuators.

6.2 Acquisition requirements. Acquisition documents must specify the following:

6.2.1 Mixers covered by specification sheets:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable specification sheet, and the military PIN (see 6.4).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).
- d. Additional special marking, if required.
- e. Packaging (see 5.1).

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- f. Whether or not additional space level component screening requirements (see 3.22, 3.23) apply.

6.2.2 Mixers not covered by specification sheets:

- a. Title, number, and date of this specification.
- b. Information pertaining to inspection (see 3.2).
 - (1) The laboratory at which the inspection is to be performed (see 4.5).
 - (2) Submission of samples and data (see 4.5).
- c. Applicable design and construction requirements (see 3.5).
- d. Additional special marking, if required.
- e. Packaging (see 5.1).

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 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, Code DSCC-VQE, P.O. Box 3990, Columbus OH 43216-5000 (mailto: vqe.chief@dla.mil). Application for qualification tests is to be made in accordance with "Provisions Governing Qualification", SD-6.

6.3.1 Noncompliance. If a sample fails to pass group B inspection, the manufacturer must notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product must be discontinued until corrective action, acceptable to the qualifying activity has been taken. After the corrective action has been taken, group B inspection must be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the qualifying activity). Group A inspection may be reinstituted; however, final acceptance and shipment must be withheld until the Group B inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure must be furnished to the cognizant inspection activity and the qualifying activity.

6.4 Part or Identifying Number (PIN). The military PIN must consist of the letter "M" followed by the basic number of the specification sheet, an assigned dash number (see 3.1), and the letter N or S; where N indicates a nonscreened item and S indicates a screened item (see 3.5, 3.6, and table III.)

	M28837/1	-	01	N	or	S
Military designator and specification sheet number						
Dash number designated on specification sheet						
Nonscreened						
Screened						

6.5 Marking. In addition to any other special marking required by the contract (see 6.2), each unit package, intermediate and exterior container, and unitized load must be marked in accordance with MIL-STD-129. All unit packages fabricated with barrier material conforming to MIL-PRF-81705 type I must be marked with the term "ES/EM shielded" in accordance with the special marking requirements of MIL-STD-129.

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6.6 Symbols.

LO: Frequency of the local oscillator.
 RF: Frequency of the RF oscillator.
 IF: Intermediate frequency.
 PL: Power of local oscillator input to mixer expressed in dBm.
 PV: Power input to voltmeter expressed in dBm.
 PF: Power attenuation to filter, expressed in dB.
 PR: Power of RF source input to mixer expressed in dBm.
 PL: Power of LO source input to mixer expressed in dBm.
 SSB: Single side band.
 NF: Noise figure.

6.7 Subject term (key word) listing.

attenuator	isolation	single side band
balanced	leakage	socket pins
coaxial connector	local oscillator	solderability
conversion loss	modulators	VSWR
hermetic	noise figure	waveguide
insertion loss	power attenuator	waveguide flanges
intermodulation		

6.8 Waveguide flanges. History has proven that waveguide flanges used on mixers that mate electrically and mechanically with flanges covered by MIL-DTL-39000 meet the requirements of this specification (see 3.4.6.2).

6.9 Waveguides (see 3.4.7). History has proven that waveguides conforming to MIL-DTL-23351 can be used successfully in manufacturing the mixers specified herein.

6.10 Tin plated finishes. Tin plating is prohibited (see 3.4.8.4) since it may result in tin whisker growth. Tin whisker growth could adversely affect the operation of electronic equipment systems. For additional information on this matter, refer to ASTM B545 Electrodeposited Coatings of Tin.

6.11 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. Table VI lists the Environmental Protection Agency (EPA) top seventeen hazardous materials targeted for major usage reduction. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

Table VI. EPA top seventeen hazardous materials.

Benzene	Dichloromethane	Tetrachloroethylene
Cadmium and Compounds	Lead and Compounds	Toluene
Carbon Tetrachloride	Mercury and Compounds	1,1,1 - Trichloroethane
Chloroform	Methyl Ethyl Ketone	Trichloroethylene
Chromium and Compounds	Methyl Isobutyl Ketone	Xylenes
Cyanide and Compounds	Nickel and Compounds	

6.12 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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Custodians:

Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

(Project 5985-1293)

Review activities:

Army - AR, MI
Navy - AS, CG, MC, OS
Air Force - 19

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at www.dodssp.daps.mil.)