

INCH-POUND

MIL-DTL-28837A
October 30, 2001
 SUPERSEDING
 MIL-M-28837
 2 September 1977

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-S-4043	-	Steel, Corrosion-Resisting (Extra Low Carbon Type 304), Plate, Sheet, and Strip.
MIL-C-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-F-14072	-	Finishes for Ground Based Electronic Equipment.
MIL-W-23351	-	Waveguide, Single Ridge and Double Ridge, General Specification for.
MIL-P-24691/3	-	Pipe and Tube, Corrosion-Resistant, Stainless Steel, Seamless or Welded.
MIL-C-26074	-	Coatings, Electroless Nickel, Requirements for.
MIL-H-28719	-	Header, Hermetically Sealed.
MIL-F-39000	-	Flanges, Waveguide, Ridge, General Specification for.
MIL-PRF-39012	-	Connectors, Coaxial, Radio Frequency, General Specification for.
MIL-C-55302	-	Connectors, Printed Circuit Subassembly and Accessories.

Beneficial comments (recommendations, additions, deletions) and any pertinent data of use in improving this document should be addressed to: (Defense Supply Center, Columbus, ATTN: DSCC-VAT, P. O. Box 3990, Columbus, OH 43216-5000), by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5985

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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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.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automation and Production Service, Building 4D (DPM-DODSSP), 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.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

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-B545 - Electrodeposited Coatings of Tin (DoD adopted).
 ASTM-B700 - Electrodeposited Coatings of Silver for Engineering Use.
 ASTM-D5948 - Molding Compounds, Thermosetting (DoD adopted).

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(Application for copies should be addressed to the America Society of Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

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-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-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.

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, 4.6, and 6.5). When there are no products listed or approved for listing on the qualified products list, the qualifications requirement is waived and acquiring activities shall invoke first article inspection.

3.3 First article. Mixers furnished under this specification which are not listed on qualified products list shall be products that have been tested and passed first article inspection (see 4.6 and 6.4).

3.4 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 MIL-S-4043. 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.
- 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.

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

3.4.2 Plastic. Plastic shall conform to ASTM-D5948.

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

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

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

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

3.5.2 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.

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

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

3.5.5 Mounting. Mixers shall be mounted in any position.

3.5.6 RF connections.

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

3.5.6.2 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 MIL-F-39000.

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

3.5.6.4 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.

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

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

3.5.6.7 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.

3.5.7 Waveguide. Waveguides used in the manufacturing of the mixers shall conform to MIL-DTL-85 or MIL-W-23351, as applicable (see 3.1).

3.5.8 Finish. Unless otherwise specified (see 3.1), the finish shall be as specified in 3.5.8.1 through 3.5.8.3.

3.5.8.1 RF mating surfaces. Mating surfaces shall be finished in gold, nickel, silver, or tin conforming to SAE-AMS2422, MIL-C-26074, ASTM-B700, or ASTM-B545, and ASTM-B339. Nickel shall be used only if no other surface finish can meet the performance requirements.

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

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

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

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

3.5.11 Life. Unless otherwise specified (see 3.1), the manufacturer shall submit to the qualification activity evidence that mixers are designed to operate for 1 year and degradation for this period shall not exceed the specified limits (see 3.1). This evidence on each mixer for which qualification is requested shall be in the form of 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.

3.6 Preconditioning (screened only). All screened mixers shall be preconditioned as specified in 4.8.2 and shall subsequently meet the electrical requirements specified (see 3.1).

3.7 Burn-in (screened only). All screened mixers shall be burned in as specified in 4.8.3, and shall subsequently meet the electrical requirements specified (see 3.1).

3.8 Electrical characteristics. When mixers are tested as specified in 4.8.4, the applicable electrical characteristics and tolerances shall be as specified (see 3.1 and 6.2.2).

3.9 Thermal shock. When mixers are tested as specified in 4.8.5, there shall be no physical damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.10 Vibration. When mixers are tested as specified in 4.8.6, there shall be no evidence of damage and no vibration induced amplitude modulation beyond the limits specified (see 3.1).

3.11 Shock. When mixers are tested as specified in 4.8.7, there shall be no evidence of damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.12 Seal. After mixers are tested as specified in 4.8.8, they shall meet the electrical requirements specified (see 3.1).

3.13 Barometric pressure (when specified, see 3.1). When mixers are tested as specified in 4.8.9, there shall be no evidence of damage. During the test, electrical characteristics, as applicable, shall be as specified (see 3.1).

3.14 Solderability (as applicable). When mixers with solderable connections are tested as specified in 4.8.10, the terminals shall meet the criteria specified herein.

3.15 Resistance to solvents. When mixers are tested as specified in 4.8.11, there shall be no evidence of illegible marking, mechanical damage, or deterioration of material or finishes.

3.16 Resistance to soldering heat (as applicable). When mixers with solderable terminals are tested as specified in 4.8.12, 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.

3.17 Temperature extreme. When mixers are tested as specified in 4.8.13, there shall be no evidence of damage. During this test, the mixers shall meet the conversion loss and isolation requirements.

3.18 Terminal strength. When mixers are tested as specified in 4.8.14, the terminal strength shall be no less than the value specified.

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3.19 Moisture resistance. When mixers are tested as specified in 4.8.15, there shall be no evidence of damage. Upon completion of this test, mixers shall meet the conversion loss and isolation requirements.

3.20 Salt spray (when specified) (see 3.1). When mixers are tested as specified in 4.8.16, 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.

3.21 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	MXXXXX/ 1-01S ZZZZZ	PIN
		Manufacturer's source code
Permissible	M XXXXX/ 1-01S ZZZZZ	

3.21.1 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.

3.22 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.

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. First article inspection (see 4.6).
- d. Conformance inspection (see 4.7).

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.

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TABLE I. Materials inspection.

Material	Requirement paragraph	Applicable specification(s)
Aluminum -----	3.4	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 -----	3.4	SAE-AMS-I-23011
Brass -----	3.4	ASTM-B16/B16M, ASTM-B36/B36M, ASTM-B121/B121M, ASTM-B124/B124M
Copper -----	3.4	ASTM-B36/B36M, ASTM-B121/B121M, ASTM-B194
Steel -----	3.4	ASTM-A240/240M, ASTM-A666, ASTM-A693, MIL-S-4043, MIL-P-24691/3
Plastics -----	3.4.2	ASTM-D5948
Finish -----	3.5.8	MIL-C-26074, ASTM-B545, ASTM-B700, SAE-AMS2422

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.
- 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.

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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, 3.4 through 3.5.8.3, 3.21 and 3.22	4.8.1
Preconditioning <u>1/</u> -----	3.6	4.8.2
Burn-in <u>1/</u> -----	3.7	4.8.3
Electrical characteristics <u>2/</u> -----	3.8	4.8.4
Conversion loss-----	---	4.8.4.1
Noise figure-----	---	4.8.4.2
Isolation-----	---	4.8.4.3
Conversion compression-----	---	4.8.4.4
Conversion desensitization-----	---	4.8.4.5
Intermodulation-----	---	4.8.4.6
Insertion loss-----	---	4.8.4.7
VSWR-----	---	4.8.4.8
RF leakage-----	---	4.8.4.9
<u>Group II</u>		
<u>Subgroup I (2 sample units)</u>		
Thermal shock-----	3.9	4.8.9
Vibration-----	3.10	4.8.6.1 and 4.8.6.2
Shock-----	3.11	4.8.7
Seal-----	3.12	4.8.8
Barometric pressure <u>3/</u> -----	3.13	4.8.9
Electrical characteristics <u>2/</u> -----	3.8	4.8.4
<u>Group III (2 sample units)</u>		
Solderability <u>2/</u> -----	3.14	4.8.10
Resistance to solvent <u>2/</u> -----	3.15	4.8.11
Resistance to soldering heat <u>2/</u> -----	3.16	4.8.12
Temperature extreme-----	3.17	4.8.13
Terminal strength-----	3.18	4.8.14
Moisture resistance-----	3.19	4.8.15
Salt spray <u>3/</u> -----	3.20	4.8.16
Electrical characteristics <u>2/</u> -----	3.8	4.8.4

1/ Screened only.

2/ As applicable (see 3.1).

3/ When specified (see 3.1).

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4.5.6 Qualification by first article (see 4.6). Qualification may be granted to contractors' products which have passed all the first article tests specified in table II. The contractor shall furnish the contract number under which first article testing was performed and copies of the test reports to the qualifying activity.

4.5.7 Qualification through original equipment manufacturers (OEM) testing. Qualification may be granted to contractors' products which have passed OEM testing for a military system provided the tests are equivalent to table II and the tests were performed 24 months prior to the date of this specification or anytime thereafter. The contract number and test reports covering the testing shall be furnished to the qualifying activity.

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

4.6 First article inspection. This inspection consists of meeting all the qualification tests of 4.5 through 4.5.3, and table II. Acquiring activities may require contractors to furnish first article samples of those mixers that they propose to supply for Government inspection and contractual approval. First article approval is valid only on the contract under which it is granted, unless extended by the Government to another contract. If a supplier desires to have his first article test data also considered for qualification, he must notify the Defense Supply Center Columbus (Code DSCC-VQE) immediately upon award of contract and prior to the start of testing (see 6.3). If the contractor passes first article tests in table II within 24 months prior to the date of this specification or all the original equipment manufacturer's (OEM) requirements for a military system and the tests in table II have been approved within 24 months prior to the date of this specification, he may also qualify. First article inspection is performed by the contractor after award of contract and prior to production.

4.7 Conformance inspection.

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

4.7.1.1 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.

4.7.1.2 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.

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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, 3.4 through 3.5.8.3, inclusive, 3.21 and 3.22	4.8.1
Seal -----	3.12	4.8.8
Electrical characteristics <u>1/</u> -----	3.8	4.8.4
Conversion loss-----	---	4.8.4.1
Noise figure -----	---	4.8.4.2
Isolation -----	---	4.8.4.3
Conversion compression -----	---	4.8.4.4
Conversion desensitization -----	---	4.8.4.5
Intermodulation-----	---	4.8.4.6
Insertion loss-----	---	4.8.4.7
VSWR -----	---	4.8.4.8
RF leakage-----	---	4.8.4.9
<u>Subgroup 2 (screened samples only)</u>		
Thermal shock-----	3.9	4.8.5
Vibration-----	3.10	4.8.6.1
Seal -----	3.12	4.8.8
Electrical characteristics <u>1/</u> -----	3.8	4.8.4

1/ As applicable (see 3.1).

4.7.1.2.1 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
1 - 13	100 percent
14 - 150	13
151 - 280	20
281 - 500	29
501 - 1,200	34
1,201 - 3,200	42
3,201 - 10,000	50
10,001 - 35,000	60
35,001 - 150,000	74
150,001 - 500,000	90
500,001 and over	102

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4.7.1.2.2 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. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.7.2 Periodic inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance with the applicable requirements (see 6.4.1), delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections.

4.7.2.1 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.

TABLE V. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
<u>Subgroup 1 (2 sample units)</u>		
Thermal shock -----	3.9	4.8.5
Vibration -----	3.10	4.8.6
Shock -----	3.11	4.8.7
Seal -----	3.12	4.8.8
Barometric pressure <u>1/</u> -----	3.13	4.8.9
Electrical characteristics <u>2/</u> -----	3.8	4.8.4
<u>Subgroup 2 (2 sample units)</u>		
Solderability <u>2/</u> -----	3.14	4.8.10
Resistance to solvent <u>2/</u> -----	3.15	4.8.11
Resistance to soldering heat <u>2/</u> -----	3.16	4.8.12
Temperature extreme-----	3.17	4.8.13
Terminal strength <u>2/</u> -----	3.18	4.8.14
Moisture resistance-----	3.19	4.8.15
Salt spray <u>1/</u> -----	3.20	4.8.16
Electrical characteristics <u>2/</u> -----	3.8	4.8.4

1/ When specified (see 3.1).

2/ As applicable (see 3.1).

4.7.3 Inspection of packaging. Except when commercial packaging is specified, the sampling and inspection of the preservation-packaging and interior package marking shall be in accordance with the groups A and B conformance inspection requirements and MIL-STD-2073-1. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the verification provisions of the applicable container specification and the marking requirements of MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract (see 6.2).

4.8 Methods of examination and test.

4.8.1 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, 3.4 to 3.5.8.3, inclusive, 3.21, and 3.22).

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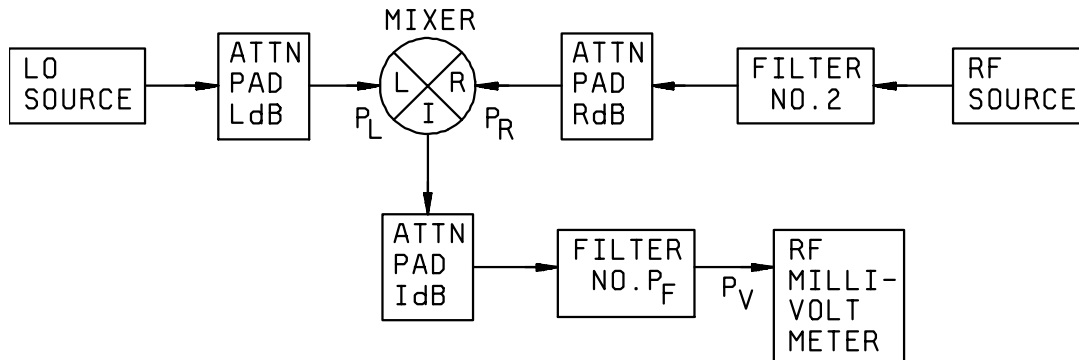
4.8.2 Preconditioning (screened only) (see 3.6). Unless otherwise specified, all screened mixers shall be preconditioned by subjecting them to the maximum operating temperature (see 3.1), for a 24 hour period. Subsequently each mixer shall meet the requirements of table III in the order shown.

4.8.3 Burn-in (screened only) (see 3.7). 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.

4.8.4 Electrical characteristics (see 3.8). The electrical characteristics shall be determined by the tests specified herein, as applicable (see 3.1 and 6.2.2). 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.

4.8.4.1 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 4.8.4). 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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4.8.4.2 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.

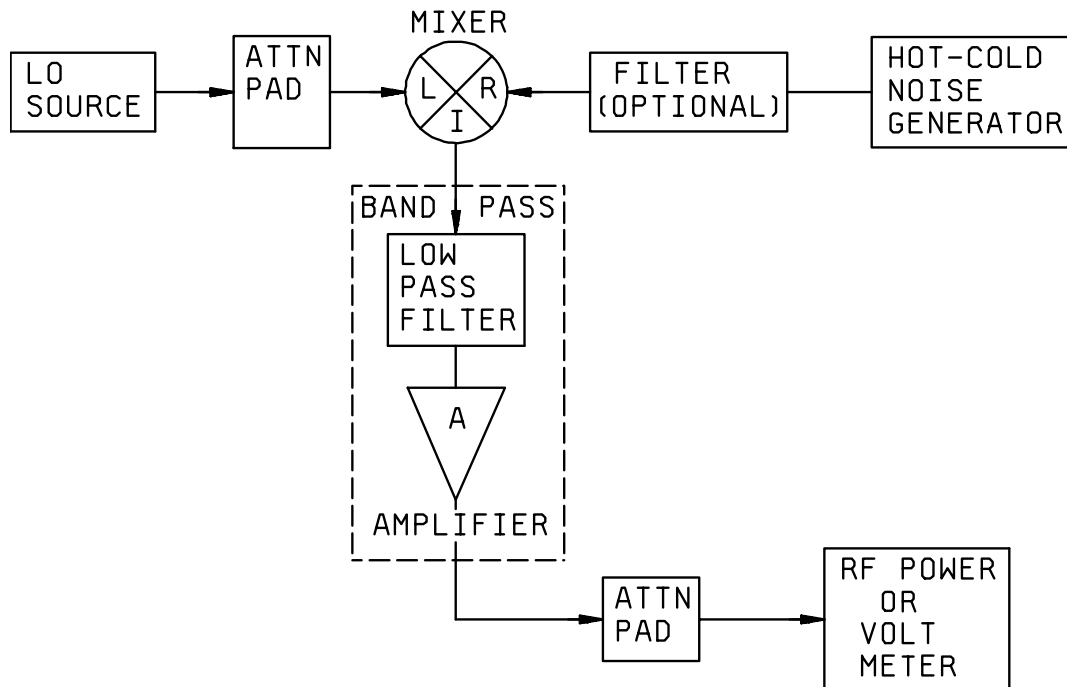
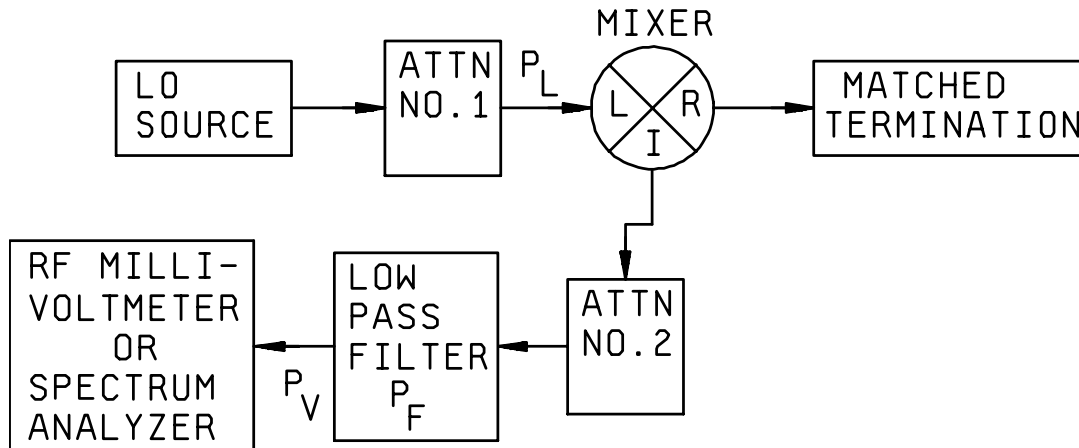


FIGURE 2. Noise figure test setup.

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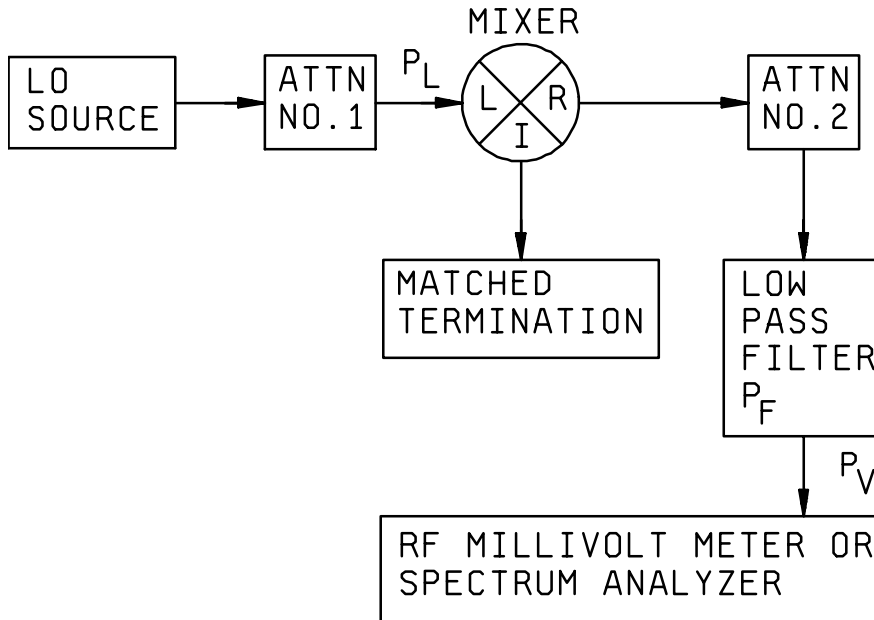
4.8.4.3 Isolation. The isolation between the LO to IF, LO to RF, and RF to IF ports shall be measured at the low end, center, and high end of the specified frequency (see 3.1) using the test setup in figures 3, 4, and 5. The input power shall be as specified (see 3.1). An acceptable alternate test method 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).



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

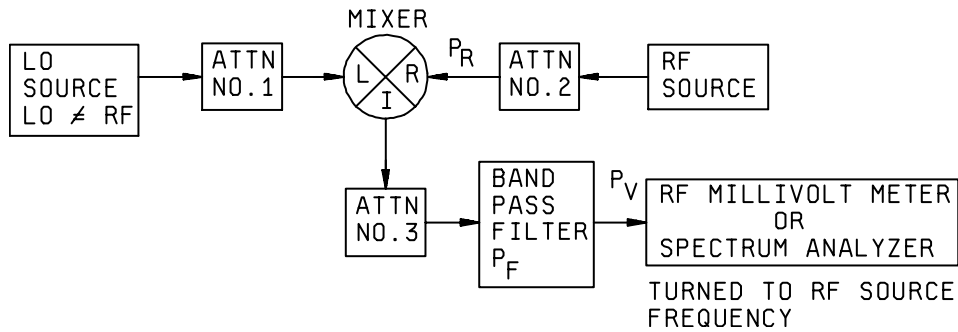
FIGURE 3. LO to IF isolation test setup.

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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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4.8.4.4 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 4.8.4.1, 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.

4.8.4.5 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 4.8.4.1, 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).

4.8.4.6 Intermodulation. The intermodulation products of the mixer shall be tested as specified in 4.8.4.6.1 or 4.8.4.6.2.

4.8.4.6.1 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.

4.8.4.6.2 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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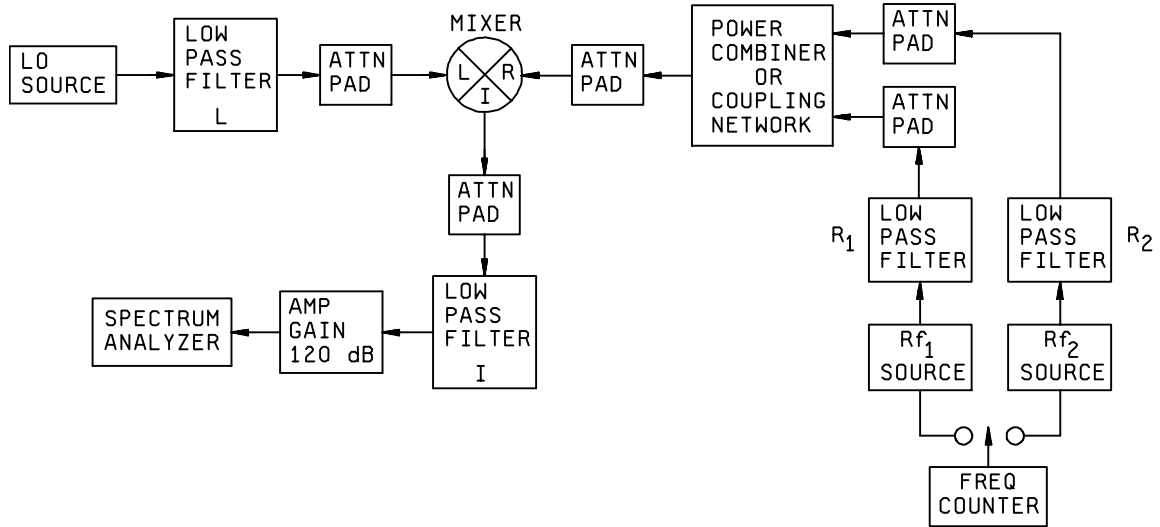


FIGURE 6. Two-tone, third-order intermodulation test setup.

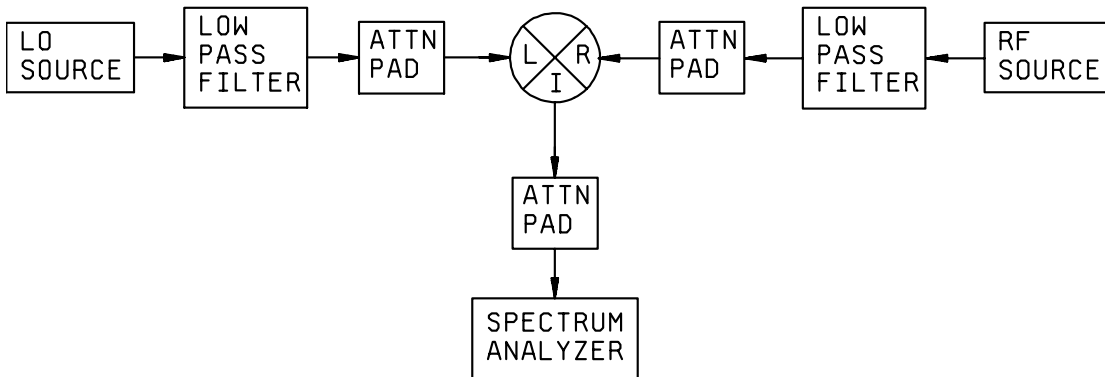
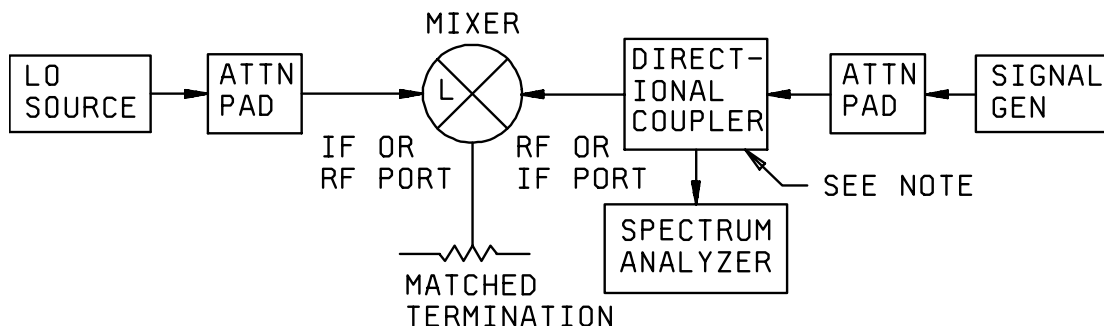


FIGURE 7. Harmonics intermodulation product test setup.

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4.8.4.7 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).

4.8.4.8 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.

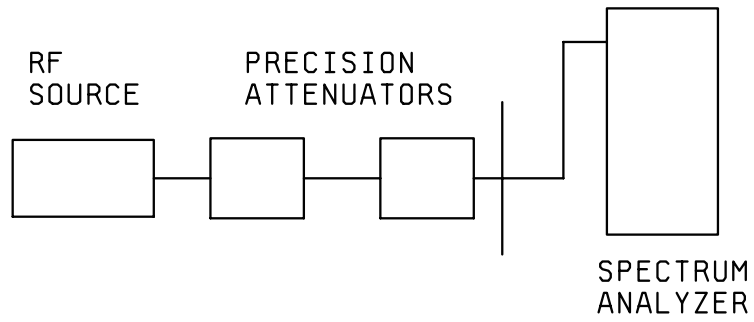


NOTE: The directivity of the directional coupler shall be such as to permit measurement of the VSWR with the appropriate accuracy.

FIGURE 8. VSWR test setup.

4.8.4.9 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.

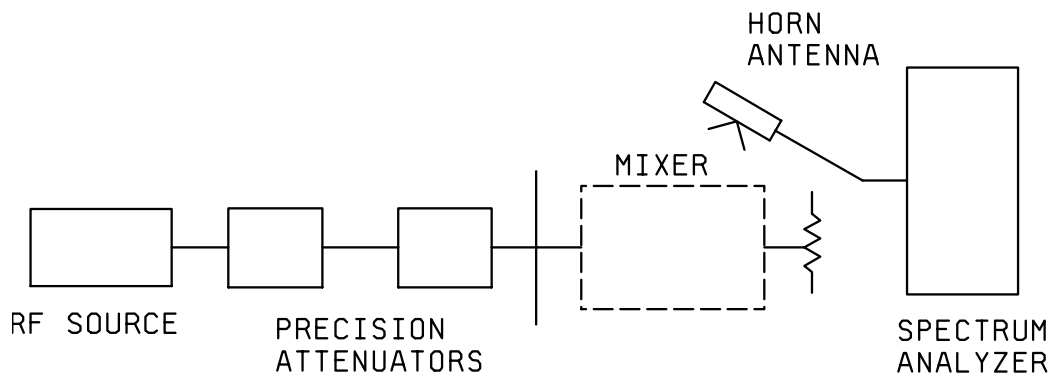


FIGURE 9. RF leakage test setup.

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4.8.5 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).

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

4.8.6.1 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).

4.8.6.2 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).

4.8.7 Shock (see 3.11). 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).

4.8.8 Seal (see 3.12). Mixers shall be tested as specified in 4.8.8.1, 4.8.8.2, or 4.8.8.3, as applicable (see 3.1).

4.8.8.1 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.

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.

4.8.8.2 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.

4.8.8.3 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.

4.8.9 Barometric pressure (when specified (see 3.1) (see 3.13)). 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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4.8.10 Solderability (as applicable) (see 3.14). 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.

4.8.11 Resistance to solvents (see 3.15). 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.

4.8.12 Resistance to soldering heat (as applicable) (see 3.16). 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: $.060 \pm .020$ of header.
- f. Test condition letter: B.
- g. Cooling time: Stabilize to $+25^{\circ}\text{C}$.
- h. Examinations and measurements before and after the test: Conversion loss and seal tests.

4.8.13 Temperature extreme (see 3.17). The mixer shall be tested at both the specified high temperature and low temperature ranges (see 3.1).

4.8.14 Terminal strength (as applicable) (see 3.18). 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.

4.8.15 Moisture resistance (see 3.19). Mixers shall be tested in accordance with method 106 of MIL-STD-202.

4.8.16 Salt spray (when specified, see 3.1 and 3.20). 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.

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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 1.2).
- 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. Applicable performance requirements (see 3.6 through 3.22, inclusive).
- e. Inspection of commercial packaging (see 4.7.3).
- f. Additional special marking, if required.

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 and 3.3).
 - (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. Applicable performance and environmental requirements (see 3.6 through 3.22).
- e. Inspection of commercial packaging (see 4.7.3).
- f. Additional special marking, if required.

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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. Application for qualification tests is to be made in accordance with "Provisions Governing Qualification", SD-6.

6.3.1 Qualification through first article. Suppliers requesting qualification as a result of having passed first article testing must submit to the qualifying activity the following information:

- a. The Government contract number under which the first article testing was performed.
- b. Copies of the test reports.

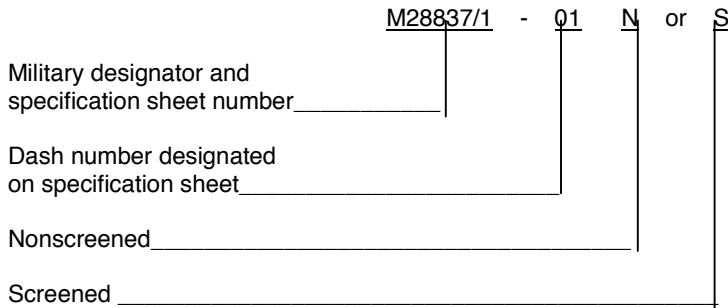
6.3.2 Qualification through original equipment manufacturers (OEM) requirements. Suppliers requesting submission as a result of having passed OEM testing requirements that are no less than specified herein must submit to the qualifying activity the following information:

- a. The military system contract number.
- b. The original equipment manufacturers name.
- c. Copies of the test reports.

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

6.4.1 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 reinstated; 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.

6.5 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 3.6, 3.7, and table III.)



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6.6 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.

6.7 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.

6.8 Subject (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		

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

Preparing activity:
 DLA - CC
 (Project 5985-1230)

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

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-DTL-28837

2. DOCUMENT DATE (YYMMDD)
011030

3. DOCUMENT TITLE
MIXER STAGES, RADIO FREQUENCY, GENERAL SPECIFICATION FOR

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
(1) Commercial

(2) DSN
(if applicable)

7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

a. NAME

Defense Supply Center Columbus
Code DSCC-VAT

b. TELEPHONE (Include Area Code)

(1) Commercial (2) DSN
614-692-0510 850-0510

c. ADDRESS (Include Zip Code)

P.O. Box 3990
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