

NOTICE OF
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MIL-STD-981
NOTICE 1
27 APRIL 1993

DESIGN, MANUFACTURING AND QUALITY STANDARDS FOR CUSTOM
ELECTROMAGNETIC DEVICES FOR SPACE APPLICATIONS

TO ALL HOLDERS OF MIL-STD-981B

1. THE FOLLOWING PAGES OF MIL-STD-981B HAVE BEEN REVISED AND
SUPERSEDE THE PAGES LISTED:

<u>NEW PAGE</u>	<u>DATE</u>	<u>SUPERSEDED PAGE</u>	<u>DATE</u>
1	27 April 1993	1	31 January 1992
1A	27 April 1993	1	---
1B	27 April 1993	NEW	---
2	31 January 1992	2	Reprinted without change
7	27 April 1993	7	31 January 1992
8	27 April 1993	8	31 January 1992
9	27 April 1993	9	31 January 1992
9A	27 April 1993	9	31 January 1992
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2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-STD 981B will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military standard is completely revised or canceled.

NOTE: The margins of this notice are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous revision 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 in relationship to the last previous revision.

Custodians:
NASA - NA
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Preparing activity
NASA-NA

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Project 5950-0817

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1. SCOPE

- 1.1 Scope. This standard establishes the requirements for acceptable design, manufacturing, and quality control criteria for custom electromagnetic devices for space applications.
- *1.1.1 **Intended use of or reference to MIL-STD-981.** When this document is referenced or is used as a standard for the design, processing, manufacturing and screening of custom electromagnetic devices for space flight applications, such design, processing, manufacturing, and screening shall be in full conformance with all the applicable general and detailed requirements of this standard for the individual device type. Any device meeting only selected provisions of this standard is considered noncompliant.
- *1.1.2 **Compliant electromagnetic devices.** Compliant electromagnetic devices shall meet without exception all of the applicable requirements and quality standards of MIL-STD-981. Any device that is processed with deviations, omissions, or does not meet the full intent of this standard shall not be claimed to be compliant.
- *1.1.3 **Noncompliant electromagnetic devices.** Any device that is processed with deviations and which is not processed in compliance with the provisions of this standard shall not be claimed to be compliant and shall not be marked in any manner that would indicate compliance or partial compliance. Only compliant devices shall be marked in accordance with 5.4. All applicable documentation (including detail specifications and responses to Request For Quotations invoking MIL-STD-981) shall clearly and specifically define the areas of nonconformance and identify each as a deviation.
- 1.2 **Classification.**
- 1.2.1 **Families.** Table I shows the numerical designations that are used in this standard to indicate various device types.

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TABLE I. Device types.

Device Type	Family	Applicable Military Specification
Transformer, power	03	MIL-T-27
Inductor, power	04	MIL-T-27
Transformer, R.F., fixed	11	MIL-T-55631
Transformer, R.F., variable	12	MIL-T-55631
Coil, R.F., fixed	13	MIL-C-15305
Coil, R.F., variable	14	MIL-C-15305
Inductor, audio	20	MIL-T-27
Transformer, audio	21	MIL-T-27
Transformer, pulse, low power	31	MIL-T-21038
Transformer, pulse, high power	36	MIL-T-27
Inductor, charging	37	MIL-T-27
Transformer, saturable	40	MIL-T-27
Inductor, saturable	41	MIL-T-27
Coil, R.F. chip, fixed	50	MIL-C-83446
Coil, R.F. chip, variable	51	MIL-C-83446

- 1.2.2 **Classes.** Two classes of requirements are defined in this standard. Class S parts are intended for critical flight and mission-essential ground support applications and any application that is critical to safety. Class B parts are for use in noncritical flight and non-mission-essential ground support applications.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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.

SPECIFICATIONS

FEDERAL

- J-W-1177 - Wire, Magnet, Electrical
- QQ-S-571 - Solder, Tin Alloy; Tin-Lead Alloy and Lead Alloy

MILITARY

- MIL-T-27 - Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification For.
- MIL-F-14256 - Flux, Soldering, Liquid (Rosin Bath).
- MIL-C-15305 - Coils, Fixed and Variable, Radio Frequency, General Specification For.
- MIL-T-21038 - Transformers, Pulse, Low Power, General Specification For.
- MIL-S-22473 - Sealing, Locking and Retaining Compounds, Single Component.
- MIL-W-22759 - Wire, Electric Fluorocarbon Insulated, Copper or Copper Alloy.
- MIL-T-55631 - Transformers, Intermediate Frequency, Radio Frequency and Discriminator, General Specification For.
- MIL-C-83446 - Coils, Radio Frequency, Chip, Fixed or Variable, General Specification For.

STANDARDS

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-975 - Standard Parts List for Flight and Mission Essential Ground Support Equipment.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.
- MIL-STD-45662 - Calibration System Requirements.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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- 5.1.6 Screws, nuts, and washers. All mounting and terminal screws, nuts, and washers shall be protected against corrosion. Cadmium or Zinc plating shall not be used on any surface exposed to space environment. Tin plating shall be fused if such plating is used externally. All materials shall be compatible and not support galvanic corrosion.
- 5.2 Internal elements. Packaged or unpackaged parts (other than the wound magnetic elements) used within these devices shall be selected from MIL-STD-975. Parts selected shall be of the same class as the device in which they are used. Use of any other part shall require approval of the procuring activity. The request for approval must justify the need for the part and provide sufficient data to substantiate the suitability of the part in the application. Procurement documentation for the part shall be submitted to the procuring activity for approval.

TABLE II. Wire limitations for magnet wire (see 5.1.4.1).

Family	Minimum Wire Size (AWG) (1)	
	Class S	Class B
03, 04, 36, 37, 40, and 41	38	44
11, 12, 13, 14, 20, 21, 31, 50, and 51	44	50

(1) Procuring activity approval shall be required when other sizes of magnet wire are used.

TABLE III. Termination limitations (see 5.1.4.3).

Type of Termination	Minimum Terminal/Self Lead Wire Size (AWG)	
	Class S	Class B
Interconnected lead	29	32
External terminal/self lead (1)	26	28

(1) Spliced internal lead diameter ratios shall not exceed 5 to 1 for magnet wire sizes larger than # 44.

- 5.3 Radiographic inspection (when applicable). Devices shall be inspected in accordance with appendix C.
- *5.4 Marking. Devices shall be marked as specified in the procurement document on the part in accordance with Method I of MIL-STD-1285. The marking as a minimum shall include the procurement document number, manufacturer's part number and CAGE, trademark or symbol, terminal identification, lot date code, and the word "C981". The "C981" shall designate the device as being fully compliant to MIL-STD-981.

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- 5.5 **Manufacturing practices.** The contractor shall provide to the procuring activity for review and approval a copy of the contractor's written procedures covering manufacturing practices. Proprietary documents shall be reviewed, approved, and maintained at the manufacturer's facility. These procedures shall, as a minimum, conform to the requirements specified herein. Any change from the approved procedures shall require approval of the procuring activity in writing. The contractor may, at his option, provide separate sets of procedures for classes S and B.
- 5.5.1 **Clean handling.** Operators shall have clean hands (free from handcream, etc.) while handling these devices. The use of clean, lint-free gloves or finger cot is recommended whenever practical. Magnet wire spools shall be handled by the rims of the spools only. Materials and piece parts stored, or being transferred to or between work stations shall be kept in covered containers to maintain a dust-free seal.
- *5.5.1.1 **Solvents.** crazing of magnet wire may occur as a result of uncontrolled exposure to solvents such as water or alcohol. The use of alcohol or alcohol based cleaning agents for the cleaning of magnet wire or assemblies shall be controlled and properly documented.
- 5.5.2 **Work areas.** Work and inspection areas must be cleared of all foreign materials before parts or materials for these devices are placed thereon. While working on these devices, the work areas shall not be used to store any parts, materials, or devices used on any other devices.
- 5.5.3 **Foreign material.** Care must be exercised to prevent introduction of foreign materials into the component. At each in-process inspection, the operator shall examine the device under 3X to 10X magnification to assure that no foreign materials are present. Special attention should be given to loose wire-ends, solder splashes, wire scrapings, or residues.
- 5.5.4 **Tools.** Except for cutting pliers, the tools used shall not be capable of cutting, nicking, or damaging the wire insulation in any manner. All tools used in the handling of magnet wire shall be free of sharp or rough surfaces or edges. This may be accomplished by the application of an epoxy or by filing any of the sharp surfaces or edges.
- 5.5.5 **Carriers.** Wound cores, coils or bobbins shall not be carried or stored on pegboards with nails or other sharp pegs that may cause damage to wire or insulation. All sharp or abrasive pegs shall be sufficiently covered to insure against damaging wire. The carriers shall be covered with a material that will prevent contamination by foreign materials during transport and storage.
- 5.5.6 **Damaged material.** Material that exhibits evidence of damage shall not be used in the fabrication of the devices.
- 5.5.7 **Travelers.** A lot traveler specifying each operation in the proper sequence shall be provided with each lot. Initialing or stamping of the individual traveler by the operator or inspector prior to moving to the next work station shall be required for each operation in the manufacturing process.
- 5.5.8 **In-process inspection.** All critical in-process operations used in the manufacturing of these devices shall be inspected by an adequately trained inspector. If circumstances preclude inspections after the process is complete, the inspection shall occur during the process. These inspection stations shall be as defined in the manufacturing process.

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5.5.9 Coil windings.

5.5.9.1 Tension. A suitable device shall be used to provide near uniform tension during the machine winding process of any coil of wire size number 18 AWG or finer. For coils wound on square forms, special provision must be made to prevent excessive tension on the corners. This device and the winding machine used shall be inspected for proper operation a minimum of twice daily or once each lot whichever is more frequent. Tension control on larger wire is preferred but not mandatory. For machines which cannot accommodate any tension device, other criteria shall be established. Any portion of the device which contacts the magnet wire (pulleys, sliders, etc) shall be free of nicks, burrs, rough spots, or any other anomalies that could cause damage to the coil wire.

5.5.9.2 Wire breaks. There shall be no wire breaks for any winding within the coil. The winding operation can be considered complete only when the coil has been made with an unbroken winding. Should the magnet wire break during winding operations, the magnet wire may be unwound and rewound. In no case may a broken coil wire be repaired. If magnet wire opens after assembly, the entire device shall be rejected. Those devices that are designed as multi-series connected windings are not to be identified as wire breaks within the definition of this paragraph.

5.5.9.3 Crossed wires. Winding shall be even and smooth. In insulation interleaved layer-wound coils, no uninsulated turns shall cross over other turns. In toroidal and cylindrical or random wound bobbin coils wound in segments, there shall be no uninsulated cross-over of any one turn to the adjacent winding segment. All situations where the voltage stress exceeds the ability of the magnet wire insulation to withstand it shall be avoided.

5.5.9.4 Kinks, nicks, and damaged insulation. The winding process shall not introduce any kinks, nicks, and insulation damage.

5.5.9.5 Tapes. The use of pressure sensitive adhesive tapes shall be kept to a minimum. The adhesive system must meet the outgassing requirements of 5.1.1.

*5.5.9.6 Terminations. The recommended method to anchor the lead is shown in Figures 1 and 2. The lead anchor should be performed with minimum use of tape wrap to keep the outgassing low. See 5.5.9.5.

5.5.9.7 Magnet wire to terminal post connections. Recommended magnet wire (wire or coil) to terminal post connections are depicted in figures 3a-h, j, k, m, n, and p. For high voltage, corona-free connections, no protruding wires are allowed and balling of the joint is recommended. Care shall be exercised when using the heat shrink tubing to avoid the concentration of heat at the soldered joint. Heat shall be controlled in accordance with the tube manufacturer's stated recommended conditions.

5.5.9.8 Antirotation feature. Each terminal lead shall be internally constructed as illustrated on figure 4 or equivalent. Flattened or dimpled area thickness shall be no less than one-half the lead diameter and shall not exhibit sharp edges. The radius, R, shall be no greater than twice, or less than one times the diameter of the terminal lead. This radius shall be formed prior to soldering. The antirotation feature shall be completely contained within the magnetic device package.

5.5.9.9 Terminal twist. Finished devices with solid wire terminals shall be capable of passing the terminal twist test in accordance with method 211, test condition D of MIL-STD-202 without causing discontinuity in the winding. When the bending of the terminal leads, as specified in MIL-STD-202, is impractical, the device shall be held stationary. The lead shall be clamped in a hand chuck and the chuck rotated as required. During the twist test, the winding shall be monitored for open circuit of 100 microseconds or longer duration.

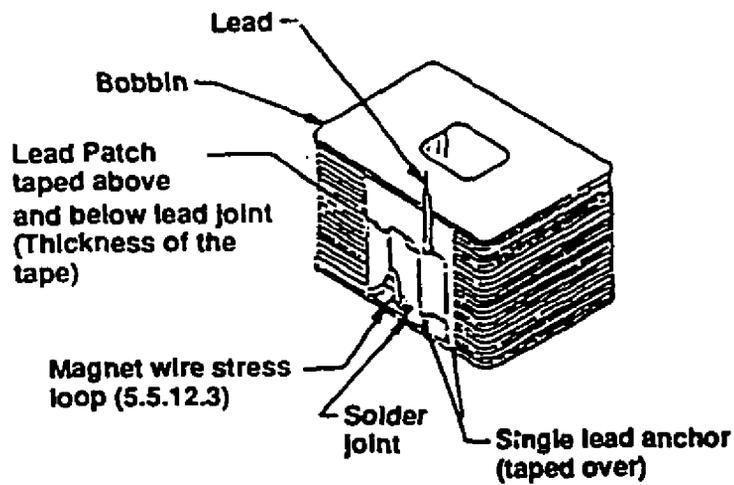
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- 5.5.9.10 Toroidal winders.** Shuttle rings and sliders must be inspected for nicks, burrs and rough spots. Inspect the toroid for physical damage after removal from the shuttle.
- 5.5.9.11 De-reeling.** De-reeling (de-spooling) devices shall be such that they do not cause variations in tension beyond the control of the tension device (see 5.5.9.1). All portions of the device which contact the magnet wire (pulleys, sliders, spool flange, etc) shall be free of nicks, burrs, and rough spots.

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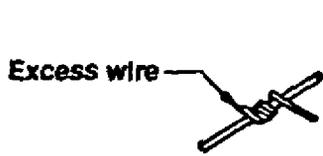
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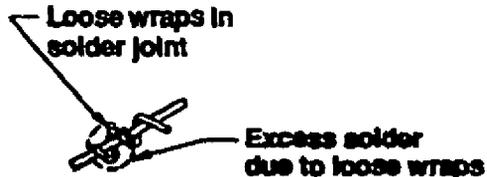
Note: The recommended method to anchor the lead is shown. The lead anchor should be performed with minimum use of tape wrap to keep the outgassing low.

FIGURE 1. Recommended bobbin coil termination anchoring (see 5.5.9.6).

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(k) Not acceptable



(m) Not acceptable

Note: There shall be no evidence of wire "pigtails" protruding more than 2 wire diameters from a wrapped terminal, nor shall there be loose wraps secured by excess solder.



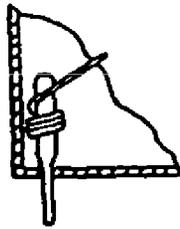
(n) Sleeving - acceptable on AWG 18 or smaller diameter wire. Crimp necessary.



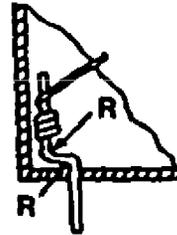
(p) "Third wire" - acceptable on AWG 18 through AWG 30 wire. Third wire must be uninsulated.

Note: Other acceptable termination methods shall exhibit adequate mechanical strength prior to soldering.

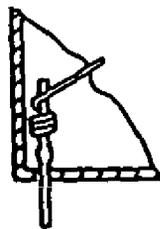
FIGURE 3 (4 of 4). Recommended magnet wire-to-post terminations (see 5.5.9.7).



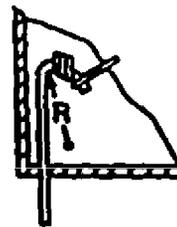
Flattened



Z-bend



Dimpled



Radius (R) of bend

FIGURE 4. Antirotation features (see 5.5.9.8).

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- a. Verification from the magnet wire supplier that the groups A, B and C inspections of J-W-1177 have been performed for the class and type of magnet wire being used.
- b. Each spool of magnet wire prior to being used shall be subjected to the following tests of J-W-1177:
 - (1) Dielectric test.
 - (2) Visual and dimensional examination.
 - (3) Check of bare wire size of the magnet wire by a dc resistance measurement.
- c. Provision shall be made to procure and utilize magnet wire not older than two years from the date of its manufacture. Each spool of wire exceeding the two year life shall be subjected to evaluation to verify its performance. Each performance evaluation shall be valid for a period of one year. Wire older than five years from the date of its manufacture shall not be used. Wire shall pass the following evaluation tests in accordance with J-W-1177:
 - (1) Visual and dimension
 - (2) Adhesion and flexibility including mandrel test
 - (3) Elongation
 - (4) Springback
 - (5) DWV at rated temperature
 - (6) Bend (rectangular wire only)
 - (7) Heat shock
- d. Magnet wire shall be stored in protective resealable containers to protect against dust.
- e. Magnet wire shall be stored in a clean controlled environment, at a temperature of +25°C ($\pm 7^\circ\text{C}$), a pressure of no less than one Standard Atmosphere, and a relative humidity of between 30 and 70 percent.

5.6.2.2 Layer insulation. Dielectric strength, tensile strength, volume resistivity and flexibility.

5.6.3 Calibration. Calibration shall be in accordance with MIL-STD-45662.

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

- a. Materials inspection.
- b. First article inspection.
- c. Quality conformance inspection.

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- 5.6.5 **Materials inspection.** Materials inspection shall be as specified in MIL-T-27, MIL-C-15305, MIL-T-21038, MIL-T-55631 or MIL-C-83446 as applicable.
- 5.6.6 **First article inspection.**
- *5.6.6.1. **First article inspection requirements for qualification.** First article inspection shall be performed in lieu of the qualification inspection specified in MIL-T-27, MIL-C-15305, or MIL-T-55631 as applicable. Requirements pertaining to First article inspection shall be as specified in MIL-T-27, MIL-C-15305, or MIL-T-55631. Qualification inspection specified under MIL-T-21038 and MIL-C-83446 shall serve as First article inspection requirements and shall be performed for the applicable part type under MIL-T-21038 or MIL-C-83446. First article approval is valid only on the contract under which it is granted, for a period not exceeding three years from the date of initial qualification, unless extended by the government to another contract, provided that during this period the device has been manufactured at least once during each successive twelve month period.
- *5.6.6.2 **Qualification of transformers and inductors based on similarity.** Only a transformer or an inductor having passed the First article inspection requirements of 5.6.6.1 shall be used as the reference device to establish a qualification by similarity. A Class S device shall not be qualified on the basis of similarity. The Class B transformer or inductor to be qualified on the basis of similarity shall be manufactured at the same production facility utilizing the same processes as the reference device.
- 5.6.6.2.1 **Similar transformers and inductors.** A similar device is defined as a transformer or inductor that meets the following conditions when compared to the reference device:
- a. Same or lower operating temperature.
 - b. Same or lower operating frequency and the same or lower operating power.
 - c. Same or lower ambient temperature.
 - d. To be used at an atmospheric pressure of the same or lower altitude.
 - e. To be used at the same or lower operating voltages and the same or lower dielectric stress per mil of same insulation.
 - f. Same or lower shock and vibration requirements.
 - g. Same or greater life time expectancy.
 - h. Same or lower temperature class.
 - i. Same family as defined in 4.2 thru 4.6.
 - j. Same grade as defined in the applicable military specifications.
 - k. Same type of external and internal mounting, same type of case construction with nominal wall thickness within 25 percent when a case is used, same shape, and same termination (pin or hook terminals).
 - l. Linear envelope dimensions neither greater than 150 percent nor less than 70 percent of the corresponding dimension. The total volume of envelope not to exceed 250 percent.
 - m. Same or greater wire size (cross-sectional area), and the same wire coating material for corresponding windings.
 - n. Same processing material and specification for case, finish and marking.
 - o. Same processing material and composition for potting, insulation (tapes and films), impregnation, staking and filling.
 - p. Same material composition, characteristic and coating for the ferrite and MPP core, same shape, and the same manufacturer.
 - q. Same bobbin material and characteristics.
 - r. Same solder composition and welding.

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- s. Same construction and material for the terminals. For terminals of the same dimensions the required terminal strength requirements to be the same or lower.
- *5.6.6.2.2 **Inspection requirements.** Transformers and inductors shall be subjected to and pass the applicable quality conformance inspection requirements of 5.6.7.
- 5.6.7 **Quality conformance inspection.**
- 5.6.7.1 **Inspection of product for delivery.**
- *5.6.7.1.1 **Class S devices.** Inspection of product for delivery shall consist of the applicable group A screening tests in appendix B and the applicable group B tests (see tables IV through VII). Sample size for group B tests shall be as specified under the sampling plan (see 5.6.7.4.1.2).
- *5.6.7.1.2 **Class B devices.** Inspection of product for delivery shall consist of the applicable group A screening tests in appendix B. A device to be qualified by similarity shall be subjected to the tests specified in Table XI. Samples of each part type shall be selected at random from the inspection lot which has passed the group A tests.
- 5.6.7.2 **Inspection lot.**
- 5.6.7.2.1 **Class B.** An inspection lot shall include completely assembled devices of the same grade, construction, class, family, and electrical characteristics, manufactured under essentially the same conditions and having similar construction and materials. (Similar construction and materials shall be construed to include differences that will not affect test results.) Sample units shall be so selected as to be, as far as practicable, representative of the volt-ampere range of electrical values and physical dimensions included in the lot.
- 5.6.7.2.2 **Class S.** An inspection lot shall consist of completely assembled devices of a single grade, construction, class, family, and part number from one procurement document. Each lot shall meet all the lot controls specified in 5.6.1.1.1.2 for class S devices.
- 5.6.7.3 **Group A screening inspection.** Screening inspections shall consist of the examinations and tests specified in appendix B.
- 5.6.7.3.1 **Lot acceptance.** If, during the 100-percent inspection of subgroup I, screening requires that over 5 percent or (1) device whichever is greater be discarded, the lot shall be rejected.
- 5.6.7.3.2 **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 100 percent inspected. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots. Rework of class S devices shall not be permitted unless approved by the procuring activity.
- *5.6.7.4 **Group B inspection.** Group B inspection shall consist of the applicable group B tests (see tables IV through VII). For Class S devices, the group B inspection shall be performed on sample units selected at random from each inspection lot that passed group A inspection. Group B inspection shall not apply to those lots from which devices are sampled for First article inspection. Group B inspection for Class B devices shall be performed when specified by the procurement document. The group B inspection, when specified for Class B devices, shall be performed on sample units selected at random from inspection lots which have passed the group A inspection. Group B inspection shall not apply to those lots from which devices are sampled for First article inspection.

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5.6.7.4.1 Sampling plan.

*5.6.7.4.1.1 Class B. The sampling plan shall be specified in the procurement document. For device qualification based on similarity, a sample consisting of three of the devices shall be subjected to the applicable tests specified in Table XI.

5.6.7.4.1.2 Class S. Four sample units shall be subjected to the applicable group B tests. Two sample units shall be subjected to the tests of subgroup 1 and two sample units to the tests of subgroup 2.

5.6.7.4.2 Failures.

5.6.7.4.2.1 Class S. If the number of failures exceed the number allowed in Tables IV through VII, the sample shall be considered to have failed. (See 5.6.7.4.4.)

5.6.7.4.2.2 Class B. The number of allowable failures shall be specified in the procurement document.

5.6.7.4.3 Disposition of sample units. Disposition of sample units which have been subjected to the group B inspection shall be as specified in the procurement document.

5.6.7.4.4 Noncompliance.

5.6.7.4.4.1 Class B devices. If a sample fails to pass group B inspection, the manufacturer shall notify the procuring 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 conditions, with essentially the same materials, processes, etc., and which are considered *subject to the same failure*. Acceptance and shipment of the product shall be discontinued until corrective action acceptable to the procuring activity has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the qualifying activity). Group A inspection may be reinstated; however, final acceptance and shipment shall 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 shall be furnished to the cognizant inspection activity and the procuring activity.

5.6.7.4.4.2 Class S devices. If an inspection lot fails to pass group B inspection, the inspection lot shall not be delivered on the contract or purchase order. The manufacturer shall notify the procuring activity and cognizant inspection activity of the failure and take corrective action on the material or processes, or both as warranted. A failure analysis (see 5.6.7.4.4.2.1) shall be performed on the failing product and forwarded to the procuring activity. A copy of the results shall be maintained by the manufacturer.

5.6.7.4.4.2.1 Failure analysis. If any of the sample units subjected to the group B tests fail during testing, a detailed failure analysis shall be conducted to establish the cause of failure and the corrective actions that would eliminate subsequent failures of a similar type. A failure is categorized as lot oriented if its occurrence is apparently related to an identified lot or lots. A failure is categorized as not lot oriented if its occurrence is random and it cannot be related to a specific lot or lots. Each failure is further identified as screenable or not screenable from the completed production items. If the failure analysis shows that the failure mechanism is screenable, the entire failed lot may be screened and the group B test in which the failure occurred shall be repeated. If a failure occurs during the second group B test, the entire production lot shall be rejected. If the failure mechanism is screenable, all prior and subsequent production lots that may contain the identified failure

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mechanism shall also be screened. Except as may be stated otherwise in the detailed requirements for the specific part type. If the failure mechanism is lot oriented and not screenable, all production lots that contain the identified failure mechanism shall be rejected unless other disposition is directed by the contracting officer and procuring activity.

5.6.7.5 Inspection of packaging. Inspection of packaging for delivery shall be as specified in MIL-T-27, MIL-C-15305, MIL-T-21038, MIL-T-55631 or MIL-C-83446 as applicable.

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TABLE IV. Group B tests for power transformers, power inductors, audio inductors audio transformers, high power pulse transformers, charging inductors, saturable transformers, and saturable inductors (families 03, 04, 20, 21, 36, 37, 40, and 41 respectively) and low power pulse transformers (family 31) (see 5.6.7.4).

Test (1)	Class S	
	Sample Size	Defective Units Allowed
<i>Subgroup 1</i> Resistance to soldering heat Terminal strength Induced voltage (2) (3) Dielectric withstanding voltage (2) (at atmospheric pressure) Electrical characteristics Visual and mechanical examination (internal) *(one sample unit)	2	0
<i>Subgroup 2</i> Vibration Shock Resistance to solvents Solderability Life (4) Dielectric withstanding voltage (at reduced voltage) Insulation resistance (5) Electrical characteristics Visual and mechanical examination (external) Visual and mechanical examination (internal) (one sample unit)	2	0
* <i>Subgroup 3</i> Corona discharge (6)	2	0

- (1) Specified tests shall be performed in accordance with MIL-T-27, except tests for family 31 shall be performed in accordance with MIL-T-21038.
- (2) At maximum temperature for the class.
- (3) Applicable when any winding has a rated voltage in excess of 25 volts rms.
- (4) Raise temperature one class, for 500 hrs.
- (5) At specified voltage with IR of 7,500 megohms minimum.
- * (6) Applicable when materials stressed greater than 100 volts/mil due to maximum operating voltage. Subject one sample each from subgroups 1 and 2 to this test.

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TABLE V. Group B tests for RF coils (families 13 and 14) (see 5.6.7.4).

Test (1)	Class S	
	Sample Size	Defective Units Allowed
<i>Subgroup 1</i> Electrical characteristics (initial) Resistance to soldering heat Terminal strength Temperature rise Vibration Shock (specified pulse) Electrical characteristics (final) Visual and mechanical examination (external) Visual and mechanical examination (internal) (one sample unit)	2	0
<i>Subgroup 2</i> Resistance to solvents Solderability Electrical characteristics (initial) Life Electrical characteristics (final)	2	0

(1) Specified tests shall be performed in accordance with MIL-C-15305.

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TABLE VI. Group B tests for RF transformers (families 11 and 12) (see 5.6.7.4).

Test (1)	Class S	
	Sample Size	Defective Units Allowed
<i>Subgroup 1</i> Resistance to soldering heat Terminal strength Operating torque (when applicable) Temperature rise Dielectric withstanding voltage (2 x working voltage) (2) Electrical characteristics Vibration, winding continuity Shock, winding continuity Visual and mechanical examination (external) Visual and mechanical examination (internal) *(one sample unit)	2	0
<i>Subgroup 2</i> Resistance to solvents Solderability Life (3) Dielectric withstanding voltage (at reduced voltage) Insulation resistance (4) Electrical characteristics (final) Visual and mechanical examination (external)	2	0
* <i>Subgroup 3</i> Corona discharge (5)	2	0

(1) Specified tests shall be performed in accordance with MIL-T-55631.

(2) At maximum temperature for the class.

(3) Raise temperature one class, for 500 hrs.

(4) Full voltage with IR of 1.5 times the specified value.

- * (5) Applicable when material is stressed greater than 100 volts/mil due to maximum operating voltage. Subject one sample each from subgroups 1 and 2 to this test.

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TABLE VIII. Group A screening tests for families 03, 04, 11, 12, 20, 21, 31, 36, 37, 40, and 41, respectively
(see 30.1, 30.2 and 30.4).

Examination/Test	Class		Applicable Military Specification	Inspection
	S	B		
<i>Subgroup I</i>				
Thermal shock	X	X	See 30.1.1	100 percent
Burn-in	X	X	See 30.1.2	
Seal (when applicable)	X	X	MIL-T-27	
Dielectric withstanding voltage *(at atmospheric pressure)	X	X	MIL-T-27	
Induced voltage	X	X	MIL-T-27	
Insulation resistance	X	X	MIL-T-27	
Electrical characteristics	X	X	MIL-T-27	
Radiographic inspection	X	*(1)	See appendix C	
<i>Subgroup II</i>				
Visual and dimensional examination (external)	X	X	MIL-T-27	100 percent

*(1) When specified.

**30.1.2.1.2 No load burn-in (applicable for transformers with an output equal to or less than 0.8 watts).
Devices shall be tested as follows:**

- a. Test duration: 96 hours minimum
- b. Test temperature: Maximum rated ambient temperature
- c. Test voltages and current: Rated input voltage and current at minimum rated frequency with no load.

30.1.2.2 No-load burn-in for inductors. Devices shall be tested as follows:

- a. Test duration: 96 hours minimum
- b. Test temperature: Maximum operating temperature
- c. Test voltages and currents: Not applicable.

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- 30.2 Radio frequency, fixed, and variable transformers (families 11 and 12, respectively). These devices shall be subjected to the group A screening tests in table VIII except tests shall be performed in accordance with MIL-T-55631 in lieu of MIL-T-27.
- 30.3 Radio frequency fixed and variable coils (families 13 and 14). These devices shall be subjected to the group A screening tests in table IX.

TABLE IX. Group A screening tests for families 13 and 14 (30.3).

Examination/Test	Class		Applicable Military Specification	Inspection
	S	B		
<i>Subgroup I</i>				
Thermal shock	X	X	See 30.3.1	100 percent
No-load burn-in	X	X	See 30.3.2	
Dielectric withstanding	X	X	MIL-C-15305	
Insulation resistance	X	X	MIL-C-15305	
Inductance	X	X	MIL-C-15305	
Q	X	X	MIL-C-15305	
Self resonant frequency	X	X	MIL-C-15305	
DC resistance	X	X	MIL-C-15305	
Radiographic inspection	X	*(1)	MIL-C-15305	
<i>Subgroup II</i>				
Visual and mechanical examination	X	X	MIL-C-15305	100 percent

*(1) When specified.

30.3.1 Thermal shock. Thermal shock screening shall be in accordance with MIL-C-15305 and as follows: (Note: End point measurements per MIL-C-15305 shall not apply).

- a. Number of cycles: 25.
- b. Continually monitor continuity during the entire final cycle to verify no intermittent conditions. Continuity monitoring current shall not exceed 100 microamperes. Equipment shall be capable of detecting intermittent opens exceeding 100 microseconds.
- c. Class S parts using magnet wire smaller than AWG 38 shall have dc resistance measured before and after the thermal shock screen. The change in resistance shall not exceed ± 3 percent.

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TABLE X. Group A screening tests for families 50 and 51 (see 30.5).

Examination/Test	Class		Applicable Military Specification	Inspection
	S	B		
<i>Subgroup I</i>				
Thermal shock	X	X	See 30.5.1	100 percent
No-load burn-in	X	X	See 30.5.2	
Dielectric withstanding voltage	X	X	MIL-C-83446	
Insulation resistance	X	X	MIL-C-83446	
Inductance	X	X	MIL-C-83446	
Q	X	X	MIL-C-83446	
Self resonant frequency	X	X	MIL-C-83446	
DC resistance	X	X	MIL-C-83446	
Radiographic inspection	X	*(1)	MIL-C-83446	
<i>Subgroup II</i>				
Visual and mechanical examination (external)	X	X	MIL-C-83446	100 percent

*(1) When specified.

30.5 Radio frequency, fixed and variable, chip coils (families 50 and 51, respectively). These devices shall be subjected to the group A screening tests in table X.

30.5.1 Thermal shock. Thermal shock screening shall be in accordance with MIL-C-83446 and as follows:

- a. Number of cycles: 25
- b. Continually monitor continuity during the entire final cycle to verify no intermittent conditions. Continuity monitoring current shall not exceed 3 microamperes. Equipment shall be capable of detecting intermittent opens exceeding 100 microseconds.
- c. Class S parts using magnet wire smaller than AWG 38 shall have dc resistance measured before and after the thermal shock screen. The change in resistance shall not exceed ± 3 percent.

30.5.2 No-load burn-in.

- a. Test duration: 96 hours minimum.
- b. Test temperature: Maximum rated operating temperature.
- c. Test voltage: Not applicable.

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TABLE XI. Inspection of transformers and inductors similar to transformers and inductors that have been qualified by test.

Test (1)	Class S	
	Sample Size	Reject allowed
Visual and mechanical examination (external) Resistance to soldering heat Terminal strength Dielectric withstanding voltage (at atmospheric pressure) (2) Temperature rise Vibration Shock Dielectric withstanding voltage (at reduced voltage) Insulation resistance Winding continuity Solderability Electrical characteristics Life (1000 hours) Dielectric withstanding voltage (at reduced voltage) Insulation resistance (3) Electrical characteristics Visual and mechanical examination (external) Visual and mechanical examination (internal) (one sample unit)	3	0

- (1) Specified tests shall be performed in accordance with MIL-T-27 or MIL-T-21038 as applicable and in the order shown herein.
- (2) At maximum temperature for the class.
- (3) At specified voltage with IR of 7,500 megohms minimum.

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RADIOGRAPHIC INSPECTION

10. SCOPE

This appendix contains details for performance of the radiographic inspection for devices specified in accordance with this standard. This appendix is a mandatory part of this standard. The information contained herein is intended for compliance only.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. RADIOGRAPHIC INSPECTION

30.1 Radiographic inspection. Devices shall be tested in accordance with Method 209 of MIL-STD-202. The following details and exceptions shall apply:

a. Radiographic quality: The radiograph shall render a clear sharp image of the penetrameter.

b. Image quality indicator: A radiograph of the penetrameter shall be included on each radiograph film. The penetrameter may be made from a sample of the same type as that being radiographed, with an AWG number 48 tungsten wire mounted across the body.

30.1.1 Transformers and inductors. Examples of typical construction and terminology are shown on figure 5.

30.1.1.1 Views. Radiographs shall be taken of each device in each of three axes; X, Y, and Z. When inadequate coverage is provided, additional views shall be taken as deemed necessary to satisfy the criteria defined herein. Axial orientation is shown on figure 6.

30.1.1.2 Examination. The radiographic examination shall include, but not be limited to, inspection for extraneous materials, alignment, clearance and processing damage.

30.1.1.2.1 Extraneous material. There shall be no visible extraneous materials that can cause damage to insulation or electrical short circuit between conductors or connections. Loose or excessive bonding material such as weld or solder splash, solder balls and short lengths of unattached wire shall be considered extraneous material. See figure 7.

30.1.1.2.2 Alignment and clearances. Acceptable parts shall exhibit adequate internal electrical and mechanical clearances. Criteria for determining adequate clearance by inspection of radiographs shall be established by each manufacturer and must be approved by the qualifying activity, except as specified otherwise herein. Unacceptable alignment and clearances include the following:

a. Insufficient clearance between wires and metallic case, other conductive support, or external surfaces. See figure 8.

b. Lead wire under tension that can be subjected to further stress under thermal expansion. See figure 8(g).