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SCREENING REQUIREMENTS

FOR

NONSTANDARD ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS

This document (formerly MSFC Drawing 85M03876) was prepared and is maintained by the Electrical, Electronic and Electromechanical (EEE) Parts Branch, EB13.

Approved by:

Distribution:

EB13 10 copies

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Parts Branch, EB13

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING	1/11/85	Screening Requirements for Nonstandard Electrical, Electronic and Electro-Mechanical (EEE) Parts	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
	DRAFTSMAN	CHECKER		
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1.0 SCOPE

1.1 Scope - This document establishes minimum screening requirements for nonstandard electrical and electronic parts, as specified in the applicable appendices, that are to be used in high-reliability electronic equipment for space applications.

1.2 Limitations - This document does not cover all detailed product and performance requirements necessary for complete screening. These details are to be supplied by the procuring activity. (See 3.1.4.)

1.3 Use - This document should be used only for devices which are not otherwise covered by an adequate detail specification and is not to be used to circumvent an existing standard parts specification.

1.4 Objective - The objective of this document is to provide screening requirements for the purpose of eliminating potential part failures prior to the installation of parts into hardware.

1.5 Application - This document, when contractually invoked, is applicable to parts used in electrical and electronic equipment for launch vehicles, space, and planetary exploration equipment, mission-essential support equipment, and elements thereof.

2.0 APPLICABLE DOCUMENTS

2.1 The following publications form a part of this document to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposals shall apply:

SPECIFICATIONSMilitary

MIL-T-27	Transformers and Inductors (Audio, Power, and Pulse)
MIL-C-15305	Coil, Radiofrequency and Transformers, Intermediate Frequency and Radiofrequency, General Specification for
MIL-F-15733	Filter, Radio Interference
MIL-C-18388	Coils, Tube Deflection; and Coils, Tube Focusing
MIL-T-21038	Transformer, Pulse, Low Power, General Specification for
MIL-C-39020	Crystal Units, Quartz, Established Reliability, General Specification for
MIL-T-55631	Transformers; Intermediate Frequency, Radio Frequency and Discriminator, General Specification for

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STANDARDSMilitary

MIL-STD-975 (NASA)	NASA Standard Electrical, Electronic and Electromechanical (EEE) Parts List
MIL-STD-981	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications
DoD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-883	Test Method and Procedures for Microelectronics

NASA

NHB 1700.7	Safety Policy & Requirements for Payloads using the Space Transportation System (STS)
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George C. Marshall Space Flight Center

MSFC-STD-355	Radiographic Inspection of Electronic Parts
MC 172	Fitting End, Bulkhead Flared Tube Connection and Nonmetallic Seal

SPECIFICATIONSGeorge C. Marshall Space Flight Center

MSFC-SPEC-522A	Design Criteria for Controlling Stress Corrosion Cracking
MSFC-SPEC-250A	Protective Finishes for Space Structures and Associated Equipment
MSFC-SPEC-592	Specification for the Selection and Use of Organic Adhesives in Hybrid Microcircuits

Military

MIL-M-38510	Microcircuits, General Specification for
MIL-S-19500	Semiconductor Devices, General Specification for

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the printing activity or as directed by the contracting officer.)

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3.0 GENERAL REQUIREMENTS

3.1 Screening Requirements

3.1.1 Screening - Each part shall be subjected, in the order specified, to all applicable measurements and tests specified in the appropriate appendix, and shall meet the requirements specified in Appendix X for the specific part type.

3.1.2 Test Procedures - Test procedures for all inspections, tests, and measurements performed shall be retained by the screening facility for two years.

3.1.3 Test Data and Submission - The results of all examinations, tests and measurements performed shall be recorded. This test data shall show the serial number of each part associated with the results for each test to which the part was subjected. Radiographs, when required, shall show the serial number of the part being radiographed. One copy of this recorded data and one copy of each radiograph, when radiographing is required, shall be retained by screening facility for two years. One copy of all data and all applicable radiographs shall be shipped with the parts.

3.1.4 Detail Test Requirements - When any appendix specifies that requirements shall be "as specified," it is the responsibility of the procuring activity to specify in his purchase order the design, construction, identification, parameters and stress details required to complement the screening inspection and test requirements contained herein for the specific parts being screened.

3.2 Requirement for Deviations - A request for deviation from any requirement of this document may be submitted by the procuring activity to MSFC. Each request shall fully describe the reason for requesting the deviation. Each request to add any new test or examination or to modify any existing test or examination shall fully describe the new or modified procedure.

3.3 Screening Facility - The facility performing the screening inspections and tests specified in this document may be the procuring activity, the part manufacturer or a commercial laboratory. The procuring activity is solely responsible for assuring that the facility meets the requirements pertaining to the parts being screened. Only commercial laboratories that have demonstrated to MSFC the ability to meet facility requirements will be approved.

3.4 Screening Facility's Responsibility - The screening facility shall:

- a. Meet all applicable requirements specified herein and all requirements pertaining to the parts being screened.
- b. Subject each part to all applicable tests.
- c. Mark each part as specified in paragraph 10.1 of the applicable appendix when the part successfully completes all inspections and tests.
- d. Remove from the lot all parts that fail the screening inspection or tests, and permanently mark the failed parts to preclude the possibility of acceptance.

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<p>e. Notify the procuring activity and MSFC of any screening test that, in the screening facility's opinion, could create new failure mechanisms.</p> <p>f. Notify the procuring activity and MSFC of any change in an existing test or of any new test that would, in the screening facility's opinion, more effectively detect existing failure mechanisms.</p> <p>g. Record and submit all screening test data including radiographs when specified.</p> <p>h. Maintain controls to prevent transients, stray currents or other overloads from being imposed on the parts during screening and adequate precautions must be maintained to prevent abuse of parts during handling, testing, storing and shipping.</p> <p>i. Wherever tests have gone out of control for any reason, or if any mishandling of the parts has occurred, notify the procuring activity and MSFC within 24 hours after the time the discrepancy occurs. A written report shall be made within 72 hours explaining the discrepancy, stating whether the parts are recommended for use or should be rejected, and detailing corrective measurements to prevent recurrence of the discrepancy.</p> <p>j. Submit to the procuring activity a certificate of completion stating that all parts received have been subjected to all applicable examinations, tests and measurements.</p> <p>k. If parts are substituted or deviations taken to applicable specification requirements, report such occurrences immediately to the procuring activity.</p> <p>4.0 DETAIL REQUIREMENTS</p> <p>4.1 <u>Minimum Screening Requirements</u> - Minimum screening requirements for nonstandard electrical and electronic parts are specified in the appendices as follows:</p> <ol style="list-style-type: none"> 1. Capacitors (Appendix A) 2. Circuit Breakers (Appendix B) 3. Crystals, Frequency Standard (Appendix C) 4. Electromagnetic Parts (Transformers, Inductors, Filters and Rotating Parts) (Appendix D) 5. Fuses (Appendix E) 6. Meters (Appendix F) 7. Microcircuits (Appendix G) 8. Relays (Appendix H) 9. Resistors (Appendix I) 			

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- 10. Semiconductor Devices (Appendix J)
- 11. Switches (Appendix K)
- 12. Transducers (Appendix L)
- 13. Nonstandard Parts Selection and Application Criteria (Appendix X)

5.0. NOT APPLICABLE

6.0 NOTES

6.1 Definitions

6.1.1 Screening - The application of appropriate stresses and inspection at a level which will not jeopardize usage or shorten the life of acceptable parts, but which will reveal defects and accelerate failure mechanisms that are detectable by inspection or parameter measurement.

6.1.2 Inspection - The examination and testing of parts to determine whether they conform to specified requirements.

6.1.3 Examination - An element of inspection consisting of investigation, without the use of special laboratory appliances or procedures, of parts, to determine conformance to those specified requirements which can be determined by such investigations. Examination is nondestructive and includes, but is not limited to, visual, auditory, olfactory, tactile, gustatory, and other investigations, simple physical manipulation, gauging, and measurement.

6.1.4 Testing - An element of inspection denoting the determination, by technical means, of the properties of elements of parts, including functional operation, and involves the application of established scientific principles and procedures.

6.1.5 Screening Inspection - Inspection in which each part is inspected, as defined above in "screening," for designated characteristics and all defective items are removed.

6.1.6 Part - One piece or two or more pieces joined together and not normally subject to disassembly without destruction of designed use, e.g., composition resistor, transistor, and diode.

6.1.7 NASA Standard Parts - Grade 1 and Grade 2 parts listed in MIL-STD-975 (NASA), entitled, "NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List," are standard parts.

6.1.8 Nonstandard Parts - EEE parts which are not listed in NASA MIL-STD-975 are nonstandard parts. Grade 2 parts used in Grade 1 applications are nonstandard.

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6.1.9 Nondestructive Tests - Test which produce no significant evidence of cumulative degradation of any part in the sample are considered nondestructive. Some examples which are considered nondestructive for most parts are X-ray, seal leak, etc.

6.1.10 Commercial Laboratory - A commercial laboratory is a facility other than a part user or part manufacturer who specializes in the screening of electrical parts.

6.2 Information Concerning this Document - Any information, questions or comments concerning this document should be directed to the Marshall Space Flight Center, Electrical/Electronic Parts Branch, EB13, telephone (205) 544-3348.

Custodian:

NASA/George C. Marshall
Space Flight Center

Preparing Activity:

NASA/George C. Marshall
Space Flight Center

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APPENDIX A

Minimum Screening Requirements for Capacitors

10. General Requirements - Capacitors shall meet all applicable requirements of this document.

10.1 Screening Requirements - Capacitors shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified", these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each capacitor supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in Table I. Capacitors that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, External - Capacitors that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit or function of the capacitor (7X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7X).
- c. Glass seals shall be free of cracks and imperfections (7X).
- d. Insulated sleeves, if used, shall be free of nicks and gouges (7X).
- e. Marking shall include, but not be limited to:
 1. Part number (1X).
 2. Lot or date code (1X).
- f. The following characteristics shall be as specified:
 1. External design and construction (1X).
 2. Dimensions (1X).
 3. Weight (1X).

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Table I. Screening Requirements

Examination or Test	Tantalum Capacitors			Non-Hermetic Ceramic and Plastic	Hermetic Paper and Plastic	Glass and Mica
	Solid Electrolyte	Non-Solid Electrolyte				
		Slug	Foil			
1. Electrical Measurements, EM1	10.3	10.3	10.3	10.3	10.3	10.3
2. Temperature Cycling		10.4.1				
3. Thermal Vacuum Bake		10.4.2				
4. Seal Leak, Fine	10.4.3.1				10.4.3.1	
5. Seal Leak, Gross	10.4.3.2				10.4.3.2	
6. Seal Leak, Electrolyte		10.4.3.3.1	10.4.3.3.2			
7. Radiographic	10.4.4	10.4.4	10.4.4	10.4.4	10.4.4	
8. Burn-In	10.4.5.1	10.4.5.2	10.4.5.2	(Notes 1 and 2)	(Notes 2 and 3)	10.4.5.6
9. Seal Leak, Electrolyte		10.4.3.3.1, b				
10. Electrical Measurements, EM2	10.3	10.3	10.3	10.3	10.3	10.3
11. Visual Examination, External	10.2	10.2	10.2	10.2	10.2	10.2

NOTES:

1. Burn-in for ceramic capacitors shall be as specified in 10.4.5.3.
2. Burn-in for plastic capacitors shall be as specified in 10.4.5.4.
3. Burn-in for paper capacitors shall be as specified in 10.4.5.5.

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10.3 Electric Measurements - The electrical measurements EM1 and EM2 shall consist of the measurements specified in the following tables, made in the order shown:

- a. Tantalum capacitors - Table II
- b. Nonhermetic (ceramic and plastic) capacitors - Table III
- c. Hermetic sealed (paper and plastic) capacitors - Table IV
- d. Glass and mica capacitors - Table V

The accept-reject criteria shall be as specified herein, or when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

Table II. Electrical Measurements, Tantalum Capacitors

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM1</u>			
1. Capacitance	All	10.3.2.1.1	10.3.2.2
2. Dissipation/Power Factor	All	10.3.3.1.1	10.3.3.2
3. DC Leakage	Solid	10.3.4.1.1	10.3.4.2
4. DC Leakage	Nonsolid	10.3.4.1.2	10.3.4.2
5. Insulation Resistance	All	10.3.6.1.1	10.3.6.1.2
<u>EM2</u>			
6. Capacitance	All	10.3.2.1.1	10.3.2.2
7. Dissipation/Power Factor	All	10.3.3.1.1	10.3.3.2
8. DC Leakage	Solid	10.3.4.1.1	10.3.4.2
9. DC Leakage	Nonsolid	10.3.4.1.2	10.3.4.2
10. Insulation Resistance	All	10.3.6.1.1	10.3.6.1.2

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Table III. Electrical Measurements, Nonhermetic (Ceramic and Plastic) Capacitors.

Measurements	Types	Test Method Paragraph	Accept - Reject Criteria Paragraph
<u>EM1</u>			
1. Capacitance	Ceramic	10.3.2.1.2	10.3.2.2
2. Capacitance	Plastic	10.3.2.1.3	10.3.2.2
3. Dissipation/Power Factor	Ceramic	10.3.3.1.2	10.3.3.2
4. Dissipation/Power Factor	Plastic	10.3.3.1.3	10.3.3.2
5. Dielectric Strength	Ceramic	10.3.5.1.1 10.3.5.1.2	10.3.5.2
6. Dielectric Strength	Plastic	10.3.5.1.1 10.3.5.1.3	10.3.5.2
7. Insulation Resistance	Ceramic	10.3.6.2.1	10.3.6.2.2
<u>EM2</u>			
8. Capacitance	Ceramic	10.3.2.1.2	10.3.2.2
9. Capacitance	Plastic	10.3.2.1.3	10.3.2.2
10. Dissipation/Power Factor	Ceramic	10.3.3.1.2	10.3.3.2
11. Dissipation/Power Factor	Plastic	10.3.3.1.3	10.3.3.2
12. Dielectric Strength	Ceramic	10.3.5.1.1 10.3.5.1.2	10.3.5.2
13. Dielectric Strength	Plastic	10.3.5.1.1 10.3.5.1.3	10.3.5.2
14. Insulation Resistance	Ceramic	10.3.6.2.1	10.3.6.2.2

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Table IV. Electrical Measurements, Hermetic (Paper and Plastic) Capacitors.

Measurements	Types	Test Method Paragraph	Accept - Reject Criteria Paragraph
<u>EM1</u>			
1. Capacitance	Paper	10.3.2.1.4	10.3.2.2
2. Capacitance	Plastic	10.3.2.1.5	10.3.2.2
3. Dissipation/Power Factor	Paper	10.3.3.1.3	10.3.3.2
4. Dissipation/Power Factor	Plastic	10.3.3.1.4	10.3.3.2
5. Dielectric Strength	Paper	10.3.5.1.1 10.3.5.1.4	10.3.5.2
6. Dielectric Strength	Plastic	10.3.5.1.1 10.3.5.1.5	10.3.5.2
7. Insulation Resistance	Paper	10.3.6.3.1	10.3.6.2.2
8. Insulation Resistance	Plastic	10.3.6.4.1	10.3.6.4.2
<u>EM2</u>			
9. Capacitance	Paper	10.3.2.1.4	10.3.2.2
10. Capacitance	Plastic	10.3.2.1.5	10.3.2.2
11. Dissipation/Power Factor	Paper	10.3.3.1.3	10.3.3.2
12. Dissipation/Power Factor	Plastic	10.3.3.4	10.3.3.2
13. Dielectric Strength	Paper	10.3.5.1.1 10.3.5.1.4	10.3.5.2
14. Dielectric Strength	Plastic	10.3.5.1.1 10.3.5.1.5	10.3.5.2
15. Insulation Resistance	Paper	10.3.6.3.1	10.3.6.2.2
16. Insulation Resistance	Plastic	10.3.6.4.1	10.3.6.2.2

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Table V. Electrical Measurements, Glass and Mica Capacitors

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph
<u>EM1</u>			
1. Capacitance	All	10.3.2.1.6	10.3.2.2
2. Dissipation/Power Factor	Glass	10.3.3.1.5	10.3.3.2
3. Dissipation/Power Factor	Mica	10.3.3.1.6	10.3.3.2
4. Dielectric Strength	Glass	10.3.5.1.1 10.3.5.1.6	10.3.5.2
5. Dielectric Strength	Mica	10.3.5.1.1 10.3.5.1.7	10.3.5.2
6. Insulation Resistance	Glass	10.3.6.5.1	10.3.6.5.2
7. Insulation Resistance	Mica	10.3.6.6.1	10.3.6.6.2
<u>EM2</u>			
8. Capacitance	All	10.3.2.1.6	10.3.2.2
9. Dissipation/Power Factor	Glass	10.3.3.1.5	10.3.3.2
10. Dissipation/Power Factor	Mica	10.3.3.1.6	10.3.3.2
11. Dielectric Strength	Glass	10.3.5.1.1 10.3.6.1.6	10.3.5.2
12. Dielectric Strength	Mica	10.3.5.1.1 10.3.5.1.7	10.3.5.2
13. Insulation Resistance	Glass	10.3.6.5.1	10.3.6.5.2
14. Insulation Resistance	Mica	10.3.6.6.1	10.3.6.6.2

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10.3.2 Capacitance10.3.2.1 Test Methods

10.3.2.1.1 Capacitance, Tantalum Capacitors - Tantalum capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

- a. Test frequency - 120 ± 5 Hz
- b. Measurement accuracy -2 percent
- c. Polarizing voltage - 2.2 Vdc
- d. Impressed voltage - 1.0 Vrms max.

10.3.2.1.2 Capacitance, Ceramic Capacitors - Ceramic capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

- a. Test frequency:
 - 0 to 100 pF - 1000 ± 100 kHz
 - Greater than 100 pF - 1000 ± 100 Hz
- b. Measurement accuracy -0.5 V
- c. Impressed voltage - 2 ± 1 Vrms

10.3.2.1.3 Capacitance, Nonhermetic Plastic Capacitors - Nonhermetic plastic capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

- a. Test frequency - 1000 ± 100 Hz
- b. Measurement accuracy - 1.0 percent

10.3.2.1.4 Capacitance, Paper Capacitors - Paper capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

- a. Test frequency - 1000 ± 100 Hz
- b. Measurement accuracy - ± 0.5 percent

10.3.2.1.5 Capacitance, Hermetic Plastic Capacitors - Hermetic plastic capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

- a. Test frequency:
 - 0 to 1 uF - 1000 ± 100 Hz
 - Greater than 1 uF - 60 ± 6 Hz
- b. Measurement accuracy -2 percent

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10.3.2.1.6 Capacitance, Glass Capacitors and Mica Capacitors - Glass capacitors and mica capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency:

0 to 1000 pF - 1000 \pm 100 kHz
Greater than 1000 pF - 1000 \pm 100 Hz

b. Measurement accuracy - 0.2 percent of nominal capacitance or ± 0.2 pF, whichever is greater.

10.3.2.1.7 Capacitance, Variable Capacitors - Variable capacitors shall be measured as specified in Method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1000 kHz \pm 100 Hz

b. Measurement accuracy - 1 percent or 0.5 pF whichever is less.

10.3.2.2 Accept-Reject Criteria - Capacitors shall meet the capacitance requirements as specified. Capacitors that fail to meet these requirements shall be removed from the lot.

10.3.3 Dissipation/Power Factor10.3.3.1 Test Methods

10.3.3.1.1 Dissipation/Power Factor, Tantalum Capacitors - Tantalum capacitors shall be measured using a polarized capacitance bridge, under the conditions as follows:

a. Test frequency - 120 \pm 5 Hz

b. Polarizing voltage - 2.2 Vdc

c. Impressed voltage - 1.0 Vrms max.

d. Dial reading accuracy - 0.1 percent of dissipation factor

e. Measurement accuracy - 2 percent of measured dissipation factor plus 0.1 percent

10.3.3.1.2 Dissipation/Power Factor, Ceramic Capacitors - Ceramic capacitors shall be measured under the following conditions:

a. Test frequency:

0 to 100 pF - 1000 \pm 100 kHz
Greater than 100 pF - 1000 \pm 100 Hz

b. Measurement accuracy - 2 percent of measurement

c. Impressed voltage - 2 \pm 1 Vrms

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10.3.3.1.3 Dissipation/Power Factor, Nonhermetic Plastic Capacitors and Paper Capacitors - Nonhermetic plastic capacitors and paper capacitors shall be measured under the following conditions:

- a. Test frequency - 1000 ± 100 Hz
- b. Test voltage -20 percent of rated voltage
- c. Measurement accuracy - 2 percent

10.3.3.1.4 Dissipation/Power Factor, Hermetic Plastic Capacitors - Hermetic plastic capacitors shall be measured under the following conditions:

- a. Test frequency:
 - 0 to 1 μ F - 1000 ± 100 Hz
 - Greater than 1 μ F - 60 ± 6 Hz
- b. Test voltage - 5 percent of rated voltage

10.3.3.1.5 Dissipation/Power Factor, Glass Capacitors - Glass capacitors shall be measured under the following conditions:

- a. Test frequency - 1000 ± 100 Hz
- b. Measurement accuracy - 2 percent of 0,0005 pF whichever is greater.

10.3.3.1.6 Dissipation/Power Factor, Mica Capacitors - Mica capacitors shall be measured under the conditions as follows:

- a. Test frequency:
 - 0 to 1000 pF - 1000 ± 100 kHz
 - Greater than 1000 pF - 1000 ± 100 Hz
- b. Measurement accuracy - 2 percent

10.3.3.2 Accept-Reject Criteria - Capacitors shall meet the dissipation/power factor requirements as specified. Capacitors that fail to meet these requirements shall be removed from the lot.

10.3.4 DC Leakage

10.3.4.1 Test Methods

10.3.4.1.1 DC Leakage, Solid Tantalum Capacitors - Solid tantalum capacitors shall be tested as specified in Method 302 of Standard MIL-STD-202. Nonpolar capacitor measurement shall be made in both directions. The dc leakage measurement shall be made within 5 minutes after the voltage is applied. A 1000-ohm resistor shall be placed in series with the capacitor to limit charging current. Capacitors shall be tested at 25°C, 85°C and 125°C with rated voltage, as specified, applied. Measurement accuracy shall be 2 percent or 0.002 microampere, whichever is greater.

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10.3.4.1.2 DC Leakage, Nonsolid Tantalum Capacitors - Nonsolid tantalum capacitors shall be tested as specified in Method 302 of Standard MIL-STD-202. Nonpolar capacitor measurements shall be made in both directions. The dc leakage measurement shall be made within 5 minutes after the voltage has been applied. Capacitors shall be measured at 25°C with rated voltage, as specified, applied. Measurement accuracy shall be 2 percent or 0.02 microampere, whichever is greater.

10.3.4.2 Accept-Reject Criteria - Capacitors shall meet the dc leakage requirements as specified. Capacitors that fail to meet these requirements shall be removed from the lot.

10.3.5 Dielectric Strength

10.3.5.1 Test Methods

10.3.5.1.1 Dielectric Strength, General - Capacitors shall be tested as specified in Method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground.
- b. Examination after test - For evidence of arcing, flashover, breakdown of insulation, or other damage.
- c. Test voltage, duration of application of test voltage, and limiting value of surge current shall be as specified in the applicable paragraphs referenced in table II to table V inclusive.

10.3.5.1.2 Dielectric Strength, Ceramic Capacitors - The following details shall apply for the dielectric strength test:

a. Applied voltage:

Rated voltage 0 to 500 Vdc - 250 percent of rated voltage.

Rated voltage greater than 500 Vdc - 175 percent of rated voltage.

- b. Points of application of applied voltage - Between terminals.
- c. Duration of application of test voltage - 5 ± 1 seconds.
- d. Surge current limit - 50 mA.

10.3.5.1.3 Dielectric Strength, Nonhermetic Plastic Capacitors - The following details shall apply for the dielectric strength test:

- a. Applied voltage - 400 percent of rated voltage
- b. Duration of application of test voltage - 15 ± 1 second.
- c. Surge current limit - 1A

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10.3.5.1.4 Dielectric Strength, Paper Capacitors - The following details shall apply for the dielectric strength test:

a. Applied voltage:

For measuring between terminals - 200 percent of rated dc voltage.
For measuring terminal to case - 250 percent of rated dc voltage.

b. Duration of applied voltage - For measuring terminal to case, 5 \pm 1 second.

c. Surge current limit - 1A

10.3.5.1.5 Dielectric Strength, Hermetic Plastic Capacitors - The following details shall apply for the dielectric strength test:

a. Applied voltage - 200 percent of rated voltage.

b. Duration of applied voltage - 5 \pm 1 second.

c. Surge current limit - 1A.

10.3.5.1.6 Dielectric Strength, Glass Capacitors - The following details shall apply for the dielectric strength test:

a. Applied voltage - 300 percent of rated voltage

b. Points of application of applied voltage - between terminals

c. Duration of applied voltage - 5 \pm 1 seconds

d. Surge current limit - 20 mA

10.3.5.2 Accept-Reject Criteria - Capacitors that have leakage currents greater than the specified maximum limit, as specified by the procuring activity, indicated by the current measuring device or fault indicator, or that show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

10.3.6 Insulation Resistance

10.3.6.1 Insulation Resistance, Tantalum Capacitors

10.3.6.1.1 Test Method - Tantalum capacitors with plastic insulated sleeves shall be tested as specified in Method 302 of Standard MIL-STD-202. The following details shall apply:

a. Test temperature - 25°C

b. Test voltage - 500 \pm 5 Vdc

c. Duration of applied voltage - 60 \pm 10 seconds

d. Points of measurement - Between case and ground

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10.3.6.1.2 Accept-Reject Criteria - The insulation resistance of capacitor sleeving shall be not less than 1000 megohms. Capacitors that fail to meet this requirement shall be removed from the lot.

10.3.6.2 Insulation Resistance, Ceramic Capacitors

10.3.6.2.1 Test Method - Ceramic capacitors shall be tested as specified in Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test temperatures - 25°C
- b. Test voltage - Rated voltage
- c. Duration of applied voltage - 5 seconds
- d. Points of measurement - Between all mutually insulated points
- e. Surge current limit - 50 mA

10.3.6.2.2 Accept-Reject Criteria - The insulation resistance shall be 100,000 megohms. Capacitors that fail to meet this requirement shall be removed from the lot.

10.3.6.3 Insulation Resistance, Paper Capacitors

10.3.6.3.1 Test Methods - Paper capacitors shall be tested as specified in Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test temperature - $25 \pm 3^\circ\text{C}$ and maximum rated temperature $\pm 3^\circ\text{C}$.
- b. Points of measurements
 1. Terminal to terminal - Insulation resistance shall be measured between terminals at $25 \pm 3^\circ\text{C}$, and at the maximum rated temperature $\pm 3^\circ\text{C}$.
 2. Terminals to case - When the case is not a terminal, the measurement shall be made between each terminal and the case at $25 \pm 3^\circ\text{C}$.
- c. Test voltage - Rated voltage or 500 ± 50 Vdc, whichever is lower.
- d. Time constant of measuring circuit (including capacitor) - Not more than 30 seconds.
- e. Surge current limit - 1A.

10.3.6.3.2 Accept-Reject Criteria - Capacitors shall meet the insulation resistance requirements as specified. Capacitors that fail to meet these requirements shall be removed from the lot.

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10.3.6.4 Insulation Resistance, Hermetic Plastic Capacitors

10.3.6.4.1 Test Method - Hermetic plastic capacitors shall be tested as specified in Method 302 of MIL-STD-202. The following details shall apply:

- a. Test temperature - $25 \pm 3^{\circ}\text{C}$
- b. Test voltage - Rated voltage or 500 ± 50 Vdc, whichever is lower
- c. Duration of applied voltage - 60 ± 10 seconds
- d. Points of measurement - From terminal to terminal and from each terminal to case.

10.3.6.4.2 Accept-Reject Criteria - The insulation resistance shall be as follows:

- a. Terminal to terminal
 - (1) 0 to 0.68 microfarads - 100,000 megohms minimum
 - (2) Greater than 0.68 microfarads - 68,000 megohms
- b. Terminal to case - 100,000 megohms

Capacitors that fail to meet these requirements shall be removed from the lot.

10.3.6.5 Insulation Resistance, Glass Capacitors

10.3.6.5.1 Test Method - Glass capacitors shall be tested as specified in Method 302 of MIL-STD-202. The following details shall apply.

- a. Test temperature - $25 \pm 3^{\circ}\text{C}$
- b. Duration of applied voltage - 5 seconds minimum
- c. Test voltage - Rated voltage
- d. Points of measurements - Terminal to terminal
- e. Surge current limit - 50 mA

10.3.6.5.2 Accept-Reject Criteria - The insulation resistance shall be 500,000 megohms. Capacitors that fail to meet this requirement shall be removed from the lot.

10.3.6.6 Insulation Resistance, Mica Capacitors

10.3.6.6.1 Test Method - Mica capacitors shall be tested as specified in Method 302 of MIL-STD-202. The following details shall apply:

- a. Test temperature - $25 \pm 3^{\circ}\text{C}$
- b. Test voltage - 100 ± 10 volts

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- c. Electrification time - 10 seconds to 2 minutes
- d. Points of measurement - Terminal to terminal
- e. Surge current limit - 5 mA

10.3.6.6.2 Accept-Reject Criteria - The insulation resistance shall be as follows:

- a. Nominal capacitance 10,000 pF or less - 100,000 megohms
- b. Nominal capacitance greater than 10,000 pF - 1000 megohms

Capacitors that fail to meet these requirements shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in MIL-STD-292.

10.4.1 Temperature Cycling - Temperature cycling shall be as specified in Method 102 of MIL-STD-202. The test shall consist of 10 cycles, performed continuously at test condition C.

10.4.2 Thermal Vacuum Bake - Thermal vacuum bake shall be performed as follows:

- a. Pressure - 10^{-3} torr
- b. Temperature - 125°C
- c. Time - 24 hours

10.4.3 Seal Leak

10.4.3.1 Seal Leak, Fine - Capacitors shall be tested in accordance with Method 112 of MIL-STD-202. The following details shall apply:

a. Test condition C (except that the gross leak test shall be as specified in paragraph 10.4.3.2).

(1) Procedure number - III

(2) Degree of leakage rate sensitivity - 10^{-8} atm cc/sec

Capacitors that fail to meet this leakage rate requirement shall be rejected from the lot.

10.4.3.2 Seal Leak, Gross - Capacitor shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the part shall not exceed 40°C at the time of immersion. During the time the part is in the water bath, there shall be no continuous flow of air bubbles or leakage of compound from the part body. Capacitors that fail to meet this requirement shall be rejected from the lot. After removal from the bath, the part shall be dried for 2 hours at 25°C .

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10.4.3.3 Seal Leak, Electrolyte

10.4.3.3.1 Seal Leak, Tantalum Slug Capacitors - Capacitors shall be tested by one of the following methods:

- a. Thymol blue - Apply thymol blue (0.04 percent) indicator to each capacitor around the cover seal and anode lead. Evidence of electrolyte leakage will be indicated by change of color of thymol blue from yellow to red. Remove the thymol blue with deionized water rinse.
- b. Litmus paper - Moisten blue litmus paper with deionized water and apply to the seal and anode areas of each capacitor with a wiping motion. Electrolyte leakage will be indicated by a change in paper color from blue to pink or red.

Capacitors that show evidence of leakage shall be rejected from the lot.

10.4.3.3.2 Seal Leak, Tantalum Foil Capacitors - Capacitors shall be placed with the terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature with $\pm 3^{\circ}\text{C}$ of the applicable maximum rated temperature for a minimum of 1 hour. After the test, capacitors shall be visually examined for evidence of leakage of liquid or filling compound, or bubbles from the seal. Capacitors that show evidence of leakage shall be rejected from the lot.

10.4.4 Radiographic

10.4.4.1 Radiographic Procedure - Capacitors shall be subjected to radiographic examination as specified in Standard MSFC-STD-355 to determine that internal construction is as specified.

10.4.4.2 Radiographic Analysis - Each radiograph shall be analyzed in accordance with the following criteria. Capacitors exhibiting deviation from these criteria shall be removed from the lot.

- a. Interior elements shall be properly positioned.
- b. There shall be no voids in encapsulating or potting compounds.
- c. There shall be no inhomogeneities in materials.
- d. There shall be no foreign materials.
- e. There shall be no broken elements.

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10.4.5 Burn-in

10.4.5.1 Burn-in, Solid Electrolyte Tantalum Capacitors - Capacitors shall be conditioned as specified in Method 108 of MIL-STD-202. The following details shall apply:

- a. Applied voltage - 100 percent of rated voltage for 125°C operation.
- b. Time - 248_{-0}^{+8} hours
- c. Temperature - 125 $\pm 2^{\circ}\text{C}$
- d. The power supply be capable of delivering 30 amperes to a shorted capacitor.
- e. Polarity (nonpolar capacitors) - Equal time in each direction

10.4.5.2 Burn-in Nonsolid Electrolyte Tantalum Capacitors - Capacitors shall be conditioned as specified in Method 108 of Standard MIL-STD-292. The following details shall apply:

- a. Applied voltage - 100 percent of rated voltage for 85°C operation.
- b. Time - 240_{-0}^{+8} hours
- d. The power supply be capable of delivering 30 amperes to a shorted capacitor.
- e. Polarity (nonpolar capacitors) - Equal time in each direction

10.4.5.3 Burn-in, Ceramic Capacitors - Capacitors shall be conditioned as specified in Method 108 of MIL-STD-202. The following conditions shall apply:

- a. Applied voltage:
 - Voltage rating up to 1000V - 200 percent of rated voltage
 - Voltage rating greater than 1000 volts - 100 percent or rated voltage
- b. Time - 48 ± 8 hours
- c. Temperature - 125 $\pm 2^{\circ}\text{C}$
- d. Voltage surge limit - 25 percent of applied voltage

10.4.5.4 Burn-in, Hermetic and Nonhermetic Plastic Capacitors - Capacitors shall be conditioned as specified in Method 108 of Standard MIL-STD-202. The following details shall apply:

- a. Applied voltage - 100 percent of rated voltage
- b. Time - 48_{-0}^{+8} hours
- c. Temperature - 125 $\pm 2^{\circ}\text{C}$
- d. Voltage surge limit - 10 percent of applied voltage

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10.4.5.5 Burn-in, Paper Capacitors - Capacitors shall be conditioned as specified in Method 108 of MIL-STD-202. The following details shall apply:

- a. Applied voltage - 100 percent of rated voltage
- b. Time - 48^{+8}_{-0} hours
- c. Temperature - $125 \pm 2^{\circ}\text{C}$
- d. Voltage surge limit - 25 percent of applied voltage

10.4.5.6 Burn-in, Glass Capacitors and Mica Capacitors - Capacitors shall be conditioned as specified in Method 108 of MIL-STD-202. The following details shall apply:

- a. Applied voltage - 300 percent of rated voltage
- b. Time - 48^{+8}_{-0} hours
- c. Temperature - $125 \pm 2^{\circ}\text{C}$
- d. Voltage surge limit - 10 percent of applied voltage

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APPENDIX B

Minimum Screening Requirements for Circuit Breakers

10. General Requirements - Circuit breakers shall meet all applicable requirements of this document.

10.1 Screening Requirements - Circuit breakers shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified" these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each circuit breaker supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, tests, and measurements shall be performed after all manufacturing processes have been performed. All circuit breakers that pass these examinations, tests, and measurements shall be marked with the symbol "S" in front of the part number.

Table I. Screening Requirements

Examination or Test	Hermetic Sealed	Nonhermetic
1. Visual examination, internal	10.2.1	10.2.1
2. Electrical and mechanical measurements, EM1	10.3	10.3
3. Vibration	10.4.1	10.4.1
4. Thermal shock	10.4.2	10.4.2
5. Burn-in	10.4.3	10.4.3
6. Seal leak, fine	10.4.4.1	
7. Seal leak, gross	10.4.4.2	
8. Electrical and mechanical measurements, EM2	10.3	10.3
9. Radiographic	10.4.5	10.4.5
10. Visual examination, external	10.2.2	10.2.2

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10.2 Visual Examinations - Unless otherwise specified all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal- Circuit breakers that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot.

- a. Soldering and welding shall be free of imperfections (10X).
- b. Assembly of internal parts shall indicate that proper manufacturing techniques have been used (10X).
- c. There shall be no cuts, breaks or abrasions in insulation (10X).
- d. Wire shall be the correct length and shall contain no kinks (10X).
- e. Wire insulation shall contain no cracks, breaks or cuts (10X).
- f. Circuit breaker shall contain no solder flux or other foreign matter (10X).
- g. There shall be no defects in workmanship, construction, design, materials and processes which could render any circuit breaker unsuitable for its intended use (10X).
- h. When lubrication is required, the quantity, quality and application shall be suitable for proper lubrication of the moving parts (10X).
- i. The following characteristics shall be as specified:
 1. Minimum clearances (10X).
 2. Critical dimensions (10X).
 3. Internal design and construction (1X).

10.2.2 Visual Examination, External - Circuit breakers that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit or function of the circuit breaker (7X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7X).
- c. Glass seals shall be free of cracks (7X).

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d. Marking shall include, but not be limited to:

1. Part number (1X).
2. Lot or date code (1X)..
3. Serial number (1X).

e. The following characteristics shall be as specified:

1. External design and construction (1X).
2. Dimensions (1X).
3. Weight (1X).

10.3 Electrical and Mechanical Measurements - The electrical and mechanical measurements EM1 and EM2 shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. All measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Dielectric Strength

10.3.2.1 Test Method - Circuit breakers shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Special preparations - Circuit breakers shall be mounted or placed on a metal plate (ground) or V- block, as applicable.
- b. Test voltage - The test voltage shall be as specified in table III.
- c. Duration of test voltage - The test voltage shall be applied for 60 ± 10 seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground with the circuit breaker in each of its operating positions.
- e. Examination during test - Leakage current shall be monitored during test.
- f. Examination after test - Parts shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

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Table II. Electrical and Mechanical Measurements

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph
<u>EM1</u>			
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Voltage Drop	Magnetic	10.3.3.1	10.3.3.2.1
3. Voltage Drop	Thermal	10.3.3.1	10.3.3.2.2
4. Contact Resistance	Magnetic	10.3.4.1.1	10.3.4.1.2
5. Contact Resistance	Thermal	10.3.4.2.1	10.3.4.2.2
6. Performance Test	All	10.3.5.1	10.3.5.2
7. Operating Force	All	10.3.6.1	10.3.6.2
8. Insulation Resistance	All	10.3.7.1	10.3.7.2.1
<u>EM2</u>			
9. Dielectric Strength	All	10.3.2.1	10.3.2.2
10. Voltage Drop	Magnetic	10.3.3.1	10.3.3.2.1
11. Voltage Drop	Thermal	10.3.3.1	10.3.3.2.2
12. Contact Resistance	Magnetic	10.3.4.1.1	10.3.4.1.2
13. Contact Resistance	Thermal	10.3.4.2.1	10.3.4.2.2
14. Performance Test	All	10.3.5.1	10.3.5.2
15. Insulation Resistance	All	10.3.7.1	10.3.7.2.2

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Table III. Test Specifications

Working Voltage (See Note 1)		Dielectric Strength rms Test Voltage	Insulation Resistance	
Greater Than	Up to and Including		DC Test Voltage	Minimum Insulation Resistance Megohms
0 V	100 V	300	100	1000
100 V	175 V	500	300	7500
175 V	700 V	2.8 X working voltage (See note 1)	500	7500
700 V		1.4 X working voltage plus 1000 V	1000	10,000

NOTE:

- The working voltage shall be as specified.

10.3.2.2 Accept-Reject Criteria - Circuit breakers that have leakage current paths that exceed 100 microamperes or show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

10.3.3 Voltage Drop

10.3.3.1 Test Method - The voltage drop test shall consist of the following steps in the sequence listed:

- Nominal rated current shall be applied for 30 minutes.
- The circuit breaker shall be activated six times with the nominal current flowing.
- The voltage drop shall be measured, with the nominal current flowing, by the voltmeter-ammeter method. (The measurement accuracy shall be ± 5 percent).
- Steps b and c shall be repeated twice, for a total of three measurements.

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10.3.3.2 Accept-Reject Criteria

10.3.3.2.1 Accept-Reject Criteria, Magnetic Circuit Breakers - The voltage drop for any measurement shall not exceed 0.2 volts. Circuit breakers that fail to meet this requirement shall be removed from the lot.

10.3.3.2.2 Accept-Reject Criteria, Thermal Circuit Breakers - Thermal circuit breakers shall meet the following requirements.

- a. The voltage drop shall not exceed 0.2 volts.
- b. The power dissipated shall not exceed 15 watts.

Circuit breakers that fail to meet these requirements shall be removed from the lot.

10.3.4 Contact Resistance

10.3.4.1 Contact Resistance, Thermal Circuit Breakers

10.3.4.1.1 Test Method - The contact resistance of circuit breakers shall be measured as specified in Method 307 of Standard MIL-STD-202. The following details shall apply:

- a. Measurements - Between the terminals of the contacts of the same pole forming a switching circuit. Measurements shall be made with the circuit breaker in each of its operating positions.
- b. Test current - 100 percent rated.
- c. Number of test actuations - one.
- d. Number of measurements per actuation - One.

10.3.4.1.2 Accept-Reject Criteria - Circuit breakers that fail to meet the requirements specified in table IV shall be removed from the lot.

10.3.4.2 Contact Resistance, Thermal Circuit Breakers

10.3.4.2.1 Test Method - The circuit breakers contacts shall be manually operated to successively interrupt and make a test circuit having a dc resistive load of one-half the current rating of the circuit breaker or 200 mA, whichever is less, at 26 ± 2 volts. The contact resistance (specified as millivolt drop) shall be completed by averaging the results of 10 measurements, each measurement shall be taken after a consecutive contact closure. All measurements shall be made across the circuit breaker external electrical terminals.

10.3.4.2.2 Accept-Reject Criteria - Circuit breakers that fail to meet the contact resistance requirements specified shall be removed from the lot.

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10.3.5 Performance Test

10.3.5.1 Test Method - The performance test shall consist of the following steps in the sequence listed:

- a. Unless otherwise specified, 115 percent of nominal rated current shall be applied for 1 hour or until the breaker trips, whichever occurs first.
- b. Unless otherwise specified, 145 percent of nominal rated current shall be applied for one hour, or until the breaker trips, whichever is first.
- c. Unless otherwise specified, 200 percent of nominal rated current shall be applied for 40 seconds, or until the breaker tips, whichever is first.

Table IV. Contact Resistance, Magnetic Circuit Breaker

Current Rating (See Note 1) (amperes)	DC Resistance (ohms-max)	60 Hz Impedance (ohms-max)	400 Hz Impedance (ohms-max)
0.05	680.0	690.0	710.0
0.50	5.4	6.0	6.6
1.0	1.35	1.5	1.61
2.0	0.40	0.40	0.50
3.0	0.15	0.15	0.17
4.0	0.10	0.10	0.12
5.0	0.061	0.063	0.072
6.0	0.042	0.043	0.050
7.0	0.036	0.036	0.040
8.0	0.027	0.028	0.035
9.0	0.022	0.022	0.028
10.0	0.018	0.021	0.024
12.5	0.012	0.013	0.013
15.0	0.009	0.009	0.010
20.0	0.006	0.006	0.007

NOTE:

1. Current rating shall be as specified.

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10.3.5.2 Accept-Reject Criteria - Circuit breaker trip time shall be as follows:

Test a. - Trip time greater than one hour

Test b. - Trip time less than one hour

Test c. - Trip time greater than 15 seconds but less than 40 seconds.

Circuit breakers that fail to meet these requirements shall be removed from the lot.

10.3.6 Operating Force

10.3.6.1 Test Method - The force or torque, as applicable, required to change contact positions of circuit breakers shall be determined by any suitable method.

10.3.6.2 Accept-Reject Criteria - Circuit breakers that fail to meet the requirements that follow shall be removed from the lot:

a. The operating force, or torque, shall be as specified.

b. The operating force, or torque, of each part shall not vary more than 10 percent from the average of all parts bearing the same part number.

10.3.7 Insulation Resistance

10.3.7.1 Test Method - Circuit breakers shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

a. Test voltage - The test voltage shall be as specified in table III.

b. Special preparations - Circuit breakers shall be mounted or placed on a metal plate (ground) or V- block, as applicable.

c. Points of measurements - The measurements shall be made first between all mutually insulated points, and then between each insulated point and ground, with the circuit breaker in each of its operating positions.

d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or 60^{+0}_{-10} sec., whichever is greater.

10.3.7.2 Accept-Reject Criteria

10.3.7.2.1 Accept-Reject Criteria, EMI - The minimum insulation resistance shall be as specified in table III. Parts that fail to meet this insulation resistance value shall be removed from the lot.

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10.3.7.2.2 Accept-Reject Criteria, EM2 - The minimum insulation resistance shall be the highest of:

- (a) As specified in table III
- (b) 90 percent of the EMI value

Parts that fail to meet the insulation resistance value specified above shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be conducted at the general test conditions specified in Standard MIL-STD-202.

10.4.1 Vibration - The following details and conditions shall apply to the vibration test:

- a. Mounting - Circuit breakers shall be rigidly mounted by normal mounting means.
- b. Axes of vibration and time - Circuit breakers shall be vibrated for one minute in each circuit breaker position and in each of three mutually perpendicular planes. (6 minutes total)
- c. Vibration level - Circuit breakers shall be subjected to the following spectrum of random vibration:

20 to 80 Hz	3 db/octave increase from 0.03 g ² /Hz to 0.3 g ² /Hz
80 to 500 Hz	0.3 g ² /Hz (20.g) constant
500 to 2000 Hz	3 db/octave decrease from 0.3 g ² /Hz to 0.03 g ² /Hz

- d. Characteristic monitored during vibration - Contact chattering as specified in Method 310, test condition A, test circuit B, of Standard MIL-STD-202 shall be monitored during vibration.
- e. Accept-reject criteria - There shall be no opening of closed contacts greater than 10 microseconds in duration, and no closing of open contacts greater than 10 microseconds in duration. Circuit breakers that fail to meet these requirements shall be removed from the lot.

10.4.2 Thermal Shock - Circuit breakers shall be tested in accordance with Method 107 of MIL-STD-202. The following details shall apply:

- a. Mounting - Normal mounting means, and in such a manner that there is least 1 inch of free air space around each circuit breaker.
- b. Test condition - B (except that the number of cycles shall be three instead of five;) monitor continuity of contacts.

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- c. Examination after cycling - Circuit breakers shall be examined for evidence of mechanical damage.
- d. Discontinuities - No discontinuities during thermal shock are allowed.

10.4.3 Burn-In - With the circuit breaker in the on position, subject it to the maximum operating temperature specified for the circuit breaker at the specified current for that temperature for 24 hours. Allow circuit breaker to return to 25°C before further testing.

10.4.4 Seal Leak

10.4.4.1 Seal Leak, Fine - Circuit breakers shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

Test condition - C (except that the gross leak test shall be as specified in paragraph 10.4.4.2).

- (1) Procedure number - III
- (2) Degree of leakage rate sensitivity - 10^{-8} atm cc/sec

Parts that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.4.2 Seal Leak, Gross - Circuit breakers shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the part shall not exceed 40°C at the time of immersion. During the time the part is in the water bath there shall be no continuous flow of air bubbles or leakage of compound from the part body. Parts that fail to meet this requirement shall be removed from the lot. After removal from the bath the part shall be dried for 2 hours at 25°C .

10.4.5 Radiographic

10.4.5 Radiographic Procedure - Circuit breakers shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355.

10.4.5.2 Radiographic Analysis - Each radiograph will be analyzed in accordance with the following criteria. Circuit breakers exhibiting deviations from this criteria shall be removed from the lot:

- a. Acceptable lots shall be of a homogeneous construction, and shall be as specified. Circuit breakers bearing the same part number shall have the same internal construction.
- b. The radiographic examination shall include, but not be limited to, inspection for foreign particles, solder splash, loose or misaligned parts.
- c. Wires shall not be pulled tight unless specifically designed in this manner. There shall be no loops or excessive bends in the lead wire.

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- d. There shall be no visible extraneous material (loose bonding material will be considered extraneous material).
- e. There shall be no wires present other than those connecting specific areas of the part, except where the design of the part calls for the use of additional wires.
- f. There shall be no evidence of defects in any internal element in the part.

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APPENDIX C

Minimum Screening Requirements for Crystals, Frequency Standard

10. General Requirements - Crystals shall meet all applicable requirements of this document.

10.1 Screening Requirements - Crystals shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified" these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each crystal supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, test and measurements shall be performed after all manufacturing processes have been performed. All crystals that pass these examinations, tests, and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal - Crystals that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Assembly of crystals to mounting brackets and terminal headers shall indicate that proper manufacturing techniques have been used (10X).
- b. Wire shall be the correct length and shall contain no kinks (10X).
- c. Wire insulation shall contain no cracks, breaks or cuts (10X).
- d. Crystals shall contain no solder flux or other foreign matter (10X).
- e. Soldering and welding shall be free of imperfections and splashes (10X).
- f. The lead wire shall be adequately bonded to the crystal chip (10X).
- g. There shall be no scratches on the resonator plate (10X).
- h. There shall be no scratches on the silver and nickel deposition (10X).
- i. The resonator plate edge shall not be chipped (10X).

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Table I. Screening Requirements

Examination or Test	Hermetic Sealed Crystals	Clear Glass Encased Crystals
Visual Examination, Internal	10.2.1	10.2.1
Electrical Measurements, EM1	10.3	10.3
Thermal Shock	10.4.1	10.4.1
Shock	10.4.2	10.4.2
Electrical Measurements, EM2	10.3	10.3
Vibration	10.4.3	10.4.3
Burn-In	10.4.4	10.4.4
Seal Leak, Fine	10.4.5.1	10.4.5.1
Seal Leak, Gross	10.4.5.2.1	10.4.5.2.1
Electrical Measurements, EM3	10.3	10.3
Particle Impact Noise Detection (PIND)	10.4.7	10.4.7
Radiographic	10.4.6	10.4.6
Visual Examination External	10.2.2.1	10.2.2.2

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- j. The support post shall not be bent (1X).
- k. There shall be no pinholes in, and no unevenness of deposition over the electrodes (10X).
- l. There shall be no defects in workmanship, construction, design, materials and processes which could render any crystal unsuitable for its intended use (10X).
- m. The following characteristics shall be as specified:
 - 1. Minimum clearances (10X).
 - 2. Critical dimensions (10X).
 - 3. Internal design and construction (1X).

10.2.2 Visual Examination, External

10.2.2.1 Visual Examination, External, Hermetic Sealed Crystals - Hermetic sealed crystals that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operational characteristics, or form, fit or function of the crystal (7X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7X).
- c. Glass seals shall be free of cracks (7X).
- d. Insulated sleeves (if used) shall be free of nicks and gouges (7X).
- e. Marking shall include, but not be limited to:
 - 1. Part number (1X).
 - 2. Lot or date code (1X).
 - 3. Serial number (1X).
- f. The following characteristics shall be as specified:
 - 1. External design and construction (1X).
 - 2. Dimensions (1X).
 - 3. Weight (1X).

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<p>10.2.2 <u>Visual Examination, External, Clear Glass Encased Crystals</u> - Clear glass encased crystals that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:</p> <ol style="list-style-type: none"> a. Each crystal shall indicate that proper manufacturing techniques have been used (10X). b. Wire shall be the correct length and shall contain no kinks; wire insulation shall contain no cracks, breaks or cuts (10X). c. Crystals shall contain no solder flux or other foreign matter (10X). d. There shall be no cracks in the glass encasement (10X). e. There shall be no defects in workmanship which could render any crystal unsuitable for its intended use (10X). f. There shall be no imperfections affecting operational characteristics, or form, fit or function of the crystal (7X). g. Marking shall include, but not be limited to: <ol style="list-style-type: none"> 1. Part number (1X). 2. Lot or date code (1X). 3. Serial number (1X). h. The following characteristics shall be as specified: <ol style="list-style-type: none"> 1. Internal design and construction (1X). 2. External design and construction (1X). 3. Dimensions (1X). 4. Weight (1X). <p>10.3 <u>Electrical Measurements</u> - The electrical measurements EM1, EM2, and EM3 shall consist of the measurements specified in Table II, made in the order shown. The accept-reject criteria shall be as specified herein or, as specified by the procuring activity. All measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3:1.3.</p>			

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph (See Note 1)
<u>EML</u>			
1. Insulation Resistance	All	10.3.2.1	10.3.2.2.1
2. Frequency & Equivalent Resistance Rated - Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1
3. Frequency & Equivalent Resistance Rated Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1
4. Frequency & Equivalent Resistance Minimum Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1
5. Frequency & Equivalent Resistance Minimum Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2
6. Stability	Controlled Temperature	10.3.4.1 10.3.3.1.2 10.3.3.1.5	10.3.4.2
7. Stability	Noncontrolled Temperature	10.3.5.1 10.3.3.1.2 10.3.3.1.5	10.3.5.2

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Table II. Electrical Measurements (Continued)

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph (See Note 1)
8. Capacitance, Shunt	All	10.3.6.1	10.3.6.2.1
9. Capacitance, Series	All	10.3.7.1	10.3.7.2.1
10. Unwanted Modes	Controlled Temperature	10.3.8.1 10.3.3.1.2 10.3.3.1.5 10.3.3.1.6	10.3.8.2
11. Unwanted Modes	Noncontrolled Temperature	10.3.8.1 10.3.3.1.2 10.3.3.1.5 10.3.3.1.7	10.3.8.2
12. Reduced Drive Level	All	10.3.9.1	10.3.9.2
<u>EM2</u>			
13. Frequency & Equivalent Resistance Rated Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.3 10.3.3.2.4
14. Frequency Equivalent Resistance Rated Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.3 10.3.3.2.4
15. Frequency Equivalent Resistance Minimum Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.3 10.3.3.2.4

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Table II. Electrical Measurements (Continued)

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph (See Note 1)
16. Frequency & Equivalent Resistance Minimum Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.3 10.3.3.2.4
<u>EM3</u>			
17. Insulation Resistance	All	10.3.2.1	10.3.2.2.1 10.3.2.2.2
18. Frequency & Equivalent Resistance Rated Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.4 10.3.3.2.5
19. Frequency & Equivalent Resistance Rated Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.2 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.4 10.3.3.2.5
20. Frequency & Equivalent Resistance Minimum Drive Level	Controlled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.6 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.4 10.3.3.2.5
21. Frequency & Equivalent Resistance Minimum Drive Level	Noncontrolled Temperature	10.3.3.1.1 10.3.3.1.3 10.3.3.1.4 10.3.3.1.5 10.3.3.1.7 10.3.3.1.8	10.3.3.2.1 10.3.3.2.2 10.3.3.2.4 10.3.3.2.5

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Table II. Electrical Measurements (Continued)

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph (See Note 1)
22. Stability	Controlled Temperature	10.3.4.1 10.3.3.1.2 10.3.3.1.5	10.3.4.2
23. Stability	Noncontrolled Temperature	10.3.5.1 10.3.3.1.2 10.3.3.1.5	10.3.5.2
24. Capacitance, Shunt	All	10.3.6.1	10.3.6.2.1 10.3.6.2.2
25. Capacitance, Series	All	10.3.7.1	10.3.7.2.2 10.3.7.2.2
26. Unwanted Modes	Controlled Temperature	10.3.8.1 10.3.3.1.2 10.3.3.1.5 10.3.3.1.6	10.3.8.2
27. Unwanted Modes	Noncontrolled Temperature	10.3.8.1 10.3.3.1.2 10.3.3.1.5 10.3.3.1.7	10.3.8.2
28. Reduced Drive Level	All	10.3.9.1	10.3.9.2

NOTE: 1. When more than one requirement is included for any test, each crystal shall meet all of these requirements.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

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10.3.2 Insulation Resistance

10.3.2.1 Test Method - Crystals shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be as specified in table III, or as specified by the procuring activity, whichever is greater.
- b. Special preparations - Parts shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- c. Points of measurement - The measurements shall be made between each insulated point and ground.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or $60 \pm_{10}^0$ seconds, whichever is greater.

10.3.2.2 Accept-Reject Criteria

10.3.2.2.1 Accept-Reject Criteria, EMI - Unless otherwise specified by the procuring activity, the insulation resistance shall be as specified in table III. Crystals that fail to meet this insulation resistance value shall be removed from the lot.

Table III. Test Specifications, Insulation Resistance

Working Voltage (Note 1)		Test Voltage dc	Minimum Insulation Resistance (megohms)
Greater Than	Up to and Including		
0 V	100 V	100	1000
100 V	175 V	300	7500
175 V	700 V	500	7500
700 V	---	1000	10000

NOTE: 1. The working voltage is defined as the maximum instantaneous voltage stress that may appear under normal rated operations across the insulation being considered, and shall be as specified.

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10.3.2.2.2 Accept-Reject Criteria, EM3 - The minimum insulation resistance shall be 90 percent of EMI measurement. Crystals that fail to meet this insulation resistance value shall be removed from the lot.

10.3.3 Frequency and Equivalent Resistance

10.3.3.1 Test Method

10.3.3.1.1 Mounting - The crystal unit shall be inserted into the applicable test set specified in MIL-C-39020 and the frequency and equivalent resistance shall be measured with the unit in thermal equilibrium. For crystal units in metal holders, measurements of frequency or equivalent resistance, or both, shall be made with the holder grounded. For units with long wire lead terminals in place of pins, the test point shall be 6.35 plus 1.5 mm minus 0 mm ($1/4 + 1/16 - 0$ inch) from the holder base. The methods and conditions specified in the paragraphs referenced in table II shall apply.

10.3.3.1.2 Drive Level Conditions for Measurements at Rated Drive Level - The drive level shall be at rated drive level for measurements, as specified.

10.3.3.1.3 Drive Level Conditions for Measurements at Minimum Drive Level - The drive level shall be at minimum drive level for measurements, as specified.

10.3.3.1.4 Drive Level Conditions for Repeated Measurements - The actual drive level used for the EMI measurement shall be recorded and used for the EM2 and EM3 measurements.

10.3.3.1.5 Temperature Measurement - A means of determining the temperature of the quartz vibrator shall be employed which will take into account any differential between the vibrator and the point at which the temperature sensing device is located, while temperature is changing. The final criterion is that the crystal unit shall resonate within the specified frequency limits, when conditions are stabilized at any and all ambient temperatures within the specified range. When these measurements are made the unit shall not be disassembled.

10.3.3.1.6 Temperature, Controlled Crystals - The temperature shall be the applicable controlled reference temperature as specified.

10.3.3.1.7 Temperature, Noncontrolled Crystals - The temperature shall be $25 \pm 3^\circ\text{C}$.

10.3.3.1.8 Temperature for Repeated Measurements - The actual temperature used for the EMI measurements shall be recorded and the same temperature $\pm 1^\circ\text{C}$ shall be used when making the EM2 and EM3 measurements.

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10.3.3.2 Accept-Reject Criteria

10.3.3.2.1 Frequency, Actual - Crystals that are not within the frequency requirements specified shall be removed from the lot.

10.3.3.2.2 Equivalent Resistance, Actual - Crystal that are not within the equivalent resistance requirements specified shall be removed from the lot.

10.3.3.2.3 Frequency Change EM2 - The change in frequency with respect to the EM1 measurement shall not exceed two parts per million. Crystals that fail to meet this requirement shall be removed from the lot.

10.3.3.2.4 Equivalent Resistance Change, EM2 and EM3 - The change in equivalent resistance, with respect to the EM1 measurement shall not exceed 25 percent. Crystals that fail to meet this requirement shall be removed from the lot.

10.3.3.2.5 Frequency Change EM3 - The change in frequency, with respect to the EM1 measurement, shall not exceed three parts per million. Crystals that fail to meet this requirement shall be removed from the lot.

10.3.4 Stability, Controlled Type Crystals

10.3.4.1 Test Method - Measurements of frequency and equivalent resistance of crystal units, designed for operation under controlled temperature conditions, shall be made at intervals no greater than 2.5°C over the operating temperature range as specified. The measurement temperatures shall include the reference temperature and the two extremes of the operating temperature range. The vibrator within the crystal unit shall reach thermal equilibrium at each measurement temperature before the measurement is made. These conditions specified in the paragraphs referenced in table II shall apply.

10.3.4.2 Accept-Reject Criteria - Crystals shall be removed from the lot if the frequency or equivalent resistance measured at any controlled temperature deviates by more than the specified value from the frequency or equivalent resistance measurement at the reference temperature.

10.3.5 Stability, Noncontrolled Type Crystals

10.3.5.1 Test Method - The temperature of the vibrator shall be varied over the operating range starting at or below the lower limit and at a rate no faster than 2.5°C per second, except that the range from -30°C and +20°C shall be transversed in less than one minute. During the interval of one minute or less when the temperature of the vibrator is between -30°C and +20°C, frequency and equivalent resistance shall be either continuously recorded, or recorded (by digital readout) at the intervals of no more than one second, to ascertain that tolerances for frequency and equivalent resistance are not exceeded at any instant. Test conditions specified in the paragraph referenced in table II shall apply.

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10.3.5.2 Accept-Reject Criteria - The frequency and equivalent resistance shall each be within the tolerances specified at all times during the test. Crystals that fail to meet these requirements shall be removed from the lot.

10.3.6 Capacitance, Shunt

10.3.6.1 Test Method - Crystal units shall be tested in accordance with Method 305 of Standard MIL-STD-202. The capacitance shall be measured from pin to pin, with the crystal holder ungrounded, at a frequency lower than the fundamental frequency of the unit, and at which the unit shows no indication to oscillate.

10.3.6.2 Accept-Reject Criteria

10.3.6.2.1 Shunt Capacitance, Actual - Crystals that fail to meet the shunt capacitance requirements specified shall be removed from the lot.

10.3.6.2.2 Shunt Capacitance, Change - The change in shunt capacitance, with respect to the EMI measurements, shall not exceed 5 percent. Crystals that fail to meet this requirements shall be removed from the lot.

10.3.7 Capacitance, Series

10.3.7.1 Test Method - Series capacitance shall be calculated using the following equation:

$$C \text{ (in farads)} = \frac{2 (C_0 + C_1) \Delta f}{f}$$

Where: Δf = The difference between the resonant frequency and the antiresonant frequency in Hz.

f = The specified nominal frequency of the crystal unit in Hz.

C_0 = The shunt capacitance (see 10.3.6.1) of the crystal in farads. If the shunt capacitance of the crystal has been measured more than once, the last measurements shall be used.

C_1 = The load capacitance

10.3.7.2 Accept-Reject Criteria

10.3.7.2.1 Series Capacitance, Actual - Crystals that fail to meet the series capacitance requirements specified shall be removed from the lot.

10.3.7.2.2 Series Capacitance, Change - The change in series capacitance, with respect to the EMI measurement, shall not exceed 5 percent. Crystals that fail to meet this requirement shall be removed from the lot.

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10.3.8 Unwanted Modes

10.3.8.1 Test Method - The test procedure shall be as follows:

- a. The test shall be performed in the test set specified in MIL-C-39020.
- b. A fixed resistor equal to the maximum equivalent resistance, as determined in 10.3.3, shall be inserted in the test set (if the equivalent resistance has been measured more than once, the last measurement shall be used). The output frequency of the test set shall be adjusted to a frequency 20 percent lower than the specified nominal frequency, and then to a frequency 20 percent higher than the specified nominal frequency. The adjacent band of the test set or another test set shall be used when necessary.
- c. The dial settings of the tuning control on the test set obtained in b shall be recorded.
- d. With the test set at the plus 20 percent frequency setting, replaced the fixed resistor with the crystal unit.
- e. The tuning control shall be varied, slowly, between the dial settings recorded in c., beginning with the setting 20 percent higher than the specified frequency, while monitoring the output signal.

Test conditions specified in the paragraphs referenced in Table II shall apply.

10.3.8.2 Accept-Reject Criteria - Crystals that fail to meet the requirements as follows shall be rejected from the lot.

- a. Unless otherwise specified, there shall be no unwanted modes of oscillation (resonant frequencies other than the desired specified operating frequency).
- b. There shall be no abrupt frequency shifts and no intermittent oscillations.

(Some crystal units may not start oscillating immediately at the plus 20 percent setting, or may cease oscillating during detuning. These conditions are permitted).

10.3.9 Reduced Drive Level

10.3.9.1 Test Method - Crystals shall be tested at 25 percent of the rated drive level as specified by the procuring activity.

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10.3.9.2 Accept-Reject Criteria - Crystals shall oscillate, but not necessarily at the specified frequency. Parts that fail to meet this requirement shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at room temperature ($25 \pm 3^{\circ}\text{C}$) and a relative humidity of less than 50 percent.

10.4.1 Thermal Shock - Crystals shall be tested as specified in Method 107 of Standard MIL-STD-202. The following details shall apply.

- a. Test temperature - Test condition B.
- b. Exposure time - The time required for frequency to stabilize plus one minute.
- c. Monitoring during cycling - Frequency

Crystals that show any evidence of physical damage or any discontinuities in the monitored characteristic shall be removed from the lot.

10.4.2 Shock - Crystals shall be tested in accordance with Method 202 of Standard MIL-STD-202. The following details shall apply:

- a. Mounting method - The crystal shall be successively mounted on each of its three principal axes, using a mounting method which rigidly supports the body of the part and assures that it is experiencing the specified shock level.
- b. Acceleration requirements - 100 g.
- c. Number of blows - One blow in each of the positive and negative directions of the three mutually perpendicular axes (total of six blows).
- d. Frequency shall be monitored during shock test.
- e. Crystals shall be removed from the lot for discontinuities observed during shock and evidence of physical damage such as cracks, bursting or bulging of parts.

10.4.3 Vibration - Crystals shall be subjected to the following vibration scan test, unless a higher level is specified by the procuring activity, then the higher levels shall be used.

- a. Preparation - Crystals shall be rigidly mounted with their normal mounting means, and shall be energized at rated frequency throughout the test. Accelerometers shall be mounted on top of the test fixture

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near the part support points to monitor vibration. Acceleration in either of the minor planes (crosstalk) shall not exceed 5g.

- b. Simple harmonic motion - Each crystal shall be subjected to simple harmonic motion at a double amplitude (total excursion) of 6.35 mm (0.250 inch) or 30g, whichever is less, over the frequency range of from 10 Hz to 3000 Hz and back to 10 Hz in a period of 10 minutes in each of the three mutually perpendicular planes. The rate of change of frequency shall be logarithmic.
- c. Random vibration - Each crystal shall be subjected to a random vibration acceleration spectral density of $0.6g^2$ per Hz with a flat frequency spectrum (no more than 3 db down) between 20 Hz and 2000 Hz. The duration of random vibration shall be 4 minutes in each of the three mutually perpendicular planes.
- d. Monitoring - Frequency shall be monitored during vibration with a device capable of detecting and indicating discontinuities greater than 10 microseconds in duration.
- e. Rejection - Parts shall be removed from the lot for the following reasons:
 1. Discontinuities observed during vibration.
 2. Fluctuations in frequency observed during vibration.
 3. Evidence of physical damage such as cracks, bursting or bulging of parts observed after vibration.

10.4.4 Burn-In - Crystals shall be subjected to burn-in conditions as follows:

- a. Temperature - $125 \pm 2^\circ\text{C}$
- b. Power - No power shall be applied
- c. Time - 500 ± 10 hours

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10.4.5 Seal Leak

10.4.5.1 Seal Leak, Fine - Crystals shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - C (except that the gross leak test shall be as specified in 10.4.5.2.1 or 10.4.5.2.2).
 - (1) Procedure Number - III
 - (2) Degree of leakage rate sensitivity - 10^{-8} atm cc/sec.

Crystals that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.5.2 Seal Leak, Gross

10.4.5.2.1 Water Bath Test, Hermetic Sealed Crystals - Crystals shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ} \pm 5^{\circ}\text{C}$. The temperature of the crystal shall not exceed 40°C at the time of immersion. During the time the crystal is in the water bath there shall be no continuous flow of air bubbles or leakage compound from the part body. Crystals that fail to meet the requirement shall be removed from the lot. After removal from the bath the crystal shall be dried for 2 hours at 25°C .

10.4.5.2.2 Dye Penetrant Method, Clear Glass Encased Crystals - Crystals shall be placed in a tank of fluorescent penetrant dye and subjected to a pressure of 414 N/cm^2 (600 psig) for a minimum period of 30 minutes. After rinsing and drying, the crystals shall be illuminated by ultraviolet light and examined under 20 power magnification. Crystals displaying traces of the characteristic fluorescent dye shall be removed from the lot.

10.4.6 Radiographic

10.4.6.1 Radiographic Procedure - Crystals shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355, to determine that internal construction is as specified.

10.4.6.2 Radiographic Analysis - Each radiograph will be analyzed in accordance with the following criteria. Parts exhibiting deviations from this criteria shall be removed from the lot.

- a. Crystals shall be of a homogeneous construction, and shall be as specified. Crystals bearing the same part number shall have the same internal construction.
- b. The radiographic examination shall include, but not be limited to inspection for foreign particles, solder splash, and loose or mis-aligned parts.

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- c. The tension on all wires shall be as specified. (There shall be no loops or excessive bends in the lead wire).
- d. There shall be no visible extraneous material (loose bonding material will be considered extraneous material).
- e. There shall be no wires present except those specified.
- f. There shall be no evidence of defects in any internal element in the part.
- g. Crystals shall be aligned and centered.
- h. Teflon shields shall be in place for all applicable crystals.

10.4.7 Particle Impact Noise Detection (PIND)

10.4.7.1 PIND Procedure and Acceptance Criteria - The inspection lot (or sublots) shall be submitted to 100 percent PIND testing a maximum of three runs in accordance with Method 217 of MIL-STD-202 (paragraph 3.3.3, testing sequence of Method 217 constitutes one test cycle or run). The lot may be accepted on any of the three runs if the percentage of the defective devices is less than 5 percent (or one device, whichever is greater). All defective devices shall be removed after each run. Lots which do not meet the 5 percent PDA on the third run, or exceed 25 percent defectives cumulative, shall be rejected and resubmission is not allowed.

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APPENDIX D

Minimum Screening Requirements for
Electromagnetic Parts (Transformers,
Inductors, Filters and Rotating Parts)

10. General Requirements - Non-custom electromagnetic parts shall meet all applicable requirements of this document. Custom electromagnetic parts shall meet all applicable requirements of MIL-STD-981.

10.1 Screening Requirements - Non-custom electromagnetic parts shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified," these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each non-custom electromagnetic part supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, when required, shall be performed immediately prior to sealing or potting, as applicable, regardless of how many times it has been performed prior to this time. All other examinations, tests and measurements shall be performed after all manufacturing processes have been performed. All electromagnetic parts that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examintions - Unless otherwise specified, all visual examinations shall be made at room temperature ($25 \pm 3^{\circ}\text{C}$) and at a relative humidity of less than 50 percent.

10.2.1 Visual Examination, Internal (Sealed and Potted Parts), External (Open Parts) - Electromagnetic parts that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Coils shall be uniformly wound with no misaligned, damaged, or broken parts (5 to 10 X).
- b. Soldering and welding shall be free of imperfections (5 to 10 X).
- c. Assembly of internal parts to cores, mounting brackets, and terminal boards shall indicate that proper manufacturing techniques have been used (1 X).
- d. There shall be no outs, breaks, or abrasions in the insulation (5 to 10 X).
- e. Lead wire shall be the correct length and shall contain no kinks (5 to 10 X).
- f. Wire insulation shall contain no cracks, breaks or outs (5 to 10 X).

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Table I. Screening Requirements

Examination or Test	Open Type	Hermetic	Potted
1. Visual Examination, Internal		10.2.1	10.2.1
2. Electrical Measurements, EM1	10.3	10.3	10.3
3. Thermal Shock	10.4.1	10.4.1	10.4.1
4. Burn-In	10.4.2.1 10.4.2.2	10.4.2.1	10.4.2.1
5. Vibration, Low Frequency (See Note 1)	10.4.3	10.4.3	10.4.3
6. Vibration, High Frequency (See Note 1)	10.4.4	10.4.4	10.4.4
7. Seal Leak, Fine		10.4.5.1	
8. Seal Leak, Gross (See Note 2)		10.4.5.2	10.4.5.2
9. Electrical Measurements, EM2	10.3	10.3	10.3
10. Radiographic	10.4.6	10.4.6	10.4.6
11. Visual Examination, External	10.2.1 10.2.3	10.2.2 10.2.3	10.2.2 10.2.3

- NOTES: 1. Vibration, Low Frequency, and Vibration, High Frequency, are applicable only when specified.
2. The first EM2 measurement shall be made within 4 hours of the completion of gross seal leak test.

10.2.1 (cont'd.)

- g. Parts shall contain no solder flux or other foreign material (5 to 10 X).
- h. There shall be no defects in workmanship, construction, design, materials and processes which could render the part unsuitable for its intended purpose (5 to 10 X).
- i. When impregnation is required, the impregnant shall be properly cured to the impregnant manufacturer's specifications.

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- j. When impregnation is not required, coil insulation shall overlap 50 percent, and shall contain no cuts or breaks (1 to 5 X).
- k. When lubrication is required, the quantity, quality and application shall be suitable for proper lubrication of the moving parts (5 to 10 X).

10.2.2 Visual Examination, External (Sealed Parts) - Electromagnetic parts that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfection affecting operating characteristics or form, fit, or function of the part (5 to 10 X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (5 to 10 X).
- c. Glass seals shall be free of cracks (5 to 10 X).

10.2.3 Visual Examination, External (All Parts) - Electromagnetic parts that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Insulated sleeves, if used, shall be free of nicks or gouges (5 to 10 X).
- b. Marking shall include but not be limited to:
 - 1. Part number (1X).
 - 2. Lot or date code (1X).
 - 3. Serial number (1X).
- c. The following characteristics shall be specified by the procuring activity:
 - 1. External design and construction (1X).
 - 2. Dimensions (1X).
 - 3. Weight (1X).

10.3 Electrical Measurements - The electrical measurements EM1 and EM2 shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurements Conditions - Unless otherwise specified, all measurements shall be performed at room temperature ($25 \pm 3^\circ\text{C}$) and at a relative humidity of less than 50 percent.

10.3.2 Dielectric Strength, Filters -

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM1</u>			
1. Dielectric Strength	Filters	10.3.2.1	10.3.2.2
2. Dielectric Strength	Other Parts	10.3.3.1	10.3.3.2
3. Corona	Filters (See Note 1)	10.3.4.1	10.3.4.2
4. Corona	Other Parts (See Note 1)	10.3.5.1	10.3.5.2
5. Induced Voltage	Pulse Parts	10.3.6.1	10.3.6.2
6. Insulation Resistance	Filters	10.3.7.1	10.3.7.2.1
7. Insulation Resistance	Other Parts	10.3.8.1	10.3.8.2.1
8. Electrical Characteristics	All	10.3.9.1	10.3.9.1
<u>EM2</u>			
9. Dielectric Strength	Filters	10.3.2.1	10.3.2.2
10. Dielectric Strength	Other Parts	10.3.3.1	10.3.3.2
11. Corona	Filters (See Note 1)	10.3.4.1	10.3.4.2
12. Corona	Other Parts (See Note 1)	10.3.5.1	10.3.5.2
13. Induced Voltage	Pulse Parts	10.3.6.1	10.3.6.2
14. Insulation Resistance	Filters	10.3.7.1	10.3.7.1
15. Insulation Resistance	Other Parts	10.3.8.1	10.3.8.2.1
16. Electrical Characteristics	All	10.3.9.1	10.3.9.2

NOTE: 1. The corona test applies only to electromagnetic parts having at least one winding with a working voltage rating in excess of 100 volts. (The working

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Note: (cont'd.)

voltage, which shall be as specified, is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered. This insulation may be between windings or between a winding and the case or core.)

10.3.2.1 Test Method - Filters shall be tested as specified in method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Mounting - The filter shall be placed on a metal plate (ground) or a V-block, as applicable.
- b. Test voltage - As specified in table III.
- c. Duration of applied voltage - $60 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and between all insulated points and ground.
- e. Surge Current Limit - Maximum rated current or 1 A, whichever is less.

10.3.2.2 Accept Reject Criteria - Filters that have leakage currents greater than the specified maximum limit, as specified by the procuring activity, indicated by the current measuring device or fault indicator, or that show any evidence of arcing, flash-over, breakdown of insulation, or other damage shall be removed from the lot.

10.3.3 Dielectric Strength, Electromagnetic Parts (Other than Filters) -

10.3.3.1 Test Method - Electromagnetic parts (other than filters) shall be tested as specified in Method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Mounting - The part shall be placed on a metal plate (ground) or a V-block, as applicable.
- b. Test voltage - As specified in table IV (unless a higher voltage is specified by the procuring activity).
- c. Duration of applied voltage - $60 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds.
- d. Points of application of test voltage - Between all mutually insulated points and these points to case or ground.
- e. Rate of application of test voltage - For test voltages greater than 1000 V, the rate of application shall not exceed 500 V per second.

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Table III. Test Requirements, Filters (See Note 1)

Rated Voltage (See Note 2)		Test Voltage		Minimum Insulation Resistance (megohms)
Greater Than	Up to and Including	Dielectric Strength	Insulation Resistance	
0 Vdc	50 Vdc	100 Vdc	100 Vdc	500
50 Vdc	100 Vdc	2 X rated voltage dc	100 Vdc	1000
100 Vdc	175 Vdc	2 X rated voltage dc	300 Vdc	7500
175 Vdc	—	2 X rated voltage dc	500 Vdc	7500
0 Vac rms	50 Vac rms	100 Vac rms	100 Vdc	500
50 Vac rms	100 Vac rms	300 Vac rms	100 Vdc	1000
100 Vac rms	175 Vac rms	500 Vac rms	300 Vdc	7500
175 Vac rms	700 Vac rms	2.8 X rated voltage rms	500 Vdc	7500
700 Vac rms	—	2.8 X rated voltage rms	1000 Vdc	10,000

Noted: 1. The requirements contained in this table are minimum requirements. If the procuring activity specifies a higher test voltage or higher insulation resistance, or both, then the higher requirement, or requirements, shall be used.

2. Rated voltage shall be as specified.

10.3.3.2 Accept-Reject Criteria - Electromagnetic parts (other than filters) that have leakage currents greater than the specified maximum limit as specified by the procuring activity, indicated by the current measuring device or fault indicator, or that show any evidence of arcing, flashover, breakdown of insulation, or other damage shall be removed from the lot.

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Table IV. Test Requirements

Working Voltage (See Note 1)		Test Voltage			Minimum Insulation Resistance (megohms)
Greater Than	Up to and Including	Dielectric Strength (voltage rms)	Corona (voltage rms)	Insulation Resistance (dc voltage)	
0 V	100 V	300	300	100	1000
100 V	175 V	500	300	300	7500
175 V	230 V	2.8 times working voltage	300	500	7500
230 V	700 V	2.8 times working voltage	1.3 times working voltage	500	7500
700 V	—	1.4 times working voltage plus 1000 V	1.3 times working voltage	1000	10,000

Notes: 1. The working voltage, which is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered, shall be as specified.

10.3.4 Corona, Filters

10.3.4.1 Test Method - Filters shall be tested as specified in Method 105 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - C
- b. Tests during reduced pressure - Dielectric strength, as specified in 10.3.2.1, except that test voltage shall be 1.25 X rated dc voltage.
- c. Monitoring during test - The level of corona shall be monitored with the test circuit shown in figure 1. The oscilloscope sensitivity shall be set at 0.05 V peak-to-peak per cm.

10.3.4.2 Accept-Reject Criteria - The level of corona shall not exceed 0.1 V peak-to-peak. Filters that fail to meet this requirement shall be removed from the lot.

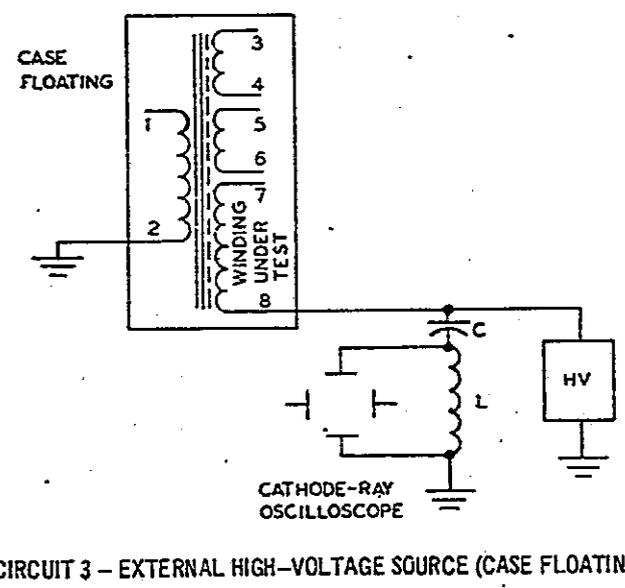
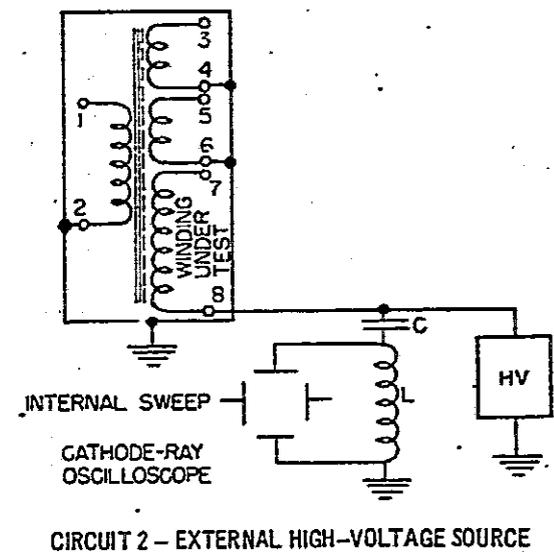
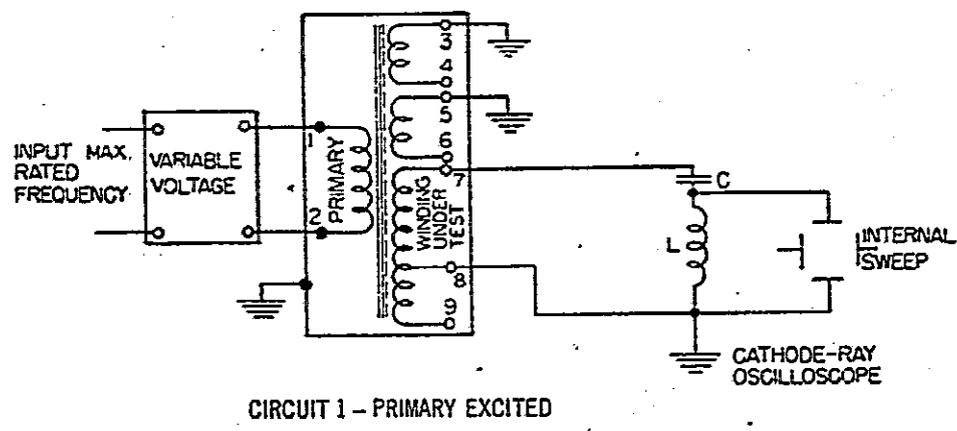
10.3.5 Corona, Other Electromagnetic Parts

10.3.5.1 Test Method - Electromagnetic parts shall be tested as specified in Method 105 of Standard MIL-STD-202. The following details shall apply:

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NOTES:

1. When using circuits 1 and 2, ground the case of the transformer or inductor, and all windings except that being tested.
2. Legend for test circuits: C = 200 picofarad mica capacitor, corona free; L = RF choke, 20 to 30 millihenries inclusive, with a minimum Q of 50 at 100 kilohertz; HV = high voltage source, corona free.
3. Corona will be evident as a superimposed high-frequency oscillation on the basic power wave.

Figure 1. Test Circuits, Corona

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- a. Test condition - C
- b. Tests during reduced pressure - Dielectric strength, as specified in 10.3.3.1, except that test voltage shall be as specified in table IV for corona.
- c. Monitoring during test - The level of corona shall be monitored with the test circuit shown in figure 1. The oscilloscope sensitivity shall be set at 0.05 V peak-to-peak per cm.

10.3.5.2 Accept-Reject Criteria - The level of corona shall not exceed 0.1 V peak-to-peak. Electromagnetic parts that fail to meet this requirement shall be removed from the lot.

10.3.6 Induced Voltage, Pulse Type Electromagnetic Parts

10.3.6.1 Test Method - The induced voltage test of pulse type electromagnetic parts shall be accomplished by applying to any winding the following pulse voltage:

- a. Amplitude - Two times rated voltage.
- b. Repetition rate - As specified for unit under test
- c. Pulse width - Sufficient to induce a voltage across any winding greater than 25 percent, but less than 50 percent, of the specified rated pulse width
- d. Duration of test voltage - $60 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds

10.3.6.2 Accept-Reject Criteria - During the time the test voltage is applied, there shall be no continuous arcing, breakdown of insulation, nor shall there be any random abrupt changes over 10 percent of steady state measured values of input current. Parts that fail to meet these requirements shall be removed from the lot.

10.3.7 Insulation Resistance, Filters

10.3.7.1 Test Method - Parts shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be as specified in table III.
- b. Special preparations - Parts shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- c. Points of measurement - The measurements shall be made between each insulated point and ground with all other insulated points connected to ground.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or $120 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds, whichever is greater.

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10.3.7.2 Accept-Reject Criteria

10.3.7.2.1 Accept-Reject Criteria, EMI - Parts that fail to meet the insulation resistance value specified in table III shall be removed from the lot.

10.3.7.2.2 Accept-Reject Criteria, EM2 - The minimum insulation resistance shall be 90 percent of the EMI value. Parts that fail to meet this insulation resistance value shall be removed from the lot.

10.3.8 Insulation Resistance, Other Electromagnetic Parts

10.3.8.1 Test Method - Electromagnetic parts shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be as specified in table IV.
- b. Special preparations - Electromagnetic parts shall be mounted or placed on a metal plate (ground) or "v" block, as applicable.
- c. Points of measurement - The measurements shall be made between each winding and ground with all other windings connected to ground.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or $60 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds, whichever is greater.

10.3.8.2 Accept-Reject Criteria

10.3.8.2.1 Accept-Reject Criteria, EMI - Electromagnetic parts that fail to meet the insulation resistance specified in table IV shall be removed from the lot.

10.3.9 Electrical Characteristics

10.3.9.1 Test Methods - Except that tests specified in tables I and II shall not be repeated, electromagnetic parts shall be subjected to all electric characteristic tests specified for acceptance testing in the applicable specification specified in table V. These tests shall be performed as specified in these specifications.

10.3.9.2 Accept-Reject Criteria

10.3.9.2.1 Accept-Reject Criteria EMI - Electromagnetic parts that fail to meet the requirements specified shall be removed from the lot.

10.3.9.2.2 Accept-Reject Criteria, EM2 - Electrical characteristic measurements shall not vary more than the following from the EMI measurements:

- a. DC resistance - 0.5 percent
- b. Inductance - 1.5 percent

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- c. Turns ratio - 0.5 percent
- d. All other measurements - 5 percent

Electromagnetic parts that fail to meet these requirements shall be removed from the lot.

Table V. Electrical Characteristics

Type Part	Test Specification
Transformers and inductors, audio power and high power pulse	MIL-T-27
Transformers, pulse, low power	MIL-T-21038
Transformers, R'F', Fixed and Variable	MIL-T-55631
Coils and transformers, intermediate and radio frequency	MIL-C-15305
Filters, radio interference	MIL-F-15733
Filters, high pass, low pass, band pass, band suppression and dual functioning	MIL-F-39025
Coils, tube deflection; and coils, tube focusing	MIL-C-18388
Rotating parts	Applicable military procurement document as specified by the procuring activity.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in MIL-STD-202.

10.4.1 Thermal Shock - Electromagnetic parts shall be tested as specified in Method 107 of MIL-STD-202. When this test is conducted, the time of exposure of electromagnetic parts to the temperature extremes (step 1 and step 3) shall be the time required for the dc resistance to stabilize plus one minute. The following details shall apply:

- a. Test condition letter
 - (1) For parts with a high temperature rating between 0° and 85°C - A

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| (2) | For parts with a high temperature rating between 125° and 180°C | - B, except that the high temperature shall be the part's temperature rating |
| (3) | For parts with a high temperature rating above 180°C | - C, except that the high temperature shall be the part's temperature rating |
| (4) | For parts with a low temperature rating between 0° and -65°C | - C, except that the high temperature shall be the part's temperature rating |

b. Monitoring during cycling

- (1) DC resistance
- (2) Discontinuities (greater than 30 microseconds)

Electromagnetic parts that show any evidence of the following shall be removed from the lot:

- a. Physical damage
- b. Radical changes in resistance
- c. Discontinuities greater than 30 microseconds

10.4.2 Burn-in

10.4.2.1 General Procedure - Burn-in shall consist of 24 hours during which time the part shall be operated at maximum operating temperature with loading equal to, but no greater than, 125 percent of the rated ac and dc voltages and currents and maximum rated pulse duration when applicable, followed by 28 hours with excitation at room ambient temperature for a total of 48 hours. Special switching transformers that require actual operational circuits to accomplish pulse duration and loading may be burned in at no voltage for 48 hours at the part's high temperature rating. This temperature shall not be less than 95°C. For transformers only, test may be performed with parts loaded back-to-back, provide the above mentioned loading requirements are met. For rotating devices which have a short life, the test may be performed with no voltage applied to the windings. Except for rotating devices tested with no voltage applied, this test may be performed at any ambient temperature and with any temperature rise, provided that the maximum operating temperature of the part is held within +10/-5°C and no drafts or varying air velocities are present. For rotating devices tested with no voltage applied, the oven temperature shall be equal to the maximum ambient temperature plus the temperature rise of the device in the expected environment.

10.4.2.2 Open Type Electromagnetic Parts Post Cycling Procedure - Upon completion of cycling, the parts shall be subjected to the following procedure:

1. Cool 12 hours in a vacuum

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2. Seal each part individually in a package provided with a desiccant.

Note: It is recommended that the part remain in this package, except for EM2 testing, until it is installed in the next higher assembly and that the next higher assembly be prebaked at 85°C for at least 4 hours prior to encapsulation, to insure that parts are free from moisture.

10.4.3 Vibration, Low Frequency - Electromagnetic parts shall be tested in accordance with Method 201 of MIL-STD-202. The following details and exceptions shall apply:

- a. Tests and measurements prior to vibration - Not applicable.
- b. Method of mounting - Transformers and inductors shall be rigidly mounted by their normal mounting means.
- c. Procedure - When specified, transformers and inductors shall be placed in a test chamber and preheated to the specified maximum ambient temperature for the class plus one-half the allowable temperature rise. Vibration in each plane shall begin 5 minutes after removal from the test chamber.
- d. Apparatus:
 1. For transformers and inductors weighing 10 pounds or less - May be tested on a horizontally, or vertically, vibrating machine. Units which are normally supported by their wire-lead terminals shall be mounted and soldered to rigidly supported terminals, so placed that length of each wire-lead terminal shall be approximately 5/8 inch.
 2. For transformers and inductors weighing more than 10 pounds - The sequence of vibration shall be as follows: First, vertically, and then horizontally in two mutually perpendicular directions. Two machines may be used (one vibrating horizontally and one vibrating vertically), or a single machine may be used which provides for both vertical and horizontal table motion, or a vertical vibrating machine, at the option of the supplier.
- e. Other requirements shall be as specified.
- f. Examinations after vibration - Transformers and inductors shall be examined for evidence of leakage and physical damage.

10.4.4 Vibration, High Frequency - Electromagnetic parts shall be tested in accordance with Method 204 of MIL-STD-202. The following details and exception shall apply:

- a. Mounting of specimens - As specified in 10.4.3,b

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- b. Test condition - D, unless otherwise specified.
- c. Other requirements - as specified
- d. Examinations after vibration - as specified in 10.4.3.f.

10.4.5 Seal Leak

10.4.5.1 Seal Leak, Fine - Electromagnetic parts shall be tested in accordance with Method 112 of MIL-STD-202. The following details shall apply:

- a. Test condition - C (except that the gross leak test shall be as specified in paragraph 10.4.5.2)
 - (1) Procedure - II
 - (2) Degree of leakage rate sensitivity - 10^{-8} atm cc/sec.

Parts that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.5.2 Seal Leak, Gross - Electromagnetic parts shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the part shall not exceed 40°C at the time of immersion. During the time the part is in the water bath, there shall be no continuous flow of air bubbles or leakage of compound from the part body. Parts that fail to meet this requirement shall be removed from the lot. After removal from the bath, the part shall be dried for 2 hours at 25°C .

10.4.6 Radiographic

10.4.6.1 Radiographic Procedure - Electromagnetic parts, except transformers, chokes and delay lines, shall be subjected to radiographic inspection as specified in MSFC-STD-355 to determine that internal construction is as specified.

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APPENDIX E

Minimum Screening Requirements for Fuses

10. General Requirements - Fuses shall meet all applicable requirements of this document.

10.1 Screening Requirements - Fuses shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified", these requirements shall be specified by the procuring activity in the ordering data.

10.1.2 Screening Inspection - Each fuse supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, tests and measurements shall be performed after all manufacturing processes have been performed. All fuses that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal - Fuses that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Soldering and welding shall be free of imperfections (10 X).
- b. Assembly of internal parts, including fuse link wire to end cap parts, shall indicate that proper manufacturing techniques have been used (10 X).
- c. Fuse link wire shall be the correct length and shall contain no kinks (10 X).
- d. Fuses shall contain no solder flux or other foreign matter (10 X).
- e. There shall be no defects in workmanship, construction, design, materials and processes which could render any fuse unsuitable for its intended use (10 X).
- f. Each end of the wire link shall be enclosed in solder (10 X).
- g. The following characteristics shall be as specified:
 1. Minimum clearance (10 X).
 2. Critical dimensions (10 X).
 3. Internal design and construction (1 X).

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Table I. Screening Requirements

Examination or Test	Hermetic	Clear Glass Encased	Ceramic or Fiber
1. Visual Examination, Internal	10.2.1	10.2.1	10.2.1
2. Electrical Measurements, EMI	10.3	10.3	10.3
3. Pull Test	10.4.1	10.4.1	10.4.1
4. Thermal Shock	10.4.2	10.4.2	10.4.2
5. Shock	10.4.3	10.4.3	10.4.3
6. Vibration	10.4.4	10.4.4	10.4.4
7. Seal Leak, Fine	10.4.5.1		
8. Seal Leak, Gross	10.4.5.2.1	10.4.5.2.2	10.4.5.2.1
9. Electrical Measurements, EM2	10.3	10.3	10.3
10. Radiographic	10.4.6		10.4.6
11. Visual Examination, External	10.2.2	10.2.2	10.2.2

10.2.2 Visual Examination, External - Fuses that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit or function of the fuse (7 X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7 X).
- c. Glass seals and encasements shall be free of cracks or chips (7 X).
- d. Insulated sleeves, if used, shall be free of nicks and gouges (7 X).

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- e. Plating on caps shall not be discolored or show evidence of peeling. Cadmium or zinc shall not be used for plating (7 X).
- f. Marking shall include but not be limited to:
 1. Part number (1 X)
 2. Lot or date code (1 X)
 3. Serial number (1 X).
- g. The following characteristics shall be as specified.
 1. External design and construction (1 X)
 2. Dimensions (1 X)
 3. Weight (1 X).

10.3 Electrical Measurements - The electrical measurements EM1 and EM2 shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Dielectric Strength

10.3.2.1 Test Method - Fuses shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Special preparations - Fuses shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- b. Test voltage - The test voltage shall be as specified in table III or as specified by the procuring activity, whichever is greater.
- c. Duration of test voltage - The test voltage shall be applied for 60^{+0}_{-10} seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground.
- e. Examination during test - Leakage current shall be monitored during test.
- f. Examination after test - Fuses shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

10.3.2.2 Accept-Reject Criteria - Fuses that have leakage current paths that exceed 100 microamperes, or show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM1</u>			
1. Dielectric Strength	A11	10.3.2.1	10.3.2.2
2. Insulation Resistance	A11	10.3.3.1	10.3.3.2.1
3. DC Resistance	A11	10.3.4.1	10.3.4.2.1
4. Voltage Drop	A11	10.3.5.1	10.3.5.2.1
<u>EM2</u>			
5. Dielectric Strength	A11	10.3.2.1	10.3.2.2
6. Insulation Resistance	A11	10.3.3.1	10.3.3.2.2
7. DC Resistance	A11	10.3.4.1	10.3.4.2.2
8. Voltage Drop	A11	10.3.5.1	10.3.5.2.2

10.3.3 Insulation Resistance

10.3.3.1 Test Method - Fuses shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be as specified in table III or as specified by the procuring activity whichever is greater.
- b. Special preparations - Parts shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- c. Points of measurement - The measurements shall be made first between all mutually insulated points, and then between each insulated point and ground.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or $120 \begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds, whichever is greater.

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Table III. Test Specifications

Working Voltage (See Note 1)		Dielectric Strength Test Voltage rms (See Note 1)	Insulation Resistance	
			Test Voltage (dc)	Minimum Insulation Resistance (Megohms)
Greater Than	Up to and Including			
0 V	100 V	300	100	1000
100 V	175 V	500	300	7500
175 V	700 V	2.8 X working voltage	500	7500
700 V	-	1.4 X working voltage plus 1000 V	1000	10,000

Notes: 1. The working voltage, which is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered, shall be as specified.

10.3.3.2 Accept-Reject Criteria.

10.3.3.2.1 Accept-Reject Criteria, EM1 - The minimum insulation resistance shall be the greater of:

- a. As specified in table III, or
- b. As specified by the procuring activity.

Fuses that fail to meet the insulation resistance value specified above shall be removed from the lot.

10.3.3.2.2 Accept-Reject Criteria, EM2 - The minimum insulation resistance shall be 90 percent of the EM1 value. Parts that fail to meet this insulation resistance value shall be removed from the lot.

10.3.4 DC Resistance (Hot)

10.3.4.1 Test Method - The dc resistance shall be measured as specified in Method 303 of Standard MIL-STD-202 at 100 percent of the rated fuse current.

10.3.4.2 Accept-Reject Criteria

10.3.4.2.1 Accept Reject Criteria, EM1 - Fuses that fail to meet the hot dc resistance requirements specified shall be removed from the lot.

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10.3.4.2.2 Accept-Reject Criteria, EM2 - The hot dc resistance shall meet the original requirements and shall not vary more than 5 percent from the EM1 value. Fuses that fail to meet this requirement shall be removed from the lot.

10.3.5 Voltage Drop

10.3.5.1 Test Method - Fuses shall be subjected to 75 percent of the rated current for five minutes. The voltage drop shall then be measured by the voltmeter-ammeter method at 75 percent of rated fuse current.

10.3.5.2 Accept-Reject Criteria, EM1

10.3.5.2.1 Accept-Reject Criteria, EM1 - Fuses that fail to meet the voltage drop requirements specified shall be removed from the lot.

10.3.5.2.2 Accept-Reject Criteria, EM2 - The voltage drop of each fuse shall meet the original requirement and shall not vary more than 5 percent from the EM1 value. Fuses that fail to meet this requirement shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.4.1 Pull Test - Each fuse shall be subjected to an axial pull test. The force applied shall be the larger of:

- a. 22.24 Newtons (5 pounds)
- b. The force specified.

Fuses that fail to meet the above requirements, or that show evidence of damage, shall be removed from the lot.

10.4.2 Thermal Shock - Fuses shall be tested as specified in Method 107 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - B
- b. Exposure time - The time required for dc resistance to stabilize plus one minute
- c. Monitoring during cycling - DC resistance.

Fuses that show evidence of physical damage or discontinuities greater than 10 microseconds in duration shall be removed from the lot.

10.4.3 Shock - Fuses shall be tested in accordance with Method 202 of Standard MIL-STD-202. The following details shall apply:

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- a. Mounting method - The unit shall be successively mounted on each of its three principal axes, using a mounting method which rigidly supports the body of the fuse and assures that the fuse is experiencing the specified shock level.
- b. Acceleration requirements - 100 g.
- c. Number of blows - One blow in each of the three mutually perpendicular planes (total of three blows).
- d. Continuity shall be monitored during shock test.

Fuses shall be removed from the lot for discontinuities greater than 10 microseconds in duration observed during shock and for evidence of physical damage such as cracks, bursting, or bulging of parts.

10.4.4 Vibration - Fuses shall be subjected to the following vibration scan test.

10.4.4.1 Preparation - Fuses shall be rigidly mounted by their normal mounting means, and shall be energized throughout the test at 3/4 rated current. Accelerometers shall be mounted on top of the test fixture near the part support points to monitor vibration. Acceleration in either of the minor planes (crosstalk) shall not exceed 5g.

10.4.4.2 Simple Harmonic Motion - Each fuse shall be subjected to simple harmonic motion at a double amplitude (total excursion) of 6.35 mm (0.250 inch) or 30g, whichever is less, over the frequency range of from 10 Hz to 3000 Hz and back to 10 Hz in a period of 10 minutes in each of the three mutually perpendicular planes. The rate of change of frequency shall be logarithmic.

10.4.4.3 Random Vibration - Each fuse shall be subjected to a Random Vibration acceleration spectral density of $0.6g^2$ per Hz with a flat frequency spectrum (no more than 3 db down) between 20 Hz and 2000 Hz. The duration of random vibration shall be 4 minutes in each of the three mutually perpendicular planes.

10.4.4.4 Monitoring - Current shall be monitored during vibration with a device capable of detecting and indicating discontinuities greater than 10 microseconds in duration.

10.4.4.5 Rejection - Fuse shall be removed from the lot for the following reasons:

- a. Discontinuities greater than 10 microseconds observed during vibration.
- b. Evidence of physical damage such as cracks, bursting or bulging of parts observed after vibration.

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10.4.5 Seal Leak

10.4.5.1 Seal Leak, Fine - Parts shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - G (except that the gross leak test shall be as specified in 10.4.6.2.1 or 10.4.6.2.2)
 1. Procedure number - III
 2. Degree of leakage rate sensitivity - 10^{-8} atm cc/sec.

Parts that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.5.2 Seal Leak, Gross

10.4.5.2.1 Water Bath Test, Hermetic and Ceramic or Fiber - Fuses shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the fuse shall not exceed 40°C at the time of immersion. During the time the fuse is in the water bath, there shall be no continuous flow of air bubbles or leakage of compound from the fuse body. Fuses that fail to meet this requirement shall be removed from the lot. After removal from the bath, the fuse shall be dried for 2 hours at 25° .

10.4.5.2.2 Dye Penetrant Method, Clear Glass Fuses - Clear glass encased fuses shall be placed in a tank of fluorescent penetrant dye and subjected to a pressure of 4173 N/cm^2 (600 psig) for a minimum period of 30 minutes. After rinsing and drying, the devices shall be illuminated by ultraviolet light and examined under 20 power magnification. Devices displaying traces of the characteristic fluorescent dye shall be removed from the lot.

10.4.6 Radiographic

10.4.6.1 Radiographic Procedure - Fuses shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355, to determine that internal construction is as specified by the procuring activity.

10.4.6.2 Radiograph Analysis - Each radiograph will be analyzed in accordance with the following criteria. Fuses exhibiting deviations from this criteria shall be removed from the lot.

- a. Fuses shall be of a homogeneous construction, and shall be as specified. Fuses bearing the same part number shall have the same internal construction.
- b. The radiographic examination shall include, but not be limited to inspection for foreign particles, solder splash, loose or misaligned parts.
- c. There shall be no excessive bend in the fuse link wire.
- d. There shall be no visible extraneous material (loose bonding material will be considered extraneous material).
- e. There shall be no evidence of defects in any internal element in the fuse.

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APPENDIX F

Minimum Screening Requirements for Meters

10. General Requirements- Meters shall meet all applicable requirements of this document.

10.1 Screening Requirements- Meters shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified" these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection- Each meter supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, test and measurements shall be performed after all manufacturing processes have been performed. All meters that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations- Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal- Meters that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Soldering and welding shall be free of imperfections (7X).
- b. Assembly of internal parts to laminations, mounting brackets and terminal boards shall indicate that proper manufacturing techniques have been used (7X).
- c. There shall be no cuts, breaks or abrasions in insulation (7 X).
- d. Wire shall be the correct length and shall contain no kinks (1X to 7X)
- e. Wire insulation shall contain no cracks, breaks or cuts (1X to 7X).
- f. Meters shall contain no solder flux or other foreign matter (7 X).
- g. Glass windows shall be protected by a shatter resistant film on each front and rear surface of glass (1X to 10X).
- h. There shall be no defects in workmanship, construction, design, materials and processes which could render any meter unsuitable for its intended use (7 X).

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Table I. Screening Requirements

Examination	Hermetic		Non-Hermetic	
	Electrical Indicating	Time Totalizing	Electrical Indicating	Time Totalizing
1. Visual Examination, Internal	10.2.1	10.2.1	10.2.1	10.2.1
2. Electrical Measurements, EM1	10.3	10.3	10.3	10.3
3. Vibration	10.4.1	10.4.1	10.4.1	10.4.1
4. Electrical Measurements, EM2	10.3		10.3	
5. Thermal Shock	10.4.2	10.4.2	10.4.2	10.4.2
6. Burn-In	10.4.3.1	10.4.3.2	10.4.3.1	10.4.3.2
7. Seal Leak, Fine	10.4.4.1	10.4.4.1		
8. Seal Leak, Gross	10.4.4.2	10.4.4.2		
9. Electrical Measurements, EM2		10.3		10.3
10. Electrical Measurements, EM3	10.3		10.3	
11. Radiographic	10.4.5	10.4.5	10.4.5	10.4.5
12. Visual Examinations, External	10.2.2	10.2.2	10.2.2	10.2.2

- i. When lubrication is required the quantity, quality and application shall be suitable for proper lubrication of the moving parts (7 X).
- j. When impregnation is required there shall be no air bubbles, improper curing, voids or lack of impregnation (7 X).
- k. The following characteristics shall be as specified:
1. Minimum clearances (10 X).

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2. Critical dimensions (10 X).

3. Internal design and construction (1 X).

10.2.2 Visual Examination, External- Meters that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operation characteristics, or form, fit or function of the meter (7 X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7 X).
- c. Glass face plates and pin or terminal seals shall be free of cracks (1X to 7X)
- d. Insulated sleeves (if used) shall be free of nicks or gouges (7 X).
- e. Marking shall include, but not be limited to:
 1. Part number (1 X).
 2. Lot or date code (1 X).
 3. Serial number (1 X).
- f. The following characteristics shall be as specified:
 1. External design and construction (1 X).
 2. Dimensions (1 X).
 3. Weight (1 X).

10.3 Electrical Measurements - The electrical measurements EM1, EM2, and EM3 shall consist of the measurements made in the order shown below:

- a. Electrical indicating meters - Table II
- b. Time totalizing meters - Table III

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Table II. Electrical Measurements, Electrical Indicating Meters

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Insulation Resistance	All	10.3.3.1	10.3.3.2.1
3. Position Influence	All	10.3.4.1	10.3.4.2
4. Sticking Below Zero	With external zero adjuster	10.3.5.1	10.3.5.2
5. Sticking Below Zero	Without external zero adjuster	10.3.6.1	10.3.6.2
6. Calibration	All	10.3.7.1	10.3.7.2.1
7. Damping Factor	All	10.3.8.1	10.3.8.2.1
8. Response Time	All	10.3.9.1	10.3.9.2.1
9. Power Consumption	All	10.3.10.1	10.3.10.2.1
<u>EM2</u>			
10. Calibration	All	10.3.7.1	10.3.7.2.2
<u>EM3</u>			
11. Dielectric Strength	All	10.3.2.1	10.3.2.2.
12. Insulation Resistance	All	10.3.3.1	10.3.3.2.2
13. Sticking Below Zero	With external zero adjuster	10.3.5.1	10.3.5.2
14. Sticking Below Zero	Without external zero adjuster	10.3.6.1	10.3.6.2
15. Calibration	All	10.3.7.1	10.3.7.2.2
16. Damping Factor	All	10.3.8.1	10.3.8.2.2
17. Response Time	All	10.3.9.1	10.3.9.2.2

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Table II. Electrical Measurements, Electrical Indicating Meters (Continued)

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
18. Power Consumption	All	10.3.10.1	10.3.10.2.2

Table III. Electrical Measurements, Time Totalizing Meters

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EML</u>			
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Insulation Resistance	All	10.3.3.1	10.3.3.2.1
3. Time to Come to Synchronism	All	10.3.11.1	10.3.11.2.1
4. Operational Check	115 V 400 Hz	10.3.12.1	10.3.12.2
5. Operational Check	115 V 60 Hz	10.3.13.1	10.3.13.2
6. Operational Check	28 Vdc	10.3.14.1	10.3.14.2
7. Power Supply Tolerance	115 V 400 Hz	10.3.15.1	10.3.15.2
8. Power Supply Tolerance	115 V 60 Hz	10.3.16.1	10.3.16.2
9. Power Supply Tolerance	28 Vdc	10.3.17.1	10.3.17.2
10. DC Resistance	All	10.3.18.1	10.3.18.2

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Table III. Electrical Measurements, Time Totalizing Meters (Continued)

Measurements	Types	Test Method Paragraph	Accept- Reject Criteria Paragraph
11. Exciting Current	A11	10.3.19.1	10.3.10.2.1
12. Input Impedance	A11	10.3.20.1	10.3.20.2
<u>EM2</u>			
13. Dielectric Strength	A11	10.3.2.1	10.3.2.2
14. Insulation Resistance	A11	10.3.3.1	10.3.3.2.2
15. Time to come to Synchronism	A11	10.3.11.1	10.3.11.2.2
16. Operational Check	115 V 400 Hz	10.3.12.1	10.3.12.2
17. Operational Check	115 V 60 Hz	10.3.13.1	10.3.13.2
18. Operational Check	28 Vdc	10.3.14.1	10.3.14.2
19. Power Supply Tolerance	115 V 400 Hz	10.3.15.1	10.3.15.2
20. Power Supply Tolerance	115 V 60 Hz	10.3.16.1	10.3.16.2
21. Power Supply Tolerance	28 Vdc	10.3.17.1	10.3.17.2
22. Exciting Current	A11	10.3.19.1	10.3.19.2.2

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The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Dielectric Strength

10.3.2.1 Test Methods- Meters shall be tested in accordance with method 301 of Standard MIL-STD-202. The following shall apply:

- a. Special preparations - Parts shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- b. Test voltage - The minimum test voltage shall be as specified in table IV.
- c. Duration of test voltage - The test voltage shall be applied for 60 ⁺⁰ ₋₁₀ seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground.
- e. Methods of applying test voltage - Voltage shall be applied to non-metallic zero-adjusters with a high-potential test electrode of suitable size and shape to provide a normal fit when inserted into the slot of the zero adjusters. Voltage shall be applied to the face of the meter with a 6.35 mm (1/4 inch) diameter test probe having a 3.18mm (1/8 inch) radius tip.
- f. Examination during test - Leakage current shall be monitored during test.
- g. Examination after test - Meters shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

10.3.2.2 Accept-Reject Criteria - Meters that have leakage current paths that exceed 20 microamperes or show evidence of arcing, flashover, breakdown of insulation, or other damage shall be removed from the lot.

10.3.3 Insulation Resistance

10.3.3.1 Test Method- Meters shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details shall apply:

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Table IV. Test Specifications

Working Voltage (See Note 1)		Test Voltage Dielectric Strength (RMS voltage)	Insulation Resistance	
Greater Than	Up to and Including		Test Voltage (dc)	Minimum Insulation Resistance Megohms
0 V	100 V	300	100	1000
100 V	175 V	500	300	7500
175 V	700 V	2.8 X Working Voltage (See note 1)	500	7500
700 V		1.4 X Working voltage plus 1000 V (See note 1)	1000	10,000

Notes:

1. The working voltage which is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered, shall be as specified.
 - a. Test voltage- The minimum test voltage shall be as specified in table IV, unless a higher voltage is specified by the procuring activity.
 - b. Special preparations - Parts shall be mounted or placed on a metal plate (ground) of V-block, as applicable.
 - c. Points of Measurement - The measurements shall be made first between all mutually insulated points, and then between each insulated point and ground.
 - d. Electrification time- The electrification time shall be the time required for the resistance reading to stabilize, or 120^{+0}_{-10} seconds whichever is greater.

10.3.3.2 Accept-Reject Criteria

10.3.3.2.1 Accept-Reject Criteria, EMI - The minimum insulation resistance shall be as specified in table IV. Meters that fail to meet this insulation resistance requirement shall be removed from the lot.

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10.3.3.2.2 Accept-Reject Criteria, EM2 and EM3 - The minimum insulation resistance shall be 90 percent of the EM1 value. Meters that fail to meet these insulation resistance requirements shall be removed from the lot.

10.3.4 Position Influence

10.3.4.1 Test Method - The meter shall be mounted in the normal vertical position and the position of the pointer noted. On meters provided with an external zero-adjuster, the pointer shall be set at the center of the zero mark. The meter shall then be rotated 60° from this normal vertical position in both clockwise and counter-clockwise directions.

10.3.4.2 Accept-Reject Criteria - Unless otherwise specified, the maximum deviation of the pointer, expressed as a percentage of the full scale length, shall not be greater than 2 percent. Meters that fail to meet this requirement shall be removed from the lot.

10.3.5 Sticking Below Zero, Meters with External Zero-Adjuster-

10.3.5.1 Test Method - The external zero-adjuster shall be turned until the pointer touches the stop below the zero mark, then turned in the opposite direction until the pointer leaves the stop. The position at which the pointer comes to rest shall be noted.

10.3.5.2 Accept-Reject Criteria - Meters that show any evidence of sticking below zero shall be removed from the lot.

10.3.6 Sticking Below Zero, Meters Without External Zero Adjuster

10.3.6.1 Test Method - Meters shall be energized to approximately one-third full-scale deflection, then suddenly de-energized.

10.3.6.2 Accept-Reject Criteria - Meters that show any evidence of sticking below zero shall be removed from the lot.

10.3.7 Calibration

10.3.7.1 Test Method - Meters shall be mounted on a nonmagnetic panel 2.29mm (0.09 inches) thick and checked for accuracy at a temperature of 25± 2°C. The meter shall be connected to a transfer standard capable of measuring 0 to 5 volts ac or dc, as applicable, to accuracies of 0.2 percent. Voltage shall be applied to the terminals to deflect the pointers to the center of each index mark. At least nine uptapped readings or one reading for each scale increment, shall be taken while increasing and decreasing through the scale range. The difference between ascending or descending readings, as measured by the standard, and the nominal input signal is the error. The nominal input voltage shall be the percent of total deflection times the full scale value.

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10.3.7.2 Accept-Reject Criteria

10.3.7.2.1 Accept-Reject Criteria, EM1 - Unless otherwise specified, the maximum error for each meter shall be 2 percent of full scale. Meters that fail to meet this calibration requirement shall be removed from the lot.

10.3.7.2.2 Accept-Reject Criteria, EM2 and EM3 - The calibration shall not vary more than 10 percent from the EM1 value. Meters that fail to meet this requirement shall be removed from the lot.

10.3.8 Damping Factor

10.3.8.1 Test Method - Electric power sufficient to produce momentary end-scale deflection shall be applied to the meter. (Decibel meters shall be deflected to the 0 db scale position.) The maximum momentary deflection (dm) shall be observed and recorded. When making this test on meters in which the damping factor (Df) can be significantly changed by the shunting effect of the power circuit, the circuit resistance shall be not less than 100,000 ohms and such that no additional damping is added to the system. The damping factor shall be as follows:

$$DF = \frac{ds}{dm - ds}$$

Where:

Df = Damping factor

ds = Steady deflection in degrees

dm = Maximum momentary deflection in degrees

10.3.8.2 Accept-Reject Criteria

10.3.9.2.1 Accept-Reject Criteria, EM1 - Meters that fail to meet the damping factor requirements specified shall be removed from the lot.

10.3.8.2.2 Accept-Reject Criteria, EM3 - The damping factor shall not vary more than 10 percent from the EM1 value. Meters that fail to meet this requirement shall be removed from the lot.

10.3.9 Response Time

10.3.9.1 Test Method - Steady electric power sufficient to produce momentary end-scale deflection shall be applied to the meter. (Decibel meters shall be deflected to 0 db scale position.) The length of time, in seconds, required for the pointer to come to apparent rest shall be recorded. The pointer shall be considered as having come to apparent rest when it has attained the actual point of rest within 1 percent of the full-scale value. The test shall be repeated five times, and the average

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length of time recorded for all measurements shall be considered as the response time of the meter. When making this test on meters in which the response time can be significantly changed by the shunting effect of the power circuit, the circuit resistance shall be not less than 100,000 ohms and such that no additional damping is added to the system.

10.3.9.2 Accept-Reject Criteria

10.3.9.2.1 Accept-Reject Criteria, EM1 - Unless otherwise specified the response time for each meter shall not exceed 1.5 seconds. Meters that fail to meet this requirement shall be removed from the lot.

10.3.9.2.2 Accept-Reject Criteria, EM3 - Response time shall not vary more than $+0$ second from the EM1 value. Meters that fail to meet this requirement shall be -10 removed from the lot.

10.3.10 Power Consumption (loss)

10.3.10.1 Test Method - The power consumption (loss) shall be measured at end-scale deflection of the meter and recorded in terms of current, voltage, volt-amperes, or ohms, as applicable.

10.3.10.2 Accept-Reject Criteria

10.3.10.2.1 Accept-Reject Criteria, EM1 - Meters that fail to meet the power consumption (loss) requirements specified by the procuring activity shall be removed from the lot.

10.3.10.2.2 Accept-Reject Criteria, EM3 - Power consumption shall not vary more than 5 percent from the EM1 value. Meters that fail to meet this requirement shall be removed from the lot.

10.3.11 Time to come to Synchronism

10.3.11.1 Test Method - The meter shall be stabilized at a temperature of -65°C , then operated, and the time recorded for it to reach synchronism. This shall be repeated at 25°C and 125°C .

10.3.11.2 Accept-Reject Criteria

10.3.11.2.1 Accept-Reject Criteria - Unless otherwise specified the maximum time for the meter to start and come to synchronism shall be as follows:

At -65°C -30 seconds

At 25°C -5 seconds

At 125°C - 5 seconds

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Meters that fail to meet these requirements shall be removed from the lot.

10.3.11.2.2 Accept-Reject Criteria, EM2 - Time to come to synchronism shall not vary more than 10 percent from the EM1 value. Meters that fail to meet this requirement shall be removed from the lot.

10.3.12 Operational Check, 400 Hz, 115 Volt Meters

10.3.12.1 Test Method - Meters shall be connected to each of the following voltage-frequency combinations and checked for instant starting and synchronous operation:

380 Hz, 102 volts

420 Hz, 102 volts

400 Hz, 115 volts

380 Hz, 128 volts

420 Hz, 128 volts

10.3.12.2 Accept-Reject Criteria - Meters shall start and run synchronously at all applied voltage-frequency combinations and shall register the correct elapsed time at 400 Hz, 115 volts. Meters that fail to meet these requirements shall be removed from the lot.

10.3.13 Operational Check 60 Hz, 115 Volt Meters

10.3.13.1 Test Method - Meters shall be connected to each of the following voltage-frequency combinations and checked for instant starting and synchronous operation:

55 Hz, 102 volts

65 Hz, 102 volts

60 Hz, 115 volts

55 Hz, 128 volts

65 Hz, 128 volts

10.3.13.2. Accept-Reject Criteria - Meters shall start and run synchronously at all applied voltage-frequency combinations and shall register the correct time at 60 Hz, 115 volts. Meters that fail to meet these requirements shall be removed from the lot.

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10.3.14 Operational Check, 28 Volt dc Meters

10.3.14.1 Test Method - Meters shall be connected to dc voltages of 23 volts and 29 volts and checked for instant starting. Meters shall then be connected to a dc voltage of 28 volts and the accuracy of the recorded time shall be checked over the temperature range of -65°C to 125°C.

10.3.14.2. Accept-Reject Criteria- At 28 volts, over the temperature range of -65° to 125°C, meters shall register correct time within \pm 5 percent, unless otherwise specified. Meters that fail to meet this requirement shall be removed from the lot.

10.3.15 Power Supply tolerance, 400 Hz 115 Volt Meters

10.3.15.1 Test Method - Meters shall be operated for 30 minutes at 115 volts, 300 Hz and then checked for normal operation at 115 volts, 400 Hz. Meters shall then be operated for 30 minutes at 128 volts, 500 Hz and checked for normal operation at 115 volts, 400 Hz.

10.3.15.2 Accept-Reject Criteria - Meters that show any evidence of damage, or fail to operate normally when returned to the nominal power supply voltage, shall be removed from the lot.

10.3.16 Power Supply Tolerance, 60 Hz 115 Volt Meters

10.3.16.1 Test Method - Meters shall be operated for 30 minutes at 115 volts, 50 Hz and then checked for normal operation at 115 volts, 60 Hz. Meters shall then be operated for 30 minutes at 128 volts, 70 Hz and checked for normal operation at 115 volts, 60 Hz.

10.3.16.2 Accept-Reject Criteria - Meters that show any evidence of damage, or fail to operate normally when returned to the nominal power supply voltage, shall be removed from the lot.

10.3.17 Power Supply Tolerance, 28 Volt DC Meters

10.3.17.1 Test Method - Meters shall be operated for 30 minutes at 23 volts dc and then checked for normal operation at 28 volts dc.

10.3.17.2 Accept-Reject Criteria - Meters that show evidence of damage, or fail to operate normally when returned to the nominal power supply voltage, shall be removed from the lot.

10.3.18 DC Resistance

10.3.18.1 Test Method - The dc resistance of meters shall be measured as specified in Method 303 of Standard MIL-STD-202.

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10.3.18.2 Accept-Reject Criteria - Meters that fail to meet the dc resistance requirements specified shall be removed from the lot.

10.3.19 Exciting Current

10.3.19.1 Test Method - The exciting current of each meter shall be measured by applying the nominal input voltage, as specified while the meter is at 25°C, and measuring the input current.

10.3.19.2 Accept-Reject Criteria

10.3.19.2.1 Accept-Reject Criteria, EM1 - Meters that fail to meet the exciting current requirements specified shall be removed from the lot.

10.3.19.2.2 Accept-Reject Criteria, EM2 - Exciting current shall not vary more than 5 percent from the EM1 value. Meters that fail to meet this requirement shall be removed from the lot.

10.3.20 Input Impedance

10.3.20.1 Test Method - The input impedance shall be measured by any suitable ac voltmeter-ammeter method.

10.3.20.2 Accept-Reject Criteria - Meters that fail to meet the input impedance requirements specified shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, tests shall be performed at the general test conditions specified in Standard MIL-STD-202, except that the relative humidity shall be less than 50 percent.

10.4.1 Vibration - Apply a half-scale signal to each meter during vibration. Each meter shall be subjected to random vibration along three mutually perpendicular axes according to the following spectrum:

20 to 80 Hz + 3 db/octave to 0.068 g²/Hz

80 to 350 Hz @ 0.068 g²/Hz

350 to 430 Hz -6 db/octave to 0.045 g²/Hz

430 to 1100 Hz @ 0.045 g²/Hz

1100 to 2000 Hz -6 db/octave

Overall RMS acceleration 8.8 g

Duration 60 seconds per axis

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Causes for rejection of the meter during or after testing shall be:

- (1) Indication of loose electrical connections detected by current monitoring.
- (2) Visual or aural evidence of loosened or broken parts.

10.4.2 Thermal Shock - Meters shall be tested as specified in method 107 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition-B
- b. Exposure time- The time required for resistance or current to stabilize plus one minute.
- c. Monitoring during cycling- Resistance or current meters that show evidence of physical damage or discontinuities in the resistance, or current greater than 10 microseconds in duration, shall be removed from the lot.

10.4.3 Burn-In

10.4.3.1 Burn-In, Electrical Indicating Meters - Electrical indicating meters shall be subjected to burn-in under the following conditions:

Temperature - Maximum temperature specified for the part

Power applied - To cause 3/4 scale defection

Time - 168 \pm 4 hours

10.4.3.2 Burn-In, Time Totalizing Meters - Time totalizing meters shall be subjected to burn-in under the following conditions:

Temperature - Maximum temperature specified for each meter

Power Applied - Rated power

Time - 72 \pm 4 hours

10.4.4 Seal Leak

10.4.4.1 Seal Leak, Fine - Meters shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

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- a. Test condition-C (except that the gross leak test shall be as specified in paragraph 10.4.4.2)

(1) Procedure Number -III

(2) Degree of leakage rate sensitivity -10^{-8} atm cc/sec

Meters that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.4.2 Seal Leak, Gross - Meters shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the meter shall not exceed 40°C at the time of immersion. During the time the meter is in the water bath, there shall be no continuous flow of air bubbles or leakage of compound from the part body. Meters that fail to meet this requirement shall be removed from the lot. After removal from the bath, the meter shall be dried for 2 hours at 25° .

10.4.5 Radiographic

10.4.5.1 Radiographic Procedure - Meters shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355, to determine that internal construction is as specified.

10.4.5.2 Radiograph Analysis - Each radiograph will be analyzed in accordance with the following criteria. Meters exhibiting deviations from this criteria shall be removed from the lot.

- a. Meters shall be of a homogeneous construction, and shall be as specified. Meters bearing the same part number shall have the same internal construction.
- b. The radiographic examination shall include, but not be limited to, inspection for foreign particles, solder splash, loose or misaligned parts.
- c. The tension on all wires shall be as specified. (There shall be no loops or excessive bends in the lead wire).
- d. There shall be no visible extraneous material (loose bonding material will be considered extraneous material).
- e. There shall be no wires present except those specified.
- f. There shall be no evidence of defects in any internal element in the meter.

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APPENDIX G

Minimum Screening Requirements for Microcircuits

10. General Requirements - Microcircuits shall meet all applicable requirements of this document. In addition, custom hybrid and custom multichip microcircuit designs shall comply with MIL-M-38510, Appendix G, requirements and as specified herein.

10.1 Screening - The screening requirements for nonstandard microcircuits for use in Grade 1 and Grade 2 applications shall be in accordance with the applicable requirements of MIL-STD-883, Methods 5004 and 5008, and Appendix X, herein.

10.1.1 Monolithic Microcircuits for Grade 1 Applications - Each nonstandard microcircuit used in Grade 1 applications shall, as a minimum, have successfully completed the following requirements:

a. Class S requirements of Method 5004, MIL-STD-883, with the addition of dynamic and functional final electrical tests at minimum and maximum rated operating temperature.

b. Destructive Physical Analysis (DPA) in accordance with Method 5009 of MIL-STD-883.

10.1.2 Monolithic Microcircuits for Grade 2 Applications - Each nonstandard microcircuit used in Grade 2 applications shall, as a minimum, have successfully completed the following requirements:

a. Class B requirements of Method 5004, MIL-STD-883.

b. Destructive Physical Analysis (DPA) in accordance with Method 5009 of MIL-STD-883.

c. Particle Impact Noise Detection (PIND) test in accordance with Method 2020 (Condition B) of MIL-STD-883, and lot acceptance/rejection criteria per MIL-M-38510.

d. Radiographic Examination in accordance with Method 2012 (two views) of MIL-STD-883.

10.1.3 Hybrid and Multichip Microcircuits for Grade 1 Applications - Each nonstandard hybrid or multichip microcircuit used in Grade 1 applications shall, as a minimum, have successfully completed the following requirements:

a. Class S requirements of Method 5008, MIL-STD-883, with the addition of dynamic and functional final electrical tests at minimum and maximum rated operating temperature.

b. Destructive Physical Analysis (DPA) in accordance with Method 5009 of MIL-STD-883.

10.1.4 Hybrid and Multichip Microcircuits for Grade 2 Applications - Each nonstandard hybrid or multichip microcircuit used in Grade 2 applications shall, as a minimum, have successfully completed the following requirements:

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APPENDIX H

Minimum Screening Requirements for Relays

1.0 General Requirements - Relays shall meet all applicable requirements of this document.

10.1 Screening Requirements - Relays shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified", these requirements shall be specified by the procuring activity in the ordering data

10.1.1 Screening Inspection - Each relay supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, test and measurements shall be performed after all manufacturing processes have been performed. All relays that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

Table I. Screening Requirements

Examination of Test	Dry Circuit Relays	Other Relays
1. Visual Examination, Internal	10.2.1	10.2.1
2. Moisture Detection	10.4.1	10.4.1
3. Electrical Measurements ,EM1	10.3	10.3
4. Vibration	10.4.2	10.4.2
5. Burn-In	10.4.3	10.4.4
6. Seal Leak, Fine	10.4.5.1	10.4.5.1
7. Seal Leak, Gross	10.4.5.2	10.4.5.2
8. Electrical Measurements ,EM2	10.3	10.3
9. Radiographic	10.4.6	10.4.6
10. Visual Examination, External	10.2.2	10.2.2

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10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal - Relays that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Soldering and welding shall be free of imperfections (10 X).
- b. Assembly of internal parts to mounting brackets and terminal boards shall indicate that proper manufacturing techniques have been used (10 X).
- c. There shall be no cuts, breaks or abrasions in insulation (10 X).
- d. Wire shall be the correct length and shall contain no kinks. (1X to 10 X).
- e. Wire insulation shall contain no cracks, breaks or cuts (1X to 10 X).
- f. Relays shall contain no solder flux or other foreign matter (10 X).
- g. There shall be no defects in workmanship, construction, design, materials and processes which could render any relay unsuitable for its intended use (1X to 10X).
- h. When lubrication is required, the quantity, quality and application shall be suitable for proper lubrication of the moving parts (10 X).
- i. When impregnation is required, there shall be no air bubbles, improper curing, voids or lack of impregnation.
- j. The following characteristics shall be as specified:
 1. Minimum clearances (10 X).
 2. Critical dimensions (10 X).
 3. Internal design and construction (1 X).

10.2.2 Visual Examination, External - Relays that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

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- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit, or function of the relay (7 X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7 X).
- c. Glass header seals shall be free of cracks (7 X).
- d. Marking shall include, but not be limited to:
 1. Part number (1 X)
 2. Lot or date code (1 X)
 3. Serial number (1 X)
- e. The following characteristics shall be as specified:
 1. External design and construction (1 X)
 2. Dimensions (1 X)
 3. Weight (1 X)

10.3 Electrical and Mechanical Measurements - The electrical and mechanical measurements EM1 and EM2 shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3:1.3

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Dielectric Strength

10.3.2.1 Test Method - Relays shall be tested in accordance with method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Special preparations - Relays shall be mounted or placed on a metal plate (ground) or metal V-block as applicable.
- b. Test voltage - The minimum test voltage shall be as specified in table III, or as specified by the procuring activity, whichever is greater.

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept Reject Criteria
<u>EM1</u>			
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Insulation Resistance	All	10.3.3.1	10.3.3.2.1
3. Operating Voltage	Dual Coil Latch, Dry Circuit	10.3.4.1 10.3.4.2	10.3.4.3
4. Operating Voltage	Dual Coil Latch, Other	10.3.4.1	10.3.4.3
5. Operating Voltage	General Purpose, Dry Circuit	10.3.5.1 10.3.4.2	10.3.5.2
6. Operating Voltage	General Purpose, Other	10.3.5.1	10.3.5.2
7. Contact Resistance	Dry Circuit	10.3.6.1 10.3.4.2	10.3.6.2
8. Contact Resistance	Other Relays	10.3.7.1	10.3.7.2
9. Simultaneity	Multipole Relays	10.3.8.1	10.3.8.1
10. DC Coil Resistance	All	10.3.9.1	10.3.9.2.1
11. Coil Current (Exciting)	All	10.3.10.1	10.3.10.2.1
12. Operate and Release Times	Dry Circuit	10.3.11.1.1	10.3.11.1.2
13. Operate and Release Times	Other Relays	10.3.11.2.1	10.3.11.2.2
14. Coil Transient Voltage	Bifilar	10.3.12.1	10.3.12.2
<u>EM2</u>			
15. Dielectric Strength	All	10.3.2.1	10.3.2.2
16. Insulation Resistance	All	10.3.3.1	10.3.3.2.2

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Table II. Electrical Measurements (Continued)

Measurements	Types	Test Method Paragraph	Accept Reject Criteria
17. Simultaneity	Multipole Relays	10.3.8.1	10.3.8.2
18. DC Coil Resistance	All	10.3.9.1	10.3.9.2.2
19. Coil Current Exciting	All	10.3.10.1	10.3.10.2.2
20. Operate and Release Times	Dry Circuit	10.3.11.1.1	10.3.11.1.2
21. Operate and Release Times	Other Relays	10.3.11.2.1	10.3.11.2.2
22. Coil Transient Voltage	Bifilar	10.3.12.1	10.3.12.2

Table III. Test Specifications

Working Voltage (See Note 1)		Dielectric Strength rms Test Voltage (See Note 1)	Insulation Resistance	
			dc Test Voltage	Minimum Insulation Resistance (Megohms)
Greater than	Up to and Including			
0 V	50 V	100	100	1000
50 V	100 V	100	100	1000
100 V	175 V	300	100	1000
175 V	700 V	2.8 working voltage	500	7500
700 V		1.4 working voltage + 1000	1000	10,000

NOTES: 1. The working voltage shall be as specified, and is defined as the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered.

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- c. Duration of test voltage - The test voltage shall be applied for 60 $\begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground with the relay energized and deenergized.
- e. Examination during test - Leakage current shall be monitored during test.
- f. Examination after test - Relays shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

10.3.2.2 Accept-Reject Criteria - Relays that have leakage current paths that exceed 1.0 milliamperere or show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

10.3.3 Insulation Resistance

10.3.3.1 Test Method - Relays shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - Test voltage shall be as specified in table III, or as specified by the procuring activity, whichever is greater.
- b. Special preparations - Relays shall be mounted or placed on a metal plate (ground) or metal V-block, as applicable.
- c. Points of measurement - The measurements shall be made first between all mutually insulated points and ground with the relay energized, and then with the relay deenergized.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or 120 $\begin{smallmatrix} +0 \\ -10 \end{smallmatrix}$ sec., whichever is greater.

10.3.3.2 Accept-Reject Criteria

10.3.3.2.1 Accept-Reject Criteria, EM1 - The minimum insulation resistance shall be as specified in table III. Relays that fail to meet the insulation resistance value specified shall be removed from the lot

10.3.3.2.2 Accept-Reject Criteria, EM2 - The minimum insulation resistance shall be 90 percent of the EM1 value. Relays that fail to meet this insulation resistance

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value shall be removed from the lot.

10.3.4 Operating Voltage or Current, Dual Coil Latch Relays

10.3.4.1 Test Method - Prior to measuring the energizing voltage or current, as applicable, the reset coil shall be energized at the rated voltage (or current) for a maximum of 2 seconds. The energizing potential shall be reduced to zero. A potential shall then be applied to the set coil and gradually increased until all contacts operate. A suitable device shall be used to determine if each contact operates properly. The energizing potential shall be reduced to zero and the reset coil shall be energized at the rated voltage (or current) for a maximum of 2 seconds. The energizing potential shall be reduced to zero and the set coil shall be energized at the rated voltage (or current) for a maximum of 2 seconds. The energizing potential shall be reduced to zero. A potential shall then be applied to the reset coil and gradually increased until all contacts operate. A suitable device shall be used to determine if each contact operates properly.

10.3.4.2 Applied Power, dry Circuit Relay Contacts - Power applied to the contacts of dry circuit relays shall be supplied by a power supply that meets the following requirements:

- a. The open circuit voltage shall be 30 ± 5 m V.
- b. When power is applied to closed contacts the current shall be automatically regulated at 10 ± 5 uA.

10.3.4.3 Accept-Reject Criteria - The relays shall operate, and all switching circuits shall make positive contact in each energized position after the coil voltage or current attains a value not greater than that specified. Parts that fail to meet these requirements shall be removed from the lot.

10.3.5 Operating Voltage or Current, General Purpose Relays

10.3.5.1 Test Methods

10.3.5.1.1 Energizing Voltage or Current - Prior to measuring the energizing voltage or current, as applicable, the coil shall be energized at the rated voltage or current for a maximum of 2 seconds. The energizing potential shall be reduced to zero, and then increased until all contacts operate. A suitable indicating device shall be used to determine if all contacts operate properly.

10.3.5.1.2 Release Voltage or Current - The relay coil shall be energized at the rated voltage or current, and shall then be gradually reduced until all contacts return to the deenergized position. A suitable indicating device shall be used to determine if all contacts operate properly.

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10.3.5.2 Accept-Reject Criteria - The relays shall operate, and all switching circuits shall make positive contact in the energized position when the coil voltage or current attains a value not greater than that specified. Also, the relays shall release, and all switching circuits shall make positive contact in the deenergized position when the coil voltage or current is reduced to the value specified. Relays that fail to meet these requirements shall be removed from the lot.

10.3.6 Contact Resistance, Dry Circuit Relays

10.3.6.1 Test Method - The dynamic contact resistance shall be measured under the following conditions:

- a. The normally closed contacts shall be connected in series when the relay is deenergized.
- b. The normally open contacts shall be connected in series when the relay is energized at rated coil voltage (or current).

10.3.6.2 Accept-Reject Criteria - The dynamic contact resistance shall not exceed 500 ohms. Relays that fail to meet this requirement shall be removed from the lot.

10.3.7 Contact Resistance, Other Relays

10.3.7.1 Test Method - The contact resistance shall be measured as specified in Method 307 of Standard MIL-STD-202. The following details shall apply:

- a. Measurements shall be made between the terminals of the contacts of the same pole forming a switching circuit. Measurements shall be made for all poles in a relay at each of the actuator positions. The reset coils of latch relays should be deenergized before measuring contact resistance on either position.
- b. Test current - 0.1 A
- c. Open-circuit test voltage - 6 Vdc maximum, unless otherwise specified.
- d. Number of test actuations - Three
- e. Number of measurements per actuation - One.

10.3.7.2 Accept-Reject Criteria - Relays that fail to meet the contact resistance requirements specified shall be removed from the lot.

10.3.8 Simultaneity

10.3.8.1 Test Method - Each relay shall be held rigidly by its mounting means. The time differential between the point of initial electrical contact, or break

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on the corresponding set of contacts on all other poles of the relay shall be measured. The cycling of the relay shall be performed by applying the rated voltage (or current) to the applicable relay coil.

10.3.8.3 Accept-Reject Criteria - The time differential between the point of initial contact or break of the corresponding set of contracts on all other poles of the relay including transfer and bounce time shall be as follows:

- a. For 2-pole relays 10 milliseconds, maximum.
- b. For 3-pole relays 20 milliseconds, maximum.
- c. For relays with 5 or more poles, as specified.

Relays that fail to meet this requirement shall be removed from the lot.

10.3.9 DC Coil Resistance

10.3.9.1 Test Method - The dc coil resistance of all relay coils shall be measured as specified in Method 303 of Standard MIL-STD-202.

10.3.9.2 Accept-Reject Criteria

10.3.9.2.1 Accept-Reject Criteria, EM1 - Unless otherwise specified, the dc coil resistance of each relay coil shall be of the value specified or ± 10 percent of nominal value, whichever is the lower limit value. Relays that fail to meet this requirement shall be removed from the lot.

10.3.9.2.2 Accept-Reject Criteria, EM2 - The dc resistance of coils shall not vary more than ± 1 percent from the EM1 value. Relays that fail to meet this requirement shall be removed from the lot.

10.3.10 Coil Current (Exciting)

10.3.10.1 Test Method - The coil current of relay coils shall be measured by applying nominal input voltage to each coil, while it is at 25°C, and measuring the input current. The current flow in the coil shall be measured within 30 seconds after application of coil voltage.

10.3.10.2 Accept-Reject Criteria

10.3.10.2.1 Accept-Reject Criteria, EM1 - The value of input current shall be as specified or ± 10 percent of nominal value, whichever is the lower limit value. Relays that fail to meet this requirement shall be removed from the lot.

10.3.10.2.2 Accept-Reject Criteria, EM2 - The coil current shall not vary more than ± 2 percent from the EM1 value. Relays that fail to meet this requirement shall be removed from the lot.

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10.3.11 Operate and Release Times (including Contact Bounce)

10.3.11.1 Operate and Release Time, Dry Circuit Relays

10.3.11.1.1 Test Method - Operate and release times shall be measured on each contact set of the relay. The circuit shown in figure 1, or an equivalent, shall be used. Rated coil voltage (or current) shall be applied to the coil when measuring operate and release times. The relay coil shall be connected directly to the power supply. The use of resistors in series, or parallel with the coil, or the use of a diode in parallel with the coil, should be avoided. The contact bounce test shall be performed on each contact set of the relay. Open circuit contact voltage shall be 30 ± 5 millivolts dc and contact load shall be 10 ± 5 microamperes. Figure 2 illustrates a typical oscilloscope presentation. Care should be taken to exclude any irregularities caused by switching. Total operate time shall include bounce.

10.3.11.1.2 Accept-Reject Criteria - The operate time, release time, and contact bounce of relays shall not exceed the values specified. Relays that fail to meet this requirement shall be removed from the lot.

10.3.11.2 Operate and Release Times, Other Relays

10.3.11.2.1 Test Method - Operate and release times shall be measured on each contact set of the relay. The circuit shown in figure 1, or an equivalent, shall be used. Rated coil voltage (or current) shall be applied to the coil when measuring operate and release times. The relay coil shall be connected directly to the power supply. The use of resistors in series, or parallel with the coil, or the use of a diode in parallel with the coil, should be avoided. The contact bounce test shall be performed on each contact set of the relay. Open circuit contact voltage shall be 6 Vdc maximum and contact load shall be 100 milliamperes maximum. Figure 2 illustrates a typical oscilloscope presentation. Care should be taken to exclude any irregularities caused by switching. Total operate time shall include bounce.

10.3.11.2.2 Accept-Reject Criteria - The operate time, release time, and contact bounce of relays shall not exceed the values specified. Relays that fail to meet this requirement shall be removed from the lot.

10.3.12 Coil Transient Voltage

10.3.12.1 Test Method - With the relay stabilized at room temperature, the rated operating voltage shall be applied to the coil terminals for not more than 10 seconds. The relay shall be deenergized and the coil transient voltage measured with an oscilloscope or other comparable means, using the circuit shown in figure 3 or an equivalent. The maximum allowable peak transient voltage shall not exceed a value equal to 175 percent of rated coil voltage. A typical oscilloscope presentation of a coil transient voltage is shown in figure 4. The relay coil shall be connected directly to the power supply. The use of resistors, capacitors, inductors, or semiconductor devices in series, or parallel with the coil, not inherent in the properly set up test circuit shall be strictly forbidden. The transient voltage shall be measured a minimum of three times and the largest transient value recorded as the actual value.

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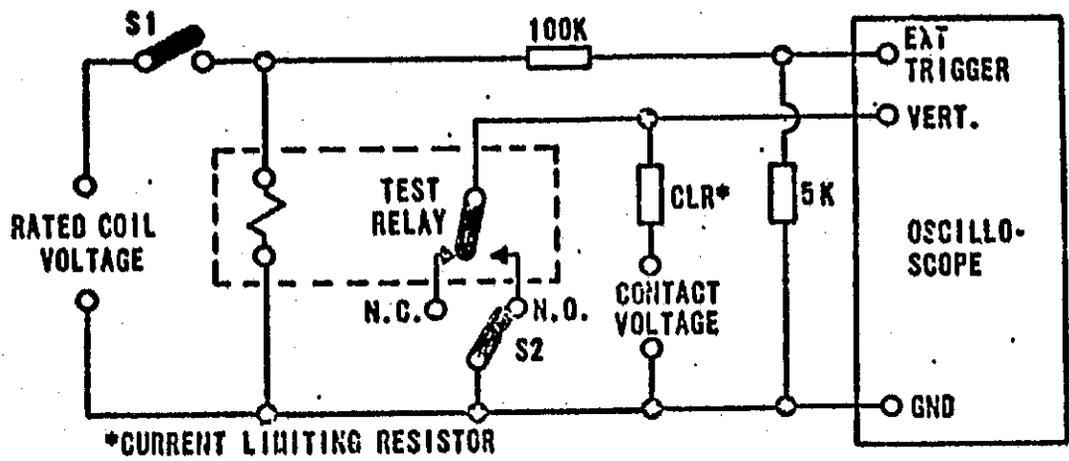


Figure 1. Typical Test Circuit for Operate and Release Times

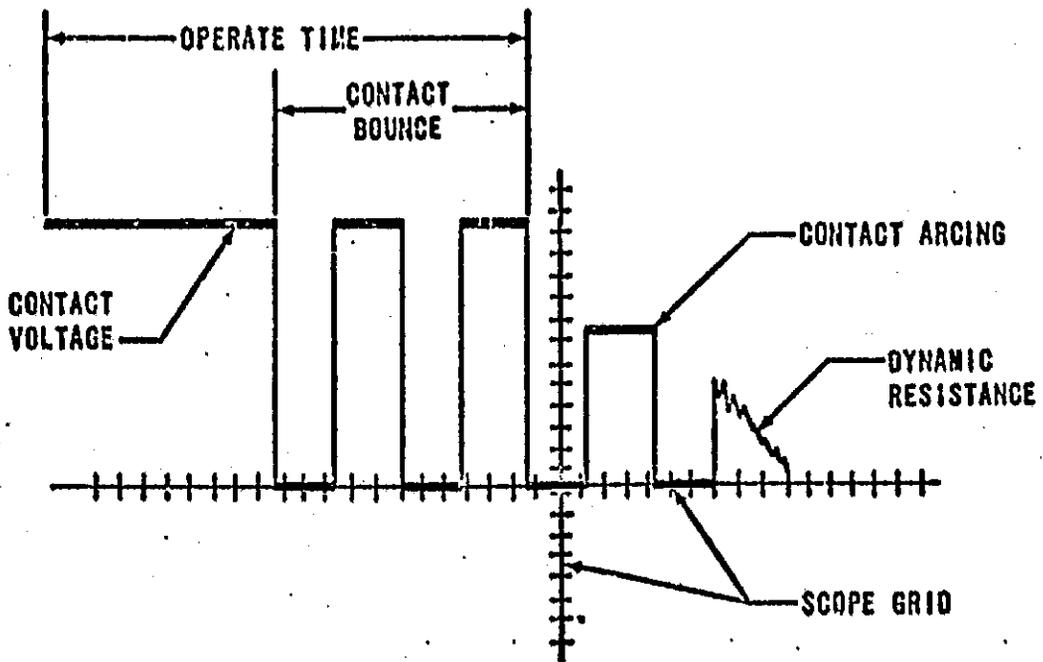


Figure 2. Typical Oscilloscope Presentation of Operate Time (Contact Bounce Included)

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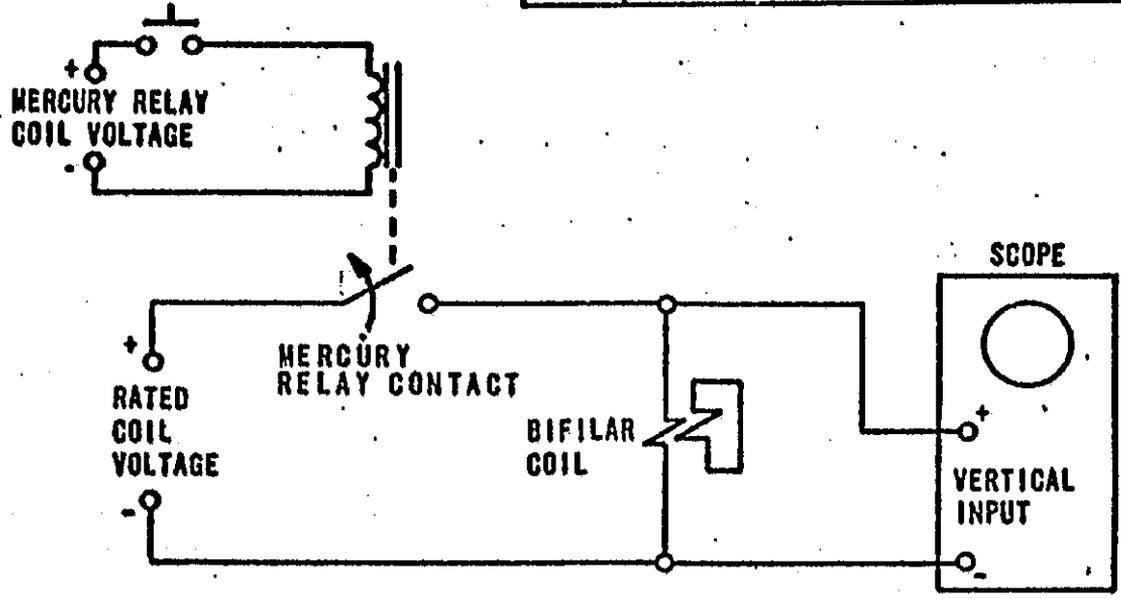


Figure 3. Typical Test Circuit for Coil Transient Measurement

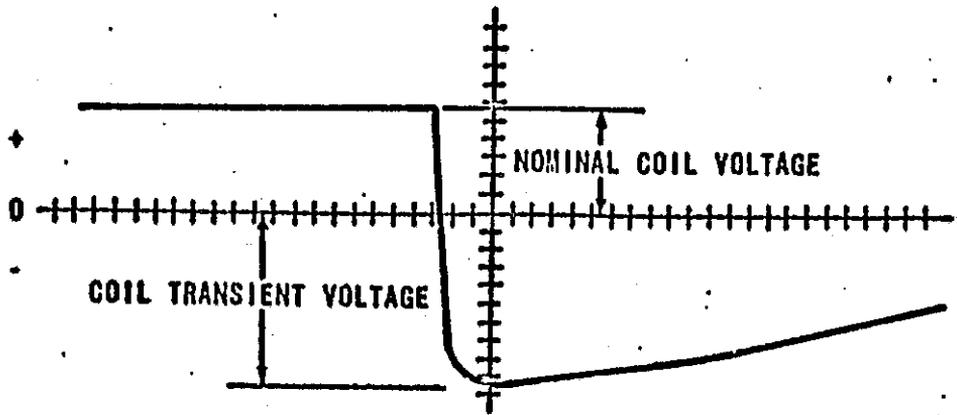


Figure 4. Typical Oscilloscope Presentation of Coil Transient Voltage

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10.3.12.2 Accept-Reject Criteria - When the coil transient voltage is measured as specified above, the value shall not exceed 175 percent of rated coil voltage. Relays that fail to meet this requirement shall be removed from the lot.

NOTE: It is recommended that the device used to deenergize the relay under test be a mercury watted relay contact. When a mercury relay is used as the switching device, its coil should be operated from a separate source, isolated from the source used to operate the relay coil under test. The oscilloscope in use should have a rise-time equal to, or less, than 0.2 microsecond. Photographs of the oscilloscope traces are helpful in ascertaining precise voltage measurements of the transients, but are not required. In order to observe the maximum vertical excursion of the transient voltage, horizontal sweep times of from 100 microseconds per centimeter to 20 microseconds per centimeter may be necessary.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in Standard MTL-STD-202.

10.4.1 Moisture Detection - Relays shall be subjected to a moisture detection test consisting of the following steps.

- a. Position - Relay header in the down position
- b. Applied voltage - 140 percent of rated coil voltage
- c. Time - 2 1/2 minutes
- d. Monitoring during time voltage is applied - insulation resistance

If the insulation resistance of any relay decreases more than 10 percent that relay shall be removed from the lot.

10.4.2 Vibration - The vibration test shall be accomplished as follows:

- a. Mounting - Relays shall be rigidly mounted by their normal mounting means.
- b. Axes of vibration - Relays shall be vibrated, for the time specified, in each of three mutually perpendicular planes.
- c. Vibration level
 - 1) Simple harmonic motion - 500 Hz to 2000 Hz or 500 Hz to 3000 Hz, as applicable, at 30 peak.
 - 2) Random - The random vibration acceleration spectral density shall be 0.6 g^2 per Hz with a flat frequency spectrum (no more than 3 db down) between 20 Hz and 2000 Hz or 3000 Hz as applicable.

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d. Vibration time

- 1) Simple harmonic motion - Five minutes from low to high frequency and five minutes from high to low frequency with the relay energized and then deenergized (total time of 20 minutes) in each of three mutually perpendicular planes.
- 2) Random vibration - Five minutes with the relay energized and 5 minutes with the relay deenergized (total time of 10 minutes) in each of three mutually perpendicular planes.

e. Characteristics monitored during vibration - Contact chattering. See figure 5 for suggested circuit. It is recommended that closed contacts be wired in series during monitoring. For dry-circuit relays the contacts should not be switched without first removing the load of the detector.

f. Examination after vibration - For evidence of mechanical or structural damage.

g. Accept-Reject Criteria - There shall be no opening of closed contacts greater than 10 microseconds, no closing of open contacts, and no bridging between open and closed contacts. Parts that fail to meet this requirement or that show any evidence of mechanical or structural damage shall be removed from the lot.

10.4.3 Burn-In, Dry Circuit Relays

10.4.3.1 Rated Operation - Relays shall be operated at a maximum rate of 60 cycles per minute with a duty cycle of 50 ± 10 percent at the cycles and temperatures as follows:

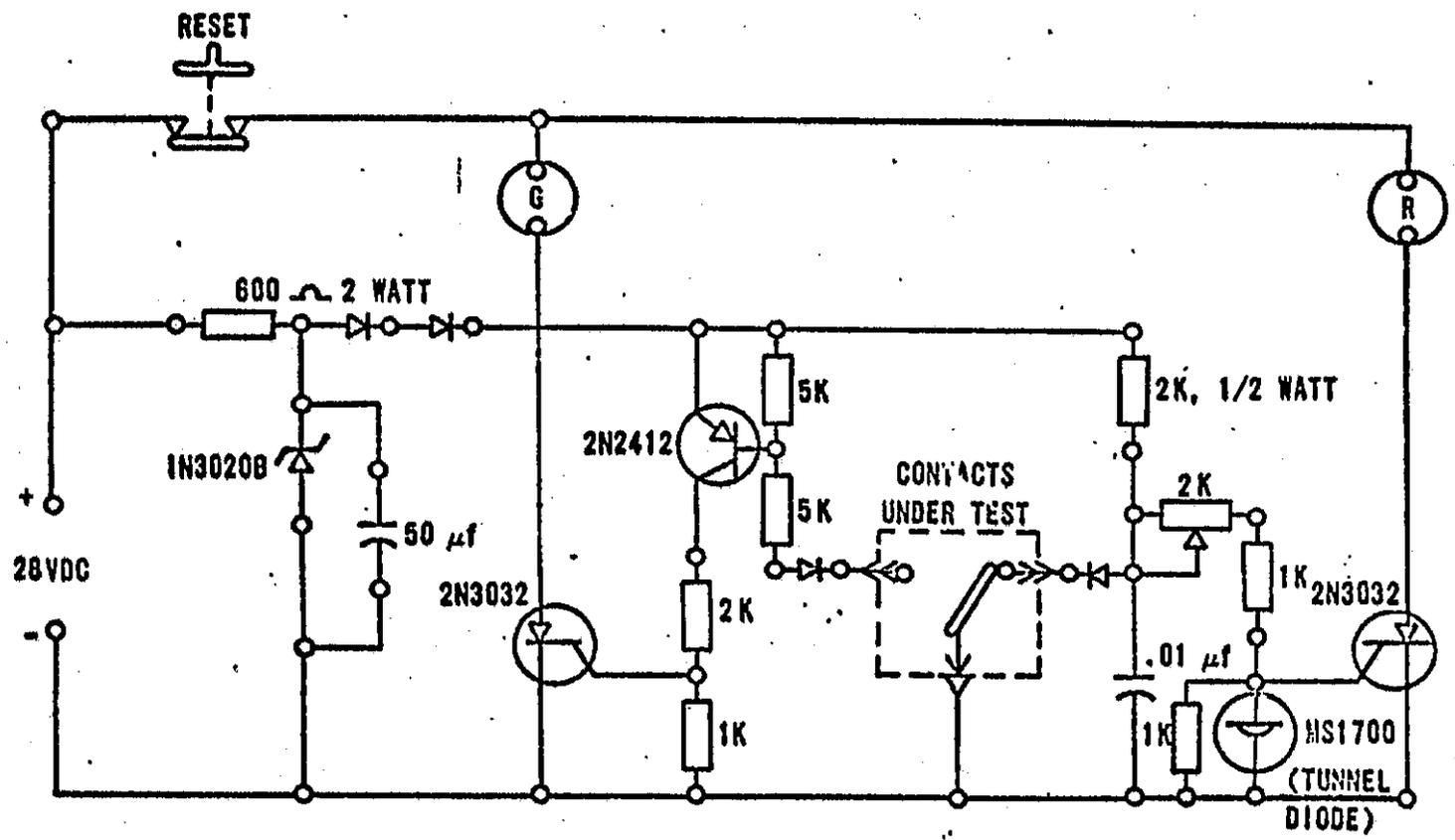
- (a) 25°C - 1-hour soak with relay deenergized followed by 1000 cycles run-in.
- (b) 125°C - 1-hour soak with relay energized (dual coil latch relays should have each coil energized 30 minutes separately) followed by 2000 cycles run-in.
- (c) Minus 65°C - 1-hour soak with relay deenergized, followed by 2000 cycles run-in.
- (d) 25°C - 1-hour soak with relay deenergized, followed by 1000 cycles run-in.

10.4.3.1.1 Contact Loads - Each contact shall make, break, and carry the rated load as specified. The power applied shall be as specified in 10.3.4.2.

10.4.3.1.2 Monitoring Circuit - The monitoring equipment shall provide a record

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All Resistors 1/4 Watt Unless Otherwise Specified
 All Diodes are IN645 - IN649 Series
 10 μsec Chatter Detector

Figure 5. Test Circuit for Monitoring Contact Chatter

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of the number of cycles and shall record failures or discontinue the test if a failure occurs. Occurrence of a dynamic resistance greater than 500 ohms, or failure of a relay contact to transfer shall be considered a failure. During each closure, the contact potential shall be monitored for at least 50 percent of the time the contacts are closed.

10.4.3.1.3 Accept-Reject Criteria- Relays shall be removed from the lot for the following reasons:

- a. Failure to meet the requirements specified in 10.4.3.1.1
- b. Failure of relay contacts to transfer
- c. Occurrence of a dynamic resistance greater than 500 ohms

10.4.4 Burn-In, other Relays

10.4.4.1 Rated Operation - Relays shall be operated at a maximum rate of 60 cycles per minute with a duty cycle of 50 \pm 10 percent at the cycles and temperatures as follows:

- (a) 25°C - 1-hour soak with relay deenergized, followed by 1000 cycles run-in.
- (b) 125°C - 1-hour soak with relay energized (dual coil latch relays should have each coil energized 30 minutes separately), followed by 2000 cycles run-in.
- (c) 25°C - 1-hour soak with relay deenergized, followed by 1000 cycles run-in.

10.4.4.1.1 Contact Loads - Each contact shall make, break, and carry the rated load as specified. For AC inductive loads the power factor shall be 0.75 to 0.80. For AC resistive load the power factor shall be 0.90 to 1.0. For DC inductive loads, the time constant (L/R ratio) shall be 0.02 to 0.03.

10.4.4.1.2 Monitoring Circuit - The monitoring equipment shall provide a record of the number of cycles and shall record failures or discontinue the test if a failure occurs. During each closure the contact potential shall be monitored for at least 50 percent of the time the contacts are closed.

10.4.4.1.3 Accept-Reject Criteria- Relays that fail to meet the requirements specified in 10.4.4.1.1 shall be removed from the lot.

10.4.5 Seal Leak

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10.4.5.1 Seal Leak, Fine - Relays shall be tested in accordance with Test Method 112 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition-C (except that the gross leak test shall be as specified in 10.4.5.2)
 - 1) Procedure number - III
 - 2) Degree of leakage rate sensitivity - 10^{-8} atm cc/sec.

Relays that fail to meet the leakage requirement shall be removed from the lot.

10.4.5.2 Seal Leak, Gross - Relays shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\text{C} + 5^{\circ}\text{C}$. The temperature of the relay shall not exceed 40°C at the time of immersion. During the time the relay is in the water bath there shall be no continuous flow of air bubbles or leakage of compound from the relay body. Relays that fail to meet this requirement shall be removed from the lot. After removal from the bath the part shall be dried for 2 hours at 25°C .

10.4.6 Radiographic

10.4.6.1 Radiographic Procedure - Relays shall be inspected in accordance with the general requirements of Standard MSFC-STD-355.

10.4.6.2 Radiographic Analysis - The examination shall include those listed in MSFC-STD-355 in addition to the following:

- a. Extraneous Material - There shall be no visible loose hardware or extraneous materials or contaminants, such as weld or solder splashed and solder balls.
- b. Parts Clearance - Acceptable relays shall exhibit internal electrical and mechanical clearance.
- c. Miscellaneous Defects - There shall be no omitted, broken or defective parts. Relays that fail to meet the requirements specified above or in Standard MSFC-STD-355 shall be removed from the lot.

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APPENDIX I

Minimum Screening Requirements for Resistors

10. General Requirements - Resistors shall meet all applicable requirements of this document.

10.1 Screening Requirements - Resistors shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified", these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each resistor supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. All examinations, tests and measurements shall be performed after all manufacturing processes have been performed. All resistors that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examination, External - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Examination with Magnification - Resistors that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit, or function of the resistor (7 X).
- b. There shall be no imperfections in seals, coating, casting or plating. (7 X).
- c. Marking shall include, but not be limited to:
 1. Part number (1 X).
 2. Lot or date code (1 X).
- d. The following characteristics shall be as specified:
 1. External design and construction (1 X).
 2. Dimensions (1 X).
 3. Weight (1 X).

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Table I. Screening Requirements

Examination or Test	Wirewound Accurate; Thermistor	Wirewound Chassis Mount; Wirewound Power	Film High Stability	Film Insulated	Comp Insulated	Variable Trimmers	Variable Precision	Film High Voltage
1. Electrical Measurement EM1	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
2. Overload			10.4.1	10.4.1				10.4.1
3. Thermal Shock	10.4.2	10.4.2	10.4.2	10.4.2		10.4.2	10.4.2	10.4.2
4. Electrical Measurement EM2			10.3					10.3
5. Burn-In	10.4.3	10.4.3	10.4.3	10.4.3	10.4.3	10.4.4	10.4.5	
6. Electrical Measurement EM3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
7. Radiographic	10.4.6					10.4.6	10.4.6	
8. Seal Leak, Fine							10.4.7.1	
9. Seal Leak, Gross			10.4.7.3				10.4.7.2	
10. Visual Examination, External	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2

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10.3 Electrical Measurements - The electrical measurements EM1, EM2 and EM3 shall consist of the measurements specified in table II in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Resistance10.3.2.1 Test Methods

10.3.2.1.1 General Test Method - Resistors shall be tested in accordance with Method 303 of Standard MIL-STD-202. The following details and exceptions shall apply:

- a. Measuring apparatus - Resistance bridge
- b. Limit of error of measuring apparatus - One fourth of the specified initial resistance tolerance or 0.1 percent, whichever is less, + 0.002 ohm.
- c. Test voltage - Measurements of resistance shall be made by using a dc potential resulting in not more than 1 percent of rated wattage specified. This same voltage shall be used whenever a subsequent resistance measurement is made.
- d. Points of application of test voltage for initial resistance tolerance measurement - For axial-lead resistors of 20 ohms or less, $9.53^{+1.59}_{-0}$ mm ($3/8^{+1/16}$ inch) from the end of the body. For tab-terminal resistors of 20 ohms or less, locate on tab in line of hole parallel to resistor body. For all resistors above 20 ohms, locate wherever practical on lead or tab.
- e. Other details shall be as specified in the applicable paragraphs referenced in table II.

10.3.2.1.2 Test Method, Variable Resistors - Total resistance shall be measured between the resistance-element terminals.

10.3.2.1.3 Test Method, Thermistor -

- a. Temperature - All resistance measurements shall be made in a controlled uniform medium. Accuracy of temperature measuring equipment shall be as follows:
 1. $\pm 0.01^{\circ}\text{C}$ for beads, beads in rods, and beads in probes.
 2. $+0.05^{\circ}\text{C}$ for all other types.

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM1</u>			
1. Resistance	Wirewound Power	10.3.2.1.1	10.3.2.2.1
2. Resistance	Wirewound Precision	10.3.2.1.1	10.3.2.2.1
3. Resistance	Wirewound Chassis Mount	10.3.2.1.1	10.3.2.2.1
4. Resistance	Film, High Stability	10.3.2.1.1	10.3.2.2.1
5. Resistance	Film, Insulated and Film, High Voltage	10.3.2.1.1	10.3.2.2.1
6. Resistance	Composition Trimmers	10.3.2.1.1	10.3.2.2.1
7. Resistance	All Variable	10.3.2.1.1 10.3.2.1.2	10.3.2.2.1
8. Resistance	Thermistors	10.3.2.1.1 10.3.2.1.3	10.3.2.2.1
9. Output	Wirewound Variable	10.3.3.1	10.3.3.2
10. Output	Nonwirewound Variable	10.3.4.1	10.3.4.2
11. Dielectric Strength	Variable Precision	10.3.5.1	10.3.5.2
12. Insulation Resistance	All Variables	10.3.6.1	10.3.6.2
13. Resistance-Temperature Characteristics	Thermistors	10.3.7.1	10.3.7.2
<u>EM2</u>			
14. Resistance	Film, High Stability	10.3.2.1.1	10.3.2.2.2
15. Resistance	Film, High Voltage	10.3.2.1.4	10.3.2.2.2

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Table II. Electrical Measurements (Continued)

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM3</u>			
16. Resistance	Wirewound Power	10.3.2.1.1	10.3.2.2.3
17. Resistance	Wirewound Precision	10.3.2.1.1	10.3.2.2.7
18. Resistance	Wirewound Chassis Mount	10.3.2.1.1	10.3.2.2.3
19. Resistance	Film, High Stability	10.3.2.1.1	10.3.2.2.3
20. Resistance	Film, Insulated and Film, High Voltage	10.3.2.1.1	10.3.2.2.8
21. Resistance	Composition Insulated	10.3.2.1.1	10.3.2.2.3
22. Resistance	Variable Trimmers	10.3.2.1.1 10.3.2.1.2	10.3.2.2.4
23. Resistance	Variable Precision	10.3.2.1.1 10.3.2.1.2	10.3.2.2.5
24. Resistance	Thermistors	10.3.2.1.1 10.3.2.1.3	10.3.2.2.6
25. Continuity of Contact Arm	All Trimmers	10.3.8.1	10.3.8.2

- b. Equipment - Wheatstone bridge or equivalent, accurate to +0.05 percent or better.
- c. Mounting - Thermistors shall be mounted by normal mounting means in corrosion resistant clips mounted on a 3.18mm (1/8 inch) diameter brass rod.
1. Beads - Flat noncorrosion clips shall be used. The leads shall be gripped $6.35 \begin{smallmatrix} +1.59 \\ -0 \end{smallmatrix}$ mm ($1/4 \begin{smallmatrix} +1/16 \\ -0 \end{smallmatrix}$ inch) from the end of the thermistor body.

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- d. Test procedure - Zero-power resistance shall be measured at 25°C and 125°C. With the input voltage source disconnected, the output indicator shall be adjusted to the zero output position. The input voltage source shall be connected, the zero-power resistance measured, and the power source disconnected. The output shall return to initial zero output position +0.05 percent.

10.3.2.1.4 Test Method, Film, High Voltage Resistors, EM2 - Resistance shall be measured with voltage applied as follows:

- a. Resistors 1/4 watt and under - 150 V, but not exceeding wattage rating ($P = E^2/R$)
- b. Resistors over 1/3 watt - rated voltage or 10 kV, whichever is less, but not exceeding wattage rating ($P = E^2/R$)
- c. Resistors under 1 megohm shall not be tested.

10.3.2.2 Accept-Reject Criteria

10.3.2.2.1 Accept-Reject Criteria, EM1 - Resistors that fail to meet the resistance requirements specified shall be removed from the lot.

10.3.2.2.1 Accept-Reject Criteria, Film, High Voltage Resistors, EM2 - Resistors shall be within the specified tolerance plus the anticipated change due to voltage coefficient as specified.

10.3.2.2.3 Accept-Reject Criteria, EM2 and EM3 - The resistance shall not vary more than 0.2 percent +0.05 ohms from the EM1 value. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.2.2.4 Accept-Reject Criteria, Variable Trimmers, EM3 - The resistance shall not vary more than 1.0 percent from the EM1 measurement. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.2.2.5 Accept-Reject Criteria, Variable Precision, EM3 - The resistance shall not vary more than 5 percent from the EM1 measurement. Resistors that fail to meet this requirement shall be removed from the lot.

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10.3.2.2.6 Accept-Reject Criteria, Thermistors, EM3 - The resistance shall not vary more than 2.0 percent from the EM1 measurement. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.2.2.7 Accept-Reject Criteria, Wirewound Precision Resistors, EM3 - The resistance shall not vary more than 0.25 percent from the EM1 measurement. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.2.2.8 Accept-Reject Criteria, Film Insulated and Film High Voltage, EM3 - The resistance shall not vary more than 0.5 percent from the EM1 measurement. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.3 Output, Wirewound Variable Resistors

10.3.3.1 Test Method - Peak-noise resistance shall be measured with the circuit shown in figure 1, or its equivalent. The lead screw shall be rotated in both directions through 90 percent of the actual effective electricity travel for a total of six cycles. Only the last three cycles shall count in determining whether or not a noise is observed at least twice in the same location. The rate of rotation of the lead screw shall be such that the wiper completes one cycle in 5 seconds, minimum, to two minutes, maximum. The equivalent resistance shall be calculated using the following formula:

$$\text{Noise} = \frac{E_{pn}}{0.001} \text{ ohms}$$

Where: E_{pn} = peak noise signal voltage presented in the oscilloscope screen.

10.3.3.2 Accept-Reject Criteria - The peak noise shall not exceed 100 ohms. Resistors that fail to meet this requirement shall be removed from the lot.

10.3.4 Output, Nonwirewound Variable Resistors

10.3.4.1 Test Method - Contact resistance variation shall be measured with the measuring circuit shown on figure 2 or its equivalent. During this test, the lead screw shall be rotated in both directions for a total of three cycles, through 90 percent of the actual effective electrical travel, at the rate of one cycle for 5 seconds, minimum, to 2 minutes, maximum. Contact resistance variation shall be defined as any abrupt change from one contact-resistance level to another, exclusive of the roll-on or roll-off points where the contact arm moves from the termination on to, or off, the resistance element.

10.3.4.2 Accept-Reject Criteria - The maximum contact resistance shall be 3 percent or 3 ohms, whichever is greater. Resistors that fail to meet this requirement shall be removed from the lot.

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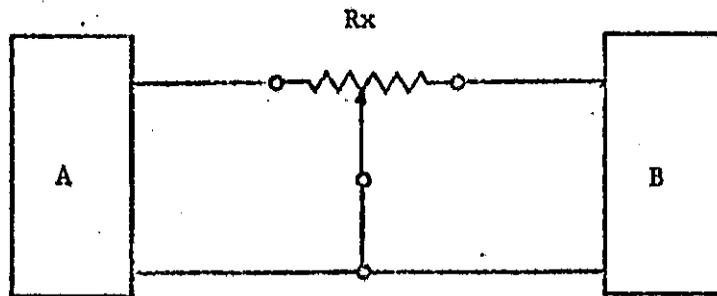
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A - 1 mA dc Constant-Current Source

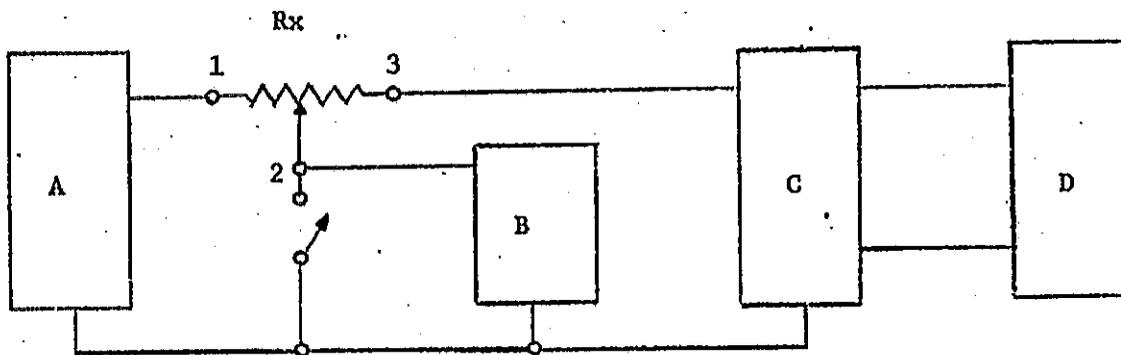
B - Oscilloscope or Test Circuit

Band Width - DC to 500 KHz

Minimum Input Impedance - 1.0 megohm at 400 Hz

Rx - Test Unit

FIGURE 1. PEAK-NOISE MEASURING CIRCUIT



A - Constant-Current Source (not to exceed rating of unit being tested).

B - Calibration Decade - At calibration of the decade, terminals 1 and 2 must be coincident. Calibration decade is to be set for the contact-resistance (CRV) level of the specific nominal resistance being tested.

C - AC Amplifier

D - Oscilloscope:

Band Width - 100 Hz to 50 KHz

Minimum Input Impedance - At least 10 times the nominal resistance being tested.

Rx - Test Unit

FIGURE 2. CONTACT-RESISTANCE VARIATION MEASURING CIRCUIT.

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10.3.5 Dielectric Strength

10.3.5.1 Test Method - The resistors shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting - The resistors shall be mounted on metal plates of sufficient size to extend beyond the resistor extremities. The metal plates and the shaft shall make electrical contact with each other. The terminals of each section shall be tied together.
- b. Magnitude of test voltage - 750 volts rms for resistors of 28.58 mm (1.125-inch) diameter and smaller; 1,000 volts rms for resistors having diameters larger than 28.58 mm (1.125 inches).
- c. Nature of potential - From an alternating current supply at commercial-line frequency and waveform. This potential shall be applied with the operating shaft traversing the mechanical travel in a minimum of 5 and not more than 60 seconds.
- d. Points of application of test voltage - For single-section resistors, between the terminals connected together and the shaft; for multi-section resistors, between the terminals of adjacent sections and between the terminals of each section and the shaft.
- e. Measurement and examination during test - The leakage current shall be measured; resistors shall be examined for evidence of arcing, flash-over, breakdown of insulation or other damage.

10.3.5.2 Accept-Reject Criteria - Leakage current shall not exceed 1 mA. There shall be no evidence of arcing, flashover, breakdown of insulation or other damage. Resistors that fail to meet these requirements shall be removed from the lot.

10.3.6 Insulation Resistance

10.3.6.1 Test Method - Resistors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition - A or B, whichever is more practical.
- b. Special preparation - Resistors shall be mounted on metal plates of sufficient size to extend beyond the resistor extremities in such a manner that measurements can be made between the terminals tied together and any other external metal parts.
- c. Points of measurements - Between the terminals connected together and all external metal portions of the resistors and metal-mounting plate.

10.3.6.2 Accept-Reject Criteria - The minimum insulation resistance shall be 1000 megohms. Resistors that fail to meet this requirement shall be removed from the lot.

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10.3.7 Resistance Temperature Characteristics

10.3.7.1 Test Method - Each resistor shall be stabilized at each of the ambient temperatures listed in table III. Zero-power resistance shall be made at each specified temperature after a stabilization time equal to or not less than 10 times the applicable thermal time constant. Resistance shall be tabulated for each measurement.

10.3.7.2 Accept-Reject Criteria - Resistors that fail to meet the resistance temperature characteristics specified shall be removed from the lot.

Table III. Resistance-Temperature Characteristics

Sequence	Temperature	Resistance Tolerance of Thermistors Being Tested			
		F (± 1 Percent)	G (± 2 Percent)	J (± 5 Percent)	K (± 10 Percent)
1	-55	10	12	15	20
2	-15	5	6	9	14
3	0	3	4	7	12
4	25	1	2	5	10
5	50	3	4	7	12
6	75	5	6	9	14
7	100	7	9	12	17
8	125	10	12	15	20
9	200 (See Note 1)	15	18	25	30
10	275 (See Note 1)	20	25	35	40

NOTES: 1. Thermistors shall not be tested at any temperature higher than the temperature rating.

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10.3.8 Continuity of Contact Arm

10.3.8.1 Test Method - The lead-screw actuator shall be rotated at a uniform rate such that the wiper traverses the effective electrical travel in both directions within 1-1/4 minutes. During rotation, a suitable electrical device shall be connected between the wiper and either end terminal and monitored for smooth and unidirectional change in voltage or resistance. Precaution shall be exercised to prevent excessive current flow in the resistor during the test.

10.3.8.2 Accept-Reject Criteria - Resistors that show any ohmeter discontinuity upon reversal of lead screw shall be removed from the lot.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.4.1 Overload - Resistors shall be tested as follows:

- a. Mounting - Mount in any position.
- b. Temperature - $25 \pm 10^{\circ}\text{C}$ (the velocity of forced air for cooling shall not exceed 152.4 m (500 feet) per minute, and there shall be no direct impingement on the resistors).
- c. Applied voltage - As specified in table IV.
- d. Duration of voltage - As specified in table IV.

Parts that show any evidence of arcing, burning or charring shall be rejected from the lot.

10.4.2 Thermal Shock - Resistors shall be tested as specified in Method 107 of Standard MIL-STD-202. The following details shall apply:

- a. Test Temperatures - Test temperatures shall be as specified in table V.
- b. Exposure time - The time required for resistance to stabilize plus one minute.
- c. Monitoring during cycling - Continuity.

Resistors that show any evidence of physical damage or any discontinuities in resistance shall be rejected from the lot.

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Table IV. Overload Test Conditions

Rating	Overload Percent of Rated Power (See Note 1 and Note 2)	Voltage ac or dc (maximum)	Time
<u>Film, Insulated</u>			
1/8 and 1/4 watt	150	250	24 hours
1/2 watt	150	350	24 hours
1 and 2 watts	150	500	24 hours
<u>Film, High Stability</u>			
1/20, 1/10, and 1/8 watt	500	500	1 hour
1/4 watt	400	600	1 hour
1/2 and 1 watt	225	700	1 hour
High Voltage	100 (See Note 3)	1.5 X rated dc	100 hours

- NOTES: 1. Rated power shall be as specified.
2. For resistors outside the military specification resistance range the overload and voltage shall be as specified.
3. Wattage shall be decreased as required by the resistance of the resistor so that specified wattage is not exceeded.

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Table V. Test Conditions-Thermal Shock

Temp. Rating of Part (See Note 1)	Test Temperature °C			
	Step 1	Step 2	Step 3	Step 4
125°C	-65	25	125	25
200°C	-65	25	200	25
Above 200°C	-65	25	Maximum Rated (See Note 1)	25

NOTES: 1. Temperature rating of parts shall be as specified.

10.4.3 Burn-In, Fixed Resistors and Variable Resistors Trimmers - Resistors shall be conditioned in accordance with Method 108 of Standard MIL-STD-202. The following details and exceptions shall apply:

- a. Method of mounting - Supported by their terminal leads. Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft on the resistors.
- b. Test conditions - The temperature, power on-power off cycling and total time shall be as specified in table VI. The applied power shall be the rated power specified for the temperature shown in table VI.

10.4.4 Burn-In Variable Resistors, Precision - Resistors shall be conditioned in accordance with Method 108 of Standard MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting - Resistors shall each be centrally mounted on 10.16cm (4 inches square) 6.35mm (0.250 inch) thick, 3.18mm (0.125 inch) for bushing mounted units, 2024 S alloy aluminum panels by their normal mounting means. The chamber dimensions shall be such that they permit a minimum spacing of 15.24 cm (6 inches) between any two adjacent resistors and 10.16 cm (4 inches) between any resistor and the chamber walls. The method of support used to restrain the resistor body from rotating shall be such that it will minimize heat transfer through the support.

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Table VI. Burn-In Conditions-Resistors

Resistor Type	Temp. $\pm 2^{\circ}\text{C}$	Power Cycles	Time Hours
Wirewound Fixed, Power	25	1-1/2 hours on, 1/2 hour off	96 + 8 - 0
Wirewound Fixed, Chassis Mount	25	1-1/2 hours on, 1/2 hour off	96 + 8 - 0
Wirewound Fixed, Accurate	125	1-1/2 hours on, 1/2 hour off	96 + 8 - 0
Fixed Film High Stability	125	1-1/2 hours on, 1/2 hour off	96 + 8 - 0
Fixed Film Insulated	25	1-1/2 hours on, 1/2 hour off	96 + 8 - 0
Composition Fixed Insulated	100	No power	48 + 12 - 0
Thermistors	25	Continuous	96 + 8 - 0
Variable Wirewound Trimmer	85	1/2 hour on, 1/2 hour off	96 + 8 - 0
Variable Non-Wirewound Trimmer	85	1/2 hour on, 1/2 hour off	96 + 8 - 0
Variable Wirewound Precision	85	1-1/2 hour on, 1/2 hour off	96 + 8 - 0
Variable Non-Wirewound Precision	85	1-1/2 hour on, 1/2 hour off	96 + 8 - 0

- b. Test conditions - The temperature, power on-power off cycling and total time shall be as specified in table VI. For resistors with a nominal resistance value of 10,000 ohms or more, the applied voltage shall be the rated dc voltage, as specified, or 100 volts dc, whichever is the lower value. For resistors with a nominal resistance value of less than 10,000 ohms, the applied voltage shall be the dc voltage required to cause 10 ± 1 mA to flow in the resistor, or the rated voltage, as specified,

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whichever is the lower value. After 48 ± 8 hours the voltage shall be removed and the operating shaft shall be continuously cycled through not less than 95 percent of the actual electrical travel at a rate of 40 ± 5 rpm with no voltage applied. A cycle shall consist of travel through 95 percent of the actual electrical travel and return to the starting point. The total number of cycles to be performed shall be 10 percent of rotational life, as specified. After the mechanical operation cycles are completed, the specified voltage cycling shall be continued.

10.4.6 Radiographic - Resistors shall be subjected to radiographic examination as specified in Standard MSFC-STD-355. Resistors that fail to meet the applicable requirements specified in Standard MSFC-STD-355 shall be removed from the lot. In addition, wire wound accurate resistors shall have all windings concentric to the core.

10.4.7 Seal Leak

10.4.7.1 Seal Leak, Fine - Resistors shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - C (except that gross leak test shall be as specified in 4.10.7.2).
 1. Procedure number - III
 2. Degree of leakage rate sensitivity - As specified.

Parts that fail to meet the leakage rate requirement specified shall be removed from the lot.

10.4.7.2 Seal Leak, Gross, Oil Bath - Resistors shall be tested as specified in Method 112 of Standard MIL-STD-202. The following conditions shall apply:

Test condition - A (except that the oil temperature shall be 125°C)

There shall be no continuous flow of air bubbles or leakage of compound from the part body. Resistors that fail to meet this requirement shall be removed from the lot. After removal from the bath, the resistor shall be dried for 2 hours at 25°C .

10.4.7.3 Seal Leak Gross (Low Pressure) -

10.4.7.3.1 Transparent Envelopes - Resistors shall be tested as specified in Standard MIL-STD-883, Condition D of method 1014. The chamber shall be maintained at 28-30 inches Hg gauge pressure for a minimum of two minutes prior to pressurization.

10.4.7.3.2 Nontransparent Envelopes - Resistors shall be tested as specified in 10.4.7.3.1 except that after cleaning, the resistors shall be rotated about their longitudinal axis for a minimum of two minutes, at a minimum ambient temperature of 80°C . Any evidence of dye coming from a resistor shall constitute a failure.

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APPENDIX J

Minimum Screening Requirements for Discrete Semiconductor Devices

10. General Requirements - Discrete semiconductor devices shall meet all applicable requirements of this document.

10.1 Screening - The screening requirements for nonstandard semiconductors for use in Grade 1 and Grade 2 applications shall be in accordance with Table II of MIL-STD-19500 and Appendix X herein.

10.1.1 Semiconductors for Grade 1 Applications - Each nonstandard semiconductor device used in Grade 1 applications shall, as a minimum, have successfully completed the following requirements:

a. JANS level screening per Table II of MIL-S-19500 with a 5% PDA after each burn-in test (HTRB, Steady-state Power, etc.)

b. Destructive Physical Analysis (DPA) per MIL-STD-883, Method 5009 and MIL-S-19500, and the applicable test methods of MIL-STD-750 (Decap-internal visual per Method 2072 or Methods 2073 and 2074, as applicable, SEM per Method 2077, die shear per Method 2017, etc.). The sample size shall be two devices or 1% of the inspection lot, whichever is greater, to a maximum of 5 total devices with zero reject.

10.1.2 Semiconductors for Grade 2 Applications - Each nonstandard semiconductor device used in Grade 2 applications shall, as a minimum, have successfully completed the following requirements:

a. JANTEXV level screening per Table II of MIL-S-19500 with the applicable PDA.

b. Destructive Physical Analysis (DPA) per MIL-STD-883, Method 5009, and in accordance with JANTEXV level requirements of MIL-S-19500 and the applicable test methods of MIL-STD-750 (Decap-internal visual per Method 2072 or Methods 2073 and 2074, as applicable, SEM per Method 2077, bond strength per Method 2037, die shear per Method 2017, etc.). The sample size shall be two devices or 1% of the inspection lot, whichever is greater, to a maximum of 5 total devices with zero rejects.

c. Particle Impact Noise Detection (PIND) test in accordance with Method 2052 (Condition B) of MIL-STD-750 for all semiconductors with an internal cavity, and lot acceptance/rejection criteria per paragraph 4.6.4.2 of MIL-S-19500.

d. Radiographic Examination in accordance with Method 2076 (two views) of MIL-STD-750.

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10.2 Marking - Marking shall be in accordance with MIL-S-19500, paragraph 3.7 to the extent specified herein as a minimum:

- a. A unique marking to signify compliance with the requirements specified herein.
- b. Manufacturer's identification (name, symbol or trademark).
- c. Serial number.
- d. Lot identification code (date code).

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APPENDIX K

Minimum Screening Requirements for Switches

10. General Requirements - Switches shall meet all applicable requirements of this document.

10.1 Screening Requirements - Switches shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified", these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each switch supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, tests and measurements shall be performed after all manufacturing processes have been performed. All switches that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal - Switches that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Soldering and welding shall be free of imperfections (10 X).
- b. Assembly of internal parts shall indicate that proper manufacturing techniques have been used (10 X).
- c. There shall be no cuts, breaks or abrasions in insulation (10 X).
- d. Wire shall be the correct length and shall contain no kinks (1 X to 10 X).
- e. Wire insulation shall contain no cracks, breaks or cuts (1 X to 10 X).
- f. Switches shall contain no solder flux or other foreign matter (10 X).
- g. There shall be no defects in workmanship, construction, design, materials and processes which could render any switch unsuitable for its intended use (10 X).
- h. When lubrication is required the quantity, quality and application shall be suitable for proper lubrication of the moving parts (10 X).

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Table I. Screening Requirements

Examination or Test	Paragraph
1. Visual Examination, Internal	10.2.1
2. Electrical and Mechanical Measurements, EM1	10.3
3. Vibration	10.4.1
4. Burn-In	10.4.2
5. Seal Leak, Fine (See Note 1)	10.4.3.1
6. Seal Leak, Gross	10.4.3.2
7. Electrical and Mechanical Measurements, EM2	10.3
8. Radiographic	10.4.4
9. Visual Examination, External	10.2.2

NOTES: 1. The seal leak, fine, test is applicable to hermetic sealed switches only.

i. The following characteristics shall be as specified:

1. Minimum clearances (10 X).
2. Critical dimensions (10 X).
3. Internal design and construction (1 X).

10.2.2 Visual Examination, External - Switches that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit or function of the switch (1 X to 10 X).

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- b. There shall be no imperfections in seal welds, coating, casting or plating (7 X).
- c. Glass seals shall be free of cracks (7 X).
- d. Marking shall include, but not be limited to:
 - 1. Part number (1 X).
 - 2. Lot or date code (1 X).
 - 3. Serial number (1 X).
- e. Insulated sleeves, if used, shall be free of nicks and gouges (7 X).
- f. The following characteristics shall be as specified:
 - 1. External design and construction (1 X).
 - 2. Dimensions (1 X).
 - 3. Weight (1 X).

10.3 Electrical and Mechanical Measurements - Electrical and mechanical measurements EM1 and EM2 shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein, or when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.3.2 Dielectric Strength

10.3.2.1 Test Method - Switches shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Special preparations - Switches shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- b. Test voltage - The test voltage shall be 1000 Vrms 60 Hz.
- c. Duration of test voltage - The test voltage shall applied for 60 ± 10 seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground with the switch in each of its operating positions.
- e. Examination after test - Switches shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

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Table II. Electrical and Mechanical Measurements

Measurements	Types	Test Method Paragraph	Accept-Reject Criteria Paragraph
<u>EM1</u>			
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Insulation Resistance	All	10.3.3.1	10.3.3.2
3. Operating Characteristics	All	10.3.4.1	10.3.4.2
4. Contact Resistance	All	10.3.5.1	10.3.5.2.1
5. Operating Force	See Note 1	10.3.6.1	10.3.6.2
<u>EM2</u>			
6. Dielectric Strength	All	10.3.2.1	10.3.2.2
7. Insulation Resistance	All	10.3.3.1	10.3.3.2
8. Contact Resistance	All	10.3.5.1	10.3.5.2.2

NOTES: 1. Operating force test applicable to all except dry reed or coax switches.

10.3.2.2 Accept-Reject Criteria - Switches that have leakage currents greater than the specified maximum limit, as specified by the procuring activity, indicated by the current measuring device of fault indicator, or that show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

10.3.3 Insulation Resistance

10.3.3.1 Test Method - Parts shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be 500 Vdc.
- b. Special preparations - Parts shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- c. Points of measurement - The measurements shall be made between all mutually insulated points, and then between each insulated point and ground with the switch in each of its operating positions.

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- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or 60 ± 10 seconds, whichever is greater.

10.3.3.2 Accept-Reject Criteria - The minimum insulation resistance shall be 1000 megohms. Switches that fail to meet this insulation resistance value shall be removed from the lot.

10.3.4 Operating Characteristics

10.3.4.1 Test Method - Switches shall be tested to determine that each operating position, locked, maintained, or momentary, is as specified.

10.3.4.2 Accept-Reject Criteria - Switches shall meet the operating characteristics specified. Switches that fail to meet this requirement shall be removed from the lot.

10.3.5 Contact Resistance

10.3.5.1 Test Method - The contact resistance of switches shall be measured as specified in Method 307 of Standard MIL-STD-202. The following details shall apply:

- a. Measurements shall be made between the terminals of the contacts of the same pole forming a switching circuit. Measurements shall be made with the switch in each of its operating positions.
- b. Test current - 0.1 ampere
- c. Open-circuit test voltage - 6 ± 2 Vdc
- d. Number of actuations - Three
- e. Number of measurements per actuation - One.

10.3.5.2 Accept-Reject Criteria

10.3.5.2.1 Accept-Reject Criteria, EM1 - Switches that fail to meet the contact resistance requirements specified shall be removed from the lot.

10.3.5.2.2 Accept-Reject Criteria, EM2 - The resistance shall not vary more than 50 percent from the EM1 value. Switches that fail to meet this requirement shall be removed from the lot.

10.3.6 Operating Force

10.3.6.1 Test Method - The force, or torque, as applicable, required to change contact positions of switches shall be determined by any suitable method.

10.3.6.2 Accept-Reject Criteria - Switches that fail to meet the requirements that follow shall be removed from the lot:

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- a. The operating force, or torque, shall be as specified.
- b. The operating force, or torque, of each part shall not vary more than 20 percent from the average of all parts bearing the same part number.

10.4 Conditions and Methods of Testing - Unless otherwise specified, all tests shall be performed at the general test conditions specified in Standard MIL-STD-202.

10.4.1 Vibration - Switches shall be vibrated to the following spectrum for one minute $\begin{matrix} +15 \\ -0 \end{matrix}$ percent per axis in each of three principal axes:

- 20 - 80 Hz, 3db/oct increase from 0.03g²/Hz to 0.3g²/Hz
- 80 - 500 Hz 0.3g²/Hz (20.g) constant
- 500 - 2000 Hz 3db/oct decrease to 0.03g²/Hz

Contact chattering shall be monitored during vibration as specified in Method 310, test condition A, test circuit B, of Standard MIL-STD-202. Switches that fail to meet the following requirements shall be removed from the lot:

- a. There shall be no opening of closed contacts greater than 10 micro-seconds in duration.
- b. There shall be no closing of open contacts greater than 10 micro-seconds in duration.

10.4.2 Burn-In

10.4.2.1 Operation - Switches shall be operated at a maximum rate of 60 cycles per minute at the temperature specified below. The total number of cycles shall be as follows:

- 100 cycles, no load - room ambient temperature, measure contact resistance.
- 100 cycles, rated load - room ambient temperature, measure contact resistance.

10.4.2.2 Contact Loads - Each contact shall make, break, and carry the rated load as specified.

10.4.2.3 Monitoring Circuit - The monitoring equipment shall provide a record of the number of cycles and shall record failures or discontinue the test if a failure occurs. During each closure the contact potential shall be monitored for at least 50 percent of the time the contacts are closed.

10.4.3 Seal Leak

10.4.3.1 Seal Leak, Fine - Hermetic sealed switches shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

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- a. Test condition - C (except that the gross leak test shall be as specified in paragraph 10.4.3.2)
 1. Procedure number - III
 2. Degree of leakage rate sensitivity - 10^{-8} atm cc/sec.

Switches that fail to meet this leakage rate requirement shall be removed from the lot.

10.4.3.2 Seal Leak, Gross - Switches shall be immersed in an enclosure containing water. The enclosure shall be subjected to a vacuum resulting in an absolute pressure equal to 63.5 mm (2.5 inches) of mercury, for 5 minutes. The immersed switches shall be observed for leakage as evidenced by a continuous stream of bubbles emanating from the switch case. The switches shall be removed from the water prior to release of the vacuum. Switches that fail to meet this requirement shall be removed from the lot. After removal from the bath, switches shall be dried for two hours at 25°C.

10.4.4 Radiographic

10.4.4.1 Radiographic Procedure - Sealed switches shall be inspected in accordance with the general requirements of Standard MSFC-STD-355 in addition to the following detail requirements:

- a. Radiographs shall be made with the toggle in the keyway position and the opposite keyway position.
- b. The radiographs shall show a side and end view.
- c. For the side view, the keyway shall be to the left. For the end view, the keyway shall be up.

10.4.4.2 Radiographic Analysis - When inspected as specified, the examination shall include, but not be limited to, the following:

- a. Extraneous material - There shall be no visible loose or extraneous materials or contaminants, such as weld or solder splashes and solder balls.
- b. Parts clearance - Acceptable switches shall exhibit adequate internal electrical and mechanical clearances.
- c. Miscellaneous defects - There shall be no omitted, broken or defective parts. Switches that fail to meet the requirements specified above, or in Standard MSFC-STD-355, shall be removed from the lot.

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APPENDIX L

Minimum Screening Requirements For Transducers

10. General Requirements - Transducers shall meet all applicable requirements of this document.

10.1 Screening Requirements - Transducers shall meet all applicable screening requirements specified in this appendix. When this appendix specifies that requirements shall be "as specified" these requirements shall be specified by the procuring activity in the ordering data.

10.1.1 Screening Inspection - Each transducer supplied to this document shall be subjected, in the sequence shown, to all applicable examinations, tests and measurements specified in table I. The visual examination, internal, shall be performed immediately prior to sealing, regardless of how many times it has been performed prior to this time. All other examinations, tests and measurements shall be performed after all manufacturing processes have been performed. All transducers that pass these examinations, tests and measurements shall be marked with the symbol "S" in front of the part number.

10.2 Visual Examinations - Unless otherwise specified, all visual examinations shall be made at the general test conditions specified in Standard MIL-STD-202.

10.2.1 Visual Examination, Internal - Transducers that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. Soldering and welding shall be free of imperfections (10 X).
- b. Assembly of internal parts to cores, mounting brackets and terminal boards shall indicate that proper manufacturing techniques have been used (10 X).
- c. Wire shall be the correct length and shall contain no kinks (10 X).
- d. Transducers shall contain no solder flux or other foreign matter (10 X).
- e. There shall be no defects in workmanship, construction, design, materials and processes which could render any transducer unsuitable for its intended use (10 X).
- f. When impregnation is required there shall be no air bubbles, improper curing, voids or lack of impregnation (10 X).
- g. The following characteristics shall be as specified:
 1. Minimum clearances (10 X).
 2. Critical dimensions (10 X).
 3. Internal design and construction (1 X).

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Table I. Screening Requirements

Examination or Test	Thermal Transducer	Pressure Transducers	Electro Magnetic Transducer	Position Transducer
1. Visual Examination Internal	10.2.1	10.2.1	10.2.1	10.2.1
2. Electrical Measurements, EM1	10.3	10.3	10.3	10.3
3. Vibration		10.4.1		
4. Electrical Measurements, EM2		10.3		
5. Thermal Shock	10.4.2	10.4.2	10.4.2	10.4.2
6. Burn-In	10.4.3	10.4.3	10.4.4	10.4.5
7. Proof-Pressure		10.4.6		
8. Seal Leak, Fine (See Note 1)	10.4.7.1	10.4.7.1	10.4.7.1	10.4.7.1
9. Seal Leak, Gross	10.4.7.2	10.4.7.2	10.4.7.2	10.4.7.2
10. Electrical Measurements, EM3	10.3	10.3	10.3	10.3
11. Radiographic	10.4.8	10.4.8	10.4.8	10.4.8
12. Visual Examination External	10.2.2	10.2.2	10.2.2	10.2.2

Notes: 1. Seal leak, fine, paragraph 10.4.7.1, applicable to hermetic sealed transducers only.

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10.2.2 Visual Examination, External - Transducers that fail to meet the following requirements, when examined under the magnification specified, shall be removed from the lot:

- a. There shall be no cracks, blisters, or any other imperfections affecting operating characteristics, or form, fit or function of the transducer (7 X).
- b. There shall be no imperfections in seal welds, coating, casting or plating (7 X).
- c. Glass seals and encasements shall be free of cracks or chips (7 X).
- d. Insulated sleeves, if used, shall be free of nicks and gouges (7 X).
- e. Plating on all surfaces shall not be discolored or show evidence of peeling. Cadmium or zinc shall not be used for plating (7 X).
- f. Marking shall include, but not be limited to:
 1. Part number (1 X)
 2. Lot or date code (1 X)
 3. Serial number (1 X)
- g. The following characteristics shall be as specified:
 1. External design and construction (1 X)
 2. Dimensions (1 X)
 3. Weight (1 X)

10.3 Electrical Measurements - The electrical measurements EM1, EM2, and EM3, shall consist of the measurements specified in table II, made in the order shown. The accept-reject criteria shall be as specified herein or, when applicable, as specified by the procuring activity. Measurements shall be recorded and submitted to the procuring activity as specified in paragraph 3.1.3.

10.3.1 Measurement Conditions - Unless otherwise specified, all measurements shall be performed at the general test conditions specified in Standard MIL-STD-202. For non hermetic sealed parts the relative humidity shall be less than 50 percent.

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Table II. Electrical Measurements

Measurements	Types	Test Method Paragraph	Accept Reject Criteria Paragraph
<u>EM2</u>			
1. Dielectric Strength	All	10.3.2.1	10.3.2.2
2. Insulation Resistance	All	10.3.3.1	10.3.3.2.1
3. Inductance and Quality Factor	Thermal and Magnetic	10.3.4.1	10.3.4.2
4. DC Resistance	Pressure	10.3.5.1.1	10.3.5.2.1
5. DC Resistance	Other than Pressure	10.3.5.1.2	10.3.5.2.1
6. Exciting Current	Thermal and Magnetic	10.3.6.1	10.3.6.2
7. Operational Check	Thermal	10.3.7.1	10.3.7.1.1 10.3.7.1.2
8. Operational Check	Pressure	10.3.8.1	10.3.8.2
9. Operational Check	Magnetic	10.3.9.1	10.3.9.2.1
10. Operational Check	Position	10.3.10.1	10.3.10.2
<u>EM2</u>			
11. Operational Check	Pressure	10.3.8.1	10.3.8.2
<u>EM3</u>			
12. Dielectric Strength	All	10.3.2.1	10.3.2.2
13. Insulation Resistance	All	10.3.3.1	10.3.3.2.2
14. DC Resistance	Pressure	10.3.5.1.1	10.3.5.2.2
15. DC Resistance	Other than Pressure	10.3.5.1.2	10.3.5.2.2
16. Exciting Current	Magnetic	10.3.6.1	10.3.6.2
17. Operational Check	Thermal	10.3.7.1	10.3.7.1.3
18. Operational Check	Pressure	10.3.8.1	10.3.8.2
19. Operational Check	Magnetic	10.3.9.1	10.3.9.2.2
20. Operational Check	Position	10.3.10.1	10.3.10.2

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10.3.2 Dielectric Strength

10.3.2.1 Test Method - Transducers shall be tested in accordance with method 301 of Standard MIL-STD-202. The following details shall apply:

- a. Special preparations - Transducers shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- b. Test voltage - The test voltage shall be as specified in table III, or as specified by the procuring activity, whichever is greater.
- c. Duration of test voltage - The test voltage shall be applied for 60 ± 0 seconds.
- d. Points of application of test voltage - Between all mutually insulated points, and then between all insulated points and ground.
- e. Examination during test - Leakage current shall be monitored during test.
- f. Examination after test - Parts shall be examined for evidence of arcing, flashover, breakdown of insulation or other damage.

10.3.2.2 Accept-Reject Criteria - Transducers that have leakage current paths that exceed 100 microamperes or show evidence of arcing, flashover, breakdown of insulation or other damage shall be removed from the lot.

10.3.3 Insulation Resistance

10.3.3.1 Test Method - Transducers shall be tested in accordance with method 302, Standard MIL-STD-202. The following details shall apply:

- a. Test voltage - The test voltage shall be as specified in table III, or as specified by the procuring activity, whichever is greater.
- b. Special preparations - Transducers shall be mounted or placed on a metal plate (ground) or V-block, as applicable.
- c. Points of measurement - The measurements shall be made first between all mutually insulated points, and then between each insulated point and ground.
- d. Electrification time - The electrification time shall be the time required for the resistance reading to stabilize, or 60 ± 0 seconds, whichever is greater.

10.3.3.2 Accept-Reject Criteria

10.3.3.2.1 Accept-Reject Criteria, EMI - The minimum insulation resistance shall be the greater of:

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- a. As specified in table III.
- b. As specified by the procuring activity.

Transducers that fail to meet the insulation resistance value specified above shall be removed from the lot.

10.3.3.2.2 Accept-Reject Criteria, EM3 - The minimum insulation resistance shall be the greater of:

- a. As specified in table III
- b. As specified by the procuring activity
- c. 90 percent of the EMI value

Transducers that fail to meet the insulation value specified above shall be removed from the lot.

Table III. Test specifications

Working Voltage (See Note 1)		Dielectric Strength rms Test voltage (See Note 1)	Insulation Resistance	
Greater Than	Up and Including		dc Test Voltage	Minimum Insulation Resistance (Megohms)
0 V	100 V	300	100	1000
100 V	175 V	500	300	7500
175 V	700 V	2.8 X working volt- age	500	7500
700 V		1.4 X work- ing voltage + 1000 volts	1000	10,000

Notes: 1. The working voltage, which is the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered, shall be as specified.

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10.3.4 Inductance and Quality Factor -

10.3.4.1 Test Method - The inductance and quality factor of all inductive elements in transducers shall be measured as specified.

10.3.4.2 Accept-Reject Criteria - The inductance and quality factor shall be as specified, or the nominal value \pm 10 percent, whichever is the lower limit value. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.5 DC Resistance10.3.5.1 Test Methods

10.3.5.1.1 DC Resistance, Pressure Transducers - The dc resistance of pressure transducers shall be measured as specified in method 303 of Standard MIL-STD-202. This measurement shall be made with no external pressure applied to the transducer.

10.3.5.1.2 DC Resistance, other than Pressure Transducers - The dc resistance shall be measured as specified in method 303 of Standard MIL-STD-202.

10.3.5.2 Accept-Reject Criteria

10.3.5.2.1 Accept-Reject Criteria, EMI - The dc resistance shall be as specified, or the nominal value \pm 10 percent, whichever is the lower limit value. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.5.2.2 Accept-Reject Criteria EM3 - The dc resistance shall not vary more than 2 percent from the EMI value. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.6 Exciting Current

10.3.6.1 Test Method - The exciting current of transducers shall be measured by applying the nominal input voltage and measuring the input current.

10.3.6.2 Accept-Reject Criteria - The value of the input current shall be as specified, or the nominal value \pm 10 percent, whichever is the lower limit value. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.7 Operational Check, Thermal Transducer10.3.7.1 Test Methods

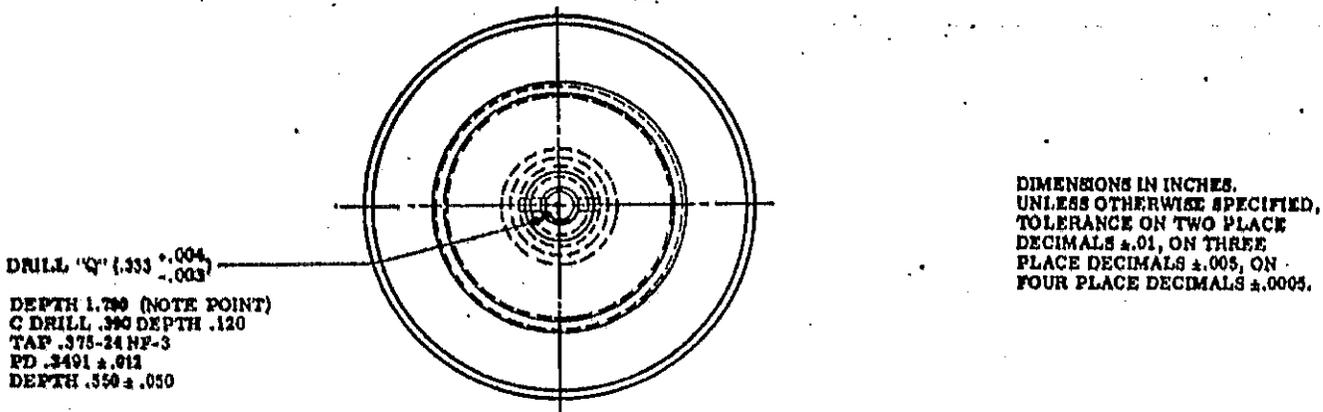
10.3.7.1.1 General - Unless otherwise specified, operational checks performed on thermal transducers shall use the test jig specified in figure 1.

10.3.7.1.2 EMF Output - Unless otherwise specified, the EMF produced by each thermal transducer shall be measured in 50°C steps over its operating range.

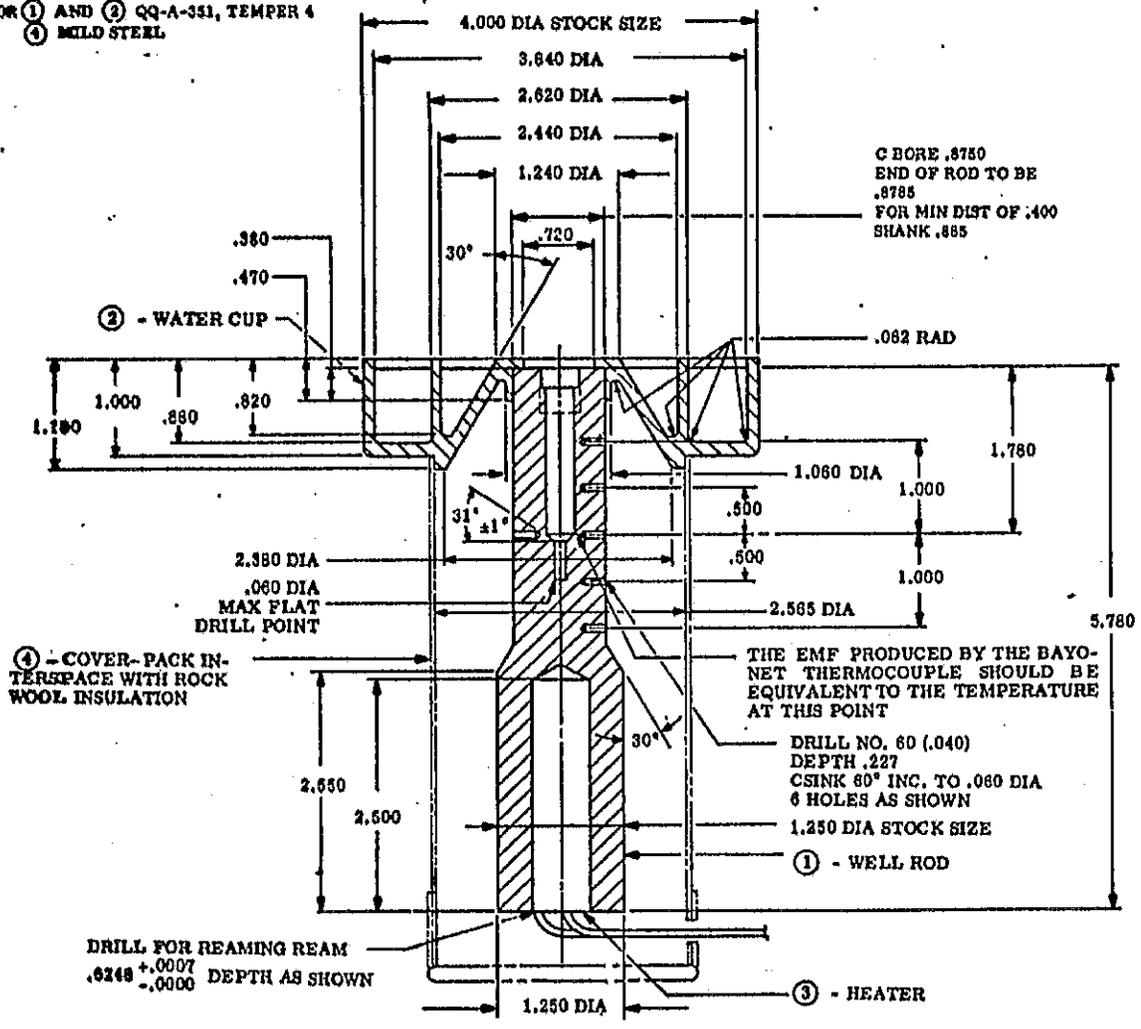
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MATERIAL - FOR ① AND ② QQ-A-351, TEMPER 4
 ④ MILD STEEL



BEFORE ASSEMBLY OF ① - WELL ROD, AND ② - WATER CUP, INSTALL SIX FE-CONST THERMOCOUPLES WITH 2 FT LEADS AS FOLLOWS: ARC WELD A SMALL BEAD TO FORM JUNCTION ON SPECIALLY SELECTED NO. 30 B & S GAGE, GLASS COVERED, IRON-CONSTANTAN, DUPLEX THERMOCOUPLE WIRE BY ELECTRICAL CONTACT OF TWISTED JUNCTION ON SURFACE OF MERCURY POOL. (USE 12-24V-DC). REMOVE OUTER GLASS BRAID FOR DISTANCE OF .500 FROM TIP, LEAVING INSULATION TO JUNCTION ON INDIVIDUAL WIRES. INSTALL TO FULL DEPTH OF HOLE BY CEMENTING WITH TECHNICAL - B COPPER DENTAL CEMENT. WRAP WIRES 1/2 TURN AROUND ROD, CEMENT TO ROD SURFACE WITH GLYPTAL, AND LASH TOGETHER, TAG WIRES TO SHOW LOCATION IN ROD. ASSEMBLE ① - WELL ROD, AND ② - WATER CUP, BY PRESSING TOGETHER. INSTALL ③ - HEATER IN BORE, PEEN LIGHTLY TO HOLD IN PLACE BRINGING INTEGRAL LEADS THRU ④, NEAR BOTTOM. SPLICE ON 3 FT OF LAMP CORD AND ATTACH STD 2 PRONG RECEPTICAL PLUG. PACK ROCK WOOL AROUND ① AND TIE IN PLACE WITH STRING BEFORE PRESSING ASSEMBLY INTO ④ - COVER.

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Figure 1. Thermocouple Test Jig.

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10.3.7.1.3 Response Time - Unless other temperatures are specified, response time of thermal transducers shall be measured using the temperatures specified herein. The tip temperature of the transducer shall be $200 \pm 2^{\circ}\text{C}$. The transducer shall be quickly transferred to another fixture which has a temperature of $260 \pm 2^{\circ}\text{C}$. The time required, after inserting the transducer into the second fixture, for the transducer to produce an EMF equivalent to 250°C as specified shall be noted. The response time shall be considered to be the average of ten measurements.

10.3.7.2 Accept-Reject Criteria

10.3.7.2.1 EMF Output, EM1 - The value of the EMF output shall be as specified, or the nominal EMF output ± 0.16 mV, whichever is the lower limit value. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.7.2.2 Response Time, EM1 - The average response time shall not exceed 20 seconds. Transducers that fail to meet this requirement shall be removed from the lot.

10.3.7.2.3 Accept-Reject Criteria, EM3 - The EMF output and the response time shall not vary more than 0.1 percent from the EM1 values. Transducers that fail to meet this requirement shall be rejected from the lot.

10.3.8 Operational Check, Pressure Transducers

10.3.8.1 Test Method

- a. The transducer excitation shall be 5.000 ± 0.005 Vdc, unless otherwise specified.
- b. The pressure fitting shall be protected to maintain requirements of MC-172 MSFC Design Standard by using a cavity pressure connector that seals onto the hex nut portion of the fitting and not the cone portion. The transducer pressure fittings must not be subjected to a torque greater than 60 pound inches.
- c. Each calibration point shall be approached from the lower side when progressing up scale and from the upper side when progressing down scale. There shall be no overshoot.
- d. The overall calibration accuracy of the test equipment shall be ± 0.2 percent or better of the transducer full scale output when computed by the square root of the sum of the squares method.
- e. The transducer calibration circuit shall be as specified.
- f. One full scale calibration run shall be made. It shall consist of 10 equally increasing pressure increments (including the end points) and the same 10 equally spaced increments with decreasing pressure. At every increment, two transducer output voltage

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readings shall be taken, one before dithering and one after dithering. Each calibration point shall be set to the nominal value within the accuracy of the test equipment.

8. A best fit curve shall be drawn through the points obtained during the one calibration run of f above.

10.3.8.2 Accept-Reject Criteria - Transducers shall meet the requirements as follows:

- a. Static error - The deviation of the undithered data points from the best fit curve of paragraph 10.3.8.1, f, shall not exceed ± 1.2 percent of the full scale output.
- b. Dynamic error - The deviation of the dithered data points from the best fit curve of paragraph 10.3.8.1, f, shall not exceed ± 0.75 percent of the full scale output.
- c. Independent linearity - The maximum deviation of the best fit curve from the best straight line (drawn through the same data points used to determine the best fit curve of paragraph 10.3.8.1, f,) shall not exceed ± 1.0 percent of full scale output.
- d. End point tolerances - The end point tolerances of the best fit curve of paragraph 10.3. 8.1, f, shall be as shown below: . . .

<u>Position</u> % of Full Scale	<u>Output Voltage (Vdc)</u> % of Full Voltage
0	2.0 ± 1.6
50	50.0 ± 2.0
100	98.0 ± 1.5 2.5

NOTE: Full scale output voltage shall be 5.0 Vdc unless otherwise specified.

Transducers that fail to meet these requirements shall be removed from the lot.

10.3.9 Operational Check, Electromagnetic Transducers

10.3.9.1 Test Method - Position electromagnetic transducer adjacent to rotating disc as shown in figure 2.

10.3.9.2. Accept-Reject Criteria

10.3.9.2.1 Accept-Reject Criteria EMI - Transducers shall meet the requirements as follows:

- a. Output waveform shall consist of alternate positive and negative

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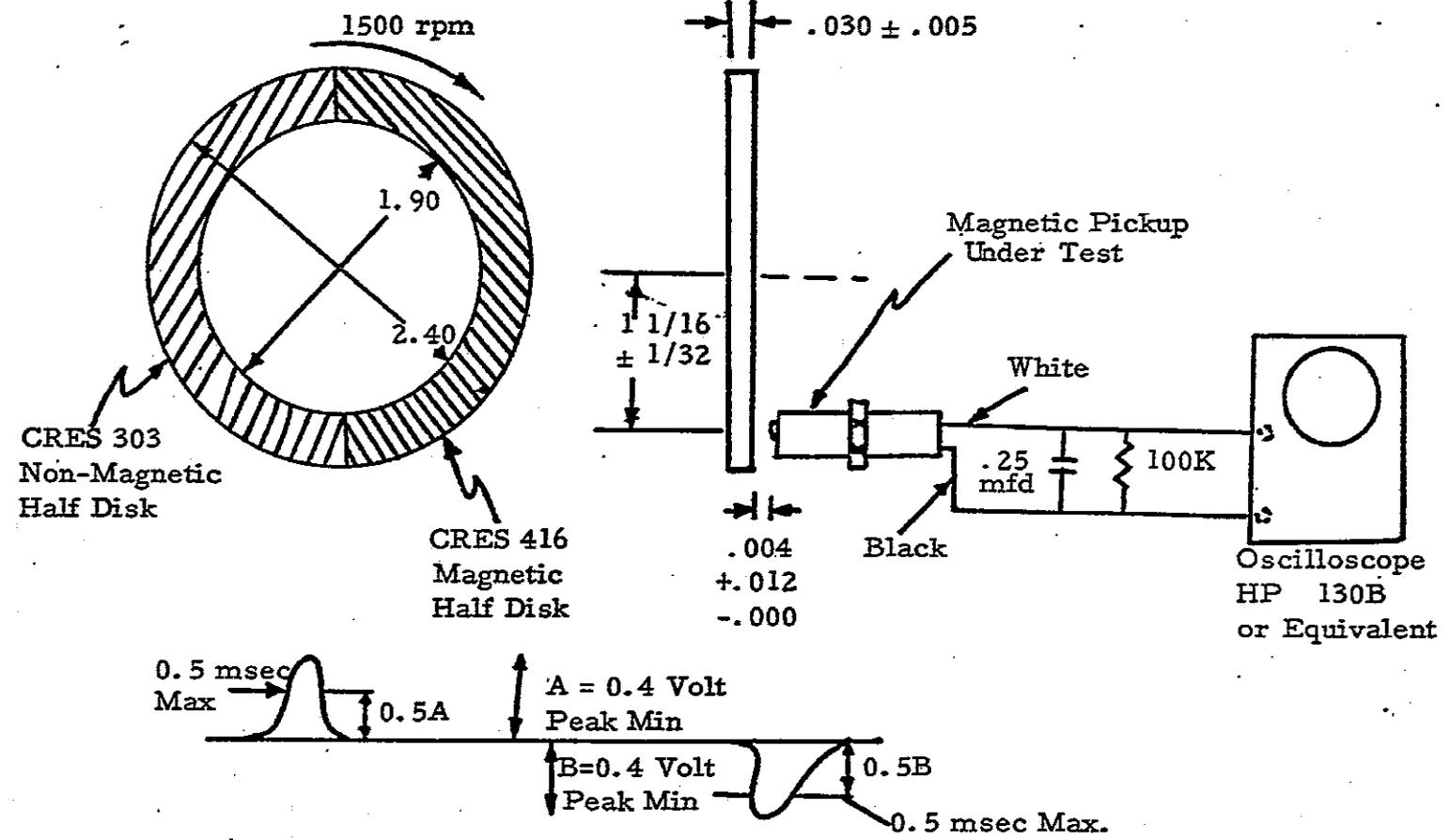


Figure 2. Voltage Output Measurement

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pulses, each pulse having the characteristics as specified.

1. Peak voltage amplitude - As specified.
2. Pulse width at 50 percent of peak amplitude- As specified.

- b. Output voltage pulse must be positive with respect to ground as specified as the disk adjacent to the pickup changes from the nonmagnetic half to the magnetic half. (This may be determined by rotating the disk manually, if desired.)

A typical waveform is shown in figure 2.

Transducers that fail to meet these requirements shall be rejected from the lot.

10.3.9.2.2 Accept-Reject Criteria EM3 - Transducers shall meet the requirements as follows:

- a. Output waveform shall consist of alternate positive and negative pulses, each pulse having the characteristics as specified.
 1. Peak voltage amplitude - Shall not vary more than 0.1 percent from the EM1 value.
 2. Pulse width at 50 percent of peak amplitude - As specified.
- b. Output voltage pulse must be positive with respect to ground as specified as the disk adjacent to the pickup changes from the non-magnetic half. (This may be determined by rotating the disk manually, if desired.)

Parts that fail to meet these requirements shall be removed from the lot.

10.3.10 Operational Check, Position Transducer

10.3.10.1 Test Method

- a. A position calibration run shall be made on each transducer. It shall consist of 10 equally increasing position increments (including the end points) and the same 10 equally spaced increments with decreasing positions. At every increment, two transducer output voltage readings shall be taken, one before dithering and one after dithering. Each calibration point shall be set to the nominal value within the accuracy of the test equipment.

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- b. The transducer excitation shall be 5.000 ± 0.005 Vdc unless otherwise specified. Each calibration point shall be approached from the lower side when progressing up scale and the upper side when progressing down scale. There shall be no overshoot. The overall calibration accuracy of the test equipment shall be $\pm 0.2\%$ or better of the transducer full scale output, when computed by the square root of the sum of the squares method.
- c. One full scale calibration cycle shall be performed consisting of zero, 20, 50, 80, 100, 80, 50, 20 and zero percent of full scale position points. At each point, two transducer output voltage readings shall be taken, one before dithering and one after dithering.
- d. A best fit curve shall be drawn through the points determined by averaging the dithered data points obtained during the one calibration run of c above.

10.3.10.2 Accept-Reject Criteria - Transducers shall meet the following requirements:

- a. Static error - The deviation of the undithered data points from the best fit curve of paragraph 10.3.10.1, d, shall not exceed ± 1.2 percent of the full scale output.
- b. Dynamic error - The deviation of the dithered data points from the best fit curve of paragraph 10.3.10.1, d shall not exceed ± 0.75 percent of the full scale output.
- c. Independent linearity - The maximum deviation of the best fit curve from the best straight line (drawn through the same data points used to determine the best fit curve of paragraph 10.3.10.1, d) shall not exceed ± 1.0 percent of full scale output.
- d. End point tolerances - The end point tolerances of the best fit curve of paragraph 10.3.10.1, d, shall be as shown below.

<u>Position</u> % of Full Scale	<u>Output Voltage (Vdc)</u> % of Full Scale
0	2.0 ± 1.6
100	$98.0 + 1.5$ $- 2.5$

NOTE: Full scale output voltage shall be 5.0 Vdc unless otherwise specified.

Parts that fail to meet these requirements shall be removed from the lot.

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10.4 Conditions and Methods of Test - Unless otherwise specified, all tests shall be performed at the general test conditions specified in Standard MIL-STD-202. For nonhermetic sealed parts the relative humidity shall not exceed 50 percent.

10.4.1 Vibration- Transducers shall be subjected to the following vibration scan test, unless a higher level is specified, then the higher levels shall be used.

- a. Preparation - Transducers shall be rigidly mounted with their normal mounting means, and shall be energized at rated frequency throughout the test. Accelerometers shall be mounted on top of the test fixture near the part support points to monitor vibration. Acceleration in either of the minor planes (crosstalk) shall not exceed 5g.
- b. Simple harmonic motion - Each transducer shall be subjected to simple harmonic motion at a double amplitude (total excursion) of 6.35 mm (0.250 inch) or 30g, whichever is less, over the frequency range of from 10 Hz to 3000 Hz and back to 10 Hz in a period of 10 minutes in each of the three mutually perpendicular planes. The change of frequency shall be logarithmic.
- c. Random vibration - Each transducer shall be subjected to a random vibration acceleration spectral density of $0.6g^2$ per Hz with a flat frequency spectrum (no more than 3 db down) between 20 Hz and 2000 Hz. The duration of random vibration shall be 4 minutes in each of the three mutually perpendicular planes.
- d. Monitoring - Continuity shall be monitored during vibration with a device capable of detecting and indicating discontinuities greater than 10 microseconds in duration.
- e. Rejection - Transducers shall be removed from the lot for the following reasons:
 1. Discontinuities observed during vibration.
 2. Evidence of physical damage such as cracks, bursting or bulging of transducers observed after vibration.

10.4.2 Thermal Shock - Transducers shall be tested as specified in method 107, of Standard MIL-STD-202. The following details shall apply:

- a. Test temperatures - As specified in table IV.
- b. Exposure time - The time required for resistance or voltage output, as applicable, to stabilize plus one minute.
- c. Monitoring during cycling -
 1. Thermal transducers-Output voltage

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Table IV. Test Conditions Thermal Shock

Temperature Rating of Part (See Note 1)	Step 1	Step 2	Step 3	Step 4
125°C	-65	25	125	25
200°C	-65	25	200	25
Above 200°C	-65	25	Maximum Rated (See Note 1)	
Below 65°C	Minimum Rated (See Note 1)	25	200	25

Notes: 1. Temperature rating of parts shall as specified.

2. Other transducers-Resistance

Transducers that show any evidence of physical damage or any discontinuities in the monitored characteristic shall be removed from the lot.

10.4.3 Burn-In, Pressure and Thermal Transducers - Transducers shall be subjected to burn-in conditions as follows:

- a. Temperature-Maximum operating temperature as specified.
- b. Applied input-Rated input as specified.
- c. Time - 168 \pm 4 hours

10.4.4 Burn-In, Electromagnetic Transducers - Transducers shall be subjected to five burn-in cycles totaling 168 hours (one week). Four of the cycles shall consist of 20 hours during which time the part shall be operated at maximum operating temperature as specified, with loading equal to rated ac or dc voltage as specified, followed by 4 hours at room ambient temperature without excitation. The fifth cycle shall be 68 hours at maximum operating temperature with parts loaded as before and 4 hours without excitation at room ambient temperature. This test may be performed at any ambient temperature and with any temperature rise provided that the maximum operating temperature of the part is held within $\pm 10^\circ$ and no drafts or varying air velocities are present.

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10.4.5 Burn-In, Position Indicating Transducers - Transducers shall be con-
details and exceptions shall apply:

- a. Mounting - Transducers shall be mounted by their normal mounting means. The chamber dimensions shall be such that they permit a minimum spacing of 6 inches between any two adjacent parts and 4 inches between any two adjacent parts and 4 inches between any part and the chamber walls.
- b. Test conditions - The temperature shall be the maximum operating temperature specified. For transducers with a nominal resistance value of 10,000 ohms or more the applied voltage shall be the dc voltage required to cause 10 ± 1 mA to flow in the part, or the rated voltage, as specified, whichever is the lower value.
- c. Test cycling-

Step one - 24 ± 1 cycles consisting of power on 1 1/2 hours and power off 1/2 hour.

Step two - The transducer shall be activated from high to low to high (one cycle) through not less than 95 percent of the actual electrical travel of the part as indicated by the output signal. The total number of cycles to be performed shall be 5 percent of expected life as specified.

Step three- 60 ± 1 cycles consisting of power on 1 1/2 hours and power off 1/2 hour.

10.4.6 Proof Pressure - Transducers shall be subjected to a proof pressure test under the conditions specified.

10.4.7 Seal Leak

10.4.7.1 Seal Leak, Fine - Transducers shall be tested in accordance with Method 112 of Standard MIL-STD-202. The following details shall apply:

- a. Test condition - C (except that the gross leak test shall be as specified in paragraph 10.4.7.2).
 1. Procedure number - III
 2. Degree of leakage rate sensitivity -10^{-8} atm cc/sec.

Transducers that fail to meet this leakage rate requirement shall be rejected from the lot.

10.4.7.2 Seal Leak, Gross - Parts shall be immersed for 4 to 5 minutes in a

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water bath maintained at a temperature of $85^{\circ} + 5^{\circ}\text{C}$. The temperature of the transducer shall not exceed 40°C at the time of immersion. During the time the transducer is in the water bath there shall be no continuous flow of air bubbles or leakage of compound from the transducer body. Transducers that fail to meet this requirement shall be rejected from the lot. After removal from the bath the part shall be dried for 2 hours at 25°C .

10.4.8 Radiographic

10.4.8.1 Radiographic Procedure - Transducers shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355 to determine that internal construction is as specified.

10.4.8.2 Radiographic Analysis - Each radiograph shall be analyzed in accordance with the following criteria. Transducers exhibiting deviations from this criteria shall be rejected from the lot.

- a. Transducers shall be of a homogeneous construction, and shall be as specified. Parts bearing the same part number shall have the same internal construction.
- b. The radiographic examination shall include, but not be limited to, inspection for foreign particles, solder splash, loose or mis-aligned parts.
- c. The tension on all wires shall be as specified. (There shall be no loops or excessive bends in the lead wire.)
- d. There shall be no visible extraneous material (loose bonding material will be considered extraneous material).
- e. There shall be no wires present except those specified.
- f. There shall be no evidence of defects in any internal element in the part.

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APPENDIX X

Nonstandard Parts

10.0 Nonstandard Parts Selection and Application Criteria

10.1 Introduction - The nonstandard parts selection criteria is a compilation of the "do's" and "do not's" of parts technology learned from prior application and space programs that are applicable to this program.

10.2 Nonstandard Parts Selection Criteria - Nonstandard parts shall be selected with first consideration given to the inherent capability of the parts to withstand the space, terrestrial, and mission environments to which the parts will be subjected. When making nonstandard parts selections, previous parts experience and known failure mechanisms, which have been documented in "GIDEP Failure Experience Data Bank Summary," shall be reviewed to assure that the selected parts do not have the same or similar design deficiencies or failure mechanisms. Parts with these known inadequacies shall not be selected. The additional general and specific criteria to be considered for each part type are contained in this section.

10.3 Nonstandard Parts Screening - Screening is the application of stresses and inspections at a level which will not jeopardize usage or reduce the life of acceptable parts, but which will reveal defects and accelerate failure mechanisms that are detectable by inspection or parameter measurement. All parts used by the contractor and their subcontractors shall be subjected to screening tests on a 100% basis. Screening tests shall be per paragraph 4.0 herein and may be included in a detail Specification Control Drawing (SCD) prepared by the contractor or their subcontractor as follows:

a. A nonstandard part with existing military specifications and listed in the Military Qualified Products List (QPL) is acceptable for use as a Grade 1 non-standard part without contractor or subcontractor SCD, but requires contractor (or subcontractor) mandatory source inspection for suppliers and PIND test and X-ray for all devices with an internal sealed cavity.

b. A nonstandard part with existing military specification, but not listed in the Military Qualified Products List (QPL) shall be controlled by an SCD as a cover sheet to the military specification, modified to include all additional requirements of a Grade 1 or Grade 2 part, as applicable, and contractor (or subcontractor) mandatory source inspection for suppliers and PIND test and X-ray for all devices with an internal sealed cavity.

c. A nonstandard part without an existing military specification shall be controlled by an SCD as a cover sheet to the vendor specification, modified to include all additional requirements of a Grade 1 or Grade 2 part, as applicable, and contractor (or subcontractor) mandatory source inspection for suppliers. The minimum screening requirements shall be as specified in paragraph 4.0.

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d. Qualification at the piece part level is required for all nonstandard parts. Qualification requirements shall be equivalent to or exceed the requirements imposed on standard parts and shall include requirements for qualification to all projected environments and proposed applications; e.g., temperature, vibration, radiation, etc. A qualification basis may be established by (a) existing data on the same part type, (b) similarity to qualified parts, or (c) by test. As a minimum, qualification by existing data and by similarity shall be based on qualification by test of the previous part type and both part types being produced by the same manufacturer on the same production line using similar in-process controls; and satisfactory completion of supplemental analyses and tests to the extent necessary to qualify any differences in design, manufacturer screening, and environmental levels with the previously qualified part. If adequate test data is not available in any of the above categories, qualification by test at the part level will be necessary in accordance with the applicable general military specifications and standards. In addition, for parts of unusual design, materials, or construction techniques and/or parts without satisfactory space flight history, qualification by test at the part level is mandatory.

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10.4 General Parts Selection Criteria

10.4.1 Flammability and Offgassing - Electrical and electromechanical devices exposed to an oxygen enriched atmosphere capable of sustaining combustion shall operate without introducing any fire hazard due to either normal operation or malfunctions occurring during the life of the components. These type parts must be hermetically sealed or in a sealed container. The hazardous characteristics of arc generation, flammability, and offgassing of all parts and materials shall be considered and shall meet the requirements of NHB 8060.1B.

10.4.2 Cadmium - Cadmium fumes are toxic and cadmium is prone to vaporize rapidly at combinations of temperature and pressure encountered in space flight applications and shall not be used.

10.4.3 Mercury - Mercury is a particularly hazardous liquid because of its toxicity and tendency to penetrate joints and amalgamate with structural materials and shall not be used.

10.4.4 Polyvinyl Chloride - Polyvinyl chloride outgasses products which are hazardous and corrosive and shall not be used. Products include HCL, CO, CO₂, phosgene, chlorine monoxide, and acidic carbonaceous coke.

10.4.5 Sealed Packages - The atmospheric environment encountered during launch ranges from sea level to hard vacuum. Therefore, only hermetically sealed parts should be selected for use in this environment. When hermetically sealed parts are not available, nonhermetically sealed parts used will be reviewed to assure that offgassing, sublimation, moisture penetration, or absorption will not be detrimental.

10.4.6 Construction - Parts with all-welded closure construction shall be used in preference to parts with other types of construction. The risk of galvanic corrosion (electrolytic corrosion) shall be minimized by consideration of relative galvanic potential in the selection and application of metals. Metals that differ in potential by more than 0.25 volts shall not be used in direct contact when exposed to a common electrolyte such as the atmosphere. Metal couples prohibited by the 0.25 volt limit shall not be used until they have been demonstrated to be satisfactory in the proposed application.

10.4.7 General Corrosion - General corrosion shall meet the requirements of MSFC-SPEC-150A.

10.4.8 Stress Corrosion - Stress corrosion cracking shall be controlled in accordance with MSFC drawing MSFC-SPEC-522A.

10.4.9 Conductive/Nonconductive Epoxy - Conductive epoxy or nonconductive epoxy may be used to attach uncased devices to the hybrid substrate. The epoxy material must meet the requirements outlined in MSFC-SPEC-592, Revision B.

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10.5 Specific Part Guidelines

10.5.1 Cable Accessories - Cable accessories such as ties, identification marks, and protective covers shall not generate toxic fumes nor burn when exposed to the heat of a short circuit in accordance with the applicable compartment requirements.

10.5.2 Capacitors

10.5.2.1 Ceramic

10.5.2.1.1 Feed-thru and Stand-off Types - These types of ceramic capacitors are considered "heat-sensitive" due to the use of soft-solder (360°F) at the internal lead-to-element bond. Users should specify high-temperature (530°F) solder. Most manufacturers can comply with this requirement. Heat-sink devices should always be used during installation, along with all precautions concerning time, temperature control, and size of soldering devices in order to prevent solder reflow within the capacitor.

10.5.2.1.2 Disc, Tubular and Rectangular Types - The precautions given in paragraph 10.5.2.1.1 apply to disc, tubular and rectangular types. In addition, leads should not be bent close to the capacitor body. When the application requires an epoxy bodied capacitor and the requirements prohibit outgassing, this type capacitor must be coated to inhibit outgassing.

10.5.2.2 Mica - Mica capacitors are classed as nonhermetically sealed. Epoxy-bodied mica capacitors will require adequate conformal coating to inhibit outgassing. However, some mica manufacturers use designs and fabrication that do not meet high reliability requirements. For this reason, mica capacitors must be specified with care. Each capacitor must be burned in for 48 hours at 200% of rated voltage at 125°C, and after burn-in, the capacitance measured.

10.5.2.3 Electrolytic

10.5.2.3.1 Aluminum - Aluminum electrolytic capacitors are unacceptable for space equipment.

10.5.2.3.2 Tantalum, Silver Cased Wet Slug - Silver cased wet slug tantalum capacitors are unacceptable for use in space equipment.

10.5.3 Circuit Breakers

10.5.3.1 Construction - Getters shall not be used. The construction shall be such to inhibit production of particles and internal damage during the closure and sealing process. Welded internal connections are preferred.

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10.5.3.2 Operation - The circuit breaker shall function as required regardless of the mounting position or physical restraint of the set-reset level.

10.5.3.3 Calibration - Changing the calibration or dismantling the circuit breaker must destroy the calibration seal.

10.5.3.4 Finishes - Nickel-flash or other noncorrosive finishes are recommended instead of paint.

10.5.3.5 Materials - Molybdenum, cadmium, and zinc shall not be used.

10.5.3.6 Thermal - The thermal transfer of energy by conduction (heat sinks), convection (atmosphere condition) and radiation and the environmental extremes to which the circuit breaker will be subjected must be considered when making the part selection.

10.5.4 Connectors

10.5.4.1 Plating - Zinc, cadmium, alloys of zinc or cadmium or plating using zinc or cadmium shall not be used because cadmium and zinc tend to vaporize at temperatures and pressures encountered in space applications and redeposit as conductive films on adjacent surfaces. Gold-over-silver contact plating should not be used because of the silver migration problem.

10.5.4.2 Contacts - Beryllium copper socket contacts of the split leaf design should be used. Each socket contact should be tested for pin retention to assure proper spring forces.

10.5.4.3 Outgassing - Baking for 48 hours minimum to 100 hours maximum at 350°F shall be performed to prevent outgassing and to relieve stress corrosion.

10.5.5 Cores

10.5.5.1 Powder - Powder cores to be used outside environmentally controlled areas shall be stabilized from -55 to +125°C. Tapewound cores shall be encased in aluminum boxes with a glass epoxy insert and damped with an inert silicone cushioning compound; Tapewound bobbin, and powder cores shall have a protective finish which will seal the core and shall withstand a 2200 volt rms 60 Hz test. All cores shall have a cure temperature greater than 170°C.

10.5.6 Diodes

10.5.6.1 Packaging - Diodes sealed or encapsulated with plastic shall not be used.

10.5.6.2 Chip Mount - Devices which have the chip mounted away from the header are sensitive to vibration and shall not be used. Soft solder die attach for power semiconductor devices shall not be used.

10.5.6.3 Cases - To promote standardization or parts for interchangeability, Joint Electron Device Engineering Council (JEDEC) registered case types and tolerances shall be used.

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10.5.6.4 Monolithic Double-Heat Sink Diode - Monolithic double-heat sink diodes shall be used whenever they are available.

10.5.6.5 Whisker Type Diodes - The whisker type diode construction shall not be used.

10.5.6.6 S-Bend Type Diodes - The S-bend or C-bend type diodes with rectangular cross section ribbon are undesirable except for transient voltage suppression diodes.

10.5.7 Fuses

10.5.7.1 Thermal - The thermal transfer of energy by conduction (heat sinks), convection (atmosphere condition), and radiation, and the environmental extremes to which the fuses will be subjected, must be considered when making the part selection.

10.5.8 Inductors

10.5.8.1 Design - Inductors should be selected from, and tested to, the applicable military specification as Grade 4 (hermetically sealed metal case) or Grade 5 (open end, encapsulated), Class S (130°C) or V (155°C), Operating Temperature and Life Expectancy X (10,000 hours minimum).

10.5.8.2 Potting and Impregnation - Parts should be vacuum-impregnated and either potted or metal-encased. Pre-baking and cure-baking procedures should be used. Thermo-setting adhesive tapes and compounds shall be cured as specified by the manufacturer.

10.5.8.3 Open-Type Construction - The use of impregnated open-type construction is not recommended for new designs. When the use of open type construction is mandatory, the device must be screened in accordance with Appendix D herein. Particular attention must be given to the post-cycling procedure.

10.5.8.4 Magnet Wire - The use of wire sizes smaller than 38 AWG is not recommended. Wire should be procured to the applicable military specification. The class will be dependent on the maximum hot spot temperature of the electro-magnetic device in the environment specified. All magnet wire windings shall be wound in the same direction using a constant tension device.

10.5.8.5 Lead Wire - Whenever the winding wire is smaller than 26 AWG, color-coded, nickel-plated lead wire shall be used and shall be secured to withstand a force at least 50 percent of the lead wire's tensile strength.

10.5.8.6 Insulation System - The use of a dual insulation system is not recommended. When an impregnant does not permeate an insulator, the result is a dual insulation system. In some cases, the dielectric strength (test voltage) of a combination of dielectrics is less than the strength of each dielectric when tested separately. The thickness of insulation shall be governed by the maximum instantaneous working voltage across the insulation of the device.

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10.5.9 Lamps, Incandescent

10.5.9.1 Mounting - Bayonet mounting is preferred since screw and wedge types tend to become loose when subjected to vibration.

10.5.10.1 Plastic Sealing Materials - Microcircuits sealed or encapsulated with plastic shall not be used.

10.5.10.2 Hybrid - Custom hybrid and custom multichip microcircuit designs shall comply with MIL-M-38510, Appendix G, and as specified herein.

10.5.10.3 Palladium Resistive Elements - Resistive elements of palladium compounds must be protected from the element hydrogen, or compounds of hydrogen, since the palladium resistive elements and hydrogen react causing the resistance to change drastically.

10.5.11 Relays, Electromechanical

10.5.11.1 Construction - Getters shall not be used. The construction shall be used to inhibit production of particles and internal damage during the closure and sealing process. Internal connection shall be secured by welds.

10.5.11.2 Operation - The relay shall function as required, regardless of mounting position.

10.5.11.3 Finishes - Nickel plating or other noncorrosive finishes are recommended instead of paint.

10.5.11.4 Materials - Molybdenum, cadmium, and zinc shall not be used.

10.5.11.5 Contact Erosion - The terminal glass beads shall be protected by a splatter shield whenever the possibility of contact erosion exists.

10.5.12 Relays, Solid-state

10.5.12.1 A solid-state relay is considered as a combination of discrete parts with a semiconductor power switch in a modular assembly, or as a custom design hybrid microcircuit with a semiconductor power switch which performs the function of an electromechanical relay. Although solid-state relays do not appear in the standard parts list, their use is encouraged. The solid-state relays will be controlled by specifications. The custom design hybrids are to be designed in accordance with MIL-M-38510, Appendix G, and as specified herein.

10.5.13 Resistors

10.5.13.1 Talon Leads - Resistors with talon leads shall not be used because they are subjected to loss of termination and migration of the metal additives in compounds used in terminating the resistive element. End-cap construction should be specified.

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10.5.13.2 Palladium-Silver Resistive Elements - Palladium type resistor elements shall not be used since they are subject to chemical reduction when exposed to hydrogen.

10.5.13.3 Soft Solder - Resistors which use soft solder to connect resistance elements to the terminal leads are not applicable for space use. During soldering operations, sufficient heat may be conducted by the lead to cause solder flow at the internal connections.

10.5.13.4 Dumet Leads - The lead diameter shall not exceed 0.5 millimeter (0.020 inch) for glass-core or glass-encased resistors. Bending larger size Dumet wire for assembly, unless carefully controlled, may induce stresses within the glass which can lead to cracking.

10.5.13.5 Wire Size - Wire shall not be less than 0.02 millimeter (0.001 inch) in diameter for precision fixed wire-wound resistors and not less than 0.4 millimeter (0.00175 inches) in diameter for fixed wire-wound power resistors.

10.5.14 Switches, Electromechanical

10.5.14.1 Construction - Getters shall not be used. The construction shall be such to inhibit production or particles and internal damage during the closure and sealing process. Internal structure shall be secured by welds.

10.5.14.2 Operation - The switch shall function as required regardless of mounting position.

10.5.14.3 Finishes - Nickel plating or other noncorrosive finishes are recommended instead of paint.

10.5.14.4 Materials - Molybdenum, cadmium, and zinc shall not be used.

10.5.14.5 Contact Erosion - Terminal glass beads shall be protected by a splatter shield whenever the possibility of contact erosion exists.

10.5.15 Switches, Solid-state

10.5.15.1 A solid-state switch is considered as a discrete semiconductor switch, as a combination of discrete parts with a semiconductor switch in a modular assembly, or as a custom design hybrid microcircuit with a semiconductor switch which performs the function of an electromechanical switch. Presently, solid-state switches do not appear in the Preferred Parts List since standards have not been established, though their use is encouraged. Discrete transistor switches, however, are listed as transistors. Solid-state switch parts will be controlled by the specifications of the discrete parts. Custom design hybrids shall be designed in accordance with MIL-M-38510, Appendix G, and as specified herein.

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10.5.16 Terminals

10.5.16.1 Style - Crimp-type terminals should be used whenever possible.

10.5.16.2 Plating - Particular attention should be taken to assure that cadmium plating is not used, especially on stud mounted terminals.

10.5.17 Transformers

10.5.17.1 Design - Transformers should be selected from, and tested to, the applicable military specification as Grade 4 (hermetically sealed metal case) or Grade 5 (open end, encapsulated), Class S (130°C) or V (155°C), Operating Temperature and Life Expectancy X (10,000 hours minimum).

10.5.17.2 Potting and Impregnation - Parts should be vacuum-impregnated then potted or metal encased. Pre-baking and cure-baking procedures should be used. Thermo-setting adhesive tapes and compounds shall be cured as specified by the manufacturer.

10.5.17.3 Open Type Construction - The use of impregnated open type construction is not recommended for new designs. When the use of open type construction is mandatory, the devices must be screened per the requirements of this document. Particular attention must be given to the post-cycling procedure for open type parts.

10.5.17.4 Magnet Wire - The use of wire sizes with a cross section area less than 38 AWG is not recommended. Wire should be procured to the applicable military specification. The class will be dependent on the maximum hot spot temperature of the electromagnetic device in the environment specified. All magnet wire windings shall be wound in the same direction using a constant tension device.

10.5.17.5 Lead Wire - Whenever the winding wire is smaller than 26 AWG, color-coded, multi-strand, nickel-plated lead wire shall be used and shall be secured to withstand a force of at least 50 percent of the lead wire's tensile strength.

10.5.17.6 Insulation System - The use of a dual insulation system should be avoided whenever possible. When an impregnant does not permeate an insulator, the result is a dual insulation system. In some cases, the dielectric strength (test voltage) of a combination of dielectrics is less than the strength of each dielectric when tested separately. The thickness of insulation shall be governed by the maximum instantaneous working voltage across the insulation of the device.

10.5.18 Transistors

10.5.18.1 Packaging - Transistors which are sealed or encapsulated with plastic shall not be used.

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10.5.18.2 Chip Mount - Devices which have the chip mounted away from the header are sensitive to vibration and shall not be used. Soft solder die attach for power semiconductor devices shall not be used.

10.5.18.3 Mesa Construction - Mesa type construction for transistors should be avoided. The junctions are exposed and susceptible to leakage and contamination. If these devices are required, the semiconductor chip should be passivated to prevent junction leakage and contamination.

10.5.18.4 Cases - To promote standardization of parts for interchangeability, JEDEC registered case types and tolerance shall be used where possible.

10.5.18.5 Germanium - Germanium transistors should not be used. They do not offer the wide temperature range necessary for space applications. However, when certain characteristics only available in germanium transistors are required, extreme caution should be employed to insure that the operating range of the transistor is not exceeded.

10.5.19 Wire, Electrical

10.5.19.1 Plating - Silver-plated copper wire (see MIL-STD-975).

10.5.19.2 Insulation - The preferred insulation for all applications is Teflon.

10.5.20 Static Sensitive Parts - Electrostatic Discharge (ESD) control for static sensitive parts shall comply with the requirements of DOD-STD-1681, except paragraph 5.2.1 is deleted.

10.5.21 Parts Derating Criteria - The EEE parts derating shall comply with the derating criteria of MIL-STD-975, Appendix A.

CODE IDENT NO	DWG SIZE	MSFC-SPEC-1198	
	A	SHEET	X-10

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL
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a. Class B requirements of Method 5008, MIL-STD-883.

b. Destructive Physical Analysis (DPA) in accordance with Method 5009 of MIL-STD-883.

c. Particle Impact Noise Detection (PIND) test in accordance with Method 2020 (Condition B) of MIL-STD-883, and lot acceptance/rejection criteria per MIL-M-38510.

d. Radiographic Examination in accordance with Method 2012 (two views) of MIL-STD-883.

10.2 Marking - Marking shall be in accordance with MIL-M-38510, paragraph 3.6, to the extent specified herein as a minimum:

a. A unique marking to signify compliance with the requirements specified herein.

b. Manufacturer's identification (name, symbol or trademark).

c. Serial number.

d. Inspection lot identification code (date code).

CODE IDENT NO	DWG SIZE	MSFC-SPEC-1198
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FILE NO. MSFC-SPEC-1198

202 -

DR060PRO

PACKAGE NO. 10443R

DOCUMENTATION RELEASE LIST
GEORGE C. MARSHALL SPACE FLIGHT CENTERMSFC CODE IDENT 14981/339B2
ISSUE DATE FEB 22 2007

PAGE 1

C H	DOCUMENT NUMBER	DRL DRL DSH REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
*	MSFC-SPEC-1198	202 -	SCREENING REQUIREMENTS FOR NON-STANDARD ELECTRICAL AND ELECTRONIC PARTS	000-00-0000	0000000	ZA	NONE

CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION	
	C	SCN000	F. VILLELLA	EB13	03/02/94	REVISION 'C' RELEASED 11/23/87.	
*	1	C	SCN000	EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.

CHECKER

N/A
02/15/07

(FINAL)

PACKAGE NO: 10443R

PROGRAM/PROJECT: MULTI

LAST UPDATED: 02/22/07

NOMENCLATURE: MSFC-STD- GOING TO NONE EFFECTIVITY

ECR NO:	PCN:	CCBD NO:	DATE PREPARED:
EO03-0000	0000000	000-00-0000 SB3-00-0000	02/22/07

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
			MSFC-RQMT-1282		202	-			
			MSFC-SPEC-1198		202	-			
			MSFC-SPEC-1238		202	-			
			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
			MSFC-SPEC-1870		202	-			
			MSFC-SPEC-1918		203	-			
			MSFC-SPEC-1919		206	-			
			MSFC-SPEC-2083		202	-			
			MSFC-SPEC-2223		202	-			
			MSFC-SPEC-2489		206	-			
			MSFC-SPEC-2490		205	-			
			MSFC-SPEC-2491		203	-			
			MSFC-SPEC-2492		203	-			
			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
			MSFC-SPEC-445		202	-			
			MSFC-SPEC-504		202	-			
			MSFC-SPEC-521		202	-			
			MSFC-SPEC-548		202	-			
			MSFC-SPEC-560		202	-			
			MSFC-SPEC-626		202	-			
			MSFC-SPEC-684		202	-			
			MSFC-SPEC-708		202	-			
			MSFC-SPEC-766		202	-			
			MSFC-STD-1249		202	-			
			MSFC-STD-1800		202	-			
			MSFC-STD-246		202	-			
			MSFC-STD-2594		203	-			

DOCUMENTATION PACKAGE/ROUTING REPORT

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DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES	ACTION
EO03		X		X		EO03

PREPARED BY:
EUGENA GOGGANS
12/19/06

SUBMITTED BY:

CONCURRENCE:

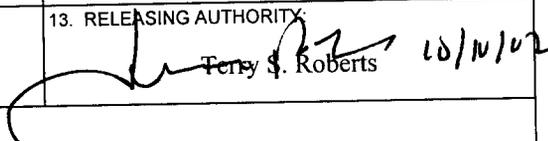
TRANSMITTAL DATES
TO RELEASE DESK 02/22/07 10:00
TO MSFC DOC REP 02/22/07 00:00

REMARKS:

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MSFC DOCUMENTATION REPOSITORY - DOCUMENT INPUT RECORD

I. GENERAL INFORMATION

1. APPROVED PROJECT: Multi-program projects	2. DOCUMENT/ DRAWING NUMBER: MSFC-SPEC-1198 Revision C	3. CONTROL NUMBER:	4. RELEASE DATE: 10/09/1987	5. SUBMITTAL DATE: 10/09/2002
6. DOCUMENT/DRAWING TITLE: Screening Requirements for Nonstandard EEE Parts			7. REPORT TYPE: MSFC Specification	
8. CONTRACT NUMBER / PERFORMING ACTIVITY:		9. DRD NUMBER:	10. DPD / DRL / IDRD NUMBER:	
11. DISPOSITION AUTHORITY (Check One): <input checked="" type="checkbox"/> Official Record - NRRS 8/12/A <input type="checkbox"/> Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)		12. SUBMITTAL AUTHORITY: Charles L. Gamble, Jr./ED16		13. RELEASING AUTHORITY:  Terry S. Roberts 10/11/02
14. SPECIAL INSTRUCTIONS: Document will be available on the Electronic Master List. <i>Arene Taylor / ED10 CER</i>				
15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER: ED16 Charles L. Gamble, Jr. (256) 544-3353			16. ORIGINATING NASA CENTER: MSFC	
			17. OFFICE OF PRIMARY RESPONSIBILITY: ED16	
18. PROGRAMMATIC CODE (5 DIGITS):			19. NUMBER OF PAGES: 163	

II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:
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III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION: <i>C</i>	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
30. ISSUE:	31. ANNEX:	32. SCN:	33. DCN:	34. AMENDMENT:	
35. APPENDIX:	36. ADDENDUM:	37. CCBD:	38. CODE ID:	39. IRN:	

IV. EXPORT AND DISTRIBUTION RESTRICTIONS

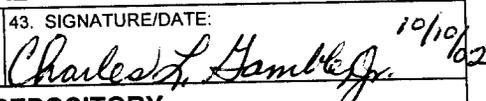
- Privacy Act (see MWI 1382.1)

 EAR (see MPG 2220.1)
- Proprietary (see MPD 2210.1)

 Other ACI (see NPG 1620.1 and MPG 1600.1)
- Patent (see MPG 2220.1)

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V. ORIGINATING ORGANIZATION APPROVAL

40. ORG. CODE: ED16	41. PHONE NUMBER: (256) 544-3353	42. NAME: Charles L. Gamble, Jr.	43. SIGNATURE/DATE:  10/10/02
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VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY: <i>Jammy Wise</i>	45. DATE RECEIVED: 10-15-03	46. WORK ORDER:
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