EEE Parts Verification Specification

for Domestic Space Program

(Top Level Guideline)

CONTENTS

I. Top Level Guideline

Summary

1. Purpose

- This specification documents issued for use in domestic space program as a guideline for verification of EEE parts. This document can be used in domestic test facility for EEE part verification test.

2. Scope

- This document and related specifications are intended to focus on verification test requirements of the EEE parts at this time
- General developments and quality requirements other than test are not fully covered by this verification documents
- This document address top level guidelines to use this and related documents for verification application of EEE parts

3. General Policy

- This top level document address overall policy of verification test, and as a lower level document, generic specification, defines generic requirements for each part types. Specific test conditions and flows shall be defied in detail specification including any deviations from generic specification.

4. Documents Structure

- KR-EEE-001, EEE Parts Verification Specification for Domestic Space Program: Top level document of verification test specifications
- KR-EEE-GSP-001, Generic EEE Parts Verification Test Specification for Domestic Space Program

5. Applicable Documents

- MIL- STD-883 Test Method Standard, Microcircuits
- MIL- STD-750 Test Methods for Semiconductor Devices
- MIL-STD-202 Test Method Standard, Electronic and Electrical Component Parts
- MIL-STD-1580 Test Method Standard, Destructive Physical Analysis for EEE Parts
- EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating
- ECSS-Q-ST-60, Space Product Assurance - Electrical, electronic and electromechanical (EEE) components

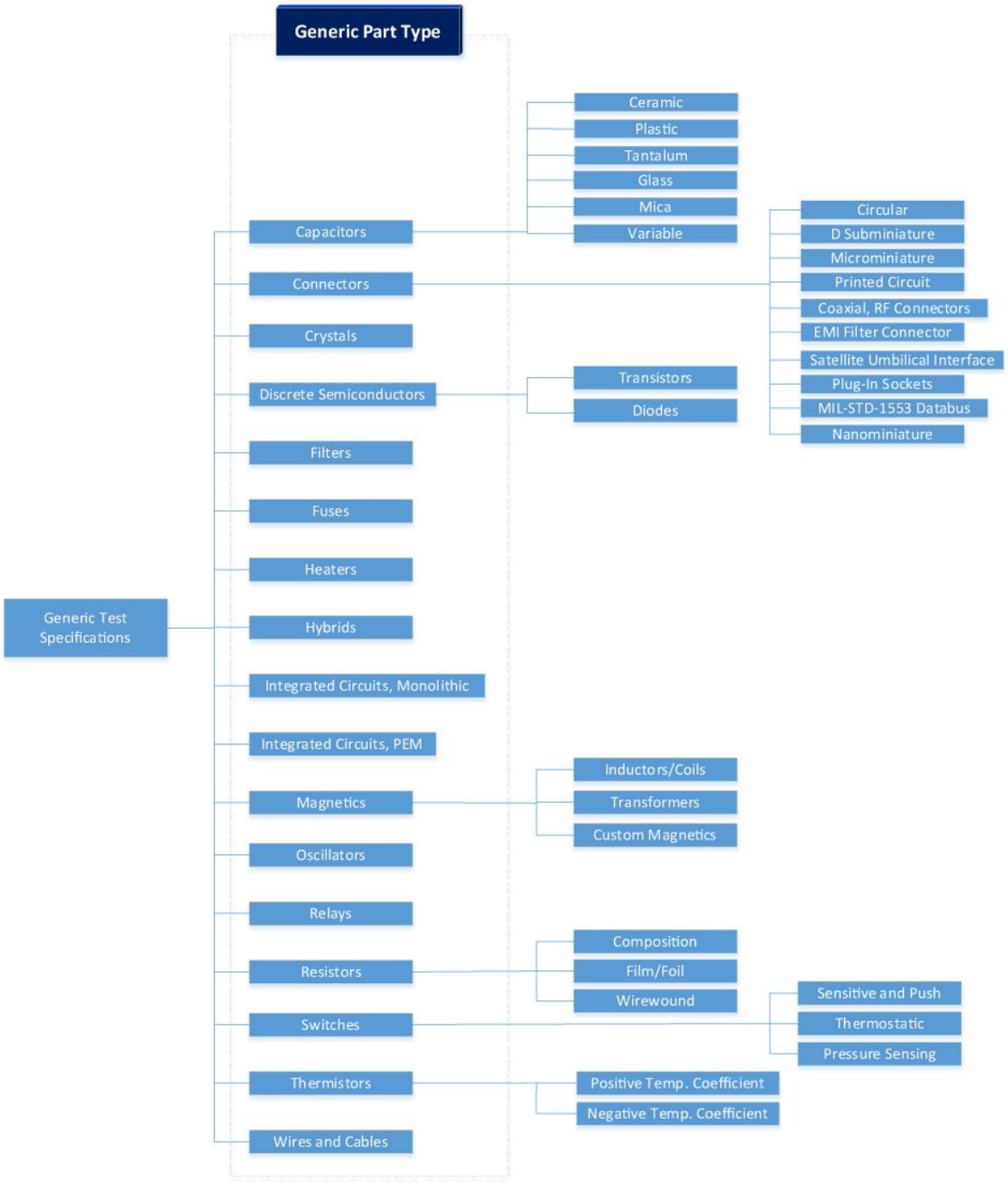
6. Order of Precedence

- In the event of a conflict between the text of this specification and the applicable specifications, the following order of precedence shall apply:
  - i) Detail specification
  - ii) Generic specification
  - iii) This document

7. Categories of EEE part

- Part type covered in this document and generic document, KR-EEE-GSP-001, categorized as following
  - i) Generic part type: General type of part which contains various detail part type
  - ii) Detail part type: Detail type of part, categorized from generic part type according to variance of function, material, package, etc.

Summary


Generic Part Type
Generic Test Specifications
Capacitors
Ceramic
Plastic
Tantalum
Glass
Mica
Variable
Connectors
Circular
D Subminiature
Microminiature
Printed Circuit
Coaxial, RF Connectors
EMI Filter Connector
Satellite Umbilical Interface
Plug-In Sockets
MIL-STD-1553 Databus
Nanominiature
Crystals
Discrete Semiconductors
Transistors
Diodes
Filters
Fuses
Heaters
Hybrids
Integrated Circuits, Monolithic
Integrated Circuits, PEM
Magnetics
Inductors/Coils
Transformers
Custom Magnetics
Oscillators
Relays
Resistors
Composition
Film/Foil
Wirewound
Switches
Sensitive and Push
Thermostatic
Pressure Sensing
Thermistors
Positive Temp. Coefficient
Negative Temp. Coefficient
Wires and Cables

8. Verification Test

- Various kind of test flow exist which shall be applied in space application by purpose of verification and quality status of the part. Definitions and guidelines of each verification test are as follows

i) Screening test :

- The purpose of screening is to detect and remove defective parts and reduce infant mortality failures (parts with random defects that are likely to result in early failures, known as infant mortality).
  - Screening test should be performed on all samples of part (100% samples)
  - Screening test flow is the first step of verification test.
  - Test requirements are different for each part type and each quality level. Generic and detail specification describe specific screening guidelines for each part type and each quality level.

ii) Qualification test

- Qualification testing consists of mechanical, electrical, and environmental inspections, and is intended to verify that materials, design, performance, and long-term reliability of the part are consistent with the specification and intended application, and to assure that manufacturer processes are consistent from lot to lot
- Qualification test shall be performed on samples from screened parts
- Qualification guidelines are described in generic and detail specifications for each part type.

iii) Lot Acceptance test

- The purpose of the Lot Acceptance test is to evaluate lot conformity
- Test consists of electrical, mechanical, and environmental inspections
- Lot Acceptance test shall be performed on samples from screened parts per each procured lot
- Lot Acceptance test requirements shall be defined in the detail specification with level of evaluation tests and conditions depending on the application quality requirement
- High level test conditions are to ensure that no wear-out mechanisms would cause premature failures during the part storage, ground phase integration period, and spacecraft mission.
- LAT/QCI sample shall not be used as flight part

iv) DPA

- The purpose of DPA test is to determine whether the lot has any design, material, workmanship, or process flaws that may not show up during screening and qualification tests and cause degradation or failures during the hardware integration period and spacecraft mission lifetime.
- DPA shall be performed on samples from each lot
- General DPA test items are as follows
  - External visual examination
  - Hermeticity testRadiographic inspection
  - PIND
  - Internal visual examination (Optical magnification inspection)
  - Bond pull test
  - SEM
  - Die shear
- Reference document is MIL-STD-1580 for each type of part

v) Re-life

- Due to latent failure modes are progressed, part whose date code over 7 years from installation shall be re-evaluated by re-life test
- Parts whose date code over 10 years shall not be used as space flight part
- Re-life test procedure (spec.) shall be defined in separate document

vi) Radiation Verification Test (RVT)

- Any active devices intended to be applied in satellite equipment shall be reviewed on its radiation characteristics.
- RVT test shall follow standard test procedure. There are two standards procedure, one is from ESCC spec. and the other is from US Military spec.
  - Total Ionizing Dose (TID) test procedure
    A. ESCC no. 22900, TOTAL DOSE STEADY-STATE IRRADIATION TEST METHOD
    B. MIL-STD-883, Method 1019.9, Ionizing Radiation (Total Dose) Test Procedure

- Single Event Effects (SEE) test procedure

  A. ESCC no. 25100, SINGLE EVENT EFFECTS TEST METHOD AND GUIDELINES

9. Application of Test Flow

- Overall verification items that shall be applied for each EEE part shall be specified in the verification order sheet
- Following verification guidelines can be applied depending on the part quality status

  i) Commercial parts

  - Screening Test + Lot Qualification Test + DPA + PIND & Radiography (when applicable) + RVT (for active parts)
  - Level of Screening & Qualification shall be specified in order sheet
  - Commercial parts need to be qualified on lot to lot base for space application

  ii) Manufacturer's High Reliability (Hi-Rel) parts which include qualified heritage

  - Screening Test + Lot Acceptance Test + DPA + PIND & Radiography (when not included) + RVT (if necessary)
  - Level of Screening & Lot Acceptance Test shall be specified in order sheet

  iii) Standard numbered parts from ESCC, NASA or US Military specifications

  - In case equal or exceed of intended quality level
    - DPA (optional depending on the criticality) + PIND & Radiography (when not included) + RTV (if necessary)
  - In case below of intended quality level
    - Up-screening + Lot Acceptance Test + DPA (optional depending on the criticality) + PIND & Radiography (when not included) + RTV (if necessary)

  iv) PIND test is mandatory inspection for all hermetic packaged parts which have internal cavity. It shall be performed on 100% samples

  v) Radiation characteristics shall be evaluated for each active parts, especially for microcircuit devices.

10. Applicable Quality Level

- Level 1

  i)This quality level is intended for highest reliability and lowest level of risk

- Level 2

  i)This quality level has moderate risk level balanced by cost constraints and mission objectives

- Level 3

  i)This quality level has high risk and unknown risk for space applications

11. Part Number and Marking

- All parts tested according to this specification system shall be Identified with unique number or symbol

12. Nonconformance

- Any failure during the test shall be recorded and isolated from the test lot
- Failed part shall be identified with unique mark

Ⅱ. Generic EEE Parts Verification Test Specification

Summary

1. Scope

- This generic specification specifies general verification requirements for each part types. Specific requirements and any deviation from this document shall be described in detail specification (or SCD (Source Control Drawing))

2. Applicable Documents

- EEE Parts Verification Specification for Domestic Space
- MIL- STD-883 Test Method Standard, Microcircuits
- MIL- STD-750 Test Methods for Semiconductor Devices
- MIL-STD-202 Test Method Standard, Electronic and Electrical Component Parts
- MIL-STD-1580 Test Method Standard, Destructive Physical Analysis for EEE Parts
- EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating
- ECSS-Q-ST-60-05, Generic Procurement Requirements for Hybrid

3. Order of Precedence

- In the event of a conflict between the text of this specification and the applicable specifications, the following order of precedence shall apply:
  - i) Detail specification
  - ii) Generic specification
  - iii) Applicable documents of this specification

4. Categories of EEE part

- Part type covered in this document categorized as following
  - i) Generic part type: General type of part which contains various detail type of part
  - ii) Detail part type: Detail part type General part type can be categorized to with functional, material, packaging

5. Applicable Quality Level

i) This quality level is intended for highest reliability and lowest level of risk

- Level 2

i) This quality level has moderate risk level balanced by cost constraints and mission objectives

- Level 3

i)This quality level has high risk and unknown risk for space applications

6. Part Number and Marking

- All parts tested according to this specification system shall be Identified with unique number or symbol

7. Nonconformance

- Any failure during the test shall be recorded and isolated from the test lot
- Failed part shall be identified with unique mark

8. Whisker Control

- Pure tin finish is not permitted as is due to whisker problems. Terminal lead material shall be checked before verification testing.

9.List of Generic Specification

- List of generic specification for each part type is as follows

No.	Item
2	Hybrid
3	Heaters
4	Magnetics
5	Microcircuits, Monolithic
6	Microcircuits, PEM
7	Discrete Semiconductor Devices
8	Capacitors
9	Crystal
10	Crystal Oscillators
11	Relays
12	Resistors
13	Filters
14	Fuses
15	Thermistors
16	Wire and Cable

2: HYBRID MICROCIRCUITS

Scope

This Section covers verification of hermetically sealed hybrid microcircuits, multi-chip modules (MCMs), and similar devices as defined in MIL-PRF-38534, General Specification for Hybrid Microcircuits, and ECSS-Q-ST-60-05, Generic Procurement Requirements for Hybrid.

For Plastic encapsulated hybrids, refer to PEM Section.

The hybrids shall be verified for required class or grade level in accordance with Table for space application

Table 1 lists screening and qualification testing required for each part designation when applied to various program classes or grade levels. Additional testing may be required depending on vendor reliability history and problems/failures experienced in previous space programs.

The various hybrid classes are defined below:

1) Class K from MIL-PRF-38534 and Level 1 & 2 from ECSS-Q-ST-60-05 is the highest reliability and verification level provided from the standard specification.
2) Class H is the standard military quality level in the MIL-PRF-38534 specification.
3) Non-QML indicates a hybrid microcircuit device that is not listed in the QML-38534 or ESCC QPL/QML document.

Application

The requirements within this section are generally categorized in quality level. Detail specification for each device can supplement it to meet the specific application requirements

Table 1. HYBRID MICROCIRCUIT REQUIREMENTS 1/

Part Designation	Use As Is	Screen in Accordance with Table 2	Qualify in Accordance with Table 3	Element Evaluation in Accordance with Table 4
Level 1: 1)ECSS Level 1 2)Class K 3)Class H 4)Non-QML 3/,4/	O 2/	O O O	O	O
Level 2: 1)ECSS Level 1 & 2 2)Class K 3)Class H 4)Non-QML 4/	O 2/	O O O	O	O
Level 3: 1)ECSS Level 1 & 2 2)Class K 3)Class H 4)Non-QML 4/	O 2/ O	O O		

Notes:

1/ Plastic encapsulated hybrid microcircuits are not covered in this section. Refer to Section for PEMs (Plastic Encapsulated Microcircuits) requirements.

2/ Document of ECSS-Q-ST-60-05, Generic Procurement Requirements for Hybrid, includes Screening and Lot Acceptance requirements that can be applied as is.

3/ Non-QML hybrid microcircuits are not recommended for use in level 1 applications, and a SCD/ Detail specification is required if a Class K, H, or EPPL part is not available. SCD/Detail specification shall meet all requirements as specified in Tables 2 and 3.

4/ Non-QML hybrid microcircuits for level 2 and level 3 shall be procured using a user-controlled procurement specification or source control drawing. The procurement specification or SCD shall meet all requirements of Tables 2 and 3.

Table 2. SCREENING REQUIREMENTS FOR HYBRID MICROCIRCUITS (Page 1 of 2)

Screen	Test Methods and Conditions	Level 1				Level 2				Level 3	
		ECSS 6/	K	H	Non-QML	ESCC 6/	K	H	Non-QML	H	Non-QML
1. Preseal Burn-in	MIL-STD-883, Method 1030				O				O		O
2. 100% Nondestructive Bond Pull	MIL-STD-883, Method 2023, 2% PDA				O				O		O
3. Internal Visual 1/	MIL-STD-883, Method 2017				O				O		O
4. Temperature Cycling	MIL-STD-883, Method 1010, Condition C				O				O		O
5. Constant Acceleration	MIL-STD-883, Method 2001, Condition 3,000 g, Y1 direction only				O				O		O
6. Particle Impact Noise Detection (PIND) 2/	MIL-STD-883, Method 2020, Condition A (Class K) or B			O	O			O	O	O	O
7. Preburn-in Electrical Test	As specified				O				O		O
8. Burn-In 3/	Level 1: MIL-STD-883, Method 1015, 320 hours at 125 °C minimum Levels 2 & 3: MIL-STD-883, Method 1015, 168 hours at 125 °C minimum				O				O		O
9. Final Electrical Test 4/	As specified				O				O		O
10. Calculate Delta and Percent Defective	Level 1: 2 percent PDA Level 2 10 percent PDA Level 3: 10 percent PDA				O				O		O
11. Seal Fine Gross	MIL-STD-883, Method 1014, Conditions A or B, MIL-STD-883, Method 1014, Condition C				O				O		O

Table 2. SCREENING REQUIREMENTS FOR HYBRID MICROCIRCUITS (Page 2 of 2)

Screen	Test Methods and Conditions	Level 1				Level 2				Level 3	
		ECSS 6/			Non-QML	ESCC 6/			Non-QML	H	Non-QML
12. Radiographic 5/	MIL-STD-883, Method 2012			O	O			O	O	O	O
13. External Visual 1/	MIL-STD-883, Method 2009				O				O	O	O
14. Destructive Physical Analysis (DPA)	MIL-STD-883, Method 5009	O	O	O	O	O	O	O	O	O	O

Notes:

1/ Pure tin plating is prohibited as a final finish in EEE components

2/ The lot may be accepted on any of the five runs if the percentage of defective devices is less than 1 percent or one device, whichever is greater. All defective devices shall be removed after each run. Lots that do not meet the 1 percent PDA on the fifth run, or exceed 25 percent defectives cumulative, shall be rejected for use as level 1 and level 2 devices.

3/ For level 1 hybrids, the burn-in shall be equally divided into two successive burn-ins i.e. 160 hours pre seal and 160 hours post seal. If pre seal burn-in cannot be applied, 240hours post seal burn-in can be applied as an alternative. If another temperature need to be selected, the burn-induration shall be adjusted in conformance withMIL-STD-883method 1015.

4/ Interim electrical tests shall be performed after the first burn-in to determine acceptable devices for the second burn-in.

5/ X-ray may be performed at any step in the sequence after PIND test.

6/ ECSS-Q-ST-60-05, Generic Procurement Requirements for Hybrid, level 1 and 2 can be applied as is for respective quality level.

Table 3. QUALIFICATION TEST REQUIREMENTS FOR HYBRID MICROCIRCUITS

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1				
Physical Dimensions 1/	MIL-STD-883, Method 2016	O	O	2 (0)
Solderability	MIL-STD-883, Method 2003, soldering temperature 245 °C ± 5 °C	O	O	2 (0)
Resistance to Solvents	MIL-STD-883, Method 2015	O	O	3 (0)
Group 2				10 (0)
External Visual	MIL-STD-883, Method 2009	O	O	
PIND	MIL-STD-883, Method 2020, A or B 2/	O	O	
Temperature Cycling	MIL-STD-883, Method 1010, C, 100 cycles	O	O	
Mechanical Shock and	MIL-STD-883, Method 2002, B, Y1 direction	O	O	
Constant Acceleration	MIL-STD-883, Method 2001, 5,000 gs, Y1 direction	O	O	
Seal (Fine and Gross)	MIL-STD-883, Method 1014	O	O	
PIND	MIL-STD-883, Method 2020, A or B	O	O	
Visual Examination	MIL-STD-883, Method 1010	O	O	
End-Point Electrical	Per device specification	O	O	
Group 3				
Steady-State Life	MIL-STD-883, Method 1005, 1,000 hours at 125 °C or equivalent in accordance with 1005	O	O	22 (0)
End-Point Electrical	Per device specification	O	O	
Group 4				
Internal Water Vapor Content	MIL-STD-883, Method 1018 at 100 °C	O	O	3 (0)

N o t e s :

1/ In case of failure, 100 percent inspection for physical dimensions shall be performed.
2/ Option.

Table 4A. ACTIVE ELEMENT EVALUATION REQUIREMENTS 1/

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1 Element Electrical	Group A Tests at 25 °C	O	O	100 percent
Group 2 Element Visual	MIL-STD-883, Method 2010 MIL-STD-750, Method 2072 MIL-STD-750, Method 2073	O	O	100 percent
Group 3 Internal Visual	MIL-STD-883, Method 2010 MIL-STD-750, Method 2072 MIL-STD-750, Method 2073	O	O	10 (0)
Group 4 Temperature Cycling Mechanical Shock or Constant Acceleration Interim Electrical Burn-In Post Burn-In Electrical 2/ Steady State Life Final Electrical 2/	 MIL-STD-883, Method 1010, Condition C MIL-STD-883, Method 2002, B, Y1 direction MIL-STD-883, Method 2001, 3,000 gs, Y1 direction MIL-STD-883, Method 1015, 240 hours min. at 125 °C MIL-STD-883, Method 1005	 O O O O O O		10 (0)
Group 5 Wire Bond Evaluation	MIL-STD-883, Method 2011	O	O	10 (0) or 20 (1) wire
Group 5 SEM Inspection	MIL-STD-883, Method 2018	O		See method 2018

Notes:

1/ These requirements apply to all non-QML hybrids procured for level 1 and 2 applications.

2/ Post burn-in and final electrical tests shall consist of static tests (including functional tests) at 25℃, minimum, and Maximum operating temperatures.

Table 4B. PASSIVE ELEMENT EVALUATION REQUIREMENTS 1/

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1 Element Electrical 2/	Group A Tests at 25 °C	O	O	100 percent
Group 2 Visual Inspection	MIL-STD-883, Method 2032	O	O	100 percent 22 (0)
Group 3				10 (0)
Temperature Cycling	MIL-STD-883, Method 1010, Condition C	O		
Mechanical Shock or	MIL-STD-883, Method 2002, B, Y1 direction	O		
Constant Acceleration	MIL-STD-883, Method 2001, 3,000, Y1 direction	O		
Voltage Conditioning or	As specified	O		
Aging (Capacitors)				
Visual Inspection	MIL-STD-883, Method 2017			
Electrical 2/				
Group 4 Wire Bond Evaluation	MIL-STD-883, Method 2011	O	O	10 (0) or 20 (1) wires

Notes:

1/ These requirements apply to all non-QML hybrids procured through SCDs for level 1 and 2 applications.

2/ Test at 25℃for the following electrical characteristics (minimum):

a) Resistors: DC resistance

b) Capacitors: 1) Ceramic: Dielectric withstanding voltage, insulation resistance, capacitance and dissipation factor.
2) Tantalum: DC leakage current, capacitance, and dissipation factor.
3) Metal Insulation Semiconductor: DC leakage current, capacitance, and dielectric withstanding voltage.

c) Inductors: DC resistance, inductance, and quality factor

Table 4C. SAW (Surface Acoustic Wave) ELEMENT EVALUATION REQUIREMENTS 1/

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1 RF Electrical Probe	25 °C, as specified	O	O	100 percent
Group 2 Visual Inspection	MIL-STD-883, Method 2032	O	O	100 percent
Group 3 Wire Bond Evaluation	MIL-STD-883, Method 2011	O	O	10 (0) or 20 (1) wires

Notes:

1/ These requirements apply to all non-QML hybrids procured through SCDs for level 1 and 2 applications.

Table 4D. SUBSTRATE EVALUATION REQUIREMENTS 1/

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1				
Element Electrical	25 °C , as specified	O	O	100 percent
Group 2				
Visual Inspection	MIL-STD-883, Method 2032	O	O	100 percent
Group 3				5 (0)
Physical Dimensions	MIL-STD-883, Method 2016	O	O	
Visual Inspection	MIL-STD-883, Method 2032	O	O	
Electrical 2/	25 °C	O	O	
Group 4				3 (0)
Conductor Thickness or Conductor Resistivity	As specified	O	O	
Film Adhesion Test	MIL-STD-977, Method 4500	O	O	
Solderability	Solderable substrates only	O	O	
Group 5				
TCR	MIL-STD-202, Method 304	O	O	2 (0)
Wire Bond Evaluation	MIL-STD-883, Method 2011	O	O	10 (0) or 20 (1) wires
Die Shear Evaluation	MIL-STD-883, Method 2019	O	O	2 (0)

Notes:

1/ These requirements apply to all non-QML hybrids procured through SCDs for level 1 and 2 applications.

2/ Test for the following characteristics and as specified in procurement specification:
a) Resistors: DC resistance.

b) Capacitors: Capacitance and, if specified, dielectric withstanding voltage, insulation resistance, and dissipation factor.

c) Multilayered Substrates: Continuity and isolation as specified.

Table 4E. PACKAGE EVALUATION REQUIREMENTS 1/, 2/

Inspection/Test	Test Methods and Conditions	Level 1 Non-QML	Level 2 Non-QML	Quantity (Accept Number)
Group 1 Physical Dimensions	MIL-STD-883, Method 2016	O	O	3 (0)
Group 2 Solderability	MIL-STD-883, Method 2003, soldering temperature 245 °C ± 5°C	O	O	3 (0)
Group 3 Thermal Shock High Temperature Bake Lead Integrity Seal a. FineLeak b. GrossLeak	MIL-STD-883, Method 1011, Condition C, 20 cycles MIL-STD- 883, Method 1008, 1 hour at 150 °C MIL-STD-883, Method 2004, B2 (lead fatigue) D (leadless chip carriers) MIL-STD-883, Method 2028, B1 for rigid leads (pin grid array leads) MIL-STD-883, Method 1014, Conditions A or B MIL-STD-883, Method 1014, Conditions C or D	O	O	10 (0) or 20 (1) wires 15 (0) leads
Group 4 Metal Package Isolation	MIL-STD-883, Method 1003, 600V DC 100 nA maximum	O	O	3 (0)

Notes:

1/ These requirements apply to all non-QML hybrids procured through SCDs for level 1 and 2 applications.

2/ Generic data is acceptable for all tests listed herein for Level 3 devices

3 : H E A T E R S

Table 1 HEATER REQUIREMENTS

Procurement Specification 1/	Use As Is	Screen to Requirements in Table 2	Qualify to Requirements in Table 3
Level 1			
ESCC 4009	O		
S-311-P-079	O		
SCD		O	O
Level 2			
ESCC 4009	O		
S-311-P-079	O		
SCD		O	O
Commercial		O	O
Level 3			
ESCC 4009	O		
S-311-P-079	O		
SCD		O	
Commercial		O	

N o t e s :

1/ Most heaters for space applications are custom designed for the intended application

Table 2 SCREENING REQUIREMENTS FOR HEATERS

Inspection/Test	Test Methods, Conditions and Requirements Reference S-311-P-079	Level 1	Level 2		Level 3	
		SCD	SCD	Commercial	SCD	Commercial
1. Voltage Conditioning	S-311-P-079 Para. 4.7.2 Duration (hours)	O 160	O 96	O 96	O 48	O 48
2. Thermal Shock	MIL-STD-202, Method 107, Test Condition D with the exception of a high temperature limit of 200°C	O	O	O		
3. Dielectric Withstanding Voltage (DWV)	MIL-STD-202, Method 301 at 500 VRMS applied for 1 minute max. between the element and conductive plates in contact with the outer surface of the heater	O	O	O		
4. Insulation Resistance	MIL-STD-202, Method 302, Test Condition B at 25 °C	O	O	O	O	O
5. DC Resistance	MIL-STD-202, Method 303 at 25 °C measured between heater leads	O	O	O	O	O
6. Visual / Mechanical	S-311-P-079 Para.4.7.1	O	O	O	O	O

Table 3 QUALIFICATION TEST REQUIREMENTS FOR HEATERS

Inspection Test 1/	Test Methods and Procedures S-311-P-079 Paragraph	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
		SCD	SCD or Commercial	
Group 1		22(1)	12(1)	Not Required
Conditioning	4.7.2	O	O	
DC Resistance	4.7.5	O	O	
Visual and Mechanical	4.7.1	O	O	
Group 2 2/		10(0)	5(0)	
Thermal Shock	4.7.7	O		
Low Temperature Operation	4.7.8	O	O	
DWV	4.7.3	O	O	
Insulation Resistance	4.7.4	O	O	
DC Resistance	4.7.5	O	O	
Lead Pull Strength	4.7.6	O		
Group 3 2/		10(0)	5(0)	
Life	4.7.9	O	O	
Group 4 2/		1 (0)	1 (0)	1 (0)
Thermal Vacuum Outgassing	4.7.10	O	O	O

N o t e s :

1/ Any test that has been performed during screening on the samples selected for qualification tests need not be repeated.

2/ Samples for Groups 2, 3, and 4 should be selected from parts that have passed Group 1 tests.

4 : M A G N E T I C S

Table 1. MAGNETIC PART REQUIREMENTS 1/ (Page 1 of 2)

Part Type	Procurement Specification	Level 1	Level 2	Level 3
Custom Magnetic Devices 2/	MIL-STD-981	Class S	Class S, B	Class S, B
	ESCC 3201	Level B or C	Level B or C	Level B or C
Inductors/Coils				
RF Fixed Coils	MIL-PRF-39010 9/	R 3/	R, P	R, P
RF Fixed and Variable Coils	MIL-PRF-15305 9/	4/	5/	O
RF Fixed and Variable Chip Coils	MIL-PRF-83446 9/	4/	O	O
Inductors, Power, Audio, Charging, and Saturable	MIL-PRF-27 8/ 9/		T, M 7/	T, M 7/
All Coil and Inductor Types	ESCC 3201	O	O	O
All Coil and Inductor Types	SCD 9/	4/	4/	4/
All Coils and Inductor Types	Commercial 9/		4/	4/
Transformers				
RF Fixed and Variable	6/ 9/	4/	4/	4/
Lower Power Pulse	MIL-PRF-21038 8/ 9/	T 4/	T, M	T, M
Transformers Power, Audio, Charging, and Saturable	MIL-PRF-27 8/ 9/	T 7/	T, M 7/	T, M 7/
All Transformer Types	ESCC 3201			O
All Transformer Types	SCD 9/	4/	4/	4/
All Transformer Types	Commercial 9/		4/	4/

Notes:

1/ The character “O” designates “use as is.” Magnetic part groups and families are provided in Table 1A.

2/ All magnetic parts processed to the Class S requirements of MIL-STD-981 are acceptable as level 1 parts. Magnetics processed to Class B requirements of MIL-STD-981 are acceptable as level 2 parts. All level 1 and 2 custom magnetics shall be processed to the applicable requirements of MIL-STD-981. In the event, a Class B part is intended for a level 1 application, the additional level test requirements of Tables 2 and 3 are applicable. Magnetic parts processed to the requirements of ESCC 3201 are acceptable as all quality level.

3/ MIL-PRF-39010 provides for R and P established reliability failure rate levels (FRL). Both FRL R and P coils require 100% X-ray per MIL-ST-981.

4/ Screening in accordance with Table 2 and qualification in accordance with Table 3 are required. Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test groups of qualification tests must be submitted to show that tests were performed with acceptable results.

5/ MIL-PRF-15305 coils shall receive radiographic inspection and burn-in in accordance with MIL-STD-981 for level 2 applications.

6/ These parts were formerly available to MIL-T-55631. This specification was declared as inactive for new design.

7/ Inductors and transformers can be procured to MIL-PRF-27 detail specification (slash sheets) when they are available, provided they satisfy the requirements of Tables 2 and 3 herein.

8/ MIL-PRF-27 and MIL-PRF-21038 have three product levels. Only levels T and M are acceptable for space flight use, subject to the Requirement specified in this table.

9/ Parts must be fabricated with wires that meet or exceed the following minimums for magnet wire and terminations/self leads:

Table 1. MAGNETIC PART REQUIREMENTS 1/ (Page 2 of 2)

Part Type	Level 1	Levels 2 and 3
Power Transformers Power Inductors High Power Pulse Transformers Charging Inductors Saturable Transformers Saturable Inductors	38 AWG	44 AWG
RF Fixed and Variable Transformers RF Fixed and Variable Coils Audio Inductors Audio Transformers Low Power Pulse Transformers RF Fixed and Variable Chip Coils	44 AWG	50 AWG

Type of Termination	Level 1	Levels 2 and 3
Interconnected Lead	29 AWG	32 AWG
External Terminal/Self Lead A/	26 AWG	28 AWG

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

Table 1A. PART TYPE GROUPINGS FOR SCREENING AND QUALIFICATION

Part Types	Applicable Military Specification
Family 1	
Power Transformers	MIL-PRF-27
Power Inductors Audio	MIL-PRF-27
Transformers Audio	MIL-PRF-27
Inductors	MIL-PRF-27
High Power Pulse Transformers	MIL-PRF-27
Charging Inductors	MIL-PRF-27
Saturable Transformers	MIL-PRF-27
Saturable Inductors	MIL-PRF-27
RF Fixed and Variable Transformers Low	1/
Power Pulse Transformers	MIL-PRF-21038
Family 2	
RF Fixed and Variable Coils	MIL-PRF-15305
Family 3	
RF Fixed and Variable Chip Coils	MIL-PRF-83446

Notes:

1/ These parts were formerly available to MIL-T-55631. This specification was declared as inactive for new design.

Table 2. MAGNETIC PART SCREENING REQUIREMENTS (Page 1 of 3)

Inspection/Test	Test Methods and Conditions 1/	Part Family Type per Table 1A								
		Family 1 Level			Family 2 Level			Family 3 Level		
		1	2	3	1	2	3	1	2	3
1. External Visual and Dimensional Inspection	As specified in the detailed drawing; at a minimum, shall include material, physical dimensions and configuration, weight, marking, and workmanship. 2/	O	O	O	O	O	O	O	O	O
2. Electrical Characteristics										
Insulation Resistance	MIL-STD-202, Method 302. Devices rated at insulation at 100 Vdc. Devices rated at 100 Vdc or more, measure at 2.5x the rated voltage or 500 Vdc, whichever is less. Test duration 2 minutes + 30 seconds. Insulation resistance 1,000 Mohms minimum.	O	O	O	O	O	O	O	O	O
DC Winding Resistance	Use Kelvin bridge or equivalent for resistances less than 1 ohm. Pre and post thermal shock delta R limit shall be less than 3 percent.	O	O	O	O	O	O	O	O	O
Winding Inductance	Measure at voltage, frequency, and test current as specified in the device detail drawing. The pre and post thermal shock delta L limit shall be less than 3 percent.	O	O	O	O	O	O	O	O	O
Turns Ratio or Voltage Ratio	Apply 1 Vrms at a specified frequency to each set of primary windings; monitor voltage across each secondary winding. Ratio not to exceed the specified limit. Use Wayne Kerr or equivalent instrument.	O	O	O						
Polarity	With the respective terminals excited at reference frequency, the instantaneous voltage measured at the output leads shall be in phase with the input or as specified.	O	O	O						

Table 2. MAGNETICS SCREENING REQUIREMENTS (Page 2 of 3)

Inspection/Test	Test Methods and Conditions 1/	Part Family Type per Table 1A								
		Family 1 Level			Family 2 Level			Family 3 Level		
		1	2	3	1	2	3	1	2	3
3. Thermal Shock 25 Cycles 10 Cycles 5 Cycles	MIL-STD-202, Method 107. Continually monitor during final cycle to verify no intermittent conditions. 3/	O	O	O	O	O	O	O	O	O
4. Vibration	MIL-STD-202, Method 204. Test Condition as specified in the detail drawing.	O			O					
5. Burn-In	MIL-STD-981, App. B, Paragraph 30.1.2 for Family 1. For Transformers > ~~0~~.8 watts output 96 hours at maximum rated temperature at rated input voltage and current at minimum rated frequency and at maximum rated load. For Transformers < 0.8 watts output 96 hours at maximum rated temperature at rated input voltage and current at minimum rated frequency with no load. For Inductors 96 hours at maximum operating temperature. 30.3.2 for Family 2. 96 hours at maximum rated operating temperature. 30.5.2 for Family 3. 96 hours at maximum rated operating temperature.	O	O		O	O		O	O	

Table 2 MAGNETICS SCREENING REQUIREMENTS (Page 3 of 3)

Inspection/Test	Test Methods and Conditions 1/	Part Family Type per Table 1A								
		Family 1 Level			Family 2 Level			Family 3 Level		
		1	2	3	1	2	3	1	2	3
6. Seal (If Applicable)	MIL-PRF-27 paragraph 4.7.8	O	O							
7. D W V	MIL-STD-202, Methods 301 and 105 4/	O	O	O	O	O	O	O	O	O
8. Q	As specified				O	O		O	O	
9. Induced Voltage (Transformers With Greater Than 25 Volts per Winding)	MIL-PRF-27 paragraph 4.7.10. 2x rated voltage 5/	O	O	O						
10. Self Resonant Frequency	As specified 6/				O	O		O	O	
11. Electrical Characteristics	As specified	O	O	O	O	O	O	O	O	O
12. Radiographic	MIL-STD-981 Appendix C	O			O			O		
13. Visual	As specified	O	O	O	O	O	O	O	O	O
14. Lot Rejection Criteria	5% or 1 device, whichever is greater 7/	O	O	O	O	O	O	O	O	O

Notes:

1/ Users should refer to the nearest equivalent military or ESCC specification listed in Table 1 if required for better definition of testing requirements.

2/ Perform inspection using a microscope with 10x minimum magnification.

3/ For level 1 parts with magnet wire less than 30 AWG, measure DC resistance before and after each cycle.

4/ Dielectric withstanding voltage shall be measured at sea level and at high altitude. Test voltage and conditions shall be specified.

5/ For saturating core, applied voltage shall be two times rated peak to peak voltage at two times rated frequency. For pulse transformers, the applied voltage shall be as specified in Table XIV of MIL-PRF-27.

6/ Use a Q meter, impedance analyzer, network analyzer, or equivalent.

7/ For Levels 2 and 3, a rejected lot may be reworked to correct the defects, or screen out the defective units, and be resubmitted for re-inspection. Such lots shall be separate from new lots and shall be clearly identified as re-inspected lots. Rework of level 1 lots shall not be permitted unless approved.

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 1 of 4) 1/

Inspection/ Test 2/	Test Methods and Conditions	Part Family 1 Level			Part Family 2 Level			Part Family 3 Level		
		1	2	3	1	2	3	1	2	3
Subgroup I		6 (0)	6 (0)		6 (0)	6 (0)		6 (0)	6 (0)	
Operating Torque (when Applicable)	In accordance with MIL-PRF-15305, paragraph 4.8.7 or MIL-PRF-83446, paragraph 4.6.8.				O	O		O	O	
Temperature Rise	For Group 1, in accordance with paragraph 4.7.13 of MIL-PRF-27. For Group 2, in accordance withparagraph 4.8.9 of MIL-PRF-15305. For Group 3, in accordance withparagraph 4.6.12 of MIL-PRF-83446.	O	O		O	O		O	O	
Overload	Perform test in accordance with: MIL- PRF-27, paragraph 4.7.21, MIL-PRF-83446, paragraph 4.6.13, or MIL-PRF-15305, paragraph 4.8.10.	O	O		O	O		O	O	
Resistance to Soldering Heat	Perform in accordance with: MIL-PRF- 27, paragraph 4.7.6, MIL-PRF-21038, paragraph 4.7.6, MIL-T-55631, paragraph 4.7.13, or MIL-PRF-15305, paragraph4.8.11.	O			O					
Terminal Strength	Finished devices with solid wire terminals shall be capable of passing the terminal twist test in accordance with MIL-STD- 202, Method 211, Test Condition D,without causing discontinuity in the winding. When the bending of the terminal leads, as specified in MIL-STD- 202, is impractical, the device shall be held stationary. The lead shall be clamped in a hand chuck and the chuck rotated as required. During the twist test, the winding shall be monitored for open circuit of 100 microseconds or longer duration.	O	O		O	O				

Table 3. MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 2 of 4) 1/

Inspection/ Test 2/	Test Methods and Conditions	Part Family 1 Level			Part Family 2 Level			Part family 3 Level		
		1	2	3	1	2	3	1	2	3
Induced Voltage 3/	MIL-PRF-27, paragraph 4.7.10, 2x rated voltage.	O	O							
Vibration	Perform test in accordance with: MIL-STD-202, Method 204, specify the test condition, MIL-PRF-15305, paragraph 4.8.15, or MIL-PRF-21038, paragraph 4.7.10.	O	O		O	O				
Shock	For MIL-PRF-27 and MIL-PRF-21038 part types, test in accordance with MIL- STD-202, Method 213, pulse as specified (H or I). For MIL-PRF-15305, paragraph 4.8.16, Test Condition I.	O	O		O	O				
Dielectric Withstanding Voltage At Reduced Pressure	MIL-STD-202, Method 105. Leakage current shall be as specified in thedetailed part drawing.	O	O		O	O		O	O	
Insulation Resistance	MIL-STD-202, Method 302. Devices rated at 28 Vdc or less, measure insulation at 100 Vdc. Devices rated at 100 Vdc or more, measure at 2.5x the rated voltage or 500 Vdc, whichever is less. Test duration 2 minutes +30 seconds. Insulation resistance 1,000 Mohms minimum.	O	O		O	O		O	O	
Electrical CharacteristicsDC Winding Resistance Winding Inductance	Use Kelvin bridge or equivalent for resistances less than 1 ohm. Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	O	O		O	O		O	O	

Table 3. MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 3 of 4) 1/

Inspection/ Test 2/	Test Methods and Conditions	Part Family1 Level			Part Family 2 Level			Part Family 3 Level		
		1	2	3	1	2	3	1	2	3
Visual and Mechanical Examination (External)	As specified in the detailed drawing. At a minimum shall include materials, physical dimensions and configuration, weight, marking, and workmanship.	O	O		O	O		O	O	
Subgroup II		6 (0)	6 (0)		6 (0)	6 (0)		6 (0)	6 (0)	
Life	Transformers shall be subjected to five life cycles a week for a minimum of 12 weeks, i.e., a total of 2,016 hours. Four of these cycles shall consist of a 20 hour period during which the transformers are operated at a temperature of 85 degrees Celsius with electrical conditions as specified in the detail drawing or specification and a 4 hour period of operation at room ambient temperature without excitation. The fifth cycle of the week shall be a 68 hour period at a temperature of 85 degrees Celsius and a 4 hour period of excitation at room ambient temperature. An electrical test circuit shall be devised so that an open circuit or short circuit during this life cycle test shall be detected and the time of failure recorded. Upon completion of the life test, transformers shall be tested for insulation resistance and dielectric withstanding voltage (at reduced voltage). Sample also shall be examined for physical and electrical damage. The procuring activity shall be notified within 48 hours of any failures.	O	O		O	O		O	O	

Table 3. MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 4 of 4) 1/

Inspection/ Test 2/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Part Family 1 Level			Part Family 2 Level			Part Family 3 Level		
		1	2	3	1	2	3	1	2	3
Life (Continued)	Catastrophic failures (electrical failures, physical damage) shall be subjected to failure analysis to determine the cause of failure. For MIL-PRF-83446 types the test shall be conducted in accordance with paragraph 4.6.9 and MIL-STD-202, Method 108. For MIL-PRF-15305 types the test shall be performed in accordance with paragraph 4.8.13 MIL-STD-202, Method 108.	O	O		O	O		O	O	
Electrical Characteristics DC Winding Resistance Winding Inductance	 Use Kelvin bridge or equivalent for resistances less than 1 ohm. Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	O	O		O	O		O	O	
Visual and Mechanical Examination (External)	As specified in the detail drawing. At a minimum shall include materials, physical dimensions and configuration, weight, marking, and workmanship.	O	O		O	O		O	O	
Radiographic Two units for Groups 1, 2, and	MIL-STD-981, Appendix C.	O	O		O	O		O	O	
Radiographic Two units for Groups 1, 2, and	MIL-STD-981, Appendix C.	O	O		O	O		O	O	
Subgroup III Thermal Outgassing 4/	 ASTM E 595 TML = 1.0% maximum CVCM = 0.10% maximum	O	O	O	O	O	O	O	O	O

Notes:

1/ All sample units submitted for qualification testing must have successfully completed screening to the requirements of Table 2.

2/ For test methods, conditions, and requirements, refer to MIL-STD-981 or ESCC 3201.

3/ Required only when any winding has a rated voltage in excess of 25 volts RMS.

4/ Materials listed in NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

5: INTEGRATED CIRCUITS (MONOLITHIC)

Scope

This section covers hermetically sealed Monolithic Integrated Circuits only. For Plastic Encapsulated Microcircuits(PEMs), refer to Section PEM. Monolithic Integrated Circuits shall be selected for the applicable program class or grade level in accordance with Table 1. Table 1 also indicates screening and qualification testing required for each part designation when applied to the various program classes or grade levels. The part designations are discussed below:

(1) ESCC 9000. This designation includes ESCC certified and qualified parts by ESCC 9000 specification. This specification defines the general requirements for microcircuit devices which intended for space application.

(2) Class V, Q, S, and B. These designations include parts that are procured as “Class V,” “Class Q,” “Class S,” or “Class B” as defined in MIL-PRF-38535; are tested to MIL-PRF- 38535 Tables Ia, II, III, IV, and V, as well as Appendixes A (and B, if applicable); and are listed in Part I or Part II of QML-38535.

(3) MIL-STD-883 Compliant or Class M. This designation includes parts that are procured as compliant to Paragraph 1.2.1 of MIL-STD-883. The parts may be manufacturer’s “Hi-Rel” flow processed parts marked with “/883” or otherwise claim compliance to Paragraph 1.2.1 of MIL-STD-883, or parts procured to DSSC drawings that specify “Non-JAN” MIL-STD- 883 compliant parts, or parts procured to Standard Military Drawings (SMD) quality level “M.” These parts require that all provisions of Appendix A of MIL-PRF-38535 shall be met by the part manufacturer.

(4) Source Control Drawing (SCD). This designation includes parts that are not available to other acceptable procurement methods listed for a specific grade level, and must be procured to a user’s controlled specification (SCD). The SCD shall include screening and qualification requirements as specified in Tables 2 and 3 herein.

(5) Manufacturer High Reliability (Mfr. Hi-Rel). This designation includes parts that are available only to a manufacturer's controlled test program as described in the manufacturer's catalog. These parts are controlled only by the manufacturer, who assigns them a special part number and provides a certificate of compliance that they have been tested as advertised. This category includes Non-Compliant, Non-JAN parts.

(6) Commercial Parts. This designation includes parts that are either hermetic, commercial-off- the-shelf (COTS), or non-hermetic Plastic Encapsulated Microcircuits (PEMs). Hermetic COTS are available only to a manufacturer's specification datasheet and are controlled by a test program as described in the manufacturer's catalog. It is the responsibility of the user to assure that the parts meet or exceed the testing requirements in Tables 2 and 3 herein.

Commercial parts are not approved for Program level 1 applications. Non-hermetic PEMs requirements are covered in Section M3.

(7) Application-Specific Integrated Circuits (ASIC), Highly Complex System-on-Chip (SOC), Semi-Custom, and Masked Gate Arrays. These devices shall meet the requirements of Tables 2, 3, and 4 herein and the following:

a. For ASICs, additional requirements shall include means of verification of design, simulation, debugging, layout and timing, test pattern generation, and calculation of fault coverages. All ASICs for Program level 1 and level 2 applications require SCDs.
b. SOC, Semi-Custom, and Masked Gate Array designs that combine multiple technologies, such as analog, digital, and/or RF, as well as intellectual property (IP) cores from outside sources, shall require SCDs.

Table 1. MONOLITHIC INTEGRATED CIRCUIT REQUIREMENTS (Page 1 of 2) 1/

Part Designation	Use As Is	Screen To Requirements in Table 2 2/	Qualify To Requirements in Table 3 2/
Level 1:			
1) ESCC 9000	O		
2) Class V or Class S	O		
3) Class Q or Class B		O 3/, 4/	
4) SCD		O 3/, 4/	O
5) 883-Compliant or Class M		O 3/, 4/	O
Level 2:			
1) ESCC 9000	O		
2) Class V or Class S	O		
3) Class Q or Class B		O 3/	
4) 883-Compliant or Class M		O 3/	O
5) SCD		O 3/	O
6) Mfr. Hi-Rel 5/		O 3/	O
7) Commercial		O 3/	O
Level 3:			
1) ESCC 9000	O		
2) Class V (or S)	O		
3) Class Q (or B)		O 3/	
4) 883-Compliant or Class M		O 3/	
5) SCD		O 3/	
6) Mfr. Hi-Rel 6/		O 3/	
7) Commercial 6/		O 3/	

Table 1. MONOLITHIC INTEGRATED CIRCUIT REQUIREMENTS (Page 2 of 2)**1/**

Notes:

1/ Plastic Encapsulated Microcircuits (PEMs) are not covered in this section. Refer to Section PEM requirements.

2/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated.

3/ All microcircuits with a housing cavity (except ESCC, Class V and Class S) require PIND in accordance with MIL-STD-883, Method 2020, condition A.

4/ Class Q or Class B and Compliant Non-JAN microcircuits used in level 1 applications require DPA. DPA is required in any level depending on the criticality in application

5/ Use of Mfr. Hi-Rel and commercial parts in level 1 and 2 applications requires use of SCD/Detail specification that specifies screening and qualification testing.

6/ Level 3 applications parts shall require screening to Table 2. No qualification testing per Table 3 is mandatory; however, it is strongly recommended that all non-QPL/QML devices have life test in accordance with MIL-STD-883, Method 1005, conditions A-D (as appropriate for device type), for 1,000 hours at 125℃(or equivalent time/temperature per Method 1005, Table 1).

Table 2. SCREENING REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 1 of 2)

Inspection/Test	MIL-STD-883		Level 1			Level 2			Level 3		
	Methods	Conditions	Class Q or B	SCD	883 or Class M 1/	Class Q or B	883 or Class M 1/	SCD/Mfr.Hi-Rel /Commercial 1/	Class Q or B	883 or Class M	SCD/Mfr.Hi-Rel /Commercial 1/
1. Wafer Lot Acceptance	5007			O	O		O	O			
2. Nondestructive Bond full	2023			O							
3. Internal Visual	2010	A or B	O	O	O		O	O			O
4. Temperature Cycling	1010	C		O	O		O	O			
5. Constant Acceleration	2001	E Y1 Orientation Only		O	O		O	O			
6. PIND 2/	2020	A	O	O	O	O	O	O	O	O	O
7. Radiographic 3/	2012	Two views		O	O						
8. Serialization				O							
9. Initial Electrical Measurements @ 25℃4/ , 5/		Per Table 2A herein and applicable device specification	O Read/ Record	O Read/ Record	O Read/ Record		O Read/ Record	O Read/ Record			O
10. Burn-in 6/, 7/, 8 /	1015	A, C, or D duration (hrs.)	O 48/160	O 72/240	O 48/160		O 160	O 160			O 160
11. Final Electrical Measurements @ 25 °C, min. and max. Operating Temp. 6/, 9/		Per Table 2A herein and applicable device specification	O Read/ Record	O Read/ Record	O Read/ Record		O Read/ Record	O Read/ Record			O
12. Calculate Delta 6/		Per Table 2A herein and applicable device specification	O	O	O		O	O			

13. Calculate PDA 10/		PDA	5%	5%	5%		10%	10%			20%
14. Hermetic Seal	1014										
a. FineLeak		A or B	O	O	O		O	O			
b. GrossLeak		C	O	O	O		O	O			
15. External Visual 11/	2009	3 to 10x	O	O	O		O	O			O

Table 2. SCREENING REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 2 of 2)

Notes:

1/ Tests that are performed as part of manufacturer's normal practice do not need to be repeated if the test conditions are equal or better than the conditions imposed by Table 2A.

2/ PIND testing need not be repeated if it has been performed by the manufacturer as part of the process flow.

3/ X-ray can be performed at any sequence after PIND.

4/ Read and record (as a minimum) delta parameters listed in Table 2A . The non-delta parameters may be tested "go/no-go."

5/ For one-time programmable read-only memories (PROMs) and programmable logic devices/arrays (PLDs/PLAs), steps 9 through 11, shall be performed after the programming. This specific requirement shall be given in detail part specification depending on the device types and criticality.

6/ If more than one burn-in type is required per Table 2A, the delta parameters shall be measured after each required burn-in step. Also, the delta calculations shall be made after each burn-in step.

7/ See Table 2A and notes 6/ and 7/ therein. The burn-in duration specified herein indicated as "Static/Dynamic" or "Static or Dynamic." Examples: 72/240 requires 72 hours of static burn-in (if applicable) and 240 hours of dynamic burn-in (if applicable), whereas 160 requires 160 hours of either static of dynamic burn-in, as specified in Table 2A.

8/ Limit Burn-in temperature to the maximum operating temperature of diode as specified by the manufacturer. This temperature may be lower than 125°C for commercial or manufacturer's in house Hi- REL parts.

9/ Minimum and maximum application temperatures may be used when measuring electrical parameters.

10/ PDA applies to cumulative failures during all burn-in steps. The cumulative failures for all levels shall include functional/DC parametrics (excluding deltas) for the lot to be accepted.

11/ Pure Tin plating is prohibited as a final finish in EEE parts.

Table 2A. BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR ICs (Page 1 of 3)

IC Type	Required Burn-in 1/		Delta	Electrical Measurements 2/, 3/, 4/
	Static (Condition C)	Dynamic (Condition D)		
Digital Bipolar & Digital MOS/ BiCMOS: 6/, 7/ LOGIC (Gates, Buffers, Flip-Flops, Multiplexers, Registers and Counters, etc.) RAMs FIFOs Microprocessors/DSPs Interface Peripherals FPGAs PROMs, PLD/PLA 5/	Not required for Digital Bipolar Technology. Required for Digital MOS Technology. TA = 125℃ Vin= VDD across one-half input pins and VSS across the remaining inputs. Vout= 0.5 VDD through RL	Required for both technologies. TA = 125℃ Vin = Square wave, 50% Duty Cycle to input pins and control pins. Frequency= 100 Hz to 1 Mhz. Vout = VCC /2 or VDD/2 through RL..	ΔICC or ΔIDD	DC: VIC, VOH, VOL, ICC(IEE), IIL, IIH, IDD, IOZL, IOZH, IOS AC: TPLH, TPHL, TTLH, TTHL, TPZH, TPHZ, TPLZ, TPZL, TA, TS, TH Functional Tests: a) For simple logic devices, verify truth table. b) For complex logic devices such as microprocessors, FPGAs, etc., functional testing includes fault coverage calculations required per MIL-STD-883, Method 5012. c) For PROMs, check fuse map; for RAMs, perform patternsensitive tests such as March, Galpat, etc.
Linear MOS, Bipolar, and Bi-FET: 7/ Op-Amp, Instrument Amplifiers, S/H, and Comparator	TA = 125℃ Vout= Terminated to ground through RL	TA = 125℃ Vin= Square wave or sine wave F=10Hz to 100 KHz, 50% duty cycle Vout= Terminated to ground through RL	ΔIIB ΔIIO ΔVIO	DC: ICC, IEE, IIO, VIO, VOPP, AV, CMRR, PSRR AC: Slew rate

Table 2A. BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR ICs (Page 2 of 3)

IC Type	Required Burn-in 1/		Delta	Electrical Measurement 2/, 3/, 4/
	Static (Condition C)	Dynamic (Condition D)		
Linear MOS, Bipolar and JFET: 7/ Line Drivers and Receivers	TA = 125℃ Vin= VDD max across one-half input pins and VSS across the remaining inputs.	TA = 125℃ Vin= Square wave at a specified frequency and duty cycle Vout= VCC through RL	ΔICC ΔIIH	DC: VOH, VOL, ICC, IIL, IIH, IOS AC: TPLH, TPHL, TTLH, TTHL Functional Test: Verify truth table.
Linear MOS, Bi-FET, and Bipolar: 6/, 7/ Analog Switches and Multiplexers	TA = 125℃ Vin= VDD max across one-half of inputs and VSS across the other remaining inputs. Vout=±VCC through RL	TA = 125℃ Vin= Square wave F= 100 Khz and 50% duty cycle Vout=±VCC through RL	ΔICC ΔID(OFF) ΔIS(OFF) ΔR(ON)	DC: ICC, ID(ON), R(ON), ID(OFF), IS(ON), IS(OFF) AC: T(ON) , T(OFF) break-before-make-time
Linear Bipolar: Voltage Regulators	TA =125℃ Vout= Terminated to ground through RL	Not required.	ΔISCD ΔVOUT	DC: ICC, VOUT, IOS, line/load regulation
Linear Bipolar: Pulse-width-modulator	Not required.	TA = 125℃ Vout= Terminated to ground through RL Rext, Cext connected if applicable.	ΔIIO ΔVREF	DC: VREF, IIB, IIO, IOS, VIO, VOL, VOH, AV, CMRR, PSRR AC: TR , TF, fOSC
Darlington Transistor Array	TA = 125℃ Vout= 15 Vdc through RL	Not required.	ΔICEX ΔhFE	DC: VCE(SAT), VF, ICEX, IF AC: hFE, tPHL, tPLH
Linear CMOS Timers	TA = 125℃ Vout= VCC through RL	Not required.	ΔICEX ΔVOH ΔVOL	DC: VTRIG, VTH, VR, VOL, VOH, VSAT, ICC, ITRIG, ITH, IR, ICEX AC: TTLH, TTHL

Table 2A BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR ICs (Page 3 of 3)

IC Type	Required Burn-in 1/		Delta	Electrical Measurement 2/, 3/, 4/
	Static (Condition C)	Dynamic (Condition D)		
Linear MOS and Bipolar: Active Filters	Not required	TA = 125℃ Vin= Sine wave at frequency < fo Vout= Terminated to ground through RL	ΔICC ΔVOS	DC: ICC, ISS, VOS AC: fo, Q, input frequency range.
Mixed Signal MOS, Bi-CMOS and Bipolar: 7/ Analog to Digital (A/D) Converters	TA = 125℃ Vin = Max analog DC input Vout = VCC/2 through RL	TA = 125℃ Vin= Analog input to generate maximum digital codes. Vout = VCC/2 through RL	ΔICC ΔIEE ΔVIO	DC: VREF, VOH, VOL, VIO, ICC, IEE, IIL, IIH, IOZL, IOZH, IOS, zero error, gain error, linearity error. AC: TC, TS, TH Functional Test: Verify codes.
Mixed Signal MOS, Bi-CMOS and Bipolar 7/ Digital to Analog (D/A) Converters	TA = 125℃ Vin= VDD on one-half data inputs and VSS on remaining inputs. Vout= Terminated to ground through RL	TA = 125℃ Vin = Apply appropriate digital codes for all inputs and for control signals. Vout = Terminated to ground through RL.	ΔICC ΔIEE	DC: ICC, IEE, IIL, IIH, IOZL, IOZH, IOS, zero error, gain error, linearity error, PSRR AC: TC, TS, TH Functional Test: Verify codes.

Notes:

1/ Static and dynamic burn-in shall be performed at maximum recommended operating supply voltage @ TA = 125℃. Biasing conditions including the value of RL shall be selected to assure that the junction temperature shall not exceed Tjmax specified for the device type.

2/ See MIL-HDBK-1331: Parameters to be controlled for the Specification of Microcircuits, for symbol definitions.

3/ These are typically recommended electrical parameters based on MIL specifications and SMDs. Since electrical parameters are device dependent, refer to detail specifications or manufacturing data sheets for actual DC and AC parametric test conditions and limits.

4/ For digital devices, all DC parameters, functional tests, and switching tests shall be tested at 25℃, at minimum operating temperature and at maximum operating temperature.

For linear devices, all DC parameters shall be tested at 25℃, at minimum operating temperature and at maximum operating temperature. All AC and switching tests shall be performed at 25℃.

5/ For level 1 and level 2 applications, one-time programmable devices (e.g., PROMs, PLDs/PLAs), shall be subjected to dynamic burn-in with user application specific burn-in circuit. The post burn-in should include DC, AC, and functional tests for user's program verification.

6/ Dynamic burn-in required for level 1 applications.

7/ Static or dynamic burn-in acceptable for level 2 and level 3 applications.

Table 3. QUALIFICATION TEST REQUIREMENTS

FOR MONOLITHIC INTEGRATED CIRCUITS (Page 1 of 5)

1 /

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD				
			Level 1		Level 2		Level 3
	Test Methods	Conditions/ Sample Size (No. of Rejects)	883 or Class M 3/	SCD 3/, 5/	883 or Class M	Mfr. Hi-Rel/ SCD/ Commercial 5/	Mfr. Hi-Rel /SCD/ Commercial 6/
Group B							
Subgroup 1 2/		3(0)	O	O	O	O	
Resistance to Solvents	2015						
Subgroup 2		22(0) 22 wires chosen at random from 3 samples	O	O	O	O	
Bond Strength	2011						
(1) Thermocompression		(1) Condition C or D					
(2) Ultrasonic or Wedge		(2) Condition C or D					
(3) Flip-Chip		(3) Condition F					
(4) Beam Lead		(4) Condition H					
Die Shear Test (or Stud Pull)	2019 or 2027	3(0)	O	O	O	O	
Subgroup 3							
Solderability	2003	Soldering temperature of 245 °C ± 5 °C	O	O	O	O	

Table 3. QUALIFICATION TEST REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 2 of 5)

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD				
			Level 1		Level 2		Level 3
	Test Methods	Conditions/ Sample Size (No. of Rejects)	883 or Class M 3/	SCD 3/, 5/	883 or Class M 3/	Mfr. Hi-Rel/ SCD/ Commercial3/, 5/	Mfr. Hi-Rel /SCD/ Commercial 6/
Group C			22(0)	45(0)	22(0)	22(0)	
Operation Life Test 5/	1005	Condition A, C, or D, (1,000 hours at +125oC or equivalent)	O	O	O	O	
End-point electrical parameters		As specified in the applicable device procurement specification and Table 2A herein.	O	O	O	O	

Table 3. QUALIFICATION TEST REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 3 of 5)

Inspection/Test	MIL-STD-883		Quantity(AcceptNumber) or LTPD				
			Level 1		Level2		Level 3
	Test Methods	Conditions/ Sample Size (No. of Rejects)	883 or Class M 3/	SCD 3/, 5/	883 or Class M 3/	Mfr. Hi- Rel/ SCD/ Commercia l 3/, 5/	Mfr. Hi-Rel /SCD/ Commercial 6/
Group D							
Subgroup 1 2/		15(0)	O	O	O	O	
Physical Dimensions	2016						
Subgroup 2		15(0)	O	O	O	O	
a. Lead Integrity	2004	A, B2, or D (use Method 2008 for PGA packages)					
b. Seal	1014						
(1) Fine							
(2) Gross							
Subgroup 3		15(0)	O	O	O	O	
a. Thermal Shock	1011	B, 15 cycles					
b. Temperature Cycling	1010	C, 100 cycles					
c. Moisture Resistance	1004						
d. Seal	1014						
(1) Fine							
(2) Gross							
Subgroup 4							
a. Shock	2002	15(0)	O	O	O	O	
b. Vibration, Variable Frequency	2007	B					
		A					
c. Acceleration	2001	E, Y1 orientation					

Table 3. QUALIFICATION TEST REQUIREMENTS FOR

MONOLITHIC INTEGRATED CIRCUITS (Page 4 of 5)

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD				
			Level 1		Level 2		Level 3
	Test Methods	Conditions/ Sample Size (No. of Rejects)	883 or Class M 3/	SCD 3/, 5/	883 or Class M 3/	Mfr. Hi- Rel/ SCD/ Commercia l 3/, 5/	Mfr. Hi-Rel /SCD/ Commercial 6/
Subgroup 4 (continued)							
d. Seal	1014	As applicable					
(1) Fine							
(2) Gross							
e. Visual Examination							
f. End-point Electricals	2009	As specified in device specification					
Subgroup 5							
Internal Water Vapor (Cavity Packages)	1018	3(0) or 5(1) 5,000 ppm maximum water content at 100 °C	O	O	O	O	
Subgroup 6			O	O	O	O	
Adhesion of Lead Finish	2025	15(0)					
Subgroup 7			O	O	O	O	
Lid Torque	2024	5(0)					

Table3. QUALIFICATION TEST REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 5 of 5)

Notes :

1/ Samples shall be selected from the parts that have passed the screening requirements in Table 2.

2/ Subgroup 1 can be performed on electrical rejects.

3/ Lot specific QCI attributes data is acceptable, provided it meets all inspection/test requirements of Table 3.

4/ Use conditions specified in Table 2A (dynamic burn-in condition as applicable). Burn-in temperature and biasing conditions shall be selected to assure that the junction temperature does not exceed Tjmax specified for the device type by the manufacturer.

5/ Use of Mfr. Hi-Rel and commercial parts in level 1 and 2 applications requires use of SCD/Detail specification that specifies screening and qualification testing.

6/ For level 3 applications, no qualification testing is mandatory; however, it is strongly recommended that all non-QPL/QML devices have life test in accordance with MIL-STD-883, Method 1005, conditions A-D (as appropriate for device type), for 1,000 hours at 125 °C (or equivalent time/temperature per Method 1005, Table 1)

6: MICROCIRCUITS, PLASTIC ENCAPSULATED (PEM)

Policy for PEM Devices

The use of Plastic Encapsulated Microcircuits (PEMs) shall be limited when no alternative parts are available in functional and performance wise. It can be permitted certain application provided each use is thoroughly evaluated for thermal, mechanical, and radiation implications of the specific application and found to meet mission requirements.

Due to the rapid change in wafer-level designs typical of commercial parts and the unknown traceability between packaging lots and wafer lots, lot-specific testing is required for PEMs.

PEMs must be:

- Stored under temperature controlled, clean conditions, protected from ESD and humidity
- Traceable to the branded manufacturer
- Procured from the manufacturer or their approved distributor
- Tested to verify compliance with the performance requirements of the application environment over the intended mission lifetime

Testing in accordance with PEM-INST-001 or ECSS-Q-ST-60-13 shall be performed as necessary to qualify and screen the devices, in order to verify compliance with the application requirements. Radiation evaluation shall address all threats appropriate for the technology, application, and environment, including Total Ionizing Dose (TID), Single Event Effects (SEE), and displacement damage.

Terminal finish of all commercial parts shall be assessed by incoming inspection. Use of PEMs with pure tin plated terminations requires special precautions and mitigations to preclude failures caused by tin whiskers. A Review of mitigation strategies is required.

Table 1. PEM REQUIREMENTS 1/

Project Requirement	Screening (per Table 2)	Qualification 2/ (per Table 3)	DPA 3/
Level 1	O	O	O
Level 2	O	O	O
Level 3	O	O	O

Notes:

1.1/ For detailed instructions on PEM requirements and test procedures, including screening, qualification, DPA test procedure, additional evaluation analysis, derating, and handling and storage guidelines refer to Instructions for PEM Selection, Screening, and Qualification, PEM- INST-001 or Commercial EEE Components, ECSS-Q-ST-60-13.

1.2/ PEMs qualified according to this document are intended for operation within the manufacturer's data sheet limits. Any uprating and use of PEMs outside the manufacturer's specified range, particularly the temperature limits, is not acceptable.

1.3/ Radiation Lot Acceptance Testing (RLAT) of PEMs shall be performed independently of any data that may exist for equivalent or similar hermetically sealed devices. This is necessary as market conditions may drive unannounced process changes, creating differences in radiation response.

1.4/ Most of the requirements described in this document are also applicable to commercial discrete and hybrid semiconductor devices encapsulated in plastics. However, for some parts tailoring of the screening, qualification, and DPA procedures might be necessary. In this case adjustments of the procedures for a particular part type should be done in detail specification or SCD of the part. For discrete semiconductor devices refer to MIL-STD-750 for the appropriate test methods.

2/ Qualification by Flight History or similarity is not acceptable for PEMs. Commercial PEM manufacturers are known to produce the same part number with die sourced from different wafer lots having different die revisions. The same part number may also be made by multiple production plants and processed according to requirements that vary between wafer and assembly plants.

3/ DPA for PEMs shall focus on three major areas of concerns: 1) integrity of the package, 2) quality of assembly, and 3) defects in the die. This analysis shall also evaluate package and die-level homogeneity of the lot. When obvious gross defects are revealed during DPA, it is usually an indication that manufacturer's processes are out of control, and a replacement of the lot might be required. Therefore, it is recommended that DPA or Construction Analysis be performed prior to screening and qualification of the lot. Additional evaluations might be necessary to further mitigate risks associated with the use of PEMs.

Table 2 SCREENING REQUIREMENTS FOR PEMS 1/

Screen	Test Method and Conditions	Level 1	Level 2	Level 3
1. External visual, and serialization 2/	Per paragraph 5.3.1. of PEM-INST-001	O	O	O
2. Temperature cycling	MIL-STD-883, Method 1010, Condition B (or to the manufacturer's maximum storage temperature range, whichever is less). Temperature cycles, minimum.	20	20	10
3. Radiography 3/	Per paragraph 5.3.2. of PEM-INST-001	O	O	O
4. C-SAM inspection 4/	Per paragraph 5.3.3. of PEM-INST-001	O	O	O
5. Initial (pre-burn-in) electrical measurements (EM) 5/	Per device specification, at 25℃ At min. and max. rated operational temperatures.	O O	O O	O
6. Engineering review (Steps 1 to 5) 6/				
7. Static (steady-state) burn-in (BI) test at 125℃or at max. operating temperature 7/	MIL-STD-883, Method 1015, condition A or B. Hours, minimum depending on the BI temperature.	240 hrs. at 125℃ 445 hrs. at 105℃ 885 hrs. at 85℃ 1,560 hrs. at 70℃	160 hrs. at 125℃ 300 hrs. at 105℃ 590 hrs. at 85℃ 1,040 hrs. at 70℃	160 hrs. at 125℃ 300 hrs. at 105℃ 590 hrs. at 85℃ 1,040 hrs. at 70℃
7a. Post static BI electrical measurements @ 25 °C	Per device specification. Calculate Delta when applicable.	O	O	O
9. Dynamic burn-in test at 125℃or at max. operating temperature 7/	MIL-STD-883, Method 1015, Cond. D. Hours, minimum.	Same as test step 7.	Same as test step 7.	Same as test step 7.

10. Final parametric and functional tests	Per device specification (at 25 °C, maximum, and minimum rated operating temperatures).	O	O	O
11.Calculate percent defective (Steps 7 to 10) 6/	Maximum acceptable PDA.	5%	10%	10%
12. External visual/packing 2/	Per paragraph 5.3.1 and Section 8 of PEM-INST-001.	O	O	O

Table 2. SCREENING REQUIREMENTS FOR PEMS 1/

1/ General

1.1/ Screening is performed on 100% of flight parts.

1.2/ Historically, only parts with tight lot-specific controls imposed during manufacturing had been allowed for applications in level 1 projects. Such a control is impossible for PEMs, and the suggested screening procedures are not considered as a substitute for manufacturing control, but rather as risk mitigation measures.

1.3/ Any pure tinned parts shall be screened after retinning mitigation applied.

2/ It is recommended to combine the incoming/outgoing visual inspections with the serialization and packaging to reduce handling and possible damage to the parts. Serialization should be performed in such a way to allow a topside C-SAM inspection. Flight parts should be handled and stored in a manner to prevent mechanical and ESD damage, contamination, and moisture absorption.

3/ To minimize handling, only a top view X-ray inspection is required. Focus to inspect for wire sweeping and obvious defects in the part. Depending on the results of the top view X-ray and/or part construction, a side view may be required.

4/ Acoustic Microscopy (C-SAM)

4.1/ *General*. Acoustic microscopy is performed to screen out defects at critical die surface and lead tip wire-bond areas of the parts and screening, except for power devices, is performed only at the topside.

4.2/ *Coated Die.* Topside of the internal portion of the leads is inspected in PEMs with polymer die coating. Inspection of the die area is not required, as the die coating has a low acoustic impedance that appears as a false delamination.

4.3/ *Power Devices.* For power parts, the bottom side inspection of die attachment might be replaced with the thermal impedance measurements.

4.4/ *Rejection Criteria.*

- Any measurable amount of delamination between molding compound and the die surface.
- Any delaminations on the leads at wire bond areas.
- Delaminations extending more than 2/3 the length of internal part of the leads.

5/ Electrical Measurements

5.1/ Special Testing.In addition to parametric and functional measurements per data sheets, supplement and/or innovative testing techniques (e.g. IDDQ leakage currents, thermal impedance, output noise, etc.) can be used to select better quality parts from the lot (cherry pick) as flight candidates.

5.2/ Failure modes (parametric or catastrophic) should be recorded for each failed part.

6/ Engineering review

6.1/ More than 10% CSAM rejects might require additional evaluation of thermo-mechanical integrity of the lot or its replacement.

6.2/ Most established PEMs manufacturers guarantees 3-sigma level process minimum, which means that less than 0.27% of the parts can be out of specification. Excessive fallouts during initial electrical measurements at room temperature might be due to a poor quality of the lot, effect of temperature cycling performed before electrical measurements, or it might be an indication of problems with the testing lab. When excessive rejects are experienced, the project PE decides whether a lot replacement or additional evaluation is needed based on observed failure modes and results of failure analysis. Excessive rejects during initial electrical measurements might be a legitimate cause for lot replacement.

7/ Burn-in (BI)

7.1/ *General.* Burn-in is a complex, product-specific test and if possible should be conducted by the manufacturer of the part. If a user performs this test, special care should be taken not to exceed maximum current, voltage, and die temperature limits.

7.2/ *Burn-in Temperature.* The BI temperature is a “stress” temperature used to precipitate failure of defective parts and is typically much higher than the operational temperature of the part, where the characteristics are guaranteed to remain within the data sheet limits. Most PEM manufacturers use temperatures in the range from 125℃to 150℃to periodically perform BI to monitor quality of their product. However, if the parts engineer is unable to justify the suitability of burn-in at 125℃, the burn-in ambient temperature shall be

limited to the maximum operating temperature per the device specifications provided by the manufacturer.

7.3/ *Junction Temperature.* The junction temperature during BI testing should not exceed the absolute maximum rated junction temperature for the part.

7.4/ *Molding Material Glass Transition Temperature.* When the die temperature is close to or exceeds the glass transition temperature (Tg) of the molding compound (MC), electrical and mechanical properties of MC may change significantly and new degradation mechanisms may cause failures of the part. For most molding compounds, Tg values exceed 140 to 150℃, which gives a necessary temperature margin for 125℃BI. Reliability of the PEMs, which are manufactured with low-Tg molding compounds (Tg < 120℃), is difficult to assess, and such parts are not recommended for space projects without additional extensive analysis and testing. Glass transition temperature measurements are recommended prior to BI if usage of low-Tg molding compound for the lot is suspected.

7.5/ *Protection.* In some parts the sensitivity of the input/output ESD protection circuits increases with temperature and these circuits can be turned on easily, at lower and/or shorter voltage spikes, than at room temperature. For this reason, special care should be taken to prevent possible power line transients during burn-in testing.

7.6/ Excessive proportion of functional BI failures, even when the total number of failures is within the PDA limits, might be an indication of serious lot reliability problems. In these cases additional testing and analysis of the parts might be required.

7.7/ Steady-state burn-in is performed on all linear and mixed signal devices (see Table 2A for details on burn-in conditions). The duration of steady-state burn-in can be reduced 50% if the parts are to be subjected to dynamic burn-in testing.

7.8/ Dynamic burn-in is not required for parts operating under steady-state conditions, e.g. voltage references, temperature sensors, etc.

7.9/ Only one type of BI test, either static or dynamic, is required for level 2 and 3 parts.

7.10 Under special circumstances, when it is technically and economically viable, and for components, which are difficult to assess at the piece part level, alternative testing in lieu of static and/or dynamic BI testing (for example, board-level burn-in) may be permitted. Board-level burn-in shall not be routinely substituted for piece part burn-in as a convenience.

Table 3. QUALIFICATION REQUIREMENTS FOR PEMS 1/ (Page 1 of 2)

Process	Sub Test	Test Methods & Conditions	QTY (Failures)		
			Level 1	Level 2	Level 3
1. Visual inspection & serialization 2/		Section 5, paragraph 5.3.1 of PEM-INST-001	32	32	17
2. Radiation analysis		TID and SEE	3/	3/	3/
3. Baseline C-SAM	(Parts in subgroup 1 only)	Section 5, paragraph 5.3.1 of PEM-INST-001	22	22	N/A
5. Preconditioning	Moisture soak 4/ SMT devices Reflow simulation (with flux application, cleaning, and drying) Through hole devices Resistance to soldering temperature	JESD22 – A113-B, para. 3.1.5, condition A (168 hours,+85°C, 60% RH). JESD22-A113-B, Table 2 and paragraphs. 3.1.6 through 3.1.9. Peak solder reflow temperature +235 °C. JESD22-B106-B.	32 32 32	32 32 32	17 17 17
4. Electrical measurements	Per device specification	Measure at 25℃, min. & max. rated temperatures.	32(0)	32(0)	17(0)
6. Life testing Subgroup 1	HTOL, 125℃5/, 6/	MIL-STD-883, Method 1005, Cond. D Hours, minimum.	22 2,000	22 1,500	10 500
	Electrical measurement (per specification)	Measure at 25℃, min. & max. rated temperatures.	22(0)	22(0)	10(0)
6a. Temperature cycling Subgroup 1	Temperature cycling 5/, 7/	MIL-STD-883 Method 1010, Cond. B (-55 °C to +125 °C), cycles, minimum.	22 500	22 200	10 100
	Electrical measurement (per specification)	Measure at 25℃, min. & max. rated temperatures.	22(0)	22(0)	10(0)
	C-SAM 8/	Section 5, paragraph 5.3.3.	22	22	N/A
	DPA or FA	9/	O	O	N/A

7. Highly accelerated stress test (HAST) Subgroup 2	Biased HAST 5/	JESD22 - A110, with continuous bias (96 hours, +130 °C, 85% RH).	10	N/A	N/A
	Unbiased HAST 5/	JESD22-A118, Condition A (96 hours, +130 °C, 85% RH).	N/A	10	7

Table 3 QUALIFICATION REQUIREMENTS FOR PEMS 1/ (Page 2 of 2)

1/ All parts shall be selected from a screened lot.

2/ This step is not performed if results of the screening are available.

3/ Radiation hardness of the parts must be assessed on a lot-specific basis according to the application requirements. So that analysis can be completed prior to screening and qualification, un-screened samples can be used for this test. An additional number of samples, depending on radiation requirements, shall be provided to perform this test.

4/ Moisture soak is performed as a part of preconditioning to mimic worst-case moisture absorption conditions of the PEM molding material, which could cause PEMs to be damaged during soldering to boards.

5/ Conditions of the temperature cycling, HAST, and high temperature life testing (HTOL) can be tailored according to specifics of the device application.

6/ The junction temperature should not exceed the absolute maximum rated junction temperature for the part. If 125 °C ambient causes the maximum rated junction temperature to be exceeded, the ambient temperature should be decreased appropriately.

7/ Temperature cycling is performed after HTOL testing on the same samples only for economic reasons. This test can be also performed on a separate group of parts if additional samples are provided (22, 22, and 10 samples for levels 1, 2, and 3, respectively).

8/ This C-SAM examination is performed to estimate mechanical damage to the part due to temperature cycling and reflow simulation (or resistance to soldering test) by comparing acoustic images with the baseline measurement results.

9/ Failure analysis is performed on any failures during qualification tests to determine whether they are caused by lot-related defects, manufacturing process problems, or improper testing. If no failures are observed, a special evaluation (DPA) should be performed to ensure that no degradation of wire bonding, cratering, and mechanical damage to glassivation and metallization systems occurred (for level 1 and 2 parts only).

Applicable Standards for Test Methods

JESD22-A113-B: Preconditioning of nonhermetic surface mount devices prior to reliability testing.

JESD22-B106-B: Resistance to Soldering Temperature for Through-Hole Mounted Devices

JESD22-A110-B: Highly-Accelerated Temperature and Humidity Stress Test (HAST)

JESD22-A118: Accelerated Moisture Resistance - Unbiased HAST

Destructive Physical Analysis (DPA) & Construction Analysis (CA)

Destructive Physical Analysis, or Construction Analysis (CA), shall be performed to obtain information regarding design, workmanship, and process quality related to a PEM manufacturing lot. Samples for DPA or CA (5 pcs. minimum) should be selected randomly from different portions of the procurement lot.

A) Construction Analysis (CA) Sequence

TEST	SN1	SN2	SN3	SN4	SN5	PROCEDURE	COMMENTS
External visual inspection	X	X	X	X	X	MIL-STD-750 method 2071 MIL-STD-883 method 2009	MIL specifications are not fitted to visual inspection of PED but can be used as reference (Note 1)
X-ray inspection	X	X	X	X	X	MIL-STD-750 method 2076 MIL-STD-883 method 2012	-
C-SAM test	X	X	X	X	X	JEDEC J-STD-020	Only applicable to plastic package
Permanence of marking	X	X	X	X	X	ESCC 24800	-
PIND test (cavity package)	X	X	X	X	X	MIL-STD-750 method 2052 MIL-STD-883 method 2020	-
Hermeticity (cavity package)			X	X	X	MIL-STD-750 method 1071 MIL-STD-883 method 1014	-
Residual gas analysis (cavity package)			X	X	X	MIL-STD-750 Method 1018 MIL-STD-883 Method 1018	5000 ppm H_2O max at 100°C
Lead finish analysis and pure tin identification	X	X				Energy Dispersive X-ray analysis (EDX), X-ray fluorescence, Microfluorescence, Differential Scanning Calorimeter (DSC)	Analysis to identify lead finish w.r.t. RoHs problematic
Solderability	X	X				MIL-STD-750 method 2026 MIL-STD-883 method 2003	-

Terminal strength	X	X				MIL-STD-750 Method 2036 MIL-STD-883 Method 2004	-
Delidding	X	X	X	X		-	-
Internal visual inspection	X	X	X	X		ESCC 2045000 ESCC 2045010 ESCC 2059000	The die revision shall be identified and recorded
SEM inspection	X	X				MIL-STD-750 method 2077 MIL-STD-883 method 2018	To verify the quality of wire bonding, glassivation integrity, die interconnect metallization
Bond strength (for wedged bonding)	X	X	X			MIL-STD-750 method 2037 MIL-STD-883 method 2011	-
Bond shear (for ball bonding)	X	X	X			JEDEC JASD22-B116	-
Glassivation integrity		X	X	X		MIL-STD-883 method 2021	Make sure that the chemical etchant is suitable for the metallization
Die shear test (cavity package)	X	X	X			MIL-STD-750 method 2017 MIL-STD-883 method 2019	-
Package level cross-sectioning					X	Micro-sectioning of leads shall be performed to assess presence and characteristics of the under-layer	Including die micro-sectioning
Visual, SEM and material analysis					X	-	-

Note 1: In addition to MIL specification criteria, inspect for any evidence of:

- -Package deformation
- -Foreign inclusions in the package, voids and cracks in the plastic encapsulant
- -Deformed leads, peeling, blistering or corrosion of finishing
- -Legibility and correctness of marking
- -Homogeneity of the lot (package level)

B) Destructive Physical Analysis (DPA) Sequence

TEST	SN1	SN2	SN3	PROCEDURE	COMMENTS
External visual inspection	X	X	X	MIL-STD-750 method 2071 MIL-STD-883 method 2009	MIL specifications are not fitted to visual inspection of PED but can be used as reference (Note 1 of section H.3)
PIND test (cavity package)	X	X	X	MIL-STD-750 method 2052 MIL-STD-883 method 2020	-
Hermeticity (cavity package)	X	X	X	MIL-STD-750 method 1071 MIL-STD-883 method 1014	-
Solderability	X	X		MIL-STD-750 method 2026 MIL-STD-883 method 2003	-
Delidding	X	X	X	-	-
Internal visual inspection	X	X	X	ESCC 2045000 ESCC 2045010 ESCC 2059000	-
Bond strength (for wedged bonding)	X	X	X	MIL-STD-750 method 2037 MIL-STD-883 method 2011	-
Bond shear (for ball bonding)	X	X	X	JEDEC JASD22-B116	-
Glassivation integrity		X	X	MIL-STD-883 method 2021	Make sure that the chemical etchant is suitable for the metallization
Die shear test (cavity package)	X	X	X	MIL-STD-750 method 2017 MIL-STD-883 method 2019	-

7: SEMICONDUCTOR DEVICES, DISCRETE

(Diodes, Transistors)

Table 1 DISCRETE SEMICONDUCTOR REQUIREMENTS 1/

Procurement Specification	Use As Is	Screen to Requirements in Tables 2 or 2B 2/	Qualify to Requirements in Tables 3 or 3A 2/
Level 1:			
1) ESCC 5000	O		
2) JANS	O		
3) JANTXV, JANTX		O	
4) JANJ, SCD		O	O
Level 2:			
1) ESCC 5000	O		
2) JANS	O		
3) JANTXV, JANTX		3/	
4) JANJ, SCD, Mfg. HI-REL 4/		O	O
5) Commercial		O	O
Level 3:			
1) ESCC 5000	O		
2) JANS	O		
3) JANTXV, JANTX		3/	
4) JANJ		3/	
5)SCD, Mfg. Hi-Rel, Commercial		O 5/	

Notes:

1/ JANS, JANTXV, JANTX and JANJ designations are defined in MIL-PRF-19500(General Specification for Semiconductor Devices). Plastic encapsulated semiconductors are not covered by this Section. Refer to section M3 for tests required on PEMs.

2/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated.

3/ All cavity devices shall require PIND testing. Condition A, Method 2052, ofMIL-STD-750shall be used.

4/ Manufacturer High Reliability (Mfr. Hi-Rel). This designation includes pats that are available only to a manufacturer's controlled reliability test program as described in the manufacturer's catalog. These test programs vary from manufacturer to manufacturer

5/ Level 3 applications parts shall require screening to Table 2. No qualification testing per Table 3 is mandatory; however, it is strongly recommended that all non- military/ESCC devices have life test in accordance with MIL-STD-750, Method 1005, conditions A-D (as appropriate for device type), for 1,000 hours at 125 °C (or equivalent time/temperature per Method 1005, Table 1).

Table 2 DIODE SCREENING REQUIREMENTS (Page 1 of 2)

Inspection/Test	MIL-STD-750		Level 1		Level 2		Level 3
	Methods	Conditions	JANTXV, JANTX	JANJ, SCD	JANJ, SCD, Mfg. HI-REL	Commercial	SCD, Mfg. HI- REL, Commercial
1. Internal Visual	2074 or 2073			O	1/	1/	1/
2. Temperature Cycling 2/	1051	No dwell required at 25 °C. Use maximum storage temperature range, 20 cycles, 10 minutes min. at extremes.		O	O	O	
3. Surge Current 3/	4066	Condition B 10 surges, one per minute, 7 msec minimum.		O	O	O	
4. Constant Acceleration	2006	20,000 Gs Y1 direction except 10,000 Gs for power rating > 10 Watts @ +25 °C.		O			
5. PIND4/	2052	Condition A.	O	O	O	O	O
6. FIST5/	2081	Axial lead diodes only.		O			
7. BIST5/	2082	Axial lead diodes only.		O			
8. Serialization			O	O			
9. Initial Electrical Measurements		Per Table 2A herein. @ 25 °C	O Read/Record 6/	O Read/Record 6/	O	O	O 7/
10. Burn-in 7/	1038	Per Table 2A herein. Condition A and B Duration (hours). HTRB. Power	O 48 160	O 96 240	O 48 160	O 48 160	O 9/ 0 160
11. Final Electrical Measurements		Per Table 2A herein. @ 25 °C, min . and max Operating Temp. 8/	O Read/Record	O Read/Record	O	O	O 8/
12. Calculate Deltas		Per Table 2A herein.	O	O			
13. Calculate PDA 10/			5%	5%	10%	10%	20%
14.Hermetic Seal a.Fine Leak b.Gross Leak	1071	 G or H C or K	O	O	O	O	

15. Radiographic	2076		O	O	O	O	
16. External Visual 11/	2071		O	O	O	O	O

Table 2 DIODE SCREENING REQUIREMENTS (Page 2 of 2)

Notes:

1/ DPA shall be performed on five samples to the requirements of S-311-M-70 in lieu of internal visual. No failures are permitted.

2/ For glass bodied diodes, perform thermal shock, instead of the temperature cycling test, per MIL-STD-750, Method 1056, condition A.

3/ Not required for voltage reference, transient voltage suppressor, current regulator, or varactor diodes.

4/ All cavity devices shall require PIND testing. Condition A, Method 2052, of MIL-STD-750 shall be used.

5/ Not required for double plug or case mounted diodes. Omit FIST for temperature compensated reference diodes.

6/ Read and Record (as a minimum) delta parameters listed in Table 2A . The non- delta parameters may be tested as “go/no-go”

7/ See Table 2A to determine if the HTRB and Power burn-in are both applicable or not. For thyristors, use MIL-STD-750, Method 1040, condition B, +25°C, for the same durations. If more than one burn-in type is required per Table 2A, the delta parameters shall be measured after each required burn-in step. Also, the delta calculations shall be made after each burn-in step.

8/ Minimum and maximum application temperatures may be used when measuring electrical parameters.

9/ Limit Burn-in temperature to the maximum operating temperature of diode as specified by the manufacturer. This temperature may be lower than 125°C for commercial or manufacturer’s in house Hi- REL parts.

10/ PDA applies to cumulative failures during all burn-in steps. The cumulative failures for all levels shall include functional/DC parametrics (excluding deltas) for the lot to be accepted.

11/ Pure tin plating is prohibited as a final finish on EEE parts.

Table 2A BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR DIODES

Diode Types	Required Burn-In		Delta Parameters	Electrical Measurements (Notes 1, 2, and 3)
	HTRB (Condition A)	Power (Condition B)		
Rectifier (Power, Fast Recovery, High Voltage)	80% rated VRM (Note 4) 125°C<TA<150°C	60 Hz Sinewave Rated VRWM and IO TA = 25℃	ΔVF ΔIR	VF, IR, VR, VBR, IFSM trr, Cj.
Switching (General Purpose, Schottky, RF, PIN)	80% rated VRM 125°C<TA<150°C	60 Hz Sinewave Rated VRWM and IO TA = 25℃	ΔVF ΔIR	VF, VR, VBR, IR, trr,τ, Cj, Po/Pi
Zener (Voltage Reference)	Not applicable	Specify IZ to meet rated Pd TA = 125℃	ΔVZ	VF, Vz, Iz ,ZZ,αVz
Current Regulator Diode	Not required	Rated VPOV TA = 25℃	ΔIs	VL, ZS, ZK, Vs, Is,αIs.
Transient Suppressor Diode	80% rated VRWM 125°C<TA<150°C	Specify Ip, Tp, number of pulses TA = 25 °C (Note 5)	ΔVBR ΔIR	VBR, VCM, ISM, IR.
Light Emitting Diode	Not applicable	Rated IF TA =25℃	ΔVF ΔIV	IV, IR, VF CT
Tunnel Diode (Microwave)	Rated VR 125°C<TA<150°C	Specify IF & VF to meet max. Pd TA =25℃	ΔVP ΔVR	IP, IV, VR, VF, VV CT
Varactor (Tuning)	80% rated VRM 125°C<TA<150°C	Not required	ΔIR ΔCT	IR, VBR CC, CT, Q, Ct1, LS, Ctz
Thyristor (SCRs)	80% rated VRM 80% rated VDM 125°C<TA<150°C	Rated VDWM & VRWM. Specify VGT & VGQ. (Note 6) TA = 25℃	ΔIDM ΔIRM	IDM, IGM, IGT, IL, IRM, VBR, VGT, dV/dt, ton, toff

Notes:

1/ See MIL-PRF-19500, Appendix B for symbol definitions.

2/ Minimum required parameters are specified. When necessary, application critical parameters not listed in the table shall also be measured.

3/ All DC parameters shall be tested at 25℃, at minimum and at maximum operating temperatures. All AC parametric measurements shall be performed at the required 25 °C.

4/ Case mounted rectifiers with IO rated > 10 A @Tc= 100℃do not require HTRB.

5/ Refer to slash sheets (e.g., /516) for the unique power burn-in sequence of transient suppressor diodes.

6/ Power burn-in is applied only to SCR specifically designed with gate turn-off control; otherwise, use method 1040, condition A or B.

Table 2B TRANSISTOR SCREENING REQUIREMENTS (Page 1 of 2)

Inspection/Test	MIL-STD-750		Level 1		Level 2		Level 3
	Methods	Conditions	JANTXV/ JANTX	JANJ, SCD	JANJ, SCD, Mfg. HI- REL	Commercial	SCD, Mfg. HI-REL, Commercial
1. Internal Visual	2072	For power FETs, use Method 2069; for RF types, use Method 2070.	1/	1/	1/	1/	1/
2. Temperature Cycling	1051	No dwell required at 25℃. Use maximum storage temperature range, 20 cycles. Extremes > 10 min.		O	O	O	
3. Constant Acceleration	2006	20,000 Gs Y1 direction except 10,000 Gs for power rating > 10 Watts +25℃.		O			
4. PIND	2052	Condition A.	O	O	O	O	O
5. Serialization			O	O			
6. Initial Electrical Measurements		Per Table 2C herein. @ 25 °C,	O Read/Record 2/	O Read/Record 2/	O	O	O
7. Burn-in 3/, 4/	1039	Per Table 2C herein. Condition A or B. Duration (hours). HTRB Power	O 48 160	O 96 240	O 48 160	O 48 160	O 160
8. Final Electrical Measurements		Per Table 2C herein. @ 25 °C, min. and max. Operating Temp. 5/	O Read/Record	O Read/Record	O	O	O 4/
9. Calculate Deltas 6/		Per Table 2C herein.	O	O			
10. Calculate PDA 7/			5%	5%	10%	10%	20%

11. Hermetic Seal a. Fine Leak b. Gross Leak	1071	 G or H C or K	O	O	O	O	
12. Radiographic	2076		O	O			
13. External Visual 8/	2071		O	O	O	O	O

Notes on next page.

Table 2B TRANSISTOR SCREENING REQUIREMENTS (Page 2 of 2)

Notes:

1/ DPA shall be performed on five samples in lieu of internal visual. No failures are permitted.

2/ Read and Record (as a minimum) delta parameters listed in Table 2A . The non- delta parameters may be tested as “go/no-go”.

3/ See Table 2A to determine if the HTRB and Power burn-in are both applicable or not. For Power FETs, use MIL-STD-750, Method 1042, condition A and B, for the same duration. For thyristors, use Method 1040. If more than one burn-in type is required per Table 2A, the delta parameters shall be measured after each required burn-in step. Also, the delta calculations shall be made after each burn-in step.

4/ Limit Burn-in temperature to the maximum operating temperature of transistor as specified by the manufacturer. This temperature may be lower than 125°C for commercial or manufacturer’s in house Hi-REL parts.

5/ Minimum and maximum application temperatures may be used when measuring electrical parameters.

6/ For delta failures greater than 10%, lot shall be reviewed for acceptance.

7/ PDA applies to cumulative failures during all burn-in steps. The cumulative failures for all levels shall include functional/DC parametrics (excluding deltas) for the lot to be accepted.

8/ Pure tin plating is prohibited as a final finish on EEE parts.

Table 2C BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR TRANSISTORS

Transistor Type	Required Burn-in		Delta Parameters	Electrical Measurements (Notes 1, 2, and 3)
	HTRB (Condition A)	Power (Condition B)		
Bipolar Transistors (Switching, Low High Power, Dual, General Purpose.)	80% rated VCBO 125°C<TA<150°C	Specify VCB or VCE to meet max PT TA = 25 °C	ΔICBO orΔICEO ΔhFE	ICB, ICEO, ICBO, IEBO, V(BR)CEO, V(BR)CBO, V(BR)EBO, V(BR)CES, VCE(SAT), VBE(SAT), hFE, ton, toff, ts, tf, hfe, Cobo, Cibo
Bipolar Transistors(RF, High-Frequency)	80% rated VCBO 125°C<TA<150°C	Specify VCB to meet max PT TA = 25 °C	ΔICEO ΔhFE	ICEO, V(BR)CEO, V(BR)CBO, V(BR)EBO VCE(SAT), hFE GPE, NF, hfe,η, Cobo
Junction Field Effect (JFET)	80% rated VGS VDS = 0 125°C<TA<150°C	80% rated VGS Specify VDS to meet max PT TA = 25 °C	ΔIDSS orΔIGSS Δyfs	VDS(ON), VGS(OFF), V(BR)GSS, IGSS, IDSS, Ciss, Crss, yfs, yos.
MOSFET	80% rated VDS VGS= 0V TA= 125 °C	80% of rated VGS VDS= 0V TA= 125 °C	ΔIDSS orΔIGSS ΔVGS(TH) Δrds(on)	V(BR)DSS, VGS(TH), VDS(ON), VSD, rds(on), ton, toff, trr, CT.
Darlington	80% rated VCBO 125°C<TA<150°C	Specify VCB or VCE to meet max PT TA = 25 °C	ΔhFE ΔICE	VCE(SAT), VBE(SAT), VBE(TH), V(BR)CEO, ICEO, IEBO, ICE
Optocoupler	IF = 0 80% Rated VCBO TA = 125 °C	IF = rated max Specify VCE tomeetmaxPT TA = 25 °C	ΔhFE ΔIC(OFF) ΔIC(ON)	VCE(SAT), V(BR)CEO, VF IC(OFF), IC(ON), IR, hFE, tr, tf, Cobo.

Notes:

1/ See MIL-PRF-19500, Appendix B for symbol definitions.

2/ Recommended electrical parameters are specified. Since electrical parameters are device dependent, the conditions and limits pertaining to a device type shall be specified in a detail specification.

3/ All DC parameters shall be tested at 25°C, at minimum operating temperature and at maximum operating temperature. All AC parametric measurements shall be made at the required 25°C.

Table 3 DIODE QUALIFICATION TEST REQUIREMENTS 1/, 2/ (Page 1 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept Number)			
			Level 1	Level 2		Level 3
	Methods	Conditions	JANJ, SCD	JANJ, SCD, Mfg. HI-REL	Commercial	SCD, Mfg. Hi-REL, Commercial
Subgroup 1		Separate samples may be used for each test.	6 (0)	4 (0)	4 (0)	Not Required
Physical Dimensions	2066	Dimensions in accordance with specified case outline. In case of failure, 100% dimensional inspection shall be performed.	O	O	O	
Solderability	2026		O	O	O	
Resistance to Solvents	1022		O	O	O	
Subgroup 2			6 (0)	Not Required	Not Required	Not Required
Decap-Internal Visual	2075	In accordance with internal visual precap criteria.	O			
SEM	2077	Die with expanded metallization contacts or metallization interconnects.	O			
Bond Strength (Wire or Clip Bonded Devices)	2037	All wire bonds.	O			
Die Shear (Exclude Axial Lead Devices)	2017		O			
Subgroup 3		Bias conditions as specified:	12 (0)	Not Required	Not Required	Not Required
Accelerated Steady State Operation Life	1027	Eutectic die attach. Tj = +275°C for 96 hours minimum.	O			
		or				
		Soft solder die attach. Tj = +225 °C for 168 hours minimum.	O			
	1038	Schottky diodes				
		Tj = rated Tj for 240 hours minimum.	O			
Electrical Measurements		As specified in Table 2A herein.	O			

Table 3 DIODE QUALIFICATION TEST REQUIREMENTS 1/, 2/ (Page 2 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept number)			
			Level 1	Level 2		Level 3
	Methods	Conditions	JANJ, SCD	JANJ, SCD, Mfg. HI-REL	Commercial	SCD,Mfg. HI-REL, Commerc
Subgroup 4 Operation Life			22 (0)	12 (0)	22 (0)	Not Required
Steady State	1026	1,000 hours minimum at maximum operating junction temperature.	O	O	O	
or			Or	Or	or O	
Intermittent	1037	6,000 cycles min.	O	O	O	
or			Or	Or	or	
Blocking	1048		O	O	O	
Electrical Measurements		As specified in Table 2A herein.	O	O	O	

Notes:

1/ QCI testing to MIL-PRF-19500 JANS or JANTXV requirements is acceptable for all quality levels.

2/ Samples shall be selected from parts that have passed the screening requirements in Table 2.

Table 3A TRANSISTOR QUALIFICATION TEST REQUIREMENTS 1/, 2/ (Page 1 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept number) or LTPD			
			Level 1	Level 2		Level 3
	Methods	Conditions	JANJ, SCD,	JANJ, SCD, Mfg.HI-REL	Commercial	SCD,Mfg. HI-REL, Commerci al
Subgroup 1		Separate samples may be used for each test.	6 (0)	4 (0)	4 (0)	Not Required
Physical Dimensions	2066	Dimensions in accordance with specified case outline. In case of failure, 100% dimensional inspection shall be performed.	O	O	O	
Solderability	2026				O	
Resistance to Solvents	1022		O	O	O	
Subgroup 2			6 (0)	Not Required	Not Required	Not Required
Decap-Internal Visual	2075		O			
SEM	2077	Die with expanded metallization contacts or metallization interconnects.	O			
Bond Strength	2037	All wire bonds.	O			
Die Shear	2017		O			
Subgroup 3			6 (0)	Not Required	Not Required	Not Required
Intermittent Operation Life Test	1037 or 1042	2,000 cycles.	O			
		For Power MOSFETs Cond. D, 2,000 cycles.	O			
Electrical Measurement		As specified in Table 4A herein.	O			

Table 3A TRANSISTOR QUALIFICATION TEST REQUIREMENTS 1/, 2/ (Page 2 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept number) or LTPD			
			Level 1	Level 2		Level 3
	Methods	Conditions	JANJ, SCD	JANJ, SCD, Mfg. HI-REL	Commercial	SCD, Mfg. HI-REL, Commercial
Subgroup 4			12 (0)	Not Required	Not Required	Not Required
Accelerated Steady State Life Test	1027	For eutectic die attached device, TJ = +275℃for 96 hours minimum.	O			
		For soft solder die attached device, TJ = +225℃for 168 hours minimum.	O			
	1042	For Power MOSFETs, 3/ 1)Reverse bias, Cond. A, TA = +175℃, VDS = Rated, 24 hours. 2)Gate Stress, Cond. B, TA = + 175℃, VGS = Rated, 24 hours.	O			
Electrical Measurement		As specified in Table 2C herein.	O			
Subgroup 5			22 (0)	12 (0)	22 (0)	Not Required
Steady State Life Test	1026	TJ = Max Operating TJ 1,000 hours min.	O	O	O	
Electrical Measurement		As specified in Table 2C herein.	O	O	O	

Notes:

1/ QCI testing to MIL-PRF-19500 JANS or JANTXV requirements is acceptable for all quality levels.

2/ Samples shall be selected from parts that have passed the screening requirements in Table 2

3/ Electrical measurements shall be performed after the reverse bias life test and before the gate stress life test.

8: CAPACITORS

Table 1 CAPACITOR REQUIREMENTS (Page 1 of 2)

Part Family	Capacitor Style and Type		Reference Specification	Failure Rate Level (FRL) Required 1/		
				Level 1	Level 2	Level 3
Ceramic						
	ESCC3009	Chip,Ceramic	ESCC3009	O	O	O
	CCR	Encapsulated,Temp.Compensating	MIL-PRF-20	S 2/	R 3/	P
	CKR	Encapsulated,EstablishedReliability	MIL-PRF-39014	2/	S 2/	R
	CKS	Encapsulated&Chip,HighReliability (Space Level)	MIL-PRF-123	O	O	O
	CDR	Chip,EstablishedReliability	MIL-PRF-55681	S 2/	R 2/	P
	HVR	HighVoltage,Leaded	MIL-PRF-49467	S	R	P
	PC	Variable(Non-ER)	MIL-PRF-14409	2/	2/	O
	CV	Variable(Non-ER)	MIL-PRF-81	2/	2/	O
	CPC	SinglePlate	MIL-C-49464	S	R	P
	PS	SwitchModePowerSupply	MIL-PRF-49470	T	B	B
Tantalum	ESCC3003	Non-solidtantalum,Electrolytic	ESCC3003	O	O	O
	ESCC3002	Solidtantalum,Electrolytic	ESCC3002	O	O	O
	CSR	SolidElectrolyte	MIL-PRF-39003	C 2/	B	B
	CSS	SolidElectrolyte	MIL-PRF-39003	C	B	B
	CWR	Chip(SolidElectrolyte)	MIL-PRF-55365	C 2/	B	B
	CLR	Non-SolidElectrolyte	MIL-PRF-39006	R	P	P
Mica	ESCC3007	Mica	ESCC3007	O	O	O
	CMS	Fixed,HighReliability(Space)	MIL-PRF-87164	O	O	O
	CMR	Fixed,EstablishedReliability	MIL-PRF-39001	2/	2/	R

Notes at end of table.

Table 1 CAPACITOR REQUIREMENTS (Page 2 of 2)

Part Family	Capacitor Style and Type	Reference Specification	Failure Rate Level (FRL) Required 2/		
			Level 1	Level 2	Level 3
Paper or Plastic Film	ESCC3006 Super Metalized Plastic Film	ESCC3006	O	O	O
	CQR Foil,HermeticallySealed	MIL-PRF-19978	2/	2/	R
	CHR Metallized,HermeticallySealed, DC and AC	MIL-PRF-39022	2/	2/	R
	CHS Supermetallized,HermeticallySealed,DC	MIL-PRF-87217	O	O	O
	CRH Metallized,HermeticallySealed, DC, AC, or DC and AC	MIL-PRF-83421	R	R	R
Glass	CYR EstablishedReliability	MIL-PRF-23269	S	R	P
Commercial, High Rel, or SCD	All Types (Ceramic, Tantalum, Glass, Paper, Plastic, etc.) 3/	N/A	4/	4/	4/

Notes:

1/ The FRL letters indicate use “as is” for the specified grade level. When capacitors can be purchased to acceptable specifications which do not include FRLs, an “O” indicates use “as is.” FRLs are not applicable (N/A) for capacitors procured to SCDs or commercial capacitors.

2/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot-specific attributes data for screening tests, and lot-specific or generic attributes data as applicable to various test groups of qualification tests, must be submitted to show that tests were performed with acceptable results.

3/ The construction of commercial parts may not be as robust as equivalent military parts.

4/ Capacitors shall meet the screening and qualification requirements of Tables 2 and 3. Any test required by Tables 2 and 3 that is already performed by the procurement specification (ESCC, military or SCD) need not be repeated. However, lot-specific attributes data for screening tests, and lot-specific or generic attributes data as applicable to various test groups of qualification tests, must be submitted to show that tests were performed with acceptable results.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level																	
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1. a.Visualand Mechanical Examination b. Electrical Measurements (See step 6 for details of tests required and test conditions)	Visual and sample based mechanical inspection to be performed to requirements of nearest military specification	O	O	O	O	O	O	O	O	O	O	O	OO	O	O	O	O	O	O	O	O	O
2. ThermalShock	MIL-STD-202, Method 107, Condition B, min. rated temp. to max. rated temp. (when specified in the product specification/ data sheet, the min. and max. “storage” temp. shall be used in lieu of the specified operating temp.)	O	O		O	O		O	O		O	O		O	O		O	O		O	O	

Notes at end of table.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level																			
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
3. Voltage Conditioning (Burn-In)	2 x rated voltage, 2/																					
	125 °C, 160 hours	O												O								
	125 °C, 96 hours		O												O						O	
	125 °C, 48 hours			O												O						O
	140% rated voltage, 125°C or max rated temp. whichever is less, 48 hours				O	O	O										O	O				
	Rated voltage, 85 °C																					
	160 hours							O														
	96 hours								O													
	48 hours									O												
	1500 Vdc (for parts rated≥300 Vdc); 4x rated voltage (for parts rated <300 Vdc); room temp., 48 hours										O	O										
4. SurgeCurrent3/	-55 °C to 85 °C 3/							O														
	25 °C 3/								O	O												
5. High Impedance temp. and voltage ramp 4/	5 cycles, -55 °C to 100 °C in accordance with MIL-PRF-87217				O	O																

Notes at end of table.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level																	
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
6. Electrical Measurements	As specified 5/																					
Capacitance	MIL-STD-202, Method 305	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Dissipation Factor	MIL-STD-202, Method 305	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
DWV	MIL-STD-202, Method 301	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Insulation Resistance 1	MIL-STD-202, Method 302, room temp.	O	O	O	O	O	O					O	O	O	O	O	O	O	O	O	O	O
Insulation Resistance 2	Repeat at max. rated temp.	O			O						O			O			O			O		
DC Leakage 1	MIL-STD-202, Method 301							O	O	O												
DC Leakage 2	Repeat at 85 °C							O	O													
Equivalent Series Resistance								O	O													
Quality Factor																	O	O	O			
Driving Torque																	O	O				
7. Percent Defective Allowable	5% 10% 20%	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
8. Partial Discharge 6/	MIL-PRF-49467 Appendix B	O	O																			
9. Seal Test (Hermetic Types Only) Gross Leak Fine Leak	MIL-STD-202, Method112 ConditionAorB ConditionC				O O	O		O O	O													

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 4 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level																					
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power Supply				
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
10. Radiographic Inspection	MSFC-STD-355C	O			O			O						O			O			O			
11. Visual and Mechanical Examination	Dimensions, Marking, Work-manship	O	O		O	O		O	O		O	O		O	O		O	O		O	O		
12. Humidity Steady State, Low Voltage 7/	MIL-STD-202, Method 103, Condition A and MIL-PRF-123, Group B	12(0)	5(0)																	5(0)	5(0)		

Notes:

1/ User should refer to the nearest equivalent military specification listed in Table 1 if required for better definition of testing requirements.

2/ For high voltage capacitors (>500 V) that have unique requirements based on rated voltage, refer to the nearest equivalent military specification listed in Table 1.

3/ Solid tantalum capacitors are susceptible to failure when subjected to current surges. Therefore, surge current testing, as described below is required for solid tantalum capacitor styles used in level 1, 2, and 3 applications. Surge current testing is not applicable to wet tantalum capacitor styles.

a) Level 1 applications shall use the surge current test method from MIL-PRF-39003/10(-55 °C and +85 °C) for leaded devices and MIL-PRF-55365/4(-55°C and +85°C, Option B) for chips.

b) Level 2 and Level 3 applications shall use the surge current test method from MIL-PRF-39003/9(25 °C) for leaded devices and MIL-PRF-55365/4 (+25°C, option A) for chips.

4/ Required only for metallized polycarbonate low energy, high impedance capacitors similar to those specified by MIL-PRF-87217.

5/ It is the responsibility of the user to define minimum and maximum values for each parameter (pass/fail criteria) and delta criteria, if applicable. These values should be based on the nearest equivalent military specification, manufacturer specifications, or the application, whichever is most stringent.

6/ Partial Discharge testing is required only for high voltage capacitors similar to those specified by MIL-PRF-49467 rated at 1,000 volts and higher. This test requirement may affect capacitor design and should be performed by the manufacturer. If performed by the user, it could result in a high probability of failure.

7/ Humidity, Steady State, Low Voltage testing is required only for non-ESCC QPL or non-MIL QPL/QML, not qualified range of values, ceramic capacitors if its rated voltage<50V and C>1uF.

Table 3A CERAMIC CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Use parts that have passed screening tests of Table 2.	100% O	100% O	N/A
Group 2 Voltage/Temperature Limits	Capacitance change over the range of temperatures and voltages specified shall not exceed limits of specification.	12(1) O	6(1) O 5/	N/A
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification.	O	O 5/	
Group 3 Terminal Strength 3/	MIL-STD-202, Method 211 Condition A (all leaded devices) Condition C (radial leaded and DIP devices only) Condition D (axial leaded devices only)	12(0) O	6(1) O	N/A
Resistance to Solder Heat (N/A to variable devices)	MIL-STD-202, Method 210 Condition C (chips), Condition G (leaded) IR,ΔC and DF to specification	O	O	
Moisture Resistance	MIL-STD-202, Method 106 20 cycles (first 10 cycles with Vrated applied) DWV, IR andΔC to specification	O	O(0)	
Fatigue (Variable devices)	100 cycles in 5 minutes	O	O	

Notes at end of table.

Table 3A CERAMIC CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 4 Humidity Steady State, Low Voltage 4/	MIL-STD-202, Method 103, Condition A and MIL-PRF- 123, Group B	12(0) O	5(0) O	N/A
Group 5 Solderability Destructive Physical Analysis	MIL-STD-202, Method 208 EIA-469	5(0) O O	3(0) O	N/A
Group 6 Life (at elevated temp.) 5/ Partial Discharge 6/	MIL-STD-202, Method 108 Ttest = maximum operating temperature Vtest = 2 x Vrated Duration: 2000 hours for level 1, 1000 hours for levels 2 and 3 IR,ΔC, and DF to specification MIL-PRF-49467 Appendix B	44(0) or 22(0) O O	44(0) or 22(0) O O	N/A

Notes at end of table.

Table 3A CERAMIC CAPACITOR QUALIFICATION REQUIREMENTS (Page 3 of 3)

Notes:

1/ Qualification shall consist of the tests specified in Table 3A in the order as shown. All parts submitted for qualification testing shall have passed screening tests as described in Table 2. These sample units shall then be divided as shown in Table 3A for Groups 2 through 5 and subjected to the tests for their particular group.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection in detail specification. These values shall be based on the nearest equivalent ESCC or military specification, the manufacturer's specification, or the application, whichever is most severe. Refer to Table 1 for the nearest equivalent military specification.

3/ This test is not applicable to chip capacitors.

4/ Humidity, Steady State, Low Voltage testing is required only for non-ESCC QPL or non-MIL QPL/QML, not qualified range of values, ceramic capacitors if its rated voltage<50V and C>1uF.

5/ When qualifying a range of capacitance values and voltage ratings, quantities for the life test group shall be selected as follows:

Qualifying	Select
A single value and voltage rating:	22 parts of the same value and voltage rating
A range of values in a single voltage rating:	11 parts of the highest value and 11 parts of the lowest value in the range
A range of values in a range of voltage ratings:	11 parts of the highest value and 11 parts of the lowest value in the highest voltage rating, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

6/ Partial Discharge testing is required only for high voltage capacitors similar to those specified by MIL-PRF-49467 rated at 1000 volts and higher. This test requirement may affect capacitor design and should be performed by the manufacturer. If performed only by the user, it could result in a false identification of defective parts.

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Use parts that have passed screening tests of Table 2.	100% O	100% O	100% N/A
Group 2 Shock (Cavity devices only) 3/	MIL-STD-202, Method 213 Wet slugs Levels 1 and 2: Cond. D (500 Gs) Level 3: Cond. I (100 Gs) Dry slugs Levels 1, 2, and 3: Cond. I (100 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	12(0) O	6(1) O	N/A
Vibration, High Frequency (Cavity devices only) 3/	MIL-STD-202, Method 204 Two axes, 4 hours each axis Wet slugs Levels 1 and 2: Cond. H (80 Gs) Level 3: Cond. D (20 Gs) Dry slugs Levels 1, 2, and 3: Cond. D (20 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection. DCL,ΔC and DF to specification.	O	O	
Vibration, Random (Wet slug styles only) 3/	MIL-STD-202, Method 214 Condition IIK for 1.5 hours in each of three mutually perpendicular directions. Intermittent contacts greater than 0.5 ms shall be cause for rejection. DCL,ΔC and DF to specification.	O	O	

Notes at the end of table.

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 2/ (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 3		5(0)	3(0)	N/A
Solderability 3/	MIL-STD-202, Method 208	O	O	
Terminal Strength	MIL-STD-202, Method 211 Condition A Condition B	O	O	
Group 4		12(1)	6(1)	N/A
Resistance to Solvents	MIL-STD-202, Method 215	O	O 4/	
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition C (chips), Condition G (leaded) IR,ΔC and DF to specification	O	O 4/	
Moisture Resistance	MIL-STD-202, Method 106 20 cycles (first 10 cycles with 6 Vdc applied) DWV, IR andΔC to specification	O	O 4/	

Notes at the end of table.

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 5		12(1)	6(1)	N/A
Stability at Low and High Temperature	In accordance with MIL-PRF-39003 DCL, C, and DF shall be within specification at the applicable test temperature.	O	O	
Surge Voltage	Wet slugs In accordance with MIL-PRF-39006 Dry slugs In accordance with MIL-PRF-39003 Chips In accordance with MIL-PRF-55365	O	O	
Reverse Voltage (Polarized wet slug styles only)	Vtest = Reverse voltage rating (Vdc) Ttest = 85 °C Duration: 125 hours level 1 48 hours level 2 DCL,ΔC and DF to specification	O	O	

Group 6 Life 5/ (at elevated temp.) (Dry slug styles only)	 MIL-STD-202, Method 108 Ttest = 85 °C Vtest = Vrated Duration: 2000 hours for level 1 1000 hours for level 2 DCL,ΔC and DF to specification	44(0) or 22(0) X O	44(1) or 22(1) X O	N/A
AC Ripple Life (Wet slug styles only)	MIL-STD-202, Method 108 Ttest = 85 °C Vtest = Vrated + Rated Ripple Current at 40 kHz Duration: 2000 hours for level 1 1000 hours for level 2 DCL,ΔC and DF to specification			

Notes at end of table.

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

1/ Qualification shall consist of the tests specified in Table 3B in the order as shown. All parts submitted for qualification testing shall be subjected to screening tests. These sample units shall then be divided as shown in Table 3B for Groups 2 through 6 and subjected to the tests for their particular group.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection in detail specification. These values shall be based on the nearest equivalent ESCC or military specification, the manufacturer's specification, or the application, whichever is most severe. Refer to Table 1 for the nearest equivalent military specification.

3/ This test is not applicable to chip capacitors.

4/ Generic data is an acceptable basis for qualification for the indicated tests.

5/ When qualifying a range of capacitance values and voltage ratings, quantities for the life test group shall be

Qualifying	Select
A single value and voltage rating:	22 parts of the same value and voltage rating
A range of values in a single voltage rating:	11 parts of the highest value and 11 parts of the lowest value in the range
A range of values in a range of voltage ratings:	11 parts of the highest value and 11 parts of the lowest value in the highest voltage rating, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Use parts that have passed screening tests of Table 2.	100% O	100% O	N/A
Group 2 Vibration, High Frequency (Cavity devices only)	MIL-STD-202, Method 204 Levels 1 and 2: Condition E (50 Gs) Level 3: Condition D (20 Gs) Two axes, 4 hours each axis Vtest = 0.5 x Vrated + 1.0 Vrms at 1 kHz Intermittent contacts greater than 0.5 ms shall be cause for rejection.	12(0) O	6(0) O	N/A
Group 3 Shock (Cavity devices only)	MIL-STD-202, Method 213 Condition I Vtest = 0.5 x Vrated Intermittent contacts greater than 0.5 ms shall be cause for rejection.	12(0) O	6(0) O	N/A
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition G IR,ΔC and DF to specification	O	O	
Moisture Resistance	MIL-STD-202, Method 106 Vtest = Vrated (100 Vdc maximum) for 50% of parts. Vibration is applicable during step 7. DWV, IR,ΔC and DF to specification MIL-STD-202, Method 103 Condition B, no bias DWV, IR and ΔC to specification	O	O	

Notes at the end of table.

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 4		5(0)	3(0)	N/A
Solderability	MIL-STD-202, Method 208	O	O	
Terminal Strength 3/	MIL-STD-202, Method 211 Condition A (all leaded devices) and: Condition C (radial leaded devices only) Condition D (axial leaded devices only)	O	O	
Resistance to Solvents	MIL-STD-202, Method 215	O	O	
Group 5		44(0) or 22(0)	44(1) or 22(1)	N/A
Temperature Coefficient	Capacitance change over the range of temperatures specified shall not exceed limits of specification. MIL-	O		
Life (Accelerated)	STD-202, Method 108 Ttest = 100 °C Vtest = 1.4 x Vrated Duration: 2000 hours for level 1 1000 hours for levels 2 and 3 IR,ΔC, and DF to specification	O	O	
Group 6		6(0)	N/A	N/A
Vibration, Random (Hermetically sealed styles only) 3/	MIL-STD-202, Method 214 Condition IIK for 15 minutes in each of two mutually perpendicular directions. Vtest = 1 Vrms at 1 kHz Intermittent contacts greater than 0.5 ms shall be cause for rejection DCL,ΔC and DF to specification	O		

Notes at the end of table.

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS (Page 3 of 3)

Notes:

1/ Qualification shall consist of the tests specified in Table 3C in the order as shown. All parts submitted for qualification testing shall be subjected to screening tests. These sample units shall then be divided as shown in Table 3C for Groups 2 through 6 and subjected to the tests for their particular group. The user must subject an appropriate number of samples to screening tests to meet the PDA requirement and still have enough passing samples for Groups 2 through 6.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection in detail specification. These values shall be based on the nearest equivalent military specification, the manufacturer's specification, or the application, whichever is most severe. Refer to Table 1 for the nearest equivalent military specification.

3/ This test is not applicable to chip capacitors.

4/ When qualifying a range of capacitance values and voltage ratings, quantities for the life test group shall be selected as follows:

Qualifying	Select
A single value and voltage rating:	22 parts of the same value and voltage rating
A range of values in a single voltage rating:	11 parts of the highest value and 11 parts of the lowest value in the range
A range of values in a range of voltage ratings:	11 parts of the highest value and 11 parts of the lowest value in the highest voltage rating, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1		100%	100%	
Screening to Table 2	Use parts that have passed screening tests of Table 2.	O	O	N/A
Group 2		6(0)	3(0)	N/A
Solderability	MIL-STD-202, Method 208	O	O	
Vibration, High Frequency	MIL-STD-202, Method 204 Condition B (15 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	O	O	
Vibration, Random	MIL-STD-202 Method 214 Condition E of Table 214E-II Three axes for 1.5 hours each axis. No intermittent contacts in excess of 0.5 ms during final 30 minutes of each axis.	O	O	
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification.	O		
Thermal Shock	MIL-STD-202, Method 107 Condition B except Tmax = maximum operating temperature Tmin = minimum operating temperature Level 1: 25 cycles Level 2: 10 cycles Level 3: 5 cycles DWV, IR,ΔC, C and DF to specification	O	O	

Notes at the end of table.

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 3		12(0)	6(1)	N/A
Shock 2/	MIL-STD-202, Method 213 Condition I (100 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	O	O	
Terminal Strength 2/, 3/	MIL-STD-202, Method 211 Condition A Condition D	O	O	
Resistance to Solder Heat 2/	MIL-STD-202, Method 210 Condition G IR,ΔC and DF to specification	O	O	
Moisture Resistance 2/	Risk Levels 1 and 2: MIL-STD-202, Method 106 Apply Vrated (100 V maximum) to 50% of test parts. Vibration step not applicable. IR,ΔC and DF to specification	O	O (0)	
Group 4 6/		44(0) or 22(0) X	44(1) or 22(1) X	N/A
Life 2/, 4/	Precondition parts at –55 °C for 48 hours minimum.			
(Accelerated condition)	Ttest = maximum operating temperature Vtest = 1.5 x Vrated Duration: 2000 hours for level 1 1000 hours for levels 2 and 3 DWV, IR,ΔC and DF to specification			
Group 5		5(0)	5(0)	N/A
Resistance to Solvents 2/	MIL-STD-202, Method 215	O	O	

Notes at the end of table.

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS (Page 3 of 3)

Notes:

1/ Qualification shall consist of the tests specified in Table 3D in the order as shown. All parts submitted for qualification testing shall be subjected to screening tests. These sample units shall then be divided as shown in Table 3D for Groups 2 through 5 and subjected to the tests for their particular group. The user must subject an appropriate number of samples to screening tests to meet the PDA requirement and still have enough passing samples for Groups 2 through 5.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection in detail specification. These values shall be based on the nearest equivalent military specification, the manufacturer's specification, or the application, whichever is most severe. Refer to Table 1 for the nearest equivalent military specification.

3/ This test is not applicable to chip capacitors.

4/ When qualifying a range of capacitance values and voltage ratings, quantities for the life test group shall be selected as follows:

Qualifying	Select
A single value and voltage rating:	22 parts of the same value and voltage rating
A range of values in a single voltage rating:	11 parts of the highest value and 11 parts of the lowest value in the range
A range of values in a range of voltage ratings:	11 parts of the highest value and 11 parts of the lowest value in the highest voltage rating, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2 1/ 2/	 Use parts that have passed screening tests of Table 2.	100% O	100% O	N/A
Group 2 Thermal Shock 2/	 MIL-STD-202,Method 107 Condition B IR, C,ΔC and DF to specification	12(0) O	6(1) O	N/A
Quality Factor 2/	MIL-STD-202, Method 306	O	O	
Shock 2/	MIL-STD-202, Method 213 Condition I (100 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	O	O	
Vibration, High Frequency 2/	MIL-STD-202, Method 204 Condition D (20 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	O	O	
Group 3 Solderability 2/	 MIL-STD-202, Method 208	12(1) O (1)	6(1) O	N/A
Terminal Strength 2/	MIL-STD-202, Method 211 Condition A (all leaded devices) and: Condition C (radial leaded devices only) Condition D (axial leaded devices only)	O (0)	O	
Temperature Coefficient and Drift 2/	Capacitance change over the range of temperatures specified shall not exceed limits of specification.	O (0)	O 3/	

Notes at the end of table.

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Risk Level 1	2	3
Group 4		12(1)	6(1)	N/A
Resistance to Solvents 2/	MIL-STD-202,Method 215	O	O 3/	
Resistance to Solder Heat 2/	MIL-STD-202, Method 210 Condition G IR,ΔC and DF to specification	O	O	
Moisture Resistance 2/	MIL-STD-202, Method 106 20 cycles (first 10 cycles with 100 Vdc applied) IR, C,ΔC and DF to specification	O (0)	O (0)	
Group 5 5/		44(0) or 22(0)	44(1) or 22(1)	N/A
Life 2/, 4/ (Accelerated condition)	MIL-STD-202, Method 108 Ttest = 125°C Vtest = 1.5 x Vrated Duration = 2000 hours for level 1 1000 hours for levels 2 and 3 IR,ΔC and DF to specification	O	O	

Notes at end of table.

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS (Page 3 of 3)

Notes:

1/ Qualification shall consist of the tests specified in Table 3E in the order as shown. All parts submitted for qualification testing shall be subjected to screening tests. These sample units shall then be divided as shown in Table 3E for Groups 2 through 5 and subjected to the tests for their particular group. The user must subject an appropriate number of samples to screening tests to meet the PDA requirement and still have enough passing samples for Groups 2 through 5.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection in detail specification. These values shall be based on the nearest equivalent military specification, the manufacturer's specification, or the application, whichever is most severe. Refer to Table 1 for the nearest equivalent military specification.

3/ Generic data is an acceptable basis for qualification for the indicated tests.

4/ When qualifying a range of capacitance values and voltage ratings, quantities for the life test group shall be selected as follows:

Qualifying	Select
A single value and voltage rating:	22 parts of the same value and voltage rating
A range of values in a single voltage rating:	11 parts of the highest value and 11 parts of the lowest value in the range
A range of values in a range of voltage ratings:	11 parts of the highest value and 11 parts of the lowest value in the highest voltage rating, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

9 : C R Y S T A L S

Table 1 REQUIREMENTS FOR CRYSTALS

Procurement Specification	Use As Is	Screen to Table 2 2/	Qualify to Table 3 2/
Level 1			
1) ESCC3501,LevelB	O		
2) MIL-PRF-30981/		O 3/	
3) SCD4/,5/			O
Level 2			
1) ESCC3501,LevelB	O		
2) MIL-PRF-30981/	O		
3) SCD4/		O	O
4) Commercial		O	O
Level 3			
1) ESCC3501,LevelB	O		
2) MIL-PRF-30981/	O		
3) SCD or Commercial		O	

Notes:

1/ MIL-PRF-3098, Crystal Units, Quartz, General Specification for, has no provision for radiation hardness. If radiation hardness is a requirement for the success of the mission, parts must be procured to a specification control drawing (SCD) that includes the requirement for radiation testing to the specified total dose. Also, only parts using at least a three point mount shall be used.

2/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test groups of qualification tests must be submitted to show that tests were performed with acceptable results.

3/ MIL-PRF-3098 does not require 100% conformance testing of all parts in a lot. Also, the specification does not require PIND testing. Therefore, all parts procured to a MIL-PRF-3098 part number must be screened to the requirements of Table 2 before use in a Level 1 application unless lot specific attributes data is obtained from the manufacturer.

4/ All SCDs must be written in accordance with the requirements of ESCC 3501 or MIL-PRF-3098 with Tables 2 and 3 of this section, and

contain the following design requirements: crystals shall be swept synthetic quartz meeting the infrared quality requirements of grade A or B of IEC60758;and shall be mounted with at least a three point mount. The full title of the IEC document is Synthetic Quartz Crystal – Specifications and Guide to the Use, IEC60758(1993-04), International Electrotechnical Commission, Geneva, Switzerland.

4.1/ The IEC specification lists six levels of infrared quality, which are designated from Aa (the best) to E (the worst). A and B are the levels that several prominent oscillator manufacturers recommend for space and military applications. Infrared quality is an indirect measure of the level of impurities in a crystal. Impurities can affect frequency aging characteristics

Table 2 SCREENING REQUIREMENTS FOR CRYSTALS

Inspection/Test	Test Methods and Conditions 1/, 2/	Level 1	Level 2		Level 3
		SCD	SCD	Commercial	SCD or Commercial
1. Internal visual inspection	MIL-PRF-3098, paragraph 4.7.2.2	6(0)	6(0)	6(0) 2/	4(0) 2/
2. External visual and mechanical inspection 4/	MIL-PRF-3098, paragraph 4.7.2	O	O	O	O
3. Low temperature storage	MIL-PRF-3098, paragraph 4.7.8.4	O	O	O	O
4. Frequency and equivalent resistance Frequency stability (controlled) Operable temperature range (controlled)	MIL-PRF-3098, paragraph 4.7.8 MIL-PRF-3098, paragraph 4.7.8.2 MIL-PRF-3098, paragraph 4.7.8.3	O	O	O	O
5. Capacitance shunt (when	MIL-PRF-3098, paragraph 4.7.7	O	O	O	O
6. Unwanted modes	MIL-PRF-3098, paragraph 4.7.9	O	O	O	O
7. Seal	MIL-PRF-3098, paragraph 4.7.11	O	O	O	O
8. Accelerated aging	MIL-PRF-3098, paragraph 4.7.14.1	O	O	O	O
9. PIND	MIL-STD-883, Method 2020	O	O	O	O
10. Radiographic inspection	MIL-STD-202, Method 209, view 1 in Y1 direction, second view 90° relative to first view	O	O	O	
11. Percent defective allowable (PDA)		5	10	10	10

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and define pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, the manufacturer's specification, or the application, whichever is more severe.

2/ Except for internal visual inspection, screening will be performed on all parts in the lot.

3/ In lieu of interval visual, DPA shall be performed to the requirements of S-311-M-70 specification.

4/ Pure Tin finish is prohibited as a final finish on EEE parts.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR CRYSTALS 1/ (Page 1 of 2)

Inspection/Test	Test Methods and Conditions	Level 1	Level 2		Level 3
		SCD	SCD	Commercial	SCD or Commercial
Subgroup I		10(0)	10(0)	10(0)	10(0)
Visual and mechanical inspection	MIL-PRF-3098, paragraph 4.7.2	O	O	O	O
Solderability	MIL-PRF-3098, paragraph 4.7.3	O	O	O	O
Shock (specified pulse)	MIL-PRF-3098, paragraph 4.7.4	O	O	O	O
Vibration	MIL-PRF-3098, paragraph 4.7.5	O	O	O	O
Low temperature storage	MIL-PRF-3098, paragraph 4.7.8.4	O	O	O	O
Reduced drive level 2/	MIL-PRF-3098, paragraph 4.7.6	O	O	O	O
Frequency and equivalent resistance	MIL-PRF-3098, paragraph 4.7.8	O	O	O	O
Frequency stability (controlled)	MIL-PRF-3098, paragraph 4.7.8.2				
Operable temperature range (controlled)	MIL-PRF-3098, paragraph 4.7.8.3				
Capacitance shunt (when specified)	MIL-PRF-3098, paragraph 4.7.7	O	O	O	O
Unwanted modes	MIL-PRF-3098, paragraph 4.7.9	O	O	O	O
Thermal shock	MIL-PRF-3098, paragraph 4.7.10	O	O	O	O
Seal	MIL-PRF-3098, paragraph 4.7.11	O	O	O	O
Aging	MIL-PRF-3098, paragraph 4.7.14	O	O	O	O
Terminal strength	MIL-PRF-3098, paragraph 4.7.15	O	O	O	O

Notes at end of table.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR CRYSTALS 1/ (Page 2 of 2)

		Level 1	Level 2		Level 3
Inspection/Test	Test Methods and Conditions	SCD	SCD	Commercial	SCD or Commercial
Subgroup 1 (cont.) Visual and mechanical inspection (internal)	MIL-PRF-3098, paragraph 4.7.2.2	O	O	O	O
Bond strength (when specified)	MIL-PRF-3098, paragraph 4.7.16	O	O	O	O
Subgroup 2 3/ Radiation hardness Total dose (when specified))	MIL-STD-883, method 1019 4/	5(0)	5(0)	5(0)	5(0)

Notes:

1/ All parts submitted for qualification testing shall have successfully completed the screening per Table

2/ Applicable to overtone units, and when specified, fundamental units.

3/ Choose the samples from those successfully completing subgroup 1 tests.

4/ For total dose levels below 1 Mrad, the frequency shall be measured during the irradiation. The temperature of the crystal units shall be maintained at a turnover temperature. For total dose levels above 1 Mrad, the frequency and resistance shall be measured within 4 days following irradiation in accordance with paragraph 4.7.8 of MIL-PRF-3098.

10: CRYSTAL OSCILLATORS

Table 1 REQUIREMENTS FOR CRYSTAL OSCILLATORS 1/ 2/

Procurement Specification	Use As Is	Screen to Table 2 3/	Qualify to Table 3 3/
Level 1			
1) ECSS-Q-60-05,Level1	O		
2) MIL-PRF-55310,ClassS4/	O		
3) MIL-PRF-55310,ClassB		O	
4) SCD5/		O	O
Level 2			
1) ECSS-Q-60-05,Level1	O		
2) MIL-PRF-55310,ClassS	O		
3) MIL-PRF-55310,ClassB		O	
4) SCD5/		O	O
5) Commercial		O	O
Level 3			
1) ECSS-Q-60-05,Level1	O		
2) MIL-PRF-55310,ClassS	O		
3) MIL-PRF-55310,ClassB	O		
4) SCDorCommercial		O	

Notes:

1/ Any oscillator must be evaluated or tested to determine it ability to meet the Total Ionizing Dose (TID) and Single Event Upset (SEU) requirements of the mission.

2/ Custom crystal oscillators, which employ hybrid microcircuit construction techniques, shall satisfy the element evaluation requirements of Section M2 herein. This requirement does not apply to oscillators that are standard parts available in a manufacturer's catalog.

3/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (ECSS, military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test groups of qualification tests must be submitted to show that tests were performed with acceptable results.

4/ MIL-PRF-55310, Oscillator, Crystal Controlled, General Specification for.

5/ An SCD must be written in accordance with the requirements of MIL-PRF-55310 and contain the following design requirements:

Crystals shall be swept synthetic quartz, meeting the infrared quality requirements of grade A or B of Synthetic Quartz Crystal – Specifications and Guide to the Use, IEC60758(1993-04), International Electrotechnical Commission, Geneva, Switzerland. Crystals shall be mounted with at least a three point mount; no parts shall be used that latch up in a Single Event Upset (SEU) environment; all active and passive parts shall be derated in accordance with the derating guidelines of MIL-STD-975, EEE-INST-002, or ECSS-Q-ST-30-11.

5.1/ The IEC specification lists six levels of infrared quality, which are designated from Aa (the best) to E (the worst). A and B are the levels that several prominent oscillator manufacturers recommend for space and military applications. Infrared quality is an indirect measure of the level of impurities in a crystal. Impurities can affect frequency aging characteristics.

Table 1A OSCILLATOR TYPES PER MIL-PRF-55310

Description	Type Number
Crystal Oscillators (XO)	1
Voltage Controller Crystal Oscillators (VCXO)	2
Temperature Compensated Crystal Oscillators(TCXO)	3
Oven Control Crystal Oscillators (OXCO)	4
Temperature Compensated-Voltage Controlled Crystal Oscillators (TCVCXO)	5
Oven Controlled Voltage Controlled Crystal Oscillators (OCVCXO)	6
Microcomputer Compensated Crystal Oscillators(MCXO)	7
Rubidium—Crystal Oscillators (RUXO)	8

Table 2 SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, DISCRETE COMPONENT CONSTRUCTION (Page 1 of 2)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2			Level 3
		Class B	SCD	Class B	SCD	Commercial	SCD or Commercial
1. Internal Visual Inspection a. Soldering b. Workmanship	NASA-STD-8739.3 MIL-PRF-55310, paragraph 3.9		O		O	O 2/	O 2/
2. Random Vibration	MIL-STD-202, Method 214, Condition I-B, 5 minutes per axis		O				
3. Thermal Shock	MIL-STD-202, Method 107, Condition A-1		O		O	O	
4. Pre Burn-in Electrical Input Current—Power Output Waveform Output Voltage—Power	MIL-PRF-55310, paragraph 4.8.5 Verify the type of output waveform. MIL-PRF-55310, paragraph 4.8.21		O		O	O	O
5. Burn-in (Load)	Max. operating temperature. Nominal supply voltage and load as specified.		240 hours		160 hours	160 hours	48 hours
6. Post Burn-in Electrical	Repeat step 4 above.		O		O	O	O
7. Frequency Aging	MIL-PRF-55310, paragraph 4.8.35		30 days				
8. PDA 3/			5%		10%	10%	20%
9. Radiographic Inspection	MIL-STD-202, Method 209, 1 View 1 in Y1 direction, second view 90° relative to first view.	O	O	O	O	O	
10. Additional Electrical Measurements	Table 2B herein.		O				
11. Seal Test	MIL-STD-202, Method 112 and MIL-PRF-55310, Paragraph 4.8.2		O		O	O	
12. External Visual 4/	Mil - Std. 883, Method 2009	O	O	O	O	O	O

Table 2 SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, DISCRETE COMPONENT CONSTRUCTION (Page 2 of 2)

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and define pass/fail criteria for each test. These values shall be based on the nearest equivalent military/ ECSS specifications, the manufacturer's specification, or the application, whichever is more severe.MIL-PRF-55310is the reference specification..

2/ In lieu of internal visual, DPA shall be performed on five samples to the requirements ofS-311-M-70.No failures are permitted.

3/ Percent Defective Allowable (PDA) calculations shall include both burn-in and frequency aging failures for grade 1 parts.

4/ Pure tin plating is prohibited as a final finish on EEE parts.

Table 2A SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, HYBRID MICROCIRCUIT CONSTRUCTION (Page 1 of 2)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2			Level 3
		Class B	SCD	Class B	SCD	Commercial	Commercial or Existing SCD
1. Non Destructive Bond Pull	MIL-PRF-55310, paragraph 4.4.1		O				
2. Internal Visual	MIL-PRF-55310, paragraph 4.4.2		O		O	O 2/	
3. Stabilization Bake (Prior to Seal)	~~MIL-STD-883,~~ method 1008, condition C, 150°C, min. hours		O 48		O 24	O 24	
4. Thermal Shock	MIL-STD-883, method 1011, condition A		O				
5. Temperature Cycling	MIL-STD-883, method 1010, condition B		O		O	O	
6. Constant Acceleration	MIL-STD-883, method 2001, condition A, Y1 only, 5,000 Gs		O		O	O	
7. PIND	MIL-STD-883, method 2020, condition B	O	O	O	O	O	
8. Pre Burn-In Electrical Tests Input Current – Power Output Waveform Output Voltage – Power	 MIL-PRF-55310, paragraph 4.8.5 Verify the type of output waveform. MIL-PRF-55310, paragraph 4.8.21		O		O	O	O
9. Burn-in (Load)	125 °C, nominal supply, voltage and burn-in loads		240 hours		168 hours	168 hours	48 hours
10. Post Burn-in Electrical	Repeat step 8 above		O		O	O	O
11. Frequency Aging	MIL-PRF-55310, paragraph 4.8.35		30 days				
12. PDA 3/			5%		10%	10%	20%
13. Additional Electrical Measurements	Table 2B herein		O				

Notes at end of table.

Table 2A SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, HYBRID MICROCIRCUIT CONSTRUCTION (Page 2 of 2)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2			Level 3
		Class B	SCD	Class B	SCD	Commercial	Commercial or Existing SCD
14. Radiographic Inspection	MIL-STD-883, Method 2012	O	O	O	O	O	
15.Seal Test a.Fine Leak b.Gross Leak	MIL-STD-883, Method 1014 Condition A or B Condition C		O		O	O	O
16. External Visual 4/	MIL-STD-883, Method 2009		O		O	O	O

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and define pass/fail criteria for each test. These values shall be based on the nearest equivalent military/ ECSS specifications, the manufacturer's specification, or the application, whichever is most severe. MIL-PRF-55310 is the reference specification.

2/ DPA in accordance with GSFC S-311-M-70 may be performed in lieu of internal visual.

3/ Percent Defective Allowable (PDA) calculations shall include both burn-in and frequency aging failures for level 1 parts.

4/ Pure tin plating is prohibited as a final finish on EEE parts.

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Table 2B ADDITIONAL ELECTRICAL MEASUREMENTS

Test	Test Methods, Conditions, and Requirements 1/	Oscillator Type
1. Oscillator Supply Voltage	Measure voltage magnitude, tolerance, polarity, regulation, peak to peak ripple, ripple frequency, and noise across oscillator input terminals with specified load.	All
2. Modulation—ControlInput Voltage	Same as 1 above, but also measure modulation magnitude and DC level limits or DC control magnitude.	2, 5, 6
3. OvenSupplyVoltage	Same as 1 above, but measure oven voltage etc. across input terminals of oven.	4, 6
4. Overvoltage Survivability	Apply overvoltage 20% above maximum specified supply voltage for 1 minute, with no performance degradation. Do not exceed 16.5 volts for oscillators employing CMOS parts.	All
5. FrequencyAdjustment	Stabilize at reference temperature and determine by frequency measurements that output signal can be set to either nominal frequency or marked frequency offset with specified resolution and adjusted oven specified range.	Adjustable
6. InitialFrequency—Temperature Accuracy	Stabilize at lowest specified temperature and measure frequency. Increase temperature in specified steps (allowing stabilization) and record frequency until highest specified temperature is reached. Calculate frequency-temperature accuracy in accordance with paragraph 4.8.10.	All
7. Frequency—Voltage Tolerance	Set oscillator supply voltage (oven supply voltage, if applicable) to nominal, minimum, and maximum values and measure output frequency. Determine frequency-voltage tolerance in accordance with paragraph 4.8.14.	All
8. RiseandFallTimes	Measure between specified voltage levels. For TTL and CMOS compatible oscillators, the lower measurement level shall be 0.8 volts and 10% of signal level, respectively. The upper measurement level shall be 2.0 volts and 90% of signal level respectively.	Square Wave
9. DutyCycle	Measure at 50% voltage level, referenced to ground, and express as percent of wave form period. The measurement level for TTL and CMOS compatible oscillators shall be 1.4 volts and 50% VDD, respectively.	Square Wave
10. Modulation—Control Input Impedance	Apply modulation-control input voltage to input terminals through series resistance. Measure voltage across series resistor and input terminals and calculate input impedance in accordance with paragraph 4.8.30.	2, 5, 6
11. FrequencyDeviation	Assemble test equipment in accordance with Figure 13 of MIL-PRF-55310, and measure (calculate) total deviation, deviation slope polarity, and deviation linearity in accordance with paragraph 4.8.31.	2, 5, 6

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and define pass/fail criteria for each test. These values shall be

based on the nearest equivalent military specifications, the manufacturer's specification, or the application, whichever is most severe. MIL-PRF-55310 is the reference specification.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR CRYSTAL OSCILLATORS (Page 1 of 2) 1/

Inspection/Test	Test Methods and Conditions	Level 1	Level 2		Level 3
		SCD	SCD	Commercial 2/	SCD or Commercial
Group 1		8 (0)	8 (0)	8 (0)	Not required
Frequency Aging	MIL-PRF-55310, paragraph 4.8.35				
Input Power Aging (Type 4 and Type 6)	MIL-PRF-55310, paragraph 4.8.36				
Group 2 2/		8 (0)	8 (0)	8 (0)	
Vibration, Sine	MIL-STD-202, Method 204 and MIL-PRF-55310, paragraph 4.8.39.1				
Mechanical Shock	MIL-STD-202, Method 213 and MIL-PRF-55310, paragraph 4.8.41				
Acceleration (When Specified)	MIL-STD-202, Method 212 and MIL-PRF-55310, paragraph 4.8.42.1				
Group 3 2/		4 (0)	4 (0)	4 (0)	
Thermal Shock	MIL-STD-202, Method 107 and MIL-PRF-55310, paragraph 4.8.45				
Radiation Hardness (Operating) (When Specified)	MIL-PRF-55310, paragraph 4.8.48				
Group 4 2/		2 (0)	2 (0)	2 (0)	
Resistance to Soldering Heat	MIL-STD-202, Method 210 and MIL-PRF-55310, paragraph 4.8.49				
Moisture Resistance	MIL-STD-202, Method 106 and MIL-PRF-55310, paragraph 4.8.50				
Terminal Strength	MIL-STD-202, Method 211 and MIL-PRF-55310, Paragraph 4.8.52				

Solderability Resistance to Solvents	MIL-STD-202, Method 208, Each Lead MIL-STD-202, Method 215				
Group 5 Internal Water Vapor Content 3/	 MIL-STD-883, Method 1018 5,000 ppm at 100℃	3 (0) or 5 (1)	3(0) or 5 (1)	3(0) or 5 (1)	Not required

Notes:

1/ Sample units shall have previously passed all the requirements of the screening tests of Table 2, 2A, or 2B for the product level and type of construction for which qualification is requested.

2/ Samples for this group come from the group 1 samples.

3/ Applies only to hybrid microcircuit construction. Generic data is not acceptable.

11: RELAYS (ELECTROMAGNETIC)

Table 1 RELAY REQUIREMENTS 1/

Procurement Specification	Relay Type	NASA/MIL Reference Specification	Level 1	Level 2	Level 3
ESCC Specification	Relays, Electromagnetic, Latching and Non-latching	ESCC 3601 & 3602	O	O	O
NASA/GSFC	Relays, Electromagnetic, Latching and Non-latching, Low Level to 25 Amperes	S-311-P-754 2/	O	O	O O
MIL Specification	Relays, Electromagnetic, Latching and Non-latching, 25 Amperes and Up (Includes Some Lower Contact Ratings)	MIL-PRF-6106	3/	3/, 4/	O
	Relays, Electromagnetic, Established Reliability, Latching and Non-latching, Low Level to 5 Amperes	MIL-PRF-39016	M, P, R 3/	M, P, R 3/, 4/	L, M, P, R
	Relays, Electromagnetic, Established Reliability, Latching and Non-latching, Low Level to 25 Amperes	MIL-PRF-83536	M, P, R 3/	M, P, R 3/, 4/	L, M, P, R
SCD			5/, 6/	5/, 6/	5/, 6/
Commercial			7/	5/, 6/	5/, 6/

Notes:

1/ The character “O” designates “use as is.”

2/ This specification covers all types of relays intended for level 1 applications.

3/ Acceptable for use in levels 1 and 2 provided they are procured to failure rate “M” or better (when applicable), the procurement lot is verified to have been subjected to small particle cleaning and internal inspection during assembly, and to PIND testing afterwards.

4/ For level 2, in lieu of the internal cleaning and inspection, three random samples from the procurement lot may be subjected to and pass DPA in accordance with the requirements in GSFC S-311-M-70 with the following exception: resisudal gas analysis (RGA) is not applicable.

5/ Screening in accordance with Table 2 herein and qualification in accordance with Table 3 herein are required.

6/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test groups of qualification tests must be submitted to show that tests were performed with acceptable results.

7/ Relays fabricated to manufacturer's "high reliability" or "space grade" flow and meeting all of the Table 2 and Table 3 requirements may be considered acceptable for use without an SCD.

Table 2 RELAY SCREENING REQUIREMENTS 1/, 2/ (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Level		
		1	2	3
1. Cleaning and Small Particle Inspection 4/,5/	Manufacturer's approved procedure.	O	O	
2. Visual Inspection (External) 6/	Materials, design, construction, header glass, marking, and workmanship.	O	O	O
3. Mechanical Inspections 7/	Critical physical dimensions.	O	O	
4. Initial Electrical Inspections 8/	Table 2A.	O		
5. Vibrational Scan (Sinusoidal) 9/, 10/ 11/, 12/	MIL-STD-202, Method 204. Specified test condition (amplitude, frequency range, sweep time and duration). Specified electrical load conditions. Specified contact load. Contact monitoring to specification. Contact transfer to specification.	O		
6. PIND 13/	Manufacturer's approved procedure.	O	O	O
7. Internal Moisture Detection	Relay dwell with coils deenergized for 30 minutes at 20±5 °C. IR≥10,000 megohms (between all contact pins together and case). Energize relay coil at 140% rated voltage for 2.5 minutes. Repeat for two-coil latching relays. IR≥10,000 megohms (between all contact pins together and case).	O	O	
8. High Temperature Soak	16 hours at maximum rated operating temperature. Energize coil at 120% rated voltage. For two coil latching relays, alternately energize coils 4 hours at a time.	O		

Notes at the end of table.

Table 2 RELAY SCREENING REQUIREMENTS 1/, 2/ (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements	Level		
		1	2	3
9. Run-In Tests 14/	Low Temperature Run-in 1 hour dwell at minimum rated operating temperature Pickup or latch/reset voltage to specification Contact loading: Open circuit load voltage at 10 to 50mV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 Level 2 – 1,000 cycles Miss level: 100 ohms maximum	O	O	
	High Temperature Run-in Rated coil voltage for 1 hour at maximum rated operating temperature For two-coil latching relays, 30 minutes each coil Pickup or latch/reset voltage to specification Contact loading: Open circuit load voltage at 10 to 50mV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 cycles Level 2 – 1,000 cycles Miss level: 100 ohms maximum	O	O	
	Room Temperature Run-in 1 hour dwell at 25±5 °C Pickup or latch/reset voltage to specification Contact loading: Open circuit load voltage at 10 to 50mV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 cycles Miss level: 100 ohms maximum	O		

Table 2 RELAY SCREENING REQUIREMENTS 1/, 2/ (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements	Level		
		1	2	3
10. Radiographic Inspection	MSFC-STD-355C	O		
11. Hermetic Seal	Fine Leak: MIL-STD-202,Method112 Test Condition C 1.0 x 10-8 cc/sec. or MIL-STD-883, Method 1014 Test Condition A1, A2, or B 1.0 x 10-8 cc/sec. Gross Leak: MIL-STD-883, Method 1014 Condition D	O O	O O	
12. Final Electrical Inspections 8/, 15/	Table 2A	O	O	O
13. Percent Defective Allowable (PDA) 15/	Level 1 – 5% Level 2 – 15%	O	 O	

Notes:

1/ This screening table is suitable for both low level and high level relays, latching and non-latching. Unless otherwise specified, relays with DC resistive contact ratings up to and including 2 amperes shall be considered low level relays. Relays with DC resistive contact ratings higher than 2 amperes shall be considered high level relays.

2/ For level 1 applications, screening in accordance with ESCC 3601/3602 or GSFC S-311-P-754 is acceptable in lieu of the screening specified in this table. For levels 2 and 3, screening in accordance with MIL-PRF-39016, MIL-PRF-6106, MIL-PRF-83536, GSFC S-311-P-754, or ESCC 3601/3602 as applicable, is acceptable in lieu of the screening specified in this table, except PIND testing is also required for level 2 applications.

Table 2 RELAY SCREENING REQUIREMENTS 1/, 2/ (Page 4 of 4)

3/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military/ESCC specifications, manufacturer's specification, or the application, whichever is most severe. Unless otherwise specified, 100% of the relays shall be submitted to the tests and inspections in this table in the order shown.

4/ For level 2, if cleaning and small particle inspection are not performed, a DPA is required. Recommended DPA procedure is S-311-M-70 with the following exception: residual gas analysis (RGA) is not applicable.

5/ Appendix A to MIL-PRF-39016 may be used as a guideline.

6/ The use of pure tin finish is prohibited as a final finish or undercoat. Header glass inspection shall be performed with microscopic power of at least 10x and shall include examinations for the following types of irregularities: blisters, foreign material, dark spots, cracks, and chips. Meniscuses shall not extend up the terminal more than 0.20 inch or one-third the terminal diameter, whichever is greater.

7/ A minimum of three relays shall be measured. In the event of a failure, the entire lot shall be screened for dimensions and rejects discarded.

8/ Relays possessing high level and low level capabilities that are intended for low level use should not be subjected to contact loads (current and voltage) that exceed the manufacturer's recommended limit for preserving the low level functionality. For example, the popular TO-5 relays should not be tested with a contact load exceeding 10 milliamperes or 6 volts open circuit (DC or peak AC) if subsequent use in a low level application is planned.

9/ All relays shall be vibrated in the direction of contact motion. In addition, if qualification testing is required after screening, a sample quantity shall be vibrated in each of three mutually perpendicular planes, one of which must be the direction of contact motion.

10/ Contacts shall be monitored with an adequate test circuit to verify that no opening of closed contacts in excess of 10 microseconds, nor closing of open contacts in excess of 1 microsecond, occurs. The contact load shall be 10 mA maximum at 6 Vdc maximum.

11/ Prior to removal from the test fixture, apply maximum over the temperature range pickup or latching voltage to the coil and verify that relay contacts have switched. Remove pickup voltage or apply reset voltage and verify that contacts have switched again. Failure of relay contacts to transfer in either direction shall be cause for rejection.

12/ External visual examination required after testing to verify no evidence of mechanical damage.

13/ Appendix B to MIL-PRF-39016 may be used as a guideline.

14/ The specified sequence (low temperature, high temperature, room temperature) is preferred but not mandatory

15/ Only the final electrical inspection results shall be used to determine the defect rate for the PDA

.

Table 2A RELAY ELECTRICAL INSPECTIONS 1/ (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Level 1	Level 2	Level 3
DC Coil Resistance	MIL-STD-202, Method 303	O	O	O
Static Contact Resistance or	Low Level Relays MIL-STD-202, Method 307 Test load: 10 mA maximum at 6 V maximum (DC or peak AC) No actuations prior to measurement Measurements between all contact pairs One measurement for each of three actuations (use average value) Static contact resistance to specification	O or	O or	O or
Contact Voltage Drop 3/	High Level Relays MIL-STD-202, Method 307 Test load: Rated DC resistive contact current at 6 V maximum (DCor peak AC) No actuations prior to measurement Measurements between all contact pairs One measurement for each of 10 actuations (use average value) Contact voltage drop to specification	O	O	O
Pickup, Hold, and Dropout Voltages or	Non-latching Relays Gradually step or ramp coil voltage until the relay contacts switch Pickup voltage to specification Gradually reduce coil voltage to specified hold voltage No switching of contacts Gradually reduce coil voltage until contacts switch to their original state Dropout voltage to specification	O or	O or	O or
Latch/Reset Voltages 4/	Latching Relays Gradually step or ramp latch coil voltage until the relay contacts switch Latch voltage to specification Remove latching voltage Gradually step or ramp reset coil voltage until the relay contactsswitch Reset voltage to specification	O	O	O

Table 2A RELAY ELECTRICAL INSPECTIONS 1/ (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Level 1	Level 2	Level 3
Operate and Release Time 3/, 5/	Use oscilloscope or other acceptable means to time each pair of contacts. Measurements shall be exclusive of bounce or stabilization times. Contact load: 10 mA maximum at 6 V maximum (DC or peak AC). Alternately apply and remove rated coil voltage a total of five times. Operate and release time to specification based on the average of five consecutive measurements.	O	O	
Contact Bounce Time 3/, 6/	Use oscilloscope or other acceptable means to time each pair of contacts. Contact load: 10 mA maximum at 6 V maximum (DC or peak AC). Alternately apply and remove rated coil voltage a total of five times. Contact bounce time to specification based on the average of five consecutive measurements.	O	O	
Contact Stabilization Time (When Specified) 3/, 7/	Use oscilloscope or other acceptable means to time each pair of contacts. Contact load: 10 mA maximum at 50 mV maximum (DC or peak AC). Alternately apply and remove rated coil voltage a total of fivetimes. Contact stabilization time to specification based on the average of five consecutive measurements.	O		
Dielectric Withstanding Voltage 8/, 9/, 10/	MIL-STD-202, Method 301 Specified test voltage. Leakage current to specification.	O		
Insulation Resistance 9/	MIL-STD-202, Method 302 Test Condition A (relays with coil and contact ratings both < 60 volts). Test Condition B (other relays). Resistance (minimum) to specification.	O		
Coil Transient Suppression 11/	Use oscilloscope or other acceptable means to observe magnitude of the induced voltage transient across the coil(s). Apply rated coil voltage. The maximum of three consecutive readings shall be recorded. Back EMF (induced voltage) to specification.	O	O	

Table 2A RELAY ELECTRICAL INSPECTIONS 1/ (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Level		
		1	2	3
Neutral Screen 12/, 13/	Rated coil voltage to both coils simultaneously for a period of 10 milliseconds minimum. Repeat three times. Neutral screen to specification. In the event of failure, apply a 10±1 ms pulse at maximum allowable latch voltage (at 25°C). Latch to specification. Apply 10±1 ms pulse at maximum allowable reset voltage (at 25 °C). Reset to specification.	O	O	
Non-Make-Before-Break 3/	Rated pickup, latch or reset voltage. Contact load: 10 mA maximum at 6 V maximum (DC or AC peak). Energize and deenergize 10 consecutive cycles. Non-make-before-break to specification.	O		

Notes:

1/ This table is suitable for both low level and high level relays, latching and nonlatching. Unless otherwise specified, relays with DC resistive contact ratings up to and including 2 amperes shall be considered low level relays. Relays with DC resistive contact ratings higher than 2 amperes shall be considered high level relays.

2/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe. Unless otherwise specified, 100% of the resistors shall be submitted to the tests and inspections in this table in the order shown.

3/ Relays possessing high level and low level capabilities that are intended for low level use should not be subjected to contact loads (current and voltage) that exceed the manufacturer's recommended limit for preserving the low level functionality. For example, the popular TO-5 relays should not be tested with a contact load exceeding 10 milliamperes or 6 volts open circuit (DC or peak AC) if subsequent use in a low level application is planned.

4/ For screening, the mounting position of the relay is optional. In addition, if qualification testing is required after screening, a minimum sample quantity equal to that specified in Group 2 of Table 3 (for the applicable quality level) shall be mounted and tested in each of three mutually perpendicular planes.

5/ Release time is not applicable to latching relays.

6/ A contact bounce shall be considered any occurrence equal to or greater than 90 percent of the open circuit voltage with a pulse width of 10 microseconds or greater. Lesser values are considered to be dynamic contact resistance.

7/ Contact stabilization time is the maximum time allowed for the contacts to reach and maintain a static contact resistance state following the actual operate or release time of the relay. Essentially, it is the sum of the contact bounce time plus the time required for the dynamic contact resistance to stabilize to static contact resistance.

8/ The DWV test duration shall be 5 seconds minimum.

9/ Points of application for testing: (1) between case, frame, or enclosure, and between all contacts in the energized and deenergized positions; (2) between case, frame, or enclosure and coil(s); (3) between all contacts and coil(s); (4) between open contacts in the energized and deenergized positions; (5) between coils of dual-coil relays; (6) and between contact poles in the energized and deenergized positions.

10/ External visual examination required after testing to verify no evidence of mechanical damage.

11/ Applicable only to DC operated relays with diodes for coil transient voltage suppression.

12/ Applicable only to latching relays.

13/ A relay that will not assume a neutral position for three successive test cycles is considered an acceptable part and does not require further testing.

Table 3 RELAY QUALIFICATION REQUIREMENTS 1/, 2/ (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Samples shall be selected from parts that have passed the screening requirements in Table 2.	100%	100%	100%
Group 2 Thermal Shock 4/, 5/, 6/, 7/	MIL-STD-202, Method 107 Level 1 – 25 cycles Level 2 – 10 cycles Level 3 - 5 cyles High temperature – max. rated operating Low temperature – min. rated operating During the last cycle, at each temperature extreme : IR to specification Pickup/hold/dropout or latch/reset voltages to specification Operate and release time to specification After completion of thermal shock : DWV to specification	9(0) O	6(0) O	3(0) O
Shock, Specified Pulse 7/, 8/	MIL-STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (Gs, pulse time, waveform). Specified electrical load conditions Specified contact load Contact monitoring to specification	O	O	

Vibration, Random 7/, 8/, 9/, 10/	MIL-STD-202, Method 214 Specified test condition (power spectral density, overall RMS G, duration) Specified electrical load conditions Specified contact load Contact monitoring to specification Contact transfer to specification	O		

Table 3 RELAY QUALIFICATION REQUIREMENTS 1/, 2/ (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 2 (continued)				
PIND 11/	Manufacturer's approved procedure			
Acceleration 7/, 12/, 13/	MIL-STD-202, Method 212	O	O	
	Specified G's			
	Acceleration to specification			
	MIL-STD-202, Method 211	O	O	
Terminal Strength 7/	Conditions A and C			
	Applied force to specification			
Electrical Inspections 6/	Table 2A	O	O	O
Hermetic Seal				
	Fine Leak: MIL-STD-202,Method112Test	O	O	O
	Condition C			
	1.0 x 10-8 cc/sec.			
	or			
	MIL-STD-883, Method 1014			
	Test Condition A1, A2, or B			
	1.0 x 10-8 cc/sec.			
	Gross Leak: MIL-STD-883, Method 1014	O	O	O
	Condition D			
Group 3		6(0)	3(0)	
Resistance to Soldering	MIL-STD-202, Method 210	O	O	
Heat (WhenApplicable)	Test Condition B			Not
4/, 5/, 7/	IR to specification			Required
	Coil resistance to specification			
	Contact resistance to specification			

	Pickup/hold/dropout or latch/reset voltages to specification			
Electrical Inspections 6/	Table 2A	O	O	
Hermetic Seal	Same as Group 2	O	O	

Table 3 RELAY QUALIFICATION REQUIREMENTS 1/, 2/ (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 4		4(0)	4(0)	
Life 14/, 15/	Maximum rated operating temperature			Not
	Specified rated contact load (current and voltage)			Required
	Specified cycling rate			
	Level 1 – 25,000 cycles	O		
	Level 2 – 10,000 cycles		O	
	Contact monitoring to specification			
	Static contact resistance or contact voltage drop≤2X initial specified value			
	Case to ground fuse electrically continuous			
Terminal Strength 7/	Same as Group 2	O		
Electrical Inspection 6/	Table 2A	O		
Hermetic Seal	Same as Group 2	O		
Group 5		3(0)	3(0)	Not
Solderability (when applicable)	MIL-STD-202, Method 208	O	O	Required
Resistance to Solvents 7/	MIL-STD-202, Method 215	O	O	
Group 6				
Thermal Outgassing 16/	ASTM E595	O	O	O
	TML =1.0%maximum			
	CVCM =0.10%maximum			

Table 3 RELAY QUALIFICATION REQUIREMENTS 1/, 2/ (Page 4 of 4)

1/ This qualification table is suitable for both low level and high level relays, latching and nonlatching. Unless otherwise specified, relays with DC resistive contact ratings up to and including 2 amperes shall be considered low level relays. Relays with DC resistive contact ratings higher than 2 amperes shall be considered high level relays. The qualification samples shall be subdivided as specified in the table for Groups 2 through 4 and Group 6, inclusive.
Group 5 inspections can be performed on unscreened samples or on samples that have completed one of the other qualification test groups.

2/ Qualification in accordance with ESCC 3601/3602, MIL-PRF-39016, MIL-PRF-6106, MIL-PRF-83536, or GSFC S-311-P-754, as applicable, is acceptable in lieu of the qualification specified in this table.

3/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

4/ Electrical inspections are as specified in Table 2A except as modified by the notes herein. Reference Note 3 in this table for test precautions for low level relays.

5/ Pickup/hold/dropout or latch/reset voltages shall be measured only in one plane.

6/ The DWV test duration shall be 60 seconds minimum.

7/ External visual examination required after testing to verify no evidence of mechanical damage.

8/ Contacts shall be monitored with an adequate test circuit to verify that no opening of closed contacts in excess of 10 microseconds, nor closing of open contacts in excess of 1 microsecond, occurs. The contact load shall be 10 mA maximum at 6 Vdc maximum.

9/ Relays shall be vibrated in each of three mutually perpendicular planes.

10/ Prior to removal from the test fixture, apply maximum over the temperature range pickup or latching voltage to the coil and verify that relay contacts have switched. Remove pickup voltage or apply reset voltage and verify that contacts have switched again. Failure of relay contacts to transfer in either direction shall be cause for rejection.

11/ It is the responsibility of the user to approve manufacturer procedures for particle impact noise detection (PIND). Appendix B to MIL-PRF-39016 may be used as a guideline.

12/ Acceleration shall be applied in each of three mutually perpendicular planes, one of which shall be the direction most likely to fail. In each direction, the coil shall be deenergized for 5 minutes, rated coil voltage shall be momentarily applied, and the voltage shall be reduced to the maximum ambient pickup voltage for 5 minutes. Latching relays shall remain in each latched position with no voltage applied to the coils. Contacts shall be monitored during testing for proper position.

13/ Acceleration failure criteria: The contacts of the relay shall remain in the deenergized position with no voltage applied to the coil and in the energized position when rated coil voltage is applied to the coil. Latching relays shall remain in each latched position with no voltage on the coil.

14/ Each relay case shall be connected to system ground through a single normal-blow fuse rated at the greater of 100 mA or 5% of the rated DC resistive contact load current.

15/ The contact miss detector's monitoring level shall be less than 100 ohms for low level testing and less than 10 percent of the open circuit voltage for high level testing.

16/ Materials listed in NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

12: RESISTORS

Table 1A FIXED RESISTOR REQUIREMENTS (Page 1 of 2)

Procurement Specification	Resistor Style and Type		ESCC/ MIL/ NASA Reference Specification	Failure Rate Level Required 1/ Level 1	Level 2	Level 3
Composition						
SCD				2/	2/	2/
Commercial					2/	2/
Film/Foil						
ESCC Specification	RNC/MB	Fixed, Film / High Precision, Fixed , Metal Foil	ESCC 4001	O	O	O
	RHV	Fixed, Film, High Voltage / Fixed, Thick and Thin Film Chip		O	O	O
		Network, Thick Film	ESCC4005	O	O	O
MIL Specification	RLR	Fixed, General Purpose, Established Reliability	MIL-PRF-39017		R, P	M
	RNX	Fixed, High Stability, Established Reliability	MIL-PRF-55182	T, S	R, P	M
	RM	Fixed, Chip, Established Reliability	MIL-PRF-55342	T, S	R, P	M
	RZ	Fixed, Network	MIL-PRF-83401	3/	3/	3/
NASA Specification	MOX	Fixed, High Voltage	S-311-P-683	4/	4/	4/
	HG	Fixed, High Voltage, Precision	S-311-P-672	4/	4/	4/
	TG	Fixed, High Voltage, Precision, Low TC	S-311-P-741	5/	5/	5/
	TK	Fixed, Precision, Low TC, Radial-Lead	S-311-P-742	4/	4/	4/
	TK	Fixed, Low TC, Precision, High Stability	S-311-P-794	5/	5/	5/
	VPR	Fixed, Foil, Precision, Power, Current Sensing	S-311-P-795	5/	5/	5/
	TK	Fixed, “Matched-Pair”, Low TC, Precision	S-311-P-796	5/	5/	5/
	P813	Fixed, Low TC, Precision, Radial Lead	S-311-P-813	4/	4/	4/
SCD				2/	2/	2/
Commercial					2/	2/

Notes at the end of table.

Table 1A FIXED RESISTOR REQUIREMENTS (Page 2 of 2)

Procurement Specification	Resistor Style and Type		ESCC/ MIL Reference Specification	Failure Rate Level Required 1/		
				Level 1	Level 2	Level 3
Wirewound						
	RWR	Power,Fixed,Wirewound	ESCC 4002	O	O	O
ESCC Specification	RER	Power,Fixed,Wirewound,ChassisMounted	ESCC 4003	O	O	O
MIL Specification	RBR	Fixed,Accurate,EstablishedReliability	MIL-PRF-39005	R	R, P	M
	RWR	Fixed,Power,EstablishedReliability	MIL-PRF-39007	T, S	R, P	M
	RER	Fixed,Power,EstablishedReliability	MIL-PRF-39009	R	R, P	M
SCD				2/	2/	2/
Commercial					2/	2/

Notes:

1 / Resistors may be used as is at the specified failure rate level. "O" designate use as is.

2/ Resistors shall satisfy the screening and qualification requirements of Tables 2A and 3A.

3/ Lot sample Destructive Physical Analysis (DPA) is required prior to use in space flight applications. Particular attention should be paid to the integrity of the termination attachment to the resistive element (i.e., cracked solder joints, misaligned connections, etc.).

4/ Resistors may be used as is.

5/ Resistors may be used as is if listed in the GSFC Qualified Parts List Directory (QPLD).

Table 1B VARIABLE RESISTOR REQUIREMENTS 1/

Procurement Specification	Resistor Style and Type	MIL/NASA Reference Specification	Failure Rate Level Required 1/		
			Level 1	Level 2	Level 3
Film/Foil					
NASA Specification	1285G Potentiometer, Precision Trimming	S-311-P-798	2/	2/	2/
MIL Specification	RJR Variable,LeadScrew,EstablishedReliability	MIL-PRF-39035	R	R, P	M
SCD			3/	3/	3/
Commercial				3/	3/
Wirewound					
MIL Specification	RTR Variable,LeadScrewEstablishedReliability	MIL-PRF-39015	R	R, P	M
SCD			3/	3/	3/
Commercial				3/	3/

Notes:

1/ Resistors may be used as is at the specified failure rate level.

2/ Resistors may be used as is if listed in the GSFC Qualified Parts List Directory (QPLD).

3/ Resistors shall satisfy the screening and qualification requirements of Tables 2B and 3B.

Table 2A FIXED RESISTOR SCREENING REQUIREMENTS (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
1. Precap Visual Inspection 2/, 3/	Networks: Particles, metallization (scratches, voids, adherence, bridging, alignment, corrosion, probe marks), laser trim faults, bonding pad defects, oxide defects Chip: Materials, design, construction and workmanship - sample size (accept number)				O 13 (0)	O 13 (0)	O 13 (0)			
2. Visual Inspections 4/	Materials, design, construction, marking, and workmanship	O	O	O	O	O	O	O	O	O
3. Mechanical Inspections 5/	Critical physical dimensions	O	O		O	O		O	O	
4. Initial DC Resistance 6/, 7/, 8/	MIL-STD-202, Method 303	O	O	O	O	O	O	O	O	O
5. Thermal Shock 9/, 10/	MIL-STD-202, Method 107 Level 1 - 25 cycles Level 2 - 10 cycles High temperature - max. rated operating Low temperature - min. rated operating				O	O				
6. Conditioning or Overload 9/, 10/, 11/ or High Temperature	MIL-STD-202, Method 108 Specified rated wattage or voltage multiple Specified temperature Specified time If time≤24 24 hours: continuous operation If time > 24 hours: 1.5 hours on, 0.5 hours off or 100 hours @ max. rated operating temperature				O	O	/16	O	O	/16

Table 2A FIXED RESISTOR SCREENING REQUIREMENTS (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
7. Final DC Resistance	MIL-STD-202, Method 303 Resistance and R tospecification				O	O				
8. Hermetic Seal 13/	Fine leak: MIL-STD-202,Method112 Test Condition C 5.0 X 10-7 cc/sec. (networks) 1.0 X 10-8 cc/sec. (others) Gross Leak: MIL-STD-883, Method 1014 Condition D				O	O				
9. Radiographic Inspection 14/	MSFC-STD-355C				O			O		
10. Percent Defective Allowable (PDA) 15/	Level 1 - 5% Level 2 - 15%	O	O		O	O		O	O	

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent ESCC/ military specifications, manufacturer's specification, or the application, whichever is most severe. Unless otherwise specified, 100% of the resistors shall be submitted to the tests and inspections in this table in the order shown.

2/ Examination shall be performed using binocular magnification of 50X to 100X.

3/ If solder is used for internal connections, it shall have a liquid point not less than +280°C.

4/ May be performed anytime during screening. Small resistors, such as chip resistors, shall be examined using 30X to 60X magnification, but in case of conflict, 30X shall be the referee power.

5/ May be performed anytime during screening. A minimum of 3 resistors shall be measured. In the event of a failure, the entire lot shall be screened for dimensions and rejects discarded.

Table 2A FIXED RESISTOR SCREENING REQUIREMENTS (Page 3 of 3)

6/ The test voltage must be specified in the SCD or by the manufacturer (commercial parts).

7/ For networks, unless otherwise specified, individual resistive elements shall be isolated (whenever possible) to minimize computation of pin-to-pin resistance values.

8/ Unless otherwise specified by the manufacturer or SCD, out of tolerance composition resistors shall be baked at +100º C (with no power applied) according to the following schedule: 1/8 watt (style RCR05), 25 ± 4 hours; 2 watt (style RCR42), 130 ± 4 hours; all other in between wattages/styles, 96± 4 hours. Resistors that remain out of tolerance after baking shall be considered failures.

9 / ΔR is optional after this inspection if ΔR is specified for thermal shock and conditioning combined.

10/ External visual examination required after testing to verify no evidence of mechanical damage.

11/ Unless otherwise specified, the manufacturer's maximum rated continuous dc working voltage should not be exceeded during conditioning as determined by $V = \sqrt{P \cdot R}$.

12/ For chip resistors only: if size or termination precludes conditioning, the high temperature exposure test shall be performed instead..

13/ Applicable only to hermetically sealed networks and resistors.

14/ Not applicable to composition, chip or network resistors.

15/ Applies to a combination of the following: initial dc resistance, thermal shock, conditioning, overload or high temperature exposure, final dc resistance, delta-R, and hermetic seal (if applicable).

16/ Power conditioning is recommended for Level 3 applications requiring resistance stability over time.

Table 2B VARIABLE RESISTOR SCREENING REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, And Requirements 1/	Part Type/Level					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Visual Inspections	Materials, design, construction, marking, and workmanship	O	O	O	O	O	O
Mechanical Inspections 2/	Critical physical dimensions	O	O		O	O	
Thermal Shock 3/, 4/, 5/ 6/	MIL-STD-202, Method 107 Level 1 - 25 cycles Level 2 - 10 cycles High temperature - max. rated operating Low temperature - min. rated operating Total resistance and ΔR to specification Setting stability (Δ%) to specification Continuity check	O	O		O	O	
Conditioning 3/, 4/, 7/	MIL-STD-202, Method 108 Specified rated wattage multiple Specified temperature 100 hours minimum (Level 1), 1.5 hours on, 0.5 hours off 50 hours minimum (Levels 2 and 3), 1.5 hours on, 0.5 hours off Total resistance and ΔR to specification	O	O		O	O	
Total Resistance 4/	MIL-STD-202, Method 303			O			O
Contact Resistance Variation or Peak Noise 8/	Contact resistance variation to specification, or Peak noise (resistance variation) to specification	O	O		O	O	

Notes at the end of table.

Table 2B VARIABLE RESISTOR SCREENING REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Immersion	Gross leak: MIL-STD-202,Method112,TestConditionD Modify as follows: 1.Precondition resistors at +125°C for 15±2 minutes. 2.Stabilize at room temperature for 15±2 minutes. 3.Immerse into fluorocarbon bath held at +85°C to +90°C, shake for 5 seconds maximum, then keep resistors submerged for a period of 1 minute ±5 seconds. 4.Discard resistors with inadequate seals as evidenced by a	O	O		O	O	
Actual Effective Electrical Travel 9/	Number of turns or angular degrees to specification	O			O		
Absolute Minimum Resistance 10/	Resistance to specification				O	O	
End Resistance 11/	Resistance to specification	O	O		O	O	
DWV 3/	MIL-STD-202, Method 301 Specified test voltage Between terminals tied together and all external metal portions	O			O		
IR	MIL-STD-202, Method 302, Test Condition A or B Between terminals tied together and all external metal portions Resistance (minimum) to specification	O			O		
Torque 12/, 13/ 14/	Operating torque to specification Clutch to specification (when applicable) Stop strength to specification (when applicable)	O	O		O	O	
Radiographic Inspection 15/	MIL-STD-202, Method 209	O			O		

Notes at the end of table.

Table 2B VARIABLE RESISTOR SCREENING REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Percent Defective Allowable (PDA) 16/	Level 1 - 5%	O			O		
	Level 2 - 15%		O			O	

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent ESCC/ military specifications, manufacturer's specification, or the application, whichever is most severe.

2/ A minimum of 3 resistors shall be measured. In the event of a failure, the entire lot shall be screened for dimensions and rejects discarded.

3/ External visual examination required after testing to verify no evidence of mechanical damage.

4/ Total resistance shall be measured between the end terminals with the movable contact arm positioned against a stop. The positioning of the contact arm and terminal shall be the same for all subsequent measurements of total resistance on the same specimen. The test voltage for total resistance measurements must be specified in the SCD or by the manufacturer (commercial parts).

5/ Setting stability in percent shall be determined by placing the movable contact arm at approximately 40% of the actual effective electrical travel. A dc test potential shall be applied between the end terminals. The measured voltage between the contact arm and one end terminal (E1) and the measured voltage between the end terminals (E2) shall be used to determine the setting stability in percent using the following formula:Setting stability (%) = (E1 X 100)/E2.

6/ There shall be no abrupt discontinuities, especially when the direction of travel is reversed, as the contact arm is rotated at a uniform rate back and forth two times across the actual effective electrical travel. During rotation, a suitable electrical device shall be connected between the contact arm and either end terminal to monitor the change in resistance or voltage.

7/ The conditioning voltage shall be applied between the end terminals. Unless otherwise specified, the manufacturer's rated continuous dc

working voltage should not be exceeded during conditioning as determined by V =√PR..

Table 2B VARIABLE RESISTOR SCREENING REQUIREMENTS (Page 4 of 4)

8/ Contact resistance variation or peak noise is a measure of any spurious variations in the electrical output as the contact arm is rotated. It is expressed either as a maximum resistance variation limit, or as a percentage of the total resistance output for the specified rotational travel increment. The output can be observed on an oscilloscope or strip chart recorder, and either method requires calibration to obtain a measure of the peak resistance spikes observed during contact arm rotation. The contact arm shall be rotated in both directions through 90 percent of the actual effective electrical travel for a total of 6 cycles. Only the last 3 cycles shall count in determining whether or not a spurious resistance variation is observed at least twice in the same location, exclusive of the roll-on or roll-off points where the contact arm moves between the termination and resistance element.

9/ The actual effective electrical travel shall be measured by placing the resistor in a suitable device and circuit, which will indicate both angular position of the operating shaft and electrical output. The actual effective electrical travel will be the number of turns, or degrees of rotation, in which a change in contact arm position gives a measurable change in electrical output.

10/ The contact arm shall be positioned at the extreme counterclockwise limit of mechanical travel, and the resistance shall be measured between the contact arm and corresponding end terminal. Caution: do not exceed rated current during this measurement.

11/ The contact arm shall be so positioned at one end of the resistance element so that a minimum value of resistance can be determined. The same procedure shall be followed for the other end of the resistance element. Caution: do not exceed rated current during this measurement.

12/ The torque required to move the contact arm on the resistance element shall be determined at approximately 10, 50, and 90 percent of actual effective electrical travel by the torque wrench method or any suitable equivalent.

13/ If the resistor contains a clutch mechanism, the contact arm shall be adjusted to each extreme limit of mechanical travel, and sufficient torque shall be applied to the actuator to permit the contact arm to idle for 25 complete mechanical turns. During idle, a suitable electrical indicating device connected between the contact arm terminal and an adjacent end terminal shall be observed for electrical continuity. After idle, the contact arm shall be rotated in the opposite direction, and the indicating device shall be observed to determine whether the contact

arm actually reversed direction.

14/ When stop strength is specified, the contact arm shall be rotated to each extreme of mechanical rotation with the specified torque applied through the operating shaft to the stop.

15/ The SCD must detail the complete procedure for examining resistors for internal defects, such as contact arm misalignment, resistive element flaws, particles, etc., via radiographic inspection.

16/ Incorrect, incomplete, or illegible marking shall be considered major defects. However, cosmetic marking defects shall not be counted for purposes of establishing the failure rate. Mechanical and radiographic rejects shall not be counted against the PDA.

Table 3A FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 6)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 1 Screening to Table 2 3/	Table 2	100%	100%	100%	100%	100%	100%	100%	100%	100%
Group 2		3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)
Solderability 4/	MIL-STD-202, Method 208	O	O	O	O	O	O	O	O	O
Resistance to Solvents 5/, 6/	MIL-STD-202, Method 215				O	O		O	O	
Group 3 7/		10(0)	6(0)	3(0)	10(0)	6(0)	3(0)	10(0)	6(0)	3(0)
Thermal Shock 5/	MIL-STD-202, Method 107									
	Level 1 - 25 cycles	O						O		
	Level 2 - 10 cycles		O						O	
	Level 3 - 5 cycles			O			O			O
	High temperature - max. rated operating									
	Low temperature - min. rated operating									
	ΔR to specification									
Resistance Temperature Characteristic 5/	MIL-STD-202, Method 304	O	O		O	O		O	O	
	Specified test temperature sequence									
	Specified reference temperature									
	PPM to specification									
Low Temperature Storage 5/	-65°C no load dwell for 24±4 hours	O			O			O		
	+25°C ambient no load dwell for 2-8 hours									
	ΔR to specification									
Low Temperature Operation 5/	-65°C no load dwell for 1 hour	O			O			O		
	Full rated voltage for 45 minutes									
	25°C ambient no load dwell for 24±4 hours									
	ΔR to specification									

Notes at the end of table.

Table 3A FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 6)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 3 (continued)										
Short-time Overload 5/	Specified voltage (wattage) multiple Specified temperature Specified time ΔR to specification	O	O		O	O		O	O	
Terminal Strength 5/, 6/	MIL-STD-202, Method 211 Conditions A and C Applied force to specification ΔR to specification	O	O	O	O	O	O	O	O	O
Hermetic Seal 8/	Fine leak: MIL-STD-202,Method112 Test Condition C 5.0 X 10-7 cc/sec.(networks) 1.0 X 10-8 cc/sec.(others) Gross				O	O	O			
	Leak: MIL-STD-883, Method 1014 Condition D				O	O	O			
Group 4 7/		9(0)	6(0)	3(0)	9(0)	6(0)	3(0)	9(0)	6(0)	3(0)
Dielectric Withstanding Voltage 5/, 6/, 12/	MIL-STD-202, Method 301 Between leads and conductive material surrounding body Specified test voltage ΔR to specification	O	O	O	O	O	O	O	O	O
Insulation Resistance 6/, 12/	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Resistance (minimum) to specification	O	O	O	O	O	O	O	O	O

Notes at the end of table.

Table 3A FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 3 of 6)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 4 (continued)										
Resistance to Soldering Heat 5/	MIL-STD-202, Method 210 Test Condition C ΔR to specification	O	O	O	O	O	O	O	O	
Moisture Resistance 5/, 12/	MIL-STD-202, Method 106 DC resistance to specification DWV to specification IR to specification				O	O		O	O	
Terminal Strength 5/, 6/	MIL-STD-202, Method 211 Conditions A and D Applied force to specification ΔR to specification	O	O	O	O	O	O	O	O	
Hermetic Seal 8/	Same as Group 3				O	O				
Group 5 7/		9(0)	6(0)		9(0)	6(0)		9(0)	6(0)	
Shock 5/, 6/	MIL-STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (g's, pulse time, waveform) ΔR to specification	O	O		O	O		O	O	
Vibration, High Frequency 5/, 6/	MIL-STD-202, Method 204 Specified test condition (amplitude, frequency range, sweep time and duration) ΔR to specification	O	O		X	X		O	O	
Hermetic Seal 8/	Same as Group 3				O	O				

Notes at the end of table.

Table 3A FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 4 of 6)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 6 7/		12(0)	9(0)		12(0)	9(0)		12(0)	9(0)	
Life 5/	MIL-STD-202, Method 108									
	Specified test temperature									
	Specified operating conditions									
	ΔR to specification									
	Level 1 - 2000 hours	O			O			O		
	Level 2 - 1000 hours		O			O			O	
Group 7A 7/, 9/					10(0)	5(0)				
Resistance to Bonding 5/	Specified mounting method				O	O				
	4-12 hours stabilization at 25±5°C									
	ΔR to specification									
Moisture Resistance 5/, 12/	MIL-STD-202, Method 106				O	O				
	DC resistance to specification									
	DWV to specification									
	IR to specification									
Group 7B 9/					10(0)	5(0)				
Adhesion 5/	Specified mounting method Specified				O	O				
	force, angle, and duration									
Group 8		5(0)	5(0)		5(0)	5(0)				
Voltage Coefficient 10/	MIL-STD-202. Method 309	O	O		O	O				
	Specified continuous working voltage									
	Specified resistance range									
	Voltage coefficient to specification									

Notes at the end of table.

Table 3A FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 5 of 6)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 9					5(0)	5(0)		5(0)	5(0)	
High Temperature Exposure 5/	Specified Temperature Specified no load dwell time ΔR to specification DWV to specification IR to specification				O	O		O	O	
Group 10										
Thermal Outgassing 11/	ASTM E595 TML =1.0%maximum CVCM =0.10%maximum	O	O	O	O	O	O	O	O	O

Notes:

1/ The qualification samples shall be subdivided as specified in the table for Groups 3 through 10 inclusive. Group 2 inspections can be performed on unscreened samples or on samples that have completed one of the other qualification test groups.

2/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent ESCC/ military specifications, manufacturer's specification, or the application, whichever is most severe.

TableA 3 FIXED RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 6 of 6)

3/ These minimum samples sizes are required for qualification:

	Composition	Film	Wirewound
Level 1	45	50	45
Level 2	32	37	32
Level 3	9	9	9

An additional 20 chip resistor qualification samples are required for Level 1 and an additional 10 are required for Level 2.

4/ Not applicable for weldable, bondable chip resistors or any type of resistor with "weldable only" leads.

5/ External visual examination required after testing to verify no evidence of mechanical damage.

6/ Not applicable to chip resistors.

7/ To qualify a range of resistance values, equally subdivide the group samples into highest, critical, and lowest resistance values. If the desired resistance range does not span the critical value, equally divide the samples into highest and lowest values except as follows: the extra resistor for odd sample sizes shall be of highest value if the resistance range is below the critical value, or of lowest value if the resistance range is above the critical value. For single resistance value qualification, the sample size shall be as specified for each applicable test group.

8/ Applicable only to hermetically sealed networks and high stability filmresistors.

9/ Applicable only to chip resistors.

10/ Applicable to resistors≥1000 ohms.

11/ Materials listed in Revision 3 of NASA Reference Publication1124that meet TML and CVCM limits are acceptable for use without further testing.

12/ Applicable to resistors built on insulative layers on conductive substrates (i.e., silicon wagers). Not applicable for dielectric substrates (i.e alumina, Beo, aluminum nitride).,

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 1 of 7)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 1							
Screening to Table 2A 3/	Table 2A	100%	100%	100%	100%	100%	100%
Group 1A			12(0)	6(0)		12(0)	6(0)
Actual Effective Electrical Travel 4/	Number of turns or angular degrees to specification		O	O		O	O
Absolute Minimum Resistance 5/	Resistance to specification						O
End Resistance 6/	Resistance to specification			O			O
DWV 7/	MIL-STD-202, Method 301 Between terminals tied together and all external metal portions Specified test voltage Leakage current to specification		O	O		O	O
IR	MIL-STD-202, Method 302, Test Condition A or B Between terminals tied together and all external metal portions Resistance (minimum) to specification		O	O		O	O
Torque 8/, 9/, 10/	Operating torque to specification Clutch to specification (when applicable) Stop strength to specification (when applicable)			O			O
Group 2		6(0)	3(0)	3(0)	6(0)	3(0)	3(0)
Solderability Resistanceto	MIL-STD-202, Method 208	O	O	O	O	O	O
Solvents 7/	MIL-STD-202, Method 215	O			O		

Notes at the end of table.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 2 of 7)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 3		12(0)	10(0)		12(0)	10(0)	
Resistance Temperature Characteristic 11/	MIL-STD-202, Method 304 Specified test temperature sequence Specified reference temperature ppm/°C to specification	O	O		O	O	
Moisture Resistance 7/, 11/	MIL-STD-202, Method 106 Modify as follows: 1. The resistor samples shall be subdivided into two groups for polarization and loading. 2. Polarization - During steps 1 to 6 inclusive, a 100 volt dc potential shall be applied with the positive lead connected to the resistor terminals tied together, and the negative lead connected to the mounting plate. 3. Loading - During the first 2 hours of steps 1 and 4, a dc test potential equivalent to 100% rated wattage shall be applied to the resistors through the end terminals. Δtotal resistance to specification DWV to specification IR to specification	O	O		O	O	
Contact Resistance Variation or Peak Noise 12/	Contact resistance variation to specification, or Peak noise (resistance variation) to specification	O	O		O	O	
Group 4		12(0)	9(0)		12(0)	9(0)	
Setability 13/	Setability to specification	O	O		O	O	

Notes at the end of table.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 3 of 7)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 4 (continued)							
Shock (Specified Pulse) 7/, 11/, 14/, 15/	MIL-STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (g's, pulse time, waveform) Setting stability (Δ%) to specification Δtotal resistance to specification	O	O		O	O	
Vibration, High Frequency 7/, 11/, 14/, 15/	MIL-STD-202, Method 204 Specified test condition (amplitude, frequency range, sweep time and duration) Setting stability (Δ%) to specification Δtotal resistance to specification	O	O		O	O	
Contact Resistance Variation or Peak Noise 12/	Same as Group 3	O	O		O	O	
Group 5		9(0)	6(0)	3(0)	9(0)	6(0)	3(0)
Resistance to Soldering Heat 7/, 11/	MIL-STD-202, Method 210 Test Condition C Δtotal resistance to specification	O	O	O	O	O	O
Low Temperature Operation 7/, 11/, 15/ 16/	Gradually reduce chamber temperature to -55°C in 1.5 hours minimum After 1 hour stabilization at -55°C, measure setting stability Apply full rated continuous working voltage for 45 minutes Remeasure setting stability 15 minutes after removing voltage Setting stability (Δ%) to specification Gradually increase to room temperature in 8 hours maximum Maintain at 25±5°C for 24 hours Δtotal resistance to specification	O	O		O	O	

Notes at the end of table.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 4 of 7)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 5 (continued)							
Low Temperature Storage 7/, 11/	No load dwell at -65°C for 72 hours Stabilize to 25±5°C Δtotal resistance to specification				O	O	
High Temperature Exposure 7/, 11/, 15/	No load dwell at 150° for 1000 hours Within 2 hours: Setting stability (Δ%) to specification Δtotal resistance to specification DWV to specification IR to specification	O	O		O	O	
Contact Resistance Variation or Peak Noise 12/	Same as Group 3	O	O		O	O	
Integrity of Shaft 7/, 11	Specified forces (pull, push, perpendicular) applied to shaft for specified times Total resistance to specification	O	O		O	O	
Group 6		9(0)	6(0)	3(0)	9(0)	6(0)	3(0)
Rotational Life 7/, 11/ 16/, 17/	Full rated continuous working voltage at 25±5°C 200 cycles Δtotal resistance to specification	O	O	O	O	O	O
Contact Resistance Variation or Peak Noise 12/	Same as Group 3	O	O	O	O	O	O

Notes at the end of table.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS 1/ (Page 5 of 7)

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 6 (continued) Terminal Strength 7/, 18/	MIL-STD-202, Method 112 Condition A Specified force Continuity check Condition A (except reverse force to apply a push force) Continuity check	O	O	O	O	O	O
Group 7 Life 7/, 11/	MIL-STD-202, Method 108 Specified test temperature Specified operating conditions Δtotal resistance to specification Level 1 - 2000 hours Level 2 - 1000 hours	12(0) O	9(0) O		12(0) O	9(0) O	
Group 8 Thermal Outgassing 19/	ASTM E595 TML =1.0%maximum CVCM =0.10%maximum	O	O	O	O	O	O

Notes:

1/ The qualification samples shall be subdivided as specified in the table for Group 1A and Groups 3 through 8 inclusive. Group 2 inspections can be performed on unscreened samples or on samples that have completed one of the other qualification test groups.

2/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS (Page 6 of 7)

3/ These minimum sample sizes are required for qualification:

Level 1 - 60 resistors
Level 2 - 55 resistors
Level 3 - 15 resistors

4/ The actual effective electrical travel shall be measured by placing the resistor in a suitable device and circuit, which will indicate both angular position of the operating shaft and electrical output. The actual effective electrical travel will be the number of turns, or degrees of rotation, in which a change in contact arm position gives a measurable change in electrical output.

5/ The contact arm shall be positioned at the extreme counterclockwise limit of mechanical travel, and the resistance shall be measured between the contact arm and corresponding end terminal. Caution: do not exceed rated current during this measurement.

6/ The contact arm shall be so positioned at one end of the resistance element so that a minimum value of resistance can be determined. The same procedure shall be followed for the other end of the resistance element. Caution: do not exceed rated current during this measurement.

7/ External visual examination required after testing to verify no evidence of mechanical damage.

8/ The torque required to move the contact arm on the resistance element shall be determined at approximately 10, 50, and 90 percent of actual effective electrical travel by the torque wrench method or any suitable equivalent.

9/ If the resistor contains a clutch mechanism, the contact arm shall be adjusted to each extreme limit of mechanical travel, and sufficient torque shall be applied to the actuator to permit the contact arm to idle for 25 complete mechanical turns. During idle, a suitable electrical indicating device connected between the contact arm terminal and an adjacent end terminal shall be observed for electrical continuity. After idle, the contact arm shall be rotated in the opposite direction, and the indicating device shall be observed to determine whether the contact arm actually reversed direction.

10/ When stop strength is specified, the contact arm shall be rotated to each extreme of mechanical rotation with the specified torque applied through the operating shaft to the stop.

Table 3B VARIABLE RESISTOR QUALIFICATION REQUIREMENTS (Page 7 of 7)

11/ Total resistance shall be measured between the end terminals with the movable contact arm positioned against a stop. The positioning of the contact arm and terminal shall be the same for all subsequent measurements of total resistance on the same specimen. The test voltage for total resistance measurements must be specified in the SCD or by the manufacturer (commercial parts).

12/ Contact resistance variation or peak noise is a measure of any spurious variations in the electrical output as the contact arm is rotated. It is expressed either as a maximum resistance variation limit, or as a percentage of the total resistance output for the specified rotational travel increment. The output can be observed on an oscilloscope or strip chart recorder, and either method requires calibration to obtain a measure of the peak resistance spikes observed during contact arm rotation. The contact arm shall be rotated in both directions through 90 percent of the actual effective electrical travel for a total of 6 cycles. Only the last 3 cycles shall count in determining whether or not a spurious resistance variation is observed at least twice in the same location, exclusive of the roll-on or roll-off points where the contact arm moves between the termination and resistance element.

13/ The movable contact arm shall be set at approximately 30%, 50%, and 75% of mechanical rotation. A dc voltage up to 2.5 volts shall be applied across the end terminals, and the contact arm shall then be adjusted smoothly without abrupt voltage change at each test point.

14/ Each resistor shall be monitored during this test to determine electrical discontinuity of the resistance element, and between the contact arm and element, by a method that shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuity of 0.1 millisecond or greater duration.

15/ Setting stability in percent shall be determined by placing the movable contact arm at approximately 40% of the actual effective electrical travel. A dc test potential shall be applied between the end terminals. The measured voltage between the contact arm and one end terminal (E1) and the measured voltage between the end terminals (E2) shall be used to determine the setting stability in percent using the following formula: Setting stability (%) = (E1 X 100)/E2.

16/ The full rated continuous working voltage, or the voltage equal to rated power, shall be determined by the formula $E = \sqrt{PR}$

17/ A cycle shall consist of rotating the movable contact arm through 90 to 100 percent of the actual effective electrical travel and returning to the starting

point. The cycle rate shall be one cycle in 2.5 minutes for multiturn units, and 5 seconds to 2 minutes for single turn units. At no time during this test shall the contact arm be allowed to idle at either end of travel.

18/ There shall be no abrupt discontinuities, especially when the direction of travel is reversed, as the contact arm is rotated at a uniform rate back and forth two times across the actual effective electrical travel. During rotation, a suitable electrical device shall be connected between the contact arm and either end terminal to monitor the change in resistance or voltage.

19/ Materials listed in Revision 3 of NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

13: FILTERS

Table 1 FILTER REQUIREMENTS

Procurement Specification	Use As Is	Screen to Requirements in Table 2 1/	Qualify to Requirements in Table 3 1/
Level 1			
ESCC 3008	O		
MIL-PRF-28861, Class S	O		
MIL-PRF-28861, Class B 2/	O		
SCD		O	O
Level 2			
ESCC 3008	O		
MIL-PRF-28861, Class S	O		
MIL-PRF-28861, Class B	O		
MIL-PRF-15733		O	
SCD		O	O
Mfr HI- REL or Commercial		O	O
Level 3			
ESCC 3008	O		
MIL-PRF-28861, Class S	O		
MIL-PRF-28861, Class B	O		
MIL-PRF-15733	O		
SCD		O	
Mfr HI- REL or Commercial		O	

Notes:

1/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (ESCC, military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test

groups of qualification tests must be submitted to show that tests were performed with acceptable results.

2 / Class B filters are acceptable as Level 1 parts only when Class S filters are not available.

Table 2 SCREENING REQUIREMENTS FOR FILTERS

Inspection/Test	Test Methods, Conditions, and Requirements Reference MIL-PRF-28861	Level 1	Level 2			Level 3
		SCD	SCD	MIL-PRF-15733	HI- REL or Commercia l	HI- REL or Commercia l
1. VisualInspection	Elements and subassemblies in accordance with paragraph 4.6.1.2.	O				
2. ExternalVisual1/	Dimensions, marking, workmanship.	O	O		O	O
3. ThermalShock	MIL-STD- 202, Method 107 Condition A except step 3 shall be 125 °C.	O	O	O	O	
4. VoltageConditioning (Burn-In) Duration (Hours)	MIL-STD-202, Method 108, 125°±3 °C. 2 x rated voltage for DC rated. 1.2 x rated AC voltage at max. rated frequency for AC, AC/DC rated.	O 2/, 3/ 240	O 160	O 96	O 160	O 48
5. InsulationResistanceor DC Leakage Current 4/	MIL-STD-202, Method 302, rated DC voltage applied for 2 minutes max., charging current of 50 mA max.	O	O	O	O	O
6. CapacitancetoGround	MIL-STD-202, Method 305, 1.0±.2V RMS. 1 Mhz±100khz for capacitors≤100 pF. 1khz ±100Hz for capacitors≥100 pF.	O	O	O	O	O
7. DissipationFactor	Frequency and voltage specified in 6) above. Accuracy shall be ± 2 percent.	O	O	O	O	
8. InsertionLoss	MIL-STD-220 and paragraph 4.6.5.	O	O	O	O 4/	
9. VoltageDrop	AC and DC, paragraph 4.6.6.	O	O		O	
10. RadiographicInspection	MIL-STD-202, Method 209, and paragraph 4.6.8.	O				
11. Seal Test (Hermetic Types Only) Gross Leak Fine Leak	MIL-STD-202, Method 112. Condition A or B. Condition C.	O O	O		O	

Notes:

1/ Pure Tin plating is prohibited as a final finish on EEE parts.

2/ Grade 1 filters shall be torqued in place and insulation resistance measured at 125 °C before removing filter from plate.

3/ Polarity shall be reversed after first 24 to 72 hours. Refer to MIL-PRF-28861 paragraph 4.6.2.2.2 and Figure 1 for test circuit

4/ Shall be measured within 1 hour after voltage conditioning

.

.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR FILTERS 1/

Inspection Test	Test Methods and Procedures MIL-PRF-28861 Paragraph	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
		SCD	SCD, HI-REL or Commercial	
Group 1		4(0)	4(0)	
Resistance to Solvents	3.21, 4.6.15	O	O	
Resistance to Soldering Heat	3.25, 4.6.20	O	O	
Solderability	3.31, 4.6.25	O	O	Not
Thermal Strength	3.29, 4.6.23	O	O	
Group 2		5(0)	5(0) OR 10(1)	
Shock (Specified Pulse)	3.28, 4.6.22	O (1,500 Gs)	O (100 Gs)	Required
Vibration (High Frequency)	3.22, 4.6.16	O	O	
Random Vibration	3.23, 4.6.17	O		
Moisture Resistance	3.30, 4.6.24	O	O	
Seal (When Applicable)	3.15, 4.6.9	O	O	
Destructive Physical Analysis	3.27, 4.6.21	O	O	
Group 3		22(0)	10(0)	
Life	3.32, 4.6.26	O	O	

Notes:

1/ Samples shall be selected from parts that have passed the screening requirements in Table 2.

1 4 : F U S E S

Table 1 FUSE REQUIREMENTS 1/, 4/, 5/

Procurement Specification	Fuse Style and Type	Reference Specification	Level 1	Level 2	Level 3
ESCC 4008	Fuse, wire link≥5A and CERMET	ESCC 4008	1/	1/	1/
Mil Specification	FM Fuse,Cartridge,InstrumentType	MIL-PRF-23419	2/	2/	2/
SCD			3/	3/	3/
Commercial				3/	3/

Notes:

1/ Burn-in (168hours/85℃/50% rated current) is mandatory on each lot/date code for wire link fuse

2/ Fuses shall be screened in accordance with Table 2.

3/ Fuses must meet the screening and qualification requirements of Tables 2 and 3.

4/ Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot specific attributes data for screening tests, and lot specific or generic attributes data as applicable to various test groups of qualification tests must be submitted to show that tests were performed with acceptable results.

5/ Table 2 (screening) and Table 3 (qualification) are not appropriate for resettable polymer-based fuses. Presently, there is no standard qualification plan for space applications for the polymer-based fuses.

Table 2 FUSE SCREENING REQUIREMENTS

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Level		
		1	2	3
1. Visual Inspections 2/	Materials, design, construction, marking, and workmanship	O	O	O
2. Mechanical Inspections 3/	Body and lead dimensions to specification	O	O	O
3. Resistance (Cold) 4/	MIL-STD-202, Method 303 Resistance to specification	O	O	O
4. Voltage Drop (Hot-1) 5/	100% rated current for 5 minutes (minimum) Voltage drop to specification (when specified)	O	O	O
5. Thermal Shock 6/, 7/	MIL-STD-202, Method 107 Condition B	O	O	O
6. Voltage Drop (Hot-2) 5/	100% rated current for 5 minutes (minimum) Ratio voltage drop: (Hot-1/Hot-2) = 0.97 to 1.03	O	O	O
7. Resistance (Cold) 4/	MIL-STD-202, Method 303 Resistance to specification	O	O	O
8. Seal	MIL-STD-202, Method 112 Test Condition A	O	O	O
9. Percent Defective Allowable (PDA) 8/	Level 1—5% Level 2—10% Level 3—15%	O	O	O

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

2/ The use of pure tin plating is prohibited as a final finish or undercoat.

3/ A minimum of three fuses shall be measured.

4/ The source current for the resistance measurement shall not exceed 10% of the nominal current rating at room temperature. If the resistance of the fuse is not specified, a continuity check shall be substituted.

5/ The voltage drop (hot) measurement must be recorded to calculate the voltage drop ratio regardless of whether or not it is a specification

requirement. Not applicable for SMT fuses.

6/ External visual examination required after testing to verify no evidence of mechanical damage.

7/ Fuse rated < +125 °C shall be tested to Condition A.

8/ Incorrect, incomplete, or illegible marking shall be considered major defects. Cosmetic marking defects and voltage ratio rejects shall not be counted for purposes of establishing the failure rate.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Samples shall be selected from parts that have passed the screening requirements in Table 2. Table 2	 100%	 100%	 100%
Group 1A Current-Carrying Capacity 2/, 3/	 Specified percentage of rated current at –60 °C, 25 °C, and at maximum rated temperature Load Time: 30 minutes after temperature stabilization but not less than 1.5 hours Case temperature rise:≤70 °C (unless otherwise specified)	12(0) O	8(0) O	4(0) O
Group 2 Terminal Strength 3/, 7/	 MIL-STD-202, Method 211 Test condition A or E (as applicable) Specified applied force Plug or lead terminals: Along terminal axis Ferrule type terminals: torque	4(0) O	2(0) O	
Overload Interrupt 3/, 4/	Specified percentage of rated current at –20 °C, 25 °C, and at maximum rated temperature Temperature soak time: 30 minutes minimum Load time: 1 minute after fuse blow Insulation resistance to specification within 1 minute	O	O	

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 2 (Continued)				
Insulation Resistance 7/	MIL-STD-202, Method 302 Specified test condition Between leads and conductive material surrounding body	O	O	
Solderability (When Applicable)	Minimum resistance to specification MIL-STD-202, Method 208	O	O	
Group 3		2(0)		
Short Circuit 3/	Specified current and voltage Temperature soak time: 30 minutes minimum Load time: 1 minute after fuse blow Insulation resistance to specification within 1 minute	O		
Group 4 8/		2(0)	2(0)	
Vibration, High Frequency 3/	MIL-STD-202, Method 204 Specified test condition (amplitude, frequency range, sweep time and duration)	O	O	
Continuity	Electrical continuity intact MIL-	O	O	
Shock, Specified Pulse 3/	STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (Gs, pulse time, waveform)	O	O	
Continuity	Electrical continuity intact	O	O	

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 5		4(0)	4(0)	4(0)
Moisture Resistance 3/	MIL-STD-202, Method 106 Specified polarizing voltage	O	O	
Thermal Shock 3/, 5/	MIL-STD-202, Method 107 Test condition B Electrical			O
Continuity	continuity intact			O
Resistance to Soldering Heat 3/	MIL-STD-202, Method 210 Specified solder temperature Specified dwell time Electrical continuity intact	O	O	
Current-Carrying Capacity 3/	Same as group 1A except 100% maximum rated current at room ambient only	O		
Overload Interrupt 3/, 4/	Same as group 2 except at room ambient only	O		
Insulation Resistance 7/	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Specified minimum resistance	O	O	
Group 6				
Thermal Outgassing 6/	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	O	O	O

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent ESCC or military specifications, manufacturer's specification, or the application, whichever is most severe.

2/ The group 1A samples shall be subdivided as specified in the table for groups 2 to 6, inclusive. These minimum sample sizes are needed for qualification:

Level 1 — 12 fuses
Level 2 — 8 fuses
Level 3 — 4 fuses

3/ External visual examination required after testing to verify no evidence of mechanical damage.

4/ The power supply shall have an open-circuit voltage not less than the specified voltage rating of the fuse under test.

5/ Fuses rated < +125 °C shall be tested to condition A.

6/ Materials listed in NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

7/ Not applicable for SMT fuses.

8/ Not applicable for SMT fuses utilizing thick or thin film technologies. Hollow SMT fuses constructed with wire-in-air technology shall be subjected to the group 4 inspections.

15: THERMISTORS

Table 1 THERMISTOR REQUIREMENTS 1/

Procurement Specification	Thermistor Style and Type	ESCC/ MIL/ NASA Reference Specification	Level 1	Level 2	Level 3
Positive Temp. Coeff.					
ESCC Specification	Resistor, Thermally Sensitive	ESCC 4006	O	O	O
Mil Specification	RTH Resistor,Thermal,Insulated	MIL-PRF-23648	O	O	O
SCD			2/	2/	2/
Commercial				2/	2/
Negative Temp. Coeff.					
ESCC Specification	Resistor, Thermally Sensitive	ESCC 4006	O	O	O
MIL/NASA Specification	RTH Resistor,Thermal,Insulated	MIL-PRF-23648	O	O	O
	311P18 Thermistor,Insulated,andUninsulated	S-311-P-18	O	O	O
	311-424 Thermistor,SuperStable,Encapsulated	S-311-424	3/	3/	3/
	311P767 Thermistor,HermeticallySealed,Cryogenic	S-311-P-767	3/	3/	3/
SCD			2/	2/	2/
Commercial				2/	2/

Notes:

1/ Character “O” designates use as is. Tests that are required by the procurement specification and/or are performed normally by the manufacturer need not be repeated by the user. However, evidence must be submitted indicating that test conditions were acceptable and that tests were performed with acceptable results.

2/ Thermistors procured to SCDs or commercial thermistors must meet the screening and qualification requirements of Tables 2 and 3.

3/ Thermistors may be used as is if listed in the GSFC Qualified Parts List Directory (QPLD).

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
1. Visual Inspections	Materials, design, construction, marking, and workmanship	O	O	O	O	O	O
2. Mechanical Inspections 2/	Body and lead dimensions to specification	O	O	O	O	O	O
3. Preconditioning 3/	+125 °C for 5 days min. followed by +50 °C for 5 days min., unless otherwise specified by the manufacturer	O	O	O	O	O	O
4. Zero-Power Resistance 4/, 5/, 6/	MIL-STD-202, Method 203 1. Measure zero-power resistance at specified reference temperature 2. Measure zero-power resistance at +125 °C or max. rated operating temperature 3. Remeasure zero-power resistance at specified reference temperature 4. ΔR (zero-power) to specification	O	O	O	O	O	O
5. Resistance Ratio Characteristic 5/, 6/	IfΔR (zero-power) is to specification,compute resistance ratio using the zero- power resistance at the reference temperature and at +125 °C or the specified max. rated operating temperature. Resistance ratio: either R(zero-power ref temp)/R(zero-power +125 °C) or R(zero-power ref temp)/R(zero-power max. operating) to specification.			O			O

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
6. Thermal Shock 5/, 6/, 7/	MIL-STD-202, Method 107 Level 1 – 25 cycles Level 2 – 10 cycles High temperature – +125 °C or max. rated operating temperature Low temperature – Min. rated operating temp.	O	O		O	O	
7. High Temperature Storage 5/, 6/, 7/, 8/	+125 °C or max. rated operating temperature, 100 hours, no load	O	O		O	O	
8. Zero-Power Resistance 4/, 5/, 6/	MIL-STD-202, Method 203 1. Measure zero-power resistance at specified reference temperature 2. ΔR (zero-power) to specification	O	O		O	O	
9. Insulation Resistance 8/	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Specified minimum resistance	O	O		O	O	

Notes at the end of table.

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
10. Resistance Temperature Characteristic 4/, 5/, 6/	Specified temperature points Stabilization time≥10 times the thermal time constant Zero-power resistance at each temperature point Resistance curve to specification within tolerance limits at each temperature point Temperature points: Level 1 – Reference temperature, each temperature extreme, and a minimum of three points between reference temperature and each temperature extreme Level 2 – Reference temperature, each temperature extreme, and a minimum of one point between reference temperature and each temperature extreme	O	O		O	O	
11. Percent Defective Allowable (PDA) 9/	Level 1 – 5% Level 2 – 10%	O	O		O	O	

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent ESCC/ military specifications, manufacturer's specification, or the application, whichever is most severe.

2/ A minimum of three thermistors shall be measured.

3/ Applicable only for surface mount thermistors.

4/ Zero-power resistance shall be measured in a controlled uniform medium capable of maintaining an accuracy of ±0.01°C for beads (any mounting construction) and ±0.05 °C for all other types. The resistance shall be measured using a Wheatstone bridge (or equivalent), accuracy to ±0.05% or better, with time response less than the thermal time constant of the thermistor under test.

5/ The specified reference temperature is usually ambient +25 °C. However, since the resistance curve tolerance varies on either side of this reference ambient, for particular applications it may be advantageous to specify the reference temperature at some other point, up to and including the temperature extremes. If a temperature extreme is used as the reference temperature, the complementary temperature for zero-power resistance and resistance ratio shall be the midpoint temperature between the temperature extremes. If the high temperature extreme is < +125 °C, this temperature shall be used for thermal shock and high temperature storage testing.

6/ Never expose a thermistor to an ambient temperature greater than its maximum operating temperature during testing under no-load conditions. Such exposure, even for brief periods, can permanently destabilize the thermistor if the Curie temperature is exceeded. The maximum operating temperature, which can be determined from the power rating, is the maximum body temperature at which the thermistor will continue to operate with acceptable stability of its characteristics. The temperature at which the power has been linearly derated to 0% corresponds to the maximum ambient temperature under no-load conditions.

7/ External visual examination required after testing to verify no evidence of mechanical damage.

8/ Not applicable for surface mount thermistors.

9/ Incorrect, incomplete, or illegible marking shall be considered major defects. However, cosmetic marking defects shall not be counted for purposes of establishing the failure rate.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Group 1							
Screening to Table 2 2/	Table 2	O	O		O	O	
Group 2		3(0)	3(0)		3(0)	3(0)	
Solderability (when applicable)	MIL-STD-202, Method 208	O	O		O	O	
Resistance to Solvents 3/	MIL-STD-202, Method 215	O	O		O	O	
Group 3		10(0)	5(0)		10(0)	5(0)	
Short Time Overload 3/	Specified zero-power resistance Use dissipation constant and resistance value to compute average voltage and current at maximum power rating Energize time: 5 minutes at specified reference temperature De-energize for 10 minutes Repeat for 10 complete cycles ΔR (zero-power) to specification	O	O		O	O	
Dielectric Withstanding Voltage 3/, 4/	MIL-STD-202, Method 301 Between leads and conductive material surrounding body	O	O		O	O	
Insulation Resistance 4/	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Specified minimum resistance	O	O		O	O	
Low Temperature Storage 3/	Specified low temperature for 3 hours min. ΔR (zero-power) to specification	O	O		O	O	

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Group 3 (continued)							
Dissipation Constant	Specified zero-power resistances Specified test chamber, chamber temperature, or temperature controlled bath Specified test circuit schematic Loading to specified voltage and current levels Specified load dwell time Specified dissipation formula Dissipation constant to specification	O	O		O	O	
Thermal Time Constant 5/	Specified zero-power resistances Specified test chamber, chamber temperature and controlled temperature bath (if applicable) Specified test circuit schematic Loading to specified voltage and current levels Specified load dwell time Specified vertical travel and travel rate (if applicable) Thermal time constant to specification	O	O		O	O	
Terminal Strength 3/, 4/	MIL-STD-202, Method 211 Test Condition A (disk and bead types) Test Conditions A and D (rod types) ΔR (zero-power) to specification	O	O		O	O	

Notes at the end of table.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)					
		Positive Temp. Coefficient			Negative Temp. Coefficient		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Group 4		5(0)	3(0)		5(0)	3(0)	
Resistance to Soldering Heat 3/	MIL-STD-202, Method 210 Specified solder temperature Specified dwell time ΔR (zero-power) to specification	O	O		O	O	
Moisture Resistance 3/	MIL-STD-202, Method 106 Loading: 50% at maximum rated power 50% at no load IR to specification ΔR (zero-power) to specification	O	O		O	O	
Group 5		10(0)	5(0)		10(0)	5(0)	
Load Life 3/	MIL-STD-202, Method 108 Specified zero-power reference temperature Specified maximum rated power, 1.5 hours on, 0.5 hours off Level 1 – 1000 hours Level 2 – 500 hours	O	O		O	O	
Group 6							
Thermal Outgassing 6/	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	O	O	O	O	O	O

Notes at the end of table.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

2/ The qualification samples shall be subdivided as specified in the table for Groups 3 through 6, inclusive. Group 2 inspections can be performed on unscreened samples or on samples that have completed one of the other qualification test groups. These minimum samples sizes are required for qualification: Level 1 – 25 thermistors; level 2 – 13 thermistors.

3/ External visual examination required after testing to verify no evidence of mechanical damage.

4/ Not applicable for surface mount thermistors.

5/ A controlled temperature bath and drive mechanism are used for beads in probes and beads in rods.

6/ Materials listed in Revision 3 of NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

16: WIRE AND CABLE

GENERAL

The following information is unique to this section.

(1) Table 1B provides a detail description of available wire and cable as an aid to designers.
(2) Table 1C delineates the properties, advantages, and disadvantages of available wire insulator materials.
(3) Depending on the application, outgassing, atomic oxygen and ultraviolet radiation degradation may need to be considered in selecting wire for space application.

PROCURMENT REQUIREMENTS

Wire and cable should be procured to ESCC or military specifications from qualified manufacturers as much as possible. A Certificate of Conformance should be requested for delivery with the order. Each spool must be permanently and legibly identified with manufacturer's cage code or manufacturer's name, ESCC/ military part number, length, size (AWG) and lot or date code of manufacture that can be used for traceability and age control.

FLAMMABILITY

Insulation materials shall be non-combustible or self extinguishing. Selection and use shall be traceable to acceptable flammability test reports in MSFC Handbook 527. When no test report exists, flammability testing shall be performed using the procedure ofNASA-STD-6001,previously NHB 8060.1C (Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion) or as otherwise specified.

OUTGASSING

Outgassing occurs in vacuum environments when unreacted additives, contaminants, absorbed gasses or moisture can evaporate from molding materials and ink. These outgassed materials can condense on cold surfaces causing performance degradation. Outgassed materials can also become more rigid or brittle. Nonmetallic materials shall not exceed 1% Total Mass Loss (TLM) or 0.1% Collected Volatile Condensable Material

(CVCM) when tested in accordance with ASTM-E595 (Test Method, Outgassing).

CRYOGENIC APPLICATIONS

There are no wires or cables that are officially rated for use in low temperature/ cryogenic applications below –200°C. However, experience has proven it is possible for many Teflon ™ insulated wires to be used successfully at cryogenic temperatures. It is recommended that samples from each prospective flight spool proposed for use at cryogenic temperature should be subjected to five cycles of cryogenic temperature cycling using sufficient low temperature to qualify wire for the intended application. Samples should be inspected for cracks and splits. If the cables are to be formed into a particular configuration, some forming of the samples prior to testing is recommended or samples should be wound on a mandrel prior to temperature cycling.

ATOMIC OXYGEN DEGRADATION

Wire and cable users need to be cautious of the corrosive effects atomic oxygen can have on wire and cable exposed to external surfaces of satellites flown in lower earth orbits (LEO). Atomic oxygen is a strong oxidizing agent, which can change silver plating to a non-conductive finish.

Polyamide insulation is rapidly degraded by exposure to atomic oxygen. All insulations may experience physical erosion such as flaking. For multi-year missions in lower earth orbits, the use of unprotected thin wall insulated wire is not recommended.

HANDLING PRECAUTIONS

1. Wire insulation can be damaged by solvents used to clean cable assemblies. Incomplete solvent removal can result in slow degradation of the insulation and/or contamination of surrounding hardware when installed and stored in sealed containers or used in a confined environment. The problem can be eliminated by performing a bakeout of the completed cable assembly after cleaning, rather than rinse, blow dry and package for storage. Solvents have been shown to degrade KaptonTMinsulation's mechanical strength, resulting in flaking of the outer insulation tape, and cracking. Solvents can cause fluorinated polymers such as TefzelTMinsulation to release trace amounts of fluorine that can react with

surrounding components resulting in corrosion to metals and other degradation.

2. Silver-coated copper wire can become corroded with powdery cuprous oxide (“red plague”) when moisture is absorbed and penetrates through pinholes or other breaks in the silver plating, and invades the silver-copper interface. The methods used to produce and store silver coated wire must be controlled. Water quenching should not be used during the wire fabrication process. Wet dielectric testing (dunk testing) should not be used. The storage environment for this wire should be controlled to reduce humidity, from the manufacture through the distributor and user. Completed wire should be shipped and stored with capped ends to prevent moisture penetration.

Table 1A WIRE AND CABLE REQUIREMENTS 1/

Procurement Specification	Level 1		Level 2		Level 3	
	Mil / ESCC	Com'l/ SCD	Mil / ESCC	Com'l/ SCD	Mil / ESCC	Com'l/ SCD
Insulated Hookup Wire						
MIL-W-22759*	O		O		O	
MIL-W-81044*	O		O		O	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Coated Magnet Wire 4/						
MWXX-C (HEAVY)	O		O		O	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Multiconductor Cable 5/						
NEMA-WC27500	O		O		O	
SCD		2/		2/		2/
Commercial		2/		2/		2/
Coaxial and Twinaxial Cable						
MIL-C-17	O		O		O	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Flexible Printed Circuit Cable						
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Low Frequency Wires and Cables (for ESCC)						
ESCC 3901	O		O		O	
High Frequency Wires and Cables (for ESCC)						
ESCC 3902	O		O		O	

Notes:

1/ For a detailed description of available wire and cable configurations, refer to Table 1B. The character "O" indicates use as is.

2/ Screening to Table 2 is required. Lot specific screening attributes data may be acquired and reviewed for acceptability in lieu of performing the required testing if the data satisfies the requirements of Table 2.

3/ Qualification to the requirements of Table 3 is required. Lot specific QCI attributes data may be acquired and reviewed for acceptability in lieu of performing the required testing if the data satisfies the requirements of Table 3.

4/ Reference NEMA Standard MW-1000, which supersedes Federal Specification J-W-1177.See Table 1 Note 9 of section M1 for acceptable table magnet wire sizes.

5/ Qualification of completed cable is not a requirement. However, qualification of the individual conductor components within the cable is required and shall be performed to the nearest military hookup wire specification or SCD. All materials used for insulation jacket material or cable fillers shall be traceable to acceptable outgassing and flammability test reports.

* These documents and their detailed slash sheets have been adopted by SAE (The Engineering Society for Advancing Mobility Land Sea Air and Space) in 2000. The SAE document numbers are AS22759 and AS81044. They can be accessed from the SAE web address: http://www.sae.org.

Table 1B WIRE AND CABLE TYPES

Procurement Specification	Description 1/
PTFE Insulated (Teflon-Polytetrafluoroethylene), Copper or Copper Alloy	
MIL-W-22759/11	Silver Coated, 600 Volt, 200°C
MIL-W-22759/12	Nickel Coated, 600 Volt, 260°C
MIL-W-22759/22	Silver Coated, 600 Volt, 200°C (High Strength)
MIL-W-22759/23	Nickel Coated, 600 Volt, 260°C (High Strength)
MIL-W-22759/9	Silver Coated, 1000 Volt, 200°C
MIL-W-22759/20	Silver Coated, 1000 Volt, 200°C (High Strength)
ETFE Insulated (Ethylene Tetrafluorethylene), Copper or Copper Alloy	
MIL-W-22759/44	Crosslinked ETFE, Silver Coated, 600 Volt, 200 °C, Light Weight
MIL-W-22759/43	Crosslinked ETFE, Silver Coated, 600 Volt, 200 °C, Normal Weight
MIL-W-22759/33	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Light Weight (High Strength)
MIL-W-22759/35	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Normal Weight (High Strength)
MIL-W-22759/45	Crosslinked ETFE, Nickel Coated, 600 Volt, 200°C, Light Weight
MIL-W-22759/41	Crosslinked ETFE, Nickel Coated, 600 Volt, 200°C, Normal Weight
PTFE Fluorocarbon/Polyamide (Kapton), Insulated, Copper or Copper Alloy 8/	
MIL-DTL-22759/86	Silver Coated, 600 Volt, 200°C, Normal Weight
MIL-DTL -22759/87	Nickel Coated, 600 Volt, 260°C, Normal Weight
MIL-DTL -22759/89	Silver Coated, 600 Volt, 200°C, Normal Weight (High Strength)
MIL-DTL -22759/90	Nickel Coated, 600 Volt, 260°C, Normal Weight (High Strength)
MIL-DTL -22759/91	Silver Coated, 600 Volt, 200°C, Light Weight
MIL-DTL -22759/92	Nickel Coated, 600 Volt, 200°C, Normal Weight
Crosslinked Polyalkene/Crosslinked PVDF, Copper and Copper Alloy	
GSFC S-311-P-13/1	Tin Coated Copper, 600V, 135°C 3/
GSFC S-311-P-13/2	Tin Coated Copper, 1000V, 135°C 3/

GSFC S-311-P-13/3	High Voltage, Tin Coated Copper, 2500V, 135°C 3/
MIL-W-81044/7	Silver coated Copper, 600V, 150°C (High Strength)
MIL-W-81044/12	Tin Coated Copper, 600V, 150°C, Light Weight 3/
Chemically Coated Copper Magnet Wire 2/	
MW-28-C (HEAVY)	Polyurethane Overcoated with Polyamide, Heavy Enameled, 130°C (Supersedes M1177/9-02C0XX)
MW-30-C (HEAVY)	Polyester-Amide-Imide, Heavy Enameled, 180°C (Supersedes M1177/12-02C0XX)
MW-35-C (HEAVY)	Polyester-Amide-Imide, Overcoated with Polyamideimide, Heavy Enameled, 200°C (Supersedes M1177/14-02C0XX)
MW-16-C (HEAVY)	Polyamide, Heavy Enameled, 220°C (Supersedes M1177/15-02C0XX)

Notes at end of table.

Table 1B WIRE AND CABLE TYPES

Procurement Specification	Description 1/
Multiconductor Cable	
NEMA-WC27500 10/	PTFE or ETFE insulated, Multiconductor, Shielded and Unshielded, Jacketed and Unjacketed.
Coaxial Cable 4/	
MIL-C-17/60	Flexible, Double Braid Shield, FEP Jacket, 12.4 GHZ Max, 50 OHMS, 200°C Max, RG 142 Type
MIL-C-17/93 6/	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 178 Type
MIL-C-17/95 5/, 6/	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 95 OHMS, 200°C Max, RG 180 Type
MIL-C-17/110 5/	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 75 OHMS, 200°C Max, RG 302 Type
MIL-C-17/111	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 303 Type
MIL-C-17/113	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200 °C Max, RG 316 Type
MIL-C-17/127	Flexible Double Braid Shield, FEP Jacket, 11 GHZ Max, 50 OHMS, 200°C Max, RG 393 Type
MIL-C-17/128	Flexible Double Braid Shield, FEP Jacket, 12.4GHZ Max, 50 OHMS, 200°C Max, RG 400 Type
MIL-C-17/130 7/	Semi Rigid, Seamless Copper Tubing, .141 OD, 20 GHZ Max, 50 OHMS, 125°C Max, RG 402 Type
MIL-C-17/133 7/	Semi Rigid, Seamless Copper Tubing, .086 OD, 20 GHZ Max, 50 OHMS, 125°C Max, RG 405 Type
MIL-C-17/152	Flexible, Double Braid Shield, FEP Jacket, 12.4 GHZ Max, 50 OHMS, 200°C Max.
Twin Axial Cable 4/	
MIL-C-17/176	Flexible Single Shield Braid, PFA Jacket, 10 MHZ Max, 77 OHMS, 200°C

Bare Bus Wire A-A-59551	Wire, Electrical, Copper (Uninsulated, ref. Type “S” Solid Wire)
Wire Braid A-A-59569	Braid, Wire (Tubular or Flat)
Flexible Printed Circuit IPC-6013 MIL-P-50884 9/	(Used as cable) Qualification and Performance Specification for Flexible Printed Boards Printed Wiring, Flexible and Rigid Flex

Notes on next page.

Table 1B WIRE AND CABLE TYPES

Notes:

1/ The following are common trade names for Insulations: PTFE and FEP are Teflon (Dupont); ETFE and Crosslinked ETFE are Tefzel (Dupont); Polyvinylidene Fluoride (PVDF or PVF2) is Kynar (Pennwalt); Polyester is Dacron (Dupont); Polyamide is Kapton (Dupont)

2/ NEMA MW1000 Magnet Wire. Detail specifications are taken from NEMA Standard MW-1000 and supersede J-W-1177 Detail Specifications. For, wire size restrictions, see Table 1A, Note 4. For additional coating options, consult NEMA MW-1000.

2.1/ Part number explanation:

MW	030	C	H	x	000022	n
NEMA Symbol	DetailSpec (Class = temp index, °C / coating material) 016 – (Class 240 / Polyamide) 030 – (Class 180 / Polyester-Amide-Imide) 035 – (Class 200 / Polyester-Amide-Imide) (Others available: Note 2.4)	Material C=Copper Note2.2	Coating Thickness S=Single H=Heavy Note2.3	Additional Information (LowerCase) x=FilmCoatedonly b=Doublethickness withglassfiber	Size(AWG) (Roundcrosssection) (ex:000022=22AWG) Detailspec(availablesizerange) 016-(000004thru000050) 030-(000004thru000050) 035-(000004thru000044)	Lubricant (LowerCase) n-None

2.2/ Copper is the preferred conductor material.

2.3/ Double coated (Heavy) wire is preferred, but requires additional design consideration for flux density, increased device size, and thermalimpedance. Use of single coated wire is discouraged due to increased risk of breakdowns from extra pinholes associated with thinner coating. It is also more prone to handling damage.

2.4/ Use of solderable insulations is discouraged due to potential for coating pullback from high temperatures incurred during operation.

2.5/ Magnet wire older than two years from manufacture should not be used without retesting. Magnet wire older than five years is prohibited.

3/ Tin coated conductors are permitted, but are only permitted with solder type contacts. They are not recommended for use with crimp type contacts.

4/ All coaxial cables contain a solid extruded PTFE dielectric core. Twin axial cables contain two PTFE cores and two PTFE fillers.

5/ There are no 75 OHM impedance connectors to accommodate this cable. Due to impedance mismatch, performance ratings are not guaranteed.

6/ M17/93-RG178 and M17/95-RG180 have very small center conductors measuring 0.012 inches that are easily damaged during striping, soldering or handling. EXTREME caution is required during termination to connectors. Use of cable with larger center conductors is preferred.

7/ M17/130-RG-402 and M17/133-RG405 Copper clad semi-rigid coaxial cable shall only be used with solder attached connectors. Crimp or compression type connectors are prohibited.

8/ Supersedes MIL-W-81381 FEP Fluorocarbon/Polyamide Kapton insulated wire.

9/ MIL-P-50884 is inactive for new design, and is superseded by MIL-PRF-31032/3. MIL-PRF-31032/3 does not perform 100% inspections consistent with high reliability product, and as such, MIL-P-50884 is preferred over MIL-PRF-31032.

Table 1B WIRE AND CABLE TYPES

10/ NEMA-WC27500(formerly MIL-C-27500) Multiconductor/Shielded/Jacketed Cable

10.1/ Part number explanation: (With designations for preferred construction.) M22759/11 (Symbol RC) or M22759/43 (Symbol SP) base wire with silver coated copper single layer shield (Symbol S) and FEP Teflon single jacket (Symbol 09) preferred as first choice. Example of complete part number with above options for three #22 AWG conductors: M27500-22RC3S09 or M27500-22SP3S09. Consult NEMA-WC27500 (Electrical Cable; supersedes MIL-C-27500) for additional construction options.

M27500	X	XX	XX	X(X)	X	XX
Military Specification Number	Braid Coverage - = 85% C = 90% (Note 8.2)	Wire AWG 26 thru 2/0 (All conductors are same AWG)	Basic Wire Insulation Type PTFE Teflon LE=MIL-W-22759/9 RC=MIL-W-22759/11 RE=MIL-W-22759/12 TK=MIL-W-22759/20 TM=MIL-W-22759/22 TN=MIL-W-22759/23 ETFE TE=MIL-W-22759/16 Crosslinked ETFE SB=MIL-W-22759/32 SC=MIL-W-22759/33 SD=MIL-W-22759/34 SM=MIL-W-22759/41 SP=MIL-W-22759/43 SR=MIL-W-22759/44	No. Of Wires 1 thru 15 (Note 8.4)	Shield Style and Material Round Shield with normal strength copper strands U = No Shield Single Layer Shield S=Silver T= Tin Double Layer Shield W=Silver	Outer Jacket 00=No Jacket Single Jacket 06=PTFE Teflon (White) 09=FEP Teflon (White) 23=Crosslinked ETFE (White) Double Jacket (Note 8.3) 59=FEP Teflon (White) 73=Crosslinked

10.2/ Designation shown for braid coverage includes preferred conductor identification method (white base color with color spiral stripe.) Optional solid identification color coding is available.

10.3/ The double jacket symbol shall only be used in conjunction with a double shield symbol. The first jacket appears between the two shields and the second jacket over the outer shield. Both jackets are the same material.

10.4/ Number of conductors shall be 1 to 15 for shielded-jacketed conductors, and 2 to 15 for unshielded-jacketed cables. Cables with 10 to 15 conductors shall be limited to AWG 12 and smaller.

Table 1C INSULATION SELECTION GUIDELINES 1/, 2/

Insulation Types	Advantages	Disadvantages
FEP and PTFE (DuPont™ Teflon) 3/	1. Excellent high temperature properties. PTFE Teflon is preferred for solder applications. FEP is preferred for jacket material. 2. Non-flammable. 3. Good outgassing characteristics. 4. Most flexible of all Insulations. 5. Resists moisture absorption and atomic oxygen erosion.	1. Susceptible to cold flow when stressed(bent) over tight radius or when laced too tightly. 2. Degraded by solar radiation above $5x10^5$ RADS. 3. FEP has poor cut through resistance. 4. Heaviest insulation.
Extruded ETFE (DuPont™ Tefzel)	1. Withstands physical abuse during and after installation. 2. Good high and low temperature properties. 3. High flex life. 4. Fair cold flow properties	1. Some ETFE Insulations fail flammability in a 30% oxygen environment. 2. Insulation tends to soften at high temperature. 3. Degraded by gamma radiation above 10^6 rads 4. Sensitive to degradation from ultraviolet light. 5. Some ETFE insulations(primarily white) are known to outgas trace amounts of fluorine over time, which can cause corrosion of unprotected metals in sealed or confined environments. 6. Some ETFE(Ethylene Tetrafluoroethylene) insulated wire has been found to fail flammability testing in a 30% oxygen environment.

Crosslinked ETFE (DuPont™ Tefzel)	1. Higher strength than extruded ETFE. 2. Resistant to cold flow and abrasion. 3. More resistant to radiation effects.(to $5x10^7$ RADS) 4. Improved physical stability at high temperature than extruded ETFE.	1. Some ETFE insulations fail flammability in a 30% oxygen environment. 2. Less flexible than extruded ETFE. More difficult to strip. 3. Some ETFE(Ethylene Tetrafluoroethylene) insulated wire has been found to fail flammability testing in a 30% oxygen environment. 4. Sensitive to degradation from ultraviolet light. 5. Some ETFE insulations (primarily white) are known to outgas trace amounts of fluorine over time, which can cause corrosion of unprotected metals in sealed or confined environments.

Table 1C INSULATION SELECTION GUIDELINES 1/, 2/

Insulation Types	Advantages	Disadvantages
Aromatic Polyamide (DuPont ™Kapton) 4/	1. Lightest weight wire insulation material. Commonly used with FEP or PTFE Teflon to form layered insulation tapes. 2. Excellent physical thermal and electric properties. Excellent cut-through resistance and cold flow resistance. 3. Excellent radiation resistance (to 5×10^9 RADS). 4. Good outgassing characteristics.	1. Inflexibility – difficult to strip. 2. Absorbs moisture. Degraded by atomic oxygen. 3. Prone to wet-arc and dry-arc tracking from abrasions and cuts. 4. More difficult to flex. 5. Not stable to ultraviolet radiation.
Crosslinked Polyalkene	1. Dual extrusion, which is fused by sintering. Combines excellent abrasion and cut through resistance of Polyvinylidene Fluoride (PVDF, PVF2 – Penwalt Corp TM Kynar) with Polyolefin for greater flexibility and improved heat resistance. Polyalkene is used mainly as a primary insulation under an outer jacket such as crosslinked ETFE or crosslinked PVDF/PVF2. 2. High dielectric constant, used in high voltage applications. 3. PVDF has good radiation resistance (to 10^8 RADS). 4. More resistant to cold flow. 5. Good outgassing characteristics.	1. Lower maximum conductor temperature rating. (135°C for GSFC S-311-P-13) (150°C for MIL-W-81044) 2. Reduced flexibility.

Silicone Rubber	1. Flexible at low temperatures. 2. Resistant to atomic oxygen. 3. Excellent corona resistance in high voltage applications 4. Good radiation resistance.	1. Must be processed for outgassing control. 2. Low mechanical strength. 3. Flammable.

Notes:

1/ Flammability properties of these wires are controlled by the applicable specifications.

2/ Wire size AWG 24 and larger is preferred for conductors used in interconnecting cable and harness assemblies. High strength copper alloy shall be used for size AWG 24 and smaller. Use of wire smaller than 26 AWG in interconnecting cables is discouraged.

3/ Due to the cold flow phenomena of Teflon insulation, the designer is advised to not route Teflon insulated wires over sharp edges and tight turns, or apply tight stitches and tie wraps to cable assemblies.

4/ Polyamide wire may be preferred for its light weight and excellent mechanical, electrical, and radiation resistance properties. However, the insulation of this wire has known reliability problems in certain applications. Extended exposure to moisture or alkaline cleaning chemicals has been shown to degrade the insulation's mechanical strength, resulting in flaking of the outer insulation tape, and cracking from vibration or movement when installed around tight radius bends. The resulting degradation may lead to flashover, arc tracking, and shorting, which may ignite the insulation.

Table 2A SCREENING REQUIREMENTS FOR INSULATED WIRE (Page 1 of 2) 8/

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Visual / Mechanical 1/, 3/	Inspect for proper marking, insulation, and color coding (if applicable). Check insulation workmanship for cracks, splits. Use 3x magnification and adequate lighting. Verify finished wire diameter per reference specification. Verify proper number of wire strands and AWG of strands. Verify weight as necessary. Inspect for discoloration or corrosion of the strands. Wire plating finish shall not flake off from normal flexing.	7/	1 foot sample per spool	7/	1 foot sample per spool		1 foot sample per spool
Insulation Flaws Test 6/ (For finished wire and primary insulation of dual insulated wire.)	Determine the presence of insulation faults by performing the Impulse Dielectric test per MIL-STD-2223 (Test Methods, Insulated Wire), method 3002. Wire shall be passed through an electrode bead chain electrode head, which will give intimate metallic contact with the wire insulation surface. Voltage potential as specified shall be applied between the electrode and conductor. Wire lengths with failed insulation shall be removed. Note 5	6/	Entire length 2/	6/	Entire length 2/		Entire length 2/
Wrap Test 4/ (Extruded Insulations)	MIL-W-22759, paragraph 4.6.3.3. Wire shall be bent back on itself, and one end shall be wound tightly around the other as a mandrel for four close turns. Sample shall be baked for 2 hours at the specified temperature. After cooling, examine for cracked insulation.		1 foot sample per spool		1 foot sample per spool		

Table 2A SCREENING REQUIREMENTS FOR INSULATED WIRE (Page 2 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l /SCD
Crosslinking Proof Test (Crosslinked ETFE Insulations Only)	MIL-STD-2223, Method 4001. Sample shall be prepared by removing one inch of insulation from each end anddraping it over a mandrel rod with diameter as specified. The ends shall be loaded with weights as specified. Thesample shall be baked for 7 hours at 300 °C or as otherwise specified in an air circulation oven. At completion of bake, the sample shall be allowed to cool to room temperature and shall be examined for color retention and pitting. The sample shall be removed from the mandrel and shall be subjected to the bend test of method 2006, followed by the wet dielectric test of method 3005.		2 foot sample		2 foot sample		
Lamination Sealing Test (Tape Sintered Insulations)	MIL-DTL-81381, paragraph 4.6.4.10. Sample shall be baked at the specified temperature for 48 hours. After cooling, visually examine for delamination of the insulation.		1 foot sample per		1 foot sample per		
Conductor Resistance	FED-STD-228 (Test Methods, Wire and Cable), Method 6021. Measurements (in ohms/1,000 ft. @ 20 °C) shall conform to MIL-W-22759, Table II limits or as otherwise specified. Wire shall be tested dry without immersion.		Eachl spool		l		

Notes:

1/ A certificate of compliance from the manufacturer shall be delivered with the wire to certify that the proper conductor material and finish were used in the manufacture of the wire.

2/ Insulation flaws test is normally a 100% screening test of primary insulation for dual layer insulated wire or finished wire. It is normally performed by the manufacturer during final winding of the wire on spools or reels. A certificate of compliance from the manufacturer that all

wire delivered to the user was subjected to and passed the impulse dielectric test is sufficient to meet this requirement. Otherwise, wire shall be screened as an incoming inspection test by the user or user designated test facility.

3/ For uncertified high strength copper wire procured from a supplier which does not have a history of supplying high reliability military or space grade wire, a mechanical pull test of a sample of the conductor stranding is recommended. Wire break strengths are provided in table I of ASTM-B624.

4/ Wrap test is used to determine if wire insulation is over sintered and could have degraded properties. For military wire, it is recommended on each lot as part of user's receiving inspection, but is not a requirement of this document. For Teflon insulated wire, Differential Scanning Calorimetry (DSC) per ASTM-E794 may also be performed to determine if wire is under sintered from incomplete processing. Either condition can lead to cracked insulation during use.

5/ The High Frequency Spark test, MIL-STD-2223 method 3008, is an acceptable alternate to the Impulse Dielectric test.

6/ 100% re-screening for insulation flaws may be performed by the user at the user's discretion, but is not a requirement of this document.

7/ Performance of mechanical construction analysis on a one foot sample is recommended in order to check for plating porosity and corrosion. This may be performed as part of user's receiving inspection, but is not a requirement of this document.

8/ For insulation materials with known outgassing instability a bakeout to reduce outgassing may be performed prior to use. Or, a bakeout to control outgassing and contamination due to handling during hardware fabrication may be performed at next assembly level. Refer to Outgassing paragraph, front of this Section.

Table 2B SCREENING REQUIREMENTS FOR COATED MAGNET WIRE 4/, 5/, 7/ (Page 1 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		NEMA/ Mil	Com'l/ SCD	NEMA /Mil	Com'l/ SCD	NEMA /Mil	Com'l/ SCD
Visual / Mechanical 1/	Inspect coating for workmanship. Coating shall be complete without porosity, blisters, wrinkles or runs. No portion of the conductor shall be exposed. Verify finish and wire dimensions per reference specification.	6/	1 foot sample per spool	6/	1 foot sample per spool		
Adherence and Flexibility 2/	a) With a 12 inch specimen clamped at 10 inches between jaws, elongate, and examine for insulation separation from the wire as specified. 3/ b) Wind around mandrel diameter as specified for 10 closely spaced turns and examine for cracks orseparation. For wire smaller than AWG 30, a 1/64 inch drill bit may be substituted. 3/	6/	1 foot sample per spool	6/	1 foot sample per spool		
Heat Shock 2/	Place the stretched and wound sample prepared from above in an oven and bake at max rated temperature +20°C or as specified in the detail spec, for 30 minutes. Examine for cracks at specified magnification. 3/		1 foot sample per spool		1 foot sample per spool		
Dielectric Strength Twist Test	ASTM-D1676 (Test Methods for Magnet Wire), Paragraph 71.1. Twist two pieces of wire together for a distance of 4.75 inches. Number of twists shall be as specified in ASTM-D1676 Table 7. Loop the ends of each conductor together, and attach the positive lead to one conductor and the negative to the second conductor. Gradually apply voltage until the rated voltage is reached and hold for five seconds. There shall be no breakdown.		Two-one foot samples per spool		Two-one foot samples per spool		

Table 2B SCREENING REQUIREMENTS FOR COATED MAGNET WIRE (Page 2 of 2)

Notes:

1/ Upon request, producers of NEMA MW1000 specification magnet wire are expected to supply the user with test data in support of the thermal class of the magnet wire. A certificate of compliance from the manufacturer shall be delivered with the wire to certify that the proper conductor material and resin coating were used in the manufacture of the wire.

2/ When Adherence and Flexibility test is performed, Heat Shock test must follow. At the project's option, when this data is available from the manufacturer, this test can be waived.

3/ Elongation requirements:

AWG Size	Elongation Rate	Minimum Elongation	Mandrel Diameter	Examined With
Copper				
4-9	12 + 1 in./min (300 25 + mm/min)	30%	none	Normal vision.
10-13	12 + 1 in./min (300 25 + mm/min)	25%	5 x sample diameter	Normal vision.
14-30	sudden jerk (2 ft/sec, min)	20%	3 x sample diameter	3X-10X magnification
31-44	sudden jerk (2 ft/sec, min)	20% or breakage	3X or 0.0156 (1/64 inch) drill bit, whichever is greater	6X-20X magnification

4/ Test methods in NEMA MW1000 (Magnet Wire) are based on ASTM-D1676.

5/ Magnet wire older than two years from manufacture date must be re-screened prior to use.

6/ Performance of mechanical inspection analysis on a one foot sample is recommended in order to check for coating porosity and cracking. Performance of Adherence and Flexibility on a one foot sample is also recommended. May be performed as part of user's receiving inspection, but is not a requirement of this document.

7/ For insulation materials with known outgassing instability a bakeout to reduce outgassing may be performed prior to use. Or, a bakeout to control outgassing and contamination due to handling during hardware fabrication may be performed at next assembly level. Refer to Outgassing paragraph, front of this Section.

Table 2C SCREENING REQUIREMENTS FOR RADIO FREQUENCY COAXIAL CABLE 4/

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l /SCD
Visual / Mechanical 1/	Inspect for proper marking. Check outer jacket for cracks, splits. Use 3X magnification and adequate lighting. Verify dimensions per reference spec. Verify quantity and AWG of inner conductor and shield strands. Inspect for discoloration or corrosion of the center conductor and shield strands. Verify weight as necessary.		1 foot sample per spool		1 foot sample per spool		1 foot sample per spool
Jacket Flaws (Not Applicable to Copper Clad Semi-rigid Cable)	Determine the presence of jacket flaws by performing the Impulse Dielectric test per MIL-STD-2223 (Test Methods, Insulated Wire), method 3002. Finished cable shall be passed through an energized bead chain electrode head which will give intimate metallic contact with the cable outer jacket. A voltage as specified in the reference spec at a frequency of 60Hz or 3K Hz shall be applied between the shield and electrode. Cable lengths which failed shall be removed (Note 3).		Entire length 2/		Entire length 2/		Entire length 2/
Continuity	Apply 25 V DC max to both ends of center conductor, followed by both ends of shield through an indicator (meter, light, or buzzer)		Each spool		Each Spool		Each spool
Voltage Withstanding	FED-STD-228 (Test Methods, Cable and Wire), Method 6111, except cable shall be tested dry without immersion. Apply voltage (potential as specified) between inner conductor and shield with the shield grounded.		Each spool 2/		Each spool 2/		

Notes:

1/ A certificate of compliance from the manufacturer shall be delivered with the wire to certify that the proper inner conductor, shield materials and finish were used in the manufacture of the wire.

2/ Test is used as a 100% screening test of finished cable during final winding of the wire on spools or reels by the manufacturer. A certificate of compliance from the manufacturer that all cable delivered to the user was subjected to and passed the spark test or voltage withstanding test is sufficient to meet this requirement. Otherwise, cable shall be screened as an incoming inspection test

3/ The High Frequency Spark test, MIL-STD-2223 method 3008, is an acceptable alternate to the Impulse Dielectric test.

4/ For insulation materials with known outgassing instability a bakeout to reduce outgassing may be performed prior to use. Or, a bakeout to control outgassing and contamination due to handling during hardware fabrication may be performed at next assembly level. Refer to Outgassing paragraph, front of this Section.

Table 2D SCREENING REQUIREMENTS FOR MULTICONDUCTOR CABLE 5/

Inspection / Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l /SCD
Visual Mechanical 1/	Inspect for proper marking. Check outer jacket for cracks, splits. Use 3X magnification and adequate lighting. Verify number of conductors, AWG and stranding of conductors, color coding or special marking of conductor insulations (as required). Inspect strands of conductors and shield for corrosion or other discoloration, and inspect for mechanical damage or flaking of the finish. Measure jacket thickness. Verify weight as required.	4/	1 foot sample per spool	4/	1 foot sample per spool		1 foot sample per spool
Jacket Flaws (Outer Jacket)	MIL-STD-2223 (Insulated Wire Test Methods), method 3002. Finished cable shall be passed through an energized bead chain electrode head which will give intimate metallic contact with the cable outer jacket. A potential of 1500 VAC at 60Hz shall be applied between the shield and spark electrode. Remove failed cable lengths (Note 3)		Entire length 2/		Entire Length 2/		Entire length 2/
Dielectric Withstanding Voltage (Between Component Wires)	MIL-STD-2223, Method 3005. Immersion is not required. Each conductor shall be tested against all others tied together with the shield (as applicable). Testing voltage shall be 1500V RMS for 600V rated conductors and 2,500V for 1000V rated conductors. Time of applied voltage shall be between 15 and 30 seconds.		Each spool 2/		Each spool 2/		
Conductor and Shield Continuity	All conductors and the shield of all finished cable shall be tested for continuity with an ohmmeter or other tester.		2/ Each spool		2/ Each spool		2/ Each spool

Notes:

1/ A certificate of conformance from the manufacturer shall be delivered with the cable to certify that the proper conductor finish, insulation and

jacket materials were used, and that the shield material, finish and shield coverage are correct as specified in the reference specification or SCD.

2/ Test is normally a 100% screening test of finished cable performed during final winding of the cable on spools or reels by the manufacturer. A certificate of compliance from the manufacturer that all cable delivered to the user was subjected to and passed the test is sufficient to meet this requirement. Otherwise, cable shall be screened as an incoming inspection.

3/ The High Frequency Spark test, MIL-STD-2223 method 3008, is an acceptable alternate to the Impulse Dielectric test. The Spark test of MIL-STD-2223, Method 3001, is also acceptable.

4/ Performance of mechanical construction analysis on a one foot sample is recommended in order to check shield stranding for plating porosity and corrosion. This may be performed as part of user's receiving inspection, but is not a requirement of this document.

5/ For insulation materials with known outgassing instability a bakeout to reduce outgassing may be performed prior to use. Or, a bakeout to control outgassing and contamination due to handling during hardware fabrication may be performed at next assembly level. Refer to Outgassing paragraph.

Table 2E SCREENING REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES

(REF IPC-6013; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Com'l/SCD	Com'l/SCD	Com'l/SCD
Visual / Mechanical Inspection 1/	Ref IPC-6013 (Flexible Printed Boards). Visually inspect surface at 10X magnification, min, using transmitted and reflected lighting.Inspect for excessive blisters, delamination, pinholes, conductorthinning, scratches, tool marks, contaminants and burrs. Edges shall be clean cut and free of nicks, tears and burrs. Accept criteriashall be as required by IPC-6013, paragraphs 3.3.1 through 3.3.9,for class 3 high reliability parts. If the condition of a suspect defectcannot be identified, use of progressively higher magnification up to 40X may be used.	100% of Flexible Circuits	100% of Flexible Circuits	100% of Flexible Circuits
Continuity	IPC-6013, paragraph 3.9.2.1 or MIL-P-50884 (Printed Wiring,Flexible), paragraph 4.8.6.3.2. A current of 250mA shall be passed through each conductor of the flex circuit. (Table 1B, Note 7.)	100% of Flexible Circuits	100% of Flexible Circuits	
Insulation Resistance	MIL-STD-202, Method 302, Test Condition A (100VDC). Theflex circuit will be checked for short circuits by applying potentialbetween conductors. Measurements shall not be less than 500Megohms.	100% of Flexible Circuits	100% of Flexible Circuits	
Processing for Outgassing Control (Contamination Controlled Applications)	Outgassing paragraph, page 1 (Front of this Section).	As required	As required	As required

Notes:

1/ Rework and Repair are permitted as agreed upon between the user and supplier to touch up minor surface imperfections, but shall not impact performance requirements.

Table 2E SCREENING REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES

(REF IPC-6013; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Com'l/SCD	Com'l/SCD	Com'l/SCD
Thermal Stress / Coupon Analysis (Doublesided or Multilayer Laminated Specimens)	Perform thermal stress testing per the requirements of IPC–6013, table 4-1. In lieu of coupons, production samples may be used. Ref IPC-TM-650 Method 2.6.8, specimen shall be conditioned at 120°C to 150°C for 6 hours minimum toremove moisture. Place specimen in a moisture absorption dessicator and allow to cool. Specimen shall be fluxed with Type RMA flux per MIL-T-14256 or Type ROL1 per J-STD-004 and laid on a solder bath of SN63 solder per QQ-S-571 or Sn63Pb37 per J-STD-006 maintained at 288°C +5°C for 10 seconds. Remove, allow to cool. Using transmitted and reflected lighting, at 10X magnification min, inspect for lifted lands, cracks, blistering or delaminations, separation of plating from conductors in excess of allowable limits of IPC-6013, paragraphs 3.3.1 through 3.3.9 for class 3 high reliability parts. For lifted lands, the maximum allowable separation distance between conductor and substrate material shall not exceed 0.001 inches. Amount of lifted land shall not exceed 50% of the land area. Post exposure cross section analysis of conductors and plated through holes shall comply with IPC-6013, table 3-8 for class 3 (High Reliability) devices. Inspect conductors using 100X magnification , minimum. Transmitted and reflectedlighting shall be used. Conductor minimum width shall not be less than 80% of the conductor pattern specified in the procurement drawing. Conductors shall not contain cracks, splits or tears in the internal foil or plating. If the condition of a suspect defect cannot be identified, use of progressively higher magnification up to 200X may be used.	4(0) coupons per panel (each corner)	2(0) coupons per panel (from opposite corners)	
Thermal Stress / Coupon Analysis (Single Layer Laminated Specimens)	Perform testing as above, except plated through hole analysis N/A. Use a 2 inch by 2 inch specimen cut from each sample. In lieu of flux, Dow Corning Silicon Fluid No. 704 or equivalent may be used to coat the side that will be placed in contact with the solder	4(0) coupons per panel (each corner)	2(0) coupons per panel (from opposite corners)	

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Perform screening to Table 2A 1/	Visual/mechanical, insulation flaws test, wrap test, Crosslinking Proof test (as required in Table 2A).	O	O	O
Insulation Resistance	MIL-STD-2223 (Test Methods, Insulated Wire), Method 3003. Sample shall have 1 inch of insulation removed from each end, and the ends shall be twisted together. The test specimen shall be immersed within six inches of each end in a water bath as specified. After 4 hours immersion time, apply a potential of 500 volts between the conductor and the water bath which serves as the second electrode. Insulation resistance shall be measured after 1 minute and shall be converted to megohms per 1000 FT. Measurement shall not be less than specified value.	26 feet per lot, minimum	26 feet per lot, minimum	
Conductor Resistance	FED-STD-228 (Test Methods, Wire and Cable), Method 6021. Wire shall be tested dry without immersion. Measurements shall conform to MIL-W-22759 Table II.	Each spool	Each spool	Each spool
Conductor Splices	There shall not be more than one strand splice in any two lay lengths of a stranded concentric lay or rope lay conductor. Splices shall not increase conductor diameter at point of brazing.	Each lot 2/	Each lot 2/	
Solderability (Tin or silver coated conductors only)	MIL-STD-202, Method 208. Steam aging is not required. Conductors shall demonstrate proper solder wetting.	1 foot per spool	1 foot per lot	
Lamination Sealing Test (Tape sintered insulations)	MIL-W-81381, paragraph 4.7.4.10. Sample shall be baked at the specified temperature for 48 hours. After cooling, visually examine for delaminations of the insulation.	1 foot per spool	1 foot per lot	
Flammability 3/ (When Necessary)	MIL-W-22759, Paragraph 4.6.3.1.4. In chamber, adjust burner for a blue flame, approximately 2 inches long. Suspend test specimen at a 60o angle form horizontal. Apply flame for 15 seconds for size 30 through 18, 30 seconds for sizes 16 through 12, and 1 minute for sizes 10 through 4. The distance of flame travel upward along the specimen and the time of flaming after removal of the flame shall be recorded and shall fall within acceptable limits.	2 foot sample per lot		

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Insulation Blocking	MIL-W-22759 Paragraph 4.6.3.5. Affix one end of the sample to a metal spool with diameter 50X diameter of finished wire for size 30 through 14, 40X for size 12 and 10, and 30X for sizes 8 through 2. The wire shall be wound on the spool for at least three turns, with the turns touching each other. Affix the free end toprevent unwinding or loosening. Place in an oven and bake for 24 hours at the specified temperature. After cooling, the wire shall be unwound and examined for adhesion (blocking) between adjacent turns.	2 foot sample per lot	2 foot sample per lot	
Cold Bend	MIL-W-22759, Paragraph 4.6.3.2. Affix one end of the sample to a metal spool with diameter as specified. Place mandrel and sample inside a cold chamber. Provision shall be made to turn the mandrel by a handle or control external to the chamber. Condition for 4 hours at temperature specified. At the end of 4 hours conditioning, slowly wind the specimen on the mandrel for its entire length. Remove from the chamber, and allow to warm to room temperature. Visually examine for cracked insulation. Post dielectric test is not required.	3 foot sample per lot		
Concentricity of Finished Wire	Wire shall be cross sectioned (potted if necessary) and wall thickness measurements shall be made. For concentric-lay wires, 100 x the minimum wall thickness to maximum wall thickness shall define % concentricity. Ratio shall not be less than 70%.	1 foot sample per lot		
Elongation and Tensile strength of Finished Wire	FED-STD-228, Method 3211. For sizes 20 and larger, test shall be performed on individual strands from the conductor. For sizes 22 and smaller, tests shall be performed upon the whole conductor removed from the finished wire and elongation shall be measured when the first strand of the conductor breaks. Tensile strength shall be in accordance with the applicableconductor material specification. (EX: ASTM-B298 for silver coated normal strength conductors)	1 foot sample per lot		

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 3 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Shrinkage	Strip one inch from each end of the sample. Cut must be square and perpendicular. Measure length of exposed conductor to the nearest 0.01 inch. Bake at temperature specified for 6 hours in an air circulating oven. Remove and allow to cool to room temperature. Remeasure length of exposed conductor. Amount insulation has receded (shrink) from either end shall fall within the specified value.	14 inch sample per spool		
Evaluation for Insulation Material Outgassing Properties	Outgassing paragraph (Front of this section)			

Notes:

1 / For wire that has been previously screened per Table 2A, screening tests do not need to be repeated as part of qualification testing.

2/ The manufacturer shall certify that the splicing requirement has been met.

3/ For insulation types that have unknown flammability properties (Reference flammability paragraph in front of this section), when necessary testing shall be performed as specified or as specified in NHB 8060.1C (NASA Handbook, Flammability, Odor, and Offgassing).

4/ Test is normally a 100% screening test of the primary insulation of dual layer insulated wire and finished wire. It is usually performed by the manufacturer during winding onto spools or reels and does not need to be repeated if the manufacturer can provide data that demonstrates acceptable test results.

Table 3B QUALIFICATION REQUIREMENTS FOR COATED MAGNET WIRE (Page 1 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Perform screening to Table 2B. 1/	Visual-mechanical, adherence and flexibility, heat shock, dielectrical strength twist test as required in Table 2B.			
Scrape Resistance	ASTM-D1676, paragraphs 170 through 176. Scraping device shall provide a scraping action perpendicular to the test sample. A 0.009 inch diameter steel music wire held rigidly between two jaws, shall provide the scraping action to the wire test sample supported between two jaws. Wires shall be attached to a potential of 7.5V DC, and continuity shall be monitored when the chemical film finish is worn away. Initial amount of force in grams shall be 90% of the force specified in the detail specification. Apply increasing force until failure occurs. Scraping action shall be in one direction for 4 inches at a speed of 15 inches per minute. Perform 3 tests on each specimen by rotating each specimen on its axis to 120° and 240°. The average of the six failures shall be less than the value specified.	Two 15 inch specimens		
Thermoplastic Flow	NEMA MW-1000, para 3.50. The thermoplastic flow tester shall exert a constant load perpendicular to and down directly over the right angle crossover point of the specimen. The specimen temperature shall be monitored with a calibrated thermocouple pyrometer and compared to a chamber control thermocouple. Failure detector mechanism shall be constructed to allow a current flow of 20 milliamps at 115VAC (60Hz) between the crossed wire. Load the intersection of the two lengths per Note 2. Increase chamber temperature at 10°C per minute until 55°C below the rated thermoplastic flow temperature in the detail specification (ref Note 3). Slow the rate of increase to 5°C per minute and apply until failure is detected. Perform on all 5 specimens. The median value shall be considered the actual thermoplastic flow temperature for the specimen. The median value shall be within 10% of the rated Thermoplastic Flow temperature.	10 foot length cut into 10 one foot samples, placed at right angles to create five specimens	10 foot length cut into 10 one foot samples, placed at right angles to create five specimens	

Notes on next page.

Table 3B QUALIFICATION REQUIREMENTS FOR COATED MAGNET WIRE (Page 2 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Springback	ASTM-D1676 (Test Methods, Magnet Wire), paragraphs 154 and 155. Magnet wire is wound under mild stress on to a mandrel with diameter as listed in ASTM-D1676 table 15. The load is removed and movement of wire toward a relaxed position (springback) is measured. For best winding formability, minimal springback is desired.	Three specimens, length as required to provide 3 windings of the mandrel		
Evaluation for Insulation Coating Outgassing Properties (When Required)	Outgassing paragraph (Front of this section)	O	O	O

Notes:

1/ For wire that has previously been screened per Table 2B, screening tests do not need to be repeated as part of qualification testing. Exception: If the previous screening was performed more than two years earlier, screening to Table 2B must be performed.

2/ Thermoplastic Flow Test Loads and Flow Temperatures for preferred NEMA MW1000 magnet wire (referenced in Table 1B, note 2.):

Wire Size Ranges, (AWG)	Test Load +/-2%, Ounces (Grams)	Detail Specification	Flow Temperature
14 - 18	70.5 (2000)	MW 35-C (Heavy, Class 200)	300°C
19 - 24	35.3 (1000)	MW 30-C (Heavy, Class 180)	300°C
25 - 26	21.2 (600)	MW 16-C (Heavy, Class 240)	450°C
27 - 29	10.6 (300)		
30 - 36	8.82 (250)		
37 - 40	5.29 (150)		
41 - 44	3.53 (100)		

3/ Scrape Resistance for preferred NEMA MW 1000 detail specifications (referenced in Table 1B, note 2.)

Specification	Flow Temperature
MW 35-C (Heavy) Class 200	300°C
MW 30-C (Heavy) Class 180	300°C
MW 16-C (Heavy) Class 240	450°C

Table 3C QUALIFICATION REQUIREMENTS FOR COAXIAL CABLE (Page 1 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Perform screening to Table 2C 1/	Visual-mechanical, jacket flaws, continuity, voltage withstanding (as required by Table 2C)	O	O	O
Characteristic Impedance	MIL-C-17, Paragraph 4.8.7. Sample shall be assembled to connectors for mating to a time domain reflectometer. The impedance of the sample shall be measured and compared to a precision airline of the same characteristic impedance of the specimen.	10 ft. min. per lot	10 ft. min. per lot	
Attenuation	MIL-C-17, paragraph 4.8.8. Cable shall be terminated to SMA type connectors. Attenuation shall fall within curves for applied power and frequency.	One sample per lot length sufficient to exhibit 1db loss, min @ low frequency		
Standing-Wave Ratio (Return Loss)	MIL-C-17, paragraph 4.8.9. Cables shall be terminated to SMA type connectors loss shall fall with curves for applied frequency.	One sample per lot length as specified		
Capacitance	MIL-C-17, Paragraph 4.8.10. Measure between inner conductor and shield with shield grounded. Measure at 1 KHZ with a capacitance bridge.	1 sample per lot, 5 ft. min	1 sample per lot, 5 ft. min	
Stress Crack Resistance (Not applicable to Semi-Rigid Cable)	Clamp one end of each specimen to a mandrel having a diameter 3X the jacket diameter of the cable. Wrap each specimen for 10 turns around the mandrel and clamp to prevent unraveling. Place in an oven for 96 hrs at 230℃. After 96hours, remove and cool to room temp for 4 hours. Unwind and examine for cracks and other flaws.	Four 3 foot samples per lot		
Bendability (Semi-Rigid Only)	Form the semirigid cable for two turns around a mandrel of diameter as specified. Remove coiled specimen and examine surface for cracks, splits or wrinkles.	Two one foot specimens per lot		

Table 3C QUALIFICATION REQUIREMENTS FOR COAXIAL CABLE (Page 2 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Dimensional Stability	MIL-C-17, paragraph 4.8.20 Flexible Cable Cut ends of cable squarely and deburr. Place in air circulated oven, coiled or straight, and bake for 6 hours, minimum at 200°C or as specified. Return to room temperature for 4 hours, minimum. Measure both ends for protrusion or contraction of the center conductor. Measured values shall conform to specified values. Semi-Rigid Cable Prepare six - 6 inch samples with squared and deburred ends. Samples shall be placed in brass fixtures and capped. Fixture shall have center diameter equal to cable outer diameter (Reference MIL-C-17 Figure 11.) Bake at 125°C for one hour in an air circulated oven. Remove and cool to room temperature for at least an hour. One at a time, remove specimens and measure both ends for protrusion or contraction of the insulation within the outer conductor. Measurements shall conform to specified values.	Flexible type, one sample per lot 5-foot, minimum Semi-rigid type, one sample per lot, 4 foot minimum		
Flammability 2/ (When necessary; not applicable to Semi-Rigid Cable)	MIL-C-17, Paragraph 4.8.23. In chamber, suspend test specimen 60o from horizontal. Adjust Bunsen burner for a blue flame approximately 3 inches long. Apply flame to the midpoint of the specimen for 30 seconds. The distance of flame travel upward along the specimen and time of burning after removal of the flame shall be recorded and shall fall within acceptable limits.	One sample 2 feet long		
Evaluation for Insulation Outgassing Properties (when required)	Outgassing paragraph (Front of this section)	O	O	

Notes:

1/ For cable that has been previously screened per Table 2C, screening tests do not need to be repeated as part of qualification testing.

2/ When insulation flammability properties are unknown (Reference flammability paragraph page 1 of this section), when necessary testing shall be performed as specified or as specified in NASA-STD-6001, previously NHB 8060.1C.

Table 3D QUALIFICATION REQUIREMENTS FOR MULTICONDUCTOR CABLE (Page 1 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Perform Screening to Table 2D 1/	Visual-mechanical, jacket flaws, dielectric withstanding voltage, conductor and shield continuity.	O	O	O
Thermal Shock (PTFE, FEP, Extruded ETFE Jackets)	NEMA-WC27500 (Electrical Cable), para. 4.3.9. Wrap cablespecimens around mandrel as specified in Note 2. Wrap specimen on mandrel for at least 6 close turns and secure ends to the mandrel. Bake for 4 hours at 230 °C for FEP jacketed cable and 285 °C for PTFE or extruded ETFE jacketed cable. At completion of test, cool and visually inspect jacket for cracks without magnification.	10 foot sample	10 foot sample	
Crosslinked and Bend Verification Test (Crosslinked ETFE orCrosslinked PVF2 Jackets)	NEMA-WC27500, para. 4.3.11. Remove 1 inch of insulation from each conductor, tie ends together, load with weights, and drape specimen over mandrel as specified in Note 2. Treat mandrel with non-adhesive Teflon tape to prevent sticking. Place in oven for 6 hours at 200 °C for PVF2 jacket and 300 °C for XL-ETFE. Remove, allow to cool, and straighten. Secure one end to the mandrel and the other with load weight used above. Rotate mandrel until full length of specimen is on mandrel. Rotate in reverse direction to unwind and rewind specimen on mandrel. Unwind. Repeat mandrel winding in each direction. For shielded cable, perform DWV between shield and conductors. No cracking of the jacket or dielectric breakdown is allowed.	24 inch sample	24 inch sample	

Table 3D QUALIFICATION REQUIREMENTS FOR MULTICONDUCTOR CABLE (Page 2 of 2)

Note:

1/ For cable that has been previously screened per Table 2D, screening tests do not need to be repeated as part of qualification testing.

2/ Test mandrel diameters and weights.

Thermal Shock Test	
Finished Cable Diameter	Mandrel Diameter (Inches)
0 to 0.083	0.750
0.084 to 0.111	1.0
0.112 to 0.139	1.250
0.140 to 0.194	1.750
0.195 to 0.250	2.250
0.251 to 0.334	3.00
0.335 to 0.444	4
0.445 to 0.556	5
0.557 to 0.667	6
0.668 to 0.889	8
0.890 to 1.111	10
1.112 to 1.556	14
1.557 to 2.000	18

Crosslinked Verification Test			
Finished Cable Diameter	Mandrel Diameter (Inches)	Wire Size (AWG)	Test Load (Lbs.) (Multiply by Number of Conductors in Cable)
0 to 0.125	3	-26	.125
0.126 to 0.250	6	-24	.250
0.251 to 0.360	10	-22	.375
0.361 to 0.750	18	-20	.500
0.751 to 1.200	30	-18	.600
1.201 to 2.000	48	-16	.750
		-14	1.00
		-12	1.50

Table 3E QUALIFICATION REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES (REF IPC-6013; Page 1 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual / Mechanical Inspection 1/	Ref IPC-6013 (Flexible Printed Boards). Visually inspect surfaceat 10X magnification, min, using transmitted and reflected lighting. Inspect for excessive blisters, delamination, pinholes,conductor thinning, scratches, tool marks, contaminants and burrs.Edges shall be clean cut and free of nicks, tears and burrs. Acceptcriteria shall be as required by IPC-6013, paragraphs 3.3.1through 3.3.9, for class 3 high reliability parts. If the condition of a suspect defect cannot be identified, use of progressively highermagnification up to 40X may beused	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Continuity	IPC-6013 para 3.9.2.1or MIL-P-50884 para 4.8.6.3.2. A currentof 250mA shall be passed through each conductor of the flexcircuit. (Note 7, Table 1B)	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Insulation Resistance (IR)	IPC-TM-650 (Test Methods, Printed Boards), method 2.6.3 or MIL-STD-202, Method 302, Test Condition A (100VDC). Theflex circuit will be checked for short circuits by applying potentialbetween conductors. Measurements shall not be less than 500Megohms.	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Dielectric Withstanding Voltage (DWV)	IPC TM-650 , method 2.5.7 or MIL-STD-202, method 301. Apply 1000 VDC for 30 seconds or as otherwise specified.Apply between adjacent conductor patterns and between adjacent layers,if applicable. There shall be no flashover or breakdown betweenconductors	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	

Flexible Endurance (If applicable by application)	Flexible Endurance testing shall be performed per IPC-TM-650,method 2.4.3, or another test method tailored to the application.Number of flex cycles (sufficient to test for the application), bendradius, rate of flex and total number of flex cycles shall be asspecified in the detail specification. To determine end of life,visual inspection and electrical testing shall be performed. Cracksgreater than 20% of the conductor width and thickness arerejectable. Delaminations larger than 0.031 in any direction or that bridge more than 25% between conductors shall be considered rejectable. Electrical testing for discontinuity and short circuits shall be performed.	2(0) Finished Flexible Circuits)	1(0) Finished Flexible Circuits	

Table 3E QUALIFICATION REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES (REF IPC-6013; Page 2 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Thermal Stress / Coupon Analysis (Doublesided or Multilayer Laminated Specimens)	Perform thermal stress testing per the requirements of IPC–6013, table 4-1. In lieu of coupons, production samples may be used. Ref IPC-TM-650 Method 2.6.8, specimen shall be conditioned at 120°C to 150°C for 6 hours minimum to remove moisture. Remove, place specimen in a moisture absorption dessicator and allow to cool. Specimen shall be fluxed with Type RMA flux per MIL-T-14256 or Type ROL1 per J-STD-004 and laid on a solder bath of SN63 solder per QQ-S-571 or Sn63Pb37 per J-STD-006 maintained at 288°C +5°C for 10 seconds. Remove, allow to cool. Using transmitted and reflected lighting, at 10X magnification min, inspect for lifted lands, cracks, blistering or delaminations, separation of plating from conductors in excess of allowable limits of IPC-6013, paragraphs 3.3.1 through 3.3.9 for class 3 high reliability parts. For lifted lands, the maximum allowable separation distance between conductor and substrate material shall not exceed 0.001 inches. Amount of lifted land shall not exceed 50% of the land area. Post exposure cross section analysis of conductors and plated through holes shall comply with IPC-6013, table 3-8 for class 3 (High Reliability) devices. Inspect conductors using 100X magnification , minimum Transmitted and reflectedlighting shall be used. Conductor minimum width shall not be less than 80% of the conductor pattern specified in the procurement drawing. Conductors shall not contain cracks, splits or tears in the internal foil or plating. If the condition of a suspect defect cannot be identified, use of progressively higher magnification up to 200X may be used.	4(0) Flexible Circuits; 2(0) If flexible endurance is performed	2(0) Flexible Circuits; 1(0) If flexible endurance is performed	

Table 3E QUALIFICATION REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES

(REF IPC-6013; Page 3 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Thermal Stress / Coupon Analysis (Single Layer Laminated Specimens)	Perform testing as above, except plated through hole analysis N/A. Use a 2 inch by 2 inch specimen cut from each sample. In lieu of flux, Dow Corning Silicon Fluid No. 704 or equivalent may be used to coat the side that will be placed in contact with the solder	4(0) Flexible Circuits; 2(0) If flexible endurance is performed	2(0) Flexible Circuits; 1(0) If flexible endurance is performed	
Evaluation for Material Outgassing Properties (When Contamination Control Is Required)		O	O	O

Notes:

1/ For flexible printed circuits used as interconnecting cables, performance of screening prior to qualification is not a requirement for Table 3E.

2/ Rework and Repair are permitted as agreed upon between the user and supplier to touch up minor surface imperfections, but shall not impact performance requirements.