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REVISION A

INSTRUCTIONS FOR EEE PARTS SELECTION, SCREENING, AND QUALIFICATION

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Prepared by:
The Parts Branch
Office of Flight Assurance
Goddard Space Flight Center

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Approved by:

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1.0 PURPOSE

The purpose of this document is to establish a baseline criteria for the selection, screening and qualification of Electrical, Electronic, and Electromechanical (EEE) parts intended for use in GSFC space systems. This will assist project managers to develop effective EEE parts program requirements, based on mission reliability objectives and budget constraints, and will also assist the contractors and subcontractors in implementing those program requirements for specific projects.

2.0 REFERENCE

Referenced NASA and military specifications are contained in each of the part type sections.

3.0 DEFINITIONS

Each part category section includes the required definitions.

4.0 SCOPE

This document establishes criteria for selecting, specifying, screening, and qualifying EEE parts to three quality levels based on mission needs (see 6.0). A quality Level 1 part has the highest level of control, testing, and reliability. Levels of part reliability confidence decrease by quality level down to Level 3. Certain application specific guidelines, considered to be sound practices by the parts engineering community, are included where applicable. However, specific program management requirements are not included in this document but rather are specified in individual project plans. This document is intended solely for compliance when specified in GSFC space systems *Statements of Work* (SOWs), *Performance Assurance Requirements* (PARs) or equivalent. Hereafter, any use of the word "requirement" assumes compliance to this document is mandatory.

EEE part requirements are specified in the following sections for each Federal Stock Class (FSC):

SECTION	PART TYPE	FSC
A	Capacitors	5910
B	Connectors	5935
C	Crystal Oscillators	5955
D	Diodes and Transistors	5961
E	Fiber Optics	60GP (FSG)
F	Filters	5915

SECTION	PART TYPE	FSC
G	Fuses	5920
H	Microcircuits, Hybrid	5962
I	Microcircuits, Monolithic	5962
J	Magnetics	5950
K	Relays	5945
L	Resistors	5905
M	Thermistors	5905
N	Wire and Cable	6145

5.0 RESPONSIBILITIES

Project managers, designers, and manufacturers of GSFC space systems are responsible for implementing this document when specified (see 4.0).

6.0 INSTRUCTIONS

EEE parts shall be selected, specified, screened, and qualified in accordance with the detail requirements specified in Sections A through N for the applicable part types and quality levels. Each section contains selection, screening, and qualification tables. Footnotes are given at the end of each table. All tests shall be performed in the order shown unless otherwise indicated. Exceptions or additions to the requirements specified in any section shall be as defined in the Project requirements document. Applicable part quality levels shall be as defined by the project. As a guide to project managers, the following are typical mission characteristics applicable to each quality level:

Level 1: Parts shall be selected and processed to this level for missions requiring the lowest acceptable level of risk. These programs typically would have high visibility both within and outside of NASA, and involve multiple, interrelated objectives which may be difficult to repeat in another mission. Mission duration is generally equal to or greater than 5 years, with phase C/D lasting for 2 or more years. The mission requires complete functional or block redundancy and requires project manager approval of any single point failures situations.

Level 2: Parts shall be selected and processed to this level for missions with low to moderate level of risk balanced by cost constraints and mission objectives. Mission duration of 1-5 years with phase C/D duration of 2-3 years are typical. The mission may be multiple or single purpose, with a repeat mission possible. Functional or block redundancy for all primary objectives in desirable but single string design may be acceptable.

Level 3: Parts shall be selected and processed to this level for missions where a moderate level of risk may be acceptable, as permitted by cost constraints.

These missions are typically for a single purpose or routine mission, with repeat missions possible. Mission duration is less than 1 year, and phase C/D less than 2 years. Single string design would normally be acceptable.

6.1 SELECTION. EEE parts shall be selected in accordance with the part designation priorities listed in Table 1 of each section. The character "X" in Table 1 indicates "use as is". Table 1 also indicates when screening (Table 2) and qualification testing (Table 3) are required for each combination of level and part designation. Part designations are discussed below in terms of the available procurement methods.

(1) Military Specification/DESC Drawings. Most preferred ("use as is") parts are available to military specifications or Standard Military Drawings (SMDs), many containing at least 2 reliability levels. Table 1 lists the acceptable military levels for the three GSFC part quality levels. For example, discrete semiconductors are listed as JANS or JANTXV, monolithic microcircuits are listed as Class V and Class Q, and some ceramic capacitors are listed as S, R, P established reliability levels. Not all military specifications are acceptable for space applications. Unless specifically allowed in this document, it is the responsibility of the user to ensure that DESC drawings and other military specifications satisfy the requirements specified herein, or to perform the additionally required inspections and tests specified herein.

(2) Compliant Non-JAN. This part designation applies only to monolithic and hybrid microcircuits which are procured as compliant to Paragraph 1.2.1 of Mil-STD-883. The parts may be manufacturer's processed parts marked with "/883" or otherwise claim compliance to Paragraph 1.2.1 of Mil-STD-883, or parts procured to Standard Military Drawing (SMDs), quality Level "M".

(3) Source Control Drawings (SCDs). This designation includes parts which are procured to a user controlled specification such as an SCD. These parts are generally not available to other acceptable procurement methods for a specific part quality level as indicated in Table 1 of each section. The SCD shall include the screening and qualification requirements specified in Table 2 and 3 in addition to performance parameters, absolute maximum ratings, case outline, terminal description, and other unique requirements. The testing required by the SCD is to be performed by the manufacturer and does not have to be repeated by the user. If an acceptable government controlled specification is not available for Level 1 programs, an SCD is required.

(4) Manufacturer High Reliability. This part designation includes parts intended for high reliability applications which are procured to a manufacturer controlled test program as described in the manufacturer's catalog. They 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. The manufacturer's hi-rel program is usually based on Mil-Std-883 equivalent or EIA/JEDEC approved test methods. However it is the responsibility of the user to verify that testing meets the

requirements specified herein. If the manufacturer's program does not meet the requirements, then a SCD is required for this type of part.

(5) Commercial. For the purpose of GSFC parts programs, this part designation represents all parts which do not conform to the categories above. This category is generally divided into commercial/industrial and commercial/consumer parts. Commercial/consumer parts should be avoided in space applications. Some high reliability commercial parts, such as Automotive Quality System (AQS) parts, may be acceptable for space applications. It is the responsibility of the user to understand and document the applicable specification or test plan requirements.

6.2 SCREENING. Screening tests are intended to remove nonconforming parts, parts with random defects, or parts likely to experience infant mortality, from an otherwise acceptable lot and thus increase confidence in the reliability of the parts selected for use. Screening tests shall be performed on flight parts in accordance with the requirements of Table 2 of each applicable section. These test are in addition to tests performed by the manufacturer for each part designation. Screening tests shall be performed in the order shown unless otherwise indicated. The user is responsible for specifying device unique requirements, if any.

6.3 QUALIFICATION. 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 controlled from lot to lot. Qualification testing shall be performed in accordance with the requirements of Table 3 of each section. Qualification tests shall be performed in the order shown unless otherwise indicated. Qualification is considered destructive and samples shall be segregated from flight parts. The required sample is indicated by a quantity (accept number) or Lot Tolerance Percent Defective (LTPD). Qualification by usage history or similarity to qualified parts may be acceptable as discussed below.

(1) History. A part can be considered qualified if it has been successfully used in (a) applications identical to that proposed (heritage design) or (b) applications different than that proposed, if the application, including derating and environmental conditions, is fully documented and is more severe than the proposed application. The part must have been used 2 years minimum total operating time in orbit. The part must have been built by the same manufacturer in the same facility using the same materials and processes to an equivalent SCD. It is the responsibility of the user to have such evidence documented.

(2) Similarity. A part can be considered qualified if it is similar to a part for which qualification test data exists, and the test data (a) satisfies the requirements specified herein for the applicable part level, and (b) is available and is less than 2 years old relative to the lot date code of flight parts. In order to be considered similar, the part shall be made by the same manufacturer on the same manufacturing line, or on a line

with only minor differences, and these differences shall be documented and shown to represent no increased reliability risk.

(3) Existing Test Data. Parts can be qualified by existing test data which meets the requirements specified herein when so indicated in Table 3.

(a) Lot Specific Data indicates that flight parts have the same lot date code as the qualification samples. Lot specific data is always acceptable in place of qualification testing when it meets the requirements specified herein.

(b) Generic Data is an acceptable basis for qualification if it is less than one year old relative to the lot data code of flight parts, and is acquired and reviewed for acceptability by the user. The user shall also verify that the data is representative of flight parts: e.g., built in the same facility using identical or equivalent processes.

6.4 AUDITS AND CUSTOMER SOURCE INSPECTION (CSI)

(1) Audits. Audits are not a requirement of this document. However, for Level 1 and Level 2 parts, a site visit to assess the manufacturer's capability in satisfying the requirements specified herein is recommended for unproven manufacturers. The term "unproven" means that the user has not previously procured parts from the manufacturer, or that the manufacturer has not established a history of supplying reliable parts for space applications. The user is encouraged to consult the NASA Core Suppliers List (CSL) on the World Wide Web for technology, process, and audit information on approved suppliers, and audit/CSI requirements for "unproven" manufacturers. The address is http://arioch.gsfc.nasa.gov.

(2) Customer Source Inspection (CSI). CSI is not a requirement of this document, but is recommended for unproven parts intended for use in Level 1 and Level 2 applications, and for parts of manufacturers with a known problem history. CSI is most effectively performed at precap visual inspection and at final electrical test and data/traveler review. If CSI is used as a substitute for required data (i.e., data is reviewed at the manufacturer's facility rather then acquired by the user), then the CSI shall be fully documented in a trip report. This should summarize the data and reference manufacturer test reports by number.

6.5 PARTS CONTROL BOARDS (PCBs) When PCBs are imposed by the project PAR or implemented by the contractor (user), all parts which are not designated "use as is" in Table 1 of each part category section shall be reviewed for compliance to established criteria by the PCB. Review information shall include specifications, screening and qualification plans, supporting data, and application requirements required to determine acceptability.

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SECTION A

CAPACITORS

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TABLE 1 CAPACITOR REQUIREMENTS 1/ (Page 1 of 2)

Part Family	Capacitor Style and Type		Reference Specification	FAILURE RATE LEVEL REQUIRED 2/ Level 1	Level 2	Level 3
CERAMIC						
	CCR	Encapsulated	MIL-C-20	S 6/	R 6/	P
	CKR	Encapsulated, Feed-Thru	MIL-C-39014	3/ 6/	S 6/	R
	CKS	Encapsulated / Chip	MIL-C-123	X	X	X
	CDR	Chip	MIL-C-55681	S 6/	R 6/	P
	HVR	High Voltage	MIL-C-49467	S	R	P
	PC	Variable (Non-ER)	MIL-C-14409	3/	3/	X
	CV	Variable (Non-ER)	MIL-C-81	3/	3/	X
	CPC	Single Plate	MIL-C-49464	S	R	P
	SMPS	Stacked Chips	DESC 87106	3/	3/	3/
			SCD	4/	4/	4/
			Commercial	4/	4/	4/
TANTALUM						
	CSR	Solid	MIL-C-39003	C 5/	B	B
	CSS	Solid	MIL-C-39003	C	B	B
	CWR	Chip (Solid)	MIL-C-55365	C 5/	B	B
	CLR	Foil (Wet)	MIL-C-39006	R	P	P
			SCD	4/	4/	4/
			Commercial	4/	4/	4/
MICA						
	CMS	Fixed, High Reliability	MIL-C-87164	X	X	X
	CMR	Fixed, Established Reliability	MIL-C-39001	3/	3/	R
			SCD	4/	4/	4/
			Commercial	4/	4/	4/

Notes at end of Table 1

TABLE 1 CAPACITOR REQUIREMENTS (Page 2 of 2)

			FAILURE RATE LEVEL REQUIRED 2/		
Part Family	**Capacitor Style and Type**	**Reference Specification**	**Level 1**	**Level 2**	**Level 3**
PAPER OR PLASTIC FILM					
	CQR Foil, Hermetically Sealed	MIL-C-19978	3/	3/	R
	CHR Metallized, Hermetically Sealed, DC and AC	MIL-C-39022	3/	3/	R
	CHS Supermetallized, Hermetically Sealed, DC	MIL-C-87217	X	X	X
	CRH Metallized, Hermetically Sealed, DC, AC, or DC and AC	MIL-C-83421	S	R	R
		SCD	4/	4/	4/
		Commercial	4/	4/	4/
GLASS					
	CYR Established Reliability	MIL-C-23269	S	R	P
		SCD	4/	4/	4/
		Commercial	4/	4/	4/

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

2/ 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 "X" indicates use as is. FRLs are not applicable (N/A) for capacitors procured to SCDs or commercial capacitors.

3/ Capacitors shall meet the screening and qualification requirements of Tables 2 and 3. Any screening or qualification tests required by the procurement specification do not have to be repeated.

4/ Capacitors procured to SCDs and commercial capacitors shall meet the screening and qualification requirements of Tables 2 and 3.

5/ Surge current testing in accordance with MIL-C-39003/10 is required.

6/ For 10 volt applications or less, capacitors shall be rated for 100 volts. If 50 volt rated parts are used, capacitors shall be screened in accordance with MIL-C-123, Group B, Subgroup 2.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 1 of 3)

Inspection/Test	Test Methods, Conditions and Requirement 1/	Part Type/ Level																							
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			RFI Feed-Thru			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	1	2	3
1. a. Visual and mechanical Examination. b. Electrical Measurements	Optional for all grades. Same as step 10 and step 5.																								
2. Thermal Shock	MIL-STD-202, Method 107, Condition B, -55°C to +125°C	X	X		X	X		X	X		X	X		X	X		X	X		X	X		X	X	
3. Voltage Conditioning (Burn-In)	2 x Rated Voltage, 125°C, 160 hours	X												X						X			X		
	125°C, 96 hours		X												X						X			X	
	125°C, 48 hours			X												X						X			X
	140% rated voltage, 125°C, 48 hours				X	X	X										X	X							
	1.2 x rated AC voltage at maximum rated frequency 160 hours																			X					
	96 hours																				X				
	48 hours																					X			
	Rated voltage 85°C 48 hours							X	X	X															
	3 x rated voltage room temp., 48 hours										X	X													

Notes at end of Table 2

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 2 of 3)

Inspection/Test	Test Methods, Conditions and Requirement 1/	Part Type/ Level																							
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			RFI Feed-Thru			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	1	2	3
4. Surge Current	MIL-C-39003/10							X																	
5. High Impedance temp. and voltage ramp 2/	5 cycles, -55°C to 100°C in accordance with MIL-C-87217 4.7.4				X																				
6. Electrical measurements	As specified. 3/																								
Capacitance	MIL-STD-202, Method 305	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dissipation Factor		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DWV	MIL-STD-202, Method 301	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance 1	MIL-STD-202, Method 302	X	X	X	X	X	X				X	X		X	X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance 2	Repeat at 125°C	X			X			X			X			X			X			X			X		
DC Leakage 1	MIL-STD-202, Method 301							X	X	X															
DC Leakage 2	Repeat at 85°C							X																	
Equivalent Series Resistance								X	X																
Quality Factor																	X	X	X						
Driving Torque																	X	X							
Insertion Loss																				X	X	X			
7. Percent Defective Allowable	5%	X			X			X			X			X			X			X			X		
	10%		X			X			X			X			X			X			X			X	
	20%			X			X			X			X			X			X			X			X

Notes at end of Table 2

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 3 of 3)

Inspection/Test	Test Methods, Conditions and Requirement 1/	Part Type/ Level																							
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			RFI Feed-Thru			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	1	2	3
8. Partial Discharge 4/	MIL-C-49467 Appendix B	X	X																						
9. Seal Test (Hermetic Types Only)	MIL-STD-202, Method 112																								
Gross Leak	Condition A or B				X	X		X	X											X	X				
Fine Leak	Condition C				X			X												X					
10. Radiographic Inspection	MSFC-STD-355C	X			X			X						X			X			X			X		
11. Visual and Mechanical Examination	Dimensions, Marking, Workmanship	X	X		X	X		X	X		X	X		X	X		X	X		X	X		X	X	
12. Humidity Steady State, Low Voltage 5/	MIL-STD-202, Method 103, Condition A and MIL-C-123, Pargraph 4.6.16.1	13(0)		5(0)																			5(0)		5(0)

Notes:

1/ User should refer to the nearest equivalent military specification listed in Table 2A if required for better definition of testing requirements.

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

3/ 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.

4/ Required only for high voltage capacitors similar to those specified by MIL-C-49467. 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 high probability of failure.

5/ Required only for capacitors with applied voltage of 10 volts or less. Parts shall be tested with zero failures allowed.

Table 2A EQUIVALENT MILITARY SPECIFICATIONS

Ceramic MIL-C-123 MIL-C-39014 MIL-C-49467 Multilayer, High Voltage MIL-C-55681 Chip, Multiple Layer MIL-C-49464 Chip, Parallel Plate	**Glass** MIL-C-23269 **Mica** MIL-C-39001 MIL-C-87164
Plastic (Paper Plastic) MIL-C-55514 Nonmetal MIL-C-83421 Metallized, Hermetic MIL-C-87217 Supermetallized, Low Energy High Impedance	**Filter** MIL-C-83439 EMI Suppression MIL-F-28861 **Variable** MIL-C-14409 Piston, Tubular Trimmer
Tantalum MIL-C-39003 Solid Electrolyte MIL-C-39006 Nonsolid Electrolyte MIL-C-83500 Nonsolid Electrolyte MIL-C-55365 Chip	**Switch Mode Power Supply** DESC 87106

Table 3A CERAMIC CAPACITOR QUALIFICATION REQUIREMENTS 1/ 6/ (Page 1 of 3)

Inspection/Test 5/	Test Methods, Conditions and Requirements	Notes	Quantity (Accept Number) Level 1	2	3
Group 1 Screening to Table 2	Table 2	1/ 2/	**100%** X	**100%** X	**100%** X
Group 2 Voltage/Temperature Limits	Capacitance change over the range of temperatures and voltages specified shall not exceed limits of specification	2/	12(1) X	6(1) X	
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification	2/	X	X	
Series Resonance (When required by application)	Refer to Electronics Industry Association EIA RS-483	2/	X	X	
Group 3 Terminal Strength	MIL-STD-202, Method 211 Condition A (all leaded devices) Condition C (radial leaded and DIP devices only) Condition D (axial leaded devices only)	2/, 4/	12(0) X	6(1) X	6(0)
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition C (chips), Condition G (leaded) IR, ΔC and DF to specification	2/	X	X	

Notes at end of Table 3A

Table 3A CERAMIC CAPACITOR QUALIFICATION REQUIREMENTS 1/ 6/ (Page 2 of 3)

Inspection/Test 5/	Test Methods, Conditions and Requirements	Notes	Quantity (Accept Number) Level 1	2	3
Moisture Resistance	MIL-STD-202, Method 106 20 cycles (1st 10 cycles with Vrated applied) DWV, IR and ΔC to specification MIL-STD-202, Method 103 Condition B, No bias DWV, IR and ΔC to specification	2/	X	X (0)	 X
Group 4 Humidity, Steady State, Low Voltage (When required by application)	 MIL-STD-202, Method 103 Vtest = 1.3 ± 0.25 Vdc IR, ΔC, and DF to specification	 2/, 7/	12(0) X	6(0) X	
Group 5 Solderability Destructive Physical Analysis	 MIL-STD-202, Method 208 EIA RS-469	 2/ 2/	5(0) X X	3(0) X	
Group 6 Life (at elevated temp.) Partial Discharge (AC Corona)	 MIL-STD-202, Method 108 Ttest = maximum operating temperature Vtest = 2 x Vrated Duration: Hours IR, ΔC, and DF to specification High Voltage Types (only) MIL-C-49467 Appendix B Corona Inception Voltage to specification	8/ 2/ 2/, 3/	44(0) or 22(0) X 2000 X	44(1) or 22(1) X 1000 X	

Notes at end of Table 3A

Notes:

1/ Qualification shall consist of the tests specified in Table 3A 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 3A for Groups 3 through 7 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 3 through 7.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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 applicable to high voltage styles only.

4/ This test is not applicable to chip capacitors.

5/ Qualification tests which are performed to the nearest equivalent military specification, using grouping and sample sizes from the military specification, are acceptable if they satisfy the minimum requirements specified in Table 3A

6/ Generic 2 data is an acceptable basis for qualification for the indicated tests.

7/ Humidity steady state, low voltage test is applicable for parts being used in low voltage applications (< 10 Vdc).

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

If Qualifying:	Select:
	Risk Level 1 and 2
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
	11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating
	Risk Level 3
A single value and voltage rating	10 parts of the same value and voltage rating
A range of values in a single voltage rating	5 parts of the highest value and 5 parts of the lowest value in the range
A range of values in a range of voltage ratings	5 parts of the highest value and 5 parts of the lowest value in the highest voltage rating
	5 parts of the highest value and 5 parts of the lowest value in the lowest voltage rating

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 1 of 4)

Inspection/Test 4/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2		1/ 2/	**100%** X	**100%** X	**100%** X
Group 2 Shock (Cavity devices only)	MIL-STD-202, Method 213 Wet slugs Level 1 and 2: Cond. D (500 G's) Level 3: Cond. I (100 G's) Dry slugs Level 1, 2 and 3: Cond. I (100 G's) No intermittent contacts greater than 0.5 ms	2/, 3/	12(0) X	6(1) X	6(1) X
Vibration, High Frequency (Cavity devices only)	MIL-STD-202, Method 204 Two axes, 4 hours each axis Wet slugs Level 1 and 2: Cond. H (80 G's) Level 3: Cond. D (20 G's) Dry slugs Level 1, 2 and 3: Cond. D (20 G's) No intermittent contacts greater than 0.5 ms DCL, ΔC and DF to specification	2/, /3	X	X	X
Vibration, Random (Wet slug styles only)	MIL-STD-202, Method 214 Condition IIK for 1.5 hours in each of three mutually perpendicular directions. No intermittent contacts greater than 0.5 ms DCL, ΔC and DF to specification	2/, /3	X	X	

Notes at the end of Table 3B

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 2 of 4)

Inspection/Test 4/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	2	3
Group 3			5(0)	3(0)	
Solderability	MIL-STD-202, Method 208	2/	X	X	
Terminal Strength	MIL-STD-202, Method 211 Condition A Condition B	2/, /3	X	X	
Group 4			12(1)	6(1)	6(1)
Resistance to Solvents	MIL-STD-202, Method 215	2/	X	X	
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition C (chips), Condition G (leaded) IR, ΔC and DF to specification	2/	X	X	
Moisture Resistance	MIL-STD-202, Method 106 20 cycles (1st 10 cycles with 6 Vdc applied) DWV, IR and ΔC to specification	2/	X	X	
	MIL-STD-202, Method 103 Condition B, No bias DWV, IR and ΔC to specification				X

Notes at the end of Table 3B

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 3 of 4)

Inspection/Test 4/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 5			12(1)	6(1)	
Stability at Low and High Temperature	In accordance with MIL-C-39003 DCL, C, and DF shall be within specification at the applicable test temperature	2/	X	X	
Surge Voltage	Wet Slugs In accordance with MIL-C-39006 Dry Slugs In accordance with MIL-C-39003 Chips In accordance with MIL-C-55365	2/	X	X	
Reverse Voltage (Polarized wet slug styles only)	Vtest = Reverse voltage rating (Vdc) Ttest = 85°C Duration: Hours DCL, ΔC and DF to specification	2/	X 125	X 48	
Group 6		6/	44(0) or 22(0)	44(1) or 22(1)	
Life (at elevated temp.) (Dry slug styles only)	MIL-STD-202, Method 108 Ttest = 85°C Vtest = Vrated Duration: Hours DCL, ΔC and DF to specification	2/	X 2000	X 1000	
AC Ripple Life (Wet slug styles only)	MIL-STD-202, Method 108 Ttest = 85°C Vtest = Vrated + Rated Ripple Current at 40 kHz Duration: Hours DCL, C and DF to specification	2/	X 2000	X 1000	

Notes at end of Tabe 3B

Table 3B TANTALUM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (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 3 through 7 and subjected to the tests for their particular group. The user must subject an appropriate number of samples to screening to meet the PDA requirement and still have enough passing samples for Groups 3 through 7.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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/ Qualification tests which are performed to the nearest equivalent military specification, using grouping and sample sizes from the military specification, are acceptable if they satisfy the minimum requirements specified in Table 3B.

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

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

If Qualifying:	Select:
Risk Level 1 and 2	
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
	11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating
Risk Level 3	
A single value and voltage rating	10 parts of the same value and voltage rating
A range of values in a single voltage rating	5 parts of the highest value and 5 parts of the lowest value in the range
A range of values in a range of voltage ratings	5 parts of the highest value and 5 parts of the lowest value in the highest voltage rating
	5 parts of the highest value and 5 parts of the lowest value in the lowest voltage rating

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 1 of 3)

Inspection/Test 4/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Table 2	1/ 2/	**100%** X	**100%** X	**100%** X
Group 2 Vibration, High Frequency (Cavity devices only)	MIL-STD-202, Method 204 Level 1 and 2: Condition E (50 G's) Level 3: Condition D (20 G's) Two axes, 4 hours each axis Vtest = 0.5 x Vrated + 1.0 Vrms at 1 kHz No intermittent contacts in excess of 0.5 ms.	2/	12(0) X	6(0) X	6(0) X
Group 3 Shock (Cavity devices only)	MIL-STD-202, Method 213 Condition I Vtest = 0.5 x Vrated No intermittent contacts in excess of 0.5 ms.	2/	12(0) X	6(0) X	6(0)
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition G IR, ΔC and DF to specification	2/	X	X	
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	2/	X	X	
	MIL-STD-202, Method 103 Condition B, No bias DWV, IR and ΔC to specification				X

Notes at the end of Table 3C

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 2 of 3)

INSPECTION/TEST 4/	TEST METHODS, CONDITIONS AND REQUIREMENTS 2/	NOTES	QUANTITY (ACCEPT NUMBER) LEVEL 1	2	3
Group 4			5(0)	3(0)	
Solderability	MIL-STD-202, Method 208	2/	X	X	
Terminal Strength	MIL-STD-202, Method 211 Condition A (all leaded devices) Condition C (radial leaded devices only) Condition D (axial leaded devices only)	2/, 3/	X	X	
Resistance to Solvents	MIL-STD-202, Method 215	2/	X	X	
Group 5		6/	44(0) or 22(0)	44(1) or 22(1)	20(1) or 10(1)
Temperature Coefficient	Capacitance change over the range of temperatures specified shall not exceed limits of specification	2/	X		
Life (Accelerated)	MIL-STD-202, Method 108 Ttest = 100°C Vtest = 1.4 x Vrated Duration: Hours IR, ΔC, and DF to specification	2/	X 2000	X 1000	
Group 6			6(0)		
Vibration, Random (Hermetically sealed styles only)	MIL-STD-202, Method 214 Condition IIK for 15 minutes in each of two mutually perpendicular directions. Vtest = 1 Vrms at 1 kHz No intermittent contacts greater than 0.5 ms DCL, ΔC and DF to specification	2/, /3	X		

Notes at the end of Table 3C

Table 3C PLASTIC FILM CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (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 3 through 7 and subjected to the tests for their particular group. The user must subject an appropriate number of samples to screemomg tests to meet the PDA requirement and still have enough passing samples for Groups 3 through 7.

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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/ Qualification tests which are performed to the nearest equivalent military specification, using grouping and sample sizes from the military specification, are acceptable if they satisfy the minimum requirements specified in Table 3C.

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

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

If Qualifying:	Select:
	Risk Level 1 and 2
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
	11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating
	Risk Level 3
A single value and voltage rating	10 parts of the same value and voltage rating
A range of values in a single voltage rating	5 parts of the highest value and 5 parts of the lowest value in the range
A range of values in a range of voltage ratings	5 parts of the highest value and 5 parts of the lowest value in the highest voltage rating
	5 parts of the highest value and 5 parts of the lowest value in the lowest voltage rating

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 1 of 3)

Inspection/Test 4/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Table 2	1/ 2/	**100%** X	**100%** X	**100%** X
Group 2 Solderability	MIL-STD-202, Method 208	2/	6(0) X	3(0) X	3(0)
Vibration, High Frequency	MIL-STD-202, Method 204 Condition B (15 G'S) No intermittent contacts in excess of 0.5 ms	2/, /3	X	X	X
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.	2/, /3	X	X	
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification	2/	X		
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 and DF to specification	2/	X	X	X

Notes at the end of Table 3D

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 2 of 3)

Inspection/Test 4/	Test Methods, Conditions And Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 3			12(0)	6(1)	6(0)
Shock	MIL-STD-202, Method 213 Condition I (100 G's) No intermittent contacts in excess of 0.5 ms	2/	X	X	
Terminal Strength	MIL-STD-202, Method 211 Condition A Condition D	2/, 3/	X	X	
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition G IR, ΔC and DF to specification	2/	X	X	
Moisture Resistance	Risk Level 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	2/	X	X (0)	
	Risk Level 3: MIL-STD-202, Method 103 Condition B, No bias IR, ΔC and DF to specification				X
Group 4		6/	44(0) or 22(0)	44(1) or 22(1)	20(1) or 10(1)
Life (Accelerated condition)	Precondition parts at -55°C for 48 hours minimum. Ttest = maximum operating temperature Vtest = 1.5 x Vrated	2/	X	X	
	Duration: Hours		2000	1000	
	DWV, IR, ΔC and DF to specification				

Notes at the end of Table 3D

Table 3D MICA CAPACITOR QUALIFICATION REQUIREMENTS 1/, 5/ (Page 3 of 3)

Inspection/Test 4/	Test Methods, Conditions And Requirements 2/	Notes	Quantity (Accept Number) Level 1	2	3
Group 5 Resistance to Solvents	MIL-STD-202, Method 215	2/	5(0) X	5(0) X	

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 3 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 3 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. 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/ Qualification tests which are performed to the nearest equivalent military specification, using grouping and sample sizes from the military specification, are acceptable if they satisfy the minimum requirements specified in Table 3D.

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

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

If Qualifying:	Select:
	Risk Level 1 and 2
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
	11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating
	Risk Level 3
A single value and voltage rating	10 parts of the same value and voltage rating
A range of values in a single voltage rating	5 parts of the highest value and 5 parts of the lowest value in the range
A range of values in a range of voltage ratings	5 parts of the highest value and 5 parts of the lowest value in the highest voltage rating
	5 parts of the highest value and 5 parts of the lowest value in the lowest voltage rating

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS 1/, 4/ (Page 1 of 3)

Inspection/Test 3/	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Table 2	1/ 2/	**100%** X	**100%** X	**100%** X
Group 2 Thermal Shock	MIL-STD-202, Method 107 Condition B IR, ΔC and DF to specification	2/	12(0) X	6(1) X	
Quality Factor	MIL-STD-202, Method 306	2/	X	X	
Shock	MIL-STD-202, Method 213 Condition I (100 G's) No intermittent contacts in excess of 0.5 ms	2/	X	X	
Vibration, High Frequency	MIL-STD-202, Method 204 Condition D (20 G's) No intermittent contacts in excess of 0.5 ms	2/	X	X	
Group 3 Solderability	MIL-STD-202, Method 208	2/	12(1) X (1)	6(1) X	
Terminal Strength	MIL-STD-202, Method 211 Condition A (all leaded devices) Condition C (radial leaded devices only) Condition D (axial leaded devices only)	2/	X (0)	X	
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification	2/	X (0)	X	

Notes at the end of Table 3E

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS 1/, 4/ (Page 2 of 3)

Inspection/Test 3/	Test Methods, Conditions And Requirements 2/	Notes	Quantity (Accept Number) Risk Level 1	2	3
Group 4			12(1)	6(1)	6(0)
Resistance to Solvents	MIL-STD-202, Method 215	2/	X	X	
Resistance to Solder Heat	MIL-STD-202, Method 210 Condition G IR, ΔC and DF to specification	2/	X	X	
Moisture Resistance	MIL-STD-202, Method 106 20 cycles (1st 10 cycles with 100 Vdc applied) IR, ΔC and DF to specification	2/	X (0)	X (0)	
	MIL-STD-202, Method 103 Condition B, No bias IR, ΔC and DF to specification				X
Group 5 Life (Accelerated condition)	MIL-STD-202, Method 108 Ttest = 125°C Vtest = 1.5 x Vrated Duration = 2000 hours IR, ΔC and DF to specification	5/ 2/	44(0) or 22(0) X	44(1) or 22(0) X	

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 3 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 3 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. 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/ Qualification tests which are performed to the nearest equivalent military specification, using grouping and sample sizes from the military specification, are acceptable if they satisfy the minimum requirements specified in Table 3E.

Table 3E GLASS CAPACITOR QUALIFICATION REQUIREMENTS 1/, 4/ (Page 3 of 3)

Notes (continued):

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 selected as follows:

If Qualifying:	Select:
	Risk Level 1 and 2
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
	11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating
	Risk Level 3
A single value and voltage rating	10 parts of the same value and voltage rating
A range of values in a single voltage rating	5 parts of the highest value and 5 parts of the lowest value in the range
A range of values in a range of voltage ratings	5 parts of the highest value and 5 parts of the lowest value in the highest voltage rating
	5 parts of the highest value and 5 parts of the lowest value in the lowest voltage rating

SECTION B

CONNECTORS AND CONTACTS

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CONNECTORS AND CONTACTS

GENERAL

Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5 for general part requirements applicable to all part types. The following additional information is unique to this section.

1) Table 1 C provides detailed descriptions of available connectors and contact configurations as an aid to designers.
2) Visual and mechanical inspection is critical for connectors and Table 4 lists defect criteria for each type of connector. Detail reject criteria is given in NASA-MSFC 85M03639. Visual inspection shall verify that connectors/contacts are properly marked, free of defects and fabricated with good workmanship. Mechanical inspection shall verify that connectors or contacts satisfy design, construction and dimensional requirements, and were manufactured with the specified materials and finish.
3) Depending on the application, outgassing, atomic oxygen and ultraviolet radiation degradation, and residual magnetism may need to be considered in selecting connectors and contacts for space application. Requirements and recommendations are provided through out the section.

MATERIALS

Materials are a primary consideration in selecting connectors for space flight application and the following requirements and guidelines are provided.

(1) Base Materials for Metal Shell Connectors. For metal shell connectors, base metals shall be used which demonstrate low permeability (i.e., resist establishment of magnetism in the material). Machined aluminum alloy, corrosion resistant steel or brass are the preferred metals. For connector contacts, copper, beryllium copper or half hard brass are the preferred metals. In some applications, it may be necessary to screen connectors and contacts for specific levels of residual magnetism.

(2) Preferred Finishes for Metal Shell Connectors and Contacts. Electroless nickel plating is the preferred finish for circular, general purpose D-Subminiature, and Microminiature metal shell connectors. Gold over copper flash is the required finish for D-Subminiature connectors when residual magnetism is a consideration. Passivated stainless steel or gold is the required finish for coaxial connectors. Gold plating in accordance with MIL-C-45204, Type II, Grade C, Class 1 (50 micro inches) is the preferred finish for contacts over the entire contact, including the engagement area.

(3) Prohibited Finishes for Metal Shell Connectors and Contacts. The use of cadmium, zinc, chemically coated cadmium or zinc, or silver shall not be used as a connector or contact finish. Silver shall also not be used as an underplate, and shall not be used as a finish due to corrosion concerns when exposed to atomic oxygen in lower earth orbits.

(4) Preferred Dielectric Materials. Diallyl phthalate (DAP) molding compound, type SDG-F or type GDI-30F of MIL-M-14, and MIL-M-24519 thermoplastic type GPT-30F (polyester, glass reinforced), type GST-40F (polyphenylene sulfide, glass reinforced), or type GLCP-30F (liquid crystalline polyester thermoplastic, glass reinforced) are the required dielectric insulating materials for multicontact connectors. Diallyl phthalate is the preferred material for solder applications. PTFE Teflon is the preferred dielectric material for radio frequency connectors. Reground materials shall not be used. In general, the non-metallic materials used in connectors shall be non-combustible or self extinguishing.

OUTGASSING

Outgassing occurs at lower pressure when unreacted additives, contaminants, absorbed gasses or moisture can evaporate and 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 when tested in accordance with ASTM-E595. Acceptable materials should be selected from NASA reference publication 1124 (Outgassing Data for Selecting Spacecraft Materials) or NASA-MSFC Handbook 527 (Materials Section List for Space Hardware Systems). However, materials listed as acceptable in these references may have been baked out for evaluation and the user may have to repeat this processing. Testing shall be performed in accordance with ASTM-E595 for materials which are not traceable to the above references. Processing usually consists of a bakeout at 125°C and 10^{-6} Torr for 24 hours.

Table 1A CONNECTOR REQUIREMENTS (Page 1 of 2)

Selection Priority 1/	Level 1	Level 2	Level 3
Circular			
NASA MSFC 40M3XXXX	X	X	X
NASA SSQ 21635	X	X	X
MIL-C-38999	2/	2/	2/
MIL-C-26482	2/	2/	2/
MIL-C-5015	2/	2/	2/
SCD	2/, 3/, 4/	2/, 3/, 4/	2/, 3/
Commercial	2/, 3/, 4/	2/, 3/, 4/	2/, 3/
D Subminiature			
NASA GSFC S-311-P-4, P-10	X	X	X
MIL-C-24308	5/, 3/	5/,3/	X
SCD	3/, 4/	3/, 4/	N/A
Commercial	3/, 4/	3/, 4/	3/
Microminiature			
MIL-C-83513	3/	3/	X
SCD	3/, 4/	3/, 4/	N/A
Commercial	3/, 4/	3/, 4/	3/
Printed Circuit			
MIL-C-55302	3/	3/	X
SCD	3/, 4/	3/, 4/	N/A
Commercial	3/, 4/	3/, 4/	3/
Coaxial			
MIL-C-39012	2/, 3/	2/	X
MIL-C-83517	2/, 3/	2/	X
SCD	2/, 3/, 4/	3/, 4/	N/A
Commercial	2/, 3/, 4/	3/, 4/	2/, 3/
EMI Filter Contact			
NASA-GSFC S-311-P-626	X	X	X
SCD	2/, 3/, 4/	2/, 3/, 4/	N/A
Commercial	2/, 3/, 4/	2/, 3/, 4/	2/, 3/

Notes at end of Table 1A

Table 1A CONNECTOR REQUIREMENTS (Page 2 of 2)

Selection Priority 1/	Level 1	Level 2	Level 3
Plug-In Sockets			
MIL-C-83734	3/	3/	X
MIL-C-83502	3/	3/	X
MIL-PRF-12883	3/	3/	X
SCD	3/, 4/	3/, 4/	N/A
Commercial	3/, 4/	3/, 4/	4/
Interface			
NASA GSFC-S-311-P-718	X	X	X
NASA SSQ 21637	X	X	X

Notes:

1/ For a detailed description of available connector and contact configurations, refer to Table 1C.

2/ Circular connectors do not satisfy outgassing requirements of 1% TML and 0.1% CVCM. Other connector types may not meet outgassing requirements depending on configuration. Processing for outgassing control in accordance with Table 2A may be required.

3/ Screening to Table 2 is required.

4/ Qualification in accordance with Table 3 is required.

5/ Nickel plated connectors are considered susceptible to magnetism. Gold plated connectors are not guaranteed to have low residual magnetism (<200 gamma).

6/ Direct solder attachment of devices with DIP, SIP or small round patterns is preferred over use of plug-in sockets.

Table 1B CONNECTOR CONTACT REQUIREMENTS (Page 1 of 2)

Selection Priority 1/	Level 1	Level 2	Level 3
Signal/Power/PC Socket Contacts			
NASA-MSFC 40M39569 NB Types	X	X	X
NASA-MSFC 40M38277 NLS Types	X	X	X
NASA-GSFC S-311-P-4/10 G10PI & G10S1 (Size 20)	X	X	X
NASA-GSFC S-311-P-4/08 G08PI & G10S1 (Size 22D)	X	X	X
NASA-GSFC S-311-P-718/2 GPXXX Types	X	X	X
NASA-SSQ 21635 NZGC-C-XX-PB & - SB	X	X	X
NASA-SSQ 21637 NU-C-XX-P&S	X	X	X
MIL-C-39029 M39029/XX-XXX	1/	1/	1/
MIL-C-55302/65 M55302/65-01 &-02	1/	1/	1/
MIL-S-83505 M83505/X-XXX Types	X	X	X
SCD	4/, 5/	4/, 5/	N/A
Commercial	4/, 5/	4/, 5/	4/

Notes at end of Table 1B

Table 1B CONNECTOR CONTACT REQUIREMENTS (Page 2 of 2)

Selection Priority 1/	Risk Level (X = Use As Is)		
	1	2	3
Coaxial			
NASA-GSFC S-311-P-4/06 GCXX Type 2/	X	X	X
NASA-GSFC S-311-P-718/2 GCXXX, GTXXX, GDXXX	X	X	X
SCD	4/, 5/	4/, 5/	N/A
Commercial	4/, 5/	4/, 5/	4/
High Voltage			
NASA-GSFC-S-311-P-4/06 GHXX Type 3/	X	X	X
	1/	1/	X
SCD	4/, 5/	4/, 5/	N/A
Commercial	4/, 5/	4/, 5/	4/

NOTES:

1/ Contact marking may not satisfy outgassing requirements of 1% TML and 0.1% CVCM. Otherwise, these contacts are acceptable. When application requires special processing for outgassing control, color bands shall be omitted from the contacts or low outgassing epoxy inks shall be used. For marking requirements, consult reference specification, SCD or manufacturer's drawing/catalog information as necessary. For coaxial and high voltage contacts, insulator material shall meet 1% TML and 0.1% CVCM requirements when tested in accordance with ASTM-E595.

2/ These coaxial contacts have a 50 ohm impedance and are recommended for frequencies below 1MHz.

3/ These high voltage contacts are rated 2800VRMS at sea level.

4/ Screening to Table 2H is required.

5/ Qualification to the requirements of Table 3H is required.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS (Page 1 of 4)

Connector Type	Description
D Subminiature Connectors	
GSFC	
S-311-P-4/07, 311P407 Types	Polarized Shell, D-Type High Density, Size 22D Crimp Contacts, Fixed Mount, Non-Magnetic, Gold Finish.
S-311-P-4/09, 311P409 Types	Polarized Shell, D-Type Normal Density Size 20 Crimp Contacts, Fixed Mount, Non-Magnetic, Gold Finish
S-311-P4/05, 311P05 Types	Polarized Shell, D-Type Combination Insert, Size 20 Crimp Contacts and Size 8 Cavities (For Coaxial and High Voltage Contacts), Fixed Mount, Non-Magnetic, Gold Finish
S-311-P-10/01, 311P10 Types	Polarized Shell, D-Type, Normal Density Solder Contacts and Combination Insert Size 20 Solder Contacts with Size 8 Cavities, For Coaxial and High Voltage Contacts, Fixed Mount Non-Magnetic, Gold Finish
S-311-P-10/02, 311P1002 Types	Polarized Shell, D-Type, Normal Density, Size 20 Contacts, Straight and Right Angle Printed Circuit Terminations
S-311-P-10/03, 311P1003 Types	Polarized Shell, D-Type, High Density, size 22D Contacts, Straight and Right Angle Printed Circuit Terminations
Military	
MIL-C-24308/2 and 4	Polarized Shell, D-Type, Receptacles and Plugs, Crimp Contacts, Standard and High Density, Fixed and Float Mount Types, Nickel Finish
MIL-C-24308/1 and /3	Polarized Shell, D-Type Receptacles and Plugs, Solder Contacts, Standard Density, Fixed Mount, Nickel Finish
MIL-C-24308/6 and /8	Polarized Shell, D-Type Receptacles and Plugs, Crimp Contacts, Standard and High Density, Fixed and Float Mount Types, Gold Finish, Brass Shell
MIL-C-24308/5 and 7	Polarized Shell, D-Type Receptacles and Plugs, Solder Contact, Standard Density, Fixed Mount, Gold Finish, Brass Shell
Microminiature Connectors	
Military	
MIL-C-83513/1 and /2, M83513/01 and /02 Types	Plugs and Receptacles, Solder Contacts, Metal Shell, Nickel Finish
MIL-C-83513/3 and /4, M83513/03 and /04 Types	Plugs and Receptacles, Pre-Wired Crimp Contacts, Metal Shell, Nickel Finish
MIL-C-83513/8 and /7, M83513/06 and /07 Types	Plugs and Receptacles, Solder Contacts, Plastic Shell
MIL-C-83513/8 and /9, M83513/08 and 09 Types	Plugs and Receptacles, Pre-Wired Crimp Contacts, Plastic Shell
MIL-C-83513/10 thru /21, M83513/10 thru /21 Types	Plugs and Receptacles, Right Angle PCB Solder Tail Contacts, Narrow and Standard Profile, Metal Shell, Nickel Finish
M83513/22 thru /27, M83513/22 thru /27 Types	Plugs and Receptacles, Straight PCB Solder Tail contacts, Metal Shell, Nickel Finish

Notes at end of Table 1C

Table 1C CONNECTOR DESCRIPTIONS (Page 2 of 4)

	Description
Circular Connectors 1/	
NASA-MSFC	
40M38277, NLS Type	Circular, High Density, Low Silhouette
40M39569, NB Type	Circular, High Density
40M38298, NBS Type	Circular, High Density
40M39580, ZG Type	Circular, Lever Actuated, Zero Gravity
NASA-SPACE STATION	
SSQ 21635, NZGL Type	Circular, Lever Actuated, Zero Gravity
SSQ21635, NATC Type	Circular, Three Way Threaded Ratchet Coupling
Military	
MIL-C-38999 Series I, MS27XXX Types	Miniature, High Density, Scoop-Proof, Bayonet Coupling
MIL-C-38999 Series II, MS27XXX Types	Miniature, High Density, Low Silhouette, Bayonet Coupling
MIL-C-38999 Series III, D38999/XX Types	Miniature, High Density, Scoop-proof, Three Way Threaded Ratchet coupling (metric)
MIL-C-38999 Series IV, D38999/XX Types	Miniature, High Density, Scoop-proof, Breech coupling (metric)
MIL-C-26482 Series 2, MS 347X Types	Miniature, Quick Disconnect, Bayonet Coupling
MIL-C-5015, MS345X Types	Threaded Coupling, Crimp Rear-Release Contacts (Use is limited to inserts with #8 and larger contacts only)
Printed Circuit Connectors	
Military	
10 Thru 70 Contacts on 0.1 Inch Spacing	
MIL-C-55302/55	Plug, Socket Contacts, Straight
MIL-C-55302/56	Receptacle, Pin Contacts, Straight
MIL-C-55302/57 and /61	Plug, Pin Contacts, Right Angle
MIL-C-55302.58 and /62	Receptacle, Socket Contacts, Straight
MIL-C-55302/63	Plug, Pin Contacts, Straight
MIL-C-55302/64	Receptacle, Socket Contacts, Straight
MIL-C-55302/65 and /66	Receptacle, Straight, Crimp Removable Socket Contacts
90, 100, 120 and 160 Cont. on .1 Inch Spacing	
MIL-C-55302/59 and /138	Plug, Pin Contacts, Right Angle
MIL-C-55302/60 and /139	Receptacle, Socket Contacts, Straight
100, 122 & 152 contacts on 0.075 Inch Spacing	
MIL-C-55302/190 and /192	Receptacle, Socket Contacts, Straight
MIL-C-55302/191 and /193	Plug, Pin Contacts, Right Angle

Notes at end of Table 1C

Table 1C CONNECTOR DESCRIPTIONS (Page 3 of 4)

SMA Series Coaxial 1/ 2/	
Military MIL- C-39012	
MIL-C-39012/55 and /56	Plug, Pin Contact, Cable Mount, Straight and Right Angle
MIL-C-39012/57	Receptacle, Socket Contact, Cable Mount
MIL-C-39012/58 and /59	Receptacle, Socket Contact, 4 Hole Flange Mount and D-Hole Jam Nut Mount
MIL-C-39012/60	Receptacle, Socket Contact, Solder Cup, 2 Hole or 4 Hole Rear Flange Mount
MIL-C-39012/61	Receptacle, Socket Contact, Solder Cup, D-Hole Front and Rear Jam Nut Mount
MIL-C-39012/62	Receptacle, Socket Contact, Hermetic Seal, Solder Lug, D-Hole Front and Rear Jam Nut Mount
MIL-C-39012/79 and /80	Plug, Pin Contact, Cable Mount, for Semi-Rigid Cable, Straight and Right Angle
MIL-C-39012/81	Receptacle, Socket Contact, Cable Mount, for Semi-Rigid Cable
MIL-C-39012/82	Receptacle, Socket Contact, 2 Hole or 4 Hole Flange Mount, for Semi-Rigid Cable
MIL-C-39012/83	Receptacle, Socket Contact, D-Hole Rear Jam Nut Mount, for Semi-Rigid Cable
MIL-C-39012/93 and /94	Receptacle, Socket Contact, Printed Circuit Mount, Straight and Right Angle
SMA Series Transmission Line	
Military MIL-C-83517	
MIL-C-83517/1, /3 and /4	Receptacle, Socket Contact, 2 Hole and 4 Hole Flange Mount, Solder Tab
MIL-C-83517/2	Plug, Pin Contact, 2 Hole and 4 Hole Flange Mount, Solder Tab
MIL-C-83517/5	Plug, Pin Contact, 4 Hole Flange Mount, Solder Tab
Satellite Interface Connectors	
NASA - GSFC	
S-311-P-718/1, 700-42-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, Low Outgassing, Size 1
S-311-P-718/3, 700-42/3-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Size 1
S-311-P-718/5, 700/42/5-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Size 2
S-311-P-718/6, 700-42-6-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Size 3
NASA - SPACE STATION	
NU-X-X-OOX-OOX-X	Umbilical Interface, Rectangular, Low Outgassing, Shell Sizes 1 through 3

Notes at end of Table 1C

Table 1C CONNECTOR DESCRIPTIONS (Page 4 of 4)

Connector Type	Description
Filter Connectors	
NASA - GSFC	
S-311-P-626/01	EMI Contact, Non-Magnetic, D-Subminiature
Connector Contacts	
Military	
MIL-C-39029, M39029/XX-XXX Types	Pins and Sockets, Crimp Removable, Gold Plated
MIL-C-55302/65, M55302/65-01 and 02	Socket Contacts, Standard or Low Insertion Force for MIL-C-55302/65 and /66 PC Connectors
MIL-S-83505, M83505/X-XXX Types	Sockets, Printed Circuit
NASA - GSFC	
S-311-P-4/10, G10P1 & G10S1 Types	D-Type, Pins and Sockets, Crimp Removable, Gold Plated, Non-Magnetic, Size 20
S-311-P-4/08, G10P1 & G08S1 Types	D-Type, Pins and Sockets, Crimp Removable, Gold Plated, Non-Magnetic, Size 22
S-311-P-4/06, GCXXX and GHXXX Types	D-Type, Pins and Sockets, Coaxial and High Voltage (Solder), Size 8
S-311-P-718/2, GXXX Type	Contacts, Power, Coaxial, Triaxial or Databus, Pins and Sockets, for Umbilical interface Connectors
NASA - SPACE STATION	
SSQ 21635, NZGC-X-XX-XX Types	Pins and Sockets, Crimp and Printed Circuit Tail
SSQ 21637 NUC-C-XX-X Types	Pins and Sockets, Crimp, for umbilical interface
Connector Accessories	
Military	
MIL-C-85049, M85049/XX Types	Backshells, with and without Strain Relief, Straight, 45° and 90°, EMI/RFI Shield Terminating and Non-Shield Terminating, for Circular Connectors and D Subminiature Connectors.
NASA-GSFC	
S-311-P-718/4, GXX Type	Backshells, for umbilical interface connectors.
NASA-Spacestation	
SSQ 21637, NUA-X-OOX Type	Backshells, for umbilical interface connectors.

Notes:

1/ NASA - MSFC connectors are specially processed for outgassing control. Military connectors require additional processing for outgassing control.

2/ The use of SMA connectors with captivated center contacts and safety wire holes is recommended for RF applications.

3/ For radio frequency applications, the use of TNC and N series connectors is discouraged due to atomic oxygen corrosion concerns of the silver plating when used in lower earth orbits.

Table 2A SCREENING REQUIREMENTS FOR CIRCULAR CONNECTORS

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10 % (0) Min of 3 (0)
Mechanical 13/	Table 4	2 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 13/	MIL-STD-1344, Method 3001, room temperature and atmosphere. Magnitude per specified service rating. When no value is specified, a voltage of 500V RMS shall be used. Duration shall be 2 seconds, minimum. Connectors shall be wired and unmated. Simulated contacts and special techniques may be used. Leakage current 2 milliamps, maximum. Six readings, minimum, shall be taken. No evidence of flashover.	2 (0) 2 seconds, minimum, 50% of contacts, minimum of 2	2 (0) 2 seconds, minimum, 50% of contacts, minimum of 2	
Insulation Resistance (Room Temperature) 1/ 13/	MIL-STD-1344, Method 3003, Test Condition B, room temperature, wired, and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, minimum.	2 (0)	2 (0)	
Processing for Outgassing Control (When Required by application)	Notes 2, 3 and Outgassing, page 2.	100%	100%	100%
Contact Engagement and Separation Force (In-Process inspection prior to assembly for Nonremovable solder socket contacts only)	MIL-STD-1344, Method 2014. MS3197, test pin shall be inserted to .7L. Measured forces shall comply with MIL-C-39029, Table IX.	2 (0) Three contacts per connector, minimum		
Hermeticity (Air Leakage) (Sealed Receptacles Only) 13/	MIL-STD-1344, Method 1008, Pressure differential across the connector shall be 1 atmosphere (14.7 PSI). Leakage shall not exceed $1x10^{-7}$ ATM CM^3/Sec or as otherwise specified.	100%	100%	
Contact Retention (Push Test) (Crimp Removable Contacts Only)	MIL-STD-1344, Method 2007, with an applied load of 6 lbs size 22D, 7 lbs size 20, 10 lbs size 16 & larger, axial displacement shall not exceed value in reference specification. A push test tool may be used.	2 (0) 50% of contacts, minimum of 2		

Notes at end of Table 2H

Table 2B SCREENING REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS (REF MIL-C-24308, S-311-P-4, S-311-P-10) (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% (0) Min of 3 (0)
Mechanical 13/	Table 4	2 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 13/	MIL-STD-1344, Method 3001, Condition I. Connectors shall be unmated. Apply potential per Tables 3 and 4 of MIL-C-24308 for 10 seconds, minimum.	2 (0)	2 (0)	
Insulation Resistance (Room Temperature) 1/ 13/	At ambient temperature, test per MIL-STD-1344, Method 3003, test condition B. Measure between 50% of adjacent pairs (4 min) and between 50% of contacts adjacent to shell and shell (6 min). Measurements shall be 5000 megohms min, unconditioned.	2 (0)		
Residual Magnetism (Non-magnetic Connectors Only)	Notes 4, 5, 10.	100%	100%	
Mating and Unmating Force	MIL-STD-1344, Method 2013. Crimp connectors require contacts to be inserted. Force shall comply with MIL-C-24308, Table II.	2 (0)	2 (0)	
Processing for Outgassing Control (Low Outgassing Applications)	Notes 3 & 7 and Outgassing, page 2	100%	100%	100%
Contact Engagement and Separation Forces 13/ (Nonremovable Solder Socket Contacts)	MIL-STD-1344, Method 2014. Insert and remove max dia MS3197 gage pin. Insert min dia gage pin; measure separation during removal of min gage pin. Insert and separate max dia gage pin three times. During third cycle, measure engagement force. All measurements shall comply with MIL-C-39029, Table IX.	2 (0) 20% of contacts, Four Min		

Notes at end of Table 2H

Table 2B SCREENING REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS (REF MIL-C-24308, S-311-P-4, S-311-P-10) (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Contact Retention (Push Test) (Crimp Removable Contacts)	MIL-STD-1344, Method 2007. With an applied force of 6 lbs for size 22D and 7 lbs for size 20 contacts, apply force in each direction along contact axis. Contact displacement shall not exceed 0.012 inch. A push test tool may be used.	2 (0) 20% of contacts, Four Min		
Solderability & Resistance to Soldering Heat (PC and Solder Contacts)	MIL-C-24308, paragraph 4.7.26. Test 20%, min of 7. Solder Cup contacts or PC terminations shall be soldered with a pencil type iron heated to 360°C using SN63 solder per QQ-S-571 for a min duration of four seconds. Flux with TYPE R or RMA per MIL-T-14256. There shall be no evidence of damage or distortion. Solder shall demonstrate proper wetting and adhesion to all surfaces of the soldercup or PC Termination.	2 (0)		

Notes at end of Table 2H

Table 2C SCREENING REQUIREMENTS FOR MICROMINIATURE CONNECTORS (REF MIL-C-83513)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% (0) Min of 3(0)
Mechanical 13/	Table 4	2 (0)	2(0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 14/)	MIL-STD-1344, Method 3001, Condition I, mated or unmated. Apply for 10 seconds min. Test potential shall be 600V RMS (Sea Level) or as otherwise specified.	100%	2(0)	
Insulation Resistance (Room Temperature) 1/ 13/	MIL-STD-1344, Method 3003, test condition B, connectors mated. Measure between 50% (four min) of adjacent pairs and between 50% (six min) of contacts adjacent to shell and shell. Measurements shall be 5000 megohms min, unconditioned.	2 (0)		
Low Signal Level Contact Resistance) 13/ 15/	MIL-STD-1344, Method 3002. Measured Contact Resistances shall be in accordance with MIL-C-83513, Table VI. Environmental conditioning is not required.	100%	100%	
Mating and Unmating Force 13/	MIL-STD-1344, Method 2013. Force shall not exceed 10 oz times the number of contacts. Mated dimension shall comply with MIL-C-83513, figure 1.	2 (0)		
Contact Retention/Wire Retention (Prewired Crimp Contacts)	MIL-STD-1344, Method 2007. Apply 3 lbs to individual wire pigtails for 6 seconds, min. Load shall not displace contact or pull the wire from the crimp contact.	2 (0) 20% of Contacts, 7 min		
Solderability & Resistance to Soldering Heat (Soldercup Contact or PC Contacts)	MIL-C-83513, paragraph 4.7.11. Solder using a pencil type iron heated to 360°C for 4 seconds per contact. There shall be no damage or distortion. Compact floating conditions if applicable, shall be maintained.	2 (0) 20% of Contacts, 7 min		
Processing for Outgassing Control (when required)	Notes 3, 6, 11 and Outgassing, page 2.	100%	100%	100%

Notes at end of Table 2H

Table 2D SCREENING REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS (REF MIL-C-55302)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% (0) Min of 3 (0)
Mechanical 13/	Table 4	2 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 13/ 16/	MIL-STD-1344, Method 3001, mated, may be board mounted. Apply voltage for 60 seconds between closest contacts and between contacts and hardware (guidepins, jackscrews, jackposts, etc.)	Note 16/	2 (0) All Contacts	
Insulation Resistance (Room Temperature) 1/ 13/	MIL-STD-1344, Method 3003, mated and may be board mounted. Apply pin to pin and pin to hardware of plug. Measurement shall not be less than 5000 megohms.	2 (0)		
Contact Engagement and Separation Forces (In process inpection for Socket Contacts) 13/	MIL-STD-1344, Method 2014. Insert MS3197 test pin to a depth of .140 ± .02 inch. Max engagement force shall be 12 oz. per contact (size 22 contacts) for standard force contacts and 4 oz. per contact for low insertion force contacts. Min separation force is 0.5 oz. per contact (each type).	2 (0) 20% of Contacts, 3 min		
Mating and Unmating Force 13/	MIL-C-55302, paragraph 4.7.4. Precondition with 3 cycles. For size 22 standard force contacts, max mating force shall be .56X no. of contacts and min withdrawal force .08X no. of contacts. For low insertion force contacts, max. mating force shall be .25X no of contacts min, and withdrawal force shall be .04X no. of contacts.	2 (0)		
Solderability & Resistance to Solder Heat	PC Type Contacts - MIL-STD-202, Method 210, Test Cond C Solder Cup Contacts - MIL-C-55302, paragraph 4.7.17, four second duration. Perform post solder visual exam at 10X magnification. There shall be no evidence of damage or distortion. Contact floating conditions, if applicable, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup or PC terminations.	2 (0)		
Low Signal Level Contact Resistance 13/ 15/	MIL-STD-1344, Method 3002. Measured Contact Resistances shall be in accordance with MIL-C-55302, Table II, unless otherwise specified. Environmental conditioning is not required.	100%	100%	

Notes at end of Table 2H

Table 2E SCREENING REQUIREMENTS FOR RADIO FREQUENCY CONNECTORS (REF MIL-PRF-39012 and MIL-C-83517)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% 3 (0) Min.
Mechanical 13/	Table 4	2 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 13/	MIL-STD-202, Method 301. SMA Type Apply 500 VRMS, 750 VRMS, or 1000 VRMS per cable size in reference specification.	2 (0)		
Insulation Resistance (Room Temperature) 1/ 13/	MIL-STD-202, Method 302, Test Condition B, between center contact and body. Measurements shall be 5000 megohms, min.	2 (0)		
Force to Engage and Disengage 13/	MIL-PRF-39012, paragraph 4.7.2, 2 inch-lbs torque, max for SMA types.	2 (0)		
Coupling Proof Torque (Plugs Only) 13/	MIL-PRF-39012, paragraph 4.7.3, 15 inch lbs torque, min, for SMA types.	2 (0)		
Hermetic Seal (Pressurized Connectors Only) 13/	MIL-STD-202, Method 112, Test Condition C, Procedure I. Leak rate shall not exceed 10^{-8} ATM CM^3/Sec or as otherwise specified.	100%	100%	
Processing for Outgassing Control (Low Outgassing Applications)	Notes 3, 12 and Outgassing, page 2.	100%	100%	100%
Center Contact Retention (Captivated Center Contact Types Only)	MIL-PRF-39012, paragraph 4.7.9. Apply 6 lbs axial force, min, in each direction along axis.	2 (0)	2 (0)	

Notes at end of Table 2H

Table 2F SCREENING REQUIREMENTS FOR MULTI-CONTRACT PLUG-IN SOCKETS, STRIPS AND TERMINALS (REF MIL-PRF-12883, MIL-S-83734, MIL-S-83502, MIL-T-55155) 18/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% Min of 3 (0)
Mechanical 13/	Table 4	2 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level) 1/ 13/	MIL-STD-1344, Method 3003. Wire all odd numbered contacts together and all even numbered contacts together. Apply voltage between the odd & even numbered contacts, and between even/odd contacts and other metallic parts, if applicable. Applied voltage shall be 600V RMS or as otherwise specified. Apply for 60 seconds. Compression mounted terminals shall be securely mounted in a test fixture as specified.	2 (0)	2 (0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003. Sockets and terminals shall be wired as in DWV test above.	2 (0)		
Insertion and withdrawal force (Plug-In Sockets & Strips) 13/	Test gauge shall be used and shall be as specified. After three insertions and withdrawals of the test gage (or as otherwise specified), insertion and withdrawal force shall be measured, and shall fall within specified values. 20% of contact positions shall be tested (3 Minimum).	2 (0)		
Processing for outgassing control (Low Outgassing Applications)	Note 3 and paragraph 6 under “Materials”	100%	100%	100%

Notes at end of Table 2H

Table 2G SCREENING REQUIREMENTS FOR EMI/RFI FILTER CONTACT CONNECTORS (REF NASA-GSFC S-311-P-626)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4 (See Circulars or DSUBS)	100%	100%	10% Min of 3 (0)
Mechanical	Table 4 (See Circular or DSUBS)	100%	2 (0)	
Voltage Conditioning	MIL-STD-202, Method 108. Perform conditioning at connector maximum temperature rating. Test duration shall be 168 hours minimum at 2X rated DC voltage. Test circuit shall be used which applies positive voltage to the contact pin. Maximum series resistance shall be 5 OHMS. A fuse with a maximum rating of 0.25 amps shall be used between the shell and ground. Upon completion of voltage conditioning and while at 125°C, measure insulation resistance.	100%	100%	100%
Dielectric Withstanding Voltage	MIL-STD-1344, Method 3003. Apply 2X rated DC voltage for 5 to 10 seconds between each contact and the shell. Charging current shall be limited to 20 milliamps.	100%	100%	2 (0)
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, Test Condition A. Apply 100V DC or rated DC Voltage, whichever is less, for 2 minutes, Max. Measure between contact & Shell.	100%		
Capacitance & Dissipation Factor	MIL-STD-202, Method 305. Measure at room temperature. Test frequency shall be 1000HZ or as otherwise specified. The AC component shall be between 0.1 to 1.0V RMS.	100%	100%	2 (0)
Attenuation	MIL-STD-220. Perform test at room temperature.	100%		
Processing for Outgassing Control (Low Outgassing Applications)	See Outgassing, page 2. (Note: High temperature exposure during voltage conditioning is sufficient to meet requirements.)	100%	100%	100%

Table 2H SCREENING REQUIREMENTS FOR CONNECTOR CONTACTS AND PRINTED CIRCUIT SOCKET CONTACTS (REF MIL-C-39029, MIL-C-55302/65, MIL-S-83505, GSFC S-311-P-4/06, /08, /10, GSFC S-311-P-718/2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual 13/	Table 4	100%	100%	10% (0) Min of 8 (0)
Mechanical 13/	Table 4	8 (0)	2 (0)	
Contact Engagement Force (Sockets Only) 13/	MIL-STD-1344, Method 2014. Contact engaged to a depth of 0.7L. Force shall comply with MIL-C-39029, table IX.	ASQC ZF- 4 AQL Level S-3	8 (0)	
Contact Separation Force (Sockets Only) 13/	(Same as above)	100%	8 (0)	
Plating Thickness 13/; (N/A PC Sockets)	MIL-G-45204, paragraph 4.5.1. See Notes 8 & 9 at end of table and note 2 under materials, page 1.	8 (0)		
Crimpability (N/A PC Sockets) 13/ 17/	Contact samples shall be prepared for the largest and smallest recommended contact conductor accommodations referenced in MIL-C-39029 table III for a total no. of samples as shown for each risk level, and shall be subjected to a visual inspection for cracks or other damage. Samples shall then be subjected to the crimp tensile strength test (pull test) per MIL-STD-1344, Method 2003. An axial load is applied to pull the wire out of the crimp or break the wire. Applied pull force shall be per MIL-C-39029 Table X.	6 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level, Coaxial Contacts)	MIL-STD-1344, method 3001, Size 8, 1000 VRMS.	3 (0)		
Residual Magnetism (Nomagnetic contacts only) 4/ 5/ 10/	GSFC S-311-P-4/08 and /10 paragraph 3.4.1. Group contacts together. Measured value for the group shall not exceed a gamma level of 0.1X the no. of contacts in the group.	100%	100%	
Processing for Outgassing Control (Low Outgassing Applications)	Outgassing, page 2	100%	100%	100%

NOTES:

1. For Level 1 programs, dielectric withstanding voltage and insulation resistance tests shall be performed on each lot of flight connectors. These tests are normally performed on a sample basis. For critical applications, a 100% inspection is recommended. All NASA MSFC connectors and military MIL-C-38999 connectors meet this requirement without additional testing. For solder type connectors, test adapters or special test jigs may be required. For this reason, the use of manufacturer's test facilities is recommended in lieu of user's facilities.
2. Additional processing for outgassing control is available from some military QPL manufacturers. Processing may also be performed in house by replacing normal lubricant with low outgassing lubricant followed by a bakeout. A selection list of low outgassing lubricants and greases is found in NASA reference publication 1124, sections 8 and 13 or NASA-MSFC Handbook 527. It should by noted that removal and replacement of lubricant requires some disassembly of the connectors and is usually labor intensive. For this reason, connectors should be procured by an approved control drawing which requires connectors to be specially processed by the manufacturer.
3. A bakeout for outgassing control may be performed by the user if necessary. A suggested bakeout time and temperature is 24 hours at 125°C and full or partial vacuum. Other variations of reduced time and increased vacuum may be used upon approval. Consult NASA reference publication 1124 for cure times and temperatures of various materials.
4. Some MIL-C-24308 QPL suppliers offer special commercial connectors constructed with nonmagnetic materials. GSFC specifications S-311-P-4 and S-311-P-10 should be used as the first choice.
5. Performance of residual magnetism screening test requires the use of specialized test equipment and should be performed at the manufacturer's facilities. There are four industry accepted levels of residual magnetism: 20,000 Gamma, 2,000 Gamma, 200 Gamma and 20 Gamma. When parts are procured, whether by GSFC part number or user SCD part number, each connector with residual magnetism levels of 20 Gamma must be tested for specific levels of residual magnetism. The test procedure in GSFC S-311-P-4 Paragraph 4.5.4 or S-311-P-10 Paragraph 4.5.5 shall apply.
6. Certain MIL-C-83513 connector plugs contain an epoxy filler or potting material which must be traceable to acceptable outgassing test results.
7. Some commercial versions of GSFC 311 type D-Subconnectors contain a rear silicone rubber sealing grommet behind the connector which provides wire support and seals the rear of the connector. The silicone rubber and bonding agent represent an outgassing concern, and additional processing is recommended for outgassing control.
8. For military contacts, MIL-C-39029 requires a minimum plating thickness of 50 microinches per MIL-C-45204. This is required for Level 1 and 2 programs and preferred for Level 3 programs.
9. Plating thickness shall be measured using any of the three methods described in MIL-C-45204. Due to the specialized test equipment required to perform this test, use of manufacturer's testing facilities is preferred.
10. In order to verify nonmagnetic properties at the user's incoming receiving and inspection facilities only, the following go-no-go test is suggested: Crimp removable nonmagnetic contacts and nonmagnetic connectors shall be checked for their nonmagnetic properties by exposing them to a mild magnetic field. A permanent magnet may be used. Any devices which are attracted to the magnet shall be rejected. After testing, contacts shall be demagnetized per application note 6.1.1 of GSFC S-311-P-4. Performance of this test is not intended as a substitute for screening to specific levels of residual magnetism that is performed at the manufacturer's facilities.

NOTES (Continued):

11. Certain MIL-C-83513 connector receptacles contain a thin press-on silicone rubber interface seal which may be an outgassing concern. If necessary, this seal should be removed with small tweezers and discarded. If a seal must be maintained, it may be necessary to bakeout the connector or the interface seal in order to prevent outgassing.
12. Certain SMA RF connector plugs contain a gasket interface seal inside the coupling nut, inside the cable mounting nut, or on the mounting flange which may represent an outgassing concern. Additional processing is recommended.
13. Connectors procured to military specifications normally have thistest performed on samples.
14. For MIL-C-83513 microminiature connectors with crimp type pig tail leads, adjacent leads shall be tested for shorting prior to DWV. Each lead shall be tested. For DWV testing, a test potential of 600 VRMS (sea level) shall be used. If the manufacturer can certify that this test is normally performed on each connector, additional testing is not required.
15. Test is intended to determine resistance of contacts with crimp joined or weld joined solid, straight or formed wire leads. Test shall be performed using a micro-ohmmeter and four wire measurements. Mated connector pairs are preferred. Attached current leads at extreme ends of contacts. Attach voltage leads at contact lead closest point to engagement barrel without touching barrel. Apply one milliamp DC or as otherwise specified. Measurement shall not exceed 15 milliohms for size 22 contacts, 20 milliohms for size 24 contacts, 32 milliohms for size 26 contacts, or as otherwise specified. Unless otherwise specified, all contacts in each connector shall be measured.
16. For Level 1, perform DWV on each connector with contact center spacing of 0.050 or less. Otherwise perform on two connector samples. For connectors with 0.100 spacing, test potential shall be 1000 VRMS. For 0.075 inch spacing, use 750 VRMS; for connectors with 0.050 inch spacing, use 600 VRMS.
17. Contact-Conductor Combinations. The contact conductor combinations shall be in accordance with the following table:

RECOMMENDED CONTACT-CONDUCTOR COMBINATIONS

Contact Wire Barrel Size	Conductor Size, AWG A/
24	24, 26, 28
22	22, 24, 26
22D	22, 24, 26, 28
20	20, 22, 24
16	16, 18, 20
12	12, 14
10	10, 12 B/
8	8, 10 B/

A/ For interconnecting cables, conductors smaller than 24 AWG shall be high strength copper.
B/ With Conductive bushing per MS3348.

18. Direct solder attachment of devices with DIP, SIP or Small round style devices is preferred over the use of plug-in sockets, except where continued insertion and extraction of devices such as programmable memories is necessary.

Table 3A QUALIFICATION REQUIREMENTS FOR CIRCULAR CONNECTORS 5/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	4(0) Mated pairs A, B, C & D	2(0) Mated pairs A & C	
Mechanical	Table 4	4(0) Mated pairs A, B, C & D	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, room temperature and atmosphere. Magnitude per specified service rating. When no value is specified, a voltage of 500V RMS shall be used. Duration shall be 2 seconds minimum. Connectors shall be wired and unmated. Simulated contacts and special techniques may be used. Leakage current 2 milliamps, maximum. Six readings, minimum, shall be taken. No evidence of flashover. Test for 2 seconds, minimum, using 50% of contacts, minimum of 2.	2(0) Mated pairs B & D	2(0) Mated pairs B & D	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, Test Condition B, room temperature, wired and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, minimum.	2(0) Mated pairs B & D		
Temperature Cycling (Except Hermetics)	MIL-STD-1344, Method 1003, Test Condition A. Maximum temperature used in Step 3 shall be the maximum temperature of the connector. There shall be no damage.	1(0) Mated pair A		
Vibration	MIL-STD-1344, Method 2005, Test condition and duration as specified. When no condition is specified, Test Condition III (10 to 2000 HZ, 15G Peak) shall be used. Connectors shall be wired and mated. All contacts shall be wired in a series circuit with 100 milliamps of current flow applied. Connectors shall be monitored for discontinuities in excess of one microsecond. There shall be no evidence of cracking, breaking or loosening of parts.	2(0) Mated pairs B & D		

Notes at end of Table

Table 3A QUALIFICATION REQUIREMENTS FOR CIRCULAR CONNECTORS 5/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Shock	MIL-STD-1344, Method 2004, Test Condition as specified. When no condition is specified, condition A (50G's) shall be used. Apply one blow in each direction along three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration testing above.	2(0) Mated pairs B & D		
Shell to Shell continuity	MIL-STD-1344, Method 3007. Voltage drop shall not exceed 50 millivolts for nickel finish with grounding fingers and 300 millivolts for nickel finishes without grounding fingers.	2(0) Mated pairs A & C		
Outgassing Control (When Required by Application)	Outgassing, page 2.	X	X	
Contact Engagement and Separation Force (In-Process inspection prior to assembly for nonremovable solder socket contacts only)	MIL-STD-1344, Method 2014. MS3197, test pin shall be inserted to .7L. Measured forces shall comply with MIL-C-39029, Table IX. Test a minimum of three contacts per connector.	2(0) Mated pairs A & C as applicable		
Thermal shock (liquid to liquid, hermetic receptacles only)	MIL-STD-202, Method 107. Ten cycles from 4°C max to 90°C min. Transfer time shall not exceed 5 seconds. Dwell time shall be 10 minutes, min at each extreme.	2(0) Mated pairs C & D	1(0) Mated pair C	
Hermeticity (Air Leakage) (Sealed Receptacles Only)	MIL-STD-1344, Method 1008. Pressure differential across the connector shall be 1 atmosphere (14.7 PSI). Leakage shall not exceed $1x10^{-7}$ ATM CM^3/Sec or as otherwise specified.	2(0) Mated pairs C & D	1(0) Mated pair C	
Contact Retention (Push Test) (Crimp Removable Contacts Only)	MIL-STD-1344, Method 2007. With an applied load of 10 lbs for size 22D, 15 lbs for size 20, 25 lbs for size 16, axial displacement shall not exceed value in reference specification.	1(0) Mated pair B		
Mating and Unmating Force (Coupling Torque) (N/A Threaded Coupling)	MIL-STD-1344, Method 2013. Torque and/or axial force shall be as specified. (For Breechlok type connectors, axial force and torque shall be measured. For lever actuated connectors, only axial force is measured).	2(0) Mated Pairs A & C		
Insert Retention	MIL-STD-1344, Method 2010. Apply axial force as specified. When no value is specified, applied force shall be 75 pounds per square inch for 5 seconds, in each direction.	2(0) Mated pairs A & C		

Notes at end of Table

Table 3B QUALIFICATION REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS (MIL-C-24308, S-311-P-4, S-311-P-10) 6/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	3(0)	2(0)	
Mechanical	Table 4	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Condition I. Connectors shall be unmated. Apply potential per Tables 3 and 4 of MIL-C-24308 for 10 seconds, minimum.	3(0)	2(0)	
Insulation Resistance (Room Temperature)	At ambient temperature, test per MIL-STD-1344, Method 3003, test condition B. Measure between 50% of adjacent pairs (4 min) and between 50% of contacts adjacent to shell and shell (6 min). Measurements shall be 5000 megohms min, unconditioned.	3(0)		
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Connector rated temperature extremes shall be used for high and low temperatures. There shall be no damage detrimental to the operation of the connector.	3(0)		
Vibration	MIL-STD-1344, Method 2005, Test Condition IV. Connectors shall be wired and mated. All contacts shall be wired in a series circuit with 100 milliamps of current flow applied. Connectors shall be monitored for discontinuities longer than one microsecond. Vibration shall not result in any damage or loosening of connector parts.	3(0)		
Shock	MIL-STD-1344, Method 2004, Test Condition E. One shock in each direction shall be applied to each of three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration testing above.	3(0)		
Residual Magnetism (Non-magnetic Connectors Only)	Note 1.	X	X	
Mating and Unmating Force	MIL-STD-1344, Method 2013. Crimp connectors require contacts to be inserted. Force shall comply with MIL-C-24308, Table II.	3(0)		

Notes at end of Table

Table 3B QUALIFICATION REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS (MIL-C-24308, S-311-P-4, S-311-P-10) 6/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Processing for Outgassing Control (Low Outgassing Applications)	See Outgassing, page 2.	X	X	
Contact Engagement and Separation Forces (Nonremovable Solder Socket Contacts)	MIL-STD-1344, Method 2014. Insert and remove max dia MS3197 gage pin. Insert min dia gage pin; measure separation during removal of min gage pin. Insert and separate max dia gage pin three times. During third cycle, measure engagement force. All measurements shall comply with MIL-C-39029, Table IX. Test 20% of contacts, four minimum.	3(0)		
Contact Retention (Push Test) (Crimp Removable Contacts)	MIL-STD-1344, Method 2007. Gradually apply a 9 lb. force in each direction along contact axis. Contact displacement shall not exceed 0.012 inch after removal of force. A push test tool may be used. Test 20% of contacts, three minimum.	3(0)		
Resistance to Soldering Heat and Solderability (PC and Solder Contacts)	MIL-C-24308, paragraph 4.7.26. Test 20%, min of 7. Solder Cup contacts or PC terminations shall be soldered with a pencil type iron heated to 360°C using SN63 solder for a min duration of four seconds. There shall be no evidence of damage or distortion. Solder shall demonstrate proper wetting and adhesion to surfaces of the solder or PC terminations.	3(0)	2(0)	
Insert Retention	MIL-STD-1344, Method 210. A force of 60 PSI shall be applied for 5 seconds in each direction. Contacts may be removed for convenience.	3(0)		

Notes at end of Table

Table 3C QUALIFICATION REQUIREMENTS FOR MICROMINIATURE CONNECTORS (REF MIL-C-83513) 6/
(Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	3(0)	2(0)	
Mechanical	Table 4	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Condition I, mated or unmated. Apply for 10 seconds min. Test potential shall be per Table I of MIL-C-83513.	3(0)	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, test condition B, connectors mated. Measure between 50% (four min) adjacent pairs and between 50% (six min) contacts adjacent to shell and shell. Measurements shall be 5000 megohms min, unconditioned.	3(0)		
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Connector rated temperature extremes shall be used for high and low temperatures. There shall be no damage detrimental to the operation of the connector.	3(0)		
Vibration	MIL-STD-1344, Method 2005, Test Condition IV. Connectors shall be wired and mated. All contacts shall be wired in a series circuit with 100 milliamps of current flow applied. Connectors shall be monitored for discontinuities longer than one microsecond. Vibration shall not result in any damage or loosening of connector parts.	3(0)		
Shock	MIL-STD-1344, Method 2004, Test Condition E. One shock shall be applied to each direction of three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration testing above.	3(0)		
Contact Engagement and Separation Forces (Pin Contacts)	MIL-C-83513, paragraph 4.7.8. Engagement force, 6 oz. per contact, max. Separation force, 0.5 oz per contact, min. Test 20% of contacts, 7 minimum.	3(0)		
Low Signal Level Contact Resistance 2/	MIL-STD-1344, Method 3002. Measured contact resistances shall be in accordance with MIL-C-83513, Table VI. Environmental conditioning is not required.	3(0)	2(0)	

Notes at end of Table

Table 3C QUALIFICATION REQUIREMENTS FOR MICROMINIATURE CONNECTORS (REF MIL-C-83513) 6/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Mating and Unmating Force	MIL-STD-1344, Method 2013. Force shall not exceed 10 oz times the number of contacts. Mated dimension between connector flanges shall not exceed .216 for metal shell connectors and .202 for plastic. Reference MIL-C-83513, figure 1.	3(0)		
Contact Retention/Wire Retention (Prewired Crimp Contacts)	MIL-STD-1344, Method 2007. Apply 5 lbs to individual wire pigtails for 6 seconds, min. Load shall not displace contact or pull the wire from the crimp contact. Test 20% of Contacts, 7 min.	3(0)		
Resistance to Soldering heat and Solderability (Soldercup Contact or PC Type Contacts)	MIL-C-83513, paragraph 4.7.11. Solder using a pencil type iron heated to 360°C using Sn63 solder for a duration of 4 seconds per contact. There shall be no damage or distortion. Solder shall demonstrate proper wetting and adhesion to surfaces of the solder cup or PC terminations. Test 20% of Contacts, 7 min.	3(0)	2(0)	
Processing for Outgassing Control (when required)	See Outgassing, page 2.	X	X	
Insert Retention (Metal Shell Types Only)	MIL-STD-1344, Method 210. A force of 50 PSI for 5 seconds shall be applied in each direction. Air pressure may be used.	3(0)		

Notes at end of Table

Table 3D QUALIFICATION REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS (REF MIL-C-55302) 6/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	3(0)	2(0)	
Mechanical	Table 4	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level) 3/	MIL-STD-1344, Method 3001, mated, may be board mounted. Apply voltage for 60 seconds between closest contacts and between contacts and hardware (guidepins, jackscrews, jackposts, etc.)	3(0)		
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, mated and may be board mounted. Apply between adjacent pins and pin to hardware of plug. Measurement shall not be less than 5000 megohms.	3(0)		
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Connector rated temperature extremes shall be used for high and low temperatures. There shall be no damage detrimental to the operation of the connector.	3(0)		
Vibration	MIL-STD-1344, Method 2005, Test Condition III. Connectors shall be wired and mated. PC connectors shall be board mounted. Mated connectors shall be fixtured as shown in MIL-C-55302 Figure 3, and a stabilizing arrangement shall be used to prevent mated connectors from separating when jack screws are not used. All contacts shall be wired in a series circuit with 100 milliamps of current flow applied, and shall be monitored for discontinuities greater than 1 microsecond. At test conclusion connectors shall be examined for damage or loosening of parts.	3(0)		
Shock	MIL-STD-1344, Method 2004, Test Condition G. Connectors shall be mated, wired, monitored and examined for damage as in vibration testing above. Perform one blow in both directions along each of three mutually perpendicular axes.	3(0)		

Notes at end of Table

Table 3D QUALIFICATION REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS (REF MIL-C-55302) 6/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Contact Engagement and Separation Forces (Socket Contacts)	MIL-STD-1344, Method 2014. Insert MS3197 test pins to a depth of .140 ± .02 inch. Max engagement force shall be 12 oz. per contact (no. 22 contacts) for standard force contacts and 4 oz. per contact for low insertion force contacts. Min separation force is 0.5 oz. per contact (each type). Test 20% of Contacts, Minimum of 4.	3(0)		
Low Signal Level Contact Resistance 2/	MIL-STD-1344, Method 3002. Measured contact resistances shall be in accordance with MIL-C-55302, Table II, unless otherwise specified. Environmental conditioning is not required. All contact shall be tested.	3(0)	2(0)	
Mating and Unmating Force	MIL-C-55302, paragraph 4.7.4. Precondition with 3 cycles. For size 22 standard force contacts, max mating force in pounds shall be .56X no. of contacts and min withdrawal force .08X no. of contacts, or as otherwise specified. For low insertion force contacts, max. mating force shall be .25X no of contacts min and withdrawal force shall be .04X no. of contacts.	3(0)		
Resistance to Solder Heat and Solderability	PC Type Contacts - MIL-STD-202, Method 210, Cond. C Solder Cup Contacts - MIL-C-55302, paragraph 4.7.17, 4 sec. duration. Perform post solder visual exam at 10X magnification. There shall be no evidence of damage or distortion. Contact floating conditions, if applicable, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup or PC terminations.	3(0)		
Contact Retention (Push Test) (All Connector Types)	MIL-STD-1344, Method 2007. Gradually apply a 5 lb axial force for PC contacts and a 10 lb axial force for all others. For removable crimp type contacts, apply load in the contact removal direction. For all others, apply force in the direction used during normal mating. A push test tool may be used. Contact displacement after removal of force shall not exceed 0.015 inches. Test a minimum of 7 contacts.	3(0)		

Notes at end of Table

Table 3E QUALIFICATION REQUIREMENTS FOR RADIO FREQUENCY CONNECTORS MIL-PRF-39012 and MIL-C-83517 7/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	6(0) Groups A & B	2(0)	
Mechanical	Table 4	6(0) Groups A & B	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, Test Condition B, between center contact and body. Measurements shall be 5000 megohms, min.	6(0) Groups A & B		
Force to Engage and Disengage	MIL-PRF-39012, paragraph 4.7.2. Force shall not exceed 2 inch-lbs torque for SMA types.	6(0) Groups A & B		
Coupling Proof Torque (Plugs Only)	MIL-PRF-39012, paragraph 4.7.3, 15 inch lbs torque, min, for SMA types.	6(0) Groups A & B		
Hermetic Seal (Pressurized Connectors Only)	MIL-STD-202, Method 112, Test Condition C, Procedure I. Leak rate shall not exceed 10^{-8} ATM CM^3/sec or as otherwise specified.	6(0) Groups A & B	2(0)	
Thermal Shock (or Temperature Cycling)	MIL-STD-202, Method 107, Test Condition B (or MIL-STD-1344, Method 1003, Test Condition A) Except temperature extremes shall be -55°C and +125°C. There shall be no damage detrimental to the operation of the connector.	4(0) Group A		
Vibration	MIL-STD-202, Method 204, Test Condition D (or MIL-STD-1344, Method 2005, Test Condition IV). Connectors shall be terminated to the appropriate type of coaxial cable and shall be mated. The inner and outer conductors shall be wired in a series circuit with 100 milliamps of current flow applied. Connectors shall be monitored for discontinuities longer than one microsecond. Vibration shall not result in any damage or loosening of connector parts.	4(0) Group A		

Notes at end of Table

Table 3E QUALIFICATION REQUIREMENTS FOR RADIO FREQUENCY CONNECTORS MIL-PRF-39012 and MIL-C-83517 7/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Shock	MIL-STD-202, Method 213, Test Condition I (or MIL-STD-1344, Method 2004, Test Condition G). Apply one shock to each direction of three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration testing, previous page.	4(0) Group A		
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Method 301. SMA Type Apply 500 VRMS, 750 VRMS, or 1000 VRMS per cable size in reference specification.	4(0) Group A	2(0)	
Cable Retention Force (Cabled Connectors Only; N/A Semi-Rigid)	Connector shall be terminated to the appropriate type of coaxial cable. Connector shall be firmly held in a fixture while a force as specified is applied away from the back of the connector. The force shall be held for 30 seconds minimum. The assembly shall be examined for mechanical failure or loosening of parts and shall be tested for continuity.	4(0) Group A		
VSWR (Cabled Connectors Only)	MIL-PRF-39012, Paragraph 4.7.11 or as otherwise specified. VSWR measurement shall conform to the value as specified.	2(0) Group B		
RF Insertion Loss (Cabled Connectors Only)	MIL-STD-220 or MIL-PRF-39012, Paragraph 4.7.24. Connectors shall be terminated to the appropriate type of coaxial cable and shall be mated. Measurements shall conform to specified values.	2(0) Group B		
Processing for Outgassing Control (Low Outgassing Applications)	See Outgassing, page 2.	X	X	
Center Contact Retention (Captivated Center Contact Types Only)	MIL-PRF-39012, paragraph 4.7.9. Apply 6 lbs axial force, min, in each direction along axis.	2(0) Group B		

Notes at end of Table

Table 3F QUALIFICATION REQUIREMENTS FOR PLUG-IN-SOCKETS, STRIPS AND TERMINALS (REF MIL-PRF-12993, MIL-S-83734, MIL-S-83502, MIL-T-55155) 8/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	6(0) Group A & B	2(0)	
Mechanical	Table 4	6(0) Group A & B	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3003. Wire all odd-numbered contacts together and all even numbered contacts together. Apply voltage between the odd and even numbered contacts, and between even/odd contacts and other metallic parts, if applicable. Applied voltage shall be 600 VRMS or as otherwise specified. Apply for 60 seconds. Compression mounted terminals shall be securely mounted in a test fixture as specified.	6(0) Group A & B	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003. Sockets and terminals shall be wired as in DWV test above.	6(0) Group A & B		
Vibration	MIL-STD-1344, Method 2005, Test Condition III or as otherwise specified. Sockets shall be mated with a dummy plug-in component. Leads of socket and plug-in component shall be wired in a series circuit with an applied current of 100 milliamps. The circuit shall be monitored for discontinuities greater than 1 microsecond. At test conclusion, sockets shall be examined for damage or loosening of contacts.	6(0) Group A & B		
Shock	MIL-STD-1344, Method 2004, Test Condition G or as otherwise specified. Sockets shall be mated, wired, monitored and examined for damage same as vibration testing above. Perform one blow in both directions along each of three mutually perpendicular axes.	6(0) Group A & B		

Notes at end of Table

Table 3F QUALIFICATION REQUIREMENTS FOR PLUG-IN-SOCKETS, STRIPS AND TERMINALS (REF MIL-PRF-12993, MIL-S-83734, MIL-S-83502, MIL-T-55155) 8/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Insertion and withdrawal Force (Plug-in sockets (strips).	Test gauge shall be used and shall be as specified. After three insertions and withdrawals of the test gage (or as otherwise specified), insertion and withdrawal force shall be measured, and shall fall within specified values. 20% of contact positions shall be tested (minimum of 3).	6(0) Groups A & B		
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Socket rated temperature extremes shall be used for high and low temperatures. There shall be no damage detrimental to the operation of the socket. Sockets shall be capable of mating and unmating without damaging plug-in component.	4(0) Group A		
Low Level Signal Contact Resistance (Plug-In Sockets Only) 2/	MIL-STD-1344, Method 3002. Sockets shall be mated with plug-in components. Measurements shall be made across individually mated socket contacts and component leads. For DIP and SIP packages, a minimum of 7 contacts positions shall be measured. For packages with less than 7 contacts, measure all positions. Contact resistance shall be 20 milliohms, max or as otherwise specified. Environmental conditioning is not required.	4(0) Group A	2(0)	
Resistance to Soldering Heat and Solderability	MIL-STD-202, Method 210, Condition B or as otherwise specified. Dip leads in solder at 260 ± 5°C to within 0.050 inch of the component body. Perform post solder visual exam at 10X magnification. There shall be no evidence of damage or distortion. Solder shall demonstrate proper wetting and adhesion to soldertails, soldercups, or, solder turrets.	2(0) Group B		
Processing for Outgassing Control (Low Outgassing-Applications)	See Outgassing, page 2.	X	X	

Notes at end of Table

Table 3G QUALIFICATION REQUIREMENTS FOR EMI/RFI FILTER CONTACT CONNECTORS (REF NASA-GSFC S-311-P-626) 9/ (Page 1 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4 (See Circulars or DSUBS as applicable)	2(0)	2(0)	
Mechanical	Table 4 (See Circulars or DSUBS as applicable)	2(0)	2(0)	
Dielectric Withstanding Voltage	MIL-STD-1344, Method 3003. Apply 2X rated DC voltage for 5 to 10 seconds between each contact and the shell. Charging current shall be limited to 20 milliamps.	2(0)	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, Test Condition A. Apply 100VDC or rated DC voltage, whichever is less, for 2 minutes, maximum. Measure between contacts and shell.	2(0)		
Voltage Conditioning	MIL-STD-202, Method 108. Perform conditioning at connector maximum temperature rating. Test duration shall be 168 hours minimum at 2X rated DC voltage. Test circuit shall be used which applies positive voltage to the contact pin. Maximum series resistance shall be 5 ohms. A fuse with a maximum rating of 0.25 AMPS shall be used between the shell and ground. Upon completion of voltage conditioning and while at 125°C, measure insulation resistance.	2(0)	2(0)	
Attenuation	MIL-STD-220. Perform test at room temperature.	2(0)		
RF Current	After attenuation measurement and with connector mounted on a grounded plane, connect an RF generator and RF ammeter. Vary frequency until the ammeter shows peak current. (NOTE: Choose generator loading such that peak current is provided at filter resonance and does not exceed generator VSWR tolerance.)	2(0)		
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Connector rated temperature extremes shall be used for high and low temperatures. There shall be no damage detrimental to the operation of the connector. Repeat dielectric withstanding voltage and insulation resistance.	2(0)		
Capacitance and Dissipation Factor	MIL-STD-202, Method 305. Measure at room temperature. Test frequency shall be 1000HZ or as otherwise specified. The AC component shall be between 0.1 to 1.0 V RMS.	2(0)	2(0)	

Notes at end of Table

Table 3G QUALIFICATION REQUIREMENTS FOR EMI/RFI FILTER CONTACT CONNECTORS (REF NASA-GSFC S-311-P-626) 9/ (Page 2 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Life	MIL-STD-202, Test Method 108, Test Condition D (1000 Hours). Test temperature shall be maximum temperature rating. Five contacts, minimum of each sample shall carry rated RF current at maximum frequency. At completion of testing, contacts shall be tested for attenuation, insulation resistance and dielectric withstanding voltage.	2(0)		
Vibration	MIL-STD-202, Method 204, Test Condition D. Filter connector sample shall be specially prepared with the ceramic filter elements shorted. Connector sample shall be securely mated. Each contact shall be monitored for continuity with the mated connector contact, and for continuity through the shorted filter capacitor to the ground plane and the connector shell. 100 milliamps shall be applied to each contact. Apply sweep in both directions along each of three mutually perpendicular axes. Connector shall be monitored for discontinuities greater than 10 microseconds. There shall be no evidence of cracking, breaking or loosening of parts.	1(0)		
Shock	MIL-STD-202, Method 213, Test Condition G. Connector shall be mated, wired, monitored and examined same as vibration testing above. Connectors shall be subjected to five blows in each direction along three mutually perpendicular axes.	1(0)		
Resistance to Soldering Heat and Solderability	Soldercup contacts or PC terminations shall be soldered with a pencil type iron heated to 360°C using SN63 solder per QQ-S-571 for a minimum duration of 4 seconds. Flux with type R or RMA flux per MIL-F-14256. There shall be no evidence of damage or distortion. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup or PC termination. Test 20% of contacts, minimum of 7.	1(0)		

Notes at end of Table

Table 3G QUALIFICATION REQUIREMENTS FOR EMI/RFI FILTER CONTACT CONNECTORS (REF NASA-GSFC S-311-P-626) 9/ (Page 3 of 3)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Mating and Unmating Force	MIL-STD-1344, Method 2013. Mating connectors with crimp removable contacts shall have contacts installed. Force shall be as specified.	1(0)		
Outgassing Control	See Outgassing, page 2.	X	X	

Notes at end of Table

Table 3H QUALIFICATION REQUIREMENTS FOR CONNECTOR CONTACTS AND PRINTED CIRCUIT SOCKET CONTACTS (REF MIL-C-39029, MIL-C-55302/65, MIL-S-83505, GSFC-S-311-P4/06, /08, /10, GSFC-S-311-P-718/2) 10/ (Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Visual	Table 4	24(0) Groups A through D	16(0) Groups A, B	
Mechanical	Table 4	8(0) Group A	8(0) Group A	
Examination, Wired Contacts (Not Applicable to PC Sockets)	Contact samples shall be prepared with the largest and smallest recommended contact-conductor accommodations referenced in MIL-C-39029, table III. Six samples shall be terminated to the largest wire size and two terminated to the smallest wire size. Samples shall be subjected to a visual inspection for cracks or other damage.	16(0) Groups A, B	16(0) Groups A, B	
Axial Concentricity (Wired) (PIN Contacts Only; N/A PC Sockets)	Wired pin contact samples which are prepared for examination (above) shall be subjected to the axial concentricity test per paragraph 4.7.3 of MIL-C-39029. When samples are mounted and rotated 360°, the total indicator reading (TIR) shall not exceed 0.012 for conductor sizes 12 to 28.	8(0) Group A		
Crimp Tensile Strength (Pull Test; N/A PC Sockets)	MIL-STD-1344, Method 2003. Wired contact samples from above shall be subjected to the crimp tensile strength test. The axial load required to pull the wire from the crimp barrel or break the wire shall not be less than the minimum value shown in MIL-C-39029 Table X. For coaxial contacts, a 15 lb load shall be used or as otherwise specified.	8(0) Group A	8(0) Group A	
Contact Engagement Force (Sockets Only) 11/	MIL-STD-1344, Method 2014. Contact engaged to a depth of 0.7L. Force shall comply with MIL-C-39029, Table IX.	8(0) Group B	8(0) Group B	
Contact Separation Force (Sockets Only) 11/	(Same as above)	8(0) Group B	8(0) Group B	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Contact rated temperature extremes shall be used for high and low temperatures. There shall be no damage to the plating or loosening of sleeves or contact springs (if applicable).	8(0) Group B		

Notes at end of Table

Table 3H QUALIFICATION REQUIREMENTS FOR CONNECTOR CONTACTS AND PRINTED CIRCUIT SOCKET CONTACTS (REF MIL-C-39029, MIL-C-55302/65, MIL-S-83505, GSFC-S-311-P4/06, /08, /10, GSFC-S-311-P-718/2) 10/ (Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
Dielectric Withstanding Voltage (Sea Level, Coaxial Contacts only)	MIL-STD-1344, Method 3001, Size 8, 1000 VRMS. Apply between center contact and shell.	8(0) Group B	8(0) Group B	
Vibration	MIL-STD-1344, Method 2005, Test Condition IV, Letter J or as otherwise specified. Contacts shall be mated and wired in a series circuit with a current of 100 milliamps applied. The circuit shall be monitored for discontinuities in excess of 1 microsecond. Duration shall be 8 hours in the longitudinal direction and 8 hours in a perpendicular direction for a total of 16 hours, or as otherwise specified. There shall be no loosening of sleeves or contact springs.	8(0) Group B		
Shock	MIL-STD-1344, Method 2004, Test Condition D or as otherwise specified. Contacts shall be mated, wired, monitored and examined, same as vibration testing above.	8(0) Group B		
Low Signal Level Contact Resistance 2/ (Size 16 and Smaller)	MIL-STD-1344, Method 3002. Contact shall be engaged to its mating connector with the pin engaged to 70% of its mated engagement length. Conditioning is not required. Measurements shall comply with MIL-C-39029 Table IV.	8(0) Group B	8(0) Group B	
Plating Thickness (N/A PC Sockets)	MIL-G-45204, Paragraph 4.5.1. See notes 8 and 9 at end of table and note 2 under materials.	4(0) Group C		
Plating Porosity (Overall Gold-Plated Finish Only; N/A PC Sockets)	Contacts shall be placed in containers and covered with Nitric Acid so that all contacts may be observed for a period of 30 seconds. There shall be no bubbling during the 30 second observation period.	4(0) Group D		
Residual Magnetism (Nonmagnetic contacts only) 1/	GSFC S-311-P-4/08 and /10, paragraph 3.4.1. Group contacts together. Measured value for the group shall not exceed a gamma level of 0.1X the no. of contacts in the group.	X	X	
Processing for Outgassing Control (Low Outgassing Applications)	Table 1B, Note 1 and Outgassing, page 2.	X	X	

Notes at end of Table

NOTES

1/ Residual magnetism testing shall be performed in accordance with the procedure in GSFC Specification S-311-P-4 paragraph 4.5.4, S-311-P-10 paragraph 4.5.5, or an alternate test method which is acceptable to the procuring activity. Connectors shall be qualified to levels of residual magnetism per the following designations: A = 2000 Gamma, B = 200 Gamma, C = 20 Gamma.

2/ Test shall be performed using a micro-ohmmeter and four wiremeasurements. Mated connector or contact pairs are preferred. Attached current leads at extreme ends of contacts. Attach voltage leads at contact lead closest point to engagement barrel without touching barrel. Apply one milliamp DC or as otherwise specified. Subtract resistance introduced by test probes. Measurement shall not exceed 15 milliohms for size 22 contacts, 20 milliohms for size 24 contacts, 32 milliohms for size 26 contacts, or as otherwise specified.

3/ For MIL-C-55302 DWV testing, apply test potential as follows:

Contact Center Spacing	Test Voltage
0.100 Inch	1000 VRMS
0.075 Inch	750 VRMS
0.050 Inch	600 VRMS

4/ MIL-PRF-39012 Cable Retention Testing

CABLE TYPE	CABLE OUTER DIAMETER	TEST FORCE (LBS)	APPLICABLE CABLE
Flexible	.036	10	
	.067	20	RG178, RG316
	.110	30	M17/152-00001
	.122 and Up	40	RG142, RG180, RG302, RG303, RG393, RG400
Semi-Rigid	.085	30	RG405
	.140	60	RG402

NOTES (continued):

5/ When candidate plug or receptacle circular connectors are submitted for qualification, mated pairs shall be prepared. For Level 1 qualification, two mating pairs of plugs and flange mount receptacles designated mated pairs A & B shall be prepared. For Level 2 qualification only, one mated pair designated mated pair A, shall be prepared. When hermetic receptacles are submitted for qualification in Level 1 applications, two mated parts designated mated pairs C & D shall be prepared. For Level 2 qualification of hermetic receptacles, one mated pair designated C shall be prepared. The connector shell size shall be the same as the shell size proposed for flight, or shall be the largest of a series of shell sizes. Connectors shall be mated or demated as required for completion of testing.

6/ When candidate plug or receptacle D-subminiature, microminiature or printed circuit connectors are submitted for qualification, completely assembled mated pairs shall be used. Connectors shall have a full complement of contacts. For Level 1 qualification, three mated pairs shall be prepared. For Level 2 qualification, two mated pairs shall be prepared. Connectors may be mated and demated as required for completion of testing.

7/ For Level 1 qualification of radio frequency connectors, six samples shall be prepared with mating connectors. The six samples shall be divided into two groups. Group A shall consist of four samples and Group B shall consist of two samples. For Level 2 qualification, two samples shall be prepared with mating connectors, and shall be submitted for the tests as designated. Connectors may be mated and demated as required for completion of testing.

8/ For Level 1 qualification of plug-in sockets, six samples are required. Some tests require all six samples to be tested. After completion of these tests, the samples shall be divided into two groups, 1 group of four and one group of two, prior to further testing. For Level 2 qualification, two samples shall be submitted for testing as designated.

9/ Two samples designated A & B shall be subjected to qualification. Both samples shall be subjected to the tests where a quantity of two is required. For Level 1 qualification, sample A shall be subjected to vibration and shock testing, and sample B shall be subjected to solderability and mating/unmating force testing.

10/ For qualification of contacts, contact sample quantity shall be divided into groups A through D for Level 1 qualification and groups A & B for Level 2. Groups shall be subjected to the tests with quantities as designated.

11/ For coaxial contacts, engagement force shall not exceed 24 ounces, and separation force shall not be less than 3 ounces, or as otherwise specified.

Table 4 WORKMANSHIP FOR CONNECTORS AND CONTACTS 1/

DEFECT	Circulars	DSUBS	Microminiature	PC	RF	Contacts	RF Contacts	Plug-In Socketc & Strips	PC Socket Contracts & Terminals
INSERT/INSULATOR BODY	X	X	X	X	X		X		
Insert to shell positioning and orientation	X	X	X		X		X		
Cracks, chips, busters, pinholes	X	X	X	X	X		X	X	
Marking	X	X	X	X				X	(Insulated Types)
HERMETIC SEALED CONNECTORS	X	X			X				
Negative meniscus glass to contact & glass to shell	X	X			X				
CONTACT CLEARENCE								X	
Below upper edge of contact cavity wall								X	
GROMMET (As Applicable)	X		X		X				
Nicks, gouges, tears, folds	X		X		X				
Marking	X								
SHELLS	X	X	X		X	X	X		X
Cracks, dents, burrs, sharp edges	X	X	X		X	X	X		X
Finish (Peeled or blistered plating, scratches, corrosion, discoloration, exposed base metal).	X	X	X		X	X	X		X
Marking completeness, legibility	X	X	X			X	X		
Sleeves (As applicable. Fixed and not free to move)						X	X		
THREADS (As Applicable)	X				X				
Nicks, dents, voids, burrs	X				X				
ADHESIVES/MOLDING MATERIAL	X	X	X	X	X				(Insulated Types)
Excess bonding material (overflow), voids	X	X	X	X	X				
LEADS (As Applicable)		X	X	X	X			X	X
Bent, nicked, cracked/broken leads, burrs.		X	X	X	X			X	X
Finish (peeling, corrosion, exposed by metal).		X	X	X	X			X	X

Notes:

1/ Refer to Visual Inspection paragraph on page 1 for additional requirements.

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SECTION C

CRYSTAL OSCILLATORS

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Table 1 REQUIREMENTS FOR CRYSTAL OSCILLATORS 1/ 2/

Selection Priority	Use As Is	Screen to Table 2	QCI to Table 3
Level 1			
1) MIL-O-55310, Class S	X		
2) MIL-O-55310, Class B 3/	X		
3) SCD		X	X
Level 2			
1) MIL-O-55310, Class B	X		
2) MIL-O-55310, Class S	X		
3) SCD		X	X
4) Commercial		X	X
Level 3			
1) MIL-O-55310, Class B	X		
2) MIL-O-55310, Class S	X		
3) Commercial		X	

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types

2/ Crystal Oscillators, which employ custom (as opposed to catalog) hybrid microcircuits, shall satisfy the element evaluation requirements of Section I herein.

3/ Class B Crystal Oscillators are acceptable as Level 1 parts only when Class S Oscillators are not available.

Table 2 SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, DISCRETE COMPONENT CONSTRUCTION (Page 1 of 3)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2		Level 3
		SCD	Class B	SCD	Commercial	Commercial
1. Internal Visual Inspection a. Soldering 2/ b. Workmanship	 MIL-S-45743 MIL-O-55310, paragraph 3.9	X		X		
2. Random Vibration	MIL-STD-202, Method 214, Condition I-B, 5 minutes per axis	X				
3. Thermal Shock	MIL-STD-202, Method 107, Condition A-1	X		X	X	
4. Pre Burn-In Electrical Input Current - Power Output Waveform	 Measure oscillators input current or calculate power from measured voltage and current. Measure oven input current or calculate power for types 4 and 6. For 8 oscillators determine syntonization energy, $Q=E\int_0^t I(t)dt$, from measured value of current. Approximate with the Trapezoidal Rule for n=10 equally spaced intervals. Verify the type of output waveform.	X		X	X	X

Notes at end of Table 2

Table 2 SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, DISCRETE COMPONENT CONSTRUCTION (Page 2 of 3)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2		Level 3
		SCD	Class B	SCD	Commercial	Commercial
Output Voltage - Power	Measure output voltage and measure or calculate output power. For VCOs, turn off the modulation-control input voltage and specify the dc input reference level. For square wave output waveforms, output logic levels shall be measured across a specified load. 3/	X		X	X	
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	X		X	X	X
7. Frequency Aging	70°C (room temperature for oven controlled oscillators). Stabilize 1 hour (48 hours for types 3 and 8). Measure initial frequency after stabilization and at intervals not to exceed 72 hours (20 hours for types 3 thru 8 with 4 m3asurements per week). Change between initial and any subsequent frequency shall not exceed specified value. See MIL-O-55310.	30 days				
8. PDA 4/		5%		10%	10%	20%
9. Radiographic Inspection	MIL-STD-202, Method 209, 1 View 1 in Y1 Direction, 2nd View 90° Relative to 1st View	X	X			
10. Additional Electrical Measurements	Table 4 Herein	X				

Notes at end of Table 2

Table 2 SCREENING REQUIREMENTS FOR CRYSTAL OSCILLATORS, DISCRETE COMPONENT CONSTRUCTION (Page 3 of 3)

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2		Level 3
		SCD	Class B	SCD	Commercial	Commercial
11. Seal Test	MIL-STD-202, Method 112 and MIL-O-55310, Paragraph 4.9.2	X		X	X	

Notes:

1/ It is the responsibility of the user to specify detail 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. MIL-O-55310 is the reference specification.

2/ Certification of soldering personnel is required.

3/ Test loads for TTL and CMOS compatible oscillator shall be as shown in Figure 7 of MIL-O-55310 unless otherwise specified.

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

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

Inspection/Test	MIL-STD-883 1/		Level 1		Level 2		Level 3
	Method	Conditions	SCD	Class B	SCD	Commercial	Commercial
1. Non Destructive Bond Pull	2023		X				
2. Internal Visual	2017		X		X	X 2/	
3. Stabilization Bake (Prior to Seal)	1008	C, 150°C, Min. Hours	X 48		X 24	X 24	
4. Thermal Shock	1011	A	X				
5. Temperature Cycling	1010	B	X		X	X	
6. Constant Acceleration	2001	A, Y_1 only, 5000G's	X		X	X	
7. PIND	2020	B	X	X	X	X	
8. Pre Burn-In Electrical			X		X	X	X
Input Current - Power	Measure oscillators input current or calculate power from measured voltage and current. Measure oven input current or calculate power for types 4 and 6. For 8 oscillators determine syntonization energy, $Q=E\int_0^t I(t)dt$, from measured value of current. Approximate with the Trapezoidal Rule for n=10 equally spaced intervals.						
Output Waveform	Verify the type of output waveform						
Output Voltage - Power	Measure output voltage and measure or calculate output power. For VCOs, turn off the modulation-control input voltage and specify the dc input reference level. For square wave output waveforms, output logic levels shall be measured across a specified load. 3/						

Notes at end of Table 2A

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

Inspection/Test	MIL-STD-883		Level 1		Level 2		Level 3
	Method	Conditions	SCD	Class B	SCD	Commercial	Commercial
9. Burn-In (Load)		125°C, Nominal Supply Voltage and Burn-In Loads	240 Hours		160 Hours	160 Hours	48
10. Post Burn-In Electrical		Repeat Step 8 Above	X		X	X	X
11. Frequency Aging	70°C (room temperature for oven controlled oscillators). Stabilize 1 hour (48 hours for types 3 and 8). Measure initial frequency after stabilization and at intervals not to exceed 72 hours (20 hours for types 3 thru 8 with 4 m3asurements per week). Change between initial and any subsequent frequency shall not exceed specified value. See MIL-O-55310.		30 days				
12. PDA 4/			5%		10%	10%	20%
13. Additional Electrical Measurements		Table 2B Herein	X				
14. Radiographic Inspection	2012		X	X			
15. Seal Test a. Fine Leak b. Gross Leak	1014	 A or B C	X		X	X	X

Notes:

1/ It is the responsibility of the user to specify detail 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-O-55310 is the reference specification.

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

3/ Test loads for TTL and CMOS compatible oscillators shall be as shown in Figure 7 of MIL-O-55310 unless otherwise specified.

4/ Percent Defective Allowable (PDA) calculations shall include both burn-in and frequency aging failures for Level 1 Parts.

Table 2B ADDITIONAL ELECTRICAL MEASUREMENTS (Page 1 of 2)

Test	Test Methods, Conditions and Requirements 1/	Type 2/
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 - Control Input Voltage	Same as 1 above, but also measure modulation magnitude and dc level limits or dc control magnitude	2, 5, 6
3. Oven Supply Voltage	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. Frequency Adjustment	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. Initial Frequency - 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 4.9.10.1.	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 4.9.14.	All
8. Rise and Fall Times	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. Duty Cycle	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 4.9.29.	2, 5, 6
11. Frequency Deviation	Assemble test equipment in accordance with Figure 13 of MIL-O-55310, and measure (calculate) total deviation, deviation slope polarity, and deviation linearity in accordance with paragraph 4.9.30.	2, 5, 6

Notes at end of Table 2B.

Table 2B ADDITIONAL ELECTRICAL MEASUREMENTS (Page 2 of 2)

Notes:

1/ It is the responsibility of the user to specify detail 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-O-55310 is the reference specification.

2/ TYPES

Type 1 - Crystal Oscillators (XO)

Type 2 - Voltage Controller Crystal Oscillators (VCXO)

Type 3 - Temperature Compensated Crystal Oscillators (TCXO)

Type 4 - Oven Control Crystal Oscillators (OXCO)

Type 5 - Temperature Compensated-Voltage Controlled Crystal Oscillators (TCVCXO)

Type 6 - Oven Controlled Voltage Controlled Crystal Oscillators (OCVCXO)

Type 7 - Microcomputer Compensated Crystal Oscillators (MCXO)

Type 8 - Rubidium - Crystal Oscillators (RUXO)

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

Inspection/Test	Test Methods and Conditions	Quantity (Accept number)				
		Level 1		Level 2		Level 3
		SCD	Class B	SCD	Commercial 1/	Commercial
Group 1		3(0)		2(0)	2(0)	Not Required
Physical Dimensions	MIL-STD-883, Method 2016 In case of failure, 100% inspection shall be performed					
Solderability	MIL-STD-202, Method 208 Each Lead					
Resistance to Solvents	MIL-STD-202, Method 215					
Group 2		3(0)		2(0)	2(0)	
Resistance to Soldering Heat	MIL-STD-202, Method 210 and MIL-O-55310, Paragraph 4.9.48					
Moisture Resistance	MIL-STD-202, Method 106 and MIL-O-55310, Paragraph 4.9.49					
Group 3		6(0)	6(0)	4(0)	4(0)	
Thermal Shock	MIL-STD-202, Method 107 and MIL-O-55310, Paragraph 4.9.44					
Mechanical Shock	MIL-STD-202, Method 213 and MIL-O-55310, Paragraph 4.9.40					
Vibration, Sine	MIL-STD-202, Method 204 and MIL-O-55310, Paragraph 4.9.38-1					
Thermal Strength	MIL-STD-202, Method 211 and MIL-O-55310, Paragraph 4.9.51					
Hermetic Seal	MIL-STD-202, Method 112 and MIL-O-55310, Paragraph 4.9.2					

Notes at end of Table 3

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

Inspection/Test	Test Methods and Conditions	Quantity (Accept number)				
		Level 1		Level 2		Level 3
		SCD	Class B	SCD	Commercial 1/	Commercial
Group 4 Internal Water Vapor Content 2/	MIL-STD-883, Method 1018 5000ppm at 100°C	3 (0) or 5 (1)	3(0) or 5 (1)	3(0) or 5 (1)	3(0) 5 (1)	Not Required
Group 5 Frequency Aging	MIL-O-55310, paragraph 4.9.34	12 (0)	6 (0)	8 (0)	8 (0)	

Notes:

1/ Generic data less than 1 year old is an acceptable basis for qualification if it satisfies the requirements specified herein.

2/ Applies only to hybrid microcircuit construction. Generic data is never acceptable.

SECTION D

DIODES AND TRANSISTORS

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Table 1 DIODE AND TRANSISTOR REQUIREMENTS 1/

Selection Priority	Use As Is	Screen to Requirements in Tables 2 and 5	Qualify to Requirements in Tables 4 or 7
LEVEL 1:			
1) JAN S	X		
2) SCD 3/		X	X
3) JANTXV 2/		X	
LEVEL 2:			
1) JANTX/TXV		X	
2) SCD 3/		X	X
3) JANS	X		
4) MFGR. HI-REL		X 4/	X 5/
5) COMMERCIAL		X	X
LEVEL 3:			
1) JANTX/TXV		X	
2) MFGR HI-REL		X	
3) JANS	X		
4) COMMERCIAL		X	

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

2/ JANTXV parts are acceptable as LEVEL 1 parts only when JANS parts are not available. Otherwise the JANS part should be used.

3/ Screening and qualification requirements for parts procured to SCDs are intended to be inclusive, i.e. tests need not be repeated if already required by the SCD.

4/ 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 and 5.

5/ Generic QCI attributes data may be acquired and reviewed for acceptability in lieu of performing the required testing.

Table 2 DIODE SCREENING REQUIREMENTS (Page 1 of 2)

Inspection/Test	MIL-STD-750		LEVEL 1		LEVEL 2				LEVEL 3		
	Methods	Conditions	SCD	JANTXV	JANTXV	SCD	MFGR HI-REL	Commercial	Commercial	JAN TXV	MFGR HI-REL
1. Internal Visual	2073 2074		X X			X X	1/	1/			
2. Temperature Cycling 2/	1051	No dwell required at 25°C. Use maximum storage temperature range, 20 cycles. 10 min. at Extremes.	X			X		X			
3. Surge Current 3/	4066	Condition B 10 surges, 1 per minute, 7 msec minimum	X			X		X			
4. Constant Acceleration	2006	20,000 g's Y_1 Direction 10,000 g's for Power Rating $\geq$ 10 Watts. 1 min., Hold time not required	X								
5. PIND	2052	Condition A	X	X	X	X	X	X	X	X	X
6. FIST 4/	2081	Axial Lead Diodes Only	X								
7. BIST 4/	2082	Axial Lead Diodes Only	X								
8. Serialization			X								
9. Initial Electrical Measurements			X	X		X		X	X 5/		
10. Burn-In 6/	1038	Condition A or B Duration (hours) Power/HTRB	X 240/96	X 160/48		X 160/48	X 96	X 160/48	X 7/ 96		
11. Final Electrical Measurements			X	X		X	X	X	X 5/		
12. Calculate Deltas			X	X							

Notes at end of Table 2

Table 2 DIODE SCREENING REQUIREMENTS 1/ (Page 2 of 2)

Inspection/Test	MIL-STD-750		Level 1		Level 2			Level 3
	Methods	Conditions	SCD	JANTXV	SCD	MFGR HI-REL	Commercial	Commercial
13. Calculate Percent Defectives		5% for Level 1 10% for Level 2 20% for Level 3	X	X	X	X	X	X
14. Hermetic Seal a. Fine Leak b. Gross Leak	1071	 G or H C or K	X	X	X	X	X	
15. Radiographic	2076		X	X				
16. External Visual	2071		X	X	X	X	X	X

Notes:

1/ DPA shall be performed on 5 samples to the requirements of 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/ Not required for double plug or case mounted diodes. Omit FIST for temperature compensated reference diodes.

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

6/ See Table 3. For thyristors, use MIL-STD-750, Method 1040, Condition B, 25°C, for the same durations.

7/ Burn-in at maximum operating temperature of diode.

Table 2a BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR DIODES (Page 1 of 2)

Diode Type	Required Burn-In		Delta Parameters Limits	Final Electrical Measurement 1/, 2/, 3/
	HTRB (Cond A)	Power (Cond B)		
Rectifier (Power, Fast Recovery)	Not Required	60HZ Sine Wave $V_R = V_{RM}$ $I_F = I_O$ max $T_A = 25°C$ 5/	$\Delta V_F \leq \pm 10\%\ V_{pk}$ $\Delta I_R \leq \pm 5\mu A$ or $\pm 100\%$, whichever is less	V_F, I_R, V_R, $V_{(BR)R}$ t_{rr}
High Voltage Rectifiers	$V_R = V_{RM}$ T_c = Max Operating Case Temperature	60HZ Sine Wave $V_R = V_{RM}$ $I_F = I_O$ max $T_A = 25°C$ 5/	$\Delta V_F \leq \pm 10\%\ V_{pk}$ $\Delta I_R \leq \pm 5\mu A$ or $\pm 100\%$, whichever is less	V_F, I_R, V_R, $V_{(BR)R}$
Switching (General Purpose, Schottky, RF, PIN)	Not Required	60HZ Sine Wave $V_R = V_{RM}$ $I_F = I_O$ max $T_A = 25°C$	$\Delta V_F \leq \pm 25mV$ $\Delta I_R \leq \pm 50nA$ or $\pm 100\%$, whichever is less	V_F, I_R, V_R, $V_{(BR)R}$ C_T, t_{rr}
Zener (Voltage Regulator, Voltage Reference)	$I_R = I_{ZM}$ T_c = Max Operating Case Temperature	Not Required	$\Delta I_Z \leq \pm 0.1\ I_{ZM}$ $\Delta V_Z \leq \pm 0.1\ V_{ZM}$ or $\pm 100\%$, whichever is less	V_F, I_R, V_Z, I_Z I_{ZM}, V_{ZM}, Z_Z
Varactor (Tuning)	$I_R = I_{RM}$ T_c = Max Operating Case Temperature	Not Required	$\Delta I_R \leq 0.1\ I_{RM}$ or $\pm 100\%$, whichever is less	V(BR)R, IR C_C, C_T, Q, Ct_1, L_S Ct_z
Thyristor (SCRs)	Not Required	$V_D = V_{DWM}$ V_{GT} = Square Wave, 50% Duty Cycle. $T_A = 25°C$	$\Delta V_{GT} \leq 0.1\ V_{GTM}$ $\Delta I_{GT} \leq 0.1\ I_{GTM}$ $\Delta I_D \leq 0.1\ I_{DM}$ or $\pm 100\%$, whichever is less	I_{DM}, I_{GM}, V_{GT}, I_{GT} I_L, I_{RM}, $V_{(BR)}$, V_{GTM} dV/dt, t_{ON}, t_{OFF}

Notes at end of Table 2a.

Table 2a BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR DIODES (Page 2 of 2)

Notes:

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

2/ Minimum required parameters are specified. Other device or application critical parameters shall also be measured.

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

4/ Use of heatsinks may be necessary.

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

	MIL-STD-750		Quantity (Accept number)				
			Level 1	Level 2			Level 3
Inspection/Test	**Methods**	**Conditions**	**SCD**	**SCD**	**MFGR HI-REL**	**Commercial**	**Commercial**
SUBGROUP 1		Separate samples may be used for each test.	6 (0)	4 (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.					
Solderability	2026						
Resistance to Solvents	1022						
SUBGROUP 2			6 (0)				Not Required
Decap-Internal Visual	2073 2074	In accordance with Internal visual precap criteria.					
SEM	2077	Die with expanded metallization contacts or metallization interconnects					
		All wire bonds					
Bond Strength (wire or clip bonded devices)	2037						
Die Shear (exclude Axial Lead Devices)	2017						
SUBGROUP 3			12 (0)				Not Required
Accelerated Steady State Operation Life	1027	Bias conditions as specified. Eutectic die attach. Tj = 275°C for 96 hours.					
		Soft Solder Die Attach. Tj = 225°C for 168 hours.					
		Schottky diodes Tj = 175°C min for 240 hours.					
Electrical Measurements		As Specified.					

Notes at end of Table 3

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

Inspection/Test	MIL-STD-750		Quantity (Accept number)				
			Level 1	Level 2			Level 3
	Methods	Conditions	SCD	SCD	MFGR HI-REL	Commercial	Commercial
SUBGROUP 4			22 (0)	10 (0)	10 (0)	10 (0)	Not Required
Operation Life							
Steady State	1026	1000 hours at maximum operating junction temperature					
or							
Intermittent	1037	6000 cycles min.					
or							
Blocking	1048						
Electrical Measurements		As Specified					

Notes:

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

Table 4 TRANSISTOR SCREENING REQUIREMENTS (Page 1 of 1)

	MIL-STD-750		Level 1		Level 2				Level 3		
Inspection/Test	**Methods**	**Conditions**	**SCD**	**JAN TXV**	**JAN TXV**	**SCD**	**MFGR HI-REL**	**Commercial**	**Commercial**	**JAN TXV**	**MFGR HI-REL**
1. Internal Visual	2072	For Power FETs, use Method 2069; for RF types, use Method 2070	X			X	1/	1/			
2. Temperature Cycling	1051	No dwell required at 25°C. Use maximum storage temperature range, 20 cycles. Extremes ≥ 10 min.	X			X		X			
3. Constant Acceleration	2006	20,000 g's Y_1 Direction 10,000 g's for Power Rating ≥ 10 Watts. 1 min, hold time not required	X								
4. PIND	2052	Condition A	X	X	X	X	X	X	X	X	X
5. Serialization			X								
6. Initial Electrical Measurements	2/		X	X		X	X	X	X 4/		
7. Burn-In 2/	1039	Condition A or B Duration (hours)	X 240	X 160		X 160	X 96	X 160	X 48		
8. Final Electrical Measurements	2/		X	X		X	X	X	X 3/		
9. Calculate Deltas	2/		X	X							
10. Calculate Percent Defectives		5% for Level 1 10% for Level 2 20% for Level 3	X	X		X	X	X	X		
11. Hermetic Seal a. Fine Leak b. Gross Leak	1071	 G or H C or K	X	X		X	X	X			
12. Radiographic	2076		X	X							
13. External Visual	2071		X	X		X	X	X	X		

Notes:

1/ DPA shall be performed on 5 samples to the requirements of 311-M-70 in lieu of Internal Visual. No failures are permitted.

2/ See Table 4A. For Power FETs, use MIL-STD-750, Method 1042, Condition A and B, for the same duration.

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

Table 4A BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR TRANSISTORS (Page 1 of 2)

Transistor Type	Required Burn-In		Delta Parameters Limits	Final Electrical Measurement 1/, 2/, 3/
	HTRB (Cond A)	Power (Cond B)		
Bipolar, NPN, PNP, Switching, Low and High Power, General Purpose, RF	Not Required	V_{CB} = 10 V P_T = Rated max except power devices 90% P_T max T_A = 25°C	ΔI_{CB0} (or I_{CES}) ≤ 10% Δh_{FE} ≤ 15%	I_{CB}, h_{FE}, $V_{(SAT)CE}$, $V_{(SAT)BE}$, I_{CEO}, I_{CBO}, I_{EBO}, $V_{(BR)CEO}$, $V_{(BR)CBO}$, $V_{(BR)EBO}$, t_{on} ($V_{BE(SAT)}$, and I_{EBO}, not required for RF types)
Junction Field Effect (JFET)	V_{GD} = 80% of Rating V_{DS} = 0 T_A = 150°C	Not Required	$V_{DS(on)}$ ≤ 20% I_{DS} ≤ 15%, whichever is less: $I_{D(OFF)}$ ≤ 0.1nA or 100% I_{DSS} ≤ 0.1nA or 100%	$V_{DS(ON)}$, I_{OS}, $I_{D(OFF)}$, I_{OSS}, $V_{DS(ON)}$, $V_{GS(OFF)}$, $V_{(BR)GSS}$
MOSFET	V_{DS} = 80% of rated V_{DS} T_A = 150°C See MIL-STD-750 Method 1042 Test A	V_{GS} = 80% of rating V_{DS} = 10V min T_A = 150°C See MIL-STD-750 Method 1042 Tests B and C	$r_{DS(ON)}$ ≤ 20% $V_{GS(TH)}$ ≤ 20%, whichever is less: I_{GSS} ≤ 20nA or 100% I_{DSS} ≤ 25uA or 100%	$V_{(BR)DSS}$, $V_{GS(TH)}$, I_{DSS}, $r_{DS(ON)}$, $V_{DS(ON)}$, V_{SD}, g_m
Darlington, PNP, NPN	Not Required	V_{CE} ≥ 10V P_T = 90% Max Rating T_A = 25°C	h_{FE} ≤ ± 40% I_{CE} ≤ 100µA or 100%, whichever is less	h_{FE}, I_{CE}, $V_{BR(CEO)}$, I_{CEO}, $V_{BE(SAT)}$, $V_{BE(TH)}$, $V_{CE(SAT)}$,
Optocoupler	T_A = 125°C I_F = 0 V_{CB} = 80% Rated V_{CBO} 48 Hrs.	T_A = 25°C I_F = Rated Max P_T = 90% Max V_{CC} = 20V V_{CE} = 10V Duration shown in Table 5	h_{FE} ≤ 20% $I_{C(OFF)}$ ≤ 25nA or 100%, whichever is less $I_{C(ON)}$ ≤ 25	I_R, $I_{C(OFF)}$, h_{FE}, $I_{C(ON)}$ V_F, C_{IO}, t_r, t_f, $V_{CE(SAT)}$ $V_{(BR)CBO}$, $V_{(BR)CBO}$, $V_{(BR)CBO}$

Notes at end of Table 6.

Table 4A BURN-IN AND ELECTRICAL MEASUREMENT REQUIREMENTS FOR TRANSISTORS (Page 2 of 2)

Notes:

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

2/ Minimum required parameters are specified. Other device or application critical parameters shall also be measured.

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

Table 5 TRANSISTOR QUALIFICATION TEST REQUIREMENTS 1/ (Page 1 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept number) or LTPD				
			Level 1	Level 2			Level 3
	Methods	Conditions	SCD	SCD	MFGR HI-REL	Commercial	Commercial
SUBGROUP 1		Separate samples may be used for each test.	4 (0)	4 (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.					
Solderability	2026						
Resistance to Solvents	1022						
SUBGROUP 2			4 (0)			3 (0)	Not Required
Decap-Internal Visual	2075						
SEM	2077	Die with expanded metallization contacts or metallization interconnects					
Bond Strength	2037	All wire bonds					
Die Shear	2017						
SUBGROUP 3			6 (0)				Not Required
Intermittent Operation Life Test	1037 or 1042	2,000 cycles For Power MOSFETs Cond. D, 2000 Cycles					
Electrical Measurement		As specified					

Notes at end of Table 7

Table 5 TRANSISTOR QUALIFICATION TEST REQUIREMENTS 1/ (Page 2 of 2)

Inspection/Test	MIL-STD-750		Quantity (Accept number) or LTPD				
			Level 1	Level 2			Level 3
	Methods	Conditions	SCD	SCD	MFGR HI-REL	Commercial	Commercial
SUBGROUP 4			12 (0)				Not Required
Accelerated Steady State Life Test	1037 or 1042	For Eutectic Die Attached Device, T_J = +275°C, 96 Hours					
		For Soft Solder Die Attached Device, T_J = +225°C, 168 Hours					
		For Power MOSFETS, 2/		10 (0)	10 (0)	10 (0)	
		1) Reverse bias, Cond. A, T_A = +175°C, VDS = Rated, 24 Hours					
		2) Gate Stress, Cond. B, T_A = + 175°C, VGS = Rated, 24 Hours					
Electrical Measurement		As specified					
SUBGROUP 5			22 (0)	10 (0)	10 (0)	10 (0)	Not Required
Steady State Life Test	1026	T_J = Max Operating T_J 1000 Hours Min.					
Electrical Measurement		As specified					

Notes:

1/ QCI testing to MIL-S-19500 JAN S or JANTXV requirements isacceptable for all quality levels.

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

SECTION E

FIBER OPTICS

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FIBER OPTICS

SELECTION

Parts covered in this section include fiber optic connectors and cable. Photonic devices such as emitters, detectors, transmitted and receivers which are used with fiber optic connectors and cable to make complete systems shall be screened as active devices.

Fiber optic parts shall be selected for the applicable program class or grade level in accordance with the priority order shown in Table I. Part designation priorities are shown in descending order from left to right at the top of the table. Table 2 also indicates screening and table 3 qualification testing required for each part designation when applied to the various program classes or grade levels.

APPLICATION NOTES

The weakest links in the fiber optic reliability chain are in fiber termination and handling. Missing or ineffective process control can lead to failure. Defects are usually introduced by the user. The termination process must be highly understood and controlled in order to reduce the chance of inducing surface crack growth in the fiber. Crack growth can be caused during any of the many steps that make up the termination process. Proper epoxies and strain relief materials must be used to avoid radial or lateral stress on the fiber. Crack growth can be a long term failure mechanism that is difficult to simulate in the laboratory.

MECHANICAL LIMITS

It is also critical that the user be aware of the mechanical limits of their optical cable and that proper harnessing practices and criteria are used. Tests may have to be performed to verify that bending losses are not induced due to designed-in bend radiuses or that radial stress is not introduced to the cable as it passes through box walls or bulkheads. Microbending can also contribute to loss and crack growth and is a long-term failure mechanism that may be difficult to simulate in the laboratory. Installers and test personnel must be aware that they are working in the vicinity of optical cable. Care should be taken to avoid undue stress to the cable or the connections, and connector demating should be controlled.

RADIATION

Optical fiber is considered susceptible to temporary or permanent damage due to exposure to gamma radiation. Qualification tests and application precautions should be applied in accordance with the use application.

OUTGASSING

Outgassing occurs at low pressures or in a vacuum where unreacted additives, contaminants, absorbed gasses or moisture can evaporate from materials. These outgassed materials can condense on cold surfaces within the spacecraft and lead to degraded performance of optics. All non-metallic materials used in the construction of connectors intended for use in space flight shall not exceed the 1% total mass loss (TML) or 0.1% collected volatile condensable materials (CVCM) requirement when tested to ASTM-E595. Selection and use of non-metallic materials shall be traceable to test reports with

acceptable levels of TML and CVCM as listed in NASA reference publication 1124 (outgassing data for selecting spacecraft materials) or NASA-MSFC Handbook 527 (Materials Selection List for Space Hardware Systems.) However materials listed as acceptable may have been baked out for evaluation and the user may have to repeat processing. Processing usually consists of a vacuum bakeout of 125°C and a vacuum of 10^{-6} TORR for 24 hours.

CLEANING

Cleanliness is critical when using fiber optics in space environments. Fiber optic connectors often contain many microscopic particles which need to be removed prior to use. Metallic shelled fiber optic connectors may also have a contaminant coating of oil or film residue from machining processes. Connectors should be subjected to a thorough cleaning process to remove particles and contamination prior to being used. The user is cautioned to use cleaning solvents and procedures which will not attack the connector materials.

Table 1 FIBER OPTIC PART REQUIREMENTS 1/

SELECTION PRIORITY	USE AS IS	SCREEN TO REQUIREMENTS IN TABLE 2	TEST TO QCI REQUIREMENTS IN TABLE 3
LEVEL 1:			
1) Military Specification		X	X
2) GSFC 311 Specification		X	
3) SCD		X	X
LEVEL 2:			
1) Military Specification	X		
2) GSFC 311 Specification	X		
3) SCD		X	X
4) Commercial		X	X
LEVEL 3:			
1) Military Specification	X		
2) GSFC 311 Specification	X		
3) Commercial		X	

Notes:

1/ The following notes are offered for guidance in screening and qualification of photonic devices used with fiber optic connectors and cable.

I. Discrete Devices (Emitters and Detectors). These devices shall meet the screening and qualification requirements as specified in Section D for diodes with the following details.

A. Screening - Perform screening to Section D, Table 2, except omit surge current, forward and backward instability shock tests (fist and bist). Perform optical measurements after completion of electrical measurements. Perform the following electrical and optical measurements.
(REF MIL-D-24260 Detectors (PIN or Avalanch Diodes) - R, C, V_{BR}, I_D, t_r, t_f, responsivity linearity.)
(REF MIL-S-24622 Emitters - V_F, P_T, t_r, t_f, λ_p, $\Delta\lambda$, $V_{(BR)R}$, Frequency Response.)

B. Qualification - Perform qualification to Section D, Table 4, except in Subgroup 4, perform steady state operation life followed by electrical and optical measurements same as screening above.

II. Transmitters and Receivers. Perform screening and qualifications as specified in Section I for hybrid microcircuits. Optical parameters are as defined in the following specifications: MIL-R-24720, MIL-R-24737, MIL-T-24721, MIL-T-24735.

III. Optocouplers. The devices shall meet all requirements as specified in Section D for transistors.

Table 2 SREENING REQUIREMENTS FOR OPTICAL CONNECTORS 1/

Test/Inspection	Test Method	Conditions	Quantity (Accept number) or LTPD				
			Level 1			Level 2	Level 3
	MIL-STD-1344		Military Specification	GSFC S-311	SCD	SCD	SCD/Commercial
Visual and Mechanical		See Table 4	100%	100%	100%	100%	10% Min 3 (0)
Contact Engage and separate force	2014	Use standard mating termini or applicable alignment sleeve. Measure axial force for complience with part ratings.	2(0)	2(0)	2(0)		
Hermeticity (Applicable parts only)	1008		100%	100%	100%	2 (0)	

Notes:

1/ Including optical termini.

Table 2A SCREENING TESTS FOR OPTICAL CABLE

Test/Inspection	Test Method	Conditions	Level 1			Level 2	Level 3
	EIA/TIA-455		Military Specification	GSFC S-311	SCD	SCD	SCD/Commercial
Visual and Mechanical		See Table 4A	2 meter sample per spool	2 meter sample per spool	2 meter sample per spool	2 meter sample per lot	2 meter sample per lot
Attenuation Rate	46		Each spool	Each spool	Each spool	Each spool	Each spool

Table 3 QUALIFICATION REQUIREMENTS FOR OPTICAL CONNECTORS 1/ (Page 1 of 4)

Test/Inspection	Test Method MIL-STD-1344	Test Method EIA/TIA-455	Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/ Level 1 Military Specification	Level 1 GSFC S-311	Level 1 SCD Commercial	Level 2 SCD	Level 3 SCD Commercial
SUBGROUP 1						[6]	[7]	[7]	[2]
Visual and Mechanical			See Table 8			All Test Parts	All Test Parts	All Test Parts	All Test Parts
Optical Tests									
Insertion Loss		34							
Return Loss		107							
Ambient Light Susceptibility		22							
Temperature Characterization			Take readings at 25°C high, and low operating temperatures	X					
SUBGROUP 2						[1]	[2]	[2]	
Insert Retention 3/	2010		75 psi, Two Directions	X 4/		1 (0)	1 (0)	1 (0)	
Contact Retention	2007		10 lb force, all Termini, do not make physical contact with optical surface	X		N/A	2 (0)	2 (0)	
Contact Insert and Remove Force			Insert and remove 9x measure force after first and last time			N/A	1 (0)	1 (0)	

Notes at the end of Table 3

Table 3 QUALIFICATION REQUIREMENTS FOR OPTICAL CONNECTORS 1/ (Page 2 of 4)

Test/Inspection	Test Method		Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/				
					Level 1			Level 2	Level 3
	MIL-STD-1344	EIA/ TIA-455			Military Specification	GSFC S-311	SCD Commercial	SCD	SCD Commercial
SUBGROUP 3					[2] 5/	[2]	[2]		
Tensile Load	2009		Condition C, 1 minute	X	2 (0)		2 (0)		
Cable Seal Flexing	2017			X	2 (0)	2 (0)	2 (0)		
Twist		36	100 times	X	1 (0)		1 (0)		
SUBGROUP 4					[1 Pair]	[1 Pair]	[1 Pair]	[1 Pair]	
Termini Engage/ Disengage	2014		Each Termini		1 Pair (0)	1 Pair (0)	1 Pair (0)	1 Pair (0)	
Coupling Torque	2013						1 Pair		
Mating Durability	2016		200 cycles, measure change in optical transmittance after every 100 cycles	X			1 Pair	1 Pair	

Notes at the end of Table 3

Table 3 QUALIFICATION REQUIREMENTS FOR OPTICAL CONNECTORS 1/ (Page 3 of 4)

Test/Inspection	Test Method MIL-STD-1344	Test Method EIA/TIA-455	Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/ Level 1 Military Specification	Level 1 GSFC S-311	Level 1 SCD Commercial	Level 2 SCD	Leve 3 SCD Commercial
SUBGROUP 5					[2 Pairs]	[2 Pairs]	[2 Pairs]	[2 Pairs]	2 [Pairs]
Impact	2015		16 drops from 8 feet	X	1 (0)	1 (0)	1 (0)	1 (0)	
Temperature Cycling	1003		100x, use storage temperature range	X	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated
Shock	2004		300G, 3ms, half sine	X	1 Pair Mated	1 Pair Mated	1 Pair Mated	1 Pair Mated	
Vibration	2005		Condition IV (20G, Sine) monitor optical discontinuity per EIA/TIA-455-32	X	1 Pair	1 Pair	1 Pair	1 Pair	2 Pairs Mated
Tensile Loading at low temperature (Life) 6/		97	Excert a 45 newton load on the cable in accordance with EIA/TIA-455-33 instead of using point bends	X	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated	2 Pairs Mated
SUBGROUP 6					[6]	[7]	[7]	[7]	[2]
Optical Tests									
Insertion Loss		34			All Test Parts	All Test Parts	All Test Parts	All Test Parts	
Return Loss		107							
Ambient Light Susceptibility		22							

Notes at the end of Table 3

Table 3 QUALIFICATION REQUIREMENTS FOR OPTICAL CONNECTORS 1/ (Page 4 of 4)

Test/Inspection	Test Method MIL-STD-1344	Test Method EIA/TIA-455	Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/ Level 1 Military Specification	Level 1 GSFC S-311	Level 1 SCD Commercial	Level 2 SCD	Leve 3 SCD Commercial
SUBGROUP 7 7/				[1]	[1]	[1]	[1]	[1]	[1]
Magnetic Permeability (when applicable)	3006		And MIL-I-17214	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	
Residual Magnetism (when applicable)			GSFC S-311-P-4, Para. 4.5.1.1	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	
Hermeticity (when applicable)	1008			1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
Outgassing (when applicable)			ASTM-E595, TML ≤ 1.0%, CVCM ≤ 0.1%	8/	8/	8/	8/	8/	8/

Notes:

1/ With the exception of visual, mechanical, outgassing, and all Subgroup 2 tests, connectors shall be assembled with applicable ferrules and cable. See XTE-ELEC-PROC-022 for termination guidelines.

2/ Part quantities shall include as many mated connector pairs as possible, completely filled with Termini (as applicable). The total number of parts required for each subgroup is shown in [ ]. Extra mating halves may be required for the change in optical transmittance tests.

3/ This test applies to multiterminus connectors.

4/ Test connector halves separately with mating "Control" halves.

5/ Subgroup 3 is required for military specification electrical connectors. These tests are included in military qualification requirements for optical connectors.

6/ These part types do not exhibit life failures due to exposure to high temperature. Aging of optical interconnections are related to the termination process (contraction of polymerics at low temperature) and crack propagation in the optical fiber. Static fatigue tests are used to accelerate crack growth (and may enable pistoning of the fiber in the ferrule).

7/ These tests are required as applicable for the part type being tested and the use application. These tests do not need to be performed on military specification parts whose specification includes the requirement.

8/ Each constituent organic material must be tested separately. Existing data listed in the NASA REF 1124 and MSFC-HDBK-527 may be used.

Table 3A QUALIFICATION REQUIREMENTS FOR OPTICAL CABLES (Page 1 of 4)

Test/Inspection	Test Method		Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/				
					Level 1			Level 2	Level 3
	MIL-STD-1344	EIA/ TIA-455			Military Specification	GSFC S-311	SCD Commercial	SCD	SCD Commercial
Visual and Mechanical			See Table 11 examine entire lot 2/		2 - 10 Meter Samples per spool	2 - 10 Meter Samples per spool	2 - 10 Meter Samples per spool	2 - 10 Meter Samples per spool	2 - 10 Meter Samples per lot
Attenuation Rate 3/		46	Measure the entire lot and each of the 10M samples. Use maximum, minimum and nominal application lengths.		Each Spool	Each Spool	Each Spool	Each Spool	Each Spool
Crosstalk (for multi-fiber cable)		42				N/A	Each Spool	Each Spool	Each Spool
Temperature Cycling	4004		Use maximum and minimum storage temperatures, 5X.	X			2 (0)	2 (0)	
Temperature Characterization			Measure change in optical transmittance at 25°C, minimum and maximum operating temperatures.	X	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)
Moisture Resistance	1004		The ends shall be protected during exposure. Inspect for jacket deformation or swelling.	X			2 (0)	2 (0)	
Cyclic Flexing		104 4/	Test at 25°C and minimum rated operating temperature, 100 cycles each.	X		2 (0)	2 (0)	2 (0)	
Crush		41 4/	Force $\geq$ 2000N/cm times the cable outer diameter.	X		2 (0)	2 (0)	2 (0)	

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR OPTICAL CABLES (Page 2 of 4)

Test/Inspection	Test Method		Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/				
					Level 1			Level 2	Leve 3
	MIL-STD-1344	EIA/ TIA-455			Military Specification	GSFC S-311	SCD Commercial	SCD	SCD Commercial
Cable Twist-Bend		91 4/	Test Load = 100N, 100 cycles at 25°C and at minimum operating temperature, precondition at each temperature for at least one hour				2 (0)		
Impact		25 4/	50 cycles at 25°C and 20 cycles at minimum operating temperature. Precondition at least one hour				2 (0)		
Corner Bend			Use MIL-C-85045, paragraph. 4.7.4.9.1	X		2 (0)	2 (0)	2 (0)	
Cable Jacket Tensile Strength and elongation	2001					2 (0)	2 (0)		
Cable to Cable Abrasion			Use MIL-C-85045, paragraph. 4.7.4.16.2			2 (0)	2 (0)		
Cable shrinkage			Age samples in an air circulating oven at 150°C for 6 hours min, measure change in length			2 (0)	2 (0)		
Blocking	4007				2 (0)	2 (0)	2 (0)		

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR OPTICAL CABLES (Page 3 of 4)

Test/Inspection	Test Method		Conditions	Post Test: Change in Optical Transmittance EIA/TIA-455-20	Quantity (Accept number) or LTPD 2/				
					Level 1			Level 2	Leve 3
	MIL-STD-1344	EIA/ TIA-455			Military Specification	GSFC S-311	SCD Commercial	SCD	SCD Commercial
Static fatigue at low temperature (aging)		97	Use minimum operating temperature	X	1000 hrs 2 (0)	1000 hrs 2 (0)	1000 hrs 2 (0)	500 hrs 2 (0)	200 hrs 2 (0)
Outgassing (when required)			Use ASTM-E-595, TML ≤ 1.0%, CVCM ≤ 0.1%		5/	5/	5/	5/	5/

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR OPTICAL CABLES (Page 4 of 4)

Notes:

1/ Quantities refer to the number of 10 meter lengths.

2/ Remove 10 meter samples from each spool.

3/ Low impact terminations should be used such that the termination itself or the related processing ofthe fiber does not impact the reliability of the cable or the attenuation measurements.

4/ During and after the test.

5/ The outgassing requirement is application driven. Each organic material shall be tested separately. Existing data listed in NASA Reference Publication 1124 and MSFC-HDBK-527 may be used instead of testing.

Table 4 VISUAL AND MECHANICAL INSPECTIONS FOR OPTICAL CONNECTORS

DIMENSIONS
WEIGHT
KEYING
MARKING (SHELL and INSERT)
WORKMANSHIP
PLATING QUALITY
FERRULE QUALITY
FERRULE HOLE CIRCULARITY AND CONCENTRICITY
INSERT QUALITY AND ORIENTATION
CONSTRUCTION AND ASSEMBLY

Table 4A VISUAL AND MECHANICAL REQUIREMENTS FOR OPTICAL CABLE

QUALITY AND WORKMANSHIP OF EACH CABLE COMPONENT
EVEN DISTRIBUTION OF STRENGTH MEMBERS
DIAMETERS
MARKING
FIBER COATING ADHESION
FIBER CIRCULARITY AND CONCENTRICITY
CABLE WEIGHT

SECTION F

FILTERS

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Table 1 FILTER REQUIREMENTS 1/

Selection Priority	Use As Is	Screen to Requirements in Table 2	Qualify to Requirements in Table 3
Level 1			
MIL-F-28861, Class S	X		
MIL-F-28861, Class B 2/	X		
SCD		X	X
Level 2			
MIL-F-28861, Class B	X		
MIL-F-28861, Class S	X		
MIL-F-15733		X	
SCD		X	X
Commercial		X	X
Level 3			
MIL-F-28861, Class B	X		
MIL-F-28861, Class S	X		
MIL-F-15733	X		
Commercial		X	

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

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-F-28861	Level 1 SCD	Level 2 SCD	Level 2 MIL-F-15733	Level 2 Commercial	Level 3 Commercial
1) Visual Inspection	Elements and subassemblies in accordance with paragraph 4.6.1.2	X	X			
2) External Visual	Dimensions, marking, workmanship	X	X		X	X
3) Thermal Shock	MIL-STD- 202, Method 107 Condition A except step 3 shall be 125°C	X 1/	X	X	X	
4) Voltage Conditioning (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	X 2/ 240	X 160	X 96	X 160	X 48
5) Insulation Resistance or DC Leakage Current	MIL-STD-202, Method 302, rated dc voltage applied for 2 minutes max., charging current of 50 mA max.	X 3/	X 3/	X	X	X
6) Capacitance to ground	MIL-STD-202, Method 305, 1.0±.2V RMS. 1 Mhz ±100khz for capacitors ≤100pF. 1khz ±100Hz for Capacitors ≥100pF	X	X	X	X	X
7) Dissipation factor	Frequency and voltage specified in 6) above. Accuracy shall be ± 2 percent.	X	X	X	X	
8) Insertion Loss	MIL-STD-220 and paragraph 4.6.5	X	X4/	X4/	X 4/	
9) Voltage Drop	ac and dc. Paragraph 4.6.6	X	X	X		
10) Radiographic Inspection	MIL-STD-202, Method 209 and paragraph 4.6.8	X				
11) Seal Test (Hermetic types only) Gross Leak Fine Leak	MIL-STD-202, Method 112 Condition A or B Condition C	 X X	 X		 X	

Notes:

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

2/ Polarity shall be reversed from first 24 to 72 hours. Refer to paragraph 4.6.2.2.2 and Figure 1 for test circuit.

3/ Shall be measured within 1 hour after voltage conditioning

4/ Insertion loss need only be performed at 25°C.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR FILTERS

Inspection Test	Test Methods and Procedures MIL-F-28861 Paragraph	Quantity (Accept number)		
		Level 1	Level 2	Level 3
		SCD	SCD or Commercial	
Group 1		4(0)	4(0)	NOT REQUIRED
Resistance to Solvents	3.21, 4.6.15	X	X	
Resistance to Soldering Heat	3.25, 4.6.20	X	X	
Solderability	3.31, 4.6.25	X	X	
Thermal Strength	3.29, 4.6.23	X	X	
Group 2		5(0)	5(0) OR 10(1)	
Shock (specified pulse)	3.28, 4.6.22	X(1500G'S)	X(100G'S)	
Vibration (high frequency)	3.22, 4.6.16	X	X	
Random Vibration	3.23, 4.6.17	X	X	
Moisture Resistance 2/	3.30, 4.6.24	X	X	
Seal (when applicable)	3.15, 4.6.9	X	X	
Destructive Physical Analysis	3.27, 4.6.21	X		
Group 3		22(0)	10(0)	
Life	3.32, 4.6.26	X	X	

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SECTION G

FUSES

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Table 1 FUSE REQUIREMENTS 1/

Selection Priority	Fuse Style and Type	Military Reference Specification	Level 1	Level 2	Level 3
Mil Specification SCD Commercial	FM Fuse, Cartridge, Instrument Type	MIL-F-23419	2/ 3/ 3/	2/ 3/ 3/	2/ 3/ 3/

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

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

3/ Fuses procured to SCD's or commercial fuses must meet the screening and qualification requirements of Tables 2 and 3.

Table 2 FUSE SCREENING REQUIREMENTS (Page 1 of 2)

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

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

2/ A minimum of three fuses shall be measured.

3/ 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.

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

Table 2 FUSE SCREENING REQUIREMENTS (Page 2 of 2)

Notes (continued):

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

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

7/ 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/	Notes	Quantity (Accept Number)		
			Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Table 2		100%	100%	100%
Group 1A			12(0)	6(0)	4(0)
Current-carrying Capacity	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) Fuse shall not blow	2/, 3/	X	X	X
Group 2			4(0)	2(0)	
Terminal Strength	MIL-STD-202, Method 211 Test Condition A or E (as applicable) Specified applied force Plug or lead terminals: 1. along terminal axis 2. ⊥ to terminal axis Ferrule type terminals: torque	3/	X	X	
Overload Interrupt	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 one minute	3/, 4/	X	X	

Notes at end of Table 3

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 2 of 4)

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

Notes at end of Table 3

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 3 of 4)

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

Notes at end of Table 3

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer 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 - 6 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 Revision 3 of NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

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SECTION H

MICROCIRCUITS, HYBRID

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Table 1 HYBRID MICROCIRCUIT REQUIREMENTS 1/ 2/

Selection Priority	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) Class K	X			
2) SCD 4/		X	X	X
3) Class H 3/		X		X
LEVEL 2:				
1) Class H		X		
2) Class K	X			
3) Compliant Non-JAN 7/		X	X 6/	
4) MFR Hi-Rel		X 8/	X 6/	X 5/
5) SCD 4/		X	X	X
6) Commercial		X	X	X
LEVEL 3:				
1) Class H		X		
2) Compliant Non-JAN		X		
3) MFR Hi-Rel		X		
4) Commercial		X		

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

2/ Level 1 and Level 2 custom hybrid microcircuits shall be procured to a user controlled specification which satisfies Level 1 requirements.

3/ Class H hybrid microcircuits are acceptable as Level 1 parts only when a Class K part is not available.

4/ Screening and qualification requirements for parts procured to SCDs are intended to be inclusive, i.e. tests need not be repeated if already required by the SCD.

5/ A DPA may be performed in lieu of element evaluation. The DPA shall include the element visual, wire bond evaluation and SEM evaluation (for Level 1) requirements of Table 4 as a minimum.

6/ Generic QCI data within 6 months of the lot date code or flight parts may be acquired and reviewed for acceptability in lieu of testing.

7/ Compliant Non-JAN hybrid microcircuits are acceptable as Level 2 parts only when a Class H part is not available.

8/ Screening attributes data on flight parts may be acquired and reviewed for acceptability in lieu of testing.

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

Inspection/Test	MIL-STD-883		Level 1		Level 2					Level 3			
	Methods	Conditions	SCD	Class H	Class H	Compliant Non-JAN	MFR Hi-Rel 1/	SCD	Commercial	Commercial	Class H	Compliant Non-JAN	MFR Hi-Rel 1/
Preseal Burn-In	1030		Optional										
Nondestructive Bond Pull PDA	2023		X 2% or 1 wire										
Internal Visual	2017		X				2/	X	X 2/				
Temperature Cycling	1010		X					X	X				
Constant Acceleration	2001	A, Y_1 Direction A or B	X					X	X				
PIND 3/	2020	A or B	X	X	X	X	X	X	X	X	X	X	X
Serialization			X										
Initial Electrical Measurements		As specified	X	X			X	X	X	X			
Burn-In 4/	1015	A, C, or D	320 Hours	160 Hours			160 Hours	160 Hours	160 Hours	96 Hours			
Interim Electrical Measurements 5/		As specified	X										
Final Electrical Measurements		As specified	X	X			X	X	X	X			
Calculate Delta and Percent defectives		As specified PDA	X 5%	X 5%			X 10%	X 10%	X 10%	20% 6/			
Hermeticity a. Fine Leak b. Gross Leak	1014	 A or B C	X	X			X	X	X				
Radiographic Inspection 7/			X	X									
External Visual			X	X			X	X	X	X			

Notes at the end of Table 2

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

Notes:

1/ Attributes data may be acquired and reviewed for acceptability in lieu of the required testing. Tests not included in data shall be performed by the user.

2/ DPA shall be performed on 5 samples in accordance with requirements of S-311-M-70 in lieu of internal visual. No failures are permitted.

3/ The lot may be accepted on any of the 5 runs if the percentage of defective devices is less than 1 percent or 1 device, whichever is greater. All defective devices shall be removed after each run. Lots which do not meet the 1 percent PDA on the fifth run, or exceed 25 percent defectives cumulative, shall be rejected for Grade 1 and Grade 2 devices.

4/ For Grade 1 hybrids, the burn-in shall be equally divided into 2 successive burn-ins.

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

6/ PDA applies only to functional failures. Delta calculations are not required.

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

Table 3 QUALIFICATION TEST REQUIREMENTS FOR HYBRID MICROCIRCUITS

Inspection/Test	MIL-STD-883		Level 1	Level 2				Level 3
	Methods	Condition	SCD	Compliant Non-JAN 2/	MFR Hi-Rel 2/	SCD	Commercial	Commercial
Group 1 Physical Dimensions 1/ Solderability Resistance to Solvents	2016 2003 2015	245°C ± 5°C	4(0)			4(0)	4(0)	Not Required
Group 2 Steady-State Life End-Point Electrical	1005	1000 hours at 125°C or equivalent, according to Table 1 of Method 1005	22(0)	12(0)	12(0)	22(0)	22(0)	
Group 3 Internal Water Vapor Content	1018	5000 PPM at 100°C	3(0) or 5(1)	3(0) or 5(1)	3(0) or 5(1)	3(0) or 5(1)	3(0) or 5(1)	
Group 4 Internal Visual and Mechanical Wire Bond Strength Element Shear	2014 2011 2019		2(0)	2(0)				
Group 5 ESD	3015	Group A-1	3(0)					

Notes:

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

2/ Generic data is acceptable. See Note 6, Table 1.

Table 4A ACTIVE ELEMENT EVALUATION REQUIREMENTS 1/

Group	Inspection/Test	MIL-STD-883		Quantity (Accept) Number		
		Method	Condition	Level 1	Level 2	Level 3
1	Element Electrical		Group A Tests at 25°C	100%	100%	
2	Element Visual	2010 2072 2/ 2073 2/		100%	100%	
3	Internal Visual	2010 2072 2/ 2073 2/		10(0)	3(0)	
4	Group 4 Stabilization Bake Temperature Cycling Mechanical Shock **or** (Constant Acceleration) Interim Electrical Burn-In Post Burn-In Electrical Steady State Life Final Electrical	 1008 1010 2002 (2001) 1015 1005 	 B, Y_1 Direction (A, Y_1 Direction) 240 hours at 125°C 3/ 1000 hours at 125°C 3/	10(0) X X X X X X X X X	10(0) X	Not Required
5	Wire Bond Evaluation	2011		10(0) or 20(1) wires	10(0) or 20(1) wires	
6	SEM Inspection	2018		See Method 2018		

Notes:

1/ Applies to hybrid procured to SCDs

2/ MIL-STD-750 Methods

3/ Post burn-in and final electrical tests shall consist of static tests (including functional tests) at 25°C, minimum, and maximum operating temperature.

Table 4B PASSIVE ELEMENT EVALUATION REQUIREMENTS 1/

Group	Inspection/Test	MIL-STD-883		Quantity (Accept) Number		
		Method	Condition	Level 1	Level 2	Level 3
1	Element Electrical		25°C	100%	100%	
2	Visual Inspection	2032		100%	22(0)	
3				10(0)	10(0)	
	Stabilization Bake	1008		X		
	Temperature Cycling	1010		X		Not
	Mechanical Shock **or**	2002	B, Y_1 Direction	X		
	Constant Acceleration	2001	A, Y_1 Direction	X		Required
	Voltage Conditioning **or**		As Specified			
	Aging (Capacitors)					
	Visual Inspection	2017				
	Electrical			2/	X 2/	
4	Wire Bond Evaluation	2011		10(0) or 20(1) wires	10(0) or 20(1) wires	

Notes:

1/ Applies to hybrids procured to SCDs

2/ Test at 25°C for the following characteristics (minimum):

a) Resistors: DC Resistive

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

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

Table 4C SAW ELEMENT EVALUATION REQUIREMENTS 1/

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

Notes:

1/ Applies to hybrids procured to SCDs

Table 4D SUBSTRATE EVALUATION REQUIREMENTS 1/, 2/

Group	Inspection/Test	MIL-STD-883		Quantity (Accept) Number		
		Method	Condition	Level 1	Level 2	Level 3
1	Element Electrical		25°C, as specified	100%	100%	Not Required
2	Visual Inspection	2032		100%	100%	
3	Physical Dimensions Visual Inspection Electrical	2016 2032	 3/ 25°C	5(0)	5(0)	
4	Conductor Thickness **or** Conductor Resistivity Film Adhesion Test Solderability	 4500 4/	As Specified 5/	3(0)	3(0)	
	TCR Wire Bond Evaluation Die Shear Evaluation	304 6/ 2011 2019		2(0) 10(0) or 30(1) wires 2(0)	2(0) 10(0) or 30(1) wires 2(0)	

Notes:

1/ Substrates fabricated by hybrid device manufacturer using a MIL-STD-1772 qualified process shall be exempt from this evaluation.

2/ Applies only to hybrid procured to SCDs

3/ Test for the following characteristics and as specified in acquisition 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.

4/ MIL-STD-977 Method.

5/ Solderable substrates only.

6/ MIL-STD-202 Method.

Table 4E PACKAGE EVALUATION REQUIREMENTS 1/

Group	Inspection/Test	MIL-STD-883 Method	MIL-STD-883 Condition	Quantity (Accept) Number Level 1	Quantity (Accept) Number Level 2	Level 3
1	Physical Dimensions	2016		3(0)	3(0)	Not Required
2	Solderability	2003	Soldering temperature 245°C ± 5°C	3(0)	3(0)	
3	Thermal Shock	1011	C, 20 cycles	3(0)		
	High Temperature Bake	1008	1 hour at 150°C			
	Lead Integrity	2004	B2 (lead fatigue)	15(0) leads	15(0) leads	
			D (leadless chip carriers)			
		2028	Pingrid Array			
	Seal	1014	A4 Unlidded Cases			
4 2/	Metal Package Isolation	1003	600V dc 100 nA maximum	3(0)	3(0)	
5 2/	Moisture Resistance	1009	A	5(0)	5(0)	

Notes:

1/ Applies only to hybrids procured to SCDs

2/ Generic data is acceptable for Group 4 and 5 tests for Level 2 devices.

SECTION I

MICROCIRCUITS, MONOLITHIC

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

Selection Priority	Use As Is	Screen To Requirements in Table 2	Qualify To Requirements in Table 3
LEVEL 1:			
1) Class V or S	X		
2) SCD 3/		X	X
1) Class Q or B 2/		X	
LEVEL 2:			
1) Class Q or B		X	
2) Compliant Non-JAN 5/		X	X 4/
3) Class V or S	X		
4) MFR. Hi-Rel		X 6/	X 4/
5) SCD 3/		X	X
6) Commercial		X	X
LEVEL 3:			
1) Compliant Non-JAN		X	
2) Class Q or B		X	
3) MFR Hi-Rel		X	
4) Class V or S	X		
5) Commercial		X	

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

2/ Class Q or B microcircuits are acceptable as a Level 1 part only when aClass V or S microcircuit is not available. Otherwise the Class V or S part should be used.

3/ Screening and qualification requirements for parts procured to SCDs are intended to be inclusive, i.e. tests need not be repeated if already required by the SCD.

4/ QCI attributes data within 6 months of the lot date code of flight parts may be purchased from the manufacturer and reviewed for acceptability in lieu of performing the required tests.

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

Notes (continued):

5/ SMD Class M or 883 compliant microcircuits are acceptable as a Level 2 part only when a Class Q or B microcircuit is not available. Otherwise the Class Q or B part should be used.

6/ 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.

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	SCD	Class Q or B	Class Q or B	Compliant Non-JAN 1/	MFR Hi-Rel	SCD	Commercial	Commercial	Class Q or B	Compliant Non-JAN 1/	MFR Hi-Rel
1. Wafer Lot Acceptance	5007		X										
2. Nondestructive Bond Pull	2023		X										
3. Internal Visual	2010	A or B	X				X 2/	X	X 2/				
4. Temperature Cycling	1010	C.	X				X	X	X				
5. Constant Acceleration	2001	E. Y_1 Orientation Only	X					X	X				
6. PIND 9/	2020	A	X	X	X	X	X	X	X	X	X	X	X
7. Radiographic 3/	2012	Two Views	X										
8. Serialization			X										
9. Initial Electrical Measurements 4/, 7		per applicable device specification	X	X				X	X	X			
10. Burn-In 5/ , 7/	1015	A, C or D Duration (hours)	X 72/240	X 48/160			X 160	X 160	X 160	X 48			
11. Final Electrical Measurements 6/, 7/		per Table III herein and applicable device specification	X Read/ Record	X Read/ Record			X	X	X	X			
12. Calculate Delta and Percent Defectives 8/		per Table III herein and applicable device spec. PDA	X 5%	X 5%			X 10%	10%	20%	30%			
13. Hermetic Seal a. Fine Leak b. Gross Leak	1014	 A or B C	X	X			X	X	X				
14. External Visual	2009	3 to 10X	X	X			X	X	X	X			

Notes at end of Table 2

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

Notes:

1/ Lot specific attributes data can be acquired and reviewed in lieu of the required burn-in and electrical testing.

2/ DPA shall be performed to the requirements of S 311-M-70 in lieu of Internal Visual. No failures are permitted.

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

4/ Read and record (as a minimum) Delta parameters listed in Table 3 at room temperature. The non-Delta parameters may be tested “go/no go”.

5/ See Table 3. The burn-in duration is indicated as "Static/Dynamic". For example, burn-in duration 72/240 requires 72 hours of static burn-in (if applicable) and 240 hours of dynamic burn-in (if applicable).

6/ If more than 1 burn-in type is required per Table 3, the delta parameters shall be measured after each required burn-in step. Also, the Delta and PDA calculations shall be made after each burn-in step.

7/ For custom designed programmable Application Specific Integrated Circuits, steps 9 through 11 shall be performed after the programming, even if they were performed on the blank devices.

8/ PDA applies to cumulative failures during all burn-in steps. For Level 1, cumulative catastrophic functional failures shall be less than 3% in order for the lot to be accepted. For Levels 2 and 3, PDA applies to the functional failures only.

9/ PIND testing need not be repeated

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

IC Type	Required Burn-In (Note 4)		Delta	Electrical Measurements (Notes 1, 2, 3)
	Static (Condition C)	Dynamic (Condition D)		
Digital Bipolar & Digital MOS/ BiCMOS: (Note 6) LOGIC (Gates, Buffers, Flip-Flops, Multiplexers, Registers and Counters) RAMs FIFOs Microprocessors Interface Peripherals ASICs FPGA, PROM, PLA (Note 5)	Not required for Digital Bipolar Technology. Required for Digital MOS Technology. $T_A \geq 125$ °C V_{in}= V_{DD} across one-half input pins and V_{SS} across the remaining inputs. V_{out}= 0.5 V_{DD} through R_L	Required for both technologies. $T_A \geq 125$ °C V_{in} = Square wave, 50% Duty Cycle to input pins and control pins. Frequency= 100 Hz to 1 Mhz. V_{out} = V_{CC} /2 or V_{DD}/2 through R_L.	ΔI_{CC} or ΔI_{DD}	**DC**: V_{IC}, V_{OH}, V_{OL}, I_{CC}(I_{EE}), I_{IL}, I_{IH}, I_{DD}, I_{OZL}, I_{OZH}, I_{OS} **AC:** T_{PLH}, T_{PHL}, T_{TLH}, T_{THL}, T_{PZH}, T_{PHZ}, T_{PLZ}, T_{PZL}, T_A, T_S, T_H **Functional Tests:** a) for simple logic devices,verify truth table b) for complex logic devices such as ASIC, FPGA, microprocessors, functional testing includes fault coverage calculations required per Mil-Std-883, Method 5012. c) for PROMs, check fuse map; for RAMs, perform pattern sensitive tests such as March, Galpat, etc.
Linear MOS, Bipolar, and Bi-FET: (Note 7) Op-Amp, Instrument Amplifiers, S/H, and Comparator	$T_A \geq 125$ °C V_{out}= Terminated to ground through R_L	$T_A \geq 125$ °C V_{in}= Square wave or sinewave F= 10Hz to 100 KHz, 50% duty cycle V_{out}= Terminated to ground through R_L	ΔI_{IB} ΔI_{IO} ΔV_{IO}	**DC**: I_{CC}, I_{EE}, I_{IO}, V_{IO}, V_{OPP}, A_V, CMRR, PSRR **AC**: Slew rate

Notes at end of Table 2A

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

IC Type	Required Burn-In (Note 4)		Delta	Electrical Measurement (Notes 1, 2, 3)
	Static (Condition C)	Dynamic (Condition D)		
Linear MOS, Bipolar and JFET: (Note 7) Line Drivers and Receivers	$T_A \geq 125$ °C V_{in}= V_{DD} max across one-half input pins and V_{SS} across the remaining inputs.	$T_A \geq 125$ °C V_{in}= Square wave at a specified frequency and duty cycle V_{out}= V_{CC} through R_L	ΔI_{CC} ΔI_{IH}	**DC**: V_{OH}, V_{OL}, I_{CC}, I_{IL}, I_{IH}, I_{OS} **AC**: T_{PLH}, T_{PHL}, T_{TLH}, T_{THL} **Functional Test**: verify truth table
Linear MOS, Bi-FET, and Bipolar: (Note 6) Analog Switches and Multiplexers	$T_A \geq 125$ °C V_{in}= V_{DD} max across one-half of inputs and V_{SS} across the other remaining inputs. V_{out}= ± V_{CC} through R_L	$T_A \geq 125$ °C V_{in}= Square wave F= 100 Khz and 50% duty cycle V_{out}= ± V_{CC} through R_L	I_{CC} $I_{D(OFF)}$ $I_{S(OFF)}$ $R_{(ON)}$	**DC**: I_{CC}, $I_{D(ON)}$, $R_{(ON)}$, $I_{D(OFF)}$, $I_{S(ON)}$, $I_{S(OFF)}$ **AC**: $T_{(ON)}$, $T_{(OFF)}$ break- before- make- time
Linear Bipolar: Voltage Regulators	$T_A \geq 125$ °C V_{out}= Terminated to ground through R_L	Not required	ΔI_{SCD} ΔV_{OUT}	**DC**: I_{CC}, V_{OUT}, I_{OS}, line/load regulation
Linear Bipolar: Pulse-width-modulator	Not required	$T_A \geq 125$ °C V_{out}= Terminated to ground through R_L R_{ext}, C_{ext} connected if applicable.	ΔI_{IO} ΔV_{REF}	**DC**: V_{REF}, I_{IB}, I_{IO}, I_{OS}, V_{IO}, V_{OL}, V_{OH}, A_V, CMRR, PSRR **AC**: T_R , T_F, f_{OSC}
Darlington Transistor Array	$T_A \geq 125$ °C V_{out}= 15 Vdc through R_L	Not required	ΔI_{CEX} Δh_{FE}	**DC:** $V_{CE(SAT)}$, V_F, I_{CEX}, I_F **AC**: h_{FE}, t_{PHL}, t_{PLH}
Linear CMOS Timers	$T_A \geq 125$ °C V_{out}= V_{CC} through R_L	Not required	ΔI_{CEX} ΔV_{OH} ΔV_{OL}	**DC**: V_{TRIG}, V_{TH}, V_R, V_{OL}, V_{OH}, V_{SAT}, I_{CC}, I_{TRIG}, I_{TH}, I_R, I_{CEX} **AC**: T_{TLH}, T_{THL}

Notes at end of Table 2A

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

IC Type	Required Burn-In (Note 4)		Delta	Electrical Measurement (Notes 1, 2, 3)
	Static (Condition C)	Dynamic (Condition D)		
Linear MOS and Bipolar: Active Filters	Not required	$T_A \geq 125$ °C V_{in}= Sine wave at Frequency < f_O V_{out}= Terminated to ground through R_L	ΔI_{CC} ΔV_{OS}	**DC**: I_{CC}, I_{SS}, V_{OS} **AC**: f_O, Q, input frequency range
Mixed Signal MOS, Bi-CMOS and Bipolar: (Note 7) Analog to Digital (A/D) Converters.	$T_A \geq 125$ °C V_{in} = Max analog dc input $V_{out} = V_{CC}/2$ through R_L	$T_A \geq 125$ °C V_{in}= Analog input to generate maximum digital codes. $V_{out} = V_{CC}/2$ through R_L	ΔI_{CC} ΔI_{EE} ΔV_{IO}	**DC**: V_{REF}, V_{OH}, V_{OL}, V_{IO}, I_{CC}, I_{EE}, I_{IL}, I_{IH}, I_{OZL}, I_{OZH}, I_{OS}, Zero Error, Gain Error, Linearity Error. **AC:** T_C, T_S, T_H **Functional Test:** Verify codes
Mixed Signal MOS, Bi-CMOS and Bipolar (Note 7) Digital to Analog (D/A) Converters.	$T_A \geq 125$ °C V_{in}= V_{DD} on one-half data inputs and V_{SS} on remaining inputs. V_{out}= Terminated to ground thru R_L	$T_A \geq 125$ °C V_{in} = Apply appropriate digital codes for all inputs and for control signals. V_{out} = Terminated to ground through R_L.	ΔI_{CC} ΔI_{EE}	**DC**: I_{CC}, I_{EE}, I_{IL}, I_{IH}, I_{OZL}, I_{OZH}, I_{OS}, Zero Error, Gain Error, Linearity Error, PSRR **AC:** T_C, T_S, T_H **Functional Test:** Verify codes

Notes:

1/ See MIL-S-1331 for symbol definitions.

2/ These are typically recommended electrical parameters. Since electrical parameters are device dependent, refer to detail specifications for actual DC and AC parametric test conditions and limits.

3/ For digital devices, all DC parameters, functional tests, and switching tests shall be tested at 25°C, at minimum operating temperature and at maximum operating temperature. AC tests (e.g CIN) are tested initially and after any design or process changes.

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

4/ Static and Dynamic burn-in shall be performed at maximum recommended operating supply voltage with V_{in} and R_L selected to assure that the junction temparature shall not exceed Tjmax specified for the device type.

5/ For one-time programmable devices (e.g. PROMs, PALs, and FPCAs), it is recommended that dynamic burn-in be performed on programmed devices with user application specific burn-in circuit for Level 1 and Level 2 programs. The post burn-in should include DC, AC and functional tests for user's program verification.

6/ Dynamic burn-in required for Grade 2 parts.

7/ Static or dynamic burn-in acceptable for Grade 2 parts.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR MONOLITHIC INTEGRATED CIRCUITS (Page 1 of 2)

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD					
			Level 1	Level 2				Level 3
	Methods	Conditions	SCD	Compliant Non-JAN 2/	MFR Hi-Rel 2/	SCD	Commercial	Commercial
SUBGROUP 1 1/			4(0)	4(0)		3 (0)	3 (0)	Not
Physical Dimensions	2016		X	X		X	X	Required
Solderability	2003 or 2022	Soldering temperature of 245 °C ± 5 °C	X	X		X	X	
Resistance to Solvents	2015		X	X				
Lead Integrity	2004 or 2028		X 4/	X 4/				
SUBGROUP 2			5(0)	5(0)		3(0)	3(0)	
Internal Water Vapor Content	1018	5,000ppm maximum water content at 100 °C	X 5/					
Decap-Internal Visual	2010 2013 2014	Cond. A (grade1), Cond. B (all other grades).	X	X				
Bond Strength (1) Thermocompression (2) Ultrasonic or Wedge (3) Flip-Chip (4) Beam Lead	2011	All wire bonds Condition C or D Condition C or D Condition F Condition H	X	X				
SEM	2018		X	X				
Die Shear	2019		X	X				

Notes at the end of Table 3

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

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD					
			Level 1	Level 2				Level 3
	Methods	Conditions	SCD	Compliant Non-JAN 2/	MFR Hi-Rel 2/	SCD	Commercial	Commercial
SUBGROUP 3			10	10	10	10	10	
Operation Life Test 6/	1005	Condition D, 1000 hours at maximum operating junction temperature	X	X	X	X	X	Not Required
Electrical Measurements		per applicable Device specification and Table 3 herein.	X	X	X	X	X	

Notes:

1/ Subgroup 1 can be performed on electrical rejects.
2/ Generic QCI attributes data is acceptable. See Note 4 of Table 1.
3/ Lot specific QCI attributes data is acceptable. See Note 5 of Table 1.
4/ The lead integrity test shall be performed on 15 leads from 1 device,or all leads of 1 device if there are fewer than 15 leads per device package.
5/ The sample size for the internal water vapor content test shall be 3(0) or 5(1).
6/ Use conditions specified in Table 3 (dynamic burn-in condition as applicable).

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SECTION J

MAGNETICS

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TABLE 1 MAGNETIC PART REQUIREMENTS 1/ 2/

Selection Priority	Procurement Military Specification	Level 1	Level 2	Level 3
INDUCTORS/COILS				
RF Fixed Coils	MIL-C-39010	R, P 3/	R, P	(P)
RF Fixed and Variable Coils	MIL-C-15305	4/	5/	X
RF Fixed and Variable Chip Coils	MIL-C-83446	4/	X	X
Inductors, Power, Audio, Charging, and Saturable	MIL-T-27 6/		X	X
SCD		4/	4/	4/
Commercial			4/	4/
Transformers				
RF Fixed and Variable	MIL-T-55631	4/	X	X
Lower Power Pulse	MIL-T-21038	4/	X	X
Transformers Power, Audio, Charging, and Saturable	MIL-T-27 6/	X	X	X
SCD		4/	4/	4/
Commercial			4/	4/

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types. 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.

3/ MIL-C-39010 provides for R and P established reliability failure rate levels. If the R FRL is not available, P Level coils shall be screened to MIL-STD-981 for Level 1 applications. R Level coils require 100% X-Ray.

4/ Screening to the requirements of Table 2 and qualification testing to the requirements of Table 3 is required.

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

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

TABLE 1A MAGNETIC PART FAMILIES AND GROUPS

Group Part Types	Family	Applicable Military Specification
GROUP 1		
Power Transformers	03	MIL-T-27
Power Inductors	04	MIL-T-27
Audio Transformers	21	MIL-T-27
Audio Inductors	20	MIL-T-27
High Power Pulse Transformers	36	MIL-T-27
Charging Inductors	37	MIL-T-27
Saturable Transformers	40	MIL-T-27
Saturable Inductors	41	MIL-T-27
RF Fixed and Variable Transformers	11, 12	MIL-T-55631
Low Power Pulse Transformers	31	MIL-T-21038
GROUP 2		
RF Fixed and Variable Coils	13, 14	MIL-C-15305
GROUP 3		
RF Fixed and Variable Chip Coils	50, 51	MIL-C-83446

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

Inspection/Test	Part Types	Test Methods and Conditions 1/	Part Type								
			Group 1 Level			Group 2 Level			Group 3 Level		
			1	2	3	1	2	3	1	2	3
External Visual and Dimensional Inspection	All	As specified in the detailed drawing. As a minimum shall include, material, physical dimensions and configuration, weight, marking and workmanship. 2/	X	X	X	X	X	X	X	X	X
Electrical Characteristics											
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 1000 Mohms minimum.	X	X	X	X	X	X	X	X	X
DC Winding Resistance	All	Use Kelvin bridge or equivalent for resistances less than one ohm. Pre and Post thermal shock delta R limit sheall be less than 3 percent.	X	X	X	X	X	X	X	X	X
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.	X	X	X	X	X	X	X	X	X

Notes at the end of Table 2

Table 2 MAGNETICS SCREENING REQUIREMENTS (Page 2 of 3)

Inspection/Test	Part Types	Test Methods and Conditions 1/	Part Type								
			Group 1 Level			Group 2 Level			Group 3 Level		
			1	2	3	1	2	3	1	2	3
Turns Ratio or Voltage Ratio		Apply 1 Vrms at a specified frequency to each set of primary windings, monitor voltage across each secondary winding. The ratio not to exceed the specified limit. Use Wayne Kerr or equivalent instrument.	X	X	X						
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.	X	X	X						
Thermal Shock		MIL-STD-202, Method 107									
25 Cycles	All	Continually monitor during	X			X	X		X	X	
10 Cycles		final cycle to verify no		X				X			X
5 Cycles		intermittent conditions. 3/			X						
Vibration	All	MIL-STD-202, Method 204. Test Condition as specified in the detail drawing.	X			X					
Burn-In		MIL-STD-981, App. B, Paragraph									
No Load	Inductors/Coils	30.1.2 for Group 1	X	X		X	X		X	X	
Power	Transformers <0.8 watts Output	30.3.2 for Group 2	X	X							
Power with Max Rated Load	Transformers ≥ 0.8 watts output	30.5.2 for Group 3 96 hours at max. temperature 4/	X	X							

Notes at the end of Table 2

Table 2 MAGNETICS SCREENING REQUIREMENTS (Page 3 of 3)

Inspection/Test	Part Types	Test Methods and Conditions 1/	Part Type								
			Group 1 Level			Group 2 Level			Group 3 Level		
			1	2	3	1	2	3	1	2	3
Seal	If Applicable	MIL-T-27 Paragraph 4.8.7	X	X							
D W V	All	MIL-STD-202, Methods 301 and 105 5/	X	X	X	X	X	X	X	X	X
Q	All	As Specified				X	X		X	X	
Induced Voltage	Transformers with greater than 25 volts per winding	MIL-T-27 Paragraph 4.8.9. 2 times rated voltage 6/	X	X	X						
Self Resonant Frequency	All	As Specified 7/				X	X		X	X	
Electrical Characteristics	All	As Specified	X	X	X	X	X	X	X	X	X
Radiographic	All	MIL-STD-981 Appendix C	X			X			X		
Visual	All	As Specified	X	X	X	X	X	X	X	X	X
Group "B"	All	MIL-STD-981 Tables IV, V, VI, and VII	X			X			X		

Notes:

1/ Unless otherwise specified, all inspection measurements and test shall be conducted at a temperature of +25°C (+5°C), a pressure of no less than one standard atmosphere and a relative humidity of between 30 and 70 percent.

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

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

4/ For power burn-in, apply rated input current and voltage at minimum rated frequency and at maximum rated load.

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

6/ For saturating core, applied voltage shall be 2 times rated peak to peak voltage at 2 times rated frequency. For pulse transformers, the applied voltage shall be as specified in Table XIII of MIL-T-27.

7/ Use instrument such as McGraw-Edison Model 159LF or equivalent.

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 1 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Group 1 Level			Group 2 Level			Group 3 Level		
		1	2	3	1	2	3	1	2	3
Subgroup I 2/		All (0)	All (0)	All (0)	All (0)	All (0)	All (0)	All (0)	All (0)	All (0)
Thermal Shock Screening	MIL-STD-202, Method 107	X	X	X	X	X	X	X	X	X
Winding Continuity	Use any suitable means to check the continuity of all windings	X	X	X	X			X	X	X
Dielectric Withstanding Voltage At atmospheric pressure At reduced pressure	 MIL-STD-202, Method 301. Leakage current shall be as specified in the detailed part drawing. MIL-STD-202, Method 105. Leakage current shall be as specified in the detailed part drawing.	X	X		X	X		X	X	
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 1000 Mohms minimum.	X	X		X	X		X	X	
Winding Inductance	Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	X	X		X	X		X	X	
Q	The test shall be performed by using any suitable equipment such as the HP260A, HP4342A, HP250B, HP4192A, HP4194A Rx meter or equivalent. Suitable means shall be used to calibrate the frequency of the instrument to within ±0.1 percent of the applicable test frequency specified in the respective MIL-STD's.				X	X		X	X	

Notes at the end of Table 3

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 2 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Group 1 Level			Group 2 Level			Group 3 Level		
		1	2	3	1	2	3	1	2	3
Self Resonant Frequency	Use MIL-C-15305, Paragraph 4.8.8.3 or MIL-C-83446, Paragraph 4.6.7.3 as applicable.				X	X		X	X	
D C Winding Resistance	Use Kelvin bridge or equivalent for resistances less than 1ohm.	X	X		X	X		X	X	
Visual and Mechanical Examination (external)	As specified in the detailed drawing. As a minimum shall include, materials, physical dimensions and configuration, weight, marking, and workmanship.	X	X	X	X	X	X	X	X	X
Subgroup II		6 (0)	4 (0)	4 (1)	6 (0)	4 (0)	4 (1)	6 (0)	4 (0)	4 (1)
Operating Torque (when Applicable)	In accordance with MIL-C-15305, paragraph 4.8.7 or MIL-C-83446, paragraph 4.6.8.				X	X		X	X	
Temperature Rise	For Group 1, in accordance with paragraph 4.8.12 of MIL-T-27 For Group 2, in accordance with paragraph 4.8.9 of MIL-C-15305 For Group 3, in accordance with paragraph 4.6.12 of MIL-C-83446	X	X		X	X		X	X	
Overload	Perform test in accordance with: MIL-T-27-paragraph 4.8.20, MIL-C-83446-paragraph 4.6.13, MIL-C-15305-paragraph 4.8.10, or MIL-T-21038-paragraph 4.7.21 as applicable.	X	X		X	X		X	X	
Resistance to Soldering Heat	Perform in accordance with: MIL-T-27-paragraph 4.8.5, MIL-T-21038-paragraph 4.7.5, or MIL-T-55631-paragraph 4.7.13.	X			X					

Notes at the end of Table 3

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 3 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Group 1 Level			Group 2 Level			Group 3 Level		
		1	2	3	1	2	3	1	2	3
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.	X	X		X	X				
Induced Voltage 3/	MIL-T-27, Paragraph 4.8.9, 2X rated voltage. 4/ MIL-T-21038, Paragraph 4.7.9, 2X rated voltage. MIL-T-55631, Paragraph 4.7.4.	X	X	X						
Vibration	Perform test in accordance with: MIL-T-202, Method 204, specify the test condition, MIL-C-15305 - paragraph 4.8.15, MIL-T-21038 - paragraph 4.7.16 and MIL-T-55631 - paragraph 4.7.15.	X	X	X	X	X	X			
Shock	For MIL-T-27, MIL-T-21038 and MIL-T-55631 part types test in accordance with MIL-STD-202, Method 213, pulse as specified (Hor I). For MIL-C-15305, Paragraph 4.8.16, Test Condition I.	X	X	X						

Notes at the end of Table 3

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 4 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Group 1 Level			Group 2 Level			Group 3 Level		
		1	2	3	1	2	3	1	2	3
Dielectric Withstanding Voltage At reduced pressure	MIL-STD-202, Method 105. Leakage current shall be as specified in the detailed part drawing.	X	X		X	X		X	X	
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 1000 Mohms minimum.	X	X	X	X	X	X	X	X	X
Electrical Characteristics DC Winding resistance Winding inductance	Use Kelvin bridge or equivalent for resistances less than 1 ohms. Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	X	X	X	X	X	X	X	X	X
Visual and Mechanical Examination (external)	As specified in the detailed drawing. As a minimum shall include, materials, physical dimensions and configuration, weight, marking, and workmanship.	X	X	X	X	X	X	X	X	X

Notes at the end of Table 3

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 5 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number								
		Group 1 Level			Group 2 Level			Group 3 Level		
		1	2	3	1	2	3	1	2	3
Subgroup III		6 (0)	4 (0)		6 (0)	4 (0)		6 (0)	4 (0)	
Life	Transformers shall be subjected to five (5) life cycles a week for a minimum of twelve (12) weeks i.e., a total of 2016 hours. Four (4) of these cycles shall consist of a twenty (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 four (4) hour period of operation at room ambient temperature without excitation. The fifth (5) cycle of the week shall be a sixty-eight (68) hour period at a temperature of 85 degrees Celsius and a four (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.	X	X		X	X		X	X	

Notes at the end of Table 3

Table 3 MAGNETIC PART QUALIFICATION REQUIREMENTS (Page 6 of 6)

Inspection/ Test 1/	Test Methods and Conditions	Test Quantity (Accept Number)								
		Group 1 Level			Group 2 Level			Group 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-C-83446 types the test shall be conducted in accordance with paragraph 4.6.9 and MIL-STD-202, Method 108. For MIL-C-15305 types the test shall be performed in accordance with paragraph 4.8.13 MIL-STD-202, Method 108	X	X		X	X		X	X	
Electrical Characteristics DC Winding resistance Winding inductance	 Use Kelvin bridge or equivalent for resistances less than 1 ohms Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	X	X	X	X	X	X	X	X	X
Visual and Mechanical Examination (external)	As specified in the detailed drawing. As a minimum shall include, materials, physical dimensions and configuration, weight, marking, and workmanship.	X	X	X	X	X	X	X	X	X
Visual and Mech. Examination (internal) 2 units for Group 1, 2, and 3	MIL-STD-981, Appendix C	X	X		X	X		X	X	

Notes:

1/ For test methods, conditions, and requirements, refer to MIL-STD-981.

2/ Testing is not required for parts which have passed Screening per Table 2

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

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SECTION K

RELAYS

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Table 1 RELAY REQUIREMENTS 1/

Selection Priority	Use As Is	Screen To Requirements In Table 2	Qualification To Requirements In Table 3
LEVEL 1:			
1) S-311-P-754 2/	X		
2) SCD		X	X
LEVEL 2:			
1) MIL SPECIFICATION 3/	X		
2) SCD		X	X
3) S-311-P-754 2/	X		
4) COMMERCIAL		X	X
LEVEL 3:			
1) MIL SPECIFICATION 3/	X		
2) SCD		X	X
3) COMMERCIAL		X	X

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

2/ This specification covers all types of relays intended for Level 1 applications. A list of S-311-P-754 relays is given in Table 4 along with their applicable detail specifications.

3/ Military specified relays may be used as is provided they are procured to failure rate “M” or better. Select a low level relay (dc resistive contact rating of 2 amperes or less) from MIL-R-39016 or MIL-R-83536. For high level relays, use MIL-R-6106 or MIL-R-83536.

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

Inspection/Test	Test Methods, Conditions and Requirements 3/	Notes	Level 1	Level 2	Level 3
Cleaning and Small Particle Inspection	Manufacturer's approved procedure	4/, 5/	X	X	
Visual Inspection (External)	Materials, design, construction, header glass, marking, and workmanship	6/	X	X	X
Mechanical Inspections	Critical physical dimensions	7/	X	X	
Initial Electrical Inspections	Table 2A	8/	X		
Vibrational Scan (Sinusoidal)	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	8/, 9/, 10/ 11/, 12/	X		
PIND	Manufacturer's approved procedure	13/	X	X	
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)		X	X	
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.		X		

Notes at the end of Table 2

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

Inspection/Test	Test Methods, Conditions and Requirements 3/	Notes	Level 1	Level 2	Level 3
Run-In Tests	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 50µV load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 - 2500 cycles Level 2 - 1000 cycles Miss level: 100 ohms maximum	14/	X	X	
	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 50µV load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 - 2500 cycles Level 2 - 1000 cycles Miss level: 100 ohms maximum		X	X	
	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 50µV load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 - 2500 cycles Miss level: 100 ohms maximum		X		

Notes at the end of Table 2

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

Inspection/Test	Test Methods, Conditions and Requirements 3/	Notes	Level 1	Level 2	Level 3
Radiographic Inspection	MSFC-STD-355C		X		
Hermetic Seal	Fine leak: MIL-STD-202, Method 112 Test Condition C 1.0×10^{-8} cc/sec. or MIL-STD-883, Method 1014 Test Condition A1, A2, or B 1.0×10^{-8} cc/sec.		X	X	
	Gross Leak: MIL-STD-883, Method 1014 Condition D		X	X	
Final Electrical Inspections	Table 2A	8/, 15/	X	X	X
Percent Defective Allowable (PDA)	Level 1- 5% Level 2- 15%	 15/	X	 X	

Notes:

1/ This screening 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/ Screening in accordance with MIL-R-39016, MIL-R-6106, MIL-R-83536, or GSFC S-311-P-754 is acceptable in lieu of the screening specified in this table.

3/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

4/ If cleaning and small particle inspection are not performed, a DPA per S-311-M-70 is recommended.

5/ It is the responsibility of the user to approve manufacturer procedures for internal visual inspection and cleaning of relays prior to canning. Appendix A to MIL-R-83536 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review. The NASA/GSFC Parts Branch (Code 311) maintains a list of relay manufacturer approved procedures.

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

Notes (continued):

6/ 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 3 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 minimum sample quantity equal to that specified in Group 2 of Table 3A (for the applicable quality level) 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/ It is the responsibility of the user to approve manufacturer procedures for particle impact noise detection (PIND). Appendix B to MIL-R-83536 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review. The NASA/GSFC Parts Branch (Code 311) maintains a list of relay manufacturer approved procedures for PIND testing.

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/	Notes	Level 1	Level 2	Level 3
DC Coil Resistance	MIL-STD-202, Method 303		X	X	X
Static Contact Resistance or Contact Voltage Drop	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 High level relays MIL-STD-202, Method 307 Test load: rated dc resistive contact current at 6 V maximum (dc or peak ac) No actuations prior to measurement Measurements between all contact pairs One measurement for each of ten actuations (use average value) Contact voltage drop to specification	3/	X or X	X or X	X or X
Pickup, Hold, and Dropout Voltages or Latch/Reset Voltages	Nonlatching 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 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 contacts switch Reset voltage to specification	4/	X or X	X or X	X or X

Notes at the end of Table 2A

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	Level 1	Level 2	Level 3
Operate and Release Time	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 5 times Operate and release time to specification based on the average of 5 consecutive measurements	3/, 5/	X	X	
Contact Bounce Time	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 5 times Contact bounce time to specification based on the average of 5 consecutive measurements	3/, 6/	X	X	
Contact Stabilization Time (when specified)	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 5 times Contact stabilization time to specification based on the average of 5 consecutive measurements	3/, 7/	X		
Dielectric Withstanding Voltage	MIL-STD-202, Method 301 Specified test voltage Leakage current to specification	8/, 9/, 10/	X		
Insulation Resistance	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	9/	X		
Coil Transient Suppression	Use oscilloscope or other acceptable means to observe magnitude of the induced voltage transient across the coil(s) Rated coil voltage The maximum of three consecutive readings shall be recorded Back EMF (induced voltage) to specification	11/	X	X	

Notes at the end of Table 2A

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	Level 1	Level 2	Level 3
Neutral Screen	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	12/, 13/	X	X	
Non-Make-Before-Break	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	3/	X		

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 define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

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.

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

Notes (continued):

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 which 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/	Notes	Quantity (Accept Number)		
			Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Table 2		100%	100%	100%
Group 2			9(0)	6(0)	3(0)
Thermal Shock	MIL-STD-202, Method 107				
	Level 1 - 25 cycles Level 2 - 10 cycles Level 3 - 5 cycles	4/, 5/, 6/, 7/	X	X	X
	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				
Shock, Specified Pulse	MIL-STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (g's, pulse time, waveform) Specified electrical load conditions Specified contact load Contact monitoring to specification	7/, 8/	X	X	
Vibration, Random	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	7/, 8/, 9/, 10/	X		

Notes at the end of Table 3

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

Inspection/Test	Test Methods, Conditions and Requirements 3/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 2 (continued)					
PIND	Manufacturer's approved procedure	11/	X	X	
Acceleration	MIL-STD-202, Method 212 Specified G's Acceleration to specification	7/, 12/, 13/	X	X	
Terminal Strength	MIL-STD-202, Method 211 Conditions A and C Applied force to specification	7/	X	X	
Electrical Inspections	Table 2A	6/	X	X	X
Hermetic Seal	Fine leak: MIL-STD-202, Method 112 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.		X	X	X
	Gross Leak: MIL-STD-883, Method 1014 Condition D		X	X	X
Group 3			6(0)	3(0)	
Resistance to Soldering Heat (when applicable)	MIL-STD-202, Method 210 Test Condition B IR to specification Coil resistance to specification Contact resistance to specification Pickup/hold/dropout or latch/reset voltages to specification	4/, 5/, 7/	X	X	
Electrical Inspections	Table 2A	6/	X	X	
Hermetic Seal	Same as Group 2		X	X	

Notes at the end of Table 3

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

Inspection/Test	Test Methods, Conditions and Requirements 3/	Notes	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 4			4(0)	4(0)	
Life	Maximum rated operating temperature Specified rated contact load (current and voltage) Specified cycling rate	14/, 15/			
	Level 1 - 25000 cycles		X		
	Level 2 - 10000 cycles			X	
	Contact monitoring to specification Static contact resistance or contact voltage drop≤ 2X initial specified value Case to ground fuse electrically continuous				
Terminal Strength	Same as Group 2	7/	X		
Electrical Inspection	Table 2A	6/	X		
Hermetic Seal	Same as Group 2		X		
Group 5			3(0)	3(0)	
Solderability (when applicable)	MIL-STD-202, Method 208		X	X	
Resistance to Solvents	MIL-STD-202, Method 215	7/	X	X	
Group 6					
Thermal Outgassing	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	16/	X	X	X

Notes at the end of Table 3

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

Notes:

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 MIL-R-39016, MIL-R-6106, MIL-R-83536, or GSFC S-311-P-754 is acceptable in lieu of the qualification specified in this table.

3/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer 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 inone 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-R-83536 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review. The NASA/GSFC Parts Branch (Code 311) maintains a list of relay manufacturer approved procedures for PIND testing.

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 100ma 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 Revision 3 of NASA Reference Publication 1124 that meet TML and CVCM limits are acceptable for use without further testing.

Table 4 NASA/GSFC RELAYS

GSFC Detail Specification 1/	Description	Similar Military Counterpart
S-311-P-754/01	Latching, 2PDT, TO-5 Can, Low Level	MIL-R-39016/12
S-311-P-754/02	Latching, 2PDT, TO-5 Can, Low Level	MIL-R-39016/29
S-311-P-754/03	Nonlatching, 2PDT, TO-5 Can, Low Level	MIL-R-39016/ 9
S-311-P-754/04	Nonlatching, 2PDT, TO-5 Can, Low Level	MIL-R-39016/15
S-311-P-754/05	Nonlatching, 2PDT, TO-5 Can, Low Level	N/A
S-311-P-754/06	Nonlatching, 2PDT, 1/2 Crystal Can, High Level	MS27401
S-311-P-754/07	Nonlatching, 2PDT, 1/2 Crystal Can, Low Level	MIL-R-39016/13
S-311-P-754/08	Latching, 4PDT, Low Profile Can, Low Level	MIL-R-39016/31
S-311-P-754/09	Nonlatching, 4PDT, Low Profile Can, Low Level	MIL-R-39016/14
S-311-P-754/10	Nonlatching, 4PDT, One Inch Cube, High Level	MS27400
S-311-P-754/11	Latching, 3PDT, One Inch Cube, High Level	MS27742

Notes:

1/ Part numbers with complete descriptions of relay characteristics are in the detail specifications.

SECTION L

RESISTORS

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Table 1 RESISTOR REQUIREMENTS 1/ (Page 1 of 2)

Selection Priority	Resistor Style And Type		MIL/NASA/DESC Reference Specification	Failure Rate Level Required 2/ Level 1	Level 2	Level 3
Composition						
MIL Specification	RCR	Fixed, Established Reliability	MIL-R-39008	S	R, P	M
SCD				3/	3/	3/
Commercial				3/	3/	3/
Film/Foil						
MIL/NASA Specification	RFP	Fixed, Precision, Established Reliability	MIL-R-122	3/	B, F, J, N, R, V	A, E, I, M, Q, U
	RLR	Fixed, General Purpose, Established Reliability	MIL-R-39017	S	R, P	M
	RNX	Fixed, High Stability, Established Reliability	MIL-R-55182	S	R, P	M
	RM	Fixed, Chip, Established Reliability	MIL-R-55342	S	R, P	M
	RZ	Fixed, Network	MIL-R-83401	4/	4/	4/
	MOX	Fixed, High Voltage	S-311-P-683	5/	5/	5/
	HG	Fixed, High Voltage, Precision	S-311-P-672	5/	5/	5/
	TG	Fixed, High Voltage, Precision, Low TC	S-311-P-741	6/	6/	6/
	TK	Fixed, Precision, Low TC, Radial-Lead	S-311-P-742	5/	5/	5/
	TK	Fixed, Low TC, Precision, High Stability	S-311-P-794	6/	6/	6/
	VPR	Fixed, Foil, Precision, Power, Current Sensing	S-311-P-795	6/	6/	6/
	TK	Fixed, “Matched-Pair”, Low TC, Precision	S-311-P-796	6/	6/	6/
	1285G	Potentiometer, Precision Trimming	S-311-P-798	6/	6/	6/
	RJR	Variable, Lead Screw, Established Reliability	MIL-R-39035	R	R, P	M
DESC		Fixed, Network, 20-Pin, Leadless Chip Carrier	87016	5/	5/	5/
SCD				3/	3/	3/
Commercial				3/	3/	3/

Notes at the end of Table 1

Table 1 RESISTOR REQUIREMENTS 1/ (Page 2 of 2)

Selection Priority	Resistor Style and Type		MIL/NASA/DESC Reference Specification	Failure Rate Level Required 2/ Level 1	Level 2	Level 3
Wirewound						
MIL Specification	RBR	Fixed, Accurate, Established Reliability	MIL-R-39005	R	R, P	M
	RWR	Fixed, Power, Established Reliability	MIL-R-39007	S	R, P	M
	RER	Fixed, Power, Established Reliability	MIL-R-39009	R	R, P	M
	RTR	Variable, Lead Screw, Established Reliability	MIL-R-39015	R	R, P	M
SCD				3/	3/	3/
Commercial				3/	3/	3/

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2 through 5, for general part requirements applicable to all part types.

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

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

4/ Resistor networks with internal solder connections shall be rescreened by repeating the Subgroup 1, Group A inspection of MIL-R-83401 with the following exceptions: power conditioning time shall be 150 hours, and seal testing of hermetic networks need not be repeated.

5/ Resistors may be used "as is".

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

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

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type/Level								
			Composition			Film/Foil			Wirewound		
			1	2	3	1	2	3	1	2	3
Precap Visual Inspection	Networks: Particles, metallization (scratches, voids, adherence, bridging, alignment, corrosion, probe marks), laser trim faults, bonding pad defects, oxide defects Others: Not applicable	2/, 3/				X					
Visual Inspections	Materials, design, construction, marking, and workmanship	4/	X	X	X	X	X	X	X	X	X
Mechanical Inspections	Critical physical dimensions	5/	X	X		X	X		X	X	
Initial dc Resistance	MIL-STD-202, Method 303	6/, 7/, 8/	X	X	X	X	X	X	X	X	X
Thermal Shock	MIL-STD-202, Method 107 Level 1 - 25 cycles Level 2 - 10 cycles High temperature - max. rated operating Low temperature - min. rated operating	9/, 10/				X	X				
Conditioning or Overload	MIL-STD-202, Method 108 Specified rated wattage or voltage multiple Specified temperature Specified time If time ≤ 24 hours: continuous operation If time > 24 hours: 1.5 hours on, 0.5 hours off	9/, 10/ 11/, 12/				X	X		X	X	

Notes at the end of Table 2

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

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type/Level								
			Composition			Film/Foil			Wirewound		
			1	2	3	1	2	3	1	2	3
Final dc Resistance	MIL-STD-202, Method 303 Resistance and ΔR to specification					X	X				
Hermetic Seal	Fine leak: MIL-STD-202, Method 112 Test Condition C 5.0×10^{-7} cc/sec. (networks) 1.0×10^{-8} cc/sec. (others) Gross Leak: MIL-STD-883, Method 1014 Condition D	13/				X	X				
Radiographic Inspection	MSFC-STD-355C	14/				X			X		
Percent Defective Allowable (PDA)	Level 1 - 5% Level 2 - 15%	15/	X	X		X	X		X	X	

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

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/ 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/ 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.

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/ Out of tolerance composition resistors shall be baked in accordance with the SCD or manufacturer's instructions and then remeasured. 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/ Not applicable to chip resistors.

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

Notes (continued):

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

13/ Applicable only to hermetically sealed networks and resistors.

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

15/ 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 2A VARIABLE RESISTOR SCREENING REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions And Requirements 1/	Notes	Part Type/Level					
			Non-Wirewound			Wirewound		
			1	2	3	1	2	3
Visual Inspections	Materials, design, construction, marking, and workmanship		X	X	X	X	X	X
Mechanical Inspections	Critical physical dimensions	2/	X	X		X	X	
Thermal Shock	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	3/, 4/, 5/, 6/	X	X		X	X	
Conditioning	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	3/, 4/, 7/	X	X		X	X	
Total Resistance	MIL-STD-202, Method 303	4/			X			X
Contact Resistance Variation or Peak Noise	Contact resistance variation to specification, or Peak noise (resistance variation) to specification	8/	X	X		X	X	

Notes at the end of Table 2A

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

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type/Level					
			Non-Wirewound			Wirewound		
			1	2	3	1	2	3
Immersion	Gross leak: MIL-STD-202, Method 112, Test Condition D 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 continuous stream of bubbles emanating from any concentrated point on the resistor.		X	X		X	X	
Actual Effective Electrical Travel	Number of turns or angular degrees to specification	9/	X			X		
Absolute Minimum Resistance	Resistance to specification	10/				X	X	
End Resistance	Resistance to specification	11/	X	X		X	X	
DWV	MIL-STD-202, Method 301 Specified test voltage Between terminals tied together and all external metal portions Leakage current to specification	3/	X			X		
IR	MIL-STD-202, Method 302, Test Condition A or B Between terminals tied together and all external metal portions Resistance (minimum) to specification		X			X		
Torque	Operating torque to specification Clutch to specification (when applicable) Stop strength to specification (when applicable)	12/, 13/, 14/	X	X		X	X	
Radiographic Inspection	MIL-STD-202, Method 209	15/	X			X		

Notes at the end of Table 2A

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

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

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer 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 $V = \sqrt{PR}$.

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.

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

Notes (continued):

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.

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

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

Notes at the end of Table 3

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number)								
			Composition			Film/Foil			Wirewound		
			1	2	3	1	2	3	1	2	3
Group 3 (continued)											
Short-time Overload	Specified voltage (wattage) multiple Specified temperature Specified time ΔR to specification	5/	X	X		X	X		X	X	X
Terminal Strength	MIL-STD-202, Method 211 Conditions A and C Applied force to specification ΔR to specification	5/, 6/	X	X		X	X		X	X	
Hermetic Seal	Fine leak: MIL-STD-202, Method 112 Test Condition C 5.0×10^{-7} cc/sec.(networks) 1.0×10^{-8} cc/sec.(others)	8/				X	X	X			
	Gross Leak: MIL-STD-883, Method 1014 Condition D					X	X	X			
Group 4		7/	9(0)	6(0)		9(0)	6(0)		9(0)	6(0)	
Dielectric Withstanding Voltage	MIL-STD-202, Method 301 Between leads and conductive material surrounding body Specified test voltage ΔR to specification	5/	X	X		X	X		X	X	
Insulation Resistance	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Resistance (minimum) to specification		X	X		X	X		X	X	

Notes at the end of Table 3

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

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

Notes at the end of Table 3

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

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

Notes at the end of Table 3

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	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	Specified Temperature Specified no load dwell time ΔR to specification DWV to specification IR to specification	5/				X	X		X	X	
Group 10											
Thermal Outgassing	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	11/	X	X	X	X	X	X	X	X	X

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 define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

3/ These minimum samples sizes are required for qualification:

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

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.

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

Notes (continued):

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 film resistors.

9/ Applicable only to chip resistors.

10/ Applicable to resistors ≥1000 ohms.

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

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

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

Notes at the end of Table 3A

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	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	MIL-STD-202, Method 304 Specified test temperature sequence Specified reference temperature ppm/°C to specification	11/	X	X		X	X	
Moisture Resistance	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. Δ total resistance to specification DWV to specification IR to specification	7/, 11/	X	X		X	X	
Contact Resistance Variation or Peak Noise	Contact resistance variation to specification, or Peak noise (resistance variation) to specification	12/	X	X		X	X	
Group 4			12(0)	9(0)		12(0)	9(0)	
Setability	Setability to specification	13/	X	X		X	X	

Notes at the end of Table 3A

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

Inspection/Test	Test Methods, Conditions and Requirements 2/	Notes	Quantity (Accept Number)					
			Non-Wirewound			Wirewound		
			1	2	3	1	2	3
Group 4 (continued)								
Shock (specified pulse)	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 Δ total resistance to specification	7/, 11/, 14/, 15/	X	X		X	X	
Vibration, High Frequency	MIL-STD-202, Method 204 Specified test condition (amplitude, frequency range, sweep time and duration) Setting stability (Δ%) to specification Δ total resistance to specification	7/, 11/, 14/, 15/	X	X		X	X	
Contact Resistance Variation or Peak Noise	Same as Group 3	12/	X	X		X	X	
Group 5			9(0)	6(0)		9(0)	6(0)	
Resistance to Soldering Heat	MIL-STD-202, Method 210 Test Condition C Δ total resistance to specification	7/, 11/	X	X		X	X	
Low Temperature Operation	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 Δ total resistance to specification	7/, 11/, 15/, 16/	X	X		X	X	

Notes at the end of Table 3A

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

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

Notes at the end of Table 3A

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

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

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 define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

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

Notes (continued):

3/ These minimum sample sizes are required for qualification:

Level 1 - 54 resistors
Level 2 - 52 resistors
Level 3 - 9 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.

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.

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

Notes (continued):

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.

SECTION M

THERMISTORS

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Table 1 THERMISTOR REQUIREMENTS 1/

Selection Priority	Thermistor Style and Type		MIL/NASA Reference Specification	Level 1	Level 2	Level 3
POSITIVE TEMP COEFF						
Mil Specification	RTH	Resistor, Thermal, Insulated	MIL-R-23648	X	X	X
SCD				2/	2/	2/
Commercial				2/	2/	2/
NEGATIVE TEMP COEFF						
MIL/NASA Specification	RTH	Resistor, Thermal, Insulated	MIL-R-23648	X	X	X
	311P18	Thermistor, Insulated, and Uninsulated	S-311-P-18	X	X	X
	311-424	Thermistor, Super Stable, Encapsulated	S-311-424	3/	3/	3/
	311P767	Thermistor, Hermetically Sealed, Cryogenic	S-311-P-767	3/	3/	3/
SCD				2/	2/	2/
Commercial				2/	2/	2/

Notes:

1/ Refer to paragraph 6.0, INSTRUCTIONS, pages 2through 5, for general part requirements applicable to all part types.

2/ Thermistors procured to SCD's 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 3)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type					
			Positive Temp Coefficient			Negative Temp Coefficient		
			Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Visual Inspections	Materials, design, construction, marking, and workmanship		X	X	X	X	X	X
Mechanical Inspections	Body and lead dimensions to specification	2/	X	X	X	X	X	X
Zero-Power Resistance	MIL-STD-202, Method 203 Zero-power resistance at specified reference temperature Zero-power resistance at +125°C Zero-power resistance at specified reference temperature ΔR (zero-power) to specification	3/, 4/, 5/	X	X	X	X	X	X
Resistance Ratio Characteristic	If ΔR (zero-power) to specification, zero-power ratio (+125°C/reference temperature) to specification	4/, 5/			X			X
Thermal Shock	MIL-STD-202, Method 107 Level 1 - 25 cycles Level 2 - 10 cycles High temperature - +125°C Low temperature - min. rated operating	4/, 5/, 6/	X	X		X	X	
High Temperature Storage	+125°C, 100 hours, no load	4/, 5/, 6/	X	X		X	X	

Notes at the end of Table 2

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 2 of 3)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type					
			Positive Temp Coefficient			Negative Temp Coefficient		
			Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Zero Power Resistance	MIL-STD-202, Method 203 Zero-power resistance at specified reference temperature ΔR (zero-power) to specification	3/, 4/, 5/	X	X		X	X	
Insulation Resistance	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Specified minimum resistance		X	X		X	X	
Resistance Temperature Characteristic	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 3 points between reference temperature and each temperature extreme Level 2- reference temperature, each temperature extreme, and a minimum of 1 points between reference temperature and each temperature extreme	3/, 4/, 5/	X	X		X	X	

Notes at the end of Table 2

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 3 of 3)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Part Type					
			Positive Temp Coefficient			Negative Temp Coefficient		
			Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Percent Defective Allowable (PDA)	Level 1- 5% Level 2 - 15%	7/	X	X		X	X	

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer specification, or the application, whichever is most severe.

2/ A minimum of three thermistors shall be measured.

3/ Zero-power resistance shall be measured in a controlled uniform medium capable of maintaining an accuracy of ±0.05°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.

4/ 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.

5/ 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.

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

7/ 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/	Notes	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	Table 2	2/	X	X	X	X	X	X
Group 2			3(0)	3(0)		3(0)	3(0)	
Solderability (when applicable)	MIL-STD-202, Method 208		X	X		X	X	
Resistance to Solvents	MIL-STD-202, Method 215	3/	X	X		X	X	
Group 3			10(0)	5(0)		10(0)	5(0)	
Short Time Overload	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	3/	X	X		X	X	
Dielectric Withstanding Voltage	MIL-STD-202, Method 301 Between leads and conductive material surrounding body	3/	X	X		X	X	
Insulation Resistance	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Specified minimum resistance		X	X		X	X	
Low Temperature Storage	Specified low temperature for 3 hours min. ΔR (zero-power) to specification	3/	X	X		X	X	

Notes at the end of Table 3

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 2 of 4)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	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		X	X		X	X	
Thermal Time Constant	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	4/	X	X		X	X	
Terminal Strength	MIL-STD-202, Method 211 Test Condition A (disk and bead types) Test Conditions A and D (rod types) ΔR (zero-power) to specification	3/	X	X		X	X	

Notes at the end of Table 3

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	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)	3(0)	5(0)	3(0)	3(0)
Resistance Temperature Characteristic	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 3- reference temperature, each temperature extreme, and a minimum of 1 point between reference temperature and each temperature extreme				X			X
Resistance to Soldering Heat	MIL-STD-202, Method 210 Specified solder temperature Specified dwell time ΔR (zero-power) to specification	3/	X	X		X	X	
Moisture Resistance	MIL-STD-202, Method 106 Loading: 50% at maximum rated power 50% at no load IR to specification ΔR (zero-power) to specification	3/	X	X		X	X	

Notes at the end of Table 3

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 4 of 4)

Inspection/Test	Test Methods, Conditions and Requirements 1/	Notes	Quantity (Accept Number)					
			Positive Temp Coefficient			Negative Temp Coefficient		
			Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Group 5			10(0)	5(0)		10(0)	5(0)	
Load Life	MIL-STD-202, Method 108 Specified zero-power reference temperature Specified maximum rated power, 1.5 hours on, 0.5 hours off	3/						
	Level 1- 1000 hours		X			X		
	Level 2- 500 hours			X			X	
Group 6								
Thermal Outgassing	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	5/	X	X	X	X	X	X

Notes:

1/ It is the responsibility of the user to define test conditions and pass/fail criteria for each inspection not specified herein. These values should be based on the nearest equivalent military specification, manufacturer 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
Level 3- 3 thermistors

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

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

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

SECTION N

WIRE AND CABLE

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WIRE AND CABLE

GENERAL

Refer to paragraph, 6.0, INSTRUCTIONS, pages 2 through 5 for general part requirements applicable to all part types. The following additional 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.

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 of NASA Handbook 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 at lower pressure when unreacted additives, contaminants, absorbed gasses or moisture can evaporate and 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 when tested in accordance with ASTM-E595. Acceptable materials should be selected from NASA reference publication 1124 (Outgassing Data for Selecting Spacecraft Materials) or NASA-MSFC Handbook 527 (Materials Section List for Space Hardware Systems). However, materials listed as acceptable in these references may have been baked out for evaluation and the user may have to repeat this processing. Testing shall be performed in accordance with ASTM-E595 for materials which are not traceable to the above references. Processing usually consists of a bakeout at 125^0C and 10^{-6} TORR for 24 hours.

ATOMIC OXYGEN DEGRADATION

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

Table 1A WIRE AND CABLE REQUIREMENTS

Wire/Cable Specification Procured Part Priority 1/	Level 1	 2	 3
Insulated Hookup Wire			
MIL-W-22759	X	X	X
MIL-W-81381	X	X	X
SCD	2/, 3/	2/, 3/	N/A
Commercial	2/, 3/	2/, 3/	2/
High Voltage Insulated Hookup Wire			
GSFC S-311-P-13	2/	2/	2/
Coated Magnet Wire 4/			
J-W-1177	X	X	X
SCD	2/, 3/	2/, 3/	N/A
Commercial	2/, 3/	2/, 3/	2/
Multiconductor Cable 5/			
MIL-C-27500	X	X	X
SCD	2/	2/	N/A
Commercial	2/	2/	2/
Coaxial Cable			
MIL-C-17	X	X	X
SCD	2/, 3/	2/, 3/	N/A
Commercial	2/, 3/	2/, 3/	2/

Notes:

1/ For a detailed description of available wire and cable configurations, refer to Table 1B.

2/ Screening to Table 2 is required. All screening tests listed in table 2A through 2D, except outgassing, are normally performed on military wire & cable.

3/ Qualification to the requirements of Table 3 is required.

4/ For Level 1 applications, wire smaller than 38 AWG shall not be used. For Level 2 applications, wire smaller than 44 AWG shall not be used.

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 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.

Table 1B WIRE AND CABLE TYPES (Page 1 of 4)

Wire/Cable 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-22759/16	Tin Coated 600 Volt, 150°C, Medium Weight Insulation 3/
MIL-W-22759/18	Tin Coated 600 Volt, 150°C, Light Weight Insulation 3/
MIL-W-22759/32	Crosslinked ETFE, Tin Coated, 600 Volt, 150°C, Light Weight 3/
MIL-W-22759/34	Crosslinked ETFE, Tin Coated, 600 Volt, 150°C, Normal Weight 3/
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
FEP Fluorocarbon/Polymide (Kapton), Insulated, Copper of Copper Alloy.	
MIL-W-81381/7	Silver Coated, 600 Volt, 200°C
MIL-W-81381/8	Nickel Coated, 600 Volt, 200°C
MIL-W-81381/21	Tin Coated, 600 Volt, 150°C 3/
MIL-W-81381/9	Silver Coated, 600 Volt, 200°C
MIL-W-81381/10	Nickel Coated, 600 Volt, 200°C
High Voltage Hookup Wire	
GSFC S-311-P-13/1	Radiation Crosslinked Polyalkene Insulated, Tin Coated Copper, 600V, 135°C 3/
GSFC S-311-P-13/2	Radiation Crosslinked Polyalkene Insulated, Tin Coated Copper, 1000V, 135°C 3/
GSFC S-311-P-13/3	Radiation Crosslinked Polyalkene Insulated, Tin Coated Copper, 2500V, 135°C 3/
Chemically Coated Magnet Wire 2/	
J-W-1177/9	Solderable Polyurethane Overcoated with Polyamide, Copper, 130°C
J-W-1177/12	Polyester-Imide or Polyester-Amide-Imide Resin, Double Coated, Copper, 180°C
J-W-1177/14	Polyester, Polyester-Imide or Polyester-Amide-Imide Resin, Double Coated, Copper, 200°C
J-W-1177/15	Polyimide, Double Coated, Copper, 220°C

Notes at the end of Table 1B

Table 1B WIRE AND CABLE TYPES (Page 2 of 4)

Wire/Cable Specification	Description 1/
Multiconductor Cable	
MIL-C-27500 6/	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	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 178 Type
MIL-C-17/95	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 95 OHMS, 200°C Max, RG 180 Type (Note 5)
MIL-C-17/110	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 75 OHMS, 200°C Max, RG 302 Type (Note 5)
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	Semi Rigid, Seamless Copper Tubing, .141 OD, 20 GHZ Max, 50 OHMS, 125°C Max, RG 402 Type
MIL-C-17/133	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.
Bare Wire	
QQ-W-343	Wire, Electrical, Copper, Uninsulated, Solid

Notes at the end of Table 1B

Table 1B WIRE AND CABLE TYPES (Page 3 of 4)

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 (PVF_2) is Kynar (Pennwalt); Polyester is Dacron (Dupont); Polyimide is Kapton (Dupont)

2/ For available wire sizes, see Table 1A, Note 4. Copper is the preferred conductor material. Double coated wire is preferred. Use of single coated wire is discouraged.

3/ Tin coated conductors are recommended for use with solder type contacts, and are not recommended for use with crimp type contacts.

4/ All coaxial cables contain a solid extruded PTFE dielectric core.

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

6/ The following is a part number explanation for MIL-C-27500 cable with designations for preferred construction. Other destinations are available.

Part number explanation (Note 6-1).

M27500	X	XX	XX	X(X)	X	XX
Military Specification Number	**Braid Coverage**	**Wire AWG**	**Basic Wire Insulation Type**	**No. Of Wires**	**Shield Style and Material**	**Outer Jacket**
	- = 85% C = 90% (Note 6-2)	26 thru 2/0 (All conductors are same AWG)	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 TG=MIl-W-22759/18 Crosslinked ETFE SB=MIL-W-22759/32 SM=MIL-W-22759/41 SC=MIL-W-22759/33 SP=MIL-W-22759/43 SD=MIL-W-22759/34 SR=MIL-W-22759/44 SE=MIL-W-22759/35 SS=MIL-W-22759/45	1 thru 10	Round Shield with normal strength copper strands U = No Shield Single Shield S=Silver T= Tin Double Shield W=Silver V=Tin	00=No Jacket Single Jacket 06=PTFE Teflon (White) 09=FEP Teflon (White) 23=Crosslinked ETFE (White) Double Jacket (Note 6-3) 59=FEP Teflon (White) 73=Crosslinked ETFE (White)

Notes at the end of Table 1B

Table 1B WIRE AND CABLE TYPES (Page 4 of 4)

Notes:

6-1. Part number explanation is for preferred construction. Use M22759/11 (Symbol RC) or M22759/43 (Symbol SP) for base wire with silver coated copper single shield (Symbol S) and FEP teflon single jacket (Symbol 09) as first choice. Other options are shown on page 16-3. Example of complete part number with above options for three #22 AWG conductors: M27500-22RC3S09 or M27500-22SP3S09. Consult MIL-C-27500 for other options.

6-2. Designation shown for braid coverage includes preferred conductor identification method (white base color with color spiral stripe.) Optional solid identification color coding is available.

6-3. 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.

Table 1C INSULATION SELECTION GUIDELINES 1/ (1 of 2)

Insulation Types	Advantages	Disadvantages
FEP and PTFE (DuPont ™ Teflon)	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 5×10^5 RADS. 3. FEP has poor cut through resistance. 4. Heaviest insulation.
ETFE (DuPont ™ Tefzel)	1. Withstands physical abuse during and after installation. 2. Good high and low temperature properties. 3. High flex life. 4. Good outgassing characteristics. 5. 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
Crosslinked ETFE (DuPont ™ Tefzel)	1. Higher strength than normal ETFE. 2. Resistant to cold flow and abrasion. 3. More resistant to radiation effects. (to 5×10^7 RADS) 4. Higher maximum temperature than normal ETFE. Tin Coating = 150°C Max Silver Coating = 200°C Max 5. Good outgassing characteristics.	1. Some ETFE insulations fail flammability in a 30% oxygen environment. 2. Less flexible than extruded ETFE.
Aromatic Polyimide (DuPont ™ Kapton)	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.

Table 1C INSULATION SELECTION GUIDELINES 1/ (Page 2 of 2)

Insulation Types	Advantages	Disadvantages
Crosslinked Polyalkene	1. Dual extrusion which is fused by sintering. Combines excellent abrasion and cut through resistance of Polyvinylidene Fluride (PVDF, PVF_2 - 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/PVF_2. 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.

1/ Application Notes

A. Flammability properties of these wires are controlled by the applicable specifications. However, applications in Space Transportation System (STS) payloads may require that the specific STS flammability hazards be addressed. Users are advised to consult the appropriate project systems safety officer.

B. 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.

C. Wire size AWG24 and larger is preferred for conductors used in interconnecting cable and harness assemblies. High strength copper alloy shall be used for size AWG24 and smaller.

D. Some ETFE (Ethylene Tetrafluoroethylene) insulated wire has been found to fail flammability testing in a 30% oxygen environment.

E. Silver-coated copper is susceptible to cuprous oxide corrosion (“red plague”) when produced, stored or used in a moist or high humidity environments. The environment for this wire must be controlled.

F. Polyimide 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 stress 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 (1 of 2)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect for proper marking, insulation, and color per reference specification. Check insulation workmanship for cracks, splits. Use 3x magnification and adequate lighting.	1 foot sample per spool	1 foot sample per spool	1 foot sample per spool
Mechanical 1/, 3/	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.	1 foot sample per spool	1 foot sample per spool	
Impulse Dielectric Test 5/ (Chain Electrode Spark Test) (For finished wire and primary insulation of dual insulated wire. Also known as)	FED-STD-228 Method 6211.1 or MIL-STD-2223 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.	Entire length 2/	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 mandrell for four close turns. Sample shall be baked for 2 hours at the specified temperature. After cooling, the sample shall be examined for cracked insulation.	1 foot sample per spool	1 foot sample per spool	
Crosslinking Proof Test (Crosslinked ETFE Insulations Only)	MIL-STD-2223, Method 4001. A two foot sample shall be prepared by removing one inch of insulation from each end and draping it over a mandrel rod with diameter as specified. The ends shall be loaded with weights as specified. The sample 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.			

Notes at end of Table 2A.

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

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
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 delamination of the insulation.	1 foot sample per spool	1 foot sample per spool	
DC Resistance	FED-STD-228, Method 6021. Measurements shall conform to MIL-W-22759, Table II or as otherwise specified. Wire shall be tested dry without immersion.	Each spool		
Outgassing Control (When Required)	Outgassing paragraph (front of this section). For insulation materials with known stability from outgassing, a bakeout to reduce outgassing of contamination due to handling may be desirable at next assembly level.	X	X	X

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/ Test is normally a 100% screening test of finished wire performed during final winding of the wire on spools or reels by the manufacturer. 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 commercial high strength copper wire procured from a supplier which does not have a history of supplying reliable 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/ Test is used to determine if wire insulation is over sinteredresulting in degraded properties. For Telfon insulated wire, Differential Scanning Calorimetry (DSC) per ASTM-E794 may also be performed to determine if wire is undersintered 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.

Table 2B SCREENING REQUIREMENTS FOR COATED MAGNET WIRE (1 of 2)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect coating for workmanship. Coating shall be complete without porosity, blisters, wrinkles or runs. No portion of the conductor shall be exposed.	1 foot sample per spool	1 foot sample per spool	1 foot sample per spool
Mechanical 1/	Verify finish wire dimensions per reference specification.	1 foot sample per spool	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 and examine for cracks or separation as specified. For wire smaller than AWG 30, a 1/64 inch drill bit may be substituted. 3/	1 foot sample per spool		
Heat Shock 2/	Bake at maximum rated temperature 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, 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 breakroom.	Two-one foot samples per spool	Two-one foot samples per spool	
Outgassing Control (When Required)	Outgassing paragraph (front of this section).	Each spool	Each spool	Each spool

Notes at the end of Table 2B

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

Notes:

1/ 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/ Required for non-military, non-NEMA magnet wire only. Otherwise a certificate of compliance shall be supplied with the wire. Heat shock test must follow adherence and flexibility test.

3/ **Elongation Requirements**

AWG Size	Elongation Rate	Minimum Elongation	Mandrel Diameter	Examined With
Copper				
4-9	12 ± 1 in./min (300 25 ±	30%	none	3X-10X magnification
10-13	mm/min)	25%	5X	6X-20X magnification
14-30	12 ± 1 in./min (300 25 ±	20%	3X	10X-30X magnification
31-44	mm/min)	20% or breakage	3X or 0.0156 (1/64	30X-60X magnification
	sudden jerk		inch drill bit),	
	sudden jerk		whichever is greater	

Table 2C SCREENING REQUIREMENTS FOR RADIO FREQUENCY COAXIAL CABLE

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect for proper marking. Check outer jacket for cracks, splits. Use 3X magnification and adequate lighting.	1 foot sample per spool	1 foot sample per spool	1 foot sample per spool
Mechanical 1/	Verify dimensions per reference spec. Verify quantity and AWG of inner conductor and shield strands. Verify weight as necessary.	1 foot sample per spool	1 foot sample per spool	
Spark Test (Not Applicable to Copper Clad Semi-rigid Cable)	FED-STD-228 Method 6211.1 or MIL-STD-2223 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 specification at a frequency of 60Hz or 3K Hz shall be applied between the shield and electrode. Cable lengths which failed shall be removed.	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, 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/	Each spool 2/
Outgassing Control (When required; not applicable to semirigid cable)	Outgassing paragraph (Front of this Section). For insulation materials with known stability from outgassing, a bakeout to reduce outgassing of contamination due to handling may be desirable at next assembly level.	Each spool	Each Spool	Each spool

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 by the user or user designated test facility.

Table 2D SCREENING REQUIREMENTS FOR MULTICONDUCTOR CABLE (1 of 2)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect for proper marking. Check outer jacket for cracks, splits. Use 3X magnification and adequate lighting.	1 foot sample per spool	1 foot sample per spool	1 foot sample per spool
Mechanical 1/	Verify number of conductors, AWG and stranding of conductors, color coding or special marking of conductor insulations (as required). Inspect shield for corrosion or other discoloration, and inspect for mechanical damage or flaking of the finish. Measure jacket thickness. Verify weight as required.	1 foot sample per spool	1 foot sample per spool	
Spark Test of Cable Jacket (Jacket Flaws)	FED-STD-228 Method 6211.1 or MIL-STD-2223 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. Cable lengths which failed shall be removed.	Entire length 2/	Entire Length 2/	Entire length 2/
Dielectric Withstanding Voltage	FED-STD-228, Method 6111. 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/	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 testing device.	Each spool 2/	Each spool 2/	Each spool 2/
Outgassing Control (when required)	Outgassing paragraph (front of this section). For insulation materials with known stability from outgassing, a bakeout to reduce outgassing of contamination due to handling may be desirable at next assembly level.	Each spool	Each spool	Each Spool

Notes at the end of Table 2D

Table 2D SCREENING REQUIREMENTS FOR MULTICONDUCTOR CABLE (2 of 2)

Notes:

1/ A certificate of conformance from the manufacturer shall be delivered with the cable to certify that the proper conductor finish, insulations and jacket materials were used. The manufacturer shall also certify 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 or after 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 test by the user or user designate test facility.

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 1 of 4)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect for proper marking and insulation per reference specification. Check workmanship for insulation cracks, splits. Use 3X magnification and adequate lighting.	1 foot sample per spool	1 foot sample per spool	1 foot sample per spool
Mechanical 1/	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 coating shall not flake off from normal flexing.	1 foot sample per spool	1 foot sample per spool	
Impulse Dielectric Test 4/ (Chain electrode spark test) (For finished wire and primary insulation of dual insulated wire).	FED-STD-228 Method 6211.1 or MIL-STD-2223 Method 3002. Wire shall be passed through an energized 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.	Entire length	Entire length	Entire length
Insulation Resistance	MIL-STD-2223, 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, 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/	

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 2 of 4)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Solderability (Tin or silver coated conductors only)	MIL-STD-202, Method 208. Steam aging is not required.	1 foot per spool	1 foot per lot	
Wrap Test (Extruded insulations)	MIL-W-22759, Paragraph 4.6.2.2. 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, the sample shall be examined for cracked insulation.	1 foot sample per spool	1 foot sample 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/	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 60° 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	2 foot sample	
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 to prevent 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	

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 3 of 4)

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		LEVEL 1	LEVEL 2	LEVEL 3
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 applicable conductor material specification. (EX: ASTM-B298 for silver coated normal strength conductors)	1 foot sample per lot		
Crosslinking Proof Test	MIL-STD-223, Method 4001. A two foot sample shall be prepared by removing one inch of insulation from each end and draping it over a mandrel rod with diameter as specified. The ends shall be loaded with weights as specified. The sample shall be baked for 7 hours at 300°C or as otherwise specified in an air circulating oven. At completion of bake, the sample shall be allowed to cool to room temperature. 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 per spool		

Notes at the end of Table 3A

Table 3A QUALIFICATION REQUIREMENTS FOR INSULATED WIRE (Page 4 of 4)

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		
Outgassing (When Required)	Outgassing paragraph (Front of this section)	X	X	

Notes:

1/ The manufacturer shall certify that the proper conductor material and coating were used in the manufacture of the wire.

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

3/ When traceability to flammability test reports cannot be found (Reference flammability paragraph in front of this section), testing shall be performed as specified or as specified in NHB 8060.1C.

4/ The high frequency spark test, MIL-STD-2223 Method 3008, is an acceptable alternate to the impulse dielectric test.

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
Visual	Inspect coating for workmanship. Coating shall be complete without porosity, blisters, wrinkles or runs. No portion of the conductor shall be exposed.	1 foot sample per spool	1 foot sample per spool	
Mechanical 1/	Verify finish wire dimensions per reference specification.	1 foot sample per spool	1 foot sample per spool	
Adhesion and Flexibility	a. Clamp 10 inches apart, elongate and examine for insulation separation from the wire as specified. 2/ b. Wind around mandrel and examine for cracks or separation as specified. For wire smaller than AWG 30, 1/64 inch drill bit may be substituted. 2/	1 foot sample per spool		
Heat Shock	Bake at maximum rated temperature for 30 minutes. Examine for cracks at specified magnification. 2/	1 foot sample per spool	1 foot sample per spool	
Dielectric Strength Twist Test	ASTM-D1676, 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. 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	
Elongation	ASTM-D1676, paragraphs 125 through 128. Specimen shall be clamped for an effective length of 10 inches. Elongate to value as specified.	Three 12 inch specimens		
Springback	ASTM-D1676, paragraphs 154 and 155. Magnet wire is wound under mild stress on to a mandrel with diameter as listed in ASTM-D1676 table 13. 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		

Notes at end of Table 3B

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
Scrape Resistance	ASTM-D1676, paragraphs 170 through 176. Scraping device shall be 0.009 inch diameter steel music wire held rigidly between two jaws, and scraped perpendicular to the 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. If no failure occurs, increase force in steps of 20% 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 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		
Outgassing (When Required)	Outgassing paragraph (Front of this section)	X	X	

Notes:

1/ 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/ **Elongation Requirements**

AWG Size	Elongation Rate	Minimum Elongation	Mandrel Diameter	Examined With
Copper				
4-9	12 ± 1 in./min (300 25 ±	30%	none	3X-10X magnification
10-13	mm/min)	25%	5X	6X-20X magnification
14-30	12 ± 1 in./min (300 25 ±	20%	3X	10X-30X magnification
31-44	mm/min)	20% or breakage	3X or 0.156 (1/64	30X-60X magnification
	sudden jerk		inch drill bit),	
	sudden jerk		whichever is greater	

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

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Visual	Inspect for proper marking. Check wire jacket for cracks and splits. Use 3x magnification and adequate lighting.	1 foot sample per spool	1 foot sample per lot	
Mechanical 1/	Verify dimensions per reference specifications. Verify quantity and AWG of inner conductor strands and shield strands. Verify weight as necessary.	1 foot sample per spool	1 foot sample per lot	
Spark Test (not applicable to copper clad semi rigid cable)	FED-STD-228 Method 6211.1 or MIL-STD-2223 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 specification at a frequency of 60 HZ or 3 KHZ shall be applied between the shield and electrode. Cable lengths which fail shall be removed.	Entire length	Entire length	
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	
Voltage Withstanding	FED-STD-228, 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	Each spool	
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	

Notes at the end of Table 3C

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

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
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° C. After 96 hours, 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		
Dimensional Stability	MIL-C-17, paragraph 4.8.20 <u>Flexible Cable</u> 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.	Flexible type, one sample per lot 5-foot, minimum		

Notes at the end of Table 3C

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

Inspection/Test	Test Methods, Conditions and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Dimensional Stability (Cont'd)	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.	Semi-rigid type, one sample per lot, 4 foot minimum		
Flammability 2/ (Not applicable to Semi-Rigid Cable)	MIL-C-17, Paragraph 4.8.23. In chamber, suspend test specimen 60° 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		
Outgassing (when required)	Outgassing paragraph (Front of this section)	X	X	

Notes

1/ The manufacturer shall certify that the proper inner conductor, shield materials and finish were used in the manufacture of the cable.

2/ Test is used as a 100% screening test of finished cable during or afterfinal winding of the cable on spools or reels by the manufacturer.

3/ When traceability to flammability test reports cannot be found (Reference flammability paragraph in front of this section), testing shall be performed as specified or as specified in NHB 8060.1C.

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