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EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating

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SECTION 1: PURPOSE, SCOPE, AND GENERAL INSTRUCTIONS APPLICABLE TO ALL EEE PART CATEGORIES

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This section provides a description of the purpose of this document, its scope, and general instructions that apply to each of the 18 electrical, electronic, and electromechanical (EEE) part categories that are covered in this document. An electronic copy of this document can be downloaded from http://nepp.nasa.gov. The electronic copy provides a direct link to the military/industry specifications and standard test methods listed in each section. However, users shall independently verify that the specifications and Test Methods are the latest revisions issued by the responsible authority.

Due to the dynamic nature of this document, users are advised to check the http://nepp.nasa.gov website prior to every usage to obtain the latest document revision.

1.0 PURPOSE

The purpose of this document is to establish baseline criteria for selection, screening, qualification, and derating of EEE parts for use on NASA GSFC space flight projects. This document shall provide a mechanism to assure that appropriate parts are used in the fabrication of space hardware that will meet mission reliability objectives within budget constraints.

All acronyms used in this document are listed in the acronym table at the end of this section on page11.

2.0 SCOPE

This document provides instructions for meeting three reliability levels of EEE parts requirements (see 6.0) based on mission needs. The terms "grade" and "level" are considered synonymous; i.e., a grade 1 part is consistent with reliability level 1. Levels of part reliability confidence decrease by reliability level, with level 1 being the highest reliability and level 3 the lowest. A reliability level 1 part has the highest level of manufacturing control and testing per military or DSCC specifications. Level 2 parts have reduced manufacturing control and testing. Level 3 Parts have no guaranteed reliability controls in the manufacturing process and no standardized testing requirements. The reliability of level 3 parts can vary significantly with each manufacturer, part type and LDC due to unreported and frequent changes in design, construction and materials.

GSFC projects and contractors shall incorporate this guideline into their Project EEE Parts Program.

3.0 DEFINITIONS

Screening. Screening tests are intended to remove nonconforming parts (parts with random defects that are likely to result in early failures, known as infant mortality) from an otherwise acceptable lot and thus increase confidence in the reliability of the parts selected for use.

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 consistent from lot to lot.

Derating. Derating is the reduction of electrical and thermal stresses applied to a part during normal operation in order to decrease the degradation rate and prolong its expected life.

Source Control Drawing (SCD) - Provides an engineering description (including configuration, part number, marking, reliability, environmental, functional / performance characteristics), qualification requirements and acceptance criteria for commercial items or vendor developed items procurable from a specialized segment of industry that provides for application critical or unique characteristics.

Vendor Item Control Drawing (Formerly known as Specification Control Drawing) - Provides an engineering description (including configuration, performance, reliability, environmental, functional characteristics) and acceptance criteria for commercial or vendor developed items that are procurable from a specialized segment of industry. The drawing is used to provide an administrative control number, but the item is marked with the vendor's part number.

NOTE: For the purposes of this EEE Part Instruction document, in the Screening and Qualification tables, the term SCD is used to convey any user developed EEE part procurement control document whether Source Control Drawing or Vendor Item Control Drawing, regardless of qualification requirement.

4.0 REFERENCES

The following documents, of the issue in effect when this document is used, form a part of this document to the extent specified herein.

GSFC Documents

GPG 1310.1	Customer Agreements
GPG 1440.1	Control of Quality Records
GPG 7120.2	Project Management
S-311-M-70	Specifications for Destructive Physical Analysis (DPA)

NASA Documents

NPD 8730.2	NASA Parts Policy

Military Standards

MIL- STD-883	Test Method Standard, Microcircuits
MIL- STD-750	Test Methods for Semiconductor Devices
MIL-STD-202	Test Method Standard, Electronic and Electrical Component Parts
MIL-STD-1580	Test Method Standard, Destructive Physical Analysis for EEE Parts

Industry Standards

ASTM E595	Standard Test Methods for Total Mass Loss and Collected Volatile Condensable Materials From Outgassing in a Vacuum Environment

5.0 IMPLEMENTATION

The instructions in this document shall be implemented when specified in GSFC space projects Statements of Work (SOWs), Mission Assurance Requirements (MARs), or their equivalents. Hereafter, any use of the word “requirement” assumes compliance to this document is mandatory.

5.1 Part Type Categories

The instructions for each part type category have been developed by the parts specialists with experience in working on a large number of GSFC projects. These instructions and the Federal Source Code (FSC) are specified in the following sections of this document:

Part Type	Document Section	Parts Specialists	FSC
General Instructions for All Part Categories	1	Dr. Kusum Sahu kusum.k.sahu@nasa.gov	N/A
Capacitors	C1	Tom Duffy tduffy@pop300.gsfc.nasa.gov	5910
Connectors and Contacts	C2	Terry King tking@pop300.gsfc.nasa.gov	5935
Crystals	C3	Gerard F. Kiernan gkiernan@qssmeds.com	5955
Crystal Oscillators	C4	Gerard F. Kiernan gkiernan@qssmeds.com	5955
Fiber Optics, Passive		Dr. Tracee Jamison tracee.l.jamison@nasa.gov Marcellus Proctor marcellus.a.proctor@nasa.gov	60GP
Filters	F2	Tom Duffy tduffy@pop300.gsfc.nasa.gov	5915
Fuses	F3	Thom Perry tperry@pop300.gsfc.nasa.gov	5920
Heaters	H1	Tom Duffy tduffy@pop300.gsfc.nasa.gov	4520
Magnetics	M1	Gerard F. Kiernan gkiernan@qssmeds.com	5950
Microcircuits, Hybrid	M2	Ashok Sharma ashok.k.sharma@nasa.gov	5962
Microcircuits, Monolithic	M3	Susan Ritter ritters@pop500.gsfc.nasa.gov	5962
Microcircuits, Plastic Encapsulated (PEMs)	M4	Dr. Alexander Teverovsky ateverov@pop300.gsfc.nasa.gov	5962
Relays, Electromagnetic	R1	Thom Perry tperry@pop300.gsfc.nasa.gov	5945
Resistors	R2	Thom Perry tperry@pop300.gsfc.nasa.gov	5905
Semiconductor Devices, Discrete	S1	Dennis Krus dkrus@pop300.gsfc.nasa.gov	5961
Switches	S2	Terry King tking@pop300.gsfc.nasa.gov	5930
Thermistors	T1	Thom Perry tperry@pop300.gsfc.nasa.gov	5905
Wire and Cable	W1	Terry King tking@pop300.gsfc.nasa.gov	6145

5.2 Other Part Types

Part types that do not fall into one of the preceding categories listed in paragraph 5.1 shall be reviewed on a case-by-case basis using the closest NASA, DSCC or government controlled specification as a baseline. The review shall ensure that parts meet the reliability requirements of its intended space flight application and shall cover the selection, screening, qualification and applicable derating. In the event a suitable government baseline specification does not exist, the user shall approach the project parts engineer to identify the parts expert who can provide information on the best available industry standards to develop procurement specifications that meet the reliability goals.

6.0 INSTRUCTIONS

EEE parts shall be processed in accordance with the detailed requirements for the applicable part types and quality levels specified in Sections C1 through W1. Each section contains selection, screening, qualification, and derating tables. All tests shall be performed in the order shown unless otherwise approved by the project. Exceptions or additions to the requirements specified in any section shall be defined in the project MARs document. Applicable part quality levels shall be as defined by the project in the MARs. As a guide to project managers, design leads, and System Assurance Managers (SAMs), 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 *highest reliability and lowest level of risk.* Level 1 active parts shall be reviewed for radiation hardness, and radiation testing is required when information is not available. The typical mission duration for Level 1 programs is 5 years or greater.

Level 2: Parts shall be selected and processed to this level for missions with *low to moderate risk*, balanced by cost constraints and mission objectives. Level 2 active parts shall be reviewed for radiation hardness, and radiation testing is required when information is not available. The typical mission duration for level 2 programs varies from 1 to 5 years.

Level 3: Parts represent inherently *high risk or unknown risk* because of the lack of formalized reliability assessment, screening and qualification. Also, there is little dependable data or flight history available for them as the continuos changes in design, materials and manufacturing processes may make the data on any particular LDC not applicable to another LDC. *Level 3 parts are intended for mission applications where the use of high-risk parts is acceptable.* Level 3 active parts shall be evaluated for radiation hardness, and radiation testing is required when information is not available. The typical mission duration for level 3 programs varies from less than 1 year to 2 years.

6.1 Parts Control Boards (PCBs)

When PCBs are required by the project MAR or implemented by the contractor or developer, the PCB shall review all parts for compliance to established criteria. Review information shall include specifications, screening and qualification plans, supporting data, and application requirements required to determine acceptability.

6.2 Part Selection

6.2.1 General. Parts shall be selected in accordance with appropriate part type specification and quality level listed in Table 1of each section in this document. Table 1 also indicates when screening (Table 2) and qualification testing (Table 3) are required for each risk level and part designation. Part procurement methods are discussed below.

6.2.2 Military Drawings (JAN Certified). Parts procured to Military Specifications or Standard Military Drawings (SMDs) usually contain up to three reliability levels. Not all military levels are acceptable "as is" for space applications. For example, monolithic microcircuits offer classes V, Q, and M. Some passive devices such as resistors and capacitors are listed with S, R, or P established reliability levels. Table 1 of each section documents which levels can be used as is and which require additional screening. It is the responsibility of the user to ensure that DSCC drawings and other military specifications satisfy the requirements specified herein, or to perform additional required inspections and tests specified in this document.

6.2.3 Developer Controlled Drawings (SCDs). When parts cannot be procured to Military Specifications, a drawing (such as a Source Control Drawing) should be prepared by the developer to control procurement requirements. The drawing shall include the screening and qualification requirements specified in Tables 2 and 3 of this document for the applicable part type. The drawing shall also include performance parameters, absolute maximum ratings, dimensions, terminal descriptions, materials, and other unique requirements. Existing developer SCDs proposed for use shall be evaluated for compliance to Table 2 and 3 requirements.

6.2.3.1 Purchase orders for Manufacturer Screened and Qualified Parts. With project approval, unique screening and qualification requirements that are not normally performed by the manufacturer as part of their normal production practice may be placed directly in the purchase order in lieu of preparation of a developer-controlled drawing. It is the responsibility of the user to require test data from the manufacturer in order to verify compliance.

6.2.3.2 For level 1 projects, if an acceptable Government-controlled specification is not available, an SCD is required. A preliminary copy of new SCDs shall be sent to the manufacturer for coordination. If procurement of the part through a SCD is not feasible due to cost, schedule or the availability of a manufacturer wiling to produce the part to the SCD requirements, the part may be procured through a purchase order specifying the unique screening and qualification requirements as detailed in 6.2.3.1.

6.2.3.3 For level 2 projects, project parts engineer and PCB shall determine if an SCD is required for a part type or the purchase order as specified in 6.2.3.1 is adequate to meet project's reliability requirements.

6.2.3.4 Level 3 projects do not require SCDs. However, if an existing procurement document is proposed for use, the SCD must meet level 3 requirements of this document for the applicable part type.

6.2.4 Manufacturer High Reliability Parts. The term "MFR HI-REL" applies to parts that are procured to a manufacturer-controlled flow as described in the manufacturer's catalog. The part flow is controlled only by the manufacturer. A certificate of compliance is furnished by the manufacturer that they have been tested as advertised. These are often referred to as high reliability parts in the manufacturer's catalog. In some cases, manufacturers add very little to their commercial process flows, and yet call their product "high reliability." It is the responsibility of the user to obtain test data to verify that the screening and qualification requirements specified in this document were met.

6.2.5 Commercial Parts. For the purpose of GSFC projects, this part designation represents all parts that do not conform to the categories defined above. These parts are procured per manufacturer's data sheet specifications. It is the responsibility of the user to assess the part manufacturer's quality capability to produce space quality parts and perform additional screening and qualification tests as defined in this document.

6.2.6 Plastic Encapsulated Microcircuits (PEMs). The use of Plastic Encapsulated Microcircuits shall be restricted to applications where no similar high reliability hermetically sealed device exists. The use of PEMs is permitted on GSFC space flight applications, provided each use is thoroughly evaluated for thermal, mechanical, and radiation implications of the specific application and found to meet mission requirements. A PEM shall not be substituted for a form, fit, and functional equivalent, high reliability, hermetic device in space flight applications. Refer to Section M4 on the detailed instructions for selection, screening qualification, and derating of these parts. Due to significant lot-to-lot variability that can occur in the fabrication processes and technology, each procurement of PEMs requires a separate evaluation that includes radiation effects. The use of Plastic Encapsulated semiconductor devices and hybrids shall follow similar guidelines as for PEMs.

6.2.7 Commercial Off-the-Shelf (COTS) Assemblies and Sub-Assemblies. Occasionally it is necessary to use sensors or other equipment of commercial origin. When commercial units or assemblies are purchased as off-the-shelf hardware items, PCB shall review their function and reliability for mission criticality.

6.2.7.1 Critical Applications for COTS. When failure of such units represents significant compromise to mission success, an analysis of the parts for compliance to the requirements of this document shall be performed. Following the results of this analysis, units may be required to undergo modification for use of higher reliability parts, or radiation hardened parts. All upgrade parts shall be subject to PCB approval. Modifications such as additional shielding for radiation effectiveness or replacement of radiation soft parts with radiation hardened parts, may be recommended and may be performed at the user's facility or user-approved facility.

6.2.7.2 Non-critical Applications for COTS. When loss of off-the-shelf units does not compromise mission success, a waiver may be granted on a case-by-case basis that exempts the unit from the requirements of this document, subject to written approval of the project. However, additional unit level testing, such as thermal cycling or thermal vacuum testing, may be directed by the project in lieu of piece part level screening.

6.3 Screening Tests

These tests shall be performed on flight parts in accordance with the requirements of Table 2 of each applicable section. Testing shall be performed on 100% of flight parts (and is implied by character "X"), unless sample testing with acceptable criteria is designated. For example, 4(0) designates four test samples, and zero failures of these samples are permitted. Screening tests shall be performed in the order shown unless otherwise indicated. *Any test required by screening Table 2 that is already performed by the procurement specification (military or SCD) or that is normally performed by the manufacturer need not be repeated. However, lot specific attributes data must be submitted to show that tests were performed with acceptable results.* The user is responsible for specifying and documenting device-unique requirements, if any. Exceptions shall not be permitted unless approved by the project, and such exceptions shall include a written rationale that describes the proposed application and its criticality to the project.

6.4 Qualification Tests

These tests shall be performed in accordance with the requirements of Table 3 of each part type section. Qualification tests shall be performed in the order shown unless otherwise indicated. *Any test required by qualification Table 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot specific or generic attributes data, as applicable, must be submitted to show that tests were performed with acceptable results.* Qualification is generally considered destructive and samples shall be segregated from flight parts. The required sample is indicated by a quantity (reject number) Ex: 4(0) 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 used successfully in (a) applications identical to that proposed (heritage design) or (b) applications different from 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 for 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 user's responsibility 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 that 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 1 year old relative to the lot date 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 similar processes.

6.5 Derating

Derating shall be performed by the designer in accordance with the requirements set in Table 4 for each category of parts documented in Sections C1 through W1. These derating factors do not preclude further more stringent derating; for example, to account for radiation induced degradation. *Developer-controlled derating plans may be used upon acceptable review and project approval.*

6.6 Manufacturer, Distributor and Test Laboratory Assessment

6.6.1 Manufacturer. For all part levels, the part manufacturer shall be assessed for its ability to produce parts with consistent quality that meet performance specifications and workmanship criteria, as well as the capability to deliver parts on schedule. A certificate of conformance should be requested for delivery with each purchase order.

6.6.2 Audits. 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 there is no successful flight heritage on parts procured from the manufacturer, or that the manufacturer has not pursued and qualified their production line for space quality parts. However, formal audits are not a requirement of this document.

6.6.3 Customer Source Inspection (CSI). CSI is not a requirement of this document, but it is recommended for unproven parts, hybrid microcircuits intended for use in level 1 and level 2 applications, and for parts from manufacturers with a known history of inconsistent quality. 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 that is submitted to the project. The report shall summarize the data reviewed and reference manufacturer test reports.

6.6.4 Distributor. Parts shall be procured from authorized distributors as much as possible with-in the federal procurement regulations. This minimizes the risk of receiving parts that have been mis-marked or misrepresented or subjected to substandard storage or handling conditions. If other distributors are used, they shall be assessed with respect to their ability to provide parts without adversely affecting their quality and integrity. Storage conditions for components should be evaluated for humidity and ESD controls. Humidity control is of particular concern when procuring PEMs. Overall distributor assessment is required whether procuring standard military parts or commercial parts.

6.6.5 Test Laboratory Assessment. Users shall assess the suitability of the test laboratory chosen to perform any screening and qualification tests on space flight parts. This shall include evaluation of test capability and quality assurance processes for handling of parts, ESD and humidity control, test plan development and implementation, documentation of test results, etc.

6.7 Additional Part Concerns

6.7.1 Commercial Parts Usage. The project shall minimize the usage of any commercial parts for all grade levels. There are no controls in commercial industry that are imposed uniformly upon all manufacturers to build in a common acceptable quality level. While many manufacturers maintain good quality controls, others do not. This can lead to significant variation in the risk associated between parts from different manufactures, as well as between various part types and Lot Date Codes from the same manufacturer, depending upon process maturity and stability. The qualification and screening processes provided in this document are intended to detect poor quality lots and screen out early random failures. However, *these tests cannot bring in quality that may not exist in the commercial manufacturing process. Before a decision to use a commercial part is made, other options such as design modifications that would allow the use of available military parts should be appropriately evaluated.* This evaluation is important from a cost standpoint also, since the screening and qualification of commercial parts can be very expensive for all grade levels. Before initiating the procurement for any commercial part, a determination of the manufacturers' reliability controls shall be performed to ensure that best common industry practices are implemented at their production facilities.

6.7.2 Part Age and Storage Restrictions. Parts drawn from inventory having lot date codes older than 5 years, shall be reviewed by PCB to determine the need for re-screen. Parts stored in conditions where moisture or ESD are not controlled shall not be used.

6.7.3 Part Obsolescence. The project shall prevent selection of parts that are inactive for new design, and shall not allow the use of obsolete parts in new projects, or allow those that are scheduled to be discontinued prior to program completion.

Exception: For projects having multiple units that are produced and deployed over a period of years, in order to facilitate sufficient quantity to complete production without redesign, arrangements may be made to procure and properly store sufficient quantities to complete production after parts become obsolete.

6.7.4 Alerts. The PPE shall continuously monitor part procurements and parts drawn from storage for impact of GIDEP Alerts and NASA advisories. Parts traceable to date codes and manufacturers listed in alerts shall not be used without additional analysis.

6.8 Related Areas of Support

When necessary, in order to aid a part evaluation, the following areas of expertise are available for consultation:

6.8.1 Radiation Effects. The Radiation Effects Branch (GSFC Code 561) can be consulted for a radiation assessment of parts that have no existing test data (for TID, SEE, etc.) or are susceptible to latchup, transients, low dose, or other radiation effects because of the device technology. The Radiation Effects Engineer shall be consulted for analysis of the radiation environment and radiation dosage level a proposed part will be exposed to in its application. The project shall document the radiation analysis on each part to show that project specific radiation requirements are met.

6.8.2 Reliability. Reliability Engineering (GSFC Code 302) can be consulted in order to determine the effectiveness of part screening such as burn-in conditions. The reliability engineer shall be consulted to assess the risk of parts proposed for use in severe applications. For example, the project shall not allow the selection of parts for use outside the manufacturer-specified temperature range without demonstrating that the parts can be used safely beyond their published temperature rating. If part reliability cannot be ensured for mission life through analysis or additional testing, an alternate part, additional redundancy, or redesign is required.

6.8.3 Materials. When necessary, the Materials Branch (GSFC Code 541) can be consulted in order to determine component material properties, such as outgassing, thermal, or physical stability of materials, in a proposed application. *Parts with unstable material properties that cannot be stabilized through additional processing for the proposed application shall not be used. Also, due to the risk of whisker growth that can lead to short circuit conditions, pure Tin, Cadmium and Zinc shall not be used as a final finish on EEE parts.*

COMMONLY USED ACRONYMS

ATR	Assistant Technical Representative
CAT	Corrective Action Team
COTS	Commercial-Off-the-Shelf
C-SAM	C-mode Scanning Acoustic Microscopy
CSI	Customer Source Inspection
CVCM	Collected Volatile Condensable Materials
DD	Displacement Damage
DPA	Destructive Physical Analysis
DSCC	Defense Supply Center Columbus
EEE	Electrical, Electronic, and Electromechanical
ELDR	Enhanced Low Dose Rate
EPIMS	Electronic Parts Information Management System
ESA	European Space Agency
FA	Failure Analysis
GIDEP	Government Industry Data Exchange Program
GSFC	Goddard Space Flight Center
HAST	Highly Accelerated Stress Testing
HTOL	High Temperature Operating Life
JAN	Joint Army Navy
JPL	Jet Propulsion Laboratory
LDC	Lot Date Code
LET	Linear Energy Transfer
LTPD	Lot Tolerance Percent Defective
MAR	Mission Assurance Requirement
MIL	Military
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MRB	Material Review Board
MS	Military Specification
MSFC	Marshall Space Flight Center
NEPP	NASA Electronics Parts and Packaging Program
NEPAG	NASA EEE Parts Assurance Group
NPSL	NASA Part Selection List
NASDA	National Space Development Agency (of Japan)
PAPL	Project Approved Parts List
PAR	Performance Assurance Requirements
PCB	Parts Control Board
PEM	Plastic Encapsulated Microcircuit
PPE	Project Parts Engineer
PPL	Preferred Parts List
PRE	Project Radiation Engineer
QSS	Quality Support Services
RDM	Radiation Design Margin
SAM	System Assurance Manager
SCD	Specification Control Drawing
SEE	Single Event Effects
SEU	Single Event Upset
SMD	A) Standard Military Drawing B) Surface Mount Device
SRC	Sigma Research Corporation
SOW	Statement of Work
SSQ	Space Station Specification
TID	Total Ionizing Dose
TML	Total Mass Loss

DOCUMENT HISTORY LOG

Status (Baseline/Revision/Cancelled)	Document Revision	Effective Date	Description
Baseline	311-INST-001	5/95	Initial release
Revision	311-INST-001, A	8/96	All sections updated
Revision	Title changed to EEE-INST-002	5/03	All sections updated; new sections added

SECTION C1: 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 (FRL) Required 2/		
				Level 1	Level 2	Level 3
Ceramic						
	CCR	Encapsulated, Temp. Compensating	MIL-PRF-20	S **3/**	R **3/**	P
	CKR	Encapsulated, Established Reliability	MIL-PRF-39014	**3/**	S **3/**	R
	CKS	Encapsulated & Chip, High Reliability (Space Level)	MIL-PRF-123	X	X	X
	CDR	Chip, Established Reliability	MIL-PRF-55681	S **3/**	R **3/**	P
	HVR	High Voltage, Leaded	MIL-PRF-49467	S	R	P
	PC	Variable (Non-ER)	MIL-PRF-14409	**3/**	**3/**	X
	CV	Variable (Non-ER)	MIL-PRF-81	**3/**	**3/**	X
	CPC	Single Plate	MIL-C-49464	S	R	P
	PS	Switch Mode Power Supply	MIL-PRF-49470	T	B	B
Tantalum						
	CSR	Solid Electrolyte	MIL-PRF-39003	C **3/**	B	B
	CSS	Solid Electrolyte	MIL-PRF-39003	C	B	B
	CWR	Chip (Solid Electrolyte)	MIL-PRF-55365	C **3/**	B	B
	CLR	Non-Solid Electrolyte	MIL-PRF-39006	R	P	P
Mica						
	CMS	Fixed, High Reliability (Space)	MIL-PRF-87164	X	X	X
	CMR	Fixed, Established Reliability	MIL-PRF-39001	**3/**	**3/**	R

Notes at end of table.

Table 1 CAPACITOR REQUIREMENTS (Page 2 of 2)

Part Family	Capacitor Style and Type	Reference Specification	Failure Rate Level (FRL) Required 2/		
			Level 1	Level 2	Level 3
Paper or Plastic Film					
	CQR Foil, Hermetically Sealed	MIL-PRF-19978	**3/**	**3/**	R
	CHR Metallized, Hermetically Sealed, DC and AC	MIL-PRF-39022	**3/**	**3/**	R
	CHS Supermetallized, Hermetically Sealed, DC	MIL-PRF-87217	X	X	X
	CRH Metallized, Hermetically Sealed, DC, AC, or DC and AC	MIL-PRF-83421	S	R	R
Glass	CYR Established Reliability	MIL-PRF-23269	S	R	P
Commercial, High Rel, or SCD	All Types (Ceramic, Tantalum, Glass, Paper, Plastic, etc.) **4/**	N/A	**5/**	**5/**	**5/**

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 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 be procured to the best FRL available and meet the screening and qualification requirements of Tables 2 and 3. Any test required by Tables 2 and 3 that is already performed by the procurement specification (military or SCD) need not be repeated. However, lot-specific attributes data for screening tests, and lot-specific or generic attributes data as applicable to various test groups of qualification tests, must be submitted to show that tests were performed with acceptable results.

4/ The construction of commercial parts may not be as robust as equivalent military parts. The user is responsible for determining suitability of the parts in each specific application.

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

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level																				
		Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power Supply		
		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 (See step 6 for details of tests required and test conditions)	Visual and sample based mechanical inspection to be performed to requirements of nearest military specification	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Thermal Shock	MIL-STD-202, Method 107, Condition B, min. rated temp. to max. rated temp. (when specified in the product specification/ data sheet, the min. and max. "storage" temp. shall be used in lieu of the specified operating temp.)	X	X		X	X		X	X		X	X		X	X		X	X		X	X	

Notes at end of table.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 2 of 4)

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

Notes at end of table.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 3 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level: Ceramic			Plastic			Tantalum			Glass			Mica			Variable			Switch Mode Power Supply		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
6. Electrical Measurements	As specified **5/**																					
Capacitance	MIL-STD-202, Method 305	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dissipation Factor	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
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
Insulation Resistance 1	MIL-STD-202, Method 302, room temp.	X	X	X	X	X	X				X	X		X	X	X	X	X	X	X	X	X
Insulation Resistance 2	Repeat at max. rated temp.	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	X													
Equivalent Series Resistance								X	X													
Quality Factor																	X	X	X			
Driving Torque																	X	X				
7. Percent Defective Allowable	5%	X			X			X			X			X			X			X		
	10%		X			X			X			X			X			X			X	
	20%			X			X			X			X			X			X			X
8. Partial Discharge **6/**	MIL-PRF-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													
Fine Leak	Condition C				X			X														

Notes at end of table.

Table 2 CAPACITOR SCREENING REQUIREMENTS (Page 4 of 4)

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

Notes:

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

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

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

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

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

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

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

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

7/ Humidity, Steady State, Low Voltage testing is required only for ceramic capacitors with applied voltage of less than 10 volts. These recommendations stem from concerns about the low voltage failure mechanism, which has been observed to occur in multilayer ceramic capacitors. In low voltage applications, multilayer ceramic capacitors with thin dielectrics and/or large voids, delaminations, inclusions, microcracks, and other defects may develop low and unstable insulation resistances. When this sample test is performed during qualification testing (see Table 3A) on the same lot as the flight lot, then the test does not have to be performed during the screening and lot acceptance testing required by Table 2.

a) For level 1 applications less than 10 volts, ceramic capacitors can be used if capacitor rated voltage is at least 100 Vdc and flight lots are subjected to lot sample testing per Group B of MIL-PRF-123 (Humidity, Steady-State, Low Voltage).

b) For level 2 low voltage applications (< 10 Vdc), ceramic capacitor rated voltage should be at least 100 Vdc. Alternatively, parts rated at less than 100 Vdc can be used if flight lots are subjected to lot sample testing per Group B of MIL-PRF-123 (Humidity, Steady-State, Low Voltage).

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

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

Notes at end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept Number) Level		
		1	2	3
Group 4		12(0)	5(0)	N/A
Humidity Steady State, Low Voltage **6/**	MIL-STD-202, Method 103, Condition A and MIL-PRF-123, Group B	X	X	
Group 5		5(0)	3(0)	N/A
Solderability	MIL-STD-202, Method 208	X	X 5/	
Destructive Physical Analysis	EIA-469	X		
Group 6		44(0) or 22(0)	44(1) or 22(1)	N/A
Life (at elevated temp.) **8/**	MIL-STD-202, Method 108 Ttest = maximum operating temperature Vtest = 2 x Vrated Duration: 2000 hours for level 1, 1000 hours for levels 2 and 3 IR, ΔC, and DF to specification	X	X	
Partial Discharge **7/**	MIL-PRF-49467 Appendix B	X	X	

Notes at end of table.

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

Notes:

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

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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 3A.

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

6/ Humidity, Steady State, Low Voltage testing is required only for ceramic capacitors with applied voltage of less than 10 volts. These recommendations stem from concerns about the low voltage failure mechanism, which has been observed to occur in multilayer ceramic capacitors. In low voltage applications, multilayer ceramic capacitors with thin dielectrics and/or large voids, delaminations, inclusions, microcracks, and other defects may develop low and unstable insulation resistances. When this sample test is performed during qualification testing (see Table 3A) on the same lot as the flight lot, then the test does not have to be performed during the screening and lot acceptance testing required by Table 2.

- a) For level 1 applications less than 10 volts, ceramic capacitors can be used if capacitor rated voltage is at least 100 Vdc and flight lots are subjected to lot sample testing per Group B of MIL-PRF-123 (Humidity, Steady-State, Low Voltage).
- b) For level 2 low voltage applications (< 10 Vdc), ceramic capacitor rated voltage should be at least 100 Vdc. Alternatively, parts rated at less than 100 Vdc can be used if flight lots are subjected to lot sample testing per Group B of MIL-PRF-123 (Humidity, Steady-State, Low Voltage).

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

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 Levels 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, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

<table>
<tr><th rowspan="3">Inspection/Test
4/</th><th rowspan="3">Test Methods, Conditions, and
Requirements 2/</th><th colspan="3">Quantity (Accept Number)</th></tr>
<tr><th colspan="3">Level</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Group 5
Stability at Low and High Temperature

Surge Voltage

Reverse Voltage
(Polarized wet slug styles only)</td><td>
In accordance with MIL-PRF-39003
DCL, C, and DF shall be within specification at the applicable test temperature.
Wet slugs
In accordance with MIL-PRF-39006
Dry slugs
In accordance with MIL-PRF-39003
Chips
In accordance with MIL-PRF-55365
Vtest = Reverse voltage rating (Vdc)
Ttest = 85 °C
Duration: 125 hours level 1
48 hours level 2
DCL, ΔC and DF to specification</td><td>12(1)
X

X

X</td><td>6(1)
X

X

X</td><td>N/A</td></tr>
<tr><td>Group 6
Life
(at elevated temp.)
(Dry slug styles only)

AC Ripple Life
(Wet slug styles only)</td><td>
MIL-STD-202, Method 108
Ttest = 85 °C
Vtest = Vrated
Duration: 2000 hours for level 1
1000 hours for level 2
DCL, ΔC and DF to specification
MIL-STD-202, Method 108
Ttest = 85 °C
Vtest = Vrated + Rated Ripple Current at 40 kHz
Duration: 2000 hours for level 1
1000 hours for level 2
DCL, C and DF to specification</td><td>44(0) or 22(0)
X

X</td><td>44(1) or 22(1)
X

X</td><td>N/A</td></tr>
</table>

Notes at end of table.

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

Notes:

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

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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 Levels 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, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

Notes:

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

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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 that 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 Levels 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, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

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

Inspection/Test 4/	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Use parts that have passed screening tests of Table 2.	100% X	100% X	N/A
Group 2		6(0)	3(0)	N/A
Solderability	MIL-STD-202, Method 208	X	X **5/**	
Vibration, High Frequency	MIL-STD-202, Method 204 Condition B (15 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	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.	X	X	
Temperature Coefficient and Drift	Capacitance change over the range of temperatures specified shall not exceed limits of specification.	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, C, ΔC and DF to specification	X	X	

Notes at the end of table.

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

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

Notes at the end of table.

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

Notes:

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

2/ It is the responsibility of the user to specify the appropriate test conditions and define the pass/fail criteria for each inspection. 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 Levels 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, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

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

Inspection/Test 3/	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 1 Screening to Table 2 **1/ 2/**	 Use parts that have passed screening tests of Table 2.	100% X	100% X	N/A
Group 2 Thermal Shock **2/**	 MIL-STD-202, Method 107 Condition B IR, C, ΔC and DF to specification	12(0) X	6(1) X	N/A
Quality Factor **2/**	MIL-STD-202, Method 306	X	X	
Shock **2/**	MIL-STD-202, Method 213 Condition I (100 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	X	X	
Vibration, High Frequency **2/**	MIL-STD-202, Method 204 Condition D (20 Gs) Intermittent contacts greater than 0.5 ms shall be cause for rejection.	X	X	
Group 3 Solderability **2/**	 MIL-STD-202, Method 208	12(1) X (1)	6(1) X	N/A
Terminal Strength **2/**	MIL-STD-202, Method 211 Condition A (all leaded devices) and: Condition C (radial leaded devices only) Condition D (axial leaded devices only)	X (0)	X	
Temperature Coefficient and Drift **2/**	Capacitance change over the range of temperatures specified shall not exceed limits of specification.	X (0)	X **4/**	

Notes at the end of table.

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

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

Notes at end of table.

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

Notes:

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

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

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 Levels 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, AND 11 parts of the highest value and 11 parts of the lowest value in the lowest voltage rating

Table 4 CAPACITOR DERATING REQUIREMENTS

Voltage derating is accomplished by multiplying the maximum operating voltage by the appropriate derating factor appearing in the chart below.

Type	Military Style	Voltage Derating Factor 1/	Maximum Ambient Temperature
Ceramic	CCR, CKS, CKR, CDR **2/**	0.60	110 °C
Glass	CYR	0.50	110 °C
Plastic Film	CRH, CHS	0.60	85 °C
Tantalum, Foil	CLR25, CLR27, CLR35, CLR3	0.5	70 °C
Tantalum, Wet Slug	CLR79, CLR81	0.60 0.40 **3/**	70 °C 110 °C
Tantalum, Solid (Note 4)	CSR, CSS, CWR	0.50 0.30 **4/**	70 °C 110 °C

Notes:

1/ The derating factor applies to the sum of peak AC ripple and DC polarizing voltage.
2/ For low-voltage applications (<10 Vdc), parts shall be rated at least 100 Vdc for styles CCR, CKR, CDR.
3/ Derate voltage linearly from 70 °C to 110 °C.
4/ The effective series resistance shall be at least 0.1 ohms per volt or 1 ohm, whichever is greater, for Grade 2 applications, and at least 0.3 ohms per volt or 1 ohm whichever is greater, for Grade 1 applications.

SECTION C2: CONNECTORS AND CONTACTS

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GENERAL

Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types. The following additional information is unique to this section.

1) Tables 1C and 1D provide detailed descriptions of available connector and contact configurations as an aid to designers.
2) Screening requirements are listed in Tables 2A through 2J. Tables are divided into commercial / SCD (Com'l/SCD) vs. Military (Mil) for three quality levels. Connectors procured to military specifications normally have tests performed periodically on samples, while commercial lines may not be as closely monitored. Consequently, in this document, military connectors do not require the same tests as commercial.
3) Visual and mechanical inspection performed in Tables 2A through 2J is critical for connectors, and Table 4 lists defect criteria for each type of connector. 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.
4) Depending on the application, outgassing, atomic oxygen, 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 ASTM-B488, Type II, Grade C, Class 1.25 (50 micro inches) (formerly MIL-C-45204, Type II, Grade C, Class 1) is the preferred finish for contacts over the entire contact, including the engagement area.

3) Prohibited Finishes for Metal Shell Connectors, Contacts, Terminals and Terminal Lugs. 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. Due to the risk of tin whisker growth, which can lead to short circuit conditions, pure tin finishes are prohibited.

4) Preferred Dielectric Materials. The following are preferred dielectric insulating materials for multicontact connectors (color is optional).

   Molding compound
   Diallyl Phthalate (DAP), type SDG-F or type GDI-30F of ASTM-D5948

   Thermoplastics
   Polyester, glass reinforced, MIL-M-24519 type GPT-30F or type TPES013G-30A0000 per ASTM-D5927).

   Polyphenylene Sulfide (PPS), glass reinforced, MIL-M-24519 type GST-40F or type PPS000G40A00000 per ASTM-D4067).

   Liquid Crystalline Polyester, glass reinforced, MIL-M-24519 type GLCP-30F.

Diallyl phthalate is the preferred material for solder applications. PTFE Teflon is the preferred dielectric material for radio frequency and Data Bus connectors. In general, the non-metallic materials used in connectors shall be non-combustible or self extinguishing.

OUTGASSING

Outgassing occurs in vacuum environments when unreacted additives, contaminants, absorbed gasses or moisture can evaporate from molding materials and ink. These outgassed materials can condense on cold surfaces causing performance degradation. Outgassed materials can also become more rigid or brittle. Nonmetallic materials shall not exceed 1% Total Mass Loss (TLM) or 0.1% Collected Volatile Condensable Material (CVCM) when tested in accordance with ASTM-E595 (Test Method, Outgassing). Acceptable materials should be selected from:

> NASA Reference Publication 1124 (Outgassing Data for Selecting Spacecraft Materials) http://outgassing.nasa.gov/ - or -
>
> MAPTIS (Materials and Process Technical Information Service) http://mpm.msfc.nasa.gov/materialdb.html.

However, materials listed as acceptable in these documents may have been baked out prior to evaluation in order to reduce outgassing, and the user needs to be aware that they may have to perform similar processing in order to achieve acceptable levels of outgassing. Testing shall be performed per ASTM-E595 for materials that are not traceable to the above references. Processing generally consists of a bakeout at 125^0C and 10^{-6} Torr for 24 hours.

CABLE ASSEMBLY TESTING

Connectors fabricated with wire into cable assemblies must be tested prior to installation in flight hardware. Fabrication and workmanship testing standards are found in NASA-STD-8739.4 "Crimping, Interconnecting Cables, Harness and Wiring". These are available on line at

> http://workmanship.nasa.gov/index.jsp

CRYOGENIC APPLICATIONS

The only connectors that are *officially* rated for use in low temperature cryogenic applications are procured to MSFC specification 40M38294 (Connectors, Cryogenic; Circular –269°C). However, experience has proven it is possible for other connector types to be used successfully at cryogenic temperatures. It is recommended that connector samples should be subjected to five cycles of cryogenic temperature cycling using sufficient low temp to qualify for the intended application. Perform post temperature cycle inspection at room ambient conditions for cracks and DWV.

Table 1A CONNECTOR REQUIREMENTS (Page 1 of 2) 1/

Procurement Specification 1/	Level 1		Level 2		Level 3	
	NASA/ Mil	Com'l/ SCD	NASA/ Mil	Com'l/ SCD	NASA/ Mil	Com'l/ SCD 11/
Circular						
NASA MSFC 40M3XXXX	X		X		X	
NASA SSQ 21635	X		X		X	
MIL-DTL-38999	2/		2/		2/	
MIL-C-26482	2/, 3/		2/, 3/		2/, 3/	
MIL-DTL-5015	2/, 3/		2/, 3/		2/, 3/	
SCD		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Commercial		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
D Subminiature **5/**						
NASA GSFC S-311-P-4, P-10	3/		3/		X	
MIL-DTL-24308	2/, 3/		2/, 3/		2/, 3/	
SCD		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Commercial		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Microminiature **10/**						
MIL-DTL-83513	2/, 3/		2/, 3/		2/, 3/	
SCD		2/, 3/, 4/		2/, 3/, 4/		3/
Commercial		2/, 3/, 4/		2/, 3/, 4/		3/
Printed Circuit						
MIL-DTL-55302	3/		3/		3/	
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/
Coaxial **6/**						
MIL-PRF-39012	2/, 3/		2/, 3/		2/, 3/	
MIL-C-83517	2/, 3/		2/, 3/		2/, 3/	
SCD		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Commercial		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
EMI Filter Contact **12/**						
NASA GSFC S-311-P-626	X		X		X	
SCD		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Commercial		2/, 3/, 4/		2/, 3/, 4/		2/, 3/
Satellite Umbilical Interface **13/**						
NASA GSFC-S-311-P-718	X		X		X	
NASA SSQ 21637	X		X		X	
SAE-AS81703	2/		2/		2/	
SCD		2/, 3/, 4/		2/, 3/, 4/		2/, 3/, 4/
Commercial		2/, 3/, 4/		2/, 3/, 4/		2/, 3/, 4/
Plug-In Sockets **7/, 9/**						
MIL-DTL-83734 (ICs)	3/		3/		X	
MIL-PRF-83502 (Transistors)	3/		3/		X	
MIL-PRF-12883 (Relays)	3/		3/		X	
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/
MIL-STD-1553 Databus **8/**						
MIL-PRF-49142	3/		3/		3/	
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/
Nanominiature **9/, 10/**						
DSCC 94031		3/		3/		3/
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/

Notes on next page.

Table 1A CONNECTOR REQUIREMENTS (Page 2 of 2)

Notes:

1/ General.

1.1/ The character "X" indicates use as is.

1.2/ The test methods, conditions and requirements documented in the screening and qualification tables are intended to summarize commonly used military test methods and procedures that can be performed by users in user designated test labs or by the manufacturer. Complete test details are contained in the referenced test method.

1.3/ When the manufacturer has a more thorough test procedure than the method contained in this document, it is not the intent of this document to impose a procedure of lesser quality, but rather to impose a test when no test is normally performed or no test exists. If a manufacturer uses a more thorough test method as part of their normal production practice, upon project approval, that test method may continue to be used in lieu of the test contained in this document. The user must provide to the project a brief rationale of its expected comparable effectiveness.

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

2/ Military 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. When a qualification basis can be traced to qualified military product, the project may elect to omit qualification on the procured lot, and such decisions shall be documented.

5/ Nickel plated D-Subminiature connectors are considered susceptible to magnetic retention, known as residual magnetism. Gold plated brass shell connectors are recommended in applications where low residual magnetisim must be maintained, but are not guaranteed to have extra low residual magnetism (<200 gamma) unless specifically tested to this level.

6/ Use of coaxial connectors with lock wire features is preferred.

7/ Direct solder attachment of devices with DIP, SIP or small round patterns is preferred. When sockets are necesssary, solder anti-wicking features should be used, and such features shall not permit solder wicking into the contact that would interfere with mating and performance.

8/ Military triaxial/twinaxial databus connectors have silver plate finish that is not recommended for space flight due to moisture corrosion and atomic oxygen corrosion concerns. Some military suppliers offer an electroless nickel plated space grade equivalent that is preferred, and such connectors shall meet table 2I requirements.

9/ Some nanominiature connectors contain pre-terminated 30 AWG insulated wires. Due to small conductor size, these connectors should be limited to board to board connections within units, and are not recommended for use as unit to unit cable assemblies.

10/ Connectors have the option of pre terminated crosslinked ETFE (Tefzel ™) insulated wire pigtails. Users are advised that some ETFE insulations are known to outgas trace amounts of corrosive fluorine. Corrosive effects of fluorine have been observed only when this wire is used with nickel coated metal shell connectors and stored in sealed plastic or ESD bags. Connectors should be inspected at receiving for corrosive by products and repackaged until use so that the connectors are protected and the wires are open to air where any outgassed fluorine is free to escape harmlessly. Refer to note 9, screening tables.

11/ It is not a requirement for users to prepare a procurement specification for Level 3 programs. However, if an existing procurement specification exists that is proposed for use, as a minimum, the SCD must meet Level 3 requirements in Table 2.

12/ Planar filter construction is preferred over tubular.

13/ NASA connectors are intended for use with orbital replacement units or to connect spacecraft modules. Military connectors may be used where spacecraft separation from launch vehicle is required. It is not intended for these connectors to be mated directly by hand in orbit.

Table 1B CONNECTOR CONTACT REQUIREMENTS 1/, 7/

Procurement Specification 1/	Level 1		Level 2		Level 3	
	NASA/ Mil	Com'l/S CD	NASA/ Mil	Com'l/S CD	NASA/ Mil	Com'l/ SCD
Contacts (Signal, Power, PC Sockets)						
NASA-Marshall						
40M39569, NB Types, Contact Sizes 8-20	X		X		X	
40M38277, NLS Types, Contact Size 22D	X		X		X	
NASA-Goddard						
S-311-P-4/10, G10P1 & G10S1 (Normal Density Size 20)	3/		3/		3/	
S-311-P-4/08, G08P1 & G08S1 (High Density Size 22D)	3/		3/		3/	
S-311-P-718/2, GPXXX Types (Sizes 8-22)	3/		3/		3/	
NASA SPACE STATION						
SSQ 21635 NZGC-C-XX-PB & - SB	X		X		X	
SSQ 21637 NU-C-XX-P&S	X		X		X	
MILITARY						
SAE-AS39029, M39029/XX-XXX Crimp Contacts	2/, 3/		2/, 3/		2/, 3/	
MIL-DTL-55302/65, M55302/65-01 &-02 PWB Crimp Cont	2/, 3/		2/, 3/		2/, 3/	
MIL-DTL-83505 M83505/X-XXX Component Lead Sockets	3/		3/		3/	3/
SCD		2/,3/,4/		2/,3/,4/		2/, 3/
Commercial		2/,3/,4/		2/,3/,4/		2/, 3/
Coaxial						
NASA-GSFC						
S-311-P-4/06, GCXX Type **5/**	3/		3/		3/	
S-311-P-718/2, (Coaxial, Triaxial, & Databus)	3/		3/		3/	
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/
High Voltage						
NASA-GSFC						
S-311-P-4/06, GHXX Type **6/**	3/		3/		3/	
SCD		3/, 4/		3/, 4/		3/
Commercial		3/, 4/		3/, 4/		3/

Notes:

1/ General.

1.1/ The character “X” indicates use as is.

1.2/ For a detailed description of available contact configurations, refer to Table 1D.

2/ Contact marking may not satisfy outgassing requirements of 1% TML and 0.1% CVCM. Use of inkless contacts is recommended. (Refer to table 2, note 11.7). Otherwise, these contacts are acceptable.

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

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

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

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

7/ Refer to Table 1A, note 1.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS 1/ (Page 1 of 5)

Connector Type	Description
D Subminiature Connectors 6/, 7/	
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, 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
Military	
MIL-DTL-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-DTL-24308/1 and /3	Polarized Shell, D-Type Receptacles and Plugs, Solder Contacts, Standard Density, Fixed Mount, Nickel Finish
MIL-DTL-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-DTL-24308/5 and /7	Polarized Shell, D-Type Receptacles and Plugs, Solder Contact, Standard Density, Fixed Mount, Gold Finish, Brass Shell
MIL-DTL-24308/23 and /24	Polarized Shell, D-Type, Receptacles and Plugs, Solder Printed Wiring Board Solder Tail Terminations, Straight and Right Angle, Standard and High Density, Nickel, Passivated CRES or Gold Finish
Microminiature Connectors (0.050 inch Contact Spacing)	
Military	
MIL-DTL-83513/1 and /2, M83513/01 and /02 Types	Plugs and Receptacles, Solder Contacts, Metal Shell, Nickel Finish
MIL-DTL-83513/3 and /4, M83513/03 and /04 Types	Plugs and Receptacles, Pre-Wired Crimp Contacts, Metal Shell, Nickel Finish
MIL-DTL-83513/8 and /9, M83513/08 and 09 Types	Plugs and Receptacles, Pre-Wired Crimp Contacts, Plastic Shell
MIL-DTL-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
MIL-DTL-83513/22 thru /27, M83513/22 thru /27 Types	Plugs and Receptacles, Straight PCB Solder Tail Contacts, Metal Shell, Nickel Finish

Notes at end of table.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS 1/ (Page 2 of 5)

Connector Type	Description
Circular Connectors 2/	
NASA-MSFC	
40M38277, NLS Type	High Density, Low Silhouette, Low Outgassing (Contact Sizes 8-20)
40M39569, NB Type	High Density, Low Outgassing (Size 22D Contacts)
40M38298, NBS Type	Circular, High Density Small Insert, Low Outgassing (2, 3, or 4 Size 20 Contacts)
40M39580, ZG Type	Circular, Lever Actuated, Zero Gravity, Low Outgassing (Contact Sizes 12-22D)
40M38294, NC Type	Circular, Cryogenic (-269°C)
NASA-SPACE STATION	
SSQ 21635, NZGL Type	Lever Actuated, Zero Gravity, Low Outgassing (Contact Sizes 0-22D)
SSQ21635, NATC Type	Three Way Threaded Ratchet Coupling, Low Outgassing (Contact Sizes 0-22D)
Military	
MIL-DTL-38999 Series I, MS27XXX Types	Miniature, High Density, Scoop-proof, Bayonet Coupling (Contact Sizes 12-22D)
MIL-DTL-38999 Series II, MS27XXX Types	Miniature, High Density, Low Silhouette, Bayonet Coupling (Contact Sizes 12-22D)
MIL-DTL-38999 Series III, D38999/XX Types	Miniature, High Density, Scoop-proof, Three Way Threaded Ratchet coupling (metric; Contact Sizes 12-22D)
MIL-DTL-38999 Series IV, D38999/XX Types	Miniature, High Density, Scoop-proof, Breech coupling (metric; Contact Sizes 12-22D)
MIL-C-26482 Series 2, MS347X Types	Miniature, Quick Disconnect, Bayonet Coupling (Contact Sizes 12-20)
MIL-DTL-5015, MS345X Types	Threaded Coupling, Crimp Rear-Release Contacts (Contact Sizes 0-16)
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 .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.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS 1/ (Page 3 of 5)

Connector Type	Description
SMA Series Radio Frequency Coaxial 2/, 3/, 8/	
Military	
MIL-PRF-39012/55 and /56	Plug, Pin Contact, Cable Mount, Straight and Right Angle
MIL-PRF-39012/57	Receptacle, Socket Contact, Cable Mount
MIL-PRF-39012/58 and /59	Receptacle, Socket Contact, 4 Hole Flange Mount and D-Hole Jam Nut Mount
MIL-PRF-39012/60	Receptacle, Socket Contact, Solder Cup, 2 Hole or 4 Hole Rear Flange Mount
MIL-PRF-39012/61	Receptacle, Socket Contact, Solder Cup, D-Hole Front and Rear Jam Nut Mount
MIL-PRF-39012/62	Receptacle, Socket Contact, Hermetic Seal, Solder Lug, D-Hole Front and Rear Jam Nut Mount
MIL-PRF-39012/79 and /80	Plug, Pin Contact, Cable Mount, for Semi-Rigid Cable, Straight and Right Angle
MIL-PRF-39012/81	Receptacle, Socket Contact, Cable Mount, for Semi-Rigid Cable
MIL-PRF-39012/82	Receptacle, Socket Contact, 2 Hole or 4 Hole Flange Mount, for Semi-Rigid Cable
MIL-PRF-39012/83	Receptacle, Socket Contact, D-Hole Rear Jam Nut Mount, for Semi-Rigid Cable
MIL-PRF-39012/93 and /94	Receptacle, Socket Contact, Printed Circuit Mount, Straight and Right Angle
SMA Series Radio Frequency Transmission Line	
Military	
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 Umbilical Interface Connectors	
NASA – GSFC	
S-311-P-718/1, 700-42-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, Low Outgassing, Shell Size 1 (Contact Sizes 8, 16, Coax)
S-311-P-718/3, 700-42/3-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Shell Size 1 (Contact Sizes 8, 16, Coax)
S-311-P-718/5, 700/42/5-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Shell Size 2 (Contact Sizes 16-22, Coax, Triax, Databus)
S-311-P-718/6, 700-42-6-X-X Type	Umbilical Interface, Rectangular, Polarized Shell, Rear Release Contacts, EMI Termination, Low Outgassing, Shell Size 3 (Contact Sizes 16-22 and Coax)
NASA - SPACE STATION	
SSQ 21637, NU-X-X-OOX-OOX-X	Umbilical Interface, Rectangular, Low Outgassing, Shell Sizes 1 thru 3 (Contact Sizes 4-20)

Notes at end of table.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS 1/ (Page 4 of 5)

Connector Type	Description
Filter Connectors	
NASA – GSFC S-311-P-626/01	EMI Contact, Non-Magnetic, D-Subminiature
TRB & TRT Series Triaxial & Twinaxial MIL-STD-1553 Databus Connectors 5/, 8/	
Military MIL-PRF-49142/3	Plug, Pin Contact, Series TRB (Bayonet Coupling)
MIL-PRF-49142/8	Plug, Pin Contact, Series TRT (Threaded Coupling)
MIL-PRF-49142/5	Receptacle, Socket Contact, Series TRB (Bayonet Coupling)
MIL-PRF-49142/9	Receptacle, Socket Contact, Series TRT (Threaded Coupling)
Nanominiature Connectors (0.025 inch contact spacing, metal lobe keyed shell) 6/	
Military (DSCC) 94032	Plug, Wire, Cable or Flex Circuit Terminated
94033	Receptacle, Wire, Cable or Flex Circuit Terminated
94034	Plug, Solder, Vertical Through Hole (single or double row) or Flex Circuit Termination
94035	Receptacle, Solder, Vertical Through Hole Terminations (single row and double row narrow profile)
94036	Plug, Solder, Right Angle Through Hole Terminations (single row and double row narrow profile)
94037	Receptacle, Solder, Right Angle Through Hole Terminations (single row and double row narrow profile)
94038	Plug, Solder, Vertical Surface Mount Terminations (double row)
94039	Receptacle, Solder, Vertical Surface Mount Terminations (single row and double row)
94040	Plug, Solder, Right Angle Surface Mount Terminations (double row)
94041	Receptacle, Solder, Right Angle Surface Mount Terminations, (single row and double row).
94042	Plug, Solder, Vertical Straight Terminations (0.025 inch soldertail spacing) and Vertical Through Hole (double row)
94043	Receptacle, Solder, Right Angle Through Hole, Narrow Profile (0.050 and 0.100 inch soldertail spacing; double row)
94044	Receptacle, Solder, Plastic Shell, Vertical Surface Mount, Low Profile (0.140 Height, double row)
94045	Mounting Hardware (Brackets, sleeves and screws)
94046	Backshell Strain Reliefs (single and double row)

Notes at end of table.

Table 1C CONNECTOR DESCRIPTIONS FOR PREFERRED CONNECTORS 1/ (Page 5 of 5)

Notes:

1/ This table represents a limited listing of connector types that have been used in space applications with acceptable results, and consequently are known as preferred. The listings in this table are limited and do not encompass the entire spectrum of all military or space grade connectors that are available.

2/ NASA - MSFC connectors are specially processed for outgassing control. Military connectors require additional processing for outgassing control when used in applications where cleanliness must be maintained.

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

4/ For radio frequency applications, the use of TNC and N series connectors is discouraged due to moisture corrosion and atomic oxygen corrosion concerns of the silver plating.

5/ Application notes for MIL-STD-1553 Databus connectors

5.1/ Military databus connectors have silver plate finish that is not recommended for space flight due to atomic oxygen corrosion concerns. Some military suppliers offer an electroless nickel plated space grade equivalent that is preferred. P/N selection to accommodate preferred databus cable M17/176-00002 is recommended.

5.2/ Tool crimp versions of these connectors require separate procurement of a calibration gage to calibrate die placement in open frame crimp tools. Consult the manufacturer for proper gage and availability.

5.3/ TRT series connectors with threaded couplings are preferred for improved shell to shell shielding and continuity.

6/ Metal shell connectors are preferred over plastic.

7/ A. GSFC specifications S-311-P-4 and S-311-P-10 should be used as the first choice where lowest residual magnetism levels are required. Connectors shall be ordered by the GSFC part number.

B. MIL-DTL-24308 Class D connectors (general purpose, /1 to /4, /23, /24) have nickel finish, but do not have non-magnetic properties. Class G connectors are not permitted.

C. MIL-DTL-24308 Class M connectors (space grade, /5 to /8, /23, /24) have gold plated shells with non-magnetic properties. For Class N connectors, only finish P (passivated stainless steel) is permitted. Class G connectors (/23 and /24 only) are not permitted.

D. MIL-DTL-24308 /23 and /24 contain a nylon or nylon-steel right angle bracket, which may require processing for contamination control due to material outgassing.

8/ Coaxial and databus connectors that require assembly are designed to accommodate specific size cables. Use of cables smaller than the connector design was intended to accommodate, is prohibited, and will likely result in improper connector assembly, improper cable support and high probability of conductor breakage or pullout and failure.

Table 1D CONTACT DESCRIPTIONS

Contact Type	Description
Military	
SAE-AS39029, 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-DTL-83505, M83505/X-XXX Types	Sockets, Component Lead, Printed Circuit
NASA – GSFC	
S-311-P-4/10, G10P1 & G10S1 Types	D-Subminiature Type, Pins and Sockets, Crimp Removable, Gold Plated, Non-Magnetic, Size 20
S-311-P-4/08, G10P1 & G08S1 Types	D-Subminiature Type, Pins and Sockets, Crimp Removable, Gold Plated, Non-Magnetic, Size 22D
S-311-P-4/06, GCXXX and GHXXX Types	D-Subminiature, 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, sizes 8 – 22.
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, sizes 4 – 20.
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 - SPACE STATION	
SSQ 21637, NUA-X-OOX Type	Backshells, for Umbilical Interface Connectors.

Table 2A SCREENING REQUIREMENTS FOR CIRCULAR CONNECTORS (REF MIL-DTL-38999, MIL-C-26482, MIL-DTL-5015, MSFC 40M38277 & 40M39569)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l / SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/**	MIL-STD-1344 (Connector Test Methods), Method 3001, condition I (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, min. Test 50% of contacts, minimum of 2. Connectors shall be wired and unmated. Simulated contacts and special techniques may be used. Six readings, min, shall be taken. Leakage current shall not exceed 2 milliamps. There shall be no evidence of flashover.		2 (0)		2 (0)		
Insulation Resistance (Room Temperature) **1/, 2/**	MIL-STD-1344, Method 3003, Test Condition B (500VDC), room temperature, wired, and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, minimum.		2 (0)		2 (0)		
Contact Engagement and Separation Force (Soldercup socket contacts only; in-process inspection prior to assembly for nonremovable)	MIL-STD-1344, Method 2014. Test three contacts per connector sample, min. Insert SAE-AS31971 gage pin to 70% of its engagement. Measured forces shall comply with SAE-AS39029, Table IX.		2 (0)				
Hermeticity (Air Leakage) (Sealed Receptacles Only) **1/**	MIL-STD-1344, Method 1008. Pressure differential across the connector shall be 1 atmosphere (14.7 PSI). Leakage shall not exceed 1×10^{-7} ATM CM^3/Sec or as specified.		100%		100%		
Coupling Force	Requires mating connector. The torque (or axial force for axial coupled connectors) that must be applied to facilitate full mating and demating shall be measured and shall meet the value specified in the detail spec.		2 (0)				
Processing for Outgassing (When contamination control required)	**Notes 11, 11.1,** and Outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2B SCREENING REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS (REF MIL-DTL-24308, GSFC S-311-P-4, S-311-P-10)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil/ NASA	Com'l /SCD	Mil/ NASA	Com'l /SCD	Mil/ NASA	Com' l/SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/**	MIL-STD-1344 (Connector Test Methods), Method 3001, Cond I. Connectors shall be unmated. Apply 1000VAC (crimp removable contacts) or 750V (hermetics) for 10 sec, min. No evidence of breakdown permitted.		2 (0)		2 (0)		
Insulation Resistance (Room Temperature) **1/, 2/**	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). Limit 5000 megohms min, unconditioned.		2 (0)		2 (0)		
Residual Magnetism	**Note 6.** (Level "C" Non-magnetic Connectors Only.)	100%	100%	100%	100%		
Mating and Unmating Force	MIL-STD-1344, Method 2013. Crimp connectors require contacts to be inserted. Force shall comply with MIL-DTL-24308, Table II for the shell size specified.		2 (0)				
Processing for Outgassing control	**Notes 11, 11.5,** and Outgassing, page 2.	100%	100%	100%	100%	100%	100%
Contact Engagement and Separation Force (In process inspection, nonremovable solder cup socket Contacts only) **1/**	MIL-STD-1344, Method 2014. Test 20% of sample's contacts, 4 min. Insert and remove max dia SAE-AS31971 Test Gage Pin. Insert min dia gage pin; measure separation force 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 SAE-AS39029, Table IX.		2 (0)				
Solderability & Resistance to Soldering Heat (PC and solder contacts)	MIL-DTL-24308, para. 4.5.24 and 4.5.27. Test 20%, min of 7. Solder Cup contacts or PC terminations shall be Solder with a pencil type iron heated to 360°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type per MIL-T-14256. There shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to all surfaces.		2 (0)				

Notes located after Table 2K.

Table 2C SCREENING REQUIREMENTS FOR MICROMINIATURE CONNECTORS (0.050 CONTACT SPACING; REF MIL-DTL-83513) 9/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com' l/SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2(0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/, 5/**	MIL-STD-1344 (Connector Test Methods), Method 3001, Condition I (Sea Level), mated or unmated. Apply for 10 seconds min. Test potential shall be 600V RMS or as otherwise specified. No evidence of flashover permitted.		100%		2(0)		
Insulation Resistance (Room Temperature) **1/, 2/**	MIL-STD-1344, Method 3003, 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)		2 (0)		
Temperature Cycling	MIL-STD-1344, Method 1003, (5 cycles, -55°C to 125°C) . There shall be no damage detrimental to the connector.		2 (0)		2 (0)		
Low Signal Level Contact Resistance) **1/, 6/**	MIL-STD-1344, Method 3002 and **note 6** for contact size 24. (Perform temperature cycling above prior to testing.).		2 (0)		2 (0)		
Mating and Unmating Force **1/**	MIL-STD-1344, Method 2013. Force shall not exceed 10 oz times the number of contacts. Mated dimension shall comply with MIL-DTL-83513, figure 1. Inspect for contact damage or pushout from connector.		2 (0)				
Solderability & Resistance to Soldering Heat (Soldercup Contact or PC Contacts)	MIL-DTL-83513, paragraph 4.5.12 and 4.5.13. Test 20% of the sample's contacts, min of 7. Solder Cup contacts or PC terminations shall be soldered with a pencil type iron heated to 300°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type. Under 10X magnification, there shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to all surfaces of the soldercup or PC Termination.		2 (0)				
Processing for Outgassing (When Contamination must be controlled)	Notes **11, 11.2** and Outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2D SCREENING REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS (REF MIL-DTL-55302; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l/SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specifications		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/, 7/**	MIL-STD-1344 (Connector Test Methods), Method 3001, mated, may be board mounted. Test all contacts in the sample. Apply voltage for 60 seconds between closest contacts and between contacts and hardware (guidepins, jackscrews, jackposts, etc.)		2 (0)		2 (0)		
Insulation Resistance (Room Temperature) **1/ 2/**	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)		2 (0)		
Contact Engagement and Separation Forces (In process inspection for Socket Contacts) **1/**	MIL-STD-1344, Method 2014. Test 20% of the sample's contacts, 3 min. Insert SAE-AS31971 test gage 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)				
Mating and Unmating Force **1/**	MIL-DTL-55302, paragraph 4.5.4. Precondition with 3 cycles of mating and unmating. For size 22 standard force contacts, max mating force shall be 0.56X no. of contacts and min withdrawal force 0.08X no. of contacts. For low insertion force contacts, max. mating force shall be 0.25X no of contacts min, and withdrawal force shall be 0.04X no. of contacts. Inspect for contact damage or pushout from connector.		2 (0)				

Notes located after Table 2K.

Table 2D SCREENING REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS (REF MIL-DTL-55302; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l/SCD
Solderability & Resistance to Solder Heat	PC Type Contacts: MIL-STD-202, Method 210, Test Condition C (260°C for 10 seconds). Solder Cup Contacts: MIL-DTL-55302, paragraph 4.5.16, four second duration. Perform post solder visual exam at 10X magnification. There shall be no evidence of damage or distortion to the insert. Contact floating conditions, if applicable, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup or PC terminations. Surface Mount Contacts (intended for soldering to a printed wiring board): An anti-wicking feature as an integral part of the contact is recommended, and such designs shall not exhibit solder wicking into the contact that would interfere with mating and performance.		2 (0)				
Low Signal Level Contact Resistance **1/, 6/**	MIL-STD-1344, Method 3002 and **Note 6**. Resistance values shall comply with **Note 6**. Environmental conditioning is not required.		2 (0)		2 (0)		
Circuit Testing (Flexible Circuit Printed Wiring Board Terminations) **12/**	Refer to section W1 (Wire and Cable), table 2E (Screening) and 3E (Qualification). Perform circuit continuity and insulation resistance on all flexible circuits prior to termination. Thermal stress testing shall be performed on samples.	100%	100%	100%	100%		
Processing for Outgassing (When Contamination must be controlled)	Notes **11, 11.6,** and Outgassing, page 2 of this section.		100%		100%		100%

Notes located after Table 2K.

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

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l/SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/, 10/**	MIL-STD-202, Method 301. May require assembly of samples. Simulated contacts and techniques may be used. Ref SMA types; apply 500 VRMS, 750 VRMS, or 1000 VRMS per cable size in **Note 8**. Relative humidity shall be 50%. There shall be no evidence of breakdown.		2 (0)		2 (0)		
Insulation Resistance (Room Temperature) **1/, 2/**	MIL-STD-202, Method 302, Test Condition B, between center contact and body. Measurements shall be 5000 megohms, min.		2 (0)		2 (0)		
Force to Engage and Disengage **1/**	MIL-PRF-39012, paragraph 4.7.2, 2 inch-lbs torque, max for SMA types.		2 (0)				
Coupling Proof Torque (Threaded Plugs Only) **1/**	MIL-PRF-39012, paragraph 4.7.3, 15 inch lbs torque, min, for SMA types.		2 (0)				
Hermetic Seal (Pressurized Connectors Only) **1/**	MIL-STD-202, Method 112, Test Condition C, Procedure I. Leak rate shall not exceed 1x 10^{-8} ATM CM^3/Sec or as otherwise specified.		100%		100%		
Center Contact Retention (Captivated Center Contact Types Only)	MIL-PRF-39012, paragraph 4.7.9. Apply 6 lbs axial force, min, to the center contact in each direction along mating axis. Contact displacement shall not exceed acceptable limits in the reference specification.		2 (0)				
Processing for Outgassing Control (Applications where contamination must be controlled)	**Notes 11, 11.3** and Outgassing, page 2.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2F SCREENING REQUIREMENTS FOR MULTI-CONTACT PLUG-IN SOCKETS, STRIPS AND FEED THROUGH TERMINALS (REF MIL-PRF-12883, MIL-DTL-83734, MIL-PRF-83502, A-A-59126; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l /SCD
Visual **1/**	Perform workmanship inspection per Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/**	MIL-STD-1344 (Connector Test Methods), Method 3003. Wire all odd #'d contacts together and all even #'d 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 specified. Apply for 60 seconds. Compression mounted terminals shall be securely mounted in a test fixture as specified. There shall be no evidence of breakdown.		2 (0)		2 (0)		
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003. Sockets and terminals shall be wired as in DWV test above. IR shall be 5000 megohms min or as specified.		2 (0)		2 (0)		
Insertion and withdrawal force (Plug-In Sockets & Strips) **1/**	Flat pin or round test gauge shall be as specified in the detail specification. After three insertions and withdrawals of the test gage (or as specified), insertion and withdrawal force shall be measured, and shall fall within specified values. 20% of contact positions shall be tested (3 Min). There shall be not contact pushout or other damage that would prevent normal function.		2 (0)				
Processing for Outgassing Control (Contamination controlled environments)	**Note 11** and Outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2F SCREENING REQUIREMENTS FOR MULTI-CONTACT PLUG-IN SOCKETS, STRIPS AND FEED THROUGH TERMINALS (REF MIL-PRF-12883, MIL-DTL-83734, MIL-PRF-83502, A-A-59126; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l /SCD
Solderability & Resistance to Solder Heat	MIL-STD-202, Method 210, Test Condition C. Test all contacts in two connector samples. Solder with a pencil type iron heated to 360°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type per MIL-T-14256. Under 10X magnification, there shall be no evidence of damage or distortion to the socket insert. Contact floating conditions, if applicable, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the solder cup, PC terminations or J-hooks. Anti-wicking features, if applicable, shall not permit solder wicking into the contact that would interfere with mating and performance.		2 (0)		2 (0)		

Notes located after Table 2K.

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

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		NASA	Com'l /SCD	NASA	Com'l /SCD	NASA	Com'l/SCD
Visual	Table 4A (See Circulars, DSUBs or Micro-minis, as appl.)		100%		100%		100%
Mechanical	Table 4 (See Circular, DSubminiature or Microminiature as applicable). Dimensions per detail specification.		2 (0)		2 (0)		
Voltage Conditioning	MIL-STD-202, Method 108 (Life Test), test duration as specified. Apply 2X rated DC voltage at connector max temp rating, with positive voltage to the contact pin. Max series resistance shall be 5 OHMS. A fuse with a max rating of 0.25 amps shall be used between the shell & ground. Upon completion of testing and while at 125°C, IR shall be measured and shall not be less than 50 Megohms.		100% (168 - 240 hours)		100% (168 hours)		100% (24 hours)
Dielectric Withstanding Voltage	MIL-STD-1344 (Test Methods, Connectors), Method 3003. Apply 2X rated DC for 5 to 10 sec between each contact and the shell. Current shall be limited to 20 milliamps. No breakdown or degraded performance permitted.		100%		100%		2 (0)
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, Test Condition (100V DC) or rated DC Voltage, whichever is less, for 2 minutes, Max. Measure between contact & Shell. Min of 5,000 megohms between any pair of contacts and between contacts and shell.		100%		100%		2 (0)
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%		
Attenuation	GSFC S-311-P-626 para 4.8.9. Perform test at temp and frequency specified. Value shall not be less than the amount specified for the selected capacitance and frequency.		100%		100%		2 (0)
Processing for Outgassing Control (Applications where contamination must be controlled)	See **note 11** and Outgassing, page 2. (Note: If completed filter connector is subjected to 125°C during voltage conditioning, high temp exposure is sufficient to meet requirement.)		100%		100%		100%
Mating and Demating Force (D-Sub and Micromini styles)	Refer to screening Table 2B (D-Sub s) or 2C (Microminis)		2 (0)				
Coupling Force (Circulars)	Refer to Screening Table 2A (Circular connectors).		2 (0)				

Notes located after Table 2K.

Table 2H SCREENING REQUIREMENTS FOR CONNECTOR CONTACTS AND PRINTED CIRCUIT PLUG-IN SOCKET CONTACTS (REF SAE AS39029, 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	
		Mil/ NASA	Com'l/ SCD	Mil/ NASA	Com'l/ SCD	Mil/ NASA	Com'l /SCD
Visual **1/**	Perform workmanship inspection per Table 4B & **Note 10**. (May be performed as contacts are drawn for use from inventory.)	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Table 4; Dimensions per detail specification.		3 (0)		2 (0)		
Residual Magnetism (Nonmagnetic contacts only) **3/**	GSFC S-311-P-4/08 and /10 paragraph 3.3.1. Group contacts together. Measured value for the group shall not exceed a gamma level of 0.1X the no. of contacts in group. Refer to **Note 3.1 for** Residual Magnetism levels.	**Note 3.2 Note 3.2**	100% level C 3(0) level B	**Note 3.2 Note 3.2**	100% level C (2) level B		
Contact Engagement Force (Sockets Only) **1/**	MIL-STD-1344 (Connector Test Methods), Method 2014. Measure force during contact insertion. Contact engaged to a depth of 0.7L. Force shall comply with SAE-AS39029 (contacts), Table IX. For Grade 1, perform on samples per ASQC-Z1.4 (American Society for Quality Control, Inspection by Attributes). For coaxial or high voltage contacts use 4(0).		AQL Level S-3		8 (0)		
Contact Separation Force (Sockets Only) **1/**	(Same as above except measure during separation)		100%		8 (0)		
Plating Thickness **1/**; (N/A PC Sockets)	Ref. ASTM-B488 (gold). **See Note 4** at end of table and note 2 under materials, page 1.		3 (0)				
Dielectric Withstanding Voltage (Sea Level, size 8 Coaxial Contacts and size 8 high voltage contacts)	MIL-STD-1344, method 3001. Apply 1000 VAC (straight coaxial) or 800VAC (90° coaxial) between center contact and shell. There shall be no breakdown. For high voltage contacts, apply 2,800VAC or as specified.		4 (0)		2 (0)		
Insulation Resistance (Room Temperature, Sea Level, size 8 Coaxial Contacts)	MIL-STD-1344, Method 3003. Sockets and terminals shall be wired as in DWV test above. IR shall be 5000 megohms min or as specified.		4 (0)		2 (0)		
Processing for Outgassing (When contamination must be controlled)	Refer to **Note 11** and outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2I SCREENING REQUIREMENTS FOR TWINAXIAL DATABASE (MIL-STD-1553) CONNECTORS (REF MIL-PRF-49142)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l /SCD
Visual **1/**	Table 4A	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2 (0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/**	MIL-STD-202, Method 301. Samples may require assembly Simulated contacts and special techniques may be used. Apply 1200 VRMS between center conductor and intermediate (middle) conductor, and 500 VRMS between intermediate (middle) conductor and outer conductor (shield) or outer body per cable size in reference spec. There shall be no evidence of breakdown.		2 (0)		2 (0)		
Insulation Resistance (Room Temperature) **1/, 2/**	MIL-STD-1344, Method 3003, Test Condition B. Apply between center contact and intermediate (middle) contact; between intermediate conductor and shield, or outer body. Measurements shall be 5000 megohms, min.		2 (0)		2 (0)		
Force to Engage and Disengage **1/**	MIL-PRF-49142, paragraph 4.6.2.1 connector shall be engaged with its mating connector. One connector shall be secured in a holding fixture. During the coupling/ uncoupling cycle, forces and/or torques necessary to fully mate shall be monitored. Longitudinal force (N/A threaded coupling) shall not exceed 4 pounds, or as specified, torque shall not exceed 2.5 inch-pounds, or as specified.		2 (0)				
Coupling Retention and Cable Retention	Connectors shall be mated and terminated to their proper cables. One cable shall be secured in a clamped fixture. The other cable shall be secured in a sleeve or other clamped fixture, and pulled longitudinally away from the mated pair in such a manner that the cable remains unbent and untwisted. A force of 40 pounds, minimum or as otherwise specified, shall be applied and held for 30 seconds, min. After testing, continuity thru the connections shall be maintained without effect on mating and demating.		2 (0)				
Processing for Outgassing (When contamination must be controlled)	**Note 11** and Outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2J SCREENING REQUIREMENTS FOR NANO-MINIATURE CONNECTORS (0.025 INCH CONTACT SPACING; REF DSCC 94031) 9/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l /SCD	Mil	Com'l /SCD	Mil	Com'l/SCD
Visual **1/**	Table 4A.	100%	100%	100%	100%	100%	100%
Mechanical **1/**	Dimensions per detail specification.		2 (0)		2(0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/, 5/**	MIL-STD-1344 (Connector Test Method), Method 3001, Cond I, mated or unmated. Apply 250VRMS or as specified for 10 sec min. No evidence of breakdown permitted.		100%		2(0)		
Insulation Resistance (Room Temperature) **1/ 2/**	MIL-STD-1344, Method 3003, applied voltage 100V DC, connectors mated. Measure between adjacent contacts and between contacts and shell. Measurements shall be 1000 megohms min, unconditioned.		2 (0)		2 (0)		
Temperature Cycling	MIL-STD-1344, Method 1003, (5 cycles, 55°C to 125°C) . One hour dwell at each extreme. There shall be no damage detrimental to the connector.		2 (0)				
Low Signal Level Contact Resistance **1/, 6/**	MIL-STD-1344, Method 3002 and **Note 11**. Temperature cycle conditioning required for grade 1.		2 (0)		2 (0)		
Mating and Unmating Force **1/**	MIL-STD-1344, Method 2013. Mating force shall not exceed 6 oz times the number of contacts. (3 oz for unmating). Inspect for contact damage or pushout.		2 (0)				
Solderability & Resistance to Soldering Heat **1/** (PC Surface Mount or Through Hole Terminations)	DSCC 94031, paragraph 4.8.24 and 4.8.26. Test 20% of sample's contacts, 9 min. PC terminations shall be solder dipped using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type per MIL-T-14256. Under 10X magnification, there shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to Terminations.		2 (0)				
Circuit Testing (Flexible Circuit Printed Wiring Board Terminations) **10/**	Refer to Section W1 (Wire & Cable), Tables 2E & 3E. Perform circuit continuity and insulation resistance on all flexible circuits prior to termination. Perform thermal stress testing on samples.		100%		100%		
Processing for Outgassing (When contamination must be controlled)	**Notes 11, 11.4,** and Outgassing, page 2 of this section.	100%	100%	100%	100%	100%	100%

Notes located after Table 2K.

Table 2K SCREENING REQUIREMENTS FOR UMBILICAL INTERFACE CONNECTORS (REF NASA GSFC S-311-P-718 [FIXED RACK AND PANEL], SAE AS 81703 [PUSH-PULL CIRCULAR])

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)					
		Level 1		Level 2		Level 3	
		Mil/ NASA	Com'l /SCD	Mil/ NASA	Com'l /SCD	Mil/ NASA	Com'l / SCD
Visual **1/**	Perform workmanship inspection per Table 4A.		100%		100%		100%
Mechanical **1/**	Dimensions per detail specification.		2(0)		2(0)		
Dielectric Withstanding Voltage (Sea Level) **1/, 2/**	MIL-STD-1344 (Connector Test Methods), Method 3001, condition I (room temperature and atmosphere). A voltage of 1000V RMS shall be used. Duration shall be 2 seconds, min. Connectors shall be wired and unmated. Simulated contacts and special techniques may be used. Apply between three pairs of adjacent contacts and between the shell and three contacts closest to the shell. Leakage current shall not exceed 2 milliamps. There shall be no evidence of flashover.		2(0)		2(0)		
Insulation Resistance (Room Temperature) **1/, 2/**	MIL-STD-1344, Method 3003, Test Condition B (500VDC), room temperature, wired, and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, minimum.		2(0)		2(0)		
Force, Mating and Unmating (Fixed Rack and Panel)	Requires mating connector. The axial force that must be applied to facilitate full mating and demating shall be measured and shall meet the forces specified in the detail spec.		2(0)				
Processing for Outgassing (When contamination control required)	**Notes 11, 11.1,** and Outgassing, page 2 of this section. (Not required for push-pull connectors that are intended to demate during launch or deployment.)	100%	100%	100%	100%	100%	100%
Operating Force (Push-Pull Circular)	Requires mating connector. The force applied to coupling rings of push-pull connectors and between shells to accomplish mate and demate shall be measured and shall meet the forces specified in the detail spec.		2(0)		2(0)		

Notes located on next page.

NOTES FOR SCREENING REQUIREMENTS TABLES 2A THROUGH 2K (Page 1 of 3)

1/ Connectors procured to military specifications or NASA specifications flagged with this note normally have this test performed on samples. Unless otherwise specified, this test does not need to be repeated, except as deemed necessary by user's receiving inspection.

2/ For Level 1 programs, Dielectric Withstanding Voltage (DWV) and Insulation Resistance (IR) 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 MIL-DTL-38999 military connectors already 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.

3/ Residual magnetism

3.1/ For non magnetic connectors and contacts, nickel shall not be used due to magnetic properties. Tests require 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 (Level "A"), 200 Gamma (Level "B") and 20 Gamma (Level "C"). Only levels B and C are qualified to GSFC S-311-P-4 or S-311-P-10. When residual magnetism levels of 20 Gamma are required, each connector must be tested. The test procedure in GSFC S-311-P-4 Paragraph 4.5.4 or S-311-P-10 Paragraph 4.5.5 shall apply. Level "B" is guaranteed by use of non magnetic materials and no further screening is required.

3.2/ In order to verify nonmagnetic properties at the user's incoming receiving and inspection facilities (optional), 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 that are attracted to the magnet, shall be rejected. After testing, connectors and contacts that are processed for 20 Gamma (Level "C"), shall be demagnetized in a field of 1500 Gauss strength, min, for not less than 2 seconds. 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.

4/ Contact Gold Plating.

4.1/ For military contacts, SAE-AS39029 (Contacts, Electrical Connectors) requires a minimum plating thickness of 50 microinches (1.27 micrometers) per ASTM-B488 (Supersedes MIL-G-45204.) This is the minimum requirement for Level 1 / 2 programs, and preferred for Level 3 programs.

4.2/ Plating thickness shall be measured using Microscopic cross sectioning, Beta backscatter or X-ray fluorescence methods described in ASTM-B488 (Gold Coating). Due to the specialized test equipment required to perform this test, use of manufacturer's testing facilities is preferred.

5/ For MIL-DTL-83513 Microminiature connectors and DSCC 94031 Nanominiature connectors with crimp type pig tail leads, adjacent leads shall be tested for shorting prior to DWV. Each lead shall be tested. For Microminiature DWV testing, a test potential of 600 VRMS (sea level) shall be used. For Nanominiature connectors, 250VRMS (sea level) shall be used. If the manufacturer can certify that this test is normally performed on each connector, additional testing is not required.

6/ Low level signal contact resistance.

6.1/ Purpose. Experience has shown occasional problems with microminiature type or PWB type connectors with straight or formed lead terminations or soldercups that are crimp or weld joined to the contact body. Low level signal contact resistance is intended to test for unacceptable welds or crimp joints. (Not to be confused with socket contact engagement sleeve and contact body. When unsure, contact vendor for construction type used in PWB connectors).

6.2/ Procedure. Unless otherwise specified, all contacts in each connector sample shall be measured. For best results, precondition temperature cycling is recommended. Measurements can be performed using a micro-ohmmeter and four wire measurements. Mated connector pairs are recommended. Attach current leads at extreme ends of mated connector contacts. Attach voltage leads inside the current leads on contact closest point to dielectric insert. If necessary, needle probes may be used. Apply one milliamp DC or as specified. Measurement shall not exceed 15 milliohms for size 22 contacts, 25 milliohms for size 24 contacts terminated to size 25 solid wire or soldercups, 32 milliohms for size 24 terminated to size 26 AWG wire pigtails, 70 milliohms for size 30, or as otherwise specified.

7/ For critical applications, perform DWV on each printed circuit connector. Otherwise perform on two connector samples.

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

8/ For SMA type coaxial connectors, apply DWV per the following table:

Cable Part Number	Outer Diameter	Voltage (RMS)
M17/93-RG178	0.075	500V
M17/113-RG316	0.102	750V
M17/60-RG142 M17/111-RG303 M17/128-RG400	0.200 0.175 0.200	1000V 1000V 1000V

9/ Some Microminiature and Nanominiature type connectors have the option of pre terminated crosslinked ETFE (Tefzel ™) insulated wire pigtails. Users are advised that some ETFE insulations are known to outgas trace amounts of corrosive fluorine over time. When this wire is used with nickel coated metal shell connectors and stored in sealed plastic or ESD bags, trapped fluorine can attack exposed metal shells and contacts. The problem appears to be worse for white insulation, and consequently, color coded insulation is preferred.

For connectors with insulated wire terminations, upon receiving new product or pulling product from storage, visual inspection should be performed using a minimum of 10X magnification for corrosive by products indicated by a dull “gun metal” appearance on the nickel coated shell. Corroded gold plated contacts have a flat black appearance. Connectors with normal shells and contacts should be repackaged such that only the connector is protected and the wire is left unpackaged, open to room conditions. Connectors with corroded contacts should be discarded. Dull connectors (with good contacts) can be carefully cleaned and used per the following procedure:

Rinse connector in distilled water for 30 seconds. Remove connector and lightly shake off excess water. Repeat the rinse a second time with fresh distilled water and shake. Rinse connector with isopropyl alcohol. Remove and shake. Repeat the rinse with fresh isopropyl alcohol and shake. Perform a bakeout of 125°C for 24 hours and full or partial vacuum is recommended prior to storage. Repackage only the connector and leave the wire unpacked, open to room conditions.

NOTES FOR SCREENING REQUIREMENTS TABLES 2A THROUGH 2K (Page 3 of 3)

10/ For crimp type contacts, the crimp barrel diameter may be checked on a "GO" "NO-GO" basis by inserting a proper size wire in the barrel. (For example, a size 22 conductor may be inserted into the crimp barrel of a size 22D contact). If the barrel will not accept the conductor, the barrel is not correctly sized. For critical applications it may be desirable to perform this test on 100% of contacts.

11/ Outgassing Control. A bakeout for outgassing control is driven by the application, and may be required where tight contamination control must be maintained. A bakeout 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 based on the material used and requires project approval. Consult NASA Reference Publication 1124 for cure times and temperatures of various materials.

11.1/ Circular connectors. The silicon rubber environmental seal and lubricant applied to keyways, are outgassing concerns. Additional processing for contamination control due to outgassing is available by special request 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 be noted that removal and replacement of lubricant requires some disassembly of the connectors and is usually labor intensive. A bakeout of military connectors is helpful in controlling outgassing, but is not guaranteed to resolve all outgassing concerns.

11.2/ MIL-DTL-83513 Microminiature connectors. Certain receptacles contain a thin press-on fluorosilicone rubber or silicone rubber interface. Silicone may represent 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.

11.3/ MIL-PRF-39012 SMA RF connectors. Certain 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 may be required for outgassing control.

11.4/ MIL-DTL-83513 Microminiature and DSCC 94031 Nanominiature connectors. Certain plugs contain an epoxy potting material that must be traceable to acceptable outgassing test results.

11.5/ D-Subminiature connectors. NASA GSFC 311 connectors have acceptable outgassing properties and no further processing is normally required. However, some commercial versions contain an optional rear silicone rubber sealing grommet behind the connector that 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. Other military and commercial connectors may contain a cadmium or zinc finish that is unacceptable for use in high temperature vacuum environments due to sublimation problems. Right angle printed wiring board connectors may have a nylon mounting bracket that may require a bakeout for outgassing control.

11.6/ MIL-DTL-55302 type Printed Wiring Board connectors. Military PWB connectors are made from molding materials with known good outgassing stability, and no further processing for outgassing control is normally required. However, certain commercial connectors may be molded with thermoplastic polyamides such as Nylon ™ that represent an outgassing concern. Certain Nylons can contain additives that can outgas. Nylon is also hygroscopic and can absorb moisture, even after a bakeout The use of Nylon is not recommended.

11.7/ Contacts. 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.

12/ For PWB connectors that are delivered from the manufacturer terminated with flexible printed wiring circuits, all flexible circuits shall be screened prior to use with PWB connectors. Refer to Section N, Table 2E. Performance class 3 shall apply.

Table 3A QUALIFICATION REQUIREMENTS FOR CIRCULAR CONNECTORS 1/, 6/
(REF MIL-DTL-38999, MIL-C-26482, MIL-DTL-5015, MSFC 40M38277 & 40M39569; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.) Level 1 Commercial/ SCD	Level 2 Commercial/ SCD	Level 3 Commercial
Visual	Inspect per Table 4A; Two mated sets of plugs and receptacles designated pair A and pair B or two mated sets of plugs and hermetic receptacles designated pair C and pair D.	2(0) Mated pairs A&B or C&D	2(0) Mated pairs A&B or C&D	Not Required
Mechanical	Dimensions per detail specification.	2(0) Mated pairs A&B or C&D	1(0) A or C	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, condition I. (room temp 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 min. Connectors shall be wired and unmated. Simulated contacts and special techniques may be used. Leakage current 2 milliamps, maximum. Six readings shall be taken. Apply voltage for 2 seconds, min, using 50% of contacts, min of 2. There shall be no evidence of flashover.	2(0) Mated pairs A & B or C & D	2(0) Mated pairs A & B or C & D	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, Test Condition B, (500VDC) room temperature, connectors wired and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, min.	2(0) Mated pairs A & B or C & D	2(0) Mated pairs A & B or C & D	
Temperature Cycling (Except Hermetics)	MIL-STD-1344, Method 1003, Test Condition A. Step 3 shall use the maximum temperature of the connector. There shall be no damage detrimental to the performance of the connector.	2(0) Mated pairs A & B	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.	1(0) Mated pairs B or D		

Notes located after Table 3K.

Table 3A QUALIFICATION REQUIREMENTS FOR CIRCULAR CONNECTORS 1/, 6/
(REF MIL-DTL-38999, MIL-C-26482, MIL-DTL-5015, MSFC 40M38277 & 40M39569; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.) Level 1 Com'l/SCD	Level 2 Com'l/SCD	Level 3 Commercial
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.	1(0) Mated pairs B or D	1(0) Mated pairs B or D	Not Required
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.	1(0) Mated pairs A or C	1(0) Mated pairs A or C	
Evaluation of Material Outgassing	See Outgassing, page 2.	X	X	
Contact Engagement and Separation Force (Soldercup socket contacts only; in-process inspection.)	MIL-STD-1344, Method 2014. Test 3 contacts min/connector sample. Insert SAE-AS31971 gage test pin to 70% of its engagement. Forces shall comply with SAE-AS39029, Table IX	1(0) Mated pairs A or C		
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. There shall be no damage detrimental to the seal or function of the connector.	2(0) Mated pairs C & D	2(0) Mated pairs C & D	
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	2(0) Mated pairs C & D	
Contact Retention (Push Test) (Crimp Removable Contacts Only)	MIL-STD-1344, Method 2007. Apply load of 10 lbs for size 22D, 15 lbs for size 20, 25 lbs for size 16 through 8, and 30 lbs for sizes 4 and 0; axial displacement shall not exceed 0.012 in for contact sizes 22D, 20, 16; and 0.025 in for sizes 8 through 0.	1(0) Mated pair B		
Mating and Unmating Force (Coupling Torque) (N/A Threaded Coupling)	MIL-STD-1344, Method 2013. Measure torque for bayonet coupled and/or axial force for push pull coupled connectors. For Breechlok type connectors, axial force and torque shall be measured. For lever actuated connectors, measure axial force is only. Force shall be as specified in the detail specification.	1(0) Mated Pairs B or D		
Insert Retention	MIL-STD-1344, Method 2010. Apply axial force of 75 lbs PSI or as specified. Inserts shall be retained without evidence of cracking, breaking, separating or loosening.	1(0) Mated pair A		

Notes located after Table 3K.

Table 3B QUALIFICATION REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS 1/, 7/ (REF MIL-DTL-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**
		Commercial/ SCD	**Commercial/ SCD**	**Commercial**
Visual	Perform workmanship inspection per Table 4A	3(0)	2(0)	
Mechanical	Dimensions per detail specification.	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Condition I. Connectors shall be unmated. Apply 1000VAC (crimp removable contacts) or 750V(hermetics) for 10 sec, min. No evidence of breakdown.	3(0)	2(0)	
Insulation Resistance (Room Temperature)	At ambient temperature, test per MIL-STD-1344, Method 3003, test condition B (500VDC). 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)	2(0)	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A (5 cycles). 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)	2(0)	Not Required
Vibration	MIL-STD-1344, Method 2005, Test Condition IV, (20G peak). Connectors shall be wired and mated. All contacts shall be wired in a series circuit with 100 milliamps of current applied. Connectors shall be monitored for discontinuities longer than one microsec. Vibration shall not result in any broken, loose, displaced, deformed or loosened connector parts.	3(0)		
Shock	MIL-STD-1344, Method 2004, Test Condition E. (50G peak, sawtooth wave, 11 millisec duration). Apply one shock in each direction to each of three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration testing.	3(0)	2(0)	
Residual Magnetism (Non-magnetic Connectors Only)	Connectors made with non-magnetic materials shall be tested per **Note 2**.	3(0)	2(0)	
Mating and Unmating Force	MIL-STD-1344, Method 2013. Crimp connectors require contacts to be inserted. Force shall comply with MIL-DTL-24308, Table II.	3(0)	2(0)	

Notes located after Table 3K.

Table 3B QUALIFICATION REQUIREMENTS FOR D-SUBMINIATURE CONNECTORS 1/, 7/ (REF MIL-DTL-24308, S-311-P-4, S-311-P-10; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Evaluation for Material Outgassing Properties	See Outgassing, page 2 of this section.	X	X	Not Required
Contact Engagement & Separation Forces (Nonremovable Soldercup Socket Contacts)	MIL-STD-1344, Method 2014. Test 20% of connector contacts, four min. Insert and remove max dia SAE-AS31971gage 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 SAE-AS39029, Table IX.	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-DTL-24308, paragraph 4.5.24 and 4.5.27. Test 20%, min of 7. Solder Cup contacts or PC terminations shall be soldered using a pencil type iron heated to 360°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys), formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes), formerly RMA type per MIL-T-14256. There shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to all surfaces of the soldercup or termination.	3(0)	2(0)	
Insert Retention	MIL-STD-1344, Method 2010. A force of 60 PSI shall be applied for 5 seconds in each direction. Contacts may be removed for convenience. Inserts shall not be displaced from their original positions.	3(0)		

Notes located after Table 3K.

Table 3C QUALIFICATION REQUIREMENTS FOR MICROMINIATURE CONNECTORS 1/, 7/ (0.050 INCH CONTACT SPACING; REF MIL-DTL-83513; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Perform workmanship inspection per Table 4A	3(0)	2(0)	Not Required
Mechanical	Dimensions per detail specification.	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Condition I, mated or unmated. Apply for 10 sec min. Test potential shall be 600V RMS or as specified. There shall be no evidence of flashover.	3(0)	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, test condition B, (500VDC) 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)	2(0)	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A (5 cycles). 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)	2(0)	
Vibration	MIL-STD-1344, Method 2005, Test Condition IV (20G peak). 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 (50G peak, sawtooth.) Apply one shock to each direction of three mutually perpendicular axes. Connectors shall be mated, wired, monitored and examined for damage same as vibration.	3(0)	2(0)	
Contact Engagement and Separation Forces (Receptacles with recessed pin contacts)	MIL-DTL-83513, paragraph 4.5.9. Requires special socket test sleeve. Engagement force, 6 oz. per contact, max. Separation force, 0.5 oz per contact, min. Test 20% of contacts, 7 min.	3(0)		
Low Signal Level Contact Resistance	Measured resistance shall be per **Note 3** for size 24 contacts.	3(0)	2(0)	

Notes located after Table 3K.

Table 3C QUALIFICATION REQUIREMENTS FOR MICROMINIATURE CONNECTORS 1/, 7/ (0.050 INCH CONTACT SPACING; REF MIL-DTL-83513; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
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 0.202 for plastic. Reference MIL-DTL-83513, figure 1. Inspect for contact damage or pushout from the connector.	3(0)		Not Required
Contact Retention / Wire Retention (Prewired Crimp Contacts)	MIL-STD-1344, Method 2007. Test 20% of connector contacts, 7 min. Apply 5 lbs to individual wire pigtails for 6 seconds, min. Load shall not displace contact or pull the wire from the crimp contact.	3(0)		
Resistance to Soldering heat and Solderability (Soldercup Contact or PC Type Contacts)	MIL-DTL-83513, paragraph 4.5.12 and 4.5.13. Test 20% of connector contacts, min of 7. Solder Cup contacts or PC terminations shall be soldered with a pencil type iron heated to 300°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes), formerly RMA type per MIL-T-14256. Under 10X magnification, there shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to all surfaces of the soldercup or PC Termination.	3(0)	2(0)	
Insert Retention (Metal Shell Types Only)	MIL-STD-1344, Method 2010. A force of 50 PSI for 5 seconds shall be applied in each direction. Insulators shall not be displaced from their original positions.	3(0)		
Evaluation of Material Outgassing Properties (Applications where contamination must be controlled)	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3D QUALIFICATION REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS 1/, 7/ (REF MIL-DTL-55302; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Perform workmanship inspection per Table 4A	3(0)	2(0)	Not Required
Mechanical	Dimensions per detail specification.	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level) **4/**	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 & posts)	3(0)	2(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)	2(0)	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Cond A (5 cycles). Rated connector temperature extremes shall be used. There shall be no damage detrimental to the operation of the connector.	3(0)	2(0)	
Vibration	MIL-STD-1344, Method 2005, Test Cond III (15G peak). Connectors wired and mated. PC connectors shall be board mounted. Connectors shall be fixtured as shown in MIL-DTL-55302 Fig 3, and a stabilizing arrangement used to prevent mated connectors from separating when mating 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 microsec. At test conclusion connectors shall be examined for damage or part loosening.	3(0)		
Shock	MIL-STD-1344, Method 2004, Test Condition G (100G peak). 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)	2(0)	
Contact Engagement and Separation Forces (Socket Contacts)	MIL-STD-1344, Method 2014. Test 20% of connector contacts, minimum of 4. Insert SAE-AS31971 test pin to a depth of 0.140 ± .02 inch. Max engagement force for standard force contacts shall be 12 oz. per contact (size 22 contacts) and 4 oz. per contact for low insertion force contacts. Min separation force is 0.5 oz.(each type).	3(0)		

Notes located after Table 3K.

Table 3D QUALIFICATION REQUIREMENTS FOR PRINTED CIRCUIT CONNECTORS 1/, 7/ (REF MIL-DTL-55302; Page 2 of 2)

Inspection / Test	**Test Methods, Conditions, and Requirements**	**Quantity (Accept No.)**		
		Level 1	**Level 2**	**Level 3**
		Commercial/ SCD	**Commercial/ SCD**	**Commercial**
Resistance to Solder Heat and Solderability	PC Type Contacts - MIL-STD-202, Method 210, Test Cond C Solder Cup Contacts - MIL-DTL-55302, paragraph 4.5.17, four second duration. Perform post solder visual exam at 10X magnification. There shall be no evidence of damage or distortion to the insert. Contact floating conditions, if appl, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup or PC tails. Surface mount contacts (Intended for soldering to a board). Anti-wicking features shall not permit solder wicking into the contact that would interfere with mating and performance.	3(0)	1(0)	Not Required
Low Signal Level Contact Resistance **3/**	MIL-STD-1344, Method 3002. Measured contact resistances shall be per MIL-DTL-55302, Table III, or as specified. Environmental conditioning is not required. Test all contacts.	3(0)	2(0)	
Mating and Unmating Force	MIL-DTL-55302 para 4.5.4. Precondition with 3 mating cycles. For size 22 standard force contacts, max mating force in pounds shall be 0.56X no. of contacts and min withdrawal force 0.08X no. of contacts, or as otherwise specified. For low insertion force contacts, max. mating force shall be 0.25X no of contacts and withdrawal force shall be .04X number of contacts.	3(0)	1(0)	
Contact Retention (Push Test) (Crimp Remove Contacts Only)	MIL-STD-1344, Method 2007. Test 7 contacts min in each connector sample. With a push test tool, 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. may be used. Contact displacement after removal of force shall not exceed 0.015 inches.	3(0)	1(0)	
Conductor Workmanship (Flexible Circuit Surface Mount Leads Only)	Refer to Section W1 (Wire and Cable), Tables 2E & 3E. All flexible circuits shall be screened and qualified prior to termination.	3(0)	2(0)	
Evaluation of Material Outgassing Properties (contamination control)	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3E QUALIFICATION REQUIREMENTS FOR RADIO FREQUENCY CONNECTORS 1/, 8/ (REFERENCE MIL-PRF-39012, MIL-C-83517; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1 Commercial/ SCD	Level 2 Commercial/ SCD	Level 3 Commercial
Visual	Table 4A (For level 1 qualification, six samples divided into two groups. Group A has 4 samples, Group B has 2.)	6(0) Groups A & B	2(0)	Not Required
Mechanical	Dimensions per detail specification.	6(0) Groups A & B	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Method 301. May require assembly of samples. Simulated contacts and special techniques may be used. Ref SMA types; apply 500 VRMS, 750 VRMS, or 1000 VRMS per cable size in **Note 13.** No evidence of breakdown.	6(0) Groups A & B	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, Test Cond B (500VDC), between center contact and body. IR shall be 5000 megohms, min.	6(0) Groups A & B	2(0)	
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 (Threaded plugs only)	MIL-PRF-39012, paragraph 4.7.3, 15 inch lbs torque, min, for SMA types.	6(0) Groups A & B	2(0)	
Hermetic Seal (Pressurized Connectors Only)	MIL-STD-202, Method 112, Test Cond C (gas), Procedure I. Leak rate shall not exceed $1x10^{-8}$ ATM CM^3/sec or as specified.	6(0) Groups A & B	2(0)	
Thermal Shock (or Temperature Cycling)	MIL-STD-202, Method 107, Test Condition B (5 cycles) (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	2(0)	
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 located after Table 3K.

Table 3E QUALIFICATION REQUIREMENTS FOR RADIO FREQUENCY CONNECTORS 1/, 8/ (REFERENCE MIL-PRF-39012, MIL-C-83517; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Shock	MIL-STD-202, Method 213, Test Condition I (100G) (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	2(0)	Not Required
Cable Retention Force **5/** (Cabled Connectors Only)	Connector shall be terminated to the appropriate size of coaxial cable. Connector shall be firmly held in a fixture while a force as specified is applied to pull 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 for the cable used.	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	2(0)	
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 center contact axis. The contact shall not be displaced from the SMA interface dimension.	2(0) Group B		
Evaluation of Material Outgassing Properties (Applications where contamination must be controlled)	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3F QUALIFICATION REQUIREMENTS FOR PLUG-IN-SOCKETS, STRIPS AND TERMINALS 1/, 9/ (REF MIL-PRF-12883, MIL-DTL-83734, MIL-PRF-83502, MIL-T-55155; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, And Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Workmanship inspection per Table 4A (Six samples divided into two groups. Group A has 4 samples, Group B has 2.)	6(0) Groups A & B	2(0)	Not Required
Mechanical	Dimensions per detail specification.	6(0) A & B	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Cond I. 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 appl. Applied voltage shall be 600 VRMS or as specified. Apply for 60 sec. Compression mounted terminals shall be securely mounted in a fixture. There shall be no evidence of breakdown.	6(0) Groups A & B	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003. Sockets and terminals shall be wired as in DWV test above. IR shall be 5000 megohms min, or as specified.	6(0) Groups A & B	2(0)	
Vibration	MIL-STD-1344, Method 2005, Test Cond III or as 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 a current of 100 milliamps. The circuit shall be monitored for discontinuities greater than 1 microsecond. Sockets shall be examined for damage or loosening of contacts.	6(0) Groups A & B		
Shock	MIL-STD-1344, Method 2004, Test Condition G (50G) 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) Groups A & B	2(0)	
Insertion and Withdrawal Force (Plug-in sockets and socket strips).	Flat pin or round test gauge shall be as specified in the detail specification. 20% of contact positions in each sample shall be tested (3 minimum). After three insertions and withdrawals of the test gage (or as otherwise specified), insertion & withdrawal forces shall be measured, and shall fall within specified values.	6(0) Groups A & B		

Notes located after Table 3K.

Table 3F QUALIFICATION REQUIREMENTS FOR PLUG-IN-SOCKETS, STRIPS AND TERMINALS 1/, 9/
(REF MIL-PRF-12883, MIL-DTL-83734, MIL-PRF-83502, MIL-T-55155; Page 2 of 2)

Inspection / Test	**Test Methods, Conditions, And Requirements**	**Quantity (Accept No.)**		
		Level 1	**Level 2**	**Level 3**
		Commercial/ SCD	**Commercial/ SCD**	**Commercial**
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A (5 cycles). 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	2(0)	Not Required
Low Level Signal Contact Resistance (Plug-In Sockets Only) **3/**	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 reqd.	4(0) Group A	2(0)	
Solderability & Resistance to Solder Heat	MIL-STD-202, Method 210, Test Cond C. Test all contacts. Solder with a pencil type iron heated to 360°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type per MIL-T-14256. Under 10X visual magnification, there shall be no evidence of damage or distortion to the socket insert. Contact floating conditions, if applicable, shall be maintained. Solder shall demonstrate proper wetting and adhesion to surfaces of the soldercup, PC terminations or J-hooks. Any anti-wicking feature as an integral part of the contact (recommended), shall not exhibit solder wicking into the contact that would interfere with mating and performance.	2 (0) Group B	2(0)	
Evaluation of Material Outgassing Properties	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3G QUALIFICATION REQUIREMENTS FOR EMI/RFI FILTER CONNECTORS 10/, 11/
(REF GSFC S-311-P-626; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Table 4A (Circulars, D-Subminiatures or Microminis as appl)	2(0)	2(0)	Not Required
Mechanical	Dimensions per detail specification.	2(0)	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. Measurements shall be within detail spec limits.	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, max. Measurements between any pair of contacts and between contacts and shell shall not be less than 5,000 megohms min.	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. There shall be no breakdown or degraded performance	2(0)	2(0)	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A (5 cycles). Connector rated temperature extremes shall be used for high and low temps. There shall be no damage detrimental to the operation of the connector. Repeat DWV and IR measurements.	2(0)	2(0)	
Attenuation	GSFC S-311-P-626 para 4.8.9. Perform test at temperature and frequency specified. Attenuation shall not be less than the value specified for the selected capacitance and frequency.	2(0)	2(0)	
RF Current	After attenuation measurement and with connector mounted and grounded, connect RF generator and RF ammeter. Vary frequency until meter shows I peak. (NOTE: Choose loading such that I peak is at filter resonance and does not exceed generator VSWR tolerance). There shall be no damage.	2(0)		
Evaluation of Material Outgassing	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3G QUALIFICATION REQUIREMENTS FOR EMI/RFI FILTER CONTACT CONNECTORS 10/, 11/
(REF NASA GSFC S-311-P-626; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
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. No cracking, breaking or loosening.	1(0) (Sample A)		Not Required
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 5 blows in each direction of three mutually perpendicular axes.	1(0) (Sample A)	1(0) (Sample A)	
Resistance to Soldering Heat and Solderability	Solder Cup contacts or PC terminations shall be soldered with a pencil type iron heated to 360°C using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys) formerly SN63 type, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type. Inspect for damage, distortion, proper wetting and adhesion to all surfaces of the soldercup or Termination.	1(0) (Sample B; test all contacts, minimum of 9)	1(0) (Sample B, test 20% of contacts, minimum of 9)	
Life	MIL-STD-202, Method 108, test condition D (1,000 Hours) using connector max temp rating. Test circuit shall apply rated RF current at maximum frequency to five filterpin contacts, min. Upon completion of conditioning, repeat attenuation, IR and DWV measurements. All measurements shall remain within acceptable limits of the detail specification.	2(0)	2(0)	
Mating and Demating Force (D-Sub-miniatures / Microminiatures) Coupling Force (Circulars)	Refer to screening Table 2B (D-Sub s) or 2C (Microminis) Refer to Screening Table 2A (Circular connectors).	2 (0) 2 (0)	1(0) 1(0)	

Notes located after Table 3K.

Table 3H QUALIFICATION REQUIREMENTS FOR CRIMP CONNECTOR CONTACTS AND PRINTED CIRCUIT SOCKET CONTACTS (Page 1 of 2) (REF SAE-AS39029, MIL-C-55302/65, MIL-S-83505, GSFC-S-311-P4/06, /08, /10, GSFC-S-311-P-718/2) 1/, 11/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Table 4B (Signal contacts, 24 samples divided into two groups of 8 designated A & B, plus two groups of 4 designated C & D. For coaxial or High Voltage, use Group A 8 contacts.	24(0) Groups A-D or 8(0) Grps E, F	16(0) Groups A, B or 8(0) Grps E, F	Not Required
Mechanical	Dimensions per detail specification.	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 **Note 14**. 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 cracked crimp barrels.	16(0) Groups A, B	16(0) Groups A, B	
Axial Concentricity (Wired Pin contacts & coaxial center pin 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 SAE-AS39029. 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. Use wired samples from above. The axial load required to pull the wire from the crimp barrel or break the wire shall not be less than the min value shown in SAE-AS39029 Table X. A 15 lb load shall be used or as specified. For coaxial contacts, perform after electricals.	8(0) Group A or 4(0) Group E	8(0) Group A or 4(0) Group E	
Contact Engagement & Separation Force (Sockets Only)	MIL-STD-1344, Method 2014. Contact engaged to a depth of 0.7L. Force shall comply with SAE-AS39029, Table IX or **12/**.	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 temp. No damage to the plating or loosening of sleeves or contact engage-ment springs. For coaxial or High Volt, terminate prior to test.	8(0) Group B or 4(0) Group E		
Low Signal Level Contact Resistance (Size 16 and Smaller) **3/**	MIL-STD-1344, Method 3002. Contact shall be engaged to its mating connector with the pin engaged to 70% of its mated engagement length. Resistance shall comply with SAE-AS39029 Table IV. For coax or High V, terminate prior to test.	8(0) Group B or 4(0) Group E	8(0) Group B or 4(0) Group E	

Notes located after Table 3K.

Table 3H QUALIFICATION REQUIREMENTS FOR CRIMP CONNECTOR CONTACTS AND PRINTED CIRCUIT SOCKET CONTACTS (Page 2 of 2) (REF SAE-AS39029, MIL-C-55302/65, MIL-S-83505, GSFC S-311-P-4/06, /08, /10, GSFC S-311-P-718/2) 1/, 11/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Com'l/ SCD	Com'l/ SCD	Commercial
Dielectric Withstanding Voltage (Sea Level, size 8 Coaxial Contacts and size 8 high voltage contacts)	MIL-STD-1344, method 3001. Apply 1000 VAC (straight coaxial) or 800VAC (90° coaxial) between center contact and shell. There shall be no breakdown. For high voltage contacts, apply 2,800VAC or as specified.	4(0) Group E	4(0) Group E	Not Required
Insulation Resistance (Room Temperature; size 8 Coaxial and high voltage contacts) **2/, 3/**	MIL-STD-1344, Method 3003, Test Cond B. Apply between center contact and intermediate (middle) contact, between intermediate conductor and shield, or outer body. Measurements shall be 5000 megohms, min.	4(0) Group E	4(0) Group E	
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 or 4(0) Group E		
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 or 4(0) Group E	8(0) Group B or 4(0) Group E	
Plating Thickness (N/A PC Sockets)	Ref ASTM-B488 para 9.4.1. Cross section. Measured plating thickness shall be per requirements.	4(0) Group C or 2(0) Group F	2(0) Group F	
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 observation.	4(0) Group D or 2(0) Group F		
Residual Magnetism (Nonmagnetic contacts only) **2/**	GSFC S-311-P-4/08 and /10, paragraph 3.3.1. Group contacts together. Measured value for the group shall not exceed a gamma level of 0.1X the no. of contacts in the group.	8(0) Group A or B	8(0) Group A or B	
Evaluation of Material Outgassing	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

TABLE 3I QUALIFICATION REQUIREMENTS FOR TWINAXIAL MIL-STD-1553 DATABASE CONNECTORS (REF MIL-PRF-49142; Page 1 of 2) 1/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Perform workmanship inspection per Table 4A	3 (0)	2 (0)	Not Required
Mechanical	Dimensions per detail specification.	3 (0)	2 (0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Method 301. May require assembly of samples. Simulated contacts and special techniques may be used. Apply 1200 VRMS between center conductor and intermediate (Middle) conductor, and 500 VRMS between intermediate (middle) conductor and outer conductor (shield) or outer body per cable size in reference specification. There shall be no evidence of breakdown.	3 (0)	2 (0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, Test Condition B. Apply between: 1) center contact and intermediate (middle) contact 2) between intermediate conductor and outer conductor (shield), or outer body. Measurements shall be 5,000 megohms, min.	3 (0)	2 (0)	
Force to Engage and Disengage	MIL-PRF-49142, paragraph 4.6.2.1 connector shall be engaged with its mating connector. One connector shall be secured in a holding fixture. During the entire coupling/uncoupling cycle, forces and/or torques necessary to fully mate shall be monitored. Longitudinal force (N/A threaded) shall not exceed 4 pounds, except as otherwise specified, torque shall not exceed 2.5 inch-pounds, unless otherwise specified.	3 (0)		
Coupling Proof Torque (Series TRT threaded plugs only)	MIL-PRF-49142, paragraph 4.6.3, 15 inch lbs torque, min. (For threaded types.) Interface dimensions shall remain as specified.	3(0)		

Notes located after Table 3K.

TABLE 3I QUALIFICATION REQUIREMENTS FOR TWINAXIAL MIL-STD-1553 DATABASE CONNECTORS (REF MIL-PRF-49142; Page 2 of 2) 1/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Coupling Retention and Cable Retention	Connectors shall be mated and terminated to their proper cables. One cable shall be secured in a clamped fixture. The other cable shall be secured in a sleeve or other clamped fixture, and pulled longitudinally away from the mated pair in such a manner that the cable remains unbent and untwisted. A force of 40 pounds, min (for 0.200 to 0.325 dia cable) or as otherwise specified, shall be applied and held for 30 seconds, min. After testing, continuity through the connections shall be maintained. There shall not be any effect on mating and demating.	3 (0)	2(0)	Not Required
Vibration	MIL-STD-202, Method 204, Test Condition B or MIL-STD-1344, Method 2005, Test Condition IV (15G, 10 to 2Khz and back; 12 times in each of 3 axes). Connectors shall be terminated to the appropriate type of coaxial cable and shall be mated. 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-202, Method 213, Test Condition I (100G sawtooth) 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, above.	3(0)	2(0)	
Thermal Shock (or Temperature Cycling)	MIL-STD-202, Method 107, Test Condition B (5 cycles) 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.	3(0)	2(0)	
Evaluation of Material Outgassing Properties	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3J QUALIFICATION REQUIREMENTS FOR NANO-MINIATURE CONNECTORS (0.025 INCH CONTACT SPACING; REF DSCC 94031; Page 1 of 2) 1/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Workmanship per Table 4A, using 10X magnification.	3(0)	2(0)	Not Required
Mechanical	Dimensions per detail specification.	3(0)	2(0)	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, Condition I, mated or unmated. Test potential shall be 250V RMS (Sea Level) or as otherwise specified. Apply for 10 sec, min. No evidence of breakdown.	3(0)	2(0)	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003. Apply 100VDC, connectors mated. Reading between adjacent contacts and between contacts and shell shall be 1000 megohms min, unconditioned.	3(0)	2(0)	
Temperature Cycling	MIL-STD-1344, Method 1003, (5 cycles, -55°C to 125°C). One hour dwell at each extreme. There shall be no damage detrimental to the connector.	3(0)	2(0)	
Low Signal Level Contact Resistance	Contact resistance shall be per **Note 3** for size 30 contacts.	3(0)	2 (0)	
Contact Engagement and Separation Forces (Receptacles with recessed socket contacts)	MIL-STD-1344, method 2014, procedure I. Using 0.0126 +/- 0.0001 dia test pin, engagement force shall be 4.0 oz. per contact, max. Separation force, 0.2 oz per contact, min.	3(0); Test 20% of sample contacts, 9 min		
Contact Retention / Wire Retention (Prewired Crimp Contacts)	MIL-STD-1344, Method 2007. Apply 2.5 lbs to individual wire pigtails for 5 seconds, min. Load shall not displace contact more than 0.003 in or pull wire from the crimp contact.	3(0); Test 20% of sample contacts, 9 min		
Solderability & Resistance to Soldering Heat (PC Surface Mount or Through Hole Terminations)	DSCC 94031, paragraph 4.8.24 and 4.8.26. PC terminations shall be solder dipped using Sn63Pb37 solder per ANSI/J-STD-006 (Solder Alloys), formerly SN63 solder per QQ-S-571, for a min duration of four seconds. Flux with Type ROL1 flux per ANSI/J-STD-004 (Solder Fluxes) formerly RMA type per MIL-T-14256. Under 10X magnification, there shall be no evidence of insert damage or distortion. Solder shall demonstrate proper wetting and adhesion to terminations.	3(0) Test 20% of sample contacts, 9 min		
Mating and Unmating Force	MIL-STD-1344, Method 2013. Mating force shall not exceed 6 oz times the number of contacts. (3 oz for unmating). Inspect for contact damage or pushout from connector.	3(0)		

Notes located after Table 3K.

Table 3J QUALIFICATION REQUIREMENTS FOR NANO-MINIATURE CONNECTORS (0.025 INCH CONTACT SPACING; REF DSCC 94031; Page 2 of 2) 1/

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Circuit Testing (Flexible Circuit Printed Wiring Board Terminations)	Refer to Section W1 (Wire and Cable), Tables 2E & 3E. All flexible circuits shall be screened and qualified prior to termination.	3(0)	2(0)	Not Required
Shock	MIL-STD-1344, Method 2004, Test Condition G (100Gs, 6 millisec duration, sawtooth wave). Three shocks shall be applied to each direction of three mutually perpendicular axes, for a total of 18 shocks. Connectors shall be wired and mated such that all contacts shall be in a series circuit with 100 milliamps of current flow applied. Connectors shall be monitored for discontinuities longer than 20 nanoseconds. Shock shall not result in any damage or loosening of connector parts.	3(0)	2(0)	
Vibration	MIL-STD-1344, Method 2005, Test Condition IV (20G, 10 – 2Khz and back to 10Hz). Apply 12 cycles in each of three mutually perpendicular axes for a total of 36 cycles. Connectors shall be mated, wired, monitored and examined for damage same as shock testing above. Vibration shall not result in any damage or loosening of connector parts.	3(0)		
Evaluation of Material Outgassing Properties	See Outgassing, page 2 of this section.	X	X	

Notes located after Table 3K.

Table 3K QUALIFICATION REQUIREMENTS FOR UMBILICAL INTERFACE CONNECTORS 1/, 6/ (REF NASA GSFC S-311-P-718 [FIXED RACK AND PANEL], SAE-AS 81703 [PUSH-PULL CIRCULAR]; Page 1 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Commercial/ SCD	Commercial/ SCD	Commercial
Visual	Inspect per Table 4A; Two mated sets of plugs and receptacles designated pair A and pair B.	2(0) Mated pairs	2(0) Mated pairs	Not Required
Mechanical	Dimensions per detail specification.	2(0) Mated pairs	1(0) Mated pair	
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-1344, Method 3001, condition I. (room temp and atmosphere). Magnitude per specified service rating. When no value is specified, a voltage of 500V RMS shall be used. Connectors shall be wired and mated. Simulated contacts and special techniques may be used. Leakage current 2 milliamps, maximum. Six readings shall be taken. Apply voltage for 60 seconds, min. Apply between three pairs of adjacent contacts and three contacts closest to the shell. There shall be no evidence of flashover.	2(0) Mated pairs	2(0) Mated pairs	
Insulation Resistance (Room Temperature)	MIL-STD-1344, Method 3003, Test Condition B, (500VDC) room temperature, connectors wired and unmated. Simulated contacts and special techniques may be used. Measurements shall be 5000 megohms, min.	2(0) Mated pairs	2(0) Mated pairs	
Temperature Cycling	MIL-STD-1344, Method 1003, Test Condition A. Step 3 shall use the maximum temperature of the connector. There shall be no damage detrimental to the performance of the connector.	2(0) Mated pairs	1(0) Mated pair	
Vibration	MIL-STD-202, Method 204, Test Condition D (10 to 2000 HZ, 20G 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.	1(0) Mated pair		

Notes located after Table 3K.

Table 3K QUALIFICATION REQUIREMENTS FOR UMBILICAL INTERFACE CONNECTORS 1/, 6/
(REF NASA GSFC S-311-P-718 [FIXED RACK AND PANEL], SAE-AS 81703 [PUSH-PULL CIRCULAR]; Page 2 of 2)

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.)		
		Level 1	Level 2	Level 3
		Com'l/SCD	Com'l/SCD	Commercial
Shock	MIL-STD-202, Method 213, Test Condition G. 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.	1(0) Mated pair	1(0) Mated pair	Not Required
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.	1(0) Mated pair	1(0) Mated pair	
Evaluation of Material Outgassing	See Outgassing, page 2.	X	X	
Contact Retention (Push Test) (Crimp Removable Contacts Only)	MIL-STD-1344, Method 2007. Apply load of 10 lbs for size 22D, 15 lbs for size 20, 25 lbs for size 16 through 8, and 15 lbs for coaxial; axial displacement shall not exceed 0.012 in for contact sizes 22D, 20, 16; and 0.025 in for size 8 and coaxial.	1(0) Mated pair		
Mating and Unmating Force	MIL-STD-1344, Method 2013. Measure axial force for push-pull coupled connectors. Force shall be as specified in the detail specification.	1(0) Mated pair		
Insert Retention	MIL-STD-1344, Method 2010. Apply axial force of 30 lbs PSI or as specified. Inserts shall be retained without evidence of cracking, breaking, separating or loosening.	1(0) Mated pair		
Operating Force (Push-Pull Circular)	Requires mating connector. The force applied to coupling rings of push-pull connectors and between shells to accomplish mate and demate shall be measured and shall meet forces specified in the detail spec.	1(0) Mated pair	1(0) Mated pair	

Notes located on next page.

NOTES FOR QUALIFICATION REQUIREMENTS TABLES 3A THROUGH 3K (Page 1 of 2)

1/ General

1.1/ Screening of connectors to Tables 2A through 2N of this section prior to performance of qualification is not a requirement. However, if connector qualification samples are taken from a screened lot, or the connector manufacturer performs this test as part of their normal production and data is available that demonstrates acceptable results, tests do not have to be repeated.

1.2/ Procedures in MIL-STD-1344 (Test Methods for Electrical Connectors) are the preferred test methods for connectors. MIL-STD-202 test methods may also be used. Alternate methods require project approval.

2/ 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 that is acceptable to the procuring activity. Connectors shall be qualified to levels of residual magnetism per the following designations: B = 200 Gamma, C = 20 Gamma.

3/ For contacts with crimp joined or weld joined solid, straight or formed wire leads. Unless otherwise specified, all contacts in each connector shall be measured. Test shall be performed using a micro-ohmmeter and four wire measurements. Mated connector pairs are preferred. Attached current leads at extreme ends of mated connector contacts. Attach voltage leads inside the current leads on contact closest point to dielectric insert. If necessary, needle probes may be used. Apply one milliamp DC or as otherwise specified. Measurement shall not exceed 15 milliohms for size 22 contacts, 25 milliohms for size 24 contacts terminated to size 25 solid wire or soldercups, 32 milliohms for size 24 terminated to size 26 AWG wire pigtails, 70 mohms for size 30, or as otherwise specified.

4/ For MIL-DTL-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

5/ Test force for cable retention pull testing shall be as follows:

Cable Type	Cable Outer Diameter	Test Force (Lbs.)	Applicable Cable
Flexible	.036	10	RG178, RG316
	.067	20	M17/152-00001
	.110	30	RG142, RG180, RG302,
	.122 and Up	40	RG303, RG393, RG400
Semi-Rigid	.085	30	RG405
	.140	60	RG402

6/ When candidate plug or receptacle circular connectors are submitted for qualification, mated pairs shall be prepared. Two mating pairs of plugs and flange mount receptacles designated mated pairs A & B shall be prepared. When hermetic receptacles are submitted for qualification, two mated pairs designated C & D 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.

NOTES FOR QUALIFICATION REQUIREMENTS TABLES 3A THROUGH 3K (Page 2 of 2)

7/ 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.

8/ 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.

9/ For Level 1 qualification of plug-in sockets, six samples are required. Some tests require all six samples to be tested, after which, the samples shall be divided into two groups, 1 group of four and one group of two, for further testing. For Level 2 qualification, two samples shall be submitted for testing.

10/ For filter pin connectors, 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.

11/ 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.

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

13/ Apply DWV per the following table:

Cable Part Number	Outer Diameter	Voltage (RMS)
M17/93-RG178	0.075	500V
M17/113-RG316	0.102	750V
M17/60-RG142 M17/111-RG303 M17/128-RG400	0.200 0.175 0.200	1000V 1000V 1000V

14/ Contact-Conductor combinations shall be in accordance with the following table:

Contact Wire Barrel Size	Conductor Size, AWG
24	24, 26, 28 A/
22	22, 24, 26 A/
22D	22, 24, 26, 28 A/
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 SAE-AS33481 Contact Bushing.

Table 4A WORKMANSHIP REQUIREMENTS FOR CONNECTORS 1/

Defect	Circular & Umbilical	DSUB-miniature	Micro-miniature	PC	RF	Plug-In Sockets & Strips	Twinax 1553 Databus	Nano-miniature
Insert/Insulator Body								
Insert to shell positioning and orientation	X	X	X					X
Cracks, chips, busters, pinholes	X	X	X	X	X	X	X	X
Marking	X	X	X	X	X	X	X	X
Hermetic Sealed Connectors								
Negative meniscus (glass to contact & glass to shell)	X	X			X			
Soldercup misalignment, rear of connector	X	X						
Contact Positioning (Molded inserts with soldertails or soldercup contacts)								
Consistent centering between contacts	X	X	X	X	X	X		X
Soldercup misalignment, rear of connector	X	X	X			X		X
Grommet (As Applicable)								
Nicks, gouges, tears, folds, discoloration	X		X		X	X		
Marking (As Applicable)	X							
Shell/Body								
Cracks, dents, burrs, sharp edges	X	X	X		X		X	X
Finish (Peeled or blistered plating, scratches / exposed base metal, corrosion discoloration)	X	X	X		X		X	X
Marking completeness, legibility	X	X	X		X		X	X
Threads (As Applicable)								
Coupling (Nicks, dents, voids, burrs)	X				X		X	
Attached hardware		X	X	X				X
Adhesives/Molding Material								
Excess bonding material (overflow), voids	X	X	X	X	X	X	X	X
Leads (As Applicable)								
Bent, nicked, cracked/broken leads, burrs.	X	X	X	X	X	X	X	X
Finish (peeling, corrosion, exposed base metal)	X	X	X	X	X	X	X	X
Flexible Circuit Terminations (As applicable)								
Cracked insulation, separations, exposed conductors, delaminations				X				X

Notes:

1/ Refer to Materials paragraph on page 1 for additional requirements.

2/ For additional details and illustrations of defects, the criteria in NASA-MSFC 85M03639 (Workmanship Limits for Connectors) may be consulted.

3/ Perform visual inspection at 3X magnification, minimum. Progressively higher magnification may be used as necessary to examine anomalies.

Table 4B WORKMANSHIP REQUIREMENTS FOR CONTACTS 1/

Defect	Removable Crimp Contacts	RF Contacts	PC Socket Contracts & Terminals
Insert/Insulator Body			(Insulated feedthrough types)
Insert to shell positioning and orientation		X	X
Cracks, chips, busters, pinholes		X	X
Marking (As Applicable)		X	X
Internal Engagement Pressure Members (Sockets only)			
Bent, broken or missing members	X	X	X
Finish (Contamination, corrosion, discoloration, exposed base metal)	X	X	X
Body			
Cracks, dents, burrs, sharp edges	X	X	X
Finish (Peeled or blistered plating, corrosion, discoloration, scratches, porosity, exposed base metal).	X	X	X
Marking (Peeling ink, if ink applicable. Inkless preferred; no color bands)	X	X	
Loose collars / sleeves (As applicable)	X	X	
Inner diameter of contact crimp barrel	X	X	
Adhesives/Molding Material			(Insulated feedthrough types)
Excess bonding material (overflow), voids			X
Leads (As Applicable)			
Bent, nicked, cracked/broken leads, burrs.			X
Finish (peeling, corrosion, exposed base metal)			X

Notes:

1/ Refer to Material paragraph on page 1 for additional requirements.

Table 5 CONNECTOR DERATING REQUIREMENTS

Connectors of all types/styles are derated by limiting the voltage stress placed on the dielectric material, and by limiting the current flow and consequent temperature rise due to the effects of resistive heating across mated contacts within the dielectric insert.

The following table establishes minimum derating for connectors.

Parameter	Derating Factor
Operating Voltage	25% of the connector Dielectric Withstanding test Voltage (at sea level, unconditioned) - or - 75% of the connector rated operating (working) voltage (at sea level), whichever is lower. **1/**
Contact Current	Less than or equal the values listed in Wire Derating (Table 4A of Section N) for the conductor size selected for use with the contact. **2/**
Temperature	Rated maximum temperature, less 25°C

Notes:

1/ Example: MIL-DTL-38999 series I connectors have a DWV test voltage of 1300VAC. They also have a suggested operating (working) voltage of 400VAC at sea level. Derated voltage would be 25% of 1300VAC (325VAC) or 75% of 400VAC (300VAC). Either value is acceptable.

2/ For printed circuit connectors, apply derating based on the contact size vs. the equivalent wire size in section W1, table 4A, for bundled cable. Example, as a minimum, a size 20 contact shall be derated the same as a 20 AWG wire used in a bundled cable assembly.

SECTION C3: CRYSTALS

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Table 1 REQUIREMENTS FOR CRYSTALS 1/

Procurement Specification	Use As Is	Screen to Table 2 3/	Qualify to Table 3 3/
Level 1			
1) MIL-PRF-3098 **2/**		X **4/**	
2) SCD **5/, 6/**		X	X
Level 2			
1) MIL-PRF-3098 **2/**	X		
2) SCD **5/, 6/**		X	X
3) Commercial		X	X
Level 3			
1) MIL-PRF-3098 **2/**	X		
2) SCD or Commercial		X	

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

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

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

5/ All SCDs must be written in accordance with the requirements of MIL-PRF-3098, Tables 2 and 3 of this section, and contain the following design requirements: crystals shall be swept synthetic quartz meeting the infrared quality requirements of grade A or B of IEC60758; and shall be mounted with at least a three point mount. The full title of the IEC document is Synthetic Quartz Crystal – Specifications and Guide to the Use, IEC60758(1993-04), International Electrotechnical Commission, Geneva, Switzerland.

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

6/ For miniature surface mount crystals in hermetic packages, a model for an SCD may be found in DSCC Drawings 94023 or 94024, issued by the Defense Supply Center, Columbus, Ohio.

Table 2 SCREENING REQUIREMENTS FOR CRYSTALS

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

Notes:

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

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

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

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

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

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

Notes at end of table.

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

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

Notes:

1/ All parts submitted for qualification testing shall have successfully completed the screening per Table 2.

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

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

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

Table 4 CRYSTAL DERATING REQUIREMENTS

Derating of crystals is accomplished by multiplying the stress parameter by the appropriate derating factors specified below.

Critical Stress Parameters 1/	Derating Factor
Maximum Rated Current	0.5
Maximum Rated Power	0.25

Notes:

1/ Choose either current or power to derate, but do not derate both. These deratings apply over the manufacturer's recommended operating temperature range.

SECTION C4: CRYSTAL OSCILLATORS

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Table 1 REQUIREMENTS FOR CRYSTAL OSCILLATORS 1/ 2/

Procurement Specification	Use As Is	Screen to Table 2 3/	Qualify to Table 3 3/
Level 1			
1) MIL-PRF-55310, Class S **4/**	X		
2) MIL-PRF-55310, Class B **5/**		X	
3) SCD **6/**		X	X
Level 2			
1) MIL-PRF-55310, Class S	X		
2) MIL-PRF-55310, Class B		X	
3) SCD **6/**		X	X
4) Commercial		X	X
Level 3			
1) MIL-PRF-55310, Class S	X		
2) MIL-PRF-55310, Class B	X		
3) SCD or Commercial		X	

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.**

1.1/ Any oscillator, which is procured to a MIL-PRF-55310 detail specification (i.e., "slash sheet"), an existing SCD, or as a manufacturer's standard catalog part, must be evaluated or tested to determine it ability to meet the Total Ionizing Dose (TID) and Single Event Upset (SEU) requirements of the mission.

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

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

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

5/ Class B crystal oscillators are acceptable as Level 1 parts only when Class S oscillators are not available.

6/ An SCD must be written in accordance with the requirements of MIL-PRF-55310 and contain the following design requirements: Crystals shall be swept synthetic quartz, meeting the infrared quality requirements of grade A or B of Synthetic Quartz Crystal – Specifications and Guide to the Use, IEC60758 (1993-04), International Electrotechnical Commission, Geneva, Switzerland. Crystals shall be mounted with at least a three point mount; no parts shall be used that latch up in a Single Event Upset (SEU) environment; all active and passive parts shall be derated in accordance with the guidelines of MIL-STD-975.

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

Table 1A OSCILLATOR TYPES PER MIL-PRF-55310

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

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

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2			Level 3
		Class B	**SCD**	**Class B**	**SCD**	**Commercial**	**SCD or Commercial**
1. Internal Visual Inspection a. Soldering **2/** b. Workmanship	 NASA-STD-8739.3 MIL-PRF-55310, paragraph 3.9		X		X	X **3/**	X **3/**
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 Output Voltage—Power	 MIL-PRF-55310, paragraph 4.8.5 Verify the type of output waveform. MIL-PRF-55310, paragraph 4.8.21		X		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	MIL-PRF-55310, paragraph 4.8.35		30 days				
8. PDA **4/**			5%		10%	10%	20%
9. Radiographic Inspection	MIL-STD-202, Method 209, 1 View 1 in Y1 direction, second view 90° relative to first view.	X	X	X	X	X	
10. Additional Electrical Measurements	Table 2B herein.		X				
11. Seal Test	MIL-STD-202, Method 112 and MIL-PRF-55310, Paragraph 4.8.2		X		X	X	
12. External Visual **5/**	Mil - Std. 883, Method 2009	X	X	X	X	X	X

Notes at the end of table.

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

Notes:

1/ It is the responsibility of the user to specify detailed test conditions and define pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, the manufacturer's specification, or the application, whichever is more severe. MIL-PRF-55310 is the reference specification. See also Soldered Electrical Connections, NASA-STD-8739.3, December 1997.

2/ Certification of soldering personnel is required.

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

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

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

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

Inspection/Test	Test Methods and Conditions 1/	Level 1		Level 2			Level 3
		Class B	SCD	Class B	SCD	Commercial	Commercial or Existing SCD
1. Non Destructive Bond Pull	MIL-PRF-55310, paragraph 4.4.1		X				
2. Internal Visual	MIL-PRF-55310, paragraph 4.4.2		X		X	X **2/**	
3. Stabilization Bake (Prior to Seal)	MIL-STD-883, method 1008, condition C, 150 °C, min. hours		X 48		X 24	X 24	
4. Thermal Shock	MIL-STD-883, method 1011, condition A		X				
5. Temperature Cycling	MIL-STD-883, method 1010, condition B		X		X	X	
6. Constant Acceleration	MIL-STD-883, method 2001, condition A, Y_1 only, 5,000 Gs		X		X	X	
7. PIND	MIL-STD-883, method 2020, condition B	X	X	X	X	X	
8. Pre Burn-In Electrical Tests Input Current – Power Output Waveform Output Voltage – Power	 MIL-PRF-55310, paragraph 4.8.5 Verify the type of output waveform. MIL-PRF-55310, paragraph 4.8.21		X		X	X	X
9. Burn-in (Load)	125 °C, nominal supply, voltage and burn-in loads		240 hours		160 hours	160 hours	48 hours
10. Post Burn-in Electrical	Repeat step 8 above		X		X	X	X
11. Frequency Aging	MIL-PRF-55310, paragraph 4.8.35		30 days				
12. PDA **3/**			5%		10%	10%	20%
13. Additional Electrical Measurements	Table 2B herein		X				

Notes at end of table.

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

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

Notes:

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

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

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

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

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Table 2B ADDITIONAL ELECTRICAL MEASUREMENTS

Test	Test Methods, Conditions, and Requirements 1/	OscillatorType
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 4.8.10.	All
7. Frequency—Voltage Tolerance	Set oscillator supply voltage (oven supply voltage, if applicable) to nominal, minimum, and maximum values and measure output frequency. Determine frequency-voltage tolerance in accordance with paragraph 4.8.14.	All
8. 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 4.8.30.	2, 5, 6
11. Frequency Deviation	Assemble test equipment in accordance with Figure 13 of MIL-PRF-55310, and measure (calculate) total deviation, deviation slope polarity, and deviation linearity in accordance with paragraph 4.8.31.	2, 5, 6

Notes:

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

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

Inspection/Test	Test Methods and Conditions	Level 1	Level 2		Level 3
		SCD	SCD	Commercial 2/	SCD or Commercial
Group 1		8 (0)	8 (0)	8 (0)	Not required
Frequency Aging	MIL-PRF-55310, paragraph 4.8.35				
Input Power Aging (Type 4 and Type 6)	MIL-PRF-55310, paragraph 4.8.36				
Group 2 2/		8 (0)	8 (0)	8 (0)	
Vibration, Sine	MIL-STD-202, Method 204 and MIL-PRF-55310, paragraph 4.8.39.1				
Mechanical Shock	MIL-STD-202, Method 213 and MIL-PRF-55310, paragraph 4.8.41				
Acceleration (When Specified)	MIL-STD-202, Method 212 and MIL-PRF-55310, paragraph 4.8.42.1				
Group 3 2/		4 (0)	4 (0)	4 (0)	
Thermal Shock	MIL-STD-202, Method 107 and MIL-PRF-55310, paragraph 4.8.45				
Radiation Hardness (Operating) (When Specified)	MIL-PRF-55310, paragraph 4.8.48				
Group 4 2/		2 (0)	2 (0)	2 (0)	
Resistance to Soldering Heat	MIL-STD-202, Method 210 and MIL-PRF-55310, paragraph 4.8.49				
Moisture Resistance	MIL-STD-202, Method 106 and MIL-PRF-55310, paragraph 4.8.50				
Terminal Strength	MIL-STD-202, Method 211 and MIL-PRF-55310, Paragraph 4.8.52				
Solderability	MIL-STD-202, Method 208, Each Lead				
Resistance to Solvents	MIL-STD-202, Method 215				

Notes at the end of table.

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

Inspection/Test	Test Methods and Conditions	Level 1	Level 2		Level 3
		SCD	SCD	Commercial 2/	SCD or Commercial
Group 5 Internal Water Vapor Content **4/**	MIL-STD-883, Method 1018 5,000 ppm at 100 °C	3 (0) or 5 (1)	3(0) or 5 (1)	3(0) or 5 (1)	Not required

Notes:

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

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

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

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

Table 4 CRYSTAL OSCILLATOR DERATING REQUIREMENTS

Derating of crystal oscillators is accomplished by multiplying the parameters by the appropriate derating factor specified below.

Stress Parameter	Derating Factor for Circuit Implementation By Part Type	
	Digital Parts	**Linear Parts**
Maximum Supply Voltage/Input Voltage (Note 1)	0.9	0.8
Maximum Specified Operating Junction Temperature (Note 2)	0.8	0.75
Maximum Output Current	0.8	0.8

Notes:

1/ Use manufacturer's recommended operating conditions but do not exceed 90% of maximum supply voltage. For voltage regulators, derate $V_{IN} - V_{OUT}$ to 0.9.

2/ Do not exceed Tj = 110 °C, or 40 °C below the manufacturer's maximum rating, whichever is lower or less.

SECTION F1: FIBER OPTICS, PASSIVE (FIBER, CABLES, CONNECTORS, AND ASSEMBLIES)

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INTRODUCTION

This section provides guidelines and recommendations for the selection, test, qualification, and application of optical fiber, cable, connectors, and assemblies based on characterization and qualification results from the GSFC Code 562 Technology Validation Assurance (TVA) Laboratory for Photonics. This laboratory provides design, development, and validation test services to NASA projects that require optical fiber space flight hardware. Recommendations concerning assembly and integration are based on knowledge gained by the Advanced Photonic Interconnection Manufacturing (APIM) Laboratory of Code 562. APIM manufactures and installs space flight project optical fiber assemblies for GSFC.

Background information, selection criteria, and application notes for fibers, cables, connectors, and fiber optic assemblies are provided on pages 1 to 8. Table 3 (page 10) provides a listing of all tests recommended for each of these part categories, as well as where these tests should be performed (by manufacturers, users, or both). Table 4 (page 12) provides the recommended test procedures for each of the tests listed in Table 3. Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

FIBER COATING MATERIALS

Acrylates and polyamides have been used for flight grade optical fiber coatings since the 1980s. Optical cable with acrylate coated fiber was qualified by GSFC during that period and is the heritage design for space flight projects. Each fiber coating material has its advantages and disadvantages.

Acrylates can be selected for strippability (example: methylene chloride). They are also fairly soft, yielding a more flexible fiber. Unfortunately, acrylates tend to have low temperature ratings (usually around 85 °C although some are available that are rated as high as 200 °C) and are known to outgas (i.e., TML ≥ 5%, CVCM greater than or equal to 0.5%). Unjacketed acrylate coated fiber can cause contamination when it is used near other optical surfaces. Acrylate coated fiber is not a problem when used in a cable assembly because terminated cable does not allow sufficient venting to occur.

Polyamides have the advantage of a 125 °C temperature rating. This is critical to programs such as the Space Station and some deep space applications. Polyamides tend to make fiber stiffer than acrylates do. Silicone and Gore-Tex® applied as a second coating have been used to improve the flexibility of polyamide coated fiber. Silicone has the disadvantage of introducing a contamination concern. Silicone outgasses and is a concern even in a cable configuration where the outer jacket can protect the system from small amounts of enclosed outgassing material. Current product typically contains

relatively large quantities of silicone. The Gore-Tex® construction has not yet been evaluated.
The task of stripping polyamide coated fiber is not trivial. Polyamide coating can be stripped only with hot sulfuric acid for space flight applications; hot sulfuric acid can be dangerous and is not portable. Mechanical stripping methods are not recommended for flight cable assemblies because they can introduce surface flaws to the glass fiber, compromising long-term reliability. Connector manufacturers have tried to circumvent this problem by offering a ferrule hole size that will accommodate the unstripped polyamide coating's outer diameter. This approach has not been accepted readily by the industry because it makes the connectors considerably more expensive and forces the user to commit to a non-standard configuration. When used in single mode applications, where perfect alignments are crucial to limiting the insertion losses, the polyamide coating still must be removed before terminating the fiber due to the tighter tolerance constraints of single mode connectors.

Hermetic polyamides over amorphous carbon coatings are susceptible to failure. The failure mode for one loose tube cable configuration was determined to be caused by method of extrusion. The full analysis is contained in reference 7, the "ISS Fiber Optic Failure Investigation Root Cause Report." There have been no reports of hermetic polyamide coated optical fiber failures in tight tube configurations. Currently, nonhermetic coatings are recommended over hermetic when feasible.

CABLES

The standard cable construction includes the coated fiber, which is supplied by a fiber manufacturer and has a unique part number, a tight or loose tube buffer, woven or spiraled strength members, and an outer jacket. Each cable component performs an important function in the overall mechanical reliability of the terminated fiber. The coating, which is physically in contact with the fiber, greatly affects optical performance. Part number traceability is limited to the finished cable and the coated fiber.

The performance and manufacturability of cables are heavily dependent on the materials used. Most optical cable jackets considered for use in space flight are extruded Teflon or Tefzel. The materials currently in use for loose tube buffers are Teflon, Tefzel, Kynar (PVDF) or Hytrel, tight fiberglass or Kevlar (Aramid). Properties of these materials are outlined in Table 1.

Table 1 MATERIALS USED IN FLIGHT GRADE FIBER OPTIC CABLE*

Material	Temperature Limits	Coefficient of Thermal Expansion (in/in/°F)	Tensile Strength
Tefzel 200	Melting Point: 270 °C (518 °F) Operating Range: -70 °C to 200 °C	20 °C to 30 °C (68 °F to 86 °F): 5×10^{-5} 50 °C to 90 °C (122 °F to 194 °F): 5.2×10^{-5} 140 °C to 180 °C (284 °F to 356 °F): 7.8×10^{-5}	44.8 MPa (6.5 kpsi)
Teflon, PFA	Melting Point: 300 °C (572 °F)	$6.7\ 10^{-5}$	27.6 MPa (4 kpsi)
Tefzel (ETFE)	Operating Range: -70 °C to 200 °C (-94 °F to 392 °F)	$\approx 10^{-5}$	34.5 – 46.9 MPa (5 – 6.8 kpsi)
Kevlar 49	Max Operating: 177 °C	$-2.2\ 10^{-6}$	400 kpsi, 12 mm diam.
Teflon PTFE	Melting Point 343 °C (620 °F) Operating Range: -80 °C to 260 °C	4×10^{-5}	3 kpsi
Teflon FEP	Melting Point: 285 °C Operating Range: -200 °C to 200 °C	$\approx 5 \times 10^{-5}$	2.9 kpsi
Gore-Tex Expanded PTFE	Melting Point: 327 °C Operating Range: -200 °C to 260 °C	$<<10^{-6}$	>5 kpsi
Kynar (PVDF)	Melting Point: 347 °F Max Operating: 135 °C	40×10^{-6}	5 kpsi
Hytrel	Operating Range: 50 °C		2 – 7 kpsi

*These numbers are intended for reference only. For manufacturer ratings, see the manufacturer's data sheet.

CONNECTOR SELECTION

A validation test should be conducted on connector ferrule hole dimensions and tolerances prior to procurement. This test ensures that the fiber will be reliably centered in the hole after termination. This test is particularly important when inspecting non-standard ferrule sizes. The ferrule sizes that are commonly used are 125 or 140 microns. An excessive amount of epoxy will be required if the ferrule hole is too large for the bare fiber outer diameter. The terminated fiber will not mate properly to another if a mismatch is created due to non-concentric fiber placement within the ferrule. Terminated fiber end faces must be visually inspected at 200X to ensure that the position of the fiber is central to the hole of the ferrule.

MATERIAL OUTGASSING

Selection and use of non-metallic materials in cables 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 in these publications may have been baked out for evaluation, and the user may have to repeat the same processing. This processing usually consists of a vacuum bakeout of 125 °C and a vacuum of 10^{-6} TORR for 24 hours.

Acrylate optical fiber coating does not pass the ASTM 595E vacuum outgas test. However, it can be used in a non-outgassing cable configuration. Other materials that are prone to outgassing in a vacuum environment are the epoxies used for terminating assemblies, connector boot materials, cable configuration materials, and all plastic connector parts. In the past Kevlar was considered to be a contamination concern for assemblies; it will absorb 3% of its weight in moisture. Any absorbed water shall be driven off with a thermal preconditioning step prior to termination.

At present there are only a few epoxies qualified for space flight cable assemblies. Goddard Space Flight Center uses Tra-Con Bipax and Tra-Bond BA-F253 for fiber optic space flight cable assemblies using the Johanson FC connector. EPO-TEK 353ND is used for termination of the Diamond AVIMS.

Two epoxies from AngstromBond were recently tested for their outgassing characteristics both inside and outside of a cable configuration. The two test epoxies used in the experiment were the AngstromBond AB9119 and the AngstromBond 9112 fiber optic epoxies. The cable test showed inconclusive results. The ASTM 595E test conducted on the epoxies alone showed that the AngstromBond AB9119 passed while the AngstromBond 9112 did not [8].

TERMINATIONS

The termination process must be well understood and controlled in order to reduce the chance of inducing surface crack growth in the fiber. Crack growth can be induced during any step of the termination process. The 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. All terminated cable assembly preparation work must be performed using space flight procedures including those found in NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation. Termination techniques that are appropriate for highly reliable assemblies in space flight environments are well understood and practiced by the APIM laboratory. Code 562's past experience has been that it is very time consuming and difficult to ensure that commercial vendors fabricate assemblies in compliance with NASA-STD-8739.5. Due to this experience, in-house fabrication is recommended.

All cable must be thermally preconditioned prior to termination. During termination chemical stripping is used to remove optical fiber coatings. Performing a strippability validation test is recommended for flight fiber to ensure that space flight termination procedures can be accomplished. Other methods of stripping fiber are available, but none at present have been approved at GSFC for space flight terminations.

HANDLING

Fiber termination and handling techniques greatly influence fiber optic system reliability. Missing or ineffective process controls can lead to failure. The user can easily introduce defects due to the mechanical limitations of optical cable. It is therefore critical for the to user institute proper harnessing and handling practices. Tests may have to be performed to verify that bending losses are not induced due to inadequate bend radiuses or that radial stress is not introduced to the cable as it passes through box walls or bulkheads. To minimize handling related failures, installers and test personnel must be made 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. Connector mating and de-mating should be controlled. All terminations should be cleaned and visually inspected prior to mating any assemblies, even if only for testing.

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 on an assembly. The user is cautioned to use cleaning solvents and procedures that will not attack the connector materials. Cleaning of the optical end faces of terminated connector assemblies is typically performed with 2-propanol alcohol. Cleaning and visual inspection should be performed prior to mating assemblies at all stages of the test and integration process.

VIBRATION

Mission specific vibration levels are usually specified for a given component or box as well as for the spacecraft. These levels must be doubled (g^2/Hz) for validation of the optical fiber assembly interconnection. Table 2 shows an example of the typical random vibration profile used to validate assemblies. This profile is used for 3 minutes duration on each of three axis directions—x, y, and z. These tests are done only on the cable interconnect systems and not on the instrument systems.

Table 2 RANDOM VIBRATION PROFILE FOR VALIDATION OF OPTICAL FIBER ASSEMBLIES

Frequency (Hz)	Protoflight Level
20 – 50	.052 g^2 / Hz
50 – 800	+6 dB / octave
800 – 2000	.32 g^2 / Hz
2000	.052 g^2 / Hz
Overall	20.0 grms

Examples of vibration validation testing are presented in references 4 and 9.

THERMAL EFFECTS

Optical Cable

Optical cable assemblies are typically sensitive to two significant thermally induced effects. One is the optical stability of a fiber optic cable configuration to a changing thermal environment. Performance can degrade due to stresses induced by the differing thermal expansion coefficients of the constituent materials. The second effect is shrinkage of components due to thermal cycling. The shrinkage of the optical cable components is usually of more concern since it can lead to the catastrophic failure of an assembly. Both characteristics need to be tested to determine if a cable is suitable for space flight.

Performance of the cable during cycling is tested by monitoring optical power transmission for the duration of the thermal cycle test sequence. The cable lengths used for characterization typically are based on the actual lengths that will be used in the application. The test cycle extremes are normally set to the survival temperature limits for the mission plus 10 ºC at each extreme. For example, testing is to be performed over a -25 ºC to +70 ºC range when the mission specification requires a survival temperature range of -15 ºC to +60 ºC.

Shrinkage testing is conducted by making interim measurements over a specified number of total cycles. The cycling extremes should be determined from the manufacturer's specification. Cycling is divided into 4 to 8 cycle sessions and after each session measurements are made. The cycling ramp rate shall be 2ºC/min or less such that the cables are not shocked by the temperature change but cycled. Cable lengths shall represent the actual lengths required for the application. Thermal cycling should continue for at least 60 cycles or when the shrinkage rate between measurements drops to less than 0.1%. Not only is this testing used to compare cables for thermal stability but it is also used to determine what preconditioning is required prior to terminating a flight cable. As an example, Figure 3 shows the shrinkage characteristics of several candidate cable assemblies.

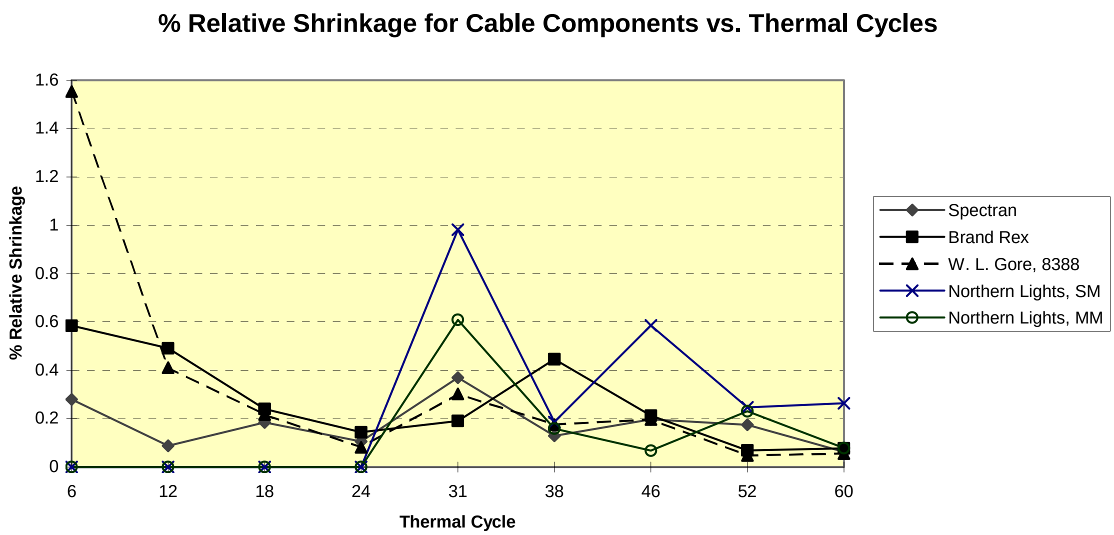

Figure 3. Representative shrinkage test results for thermally cycled cable assemblies [2].

Assemblies

Thermal cycling is an effective method of identifying assembly failure modes that are associated with the termination procedures used. If epoxy is incorrectly applied or connector parts are not secured in compliance with industry standard procedures, the interconnection will fail at some point during the testing. Failure of a termination is defined as pistoning (or pushing through) of the optical fiber into or out of the connector. If a fiber pistons through the connector and impacts with other side of the interconnection, it can chip an end face. The chipping can result in cracks that can propagate and leave the cable completely disabled. Thermal cycling of mated cables is required to characterize for pistoning. The optical transmission of the cables should be monitored during the cycling. End face visual inspections at 200X should also be conducted prior to and after testing to ensure no damage has occurred.

RADIATION

Optical fiber is susceptible to temporary and permanent damage from exposure to gamma radiation. Testing has shown that gamma radiation has a greater effect on optical fiber attenuation than does proton or neutron radiation [11]. Qualification tests and application precautions should be based on the requirements of the application. Typically, the performance of optical fiber in a space radiation environment is significantly dependent on the wavelength of operation, the thermal environment, the dose rate and total dose, and the length of the fiber. Single mode fiber tends to outperform multimode due to smaller amounts of dopants present in the silica material.

In many cases, the actual space flight environmental parameters of total dose and dose rate are not used for characterization testing. Most background radiation dose rates are very low but will add up to a considerable total dose after several years. Since this cannot be duplicated in the laboratory, models are utilized to expedite testing. For germanium doped multimode optical fiber, a two-dose rate test is conducted and the data gathered is used to extrapolate to lower dose rates [10]. Additional information concerning gamma radiation effects and radiation testing are presented in references 2 – 4. An optical fiber radiation database is available at http://nepp.nasa.gov/photonics. It contains all relevant gamma radiation data for the past decade that can be directly traced to a part number and is presented in reference 5. In some cases extrapolation data is also available.

Passive Optical Part and Assembly Characterization Technology Validation Laboratory Assurance Methods

Optical fiber cable assemblies consist of a combination of two or more of the following parts: optical fiber, cable, connectors, and assemblies. In most cases optical fiber is not used without some type of interconnection. Some of the test methods presented here have been developed at the GSFC Code 562 Technology Validation Assurance (TVA) Laboratory for Photonics and are noted as such. The TVA has developed these methods over the past 8 years to address the specific needs of space flight projects at GSFC and to address the failure modes that are common to Commercial-Off-the-Shelf (COTS) optical fiber devices. A references column is provided in Table 4 to provide insight into known failure modes and the test methods used to characterize them. All references cited here are available at http://nepp.nasa.gov/photonics web site.

It is important to note that military products cannot in general be assumed to be qualified for space flight. Military specifications are not typically written to accommodate space flight requirements. The choice of military qualified fiber components is also very limited. Therefore most of the parts and assemblies used for space flight are COTS. Many of the listed tests are common to commercial and space applications and can be conducted economically only by the manufacturer. In those cases, the manufacturer's certified results are acceptable. Tests that are critical to determining the suitability of product for space flight are either verified independently or performed in addition to manufacturers' tests.

Table 3 summarizes the tests to be performed on optical fiber, optical fiber cable, optical fiber connectors, and optical fiber assemblies that include either optical fiber terminated to connectors or optical cable terminated by connectors. For each test and part type, a symbol letter is used to designate the entity by which the test is to be conducted: the manufacturer, end user, or both. A key is included at the bottom of the table.

The Fiber Optic Test Procedures (FOTP-XXX) listed in Table 4 correlate directly to the EIA/TIA 455-XXX series. EIA/TIA 455 has been replaced by FOTP for brevity. Although more tests are done, those specified here are performed typically by the vendor. The tests presented here are required by NASA projects for validation purposes on all grade levels (i.e., levels 1, 2, and 3). There are no distinctions in the validation and qualification of fiber optic components at this time between the grade levels. Testing of fiber optics for space flight applications should be determined from the application and reliability requirements of the project.

Table 3 TEST MATRIX FOR FIBER OPTICS AND COMPONENTS

Tests	Optical Fiber	Cable	Connectors	Assembly (Fiber+/or Cable + Connect)
Bend Test		Mfr **1/**		
Low and High Temperature Bend		Mfr		
Flexibility, Flexure Endurance		Mfr		
Impact		Mfr		
Accelerated Aging		Mfr		
Cable Blocking		Mfr		
Freeze Test		Mfr		
Strength Test	Mfr	Mfr		
Mating Durability			Mfr	
End Face Geometry				Mfr
Operating Temperature	Mfr	Mfr	Mfr	Mfr
Shock			Mfr	
NA Step Index	Both **2/**	User **3/**		User
NA Graded Index, Far Field Scan	Both	User		User
Attenuation	Both	Both		User
Strippability	User	User		
Scintillation	User	User		User
Shrinkage		Both		
Torque			User	User
Ambient Light Susceptibility	Both	Both	Both	Both
Fiber Compatibility				Both
Visual Inspection				Both
Concentricity			Mfr	Both
Insertion Loss			Mfr	Both
Return Loss			Mfr	Both
Outgassing	User **3/**	User **3/**	User	User
Random Vibration			Mfr	User
Thermal Cycling				User
Gamma Radiation	User	User		User

Notes:

1/ Mfr: Implies that test is conducted by the manufacturer.
2/ Both: Implies that test is to be conducted by both manufacturer and customer user.
3/ User: Implies that test is to be conducted by customer user.

Table 4 TEST PROCEDURES FOR TESTING OF OPTICAL FIBER, CABLE, CONNECTORS, AND ASSEMBLIES (Page 1 of 4)

Performance Test	Test Procedure	Details	Sample Size (Per Lot Date)	Reference
Bend Test	FOTP-88	Performed to manufacturer specification and by manufacturer.		
Low and High Temperature Bend	FOTP-37	Performed to manufacturer specification and by manufacturer.		
Flexibility, Flexure Endurance	FOTP-104	Performed to manufacturer specification and by manufacturer.		
Impact	FOTP-25	Performed to manufacturer specification and by manufacturer.		
Accelerated Aging	FOTP-88	Performed to manufacturer specification and by manufacturer.		
Cable Blocking	FOTP-84	Performed to manufacturer specification and by manufacturer.		
Freeze Test	FOTP-98	Performed to manufacturer specification and by manufacturer.		
Strength Test	FOTP-31	Test is applied to optical fiber after cable components have been applied. This test is most significant for polyimide coated fiber inside of loose tube buffer configurations. Test is non-relevant to tight buffer configurations and acrylate coated fiber.	Each reel from lot (test conducted by vendor)	[7]
Mating Durability	FOTP-21	500 mating cycles.		
End Face Geometry	FOTP-179	Verify end face geometry with interferometer.	All assemblies	
Operating Temperature	FOTP-3	Performed to manufacturer specification and by manufacturer.		
Shock	FOTP-11	Test performed to manufacturer specification.		
Numerical Aperture (NA) Step Index	FOTP –7	NA measurement for step index single or multimode optical fiber using far field scan. Procedure can be performed using RIFOCS LCA system.	Three per lot	
Numerical Aperture (NA) Graded Index, Far Field Scan	FOTP-47	NA measurement for graded index multimode optical fiber using far field scan. Procedure can be performed using RIFOCS LCA system.	Three per lot	
Attenuation	FOTP-46 or FOTP-53	For applications that require validation of attenuation for tight power budgets, use 100 m minimum.	One per lot	

Table 4 TEST PROCEDURES FOR TESTING OF OPTICAL FIBER, CABLE, CONNECTORS, AND ASSEMBLIES (Page 2 of 4)

Performance Test	Test Procedure	Details	Sample Size (Per Lot Date)	Reference
Coating Strippability in Chemical for Polyamide Coated Optical Fiber	Internal TVA procedure for polyimide coatings	Immerse 2 inches of coated optical fiber in 100 ml of 95% – 98% sulfuric acid at 142 ºC + 5 ºC, -2 ºC for 1 minute. Dip in three beakers of 100 ml in succession, and then one beaker of 100 ml 2-propanol alcohol. Coating should remove, leaving no residue.	Three	[1]
Coating Strippability in Chemical for Acrylate Coated Optical Fiber	Internal TVA procedure for acrylate coatings	Immerse 2 inches of coated optical fiber into 5F5 methylene (Sterling-Clark-Lurton Corp) chloride chemical stripper. Leave for up to 5 minutes. Remove fiber and clean immediately with 2-propanol alcohol. Coating should remove easily, leaving no residue.	Three	[1]
Electron Induced Scintillation (Not for commercial telecommunications grade optical fiber or products previously testing)	Internal TVA procedure for Electron Induced Scintillation	When application requires wavelengths of less than 650 nm, use non-telecommunications optical fiber in application. Test should be application specific using the same amount of optical fiber that will be used in application. Optical fiber is coiled to fit output target of accelerometer and monitored in situ using a photo multiplier tube and data acquisition software. Data is recorded during exposure.	One of each type of fiber under consideration.	[6]
Shrinkage of Components	FOTP-86	Cycling shall be arranged into four to eight cycle sessions. Cycle cable through entire range of specification. Ramp rate shall be equal or less than 2 ºC/min. Dwell at extremes for a minimum of 25 minutes. Perform for 60 cycles or until % shrinkage has reached <0.1%. Monitor temperature and record throughout testing. Measurements should be made after each four to eight cycle session.	Three pieces of cable per lot minimum of 3 meters in length.	[2,3]
Torque	FOTP-184	Test to spacecraft torque value of 7 in-lb for FC type connectors.	Three connectors	
Ambient Light Susceptibility	FOTP-22	Test assemblies for ambient light leakage when using in applications requiring photon counting.	Three	
Ferrule Hole Size/Fiber Compatibility		Validation shall be conducted using 200X magnification. The purpose is to verify that the fiber is held concentric in the ferrule hole.	Three connectors terminated	See application notes

Table 4 TEST PROCEDURES FOR TESTING OF OPTICAL FIBER, CABLE, CONNECTORS, AND ASSEMBLIES (Page 3 of 4)

Performance Test	Test Procedure	Details	Sample Size (Per Lot Date)	Reference
Visual Inspection	FOTP-13	Using 200 X magnification, validate that no scratches, pits, or defects exist on fiber endface.	All terminations	[9]
Concentricity		Visual inspection at 200X; fiber shall be centered in ferrule hole.	All assemblies	
Insertion Loss	FOTP-34	Control launch conditions for accuracy using FOTP 50 to simulate long length for stability.	All assemblies	
Return Loss	FOTP-107	Typically performed with an Optical Time Domain Reflectometer (OTDR).	All assemblies	
Outgassing in Configuration	ASTM 1559	Perform ASTM1559 as a configuration. Cable should be tested unterminated with the length to be determined by the application.	One sample	[3,8]
Random Vibration	FOTP-11	Assembly test levels are usually twice the levels of the expected levels for box or component testing in the environmental specification. Typical levels are listed here for testing of the engineering model: 20 – 50 Hz, .052 g^2 / Hz 50 – 800 Hz, +6 dB / octave 800 – 2000 Hz, .32 g^2 / Hz 2000 Hz, .052 g^2 / Hz Overall Hz, 20.0 grms Test shall be conducted for 3 minutes per test for three tests total (one per x, y, and z orientation).	Three mated assemblies	[4,9]
Thermal Cycling	FOTP-3	A mated pair shall be placed inside of the thermal chamber. Assembly shall be monitored during testing. Thermal environment shall be provided by project specifications. Add 10 ºC to survival thermal requirements to determine test extremes. Ramp rates shall be 2 ºC/min or less. Dwell at extremes for a minimum of 20 minutes per cycle.	Three mated assemblies	

Table 4 TEST PROCEDURES FOR TESTING OF OPTICAL FIBER, CABLE, CONNECTORS, AND ASSEMBLIES (Page 4 of 4)

Performance Test	Test Procedure	Details	Sample Size (Per Lot Date)	Reference
Gamma Radiation	FOTP-64	Radiation characterization shall be performed when specified by project. Using low dose rate facility (<100 rads/min.), perform two tests at two distinct dose rates to the same total dose while keeping thermal environment constant, and extrapolate to lower dose rate environments. For fiber other than germanium or pure silica, other methods and models may be necessary. For more information on extrapolation model see application notes.	100 m for each of two tests. Total of 200 m tested.	[2-5]

REFERENCES

All listed references are located at http://nepp.nasa.gov/photonics

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4. Melanie Ott, Shawn Macmurphy, Patricia Friedberg, "*Characterization of a Twelve Channel Optical Fiber, Ribbon Cable and MTP Array Connector Assembly for Space Flight Environments*," SPIE Proceedings Vol. 4732, Enabling Photonic Technologies for Aerospace and Applications IV, 2002.
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8. Matthew Bettencourt, Melanie Ott, *Fiber Optic Epoxy Outgassing Study for Space Flight Applications*, NEPP Web Publication, October 4, 2001.
9. Melanie Ott, Joy Bretthauer*, Twelve Channel Optical Fiber Connector Assembly: From Commercial off the Shelf to Space Flight Use*, July 1998, SPIE Vol. 3440 Photonics for Space Environments.
10. E. J. Friebele, M. E. Gingerich, D. L. Griscom, "*Extrapolating Radiation-Induced Loss Measurements in Optical Fibers from the Laboratory to Real World Environments,"* 4th Biennial Department of Defense Fiber Optics and Photonics Conference, March 22-24, 1994.
11. H. Henschel, O. Köhn, W. Lennartz, S. Metzger, H. U. Schmidt, J. Rosenkranz, B. Glessner, B. R. L. Siebert, "*Comparison Between Fast Neutron and Gamma Irradiation of Optical Fibers,"* 1997 Fourth European Conference on Radiation and their Effects on Devices and Systems, RADECS 1997, pages 430-438.

SECTION F2: FILTERS

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Table 1 FILTER REQUIREMENTS 1/

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

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

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

Table 2 SCREENING REQUIREMENTS FOR FILTERS

Inspection/Test	Test Methods, Conditions, and Requirements Reference MIL-PRF-28861	Level 1	Level 2			Level 3
		SCD	SCD	MIL-PRF-15733	HI- REL or Commercial	HI- REL or Commercial
1. Visual Inspection	Elements and subassemblies in accordance with paragraph 4.6.1.2.	X				
2. External Visual **1/**	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	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/, 3/** 240	X 160	X 96	X 160	X 48
5. Insulation Resistance or DC Leakage Current **4/**	MIL-STD-202, Method 302, rated DC voltage applied for 2 minutes max., charging current of 50 mA max.	X	X	X	X	X
6. Capacitance to Ground	MIL-STD-202, Method 305, 1.0±.2V RMS. 1 Mhz ±100khz for capacitors ≤100 pF. 1khz ±100Hz for capacitors ≥100 pF.	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	X	X	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/ Pure Tin plating is prohibited as a final finish on EEE parts.

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

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

4/ Shall be measured within 1 hour after voltage conditioning.

Table 3 QUALIFICATION TEST REQUIREMENTS FOR FILTERS 1/

Inspection Test	Test Methods and Procedures MIL-PRF-28861 Paragraph	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
		SCD	SCD, HI-REL or Commercial	
Group 1		4(0)	4(0)	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 (1,500 Gs)	X (100 Gs)	
Vibration (High Frequency)	3.22, 4.6.16	X	X	
Random Vibration	3.23, 4.6.17	X		
Moisture Resistance	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	X	
Group 3		22(0)	10(0)	
Life	3.32, 4.6.26	X	X	

Notes:

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

Table 4 FILTER DERATING REQUIREMENTS

Class	Stress Parameter (Note 1)	Derating Factor
All	Rated current	0.50
	Rated voltage	0.50
	Maximum ambient temperature	85 °C or 30 °C less than maximum rated temperature, whichever is less

Notes:

1/ Applies to rated operating current or voltage, not the absolute maximum.

SECTION F3: FUSES

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

Procurement Specification	Fuse Style and Type	Military Reference Specification	Level 1	Level 2	Level 3
Mil Specification SCD Commercial	FM Fuse, Cartridge, Instrument Type	MIL-PRF-23419	**2/** **3/**	**2/** **3/** **3/**	**2/** **3/** **3/**

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

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

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

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

Table 2 FUSE SCREENING REQUIREMENTS

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

Notes:

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

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

3/ A minimum of three fuses shall be measured.

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

5/ The voltage drop (hot) measurement must be recorded to calculate the voltage drop ratio regardless of whether or not it is a specification requirement. Not applicable for SMT fuses.

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

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

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

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 1 of 4)

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 1	Samples shall be selected from parts that have passed the screening requirements in Table 2.			
Screening to Table 2	Table 2	100%	100%	100%
Group 1A		12(0)	8(0)	4(0)
Current-Carrying Capacity **2/, 3/**	Specified percentage of rated current at –60 °C, 25 °C, and at maximum rated temperature Load Time: 30 minutes after temperature stabilization but not less than 1.5 hours Case temperature rise: ≤70 °C (unless otherwise specified) Fuse shall not blow	X	X	X
Group 2		4(0)	2(0)	
Terminal Strength **3/, 7/**	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	X	X	
Overload Interrupt **3/, 4/**	Specified percentage of rated current at –20 °C, 25 °C, and at maximum rated temperature Temperature soak time: 30 minutes minimum Load time: 1 minute after fuse blow Insulation resistance to specification within 1 minute	X	X	

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 2 of 4)

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

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 3 of 4)

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

Notes at end of table.

Table 3 FUSE QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

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

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

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

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

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

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

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

7/ Not applicable for SMT fuses.

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

Table 4 FUSE DERATING REQUIREMENTS FOR CARTRIDGE STYLE (Notes 1-6)

Fuses are derated by multiplying the rated amperes by the appropriate derating factor listed below.

Fuse Current Rating (Amperes) @ 25 °C	Current Derating Factor	Temperature Derating Factor	Remarks
2, 2-1/2, 3, 4, 5, 7, 10, 15	50%	There is an additional derating of 0.2%/°C for an increase in the temperature of fuse body above 25 °C.	
1, 1-1/2	45%		
3/4	40%		
1/2 3/8 1/4 1/8	40% 35% 30% 25%		The flight use of fuses rated 1/2 ampere or less requires application approval by the project office.

Notes:

1/ Fuses are specified to interrupt within a maximum of 5 seconds when driven at 200% of their rated current for nominal ratings up to and including 10 amperes. A fuse with a nominal rating of 15 amperes is specified to interrupt within a maximum of 10 seconds when driven at 200% of its rated current. The power supply shall be capable of delivering appropriate levels of current to achieve short fusing times.

2/ In a space environment, the possible escape of air from inside the fuses reduces the filament cooling mechanism (heat transfer by conduction). This lowers the blow current rating and decreases current capacity with time, making it necessary to derate current ratings on fuses used in space applications.

3/ Fuses rated at 1/2 ampere or below are especially affected by loss of air; thus, their derating factors are larger.

4/ Current derating factors are based on data from fuses mounted on printed circuit boards and conformally coated. Other types of mountings require project office approval. It should be noted that the lifetime of the fuses is controlled by two factors: cold resistance of the fuse and the heat sinking provided by the installer. The thermal resistance of the fuse to the thermal ground is very important, as is the case with power transistors and power diodes mounted on circuit boards.

5/ Recent studies have shown the occurrence of enduring arcs in fuses rated at 125 volts when the applied voltage is greater than 50 volts. Therefore, the voltages on these fuses should be derated to 50 volts or less.

6/ Electrical transients produce thermal cycling and mechanical fatigue that could affect the life of the fuse. For each application, the capability of the fuse to withstand the expected pulse conditions should be established by considering the pulse cycle withstanding capability for nominal I^2t (energy let through the fuse) specified by the manufacturer.

SECTION H1: HEATERS

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Table 1 HEATER REQUIREMENTS 1/

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

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

2/ Most heaters for space and military applications are custom designed for the intended application per S-311-P-079 (GSFC procurement specifications for thermofoil heaters). Commercial heaters are not constructed to the requirements of S-311-P-079. However, manufacturers will provide an SCD and construct custom heaters to meet S-311-P-079 requirements.

Table 2 SCREENING REQUIREMENTS FOR HEATERS

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

Table 3 QUALIFICATION TEST REQUIREMENTS FOR HEATERS

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

Notes:

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

2/ Generic data may be used in lieu of testing as long as the data meets the following requirements:

i) It is obtained on parts built to S-311-P-079 specifications using the same materials and similar construction and design, and built in the same facility as the flight parts.

ii) The data is less than 2 years old relative to the lot date code of the flight parts.

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

Table 4 HEATER DERATING REQUIREMENTS

Class	Stress Parameter (Note 1)	Derating Factor
All	Rated Current	Use within manufacturer's recommended operating current.
	Rated Voltage	Use within manufacturer's recommended operating voltage.
	Maximum Ambient Temperature	85 °C or 30 °C less than maximum rated temperature, whichever is less.

Notes:

1/ Applies to rated operating current or voltage, not the absolute maximum.

SECTION M1: MAGNETICS

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

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

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** The character "X" designates "use as is." Magnetic part groups and families are provided in Table 1A.

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

3/ MIL-PRF-39010 provides for R and P established reliability failure rate levels (FRL). If the FRL "R" coil is not available, an FRL "P" coil may be used for Level 1 applications. Both FRL R and P coils require 100% X-ray per MIL-STD-981.

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

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

6/ These parts were formerly available to MIL-T-55631. This specification was declared as inactive for new design, effective 31 March 1999.

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

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

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

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

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

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

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

Table 1A PART TYPE GROUPINGS FOR SCREENING AND QUALIFICATION

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

Notes:

1/ These parts were formerly available to MIL-T-55631. This specification was declared as inactive for new design, effective 31 March 1999.

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

Inspection/Test	Test Methods and Conditions 1/	Part Family Type per Table 1A: Family 1 Level 1	Family 1 Level 2	Family 1 Level 3	Family 2 Level 1	Family 2 Level 2	Family 2 Level 3	Family 3 Level 1	Family 3 Level 2	Family 3 Level 3
1. External Visual and Dimensional Inspection	As specified in the detailed drawing; at a minimum, shall include material, physical dimensions and configuration, weight, marking, and workmanship. **2/**	X	X	X	X	X	X	X	X	X
2. 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 1,000 Mohms minimum.	X	X	X	X	X	X	X	X	X
DC Winding Resistance	Use Kelvin bridge or equivalent for resistances less than 1 ohm. Pre and post thermal shock delta R limit shall be less than 3 percent.	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
Turns Ratio or Voltage Ratio	Apply 1 Vrms at a specified frequency to each set of primary windings; monitor voltage across each secondary winding. Ratio not to exceed the specified limit. Use Wayne Kerr or equivalent instrument.	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						

Notes at the end of table.

Table 2 MAGNETICS SCREENING REQUIREMENTS (Page 2 of 3)

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

Notes at the end of table.

Table 2 MAGNETICS SCREENING REQUIREMENTS (Page 3 of 3)

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

Notes:

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

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

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

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

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

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

7/ For Levels 2 and 3, a rejected lot may be reworked to correct the defects, or screen out the defective units, and be resubmitted for reinspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots. Rework of level 1 lots shall not be permitted unless approved by the procuring activity (i.e., the GSFC Project Systems Assurance Manager).

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

Inspection/ Test 2/	Test Methods and Conditions	Part Family 1 Level			Part Family 2 Level			Part Family 3 Level		
		1	2	3	1	2	3	1	2	3
Subgroup I		6 (0)	6 (0)		6 (0)	6 (0)		6 (0)	6 (0)	
Operating Torque (when Applicable)	In accordance with MIL-PRF-15305, paragraph 4.8.7 or MIL-PRF-83446, paragraph 4.6.8.				X	X		X	X	
Temperature Rise	For Group 1, in accordance with paragraph 4.7.13 of MIL-PRF-27. For Group 2, in accordance with paragraph 4.8.9 of MIL-PRF-15305. For Group 3, in accordance with paragraph 4.6.12 of MIL-PRF-83446.	X	X		X	X		X	X	
Overload	Perform test in accordance with: MIL-PRF-27, paragraph 4.7.21, MIL-PRF-83446, paragraph 4.6.13, or MIL-PRF-15305, paragraph 4.8.10.	X	X		X	X		X	X	
Resistance to Soldering Heat	Perform in accordance with: MIL-PRF-27, paragraph 4.7.6, MIL-PRF-21038, paragraph 4.7.6, MIL-T-55631, paragraph 4.7.13, or MIL-PRF-15305, paragraph 4.8.11.	X			X					
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				

Notes at the end of table.

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

Inspection/ Test 2/	Test Methods and Conditions	Part Family 1 Level			Part Family 2 Level			Part family 3 Level		
		1	2	3	1	2	3	1	2	3
Induced Voltage **3/**	MIL-PRF-27, paragraph 4.7.10, 2x rated voltage.	X	X							
Vibration	Perform test in accordance with: MIL-STD-202, Method 204, specify the test condition, MIL-PRF-15305, paragraph 4.8.15, or MIL-PRF-21038, paragraph 4.7.10.	X	X		X	X				
Shock	For MIL-PRF-27 and MIL-PRF-21038 part types, test in accordance with MIL-STD-202, Method 213, pulse as specified (Hor I). For MIL-PRF-15305, paragraph 4.8.16, Test Condition I.	X	X		X	X				
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 1,000 Mohms minimum.	X	X		X	X		X	X	
Electrical Characteristics DC Winding Resistance Winding Inductance	 Use Kelvin bridge or equivalent for resistances less than 1 ohm. Measure inductance at voltage, frequency, and current as specified in the device detail drawing.	X	X		X	X		X	X	

Notes at the end of table.

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

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

Notes at the end of table.

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

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

Notes:

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

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

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

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

Table 4 MAGNETICS DERATING REQUIREMENTS

Insulation Class			Stress Parameter	Minimum Derating
MIL-PRF-27	MIL-PRF-39010	MIL-PRF-15305/ MIL-T-55631	Maximum Operating Temperature 1/, 2/	Derated Operating Temperature
Q	—	O	+85 °C	+65 °C
R	A	A	+105 °C	+85 °C
S	—	—	+130 °C	110 °C
—	B	B	+125 °C	+105 °C
—	C	C	> +125 °C	Max. Temp. -20 °C
—	F	—	+150 °C	+130 °C
All Part Types			Operating Voltage	Derate to 50% of the rated Dielectric Withstanding Voltage

Notes:

1/ a. Maximum operating temperature equals ambient temperature plus temperature rise plus 10 °C allowance for hot spots. The temperature rise may be calculated in accordance with MIL-PRF-27, paragraph 4.7.13. The formula is:

$$\Delta T = \frac{R - r}{r}(t + 234.5) - (T - t)$$

Where:

ΔT = Temperature rise (in °C) above specified maximum ambient temperature
R = Resistance of winding (in ohms) at temperature (T+ΔT)
r = Resistance of winding (in ohms) at temperature (t)
t = Specified initial ambient temperature in °C)
T = maximum ambient temperature (in °C) at time of power shutoff. (T) shall not differ from (t) by more than 5°C.

b. The insulation classes of MIL-style inductive parts generally have maximum operating temperature ratings based on a life expectancy of 10,000 hours. The derated operating temperatures are selected to extend the life expectancy to 50,000 hours at rated voltage.

c. Custom made inductive devices shall be evaluated on a materials basis to determine the maximum operating temperature. Devices with temperature ratings different from the military insulation classes shall be derated to 0.75 times maximum operating temperature.

2/ MIL-PRF-21038 has a maximum operating temperature range of 130 °C. For MIL-PRF-83446, refer to the detailed specification sheet for the maximum operating temperature.

SECTION M2: MICROCIRCUITS, HYBRID

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Scope

This Section covers hermetically sealed hybrid microcircuits, multi-chip modules (MCMs), and similar devices as defined in MIL-PRF-38534, General Specification for Hybrid Microcircuits. For Plastic encapsulated hybrids, refer to Section M4.

MIL-PRF-38534 allows the device manufacturers the flexibility of implementing the best commercial practices to the maximum extent possible while providing a product that meets military needs. Devices compliant to this specification are built on a manufacturing line that is controlled by the manufacturer's quality management program.

The hybrids shall be selected for applicable program class or grade level in accordance with Table 1. Table 1 also lists screening and qualification testing required for each part designation when applied to various program classes or grade levels. Additional testing may be required for DC-DC power converters depending on vendor reliability history and problems/failures experienced in previous NASA programs. Also, 3D MCMs are considered a special class of hybrids / MCMs to which all requirements in Table 1 apply, and additional testing may be required, depending on application environment. The various hybrid classes are defined below:
(1) Class K is the highest reliability level provided for in the MIL-PRF-38534 specification. It is intended for space applications.

(2) Class H is the standard military quality level in the MIL-PRF-38534 specification.

(3) Class G is a lowered confidence version of the standard military quality level (H) with QML listing per MIL-PRF-38534. It features a lowered temperature range (-40 °C to +85 °C), a manufacturer guaranteed capability to meet the Class H conformance inspection and periodic inspection testing, and a vendor specified incoming test flow. The device must meet the Class H requirements for in-process inspections and screening.

(4) Class E designates devices that are based upon one of the other classes (K, H, or G) with exceptions taken to the requirements of that class. These exceptions are specified in the device acquisition document; therefore, the device acquisition document should be carefully reviewed to insure that the exceptions do not adversely affect the performance of the system.

(5) Class D is a vendor specified quality level available to MIL-PRF-38534 t specification. This is a reduced temperature range (0° C to +70° C) part with a vendor specified test flow available from a QML listed manufacturer.

(6) Non-QML indicates a hybrid microcircuit device that is not listed in the QML-38534 document.

Application

Every hybrid is unique in its design and application. The requirements within this section may not be sufficient, depending on the specific device construction, mission life and reliability goals of the project. Project parts engineer in close coordination with design engineer shall ensure that the appropriate requirements for each application are included in the procurement, screening and qualification of these parts.

Table 1 HYBRID MICROCIRCUIT REQUIREMENTS 1/, 2/

Part Designation	Use As Is	Screen in Accordance with Table 2	Qualify in Accordance with Table 3	Element Evaluation in Accordance with Table 4
Level 1:				
1) Class K		X		
2) Class H **3/**		X		
3) Non-QML **4/, 5/**		X	X	X
Level 2:				
1) Class K		X		
2) Class H		X		
3) Non-QML **5/, 6/**		X	X	X
Level 3:				
1) Class K	X			
2) Class H		X		
3) Non-QML **6/**		X		

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** Hybrid classes G, E, and D are not listed here because the vendors used by NASA programs are not interested in supplying parts to these class levels. Any use of hybrid classes G, E, and D requires permission on a case–by–case basis from the project.

2/ Plastic encapsulated hybrid microcircuits are not covered in this section. Refer to Section M4 for PEMs (Plastic Encapsulated Microcircuits) requirements.

3/ Acceptable for use as a level 1 part only when a Class K part is not available.

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

5/ For non-QML hybrid microcircuits (i.e. parts not currently listed in QML-38534), the successful completion of a manufacturer's facility audit and / or a survey is required prior to the placement of any flight procurements.

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

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

Screen	Test Methods and Conditions	Level 1			Level 2			Level 3	
		K	**H**	**Non-QML 5/**	**K**	**H**	**Non-QML 6/**	**H**	**Non-QML 6/**
1. Preseal Burn-in	MIL-STD-883, Method 1030			X			X		X
2. 100% Nondestructive Bond Pull	MIL-STD-883, Method 2023, 2% PDA			X			X		X
3. Internal Visual 1/	MIL-STD-883, Method 2017			X			X		X
4. Temperature Cycling	MIL-STD-883, Method 1010, Condition C			X			X		X
5. Constant Acceleration	MIL-STD-883, Method 2001, Condition 3,000 g, Y1 direction only			X			X		X
6. Particle Impact Noise Detection (PIND) **2/**	MIL-STD-883, Method 2020, Condition A (Class K) or B		X	X		X	X	X	X
7. Preburn-in Electrical Test	As specified			X			X		X
8. Burn-In **3/**	Level 1: MIL-STD-883, Method 1015, 320 hours at 125 °C minimum Levels 2 & 3: MIL-STD-883, Method 1015, 160 hours at 125 °C minimum			X			X		X
9. Final Electrical Test **4/**	As specified			X			X		X
10. Calculate Delta and Percent Defective	Level 1: 2 percent PDA Level 2 10 percent PDA Level 3 10 percent PDA			X			X		X
11. Seal Fine Gross	MIL-STD-883, Method 1014, Conditions A or B, MIL-STD-883, Method 1014, Condition C			X			X		X

Notes at end of table.

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

Screen	Test Methods and Conditions	Level 1			Level 2			Level 3	
		K	H	Non-QML 5/	K	H	Non-QML 6/	H	Non-QML 6/
12. Radiographic **7/**	MIL-STD-883, Method 2012		X	X		X	X	X	X
13. External Visual **1/**	MIL-STD-883, Method 2009			X			X	X	X
14. Destructive Physical Analysis (DPA)	MIL-STD-883, Method 5009	X	X	X	X	X	X	X	X

Notes:

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

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

3/ For level 1 hybrids, the burn-in shall be equally divided into two successive burn-ins i.e. 160 hours pre seal and 160 hours post seal.

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

5/ All rework/repair on non-QML hybrids for level 1 applications must be fully documented and shall meet MIL-PRF-38534 Class K rework/repair requirements.

6/ All rework/repair on non-QML hybrids for level 2 and 3 applications must be fully documented and shall meet MIL-PRF-38534 Class H rework/repair requirements.

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

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Table 3 QUALIFICATION TEST REQUIREMENTS FOR HYBRID MICROCIRCUITS

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

Notes:

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

2/ Manufacture's option.

Table 4A ACTIVE ELEMENT EVALUATION REQUIREMENTS 1/, 2/

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

Notes:

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

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

Table 4B PASSIVE ELEMENT EVALUATION REQUIREMENTS 1/

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

Notes:

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

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

a) Resistors: DC resistance

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

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

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

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

Notes:

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

Table 4D SUBSTRATE EVALUATION REQUIREMENTS 1/

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

Notes:

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

2/ Test for the following characteristics and as specified in procurement specification:

a) Resistors: DC resistance.

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

c) Multilayered Substrates: Continuity and isolation as specified.

Table 4E PACKAGE EVALUATION REQUIREMENTS 1/, 2/

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

Notes:

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

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

Hybrid Microcircuit Derating Requirements

For hybrid devices, derating guidelines are divided into two categories: derating of components used in hybrid design and manufacture, and derating for applications in which the part is used. These guidelines are provided as follows:

1. Derating of components used in hybrid design and manufacture:

- Derating analysis for existing hybrid devices that are qualified to MIL-PRF-38534 is not required.
- Custom hybrids shall be designed such that all internal components comply with the electrical and temperature derating requirements set forth in this document for the specific commodity device types (i.e., diodes, capacitors, etc.). Derating analysis shall be reviewed and approved by the project PCB.

2. Application derating for hybrids:

A. General requirements for all applications and all device types:

- Specific electrical parameter derating shall be based on the requirements set forth for similar microcircuit device types.
- Case temperature derating shall be 75% of the maximum rated case temperature specified by the manufacturer or 80 °C, whichever is lower.

B. Special requirements for high temperature applications and high power hybrids (ex: DC-DC converters):

Additional derating beyond the general requirements stated above may be required in order to prevent localized device overheating within the hybrid, and shall be tailored on a case-by-case basis to account for the application temperature and power dissipation needs. Such derating analysis is required and shall be submitted to PCB for review and approval.

SECTION M3: MICROCIRCUITS, MONOLITHIC

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SCOPE

This section covers hermetically sealed Monolithic Integrated Circuits only. For Plastic Encapsulated Microcircuits(PEMs) , refer to Section M4. Monolithic Integrated Circuits shall be selected for the applicable program class or grade level in accordance with Table 1. Table 1 also indicates screening and qualification testing required for each part designation when applied to the various program classes or grade levels. The part designations are discussed below:

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

(2) Class T . Class T device manufacturers are QML certified and qualified by DSCC, and Class T devices are manufactured on a certified and qualified QML line. Class T flow is developed and approved through the manufacturer's Technology Review Board. Each technology flow (e.g., wafer fabrication, assembly, screening and qualification, etc.) is developed taking into account application requirements of the customers. Use of Class T devices in NASA applications requires permission on a case-by-case basis from the NASA Project Office (i.e., cognizant EEE Parts Authority).

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

(4) Source/ Vendor Control Drawing (SCD). This designation includes parts that are not available to other acceptable procurement methods listed for a specific grade level, and must be procured to a user's controlled specification (SCD). The SCD shall include screening and qualification requirements as specified in Tables 2, 3, and 4 herein. The testing required by the SCD is performed by the manufacturer and does not have to be performed by the user. For Program level 1 and level 2 applications, an audit/survey of the manufacturer's facility is recommended to verify that their quality and reliability procedures are in compliance with GSFC's requirements.

(5) Manufacturer High Reliability (Mfr. Hi-Rel). This designation includes parts that are available only to a manufacturer's controlled test program as described in the manufacturer's catalog. These parts are controlled only by the manufacturer, who assigns them a special part number and provides a certificate of compliance that they have been tested as advertised. This category includes Non-Compliant, Non-JAN parts. It is the responsibility of the user to assure that the parts meet or exceed the testing requirements in Tables 2, 3, and 4. For Program level 1 and level 2 applications, an audit/survey of the manufacturer's facility is required to verify that their quality and reliability procedures are in compliance with GSFC's requirements.

(6) Commercial Parts. This designation includes parts that are either hermetic, commercial-off-the-shelf (COTS), or non-hermetic Plastic Encapsulated Microcircuits (PEMs). Hermetic COTS are available only to a manufacturer's specification datasheet and are controlled by a

test program as described in the manufacturer's catalog. It is the responsibility of the user to assure that the parts meet or exceed the testing requirements in Tables 2, 3, and 4 herein. Commercial parts are not approved for Program level 1 applications. For level 2 applications, an audit/survey of the manufacturer's facility would be required to verify that their quality and reliability procedures are in compliance with GSFC's requirements. Non-hermetic PEMs requirements are covered in Section L.

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

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

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

Part Designation	Use As Is	Screen To Requirements in Table 2 2/	Qualify To Requirements in Table 3 2/
Level 1:			
1) Class V or Class S	X		
2) Class Q or Class B		X **3/, 4/, 5/**	
3) SCD		X **4/, 5/**	X
4) 883-Compliant or Class M **5/**		X **4/, 5/, 6/**	X
Level 2:			
1) Class V or Class S	X		
2) Class Q or Class B		X **4/**	
3) 883-Compliant or Class M **6/**		X **4/, 8/**	X **9/**
4) SCD		X **4/, 8/**	X **9/**
5) Mfr. Hi-Rel **7/**		X **4/, 8/**	X **9/**
6) Commercial		X **4/, 8/**	X **9/**
Level 3:			
1) Class V (or S)	X		
2) Class Q (or B)		X **4/**	
3) 883-Compliant or Class M **4/, 9/**		X **4/**	
4) SCD **9/**		X **8/**	
5) Mfr. Hi-Rel **10/**		X **8/**	
6) Commercial **10/**		X **8/**	

Notes follow on next page.

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

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** Plastic Encapsulated Microcircuits (PEMs) are not covered in this section. Refer to Section L for PEMs requirements.

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

3/ Class Q (or Class B) microcircuits are acceptable with additional testing as level 1 parts only when Class V (or Class S) microcircuits are not available. Otherwise, the Class V (or Class S) level parts should be used.

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

5/ Class Q or Class B and Compliant Non-JAN microcircuits used in level 1 applications require DPA in accordance with S-311-M-70. SCD devices require pre-cap Inspection. DPA can be substituted for pre-cap inspection.

6/ Class M or Non-JAN Compliant parts (with SMDs) are acceptable as a level 2 part only when a Class Q (or B) microcircuit is not available. Otherwise, the Class Q (or B) level part should be used.

7/ Use of Mfr. Hi-Rel and commercial parts in level 1 and 2 applications requires use of SCD (or program specific Parts Procurement Plan) that specifies screening and qualification testing. SCD/Parts Procurement Plan shall include audit/survey requirements to ensure the manufacturer's quality/reliability procedures, assembly, and testing criteria meets GSFC requirements.

8/ 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.

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

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

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

Inspection/Test	MIL-STD-883		Level 1			Level 2			Level 3		
	Methods	**Conditions**	**Class Q or B**	**SCD**	**883 or Class M 1/**	**Class Q or B**	**883 or Class M 1/**	**SCD/Mfr. Hi-Rel/ Commercial 1/**	**Class Q or B**	**883 or Class M**	**SCD/Mfr. Hi-Rel/ Commercial 1/**
1. Wafer Lot Acceptance	5007			X	X		X	X			
2. Nondestructive Bond Pull	2023			X							
3. Internal Visual **2/**	2010	A or B	X	X	X		X	X			X
4. Temperature Cycling	1010	C		X	X		X	X			
5. Constant Acceleration	2001	E Y_1 Orientation Only		X	X		X	X			
6. PIND **3/**	2020	A	X	X	X	X	X	X	X	X	X
7. Radiographic **4/**	2012	Two views		X	X						
8. Serialization				X							
9. Initial Electrical Measurements @ 25 °C **5/ , 6/**		Per Table 2A herein and applicable device specification	X Read/ Record	X Read/ Record	X Read/ Record		X Read/ Record	X Read/ Record			X
10. Burn-in **7/, 8/, 9/**	1015	A, C, or D duration (hrs.)	X 48/160	X 72/240	X 48/160		X 160	X 160			X 160
11. Final Electrical Measurements @ 25 °C, min . and max Operating Temp. **7/, 10/**		Per Table 2A herein and applicable device specification	X Read/ Record	X Read/ Record	X Read/ Record		X Read/ Record	X Read/ Record			X
12. Calculate Delta **7/, 11/**		Per Table 2A herein and applicable device specification	X	X	X		X	X			
13. Calculate PDA **12/**		PDA	5%	5%	5%		10%	10%			20%
14. Hermetic Seal a. Fine Leak b. Gross Leak	1014	 A or B C	 X X	 X X	 X X		 X X	 X X			
15. External Visual **13/**	2009	3 to 10x	X	X	X		X	X			X

Notes at end of table.

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

Notes:

1/ Tests that are performed as part of manufacturer's normalpractice do not need to be repeated if the test conditions are equal or better than the conditions imposed by Table 2A, and Lot specific data is available that demonstrates acceptable results.

2/ In lieu of pre-cap source inspection or internal visual, DPA shall be performed to the requirements of S-311-M-70 specification. No failures are permitted.

3/ PIND testing need not be repeated if it has been performed by the manufacturer as part of the process flow. For level 3, lot jeopardy shall not be required.

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

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

6/ For one-time programmable read-only memories (PROMs) and programmable logic devices/arrays (PLDs/PLAs), steps 9 through 11, shall be performed after the programming, even if they were performed on the blank devices.

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

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

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

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

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

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

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

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

IC Type	Required Burn-in 1/ Static (Condition C)	Required Burn-in 1/ Dynamic (Condition D)	Delta	Electrical Measurements 2/, 3/, 4/
Digital Bipolar & Digital MOS/ BiCMOS: 6/, 7/ LOGIC (Gates, Buffers, Flip-Flops, Multiplexers, Registers and Counters, etc.) RAMs FIFOs Microprocessors/DSPs Interface Peripherals FPGAs PROMs, PLD/PLA **5/**	Not required for Digital Bipolar Technology. Required for Digital MOS Technology. T_A = 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 = 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 microprocessors, FPGAs, etc., functional testing includes fault coverage calculations required per MIL-STD-883, Method 5012. c) For PROMs, check fuse map; for RAMs, perform pattern sensitive tests such as March, Galpat, etc.
Linear MOS, Bipolar, and Bi-FET: 7/ Op-Amp, Instrument Amplifiers, S/H, and Comparator	T_A = 125 °C V_{out}= Terminated to ground through R_L	T_A = 125 °C V_{in}= Square wave or sine wave 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.

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

IC Type	Required Burn-in 1/ Static (Condition C)	Required Burn-in 1/ Dynamic (Condition D)	Delta	Electrical Measurement 2/, 3/, 4/
Linear MOS, Bipolar and JFET: 7/ Line Drivers and Receivers	T_A = 125 °C V_{in}= V_{DD} max across one-half input pins and V_{SS} across the remaining inputs.	T_A = 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: 6/, 7/ Analog Switches and Multiplexers	T_A = 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 = 125 °C V_{in}= Square wave F= 100 Khz and 50% duty cycle V_{out}= ± V_{CC} through R_L	ΔI_{CC} $\Delta I_{D(OFF)}$ $\Delta I_{S(OFF)}$ $\Delta R_{(ON)}$	**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 =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 = 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 = 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 = 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.

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

IC Type	Required Burn-in 1/ Static (Condition C)	Required Burn-in 1/ Dynamic (Condition D)	Delta	Electrical Measurement 2/, 3/, 4/
Linear MOS and Bipolar: Active Filters	Not required	T_A = 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: 7/ Analog to Digital (A/D) Converters	T_A = 125 °C V_{in} = Max analog DC input V_{out} = $V_{CC}/2$ through R_L	T_A = 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 7/ Digital to Analog (D/A) Converters	T_A = 125 °C V_{in}= V_{DD} on one-half data inputs and V_{SS} on remaining inputs. V_{out}= Terminated to ground through R_L	T_A = 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/ Static and dynamic burn-in shall be performed at maximum recommended operating supply voltage @ T_A = 125 °C . Biasing conditions including the value of R_L shall be selected to assure that the junction temperature shall not exceed T_{jmax} specified for the device type.

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

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

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

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.

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

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

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

Table 3 QUALIFICATION TEST REQUIREMENTS
FOR MONOLITHIC INTEGRATED CIRCUITS (Page 1 of 5) 1/

Inspection/Test	MIL-STD-883		Quantity (Accept Number) or LTPD				
			Level 1		Level 2		Level 3
	Test Methods	Conditions/ Sample Size (No. of Rejects)	883 or Class M 3/	SCD 3/, 6/	883 or Class M 4/	Mfr. Hi-Rel/ SCD/ Commercial 4/, 6/	Mfr. Hi-Rel /SCD/ Commercial 7/
Group B							
Subgroup 1 2/		3(0)	X	X	X	X	
Resistance to Solvents	2015						
Subgroup 2		22(0) 22 wires chosen at random from 3 samples	X	X	X	X	
Bond Strength (1) Thermocompression (2) Ultrasonic or Wedge (3) Flip-Chip (4) Beam Lead	2011	(1) Condition C or D (2) Condition C or D (3) Condition F (4) Condition H					
Die Shear Test (or Stud Pull)	2019 or 2027	3(0)	X	X	X	X	
Subgroup 3							
Solderability	2003	Soldering temperature of 245 °C ± 5 °C	X	X	X	X	

Notes at the end of table.

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

Inspection/Test	MIL-STD-883 Test Methods	MIL-STD-883 Conditions/ Sample Size (No. of Rejects)	Quantity (Accept Number) or LTPD: Level 1: 883 or Class M 3/	Level 1: SCD 3/, 4/, 6/	Level 2: 883 or Class M 3/	Level 2: Mfr. Hi-Rel/ SCD/ Commercial 3/, 6/	Level 3: Mfr. Hi-Rel /SCD/ Commercial 7/
Group C			22(0)	45(0)	22(0)	22(0)	
Operation Life Test **5/**	1005	Condition A, C, or D, (1,000 hours at +125 °C or equivalent)	X	X	X	X	
End-point electrical parameters		As specified in the applicable device procurement specification and Table 2A herein.	X	X	X	X	

Notes at the end of table.

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

Inspection/Test	MIL-STD-883 Test Methods	MIL-STD-883 Conditions/ Sample Size (No. of Rejects)	Quantity (Accept Number) or LTPD: Level 1 883 or Class M 3/	Level 1 SCD 3/, 6/	Level 2 883 or Class M 3/, 4/	Level 2 Mfr. Hi-Rel/ SCD/ Commercial 3/, 4/, 6/	Level 3 Mfr. Hi-Rel /SCD/ Commercial 7/
Group D							
Subgroup 1 2/		15(0)	X	X	X	X	
Physical Dimensions	2016						
Subgroup 2		15(0)	X	X	X	X	
a. Lead Integrity	2004	A, B2, or D (use Method 2008 for PGA packages)					
b. Seal	1014						
(1) Fine							
(2) Gross							
Subgroup 3		15(0)	X	X	X	X	
a. Thermal Shock	1011	B, 15 cycles					
b. Temperature Cycling	1010	C, 100 cycles					
c. Moisture Resistance	1004						
d. Seal	1014						
(1) Fine							
(2) Gross							
Subgroup 4		15(0)	X	X	X	X	
a. Shock	2002	B					
b. Vibration, Variable Frequency	2007	A					
c. Acceleration	2001	E, Y1 orientation					

Notes at the end of table.

Table 3 QUALIFICATION TEST REQUIREMENTS

FOR MONOLITHIC INTEGRATED CIRCUITS (Page 4 of 5)

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

Notes follow on the next page.

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

Notes:

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

2/ Subgroup 1 can be performed on electrical rejects.

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

4/ Generic QCI attributes data is acceptable, provided it meets inspection/test requirements of Table 3. QCI attributes data within 12 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 testing if the data satisfies the requirements in Table 3.

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

6/ Use of Mfr. Hi-Rel and commercial parts in level 1 and 2 applications requires use of SCD (or program specific Parts Plan) that specifies screening and qualification testing. SCD/Parts Plan shall include audit/survey requirements to ensure the manufacturer's quality/reliability procedures, assembly, and testing criteria meets GSFC requirements.

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

Table 4 MICROCIRCUIT DERATING REQUIREMENTS (Note 1)

Derating of microcircuits is accomplished by multiplying the stress parameter by the appropriate derating factor specified below.

Stress Parameter	Derating Factor	
	Digital	**Linear**
Maximum Supply Voltage/Input Voltage **(Note 1)**	0.9	0.8
Power Dissipation	0.8	0.75
Maximum Specified Operating Junction Temperature **(Note 2)**	0.8	0.75
Maximum Output Current	0.8	0.8
Clock Frequency	0.8	0.8
Radiation Effects Note **3/**	Check with project radiation engineer.	

Notes:

1/ Use manufacturer's recommended operating conditions but do not exceed 90% of maximum supply voltage for digital devices and 80% of maximum supply voltage for linear devices. For voltage regulators, derate V_{IN} - V_{OUT} to 0.9.

1.1/ For low voltage (< 5V) devices, use manufacturer's recommended operating conditions.

2/ Do not exceed Tj = 110 °C or 40 °C below the manufacturer's maximum rating, whichever is lower.

3/ Consult the project radiation engineer to determine derating guidelines that account for radiation induced degradation (total ionizing dose, single event effects, and displacement damage) in parts over the lifetime of each mission.

SECTION M4: MICROCIRCUITS, PLASTIC ENCAPSULATED

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NASA/GSFC PEMS POLICY

The use of Plastic Encapsulated Microcircuits (PEMs) is permitted on NASA Goddard Space Flight Center (GSFC) space flight applications, provided each use is thoroughly evaluated for thermal, mechanical, and radiation implications of the specific application and found to meet mission requirements. PEMs shall be selected for their functional advantage and availability, not for cost saving; the steps necessary to ensure reliability usually negate any initial apparent cost advantage. A PEM shall not be substituted for a form, fit and functional equivalent, high reliability, hermetic device in space flight applications.

Due to the rapid change in wafer-level designs typical of commercial parts and the unknown traceability between packaging lots and wafer lots, lot-specific testing is required for PEMs, unless specifically excepted by the Mission Assurance Requirements (MAR) for the project. Lot-specific qualification, screening, radiation hardness assurance analysis, and/or testing shall be consistent with the required reliability level as defined in the MAR.

Developers proposing to use PEMs shall address the following items in their Performance Assurance Implementation Plan: source selection (manufacturers and distributors); storage conditions for all stages of use; packing, shipping, and handling; electrostatic discharge (ESD); screening and qualification testing; derating; radiation hardness assurance; test house selection and control; and data collection and retention. Use of PEMs outside the manufacturer's rated temperature range requires written approval from GSFC. Specifically, PEMs must be:

- Stored under temperature controlled, clean conditions, protected from ESD and humidity
- Traceable to the branded manufacturer
- Procured from the manufacturer or their approved distributor
- Tested to verify compliance with the performance requirements of the application environment over the intended mission lifetime
- Tested using practices and facilities with demonstrated capabilities sufficient to handle and test the technologies involved.

Testing in accordance with PEM-INST-001 shall be performed as necessary to qualify and screen the devices, in order to verify compliance with the application requirements and project risk level, defined in the program MAR. Radiation evaluation shall address all threats appropriate for the technology, application, and environment, including Total Ionizing Dose (TID), Single Event Effects (SEE), and displacement damage. Existing radiation data can be used only with the review and approval of the project radiation specialist.

PEMs with manufacture dates older than 3 years before the time of installation shall not be used without GSFC approval. Derating of PEMs must be addressed with consideration of specific material, device construction, device characteristics, and application requirements.

Use of PEMs with pure tin plated terminations requires special precautions to preclude failures caused by tin whiskers. GSFC approval of mitigation strategies is required.

Exceptions to testing required by PEM-INST-001 may be permitted by GSFC on a case-by-case basis, where it can be demonstrated that either existing lot-specific test data show acceptable results, or the use of high risk PEMs represents low risk of functional loss should the part fail. All rationale for such exceptions shall be documented.

NASA will use part performance data collected in accordance with this policy to evaluate the policy's effectiveness and to develop recommendations for future improvements and streamlining.

Table 1 PEM REQUIREMENTS 1/

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

Notes:

1.1/ For detailed instructions on PEM requirements and test procedures, including screening, qualification, DPA test procedure, additional evaluation analysis, derating, and handling and storage guidelines refer to Instructions for PEM Selection, Screening, and Qualification, PEM- INST-001.
Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

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

1.4/ Most of the requirements described in this document are also applicable to commercial discrete and hybrid semiconductor devices encapsulated in plastics. However, for some parts tailoring of the screening, qualification, and DPA procedures might be necessary. In this case adjustments of the procedures for a particular part type should be done by the project parts engineer and approved by code 562. For discrete semiconductor devices refer to MIL-STD-750 for the appropriate test methods.

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

3/ DPA for PEMs shall focus on three major areas of concerns: 1) integrity of the package, 2) quality of assembly, and 3) defects in the die. This analysis shall also evaluate package and die-level homogeneity of the lot. When obvious gross defects are revealed during DPA, it is usually an indication that manufacturer's processes are out of control, and a replacement of the lot might be required**.** Therefore, it is recommended that DPA be performed prior to screening and qualification of the lot. Additional evaluations might be necessary to further mitigate risks associated with the use of PEMs (refer to section 6 of PEM-INST-001).

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

Screen	Test Method and Conditions	Level 1	Level 2	Level 3
1. External visual, and serialization 2/	Per paragraph 5.3.1. of PEM-INST-001	X	X	X
2. Temperature cycling	MIL-STD-883, Method 1010, Condition B (or to the manufacturer's maximum storage temperature range, whichever is less). Temperature cycles, minimum.	20	20	10
3. Radiography 3/	Per paragraph 5.3.2. of PEM-INST-001	X	X	X
4. C-SAM inspection 4/	Per paragraph 5.3.3. of PEM-INST-001	X	X	X
5. Initial (pre-burn-in) electrical measurements (EM) 5/	Per device specification, at 25 °C At min. and max. rated operational temperatures.	X X	X X	X -
6. Engineering review (Steps 1 to 5) 6/				
7. Static (steady-state) burn-in (BI) test at 125 °C or at max. operating temperature 7/	MIL-STD-883, Method 1015, condition A or B. Hours, minimum depending on the BI temperature.	240 hrs. at 125 °C 445 hrs. at 105 °C 885 hrs. at 85 °C 1,560 hrs. at 70 °C	160 hrs. at 125 °C 300 hrs. at 105 °C 590 hrs. at 85 °C 1,040 hrs. at 70 °C	160 hrs. at 125 °C 300 hrs. at 105 °C 590 hrs. at 85 °C 1,040 hrs. at 70 °C
7a. Post static BI electrical measurements @ 25 °C	Per device specification. Calculate Delta when applicable.	X	X	X
9. Dynamic burn-in test at 125 °C or at max. operating temperature 7/	MIL-STD-883, Method 1015, Cond. D. Hours, minimum.	Same as test step 7.	Same as test step 7.	Same as test step 7.
10. Final parametric and functional tests	Per device specification (at 25 °C, maximum, and minimum rated operating temperatures).	X	X	X
11.Calculate percent defective (Steps 7 to 10) 6/	Maximum acceptable PDA.	5%	10%	10%
12. External visual/packing 2/	Per paragraph 5.3.1 and Section 8 of PEM-INST-001.	X	X	X

Notes on next page.

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

1/ **General**

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

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

1.3/ It is the responsibility of the project parts engineer to submit screening test results to Code 562 for logging into the Code 562 PEM database.

2/ It is recommended to combine the incoming/outgoing visual inspections with the serialization and packaging to reduce handling and possible damage to the parts. Serialization should be performed in such a way to allow a topside C-SAM inspection. Flight parts should be handled and stored in a manner to prevent mechanical and ESD damage, contamination, and moisture absorption (see Section 8 of PEM-INST-001).

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

4/ **Acoustic Microscopy (C-SAM)**

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

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

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

4.4/ *Rejection Criteria.*

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

5/ **Electrical Measurements**

5.1/ *Special Testing.* In addition to parametric and functional measurements per data sheets, supplement and/or innovative testing techniques (e.g. IDDQ leakage currents, thermal impedance, output noise, etc.) can be used to select better quality parts from the lot (cherry pick) as flight candidates. These techniques should be certified and approved by Code 562.

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

6/ **Engineering review.**

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

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

7/ **Burn-in (BI)**

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

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

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

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

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

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

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

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

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

7.10/ Under special circumstances, when it is technically and economically viable, and for components, which are difficult to assess at the piece part level, alternative testing in lieu of static and/or dynamic BI testing (for example, board-level burn-in) may be permitted. It is the responsibility of the project PE to document and submit a rationale for the technical feasibility and equivalency of the alternative testing to the project and GSFC Code 562 for approval. Board-level burn-in shall not be routinely substituted for piece part burn-in as a convenience.

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

Process	Sub Test	Test Methods & Conditions	QTY (Failures)		
			Level 1	Level 2	Level 3
1. Visual inspection & serialization 2/		Section 5, paragraph 5.3.1 of PEM-INST-001	32	32	17
2. Radiation analysis		TID and SEE	**3/**	**3/**	**3/**
3. Baseline C-SAM	(Parts in subgroup 1 only)	Section 5, paragraph 5.3.1 of PEM-INST-001	22	22	N/A
5. Preconditioning	Moisture soak 4/	JESD22 – A113-B, para. 3.1.5, condition A (168 hours, +85°C, 60% RH).	32	32	17
	SMT devices Reflow simulation (with flux application, cleaning, and drying)	JESD22-A113-B, Table 2 and paragraphs. 3.1.6 through 3.1.9. Peak solder reflow temperature +235 °C.	32	32	17
	Through hole devices Resistance to soldering temperature	JESD22-B106-B.	32	32	17
4. Electrical measurements	Per device specification	Measure at 25 °C, min. & max. rated temperatures.	32(0)	32(0)	17(0)
6. Life testing Subgroup 1	HTOL, 125 °C 5/, 6/	MIL-STD-883, Method 1005, Cond. D Hours, minimum.	22 1,500	22 1,000	10 500
	Electrical measurement (per specification)	Measure at 25 °C, min. & max. rated temperatures.	22(0)	22(0)	10(0)
6a. Temperature cycling Subgroup 1	Temperature cycling 5/, 7/	MIL-STD-883 Method 1010, Cond. B (-55 °C to +125 °C), cycles, minimum.	22 500	22 200	10 100
	Electrical measurement (per specification)	Measure at 25 °C, min. & max. rated temperatures.	22(0)	22(0)	10(0)
	C-SAM 8/	Section 5, paragraph 5.3.3.	22	22	N/A
	DPA or FA	9/	X	X	N/A
7. Highly accelerated stress test (HAST)	Biased HAST 5/	JESD22 - A110, with continuous bias (96 hours, +130 °C, 85% RH).	10	N/A	N/A
Subgroup 2	Unbiased HAST 5/	JESD22-A118, Condition A (96 hours, +130 °C, 85% RH).	N/A	10	7

Notes on next page.

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

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

1.2/ It is the responsibility of the project parts engineer to submit qualification test results to Code 562 for logging into the Code 562 PEM database.

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

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

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

5/ Conditions of the temperature cycling, HAST, and high temperature life testing (HTOL) can be tailored according to specifics of the device application per Code 562 approval. Guidelines for application-tailored qualification testing of PEMs shall be developed by Code 562.

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

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

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

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

Applicable Standards for Test Methods

JESD22-A113-B: Preconditioning of nonhermetic surface mount devices prior to reliability testing.
JESD22-B106-B: Resistance to Soldering Temperature for Through-Hole Mounted Devices
JESD22-A110-B: Highly-Accelerated Temperature and Humidity Stress Test (HAST)
JESD22-A118: Accelerated Moisture Resistance - Unbiased HAST

DESTRUCTIVE PHYSICAL ANALYSIS (DPA)

Destructive Physical Analysis, or Construction Analysis (CA), shall be performed to obtain information regarding design, workmanship, and process quality related to a PEM manufacturing lot. Samples for DPA (5 pcs. minimum) should be selected randomly from different portions of the procurement lot. See Section 5 of PEM-INST-001, Instructions for PEM Selection, Screening, and Qualification, August 2002, for GSFC DPA procedure.

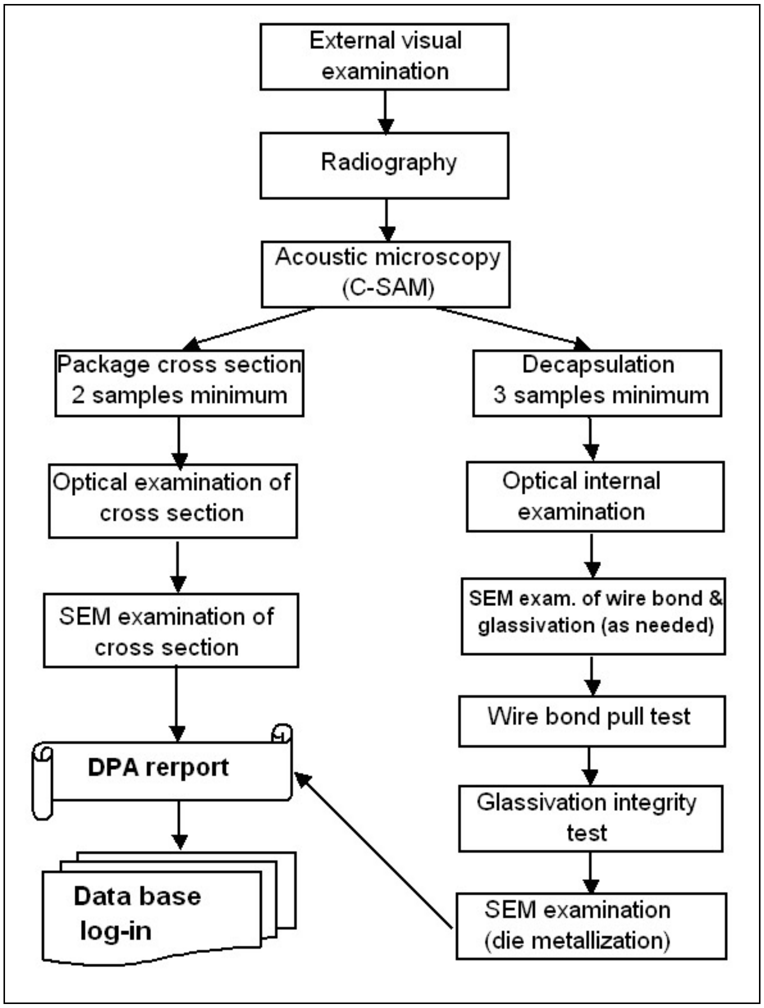

Figure 1. A typical DPA test flow for PEMs.

DERATING REQUIREMENTS

Derating requirements for PEMs are listed in Table 4. Taking a conservative approach, derating requirements for PEMs should be more stringent than the requirements for their high-reliability equivalents. In addition to the requirements in Table 4, derating specific to some PEMs may be required based on design and technology of the part intended for special application. All part-specific derating shall be approved by the project and GSFC Code 562.

Table 4 DERATING REQUIREMENTS FOR PEMs

Stress Parameter	Derating Equation/Factor	
	Digital	**Linear /Mixed Signal**
Maximum Supply Voltage 1/	$V_{n.r.}+0.5*(V_{max.r.}-V_{n.r.})$	$V_{n.r.}+0.8*(V_{max.r.}-V_{n.r.})$
Maximum Input Voltage	-	0.8
Maximum Operating Junction Temperature 2/	0.8 or 95 °C (whichever is lesser)	0.7 or 85 °C (whichever is lesser)
Maximum Output Current	0.8	0.7
Maximum Operating Frequency	0.8	0.7

Notes:

1/ $V_{n.r.}$ is the nominal rated power supply voltage; $V_{max.r.}$ is the maximum rated power supply voltage.

2/ For power devices, do not exceed 110 °C or 40 °C below the manufacturer's rating, whichever is lower.

SECTION R1: RELAYS, ELECTROMAGNETIC

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Table 1 RELAY REQUIREMENTS 1/

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

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** The character "X" designates "use as is."

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 1A along with their applicable detail specifications.

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

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

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

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

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

Table 1A NASA/GSFC RELAYS

GSFC Detail Specification 1/	Description	Similar Military Counterpart
S-311-P-754/01	Latching, 2PDT, TO-5 Can, Low Level	MIL-PRF-39016/12
S-311-P-754/02	Latching, 2PDT, TO-5 Can, Low Level	MIL-PRF-39016/29
S-311-P-754/03	Nonlatching, 2PDT, TO-5 Can, Low Level	MIL-PRF-39016/ 9
S-311-P-754/04	Nonlatching, 2PDT, TO-5 Can, Low Level	MIL-PRF-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	M83536/9 **2/**
S-311-P-754/07	Nonlatching, 2PDT, 1/2 Crystal Can, Low Level	MIL-PRF-39016/13
S-311-P-754/08	Latching, 4PDT, Low Profile Can, Low Level	MIL-PRF-39016/31
S-311-P-754/09	Nonlatching, 4PDT, Low Profile Can, Low Level	MIL-PRF-39016/14
S-311-P-754/10	Nonlatching, 4PDT, One Inch Cube, High Level	M83536/15 **3/**
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.
2/ MS27401-13 superseded by M83536/9-023; MS27401-14 superseded by M83536/9-024.
3/ MS27400-5 superseded by M83536/15-021; MS27400-6 superseded by M83536/15-022.

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

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

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Level		
		1	2	3
9. Run-In Tests **14/**	Low Temperature Run-in 1 hour dwell at minimum rated operating temperature Pickup or latch/reset voltage to specification Contact loading: Open circuit load voltage at 10 to 50 µV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 Level 2 – 1,000 cycles Miss level: 100 ohms maximum	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 50 µV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 cycles Level 2 – 1,000 cycles Miss level: 100 ohms maximum	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 50 µV Load current at 10 to 50µA Cycling rate: 60 actuations/minute (minimum) Specified number of cycles Level 1 – 2,500 cycles Miss level: 100 ohms maximum	X		

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Level 1	Level 2	Level 3
10. Radiographic Inspection	MSFC-STD-355C	X		
11. 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	
12. Final Electrical Inspections **8/, 15/**	Table 2A	X	X	X
13. Percent Defective Allowable (PDA) **15/**	Level 1 – 5% Level 2 – 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/ For level 1 applications, screening in accordance with GSFC S-311-P-754 is acceptable in lieu of the screening specified in this table. For levels 2 and 3, screening in accordance with MIL-PRF-39016, MIL-PRF-6106, MIL-PRF-83536, or GSFC S-311-P-754, as applicable, is acceptable in lieu of the screening specified in this table, except PIND testing is also required for level 2 applications.

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

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

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

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-PRF-39016 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review.

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

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

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

9/ All relays shall be vibrated in the direction of contact motion. In addition, if qualification testing is required after screening, a 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-PRF-39016 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review.

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

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

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Level 1	Level 2	Level 3
DC Coil Resistance	MIL-STD-202, Method 303	X	X	X
Static Contact Resistance	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	X	X	X
or		or	or	or
Contact Voltage Drop **3/**	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 10 actuations (use average value) Contact voltage drop to specification	X	X	X
Pickup, Hold, and Dropout 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	X	X	X
or		or	or	or
Latch/Reset Voltages **4/**	Latching Relays Gradually step or ramp latch coil voltage until the relay contacts switch Latch voltage to specification Remove latching voltage Gradually step or ramp reset coil voltage until the relay contacts switch Reset voltage to specification	X	X	X

Notes at the end of table.

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

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

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Level		
		1	2	3
Neutral Screen **12/, 13/**	Rated coil voltage to both coils simultaneously for a period of 10 milliseconds minimum. Repeat three times. Neutral screen to specification. In the event of failure, apply a 10±1 ms pulse at maximum allowable latch voltage (at 25°C). Latch to specification. Apply 10±1 ms pulse at maximum allowable reset voltage (at 25 °C). Reset to specification.	X	X	
Non-Make-Before-Break **3/**	Rated pickup, latch or reset voltage. Contact load: 10 mA maximum at 6 V maximum (DC or AC peak). Energize and deenergize 10 consecutive cycles. Non-make-before-break to specification.	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 specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe. Unless otherwise specified, 100% of the resistors shall be submitted to the tests and inspections in this table in the order shown.

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

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

5/ Release time is not applicable to latching relays.

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

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

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

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

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

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

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

12/ Applicable only to latching relays.

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

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

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 1 Screening to Table 2	Samples shall be selected from parts that have passed the screening requirements in Table 2.	100%	100%	100%
Group 2		9(0)	6(0)	3(0)
Thermal Shock **4/, 5/, 6/, 7/**	MIL-STD-202, Method 107			
	Level 1 – 25 cycles	X		
	Level 2 – 10 cycles		X	
	Level 3 - 5 cyles			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 **7/, 8/**	MIL-STD-202, Method 213 Specified number and direction of applied shocks Specified test condition (Gs, pulse time, waveform) Specified electrical load conditions Specified contact load Contact monitoring to specification	X	X	
Vibration, Random **7/, 8/, 9/, 10/**	MIL-STD-202, Method 214 Specified test condition (power spectral density, overall RMS G, duration) Specified electrical load conditions Specified contact load Contact monitoring to specification Contact transfer to specification	X		

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 2 (continued)				
PIND **11/**	Manufacturer's approved procedure			
Acceleration **7/, 12/, 13/**	MIL-STD-202, Method 212 Specified G's Acceleration to specification	X	X	
Terminal Strength **7/**	MIL-STD-202, Method 211 Conditions A and C Applied force to specification	X	X	
Electrical Inspections **6/**	Table 2A	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) **4/, 5/, 7/**	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	X	X	Not Required
Electrical Inspections **6/**	Table 2A	X	X	
Hermetic Seal	Same as Group 2	X	X	

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 3/	Quantity (Accept Number) Level 1	Level 2	Level 3
Group 4		4(0)	4(0)	
Life **14/, 15/**	Maximum rated operating temperature Specified rated contact load (current and voltage) Specified cycling rate			Not Required
	Level 1 – 25,000 cycles	X		
	Level 2 – 10,000 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 **7/**	Same as Group 2	X		
Electrical Inspection **6**/	Table 2A	X		
Hermetic Seal	Same as Group 2	X		
Group 5		3(0)	3(0)	Not Required
Solderability (when applicable)	MIL-STD-202, Method 208	X	X	
Resistance to Solvents **7/**	MIL-STD-202, Method 215	X	X	
Group 6				
Thermal Outgassing **16/**	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	X	X	X

Notes at the end of table.

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

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

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

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

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

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

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

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

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

11/ It is the responsibility of the user to approve manufacturer procedures for particle impact noise detection (PIND). Appendix B to MIL-PRF-39016 may be used as a guideline. These procedures must be documented, on file at the user's facility, and available for NASA review. The NASA/GSFC Code 562 QPLD Administrator 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 100 ma or 5% of the rated DC resistive contact load current.

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

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

Table 4 RELAY DERATING REQUIREMENTS (Note 1)

<table>
<tr><th colspan="2">Style</th><th colspan="2">Make, Break, and/or Carry Load Currents</th><th colspan="2">Transient Current Surges (Note 3)</th></tr>
<tr><td colspan="2">All</td><td colspan="2">Select the appropriate factors for T, R, and L from the subtables:
$I_{derated} = I_{rated}$ x T x R x L
(Note 2)</td><td colspan="2">For $t \leq 10\mu s$,
$I_{max} \leq 4 \times I_{rated}$
For $t > 10\ \mu s$,
$(I_{max})^2 \times t \leq 16 \times (I_{rated})^2 \times 10^{-5}$ (A^2s)</td></tr>
<tr><th colspan="2">Subtable L</th><th colspan="2">Subtable R</th><th colspan="2">Subtable T</th></tr>
<tr><th>Load Application</th><th>Factor</th><th>Cycle Rate Per Hour</th><th>Factor</th><th>Temperature Range</th><th>Factor</th></tr>
<tr><td>Make, break, and/or carry loads with an on-time duration of 0 to 500 ms. Off-time is equal to or greater than on-time.</td><td>1</td><td>>10</td><td>0.85</td><td>+85 °C to +125 °C</td><td>0.7</td></tr>
<tr><td>Carry-only loads. Relay does not make or break the load. Maximum on-time is 5 minutes. Off-time is equal to or greater than on-time.</td><td>1.5</td><td>1 to 10</td><td>0.9</td><td>+40 °C to +84 °C</td><td>0.85</td></tr>
<tr><td>All other load conditions.</td><td>0.8</td><td><1</td><td>0.85</td><td>-20 °C to +39 °C</td><td>0.9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>-65 °C to –21 °C</td><td>0.85</td></tr>
</table>

Notes:

1/ Warning: *Do not* derate coil voltage or current. Operating a relay at less than nominal coil rating can result in either switching failures or increased switching times. The latter condition induces contact damage because of the longer arcing time, thus reducing relay reliability.

2/ $I_{derated}$ = derated contact current carrying capacity
I_{rated} = rated contact current

3/ If during switching, transient current surges exceed the *derated* contact current, the following applies, where:

t = period of time that transient current exceeds rated contact current (I_{rated})

I_{max} = maximum permitted surge current

I_{rated} = rated contact current

SECTION R2: RESISTORS

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

Procurement Specification	Resistor Style and Type		MIL/NASA Reference Specification	Failure Rate Level Required 2/		
				Level 1	Level 2	Level 3
Composition						
MIL Specification	RCR	Fixed, Established Reliability	MIL-R-39008 **3/** (cancelled)	S	R, P	M
SCD				**4/**	**4/**	**4/**
Commercial					**4/**	**4/**
Film/Foil						
MIL Specification	RFP	Fixed, Precision, Established Reliability	MIL-PRF-122 **5/** (cancelled)		B, F, J, N, R, V	A, E, I, M, Q, U
	RLR	Fixed, General Purpose, Established Reliability	MIL-PRF-39017	S	R, P	M
	RNX	Fixed, High Stability, Established Reliability	MIL-PRF-55182	T, S	R, P	M
	RM	Fixed, Chip, Established Reliability	MIL-PRF-55342	T, S	R, P	M
	RZ	Fixed, Network	MIL-PRF-83401	**6/**	**6/**	**6/**
NASA Specification	MOX	Fixed, High Voltage	S-311-P-683	**7/**	**7/**	**7/**
	HG	Fixed, High Voltage, Precision	S-311-P-672	**7/**	**7/**	**7/**
	TG	Fixed, High Voltage, Precision, Low TC	S-311-P-741	**8/**	**8/**	**8/**
	TK	Fixed, Precision, Low TC, Radial-Lead	S-311-P-742	**7/**	**7/**	**7/**
	TK	Fixed, Low TC, Precision, High Stability	S-311-P-794	**8/**	**8/**	**8/**
	VPR	Fixed, Foil, Precision, Power, Current Sensing	S-311-P-795	**8/**	**8/**	**8/**
	TK	Fixed, “Matched-Pair”, Low TC, Precision	S-311-P-796	**8/**	**8/**	**8/**
	P813	Fixed, Low TC, Precision, Radial Lead	S-311-P-813	**7/**	**7/**	**7/**
SCD				**4/**	**4/**	**4/**
Commercial					**4/**	**4/**

Notes at the end of table.

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

Procurement Specification	Resistor Style and Type		MIL Reference Specification	Failure Rate Level Required 2/		
				Level 1	Level 2	Level 3
Wirewound						
MIL Specification	RBR	Fixed, Accurate, Established Reliability	MIL-PRF-39005	R	R, P	M
	RWR	Fixed, Power, Established Reliability	MIL-PRF-39007	T, S	R, P	M
	RER	Fixed, Power, Established Reliability	MIL-PRF-39009	R	R, P	M
SCD				**4/**	**4/**	**4/**
Commercial					**4/**	**4/**

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

3/ Cancelled without replacement on 18 Sept. 1998. However, these carbon composition resistors never lose their qualification status, and residual stock continues to be highly desirable for use in NASA electronic circuits. Out of tolerance parts may require a bakeout prior to use (ref note 8/ in Table 2A).

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

5/ Cancelled on 7 June 2000 with the following recommended possible substitutes: DSCC drawings 97009, 97010, and 97011. Also consider S-311-P-813 for alternate parts.

6/ Rescreening of these resistor networks is recommended in the form of a lot sample Destructive Physical Analysis (DPA) prior to use in space flight applications. Particular attention should be paid to the integrity of the termination attachment to the resistive element (i.e., cracked solder joints, misaligned connections, etc.).

7/ Resistors may be used as is.

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

Table 1B VARIABLE RESISTOR REQUIREMENTS 1/

Procurement Specification	Resistor Style and Type	MIL/NASA Reference Specification	Failure Rate Level Required 2/		
			Level 1	Level 2	Level 3
Film/Foil					
NASA Specification	1285G Potentiometer, Precision Trimming	S-311-P-798	**3/**	**3/**	**3/**
MIL Specification	RJR Variable, Lead Screw, Established Reliability	MIL-PRF-39035	R	R, P	M
SCD			**4/**	**4/**	**4/**
Commercial				**4/**	**4/**
Wirewound					
MIL Specification	RTR Variable, Lead Screw Established Reliability	MIL-PRF-39015	R	R, P	M
SCD			**4/**	**4/**	**4/**
Commercial				**4/**	**4/**

Notes:

1/ Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.

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

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

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

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

Inspection/Test	Test Methods, Conditions, and Requirements **1/**	Part Type/Level								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
1. Precap Visual Inspection **2/, 3/**	Networks: Particles, metallization (scratches, voids, adherence, bridging, alignment, corrosion, probe marks), laser trim faults, bonding pad defects, oxide defects Chip: Materials, design, construction and workmanship - sample size (accept number) Others: Not applicable				X 13 (0)	X 13 (0)	X 13 (0)			
2. Visual Inspections **4/**	Materials, design, construction, marking, and workmanship	X	X	X	X	X	X	X	X	X
3. Mechanical Inspections **5/**	Critical physical dimensions	X	X		X	X		X	X	
4. Initial DC Resistance **6/, 7/, 8/**	MIL-STD-202, Method 303	X	X	X	X	X	X	X	X	X
5. Thermal Shock **9/, 10/**	MIL-STD-202, Method 107 Level 1 - 25 cycles Level 2 - 10 cycles High temperature - max. rated operating Low temperature - min. rated operating				X	X				
6. Conditioning or Overload **9/, 10/, 11/** or High Temperature Exposure **12/**	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 or 100 hours @ max. rated operating temperature				X	X	**/16**	X	X	**/16**

Notes at the end of table.

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

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

Notes:

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

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

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

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

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

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.

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

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

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

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

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

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

13/ Applicable only to hermetically sealed networks and resistors.

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

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

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

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

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

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 1/	Part Type/Level					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Immersion	Gross leak: MIL-STD-202, 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 **9/**	Number of turns or angular degrees to specification	X			X		
Absolute Minimum Resistance **10/**	Resistance to specification				X	X	
End Resistance **11/**	Resistance to specification	X	X		X	X	
DWV **3/**	MIL-STD-202, Method 301 Specified test voltage Between terminals tied together and all external metal portions Leakage current to specification	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 **12/, 13/ 14/**	Operating torque to specification Clutch to specification (when applicable) Stop strength to specification (when applicable)	X	X		X	X	
Radiographic Inspection **15/**	MIL-STD-202, Method 209	X			X		

Notes at the end of table.

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

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

Notes:

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

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

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

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

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

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

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

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

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

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

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 1										
Screening to Table 2 **3/**	Table 2	100%	100%	100%	100%	100%	100%	100%	100%	100%
Group 2		3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)	3(0)
Solderability **4/**	MIL-STD-202, Method 208	X	X	X	X	X	X	X	X	X
Resistance to Solvents **5/, 6/**	MIL-STD-202, Method 215				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 **5/**	MIL-STD-202, Method 107									
	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 **5/**	MIL-STD-202, Method 304 Specified test temperature sequence Specified reference temperature PPM to specification	X	X		X	X		X	X	
Low Temperature Storage **5/**	-65°C no load dwell for 24±4 hours +25°C ambient no load dwell for 2-8 hours ΔR to specification	X			X			X		
Low Temperature Operation **5/**	-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	X			X			X		

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 3 (continued)										
Short-time Overload **5/**	Specified voltage (wattage) multiple Specified temperature Specified time ΔR to specification	X	X		X	X		X	X	X
Terminal Strength **5/, 6/**	MIL-STD-202, Method 211 Conditions A and C Applied force to specification ΔR to specification	X	X	X	X	X	X	X	X	X
Hermetic Seal **8/**	Fine leak: MIL-STD-202, Method 112 Test Condition C 5.0×10^{-7} cc/sec.(networks) 1.0×10^{-8} cc/sec.(others)				X	X	X			
	Gross Leak: MIL-STD-883, Method 1014 Condition D				X	X	X			
Group 4 7/		9(0)	6(0)	3(0)	9(0)	6(0)	3(0)	9(0)	6(0)	3(0)
Dielectric Withstanding Voltage **5/, 6/, 12/**	MIL-STD-202, Method 301 Between leads and conductive material surrounding body Specified test voltage ΔR to specification	X	X	X	X	X	X	X	X	X
Insulation Resistance **6/, 12/**	MIL-STD-202, Method 302 Between leads and conductive material surrounding body Resistance (minimum) to specification	X	X	X	X	X	X	X	X	X

Notes at the end of table.

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)								
		Composition			Film/Foil			Wirewound		
		1	2	3	1	2	3	1	2	3
Group 9 High Temperature Exposure **5/**	Specified Temperature Specified no load dwell time ΔR to specification DWV to specification IR to specification				5(0) X	5(0) X		5(0) X	5(0) X	
Group 10 Thermal Outgassing **11/**	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	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 specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

3/ These minimum samples sizes are required for qualification:

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

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

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

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

6/ Not applicable to chip resistors.

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

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.

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

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

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

Notes at the end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements 2/	Quantity (Accept Number)					
		Non-Wirewound			Wirewound		
		1	2	3	1	2	3
Group 6 (continued)							
Terminal Strength **7/, 18/**	MIL-STD-202, Method 112 Condition A Specified force Continuity check Condition A (except reverse force to apply a push force) Continuity check	X	X	X	X	X	X
Group 7		12(0)	9(0)		12(0)	9(0)	
Life **7/, 11/**	MIL-STD-202, Method 108 Specified test temperature Specified operating conditions Δ total resistance to specification						
	Level 1 - 2000 hours	X			X		
	Level 2 - 1000 hours		X			X	
Group 8							
Thermal Outgassing **19/**	ASTM E595 TML = 1.0% maximum CVCM = 0.10% maximum	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 specify detailed test conditions and pass/fail criteria for each test. These values shall be based on the nearest equivalent military specifications, manufacturer's specification, or the application, whichever is most severe.

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

3/ These minimum sample sizes are required for qualification:

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

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

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

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

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

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

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

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

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

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.

Table 4 RESISTOR DERATING REQUIREMENTS

Style	Description	Derating Factors (Note 1) Power	Derating Factors (Note 2) Voltage	Derating Temperatures (°C) T1	Derating Temperatures (°C) T2	Zero Power Temp. (°C) T3
G311P672	Fixed, High Voltage	0.6	0.8	70	94	110
G311P683	Fixed, Precision, High Voltage	0.6	0.8	125	185	225
G311P742	Fixed, Low TC, Precision	0.6	0.8	125	155	175
RBR	Fixed, Wirewound (Accurate), ER					
1%		0.6	0.8	125	137	145
0.5%		0.35	0.8	125	132	145
0.1%		0.25	0.8	125	130	145
RWR	Fixed, Wirewound (Power Type), ER	0.6	0.8	25	160	250
RCR	Fixed, Composition (Insulated), ER	0.6	0.8	70	**(Note 3)**	**(Note 3)**
RER	Fixed, Wirewound (Power Type), Chassis Mounted, ER	0.6	0.8	25	160	250
RTR	Variable, Wirewound (Lead Screw Actuated), ER	0.6	0.8	85	124	150
RLR	Fixed, Film (Insulated), ER					
100ppm		0.6	0.8	70	118	150
350ppm		0.6	0.8	70	103	125
RNX	Fixed, Film, ER	0.6	0.8	125	155	175
RM	Fixed, Film, Chip, ER	0.6	0.8	70	118	150
RZ	Fixed, Film, Networks	0.6	0.8	70	103	125
Others	Various	0.5	0.8	**(Note 4)**	**(Note 4)**	**(Note 4)**

Notes:

1/ Compute the resistor's derated power level by multiplying its nominal power rating by the appropriate derating factor for ambient temperatures ≤ T1. If the resistor is operated above T1, derate linearly from the T1 power level to the zero power level at T2. Exposing the resistor to temperatures exceeding T3, even under no load conditions, may result in permanent degradation.

2/ The maximum applied voltage shall not exceed the lesser of the following: (1) 80% of the specified maximum voltage rating, or (2) $\sqrt{PR}$

where

P = Derated power (Watts)

R = Resistance of that portion of the element actually active in the circuit.

This voltage derating applies to dc and regular ac waveform applications. For pulse and other irregular waveform applications, consult the manufacturer.

3/ Determine the zero power temperature (T3) from the applicable detail specification. Compute the derated zero power temperature (T2) from the following formula:

$$T2 = D_F(T3-T1) + T1$$

where:

T2 = Derated zero power temperature

D_F = Derating factor

T3 = Zero power temperature

T1 = Rated power temperature

4/ Determine the rated power, the rated power temperature (T1), and the zero power temperature (T3) from the manufacturer's specification. Calculate the derated zero power temperature (T2) as per the previous note.

SECTION S1: SEMICONDUCTOR DEVICES, DISCRETE

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Table 1 DISCRETE SEMICONDUCTOR REQUIREMENTS 1/

Procurement Specification	Use As Is	Screen to Requirements in Tables 2 or 2B 2/	Qualify to Requirements in Tables 3 or 3A 2/
Level 1:			
1) JANS	X		
2) JANTXV, JANTX **3/, 4/**		X	
3) JANJ, SCD		X	X **5/**
Level 2:			
1) JANS	X		
2) JANTXV, JANTX **4/**		**6/**	
3) JANJ, SCD, Mfg. HI-REL **7/**		X **8/**	X **5/**
4) Commercial		X	X
Level 3:			
1) JANS	X		
2) JANTXV, JANTX		**6/**	
3) JANJ		**6/**	
4) SCD, Mfg. Hi-Rel, Commercial		**X 8/, 9/**	

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** JANS, JANTXV, JANTX and JANJ designations are as defined in MIL- PRF-19500 (General Specification for Semiconductor Devices). Plastic encapsulated semiconductors are not covered by this Section. Refer to section M4 for tests required on PEMs.

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

3/ JANTXV/JANTX parts are acceptable as level 1 parts only when JANS parts are not available. Otherwise, JANS parts shall be used.

4/ JANTX parts may be used only if JANTXV parts are not available. For JANTX parts, a five-piece DPA shall be performed per the requirements of S-311-M-70 in lieu of the internal visual. Thermal impedance testing of the complete lot may be substituted in place of the DPA.

5/ QCI attributes data within 12 months of lot date code of flight parts may be acquired and reviewed for acceptability in lieu of performing the required testing if the data satisfies the requirements of Tables 3 or 3A.

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

7/ Manufacturer High Reliability (Mfr. Hi-Rel). This designation includes pats that are available only to a manufacturer's controlled reliability test program as described in the manufacturer's catalog. These test programs vary from manufacturer to manufacturer and are not monitored by DSCC.

8/ 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 Tables 2 or 2B.

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

Table 2 DIODE SCREENING REQUIREMENTS (Page 1 of 2)

Inspection/Test	MIL-STD-750 Methods	MIL-STD-750 Conditions	Level 1 JANTXV, JANTX	Level 1 JANJ, SCD	Level 2 JANJ, SCD, Mfg. HI-REL	Level 2 Commercial	Level 3 SCD, Mfg. HI- REL, Commercial
1. Internal Visual	2074 or 2073			X	**1/**	**1/**	**1/**
2. Temperature Cycling **2/**	1051	No dwell required at 25 °C. Use maximum storage temperature range, 20 cycles, 10 minutes min. at extremes.		X	X	X	
3. Surge Current **3/**	4066	Condition B 10 surges, one per minute, 7 msec minimum.		X	X	X	
4. Constant Acceleration	2006	20,000 Gs Y_1 direction except 10,000 Gs for power rating > 10 Watts @ +25 °C.		X			
5. PIND **4/**	2052	Condition A.	X	X	X	X	X
6. FIST **5/**	2081	Axial lead diodes only.		X			
7. BIST **5/**	2082	Axial lead diodes only.		X			
8. Serialization			X	X			
9. Initial Electrical Measurements		Per Table 2A herein. @ 25 °C	X Read/Record **6/**	X Read/Record **6/**	X	X	X **7/**
10. Burn-in **7/**	1038	Per Table 2A herein. Condition A and B Duration (hours). HTRB. Power	X 48 160	X 96 240	X 48 160	X 48 160	X **9/** 0 160
11. Final Electrical Measurements		Per Table 2A herein. @ 25 °C, min . and max Operating Temp. **8/**	X Read/Record	X Read/Record	X	X	X 8/
12. Calculate Deltas		Per Table 2A herein.	X	X			
13. Calculate PDA **10/**			5%	5%	10%	10%	20%
14. Hermetic Seal a. Fine Leak b. Gross Leak	1071	 G or H C or K	X	X	X	X	
15. Radiographic	2076		X	X	X	X	
16. External Visual **11/**	2071		X	X	X	X	X

Notes at end of table.

Table 2 DIODE SCREENING REQUIREMENTS (Page 2 of 2)

Notes:

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

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

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

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

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

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

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

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

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

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

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

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

Diode Types	Required Burn-In: HTRB (Condition A)	Required Burn-In: Power (Condition B)	Delta Parameters	Electrical Measurements (Notes 1, 2, and 3)
Rectifier (Power, Fast Recovery, High Voltage)	80% rated V_{RM} **(Note 4)** $125°C<T_A<150°C$	60 Hz Sinewave Rated V_{RWM} and I_O $T_A = 25$ °C	ΔV_F ΔI_R	V_F, I_R, V_R, V_{BR}, I_{FSM} t_{rr}, C_j.
Switching (General Purpose, Schottky, RF, PIN)	80% rated V_{RM} $125°C<T_A<150°C$	60 Hz Sinewave Rated V_{RWM} and I_O $T_A = 25$ °C	ΔV_F ΔI_R	V_F, V_R, V_{BR}, I_R, t_{rr}, τ, C_j, P_o/P_i
Zener (Voltage Reference)	Not applicable	Specify I_Z to meet rated P_d $T_A = 125$ °C	ΔV_Z	V_F, Vz, Iz Z_Z, αV_z
Current Regulator Diode	Not required	Rated V_{POV} $T_A = 25$ °C	ΔI_s	V_L, Z_S, Z_K, V_s, I_s, αI_s.
Transient Suppressor Diode	80% rated V_{RWM} $125°C<T_A<150°C$	Specify I_p, T_p, number of pulses $T_A = 25$ °C (Note 5)	ΔV_{BR} ΔI_R	V_{BR}, V_{CM}, I_{SM}, I_R.
Light Emitting Diode	Not applicable	Rated I_F $T_A = 25$ °C	ΔV_F ΔI_V	I_V, I_R, V_F C_T
Tunnel Diode (Microwave)	Rated V_R $125°C<T_A<150°C$	Specify I_F & V_F to meet max. P_d $T_A = 25$ °C	ΔV_P ΔV_R	I_P, I_V, V_R, V_F, V_V C_T
Varactor (Tuning)	80% rated V_{RM} $125°C<T_A<150°C$	Not required	ΔI_R ΔC_T	I_R, V_{BR} C_C, C_T, Q, C_{t1}, L_S, C_{tz}
Thyristor (SCRs)	80% rated V_{RM} 80% rated V_{DM} $125°C<T_A<150°C$	Rated V_{DWM} & V_{RWM}. Specify V_{GT} & V_{GQ}. (Note 6) $T_A = 25$ °C	ΔI_{DM} ΔI_{RM}	I_{DM}, I_{GM}, I_{GT}, I_L, I_{RM}, V_{BR}, V_{GT}, dV/dt, t_{on}, t_{off}

Notes:

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

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

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

4/ Case mounted rectifiers with I_O rated > 10 A @Tc= 100°C do not require HTRB.

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

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

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

Inspection/Test	MIL-STD-750		Level 1		Level 2		Level 3
	Methods	**Conditions**	**JANTXV/ JANTX**	**JANJ, SCD**	**JANJ, SCD, Mfg. HI-REL**	**Commercial**	**SCD, Mfg. HI-REL, Commercial**
1. Internal Visual	2072	For power FETs, use Method 2069; for RF types, use Method 2070.	**1/**	**1/**	**1/**	**1/**	**1/**
2. Temperature Cycling	1051	No dwell required at 25 °C. Use maximum storage temperature range, 20 cycles. Extremes > 10 min.		X	X	X	
3. Constant Acceleration	2006	20,000 Gs Y_1 direction except 10,000 Gs for power rating > 10 Watts +25 °C.		X			
4. PIND	2052	Condition A.	X	X	X	X	X
5. Serialization			X	X			
6. Initial Electrical Measurements		Per Table 2C herein. @ 25 °C,	X Read/Record **2/**	X Read/Record **2/**	X	X	X
7. Burn-in **3/, 4/**	1039	Per Table 2C herein. Condition A or B. Duration (hours). HTRB Power	X 48 160	X 96 240	X 48 160	X 48 160	X 160
8. Final Electrical Measurements		Per Table 2C herein. @ 25 °C, min . and max Operating Temp**. 5/**	X Read/Record	X Read/Record	X	X	X **4/**
9. Calculate Deltas **6/**		Per Table 2C herein.	X	X			
10. Calculate PDA **7/**			5%	5%	10%	10%	20%
11. Hermetic Seal a. Fine Leak b. Gross Leak	1071	 G or H C or K	X	X	X	X	
12. Radiographic	2076		X	X			
13. External Visual **8/**	2071		X	X	X	X	X

Notes on next page.

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

Notes:

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

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

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

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

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

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

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

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

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

Transistor Type	Required Burn-in: HTRB (Condition A)	Required Burn-in: Power (Condition B)	Delta Parameters	Electrical Measurements (Notes 1, 2, and 3)
Bipolar Transistors (Switching, Low High Power, Dual, General Purpose.)	80% rated V_{CBO} 125°C<T_A<150°C	Specify V_{CB} or V_{CE} to meet max P_T T_A = 25 °C	ΔI_{CBO} or ΔI_{CEO} Δh_{FE}	I_{CB}, I_{CEO}, I_{CBO}, I_{EBO}, $V_{(BR)CEO}$, $V_{(BR)CBO}$, $V_{(BR)EBO}$, $V_{(BR)CES}$, $V_{CE(SAT)}$, $V_{BE(SAT)}$, h_{FE}, t_{on}, t_{off}, t_s, t_f, h_{fe}, C_{obo}, C_{ibo}
Bipolar Transistors (RF, High-Frequency)	80% rated V_{CBO} 125°C<T_A<150°C	Specify V_{CB} to meet max P_T T_A = 25 °C	ΔI_{CEO} Δh_{FE}	I_{CEO}, $V_{(BR)CEO}$, $V_{(BR)CBO}$, $V_{(BR)EBO}$ $V_{CE(SAT)}$, h_{FE} G_{PE}, NF, h_{fe}, η, C_{obo}
Junction Field Effect (JFET)	80% rated V_{GS} V_{DS} = 0 125°C<T_A<150°C	80% rated V_{GS} Specify V_{DS} to meet max P_T T_A = 25 °C	ΔI_{DSS} or ΔI_{GSS} Δy_{fs}	$V_{DS(ON)}$, $V_{GS(OFF)}$, $V_{(BR)GSS}$, I_{GSS}, I_{DSS}, C_{iss}, C_{rss}, y_{fs}, y_{os}.
MOSFET	80% rated V_{DS} V_{GS}= 0V T_A= 125 °C	80% of rated V_{GS} V_{DS}= 0V T_A= 125 °C	ΔI_{DSS} or ΔI_{GSS} $\Delta V_{GS(TH)}$ $\Delta r_{ds\ (on)}$	$V_{(BR)DSS}$, $V_{GS(TH)}$, $V_{DS(ON)}$, V_{SD}, $r_{ds(on)}$, t_{on}, t_{off}, t_{rr}, C_T.
Darlington	80% rated V_{CBO} 125°C<T_A<150°C	Specify V_{CB} or V_{CE} to meet max P_T T_A = 25 °C	Δh_{FE} ΔI_{CE}	$V_{CE(SAT)}$), $V_{BE(SAT)}$, $V_{BE(TH)}$, $V_{(BR)CEO}$, I_{CEO}, I_{EBO}, I_{CE} h_{FE}, t_{on}, t_{off}, C_{obo}.
Optocoupler	I_F = 0 80% Rated V_{CBO} T_A = 125 °C	I_F = rated max Specify V_{CE} to meet max P_T T_A = 25 °C	Δh_{FE} $\Delta I_{C(OFF)}$ $\Delta I_{C(ON)}$	$V_{CE(SAT)}$, $V_{(BR)CEO}$, V_F $I_{C(OFF)}$, $I_{C(ON)}$, I_R, h_{FE}, t_r, t_f, C_{obo}.

Notes:

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

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

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

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

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

Notes at end of table.

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

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

Notes:

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

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

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

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

Notes at end of table.

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

Inspection/Test	MIL-STD-750 Methods	MIL-STD-750 Conditions	Quantity (Accept number) or LTPD: Level 1 JANJ, SCD	Level 2 JANJ, SCD, Mfg. HI-REL	Level 2 Commercial	Level 3 SCD, Mfg. HI-REL, Commercial
Subgroup 4			12 (0)	Not Required	Not Required	Not Required
Accelerated Steady State Life Test	1027	For eutectic die attached device, T_J = +275 °C for 96 hours minimum.	X			
		For soft solder die attached device, T_J = +225 °C for 168 hours minimum.	X			
	1042	For Power MOSFETs, **3/** 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.	X			
Electrical Measurement		As specified in Table 2C herein.	X			
Subgroup 5			22 (0)	12 (0)	22 (0)	Not Required
Steady State Life Test	1026	T_J = Max Operating T_J 1,000 hours min.	X	X	X	
Electrical Measurement		As specified in Table 2C herein.	X	X	X	

Notes:

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

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

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

Table 4 DIODE DERATING REQUIREMENTS

Derating for diodes is accomplished by multiplying the stress parameter by the appropriate derating factor.

Diode Type	Stress Parameter	Derating Factor
General Purpose, Rectifier, Switching, Pin/Schottky, and Thyristors	PIV	0.70
	Surge Current	0.50
	Forward Current	0.50
	Maximum Junction Temperature **1/**	0.80
Varactor	Power	0.50
	Reverse Voltage	0.75
	Forward Current	0.75
	Maximum Junction Temperature **1/**	0.80
Voltage Regulator	Power	0.50
	Zener Current	0.75
	Maximum Junction Temperature **1/**	0.80
Voltage Reference	Zener Current	N/A
	Maximum Junction Temperature **1/**	0.80
Zener Voltage Suppressor	Power Dissipation	0.50
	Maximum Junction Temperature **1/**	0.80
Bidirectional Voltage Suppressor	Power Dissipation	0.50
	Maximum Junction Temperature	0.80
FET Current Regulator	Peak Operating Voltage	0.80
	Maximum Junction Temperature **1/**	0.80

Notes:

1/ Do not exceed T_j = 125 °C or 40 °C below the manufacturer's maximum rating, whichever is lower.

Table 4 TRANSISTOR DERATING REQUIREMENTS

Derating for transistors is accomplished by multiplying the stress parameter by the appropriate derating factor.

Type	Stress Parameter	Derating Factor
All **(Note 2)**	Power	0.60
	Current	0.75
	Voltage **(Note 1)**	0.75
	Junction Temperature **2/**	0.80
Power MOSFETs	Gate to Source Voltage	0.60
	Source to Drain Voltage	0.75
	Junction Temperature **2/**	0.80

Notes:

1/ Worst-case combination of DC, AC, and transient voltage should be no greater than the derated limit.

2/ Do not exceed T_j = 125 °C or 40 °C below the manufacturer's maximum rating, whichever is lower or less.

3/ Power MOSFET devices under certain conditions are very susceptible to catastrophic failure mechanisms, such as Single Event Burn-out (SEB) and Single Event Gate Rupture (SEGR), resulting from heavy ion impact. Consult the project radiation engineer for further information and applicable derating criteria.

SECTION S2: SWITCHES

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GENERAL

Refer to paragraph, 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types. The following additional information is unique to switches.

SWITCH TYPE DESCRIPTIONS

There are three basic switch types that are used in space environments:

Sensitive and Push Switches: Sensitive switches are operated by mechanical movement of an actuator. When a fixed distance has been traveled by an operating plunger (actuator), the switch toggles. Switching speed is independent of actuator movement, in that the actuator can move slowly and gradually until a preset position is reached, where the switch rapidly snaps open or closed, depending on the type. Sensitive switches are generally used to sense position or movement (Ex: Instrument cover position). Rapid switch action is desirable to quickly stop movement (Ex: If cover is fully open; shut off drive motor). Rapid switch action is also desirable to reduce the potential effects of arcing across the switch contacts.

Thermostatic Switches: Switches are operated by deflection of a bi-metallic snap acting actuator caused by temperature change and they are used to open or close a circuit at specified temperatures for thermal control and/or thermal protection. (Ex: Thermostatic switches are used to control thermofoil heaters in areas of the spacecraft that must be protected from severe cold.)

Pressure Switches: These switch types are actuated by changes in pressure, where the actuator movement is controlled by applied pressure. Pressure switches are used to sense changes in pressurized containers.

SELECTION FACTORS

Current rating, voltage rating, and type of load need to be considered in selecting switches for space applications. For thermostatic switches, ambient temperature is also a consideration.

Load Current and Voltage: Switches are provided with various current and voltage ratings. Switch rating is generally given for maximum DC voltage with a resistive load at a specific maximum current within a defined temperature range. Switches used with capacitive, inductive, motor, and lamp loads are susceptible to surge currents that can be many times the actual current rating. Resistive loads are subject to arcing at voltages greater than 12 VDC. Excessive heating of switch contacts by arcing can result in contact material transfer, which degrades switch life. The worst-case failure mode is for the contacts to weld closed. Additional derating is required to add longevity to switch contact life.

Derating: Derating is applied to switches to reduce stress below the manufacturer’s rating, thereby decreasing potential degradation in the application and increasing contact life. The de-rating percentages shown in Table 4 are intended to assist in achieving reliable switching throughout the mission life. Example: A snap acting thermal switch operating 28VDC at 1 ampere will work almost indefinitely (more than 1 million cycles) while a switch operating 28VDC at 5 amperes may be near end of life at 100,000 cycles.

Table 1 SWITCH REQUIREMENTS 1/, 4/

Procurement Specification	Level 1		Level 2		Level 3	
	NASA /Mil	Com'l/ SCD	NASA /Mil	Com'l/ SCD	NASA /Mil	Com'l/ SCD 5/
Sensitive and Push Switches (Position Sensing)						
MIL-PRF-8805	**2/**		**2/**		X	
SCD		**2/, 3/**		**2/, 3/**		**2/**
Commercial		**2/, 3/**		**2/, 3/**		**2/**
Thermostatic Switches (Temperature Detecting)						
NASA GSFC S-311-641	X		X		X	
MIL-PRF-24236	**2/**		**2/**		**2/**	
SCD		**2/, 3/**		**2/, 3/**		**2/**
Commercial		**2/, 3/**		**2/, 3/**		**2/**
Pressure Switches (Pressure Sensing)						
MIL-DTL-9395	**2/**		**2/**		**2/**	X
SCD		**2/, 3/**		**2/, 3/**		**2/**
Commercial		**2/, 3/**		**2/, 3/**		**2/**

Notes:

1/ General.

1.1 The character “X” indicates “use as is”

1.2/ The test methods, conditions and requirements documented in the screening and qualification tables are intended to summarize commonly used military test methods and procedures that can be performed by users in user designated test labs or by the manufacturer. Complete test details are contained in the referenced test method.

1.3/ When the manufacturer has a more thorough test procedure than the method contained in this document, it is not the intent of this document to impose a procedure of lesser quality, but rather to impose a test when no test is normally performed or no test exists. If a manufacturer uses a more thorough test method as part of their normal production practice, upon project approval, that test method may continue to be used in lieu of the test contained in this document. The user must provide to the project a brief rationale of its expected comparable effectiveness.

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

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

4/ When switches are used in one-time applications on projects that require the highest assurance level parts (Level 1), with project approval, it may be possible to use a lower assurance level part (Ex: Applications such as a sensitive switch used in a one time sensing of solar array deployment.) Conversely, when a project with a lower assurance level (Level 3) requires switches to perform a critical function, switches made to a higher assurance level should be considered (Ex: A sensitive switch used to detect instrument sensor door position, required each time the door is opened and closed, use Level 2-3).

5/ It is not a requirement for users to prepare a procurement specification for Level 3 programs. However, if an existing procurement specification exists that is proposed for use, the SCD as a minimum must meet Level 3 requirements in Table 2.

Table 2A SCREENING REQUIREMENTS FOR SENSITIVE AND PUSH SWITCHES (POSITION SENSING, PLUNGER SNAP ACTION TYPE) (REF MIL-PRF-8805) (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Internal Visual Inspection **1/**	Inspect workmanship at 10X magnification, minimum. Switches shall be free from cracked or displaced parts, burrs or other defects that would affect performance. No films or corrosion allowed that would interfere with performance.	**1/, 2/**	100%	**2/, 3/**	100%	**5/**	**5/**
Pre-closure Cleaning and Micro-Particle Inspection **1/, 3/, 4/**	Manufacturer's approved procedure. No particles greater than 0.001 inches (or as otherwise specified) shall be permitted.	**1/, 2/**	100%	**2/, 3/**	100%	**5/**	**5/**
Vibration (Random)	MIL-STD-202, Method 214. Test condition I, test condition letter F minimum (0.3 power spectral density) shall be used. Duration of test shall be 90 minutes in each of 3 perpendicular axes. All open and closed circuits shall be monitored per MIL-STD-202, Method 310 or equivalent. There shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds. Vibration shall not result in any broken, loose, deformed or displaced parts.	100%	100%	100%	100%		
PIND	MIL-STD-202 Method 217, modified for switches to account for movable elements.	100%	100%	100%	100%	100%	100%
External Visual	Inspect workmanship for defects using 3X Magnification: Case (Dents, burrs, marking) Finish (Corrosion, peeled or blistered plating, discoloration, exposed base metal) Terminations (Cracks, corrosion)	100%	100%	100%	100%	10% (0) Min of 3 (0)	10% (0) Min of 3 (0)
Mechanical	Verify dimensions correspond to Detail Specification	2 (0)	2 (0)	2 (0)	2 (0)	1 (0)	1 (0)
Seal (Hermetic switches only)	MIL-STD-202, Method 112, test condition C (tracer gas). Leak rate shall not exceed 1 X 10^{-8} ATM CM^3/SEC.		100%		100%		100%

Notes at end of table.

Table 2A SCREENING REQUIREMENTS FOR SENSITIVE AND PUSH SWITCHES (POSITION SENSING, PLUNGER SNAP ACTION TYPE) (REF MIL-PRF-8805) (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Run-in Conditioning	Perform 500 cycles at 10 cycles per minute (or as otherwise specified) and 25°C. Monitor all make and break contacts at 6VDC & 100 mA for misses.	100% 500 cycles min	100% 500 cycles min	100% 500 cycles min	100% 500 cycles min		
Contact Resistance	MIL-STD-202, Method 307. Measurements shall be made for all poles at each actuator full switch position forming a switching circuit. Apply 6VDC, 100 mA load. Perform 3 switching operations prior to measurement. Perform 3 additional switch operations with one measurement per actuation. The average of the three measurements shall be considered the actual contact resistance value. Contact resistance shall not exceed 25 milliohms.		100%		100%		2 (0)
Operating Characteristics	The switching operation of all poles shall be inspected with the use of appropriate test circuits. Switches shall demonstrate proper snap action without binding that would interfere with contact closure or release.	100%	100%	100%	100%		
Low Temperature Operation	MIL-PRF-8805, para 4.7.24. Switches shall be mounted in a fixture that depresses and releases the actuating member and then shall be placed in a temperature chamber. The chamber shall be brought to the minimum switch temperature rating as specified and shall be maintained for 24 hours. The fixture shall be removed and within 5 seconds of removal, the fixture shall be released to allow the switch-actuating member to move to its normal position. The actuating member shall not exhibit binding that would prohibit normal switch function.	100%	100%	100%	100%		

Notes at end of table.

Table 2A SCREENING REQUIREMENTS FOR SENSITIVE AND PUSH SWITCHES (POSITION SENSING, PLUNGER SNAP ACTION TYPE) (REF MIL-PRF-8805) (Page 3 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Test Method 301. Test potential shall be 1,000 VRMS, for a duration of 2-5 seconds between all terminals of mutually insulated circuits, and between all terminals and non-current-carrying metal or grounded parts. There shall be no evidence of arcing or flashover		100%		100%		2 (0)
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, test condition B (500VDC), at ambient temperature. Measure between all terminals and non-current carrying metal or ground, and between terminals of mutually insulated poles. Measurements shall be 1000 megohms min.	100%	100%	3 (0)	3 (0)		2 (0)

Notes:

1/ Switches that have not been subjected to pre-closure inspection and cleaning are not permitted in level 1 programs.

2/ In order to have pre-closure visual inspection, cleaning, and micro-particle analysis performed for military parts, users must make arrangements with the manufacturer to have these performed prior to closure. These items are not a MIL-spec requirement for switches.

3/ For level 2 programs, if cleaning and internal inspection are not performed, Radiography (Real time preferred) and a DPA on samples in accordance with the requirements GSFC S-311-M-70, are required.

4/ It is the responsibility of the user to approve manufacturer procedures for internal micro-particle analysis and cleaning prior to closure.

5/ Internal visual inspection, pre-closure cleaning, and micro-particle analysis are recommended but not required for Level 3.

Table 2B SCREENING REQUIREMENTS FOR THERMOSTATIC SWITCHES (TEMPERATURE DETECTING) (REF MIL-PRF-24236, GSFC S-311-641) (Page 1 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Internal Visual Inspection	Inspect workmanship at 10X magnification, min. Switches shall be free from cracked or displaced parts, burrs or other defects that would affect performance. No films or corrosion on bimetallic disc or contacts allowed that would interfere with performance.	**1/, 2/**	100% **1/**	**2/, 3/**	100%	**5/**	**5/**
Pre-closure Cleaning and Micro-Particle Inspection **4/**	Manufacturer's approved procedure. No particles greater than 0.001 inches (or as otherwise specified) shall be permitted.	**1/, 2/**	100% **1/**	**2/, 3/**	100%	**5/**	**5/**
Vibration (Random)	MIL-STD-202, Method 214, except use the following profile: Frequency — Spectrum 20 Hz — $0.01g^2$ / Hz 20 - 90 Hz — Increase, 9dB / octave 90 - 350 Hz — $0.9\ g^2$ / Hz 350 - 2000 Hz — Decrease, -6dB / octave Perform for 1 minute per axis per contact position cycles in each of 3 mutually perpendicular directions, 3 hours total, or as otherwise specified and accepted by the project). Switches shall be functioning throughout testing, and shall be connected to a 28Vsupply or as specified, with an appropriate current limiting load. During testing, there shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds. Repeat with temperature 5°F below the operate point.	100%	100%	100%	100%		
PIND	MIL-STD-202 Method 217, Modified for switches to account for movable elements.	100%	100%	100%	100%	100%	100%

Notes at end of table.

Table 2B SCREENING REQUIREMENTS FOR THERMOSTATIC SWITCHES (TEMPERATURE DETECTING) (REF MIL-PRF-24236, GSFC S-311-641) (Page 2 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
External Visual	Inspect workmanship for defects using 3X Magnification: Case (Dents, burrs, marking) Finish (Corrosion, peeled or blistered plating, discoloration, exposed base metal) Terminations (Cracks, corrosion)	100%	100%	100%	100%	10% (0) Min of 3 (0)	10% (0) Min of 3 (0)
Mechanical	Verify dimensions correspond to Detail Specification	2 (0)	2 (0)	2 (0)	2 (0)	1 (0)	1 (0)
Calibration	MIL-PRF-24236, Para 4.6.3.2. Perform testing using the Air Calibration Method (Air Chamber) or Liquid Calibration Method (Liquid Bath; preferred). Air Calibration Method. Switches shall be subjected to chamber temperature exposures adjusted for the upper and lower operating temperatures as specified in the detail spec. Liquid Method. Switches shall be transferred between liquid baths adjusted for the upper and lower operating temp. Switch operating points for the opening and closing temperatures shall be within the points specified. All switches shall be operated within a period of time as specified after temperature change.		100%		100%		100%
Creepage (when applicable)	Switches shall be heated and cooled to temperatures as specified with a rate of change of less than 1°F per minute for three complete cycles. Voltage to be switched shall be 600 VDC or as specified, with sufficient load to limit current to 1 microampere max. Contact arc duration shall not exceed 5 milliseconds. Switches shall respond to specified temperature changes with immediate positive snap action. Contact bounce, when applicable, shall not exceed limit as specified in the detail spec.		100%		100%		
Seal (Hermetic switches only)	MIL-STD-202, Method 112, test condition C (tracer gas). Leak rate shall not exceed 1 X 10^{-8} ATM CM^3/SEC.		100%		100%		100%

Notes at end of table.

Table 2B SCREENING REQUIREMENTS FOR THERMOSTATIC SWITCHES (TEMPERATURE DETECTING) (REF MIL-PRF-24236, GSFC S-311-641) (Page 3 of 3)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Run-in Conditioning	Switches shall be heated and cooled to perform switching. With at 6VDC & 100 mA applied, monitor all contact make and break actions for misses.	100% 500 cycles min	100% 500 cycles min	100% 500 cycles min	100% 500 cycles min		
Contact Resistance	MIL-STD-202, Method 307. Measurements shall be made for all poles forming a switching circuit at each temperature setting as specified in the detail specification. Apply 6VDC, 100 mA load. Perform 3 switch operations, and perform one measurement per thermal actuation. Post run-in contact resistance shall be the average of the three measurements, and shall not exceed 50 milliohms.	100%	100%	100%	100%		2 (0)
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Test Method 301. Test potential shall be 1,000 VRMS plus 2X working voltage or as otherwise specified, for a duration of 5 seconds between all terminals and ground. Leakage current shall not exceed 500 microamperes. There shall be no evidence of arcing or flashover	100%	100%	100%	100%		2 (0)
Insulation Resistance (Room Temperature)	MIL-STD-202, Method 302, test condition B (500VDC), at ambient temperature. Measure between all terminals and frame or ground. Measurements 500 megohms min.	100%	100%	3 (0)	3 (0)		2 (0)

Notes:

1/ Switches that have not been subjected to pre-closure inspection and cleaning are not permitted in level 1 programs.
2/ In order to have pre-closure visual inspection, cleaning, and micro-particle analysis performed for military parts, users must make arrangements with the manufacturer to have these performed prior to closure. These items are not a MIL-spec requirement for switches.
3/ For level 2 programs, if cleaning and internal inspection are not performed, Radiography (Real time preferred) and a DPA on samples per GSFC S-311-M-70 are required.
4/ It is the responsibility of the user to approve manufacturer procedures for internal micro-particle analysis and cleaning prior to closure.
5/ Internal visual inspection, pre-closure cleaning, and micro-particle analysis are recommended but not required for Level 3.

Table 2C SCREENING REQUIREMENTS FOR PRESSURE SWITCHES (PRESSURE SENSING) (REF MIL-DTL-9395) (Page 1 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Internal Visual Inspection **1/**	Inspect workmanship at 10X magnification, minimum. Switches shall be free from cracked or displaced parts, burrs or other defects that would affect performance.	**1/, 2/**	100%	**2/, 3/**	100%		
Pre-closure Cleaning and Micro-Particle Inspection **1/, 4/**	Manufacturer's approved procedure. No particles greater than 0.001 inches (or as specified) shall be permitted.	**1/, 2/**	100%	**2/, 3/**	100%		
External Visual	Adjustments contained within the switch shall be locked to prevent changes during vibration or shock, and shall be tamperproof. Inspect for workmanship defects using 3X Magnification: Case (Dents, burrs, marking) Finish (Corrosion, peeled or blistered plating, discoloration, exposed base metal) Terminations (Cracks, corrosion) Connectors (If applicable, bent contacts, corrosion)	100%	100%	100%	100%	10% (0) Min of 3 (0)	10% (0) Min of 3 (0)
Mechanical	Verify dimensions correspond to Detail Specification	2 (0)	2 (0)	2 (0)	2 (0)	1 (0)	1 (0)
Seal (Hermetic switches only)	MIL-STD-202, Method 112, test condition C (tracer gas) Leak rate shall not exceed 1 X 10^{-8} ATM CM^3/SEC. In process inspection may be used.	**5/**	100%	**5/**	100%	**5/**	100 (0)
Calibration	Connect switches to a pressure supply, using pressure media as specified, that can be varied from zero to the system pressure specified. Rate of pressure change shall not exceed 1% of the system pressure per second within 10% of the switching points. Increase the pressure until the switch actuates and record the actuation point. Increase the pressure to the system pressure and maintain for 60 seconds. Decrease the pressure until the switch de-actuates and record the de-actuation point. Then decrease the pressure to zero. Load shall be as specified.	**5/**	100%	**5/**	100%		

Notes at end of table.

Table 2C SCREENING REQUIREMENTS FOR PRESSURE SWITCHES (PRESSURE SENSING) (REF MIL-DTL-9395) (Page 2 of 2)

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD
Proof pressure	Repeat the procedure used for "Calibration" except use the proof pressure (usually 1.5X system pressure).	**5/**	100%	**5/**	100%		
Dielectric Withstanding Voltage (Sea Level)	MIL-STD-202, Test Method 301. Test potential and duration shall be 250VAC for 28VDC at absolute pressure (full vacuum) switches and 1250VAC for all other 28VDC switches or as otherwise specified. Apply for 2 - 5 seconds between all mutually insulated points and ground. Leakage current shall not exceed 1 milliamp. There shall be no evidence of arcing or flashover.	100%	100%	100%	100%		2 (0)
Contact Resistance	MIL-STD-202, Method 307. Measurements shall be made between the terminals of contacts of the same pole forming a switching circuit. Test voltage and current may be any value but shall not exceed rated values of the switch. Perform 3 switching operations prior to measurement. Perform 3 additional switch operations, with one measurement per actuation. The average of the three measurements shall not exceed 100 milliohms.	100%	100%	100%	100%		2 (0)

Notes:

1/ Switches that have not been subjected to pre-closure inspection and cleaning are not permitted in level 1 programs.
2/ In order to have pre-closure visual inspection, cleaning, and micro-particle analysis performed for military parts, users must make arrangements with the manufacturer to have these performed prior to closure. These items are not a MIL-spec requirement for switches.
3/ For level 2 programs, if cleaning and internal inspection are not performed, Radiography (Real time preferred) and a DPA on samples per GSFC S-311-M-70 are required.
4/ It is the responsibility of the user to approve manufacturer procedures for internal micro-particle analysis and cleaning prior to closure.
5/ Switches procured to MIL-DTL-9395 (Rev G) should have this test performed 100%. Military connectors procured to MIL-S-9395 (Rev F) had this test performed on each switch. Military connectors procured to MIL-DTL-9395 (Rev G) reduced screening to samples.

Table 3A QUALIFICATION REQUIREMENTS FOR SENSITIVE AND PUSH SWITCHES (POSITION SENSING, PLUNGER SNAP ACTION TYPE) (REF MIL-PRF-8805) (Page 1 of 2) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Perform screening to table 2A	Perform preclosure inspection and cleaning, PIND, external visual and mechanical inspection, seal (if applicable), run-in conditioning, contact resistance, DWV and IR.	6 (0)	4 (0)	2 (0)
Shock	MIL-STD-202, Method 213, Test Condition I (100G saw-tooth, 6 millisec duration). Three shocks in each direction shall be applied to each of three mutually perpendicular axes). Monitor switches for chatter using MIL-STD-202, method 310 or equivalent, set up for contact opening and closing.	3(0) Group A	2(0) Group A	
Resistance to Soldering Heat and Solderability (When applicable)	Terminations shall be soldered with a pencil type iron heated to 360°C using Sn63Pb37 per ANSI J-STD-006 (solder; formerly Sn63) for a min duration of four seconds. Flux with Type ROL1 per ANSI J-STD-004 (solder flux; formerly Type RMA). There shall be no evidence of damage or distortion. There shall be no loosening or rotation of terminals. Solder shall demonstrate proper wetting and adhesion to terminals.	3(0) Group A	2(0) Group A	
Thermal Shock	MIL-STD-202, Method 107, Test Condition A (for 85°C rated devices; cycle from –55°C to 85°C in air) or B (for 125°C rated devices; cycle from –55°C to 125°C in air). Switches shall be monitored using MIL-STD-202, method 310. There shall be no damage detrimental to the operation of the switches or loosening of rivets / fasteners.	3(0) 25 cycles Group A	2(0) 10 cycles Group A	2 (0) 5 cycles
Seal (Hermetic Switches Only) (Post Environmental)	MIL-STD-202, Method 112, Test Condition C (tracer gas). Leak rate shall not exceed 1 x 10^{-8} ATM CM^3/sec.	3 (0) Group A	2 (0) Group A	2 (0)
Electrical Endurance	Switches shall be subjected to operational cycling at the rate of 10 cycles per minute or as otherwise specified. Each stroke of activation shall include full range of travel. Use AC lamp load, and duty cycle approx 30% on and 70% off. Apply AC Voltage of 60 Hz and current as specified in the detail specification so as to provide a wattage not to exceed 200 Watts. Switch contacts shall be monitored for continuity. No contact shall fail to open or close its individual circuit. Temperature rise shall not exceed 50°C. Perform 25,000 switching cycles.	3(0) Group B	2(0) Group B	

Notes at end of table.

Table 3A QUALIFICATION REQUIREMENTS FOR SENSITIVE AND PUSH SWITCHES (POSITION SENSING, PLUNGER SNAP ACTION TYPE) (REF MIL-PRF-8805) (Page 2 of 2) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Contact Resistance (Post endurance)	MIL-STD-202, Method 307. Measurements shall be made for all poles at each actuator full switch position forming a switching circuit. Apply 6VDC, 100 mA load. Perform 3 switching operations prior to measurement. Perform 3 additional switch operations with one measurement per actuation. The average of the three post endurance contact resistance measurements shall not exceed 40 milliohms.	3 (0) Group B	2 (0) Group B	
Dielectric Withstanding Voltage (sea level) (Post endurance)	MIL-STD-202, Test Method 301. Test potential shall be 1,000 VRMS, for a duration of one minute between all terminals of mutually insulated circuits, and between all terminals and non-current-carrying metal or grounded parts. There shall be no evidence of arcing or flashover.	3 (0) Group B	2 (0) Group B	
Insulation Resistance (Room Temperature) (Post endurance)	MIL-STD-202, Method 302, test condition B (500VDC), at ambient temperature. Measure between all terminals of mutually insulated circuits, and between all terminals and non-current-carrying metal or grounded parts. Measurements shall not be less than 1000 megohms min.	3(0) Group B	2(0) Group B	
Operating Characteristics (Post endurance)	The switching operation of all poles shall be inspected with the use of appropriate test circuits. Actuating force, Release force, Movement differential, Pretravel and Overtravel shall be within limits as specified. Switches shall demonstrate proper snap action without binding that would interfere with contact closure or release.	3 (0) Group B	2 (0) Group B	

Notes:

1/ For switches that have been previously screened per Table 2A, some screening tests are repeated after endurance testing. Remaining screening tests do not need to be repeated as part of qualification testing.

2/ For level 1 qualification, divide samples into two groups. Group A will be subjected to environmental tests; Group B will be subjected to electrical tests.

Table 3B QUALIFICATION REQUIREMENTS FOR THERMOSTATIC SWITCHES (TEMPERATURE DETECTING) (REF MIL-PRF-24236, GSFC S-311-641) (Page 1 of 2) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Perform screening to Table 2A.	Perform preclosure inspection and cleaning, PIND, external visual and mechanical inspection, seal (if applicable), Run-in conditioning, contact resistance, DWV and IR.	6 (0)	4 (0)	2 (0)
Shock	MIL-STD-202, Method 213, Test Condition H (75G sawtooth, 6msec duration). Three shocks in each direction shall be applied to each of three mutually perpendicular axes. Switches shall be monitored for chatter using MIL-STD-202, method 310, set up for contact opening and closing. Switches shall be checked for any changes in operation.	3(0) Group A	2(0) Group A	
Resistance to Soldering Heat and Solderability	Terminations shall be soldered with a pencil type iron heated to 360° C using Sn63Pb37 per ANSI J-STD-006 (solder; formerly Sn63) for a min duration of four seconds. Flux with Type ROL1 per ANSI J-STD-004 (solder flux; formerly Type RMA). There shall be no evidence of damage or distortion. There shall be no loosening or rotation of terminals. Solder shall demonstrate proper wetting and adhesion to terminals.	3(0) Group A	2(0) Group A	
Thermal Shock	MIL-STD-202, Method 107, Test Condition B (Cycle from -55°C to 125°C in air). Change in operation point shall not exceed +/- 5°F.	3(0) Group A 25 cycles	2(0) Group A 10 cycles	2 (0) 5 cycles
Seal (Hermetic Switches Only) (Post Environmental)	MIL-STD-202, Method 112, Test Condition C (tracer gas). Leak rate shall not exceed 1 x 10^{-8} ATM CM^3/sec.	3 (0) Group A	2 (0) Group A	2 (0)
Endurance	Switches shall be subjected to operational cycling at the rate of 6 cycles per minute or as otherwise specified. Half the specimens shall be tested with a resistive load to set current to 5 amperes at 28VDC. Remaining half the specimens shall be tested at low level of 30 millivolts DC and 10 milliamps current. Perform 100,000 switching cycles.	3(0) Group B	2(0) Group B	
Contact Resistance (Post endurance)	MIL-STD-202, Method 307. Measurements shall be made for all poles forming a switching circuit at each temperature setting as specified in the detail specification. Apply 6VDC, 100 mA load. Perform 3 switch operations, and perform one measurement per thermal actuation. The average of the three post endurance contact resistance measurements shall not exceed 100 milliohms.	3(0) Group B	2(0 Group B	

Notes at end of table.

Table 3B QUALIFICATION REQUIREMENTS FOR THERMOSTATIC SWITCHES (TEMPERATURE DETECTING) (REF MIL-PRF-24236, GSFC S-311-641) (Page 2 of 2) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Calibration (Post endurance)	MIL-PRF-24236, Para 4.6.3.2. Perform testing using the Air Calibration Method (Air Chamber) or Liquid Calibration Method (Liquid Bath; preferred). Air Calibration Method. Switches shall be subjected to chamber temperature exposures adjusted for the upper and lower operating temperatures as specified in the detail spec. Liquid Method. Switches shall be transferred between liquid baths adjusted for the upper and lower operating temperature. Switch operating temperature shall remain within 5°F of their measurements performed during screening to table 2B.	3(0) Group B	2(0) Group B	
Creepage (when applicable) (Post endurance)	Switches shall be heated and cooled as specified with a temperature rate of change of less than 1 degree Fahrenheit per minute for three complete cycles. Voltage to be switched shall be 500 VDC or as otherwise specified, with sufficient load to limit current to 1 microampere maximum. Switches shall continue to respond to specified temperature changes with immediate positive snap action. Contact bounce, when applicable, shall remain within specified limits.	3(0) Group B	2(0) Group B	
Dielectric Withstanding Voltage (Sea Level) (Post endurance)	MIL-STD-202, Test Method 301. Test potential shall be 1,000 VRMS plus 2X working voltage or as otherwise specified, for a duration of one minute between all terminals and ground. Leakage current shall not exceed 500 microamps. There shall be no evidence of arcing or flashover	3(0) Group B	2(0) Group B	
Insulation Resistance (Room Temperature) (Post endurance)	MIL-STD-202, Method 302, test condition B (500VDC), at ambient temperature. Post endurance measurements between all terminals and frame or ground shall not be less that 500 megohms.	3(0) Group B	2(0) Group B	

Notes:

1/ For switches that have been previously screened per Table 2B, some screening tests are repeated after endurance testing. Remaining screening tests do not need to be repeated as part of qualification testing.

2/ For level 1 qualification, divide samples into two groups. Group A will be subjected to environmental tests; Group B will be subjected to electrical tests.

Table 3C QUALIFICATION REQUIREMENTS FOR PRESSURE SWITCHES (PRESSURE SENSING) (REF MIL-DTL-9395) (Page 1 of 3) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.) Level 1	Level 2	Level 3
Perform screening to table 2C	Perform preclosure inspection and cleaning, external visual and mechanical inspection, seal (if applicable), calibration, proof pressure, DWV, IR and contact resistance.	6 (0)	4 (0)	2 (0)
Shock	MIL-STD-202, Method 213, Test Condition A, B, C or D as specified in the detail specification. Three shocks in each direction shall be applied to each of three perpendicular axes. Switches shall be monitored for chatter using MIL-STD-202, method 310, set up for contact opening and closing. Contact opening or closing shall not exceed 250 microseconds.	3(0) Group A	2(0) Group A	
Resistance to Soldering Heat and Solderability	Terminations shall be soldered with a pencil type iron heated to 360°C using Sn63Pb37 per ANSI J-STD-006 (solder; formerly Sn63) for a min duration of four seconds. Flux with Type ROL1 per ANSI J-STD-004 (solder flux; formerly Type RMA). There shall be no evidence of damage or distortion. There shall be no loosening or rotation of terminals. Solder shall demonstrate proper wetting and adhesion to terminals.	3(0) Group A	2(0) Group A	
High Frequency Vibration and Resonance	MIL-STD-202, Method 204. Test Condition A, B, C or D as specified in the detail specification. Checks for resonance and contact disturbance shall be conducted. Switches shall be subjected to two cycles of operation at each of these frequencies: 5, 10, 20, 40, 80, 100Hz, and every 100Hz up to 2KHz, except for test condition A, the maximum frequency shall be 500Hz. Contact disturbance shall be monitored using MIL-STD-202, method 310 or an equivalent test method. No other electrical load is applied. There shall be no opening of closed contacts or closing of open contacts in excess of 250 microseconds. No broken, deformed or displaced parts.	3(0) Group A	2(0) Group A	
Seal (Hermetic Switches Only) (Post Environmental)	MIL-STD-202, Method 112, test condition C (tracer gas). Leak rate shall not exceed 1 X 10^{-8} ATM CM^3/SEC.	3(0) Group A	2(0) Group A	

Notes at end of table.

Table 3C QUALIFICATION REQUIREMENTS FOR PRESSURE SWITCHES (PRESSURE SENSING) (REF MIL-DTL-9395) (Page 2 of 3) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Perform Life (Endurance) Test	Ref. MIL-DTL-9395, para. 4.10.20. Pressure Pulsation Testing (pump ripple). Apply actuation pressure + 10% and expose to pressure pulsation for 50 hours. After exposure, examine for evidence of malfunction, damage or leakage, and check calibration. Apply pressure to deactuation. Expose to pressure pulsation for 50 hours. Repeat examination and calibration. Apply pressure between the actuation and deactuation pressures, known as dead band. Expose to pressure pulsation for 100 hours. Total test time 200 hours. Operational Cycling. Perform 100,000 mechanical cycles and 50,000 electrical cycles at a rate of 6 cycles per minute, or as otherwise specified. Perform 30% of switching cycles at high temperature, 30% of switching cycles at low temp, and 40% of switching cycles at room temp. Rate of pressure change, electrical load and pressure media shall be as specified in the detail specification. Switch contacts shall be monitored for at least half the number of closures for continuity. No contact shall fail to open or close its individual circuit. After exposure, examine for malfunction, damage or leakage, and check calibration.	3(0) Group B	2(0) Group B	
Contact Resistance (Post Life)	MIL-STD-202, Method 307. Measurements shall be made between the terminals of contacts of the same pole forming a switching circuit. Test voltage and current may be any value but shall not exceed rated values of the switch. Perform 3 switching operations prior to measurement. Perform 3 additional switch operations, and perform one measurement per actuation. The average of the three post life contact resistance measurements shall not exceed 250 milliohms.	3(0) Group B	2 (0) Group B	

Notes at end of table.

Table 3C QUALIFICATION REQUIREMENTS FOR PRESSURE SWITCHES (PRESSURE SENSING) (REF MIL-DTL-9395) (Page 3 of 3) 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept/ No.)		
		Level 1	Level 2	Level 3
Dielectric Withstanding Voltage (Sea Level) (Post Life)	MIL-STD-202, Test Method 301. Test potential and duration shall be 250VAC for 28VDC absolute pressure (full vacuum) switches and 1050VAC for all other 28VDC switches or as otherwise specified. Apply for 1 minute between all mutually insulated points and ground. Leakage current shall not exceed 1 milliamp. There shall be no evidence of arcing or flashover.	3(0) Group B	2(0) Group B	
Insulation Resistance (Room Temperature) (Post Life)	MIL-STD-202, Method 302, test condition B (500VDC), at ambient temperature. Measure between adjacent terminals of different poles, and between each terminal and mounting. Measurements shall not be less than 500 megohms.	3(0) Group B	2(0) Group B	

Notes:

1/ For switches that have been previously screened per Table 2C, some screening tests are repeated after endurance testing. Remaining screening tests do not need to be repeated as part of qualification testing.

2/ For level 1 qualification, divide samples into two groups. Group A will be subjected to environmental tests; Group B will be subjected to electrical tests.

TABLE 4 SWITCH DERATING REQUIREMENTS

Switch contacts are usually provided with multiple ratings dependent on the type of load being switched. For lamp (filament), motor, inductive and capacitive loads, the inrush current at the instant the switch actuates, is several times higher than the nominal current flow. Switches are seldom rated for capacitive loads that are subject to similar inrush surge currents as lamp (filament) or inductive loads. Ratings for all of these types of loads are less than resistive loads.

Derating is applied by the table herein to the rated resistive, inductive and lamp ratings. Pressure and sensitive switches have additional derating applied for temperatures above 85 °C.

As a minimum, commercial switches have a resistive rating and may not be rated for inductive, motor, lamp or capacitive loads. When switches are not rated for these loads, they must be derated as a percentage of the rated resistive load.

The following table establishes derating for switches.

	Current Derating Factor @ Application Ambient Temperature			
	Military		**Commercial 1/**	
Load Type	0°C to 85°C	Above 85°C **2/**	0°C to 85°C	Above 85°C **2/**
Resistive	75% of rated Resistive load	60% of rated Resistive load	75% of rated Resistive load	60% of rated Resistive load
Inductive & Motor	75% of rated Inductive load	60% of rated Inductive load	40% of rated Resistive load	30% of rated Resistive load
Capacitive & Lamp	75% of rated Capacitive load	60% of rated Capacitive load	25% of rated Resistive load	20% of rated Resistive load

Notes:

1/ Applies mainly to relays that are rated with a resistive load current rating only.

2/ Temperature derating is not applicable to thermostatic switches.

SECTION T1: THERMISTORS

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Table 1 THERMISTOR REQUIREMENTS 1/

Procurement Specification	Thermistor Style and Type		MIL/NASA Reference Specification	Level 1	Level 2	Level 3
Positive Temp. Coeff.						
Mil Specification	RTH	Resistor, Thermal, Insulated	MIL-PRF-23648	X	X	X
SCD				**2/**	**2/**	**2/**
Commercial					**2/**	**2/**
Negative Temp. Coeff.						
MIL/NASA Specification	RTH	Resistor, Thermal, Insulated	MIL-PRF-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/**

Notes:

1/ **Refer to paragraph 6.0, Instructions, pages 4 through 10, of Section 1 for general part requirements applicable to all part types.** Character "X" designates use as is. Tests that are required by the procurement specification and/or are performed normally by the manufacturer need not be repeated by the user. However, evidence must be submitted indicating that test conditions were acceptable and that tests were performed with acceptable results.

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

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

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 1 of 4)

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

Notes at the end of table.

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 2 of 4)

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

Notes at the end of table.

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 3 of 4)

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

Notes:

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

2/ A minimum of three thermistors shall be measured.

3/ Applicable only for surface mount thermistors.

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

Table 2 THERMISTOR SCREENING REQUIREMENTS (Page 4 of 4)

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

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

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

8 Not applicable for surface mount thermistors.

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

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 1 of 4)

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

Notes at the end of table.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 2 of 4)

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

Notes at the end of table.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 3 of 4)

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

Notes at the end of table.

Table 3 THERMISTOR QUALIFICATION REQUIREMENTS (Page 4 of 4)

Notes:

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

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

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

4/ Not applicable for surface mount thermistors.

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

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

Table 4 THERMISTOR DERATING REQUIREMENTS 1/

Type	Derating
Positive Temperature Coefficient	Derate to 50% of rated power.
Negative Temperature Coefficient	Derate to a power level that limits dissipation constant to a maximum increase of 50 times, or to a maximum case temperature of 100°C, whichever is less.

Notes:

1/ Derating is applicable to thermistors operating in the self-heating mode.

SECTION W1: WIRE AND CABLE

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GENERAL

Refer to paragraph, 6.0, Instructions, pages 4 through 10, of Section 1 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.

PROCURMENT REQUIREMENTS

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

FLAMMABILITY

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

OUTGASSING

Outgassing occurs in vacuum environments when unreacted additives, contaminants, absorbed gasses or moisture can evaporate from molding materials and ink. These outgassed materials can condense on cold surfaces causing performance degradation. Outgassed materials can also become more rigid or brittle. Nonmetallic materials shall not exceed 1% Total Mass Loss (TLM) or 0.1% Collected Volatile Condensable Material (CVCM) when tested in accordance with ASTM-E595 (Test Method, Outgassing). Acceptable materials should be selected from:

> NASA reference publication 1124 (Outgassing Data for Selecting Spacecraft Materials) http://outgassing.nasa.gov/ ,
>
> or
>
> MAPTIS (Materials and Process Technical Information Service) http://mpm.msfc.nasa.gov/materialdb.html.

However, materials listed as acceptable in these documents may have been baked out prior to evaluation in order to reduce outgassing, and the user needs to be aware that they may have to perform similar processing in order to achieve acceptable levels of outgassing. Testing shall be performed in accordance with ASTM-E595 for materials, which are not traceable to the above references. Processing generally consists of a bakeout at 125^0C and 1×10^{-6} Torr for 24 hours. Use of inkless contacts is recommended.

CRYOGENIC APPLICATIONS

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

ATOMIC OXYGEN DEGRADATION

Wire and cable users need to be cautious of the corrosive effects atomic oxygen can have on wire and cable exposed to external surfaces of satellites flown in lower earth orbits (LEO). Atomic oxygen is a strong oxidizing agent, which can change silver plating to a non-conductive finish. Polyamide insulation is rapidly degraded by exposure to atomic oxygen. All insulations may experience physical erosion such as flaking. For multi-year missions in lower earth orbits, the use of unprotected thin wall insulated wire is not recommended.

HANDLING PRECAUTIONS

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

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

Table 1A WIRE AND CABLE REQUIREMENTS 1/

Procurement Specification	Level 1		Level 2		Level 3	
	Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l/ SCD 6/
Insulated Hookup Wire						
MIL-W-22759*	X		X		X	
MIL-W-81044*	X		X		X	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Coated Magnet Wire **4/**						
MWXX-C (HEAVY)	X		X		X	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Multiconductor Cable **5/**						
NEMA-WC27500	X		X		X	
SCD		2/		2/		2/
Commercial		2/		2/		2/
Coaxial and Twinaxial Cable						
MIL-C-17	X		X		X	
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/
Flexible Printed Circuit Cable						
SCD		2/, 3/		2/, 3/		2/
Commercial		2/, 3/		2/, 3/		2/

Notes:

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

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

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

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

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

6/ It is not a requirement for users to prepare a procurement specification for Level 3 programs. However, if an existing procurement specification exists that is proposed for use, the SCD as a minimum must meet Level 3 requirements in Table 2.

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

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

Procurement Specification	Description 1/
PTFE Insulated (Teflon-Polytetrafluoroethylene), Copper or Copper Alloy	
MIL-W-22759/11	Silver Coated, 600 Volt, 200°C
MIL-W-22759/12	Nickel Coated, 600 Volt, 260°C
MIL-W-22759/22	Silver Coated, 600 Volt, 200°C (High Strength)
MIL-W-22759/23	Nickel Coated, 600 Volt, 260°C (High Strength)
MIL-W-22759/9	Silver Coated, 1000 Volt, 200^0C
MIL-W-22759/20	Silver Coated, 1000 Volt, 200^0C (High Strength)
ETFE Insulated (Ethylene Tetrafluorethylene), Copper or Copper Alloy	
MIL-W-22759/44	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Light Weight
MIL-W-22759/43	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Normal Weight
MIL-W-22759/33	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Light Weight (High Strength)
MIL-W-22759/35	Crosslinked ETFE, Silver Coated, 600 Volt, 200°C, Normal Weight (High Strength)
MIL-W-22759/45	Crosslinked ETFE, Nickel Coated, 600 Volt, 200°C, Light Weight
MIL-W-22759/41	Crosslinked ETFE, Nickel Coated, 600 Volt, 200°C, Normal Weight
PTFE Fluorocarbon/Polyamide (Kapton), Insulated, Copper or Copper Alloy 8/	
MIL-DTL-22759/86	Silver Coated, 600 Volt, 200°C, Normal Weight
MIL-DTL -22759/87	Nickel Coated, 600 Volt, 260°C, Normal Weight
MIL-DTL -22759/89	Silver Coated, 600 Volt, 200°C, Normal Weight (High Strength)
MIL-DTL -22759/90	Nickel Coated, 600 Volt, 260°C, Normal Weight (High Strength)
MIL-DTL -22759/91	Silver Coated, 600 Volt, 200°C, Light Weight
MIL-DTL -22759/92	Nickel Coated, 600 Volt, 200°C, Normal Weight
Crosslinked Polyalkene/Crosslinked PVDF, Copper and Copper Alloy	
GSFC S-311-P-13/1	Tin Coated Copper, 600V, 135°C **3/**
GSFC S-311-P-13/2	Tin Coated Copper, 1000V, 135°C **3/**
GSFC S-311-P-13/3	High Voltage, Tin Coated Copper, 2500V, 135°C **3/**
MIL-W-81044/7	Silver coated Copper, 600V, 150°C (High Strength)
MIL-W-81044/12	Tin Coated Copper, 600V, 150°C, Light Weight **3/**
Chemically Coated Copper Magnet Wire 2/	
MW-28-C (HEAVY)	Polyurethane Overcoated with Polyamide, Heavy Enameled, 130°C (Supersedes M1177/9-02C0XX)
MW-30-C (HEAVY)	Polyester-Amide-Imide, Heavy Enameled, 180°C (Supersedes M1177/12-02C0XX)
MW-35-C (HEAVY)	Polyester-Amide-Imide, Overcoated with Polyamideimide, Heavy Enameled, 200°C (Supersedes M1177/14-02C0XX)
MW-16-C (HEAVY)	Polyamide, Heavy Enameled, 220°C (Supersedes M1177/15-02C0XX)

Notes at end of table.

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

Procurement Specification	Description 1/
Multiconductor Cable	
NEMA-WC27500 **10/**	PTFE or ETFE insulated, Multiconductor, Shielded and Unshielded, Jacketed and Unjacketed.
Coaxial Cable 4/	
MIL-C-17/60	Flexible, Double Braid Shield, FEP Jacket, 12.4 GHZ Max, 50 OHMS, 200°C Max, RG 142 Type
MIL-C-17/93 **6/**	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 178 Type
MIL-C-17/95 **5/, 6/**	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 95 OHMS, 200°C Max, RG 180 Type
MIL-C-17/110 **5/**	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 75 OHMS, 200°C Max, RG 302 Type
MIL-C-17/111	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 303 Type
MIL-C-17/113	Flexible Single Braid Shield, FEP Jacket, 3 GHZ Max, 50 OHMS, 200°C Max, RG 316 Type
MIL-C-17/127	Flexible Double Braid Shield, FEP Jacket, 11 GHZ Max, 50 OHMS, 200°C Max, RG 393 Type
MIL-C-17/128	Flexible Double Braid Shield, FEP Jacket, 12.4GHZ Max, 50 OHMS, 200°C Max, RG 400 Type
MIL-C-17/130 **7/**	Semi Rigid, Seamless Copper Tubing, .141 OD, 20 GHZ Max, 50 OHMS, 125°C Max, RG 402 Type
MIL-C-17/133 **7/**	Semi Rigid, Seamless Copper Tubing, .086 OD, 20 GHZ Max, 50 OHMS, 125°C Max, RG 405 Type
MIL-C-17/152	Flexible, Double Braid Shield, FEP Jacket, 12.4 GHZ Max, 50 OHMS, 200°C Max.
Twin Axial Cable 4/	
MIL-C-17/176	Flexible Single Shield Braid, PFA Jacket, 10 MHZ Max, 77 OHMS, 200°C
Bare Bus Wire	
A-A-59551	Wire, Electrical, Copper (Uninsulated, ref. Type “S” Solid Wire)
Wire Braid	
A-A-59569	Braid, Wire (Tubular or Flat)
Flexible PrintedCircuit	**(Used as cable)**
IPC-6013	Qualification and Performance Specification for Flexible Printed Boards
MIL-P-50884 **9/**	Printed Wiring, Flexible and Rigid Flex

Notes on next page.

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 (PVDF or PVF_2) is Kynar (Pennwalt); Polyester is Dacron (Dupont); Polyamide is Kapton (Dupont)

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

2.1/ **Part number explanation:**

MW	030	C	H	x	000022	n
NEMA Symbol	**Detail Spec** (Class = temp index, °C / coating material) 016 – (Class 240 / Polyamide) 030 – (Class 180 / Polyester-Amide-Imide) 035 – (Class 200 / Polyester-Amide-Imide) (Others available; **Note 2.4**)	**Material** C = Copper **Note 2.2**	**Coating Thickness** S = Single H = Heavy **Note 2.3**	**Additional Information** (Lower Case) x = Film Coated only b = Double thickness with glass fiber	**Size (AWG) (Round cross section)** (ex: 000022 = 22 AWG) Detail spec (available size range) 016 –(000004 thru 000050) 030 –(000004 thru 000050) 035 –(000004 thru 000044)	**Lubricant** (Lower Case) n – None

2.2/ Copper is the preferred conductor material.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Insulation Types	Advantages	Disadvantages
FEP and PTFE (DuPont ™ Teflon) **3/**	1. Excellent high temperature properties. PTFE Teflon is preferred for solder applications. FEP is preferred for jacket material. 2. Non-flammable. 3. Good outgassing characteristics. 4. Most flexible of all Insulations. 5. Resists moisture absorption and atomic oxygen erosion.	1. Susceptible to cold flow when stressed (bent) over tight radius or when laced too tightly. 2. Degraded by solar radiation above 5×10^5 RADS. 3. FEP has poor cut through resistance. 4. Heaviest insulation.
Extruded ETFE (DuPont ™ Tefzel)	1. Withstands physical abuse during and after installation. 2. Good high and low temperature properties. 3. High flex life. 4. Fair cold flow properties	1. Some ETFE Insulations fail flammability in a 30% oxygen environment. 2. Insulation tends to soften at high temperature. 3. Degraded by gamma radiation above 10^6 rads 4. Sensitive to degradation from ultraviolet light. 5. Some ETFE insulations (primarily white) are known to outgas trace amounts of fluorine over time, which can cause corrosion of unprotected metals in sealed or confined environments. 6. Some ETFE (Ethylene Tetrafluoroethylene) insulated wire has been found to fail flammability testing in a 30% oxygen environment.
Crosslinked ETFE (DuPont ™ Tefzel)	1. Higher strength than extruded ETFE. 2. Resistant to cold flow and abrasion. 3. More resistant to radiation effects. (to 5×10^7 RADS) 4. Improved physical stability at high temperature than extruded ETFE.	1. Some ETFE insulations fail flammability in a 30% oxygen environment. 2. Less flexible than extruded ETFE. More difficult to strip. 3. Some ETFE (Ethylene Tetrafluoroethylene) insulated wire has been found to fail flammability testing in a 30% oxygen environment. 4. Sensitive to degradation from ultraviolet light. 5. Some ETFE insulations (primarily white) are known to outgas trace amounts of fluorine over time, which can cause corrosion of unprotected metals in sealed or confined environments.

Notes on next page.

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

Insulation Types	Advantages	Disadvantages
Aromatic Polyamide (DuPont ™ Kapton) **4/**	1. Lightest weight wire insulation material. Commonly used with FEP or PTFE Teflon to form layered insulation tapes. 2. Excellent physical thermal and electric properties. Excellent cut-through resistance and cold flow resistance. 3. Excellent radiation resistance (to 5 x 10^9 RADS). 4. Good outgassing characteristics.	1. Inflexibility – difficult to strip. 2. Absorbs moisture. Degraded by atomic oxygen. 3. Prone to wet-arc and dry-arc tracking from abrasions and cuts. 4. More difficult to flex. 5. Not stable to ultraviolet radiation.
Crosslinked Polyalkene	1. Dual extrusion, which is fused by sintering. Combines excellent abrasion and cut through resistance of Polyvinylidene Fluoride (PVDF, 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.

Notes:

1/ 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.

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

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

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

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

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	**Com'l/ SCD**	**Mil**	**Com'l/ SCD**	**Mil**	**Com'l/ SCD**
Visual / Mechanical **1/, 3/**	Inspect for proper marking, insulation, and color coding (if applicable). Check insulation workmanship for cracks, splits. Use 3x magnification and adequate lighting. Verify finished wire diameter per reference specification. Verify proper number of wire strands and AWG of strands. Verify weight as necessary. Inspect for discoloration or corrosion of the strands. Wire plating finish shall not flake off from normal flexing.	**7/**	1 foot sample per spool	**7/**	1 foot sample per spool		1 foot sample per spool
Insulation Flaws Test **6/** (For finished wire and primary insulation of dual insulated wire.)	Determine the presence of insulation faults by performing the Impulse Dielectric test per MIL-STD-2223 (Test Methods, Insulated Wire), method 3002. Wire shall be passed through an electrode bead chain electrode head, which will give intimate metallic contact with the wire insulation surface. Voltage potential as specified shall be applied between the electrode and conductor. Wire lengths with failed insulation shall be removed. **Note 5**	**6/**	Entire length **2/**	**6/**	Entire length **2/**		Entire length **2/**
Wrap Test **4/** (Extruded Insulations)	MIL-W-22759, paragraph 4.6.3.3. Wire shall be bent back on itself, and one end shall be wound tightly around the other as a mandrel for four close turns. Sample shall be baked for 2 hours at the specified temperature. After cooling, examine for cracked insulation.		1 foot sample per spool		1 foot sample per spool		
Crosslinking Proof Test (Crosslinked ETFE Insulations Only)	MIL-STD-2223, Method 4001. Sample shall be prepared by removing one inch of insulation from each end 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^{O}C or as otherwise specified in an air circulation oven. At completion of bake, the sample shall be allowed to cool to room temperature and shall be examined for color retention and pitting. The sample shall be removed from the mandrel and shall be subjected to the bend test of method 2006, followed by the wet dielectric test of method 3005.		2 foot sample		2 foot sample		

Notes on next page.

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

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)					
		Level 1		Level 2		Level 3	
		Mil	Com'l/ SCD	Mil	Com'l/ SCD	Mil	Com'l /SCD
Lamination Sealing Test (Tape Sintered Insulations)	MIL-DTL-81381, paragraph 4.6.4.10. Sample shall be baked at the specified temperature for 48 hours. After cooling, visually examine for delamination of the insulation.		1 foot sample per spool		1 foot sample per spool		
Conductor Resistance	FED-STD-228 (Test Methods, Wire and Cable), Method 6021. Measurements (in ohms/1,000 ft. @ 20 °C) shall conform to MIL-W-22759, Table II limits or as otherwise specified. Wire shall be tested dry without immersion.		Each spool				

Notes:

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

2/ Insulation flaws test is normally a 100% screening test of primary insulation for dual layer insulated wire or finished wire. It is normally performed by the manufacturer during final winding of the wire on spools or reels. A certificate of compliance from the manufacturer that all wire delivered to the user was subjected to and passed the impulse dielectric test is sufficient to meet this requirement. Otherwise, wire shall be screened as an incoming inspection test by the user or user designated test facility.

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

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

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

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

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

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

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

Notes on next page.

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

Notes:

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

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

3/ **Elongation requirements:**

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

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

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

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

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

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

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

Notes:

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

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

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

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

Table 2D SCREENING REQUIREMENTS FOR MULTICONDUCTOR CABLE 5/

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

Notes:

1/ A certificate of conformance from the manufacturer shall be delivered with the cable to certify that the proper conductor finish, insulation and jacket materials were used, and that the shield material, finish and shield coverage are correct as specified in the reference specification or SCD.

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

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

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

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

Table 2E SCREENING REQUIREMENTS FOR FLEXIBLE PRINTED CIRCUIT CABLES (REF IPC-6013; Page 1 of 2)

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

Notes:

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

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

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

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

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

Notes at end of table.

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

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Insulation Blocking	MIL-W-22759 Paragraph 4.6.3.5. Affix one end of the sample to a metal spool with diameter 50X diameter of finished wire for size 30 through 14, 40X for size 12 and 10, and 30X for sizes 8 through 2. The wire shall be wound on the spool for at least three turns, with the turns touching each other. Affix the free end 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	
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		

Notes on next page.

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

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

Notes:

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

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

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

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

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

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

Notes on next page.

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

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

Notes:

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

2/ Thermoplastic Flow Test Loads and Flow Temperatures for preferred NEMA MW 1000 magnet wire (referenced in Table 1B, note 2.):

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

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

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

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

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

Notes on next page.

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

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Dimensional Stability	MIL-C-17, paragraph 4.8.20 Flexible Cable Cut ends of cable squarely and deburr. Place in air circulated oven, coiled or straight, and bake for 6 hours, minimum at 200°C or as specified. Return to room temperature for 4 hours, minimum. Measure both ends for protrusion or contraction of the center conductor. Measured values shall conform to specified values.	Flexible type, one sample per lot 5-foot, minimum		
	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/** (When necessary; not applicable to Semi-Rigid Cable)	MIL-C-17, Paragraph 4.8.23. In chamber, suspend test specimen 60º from horizontal. Adjust Bunsen burner for a blue flame approximately 3 inches long. Apply flame to the midpoint of the specimen for 30 seconds. The distance of flame travel upward along the specimen and time of burning after removal of the flame shall be recorded and shall fall within acceptable limits.	One sample 2 feet long		
Evaluation for Insulation Outgassing Properties (when required)	Outgassing paragraph (Front of this section)	X	X	

Notes:

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

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

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

Inspection/Test	Test Methods, Conditions, and Requirements	Sample Quantity (No Rejects Allowed)		
		Level 1	Level 2	Level 3
Perform Screening to Table 2D **1/**	Visual-mechanical, jacket flaws, dielectric withstanding voltage, conductor and shield continuity.	X	X	X
Thermal Shock (PTFE, FEP, Extruded ETFE Jackets)	NEMA-WC27500 (Electrical Cable), para. 4.3.9. Wrap cable specimens around mandrel as specified in Note 2. Wrap specimen on mandrel for at least 6 close turns and secure ends to the mandrel. Bake for 4 hours at 230 °C for FEP jacketed cable and 285 °C for PTFE or extruded ETFE jacketed cable. At completion of test, cool and visually inspect jacket for cracks without magnification.	10 foot sample	10 foot sample	
Crosslinked and Bend Verification Test (Crosslinked ETFE or Crosslinked PVF_2 Jackets)	NEMA-WC27500, para. 4.3.11. Remove 1 inch of insulation from each conductor, tie ends together, load with weights, and drape specimen over mandrel as specified in Note 2. Treat mandrel with non-adhesive Teflon tape to prevent sticking. Place in oven for 6 hours at 200 °C for PVF_2 jacket and 300 °C for XL-ETFE. Remove, allow to cool, and straighten. Secure one end to the mandrel and the other with load weight used above. Rotate mandrel until full length of specimen is on mandrel. Rotate in reverse direction to unwind and rewind specimen on mandrel. Unwind. Repeat mandrel winding in each direction. For shielded cable, perform DWV between shield and conductors. No cracking of the jacket or dielectric breakdown is allowed.	24 inch sample	24 inch sample	

Notes on next page.

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

Notes:

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

2/ Test mandrel diameters and weights.

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

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

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

Inspection / Test	Test Methods, Conditions, and Requirements	Quantity (Accept No.) Level 1	Level 2	Level 3
Visual / Mechanical Inspection **1/**	Ref IPC-6013 (Flexible Printed Boards). Visually inspect surface at 10X magnification, min, using transmitted and reflected lighting. Inspect for excessive blisters, delamination, pinholes, conductor thinning, scratches, tool marks, contaminants and burrs. Edges shall be clean cut and free of nicks, tears and burrs. Accept criteria shall be as required by IPC-6013, paragraphs 3.3.1 through 3.3.9, for class 3 high reliability parts._ If the condition of a suspect defect cannot be identified, use of progressively higher magnification up to 40X may be used	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Continuity	IPC-6013 para 3.9.2.1or MIL-P-50884 para 4.8.6.3.2. A current of 250mA shall be passed through each conductor of the flex circuit. (Note 7, Table 1B)	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Insulation Resistance (IR)	IPC-TM-650 (Test Methods, Printed Boards), method 2.6.3 or MIL-STD-202, Method 302, Test Condition A (100VDC). The flex circuit will be checked for short circuits by applying potential between conductors. Measurements shall not be less than 500 Megohms.	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Dielectric Withstanding Voltage (DWV)	IPC TM-650 , method 2.5.7 or MIL-STD-202, method 301. Apply 1000 VDC for 30 seconds or as otherwise specified. Apply between adjacent conductor patterns and between adjacent layers, if applicable. There shall be no flashover or breakdown between conductors	4(0) Finished Flexible Circuits	2(0) Finished Flexible Circuits	
Flexible Endurance (If applicable by application)	Flexible Endurance testing shall be performed per IPC-TM-650, method 2.4.3, or another test method tailored to the application. Number of flex cycles (sufficient to test for the application), bend radius, rate of flex and total number of flex cycles shall be as specified in the detail specification. To determine end of life, visual inspection and electrical testing shall be performed. Cracks greater than 20% of the conductor width and thickness are rejectable. Delaminations larger than 0.031 in any direction or that bridge more than 25% between conductors shall be considered rejectable. Electrical testing for discontinuity and short circuits shall be performed.	2(0) Finished Flexible Circuits)	1(0) Finished Flexible Circuits	

Notes at end of table.

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

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

Notes at end of table.

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

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

Notes:

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

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

Table 4A WIRE AND CABLE DERATING REQUIREMENTS 1/, 2/

Wire Size (AWG)	Derated Current (Amperes)	
	Single Wire	Bundled Wire or Multi-conductor Cable
30	1.3	0.7
28	1.8	1.0
26	2.5	1.4
24	3.3	2.0
22	4.5	2.5
20	6.5	3.7
18	9.2	5.0
16	13.0	6.5
14	19.0	8.5
12	25.0	11.5
10	33.0	16.5
8	44.0	23.0
6	60.0	30.0
4	81.0	40.0
2	108.0	50.0
0	147.0	75.0
00	169.0	87.5

Notes:

1/ Derated current ratings are based on an ambient temperature of 70°C or less in a hard vacuum of 10^{-6} torr. For derating above 70°C ambient, consult project parts engineer.

2/ The derated current ratings are for 200°C rated wire, such as Teflon ™ insulated (Type PTFE) wire, in a hard vacuum of 1×10^{-6} torr.
   a. For 150°C wire, use 80% of values shown in Table 4A.
   b. For 135°C wire, use 70% of values shown in Table 4A.
   c. For 260°C wire, 115% of values shown in Table 4A may be used.

Table 4B MAGNET WIRE CURRENT DENSITIES FOR CUSTOM MAGNETIC DEVICES (REFER TO EXPLANATION, NEXT PAGE)

Wire Size (AWG)	**Current Capacity, Amperes (Current Density Level, Circular Mils per Ampere)**	
	(375 $\frac{\text{CIR MIL}}{\text{AMP}}$)	**(1000 $\frac{\text{CIR MIL}}{\text{AMP}}$)**
10	27.6	10.4
11	22.0	8.25
12	17.4	6.54
13	13.8	5.18
14	10.9	4.11
15	8.70	3.26
16	6.88	2.59
17	5.48	2.05
18	4.34	1.62
19	3.44	1.29
20	2.74	1.03
21	2.17	.810
22	1.71	.640
23	1.36	.510
24	1.08	.400
25	.854	.321
26	.674	.255
27	.538	.201
28	.424	.160
29	.340	.128
30	.266	.100
31	.211	.079
32	.171	.064
33	.134	.050
34	.106	.040
35	.084	.032
36	.067	.025
37	.054	.020
38	.043	.016
39	.033	.012
40	.026	.010
41	.021	.008
42	.017	.006
43	.013	.005
44	.011	.004
45	.008	.003
46	.007	.002

Notes on next page.

EXPLANATION FOR MAGNET WIRE CURRENT DENSITIES

Magnet wire is treated differently than hookup wire in that pre-set levels of current derating are not established. Rather than select magnet wire size from established current derating tables, wire size is selected in terms of current density (amperes per wire cross sectional area, specified in Circular MILs) that is required to meet performance in the application. Due to the variations in design that are required to meet performance, pre-established current limits (derating) for custom magnetic devices and motors is not feasible. Heat rise (heat accumulation) vs. performance are the prime factors that drive wire selection. For example, a pre-established current through a given size magnet wire could result in little heat rise in a simple device or unacceptably high heat rise within a complex multilayer device having hundreds of turns of wire. High current through small wire in complex multilayer devices can result in high performance, but can also result in excessive heat rise unless proper heat sinking/extraction techniques are used.

The table on the preceding page is offered for information only and is representative of current that can be expected through various sizes of soft annealed copper magnet wire for two levels of current density. Shown are 375 Circular MILs per ampere (higher current density) and 1000 Circular MILs per ampere (lower current density). Commonly used current density levels are 375, 500, 750 and 1000 CM/A. Impedance is not a factor in determining the currents.

Notes:

1/ Use of lower current density is recommended for complex devices, but is application and performance driven. Among the factors that must be considered for selection of wire size and current density in custom magnetic devices, are complexity of the magnetic device, determined by: 1) desired performance, magnetic field strength or flux density, which influences the number of windings, wire size and insulation coating thickness (single coating vs. heavy coating), and core geometry; 2) electrical requirements: applied voltage, duty cycle, and frequency; and 3) environmental requirements: ambient temperature, and heat rise above ambient temperature, determined by the ability to dissipate or extract heat from the magnetic device.

2/ Heavy coating is preferred from a dielectric strength and abrasion resistance need, but is also a thermal barrier that restricts heat dissipation in complex devices. Heavy coating also slightly reduces the magnet flux density of the device.

3/ High temperature magnet wire (180°C or greater) is preferred for complex multilayer custom magnetic devices.

4/ Other design requirements for custom magnetic devices are listed in MIL-STD-981.

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13. ABSTRACT *(Maximum 200 words)*

The purpose of this document (EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating) is to establish baseline criteria for selection, screening, qualification, and derating of EEE parts for use on NASA GSFC space flight projects. This document shall provide a mechanism to assure that appropriate parts are used in the fabrication of space hardware that will meet mission reliability objectives within budget constraints. This document provides instructions for meeting three reliability levels of EEE parts requirements based on mission needs. The terms "grade" and "level" are considered synonymous; i.e., a grade 1 part is consistent with reliability level 1. Levels of part reliability confidence decrease by reliability level, with level 1 being the highest reliability and level 3 the lowest. A reliability level 1 part has the highest level of manufacturing control and testing per military or DSCC specifications. Level 2 parts have reduced manufacturing control and testing. Level 3 Parts have no guaranteed reliability controls in the manufacturing process and no standardized testing requirements. The reliability of level 3 parts can vary significantly with each manufacturer, part type and LDC due to unreported and frequent changes in design, construction and materials. GSFC projects and contractors shall incorporate this guideline into their Project EEE Parts Program.

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