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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

ES43

MSFC TECHNICAL STANDARD

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS MANAGEMENT AND CONTROL REQUIREMENTS FOR MSFC SPACE FLIGHT HARDWARE

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DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		11/29/99	Initial Release
Revision	A	2/14/2012	Revision A released; document authorized through MPDMS. Changed name of document from "EEE Parts Management and Control for MSFC Space Flight Hardware" to "Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware." Renumbered paragraphs throughout document as necessary. Added/deleted/updated documents in Section 2.0. Added/deleted/updated definitions, acronyms, and abbreviations in Section 3.0. Added Table I, EEE Part Types in paragraph 4.1. Renumbered baseline document Table I EEE Parts Grade Description and Table II Comparison of EEE Parts Grades to Table II and Table III, respectively, and updated contents of both tables. Moved baseline document Table 3 Derating Guidelines to Appendix A; updated derating criteria for several part types. Edited contents of Table IV Hazard Avoidance. Added Pure Tin Finish Avoidance Section 5.4.4.1. Added Section 5.4.5 Cuprous Oxide (Red Plague) Control. Added reference to the NASA Parts Selection List (NPSL) to paragraph 5.5.1 and several locations throughout the document. Added paragraph 5.5.5 Plastic Encapsulated Microcircuits (PEMs) and Appendix B Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, Qualification and Derating. Updated baseline Section 5.5.3 for the verification of parts, defining more detailed requirements, and moved it to section 6.0. Moved baseline paragraph 5.5.2 Part Substitutions to paragraph 5.5.6. Updated baseline paragraph 5.6.5 Traceability requirements and moved to paragraph 5.5.7; added paragraph 5.5.7.1 Traceability for Grade 4. Added 5.6.4 EEE Parts Application (Derating) Analysis. Renamed baseline paragraph 5.7.1 "Lifetime Parts Availability" as "Parts Availability" and moved to paragraph 5.7.3. Added paragraphs 5.7.1 Obsolescence Management and 5.7.2 Counterfeit EEE Parts Avoidance to address new requirements of NPD 8730.2C. Added paragraph 5.8.7 Reuse of EEE Parts. Replace baseline section 5.9 Off-The-Shelf Assemblies Requirements with 5.9 Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements. Updated selection and screening Tables V, VI, VII, and VIII for Grades 1, 2, 3, and 4 parts, respectively. Updated/added/renumbered screening/qualification Tables IX through XV; new tables added include Table IX, Requirements for Upgrade Screening and Qualification for Discrete Semiconductors for Use in Grade 1 Applications; Table XII, Requirements for Screening of Microcircuits; and Table XIII, Requirements for the Qualification of Microcircuits. Updated Grade 1, 2, 3, and 4 boilerplates and moved from Appendices A through B to Appendices C through F, respectively.

FOREWORD

1. This Standard establishes a uniform set of requirements for electrical, electronic, and electromechanical (EEE) parts selection, management, and control for space flight and mission essential ground support equipment for Marshall Space Flight Center (MSFC) programs. The parts requirements described in this document are to be selectively applied based on equipment grade and mission needs as specified in the Project Specification. Individual equipment needs should be evaluated to determine the extent to which each requirement should be applied.

2. This Standard:

   a. Establishes four quality levels (Grade 1, 2, 3, & 4) for EEE parts.

   b. Establishes EEE parts selection, and control requirements and provides in appendices a suggested approach for each of the above quality levels implementation.

   c. Establishes responsibility for documenting parts selection, qualification, and parts related data.

3. Questions concerning the application of this Standard shall be referred to the MSFC EEE Parts Engineering.

4. Beneficial comments and suggestions for improving this Standard may be submitted to the Office of Primary Responsibility (MSFC EEE Parts Engineering).

TABLE OF CONTENTS

PARAGRAPH **PAGE**

TABLE **PAGE**

APPENDIX **PAGE**

1.0 SCOPE

This Standard sets forth the selection, testing, and application requirements that each Project Manager shall use (tailor) to manage and control the electrical, electronic, and electromechanical (EEE) parts activities for MSFC space flight and mission essential ground support equipment in accordance with NPD 8730.2.

1.1 Implementation

While the actual selection of EEE parts is an engineering process, the detailed implementation into project baselines of the selected EEE parts shall be accomplished by the process as defined in the Project Configuration Management Plan. Should a conflict arise between this Standard and the Project Configuration Management Plan, the Project Configuration Management Plan shall govern.

1.2 Applicability

This publication applies to MSFC programs using EEE parts for flight hardware.

2.0 APPLICABLE DOCUMENTS

2.1 General

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or requests for proposal shall apply.

For canceled, inactive or superseded documents listed in this section, the latest revision prior to the canceled or superseded document shall be used. If compliance to the canceled, inactive or superseded document is not practical, the superseding document or other proposed documents must be approved by the project prior to use.

ANSI/ESD S20.20	Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
ANSI/NEMA WC27500	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded, General Specification for
ANSI/NEMA-MW-1000	Magnet Wire
ASTM B298	Standard Specification for Silver-Coated Soft or Annealed Copper Wire
EEE-INST-002	GSFC Instructions for EEE Parts Selection, Screening, Qualification, and Derating
GEIA-STD-0006	Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts

J-STD-001E	Requirements for Soldered Electrical and Electronic Assemblies
J-STD-001ES	Space Applications Electronic Hardware Addendum to Institute of Interconnecting and Packaging Electronic Circuits (IPC) J-STD-001E
J-STD-004	Requirements for Soldering Fluxes
J-STD-005	Requirements for Soldering Pastes
J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
MIL-DTL-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-DTL-5015	Detail Specification: Connectors, Electrical, Circular Threaded, AN Type, General Specification for
MIL-DTL-9395	Switches, Pressure, (Absolute, Gage, Differential), General Specification for
MIL-DTL-24308	Connectors, Electric, Rectangular, Nonenvironmental, Miniature, Polarized Shell, Rack and Panel, General Specification for
MIL-DTL-26482	Connector, Electrical, (Circular, Miniature, Quick Disconnect, Environment Resisting), Receptacles and Plugs, General Specification for
MIL-DTL-38999	Connector, Electrical Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for
MIL-DTL-55302	Connectors, Printed Circuit Subassembly and Accessories
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated Copper or Copper Alloy
MIL-DTL-83505	Sockets, (Lead, Electronic Components) General Specification for
MIL-DTL-83513	Connectors, Electrical, Rectangular, Microminiature, Polarized Shell, General Specification for
MIL-DTL-83517	Connector, Coaxial, Radio Frequency for Coaxial, Strip or Microstrip Transmission Line, General Specification for

MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-HDBK-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-PRF-20	Capacitors, Fixed, Ceramic Dielectric (Temperature Compensating), Established Reliability and Non-Established Reliability, General Specification for
MIL-PRF-27	Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification for
MIL-PRF-123	Capacitors, Fixed, Ceramic Dielectric (Temperature Stable and General Purpose), High Reliability, General Specification for
MIL-PRF-81	Capacitors, Variable, Ceramic Dielectric, General Specification for
MIL-PRF-3098	Crystal Units, Quartz, General Specification for
MIL-PRF-6106	Relays, Electromagnetic General Specification for
MIL-PRF-8805	Switches and Switch Assemblies, Sensitive, Snap Action (Basic, Limit, Push Button and Toggle Switches), General Specifications for
MIL-PRF-14409	Capacitors, Variable (Piston Type, Tubular Trimmer), General Specification for
MIL-PRF-15305	Coils, Fixed and Variable, Radio Frequency General Specification for
MIL-PRF-15733	Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-PRF-19500	Semiconductor Devices, General Specification for
MIL-PRF-19978	Capacitors, Fixed, Plastic (Or Paper-Plastic) Dielectric, (Hermetically Sealed In Metal, Ceramic, Or Glass Cases), Established and Non-Established Reliability, General Specification for
MIL-PRF-21038	Transformers, Pulse, Low Power, General Specification for
MIL-PRF-23269	Capacitors, Fixed, Glass Dielectric, Established Reliability, General Specification for

MIL-PRF-23419	Fuse, Cartridge, Instrument Type, General Specification for
MIL-PRF-23648	Resistor, Thermal (Thermistor), Insulated, General Specification for
MIL-PRF-24236	Switches, Thermostatic, (Metallic and Bimetallic), General Specification for
MIL-PRF-28861	Filters and Capacitors, Radio Frequency/Electromagnetic Interference Suppression, General Specification for
MIL-PRF-32159	Resistors, Chip, Fixed, Film, Zero Ohm, Industrial, High Reliability, Space Level, General Specification for
MIL-PRF-32192	Resistors, Chip, Thermal (Thermistor), General Specification for
MIL-PRF-38534	Hybrid Microcircuits, General Specification for
MIL-PRF-38535	Integrated Circuits (Microcircuits) Manufacturing, General Requirements for
MIL-PRF-39001	Capacitors, Fixed, Mica Dielectric Established Reliability, and Nonestablished Reliability, General Specification for
MIL-PRF-39003	Capacitors, Fixed, Electrolytic (Solid-Electrolyte) Tantalum, Established Reliability, General Specification for
MIL-PRF-39005	Resistors, Fixed, Wire-Wound, (Accurate), Nonestablished Reliability, Established Reliability, General Specification for
MIL-PRF-39006	Capacitors, Fixed, Electrolytic (Non-Solid Electrolyte) Tantalum, Established Reliability, General Specification for
MIL-PRF-39007	Resistors, Fixed, Wirewound (Power Type), Nonestablished Reliability, Established Reliability, and Space Level, General Specification for
MIL-PRF-39009	Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Nonestablished Reliability, and Established Reliability, General Specification for
MIL-PRF-39010	Coil, Radio Frequency, Fixed, Molded, Established Reliability and Non-Established Reliability, General Specification for
MIL-PRF-39012	Connectors, Coaxial, Radio Frequency, General Specification for

MIL-PRF-39014	Capacitors, Fixed, Ceramic Dielectric (General Purpose) Established Reliability, and Nonestablished Reliability, General Specification for
MIL-PRF-39015	Resistors, Variable, Wire-Wound (Lead Screw Actuated), Nonestablished Reliability, and Established Reliability, General Specification for
MIL-PRF-39016	Relays, Electromagnetic, Established Reliability, General Specification for
MIL-PRF-39017	Resistors, Fixed, Film (Insulated) Nonestablished Reliability, and Established Reliability, General Specification for
MIL-PRF-39019	Circuit Breakers, Magnetic, Low-Power, Sealed, Trip-Free, General Specification for
MIL-PRF-39022	Capacitors, Fixed, Metallized, Paper- Plastic Film or Plastic Film Dielectric, Direct and Alternating Current (AC), (Hermetically Sealed in Metal or Ceramic Cases), Established Reliability, General Specification for
MIL-PRF-39035	Resistors, Variable, Nonwire-Wound (Adjustment Type) Nonestablished Reliability, and Established Reliability, General Specification for
MIL-PRF-49142	Connectors, Triaxial, Radio Frequency, General Specification for
MIL-PRF-49464	Capacitors, Chip, Single Layer, Fixed, Parallel Plate, Ceramic Dielectric, Established Reliability, General Specification for
MIL-PRF-49467	Capacitor, Fixed, Ceramic, Multilayer, High Voltage (General Purpose), Established Reliability, General Specification for
MIL-PRF-49470	Capacitor, Fixed, Ceramic Dielectric, Switch Mode Power Supply (General Purpose and Temperature Stable), General Specification for
MIL-PRF-55182	Resistors, Fixed, Film, Nonestablished Reliability, and Established Reliability General Specification for
MIL-PRF-55310	Oscillator, Crystal Controlled, General Specification for
MIL-PRF-55342	Resistors, Fixed, Film, Chip, Nonestablished Reliability Established Reliability, General Specification for

MIL-PRF-55365	Capacitor, Fixed, Electrolytic (Tantalum), Chip, Nonestablished Reliability, Established Reliability, General Specification for
MIL-PRF-55681	Capacitors, Chip, Multiple Layer, Fixed, Ceramic Dielectric, Established Reliability and Nonestablished Reliability, General Specification for
MIL-PRF-83401	Resistor Networks, Fixed, Film, and Capacitor-Resistor Networks, Ceramic Capacitor and Fixed Film Resistors, General Specification for
MIL-PRF-83421	Capacitors, Fixed, Metallized, Plastic Film Dielectric (Direct Current (DC), AC, Or DC and AC) Hermetically Sealed In Metal or Ceramic Case, Established Reliability, General Specification for
MIL-PRF-83446	Coils, Chips, Fixed Or Variable, General Specification for
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Method Standard Microcircuits
MIL-STD-981	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications
MIL-STD-1553	Digital Time Division Command/Response Multiplex Databus
MIL-STD-1580	Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts
MSFC-RQMT-2918	Requirements for Electrostatic Discharge Control
MSFC-SPEC-548	Specification for Vacuum Baking Of Electrical Connectors for Space Applications
MSFC-SPEC-684	Specification for Vacuum Baking Of Electrical Cables for Space Applications
MSFC-SPEC-1198	Screening Requirements for Nonstandard Electrical, Electronic, and Electromechanical (EEE) Parts
MSFC-STD-355	Standard Radiographic Inspections Of Electronic Parts

MSFC-STD-3619	MSFC Counterfeit Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for Space Flight and Ground support Hardware
MSFC-STD-3620	MSFC Electrical, Electronic, Electromechanical (EEE) Parts Obsolescence Management and Control Requirements
MWI 1280.5	MSFC Alert Processing
NASA GSFC S-311-424	Thermistor (Thermally Sensitive Resistor), Insulated, Negative Temperature Coefficient, Super Stable, Glass Encapsulated, Style 311-424, Specification for
NASA GSFC S-311-641	Switches, Thermostatic, General Requirements for
NASA GSFC S-311-P-4	Connectors (and Contacts), Electrical, Rectangular, for Space Flight Use, General Specification for
NASA GSFC S-311-P-10	Connectors, Electrical, Rectangular, Miniature, Polarized Shell, Rack and Panel, for Space Flight Use
NASA GSFC S-311-P-18	Thermistor, (Thermally Sensitive Resistor), Insulated and Uninsulated, Negative Temperature Coefficient, Specification for
NASA GSFC S-311-P-626	Connectors, Electric, Miniature Polarized Shell, Rack and Panel, Pin, Electromagnetic Interference Filter Contact, Nonmagnetic Solder Type
NASA GSFC S-311-P-718	Connectors, Electrical, Rectangular, Polarized Shell, for Space Flight Use, Detail Specification for
NASA GSFC S-311-P-742	Resistor, Fixed, Low TC, Precision, Radial-Lead (Caddock Type TK)
NASA GSFC S-311-P-754	Relays, Electromagnetic, General Specification for
NASA GSFC S-311-P-767	Thermistor, Hermetically Sealed, Cryogenic
NASA GSFC S-311-P-813	Resistor, Fixed, Low Temperature Characteristic, Precision, Radial-Lead
NASA GSFC S-311-P-822	Connectors, Printed Wiring Board (PWB), 2 mm Compact Peripheral Component Interconnect (cPCI) Style, High Reliability
NASA MSFC 40M38277	Connectors, Electrical, Circular, Miniature High Density, Environment Resisting, Specification for

NASA MSFC 40M38294	Connectors, Electrical, Circular, Cryogenic Environment Resisting, Specification for
NASA MSFC 40M38298	Connectors, Electrical, Special, Miniature Circular, Environment Resisting 200 °C, Specification for
NASA MSFC 40M39569	Connectors, Electrical, Miniature Circular, Environment Resisting, Specification for
NASA SSQ 21635	Connectors and Accessories, Electrical, Circular, Miniature, Intra-vehicular Activity/Extra-vehicular Activity (IVA/EVA) Compatible, Space Quality, General Specification for
NASA SSQ 21636	Connectors and Accessories, Electrical, Rectangular, Rack and Panel, Space Quality, General Specification
NASA SSQ 21637	Connectors and Accessories, Electrical, Umbilical Interface, Environmental, Space Quality, General Specification for
NASA SSQ 21652	Wire, Electric, Silicone Insulated, Nickel Coated Copper, Space Quality, General Specification for
NASA SSQ 21653	Cable, Coaxial, Twinaxial, and Triaxial, Flexible and Semirigid, General Specification for
NASA SSQ 21654	Cable, Single Fiber, Multimode, Space Quality, General Specification for
NASA SSQ 21655	Cable, Electrical, MIL-STD-1553 Data Bus, Space Quality, General Specification for
NASA SSQ 21656	Wire and Cable, Fluoropolymer-Insulated, Nickel Coated Copper or Copper Alloy, General Specification for
NASA SSQ 21676	Coupler, Data Bus, MIL-STD-1553, Space Quality, General Specification for
NASA SSQ 22680	Connector, Rectangular (ORU) Space Quality
NASA SSQ 22681	Connector Modular Rectangular, Space Quality
NASA SSQ 22698	Connector, Electrical, Circular, EVA/IVA Compatible, Space Quality, General Specification for
NASA SSQ 22720	Wire, Crosslinked Ethylene Tetrafluoroethylene, General Specification for

NASA-STD-6001	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials In Environments That Support Combustion
NASA-STD-6016	Standard Materials and Processes Requirements for Spacecraft
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses, and Wiring
NEPAG-LLB-2001-002	NASA EEE Parts Assurance Group (NEPAG) Lessons Learned Bulletin, Reverse Polarity Concerns with Tantalum Capacitors
NPD 8730.2	NASA Parts Policy
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
SAE-AS22759	Wire, Electrical, Fluoropolymer-Insulated Copper Or Copper Alloy
SAE-AS39029	Contacts, Electrical Connector, General Specification for
SAE-AS50151	Connectors, Electrical, Circular Threaded, An Type, General Specification for
SAE-AS81703	Connectors, Electric, Circular, Miniature, Rack and Panel or Push-Pull Coupling, Environment Resisting
SAE-AS85049	Connector Accessories, Electrical, General Specification for
SP-R-0022A	Specification, Vacuum Stability Requirements Of Polymeric Material for Spacecraft Application

3.0 DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

3.1 Definitions

Boilerplate	A document that is or can be reused in new contexts or applications with little change from the original.
Commercial and Government Entity (CAGE) code	An identifying code assigned by the Government that unambiguously identifies EEE part sources.
Commercial	A classification for an assembly, part, or design for which the item manufacturer or vendor establishes performance and quality standards pursuant to market forces rather than by enforceable compliance to a government or industry standard.
Custom Processed Part	An electronic part procured to a non-military specification that is built, tested, and qualified in full accordance to the requirements of a similar military specification and meets the MSFC-STD-3012 Grade selection criteria.
Derating	Derating of a part is the intentional reduction of its electrical, mechanical and thermal stresses for the purpose of providing a margin between the applied stress and the actual demonstrated limit of the part capabilities.
Destructive Physical Analysis (DPA)	A series of inspections and tests performed on samples of a EEE part and resulting in damage to the samples. Usually part of a failure analysis or quality conformance inspection.
Deviation	A specific written authorization, granted prior to the manufacture of a Configuration Item (CI), to depart from a particular requirement of a CI's current approved configuration for a specific number of units or a specified period of time.
Franchised Distributor	A source authorized by the original component manufacturer to distribute its parts.
Government Industry Data Exchange Program (GIDEP)	An organization through which users and suppliers of EEE parts may exchange information such as part design changes and failure experiences.
Grade 1	A classification which designates EEE parts of the highest practical quality standards.
Grade 2	A classification which designates EEE parts of high, but generally not the highest, quality standards.
Grade 3	A classification which designates EEE parts which generally meet some formal industry quality standards, but usually the lowest quality class option that is available under the standards.
Grade 4	A classification which designates EEE parts for which no predefined quality classification is imposed.

Heritage Hardware	Unmodified hardware whose design has been qualified and used in space applications, and was accepted for use by NASA.
Lot Date Code (LDC)	An identification, usually marked on a EEE part and prescribed by the applicable specification, to identify parts which have been processed as a batch.
Multi-Chip Module (MCM)	A type of hybrid microcircuit consisting of multiple semiconductor chips mounted on a substrate.
Nonstandard Part	A EEE part that meets program piece part qualification requirements and is designated “nonstandard” in the applicable Grade level table.
Off-The-Shelf (OTS) Hardware	Assembly, part, or design that is readily available for procurement, usually to catalog specifications, without the necessity of generating detail procurement specifications for the item.
Qualification	Tests consisting of mechanical, electrical, and environmental inspections 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.
Qualified Manufacturers List (QML)	A classification issued by a qualifying agency that identifies products, processes, and manufacturers that have met certain standards for qualification.
Qualified Parts List (QPL)	A classification issued by a qualifying agency that identifies products and manufacturers that have met certain standards for qualification.
Quality Conformance Inspection (QCI)	Inspection, or test, used to verify conformance with requirements.
Screening	Tests 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.
Standard Part	A EEE part that meets program piece part qualification requirements and is designated “standard” in the applicable Grade level table.
Vendor Hi-Rel	A term used to describe parts that have been screened and qualified to requirements that have been enhanced from the manufacturer’s normal flow, as determined solely by the manufacturer, and offered as high reliability parts.
Waiver	A written authorization, granted after manufacture, to accept a CI that is found to depart from specified requirement(s) of the CI’s current approved configuration for a specific number of units or a specified period of time.

3.2 Acronyms and Abbreviations

AC	Alternating Current
ALERT	Acute Launch Emergency Restraint Tip
ANSI	American National Standards Institute
AOQ	Average Outgoing Quality
ASIC	Application Specific Integrated Circuit
ASTM	American Society for Testing and Materials
BIST	Backward Instability Shock Test
CA	Construction Analysis
CAGE	Commercial and Government Entity
CI	Configuration Item
COQ	Certificate of Qualification
cPCI	Compact Peripheral Component Interconnect
Cpk	Capability index
CVCM	Collected Volatile Condensable Materials
DC	Direct Current
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DPA	Destructive Physical Analysis
DTL	Detail
DWV	Dielectric Withstanding Voltage
EEE	Electrical, Electronic, and Electromechanical
ELDRS	Enhance Low Dose Rate Sensitivity
ER	Established Reliability
ESD	Electrostatic Discharge
ETFE	Ethylene Tetrafluoroethylene
EVA	Extra-vehicular Activity
FET	Field Effect Transistor
FIST	Forward Instability Shock Test
FRL	Failure Rate Level
GEIA	Government Electronics & Information Technology Association
GIDEP	Government Industry Data Exchange Program

GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HDBK	Handbook
HTOL	High Temperature Life Testing
IGA	Internal Gas Analysis (also denoted as Residual Gas Analysis (RGA))
INST	Instructions
IPC	Institute of Interconnecting and Packaging Electronic Circuits
IR	Insulation Resistance
IVA	Intra-vehicular Activity
JAN	Joint Army Navy
JEDEC	Joint Electron Device Engineering Council
LDC	Lot Date Code
LED	Light Emitting Diode
LTPD	Lot Tolerance Percent Defective
MCM	Multi-Chip Module
MIL-PRF	Military Performance
MSFC	Marshall Space Flight Center
MTBF	Mean Time Between Failure
MWI	Marshall Work Instruction
NASA	National Aeronautics and Space Administration
NTC	Negative Temperature Coefficient
NEMA	National Electrical Manufacturers Association
NEPAG	NASA EEE Parts Assurance Group
NEPP	NASA Electronic Parts and Packaging Program
NPSL	NASA Parts Selection List (maintained on the Internet by NEPP/NEPAG) (http://nepp.nasa.gov/npsl/)
NSPAR	Nonstandard Part Approval Request
NSTS	NASA Space Transportation System
OCM	Original Component Manufacturer
ORU	Orbital Replacement Unit
OTS	Off-The-Shelf
Pb	Lead

PDA	Percent Defective Allowable
PDR	Preliminary Design Review
PEM	Plastic Encapsulated Microcircuit
PIND	Particle Impact Noise Detection
PRTD	Platinum Resistance Temperature Detectors
PSIG	Pound-force per Square Inch Gauge
PTC	Positive Temperature Coefficient
PWB	Printed Wiring Board
QCI	Quality Conformance Inspection
QML	Qualified Manufacturers List
QPD	Qualified Products Database
QPL	Qualified Product List
RGA	Residual Gas Analysis (also denoted as IGA)
RHA	Radiation Hardness Assurance
RMS	Root Mean Square
RPCM	Remote Power Control Module
RQMT	Requirement
RTD	Resistance Temperature Detector
SAE	SAE International
SCD	Source Control Drawing
SEE	Single Event Effect
SMT	Surface Mount Technology
SPEC	Specification
SSQ	Space Station Quality
STD	Standard
TC	Temperature Coefficient
TFE	Polytetrafluoroethylene
TID	Total Ionizing Dose
TML	Total Mass Loss
VICD	Vendor Item Control Drawing

4.0 GENERAL

Requirements herein apply to the part types listed in Table I.

The EEE parts requirements herein also apply to EEE parts in sensor assemblies where basic sensing/transducer pieces (resistive temperature detector (RTD), strain gauge, etc.) are packaged in an assembly with other electrical part types such as wire, connector, resistor, etc.

In the absence of other requirements, electronic parts and materials should be manufactured and processed to applicable guidelines referenced in MIL-HDBK-454, General Guidelines for Electronic Equipment or MIL-HDBK-1547, Electronic Parts, Materials, and Processes for Space and Launch Vehicles.

Table I. EEE Part Types

Part Types	Federal Stock Classes	Part Types	Federal Stock Classes
Capacitors	5910	Inductors	5950
Circuit Breakers	5925	Hybrid microcircuits	5962
Connectors	5935	Magnetics	5950
Crystal Oscillators	5955	Monolithic Microcircuits	5962
Diodes	5961	Relays	5945
Fiber Optic Accessories	6070	Resistors	5905
Fiber Optic Cables	6015	Switches	5930
Fiber Optic Conductors	6010	Thermistors	5905
Fiber Optic Devices	6030	Transformers	5950
Fiber Optic Interconnects	6060	Transistors	5961
Filters	5915	Wire and Cable	6145
Fuses	5920		

4.1 Selection of EEE Part Grade

Project planning shall establish for each end item which EEE part Grade described in Table II is required. The choice of the appropriate Grade in large part determines the reliability, and the cost associated with EEE parts. The following provides some guidance for selection of an appropriate Grade.

Table II. EEE Parts Grade Description

Grade	Summary	Reliability	Mean Time Between Failure (MTBF)	Cost	Typical Use
1	"Space" quality class qualified parts, or equivalent.	Highest	Longest	Very High	Space flight
2	"Full Military" quality class qualified parts, or equivalent.	Very High	Very Long	High	Space flight or critical ground support equipment
3	"Low Military" quality class parts, and Vendor Hi-Rel or equivalent.	Medium	Variable	Moderate	Space flight experiments and ground support
4	"Commercial" quality class parts. No qualification required. No government process monitors incorporated during manufacturing.	Variable	Variable	Lowest	Flight experiments and ground support

4.1.1 Grade 1

Grade 1 EEE parts typically meet the highest reliability standards, and have been subjected to independent verification. Grade 1 should be selected for equipment requiring maximum feasible reliability because of critical mission objectives and safety. The related project typically would have high visibility both within and outside of NASA, and could involve objectives which may be difficult to repeat in another mission. Missions of 5 years or longer may also require Grade 1 parts. Repair during the mission is not a practical or desirable option. The mission requires complete functional or block redundancy and requires project manager approval of single point failure situations. The application is typically critical and/or long duration space flight equipment.

4.1.2 Grade 2

Grade 2 EEE parts typically meet rigorous (but not the highest) industry reliability standards, and have been subjected to independent verification. Grade 2 should be selected for equipment that requires high reliability, but for which a low risk of failure can be tolerated to meet cost constraints. Missions of 1 to 5 years duration may use Grade 2 parts. The mission may be multiple or single purpose, with a repeat mission possible. Repair during the mission may be practical. Functional or block redundancy for all primary objectives is desirable but single string design may be acceptable. The application usually is space flight equipment or critical ground support equipment.

4.1.3 Grade 3

Grade 3 EEE parts typically meet standards for high reliability, but there may be significant exceptions and the parts may not have been independently verified. Grade 3 parts should be selected for equipment where high reliability is desired, but is not mandatory. The missions are typically for a single purpose or routine mission with repeat missions possible. Mission duration may be less than 1 year. Repair during the mission would not necessarily be considered worthwhile. Single string design would normally be acceptable. The application is usually space flight experiments or ground support equipment.

4.1.4 Grade 4

Grade 4 EEE parts typically meet vendor standards for high reliability or commercial market place reliability, but have not been independently verified. Grade 4 should be selected for equipment where high reliability is not a primary factor, the mission is not critical, or a repeat mission is possible. The duration of a mission would typically not be lengthy. Repair may be very practical. This is a typical choice for flight experiments and ground support equipment.

5.0 EEE PARTS SELECTION AND CONTROL REQUIREMENTS

5.1 Parts Management and Control Requirements Document

All equipment containing EEE parts shall be produced under the control of an approved EEE parts management and control requirements document, herein referred to as the Control Document. The requirements of the Control Document shall be established to obtain the appropriate quality level (Grade 1, 2, 3 or 4), or equivalent, for EEE parts (reference Table III). Project requirements shall specify which Grade of EEE parts is to be applied to project equipment, and shall identify the applicable EEE Parts Control Document.

5.1.1 Parts Control Document Scope

The Control Document shall control EEE parts activities from the equipment design and development phase through use and maintenance of the system and equipment. The Control Document shall document the requirements for part qualification, quality assurance for parts, parts application criteria, parts related data, parts configuration control, life time availability of parts, manufacturing and handling considerations, and parts in Heritage Hardware and Off-The-Shelf (OTS) assemblies.

5.1.2 Implementation

Project management shall approve and oversee the implementation of the EEE parts Control Document. The Control Document shall identify the authority or organization that will serve as the focal point EEE parts organization. If a parts control board serves as the focal point EEE parts organization, the project shall determine the membership of the board. The Control Document, or requirements of the Control Document, shall be imposed on each sub-tier organization as applicable.

Table III. Comparison of EEE Part Grades

ITEM	GRADE 1	GRADE 2	GRADE 3	GRADE 4
Typical Minimum Quality Class for First Choice.	Microcircuit: Class S or V Hybrid Microcircuit: Class K Discrete Semiconductor: JANS (Joint Army-Navy, Class S) Cap. Or Resistor: Failure Rate Level (FRL) S, R or C Other: Various	Microcircuit: Class B or Q Hybrid Microcircuit: Class H Discrete Semiconductor: JANTXV Cap. Or Resistor: FRL R, P, or B Other: Various	Microcircuit: Class M, N, T, or /883 Hybrid: Class G, D, or E Discrete Semiconductor: JANTX Cap. or Resistor: P or B, and Other Other: Various Vendor Hi-Rel	Commercial (Often is PEM)
PIND & X-Ray	Intrinsic to Class	Accomplished by additional screening	Recommended but not required	No
Typical Minimum Piece Part Qualification	Military or NASA or equivalent		Variable	Not specified
Radiation Hardness Assurance (RHA) by Analysis and/or Test	Yes, when specified			Yes, where feasible
Procurement Limited to Qualified Source	Yes			No
Lot Quality Conformance Inspection Required	Yes	Yes, but less stringent than Grade 1 requirements	Yes, but much less stringent than Grade 2 requirements	No
Screening	100% minimum	100% minimum, but not as stringent as Grade 1	Some, but minimum not specified	No
Hazard Avoidance	Yes			
Specification and Control Drawings	Military, NASA, or Industry Standard, or Project prepared Control Drawing (e.g. SCD, VICD)	Mostly Military, NASA, or Industry Standards, or Project prepared Control Drawing, but also limited use of Vendor Specifications.	Vendor Specifications, Industry and Organizational Standards, and Military or NASA Standards.	Optional

continued on next page

Table III. Comparison of EEE Part Grades

(continued from previous page)

ITEM	GRADE 1	GRADE 2	GRADE 3	GRADE 4
ASSOCIATED PROJECT ACTIVITIES REQUIREMENTS				
Derating	Yes			Optional
Nonstandard Part Approval Request	For a part not listed as a standard Grade 1 part which may be determined acceptable to use in a Grade 1 application.	For a part not listed as a standard Grade 2 part which may be determined acceptable to use in a Grade 2 application.	For a part not listed as a standard Grade 3 part which may be determined acceptable to use in a Grade 3 application.	Not required
As-Designed EEE Parts List	Yes			
Traceability	By Lot and Serial Number as a Minimum	By Lot as a Minimum	By Lot as a Minimum	By Part Manufacturer
Part Selection Preferences Specified	Yes			No
Substitutions Restricted	Yes			No
As-Built EEE Parts List	Yes			

5.1.3 Affected Parts

The Control Document shall apply to the EEE part types listed in Table I. The Control Document shall also apply to the EEE parts in Table I used in sensor assemblies (refer to paragraph 4.0 herein).

5.1.4 Structure

The Control Document shall meet applicable requirements herein. The EEE parts Control Document shall be organized clearly, concisely and unambiguously. The Control Document may be a separate document or part of the Project Plan, Quality Plan, or other project document. The responsible organization may prepare a tailored Control Document, or adopt one or more of the Control Documents contained herein as appendices (Appendix C for Grade 1 parts, Appendix D for Grade 2 parts, Appendix E for Grade 3 parts, and Appendix F for Grade 4 parts).

5.2 Qualification Requirements

Grades 1, 2, and 3 EEE parts shall be qualified at the piece part level. For projects using Grade 4 EEE parts, assembly level qualification shall be sufficient.

5.2.1 Piece Part Level

Qualification at the piece part level shall be achieved by meeting designated military or NASA standards piece part qualification requirements or by other means as documented for nonstandard part approval. Requirements for qualification of nonstandard parts shall be equivalent to the requirements imposed on similar standard parts, or shall otherwise satisfactorily demonstrate that the part has an approved margin of safety beyond the demands of the equipment in which it will be used.

5.2.2 Assembly Level

Part qualification at the assembly level shall be based upon qualification testing of the assembled equipment. A part shall be qualified for a given application within the equipment by successful performance during the equipment qualification testing, or by similarity to a part which has been so qualified.

5.3 Quality Assurance Requirements

Quality assurance shall include assurance of procurement from qualified sources, lot Quality Conformance Inspection (QCI), screening, and receiving inspection. All inspections and test procedures that are used by the acquiring activity to determine the quality and/or conformance of a part to the controlling specification shall be documented by the acquiring activity. Established test methods and acceptance criteria such as those in MIL-STD-202, MIL-STD-750, MIL-STD-883, and military Established Reliability (ER) specifications shall be used as applicable.

5.3.1 Procurement Sources

EEE parts shall be procured only from the original component manufacturers (OCM) or their franchised (authorized) distributors.

5.3.1.1 Audits

Parts acquisition shall include audit of non QPL/QML/Qualified Products Databases (QPDs) manufacturers to ensure compliance to requirements herein. Audits shall be performed in accordance with NPD 8730.2. Audits are not required for Grade 4 parts.

5.3.2 Quality Conformance Inspection (QCI)

QCI shall ensure that each lot of Grade 1, 2, or 3 parts meets the requirements of the part controlling specification. The QCI provisions of applicable military standards shall be sufficient for parts listed in military or NASA QPLs, QMLs, or QPDs unless otherwise specified in MSFC-STD-3012 Tables V, VI, and VII Standard Parts Selection and Preferences for Grade 1, 2, and 3, respectively.

5.3.2.1 Destructive Physical Analysis (DPA)

Requirements for DPA shall be as designated in Tables V, VI, or VII for Grades 1, 2, and 3 EEE parts. DPA sample size shall be in accordance with MIL-STD-1580 unless otherwise specified herein. Any lot of parts not meeting the DPA acceptance criteria shall not be used in equipment without focal point EEE parts organization approval.

In addition, all DPA samples from non QPL/QML/QPD manufactured EEE part lots shall be tested internally and externally for pure tin as defined in Section 5.4.4.1 herein.

5.3.3 Screening

All Grades 1, 2 and 3 parts shall be subjected to screening. Part screening shall be designed to remove defective parts and thus increase reliability. Screening shall be in accordance with Tables V, VI, and VII.

5.3.3.1 Particle Impact Noise Detection (PIND)

PIND testing shall meet the requirements as specified in Tables V, VI, and VII for Grades 1, 2, and 3 EEE parts, respectively. PIND testing may be met in the part manufacturer's processing, in third party laboratory testing, or by the acquiring activity.

5.3.3.1.1 MSFC In-house PIND

MSFC in-house PIND testing shall meet the requirements of the applicable MSFC EEE Parts Engineering PIND Test Procedure Organizational Issuance.

5.3.3.2 Radiographic (X-Ray) Inspection

Radiographic inspection shall meet the requirements as specified in Tables V, VI, and VII for Grades 1, 2, and 3 EEE parts, respectively. Radiographic inspection may be met in the part manufacturer's processing, in third party laboratory testing, or by the acquiring activity.

5.3.3.2.1 MSFC In-house X-Ray

MSFC in-house x-ray inspection shall meet the requirements of the applicable MSFC EEE Parts Engineering Radiography Procedure Organizational Issuance.

5.3.4 Receiving Inspection

All parts shall be subjected to receiving inspection by the acquiring activity to verify compliance with the controlling specifications. Testing shall be defined in the procurement requirements.

5.3.5 Quality Assurance Data

Results of receiving inspection, destructive physical analyses, material review boards, failure review boards, and parts problems reported from the field shall be documented and submitted to the project office for appropriate distribution, review, and retention by the project office.

5.3.6 Government Industry Data Exchange Program

EEE part problems shall be reported by the equipment design organization through the Government Industry Data Exchange Program (GIDEP), either directly for GIDEP participants or through the acquiring activity for non-participants.

5.3.6.1 MSFC ALERTs

The equipment design organization shall assess and report to the project office the impact of an MSFC Acute Launch Emergency Restraint Tip (ALERT) on the equipment end item.

Alerts and Problem Advisories distributed by GIDEP and reissued by MSFC as "FULL – ALERTs" shall be evaluated for impact and corrective actions in accordance with MWI 1280.5, MSFC ALERT Processing.

5.3.6.1.1 MSFC In-house ALERT

MSFC in-house ALERT activities shall be in accordance with MWI 1280.5.

5.4 Application Criteria Requirements

Parts shall be properly applied in the design.

5.4.1 Derating

Derating requirements of Appendix A, or approved equivalent, shall be met by the design. A derating analysis (refer to paragraph 5.6.4 herein) shall be performed by the cognizant design organization and shall be submitted for project review. Project approval shall be obtained prior to use of a part in an application where derating requirements are not met. For Grade 4 parts, derating of parts and the derating analysis are optional.

For hybrid microcircuits, all active and passive elements shall be derated. Applicable source control documents shall specify element derating in accordance with Appendix A.

5.4.2 Operating Environment

EEE parts shall be tested to demonstrate the parts will perform nominally in the proposed operating environment. Operating environmental conditions include but are not limited to the temperature, humidity, shock, vibration, and radiation to which the parts will be exposed. Military qualified parts define the environmental qualifications and tend to satisfy these conditions except for radiation.

5.4.3 Ionizing Radiation

For Grades 1, 2, and 3 parts, and where feasible for Grade 4 parts, used in space flight applications, the effects of the projected ionizing radiation on each part shall be determined by analysis and/or test. Radiation evaluation shall address all threats appropriate for the technology, application, and environment, including total ionizing dose (TID), Enhance Low Dose Rate Sensitivity (ELDRS), single event effects (SEE), and displacement damage as defined in the project ionizing radiation control document and shall be assessed on a lot-specific basis according to the project requirements. Failure mitigation or a design margin shall be established by the project to assure acceptable performance in the projected radiation environment.

5.4.4 Hazard Avoidance

Grades 1, 2, and 3 EEE parts shall comply with the program requirements for hazard avoidance (e.g. NSTS 1700.7, NASA-STD-6016, or equivalent program document), Table IV, and the following subparagraphs. All EEE part grades, including Grade 4, shall avoid the prohibited materials listed in Table IV, Hazard Avoidance.

Table IV. Hazard Avoidance

ITEM	PROHIBITED
1	Zinc chromate as a finish
2	Cadmium or zinc, whether plated, unfused or fused, as a finish coat or internal to the device, must not be used in a vacuum environment or in close proximity to personnel during flight or flight simulation
3	Mercury liquid (because of its toxicity and tendency to penetrate joints or amalgamate with structural materials)
4	Polyvinyl chloride (outgasses products that are hazardous and corrosive)
5	Pure tin plated parts or hardware except for tin plated wires where specifically approved. Pure tin finish is defined as a tin alloy that contains less than 3% lead (Pb) by mass.
6	Nylon materials

5.4.4.1 Pure Tin Finish Avoidance

Any EEE part where pure tin finish is not precluded by the military QPL/QML/QPD, or specification control document, shall be tested internally and externally for pure tin as defined in Table IV. The minimum sample size shall be two devices or two percent of the lot, whichever is greater, to a maximum of five samples.

If parts fail to meet the 3% lead by mass requirement, the preferred method to mitigate the risk from pure tin is to solder dip the expose tin finish in accordance with GEIA-STD-0006, Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts. If the solder dip process is not practical, the risk from pure tin shall be mitigated in accordance with IPC J-STD-001ES, Space Applications Electronic Hardware Addendum to IPC J-STD-001E, Requirements for Soldered Electrical and Electronic Assemblies, Clause 0.1.6, Use of Lead-Free Tin.

5.4.4.2 Oxygen Enriched Atmosphere

EEE parts exposed to an oxygen-enriched atmosphere capable of sustaining combustion shall operate without introducing any fire hazard due to either normal operation or malfunctions occurring during the life of the equipment. This requirement may be met though use of hermetically sealed parts, hermetically sealed equipment enclosures, suitable conformal coatings, or choice of materials. An oxygen enriched environment is an air mixture of greater than 21 percent oxygen or high pressure air greater than 100 pound-force per square inch gauge (psig).

5.4.4.3 Parts and Materials

The hazardous characteristics of arc generation, flammability, and offgassing of all parts and materials shall be considered and the requirements of NASA-STD-6001, or equivalent, shall be met. Also, organic, polymeric, and inorganic materials (i.e. potting compounds, coatings, films, adhesives, elastomers, etc.) used in the construction of EEE parts shall meet the outgassing requirements of SP-R-0022A or equivalent.

5.4.4.4 Thermal Vacuum Bake

Connectors and backshells shall be subjected to thermal vacuum bake per MSFC-SPEC-548 or approved equivalent except when it can be shown that connectors and backshells are not susceptible to stress corrosion. Qualified space rated connectors and accessories (e.g. NASA SSQ 21635, 40M's, etc.) have already been evaluated and/or processed to control stress corrosion, outgassing, and cleanliness and negates the need for bake out or further processing.

Cable assemblies shall be thermal vacuum baked per MSFC-SPEC-684 or approved equivalent unless outgassing concerns/issues are addressed at a system level rather than the parts and/or components level.

5.4.5 Cuprous Oxide (Red Plague) Control

The use of silver plated wire in Grade 1, 2, and 3 parts applications and in Grade 4 application when feasible shall require the implementation of red plague control as outlined below. This requirement shall also be imposed upon vendors whose product contains silver plated wire. Wire not meeting the following criteria shall not be used.

5.4.5.1 Red Plague Control Summary

1. The assembly process shall be conducted in a controlled environment where the dew point is not attained. If the dew point is attained during assembly, the operation shall be stopped and the hardware relocated to a dry area as soon as possible to avoid damage to the hardware which could result in it being scrapped or discarded.
2. Before use in hardware construction, the wire shall be inspected for verification of sufficient plating and lack of “red plague” (i.e., reddish brown discoloration or corrosion of the conductors). Remove and discard the first 6 to 12" of wire from the spool. Cut an additional 6" from the spool and remove its insulation. Inspect wire sample for nicks, cuts, exposed based material and red plague using magnification between 7X and 20X.
3. For solder terminations, the insulation shall be left on the wire until assembly, at which time the wire shall be stripped and tinned immediately to minimize the exposure time of the silver to the atmosphere.

   NOTE: Wires used for crimp terminations shall not be tinned.
4. During wire assembly the bend radius shall be controlled to a minimum of one (1) diameter to avoid overstressing which could result in cracking of the insulation and/or silver plating.
5. Wire ends shall be recapped before the wire is returned to storage.
6. Silver plated wire shall be stored in a controlled environment where the dew point is not attained.
7. Non-aqueous solvents (e.g., ethyl alcohol, isopropyl alcohol, etc.) shall be used for flux removal.
8. Completed cable harness assemblies shall be stored in moisture proof protection packaging with desiccant and humidity detector.

5.4.5.2 Wire Manufacturing Controls

The following controls shall be imposed on the manufacturer of any silver plated wire:

1. Traceability to the plating bath so that a defective lot of wire can be definitely isolated.
2. Dry processing of insulation and dry dielectric testing to prevent the possibility of introducing moisture inside the insulation.
3. Specify or use wire specification requiring the silver plating thickness to be greater than 50 µin (micro-inches), thus minimizing the possibility of occurrence of red plague.
4. Shipping and storage of finished wire with the ends capped to prevent diffusion of air and water vapor into the wire through open ends.

5. Prohibition of water quenching. Only an oil quench, dry processing and sealing are to be used. Sealing shall include end capping and/or desiccation.
6. Sodium polysulfide testing per ASTM B298.
7. The wire manufacturer shall provide certification of the above.

For wire that is on hand and Item 7 cannot be produced or for wire that is over 5 years of age, the following tests are required. Cut six (6) feet of wire from each end. For each segment, cross-section the wire 2 inches from each end and in the middle and conduct a metallographic inspection to verify plating thickness and absence of cuprous oxide. Perform the sodium polysulfide test of ASTM B298 on residual pieces of the cut samples.

5.5 Configuration Control Requirements

The acquiring activity's focal point EEE parts organization (reference 5.1.2) shall review and approve all EEE part selections.

5.5.1 Part Selection

Parts shall be selected in accordance with the order of selection preference indicated in Tables V, VI, VII, and VIII. A lower ranked part selection shall not be used if a higher ranked selection is available. Commercial quality class parts (refer to Table II) shall not be used in a Grade 1 application. The NASA Parts Selection List (NPSL) (http://nepp.nasa.gov/npsl/) may be used for additional part selection provided the part selected meets the qualification and screening criteria for the intended application; however, NPSL parts not listed in the selection tables herein shall require nonstandard part approval.

5.5.2 Standard and Nonstandard Parts

Standard and nonstandard Grades 1, 2, 3, and 4 parts are as specified in the Standard Parts Selection and Preferences Tables V, VI, VII, and VIII. For Grade 4 all parts are considered standard. Parts not designated as standard parts are nonstandard and approved in accordance with paragraph 5.6.3.

5.5.3 Specifications and Control Drawings

Grade 1 and Grade 2 parts shall be defined and controlled by military/industry standard specifications and/or by control drawings. (Examples of control drawings are Source Control Drawings (SCDs), or Vendor Item Control Drawings (VICDs)). Grade 3 parts may be defined and controlled by vendor's specification, or applicable military/industry standard specifications where available. Grade 4 parts may be defined and controlled by purchase orders and vendor specifications or any other suitable means.

5.5.3.1 MSFC In-house Control Drawings

Preparation of part control drawings for MSFC in-house initiated parts procurements shall be the responsibility of the design activity, with support from MSFC EEE Parts Engineering.

5.5.4 Waivers and Deviations

Any EEE part that does not meet the requirements of a standard or nonstandard part in the appropriate Standard Parts Selection and Preferences table shall require a waiver/deviation approved by project management.

5.5.5 Plastic Encapsulated Microcircuits (PEMs)

PEMs used in MSFC Projects shall be subject to the PEMs insertion requirements contained in Appendix B, "Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification." PEMs shall not be used in applications that require Grade 1 parts without a deviation/waiver. The requirements of Appendix B do not apply to MIL-PRF-38535 Class N qualified microcircuits. Screening and qualification requirements for Class N microcircuits shall be per the standard parts and selection preferences tables herein.

5.5.6 Part Substitutions

For Grades 1, 2, and 3, substitution of different parts for the part numbers listed in assembly parts lists and bills of material shall be prohibited, or restricted to criteria or specific substitution lists having the prior approval of the acquiring activity. Substituted parts shall comply with applicable requirements of the EEE parts Control Document and shall be listed in the As-Designed EEE Parts List.

5.5.7 Traceability

The equipment manufacturer shall have a system for providing traceability for all EEE parts used in the equipment. For projects using Grade 1, 2, or 3 EEE parts, the system shall provide for tracing a specific part lot through all phases of kitting, fabrication, assembly, test, and delivery, identifying which equipment contains specific part lots.

For two way traceability:

> The contractor shall be capable of tracing each EEE part to its manufacturer and lot identifications (lot date code or batch designation and, where applicable, serial number).
>
> The contractor shall be capable of tracing a EEE part manufacturer's lot to specific assemblies and circuit locations (i.e. circuit designation; Rxxx, Qxxx, Cxxx, etc.) where installed.

Traceability can be accomplished by using the as-built parts list referenced in paragraph 5.6.5.

5.5.7.1 Traceability for Grade 4

To support Government Industry Data Exchange Program and MSFC ALERTs as addressed below, projects using Grade 4 EEE parts should provide for tracing a specific part by its manufacturer through all process steps identifying which equipment contains a specific manufacturer's part.

5.6 Parts Related Data Requirements

5.6.1 EEE Parts Management Plan

Project management shall develop a EEE parts management plan in accordance with paragraph 5.1.

5.6.2 As-Designed EEE Parts List

The equipment design activity shall submit an As-Designed EEE Parts List for focal point EEE parts organization approval. As-Designed EEE Parts List shall account for parts within all subassemblies, including subcontracted or procured subassemblies. The As-Designed EEE Parts List for an assembly may note the submittal and approval status of a subassembly's As-Designed EEE Parts List rather than individually list the parts for the subassembly. As a minimum, the As-Designed EEE Parts List shall identify the using equipment, EEE part number and specification, generic part number, EEE part qualification method and status, nonstandard part approval status, and part manufacturer(s). A preliminary As-Designed EEE Parts List shall be submitted for Preliminary Design Review (PDR). Changes to the baseline As-Designed EEE Part List shall be monitored and controlled at all levels of procurement, test, and fabrication to ensure the prompt identification, reporting, review, and disposition (approval/disapproval) of changes. The data shall be submitted in MSFC approved electronic format for MSFC review.

5.6.2.1 MSFC In-house As-Designed EEE Parts Lists

As-Designed EEE Parts Lists for MSFC in-house design shall be prepared in accordance with 5.6.2 above by the design activity and submitted to project management for approval.

5.6.3 Nonstandard Part Approval

Parts not designated as standard parts in Table V, VI, or VII as applicable, are nonstandard and their use must be approved by the focal point EEE parts organization. Unless an alternative is specified by the MSFC project office, a Nonstandard Part Approval Request (NSPAR) form (MSFC Form 4346 or equivalent) shall be submitted by the equipment design activity for each nonstandard part. As an example of an alternative method in lieu of NSPARs, a parts control board may be used to review and approve nonstandard parts. Pre-coordination of NSPARs with MSFC is recommended. The NSPAR shall be reviewed and approved at each contract tier before submittal to the next higher tier. The NSPAR shall include any applicable part specification or control documents, other than military or NASA standards. NSPARs shall identify additional screening applied to military standard parts. There are no nonstandard Grade 4 parts, therefore NSPARs are not required.

5.6.3.1 MSFC In-house NSPAR Exception

NSPAR forms shall not be required for MSFC in-house design. Instead, nonstandard part approval shall be determined during coordination between MSFC designers and MSFC EEE Parts Engineering, and approval status shall be documented on the applicable As-Designed EEE Parts List.

5.6.4 EEE Parts Application (Derating) Analysis

The equipment manufacturing activity shall submit a EEE parts application analysis for each deliverable end item to verify each EEE part meets the derating requirements given in Appendix A and is not over stressed in worst case environments, operating conditions, and duty cycles. The analysis shall address the EEE parts actually used in fabricating each unit. Individual part identification shall include electrical reference designator. The analysis shall address parts within all subassemblies, including subcontracted or procured subassemblies, unless exempt by specific project agreement.

5.6.5 As-Built EEE Parts List

The equipment manufacturing activity shall submit an As-Built EEE Parts List for each deliverable end item. The As-Built EEE Parts List shall identify the EEE parts actually used in fabricating each unit. As-Built EEE Parts List shall account for parts within all subassemblies, including subcontracted or procured subassemblies, unless exempt by specific project agreement. As a minimum, the As-Built EEE Parts List shall identify the using end item and serial number, the using assembly and serial number, EEE part number, part serial number if applicable, EEE part circuit location or reference designation (R1, CR2, etc.), EEE part manufacturer's CAGE code or equivalent identification, and EEE part Lot Date Code (LDC) or equivalent lot identification. However, the LDC or lot identification information is not required for Grade 4 EEE parts. The data shall be submitted in MSFC approved electronic format for MSFC review.

5.6.5.1 MSFC In-house As-Built EEE Parts Lists

As-Built EEE Parts Lists for MSFC in-house manufacturing shall be prepared in accordance with 5.6.5 above by the manufacturing activity and submitted to project management.

5.7 Obsolescence Management, Counterfeit Avoidance, and Parts Availability Requirements

5.7.1 Obsolescence Management

Obsolescence management shall be implemented in accordance with MSFC-STD-3620. Implementation of a proactive obsolescence management program structure is one of the primary foundations for a cost-effective parts management program. These efforts include the identification of current obsolescence and the prediction of future obsolescence to minimize life cycle vulnerability. The parts obsolescence management requirements of MSFC-STD-3620 establish the basic process and procedures used to perform EEE parts obsolescence management. This document defines the recommended strategy, organizational structure, and roles and responsibilities for managing obsolescence and diminishing manufacturing sources and material shortages (DMSMS) from initial identification to resolution implementation.

5.7.2 Counterfeit EEE Parts Avoidance

Counterfeit EEE parts avoidance shall be in accordance with MSFC-STD-3619. It outlines procedures to be employed for risk assessment actions to mitigate the entry of counterfeit EEE parts into the MSFC supply chain. This plan shall be employed in the specification, procurement, acquisition, and inspection of EEE parts used in both space flight and ground support hardware. Guidelines are recommended in the specification, procurement, and inspection of all parts including commercial grade parts to prevent entry of counterfeit parts.

5.7.3 Parts Availability

The equipment manufacturing activity shall ensure parts are available for equipment repair and new builds throughout the projected life of the equipment and design.

Unless otherwise approved by NASA, the acquiring activity shall procure a minimum quantity of 20 percent over the actual number of parts required to support equipment maintenance, planned future builds, and potential future builds where any of the following applies: (1) the part is a commercial part rather than a military or NASA standard part, (2) the applicable military or NASA standard is identified as "not for new design," or equivalent, (3) the same part may not be available for future procurement within the life of the design, (4) the minimum buy for the part exceeds the lifetime requirement for the design, or (5) reduce possibility of acquiring counterfeit parts. For further guidance refer to MSFC-STD-3620 and paragraph 5.7.1 herein.

5.8 <u>Manufacturing and Handling Requirements</u>

5.8.1 Electrostatic Discharge (ESD) Control

ESD control shall be in accordance with MSFC-RQMT-2918, ANSI/ESD S20.20, or an approved equivalent.

5.8.2 Environmental Control

Environmental conditions such as temperature, humidity, and particulate contamination shall be identified and appropriately controlled for parts handling, packaging, and storage.

5.8.3 Part Age and Storage Restriction

EEE parts older than 5 years from date of manufacture that are selected for flight hardware shall be reviewed by the responsible EEE parts engineering activity to determine the need for re-screening. Parts stored in conditions where moisture or ESD are not controlled shall not be used.

5.8.3.1 MSFC In-house Part Age and Storage Restriction

Parts intended for use within MSFC shall be retested according to requirements agreed to by MSFC EEE Parts Engineering, design engineering, quality, and test organizations.

5.8.4 Allowance for Testing Fallout

Procured quantities should allow for nominal fallout of parts in lot sample or screening tests where these losses would deduct from the quantity available for use. Where practical, it is recommended that parts be ordered from a single lot date code to reduce the number of parts needed for destructive qualification testing.

5.8.5 Manufacturing Process Compatibility

Consideration shall be given to part compatibility with planned equipment manufacturing processes. This may include guidance for or against the use of surface mount technology (SMT) or through hole parts, preferences or restrictions for lead finish, and if plastic encapsulated microcircuits (PEMs) are used, manufacturing processes shall be reviewed for compatibility with PEMs. Use of PEMs shall comply with paragraph 5.5.5 and Appendix B herein. PEMs may require a bake out prior to board assembly. Consult the manufacturer for recommended bake out times and temperatures.

5.8.5.1 MSFC In-house Manufacturing Compatibility

Solder dipped, or equivalent, lead finishes are preferred for MSFC in-house use and shall be specified where this is an option. Surface mount or through-hole packages, or a combination of both, are acceptable for MSFC in-house use. Surface mount parts packaged for pick and place are preferred.

5.8.6 Suspect Parts

Parts affected by MSFC ALERTS, and GIDEP issuances shall not be used in manufacturing without project approval and focal point EEE parts organization concurrence.

5.8.7 Reuse of EEE Parts

EEE parts (except connectors) unsoldered from printed circuit boards or assemblies shall not be reused unless approved by the appropriate project review board. If connectors are reused, the connectors shall be thoroughly cleaned, inspected, and tested per NASA-STD-8739.4 prior to reuse. No parts shall be reused from previously flown hardware.

5.9 Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements

5.9.1 Heritage Hardware

Hardware qualified and used in space applications, and accepted for use by NASA, is defined as Heritage Hardware. An As-Designed Part List and As-Built Part List shall be required for heritage hardware used in Grade 1, 2, or 3 applications. Heritage hardware shall not be used in applications that have a EEE part grade level requirement higher than the grade level to which it has been qualified. For example, Grade level 2 or 3 heritage hardware shall not be used in a Grade 1 application. EEE parts used in heritage hardware shall meet the requirements herein.

5.9.1.1 Modification to Heritage Hardware

Any EEE part configuration change to heritage hardware (e.g. a part change where the new part has a different form, fit, or function than the heritage part) is considered a modification and is no longer considered heritage hardware. This modified hardware shall meet all of the MSFC-STD-3012 EEE part requirements for new design herein.

5.9.2 Off-The-Shelf (OTS) Hardware Requirements

Off-The-Shelf (OTS) hardware is an assembly, part, or design that is readily available for procurement, usually to catalog specifications, without the necessity of generating detailed procurement specifications for the item. EEE parts used in OTS hardware shall meet the requirements herein.

5.10 Ground Support Equipment (GSE) to Flight Hardware Electrical Interfaces

Test connectors that physically mate with flight hardware electrical interfaces shall be either "flight or flight-like." Flight-like is defined as a military connector with the same physical characteristics (shell size, insert arrangement, and clocking). Flight-like connector contacts shall be compatible with the flight connector contacts and shall not damage the flight connector. The flight-like connector shall be cleaned to the same cleanliness requirements established for the flight hardware. Special avionics interfaces such as unique cryogenic or other feed-thru/receptacles, coaxial, triaxial, fiber optic, etc. shall be evaluated on a case-by-case basis by the designers and parts engineers to establish compatible hardware interfaces.

Flight connectors and/or interfaces that require multiple mating cycles or are mate sensitive should consider the use of connector savers or equivalent methods that shelter/protect the connector contacts and limit the number of mating cycles to the flight hardware interface. Connector savers shall not be used during launch and/or flight.

Appropriate inspection criteria, mating processes and procedures shall be established to prevent damage to flight interfaces and hardware.

6.0 REVIEW, AUDIT, AND VERIFICATION OF PARTS REQUIREMENTS

6.1 Review of Parts Management and Control Requirements Documents

Sub tier EEE Parts Management and Control documents shall be reviewed by the MSFC project for compliance with the Program tailored EEE parts management and control requirements document.

6.2 Audit of EEE Parts Process Requirements

EEE Parts Management and Control process requirements (e.g., GIDEP ALERT tracking, counterfeit avoidance, obsolescence analysis, etc.) shall be audited by the MSFC project for compliance with the process requirements of this document.

6.3 Verification of EEE Parts Circuit Design Requirements

Verification requirements apply to Grades 1, 2 and 3. The MSFC project shall verify the EEE parts circuit design requirements have been met. The following four records provide objective evidence of verification.

1. As-designed EEE Parts List data items shall be analyzed to determine what EEE parts are used by design.

2. Nonstandard Part Approval Requests (NSPAR) data items or equivalent data shall be analyzed to determine the terms for acceptance and use of the applicable EEE parts.
3. EEE Parts Derating Analysis Report data items shall be analyzed to determine what derating is achieved for the application.
4. As-built EEE Parts List data items shall be analyzed to determine that only traceable approved EEE parts and sources are used.

Success criteria shall be that the analyses of (1), (2), (3), and (4) above show compliance with the requirements herein.

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CAPACITOR Ceramic	MIL-PRF-123 (CKS)	All	1st	
	MIL-PRF-49470/1, /2 (PS)	FRL T	1st	Restrict per 5/
	MIL-PRF-20/27 - /31, /35 - /38 (CCR)	FRL S	2nd	
	MIL-PRF-55681/1 - /4, /7 - /11 (CDR)	FRL S	2nd	Restrict per 6/
CAPACITOR Glass	MIL-PRF-23269/1, /2, /10 (CYR)	FRL S	1st	
CAPACITOR Plastic Film	MIL-PRF-83421/1 (CRH)	FRL S	1st	Restrict per 7/
CAPACITOR Tantalum	MIL-PRF-39003/1, /2, /6, /9, /10 (CSR & CSS)	FRL D	1st	Restrict per 8/
	MIL-PRF-55365/4, /8, /11 (CWR)	FRL T	1st	Restrict per 9/
	MIL-PRF-39006/22, /25, /30, /31 (CLR) (Dash number shall include the letter "H" for vibration testing.)	FRL D	1st	Restrict per 10/
		FRL C	2nd	Restrict per 10/
CIRCUIT BREAKER	MIL-PRF-39019/1 - /6	No	1st	Restrict per 11/
	Other	No	2nd	Restrict per 12/
CONNECTOR Circular 18/	NASA SSQ 21635	Yes	1st	
	MIL-DTL-38999, Series III, Classes G and H	Yes	1st	
	NASA MSFC 40M38277	Yes	1st	
	NASA MSFC 40M38298	Yes	1st	
	NASA MSFC 40M39569	Yes	1st	
	NASA MSFC 40M38294	Yes	1st	Restrict per 13/
	MIL-DTL-38999	Yes	2nd	Restrict per 14/, 15/
	MIL-DTL-26482 Series 2	Yes	2nd	Restrict per 14/, 15/
	SAE-AS50151	Yes	2nd	Restrict per 14/, 15/, 16/
	Other	No	3rd	Restrict per 14/, 15/, 16/ 17/

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Coaxial Triaxial, and other Radio Frequency (RF)	MIL-PRF-39012	Yes	1st	Restrict per 14/, 15/
	MIL-PRF-49142			
	MIL-DTL-83517			
	Other	No	2nd	Restrict per 14/, 15/, 17/
CONNECTOR Compact PCI™ Interface	NASA GSFC S-311-P-822	Yes	1st	
	Other	No	2nd	Restrict per 14/, 17/
CONNECTOR D Subminiature	NASA GSFC S-311-P-4	Yes	1st	
	NASA GSFC S-311-P-10			
	MIL-DTL-24308			Restrict per 14/, 15/
	Other	No	2nd	Restrict per 14/, 17/
CONNECTOR EMI Filter Type	NASA GSFC S-311-P-626	Yes	1st	
	Other	No	2nd	Restrict per 14/, 17/
CONNECTOR EVA	NASA SSQ 22698	Yes	1st	
	Other	No	2nd	Restrict per 14/, 17/
CONNECTOR Microminiature	MIL-DTL-83513	Yes	1st	Restrict per 14/, 15/
	Other	No	2nd	Restrict per 14/, 15/, 17/
CONNECTOR Printed Circuit	MIL-DTL-55302	Yes	1st	Restrict per 14/, 15/
	Other	No	2nd	Restrict per 14/ ,15/, 17/
CONNECTOR Rectangular – Rack and Panel, Orbital Replacement Unit (ORU), Remote Power Control Module (RPCM)	NASA SSQ 21636	Yes	1st	
	NASA SSQ 22680			
	NASA SSQ 22681			
	Other	No	2nd	Restrict per 14/, 15/, 17/
CONNECTOR Umbilical	NASA SSQ 21637	Yes	1st	
	NASA GSFC S-311-P-718			
	SAE-AS81703			
	Other	No	2nd	Restrict per 14/, 15/, 17/
CONNECTOR Zero-G lever	NASA SSQ 21635	Yes	1st	
	Other	No	2nd	Restrict per 14/, 15/, 17/

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Contacts: Signal, Power, Coaxial, Shielded, Thermocouple, etc. (continued on next page)	NASA SSQ 21635	Yes	1st	Restrict per 18/
	NASA SSQ 21636			
	NASA SSQ 21637			
	NASA SSQ 22680			
	NASA SSQ 22681			
CONNECTOR Contacts: Signal, Power, Coaxial, Shielded, Thermocouple, etc. (continued from previous page)	NASA SSQ 22698	Yes	1st	Restrict per 18/
	NASA MSFC 40M38277			
	NASA MSFC 40M38294			
	NASA MSFC 40M38298			
	NASA MSFC 40M39569			
	NASA GSFC S-311-P-4			
	NASA GSFC S-311-P-718			
	SAE-AS39029			
	MIL-DTL-55302			
	MIL-DTL-83505			
	Other	No	2nd	Restrict per 14/, 17/ 18/
CONNECTOR Backshell	NASA SSQ 21635	Yes	1st	
	NASA SSQ 21636			
	NASA SSQ 21637			
	NASA SSQ 22680			
	NASA SSQ 22681			
	NASA SSQ 22698			
	NASA MSFC 40M38277			
	NASA MSFC 40M38294			
	NASA MSFC 40M38298			
	NASA MSFC 40M39569			
	SAE-AS85049			Restrict per 14/, 15/
	Other	No	2nd	Restrict per 14/, 15/, 17/
CRYSTALS	MIL-PRF-3098 Product Level S	Yes	1st	Restrict per 19/
	Other	No	2nd	Restrict per 20/

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CRYSTAL CONTROL OSCILLATORS	MIL-PRF-55310 Product Level S		Yes	1st	Restrict per 21/
	Other		No	2nd	Restrict per 22/
DISCRETE SEMICONDUCTOR Diodes, Transistors, Optical Couplers	MIL-PRF-19500	JANS	Yes	1st	
		JANTXV	No	2nd	Restrict per 23/
		JANTX		3rd	Restrict per 23/
	Custom processed part			4th	Restrict per 24/
FIBER OPTIC Cables	NASA SSQ 21654, NFOC-2FFF-1GRP-1		Yes	1st	
	Other		No	2nd	Restrict per 25/
FIBER OPTIC Devices	All		No	N/A	Restrict per 25/
FIBER OPTIC Interconnects	NASA SSQ 21635, NZGC-F-16PB (Pin)		Yes	1st	
	NASA SSQ 21635, NZGC-F-16SB (Socket)				
	Other		No	2nd	Restrict per 25/
FILTER	MIL-PRF-28861/1, /2, /3, /4, /5		Class S	1st	Restrict per 26/, 27/
	Other		No	2nd	Restrict per 27/, 28/
FUSE	MIL-PRF-23419/4, /8		Yes	1st	
	Rockwell Spec			2nd	Restrict per 29/
	Other		No	3rd	Restrict per 30/
HYBRID MICROCIRCUIT 31/	MIL-PRF-38534	Class K	Yes	1st	
		Class H	No	2nd	Restrict per 32/
	Custom processed part			3rd	Restrict per 33/
MAGNETICS Coils, Inductors	MIL-STD-981		Class S	1st	
	MIL-PRF-15305, Grade 1, Family K Class B or C		No	2nd	Restrict per 34/
	MIL-PRF-39010/1, /2, /3, /6, /7 FRL S				
	MIL-PRF-83446/4, /5, /10; Families 50, 51				

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
MAGNETICS Transformers	MIL-STD-981		Class S	1st	
	MIL-PRF-27 Families 03, 04, 20, 21, 36, 37, 40, 41; Product Level T		No	2nd	Restrict per 34/
	MIL-PRF-21038 Family 31				
MONOLITHIC MICROCIRCUITS 35/	MIL-PRF-38535	Class V or S	Yes	1st	
		Class Q or B	No	2nd	Restrict per 36/
	Custom processed part				Restrict per 37/
	MIL-PRF-38535 Class M			3rd	Restrict per 36/
	/883, /883B or /883S per MIL-STD-883 per paragraph 1.2.1				
	MIL-PRF-38535 Class N			4th	Restrict per 38/
RELAY	G311P754/01, /02, /03, /04, /05, /07, /08, /09, /11 (refer to NASA GSFC S-311-P-754)		No	1st	
	MIL-PRF-39016/6, /9, /11, /12, /13, /20, /21, /38 FRL P or better			2nd	Restrict per 39/
	MS27742 (MIL-PRF-6106)				
RESISTOR Film/Foil	MIL-PRF-39017, RLR		FRL R or S	1st	
	MIL-PRF-55182, RNR, RNC, RNN				
	MIL-PRF-55342, RM				
	MIL-PRF-32159, RCZ		Product Level T		
	MIL-PRF-83401, RZ		Level M		
	NASA SSQ Type 1 Qualified parts		Yes		
	NASA GSFC S-311-P-742 and NASA GSFC S-311-P-813				
	Other		No	2nd	Restrict per 25/
RESISTOR Wirewound	MIL-PRF-39007, RWR		FRL R or S	1st	
	MIL-PRF-39005, RBR				
	MIL-PRF-39009, RER				
	Other		No	2nd	Restrict per 25/
RESISTOR Other	Other		No	3rd	Restrict per 25/

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
SWITCH Pressure	MIL-DTL-9395 Hermetic Category 1 Styles Only	No	1st	Restrict per 40/, 41/, 42/
SWITCH Sensitive and Push (Position Sensing)	MIL-PRF-8805/68-029 thru -035 Category 1 Styles Only	No	1st	Restrict per 40/
	M8805/8, /41, /70, /72, /73, /74, /82 Category 1 Styles Only		2nd	Restrict per 40/, 41/, 43/
SWITCH Thermostatic	NASA GSFC S-311-641	No	1st	
	MIL-PRF-24236 Category 1 Styles Only		2nd	Restrict per 40/, 41/, 44/
THERMISTOR	MIL-PRF-32192 (Pos. & Neg. Coeff)	Product Level M	1st	
	MIL-PRF-23648 (Pos. & Neg. Coeff.)	Yes		
	NASA GSFC S-311-P-18 (Negative Coefficient)			Restrict per 45/
	NASA GSFC S-311-424 (Negative Coefficient)			
	NASA GSFC S-311-P-767 (Negative Coefficient)			
	Other	No	2nd	Restrict per 46/
WIRE & CABLE Coaxial Cable	NASA SSQ 21653	Yes	1st	
	MIL-DTL-17		2nd	Restrict per 47/, 48/
	Other	No	3rd	Restrict per 17/, 47/, 48/
WIRE & CABLE Data Bus	NASA SSQ 21676 (1553)	Yes	1st	Restrict per 48/
	Other	No	2nd	Restrict per 17/, 47/, 48/
WIRE & CABLE Hookup Wire	NASA SSQ 21656 (General purpose Polytetrafluoroethylene (TFE))	Yes	1st	
	NASA SSQ 21652 (Special purpose Silicone)			
	NASA SSQ 22720 (Special purpose Ethylene-Tetrafluoroethylene (ETFE))			
	SAE-AS22759		2nd	Restrict per 47/, 48/, 49/
	MIL-DTL-81381			Restrict per 47/, 48/, 50/
	Other	No	3rd	Restrict per 17/, 47/, 48/, 49/, 50/

Table V. Standard Parts and Selection Preferences for Grade 1

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
WIRE & CABLE Magnet Wire	ANSI/NEMA-MW-1000	Yes	1st	Restrict per 47/
	Other	No	2nd	Restrict per 17/, 47/
WIRE & CABLE Multiconductor Cable	NASA SSQ 21656	Yes	1st	
	NASA SSQ 21655			
	ANSI/NEMA WC27500		2nd	Restrict per 47/, 48/
	Other	No	3rd	Restrict per 17/, 47/, 48/

Table V Notes:

1/ This table identifies information for the part selection process, identification of standard parts, and associated restrictions and verifications. The requirements listed shall be implemented in addition to other requirements herein.

2/ All standard parts are identified in this column. The standard part designation is predicated on compliance with all applicable requirements. All nonstandard parts require nonstandard part approval.

3/ Parts selection shall be accomplished in the order indicated. A lower ranked selection shall not be used if a higher ranked selection can be obtained.

4/ This column identifies screening and associated verifications and restrictions that are required for the part to be classified as acceptable. The project EEE parts Requirements Document shall specify details as necessary to implement these requirements, and may specify additional requirements.

5/ Designers must consider the geometry and relatively high mass of MIL-PRF-49470 capacitors. Devices which are not mounted properly may be susceptible to damage, including lead shearing in high vibration and shock environments. The taller stacks where the stack height exceeds the minimum base dimension are particularly at risk. Special mounting techniques may be necessary to ensure safe application in these environments. Consult the manufacturer or parts engineering for recommendations to avoid potential damage from misuse of straps, coefficient of thermal expansion mismatches, etc.

These capacitors are very susceptible to thermal shock damage due to their large mass of ceramic. Installation temperature profiles should provide adequate temperature rise and cool-down time to prevent damage from thermal shock.

These capacitors are fragile and should be handled with extreme care. Parts which have been dropped or mishandled should be considered suspect due to the risk of microcracking which may result in latent failures.

6/ The MIL-PRF-55681/1 style CDR02 ceramic chip capacitors shall not be used in Grade 1 applications. This particular chip has a large length to width ratio (0.18" x 0.05") which makes this chip highly susceptible to cracking as a result of board flexing.

The use of MIL-PRF-55681 ceramic chip capacitors with Termination Style "W" or "Y" is PROHIBITED. Termination style "Y" is pure tin and termination style "W" gives the manufacturer the option to use either pure tin or a tin-lead alloy as a termination finish.

7/ MIL-PRF-83421 capacitors shall not be used in circuits where the energy is less than 250 microjoules. This is based on the "self healing" properties of plastic film capacitors and the need for sufficient energy to be available to promote self healing. Without adequate energy available, self healing will not occur and parts may catastrophically fail short circuit.

Parts covered by this specification contain internal soldered connections which may reflow during installation. The plastic dielectric in these parts is also temperature sensitive. Special precautions such as heat sinking are recommended when soldering onto boards.

8/ All MIL-PRF-39003/1, /2, and /10 capacitors shall be subjected to the Option C or F surge current test as specified by MIL-PRF-39003/10 (surge current testing at -55°C and +85°C).

Solid tantalum capacitors are subject to inrush current failures. Effective series resistance for MIL-PRF-39003 capacitors shall be at least 0.3 ohms/volt or 1 ohm whichever is greater. MIL-PRF-39003 capacitors shall not be used in power supply filters. MIL-PRF-39006/22 (CLR79) or MIL-PRF-39006/25 (CLR81) style parts are preferred for power supplies.

Parts covered by MIL-PRF-39003 contain internal soldered connections that may reflow during installation. The A, A1, B, B1 case sizes are particularly susceptible and special precautions such as heat sinking are recommended when soldering onto boards.

MIL-PRF-39003 style capacitors rated at 100 V and higher shall NOT be used. In order to produce the higher voltage ratings the manufacturers use alternate process steps compared to the lower voltage styles. These alternate process steps have not been found to consistently produce reliable parts.

These tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Prolonged exposure to high levels of reverse voltage can produce very high leakage currents and short circuits. Short circuited tantalum capacitors can ignite and/or produce excessive heat resulting in extreme damage to circuit boards. Reverse bias application of these parts should be avoided. MIL-PRF-39003 offers no guidance on the reverse bias performance of these capacitors. Capacitor manufacturer guidelines are generally very conservative urging against any prolonged exposure to reverse bias. Some limited experimental data exists that suggests some capacitors may be able to indefinitely withstand room temperature reverse voltages on the order of 15 to 25% of rated voltage. However, all of the factors affecting the reverse bias behavior (including size and rating of the capacitor, effects of circuit current limiting and ambient temperature) have not been studied.

Users should confirm the proper orientation of all tantalum capacitors after installation. The convention for polarity markings is often a source of potential confusion.

Part marking for MIL-PRF-39003/10 tubular case capacitors requires a stripe on the case adjacent to the cathode ("-") termination. This convention can be a source for confusion because the surface mount molded tantalum "chip" capacitors (CWR09 types per MIL-PRF-55365/4) frequently use a stripe on the case to identify the anode ("+") termination. Generally, the other styles of tubular case tantalum capacitors use a "+" to identify the anode terminal.

Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 and NEPAG Study Report "Reverse Bias Behavior of Surface Mount Solid Tantalum Capacitors" for further details.

9/ MIL-PRF-55365 capacitors shall be subjected to either option "B" or "C" surge current testing (at -55°C and +85°C) in accordance with MIL-PRF-55365 and associated slash sheet.

MIL-PRF-55365 solid tantalum capacitors are subject to inrush current failures. Effective series resistance for these capacitors shall be at least 0.3 ohms/volt or 1 ohm whichever is greater. MIL-PRF-55365 capacitors shall not be used in power supply filters.

These tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Prolonged exposure to high levels of reverse voltage can produce very high leakage currents and short circuits. Short circuited tantalum capacitors can ignite and/or produce excessive heat resulting in extreme damage to circuit boards. Reverse bias application of these parts shall be avoided. MIL-PRF-55365 offers no guidance on the reverse bias performance of these capacitors. Capacitor manufacturer guidelines are generally very conservative urging against any prolonged exposure to reverse bias. Some limited experimental data exists that suggests some capacitors may be able to indefinitely withstand room temperature reverse voltages on the order of 15 to 25% of rated voltage. However, all of the factors affecting the reverse bias behavior (including size and rating of the capacitor, effects of circuit current limiting and ambient temperature) have not been studied.

Users should confirm the proper orientation of all tantalum capacitors after installation.

Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 and NEPAG Study Report "Reverse Bias Behavior of Surface Mount Solid Tantalum Capacitors" for further details.

10/ MIL-PRF-39006 CLR79 and CLR81 styles can be a source of transient potentials (intermittent shorts) during vibration stimuli. Therefore, Condition H shall be specified for vibration and shock (i.e., 53.79 g's random vibration, 80 g's sinusoidal vibration, and 500 g's shock).

CLR79, CLR81, CLR90 and CLR91 tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Reverse bias application of these parts should be avoided. Per MIL-PRF-39006 these capacitors are capable of handling up to 3 volts of reverse polarity at 85°C regardless of capacitor voltage rating with some degradation in their leakage current characteristics. Exceeding 3 volts reverse bias may cause rapid deterioration of the capacitor, which can lead to catastrophic failure (short circuit). Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 for further details.

MIL-PRF-39006 style capacitors rated at 125 V shall NOT be used. In order to produce the higher voltage ratings the manufacturers use alternate process steps compared to the lower voltage styles. These alternate process steps have NOT been found to consistently produce reliable parts as evidenced by frequent stop shipment orders by the Military qualifying activity.

11/ Perform additional external examination, solderability, operating force, voltage drop, burn-in, and radiographic screening in accordance with applicable requirements of MSFC-SPEC-1198 or approved equivalent. Perform DPA in accordance with internal visual inspection requirements MSFC-SPEC-1198.

12/ Perform screening per applicable requirements of MSFC-SPEC-1198 or approved equivalent. Perform DPA using internal inspection requirements of MSFC-SPEC-1198 or approved equivalent. Qualify to MIL-PRF-39019 or approved equivalent.

13/ NASA MSFC 40M38294 Cryogenic connectors are qualified for cryogenic applications. However, experience has proven it is possible for other connector types to be successfully used at cryogenic temperatures. Sample connectors shall be subjected to five cryogenic cycles using sufficient low temperature to be qualified for its intended application. Perform post temperature cycle inspection at ambient room temperatures for cracks and dielectric withstanding voltage (DWV).

14/ Cadmium, zinc, or anodized plated connectors and connector accessories (i.e., backshells, contacts, jam nuts, protective caps, jackscrews, etc.) shall not be used in space flight applications. Nickel, gold, brass, and CRES 300 series corrosion resistant steel are acceptable finishes. Other plating or finishes may be acceptable but shall be approved by the MSFC parts engineering organization.

15/ Stress corrosion and outgassing properties of these connectors are not controlled and shall be evaluated for compliance to project engineering requirements. If the project documents that the application and environment is not a stress corrosion, outgassing or cleanliness concern, then the requirement of thermal vacuum baking can be omitted. If thermal vacuum baking is omitted, justification shall be documented and presented to the project for approval. If required prior to use, connectors shall be vacuum baked per MSFC-SPEC-548 or equivalent.

16/ The rear side of several connectors per this specification is not protected against moisture or debris.

17/ Screen and qualify to similar military specification.

18/ Connectors shall be procured without contacts. Contacts shall be procured in bulk quantity with lot traceability and shall be issued accordingly so that the connector population and corresponding tensile testing use the same lot.

19/ 100% screening shall be performed per MIL-PRF-3098 Table I Product Level S, including the following test inspections: PIND testing, radiographic Inspection, and Percent Defective Allowable (PDA) of 5%. Pure tin shall be prohibited as a final finish.

20/ Screening and qualification shall meet the requirements of MIL-PRF-3098 Product Level S including Note 19/ above. A source control document shall be submitted to document the details of the part including screening and qualification. To minimize risk, a manufacturer that is QPL qualified for similar products shall be selected unless otherwise approved by MSFC EEE Parts Engineering.

21/ MIL-PRF-55310 requirements for Product Level S and Temperature Range A (-55ºC – 125ºC) shall be met. The vendor's criteria for element derating shall be obtained and submitted. Product selection shall be limited to hermetic packages.

22/ MIL-PRF-55310 requirements for Product Level S and Temperature Range A (-55ºC – 125ºC) shall be met. The vendor's criteria for element derating shall be obtained and submitted. Product selection shall be limited to hermetic packages. A source control document shall be submitted to document the details of the part including screening and qualification. To minimize risk, a manufacturer that is QPL qualified for similar products shall be selected unless otherwise approved by MSFC EEE Parts Engineering.

23/ Devices with external or internal pressure contacts (die to electrical contacts) are prohibited. Screen and qualify to Table IX.

24/ Custom processed discrete semiconductors shall be procured from a QML/QPL listed manufacturer and processed on a QML/QPL line unless otherwise approved by MSFC EEE Parts Engineering. A controlling document shall specify the part performance characteristics and manufacturing requirements beginning at the wafer level. The controlling document shall specify design, processing, qualification, and screening requirements to meet the standard requirements that would be applied to a similar JANS quality part.

25/ Qualification and screening requirements shall be determined to suit the specific application.

26/ If no applicable Class S part is listed in the QPL, procurement of filters shall be to a source control document based on the "Class S" requirements given in Note 28/ below. An NSPAR or equivalent is required.

27/ Special care must be exercised during installation of these parts. Parts covered by this specification may contain internal soldered connections that can reflow during installation.

Strict adherence to the specification recommended torque is imperative. Excessive torque may crack the filter case and/or its internal components. Cracked discoidal capacitors may go undetected through post installation checkout, but lead to filter malfunction later on.

28/ Perform MIL-PRF-28861 Table VI Group A Inspection for Class S and Table III Qualification Inspection for Class B.

29/ Use Rockwell Drawings ME451-0009 (Bussman type GNZ), ME451-0010 (Bussman type GQR), ME451-0016 (Bussman type ANG), ME451-0017 (Bussman type HOB), and ME451-0018 (Bussman type GMV).

30/ Fuses shall be procured from a QPL/QML listed manufacturer and processed on a QPL/QML line unless otherwise approved by MSFC EEE Parts Engineering. Fuses shall be screened per Table X for Grade 1.

31/ Unless otherwise approved by MSFC EEE Parts Engineering, hybrid microcircuits shall be hermetic and undergo pre-cap inspection.

32/ Screen per MIL- PRF-38534, Appendix C, Table C-IX Class K as follows: PIND, serialization, electrical test, burn-in for 160 hours, final electrical test and delta limits, seal, radiographic inspection, and external visual. A two-piece DPA shall be performed in accordance with MIL-STD-1580 Requirement 16 for hybrid microcircuits. In case of high cost parts, parts with very limited availability, or parts manufactured on a controlled QPL/QML product line the sample size may be reduced if the approval of the EEE Parts Engineering is obtained.

33/ Custom processed hybrid microcircuits shall be procured from a QML listed manufacturer and processed on a QML line unless otherwise approved by MSFC EEE Parts Engineering. Qualification and screening shall be per MIL-PRF-38534 for Class K devices. Class K element evaluation is required. A two-piece DPA shall be performed in accordance with MIL-STD-1580 Requirement 16 for hybrid microcircuits. In case of high cost parts, parts with very limited availability, or parts manufactured on a controlled QPL/QML product line the sample size may be reduced if the approval of the MSFC EEE Parts Engineering is obtained. Radiation tolerance testing may be required depending on the part application. A controlling document shall be generated to specify the part performance characteristics and manufacturing requirements.

34/ Magnetics shall comply with Table XI for Class S.

35/ Except for MIL-PRF-38535 Class N used as specified, microcircuits shall be hermetic unless otherwise approved by MSFC EEE Parts Engineering.

36/ Screen and qualify in accordance with Tables XII and XIII, respectively, for Grade 1.

37/ Custom processed microcircuits shall be procured from a QML listed manufacturer and processed on a QML line unless otherwise approved by MSFC EEE Parts Engineering. Screening shall be in accordance with MIL-STD-883 Test Method 5004 Table I for Class Level S devices. Qualification shall be in accordance with MIL-STD-883 Test Method 5005 Groups A, B, and D for Class Level S devices. A DPA shall be performed in accordance with MIL-STD-1580 Requirement 16 for microcircuits. Sample size shall be in accordance with MIL-STD-1580. Internal gas analysis (IGA) is required. A controlling document shall be generated to specify the part performance characteristics and manufacturing requirements beginning at the wafer level.

38/ The environment must be considered when using Class N plastic encapsulated microcircuits (PEMs). Class N PEMs should not be used in an environment where moisture is present. Where their use can be accommodated, special handling and storage procedures must be followed to prevent exposure to moisture. Also, the radiation tolerance of the Class N PEM must be acceptable for the environment in which it will be used. Screen per MIL-STD 883, Method 5004, Table I Paragraphs: 3.1.8 Serialization; 3.1.9 Pre burn-in electrical parameters; 3.1.10 Burn-in for 160 hours; 3.3.11 Interim (post burn-in) electrical parameters; 3.1.12 Reverse bias burn-in; 3.1.13 Interim electrical parameters; 3.1.14 Percent defective allowable (PDA) and delta limits calculations; 3.1.15 Final electrical parameters; 3.1.17 Radiographic inspection; 3.1.19 External visual inspection. A DPA shall be performed in accordance with MIL-STD-1580 Requirement 16 for PEMs.

39/ Manufacturer shall submit an acceptable procedure for internal visual inspection and cleaning, or else relays shall be acceptably screened with (a) PIND or Vibration Miss testing, (b) radiographic inspection, and (c) sample DPA per MIL-STD-1580 Requirement 17.

40/ Select for compliance with hazard avoidance requirements herein (refer to section 5.4.4) by inspection or manufacturer's certification.

41/ Performs 100% pre-closure visual inspection, cleaning, and micro-particle analysis (requires pre-coordination with manufacturer).

42/ Supplement standard 100% screening in the following sequence in accordance with applicable methods of MIL-DTL-9395: seal, calibration, proof pressure, sea level DWV, and contact resistance.

43/ Supplement standard 100% screening in the following sequence in accordance with applicable methods of MIL-PRF-8805: random vibration, PIND (MIL-STD-202 method 217 modified for switches), run-in conditioning of 500 cycles at 10 cycles per minute and 25°C with monitoring of all make and break contacts at 6VDC and 100 mA for misses, operating characteristics, low temperature operation, and insulation resistance (IR).

44/ Supplement standard 100% screening in the following sequence in accordance with applicable methods of MIL-PRF-24236: random vibration, PIND (MIL-STD-202 method 217 modified for switches), run-in conditioning of 500 heat and cool switching cycles with monitoring of all make and break contacts at 6VDC and 100 mA for misses, contact resistance, sea level DWV, and room temperature insulation resistance.

45/ Refer to GSFC EEE-INST-002 for qualified parts.

46/ Thermistors shall be procured to a source control document and shall be screened per Table XIV and qualified per XV for Grade 1.

47/ Wire and cable products per these specifications may require material testing per SP-R-0022A and NASA-STD-6001, or equivalents.

48/ Silver plated copper wire shall be controlled per section 5.4.5 herein.

49/ Some ETFE (ethylene tetrafluoroethylene copolymer / trade name "Tefzel") insulated wire has been found to fail flammability testing in a 30 percent oxygen environment. In addition, 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.

50/ Polyimide (trade name "Kapton") insulated wire is susceptible to "arc tracking" when used in certain applications.

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CAPACITOR Ceramic	MIL-PRF-20/27 - /31, /35-/38 (CCR)	FRL R or P	1st	
	MIL-PRF-123 (CKS)	Yes		
	MIL-PRF-39014/1, /2, /5, /20 - /23 (CKR)	FRL S		Restrict per 5/
	MIL-PRF-49470/1, /2 (PS)	FRL T or B		Restrict per 6/
	MIL-PRF-55681/1 - /4, /7 - /11 (CDR)	FRL P or R		Restrict per 7/
CAPACITOR Glass	MIL-PRF-23269/1 - /4 (CYR)	FRL S	1st	
CAPACITOR Plastic Film	MIL-PRF-83421/1 (CRH)	FRL S or R		Restrict per 8/
CAPACITOR Tantalum	MIL-PRF-39003/1, /2, /6, /9, /10 (CSR & CSS)	FRL C. D, or B	1st	Restrict per 9/
	MIL-PRF-39006/22, /25, /30, /31 (CLR) (Dash number shall include the letter "H" for vibration testing.)	FRL R or P		Restrict per 10/
	MIL-PRF-55365/4, /8, /11 (CWR)	FRL C, D, or B		Restrict per 11/
CAPACITOR Other	Other	No	2nd	Restrict per 12/
CIRCUIT BREAKER	MIL-PRF-39019/1 - /6	Yes	1st	
	Other	No	2nd	Restrict per 13/
CONNECTOR Circular 18/	NASA MSFC 40M38277	Yes	1st	
	NASA MSFC 40M38298			
	NASA MSFC 40M39569			
	NASA SSQ 21635			
	MIL-DTL-38999	Yes	1st	Restrict per 14/, 15/
	MIL-DTL-26482			
	SAE-AS50151			Restrict per 14/, 15/, 16/
	Other	No	2nd	Restrict per 17/
CONNECTOR Coaxial Triaxial, and other Radio Frequency (RF)	MIL-PRF-39012	Yes	1st	Restrict per 15/
	MIL-PRF-49142			
	MIL-DTL-83517			
	Other	No	2nd	Restrict per 17/

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Compact PCI™ Interface	NASA GSFC S-311-P-822	Yes	1st	
	Other	No	2nd	Restrict per 17/
CONNECTOR D Subminiature	NASA GSFC S-311-P-4	Yes	1st	
	NASA GSFC S-311-P-10			
	MIL-DTL-24308			Restrict per 14/, 15/
	Other	No	2nd	Restrict per 17/
CONNECTOR EMI Filter Type	NASA GSFC S-311-P-626	Yes	1st	
	Other	No	2nd	Restrict per 17/
CONNECTOR EVA	NASA SSQ 22698	Yes	1st	
	Other	No	2nd	Restrict per 17/
CONNECTOR Microminiature	MIL-DTL-83513	Yes	1st	Restrict per 14/, 15/
	Other	No	2nd	Restrict per 17/
CONNECTOR Printed Circuit	MIL-DTL-55302	Yes	1st	Restrict per 14/, 15/
	Other	No	2nd	Restrict per 17/
CONNECTOR Rectangular – Rack and Panel, ORU, RPCM	NASA SSQ 21636	Yes	1st	
	NASA SSQ 22680			
	NASA SSQ 22681			
	Other	No	2nd	Restrict per 17/
CONNECTOR Umbilical	NASA SSQ 21637	Yes	1st	
	NASA GSFC S-311-P-718			
	SAE-AS81703			
	Other	No	2nd	Restrict per 17/
CONNECTOR Zero-G lever	NASA SSQ 21635	Yes	1st	
	Other	No	2nd	Restrict per 17/
CONNECTOR Contacts: Signal, Power, Coaxial, Shielded, Thermocouple, etc. (continued on next page)	NASA SSQ 21635	Yes	1st	Restrict per 18/
	NASA SSQ 21636			
	NASA SSQ 21637			
	NASA SSQ 22680			
	NASA SSQ 22681			

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Contacts: Signal, Power, Coaxial, Shielded, Thermocouple, etc. (continued from previous page)	NASA SSQ 22698 NASA MSFC 40M38277 NASA MSFC 40M38294 NASA MSFC 40M38298 NASA MSFC 40M39569 NASA GSFC S-311-P-4 NASA GSFC S-311-P-718 SAE-AS39029 MIL-DTL-55302 MIL-DTL-83505	Yes	1st	Restrict per 18/
	Other	No	2nd	Restrict per 17/, 18/
CONNECTOR Backshell	NASA SSQ 21635 NASA SSQ 21636 NASA SSQ 21637 NASA SSQ 22680 NASA SSQ 22681 NASA SSQ 22698 NASA MSFC 40M38277 NASA MSFC 40M38294 NASA MSFC 40M38298 NASA MSFC 40M39569	Yes	1st	
	SAE-AS85049			Restrict per 14/, 15/
	Other	No	2nd	Restrict per 14/, 15/, 17/
CRYSTALS	MIL-PRF-3098 Product Level S or B	Yes	1st	Restrict per 19/
	Other	No	2nd	Restrict per 20/
CRYSTAL CONTROL OSCILLATORS	MIL-PRF-55310 Product Level S or B	Yes	1st	Restrict per 21/
	Other	No	2nd	Restrict per 22/

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
DISCRETE SEMICONDUCTOR Diodes, Transistors, Optical Couplers	MIL-PRF-19500	JANS	Yes	1st	Exceeds requirement
		JANTXV			Restrict per 23/
		JANTX	No	2nd	Restrict per 23/, 24/
	Custom processed part			3rd	Restrict per 23/, 25/
	Other			4th	Restrict per 23/, 26/
FIBER OPTIC Cable	NASA SSQ 21654, NFOC-2FFF-1GRP-1		Yes	1st	
	Other		No	2nd	Restrict per 27/
FIBER OPTIC Devices	All		No	N/A	Restrict per 27/
FIBER OPTIC Interconnects	NASA SSQ 21635, NZGC-F-16PB (Pin)		Yes	1st	
	NASA SSQ 21635, NZGC-F-16SB (Socket)				
	Other		No	2nd	Restrict per 27/
FILTER	MIL-PRF-28861/1, /2, /3, /4, /5		Class S	1st	Exceeds requirement; restrict per 28/
			Class B		Restrict per 28/
	Other		No	2nd	Restrict per 29/
FUSE	MIL-PRF-23419/4, /8		Yes	1st	
	Rockwell Spec				Restrict per 30/
	Other		No	2nd	Select per 31/
HYBRID MICROCIRCUIT 32/	MIL-PRF-38534	Class K	Yes	1st	Exceeds requirement
		Class H			Restrict per 33/
	Custom processed part		No	2nd	Restrict per 34/
MAGNETICS Inductors, Coils	MIL-STD-981	Class S	Yes	1st	Exceeds requirement
		Class B			
	MIL-PRF-15305, Grade 1, Family K Class B or C				Restrict per 35/
	MIL-PRF-39010/1, /2, /3, /6, /7		FRL S, R, or P		
	MIL-PRF-83446/4, /5, /10 Families 50, 51		Yes		
	Other		No	2nd	Restrict per 12/

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
MAGNETICS Transformers	MIL-STD-981	Class S	Yes	1st	Exceeds requirement
		Class B			
	MIL-PRF-27 Families 03, 04, 20, 21, 36, 37, 40, 41		Product Level T or M		Restrict per 35/
	MIL-PRF-21038 Family 31		Class M		
	Other		No	2nd	Restrict per 12/
MONOLITHIC MICROCIRCUIT 36/	MIL-PRF-38535	Class V or S	Yes	1st	Exceeds requirement
		Class Q or B			Restrict per 37/
	MIL-PRF-38535 Class M		No	2nd	Restrict per 38/
	/883, /883B or /883S per MIL-STD-883 paragraph 1.2.1				
	Custom processed part			3rd	Restrict per 39/, 40/
	MIL-PRF-38535	Class N		4th	Screen per 41/
	Vendor Hi Rel			5th	Restrict per 39/, 42/
RELAY	G311P754/01, /02, /03, /04, /05, /07, /08, /09, and /11 (refer to NASA GSFC S-311-P-754)		Yes	1st	
	MIL-PRF-39016 FRL M or better			2nd	Restrict per 43/
	MS27742 (MIL-PRF-6106) FRL M or better				
	Other MIL, FRL M or better, and SCD		No	3rd	Restrict per 44/, 45/, 46/, 47/
	Other			4th	
RESISTOR Film/Foil	MIL-PRF-39017, RLR		FRL R, S, or P	1st	
	MIL-PRF-55182, RNR, RNC, RNN				
	MIL-PRF-55342, RM				
	MIL-PRF-32159, RCZ		Product Level T		
	MIL-PRF-83401, RZ		Level M		
	NASA SSQ Type 1 Qualified parts		Yes		
	NASA GSFC S-311-P-742 and NASA GSFC S-311-P-813				
	Other		No	2nd	Restrict per 27/, 48/

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
RESISTOR Wirewound	MIL-PRF-39007, RWR	FRL R, S, or P	1st	
	MIL-PRF-39005, RBR			
	MIL-PRF-39009, RER			
	Other	No	2nd	Restrict per 27/, 48/
RESISTOR Other	Other	No	3rd	Restrict per 48/, 49/
SWITCH Pressure	MIL-DTL-9395 Hermetic Category 1 Styles Only	No	1st	Restrict per 50/, 51/
SWITCH Sensitive and Push (Position Sensing)	MIL-PRF-8805/68-029 thru -035 Category 1 Styles Only	No	1st	Restrict per 50/
	M8805/8, /41, /70, /72, /73, /74, /82 Category 1 Styles Only		2nd	Restrict per 50/, 51/
SWITCH Thermostatic	NASA GSFC S-311-641	No	1st	
	MIL-PRF-24236 Category 1 Styles Only		2nd	Restrict per 50/, 51/
SWITCH Other	Other	No	3rd	Restrict per 50/, 51/, 52/, 53/
THERMISTORS	MIL-PRF-32192 (Pos. & Neg. Coeff)	Product Level M	1st	
	MIL-PRF-23648 (Pos. & Neg. Coeff.)	Yes		
	NASA GSFC S-311-P-18 (Negative Coefficient)			Restrict per 54/
	NASA GSFC S-311-424 (Negative Coefficient)			
	NASA GSFC S-311-P-767 (Negative Coefficient)			
	Other	No	2nd	Restrict per 55/
WIRE & CABLE Coaxial Cable	NASA SSQ 21653	Yes	1st	
	MIL-DTL-17			Restrict per 56/, 57/
	Other	No	2nd	Restrict per 17/, 56/, 57/
WIRE & CABLE Data Bus	NASA SSQ 21676 (1553)	Yes	1st,	Restrict per 56/
	Other	No	2nd	Restrict per 17/, 56/, 57/

Table VI. Standard Parts and Selection Preferences for Grade 2

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
WIRE & CABLE Hookup Wire	NASA SSQ 21656 (General purpose TFE)	Yes	1st	
	NASA SSQ 21652 (Special purpose Silicone)	Yes	1st	
	NASA SSQ 22720 (Special purpose ETFE)	Yes	1st	
	SAE-AS22759	Yes	1st	Restrict per 56/, 57/, 58/
	MIL-DTL-81381	Yes	1st	Restrict per 56/, 57/, 59/
	Other	No	2nd	Restrict per 17/, 56/, 57/, 58/, 59/
WIRE & CABLE Magnet Wire	ANSI/NEMA-MW-1000	Yes	1st	Restrict per 56/
	Other	No	2nd	Restrict per 17/, 56/
WIRE & CABLE Multiconductor Cable	NASA SSQ 21656	Yes	1st	
	NASA SSQ 21655	Yes	1st	
	ANSI/NEMA WC27500	Yes	1st	Restrict per 56/, 57/
	Other	No	2rd	Restrict per 17/, 56/, 57/

Table VI Notes:

1/ This table identifies information for the part selection process, identification of standard parts, and associated restrictions and verifications. The requirements listed shall be implemented in addition to other requirements herein.

2/ All standard parts are identified in this column. The standard part designation is predicated on compliance with all applicable requirements. All nonstandard parts require nonstandard part approval.

3/ Parts selection shall be accomplished in the order indicated. A lower ranked selection shall not be used if a higher ranked selection can be obtained. Grade 1 parts exceed Grade 2 requirements and may be selected.

4/ This column identifies screening and associated verifications and restrictions that are required for the part to be classified as acceptable. The project EEE parts Control Document shall specify details as necessary to implement these requirements, and may specify additional requirements.

5/ Values for MIL-PRF-39014/02, style CKR06 are limited to 0.47 uF maximum to avoid the use of parts with large areas of thin dielectric layers that have been found to be particularly susceptible to the low voltage failure mechanism and also to exhibit decreased reliability at higher stress levels. The 1 uF, 50 V CKR06 capacitor (M39014/02-1419) shall not be selected for Grade 2. For applications that require a 1 uF, 50 V capacitor in this same package size, the MIL-PRF-123/2 CKS06 1 uF, 50 V capacitor is recommended.

6/ Designers must consider the geometry and relatively high mass of MIL-PRF-49470 capacitors. Devices which are not mounted properly may be susceptible to damage, including lead shearing in high vibration and shock environments. The taller stacks where the stack height exceeds the minimum base dimension are particularly at risk. Special mounting techniques may be necessary to ensure safe application in these environments. Consult the manufacturer or electrical packaging experts for recommendations to avoid potential damage from misuse of straps, coefficient of thermal expansion mismatches, etc.

These capacitors are very susceptible to thermal shock damage due to their large mass of ceramic. Installation temperature profiles should provide adequate temperature rise and cool-down time to prevent damage from thermal shock.

These capacitors are fragile and should be handled with extreme care. Parts which have been dropped or mishandled should be considered suspect due to the risk of microcracking which may result in latent failures.

7/ The MIL-PRF-55681/1 style CDR02 ceramic chip capacitors shall not be used in Grade 1 applications. This particular chip has a large length to width ratio (0.18" x 0.05") which makes this chip highly susceptible to cracking as a result of board flexing.

The use of MIL-PRF-55681 ceramic chip capacitors with Termination Style "W" or "Y" is PROHIBITED. Termination style "Y" is pure tin and termination style "W" gives the manufacturer the option to use either pure tin or a tin-lead alloy as a termination finish.

8/ MIL-PRF-83421 capacitors shall not be used in circuits where the energy is less than 250 microjoules. This is based on the "self healing" properties of plastic film capacitors and the need for sufficient energy to be available to promote self healing. Without adequate energy available, self healing will not occur and parts may catastrophically fail short circuit.

Parts covered by this specification contain internal soldered connections which may reflow during installation. The plastic dielectric in these parts is also temperature sensitive. Special precautions such as heat sinking are recommended when soldering onto boards.

9/ MIL-PRF-39003 CSR13 and CSR09 capacitors shall be subjected to the Option C or F surge current test as specified by MIL-PRF-39003/10 (surge current testing at -55°C and +85°C).

Solid tantalum capacitors are subject to inrush current failures. Effective series resistance for MIL-PRF-39003 capacitors shall be at least 0.3 ohms/volt or 1 ohm whichever is greater. MIL-PRF-39003 capacitors shall not be used in power supply filters. MIL-PRF-

39006/22 (CLR79) or MIL-PRF-39006/25 (CLR81) style parts are preferred for power supplies.

Parts covered by MIL-PRF-39003 contain internal soldered connections that may reflow during installation. The A, A1, B, B1 case sizes are particularly susceptible and special precautions such as heat sinking are recommended when soldering onto boards.

MIL-PRF-39003 style capacitors rated at 100 V and higher shall NOT be used. In order to produce the higher voltage ratings the manufacturers use alternate process steps compared to the lower voltage styles. These alternate process steps have not been found to consistently produce reliable parts.

These tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Prolonged exposure to high levels of reverse voltage can produce very high leakage currents and short circuits. Short circuited tantalum capacitors can ignite and/or produce excessive heat resulting in extreme damage to circuit boards. Reverse bias application of these parts should be avoided. MIL-PRF-39003 offers no guidance on the reverse bias performance of these capacitors. Capacitor manufacturer guidelines are generally very conservative urging against any prolonged exposure to reverse bias. Some limited experimental data exists that suggests some capacitors may be able to indefinitely withstand room temperature reverse voltages on the order of 15 to 25% of rated voltage. However, all of the factors affecting the reverse bias behavior (including size and rating of the capacitor, effects of circuit current limiting and ambient temperature) have not been studied.

Users are urged to carefully confirm the proper orientation of all tantalum capacitors after installation. The convention for polarity markings is often a source of potential confusion.

Part marking for MIL-PRF-39003/10 tubular case capacitors requires a stripe on the case adjacent to the cathode ("-") termination. This convention can be a source for confusion because the surface mount molded tantalum "chip" capacitors (CWR09 types per MIL-PRF-55365/4) frequently use a stripe on the case to identify the anode ("+") termination. Generally, the other styles of tubular case tantalum capacitors use a "+" to identify the anode terminal.

Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 and NEPAG Study Report "Reverse Bias Behavior of Surface Mount Solid Tantalum Capacitors" for further details.

10/ MIL-PRF-39006 CLR79 and CLR81 styles can be a source of transient potentials (intermittent shorts) during vibration stimuli. Therefore, Condition H shall be specified for vibration and shock (i.e., 53.79 g's random vibration,80 g's sinusoidal vibration, and 500 g's shock).

CLR79, CLR81, CLR90 and CLR91 tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Reverse bias application of these parts should be avoided. Per MIL-PRF-39006 these capacitors are capable of handling up to 3 volts of reverse polarity at 85°C regardless of capacitor voltage rating with some degradation in their leakage current characteristics. Exceeding 3 volts reverse bias may cause rapid deterioration of the capacitor, which can lead to catastrophic failure (short circuit). Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 for further details.

MIL-PRF-39006 style capacitors rated at 125 V shall NOT be used. In order to produce the higher voltage ratings the manufacturers use alternate process steps compared to the lower voltage styles. These alternate process steps have NOT been found to consistently produce reliable parts as evidenced by frequent stop shipment orders by the Military qualifying activity.

11/ MIL-PRF-55365 capacitors shall be subjected to either option "B" or "C" surge current testing (at -55°C and +85°C) in accordance with MIL-PRF-55365 and associated slash sheet.

MIL-PRF-55365 solid tantalum capacitors are subject to inrush current failures. Effective series resistance for these capacitors shall be at least 0.3 ohms/volt or 1 ohm whichever is greater. MIL-PRF-55365 capacitors shall not be used in power supply filters.

These tantalum capacitors are polar devices that are sensitive to reverse bias voltage. Prolonged exposure to high levels of reverse voltage can produce very high leakage currents and short circuits. Short circuited tantalum capacitors can ignite and/or produce excessive heat resulting in extreme damage to circuit boards. Reverse bias application of these parts shall be avoided. MIL-PRF-55365 offers no guidance on the reverse bias performance of these capacitors. Capacitor manufacturer guidelines are generally very conservative urging against any prolonged exposure to reverse bias. Some limited experimental data exists that suggests some capacitors may be able to indefinitely withstand room temperature reverse voltages on the order of 15 to 25% of rated voltage. However, all of the factors affecting the reverse bias behavior (including size and rating of the capacitor, effects of circuit current limiting and ambient temperature) have not been studied.

Users are urged to carefully confirm the proper orientation of all tantalum capacitors after installation.

Refer to NEPAG Lesson Learned Bulletin NEPAG-LLB-2001-002 and NEPAG Study Report "Reverse Bias Behavior of Surface Mount Solid Tantalum Capacitors" for further details.

12/ NSPAR or equivalent evaluation process required, including an SCD to the nearest equivalent military specification.

13/ Perform screening per applicable requirements of MSFC-SPEC-1198 or approved equivalent. Perform DPA using internal inspection requirements of MSFC-SPEC-1198 or approved equivalent. Qualify to applicable or similar military specification.

14/ Cadmium, zinc, or anodized plated connectors and connector accessories (i.e., backshells, contacts, jam nuts, protective caps, jackscrews, etc.) shall not be used in space flight applications. Nickel is an acceptable plating material. Prior to use, connectors and backshells shall be thermal vacuum baked per MSFC-SPEC-548, or equivalent.

15/ Stress corrosion and outgassing properties of these connectors are not controlled and must be evaluated for compliance to project engineering requirements. Prior to use, connectors shall be vacuum baked per MSFC-SPEC-548, or equivalent.

16/ The rear side of several connectors per this specification is not protected against moisture or debris.

17/ Screen and qualify to similar military specification.

18/ Connectors shall be procured without contacts. Contacts shall be procured in bulk quantity with lot traceability and shall be issued accordingly so that the connector population and corresponding tensile testing use the same lot.

19/ 100% screening shall be performed per MIL-PRF-3098 Table I Product Level B, including the following Product Level S test inspections: PIND testing, radiographic Inspection, and Percent Defective Allowable (PDA) of 10%. Pure tin shall be prohibited as a final finish.

20/ Screening and qualification shall meet the requirements of MIL-PRF-3098 Product Level B including Note 19/ above. A source control document shall be submitted to document the details of the part including screening and qualification. To minimize risk, a manufacturer that is QPL qualified for similar products shall be selected unless otherwise approved by MSFC EEE Parts Engineering.

21/ MIL-PRF-55310 requirements for Product Level B and Temperature Range A (-55ºC – 125ºC) shall be met. The vendor's criteria for element derating shall be obtained and submitted. Product selection shall be limited to hermetic packages.

22/ MIL-PRF-55310 requirements for Product Level B and Temperature Range A (-55ºC – 125ºC) shall be met. The vendor's criteria for element derating shall be obtained and submitted. Product selection shall be limited to hermetic packages. A source control document shall be submitted to document the details of the part including screening and qualification. To minimize risk, a manufacturer that is QPL qualified for similar products shall be selected unless otherwise approved by MSFC EEE Parts Engineering.

23/ Devices with external or internal pressure contacts (die to electrical contacts) are prohibited. PIND testing per MIL-STD-750 Test Method 2052, Condition A is required on cavity devices. PIND testing is not applicable to double-plug diodes with no cavity or optical coupled isolators unless normally performed by the manufacturer on equivalent JANS products. Radiography inspection with two views is required per MIL-STD-750 Test Method 2076.

24/ DPA shall be require per MIL-STD-1580, Requirement 13 for diodes and Requirement 21 for wire bonded devices. The DPA sample size shall be 2% of the lot or 5 samples, whichever is greater. In additional, internal gas analysis (IGA) shall be performed on cavity devices. The IGA sample size and accept criteria shall be 3 pieces with zero rejects or 5 pieces with one reject.

25/ Custom processed semiconductors shall be procured from a QML listed manufacturer and processed on a QML line unless otherwise approved by MSFC EEE Parts Engineering. A source control document shall specify the part performance characteristics and manufacturing requirements. The controlling document shall specify design, processing, qualification, and screening requirements to match the standard requirements that would be applied to a similar JANTXV quality part.

26/ A controlling document shall specify the part performance characteristics, required screening tests and lot qualification as specified in MIL-PRF-19500 Appendix E. A sample of each production lot shall be subjected to qualification, including life testing. Life testing shall be performed per MIL-PRF-19500 Appendix E Table VIB Subgroup 3. A sample of life tested parts shall be subjected to DPA per the applicable requirement of MIL-STD-1580. The DPA sample size shall be 2% or 5 samples, whichever is greater.

27/ Screening and qualification shall be equivalent to the requirements imposed on similar standard parts.

28/ Radiography shall be performed per MIL-PRF-28861 for Class S filters.

Special care must be exercised during installation of these parts. Parts covered by this specification may contain internal soldered connections that can reflow during installation.

Strict adherence to the specification recommended torque is imperative. Excessive torque may crack the filter case and/or its internal components. Cracked discoidal capacitors may go undetected through post installation checkout, but lead to filter malfunction later on.

29/ A source control document based on "Class B" requirements of MIL-PRF-28861 is required. In addition to Group A Inspection, the SCD shall include the Group B inspection for "Class B" filters of MIL-PRF-28861 on every lot. Radiography is required and shall be performed per MIL-PRF-28861 Group A Inspection.

30/ Use Rockwell Drawings ME451-0009 (Bussman type GNZ), ME451-0010 (Bussman type GQR), ME451-0016 (Bussman type ANG), ME451-0017 (Bussman type HOB), and ME451-0018 (Bussman type GMV).

31/ Fuses shall be procured from a QPL/QML listed manufacturer and processed on a QPL/QML line unless otherwise approved by MSFC EEE Parts Engineering. Screen per Table X for Grade 2.

32/ Unless otherwise approved by MSFC EEE Parts Engineering, hybrid microcircuits shall be hermetic and undergo pre-cap inspection.

33/ PIND testing shall be performed per MIL-STD-883 Test Method 2020 Condition A. Radiograph inspections shall be performed per MIL-STD-883 Test Method 2012.

34/ Custom processed hybrid microcircuits shall be procured from a QML listed manufacturer and processed on a QML line unless otherwise approved by MSFC EEE Parts Engineering. Screening and qualification shall be per MIL-PRF-38534 for Class H devices. PIND testing shall be performed per MIL-STD-883 Test Method 2020 Condition A. Radiograph inspections shall be performed per MIL-STD-883 Test Method 2012. A two piece DPA is required. DPA shall be performed in accordance with MIL-STD-1580 Requirement 16 for hybrid microcircuits; internal gas analysis is required. In case of high cost parts, parts with very limited availability, or parts manufactured on a controlled QPL/QML product line the sample size may be reduced with the approval of MSFC EEE Parts Engineering. Radiation tolerance testing may be required depending on the radiation environment. A controlling document shall be generated to specify the part performance characteristics and manufacturing requirements.

35/ Magnetics shall comply with Table XI for Class B.

36/ Except for Class N used as specified, microcircuits shall be hermetic unless otherwise approved by MSFC EEE Parts Engineering.

37/ Perform PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012, two views. Radiation testing may be required depending on the radiation environment.

38/ Screen and qualify in accordance with Tables XII and XIII, respectively, for Grade 2.

39/ Custom processed and Vendor Hi Rel microcircuits shall be procured from a QML/QPL listed manufacturer and processed on a QML/QPL line unless otherwise approved by MSFC EEE Parts Engineering.

40/ Custom processed microcircuits shall be procured from a QML listed manufacturer and processed on a QML line unless otherwise approved by MSFC EEE Parts Engineering. Screening shall be in accordance with MIL-STD-883 Test Method 5004 Table I for Class Level B devices. Qualification shall be in accordance with MIL-STD-883 Test Method 5005 Groups A, B, C, and D for Class Level B devices. In addition PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012, two views, are required. DPA shall be performed in accordance with MIL-STD-1580, Requirement 16; internal gas analysis is required. Sample size shall be in accordance with MIL-STD-1580. Radiation testing may be required depending on the radiation environment. A controlling document shall be generated specifying the part packaging, screening, qualification, performance parameters and manufacturing requirements.

41/ The environment must be considered when using plastic encapsulated microcircuits (PEMs). PEMs shall not be used in an environment where moisture is present. Where their use can be accommodated, special handling and storage procedures must be followed to prevent exposure to moisture. Also, the radiation tolerance of the PEM must be acceptable for the environment in which it will be used. One hundred percent radiographic inspection per MIL-STD-1580 Requirement 16 for PEMs shall be performed. DPA per MIL-STD-1580 Requirement 16 for PEMs shall be performed. The DPA sample size shall be five devices.

42/ Screening and qualification for hermetic microcircuits shall be per MIL-PRF-38535 for Class Level B devices. PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012, two views, are required. DPA shall be performed in accordance with MIL-STD-1580, Requirement 16. Internal gas analysis is required. Vendor Hi Rel PEMs shall comply with paragraph 5.5.5 herein for Grade 2.

43/ Manufacturer shall submit an acceptable procedure for internal visual inspection and cleaning, or else relays shall be acceptably screened with (a) PIND testing or Vibration Miss testing, (b) radiographic inspection per MSFC-STD-355, and (c) five piece sample DPA per MIL-STD-1580 Requirement 17.

44/ Screening and qualification shall be equivalent to MIL-PRF-39016 with the additional requirements of 28/ above. Any of these tests need not be repeated if they are performed by military or SCD procurement specification or in vendor Hi Rel flow.

45/ Platings of cadmium or zinc shall not be used. Molybdenum contact material shall not be used.

46/ Components shall not be selected with "Known Reliability Suspect Designs," reference MIL-HDBK-1547.

47/ Components shall not be selected with "Known Material Hazards," reference MIL-HDBK-1547.

48/ "Other" resistors shall be procured from a QPL listed manufacturer and processed on a QPL line unless otherwise approved by MSFC EEE Parts Engineering.

49/ As a minimum screening and qualification shall consist of testing the parts to the requirements of the most applicable military specification for the part type and any additional tests needed to meet the application requirements.

50/ Select for compliance with hazard avoidance requirements herein (refer to section 5.4.4) by inspection or manufacturer's certification.

51/ If 100% pre-closure visual inspection and cleaning are not performed, 100% Radiography (real-time preferred) in accordance with MSFC-STD-355 and DPA on a minimum of five samples per MIL-STD-1580 Requirement 19 are required.

52/ Screening shall be performed per MSFC-SPEC-1198, or equivalent. Military standard qualification, or equivalent, is required.

53/ All non-QPL parts shall require a DPA in accordance with MIL-STD-1580.

54/ Refer to GSFC EEE-INST-002 for qualified parts.

55/ Thermistors shall be procured to a source control document or equivalent and shall be screened per Table XIV and qualified per XV for Grade 2.

56/ Wire and cable products per these specifications may require material testing per SP-R-0022A and NASA-STD-6001, or equivalents.

57/ Silver plated copper wire shall be controlled per section 5.4.5 herein.

58/ Some ETFE (ethylene-tetrafluoroethylene copolymer / trade name "Tefzel") insulated wire has been found to fail flammability testing in a 30 percent oxygen environment. In addition, 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.

59/ Polyimide (trade name "Kapton") insulated wire is susceptible to "arc tracking" when used in certain applications.

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CAPACITOR Ceramic	MIL-PRF-20/27 - /31, /35-/38 (CCR)	Yes	1st	
	MIL-PRF-123 (CKS)			
	MIL-PRF-39014/1, /2, /5 (CKR)			
	MIL-PRF-49464/1 (CPCR)			
	MIL-PRF-49467 (HVR)			
	MIL-PRF-49470 (PS)			
	MIL-PRF-55681/1 - /4 (CDR)			
CAPACITOR Glass	MIL-PRF-23269/1 - /4 (CYR)	Yes	1st	
CAPACITOR Mica	MIL-PRF-39001 (CMR)	FRL R	1st	
CAPACITOR Plastic Film	MIL-PRF-19978 (CQR)	Yes	1st	
	MIL-PRF-39022 (CHR)			
	MIL-PRF-83421/1 (CRH)			
CAPACITOR Tantalum	MIL-PRF-39003/1, /2, /10 (CSR & CSS)	Yes	1st	
	MIL-PRF-39006/1 - /4, /22, /25 (CLR)			
	MIL-PRF-55365/4 (CWR)			
CAPACITOR Other	Grade 1 and 2 Capacitors Listed in Tables V and VI	Yes	1st	Restrict per 5/
	Other	No	2nd	Restrict per 6/
CIRCUIT BREAKER	Any Military Specification or Source Control Document	Yes	1st	
	Other	No	2nd	Restrict per 6/
CONNECTOR Circular (continued on next page)	NASA MSFC 40M38277	Yes	1st	
	NASA MSFC 40M38298			
	NASA MSFC 40M39569			
	NASA SSQ 21635			

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Circular (continued from previous page)	MIL-DTL-38999	Yes	1st	Restrict 7/, 8/
	MIL-DTL-26482			
	MIL-DTL-5015			Restrict 7, 8/, 9/
	Other	No	2nd	Restrict per 6/, 7/, 8/, 9/
CONNECTOR Coaxial Triaxial, and other Radio Frequency (RF)	MIL-PRF-39012	Yes	1st	Restrict per 8/
	MIL-PRF-49142			
	MIL-DTL-83517			
	Other	No	2nd	Restrict per 6/, 8/
CONNECTOR Compact PCI™ Interface	NASA GSFC S-311-P-822	Yes	1st	
	Other	No	2nd	Restrict per 6/
CONNECTOR D Subminiature	NASA GSFC S-311-P-4	Yes	1st	
	NASA GSFC S-311-P-10			
	MIL-DTL-24308			Restrict 7/, 8/
	Other	No	2nd	Restrict per 6/, 7/, 8/
CONNECTOR EMI Filter Type	NASA GSFC S-311-P-626	Yes	1st	
	Other	No	2nd	Restrict per 6/
CONNECTOR EVA	NASA SSQ 22698	Yes	1st	
	Other	No	2nd	Restrict per 6/
CONNECTOR Microminiature	MIL-DTL-83513	Yes	1st	Restrict per 7/, 8/
	Other	No	2nd	Restrict per 6/, 7/, 8/
CONNECTOR Printed Circuit	MIL-DTL-55302	Yes	1st	Restrict 7/, 8/
	Other	No	2nd	Restrict per 6/, 7/, 8/
CONNECTOR Rectangular – Rack and Panel, ORU, RPCM	NASA SSQ 21636	Yes	1st	
	NASA SSQ 22680			
	NASA SSQ 22681			
	Other	No	2nd	Restrict per 6/

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Umbilical	NASA SSQ 21637	Yes	1st	
	NASA GSFC S-311-P-718			
	SAE-AS81703			
	Other	No	2nd	Restrict per 6/
CONNECTOR Zero-G lever	NASA SSQ 21635	Yes	1st	
	Other	No	2nd	Restrict per 6/
CONNECTOR Contacts: Signal, Power, Coaxial, Shielded, Thermocouple, etc.	NASA SSQ 21635	Yes	1st	
	NASA SSQ 21636			
	NASA SSQ 21637			
	NASA SSQ 22680			
	NASA SSQ 22681			
	NASA SSQ 22698			
	NASA MSFC 40M38277			
	NASA MSFC 40M38294			
	NASA MSFC 40M38298			
	NASA MSFC 40M39569			
	NASA GSFC S-311-P-4			
	NASA GSFC S-311-P-718			
	SAE-AS39029			
	MIL-DTL-55302			
	MIL-DTL-83505			
	Other	No	2nd	Restrict per 6/
CONNECTOR Backshell (continued on next page)	NASA SSQ 21635	Yes	1st	
	NASA SSQ 21636			
	NASA SSQ 21637			
	NASA SSQ 22680			
	NASA SSQ 22681			
	NASA SSQ 22698			
	NASA MSFC 40M38277			
	NASA MSFC 40M38294			

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
CONNECTOR Backshell (continued from previous page)	NASA MSFC 40M38298		Yes	1st	
	NASA MSFC 40M39569				
	NASA SSQ 21635				
	SAE-AS85049				Restrict per 7/
	Other		No	2nd	Restrict per 6/, 7/
CRYSTALS	MIL-PRF-3098		Yes	1st	
	Grade 1 and 2 Crystals Listed in Tables V and VI				Restrict per 5/
	Established Reliability and Non-ER Military Crystals				
	Vendor Hi-Rel Crystals				
	Other		No	2nd	Restrict per 6/
CRYSTAL CONTROL OSCILLATORS	MIL-PRF-55310		Yes	1st	
	Grade 1 and 2 Crystal Control Oscillators Listed in Tables V and VI				Restrict per 5/
	Established Reliability and Non-ER Military Crystal Control Oscillators				
	Vendor Hi-Rel Crystal Control Oscillators			2nd	
	Other		No	3rd	Restrict per 6/
DISCRETE SEMICONDUCTOR Diodes, Transistors, Optical Couplers	MIL-PRF-19500	JANS	Yes	1st	Exceeds requirement
		JANTXV			Restrict per 10/
		JANTX			
	Vendor Hi-Rel				
	Other		No	2nd	Restrict per 11/
FIBER OPTIC Cable	NASA SSQ 21654, NFOC-2FFF-1GRP-1		Yes	1st	Restrict per 12/
	Other		No	2nd	Restrict per 6/
FIBER OPTIC Devices	All		No	N/A	Restrict per 13/

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
FIBER OPTIC Interconnects	NASA SSQ 21635, NZGC-F-16PB (Pin)		Yes	1st	Restrict per 14/
	NASA SSQ 21635, NZGC-F-16SB (Socket)				
	Other		No	2nd	Restrict per 6/
FILTER	MIL-PRF-28861/1, /2, /3, /4, /5		Yes	1st	Restrict per 15/
	MIL-PRF-15733/54, /56, /58, /67, /72 – /75				
	Grade 1 and 2 Filters Listed in Tables V and VI				Restrict per 5/
	Established Reliability and Non-ER Military Filters			2nd	Restrict per 15/
	Vendor Hi-Rel Filters		No	3rd	
	Other			4th	Restrict per 6/, 15/
FUSE	MIL-PRF-23419/4, /8		Yes	1st	
	Rockwell Spec				Restrict per 16/
	Other		No	2nd	Restrict per 17/
HYBRID MICROCIRCUIT	MIL-PRF-38534	Class K	Yes	1st	Exceeds requirement
		Class H			Restrict per 18/
	/883S or /883B				
	Custom Processed Part				Restrict per 19/
	Vendor /883 Compliant, Vendor "Hi Rel"			2nd	Restrict per 20/
	MIL-PRF-38534	Class G	No	3rd	Restrict per 21/
		Class D, E		4th	Restrict per 22/
	Commercial and commercial off the shelf			5th	Restrict per 23/
MAGNETICS Inductors, Coils (continued on next page)	MIL-PRF-15305, Grade 1 or 2 Family K, All Classes		Yes	1st	
	MIL-PRF-39010/1, /2, /3, /6, /7				
	MIL-PRF-83446/4, /5, /7, /10 Families 50, 51				
	Grade 1 and 2 Inductors and Coils Listed in Tables V and VI				Exceeds requirement

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection		Standard Part 2/	Selection Preference Ranking 3/	Note 4/
MAGNETICS Inductors, Coils (continued from previous page)	Military Qualified Inductors and Coils, Fixed value		Yes	1st	
	Vendor Hi-Rel Inductors and Coils, Fixed value			2nd	
	Other		No	3rd	Restrict per 6/
MAGNETICS Transformers	MIL-PRF-27 Families 03, 04, 20, 21, 36, 37, 40, 41		Yes	1st	
	MIL-PRF-21038 Family 31				
	Grade 1 and 2 Transformers in MSFC-STD-3012				
	Military Qualified Transformers				
	Vendor Hi-Rel transformers			2nd	
	Other		No	3rd	Restrict per 6/
MONOLITHIC MICROCIRCUIT	MIL-PRF 38535	Class V, S	Yes	1st	Exceeds requirement
		Class Q, B			Restrict per 18/
		Class M			
	/883, /883B or /883S per MIL-STD-883 paragraph 1.2.1				
	MIL-PRF-38535	Class N			
	Vendor /883 compliant			2nd	Restrict per 24/
	Vendor Hi Rel Hermetic		No	3rd	Restrict per 25/, 26/
	Vendor Hi Rel PEMs			4th	Restrict per 27/, 28/
	Commercial Hermetic			5th	Restrict per 25/
	Commercial PEMs			6th	Restrict per 27/
RELAY	MIL Qualified		Yes	1st	Restrict per 29/, 30/
	Vendor Hi Rel				
	Other		No	2nd	
RESISTOR Film/Foil (continued on next page)	MIL-PRF-39017, RLR		FRL P	1st	
	MIL-PRF-55182, RNR, RNC, RNN				
	MIL-PRF-55342, RM				
	MIL-PRF-32159, RCZ		Product Level T or M		

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
RESISTOR Film/Foil (continued from previous page)	MIL-PRF-83401, RZ	Yes	1st	
	NASA SSQ Type 1 Qualified parts			
	NASA GSFC S-311-P-742 and NASA GSFC S-311-P-813			
	Other	No	2nd	Restrict per 6/
RESISTOR Wirewound	MIL-PRF-39007, RWR	FRL R, S, or P	1st	
	MIL-PRF-39005, RBR			
	MIL-PRF-39009, RER			
	Other	No	2nd	Restrict per 6/
RESISTOR Other	Other	No	3rd	Restrict per 13/
SWITCH	MIL Qualified, Hermetic or Environmental	Yes	1st	Restrict per 31/
	Other	No	2nd	Restrict per 6/
THERMISTOR	Any Military Specification	Yes	1st	
	NASA GSFC S-311-P-18 (Negative Coefficient)			Restrict per 32/
	NASA GSFC S-311-424 (Negative Coefficient)			
	NASA GSFC S-311-P-767 (Negative Coefficient)			
	Other	No	2nd	Restrict per 33/
WIRE & CABLE Coaxial Cable	NASA SSQ 21653	Yes	1st	
	MIL-DTL-17			Restrict per 34/, 35/
	Other	No	2nd	Restrict per 6/, 34/, 35/
WIRE & CABLE Data Bus	NASA SSQ 21676 (1553)	Yes	1st	
	Other	No	2nd	Restrict per 6/
WIRE & CABLE Hookup Wire (continued on next page)	NASA SSQ 21656 (General purpose TFE)	Yes	1st	
	NASA SSQ 21652 (Special purpose Silicone)			
	NASA SSQ 22720 (Special purpose ETFE)			

Table VII. Standard Parts and Selection Preferences for Grade 3

1/

Part Type	Selection	Standard Part 2/	Selection Preference Ranking 3/	Note 4/
WIRE & CABLE Hookup Wire (continued from previous page)	SAE-AS22759	Yes	1st	Restrict per 34/, 35/, 36/
	MIL-DTL-81381			Restrict per 34/, 35/, 37/
	Other	No	2nd	Restrict per 6/, 34/, 35/, 36/, 37/
WIRE & CABLE Magnet Wire	ANSI/NEMA-MW-1000	Yes	1st	Restrict per 34/
	Other	No	2nd	Restrict per 6/, 34/
WIRE & CABLE Multiconductor Cable	NASA SSQ 21656	Yes	1st	
	NASA SSQ 21655			
	ANSI/NEMA WC27500			Restrict per 34/, 35/
	Other	No	2rd	Restrict per 6/, 34/, 35/

Table VII Notes:

1/ This table identifies information for the part selection process, identification of standard parts, and associated restrictions and verifications. The requirements listed shall be implemented in addition to other requirements herein.

2/ All standard parts are identified in this column. The standard part designation is predicated on compliance with all applicable requirements. All nonstandard parts require nonstandard part approval.

3/ Parts selection shall be accomplished in the order indicated. A lower ranked selection shall not be used if a higher ranked selection can be obtained. Grade 1 and Grade 2 parts exceed Grade 3 requirements and may be selected.

4/ This column identifies screening and associated verifications and restrictions that are required for the part to be classified as acceptable. The project EEE parts Control Document shall specify details as necessary to implement these requirements, and may specify additional requirements.

5/ Application notes of Table V and Table VI apply.

6/ Submit screening (refer to section 5.3.3) and qualification (refer to section 5.2) for approval. NSPAR or equivalent evaluation process required, including a source control document similar to the nearest equivalent military specification. Only fixed values permitted.

7/ Cadmium, zinc, or anodized plated connectors and connector accessories (i.e., backshells, contacts, jam nuts, protective caps, jackscrews, etc.) shall not be used in space flight applications. Nickel is an acceptable plating material. Prior to use, connectors and backshells shall be thermal vacuum baked per MSFC-SPEC- 548, or equivalent.

8/ Stress corrosion and outgassing properties of these connectors are not controlled and must be evaluated for compliance to project engineering requirements. Prior to use, connectors shall be vacuum baked per MSFC-SPEC-548, or equivalent.

9/ The rear side of several connectors per this specification is not protected against moisture or debris.

10/ PIND testing and radiographic inspection are strongly recommended.

11/ The controlling documentation shall identify the part performance characteristics, required lot qualification, and screening tests. A sample of each production lot shall be subjected to qualification, including life testing and destructive physical analysis. Screening should include 100% Particle Impact Noise Detection (PIND) and x-ray examination of devices with internal cavities.

12/ Approved for use on Space Station. See SSQ-21654.

13/ Qualification and screening requirements shall be determined to suit the specific application. NSPAR or equivalent evaluation process required, including a source control document.

14/ NASA Zero-G, contact size 16, socket, fiber optic termini. Approved for use on Space Station. See SSQ-21635.

15/ Radiography per MSFC-STD-355 or equivalent is recommended. If radiography is performed on filters with tubulets, the leads through the tubulets shall be soldered a minimum of 50% of the tube length.

16/ Use Rockwell Drawings ME451-0009 (Bussman type GNZ), ME451-0010 (Bussman type GQR), ME451-0016 (Bussman type ANG), ME451-0017 (Bussman type HOB), and ME451-0018 (Bussman type GMV).

17/ Fuses shall be procured from a QPL/QML listed manufacturer and processed on a QPL/QML line unless otherwise approved by MSFC EEE Parts Engineering. Screen per Table X for Grade 3.

18/ PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012 are strongly recommended.

19/ Qualification and screening shall be per MIL-PRF 38534 for Class H devices. PIND testing and radiographic inspection are strongly recommended.

20/ PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012 are strongly recommended for devices with internal cavities.

21/ PIND testing and radiographic inspection are strongly recommended. User should verify that the device temperature range is adequate for the application.

22/ PIND testing per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012 are strongly recommended. User should

obtain the device specification from the vendor and verify that the part meets project requirements.

23/ Commercial hybrid microcircuits shall, as a minimum, be screened as follows: Burn-in at the appropriate temperature for 100 hours; Final electrical tests; PIND testing per MIL-STD-883, Method 2020, Test Condition A; and Radiographic inspection per MIL-STD-883, Method 2012. The use of plastic encapsulated hybrid microcircuits is not recommended. Commercial-off-the-shelf assemblies containing hybrid microcircuits may be considered qualified upon successful completion of environmental testing.

24/ PIND testing (when applicable) per MIL-STD-883, Method 2020, Test Condition A and radiographic inspection per MIL-STD-883, Method 2012 are strongly recommended

25/ Screen and qualify in accordance with Tables XII and XIII, respectively, for Grade 3.

26/ If the tests specified in Table XII and Table XIII have been performed by the vendor, it is not necessary to repeat the tests.

27/ Vendor Hi Rel PEMs shall comply with paragraph 5.5.5 herein for Grade 3.

28/ If the tests specified in MSFC-STD-3012 Appendix B for Grade 3 Vendor Hi Rel PEMs have been performed by the vendor, it is not necessary to repeat the tests.

29/ Platings of Cadmium or Zinc shall not be used. Molybdenum contact material shall not be used.

30/ Components shall not be selected with “Known Material Hazards,” reference MIL-HDBK-1547.

31/ Select for compliance with hazard avoidance requirements herein (refer to section 5.4.4) by inspection or manufacturer’s certification.

32/ Refer to GSFC EEE-INST-002 for qualified parts.

33/ Thermistors shall be procured to a source control document or equivalent and shall be screened per Table XIV and qualified per Table XV for Grade 3.

34/ Wire and cable products per these specifications may require material testing per SP-R-0022A and NASA-STD-6001, or equivalents.

35/ Silver plated copper wire shall be controlled per section 5.4.5 herein.

36/ Some ETFE (ethylene-tetrafluoroethylene copolymer / trade name “Tefzel”) insulated wire has been found to fail flammability testing in a 30 percent oxygen environment. In addition, 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.

37/ Polyimide (trade name “Kapton”) insulated wire is susceptible to “arc tracking” when used in certain applications.

Table VIII. Standard Parts and Selection Preferences for Grade 4

1/

Part Type	Selection 2/	Standard Part 3/	Selection Preference Ranking 4/	Note 5/
CAPACITOR Ceramic, Glass, Mica, Plastic, Tantalum, Variable, Other	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
CIRCUIT BREAKER	Military Specification		N/A	
	Commercial and Other			
CONNECTOR Connectors and Accessories	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
CRYSTALS	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
CRYSTAL CONTROL OSCILLATORS	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
DISCRETE SEMICONDUCTOR Diodes, Transistors, Optical Couplers	MIL-PRF-19500	Yes	N/A	
	Vendor Hi Rel			
	Commercial and Other			
FIBER OPTIC Cables, Devices, Interconnects	All		N/A	
FILTER	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
FUSE	MIL-PRF-23419		N/A	
	Bussman or Littlefuse			
	Commercial and Other			
HYBRID MICROCIRCUIT	MIL-PRF-38534		N/A	
	MIL-STD-883 Compliant			
	Vendor Hi Rel			
	Commercial and Other			

Table VIII. Standard Parts and Selection Preferences for Grade 4

1/

Part Type	Selection 2/	Standard Part 3/	Selection Preference Ranking 4/	Note 5/
MAGNETICS Inductors, Coils, Transformers	Military Specification	Yes	N/A	
	Vendor Hi-Rel			
	Commercial and Other			
MONOLITHIC MICROCIRCUIT	MIL-PRF-38535		N/A	
	MIL-STD-883 Compliant			
	Vendor Hi Rel			
	Commercial and Other			
RELAY	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
RESISTOR Film/Foil, Wirewound, Other	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
SWITCH	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			
THERMISTOR	Military Specification		N/A	
	NASA GSFC Specification			
	Commercial and Other			
WIRE & CABLE Coaxial Cable, Data Bus, Hookup Wire, Magnet Wire, Multiconductor Cable	Military Specification		N/A	
	Vendor Hi-Rel			
	Commercial and Other			

Table VIII Notes:

1/ This table identifies information for the part selection process, identification of standard parts, and associated restrictions and verifications. The requirements listed shall be implemented in addition to other requirements herein. All parts used in flight applications shall comply with the Hazard Avoidance requirements per MSFC-STD-3012.

2/ Refer to MIL-HDBK-1547 for selection guidance.

3/ All parts are considered standard parts for Grade 4.

4/ Selection preference ranking is not applicable for Grade 4.

5/ This column identifies screening and associated verifications and restrictions for the part, if any. The project EEE parts Control Document shall specify details as necessary to implement these requirements, and may specify additional requirements.

Table IX. Requirements for Upgrade Screening and Qualification of Discrete Semiconductors for Use in Grade 1 Applications

1/

	100% Screen (Screening per MIL-PRF-19500) 2/	**MIL-STD-750 Test Method**	**Requirement**	**Notes**
1.	Temperature Cycling	1051	Test condition C, or maximum storage temperature, whichever is less. No dwell at 25°C; 20 cycles total with ≥ 10 minutes at extremes. For axial-lead, glass-body diodes, 10 cycles of thermal shock (glass strain) in accordance with MIL-STD-750, Method 1056, Test Condition A, over the temperature range of 0° to 100°C shall be substituted for this test.	
2.	Particle Impact Noise Detection (PIND)	2052	Condition A	3/
3.	Instability (axial leaded diodes only. Omit for metallurgically bonded double-plug or stud-mounted diodes)			
	a. Forward Instability Shock Test (FIST). (Omit for temperature-compensated reference diodes.)	2081	5 shocks of 1500 g minimum (0.5 ms rise time) in each of two mutually perpendicular planes monitored continuously during shock.	
	b. Backward Instability Shock Test (BIST)	2082	Vibration at 60 ± 3 Hz; 0.1 inch minimum displacement for 30 seconds minimum, monitored continuously during vibration.	
4.	Serialization		100%	
5.	Interim Electrical Parameters		JANS interim electrical parameters per detail specification (read and record)	4/
6.	High Temperature Reverse Bias (HTRB)		48 hours minimum at TA = 150° C minimum and minimum applied voltage as follows:	
	a. Transistors	1039	Test Condition A	
	b. Power Field Effect Transistors (FETs)	1042	Test Condition B	
	c. Diodes, zeners, and rectifiers (except Light Emitting Diodes (LEDs))	1038	Test Condition A. Zener diodes shall be subjected to HTRB at 80 - 85% of nominal V_Z for $V_Z \geq 10V$. Omit test for devices with $V_Z < 10V$.	
7.	Interim Electrical and Delta Parameters (delta parameters shall be measured first)		JANS interim electrical parameters and deltas within 16 hours after removal of applied voltage per detail specification. A PDA of 5% on electricals and deltas shall be required (read and record)	

continued on next page

Table IX. Requirements for Upgrade Screening and Qualification of Discrete Semiconductors for Use in Grade 1 Applications

1/

	100% Screen (Screening per MIL-PRF-19500) 2/	MIL-STD-750 Test Method	Requirement	Notes
8.	Power Burn-In		Per JANS detail specification	
	a. Bipolar Transistors	1039	Test condition B (160 hours min)	
	b. Power FETs	1042	Test condition A (160 hours min)	
	c. Diodes, zeners, and rectifiers	1038	Test condition B (160 hours min)	
	d. Thyristor-controlled rectifiers	1040	Test condition A (160 hours min)	
			Reverse blocking test shall replace power burn-in for all thyristors and for power rectifier at ≥ 10 amp rating at $T_C \geq 100°C$.	
9.	Final Electrical Test Interim electrical and delta parameters for PDA		Per JANS electrical and delta, with a PDA of 3% (read and record). All parameter measurements shall be completed within 96 hours after removal from burn-in conditions.	4/
10.	Radiography	2076	JANS, two views	5/
11.	Hermetic Seal (Omit this test for painted glass diodes.)	1071		
	a. Fine Leak Testing (Omit this test for metallurgically bonded, double-slug d		Test Conditions G4, H1, H2, CH1, CH2	
	b. Gross Leak Testing		Test Conditions A, B, C, CH2, D, or E, G1, G2, J, L1	
12.	Visual Examination	2071		

Procedure	Requirement
Group B per MIL-PRF-19500	The following tests of Subgroup 4 in Appendix E, Table VIA shall be performed per the Lot Tolerance Percent Defective (LTPD) specified: A. Intermittent Operating Life Test Method 1037, 2000 cycles or Test Method 1042, Condition D, 2000 cycles B. Electrical parameters per JANS Detail Specification
Destructive Physical Analysis	MIL-STD-1580, Requirement 13 for diodes and Requirement 21 for wire bonded devices. Sample size shall be 2% of the lot or 5 samples, whichever is greater. In additional, internal gas analysis (IGA) shall be performed. The sample size and accept criteria shall be 3 samples with 0 failures or 5 samples with 1 failure for JANS, 5 pieces with zero rejects for JANTXV, and 10 pieces with zero rejects for JANTX.
Marking	A green dot marking shall be used to signify compliance with these requirements. A red dot shall be marked on all failures.

Table IX Notes:

1/ This table does not address radiation testing that may be required for proper performance of a part in its application.

2/ Screening sequence shall conform to the sequence in which tests are listed, except as noted.

3/ Not applicable to double-plug diodes with no cavity or optical coupled isolators unless normally performed by the manufacturer.

4/ JANS if specified, otherwise use JANTXV Deltas.

5/ May be performed any time prior to seal testing and after serialization. The Blue dot marking in Method 2076 does not apply.

Table X. Fuse Screening

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

Table X Notes:

1/ The test conditions and the pass/fail criteria shall be based on the nearest equivalent military specification, the manufacturer’s specification, or the application, whichever is most severe.

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

3/ The source current for the resistance measurement shall not exceed 10% of the nominal current rating at room temperature.

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

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

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

7/ Marking and voltage ratio rejects shall not be counted for purposes of establishing the defect rate.

Table XI. Compliance with MIL-STD-981 Requirements for Parts Qualified to Certain Military Specifications

MIL-STD-981 REQUIREMENT		**COMPLIANCE** 1/				
PARAGRAPH	**SYNOPSIS**	**MIL-PRF-27** Power and Audio Transformers & Inductors	**MIL-PRF-15305** RF Coils	**MIL-PRF-21038** Pulse Transformers	**MIL-PRF-39010** Molded RF Coils	**MIL-PRF-83446** RF Coil Chips
FOR MIL-STD-981 CLASS S DEVICES						
4.2 Power Transformers, power inductors …	Meet specified grade and class requirements of MIL-PRF-27	Grades 4 or 5, All classes. T level	N/A	N/A	N/A	N/A
4.4 Radio frequency … coils	Meet specified grade and class requirements of applicable specification	N/A	Grade 1, Family K Class A, B, or C	N/A	All classes, FRL S	N/A
4.5 Low power pulse transformers	Meet specified grade and class requirements of MIL-PRF-21038	N/A	N/A	T level	N/A	N/A
4.6 Radio frequency, chip … coils	Meet requirements of MIL-PRF-83446	N/A	N/A	N/A	N/A	Yes
5.1.1 Outgassing	Maximum total mass loss and collected volatile condensable for nonhermetic sealed	The military specification does not assure compliance. Additional selection or testing shall be required to assure compliance.				
5.1.4.1 Magnet wire	Use ANSI/NEMA-MW-1000 wire of specified minimum size	Military specification is equivalent, except minimum wire size is not assured. Additional selection shall be required to assure compliance				
5.1.4.2 Insulated wire	Use SAE-AS22759 wire of specified minimum size					
5.1.5 Solder and soldering flux	Solder: J-STD-005, J-STD-006 Flux: J-STD-004 Type L0 or L1	The military specification does not assure compliance with the flux restriction for Class S. Additional selection shall be required to assure compliance with J-STD-004 Type L0 or L1 flux.				
5.2 Internal elements	Package or unpackaged parts (other than the wound magnetic elements) used within these devices shall be approved by MSFC EEE Parts Engineering	Selection shall be in compliance with Grade 1 parts in accordance with MSFC-STD-3012, or equivalent.				
5.3 Radiographic inspection	Inspect per Appendix B	Military specification is equivalent	The military specification does not comply. Additional test shall be required to assure compliance.			
5.5.9.5 Tapes	Restricted use of adhesive tape	The military specification does not assure compliance. Additional selection or testing shall be required to assure compliance.				
5.5.9.8 Antirotation feature	Terminal lead construction specified					
5.5.12.2 Solder joints	Shall not show listed defects at 10X to 30X magnification	The military specification does not assure compliance. Additional selection or testing shall be required to assure compliance.				

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Table XI. Compliance with MIL-STD-981 Requirements for Parts Qualified to Certain Military Specifications

MIL-STD-981 REQUIREMENT		COMPLIANCE 1/				
PARAGRAPH	**SYNOPSIS**	**MIL-PRF-27** Power and Audio Transformers & Inductors	**MIL-PRF-15305** RF Coils	**MIL-PRF-21038** Pulse Transformers	**MIL-PRF-39010** Molded RF Coils	**MIL-PRF-83446** RF Coil Chips
FOR MIL-STD-981 CLASS S DEVICES (continued from previous page)						
5.5.12.3 Lead wires	Stress relief, minimum bend radius requirements. No sharp bends.	The military specification does not assure compliance. Additional selection or testing shall be required to assure compliance.				
5.5.12.4 Coils	Wind C cores and laminations on bobbins or core tubes.					
5.5.12.5 Crossover of turns	No uninsulated cross over.					
5.5.12.6 Splices	Prohibition of magnet wire splices.					
5.5.12.7 Extraneous material	No extraneous material in specified areas					
5.5.12.8 Cores	Unacceptable defects listed for laminated, ferrite, powder, and toroidal cores. Molypermalloy cores shall be coated.					
5.5.12.8.1 Protective coating	Coat or tape ferrite and powder cores where possible; protect wire from abrasion.					
5.5.13.7.1 Internal voids	Size and position restrictions on internal voids.					
5.5.13.7.2 Surface voids and depressions	Restriction on reduction in thickness of the covering.					
5.6.2.1 Magnet wire	Wire supplier to verify Groups A and B. Specified tests on each spool. Age restrictions and protective storage requirements apply.	Military specifications do not assure compliance with wire age restrictions. Additional selection shall be required to assure compliance.				
5.6.7.3.1 Lot acceptance	PDA 5% or 1 device.	Military specification is equivalent.		The military specification does not comply. Additional selection shall be required to assure compliance.	Military specification FRL is equivalent.	The military specification does not comply. Additional selection shall be required to assure compliance.

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Table XI. Compliance with MIL-STD-981 Requirements for Parts Qualified to Certain Military Specifications

MIL-STD-981 REQUIREMENT		COMPLIANCE 1/				
PARAGRAPH	**SYNOPSIS**	**MIL-PRF-27** Power and Audio Transformers & Inductors	**MIL-PRF-15305** RF Coils	**MIL-PRF-21038** Pulse Transformers	**MIL-PRF-39010** Molded RF Coils	**MIL-PRF-83446** RF Coil Chips
FOR MIL-STD-981 CLASS B DEVICES						
4.2 Power Transformers, power inductors …	Meet specified grade and class requirements of MIL-PRF-27.	Grades 4 or 5, All classes, T level	N/A	N/A	N/A	N/A
4.4 Radio frequency … coils	Meet specified grade and class requirements of applicable specification.	N/A	Grade 1, Family K Class A, B, or C	N/A	All classes, FRL S, R or P	N/A
4.5 Low power pulse transformers	Meet specified grade and class requirements of MIL-PRF-21038.	N/A	N/A	T level	N/A	N/A
4.6 Radio frequency, chip … coils	Meet requirements of MIL-PRF-83446.	N/A	N/A	N/A	N/A	Yes
5.1.1 Outgassing	Maximum total mass loss and collected volatile condensable for nonhermetic sealed devices.	The military specification does not assure compliance. Additional selection or testing shall be required to assure compliance.				
5.1.4.1 Magnet wire	Use ANSI/NEMA-MW-1000 wire of specified minimum size.	Military specification is equivalent, except minimum wire size is not assured. Additional selection shall be required to assure compliance.				
5.1.4. Insulated wire	Use SAE-AS22759 wire of specified minimum size.					
5.2 Internal elements	Package or unpackaged parts (other than the wound magnetic elements) used within these devices shall be approved by MSFC EEE Parts Engineering.	The military specification does not assure compliance. Additional selection shall be required to assure compliance with Grade 2 parts in accordance with MSFC-STD-3012, or equivalent.				

Table XI Notes:

1/ Parts qualified in accordance with the indicated military specification shall be considered in compliance with the applicable requirements of MIL-STD-981, except as indicated.

Table XII. Requirements for Screening of Microcircuits

1/

Screen 2/	MIL-STD-883 Test Method	Requirements and Conditions 3/	Notes	Grade 1	Grade 2	Grade 3
SCREENING PER MIL-STD-883, TEST METHOD 5004				100%	100%	100%
Temperature Cycling	1010	Condition C, 50 cycles		4/	X	
Constant Acceleration	2001	Condition E, Y_1 orientation only		4/	X	
Particle Impact Noise Detection (PIND)	2020	Test condition A	5/	X	X	X
Serialization		100%		X		
Pre Burn-in Electricals		Read and record.		X	X	6/
Burn-in Test	1015	160 hrs at 125°C minimum. Test condition per specification sheet. Test condition F shall not apply.		X	X	X
Post Burn-in Electricals		PDA of 5% on electricals and deltas. Read and record.		X		
Reverse Bias Burn-in Test (When specified)	1015	Test condition A or C, 75 hours at 150°C minimum or 160 hrs at 125°C minimum.		X		
Final Electrical and Deltas		Grade 1: Read and record Grade 2: PDA = 10% Grade 3: PDA = 15%		X	X	X
Radiographic Inspection	2012	For monolithic Grade 1: Two views Grade 2: One view Grade 3: One view	7/	X	X	X
Seal Test a. Fine b. Gross	1014	Reject criteria per test method.		X	X	X
External Visual	2009	Reject criteria per test method		X	X	X

TABLE XII Notes:

1/ This table does not address radiation testing that may be required for proper performance of a part in its application.

2/ Screening sequence shall conform to the sequence in which tests are listed, except as noted.

3/ Except as stated below, the requirements of applicable detail specifications shall be per class S/V for Grade 1 and per class B/Q for Grade 2 and Grade 3.

4/ This screening is not required for Class Q or B microcircuits but is required for /883, /883B, /883S, and MIL-PRF-38535 Class M microcircuits.

5/ PIND testing may be performed any time prior to seal testing and after constant acceleration testing.

6/ Read only.

7/ Radiographic inspection may be performed any time prior to seal testing and after serialization. The Blue dot marking in Method 2012 does not apply.

Table XIII. Requirements for the Qualification of Microcircuits

1/, 2/

Subgroup		MIL-STD-883 Test Method	Requirements 3/	Sample Size	Notes	Grade 1	Grade 2	Grade 3
Group B per MIL-STD-883, Test Method 5005								
1b.	Internal Gas Analysis	1018	5,000 ppm maximum water content at 100°C	3(0) or 5(1)		X	X	
5a.	End-point Electrical Parameters		Read and record. Static tests at 25° C, maximum, and minimum operating temperatures as specified in applicable device specification.	5(0) or 8(1)		4/	X	
5b.	Steady State Life Test	1005	Test Condition C, D, or E.		5/	4/	X	
5c.	End-point Electrical Parameters		Read and record. Static tests at 25° C, maximum, and minimum operating temperatures as specified in applicable device specification.			4/	X	
6a.	Electrical Parameters		Per detail specification	15(0) or 100%, whichever is less, c = 0		X	X	
6b.	Temperature Cycling	1010	Condition C, 100 cycles minimum.			X	X	
6c.	Constant Acceleration	2001	Condition E, Y_1 orientation only.			X	X	
6d.	Seal – Fine and Gross	1014				X	X	
6e.	Electrical Parameters		Per detail specification			X	X	
Group C per MIL-STD-883, Test Method 5005								
1a.	Steady State Life Test	1005	Test condition to be specified (1,000 hours at 125°C or equivalent in accordance with Table I of Test Method 5005)	Grade 1: 45(0) Grade 2: 22(0)	5/	4/	X	
1b.	End-point electrical parameters		As specified in the applicable device specification			4/	X	

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Table XIII. Requirements for Qualification of Microcircuits

(continued from previous page)

Procedure	Requirements	Notes	Grade		
			1	**2**	**3**
Destructive Physical Analysis	MIL-STD-1580, Requirement 16. Minimum sample size 2 devices or 1% of the lot, whichever is greater, up to 5 devices	3/	X	X	X
Marking	A green dot marking shall be used to signify compliance with these requirements. A red dot shall be marked on all failures.		X	X	X

TABLE XIII Notes:

1/ This table does not address radiation testing that may be required for proper performance of a part in its application. Refer to paragraph 5.4.3.

2/ Vendor qualification data shall be provided for Class M microcircuits. For /883, /883B, and /883S microcircuits used in Grade 1 and Grade 2 applications, vendor's Certificate of Qualification (COQ) for compliance to MIL-STD-883 shall be provided.

3/ Except as stated below, the requirements of applicable detail specifications shall be per class S/V for Grade 1 and per class B/Q for Grade 2 and Grade 3.

4/ Test not required for Class Q or B microcircuits. Test is required for /883, /883B, /883S and MIL-PRF-38535 Class M microcircuits.

5/ The same test temperature that was used for the screening burn-in test of Table XII shall be used for the steady state life test.

Table XIV. Thermistor Screening Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Part Type and Grade Level					
			Positive Temperature Coefficient			Negative Temperature Coefficient		
			Part Grade			Part Grade		
			1	2	3	1	2	3
Visual Inspections	Materials, design, construction, marking, & workmanship		X	X	X	X	X	X
Mechanical Inspections	Body and lead dimensions to specification	2/	X	X	X	X	X	X
Preconditioning	+125ºC for 5 days minimum followed by +50ºC for 5 days minimum, unless otherwise specified by the manufacturer or consult manufacturer to determine whether a temperature stabilization bake is required.	3/	X	X	X	X	X	X
Zero-Power Resistance	MIL-STD-202, Method 303 Zero-power resistance at specified reference temperature Zero-power resistance at +125ºC. Zero-power resistance at specified reference temperature $\Delta R_{(Zero-Power)}$ to specification	4/, 5/, 6/	X	X	X	X	X	X
Resistance Ratio Characteristic	If $\Delta R_{(Zero-Power)}$ is to specification, compute resistance ratio using the zero-power resistance at the reference temperature and at +125ºC or the specified maximum rated operating temperature. Resistance Ratio: Either: $R_{(Zero-Power\ @\ reference\ temperature)} / R_{(Zero-Power\ @\ +125ºC)}$ or $R_{(Zero-Power\ @\ reference\ temperature)} / R_{(Zero-Power\ @\ max\ operating\ temperature)}$ to specification	5/, 6/			X			X

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Table XIV. Thermistor Screening Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Part Type and Grade Level					
			Positive Temperature Coefficient			Negative Temperature Coefficient		
			Part Grade			Part Grade		
			1	2	3	1	2	3
Resistance at 0°C	MIL-STD-202, Method 303 1. Measure resistance in an ice bath or fluid bath controlled to 0 ± 0.003ºC using a measuring device with 0.005% accuracy or better. 2. Ice point resistance to specification. 3. Interchangeability to specification.	7/, 8/	X	X	X	X	X	X
Resistance at 100°C	MIL-STD-202, Method 303 1. Measure resistance in a fluid bath controlled to 100 ± 0.01ºC. 2. Resistance to specification.	7/	X	X	X	X	X	X
Resistance Ratio Characteristic	1. Compute: R (Zero-Power @ +100°C) / R(Zero-Power @ 0°C) 2. Resistance ratio to specification.	7/	X	X	X	X	X	X
Thermal Shock	MIL-STD-202, Method 107 Grade 1: 25 cycles; Grade 2: 10 cycles High temperature: +125ºC Low temperature: minimum rated operating temperature	4/, 5/, 6/, 9/	X	X		X	X	
High Temperature Storage	+125ºC or maximum rated operating temperature, 100 hours with no load	5/, 6/, 9/, 10/	X	X		X	X	
Burn-in	MIL-STD-202, Method 108 Temperature : +150 °C Bias: None Duration: 168 hours continuous	7/, 9/	X	X	X			

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Table XIV. Thermistor Screening Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Part Type and Grade Level					
			Positive Temperature Coefficient			Negative Temperature Coefficient		
			Part Grade			Part Grade		
			1	2	3	1	2	3
Resistance at 0˚C	MIL-STD-202, Method 303 1. Measure resistance in an ice bath or fluid bath controlled to 0 ± 0.003ºC using a measuring device with 0.005% accuracy or better. 2. Ice point resistance to specification. 3. Interchangeability to specification.	7/, 8/, 9/	X	X	X			
Zero-Power Resistance	MIL-STD-202, Method 303 $R_{(Zero\text{-}Power)}$ at specified reference temperature $\Delta R_{(Zero\text{-}Power)}$ to specification	4/, 5/, 6/	X	X	X	X	X	X
Insulation Resistance (IR)	MIL-STD-202, Method 302 Measure IR between leads & conductive material surrounding body Specified minimum resistance		X	X	X	X	X	X
Resistance Temperature Characteristic	Specified temperature points Stabilization time shall be $\geq$10 times the thermal time constant. $R_{(Zero\text{-}Power)}$ at each temperature point. Resistance curve to specification within tolerance limits at each temperature point. Temperature points: Grade 1 and 2 Reference temperature, each temperature extreme, and a minimum of three points between reference temperature and each temperature extreme. Grade 3 Reference temperature, each temperature extreme, and a minimum of one point between reference temperature and each temperature extreme.	4/, 5/, 6/	X	X		X	X	
Percent Defective Allowable (PDA)	Grade 1: 5% Grade 2: 10% Grade 3: 15%	11/	X	X	X	X	X	X

Table XIV Notes:

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

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 ± 0.01ºC for beads (any mounting construction) and ±0.05 ºC for all other types. The accuracy of the resistance measured shall be ± 0.05% or better when measured using a Wheatstone bridge (or equivalent). The Wheatstone bridge (or equivalent) shall have a time response less than the thermal time constant of the thermistor under test.

5/ The specified reference temperature is usually ambient +25ºC. The resistance curve tolerance varies on either side of this reference ambient; however, for particular applications it may be advantageous to specify the reference temperature at some 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 greater than +125ºC, then this high 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/ Applicable only for platinum resistance temperature detectors (PRTD).

8/ When specified by the SCD or applicable procurement document.

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

10/ Not applicable for surface mount thermistors.

11/ Marking defects shall not be counted for purposes of establishing the failure rate.

Table XV. Thermistor Qualification Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Quantity (Accept Number) Positive Temperature Coefficient Part Grade 1	2	3	Negative Temperature Coefficient Part Grade 1	2	3
Group 1			100%	100%	100%	100%	100%	100%
Screening to Table XIV	Table XIV	2/	X	X	X	X	X	X
Group 2			3(0)	3(0)		3(0)	3(0)	
Solderability (when applicable)	MIL-STD-202, Method 208		X	X		X	X	
Resistance to Solvents	MIL-STD-202, Method 215	3/	X	X		X	X	
Group 3			10(0)	5(0)		10(0)	5(0)	
Short Time Overload	For non Platinum Thermistors: Specified $R_{(Zero\text{-}Power)}$ 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 $\Delta R_{(Zero\text{-}Power)}$ to specification For Platinum Thermistors: Specified resistance at 0°C Specified test temperature Specified test duration Resistance at 0°C to specification	3/	X	X		X	X	

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Table XV. Thermistor Qualification Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Quantity (Accept Number) Positive Temperature Coefficient Part Grade 1	2	3	Negative Temperature Coefficient Part Grade 1	2	3
Group 3 (continued from previous page)			10(0)	5(0)		10(0)	5(0)	
Dielectric Withstanding Voltage	MIL-STD-202, Method 301 Measure between leads and conductive material surrounding body	3/	X	X		X	X	
Insulation Resistance (IR)	MIL-STD-202, Method 302 Measure between leads and conductive material surrounding body Specified minimum resistance		X	X		X	X	
Low Temperature Storage	Specified low temperature for 3 hours min. For non Platinum Thermistors: $\Delta R_{(Zero\text{-}Power)}$ to specification For Platinum Thermistors: Resistance at 0˚C to specification	3/	X	X		X	X	
Dissipation Constant	Manufacturer's approved procedure 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	3/	X	X		X	X	

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Table XV. Thermistor Qualification Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Quantity (Accept Number)					
			Positive Temperature Coefficient			Negative Temperature Coefficient		
			Part Grade			Part Grade		
			1	2	3	1	2	3
Group 3 (continued from previous page)			10(0)	5(0)		10(0)	5(0)	
Thermal Time Constant	Manufacturer's approved procedure Specified zero-power resistances Specified test chamber, chamber temperature and controlled temperature bath (if applicable) Specified test circuit schematic Loading to specified voltage and current levels Specified load dwell time Specified vertical travel and travel rate if applicable Thermal time constant to specification	4/	X	X		X	X	
Terminal Strength	MIL-STD-202, Method 211 For non Platinum Thermistors only: Test Condition A (disk and bead types) Test Conditions A and D (rod types) $\Delta R_{(Zero\text{-}Power)}$ to specification	3/	X	X		X	X	
Group 4			5(0)	3(0)	3(0)	5(0)	3(0)	3(0)
Shock, Specified Pulse	MIL-STD-202, Method 213 For Platinum Thermistors only: Specified number and direction of applied shocks Specified test condition (Gs, pulse time, waveform) No loss of continuity during testing	3/	X	X		X	X	

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Table XV. Thermistor Qualification Requirements

Inspection/Test	Test Methods Conditions and Requirements 1/	Notes	Quantity (Accept Number)					
			Positive Temperature Coefficient			Negative Temperature Coefficient		
			Part Grade			Part Grade		
			1	2	3	1	2	3
Group 4 (continued from previous page)			10(0)	5(0)		10(0)	5(0)	
Vibration, Random	MIL-STD-202, Method 214 For Platinum Thermistors only: Specified test condition Power spectral density, overall root mean square (RMS) G, duration	3/	X	X		X	X	
Terminal Strength	MIL-STD-202, Method 211 For Platinum Thermistors only: Test Condition A Specified applied force Resistance at 0 °C to specification	3/	X	X		X	X	
Resistance Temperature Characteristic	Specified temperature points Stabilization time shall be $\geq$10 times the thermal time constant. $R_{(Zero\text{-}Power)}$ at each temperature point. Resistance curve to specification within tolerance limits at each temperature point. Temperature points: Reference temperature, each temperature extreme, and a minimum of 1 point between reference temperature and each temperature extreme				X			X
Resistance to Soldering Heat	MIL-STD-202, Method 210 Specified solder temperature Specified dwell time $\Delta R_{(Zero\text{-}Power)}$ to specification	3/	X	X		X	X	

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Table XV. Thermistor Qualification Requirements

Inspection/Test	**Test Methods** **Conditions and Requirements** 1/	**Notes**	**Quantity (Accept Number)**					
			Positive Temperature Coefficient			**Negative Temperature Coefficient**		
			Part Grade			**Part Grade**		
			1	**2**	**3**	**1**	**2**	**3**
Group 4 (continued from previous page)			10(0)	5(0)		10(0)	5(0)	
Moisture Resistance	MIL-STD-202, Method 106 Loading: 50% at maximum rated power 50% at no load IR to specification $\Delta R_{(Zero\text{-}Power)}$ to specification	3/	X	X		X	X	
Group 5			10(0)	5(0)		10(0)	5(0)	
Load Life	MIL-STD-202, Method 108 Specified zero-power reference temperature Specified maximum rated power, 1.5 hours on, 0.5 hours off Duration: Grade 1: 1000 hours Grade 2: 500 hours	3/	X	X		X	X	
Group 6								
Thermal Outgassing	ASTM E595 Total Mass Loss (TML) = 1.0% maximum Collected Volatile Condensable Materials (CVCM) = 0.1% maximum	5/	X	X	X	X	X	X

Table XV Notes:

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

2/ The qualification samples shall be subdivided as specified in the table for Groups 3 through 6 inclusive. Group 2 inspections can be performed on unscreened samples or on samples that have completed one of the other qualification test groups. The following minimum samples sizes are required for qualification:

Grade 1: 25 thermistors
Grade 2: 13 thermistors
Grade 3: 3 thermistors

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

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

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

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APPENDIX A

DERATING REQUIREMENTS

Appendix A - Derating Requirements
Table of Contents

PARAGRAPH **PAGE**

Appendix A - Derating Requirements

CAPACITORS

Part Type		Critical Stress Parameter	Derating Factor	Condition	Note
CAPACITOR Ceramic	CCR style, MIL-PRF-20	Voltage (Applies to the sum of peak AC ripple and DC voltages)	0.60	110°C Max Ambient Temperature	
	CDR style, MIL-PRF-55681				
	CKR style, MIL-PRF-39014				
	CKS style, MIL-PRF-123				
	CPCR style, MIL-PRF-49464				
	CV style, MIL-PRF-81				
	HVR style, MIL-PRF-49467				
	PS style, MIL-PRF-49470				
CAPACITOR Glass	CYR style, MIL-PRF-23269		0.50	110°C Max Ambient Temperature	
CAPACITOR Mica	CMR style, MIL-PRF-39001		0.50	110°C Max Ambient Temperature	
CAPACITOR Plastic Film	CHR style, MIL-PRF-39022		0.60	85°C Max Ambient Temperature	
	CRH style, MIL-PRF-83421				
	CQR style, MIL-PRF-19978				
CAPACITOR Tantalum, Wet Slug	CLR79 style, MIL-PRF-39006/22		0.60	70°C Max Ambient Temperature	
			0.40	110°C Max Ambient Temperature	
	CLR81 style, MIL-PRF-39006/25		0.60	70°C Max Ambient Temperature	
			0.40	110°C Max Ambient Temperature	

continued on next page

Appendix A - Derating Requirements

CAPACITORS

Part Type		Critical Stress Parameter	Derating Factor	Condition	Note
CAPACITOR Tantalum, Solid	CSR style, MIL-PRF-39003/1, 2	Voltage (Applies to the sum of peak AC ripple and DC voltages)	0.50	70°C Max Ambient Temperature	For Grade 1 the effective series resistance shall be at least 0.3 ohms per volt or 1 ohm whichever is greater; for Grade 2 the effective series resistance shall be at least 0.1 ohms per volt or 1 ohm, whichever is greater.
			0.30	110°C Max Ambient Temperature	
	CSS style, MIL-PRF-39003/10		0.50	70°C Max Ambient Temperature	
			0.30	110°C Max Ambient Temperature	
	CWR style, MIL-PRF-55365		0.50	70°C Max Ambient Temperature	
			0.30	110°C Max Ambient Temperature	
CAPACITOR Variable	PC style, MIL-PRF-14409		0.60	110°C Max Ambient Temperature	

Appendix A - Derating Requirements

CIRCUIT BREAKERS

Part Type	Critical Stress Parameter	Derating Factor	Condition	Note
CIRCUIT BREAKER	Load Current	0.75 Rated Carry Current	$T_{CASE} < T_{(MAX\ RATED)}$ -20°C	Compatibility with transients for various types of load is largely influenced by type of circuit breaker and how that type responds to transients. Excessive derating of the carry current of a circuit breaker can reduce circuit protection unnecessarily. Use of series resistance should be considered to moderate inrush currents where necessary.

Appendix A - Derating Requirements
CONNECTORS

Part Type	Critical Stress Parameter	Derating	Condition	Note
CONNECTOR	Operating Voltage	Derate to 25% of the rated Dielectric Withstanding Voltage (DWV) at sea level -or- Derate to 75% of connector rated working (operating) voltage -or- Derate to 75% of connector part specification connector rated working (operating) voltage whichever is less	at sea level at sea level at rated actual use conditions (e.g. altitude)	
	Contact Current	Less than or equal to values provided for wire derating -or- Connector part specification contact rating whichever is less		
	Temperature	$T_{(Max\ ambient)} = T_{(Dielectric\ Insert)} - T_{(Ohmic\ Heating)} - 50°C$ -or- $T_{(Max\ ambient)} = T_{(Max\ Rated)} - 25°C$		

Appendix A - Derating Requirements

CRYSTALS

Part Type	Critical Stress Parameter	Derating	Condition	Note
CRYSTAL	Crystal Current	Derate to 50% of the rated value		In cases where the start up time is critical, 75% of the rated current can be used.
CRYSTAL OSCILLATOR HYBRID				Crystal oscillator hybrids shall be derated to the individual component (element) level.

Appendix A - Derating Requirements

DIODES

Part Type	Critical Stress Parameter	Derating Factor	Condition	Note
DIODE General Purpose, Rectifier, Switching, Pin/Schottky, and Thyristors	PIV	0.70		
	Surge Current	0.50		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE Varactor	Reverse Voltage	0.75		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE Voltage Regulator	Zener Current	$0.5(I_{Z\ MAX} + I_{Z\ NOM})$		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE Voltage Reference	Zener Current	Operate at the manufacturer's specified zener current (I_{ZT}) to optimize temperature		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE Zener Voltage Suppressor	Power Dissipation	0.50		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE Bidirectional Voltage Suppressor	Power Dissipation	0.50		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		

continued on next page

Appendix A - Derating Requirements
DIODES

Part Type	Critical Stress Parameter	Derating Factor	Condition	Note
DIODE FET Current Regulator	Peak Operating Voltage	0.80		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		
DIODE LED, Laser	Forward Current	Use manufacturer's recommended operating current		
	Maximum Junction Temperature	Do not exceed T_j = 125°C or 40°C below the manufacturer's rating, whichever is lower.		

Appendix A - Derating Requirements

FILTERS

Part Type	Critical Stress Parameter	Derating Factor	Condition	Note
FILTER All	Voltage	0.50	85°C maximum ambient temperature or 30°C below maximum rated temperature, whichever is less	
	Current	0.50		

Appendix A - Derating Requirements
FUSES

Part Type		Critical Stress Parameter	Derating Factor	Condition	Note
FUSE	0.125 Amp	Current. If calculations result in fractional values use the next highest standard fuse rating.	0.250	25°C Max Ambient Temp There is an additional derating of 0.5% per °C for an increase in the ambient temperature above 25°C.	Derating factors are based upon data from fuses mounted on printed circuit boards and conformal coated. For other types of mounting appropriate testing shall be performed to determine fuse characteristics and equivalent derating. Derating allows for loss of pressure, which lowers the blow current rating and allows for a decrease of current capability with time.
	0.25 Amp		0.300		
	0.375 Amp		0.375		
	0.5 & 0.75 Amp		0.400		
	1 & 1.5 Amp		0.450		
	2-15 Amps		0.500		

Appendix A - Derating Requirements
HYBRID MICROCIRCUITS

For hybrid devices, derating guidelines are divided into two categories: (1) derating of components used in hybrid design and manufacture, or (2) derating for applications in which the part is used. Category 2 shall not be used if category 1 can be met. Guidelines for the two categories are provided as follows:

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

A. MIL-PRF-38534 requires the derating of all active and passive elements of Class D, E, G, H, and K hybrids; however, the derating criteria are not specified. Therefore, the designer should verify with the manufacturer that the derating criteria are compatible with the application. If the derating criteria are inadequate, then an SCD specifying derating criteria is required.

B. 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 focal point EEE parts organization.

Category 2. Application derating for hybrids:

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

1. Specific electrical parameter derating shall be based on the requirements set forth for similar microcircuit device types.
2. 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 the focal point EEE parts organization for review and approval.

Appendix A - Derating Requirements

INDUCTORS

Inductor Type				Critical Stress Parameter	Derating Factor	Derated Operating Temperature ($T_{DERATED}$) 1/, 2/	Note
Insulation Class			Rated Operating Temperature (T_{RATED})				
MIL-PRF-27	MIL-PRF-39010	MIL-PRF-15305					
Q	-	O	+85°C	Operating Voltage	0.50 of DWV	+65°C	Custom-made inductors shall be evaluated on a materials basis and stressed at levels below the maximum rated operating temperature for the materials used. Devices having a maximum rated operating temperature in the range from +85° to +130°C shall be derated as follows: $T_{DERATED} = 0.75 * T_{RATED}$ (°C) Devices having a maximum rated operating temperature greater than 130°C shall be derated as follows: $T_{DERATED} = T_{RATED} - 25°C$.
R	A	A	+105°C			+85°C	
-	B	B	+125°C			+105°C	
-	-	C	> +125°C			$T_{Max\ Rated}$ - 20°C	
S	-	-	+130°C			+115°C	
-	F	-	+150°C			+130°C	
V	-	-	+155°C			+135°C	
T	-	-	+170°C			+155°C	
MIL-PRF-83446 - Chip Inductors						$T_{Max\ Rated}$ - 20°C	

Notes:

1/ Maximum operating temperature equals ambient temperature plus temperature rise plus 10°C (allowance for hot spot). Compute temperature rise as follows:

Temperature Rise Test (per MIL-PRF-27, paragraph 4.7.13)

Temperature rise (°C) = ((RE – RA)/RA * (TI + 234.5°C)) - (TM – TI)

Where RE = winding resistance at elevated temperature
RA = winding resistance at ambient temperature
TI = specified initial ambient temperature (°C)
TM = maximum ambient temperature (°C) at time of power shutoff

TM shall not differ from TI by more than 5°C

2/ The insulation classes of MIL-style inductive parts generally have maximum temperature ratings based on a life expectancy of 10,000 hours. The maximum operating temperatures in this table are selected to extend the life expectancy to 50,000 hours.

Appendix A - Derating Requirements

MICROCIRCUITS

1/

Stress Parameter	Derating Factor		Notes
	Digital	**Linear/Mixed Signal**	
Absolute Maximum Supply Voltage	0.9	0.8	2/
Absolute Maximum Input Voltage	0.9	0.8	
Absolute Maximum Power Dissipation	0.8	0.75	
Specified Absolute Maximum Junction Temperature	0.8	0.75	3/
Absolute Maximum Output Current	0.8	0.8	

Notes

1/ Derating requirements above also apply to MIL-PRF-38535 Class N PEMs. Derating requirements for all other PEMs are included in Appendix B.

2/ Do not exceed 90% of absolute maximum supply voltage for digital devices and 80% of absolute maximum supply voltage for linear/mixed signal devices except to meet the manufacturer's recommended operating conditions. For voltage regulators, derate $V_{IN} – V_{OUT}$ to 0.9.

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

Appendix A - Derating Requirements

ELECTROMECHANICAL RELAYS

Part Type	Critical Stress Parameter 1/		Derating 2/	Condition	Note
ELECTROMECHANICAL RELAY	Make or Break Contact Current	Resistive Load	0.75 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Resistive Load Rating	Operating Temperature > 85ºC	
		Capacitive Load	0.75 Capacitive Load Rating if specified, or 0.75 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Capacitive Load Rating if specified, or 0.6 Resistive Load Rating	Operating Temperature > 85ºC	
		Inductive Load	0.75 Inductive Load Rating if specified, or 0.4 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Inductive Load Rating if specified, or 0.3 Resistive Load Rating	Operating Temperature > 85ºC	
		Motor Load	0.75 Motor Load Rating if specified, or 0.3 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Motor Load Rating if specified, or 0.2 Resistive Load Rating	Operating Temperature > 85ºC	
		Filament Load	0.75 Filament or Lamp Load Rating if specified, or 0.2 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Filament or Lamp Load Rating if specified, or 0.1 Resistive Load Rating	Operating Temperature > 85ºC	
	Carry Contact Current, or Contact Power Dissipation		0.75 Max Rated Carry Current if specified, or 0.7 Rated Contact Power Dissipation	Operating Temperature ≤ 85ºC	
			0.6 Max Rated Carry Current if specified, or 0.5 Rated Contact Power Dissipation	Operating Temperature > 85ºC	

Notes:

1/ Recommended operating coil voltage should be used for reliable operation in lieu of derating the applied coil voltage.

2/ Load sharing of paralleled contacts shall not be counted on for purposes of derating. In other words, it shall be assumed that the overall combined load can flow through any one of paralleled contacts.

Appendix A – Derating Requirements

RESISTORS

Device Type	Parameter	Derating Factor	Note	Temperature (°C) 1/ Derating Temperatures: T1 (Break Point Temperature)	T2 (Zero power Temperature)	T3 (Absolute Maximum Temperature)
RESISTOR Fixed, Wirewound (Accurate) ER (MIL-PRF-39005, RBR)	Power (1%)	0.60		125	137	145
	Voltage (1%)	0.80	2/			
	Power (0.5%)	0.35		125	132	145
	Voltage (0.5%)	0.80	2/			
	Power (0.1%)	0.25		125	130	145
	Voltage (0.1%)	0.80	2/			
RESISTOR Fixed, Wirewound, (Power Type) ER (MIL-PRF-39007, RWR)	Power	0.60		25	175	250
	Voltage	0.80	2/			
RESISTOR Fixed, Wirewound (Power Type), Chassis Mounted ER (MIL-PRF-39009, RER)	Power	0.60		25	175	250
	Voltage	0.80	2/			
RESISTOR Variable, Wirewound (Lead Screw Actuated) ER (MIL-PRF-39015, RTR)	Power	0.60		85	124	150
	Voltage	0.80	2/			
RESISTOR Variable, CERMET (Lead Screw Actuated) ER (MIL-PRF-39035, RJR)	Power	0.60		85	124	150
	Voltage	0.80	2/			
RESISTOR Fixed, Film, Insulated ER (MIL-PRF-39017, RLR)	Power (100 ppm)	0.60		70	118	150
	Voltage (100 ppm)	0.80	2/			
	Power (350 ppm)	0.60		70	103	125
	Voltage (350 ppm)	0.80	2/			

continued on next page

Appendix A – Derating Requirements

RESISTORS

Device Type	Parameter	Derating Factor	Note	Temperature (°C) 1/		
				Derating Temperatures		T3 (Absolute Maximum Temperature)
				T1 (Break Point Temperature)	T2 (Zero power Temperature)	
RESISTOR Fixed, Film ER (MIL-PRF-55182, RNC, RNN, RNR)	Power	0.60		125	155	175
	Voltage	0.80	2/			
RESISTOR Fixed, Film, Chip ER (MIL-PRF-55342, RM)	Power	0.60		70	118	150
	Voltage	0.80	2/			
RESISTOR Fixed, Film, Chip, (MIL-PRF-32159, RCZ) Very Low Resistance	Power	0.60		70	118	150
	Current	0.80	3/			
RESISTOR Fixed, Film, Networks (MIL-PRF-83401, RZ)	Power	0.60	4/	70	103	125
	Voltage	0.80	2/			
RESISTOR Others (Various)	Power	0.50		5/		
	Voltage	0.80	2/			

Notes:

1/ Compute the resistor's derated power level by multiplying its nominal power rating by the appropriate derating factor for ambient temperature less than or equal to 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: (a) 80% of the specified maximum voltage rating, or (b) the square root of (P x R)

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/ The maximum applied current shall not exceed 80% of the termination rating.

4/ Below 25°C derate to 0.75 of nominal rated power; between 25°C and 70°C, nominal rated power derating decreases linearly from 0.75 to 0.6; and between 70°C and 103°C, nominal rated power derating decreases linearly from 0.6 to 0.0.

5/ Derating curve criteria must be determined on a case by case basis.

Appendix A - Derating Requirements
MECHANICAL SWITCHES

Part Type	Critical Stress Parameter		Derating 1/	Condition	Note
MECHANICAL SWITCH	Make or Break Contact Current	Resistive Load	0.75 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Resistive Load Rating	Operating Temperature > 85ºC	
		Capacitive Load	0.75 Capacitive Load Rating if specified, or 0.75 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Capacitive Load Rating if specified, or 0.6 Resistive Load Rating	Operating Temperature > 85ºC	
		Inductive Load	0.75 Inductive Load Rating if specified, or 0.4 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Inductive Load Rating if specified, or 0.3 Resistive Load Rating	Operating Temperature > 85ºC	
		Motor Load	0.75 Motor Load Rating if specified, or 0.3 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Motor Load Rating if specified, or 0.2 Resistive Load Rating	Operating Temperature > 85ºC	
		Filament Load	0.75 Filament or Lamp Load Rating if specified, or 0.2 Resistive Load Rating	Operating Temperature ≤ 85ºC	
			0.6 Filament or Lamp Load Rating if specified, or 0.1 Resistive Load Rating	Operating Temperature > 85ºC	
	Carry Contact Current, or Contact Power Dissipation		0.75 Max Rated Carry Current if specified, or 0.7 Rated Contact Power Dissipation	Operating Temperature ≤ 85ºC	
			0.6 Max Rated Carry Current if specified, or 0.5 Rated Contact Power Dissipation	Operating Temperature > 85ºC	

Notes:

1/ Load sharing of paralleled contacts shall not be counted on for purposes of derating. In other words, it shall be assumed that the overall combined load can flow through any one of paralleled contacts.

Appendix A - Derating Requirements
THERMISTORS

Part Type		Critical Stress Parameter	Derating Factor	Condition	Note
THERMISTOR	Positive Temperature Coefficient (PTC)	Power	0.50		1/
	Negative Temperature Coefficient (NTC)	Power			2/

Notes:

1/ Positive temperature coefficient thermistors are generally operated in the "self-heat" mode. Derate to 50% of the rated power, or as required by the detail specification.

2/ Negative temperature coefficient (NTC) type thermistors operated in the "self-heat" mode should be derated in accordance with the applicable dissipation constant curve to prevent "thermal runaway." Such parts should be derated to a power level causing a maximum increase of 50 times the dissipation constant, or a maximum part temperature of 100°C, whichever is less. The dissipation constant curve beginning at 0°C is 100% and remains constant out to 25°C, then decreases linearly to 0% at 200°C (case temperature).

Appendix A - Derating Requirements

TRANSFORMERS

Transformer Type		**Critical Stress Parameter**	**Derating Factor**	**Derated Operating Temperature** ($T_{DERATED}$)	**Note**
MIL-PRF-27					
Insulation Class	Rated Operating Temperature (T_{RATED})				
Q	+85°C	Operating Voltage	0.50 of DWV	+65°C	Custom-made transformers shall be evaluated on a materials basis and stressed at levels below the maximum rated operating temperature for the materials used. Devices having a maximum rated operating temperature in the range from +85° to +130°C shall be derated as follows: $T_{DERATED} = 0.75 * T_{RATED}$ (°C) Devices having a maximum rated operating temperature greater than 130°C shall be derated as follows: $T_{DERATED} = T_{RATED} - 25°C$.
R	+105°C			+85°C	
S	+130°C			+105°C	
V	+155°C			+130°C	
T	+170°C			+155°C	
MIL-PRF-21038				T_{RATED} - 25°C	MIL-PRF-21038 transformers have no insulation class.

Appendix A - Derating Requirements
TRANSISTORS

Part Type	Critical Stress Parameter	Derating Factor	Condition	Notes
TRANSISTOR Bipolar: General Purpose, Switching, Power	Power	0.50	125°C Max Junction Temp	
	Current	0.75		
	Voltage	0.75		1/
TRANSISTOR Field Effect: JFET, MOSFET 2/	Power	0.50	125°C Max Junction Temp	
	Current (I_D)	0.75		
	Voltage	0.75		1/

Notes:

1/ Worst case combination of DC, AC, and transient voltages should be no greater than the derated limit.

2/ For power MOSFET devices, also derate the gate to source voltage (VGS) to 60% of the maximum rated.

Appendix A - Derating Requirements

WIRE AND CABLE

Derating is accomplished by determining a single wire maximum current from a combination of wire size and bundle size using the wire information below. Dielectric withstanding voltage rating requires at least two times the highest application voltage. Derating values listed apply only to round single conductors on helically wound bundles. For derating information for ribbon cable, flat cable, and other wire types refer to the manufacturer's recommendation.

Single Wire Current

1/

Wire Size (AWG)	**Vacuum** (< 4.3 PSIA)	**Non Vacuum** (≥ 4.3 PSIA)
	Maximum Nominal Allowed Single Wire Current (I_{sw}) (amps) 2/, 3/, 4/	**Maximum Nominal Allowed Single Wire Current (I_{sw}) (amps)** 3/, 5/, 6/, 7/
26	3.4	3.8
24	4.7	5.4
22	6.5	7.4
20	8.8	10.0
18	11.6	13.2
16	13.3	15.0
14	18.0	20.0
12	25.0	29.0
10	34.8	40.0
8	56.0	63.0
6	80.0	92.0
4	110.0	120.0
2	150.5	170.5
1/0	220.5	260.0

Appendix A - Derating Requirements
Wire And Cable

NOTES:

1/ When wire is bundled, the maximum design current for each individual wire shall be derated according to the following:

For $N < 15$ — $I_{BW} = I_{SW} X (29 - N)/28$

For $N > 15$ — $I_{BW} = (0.5) X I_{SW}$

Where: N = number of wires
IBW = current, bundle wire
ISW = current, single wire

2/ These currents are for wires in a vacuum at 94°C (200°F) ambient.

3/ Deratings listed are for wire rated for 200°C maximum temperature. Derating factors for lower temperature rated wire shall be as follows:.

A. For 150°C wire, use 65% of value shown in vacuum column, and 80% of value shown in non vacuum column.
B. For 135°C wire, use 45% of value shown in vacuum column, and 75% of value shown in non vacuum column.
C. For 105°C wire, do not use this wire in vacuum environments, and use 65% of value shown in non vacuum column.

4/ Maximum wire temperature for the maximum single wire current is 147°C (295°F).

5/ These currents are for wires on-orbit in cabin ambient at 22°C (72°F).

6/ Wire with these currents and temperatures are not to be accessible to the crew.

7/ Maximum wire temperature for the maximum single wire current 118°C (242°F).

APPENDIX B

INSTRUCTIONS FOR PLASTIC ENCAPSULATED MICROCIRCUIT (PEM) SELECTION, SCREENING, QUALIFICATION AND DERATING

Appendix B

Table of Contents

Appendix B

TABLE

FIGURE

PREFACE

Potential users of plastic encapsulated microcircuits (PEMs) need to be reminded that unlike the military system of producing robust high-reliability microcircuits that are designed to perform acceptably in a variety of harsh environments, PEMs are primarily designed for use in benign environments where equipment is easily accessed for repair or replacement. The methods of analysis applied to military products to demonstrate high reliability cannot always be applied to PEMs. This makes it difficult for users to characterize PEMs for two reasons:

1. Due to the major differences in design and construction, the standard test practices used to ensure that military devices are robust and have high reliability often cannot be applied to PEMs that have a smaller operating temperature range and can be susceptible to moisture absorption. In contrast, high-reliability military microcircuits usually utilize large, robust, high-temperature packages that are hermetically sealed.
2. Users of PEMs have little visibility into commercial manufacturers' proprietary design, materials, die traceability, and production processes and procedures. There is no central authority that monitors PEM commercial product for quality, and there are no controls in place that can be imposed across all commercial manufacturers to provide confidence to high-reliability users that a common acceptable level of quality exists for all PEMs manufacturers. Consequently, there is no guaranteed control over the type of reliability that is built into commercial product, and there is no guarantee that different lots from the same manufacturer are equally acceptable. And regarding application, there is no guarantee that commercial products intended for use in benign environments will provide acceptable performance and reliability in harsh space environments.

The qualification and screening processes contained in this document are intended to detect poor-quality lots and screen out early random failures from use in space flight hardware. However, since it cannot be guaranteed that quality was designed and built into PEMs that are appropriate for space applications, users cannot screen in quality that may not exist. It must be understood that due to the variety of materials, processes, and technologies used to design and produce PEMs, this test process may not accelerate and detect all failure mechanisms. While the tests herein will increase user confidence that PEMs with unknown quality can be used in space environments, such testing may not guarantee the same quality level offered by military microcircuits. PEMs should only be used where due to performance needs there are no alternatives in the military high-reliability market, and projects are willing to accept higher risk. PEMs shall not be used in applications that require Grade 1 parts without a deviation/waiver.

B.1.0 SCOPE

This appendix establishes a system of product assurance for PEMs. It is based partly on existing qualification system for military and aerospace components, experience accumulated by the parts engineering community, and practices or guidelines established by high-reliability electronics industry. The requirements of this appendix do not apply to MIL-PRF-38535 Class N qualified microcircuits. Screening and qualification requirements for Class N microcircuits shall be per the standard parts and selection Tables V, VI, and VII of MSFC-STD-3012.

B.2.0 PURPOSE

The purpose of this appendix is to mitigate the risk of PEM usage, evaluate long-term reliability of the parts, and prevent failures. Commercial PEMs are primarily designed for benign environments and are considered as high-risk parts when used in space applications. For this reason, no commercial PEMs are considered acceptable in high-reliability applications "as is." Additional testing and analysis to assure adequate reliability and radiation tolerance are required.

B.3.0 APPLICABLE DOCUMENTS

J-STD-020	Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
JESD22-A110-D	Highly Accelerated Temperature and Humidity Stress Test (HAST)
JESD22-A113-F	Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
JESD22-A118-A	Accelerated Moisture Resistance – Unbiased HAST
JESD22-B106-D	Resistance to Solder Shock for Through-Hole Mounted Devices
MIL-PRF-38535	Integrated Circuits Manufacturing, General Requirements For
MIL-STD-883	Test Method Standard Microcircuits
MIL-STD-1580	Destructive Physical Analysis For Electronic, Electromagnetic, and Electromechanical Parts
MSFC-STD-3012	EEE Parts Management and Control Requirements for MSFC Space Flight Hardware

B.4.0 PEMS REQUIREMENTS

The use of PEMs is permitted on space flight applications, provided each PEM 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 savings. 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. Lot-specific qualification, screening, and radiation hardness assurance analysis and/or testing shall be consistent with the required quality level as defined in this document.

Developers proposing to use PEMs shall address the following items in their Parts Control Program 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.

PEMs shall be:

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

Testing specified herein shall be performed as necessary to screen and qualify the devices, in order to verify compliance with the application requirements. Radiation evaluation shall address all threats appropriate for the technology, application, and environment, including total Ionizing dose (TID), dose rate effects, single event effects (SEE), and displacement damage and shall be assessed on a lot-specific basis according to the project requirements. 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 approval.

Derating of PEMs shall 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. Refer to MSFC-STD-3012 section 5.4.4.1 for pure tin finish avoidance and mitigation requirements.

Exceptions to testing required herein may be permitted by MSFC EEE Parts Engineering 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.

B.5.0 REQUIREMENTS FOR SCREENING

Screening is applied to all flight parts in each lot by testing and inspecting every sample, and proactively affects reliability of the lot. Refer to Tables B.I and B.II for screening requirements of PEMs. A typical test flow for screening of PEMs is shown in Figure B.1.

B.6.0 REQUIREMENTS FOR QUALIFICATION

PEMs qualified according to this appendix are intended for operation within the manufacturer's data sheet limits. Any use of PEMs outside the manufacturer's specified range, particularly the temperature limits, is not acceptable. Qualification samples shall be selected from screened parts.

A typical test flow for qualification of plastic encapsulated microcircuits is shown in Figure B.2. Table B.III presents details of the requirements for the qualification of PEMs.

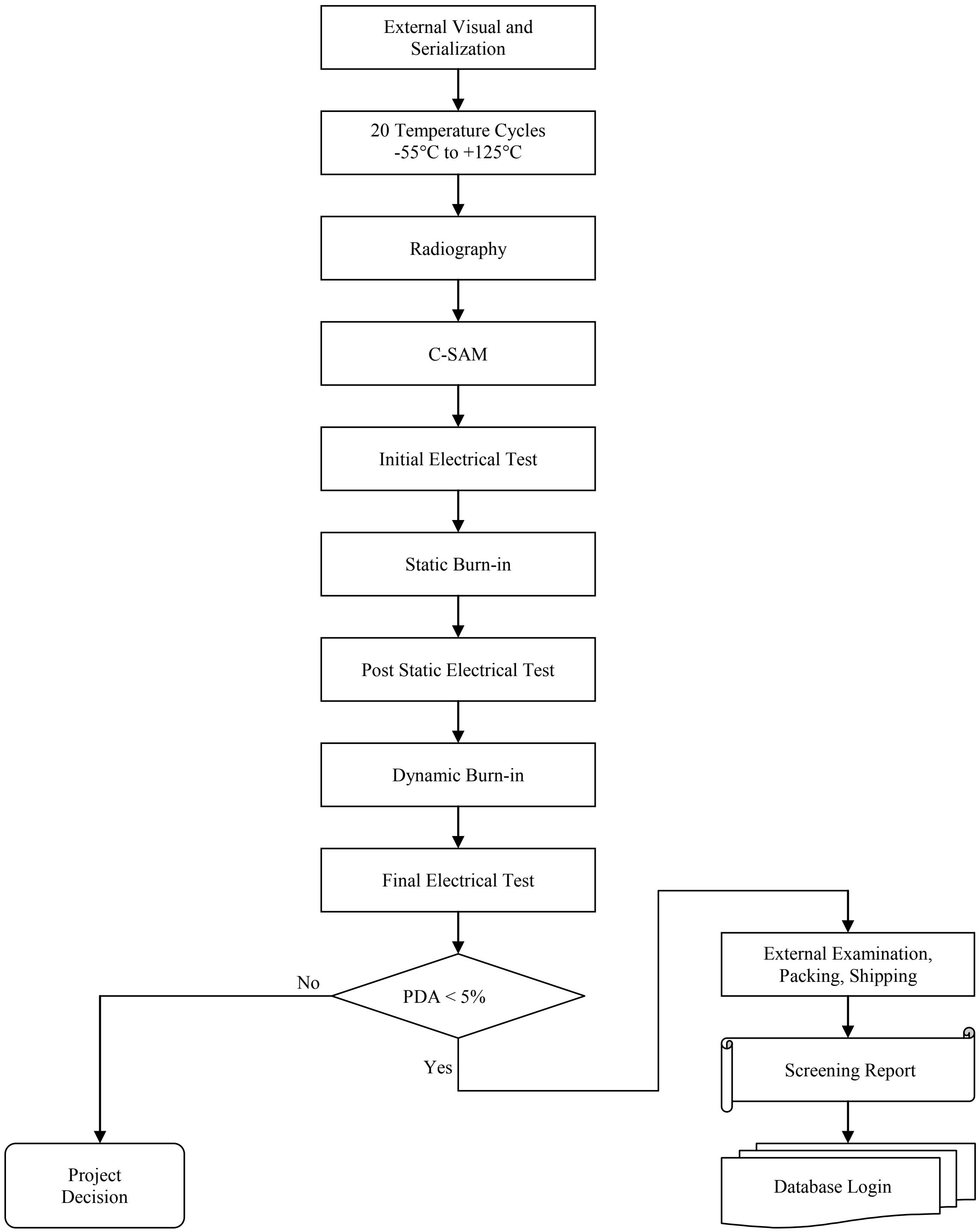

Figure B.1. Typical Screening Test Flow for PEMs

Table B.I. Screening Requirements for PEMs

1/

Screen	Test Method and Conditions	Notes	Grade Application 8/		
			1	2	3
1. External visual, and serialization	Per paragraph B.7.2.1	2/	X	X	X
2. Temperature cycling	MIL-STD-883, Method 1010, Condition B (or to the manufacturer's storage temperature range, whichever is less). Temperature cycles, minimum.		20	20	10
3. Radiography	Per paragraph B.7.2.2.	3/	X	X	X
4. C-SAM inspection	Per paragraph B.7.2.4.	4/	X	X	
5. Initial (pre-burn-in) electrical measurements (EM)	Per device specification, at 25°C At min. and max. rated operational temperatures.	5/	X	X	X
6. Engineering review (steps 1 to 5)		6/	X	X	X
7. Static (steady-state) burn-in (BI) test at 125°C or at max. operating temperature	MIL-STD-883, Method 1015, Condition A or B. Hours, minimum depending on the BI temperature. Per device specification. Calculate Delta when applicable.	7/	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 at 25°C	Per device specification		X	X	X
8. Dynamic burn-in test at 125°C or at max. operating temperature	MIL-STD-883, Method 1015, Condition D. Hours, minimum.	7/	Same as test step 7.	Same as test step 7.	Same as test step 7.
9. Final parametric and functional tests	Per device specification (at 25°C, maximum, and minimum rated operating temperatures).		X	X	X
10. Calculate percent defective (steps 7 to 10)	Maximum acceptable PDA.	6/	5%	10%	15%
11. External visual/packing	Per paragraph B.7.2.1 and Section B.9.	2/	X	X	X

Table B.I Notes:

1/ General

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

1.2/ These 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 MSFC EEE Parts Engineering.

2/ It is recommended to combine the incoming visual inspection with the serialization and outgoing visual inspection with packaging to reduce handling and possible damage to the parts. Serialization should be performed in such a way to allow a top side 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 B.9).

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. Screening, except for power devices, is performed only at the top side.

4.2/ Coated Die. Top side 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 low acoustic impedance that appears as a false delamination.

4.3/ Power Devices. For power devices the bottom side inspection of die attachment may be replaced with the thermal impedance measurements.

4.4/ Rejection Criteria.

a. Cracks in plastic package intersecting bond wires.

b. Internal cracks extending from any lead finger to any other internal feature (lead finger, chip, die attach paddle) if crack length is more than half of the corresponding distance.

c. Any crack in the package breaking the surface.

d. Any void in molding compound crossing wire bond.

e. Any measurable amount of de-lamination between plastic and die.

f. Delamination of more than half of the backside of the die paddle/plastic interface.

g. Complete lead-finger de-lamination from the plastic (either top or backside)

h. Delamination of the lead-finger that includes the wire bond area.

i. Delamination of the top tie bar area for more than half of its length.

NOTE: If rejectable internal cracks or delaminations are suspected, a polished cross section may be required to verify the suspected site.

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 approved by MSFC EEE Parts Engineering.

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

6/ Engineering Review

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

6.2/ Most established PEMs manufacturers guarantee 3-sigma level process minimum, which means that less than 0.27% of the parts can be out of specification. Excessive fallout during initial electrical measurements at room temperature may be due to a poor quality of the lot or 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 parts engineer 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 may 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 absolute maximum current, voltage, and die temperature limits.

7.2/ Burn-in Temperature. If burn-in at 125°C is not appropriate, 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. 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/ Steady-state burn-in is performed on all linear and mixed-signal devices (see Table B.II 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.

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

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

7.8/ 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 engineer to document and submit a rationale for the technical feasibility and equivalency of the alternative testing to the project and MSFC EEE Parts Engineering for approval. Board-level burn-in shall not be routinely substituted for piece part burn-in as a convenience.

8/ Use of PEMs in a Grade 1 application requires a deviation/waiver.

Table B.II. Burn-In and Electrical Measurement Requirements for PEMS

IC Type	Required Burn-In 1/, 2/		Delta	Electrical Measurement 3/, 4/
	Static (Condition C)	Dynamic (Condition D)		
Digital Bipolar & Digital MOS/ BiCMOS: LOGIC (Gates, Buffers, Flip-Flops, Multiplexers, Registers, and Counters) RAMs FIFOs Microprocessors Interface Peripherals ASICs FPGA, PROM, PAL	Not required for Digital Bipolar Technology. Required for Digital MOS Technology. VIN = VDD across one-half input pins and VSS across the remaining inputs. VOUT = 0.5 VDD through RL	Required for both technologies. Vin = Square wave, 50% duty cycle to input pins and control pins. Frequency = 100 Hz to 1 MHz. VOUT = VCC /2 or VDD/2 through RL.	ΔICC or ΔIDD	DC: VIC, VOH, VOL, ICC(IEE), IIL, IIH, IDD, IOZL, IOZH, IOS AC: TPLH, TPHL, TTLH, TTHL, TPZH, TPHZ, TPLZ, TPZL, TA, TS, TH Functional Tests: a) For simple logic devices, verify truth table. b) For complex logic devices such as ASIC, FPGA, and microprocessors, functional testing should include fault coverage calculations. c) For PROMs, check fuse map; for RAMs, perform pattern sensitive tests such as March, Galpat, etc.
Linear MOS, Bipolar, and Bi-FET: 5/ Op-Amp, Instrument Amplifiers, S/H, and Comparator	Vout terminated to ground through RL	Vin = Square wave or sine wave. F = 10Hz to 100 KHz, 50% duty cycle. Vout terminated to ground through RL	ΔIIB ΔIIO ΔVIO	DC: ICC, IEE, IIO, VIO, VOPP, AV, CMRR, PSRR AC: Slew rate
Linear MOS, Bipolar and JFET: 5/ Line Drivers and Receivers	Vin = VDD max across one-half input pins and VSS across the remaining inputs.	Vin = Square wave at a specified frequency and duty cycle. Vout = VCC through RL	ΔICC ΔIIH	DC: VOH, VOL, ICC, IIL, IIH, IOS AC: TPLH, TPHL, TTLH, TTHL Functional Test
Linear MOS, Bi-FET, and Bipolar: 5/ Analog Switches and Multiplexers	Vin = VDD max across one-half of inputs and VSS across the other remaining inputs. Vout = ±VCC through RL	Vin = Square wave. F = 100 KHz and 50% duty cycle. Vout = ±VCC through RL	ΔICC ΔID(OFF) ΔIS(OFF) ΔR(ON)	DC: ICC, ID(ON), R(ON), ID(OFF), IS(ON), IS(OFF) AC: T(ON) , T(OFF) break- before-make- time
Linear Bipolar: Voltage Regulators	Vout terminated to ground through RL	Not required	ΔISCD ΔVOUT	DC: ICC, VOUT, IOS, line/load regulation
Linear Bipolar: Pulse-width-modulator	Not required	Vout terminated to ground through RL. Rext, Cext connected if applicable.	ΔIIO ΔVREF	DC: VREF, IIB, IIO, IOS, VIO, VOL, VOH, AV, CMRR, PSRR AC: TR, TF, fOSC
Linear CMOS Timers	TA ≥ 125°C. Vout = VCC through RL	Not required	ΔICEX ΔVOH ΔVOL	DC: VTRIG, VTH, VR, VOL, VOH, VSAT, ICC, ITRIG, ITH, IR, ICEX AC: TTLH, TTHL
Mixed Signal MOS, Bi-CMOS and Bipolar: 5/ Analog to Digital (A/D) Converters.	Vin = Max analog DC input. Vout = VCC/2 through RL.	Vin = Analog input to generate maximum digital codes. Vout = VCC/2 through RL	ΔICC ΔIEE ΔVIO	DC: VREF, VOH, VOL, VIO, ICC, IEE, IIL, IIH, IOZL, IOZH, IOS, Zero Error, Gain Error, Linearity Error. AC: TC, TS, TH Functional Test: Verify codes

continued on next page

Table B.II. Burn-In and Electrical Measurement Requirements for PEMS

IC Type	Required Burn-In 1/, 2/		Delta	Electrical Measurement 3/, 4/
	Static (Condition C)	Dynamic (Condition D)		
Mixed Signal MOS, Bi-CMOS and Bipolar 5/ Digital to Analog (D/A) Converters.	Vin= VDD on one-half data inputs and VSS on remaining inputs. Vout terminated to ground through RL	Vin = Apply appropriate digital codes for all inputs and for control signals. Vout terminated to ground through RL.	ΔICC ΔIEE	DC: ICC, IEE, IIL, IIH, IOZL, IOZH, IOS, Zero Error, Gain Error, Linearity Error, PSRR AC: TC, TS, TH Functional Test: Verify codes

Table B.II Notes:

1/ Reference is MIL-STD-883, Method 1015. Static and dynamic burn-in shall be performed at maximum recommended operating supply voltage with Vin and RL selected to assure that the junction temperature shall not exceed Tjmax specified for the device type.

2/ See Table B.I for burn-in ambient temperature condition.

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

4/ For digital devices, all DC parameters, functional tests, and switching tests shall be performed 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 Grades 2 and 3 parts only one BI test, static or dynamic is required.

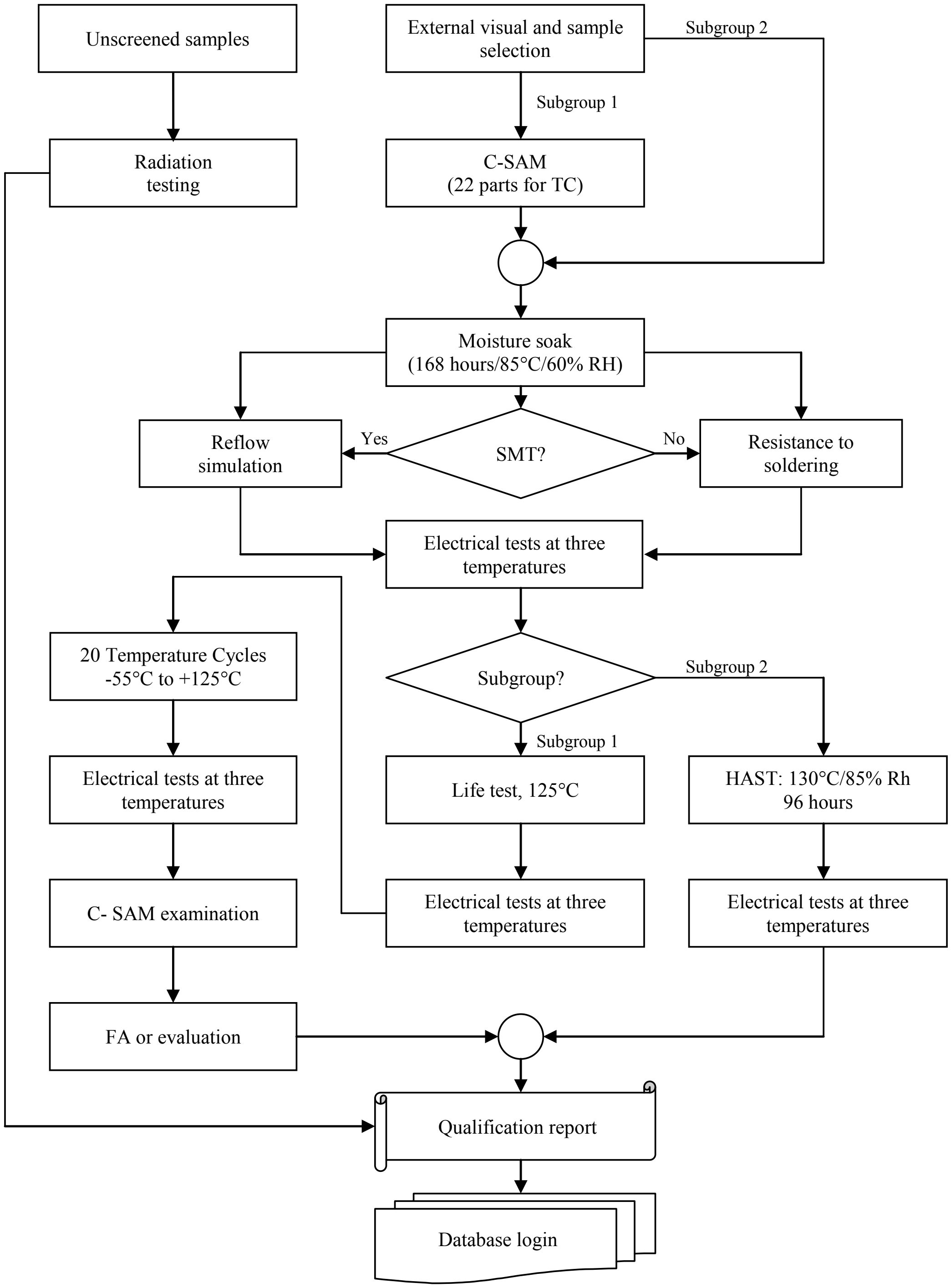

Figure B.2. Typical Qualification Test Flow for PEMs

Table B.III. Qualification Requirements for PEMS

1/

Process	Sub Test	Test Methods & Conditions	QTY (Failures)		
			Grade 1	Grade 2	Grade 3
1. External Visual Inspection 2/		Paragraph B.7.2.1	32	32	17
2. Radiation Analysis		TID and SEE	3/	3/	3/
3. Baseline C-SAM	Parts in Subgroup 1 only	Paragraph B.7.2.4	22	22	N/A
4. Preconditioning	Moisture soak 4/	JESD22-A113-F, paragraph 4.5 per applicable moisture sensitivity level per IPC/JEDEC J-STD-020	32	32	17
	SMT Devices Reflow simulation (with flux application, cleaning, and drying)	JESD22-A113-F, paragraphs 4.6 through 4.9. Peak solder reflow temperature +235°C	32	32	17
	Through-hole devices Resistance to soldering temperature	JESD22-B106-D	32	32	17
5. Electrical Measurements	Per device specification	Measure at 25°C, min. and max. rated temperatures.	32 (0)	32 (0)	17 (0)
6. Life Testing Subgroup 1	High Temperature Life Testing (HTOL), 125°C 5/, 6/	MIL-STD-883, Method 1005, Condition D. Hours minimum	22 1,500	22 1,000	10 500
	Electrical measurement (per specification)	Measure at 25°C, min. and max. rated temperatures.	22 (0)	22 (0)	10 (0)
7. Temperature Cycling Subgroup 1	Temperature cycling 5/, 7/	MIL-STD-883, Method 1010, Condition B, -55°C to 125°C Cycles, minimum	22 500	22 200	10 100
	Electrical measurement (per specification)	Measure at 25°C, min. and max. rated temperatures.	22 (0)	22 (0)	10 (0)
	C-SAM 8/	Paragraph B.7.2.4	22	22	N/A
	DPA or FA	9/	X	X	N/A
8. Highly Accelerated stress test (HAST) Subgroup 2	Biased HAST 5/	JESD22-A110-D, with continuous bias. (96 hours, +130°C, 85% RH)	10	N/A	N/A
	Unbiased HAST 5/	JESD22-A118-A, Condition A (96 hours, +130°C, 85% RH)	N/A	10	7
	Electrical measurement (per specification)	Measure at 25°C, min. and max. rated temperatures.	N/A	10 (0)	7 (0)

Table B.III Notes:

1/ General

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 MSFC EEE Parts Engineering.

1.3/ For Grade 4, qualification at the piece part level is not required. However, since commercial parts receive no screening and offer no notification of changes to design or processes it is recommended that qualification criteria listed be used when the schedule and funding will allow it.

2/ Quantities referenced in paragraph B.7.2.1 are not applicable.

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, unscreened 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 with MSFC EEE Parts Engineering approval.

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 Grades 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) shall be performed to ensure that no degradation of wire bonding, cratering, and mechanical damage to glassivation and metallization systems occurred (for Grade 1 and 2 parts only).

B.7.0 PHYSICAL ANALYSIS

This section describes purpose, test flow, and procedures for destructive physical analysis (DPA) and construction analysis (CA) of commercial PEMs and is intended to supplement MIL-STD-1580. CA shall be performed before any screening or qualification testing, and DPA shall be performed after screening.

B.7.1 Purposes for DPA and CA for PEMs

Both DPA and CA provide important information regarding design, workmanship, and process defects related to a PEM manufacturer lot. This information can be used for tailoring of screening and qualification test plans to focus on specific areas of reliability concerns. Table B.IV defines the tests for both DPA and CA.

Table B.IV. Tests for CA and DPA

TEST	DPA	CA
External visual inspection (paragraph B.7.2.1)	X	X
Radiography (paragraph B.7.2.2)	X	X
Lead finish composition (paragraph B.7.2.3)	X	X
Acoustic Microscopy (C-SAM) (paragraph B.7.2.4)	X	
Package Level Cross Section (paragraph B.7.2.5)	X	X
Decapsulation (paragraph B.7.2.6)	X	X
Internal visual inspection (paragraph B.7.2.7)	X	X
Bond Pull Test (paragraph B.7.2.8)	X	
SEM (paragraph B.7.2.9)	X	X
Glassivation Integrity Test (paragraph B.7.2.10)	X	
Report Submittal	X	

Destructive Physical Analysis is used to determine whether the lot has any design, material, workmanship, or process flaws that may not show up during screening and qualification tests and cause degradation or failures during the hardware integration period and spacecraft mission lifetime. An important benefit of DPA is to provide for comparison analysis of design and technology, to identify product change, to provide baseline data in the event of subsequent failures and application problems, and to provide data for physics of failure analysis. DPA for PEMs should focus on three major areas of concern: integrity of the package, quality of assembly, and defects in the die. This analysis should also evaluate package-and die-level homogeneity of the lot. For this purpose, samples for DPA should be selected randomly from different portions 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. Anomalies revealed by DPA raise concerns regarding quality and reliability of the parts. These concerns may be further addressed by tailoring screening and qualification procedures or by performing additional design evaluation and testing of the parts.

Construction analysis is a customized sequence of applicable analytical techniques to evaluate the inherent design and robustness of a component or assembly. A well executed construction analysis examines and documents the physical characteristics including material elemental composition, dimensions and quality details of the assembly. This testing methodology was originally created to assess commercial electronic components, i.e. plastic non-hermetic packages, but can be applied to virtually any manufactured product. Each analysis employs a series of non-destructive and destructive tests appropriate for the product type.

B.7.2 CA and DPA Procedures

CA and DPA test flow charts are shown in Figures B.3 and B.4, respectively. A CA and DPA shall be performed on each manufacturer's lot. Each analysis shall use a minimum of 5 samples. When a CA or DPA is performed by a contractor, the project engineer shall submit the report to MSFC EEE Parts Engineering for review and assessment. DPA inspection lots found to have one or more defects shall be: (a) subjected to re-sampling if the results of the first sample were inconclusive, (b) screened, (c) accepted for use with MSFC EEE Parts Engineering approval, or (d) scrapped as applicable. This requirement may be met in the part manufacturer's processing, in third party laboratory testing, or by the acquiring activity.

B.7.2.1 External Visual Examination

External visual examination shall be performed on each sample (five samples minimum) per MIL-STD-1580, Requirement 16 for PEMs.

B.7.2.2 Radiography

Radiography shall be preformed per MIL-STD-1580, Requirement 16 for PEMs on the samples that meet the requirements of B.7.2.1 (five samples minimum).

When real-time radiography is used for screening, the dose rate that the equipment emits should be estimated. Certain types of radiography can expose microcircuits to unusually high dose rates, such that damage can be introduced to sensitive parts. A radiation specialist should be consulted as necessary.

B.7.2.3 Lead Finish Composition

A lead composition analysis shall be performed on all DPA samples to verify a minimum of 3% lead (Pb) for tin plated contacts. Refer to MSFC-STD-3012 paragraph 5.4.4.1 for pure tin finish avoidance mitigation requirements.

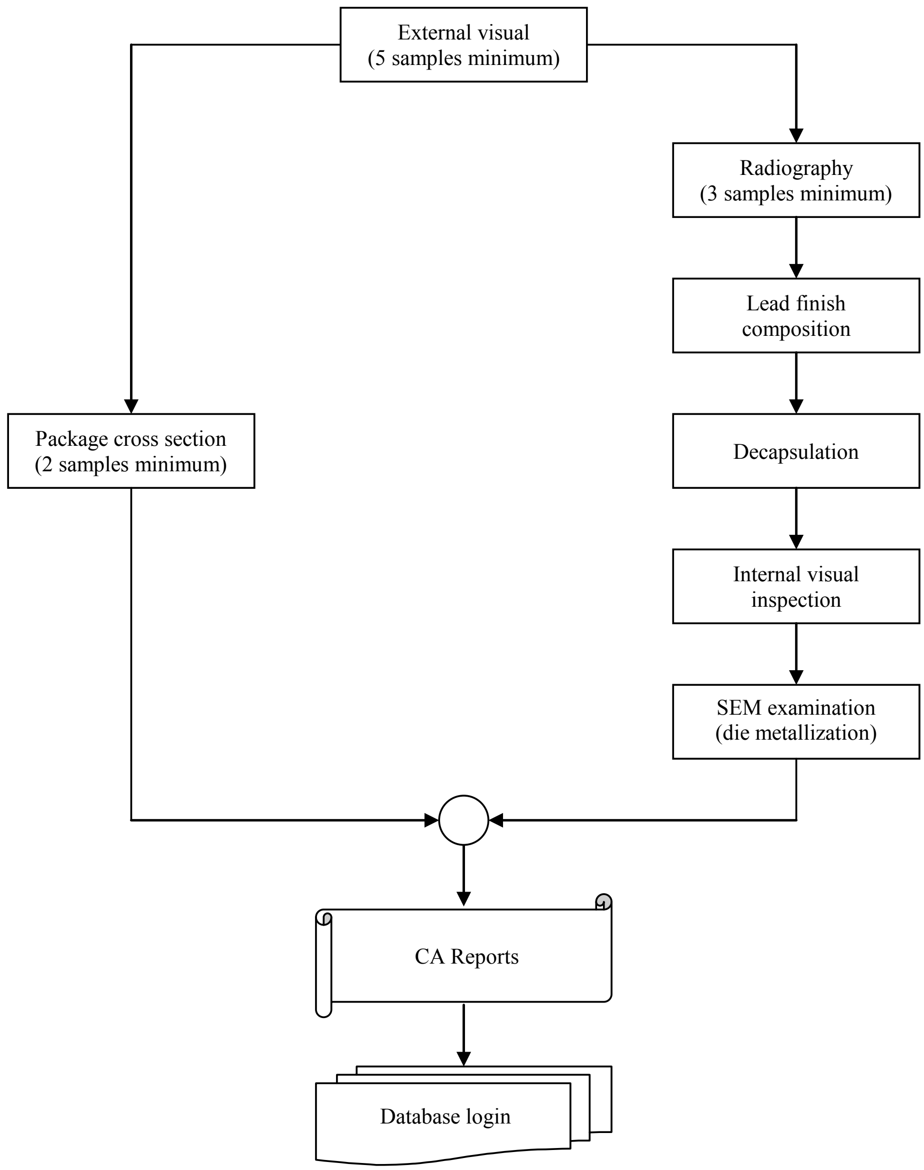

Figure B.3. CA Test Flow for PEMs

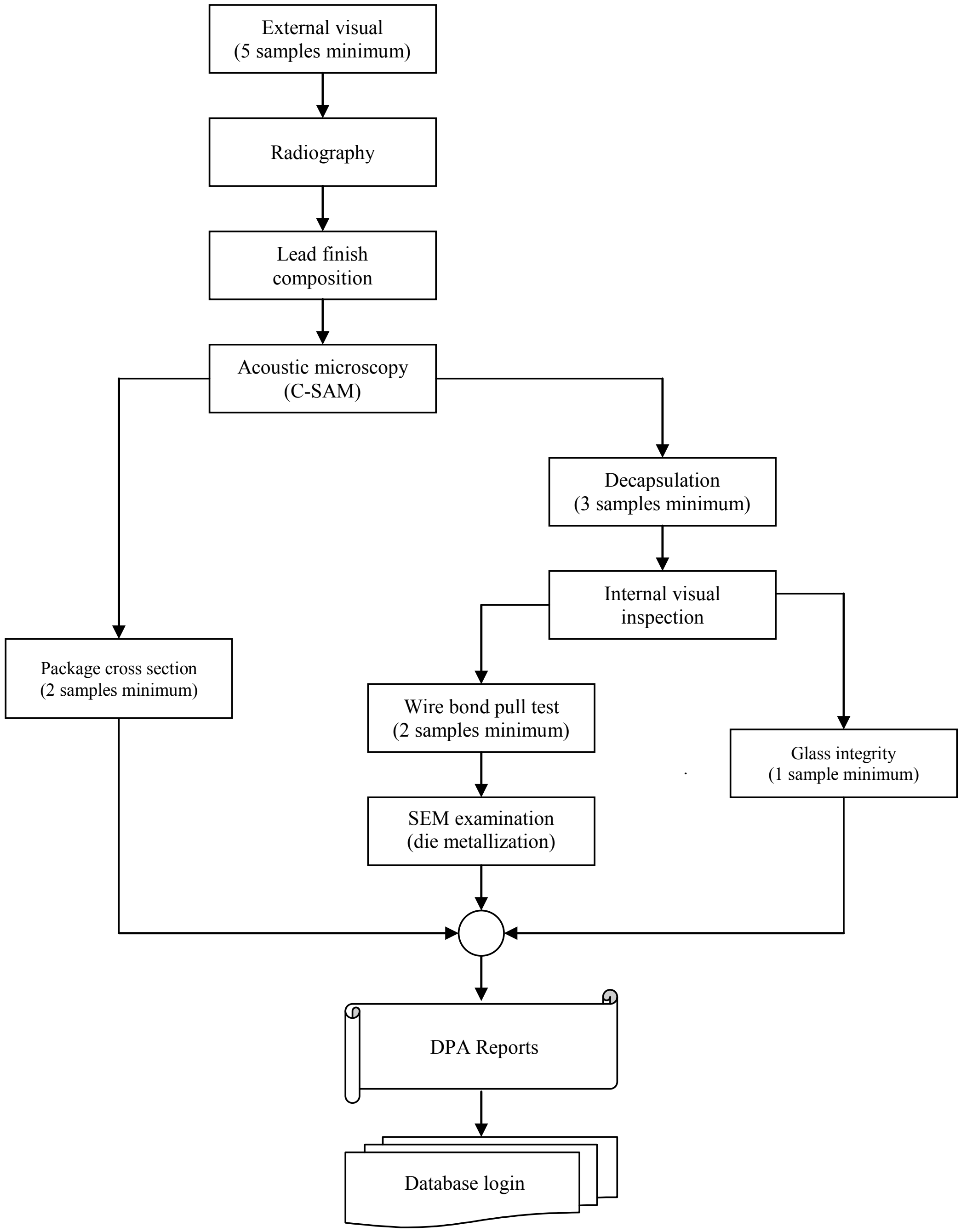

Figure B.4. DPA Test Flow for PEMs

B.7.2.4 Acoustic Microscopy (C-SAM)

This test is not used for CA.

Acoustic Microscopy shall be performed in accordance with MIL-STD-1580, Requirement 16 for PEMs on the DPA samples that meet the requirements of B.7.2.3 (five samples minimum) with the following additions:

1. A clean bath and deionized water should be used during acoustic examinations of flight parts.
2. A minimum 1-hour bake at 125°C shall be performed to remove moisture from the parts after immersion into the water bath of an acoustic microscope.
3. Anomalies and/or delaminations should be verified using A-mode analysis.

B.7.2.5 Package Level Cross-Sectioning

Forty percent of the samples (two intact samples minimum) shall be subjected to package level cross-sectioning. The DPA samples shall meet the requirements of B.7.2.4; the CA samples shall meet the requirements of B.7.2.3.

Inspect the package and die for the following defects:

1. Defects and cracks in the package.
2. Condition of die attachment.
3. Lead frame/molding compound delamination.
4. Condition of wire bonding at contact pads.
5. Contact pad cratering.
6. Condition of wire bonding at lead frame
7. Anomalies in molding compound (e.g., red particles might indicate the presence of red phosphorus used as a flame retardant; this type of flame retardant might cause part failure).
8. SEM examination at the package level cross section is performed optionally to obtain more details of anomalies observed during optical examination.

B.7.2.5.1 Cross-Sectioning Procedure

Half of the samples shall be sectioned parallel along the leads of one side of the package to halfway into the die. The remaining samples shall be sectioned perpendicular to the leads to halfway into the die. Cross-sectional planes shall be selected to cross wire bond to die and wire bond to lead frame. If suitable, a sample can be divided into two parts before potting as long as a cross-section parallel to the leads is performed on one half and a cross-section perpendicular to the same leads is performed on the other half. Each plane of cross section shall be examined microscopically first at a low power (30X to 60X) magnification and then at a high power magnification (75X to 200X). Optical examination of the bonds shall be performed at up to 1,000X magnification. Pictures of all defective bonds and package faults, as well as at least one picture of a typical bond, die attachment, and overall package layout, should be taken.

B.7.2.5.2 Evaluation Criteria

The following defects shall be considered as gross defects causing the lot to be rejected:

1. Package cracks and delaminations: Any evidence of external cracks other than between the lead and plastic at the lead entrance; large voids and delamination at the die attachment, die surface, and lead finger tips.
2. Bonding: Lifted and shifted bonds, excessive intermetallic formation at the periphery of the ball bond.
3. Molding compound: Voids and cracks in vicinity of bonding wires, presence of red phosphorus or other corrosive materials.
4. Leads: Pure tin (Sn) finish of the leads (< 3% lead (Pb) minimum), delamination of finish.

The following shall be considered as reliability concerns and additional testing and screening of the lot might be necessary:

1. Package cracks and delaminations: Any evidence of delamination or cracking of more than 0.5 of the lead or tie bar length.
2. Bonding: Abnormalities in intermetallic compound formation, cratering.
3. Die attach: Voiding of more than 50%.
4. Molding compound: Foreign intrusions.

B.7.2.6 Decapsulation

Decapsulation shall be performed per MIL-STD-1580, Requirement 16 for PEMs on 60% of the samples (three samples minimum).

B.7.2.7 Internal Visual Inspection

The decapsulated samples shall be subjected to internal visual inspection per MIL-STD-1580, Requirement 16 for PEMs.

B.7.2.8 Bond Pull Test

This test is not used for CA.

Forty percent of the samples (two samples minimum) that met the requirements of B.7.2.7 shall be subjected to bond pull testing per MIL-STD-1580, Requirement 16 for PEMs.

B.7.2.9 Examination Using Scanning Electron Microscopy (SEM)

Forty percent of the samples (two samples minimum) that met the requirements of B.7.2.7 shall be subjected to SEM analysis per MIL-STD-1580, Requirement 16 for PEMs.

B.7.2.10 Glassivation Layer Integrity

This test is not used for CA.

Twenty percent of the samples that met the requirements of B.7.2.7 (one sample minimum) shall be examined per MIL-STD-883, Method 2021, "Glassivation Layer Integrity."

B.8.0 DERATING REQUIREMENTS

General derating requirements are listed in Table B.V. Taking a conservative approach, derating requirements for PEMs should be more stringent than the requirements for their high-reliability equivalents. In some cases additional derating may be required based on specific application, design, and technology of the part. All part-specific derating shall be approved by the project and MSFC EEE Parts Engineering.

Table B.V. Derating Requirements for PEMS

Stress Parameter	Derating Factor	
	Digital	**Linear /Mixed Signal**
Maximum Supply Voltage 1/	0.9	0.8
Maximum Input Voltage	-	0.8
Maximum Operating Junction Temperature 2/	0.8 or 95°C, whichever is less	0.7 or 85°C, whichever is less
Maximum Output Current	0.8	0.7
Maximum Operating Frequency	0.8	0.7

Table B.V Notes:

1/ Do not exceed 90% of absolute maximum supply voltage for digital devices and 80% of absolute maximum supply voltage for linear/mixed signal devices except to meet the manufacturer's recommended operating conditions. For voltage regulators, derate VIN – VOUT to 0.9.

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

B.9.0 HANDLING AND STORAGE REQUIREMENTS

Handling and storage shall be in accordance with MSFC-STD-3012 section 5.8, and J-STD-033 with the following additions.

Detailed procedures for handling, storing, and maintenance of PEMs and assemblies shall be developed. The IPC/Joint Electron Device Engineering Council (JEDEC) standard J-STD-033 can be used when applicable as a guideline for safe handling and packing of PEMs regarding moisture sensitivity. The requirements should follow the entire ground-phase handling of parts including piece part testing, storage prior to installation, and board/system-level testing and storage after installation and integration into the system.

B.10.0 MANUFACTURER INFORMATION

This section describes guidelines for acquiring information from the manufacturer of PEMs, which might be useful to assess quality of the parts.

Table B.VI displays questions to be posed and manufacturer data available from Web sites, which would help to evaluate the ability of the manufacturer to produce parts with consistent quality and to provide acceptable customer support. The data are combined in four categories: general information about the part, part design and lifespan assessment, manufacturer assessment, and process assessment.

This information is of mutual interest for the parts engineering community and might be useful for different projects. For this reason, the project parts engineer should submit a spreadsheet in a standard format according to Table B.VI to MSFC EEE Parts Engineering.

Table B.VI. Manufacturer Information

Category	#	Information/Question
General Information	1.1	Part number
	1.2	Function
	1.3	Date code
	1.4	Package type
	1.5	Manufacturer
Part Attributes	2.1	Die process technology
	2.2	ESD sensitivity level
	2.3	Moisture sensitivity level
	2.4	Date of last die revision
	2.5	Date of introduction to the market
	2.6	Expected date for obsolescence
	2.7	Product storing policy (years to keep in stock)
	2.8	Packing parts for shipment, moisture control
	2.9	Type of molding compound and characteristics (glassivation temperature, CTE, flame retardant)

continued on next page

Table B.VI. Manufacturer Information

Category	#	Information/Question
Manufacturer Data	3.1	Vendor facility (location)
	3.2	Point of contact for quality assurance
	3.3	Quality certification of the vendor (ISO 9000 or equivalent)
	3.4	Mask revision control
	3.5	Application support
	3.6	Part traceability
Process	4.1	Availability of Statistical Process Control (SPC) data
	4.2	What kind of 100% outgoing inspection and screening is used?
	4.3	Availability of test flowchart
	4.5	Availability of reliability and quality assurance handbook
	4.6	Average outgoing quality (AOQ) 1/
	4.7	Major process capability indexes for the part (Cpk) 2/
	4.8	Acceptable proportion of failures at high temperature measurements
	4.9	Radiation hardness of the process or of similar parts
	4.10	Are there any military parts manufactured using same technology?

Table B.VI Notes:

1/ AOQ is the proportion of parts that are outside the manufacturer specification limits. Currently the quality assurance system employed by most established PEMs manufacturers guarantees a minimum of a 3-sigma level process. This means that AOQ = 2,700 ppm or 0.27% of all shipped parts might have parameters out of the data sheet specification. In some cases this level of failures is below 0.1% and even less than two failures in 109 parts for a 6-sigma manufacturer. However, the parts manufactured by a 6-sigma process have higher quality only when the parts are used and operate at relatively low temperatures. For example, a 6-sigma commercial product, when used in automotive applications, is considered a 3-sigma product.

2/ Cpk is a measure of how well the process fits within the specification limits. It relates process variations to the specification limits using a “natural tolerance”, 3σ, and is applicable only for normal distribution. $Cpk = [\min (HSL - \mu), (\mu - LSL)]/ (3\sigma)$, where HSL is the higher specification limit, LSL is the lower specification limit, μ is the mean value, and σ is the standard deviation. Larger Cpk values indicate lesser variations in the process and more consistent quality of the product.

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APPENDIX C

BOILERPLATE

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS MANAGEMENT AND CONTROL REQUIREMENTS DOCUMENT FOR GRADE 1 PARTS

Appendix C
Table of Contents

PARAGRAPH **PAGE**

TABLE **PAGE**

C.1.0 SCOPE

This Control Document implements requirements set forth in MSFC-STD-3012 for Grade 1 parts. Requirements are specified for EEE parts activities from the equipment design and development phase through use and maintenance of the system and equipment. Some special requirements, applicable only to MSFC, are included for MSFC in-house activities. Requirements herein are intended to apply only to flight hardware, except that a requirement is levied on ground equipment connectors that mate with flight connectors.

C.1.1 Applicability

Requirements herein apply to the part types listed in Table C.I. Part types not listed are not subject to the controls herein.

The EEE parts requirements herein also apply to EEE parts in sensor assemblies where basic sensing/transducer pieces (RTD, strain gauge, etc.) are packaged in an assembly with other electrical part types such as wire, connector, resistor, etc.

For parts approved for use with waivers/deviations, electronic parts and materials should be manufactured and processed to applicable guidelines referenced in MIL-HDBK-454, General Guidelines for Electronic Equipment or MIL-HDBK-1547, Electronic Parts, Materials, and Processes for Space and Launch Vehicles.

Table C.I. EEE Part Types

Part Types	Federal Stock Classes	Part Types	Federal Stock Classes
Capacitors	5910	Inductors	5950
Circuit Breakers	5925	Hybrids microcircuits	5962
Connectors	5935	Magnetics	5950
Crystal Oscillators	5955	Monolithic Microcircuits	5962
Diodes	5961	Relays	5945
Fiber Optic Accessories	6070	Resistors	5905
Fiber Optic Cables	6015	Switches	5930
Fiber Optic Conductors	6010	Thermistors	5905
Fiber Optic Devices	6030	Transformers	5950
Fiber Optic Interconnects	6060	Transistors	5961
Filters	5915	Wire and Cable	6145
Fuses	5920		

C.2.0 APPLICABLE DOCUMENTS

C.2.1 General

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-HDBK-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MSFC-STD-3012	Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware

C.3.0 DEFINITIONS AND ACRONYMS

Definitions and acronyms are in accordance with MSFC-STD-3012 section 3.0.

C.4.0 REQUIREMENTS

C.4.1 General

This Control Document, or MSFC approved equivalent requirements document, shall be applied to each subcontract tier for applicable equipment. The requirements of MSFC-STD-3012 for Grade 1 parts and the requirements herein shall be met.

C.4.1.1 Focal Point EEE Parts Organization

The organization serving as the focal point EEE parts organization in matters pertaining to this Control Document shall be MSFC EEE Parts Engineering.

C.4.2 Part Qualification

EEE parts shall be qualified at the piece part level. Qualification at the piece part level shall meet the Grade 1 requirements of MSFC-STD-3012 section 5.2. Where guidance is not provided within MSFC-STD-3012 for qualification of nonstandard parts, the qualification shall be equivalent to the requirements imposed on similar standard parts, or shall otherwise satisfactorily demonstrate that the part has an MSFC approved margin of safety beyond the demands of the equipment in which it will be used.

C.4.3 Quality Assurance Requirements

Quality assurance shall meet the requirements of MSFC-STD-3012 section 5.3 for Grade 1 EEE parts.

C.4.4 Application Criteria Requirements

EEE parts shall meet the application criteria requirements of MSFC-STD-3012 section 5.4.

C.4.5 Configuration Control Requirements

The acquiring activity's focal point EEE parts organization shall review and approve all EEE parts selections. At each subcontract level, the acquiring activity shall review and approve all sub-tier EEE parts selections.

C.4.5.1 Parts Selection

Grade 1 parts shall be used in the design, modification, and fabrication of the flight equipment. Parts shall be selected in accordance with the order of selection preference indicated in MSFC-STD-3012 Table V. A lower ranked selection shall not be used if a higher ranked selection can be obtained. A nonstandard Grade 1 part may be used in accordance with MSFC-STD-3012 when a standard part is not available. Commercial quality assurance level parts shall not be used in these applications without deviation/waiver and project approval. The objective is to minimize part types, utilize standard part types to the maximum extent possible, and assure that appropriate minimum quality levels are maintained.

The NASA Parts Selection List (NPSL) may be used for additional part selection provided the part selected meets the qualification and screening criteria for Grade 1 (NPSL Level 1); however, NPSL (http://nepp.nasa.gov/npsl/) parts not listed in MSFC-STD-3012 Table V shall require nonstandard part approval.

C.4.5.2 Standard and Nonstandard Parts

Standard and nonstandard Grade 1 parts are as specified in the MSFC-STD-3012 Table V, Standard Parts Selection and Preferences for Grade 1.

C.4.5.3 Specifications and Control Drawings

Grade 1 parts shall be defined and controlled by military/industry standard specifications and/or by control drawings. (Examples of control drawings are Source Control Drawings (SCDs), or Vendor Item Control Drawings (VICDs)). A part control drawing shall be used to document the performance and quality assurance characteristics required for the part where there is no military/industry standard that fully documents the requirements. The activity acquiring parts shall be responsible for preparation of part control drawings. Published vendor data sheet and catalog data may be relied on as a substitute for a part control drawing where all of the following apply: (1) a military/industry standard specification does not exist and cannot be readily obtained, (2) the vendor data adequately defines the performance and quality assurance provisions for the part, and (3) the part and/or manufacturer has a good record of use within the aerospace industry.

C.4.5.3.1 MSFC In-house Control Drawings

Preparation of part control drawings for MSFC in-house initiated parts procurements shall be the responsibility of the design activity.

C.4.5.4 Waivers and Deviations

Any EEE part that does not meet the requirements of a standard or nonstandard part in MSFC-STD-3012 Table V shall require a waiver/deviation.

C.4.5.5 Plastic Encapsulated Microcircuits (PEMs)

Commercial quality PEMs shall not be used in Grade 1 applications without a deviation/waiver and project approval.

C.4.5.6 Part Substitutions

Part substitutions shall meet the requirements of MSFC-STD-3012 paragraph 5.5.6 for Grade 1 parts.

C.4.5.7 Traceability

Traceability shall meet the requirements of MSFC-STD-3012 paragraph 5.5.7 for Grade 1 parts.

C.4.6 Parts Related Data Requirements

C.4.6.1 EEE Parts Management Plan

Project management shall develop a EEE parts management plan in accordance with paragraph C.4.1

C.4.6.2 As-Designed EEE Parts List

The As-Designed EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.2 and contractual data requirements. A typical format is shown below.

Identifying part number for the end item in which the EEE part will be used.

Applicable EEE part type (from C.1.1 above).

Part number that will appear in the using assembly's parts list as the unique identification of the EEE part.

Specification or drawing in which the detail characteristics of the EEE part are identified.

A common, or manufacturer's, number identifying the basic function of the EEE part.

End Item	Part Type	EEE P/N	EEE Spec	Generic P/N	Qual Method	Qual Status	Nonstandard Approval	Manufacturer	Quantity

Method for determining the EEE part's qualification (such as test or QPL).

Status of qualification activities for the EEE part (pending, complete, QML, etc.).

Status for approval of nonstandard EEE part by the acquiring activity (N/A, approval date, etc.).

Identification of qualified manufacturer(s) of the EEE part (QML, QPL, QPD, or name and CAGE code preferred).

Estimated quantity, if available, that will be used per end item.

Note: An indication that an item is a change from the previous submission shall be provided.

C.4.6.3 Nonstandard Parts Approval

Nonstandard parts approval shall be in accordance with MSFC-STD-3012 section 5.6.3 and contractual data requirements.

C.4.6.4 EEE Parts Application (Derating) Analysis

EEE parts applications derating analysis shall meet the requirements of MSFC-STD-3012 paragraph 5.6.4 and contractual data requirements.

C.4.6.5 As-Built EEE Parts List

The As-Built EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.5 and contractual data requirements. A typical format is shown below.

Identifying part number for the end item using the EEE part.

Serial number of the end item using the EEE part.

Identifying part number of the assembly which calls out the installation of the EEE part.

Serial number of the using assembly.

Applicable EEE part type (from C.1.1 above).

End Item	E.I. S/N	Using Assy	Assy S/N	EEE Type	EEE P/N	Ref Des	Mfg	LDC	EEE S/N

Part number that appears in the using assembly's parts list as the EEE part identification.

Reference designation that indentifies the EEE part's circuit location (i.e. R1, C1, etc.).

Precise identification of the manufacturer of the installed EEE part (name and CAGE code preferred).

Identifying code for lot identification of the installed EEE part (usually Lot Date Code).

Serial number of the installed EEE part, if applicable.

Note: An indication that an item is a change from the previous submission shall be provided.

C.4.7 <u>Obsolescence Management, Counterfeit Avoidance, and Parts Availability Requirements</u>

Obsolescence management, counterfeit avoidance, and parts availability requirements shall be in accordance with MSFC-STD-3012 section 5.7.

C.4.8 <u>Manufacturing and Handling Requirements</u>

Manufacturing and handling requirements shall be in accordance with MSFC-STD-3012 section 5.8.

C.4.9 <u>Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements</u>

Heritage and OTS hardware shall meet the requirements of MSFC-STD-3012 section 5.9 for Grade 1 parts.

C.4.10 Ground Support Equipment (GSE) to Flight Hardware Electrical Interfaces

GSE to flight hardware electrical interfaces shall meet the requirements of MSFC-STD-3012 paragraph 5.10.

C.5.0 VERIFICATION OF PARTS REQUIREMENTS

Verification of parts requirements shall be in accordance with MSFC-STD-3012 section 6.0 for Grade 1 parts.

APPENDIX D

BOILERPLATE

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS MANAGEMENT AND CONTROL REQUIREMENTS DOCUMENT FOR GRADE 2 PARTS

Appendix D
Table of Contents

PARAGRAPH **PAGE**

TABLE **PAGE**

D.1.0 SCOPE

This Control Document implements requirements set forth in MSFC-STD-3012 for Grade 2 parts. Requirements are specified for EEE parts activities from the equipment design and development phase through use and maintenance of the system and equipment. Some special requirements, applicable only to MSFC, are included for MSFC in-house activities. Requirements herein are intended to apply only to flight hardware, except that a requirement is levied on ground equipment connectors that mate with flight connectors.

D.1.1 Applicability

Requirements herein apply to the part types listed in Table D.I. Part types not listed are not subject to the controls herein.

The EEE parts requirements herein also apply to EEE parts in sensor assemblies where basic sensing/transducer pieces (RTD, strain gauge, etc.) are packaged in an assembly with other electrical part types such as wire, connector, resistor, etc.

For parts approved for use with waivers/deviations, electronic parts and materials should be manufactured and processed to applicable guidelines referenced in MIL-HDBK-454, General Guidelines for Electronic Equipment or MIL-HDBK-1547, Electronic Parts, Materials, and Processes for Space and Launch Vehicles.

Table D.I. EEE Part Types

Part Types	Federal Stock Classes	Part Types	Federal Stock Classes
Capacitors	5910	Inductors	5950
Circuit Breakers	5925	Hybrids microcircuits	5962
Connectors	5935	Magnetics	5950
Crystal Oscillators	5955	Monolithic Microcircuits	5962
Diodes	5961	Relays	5945
Fiber Optic Accessories	6070	Resistors	5905
Fiber Optic Cables	6015	Switches	5930
Fiber Optic Conductors	6010	Thermistors	5905
Fiber Optic Devices	6030	Transformers	5950
Fiber Optic Interconnects	6060	Transistors	5961
Filters	5915	Wire and Cable	6145
Fuses	5920		

D.2.0 APPLICABLE DOCUMENTS

D.2.1 General

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-HDBK-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MSFC-STD-3012	Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware

D.3.0 DEFINITIONS AND ACRONYMS

Definitions and acronyms are in accordance with MSFC-STD-3012 section 3.0.

D.4.0 REQUIREMENTS

D.4.1 General

This Control Document, or MSFC approved equivalent requirements document, shall be applied to each subcontract tier for applicable equipment. The requirements of MSFC-STD-3012 for Grade 2 parts and the requirements herein shall be met.

D.4.1.1 Focal Point EEE Parts Organization

The organization serving as the focal point EEE parts organization in matters pertaining to this Control Document shall be MSFC EEE Parts Engineering.

D.4.2 Part Qualification

Grade 2 EEE parts shall be qualified at the piece part level. Qualification at the piece part level shall meet the requirements of MSFC-STD-3012 section 5.2. Where guidance is not provided within MSFC-STD-3012 for qualification of nonstandard parts, the qualification shall be equivalent to the requirements imposed on similar standard parts, or shall otherwise satisfactorily demonstrate that the part has an MSFC approved margin of safety beyond the demands of the equipment in which it will be used.

D.4.3 Quality Assurance Requirements

Quality assurance shall meet the requirements of MSFC-STD-3012 section 5.3 for Grade 2 EEE parts.

D.4.4 Application Criteria Requirements

EEE parts shall meet the application criteria requirements of MSFC-STD-3012 section 5.4.

D.4.5 Configuration Control Requirements

The acquiring activity's focal point EEE parts organization shall review and approve all EEE parts selections. At each subcontract level, the acquiring activity shall review and approve all sub-tier EEE parts selections.

D.4.5.1 Parts Selection

As a minimum, Grade 2 parts shall be used in the design, modification, and fabrication of the flight equipment. Parts shall be selected in accordance with the order of selection preference indicated in MSFC-STD-3012 Table VI. A lower ranked selection shall not be used if a higher ranked selection can be obtained. A nonstandard Grade 2 part may be used in accordance with MSFC-STD-3012 when a standard part is not available. Commercial quality assurance level parts shall not be used in these applications without deviation/waiver and project approval.

The NASA Parts Selection List (NPSL) may be used for additional part selection provided the part selected meets the qualification and screening criteria for Grade 2 (NPSL Level 2); however, NPSL (http://nepp.nasa.gov/npsl/) parts not listed in MSFC-STD-3012 Tables V or VI shall require nonstandard part approval.

D.4.5.2 Standard and Nonstandard Parts

Standard and nonstandard Grade 2 parts are as specified in the MSFC-STD-3012 Table VI, Standard Parts Selection and Preferences for Grade 2.

D.4.5.3 Specifications and Control Drawings

Grade 2 parts shall be defined and controlled by military/industry standard specifications and/or by control drawings. (Examples of control drawings are Source Control Drawings (SCDs), or Vendor Item Control Drawings (VICDs)). A part control drawing shall be used to document the performance and quality assurance characteristics required for the part where there is no military/industry standard that fully documents the requirements. The activity acquiring parts shall be responsible for preparation of part control drawings. Published vendor data sheet and catalog data may be relied on as a substitute for a part control drawing where all of the following apply: (1) a military/industry standard specification does not exist and cannot be readily obtained, (2) the vendor data adequately defines the performance and quality assurance provisions for the part, and (3) the part and/or manufacturer has a good record of use within the aerospace industry.

D.4.5.3.1 MSFC In-house Control Drawings

Preparation of part control drawings for MSFC in-house initiated parts procurements shall be the responsibility of the design activity.

D.4.5.4 Waivers and Deviations

Any EEE part that does not meet the requirements of a standard or nonstandard part in MSFC-STD-3012 Table V or VI shall require a waiver/deviation.

D.4.5.5 Plastic Encapsulated Microcircuits (PEMs)

If Vendor Hi Rel PEMs are selected and approved for use, the PEMs shall be subject to the PEMs Grade 2 insertion requirements contained in MSFC-STD-3012 paragraph 5.5.5 and Appendix B, "Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification."

D.4.5.6 Part Substitutions

Part substitutions shall meet the requirements of MSFC-STD-3012 paragraph 5.5.6 for Grade 2 parts.

D.4.5.7 Traceability

Traceability shall meet the requirements of MSFC-STD-3012 section 5.5.7 for Grade 2 parts.

D.4.6 Parts Related Data Requirements

D.4.6.1 EEE Parts Management Plan

Project management shall develop a EEE parts management plan in accordance with paragraph D.4.1

D.4.6.2 As-Designed EEE Parts List

The As-Designed EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.2 and contractual data requirements. A typical format follows.

Identifying part number for the end item in which the EEE part will be used.

Applicable EEE part type (from D.1.1 above).

Part number that will appear in the using assembly's parts list as the unique identification of the EEE part.

Specification or drawing in which the detail characteristics of the EEE part are identified.

A common, or manufacturer's, number identifying the basic function of the EEE part.

End Item	Part Type	EEE P/N	EEE Spec	Generic P/N	Qual Method	Qual Status	Nonstandard Approval	Manufacturer	Quantity

Method for determining the EEE part's qualification (such as test or QPL).

Status of qualification activities for the EEE part (pending, complete, QML, etc.).

Status for approval of nonstandard EEE part by the acquiring activity (N/A, approval date, etc.).

Identification of qualified manufacturer(s) of the EEE part (QML, QPL, QPD, or name and CAGE code preferred).

Estimated quantity, if available, that will be used per end item.

Note: An indication that an item is a change from the previous submission shall be provided.

D.4.6.3 Nonstandard Parts Approval Request (NSPAR)

Nonstandard parts approval shall be in accordance with MSFC-STD-3012 section 5.6.3 and contractual data requirements.

D.4.6.4 EEE Parts Application (Derating) Analysis

EEE parts applications derating analysis shall meet the requirements of MSFC-STD-3012 paragraph 5.6.4 and contractual data requirements.

D.4.6.5 As-Built EEE Parts List

The As-Built EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.5 and contractual data requirements. A typical format follows.

Identifying part number for the end item using the EEE part.

Serial number of the end item using the EEE part.

Identifying part number of the assembly which calls out the installation of the EEE part.

Serial number of the using assembly.

Applicable EEE part type (from D.1.1 above).

End Item **E.I. S/N** **Using Assy** **Assy S/N** **EEE Type** **EEE P/N** **Ref Des** **Mfg** **LDC** **EEE S/N**

Part number that appears in the using assembly's parts list as the EEE part identification.

Reference designation that indentifies the EEE part's circuit location (i.e. R1, C1, etc.).

Precise identification of the manufacturer of the installed EEE part (name and CAGE code preferred).

Identifying code for lot identification of the installed EEE part (usually Lot Date Code).

Serial number of the installed EEE part, if applicable.

Note: An indication that an item is a change from the previous submission shall be provided.

D.4.7 Obsolescence Management, Counterfeit Avoidance, and Parts Availability Requirements

Obsolescence management, counterfeit avoidance, and parts availability requirements shall be in accordance with MSFC-STD-3012 section 5.7.

D.4.8 Manufacturing and Handling Requirements

Manufacturing and handling requirements shall be in accordance with MSFC-STD-3012 section 5.8.

D.4.9 Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements

Heritage and OTS hardware shall meet the requirements of MSFC-STD-3012 section 5.9 for Grade 2 parts.

D.4.10 Ground Support Equipment (GSE) to Flight Hardware Electrical Interfaces

GSE to flight hardware electrical interfaces shall meet the requirements of MSFC-STD-3012 section 5.10.

D.5.0 VERIFICATION OF PARTS REQUIREMENTS

Verification of parts requirements shall be in accordance with MSFC-STD-3012 section 6.0 for Grade 2 parts.

APPENDIX E

BOILERPLATE

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS MANAGEMENT AND CONTROL REQUIREMENTS DOCUMENT FOR GRADE 3 PARTS

Appendix E
Table of Contents

PARAGRAPH **PAGE**

TABLE **PAGE**

E.1.0 SCOPE

This Control Document implements requirements set forth in MSFC-STD-3012 for Grade 3 parts. Requirements are specified for EEE parts activities from the equipment design and development phase through use and maintenance of the system and equipment. Some special requirements, applicable only to MSFC, are included for MSFC in-house activities. Requirements herein are intended to apply only to flight hardware, except that a requirement is levied on ground equipment connectors that mate with flight connectors.

E.1.1 Applicability

Requirements herein apply to the part types listed in Table E.I. Part types not listed are not subject to the controls herein.

The EEE parts requirements herein also apply to EEE parts in sensor assemblies where basic sensing/transducer pieces (RTD, strain gauge, etc.) are packaged in an assembly with other electrical part types such as wire, connector, resistor, etc.

For parts approved for use with waivers/deviations, electronic parts and materials should be manufactured and processed to applicable guidelines referenced in MIL-HDBK-454, General Guidelines for Electronic Equipment or MIL-HDBK-1547, Electronic Parts, Materials, and Processes for Space and Launch Vehicles.

Table E.I. EEE Part Types

Part Types	Federal Stock Classes	Part Types	Federal Stock Classes
Capacitors	5910	Inductors	5950
Circuit Breakers	5925	Hybrids microcircuits	5962
Connectors	5935	Magnetics	5950
Crystal Oscillators	5955	Monolithic Microcircuits	5962
Diodes	5961	Relays	5945
Fiber Optic Accessories	6070	Resistors	5905
Fiber Optic Cables	6015	Switches	5930
Fiber Optic Conductors	6010	Thermistors	5905
Fiber Optic Devices	6030	Transformers	5950
Fiber Optic Interconnects	6060	Transistors	5961
Filters	5915	Wire and Cable	6145
Fuses	5920		

E.2.0 APPLICABLE DOCUMENTS

E.2.1 General

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

MIL-HDBK-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-HDBK-454	General Guidelines for Electronic Equipment
MSFC-STD-3012	Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware

E.3.0 DEFINITIONS AND ACRONYMS

Definitions and acronyms are in accordance with MSFC-STD-3012 section 3.0.

E.4.0 REQUIREMENTS

E.4.1 General

This Control Document, or MSFC approved equivalent requirements document, shall be applied to each subcontract tier for applicable equipment. The requirements of MSFC-STD-3012 for Grade 3 parts and the implementation requirements herein shall be met.

E.4.1.1 Focal Point EEE Parts Organization

The organization serving as the focal point EEE parts organization in matters pertaining to this Control Document shall be MSFC EEE Parts Engineering.

E.4.2 Part Qualification

Grade 3 EEE parts shall be qualified at the piece part level. Qualification at the piece part level shall meet the requirements of MSFC-STD-3012 section 5.2. Where guidance is not provided within MSFC-STD-3012 for qualification of nonstandard parts, the qualification shall be equivalent to the requirements imposed on similar standard parts, or shall otherwise satisfactorily demonstrate that the part has an MSFC approved margin of safety beyond the demands of the equipment in which it will be used.

E.4.3 Quality Assurance Requirements

Quality assurance shall meet the requirements of MSFC-STD-3012 section 5.3 for Grade 3 EEE parts.

E.4.4 Application Criteria Requirements

EEE parts shall meet the application criteria requirements of MSFC-STD-3012 section 5.4.

E.4.5 Configuration Control Requirements

The acquiring activity's focal point EEE parts organization shall review and approve all EEE parts selections. At each subcontract level, the acquiring activity shall review and approve all sub tier EEE parts selections.

E.4.5.1 Parts Selection

As a minimum, Grade 3 parts shall be used in the design, modification, and fabrication of the flight equipment. Parts shall be selected in accordance with the order of selection preference indicated in MSFC-STD-3012 Table VII. A lower ranked selection shall not be used if a higher ranked selection can be obtained. A nonstandard Grade 3 part may be used in accordance with MSFC-STD-3012 when a standard part is not available.

The NASA Parts Selection List (NPSL) may be used for additional part selection provided the part selected meets the qualification and screening criteria for Grade 3 (NPSL Level 3); however, NPSL (http://nepp.nasa.gov/npsl/) parts not listed in MSFC-STD-3012 Tables V, VI, or VII shall require nonstandard part approval.

E.4.5.2 Standard and Nonstandard parts

Standard and nonstandard Grade 3 parts are as specified in the MSFC-STD-3012 Table VII, Standard Parts Selection and Preferences for Grade 3.

E.4.5.3 Specifications and Control Drawings

Grade 3 parts shall be defined and controlled by military/industry standard specifications and/or by control drawings. (Examples of control drawings are Source Control Drawings (SCDs), or Vendor Item Control Drawings (VICDs)). A part control drawing shall be used to document the performance and quality assurance characteristics required for the part where there is no military/industry standard that fully documents the requirements. The activity acquiring parts shall be responsible for preparation of part control drawings. Published vendor data sheet and catalog data may be relied on as a substitute for a part control drawing where all of the following apply: (1) a military/industry standard specification does not exist and cannot be readily obtained, (2) the vendor data adequately defines the performance and quality assurance provisions for the part, and (3) the part and/or manufacturer has a good record of use within the aerospace industry.

E.4.5.3.1 MSFC In-house Control Drawings

Preparation of part control drawings for MSFC in-house initiated parts procurements shall be the responsibility of the design activity.

E.4.5.4 Waivers and Deviations

Any EEE part that does not meet the requirements of a standard or nonstandard part in MSFC-STD-3012 Table V, VI, or VII shall require a waiver/deviation.

E.4.5.5 Plastic Encapsulated Microcircuits (PEMs)

If PEMs are selected and approved for use, the PEMs shall be subject to the PEMs Grade 3 insertion requirements contained in MSFC-STD-3012 paragraph 5.5.5 and Appendix B, "Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification."

E.4.5.6 Part Substitutions

Part substitutions shall meet the requirements of MSFC-STD-3012 paragraph 5.5.6 for Grade 3 parts.

E.4.5.7 Traceability

Traceability shall meet the requirements of MSFC-STD-3012 section 5.5.7 for Grade 3 parts.

E.4.6 Parts Related Data Requirements

E.4.6.1 EEE Parts Management Plan

Project management shall develop a EEE parts management plan in accordance with paragraph E.4.1

E.4.6.2 As-Designed EEE Parts List

The As-Designed EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.2 and contractual data requirements. A typical format is shown below.

Identifying part number for the end item in which the EEE part will be used.

Applicable EEE part type (from E.1.1 above).

Part number that will appear in the using assembly's parts list as the unique identification of the EEE part.

Specification or drawing in which the detail characteristics of the EEE part are identified.

A common, or manufacturer's, number identifying the basic function of the EEE part.

End Item	Part Type	EEE P/N	EEE Spec	Generic P/N	Qual Method	Qual Status	Nonstandard Approval	Manufacturer	Quantity

Method for determining the EEE part's qualification (such as test or QPL).

Status of qualification activities for the EEE part (pending, complete, QML, etc.).

Status for approval of nonstandard EEE part by the acquiring activity (N/A, approval date, etc.).

Identification of qualified manufacturer(s) of the EEE part (QML, QPL, QPD, or name and CAGE code preferred).

Estimated quantity, if available, that will be used per end item.

Note: An indication that an item is a change from the previous submission shall be provided.

E.4.6.3 Nonstandard Parts Approval Request (NSPAR)

Nonstandard parts approval shall be in accordance with MSFC-STD-3012 section 5.6.3 and contractual data requirements.

E.4.6.4 EEE Parts Application (Derating) Analysis

EEE parts applications derating analysis shall meet the requirements of MSFC-STD-3012 paragraph 5.6.4 and contractual data requirements.

E.4.6.5 As-Built EEE Parts List

The As-Built EEE Parts List shall meet the requirements of MSFC-STD-3012 section 5.6.5 and contractual data requirements. A typical format is shown below.

Identifying part number for the end item using the EEE part.

Serial number of the end item using the EEE part.

Identifying part number of the assembly which calls out the installation of the EEE part.

Serial number of the using assembly.

Applicable EEE part type (from E.1.1 above).

End Item	E.I. S/N	Using Assy	Assy S/N	EEE Type	EEE P/N	Ref Des	Mfg	LDC	EEE S/N

Part number that appears in the using assembly's parts list as the EEE part identification.

Reference designation that indentifies the EEE part's circuit location (i.e. R1, C1, etc.).

Precise identification of the manufacturer of the installed EEE part (name and CAGE code preferred).

Identifying code for lot identification of the installed EEE part (usually Lot Date Code).

Serial number of the installed EEE part, if applicable.

Note: An indication that an item is a change from the previous submission shall be provided.

E.4.7 Obsolescence Management, Counterfeit Avoidance, and Parts Availability Requirements

Obsolescence management, counterfeit avoidance, and parts availability requirements shall be in accordance with MSFC-STD-3012 section 5.7.

E.4.8 Manufacturing and Handling Requirements

Manufacturing and handling requirements shall be in accordance with MSFC-STD-3012 section 5.8.

E.4.9 Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements

Heritage and OTS hardware shall meet the requirements of MSFC-STD-3012 section 5.9 for Grade 3 parts.

E.4.10 Ground Support Equipment (GSE) to Flight Hardware Electrical Interfaces

GSE to flight hardware electrical interfaces shall meet the requirements of MSFC-STD-3012 section 5.10.

E.5.0 VERIFICATION OF PARTS REQUIREMENTS

Verification of parts requirements shall be in accordance with MSFC-STD-3012 section 6.0 for Grade 3 parts.

APPENDIX F

BOILERPLATE

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS MANAGEMENT AND CONTROL REQUIREMENTS DOCUMENT FOR GRADE 4 PARTS

Appendix F
Table of Contents

PARAGRAPH **PAGE**

TABLE **PAGE**

F.1.0 SCOPE

This Control Document implements requirements set forth in MSFC-STD-3012 for Grade 4 parts. Requirements are specified for EEE parts activities from the equipment design and development phase through use and maintenance of the system and equipment. Some special requirements, applicable only to MSFC, are included for MSFC in-house activities. Requirements herein are intended to apply only to flight hardware, except that a requirement is levied on ground equipment connectors that mate with flight connectors.

F.1.1 Applicability

Requirements herein apply to the part types listed in Table F.I. Part types not listed are not subject to the controls herein.

The EEE parts requirements herein also apply to EEE parts in sensor assemblies where basic sensing/transducer pieces (RTD, strain gauge, etc.) are packaged in an assembly with other electrical part types such as wire, connector, resistor, etc.

For parts approved for use with waivers/deviations, electronic parts and materials should be manufactured and processed to applicable guidelines referenced in MIL-HDBK-454, General Guidelines for Electronic Equipment or MIL-HDBK-1547, Electronic Parts, Materials, and Processes for Space and Launch Vehicles.

Table F.I. EEE Part Types

Part Types	Federal Stock Classes	Part Types	Federal Stock Classes
Capacitors	5910	Inductors	5950
Circuit Breakers	5925	Hybrids microcircuits	5962
Connectors	5935	Magnetics	5950
Crystal Oscillators	5955	Monolithic Microcircuits	5962
Diodes	5961	Relays	5945
Fiber Optic Accessories	6070	Resistors	5905
Fiber Optic Cables	6015	Switches	5930
Fiber Optic Conductors	6010	Thermistors	5905
Fiber Optic Devices	6030	Transformers	5950
Fiber Optic Interconnects	6060	Transistors	5961
Filters	5915	Wire and Cable	6145
Fuses	5920		

F.2.0 APPLICABLE DOCUMENTS

F.2.1 General

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

MIL-HDBK-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-HDBK-454	General Guidelines for Electronic Equipment
MSFC-STD-3012	Electrical, Electronic, Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware

F.3.0 DEFINITIONS AND ACRONYMS

Definitions and acronyms are in accordance with MSFC-STD-3012 section 3.0.

F.4.0 REQUIREMENTS

F.4.1 General

This Control Document, or MSFC approved equivalent requirements document, shall be applied to each subcontract tier for applicable equipment. The requirements of MSFC-STD-3012 for Grade 4 parts and the implementation requirements herein shall be met.

F.4.1.1 Focal Point EEE Parts Organization

The organization serving as the focal point EEE parts organization in matters pertaining to this Control Document shall be MSFC EEE Parts Engineering.

F.4.2 Part Qualification

Grade 4 EEE parts shall be, as a minimum, qualified at the assembled equipment level. Qualification at the assembly level shall meet the requirements of MSFC-STD-3012 section 5.2.

F.4.3 Quality Assurance Requirements

F.4.3.1 Procurement Sources

EEE parts shall be procured only from the original component manufacturers or their franchised (authorized) distributors.

F.4.3.2 Quality Conformance Inspection (QCI)

There are no QCI requirements for Grade 4 parts.

F.4.3.3 Screening

There are no screening requirements for Grade 4 parts.

F.4.3.4 Receiving Inspection

Receiving inspection shall be in accordance with MSFC-STD-3012 paragraph 5.3.4.

F.4.3.5 Quality Assurance Data

Parts problems reported from the field shall be documented and submitted for MSFC review.

F.4.3.6 Government Industry Data Exchange Program (GIDEP) and ALERT Reporting

When feasible, GIDEP participation and ALERT reporting should be in accordance with MSFC-STD-3012 section 5.3.6.

F.4.4 Application Criteria Requirements

Parts shall be properly applied in the design.

F.4.4.1 Derating

Parts should be derated in the application to meet the derating requirements of MSFC-STD-3012 paragraph 5.4.1.

F.4.4.2 Operating Environment

EEE parts should be tested to meet the operating environmental conditions specified in MSFC-STD-3012 paragraph 5.4.2.

F.4.4.3 Ionizing Radiation

Where feasible in accordance with MSFC-STD-3012 paragraph 5.4.3, parts should be acceptable for use in the projected environment identified in project documentation. Consideration should be given to both total dose and single event effects. It should be noted that certain parts might not perform to specification in a radiation environment.

F.4.4.4 Hazard Avoidance

Grade 4 parts shall comply with the hazard avoidance requirements of MSFC-STD-3012 section 5.4.4.

F.4.4.5 Cuprous Oxide (Red Plague) Control

Where feasible, the use of silver plated wire should require the implementation of red plague control as specified in MSFC-STD-3012 section 5.4.5.

F.4.5 Configuration Control Requirements

The acquiring activity's focal point EEE parts organization should review all EEE parts selections. At each subcontract level, the acquiring activity should review all sub tier EEE parts selections.

F.4.5.1 Parts Selection

The parts, selection, and screening shall conform to the requirements in Table VIII of MSFC-STD-3012 for Grade 4 EEE parts.

F.4.5.2 Standard and Nonstandard Parts

All parts are considered standard when selected for use in Grade 4 applications. There are no Grade 4 nonstandard parts.

F.4.5.3 Specifications and Control Drawings

Grade 4 parts may be defined and controlled by purchase orders and vendor specifications or any other suitable means.

F.4.5.3.1 MSFC In-house Control Drawings

Preparation of part control drawings for MSFC in-house initiated parts procurements shall be the responsibility of the design activity.

F.4.5.4 Waivers and Deviations

Waivers and deviations are not required for the selection of Grade 4 parts.

F.4.5.5 Plastic Encapsulated Microcircuits (PEMs)

PEMs are standard parts in Grade 4 applications.

F.4.5.6 Parts Substitution

There are no part substitutions requirements for Grade 4 parts.

F.4.5.7 Traceability

Traceability should meet the requirements of MSFC-STD-3012 section 5.5.7 for Grade 4 parts.

F.4.6 Parts Related Data Requirements

F.4.6.1 EEE Parts Management Plan

Project management shall develop a EEE parts management plan in accordance with paragraph F.4.1

F.4.6.2 As-Designed EEE Parts List

If an As-Designed EEE Parts List is available, the list should meet the requirements of MSFC-STD-3012 section 5.6.2 and contractual data requirements. A typical format follows.

Identifying part number for the end item in which the EEE part will be used.

Applicable EEE part type (from F.1.1 above).

Part number that will appear in the using assembly's parts list as the unique identification of the EEE part.

Specification or drawing in which the detail characteristics of the EEE part are identified.

A common, or manufacturer's, number identifying the basic function of the EEE part.

End Item	Part Type	EEE P/N	EEE Spec	Generic P/N	Manufacturer	Quantity

Identification of manufacturer(s) of the EEE part (QML, QPL, QPD, or CAGE code preferred).

Estimated quantity, if available, that will be used per end item.

Note: An indication that an item is a change from the previous submission shall be provided.

F.4.6.2.1 MSFC In-house As-Designed EEE Parts Lists

If an As-Designed EEE Parts Lists for MSFC in-house design is available, the list should be prepared in accordance with F.4.6.2 above by the design activity and submitted to project management for approval.

F.4.6.3 EEE Parts Application (Derating) Analysis

It is recommended that EEE parts be derated. When performed, the derating analysis should meet the requirements of MSFC-STD-3012 paragraph 5.6.4.

F.4.6.4 As-Built EEE Parts List

If an As-Built EEE Parts Lists is available, the list should be submitted in accordance with MSFC-STD-3012 section 5.6.5. A typical format follows.

Identifying part number for the end item using the EEE part.

Serial number of the end item using the EEE part.

Identifying part number of the assembly which calls out the installation of the EEE part.

Serial number of the using assembly.

Applicable EEE part type (from F.1.1 above).

End Item	E.I. S/N	Using Assy	Assy S/N	EEE Type	EEE P/N	Ref Des	Mfg

Part number that appears in the using assembly's parts list as the EEE part identification.

Reference designation that indentifies the EEE part's circuit location (i.e. R1, C1, etc.).

Precise identification of the manufacturer of the installed EEE part (CAGE code preferred)

Note: An indication that an item is a change from the previous submission shall be provided.

F.4.6.4.1 MSFC In-house As-Built EEE Parts Lists

If an As-Built EEE Parts Lists for MSFC in-house manufacturing is available, the list should be prepared in accordance with F.4.6.4 above by the manufacturing activity and submitted to project management.

F.4.7 Obsolescence Management, Counterfeit Avoidance, and Parts Availability Requirements

If feasible, obsolescence management, counterfeit avoidance, and parts availability requirements should be in accordance with MSFC-STD-3012 section 5.7.

F.4.8 Manufacturing and Handling Requirements

F.4.8.1 Electrostatic Discharge (ESD) Control

ESD control shall be in accordance with MSFC-STD-3012 paragraph 5.8.1.

F.4.8.2 Environmental Control

Environmental control shall be in accordance with MSFC-STD-3012 paragraph 5.8.2.

F.4.8.3 Part Age and Storage Restriction

EEE parts older than 5 years from date of manufacture that are selected for flight hardware should be reviewed to determine the need for re-screening. Parts stored in conditions where moisture or ESD are not controlled shall not be used.

F.4.8.4 Allowance for Testing Fallout

An allowance should be made for test fallout quantities in accordance with MSFC-STD-3012 paragraph 5.8.4.

F.4.8.5 Manufacturing Process Compatibility

Parts shall be compatible with manufacturing processes in accordance with MSFC-STD-3012 section 5.8.5.

F.4.8.6 Suspect Parts

Parts affected by MSFC ALERTS, and GIDEP issuances shall not be used in manufacturing without project approval and focal point EEE parts organization concurrence.

F.4.8.7 Reuse of EEE Parts

Reuse of EEE parts shall meet the requirements of MSFC-STD-3012 paragraph 5.8.7.

F.4.9 Heritage Hardware and Off-the-Shelf (OTS) Hardware Requirements

Heritage and OTS hardware can be used in Grade 4 applications.

F.4.10 Ground Support Equipment (GSE) to Flight Hardware Electrical Interfaces

GSE to flight hardware electrical interfaces shall meet the requirements of MSFC-STD-3012 section 5.10.

F.5.0 VERIFICATION OF PARTS REQUIREMENTS

Verification of Grade 4 parts requirements is not necessary.