NASA Standards Update:

Electrical, Electronic, Electromechanical, and Electro-optical (EEEE or Quad-E) Parts Selection, Testing and Derating Standard (NASA-STD-8739.11)

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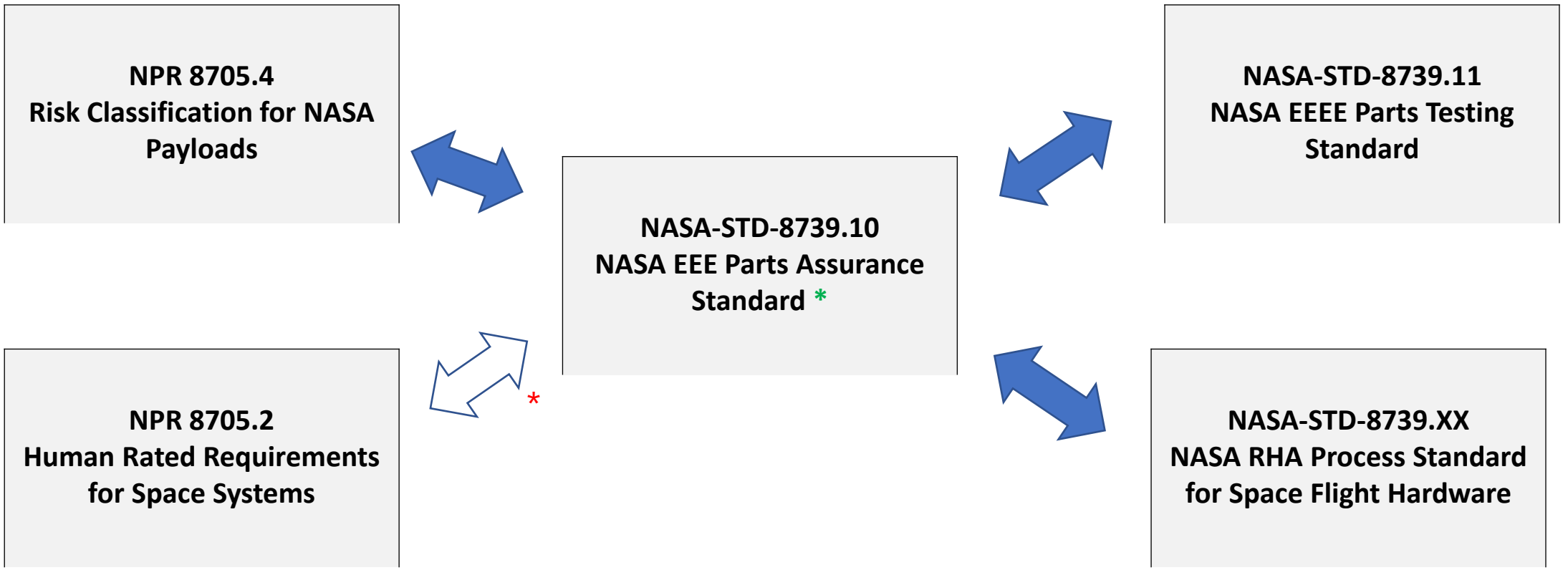
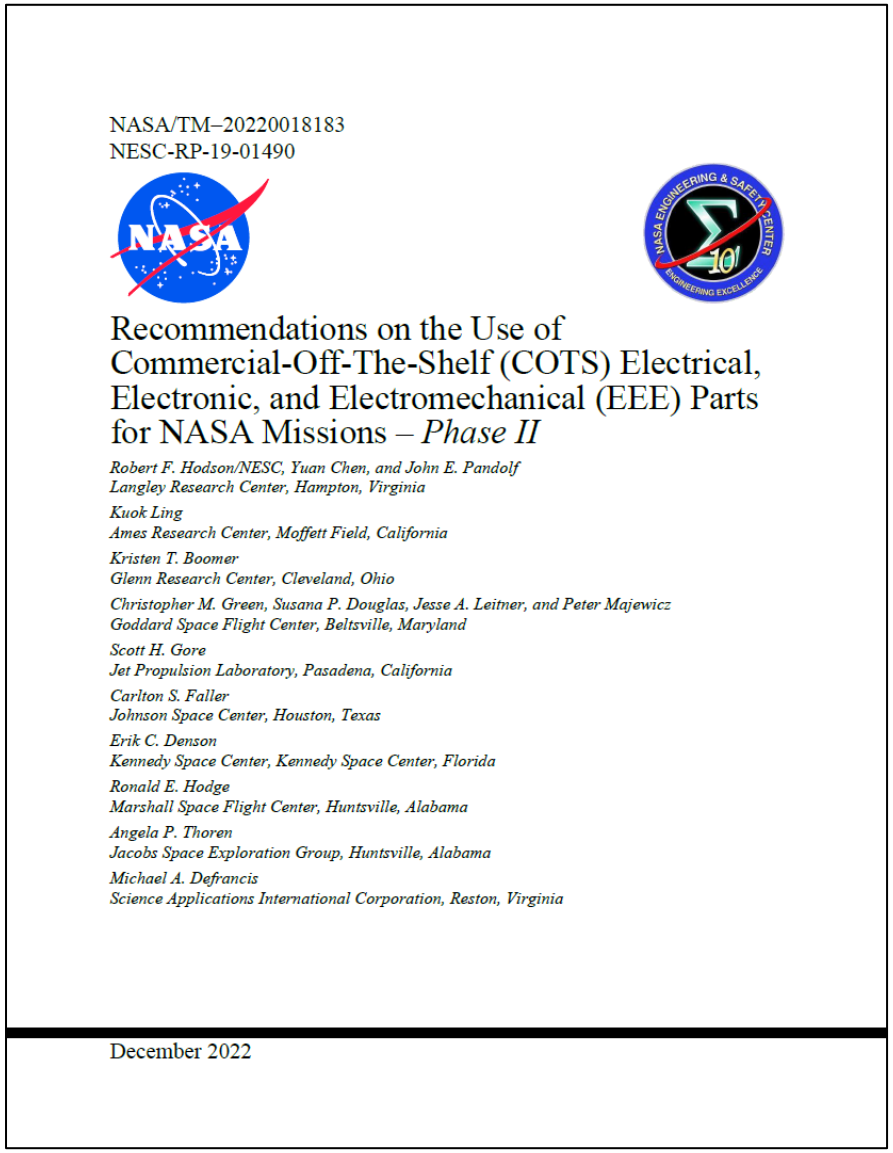
Policy / Guidance



** Not a direct reference*

** Revision planned for FY25*

NASA Engineering and Safety Center Recommendations on the Use of COTS EEE Parts for NASA Missions



NASA/TM–20220018183
NESC-RP-19-01490

Recommendations on the Use of Commercial-Off-The-Shelf (COTS) Electrical, Electronic, and Electromechanical (EEE) Parts for NASA Missions – *Phase II*

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December 2022

EEE Parts Assessment Flow Using the ILPM Process

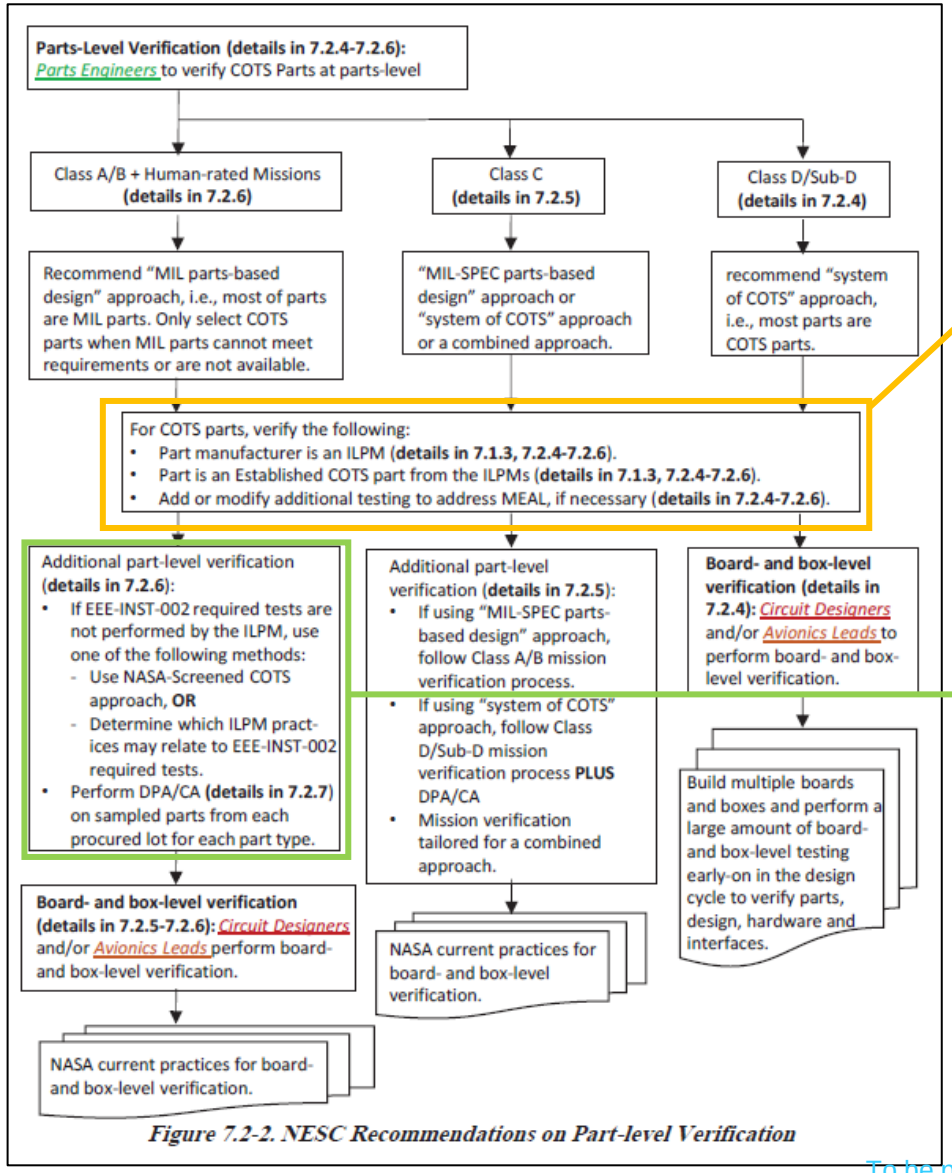

Figure 7.2-2. NESC Recommendations on Part-level Verification

NEPP ILPM Pathfinder activities are targeted here.

For COTS parts, verify the following:
- Part manufacturer is an ILPM (**details in 7.1.3, 7.2.4-7.2.6**).
- Part is an Established COTS part from the ILPMs (**details in 7.1.3, 7.2.4-7.2.6**).
- Add or modify additional testing to address MEAL, if necessary (**details in 7.2.4-7.2.6**).

Additional part-level verification (**details in 7.2.6**):
- If EEE-INST-002 required tests are not performed by the ILPM, use one of the following methods:
  - Use NASA-Screened COTS approach, **OR**
  - Determine which ILPM practices may relate to EEE-INST-002 required tests.
- Perform DPA/CA (**details in 7.2.7**) on sampled parts from each procured lot for each part type.

Implementation of ILPM Established COTS part usage in a mission is project-driven for now. Executing at an agency-level is best.

Electrical, Electronic, Electromechanical, and Electro-optical (EEEE or Quad-E) Parts Selection, Testing and Derating Standard

- Purpose:
  - Establishes a consistent set of requirements for selection, screening, lot acceptance testing, and derating of quad-E parts for use on NASA spaceflight projects.
  - Provides a mechanism to ensure that appropriate parts are used that will support mission reliability objectives within budget constraints.
- Does not attempt to adequately cover radiation effects of EEEE parts.

History

- Based on the EEE-INST-002, *Instructions for EEE Parts Selection, Screening, Qualification, and Derating*
  - GSFC document (used by other Centers)
  - 3 Quality Levels
  - 18 Device Specific Sections
  - Technology specific electrical testing (outdated)
  - Last update 2003
- Science Mission Directorate Policy: SMD Standard Mission Assurance Requirements For Payload Classification D
  - SMD encourages and empowers small mission project teams to take higher programmatic and technical risks when the potential for high scientific return at low cost has a fair likelihood of being achieved...
  - The Developer shall document and implement a Parts Control Plan.

  Per NASA-STD-8739.10, Level 4 or Commercial-Off-The-Shelf (COTS) parts may be used without additional screening.

NASA-STD-8739.11

- NASA Standard – Applicable to NASA Headquarters, Centers, JPL, contractors,... IAW contracts...
- 4 Assurance Levels
- 24 Device Specific Sections
- Includes MIL-Spec Plastic Encapsulated Classes
- Does not include technology specific electrical testing
- Lot Acceptance Testing vice Qualification
- No Screening Tests for AL 4
- No LAT Testing for AL 3 & 4

Sections (new in red)

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Review Comments: 849 Total

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Notes from comments adjudication

- Evident of meticulous review
- Not adding tests to raise “Class B” to “Class B+”
  - X-ray, PIND, NDBP
- Not limiting method of hermetic testing.
- Removed glass type capacitors
- Includes reference to ILPMs
- Wire and Cable Section in rewrite.
- Adding an option row for AEC-Q qualified devices for different data elements from manufacturer

Section M5 PEMs Table 1

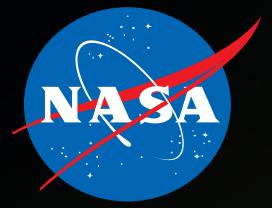
Table 1. PLASTIC ENCAPSULATED MICROCIRCUIT REQUIREMENTS 1/

Assurance Level	Monolithic Microcircuit Type	Specification	Use as Is	Screening 4/	LAT 4/	DPA 4/
Level 1	QML Class P	MIL-PRF-38535				X
	QML Class N 2/	MIL-PRF-38535		X	X	X
	Automotive, Commercial, SCD 3/	AEC-Q100, VICD, SCD		X	X	X
Level 2	QML Class P or N	MIL-PRF-38535				X
	Automotive, Commercial, SCD 3/	AEC-Q100, VICD, SCD		X	X	X
Level 3	QML Class P or N	MIL-PRF-38535				X
	Automotive, Commercial, SCD 3/	AEC-Q100, VICD, SCD		X		X
Level 4	QML Class P or N	MIL-PRF-38535	X			
	Automotive, Commercial, SCD 3/	AEC-Q100, VICD, SCD	X			

Section M5 PEMs Table 2

Table 2. PLASTIC ENCAPSULATED MICROCIRCUIT SCREENING 1/ 4/

	Test	Test Methods, Conditions, and Requirements	Level 1	Level 2	Level 3
1	Wafer Lot Acceptance	MIL-STD-883, Methods 5010 Appendix II and 5007	X		
2	Internal Visual	MIL-STD-883, Method 2010	X Cond. A		
3	Temperature Cycling	MIL-STD-883, 1010, Condition B, 10 Cycles min.	X	X	
4	External Visual	MIL-STD-883, 2009 (3 to 10X)	X	R	
5	PIND 2/	MIL-STD-883, 1010, Condition A	X	X	
6	Serialization		X	X	
7	Radiographic	PEM-INST-001 Para 5.3.2	X		
8	Burn-in 3/	MIL-STD-883, 1015, Condition D.	X 240 hr. @ 125 °C	X 160 hr. @ 125 °C	R 96 hr. @ 125 °C
9	Final Electrical Measurements at +25 °C, Min. and Max. Operating Temp.	Per applicable device procurement specification	X	X	X
10	Maximum Percent Defective Allowable (PDA)	Post Burn-in / Final Electrical Measurements @ 25 °C only	≤ 5%	≤ 10%	
11	External Visual	MIL-STD-883, 2009 (3 to 10X)	X	X	R



Questions?

4 Parts Assurance Levels

Assurance Level 1: The most stringent set of testing requirements; **typically aligns with the highest classes of MIL-SPEC space-grade parts (i.e., Class S)**. Requirements include screening, lot acceptance testing, DPA, and use of source control drawings for custom test flows.

Assurance Level 2: A substantial set of testing requirements; **typically aligns with the second-highest classes of MIL-SPEC parts (i.e., Class B)**. Requirements include screening, lot acceptance testing, and DPA, but with some tests, sample sizes, and durations reduced from Assurance Level 1. Use of source control drawings is encouraged, but not always required.

Assurance Level 3: Allows MIL-SPEC based designs and an infusion of commercial part-based designs with minimally burdensome piece-part testing requirements. **Generally, includes some screening, but does not impose lot acceptance testing.** Criteria rely heavily on DPA as an inexpensive test to obtain objective insight into manufacturer workmanship and quality.

Assurance Level 4: Use of commercial parts with **no additional screening** or qualification. In applications that have low tolerance for risk, it is essential to have detailed information about the manufacturer and part prior histories.

Example from EEE-INST-002

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

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

Notes follow on next page.

New Tables from 8739.11

Table 1. MONOLITHIC MICROCIRCUIT REQUIREMENTS 1/ 2/

Assurance Level	Monolithic Microcircuit Type	Specification	Use As Is	Screening	LAT	DPA
Level 1	QML Classes V, Y, S	MIL-PRF-38535	X			
	QML Classes; Q, B, 3/	MIL-PRF-38535		X 4/	X	
	All Types	SCD		X	X	X
Level 2	QML Classes V, Y, S	MIL-PRF-38535	X			
	QML Classes; Q, B, M	MIL-PRF-38535		X 4/		
	All Types	Automotive, Commercial, SCD		X	X	X
Level 3	QML Classes: V, Y, S	MIL-PRF-38535	X			
	QML Classes; Q, B, M	MIL-PRF-38535		R 4/		
	All Types	Automotive, Commercial, SCD		X		X
Level 4	QML Classes: V, Y, S, Q, B, M	MIL-PRF-38535	X			
	All Types	Automotive, Commercial, SCD	X			

New Tables from 8739.11

Table 1. PLASTIC ENCAPSULATED MICROCIRCUIT REQUIREMENTS 1/

Assurance Level	Monolithic Microcircuit Type	Specification	Use as Is	Screening 3/	LAT 3/	DPA 3/
Level 1	QML Class P	MIL-PRF-38535				X
	SCD 2/	SCD		X	X	X
Level 2	QML Class P or N	MIL-PRF-38535				X
	Automotive, Commercial, SCD 2/	AEC-Q100, VICD, SCD		X	X	X
Level 3	QML Class P or N	MIL-PRF-38535				X
	Automotive, Commercial, SCD 2/	AEC-Q100, VICD, SCD		X		X
Level 4	QML Class P or N	MIL-PRF-38535	X			
	Automotive, Commercial, SCD 2/	AEC-Q100, VICD, SCD	X			

New Tables from 8739.11

Table 2. MONOLITHIC MICROCIRCUITS SCREENING 1/

Test	Test Sequence	Test Methods, Conditions, and Requirements	Quality Level		
			Level 1	Level 2	Level 3
1	Wafer Lot Acceptance	MIL-STD-883, Methods 5010 Appendix II and 5007	X		
2	Nondestructive Bond Pull	MIL-STD-883, Method 2023, 2% PDA	X	X	
3	Internal Visual	MIL-STD-883, Method 2010	Condition A	Condition B	
4	Temperature Cycling	MIL-STD-883, Method 1010, Condition C, 10 Cycles min.	X	X	
5	Constant Acceleration	MIL-STD-883, Method 2001, Condition E, Y_1 Orientation Only	X		
7	PIND	MIL-STD-883, Method 2020, Condition A	X	X	R
8	Serialization		X		
9	Radiographic 2/	MIL-STD-883, Method 2012, Two Views	X		
10.	Initial Electrical Measurements	Applicable device specification at +25°C	X	X	
11	Burn-in	MIL-STD-883, Method 1015, Condition C or D.	240 hrs	160 hrs	
12	Final Electrical Measurements	Applicable device specification at +25°C, Minimum, and Maximum Operating Temperatures	X	X	R
13	Calculate Delta	25°C Pre-Post Burn-in	X		
14	Calculate PDA	Pre-Post Burn-in 25°C DC Electrical 25°C Functional	 5% 3%	 10%	
15	Seal (Hermetic Types only) a. Fine Leak b. Gross Leak	MIL-STD-883, Method 1014 Condition CH or B (or A as Alternate) for Fine Leak Condition CH, B3, or C4 for Gross Leak	 X X	 X X	
16	External Visual	MIL-STD-883, Method 2009 (3X to 10X)	X	X	X

Notes:

1/ The character "X" designates a requirement. The character "R" designates a recommendation.

2/ Only one view is required for flat packages and leadless chip carriers having lead terminal metal on four sides.

New Tables from 8739.11

Table 3. MONOLITHIC MICROCIRCUITS LOT ACCEPTANCE TESTING 1/, 2/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept Number)	
		Level 1	Level 2
Group B		3(0)	3(0)
Solderability	MIL-STD-883, Method 2003, Soldering temperature of 245 °C ± 5 °C, 3 samples min.	22 leads(0)	22 leads(0)
Group C		45(0)	22(0) 3/
Steady State Life Test	MIL-STD-883, Method 1005, Condition D, 1,000 hours at +125 °C	X	X
End-Point Electrical Parameters	Per applicable device procurement specification	X	X
Package Element Evaluation			
Subgroup 1		3(0)	3(0)
Physical Dimensions	MIL-STD-883 Method 2016, Acquisition Document	X	X
Subgroup 2			
Visual Inspection	MIL-STD-883, Method 2009	100%	100%
Device Finish	Use a recognized methodology, verify all surface finishes are compliant with specification.	3(0)	3(0)
Subgroup 3		3(0)	3(0)
Thermal Shock	MIL-STD-883, Method 1011	X	X
High Temperature Bake	MIL-STD-883, Method 1008	X	X
Lead Integrity	MIL-STD-883, Method 2004		
	Condition A1 (braze attached leads, 3 lead min.)	X	X
	Condition B1 (Rigid Leads and terminals only)	X	X
	Condition B2 (Lead Fatigue)	X	X
	Condition D (Pad adhesion of leadless chip carriers)	X	X
	Condition E (Plating integrity of flexible and semi-flexible lead, 3 leads min.)	X	X
	MIL-STD-883, Method 2028 for Pin grid array leads	X	X
Seal	MIL-STD-883, Method 1014 Condition A4 Unlidded cases	X	X
Subgroup 4		3(0)	3(0)
Metal Package Isolation	MIL-STD-883 Method 1003, Condition E, 100nA max.	X	X
Subgroup 5			
Solderability	MIL-STD-883, Method 2003, Condition Soldering Temperature +245°C ±5°C	3(0)	3(0)