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AEC to MILSPEC Comparison

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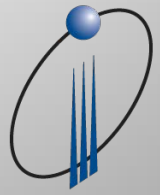

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Agenda

- AEC vs Mil Grade / Space Grade Overview – Allyson Yarborough
- Microcircuits - AEC vs Mil Grade / Space Grade – Larry Harzstark
- Discretes - AEC vs Mil Grade / Space Grade – Sultan Lilani
- Passive - AEC vs Mil Grade / Space Grade – Mike Cozzolino

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AEC vs Mil Grade / Space Grade Overview

Allyson Yarborough

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AEC vs Mil Grade / Space Grade Overview

Item	COTs	AEC	Mil / Space Grade Parts
Application Suitability	Non-critical	Small Sats / Less Than 5 Year Missions / Low Orbit	All Applications / Durations (Depending Upon Level)
Typical Screening (lot by lot)	25C Electrical	3 Temp Electrical	Temp Cycle X-Ray 3 Temp Electrical Burn-In Lead / PIND (Hermetic Package)
Qual	One Time / Major Changes	One Time / Major Changes	Every Lot
Reliability Stress Testing	Non-sequential; Each Individual Failure Mode Assessed Separately	Non-sequential; Each Individual Failure Mode Assessed Separately	Periodic Reliability Monitor Tests on Product and Technology
Radiation Tolerance	No	No	Yes for Space
DPA Required	No	No	Yes for Space

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AEC vs Mil Grade / Space Grade Overview

Item	COTs	AEC	Mil / Space Grade Parts
Typical Package Type	Plastic / Non-Hermetic	Plastic / Non-Hermetic	Hermetic Plastic / Non-Hermetic (Limited)
Manufacturing Location Control	No	Yes	Yes (Lot by Lot and by Wafer for Radiation)
Lot Date Code Control	No	No	Yes - Homogeneous
PCN Control	No	Yes	Yes
SPC	Depends on Manufacturer	Extensive - PPAP Controlled	Extensive
Tin Whisker Mitigation	Lead Finish: Pure Tin	Lead Finish: Pure Tin	Lead Finish: Tin/Lead and Gold
Availability	Wide	Wide	Limited - Older Technologies Fade Out After Time. New Technology Devices Behind COTs/AEC
Lead Time	Off The Shelf	Some Times Off The Shelf	Typically Long Lead Times Compared to COTs/AEC
EOL	Longer	Longer	Longest
Cost	Inexpensive	Not so Expensive	Expensive

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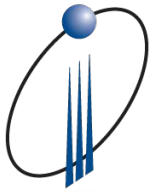
AEC vs Mil Grade / Space Grade – Some Comments

Sultan Lilani



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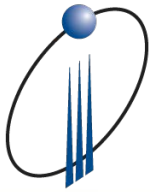
❑ Automotive Grade Part is Getting The Most Attention

- Most commonly heard terms:
  - AEC-Q100 qualified
  - AEC-Q100 certified
  - AEC-Q100 compliant
  - Automotive like

- AEC Qualified
  - One time qualification; no on-going Reliability monitoring tests
  - No special screening except extended temperature testing
    - Most of them have no burn-in
  - SPC controlled line
  - Re-qualification only in case of process / material change
  - No whisker mitigation (pure tin)
  - Third party ISO certification
    - PPAP data package review – Content quality varies by manufacturer

- AEC-Q100 compliant / Automotive like
  - Fuzzy definition
  - Likely to use same manufacturing line as AEC Qualified
  - Like to use same AEC-Q100 initial qual requirements but test methods may be substituted, changed or sample size is reduced



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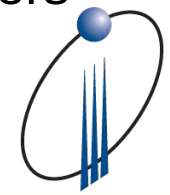
How Do We Mitigate Gate Risks Associated with Mid Grade EEE Parts

A Step Approach To Use Mid Grade EEE Parts

1. Assess and Quantify The Risks The Project Can Tolerate

2. Devise Risk Mitigation Around Commonly Used Risk Mitigation Techniques by Users
   - Understand the device design and manufacturing technology
   - Use reputable manufacturers
   - Use manufacturer's available data for level Quality / Reliability assessment
   - Use statistical approach to assessing product reliability
   - More failure analysis for all failures across supply chain
   - Three temperature testing

3. Seeing is Believing
   - Audits
   - Have technical assessment with manufacturers



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Step 1: Assess and Quantify The Risks

- Understand
  - Project application
  - Mission duration
  - Project design for risk aversion / redundancies
- Quantity Mission FIT and PPM requirements
- Look at BOMs And What Kinds of Parts Can Be Used
  - Define minimum level grade parts to be used to meet Quality / Reliability of the mission
  - Define minimum product screening flow required for the parts
  - Check to see what types of parts are readily available and see if these parts can be economically used in application
  - Define minimum product screening flow required for the parts

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- More Construction Analysis (CA) instead of Mil Std 1580 DPAs
- Analyze all failures across supply chain. This will tell us more about OCM process controls and part reliability than any other validation testing. Use OCM for failure analysis whenever practical and possible
- Use manufacturer available data Quality and Reliability data. This will
  - Provide process maturity information
  - Tell you what kind of process controls manufacturer has
  - Tell you the screening flow manufacturer uses
  - Tell you how detail assessment manufacturer does to validate Quality and Reliability of the product
  - Tell you the screening flow manufacturer uses

- Three temperature testing

- Looks for delta change before and after burn-in and life test
  - Cost and lead times may not allow long term reliability assessment. Sample size may be small. Consider:
    - Delta change pre and post burn-in
    - Delta change pre and post life test

Delta changes are typically a good indicator of parametric value shift or potential reliability issue

- See
  - On-site visit; even for a short time, will tell you a lot about the manufacturer; specially with small OCMs
  - Take a walk into the manufacturing line and see equipment and process real time

- Engage in technical dialogue with manufacturer. This will:
  - Help understand the product Quality / Reliability / Performance
  - Help in mitigating issues when failures or questions come up
  - Understand the true parts capabilities

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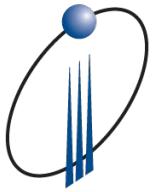
Thank You!



This is the instructions for filling out the matrix.

But first, some definitions:

1. Mission Duration: 6 months to 5 years max
2. Small Sat mass: 180kg (wet weight)
3. Orbit Altitude: 1200 miles (LEO) or below
4. Mission Type: All (communications, navigation, atmosphere, astronomy, remote sensing, reconaissance)
5. Other drivers to consider: schedule, obsolescence, availability

The Assessment column would contain one of four colors

Blue = AEC requirement fully meets or exceeds that of the MIL-PRF
Green = Meets Intent (for example, test might be different, but tests for same failure mechanism)
Yellow = Partially Meets Intent
Red = Fails to Meet Intent
Gray = Not applicable for short term mission payloads

MIL-PRF-38535 vs. AEC-Q100
Integrated Circuits (Microcircuits)
Sultan Lilani (Integra Technologies)

Table 1A Screening procedure for hermetic classes Q, V, and non-hermetic class Y microcircuits

Inspections	MIL-STD-883		AEC-Q100	TM	TM Description/Additional Requirements	Sample Lot	Sample Size	Assessment	Rationale
	Method (Class V)	Condition	Test #						
Wafer acceptance lot test	QM plan or TM 5007	Wafer thickness, metallization thickness, thermal stability, SEM, glassivation thickness, gold backing thickness							No formal WLAT done by AEC
Non-destructive bond pull test	TM 2023	Reveal non-acceptable wire bonds, but avoid damaging acceptable ones.							Destructive bond pull done during qual
Internal Visual Inspection	TM 2010, Cond A								2nd op and other visuals meet most items but not all and not lot by lot
Temp Cycling	TM 1010, Cond C	-65 to 150°C, 10 cycles min	A4	JESD22-A104 and Appendix 3	Grade 0: -55 to 150°C, 2000x; test before and after TC at hot T	3	77		not done lot by lot; during qual or group testing
Constant Acceleration	TM 2001, Cond E	minimum 1 min each in X1, X2, Y1, Y2, Z1, and Z2 orientations; 30000 Gs	G3	MIL-STD-883, TM200	Y1 only, 30000 Gs for <40 pin packages, 20000 Gs for >40 pins	1	15		Y1 plane only
Visual Inspection	100%								not done lot by lot; during qual or group testing
PIND	TM 2020, Cond A	3 pre-test shocks and vibration 3±1 s – repeat 4 times							Not performed
Serialization	Device Specification								Not performed
Pre Burn In (interim) electrical parameters test	Device Specification		E1	Supplier data sheet or user specs		All	All		
Burn In test	TM 1015, Cond D	Parallel excitation; 240 hrs at 125°C	B2?	AEC-Q100-008	Early Life Failure Rate	3	800		only initial 3 lots and during qual/group testing; not on a lot by lot basis
Post Burn In (Interim) electrical parameters test	Device Specification		A6	JESD22-A103	High Temperature Storage Life: Store at 175 for 1000hrs or 150C for 2000 hrs for Grade 0	1	45		
Reverse Bias Burn In Test (Static Burn In)	TM 1015, Condition A or C	Staedy-state, reverse bias or power and reverse bias; 144 hours at +125°C, 72 hours at +150°C minimum	A5	JESD22-A105	PTC: -40C to +150C for 1000 cycles for Grade 0	1	45		only initial 3 lots and during qual/group testing; not on a lot by lot basis
Post Burn In (Interim reverse bias) electrical parameters test	Device Specification		A6	JESD22-A103	High Temperature Storage Life: Store at 175 for 1000hrs or 150C for 2000 hrs for Grade 0	1	45		
Percent defective allowable	5% PDA, 3% DPA for functional parameters at 25°C (all lots)								PDA exists for lots during qual or group testing
Final Electrical Tests	Device Specification								
Static test : (1) at 25°C (2) Maximum and Minimum operating temperature			Which tests correspond to these final electrical tests?						
Dynamic or functional test : (1) at 25°C (2) Maximum and Minimum operating temperature									
Switching test : (1) at 25°C (2) Maximum and Minimum operated temperature									
Seal test: Fine leak and Gross Leak	TM 1014		G4	MIL-STD-883, TM 1014	Fine leak test followed by gross test. For ceramic packges, cavity devices only.				not done lot by lot; during qual or group testing
Radiograph or C-SAM	TM 2012 or TM 2030	Non-destructive evaluation of devices							not done lot by lot; during qual or group testing
External Visual Inspection	TM 2009	Verify workmanship; use 1.5X to 10X magnification							I don't see this in AEC
Qualification or QCI/TCI									Various group testing required periodically
Radiation dose rate induced latch up Test	Burn		E4	AEC-Q100-004	Latch Up				
			D1		Electromigration				performed by AEC and mil prf 38535 during qual or characterization
			D2		Time Dependent Dielectric Breakdown				performed by AEC and mil prf 38535 during qual or characterization
			D3		Hot Carrier Injection				performed by AEC and mil prf 38535 during qual or characterization
			D4		Negative Bias Temperature Instability				performed by AEC and mil prf 38535 during qual or characterization
			D5		Stress Migration				performed by AEC but not by mil prf 38535 during qual or characterization
			A1	JEDEC J-STD-020 JESD22-A113	Preconditioning				performed by AEC and mil prf 38535 during qual or characterization

Table 1B. Tests/monitors for plastic packages

Inspections	MIL-STD-883		AEC-Q100 Test #	TM	TM Description/Additional Requirements	Assessment	Rationale
	Method	Condition					
Wafer Acceptance	TRB/ QM plan	Wafer thickness, metallization thickness, thermal stability, SEM, glassivation thickness, gold backing thickness					
Internal Visual	TM 2010						
Temp Cycling/Thermal Shock	TM 1010/ TM 1011	-65 to 150°C, 10 cycles min	A4	JESD22-A104	Temperature Cycle		
Resistance to Solvents	TM 2015						
Bond Strength	TM 2011	Destructive bond pull test	C2	MIL-STD-883 - 2011	Wire Bond pull strength		
Ball Shear	ASTM F1269		C1	AEC Q100-001	Wire Bond shear		
Solderability	TM 2003	Evaluate solderability of terminations for tin-lead eutectic.	C3	JESD22-B102 or J-STD-002D	Solderability		
Die Shear or Stud Pull	TM 2019 or TM 2027		G7	MIL-STD-883 - 2019	Die Shear Strength		
Steady State life test (End point electricals)	TM 1005	Demonstrate quality or reliability of devices over extended time period. 1000 h minimum at 125°C.					
Physical Dimensions	TM 2016		C4	JESD22-B100/B108	Physical Dimension		
Lead Integrity	TM 2004	Determine integrity of leads, welds and seals. See TM for more details on various tests.	C6	JESD22-B105			Lead integrity
Inspection for delamination	TM 1034, cross section, C-SAM (TM 2030)	Dye penetrant test (1034).					
Highly accelerated stress testing (HAST)	JESD22-A118 (100 hrs, +130C, 85% RH)		A2	JEDEC JESD22-A101 or A110	Biased HAST		
Autoclave	JESD22-A102 (no bias) 2 atm, +121C		A3	JEDEC JESD22-A102, A118, or A101	Unbiased HAST or Autoclave		
Salt Atmosphere	TM 1009	Accelerated laboratory corrosion test					
Adhesion to lead finish	TM 2025	Bend stress applied to randomly selected leads from each device					
Interim pre burn in electricals	Device Specifications						
Burn In test	TM 1015	125°C, 160 h	B1	JESD22-A108	High temp operating life		
Interim post burn in electricals	Device Specifications						
PDA	1% PDA						
Switching Test	Device Specifications						
External Visual Inspection Test	TM 2009 or JESD22-B101						

AE-Q100 Notes:
Additonal testing include unbiased HAST, ESD, power temp cycle, high temp operating life, statisical binning, characterization, lead free, etc..
Goal of qual is zero defect. Qual is three lots for several of the stress tests, Generic data for family is encouraged to reduce qual test unless there is a failure, no time limit for generic data to be accepted.
Supplier required to provide stress data and certificate of design and construction.
AE-Q100 calls out different grades of parts (0 through 3) based on temp range. Test temp at hot and cold should be equivalent to grade. Junction temp during stress should be equal to or higher than upper limit above.
Table 1: Part Operating Temperature Grades which is different from Space level -55 to 125C
Grade Ambient Operating Temperature Range
0 -40°C to +150°C
1 -40°C to +125°C
2 -40°C to +105°C
3 -40°C to +85°C

Table II. Group B tests (Mechanical and environmental test)

Inspections	MIL-STD-883		MIL-STD-883		MIL-STD-883		AEC-Q100 Test #	TM	TM Description/Additional Requirements	Assessment			Rationale
	Method (Class V and Y)	Condition	Method (Class B)	Condition	Method (Class S)	Condition				vs. Class V and Y	vs. Class B	vs. Class S	
Subgroup 1	Resistance to Solvents	TM 3015			Physical Dimensions	TM 2016						Phy Dim: Yes	
					Internal Water Vapor	TM 1018							
Subgroup 2	Bond Strength	TM 2011	Resistance to Solvents	TM 3015	Resistance to Solvents	TM 3015	C2	Wire Bond Pull	TM 2011, AEC-Q003				Not as critical test; can use manufacturer's data or can skip test
	Die Shear Test or Substrate Attach Strength or Stud Pull Test	TM 2019 or TM 2027			Internal Visual and Mechanical	TM 2013, TM 2014							Since AEC does not require DPA; this test should be done or mil std 1580 DPA should be done
	Flip Chip Pull Off Test	TM 2031 or TM 2011			Bond Strength	TM 2011							
	Flip Chip Die Shear Strength Test or Substrate Attach Strength Test	TM 2019 or TM 2027			Die Shear Test or Substrate Attach Strength or Stud Pull Test	TM 2019 or TM 2027							
					Flip Chip Pull Off Test	TM 2031 or TM 2011							This test should be done
					Flip Chip Die Shear Strength Test or Substrate Attach Strength Test	TM 2019 or TM 2027							This test should be done
Subgroup 3	Solderability 245C ±5C	TM 2003	Solderability 245C ±5C	TM 2003	Solderability 245C ±5C	TM 2003	C3	Solderability	JESD22-B102, J-STD-002D				
Subgroup 3	Solderability 245C ±5C	TM 2003	Solderability 245C ±5C	TM 2003	Solderability 245C ±5C	TM 2003	C3	Solderability	JESD22-B102, J-STD-002D				
Subgroup 4	Ball Shear Test for BGA or Solder Column Pull Test for CGA (Note: Meets Ball shear bit does not meet solder column)	JESD22-B117 or TM 2038			Lead Integrity	TM 2004	C5	Solder Ball Shear	AEC Q100-010, AEC-Q003				Need to add solder column pull test for CGA parts
	Meets Ball shear bit does not meet solder column)	JESD22-B117 or TM 2038			Lead Integrity	TM 2004	C5	Solder Ball Shear	AEC Q100-010, AEC-Q003				
					Seal Test	TM 1014	C6	Lead Integrity	JESD22-B102				
					Fill Torque	TM 2024							
					Lid Torque	TM 2024							
					Ball Shear Test for BGA or Solder Column Pull Test for CGA (Note: Meets Ball shear bit does not meet solder column)	JESD22-B117 or TM 2038							Need to add solder column pull test for CGA parts
					Ball Shear Test for BGA or Solder Column Pull Test for CGA (Note: Meets Ball shear bit does not meet solder column)	JESD22-B117 or TM 2038							
			Bond Strength	TM 2011	End Point Electrical Parameters	As specified							
Subgroup 5			Die Shear Test or Substrate Attach Strength or Stud Pull Test	TM 2019 or TM 2027	Steady State Life Test	TM 1005							
Subgroup 5			Flip Chip Pull Off Test	TM 2031 or TM 2011	End Point Electrical Parameters	As specified							
			Flip Chip Die Shear Strength or Substrate Attach Strength Test	TM 2019 or TM 2027	Steady State Life Test	TM 1005							
					End Point Electrical Parameters	As specified							
					Temperature Cycling, test condition C, 100 cycles min	TM 1010							
Subgroup 6					Constant Acceleration	TM 2001							
Subgroup 6					Seal Test - Fine and Gross	TM 1014							
					End Point Electrical Parameters	As specified							
							C4	Physical Dimensions	JESD22-B100 and B108, AEC-Q003				
							C4	Physical Dimensions	JESD22-B100 and B108, AEC-Q003				

Table III. Group A (electrical tests)

Inspections	MIL-STD-883		Minimum sample size quantity			AEC-Q100 Test #	TM	TM Description/Additional Requirements	Sample Size	Acceptance Criteria	Assessment	Rationale
	Method	Condition	Class Q	Class V	Class Y							
Subgroup 1	TM 5005	Static tests at +25C	116 or 100 %/ 0 sample	116 or 100 %/ 0 sampl	116 or 100 %/ 0 sample	E5	Electrical Distributions - Test at room, hot, and cold	AEC-Q100-009 and AECQ-003	30 samples, 3 lots	Where applicable, Cpk >1.67		AEC-Q100 does not specify exact test conditions. Only lists electrical testing at room, hot, and cold temperatures.
Subgroup 2	TM 5005	Static tests at maximum rated operating temperature										
Subgroup 3	TM 5005	Static tests at minimum rated operating temperature										
Subgroup 4	TM 5005	Dynamic tests at +25C	116 or 100 %/ 0 sample	116 or 100 %/ 0 sampl	116 or 100 %/ 0 sample							
Subgroup 5	TM 5005	Dynamic tests at maximum rated operating temperature										
Subgroup 6	TM 5005	Dynamic tests at minimum ratedoperating temperature										
Subgroup 7	TM 5005	Functional tests at +25C	116 or 100 %/ 0 sample	116 or 100 %/ 0 sampl	116 or 100 %/ 0 sample							
Subgroup 8A	TM 5005	Functional tests at maximum rated operating temperature										
Subgroup 8B	TM 5005	Functional tests at minimum rated operating temperature										
Subgroup 9	TM 5005	Switching tests at +25C	116 or 100 %/ 0 sample	116 or 100 %/ 0 sampl	116 or 100 %/ 0 sample							
Subgroup 10	TM 5005	Switching tests at maximum rated operating temperature										
Subgroup 11	TM 5005	Switching tests at minimum rated operating temperature										

One supplier - upfront construction analysis on the lot prior to testing. MIL STD 1580 with materials testing
Looking for variation in performance over Temp so not getting degradation over temp range
Burn In: look at before and after and see if it is changing over time which indicates smtg unstable or latent defect over time.
Performance - if part not performing then not insert into hardware. Not necessary just to check variation/degradation, but over the temp range make sure parameters are within specifications
Type of test is dependent on mission and environment/application and if it is more dependent on static or dynamic parametrers. Test box over temp instead of testing part (b/c of costs).
If mission is -20C to 70C, then don't need to go to 125C . At times, ie ASIC, then probing is done at the die level, but enough data at the die level so package level testing is done at perhaps one temp
Linear part may be more concerned at offset vs Digital part may not be as affected. Dependent on what is important to you
100% testing/screening is not the spirit of AEC-Q100. Question is whether or not SPC data is sufficient for the mission life
Less expensive parts and more readily available, but have to add cost via additional upgraded testing.
Certain parts in PEMs that is not available in military grade. So have to use PEMs.
Electrical testing as part of 100% testing is costly. Environmental is not as big of a hurdle.
If a suppplier is willing to help with the electrical testing, that is the best scenario.

Table IV. Group C Life Tests

Inspections	MIL-STD-883		Minimum sample size quantity	Accept number	AEC-Q100 Test #	TM	TM Description/Addition	Sample Size	Assessment	Rationale
	Method (Class Q)	Condition								
Steady-state life test	MIL-STD-883 TM 1005 J (K not available on DLA site)	1000 h at 125°C;	45 – use actual devices for lots >200 units. 5 devices or 10% of the lot, whichever is greater (for large lot <200 units). Every 3 months, unless major assembly changes	0	B2	JESD22-A108	1000 h at 125°C for Grade 1; +150°C Ta for 1000 h for Grade 0	3 lots, 77 samples		1.) As noted in AEC- Q100, qualification is performed only once and maintained through SPC. An integral part of the Near Term Tech specification will need to identify all required SPC. 2.) SPC will need to be an integral part of the specification. This includes determining the independent variables such as wafer to wafer and onwafer location variablitity as well as assembly variability. These variables should be forced during sampling.
Test Conditions		A. Reverse Bias (All) B. Forward Bias (A/D) C. Power & Reverse (D/Lin) D. Parallel E. Ring oscillator				Q100-008	Early Life Failure Rate SS=800; 3 lots (Can be used for production)			Thermal Derating and Appropriate biasing will need to be determined
					Endurance data retention	Q100-005				Thermal Derating and Appropriate biasing will need to be determined
End-point electrical paramete	As specified in the applicable device procurement specification								data can include sufficient SPC	

*No fails in 231 devices (77 devices from 3 lots) are applied as pass criteria for the major environmental stress tests. This represents an LTPD (Lot Tolerance Percent Defective) = 1, meaning a maximum of 1% failures at 90% confidence level

*This sample size is NOT sufficient or intended for process control or PPM evaluation. Manufacturing variation failures (low ppm issues) are achieved through proper process controls and/or screens such as described in AEC-Q001 and AEC-Q002.

TM=detailed specs for how to bias parts
requirements for process control?

Table V. Group D Tests (Package related tests)

Subgroup Tests	Tests	MIL-STD-883 Method (Class Q)	MIL-STD-883 Condition	MIL-STD-883 Method (Class V)	MIL-STD-883 Condition	MIL-STD-883 Method (Class Y)	MIL-STD-883 Condition	AEC-Q100 Test #	TM	TM Description/Additional Requirements	Assessment vs. Class V and Y	Rationale
Subgroup 1	Physical Dimensions	TM 2016						C4	Physical Dimensions	JESD22-B100 and B108 and AEC-Q003	Meets intent	MIL-STD-883E TM 2016 requires measuring the package IAW case outline drawing. No other requirements on equipment calibration, accuracy or repeatability. AEC Q-100 C4 refers to JEDEC JESD22-B100B, a slightly more detailed drawing.
Subgroup 2	Lead/Terminal Integrity	TM 2004	B2 (lead fatigue) or applicable for the package technology style	TM 2004	B2 (lead fatigue) or applicable for the package technology style	TM 2004	B2 (lead fatigue) or applicable for the package technology style	C6	Lead Integrity	JESD22-B105	TBD	AEC-Q-100 does not require this for SMD parts.
	Seal Test - Fine and Gross	TM 1014	Test condition as appli	TM 1014	Test condition as applicable		Not applicable for class Y non-hermetic mocrocircuits devices	G4	Gross/Fine Leak	TM1014	Meets intent	AEC-Q-100 refers to MIL-STD-883 TM 1014. Leak tests are not applicable to PEMS devices. Moisture resistance might be a more perceptive test.
	Ball Shear for BGA and Solder Column Pull Test for CGA package	BGA package: JESD22-B117 CGA package: TM 2038	BGA: 45 balls from 2 devices min.; CGA: 45 columns from 2 devices min.	BGA package: JESD22-B117 CGA package: TM 2038	BGA: 45 balls from 2 devices min.; CGA: 45 columns from 2 devices min.	BGA package: JESD22-B117 CGA package: TM 2038	BGA: 45 balls from 2 devices min.; CGA: 45 columns from 2 devices min.	C5	Solder Ball Shear	AEC-Q100-010 or AEC-Q003	Meets Intent	AEC-Q-100 specifies a Cpk and Ppk for overall ball shear and solder shear statistics for manufacturing line rather than lot by lot basis so fewer samples per lot is taken but overall line has more data points.
Subgroup 3	Thermal shock, 15 cycles	TM 1011	Test condition B, 15 cy	TM 1011	Test condition B, 15 c	TM 1011	Test condition B, 15 cycles min.				ails to meet inter	
	Temperature cycling, Test Condition C 100 cycles min	TM 1010	Test condition C, 100 cycles min.	TM 1010	Test condition C, 100 cycles min.	TM 1010	Test condition C, 100 cycles min.	A5	Power temperature cycling	AEC-Q-100	Meets intent	These are two different tests and address different failure mechanisms. TM 1010 cycles in an electrically inactive state.
	Moisture resistance	TM 1004	8/	TM 1004	8/	JESD22-A118	Condition B	A2, A3	Temperature/Humididty	AEC-Q-100	Meets or exceed	AEC-Q-100 has more stringent flow including autoclave.
	Visual examination	TM 1004 or TM 1010		TM 1004 or TM 1010		TM 1004 or TM 1010					ails to meet inter	No visual inspection TM in AEC-Q-100.
	Seal Test - Fine and Gross	TM 1014	Test condition as applicable	TM 1014	Test condition as applicable	TM 1014	Test condition as a	G4	Gross/Fine Leak	TM1014	Meets intent	AEC-Q-100 refers to MIL-STD-883 TM 1014. Leak tests are not applicable to PEMS devices. Moisture resistance might be a more perceptive test.
	End Point Electrical Parameters	As Specified		As Specified		As Specified			AEC-Q-100 Test Group E		Meets intent	Test group E includes pre and post stress parameters, electrical characteristics in addition to others such as ESD and latch up.
Subgroup 4	Mechanical shock	TM 2002	Condition B minimum	TM 2002	Condition B minimum	TM 2002	Condition B minim	G1	Mechanical Shock	JESD22-B104	Meets intent	1500g peak with .5ms pulse duration is the TM2002 default test condition. AECQ-100 refers to JESD22-B104, 5 shocks per orientation, total of 30 shocks. acceleration spec range is 100g to 2900g; pulse duration range is 0.3 – 2.0ms. JESD22-B104 does not have the 1500g/.5ms default test condition.
	Vibration, variable frequency	TM 2007	Condition A minimum	TM 2007	Condition A minimum	TM 2007	Condition A minim	G2	Variable Frequency Vibration	JESD22-B103		20 Hz to 2 KHz to 20 Hz (logarithmic variation) in >4 minutes, 4X in each orientation, 50 g peak acceleration. TEST before and after at room temperature.
	Constant acceleration	TM 2001	Test condition E, Y1 or	TM 2001	Test condition E, Y1 c	TM 2001	Test condition E, Y	G3	Constant Acceleration	MIL STD 883, Method 2001		AEC-Q100 uses the same TM as MIL-STD-883, so the difference will be in test conditions.
	Seal Test - Fine and Gross	TM 1014	Test condition as appli	TM 1014	Test condition as applicable		Not applicable for class Y non-hermetic mocrocircuits devices	G4	Gross/Fine Leak	TM1014		AEC-Q-100 refers to MIL-STD-883 TM 1014. Leak tests are not applicable to PEMS devices. Moisture resistance might be a more perceptive test.
	Visual examination	TM 2007		TM 2007		TM 2007						This test does not exist in AEC Q-100.
	End Point Electrical Parameters	As Specified		As Specified		As Specified			AEC-Q-100 Test Group E			Test group E includes pre and post stress parameters, electrical characteristics in addition to others such as ESD and latch up.
Subgroup 5	Salt atmosphere	TM 1009	Test condition A, minimum	TM 1009	Test condition A, minimum	TM 1009	Test condition A, minimum					
	Visual examination	TM 1009		TM 1009		TM 1009						
	Seal Test - Fine and Gross	TM 1014	Test condition as applicable	TM 1014	Test condition as applicable		Not applicable for class Y non-hermetic mocrocircuits devices	G4	Gross/Fine Leak	TM1014		AEC-Q-100 refers to MIL-STD-883 TM 1014. Leak tests are not applicable to PEMS devices. Moisture resistance might be a more perceptive test.
Subgroup 6	Internal water vapor test (cavity packages) - 5000 ppm max at 100C	TM 1018	3 (0) samples, 5000 ppm max water content at 100°C	TM 1018	3 (0) samples, 5000 ppm max water content at 100°C		Not applicable for class Y non-hermetic mocrocircuits devices	G8	Internal Water Vapor	MIL STD 883, Method 1018		MIL-STD-883 TM 1018; AEC-Q-100 uses the same TM, no differences except those of detailed failure definitions.
Subgroup 7	Adhesion of lead finish	TM 2025	Where applicable	TM 2025	Where applicable	TM 2025	Where applicable					No method in AEC-Q-100
Subgroup 8	Lid Torque	TM 2024	Where applicable	TM 2024	Where applicable	TM 2024	Where applicable	G6	Lid Torque	MIL STD 883, Method 2024		MIL-STD-883 TM 2024; AEC-Q-100 uses the same TM, no differences except those of detailed failure definitions.
Subgroup 9	Soldering heat	TM 2036	Where applicable	TM 2036	Where applicable	TM 2036	Where applicable					No method in AEC-Q-100
	Seal Test - Fine and Gross	TM 1014	Where applicable	TM 1014	Where applicable	TM 1014	Where applicable	G4	Gross/Fine Leak	TM1014		AEC-Q-100 refers to MIL-STD-883 TM 1014. Leak tests are not applicable to PEMS devices. Moisture resistance might be a more perceptive test.
	Visual examination	TM 2009		TM 2009		TM 2009						No visual inspection TM in AEC-Q-100.
	End Point Electrical Parameters	As Specified		As Specified		As Specified			AEC-Q-100 Test Group E			Test group E includes pre and post stress parameters, electrical characteristics in addition to others such as ESD and latch up.
Subgroup ?								G5	Package Drop			No package drop test in MIL-STD-883
Subgroup ?	Die shear	TM2019						G7	Die Shear	MIL STD 883, Method 2019		AEC-Q100 uses the same TM as MIL-STD-883, so the difference will be in test conditions.

The Assessment column would contain one of four colors
Blue = AEC requirement fully meets or exceeds that of MIL-PRF-38535
Green = Meets Intent of MIL-PRF-38535 (test may be different, but tests for same failure mechanism)
Yellow = Partially Meets Intent of MIL-PRF-38535.
Red = Fails to Meet Intent of MIL-PRF-38535.
Gray = Not applicable for short term mission payloads.

MIL-PRF-19500 vs. AEC-Q101
Semiconductor Devices
Song Pyun (Raytheon)

Table E-IV. Screening Requirements

Inspection	MIL-STD-750 Method	MIL-STD-750 Condition	JANS	JANTXV	JANTX	TM	TM Description/Additional	Sample Size	Assessment	Rationale
Die visual for glass diodes	2073	Condition B, die form prior to assembly	100%	NA	NA		Not specified			No requirements in AEC-Q101
Internal visual (pre-cap) inspection: For diodes For power FETs For microwave transistors For transistors	 2074 2069 2070 2072		100%	100%	NA		Not specified			No requirements in AEC-Q101
High Temp life (non operating life) (stabilization bake)	1032	Less than or equal to maximum rated storage temperature, t = as specified (340 h min, unless specified)	Optional	Optional	Optional		Not specified			No requirements in AEC-Q101
Temperature Cycling	1051	20 cycles. No dwell time is required at +25°C. Test condition C (-55 to 175°C) or maximum storage temperature, whichever is less.	100%	100%	100%	JESD22-A104	1000 cycles (-55°C to max rated junction T, not to exceed 150°C). Reduce to 400 cycles (25°C over part max rated junction T or 175°C if rated >150°C). No 100% Screening, Initial Qualification only	3 lots 77 samples each		Only performed for qual. Similar temperature ranges
Surge	4066	Condition A (sinusoidal current surge) or B (rectangular current phase), as specified	100%	100%	100%		Not specified			No requirements in AEC-Q101
Thermal Impedance Transistors, Power FETs Bipolar Diodes IGBT GaAs FET	 3161 3131 3101 3103 3104	As specified	100%	100%	100%	JESD24-3 JESD24-4 JESD24-6	No 100% Screening, Initial Qualification only	1 lot 10 samples each for pre- and post-change		Test to assure specification compliance and provide process change comparison data
Constant acceleration. Not required for stud devices and metallugically bonded diodes.	2006	Y1 direction at 20,000 G minimum, except at 10,000 G minimum for devices with power rating of ≥10 watts at TC = +25°C. The 1 minute hold time requirement shall not apply.	100%	Optional	Optional	MIL-STD-750, Method 2006	Y1 plane only, 15K g-force. Test before and after CA. No 100% Screening, Initial Qualification only	1 lot 30 samples		Lower g-force. Only perrformed for qual.
PIND	2052	Condition A (20 g's peak at 40-250 Hz) or B (10 g's peak at 60 Hz minimum), as specified	100%	NA	NA		Not specified			No requirements in AEC-Q101
Instability shock test (axial lead diodes only) FIST BIST	 2081 2082		100%	NA	NA		Not specified			No requirements in AEC-Q101
Hermetic Seal Fine Gross	 1071	Fine leak not required for double plug diodes.	Optional	Optional	Optional	JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		
Serialization			100%	100%	100%		Not specified			No requirements in AEC-Q101
Interim electrical parameters		As specified	100% (read and record)	For case mounted rectifiers as specified	For case mounted rectifiers as specified	User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
High temperature reverse bias (HTRB): For Transistors For power FETs For diodes and rectifiers	 1039 1042 1038	Test condition A (steady-state reverse bias): 80 percent (minimum) of rated VCB (bipolar), VGS(FET), or VDS(FET), as applicable. Test condition B: 80 percent (minimum) of rated VGS Test condition A: Diodes (not required for LEDs, Zeners, and case mounted rectifiers) 80% minimum of rated VR or VRWM when DC conditions are specified. 95 - 100% of VRWM, when half sine condition is specified.	100%	100%	100%	MIL-STD-750, Method 1038	1000 h at max DC Reverse Voltage rated junction T. No 100% Screening, Initial Qualification only	3 lots 77 samples each		Method 1038 is only for diodes, rectifiers, and zeners. Testing methods for transistors and power FETs not specified in AEC.
Interim electrical and delta parameter for PDA		As specified but including all delta parameters as a minimum. When HTRB is performed leakage current shall be measured on each device before any other specified parametric test is made.	100-percent (Measure all specified parameters. Measure leakage current within 16 hours after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 13 of table EIV.)	100-percent (Measure all specified parameters. Measure leakage current within 24 hours after removal of applied voltage in HTRB. Record those Parameters which have a delta limit.) (See screen 13 of table EIV.)	100-percent (Measure all specified parameters. Measure leakage current within 24 hours after removal of applied voltage in HTRB. Record those Parameters which have a delta limit.) (See screen 13 of table E-IV.)	User specification or supplier's standard specification	As needed for pre- and post-stress electrical test (no PDA)	All qualification parts submitted for testing		
Burn in for: Bipolar Transistors Power FETs Diodes, Zeners, and rectifiers Case mount rectifiers Thyristors Bipolar small die transistors Bipolar power transistors	 1039 1042 1038 1040 1039 1039	 Test condition B Test condition A Test condition B Condition A (HTRB), JANTX and JANTXV only Condition B, for JANS Condition B Condition B	 100-percent 240 hours (minimum) 240 hours (minimum) 240 hours (minimum) Not applicable 240 hours (minimum) 240 hours (minimum) 240 hours (minimum) 240 hours (minimum)	 100-percent 160 hours (minimum) 160 hours (minimum) 96 hours (minimum) 48 hours (minimum) Not applicable 96 hours (minimum) 160 hours (minimum) 160 hours (minimum)	 100-percent 160 hours (minimum) 160 hours (minimum) 96 hours (minimum) 48 hours (minimum) Not applicable 96 hours (minimum) 160 hours (minimum) 160 hours (minimum)	MIL-STD-750, Method 1038 Method 1040	1000 h at max DC Reverse Voltage rated junction T. 1000 h at max AC blocking voltage and junction T. No 100% Screening, Initial Qualification only	3 lots - 77 samples each		
Final electrical test Interim electrical and delta parameters for PDA Other electrical parameters	 As specified		100-percent Group A, subgroup 2, interim electrical and delta parameters. (read and record) Group A, subgroup 3	100-percent Group A, subgroup 2. Read and record interim electrical and delta parameters Not applicable	100-percent Group A, subgroup 2. Read and record interim electrical and delta parameters (see Not applicable	User specification or supplier's standard specification	As needed for pre- and post-stress electrical test (no PDA)	All qualification parts submitted for testing		
Hermetic Seal Fine Gross	 1071	Omit for double plug diodes	100%	100%	100%	JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		
Radiography	2076	Detect defects within sealed cases	100%	Not Applicable	Not Applicable		Not specified			No requirements in AEC-Q101
External visual examination	2071	To be performed after complete marking and prior to lot acceptance.	100%	Not Applicable	Not Applicable	JESD22-B101	No 100% Screening, Initial Qualification only	All qualification parts submitted for testing		
Case Isolation	1081	To be performed on all case isolated packages, as specified.	100%	100%	100%		Not specified			No requirements in AEC-Q101

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Semiconductor Devices
Song Pyun (Raytheon)

Table E-VIA Group B Inspections for JANS devices

Inspections	MIL-STD-750		Qualification and Large Lot Conformance	Small Lot Conformance Inspection	TM	TM Description/Additional Requirements	Sample Size	Assessment	Rationale
	Method	Condition							
Subgroup 1									
Physical dimensions	2066	Dimensions in accordance with case outline specified in specification sheets.	22 devices, c = 0	8 devices, c = 0	JESD22 B-100	Part of Initial Qualification	1 lot, 30 samples		
Subgroup 2	Separate samples may be used for each test.								
Solderability	2026	The sample plan applies to the number of leads inspected. A minimum of three devices shall be tested.	15 leads, c = 0	6 leads, c = 0	J-STD-002 JESD22-B102	Part of Initial Qualification	1 lot, 10 samples		Lower quantity in AEC
Resistance to Solvents	1022	Ink marked devices only. Not required if marking is etched into the device.	15 devices, c = 0	6 devices, c = 0	JESD22-B107	Part of Initial Qualification	1 lot, 30 samples		
Salt Atmosphere (corrosion)	1041	Salt atmosphere at +35°C passed thru chamber for 24 +2/-0 h at rates of 10 - 50 g/m^2 per 24 h; examine post test. Laser marked devices only. Not required for non-corrrosive base metals.	6 devices, c = 0	6 devices, c = 0		Not specified			No requirements in AEC-Q101
Subgroup 3									
Thermal shock (liquid-to-liquid)	1056	25 cycles, condition B (glass diodes only)	22 devices, c = 0	6 devices, c = 0		Not specified			No requirements in AEC-Q101
Temperature cycling (air-to-air)	1051	Test condition C, or maximum storage temperature, whichever is less. (100 cycles).			JESD22-A104	Part of Initial Qualification	3 lots, 77 samples each		
Surge	4066	As specified.				Not specified			No requirements in AEC-Q101
Hermetic seal Fine Gross	1071	Fine leak not required for double plug diodes.			JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		
Electrical Measurements		Group A, subgroup 2			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Decap-internal visual (design verification)	2075	Visual criteria in accordance with qualified design and internal visual precap criteria.	6 devices, c = 0	6 devices, c = 0		Not specified			No requirements in AEC-Q101
Bond strength (wire or clip bonded devices only)	2037	Condition D: testing for internal bonds at the die or substrate and the lead frame. Similar to Condition C, but uses a hook under the lead wire.	22 wires or 11 devices, c = 0, (whichever requires the smaller number of devices.)	12 wires or 6 devices, c=0 (whichever requires the smaller number of devices.)	MIL-STD-750, Method 2037	500 h, T_A = max rated T_j for bonding of dissimilar metals, decap and wire pull/bond inspection after WBI on all wires.	10 bonds from min of 5 parts		Same as wire bond integrity in AEC?
SEM for applicable designs)	2077		See MIL-STD-750 TM 2077 for details.			Not specified			No requirements in AEC-Q101
Die shear (excluding axial leaded devices)	2017		The same number of devices used for bond strength will also be used for die shear (minimum of six die).		MIL-STD-750, Method 2017	Not specified	1 lot, 5 samples		Lower quantity in AEC
Subgroup 4									
Intermittent operation life	1037 or 1042	2,000 cycles, Condition D. Devices with .008 inch or larger bond wires, 6,000 cycles.	22 devices, c = 0	12 devices c = 0	MIL-STD-750, Method 1037	Part of Initial Qualification	3 lots, 77 samples each		
Hermetic seal Fine Gross	1071	Fine leak not required for double plug diodes.			JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		
Electrical measurements		Group A, subgroup 2 and as specified.			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Bond strength (wire or clip bonded devices only)	2037	Condition D. The sample shall include a minimum of three devices and shall include all wire sizes.	11 wires, c = 0	11 wires, c = 0	MIL-STD-750, Method 2037	Part of Qualification	10 bonds from min of 5 parts		Same as wire bond integrity in AEC?
Subgroup 5									
Accelerated steady-state operation life	1027	Bias conditions as specified. TJ = +275°C minimum (for 96 hours minimum) or TJ = +225°C minimum (for 216 hours minimum) or TJ = rated °C minimum (for 1,000 hours minimum).	22 devices, c = 0	12 devices c = 0		Not specified			No requirements in AEC-Q101
Electrical measurements		Group A, subgroup 2 and 3			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Schottky diodes, Case mount rectifiers	1038	TJ = rated TJ maximum (for 1,000 hours minimum).			MIL-STD-750, Method 1038	Part of Qualification	3 lots 77 samples each		
Electrical measurements		Group A, subgroup 2 and 3.			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Accelerated steadystate gate stress power MOSFETS	1042	Condition B, VGS = rated, TA = +175°C, t = 24 hours or TA = 150°C, t = 48 hours.			JESD22-A108	Part of Qualification	3 lots 77 samples each		
Electrical measurements		Group A, subgroup 2 and 3.			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Accelerated steady-state reverse bias power MOSFETS	1042	Condition A, VDS = rated, TA = +175°C, t = 120 hours or TA = 150°C, t = 240 hours and as specified.			JESD22-A108	Part of Qualification	3 lots 77 samples each		
Electrical measurements		Group A, subgroup 2 and 3.			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Bond strength (wire or clip bonded devices only)	2037	As specified. Bond strength samples shall have passed accelerated steady-state operation life.	20 wires, c = 0	20 wires, c = 0	MIL-STD-750, Method 2037	Part of Qualification	10 bonds from min of 5 parts		Same as wire bond integrity in AEC?
Subgroup 6									
Thermal resistance									
Diodes	3101 or 4081	As specified. Thermal resistance may be performed on a group C frequency whenever 100% thermal impedance is performed, except for power and case mounted devices	22 devices, c = 0	8 devices c = 0		Not specified			No requirements in AEC-Q101
Transistors (bipolar)	3131				JESD24-4	Part of Qualification	1 lot, 10 samples		Lower quantity in AEC
Transistors (POWER FETS)	3161				JESD24-3	Part of Qualification	1 lot, 10 samples		Lower quantity in AEC
Thyristors	3181					Not specified			No requirements in AEC-Q101
IGBT	3103				JESD24-6	Part of Qualification	1 lot, 10 samples		Lower quantity in AEC
GaAs FET	3104					Not specified			No requirements in AEC-Q101
Subgroup 7									
High temperature life (non-operating)	1032	340 hours minimum, T_STG(max) = T_A	32 devices, c = 0	12 devices c = 0		Not specified			No requirements in AEC-Q101
Electrical Measurements		Group A, subgroup 2			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		

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Song Pyun (Raytheon)

Table E-VIB Group B Inspections for JAN, JANTX, and JANTXV devices

Inspection	MIL-STD-750 Method	MIL-STD-750 Condition	Qualification and Large Lot	Small Lot Conformance Inspection	TM	TM Description/Additiona	Sample Size	Assessment	Rationale
Subgroup 1	Separate samples may be used for each test								
Solderability	2026	The sample plan applies to the number of leads inspected. A minimum of 3 devices shall be tested.	15 leads c = 0	4 leads c = 0	J-STD-002 JESD22-B102	Part of Qualification	1 lot 10 samples		Lower quantity in AEC
Resistance to Solvents	1022	Not required if marking is etched into the device.	15 leads c = 0	3 leads c = 0	JESD22-B107	Part of Qualification	1 lot 30 samples		
Subgroup 2									
Thermal Shock (liquid to liquid)	1056	10 cycles, condition B, (glass diodes only).	22 devices c = 0	6 devices c = 0		Not specified			No requirements in AEC-Q101
Temperature Cycling (air to air)	1051	Test condition C, or maximum storage temperature, whichever is less. (45 cycles including screening)			JESD22-A104	Part of Qualification	3 lots 77 samples each		
Surge	4066	As specified.				Not specified			No requirements in AEC-Q101
Salt atmosphere (corrosion)	1041	Salt atmosphere at +35°C passed thru chamber for 24 +2/-0 h at rates of 10 - 50 g/m^2 per 24 h; examine post test. Laser marked devices only.				Not specified			No requirements in AEC-Q101
Hermetic seal Fine Gross	1071	Fine leak not required for double plug diode.				Not specified			No requirements in AEC-Q101
Electrical Measurements		Group A, subgroup 2			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Subgroup 3									
Steady-state operation life	1027	Bias conditions as specified, 340 hours (minimum)	45 devices c = 0	45 devices, c = 0		Not specified			No requirements in AEC-Q101
Electrical measurements or Intermittent operation life	1037 1042	Group A, subgroup 2 2,000 cycles (min) Condition D, 2,000 cycles (min)			MIL-STD-750, Method 1037	T_J >100°C: 60000/(x+y), 15000 cycles T_J >125°C: 30000/(x+y), 7500 cycles	3 lots 77 samples each		
Hermetic seal Fine Gross	1071	Fine leak not required for double plug diodes.			JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		Lower quantity in AEC
Electrical measurements		Group A, subgroup 2			User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		
Bond strength (wire or clip bonded devices only)	2037	Condition D. The sample shall include a minimum of three device and shall include all wire sizes.	11 wires c = 0	11 wires c = 0	MIL-STD-750, Method 2037	Part of Qualification	10 bonds from min of 5 parts		
Subgroup 4									
Decap internal visual (design verification)	2075	Visual criteria in accordance with qualified design.	1 device c = 0	1 device c = 0		Not specified			No requirements in AEC-Q101
Subgroup 5									
Thermal resistance		As specified. Thermal resistance maybe performed on group C frequency whenever 100% thermal impedance is performed except for power and case mounted devices.	15 devices c = 0	6 devices c = 0					
Diodes	4081					Not specified			No requirements in AEC-Q101
Transistors (bipolar)	3131				JESD24-4	Part of Qualification	1 lot 10 samples		Lower quantity in AEC
Transistors (POWER FETS)	3161				JESD24-3	Part of Qualification	1 lot 10 samples		Lower quantity in AEC
Thyristors	3181					Not specified			No requirements in AEC-Q101
IGBT	3103				JESD24-6	Part of Qualification	1 lot 10 samples		Lower quantity in AEC
GaAs FET	3104					Not specified			No requirements in AEC-Q101
Subgroup 6									
High-temperature life (non-operating)	1032	340 hours minimum, TSTG(max) = TA Group A, subgroup 2	32 devices, c = 0	12 devices, c = 0		Not specified			No requirements in AEC-Q101
Electrical measurements					User specification or supplier's standard specification	As needed for pre- and post-stress electrical test	All qualification parts submitted for testing		

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Semiconductor Devices
Bill Cantarini (HiRel Components Engineering & Manufacturing)

Group A Inspection

Subgroups	MIL-STD-750 Method	MIL-STD-750 Condition	JANS sample plan	JAN, JANTX, JANTXV sample plan	TM	TM Description/Additional Requirements	Sample	Assessment	Rationale
Subgroup 1 (all devices except small die flow)									
Visual and mechanical inspection	2071	Verify workmanship of hermetically packaged semiconductor devices	15 devices c = 0	116 devices, c = 0 (JANTXV) 45 devices, c = 0 (JAN, JANTX)	JESD22 B-101	inspect part construction, marking and workmanship	1 lot 30 samples		Qty higher than JANS, but JANS devices are manufactured to higher standards.
Subgroup 1 (for small die flow only 2/ 3/)									
Visual and mechanical inspection 4/	2071	Verify workmanship of hermetically packaged semiconductor devices		116 devices, c = 0 (JANTXV) 45 devices, c = 0 (JAN, JANTX)	JESD22 B-101	inspect part construction, marking and workmanship	1 lot 30 samples		Lower quantity in AEC
Solderability 4/	2026 (J-STD-002)			15 leads, c = 0	J-STD-002 JESD22B102	Magnification 50x. Reference solder conditions in Table 2B. Apply test method A for through-hole, or both test methods B and D for SMD.	1 lot 10 samples		Lower quantity in AEC
Resistance to solvents 4/ 5/	1022	Verify that the markings will not become illegible on devices when subjected to solvents.		15 devices, c = 0	JESD22-B107	Verify marking permanency (not required for laser etched parts or parts with no marking)	1 lot 30 samples		
Salt Atmosphere (corrosion), (Laser marked devices only. Not required for non-corrosive base metals)	1041	Salt atmosphere at +35°C passed thru chamber for 24 +2/-0 h at rates of 10 - 50 g/m^2 per 24 h; examine post test.		6 devices, c = 0					Salt not listed but Autoclave and Corrosion are referenced
Temperature cycling (air to air)	1051	Default test conditions: minimum of 20 cycles using test condition C (-55 to 175°C).		Test condition C, or maximum storage temperature, whichever is less, 25 cycles. 22 devices, c = 0	JESD22 A-104, Appendix 6	1000 cycles (Ta = minimum range of -55°C to maximum rated junction temperature, not to exceed 150°C). Can reduce duration to 400 cycles using Ta (max) = 25°C over part maximum rated junction tempreature or using Ta(max) = 175°C if the maximum rated junction tempreature is above 150°C. Test before and after TC	3 lots 77 samples each		
Electrical measurements (group A, subgroup 2)	Group A, subgroup 2				User specification or supplier's standard specification		All qualification parts submitted for testing		
Hermetic seal 6/ Fine leak Gross leak	1071	Fine leak not required for double plug diodes.		22 devices, c = 0	JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		Refer to page 12
Bond strength 4/	2037			Precondition: Ta = +250°C at t = 24 h or Ta = +300°C at t = 2 h; 11 wires, c = 0	MIL-STD-750 Method 2037	Pre- & post-process change comparison to evaluate process change robustness	10 bonds from min of 5 parts		
Decap internal visual (design verification)	2075	Verify that design and construction of dvice are the same as those documented in qualified design report.		4 devices, c = 0	AEC-Q101-004, Section 4 (DPA)	Random sample of parts that have successfully completed H3TRB or HAST, and TC	2 samples, 1 lot		Only DPA specified.
Subgroup 2									
DC (static) test		+25°C ± 3°C	116 devices c = 0 7/ 9/	116 devices c = 0 7/	User specification or supplier's standard specification	Test is performed as specified in the applicable stress reference at room temperature	3 Qual lots 77parts/lot		
Subgroup 3									
DC (static) test		High (-0°C, +10°C) and low (+0°C, -10°C) specified temperatures	116 devices c = 0 7/ 9/	116 devices c = 0 7/ 8/	User specification or supplier's standard specification	Test is performed as specified in the applicable stress reference at room temperature	All qualification parts submitted for testing		No temperature testing stated in specifications
Subgroup 4									
Dynamic tests		+25°C ± 3°C	116 devices c = 0 7/ 9/	116 devices c = 0 7/ 8/	User specification or supplier's standard specification	Test is performed as specified in the applicable stress reference at room temperature	All qualification parts submitted for testing		Note 1
Subgroup 5									
Safe operating area test (for transistors only): a. DC b. Clamped inductive (only when applicable) End-point electrical measurements			45 devices c = 0 10/	45 devices c = 0					Note 2
Safe operating area test c. Unclamped inductive (only when applicable) End-point electrical measurements				45 devices c = 0	AEC-Q101-004 Section 2	Pre- & Post-process change comparison to evaluate process change robustness (Power MOS and internally clamped IGBTs only).	1 lot 5 samples		See Table 2 Item 26
Subgroup 6									
Surge current (for diodes/rectifiers only) End-point electrical measurements				22 devices c = 0	User specification or supplier's standard specification	Surge not referenced in AEC100	All qualification parts submitted for testing		Note 2
Subgroup 7									
Selected static and dynamic tests			45 devices c = 0 10/	22 devices c = 0	User specification or supplier's standard specification	As needed for pre- and post-stress electrical test (no PDA)	All qualification parts submitted for testing		MIL-PRF does not specify tests and is assignable by the customer similar to AEC-Q101

1) As noted in AEC- Q100, qualifiation is performed only once and maintained through SPC. An integral part of the Near Term Tech specification will need to identify all required SPC.
2) SPC will need to be an integral part of the specification. This includes determining the independent variables such as wafer to wafer and onwafer location variablitity as well as assembly variability. These variables should be forced during sampling.

Note 1 - Under AEC101 Apendix 5 "Minimum Parametric Test" there is no listing for SOA tests
Note 2- Under AEC101 Apendix 5 "Minimum Parametric Test" there is no listing for Surge tests

MIL-PRF-19500 vs. AEC-Q101
Semiconductor Devices
Sultan Lilani (Integra Technologies)

Group C Periodic Inspections (all quality levels)

Tab: Table E-VII

Inspections	MIL-STD-750 Method	MIL-STD-750 Condition	Sample Plan	Sample size for conformance	TM	TM Description/Additional Requirements	Sample Size	Assessment	Rationale
Subgroup 1									
Physical dimensions 1/(not required for JANS)	2066	Dimensions in accordance with case outline specified in specification sheets	15 devices c=0	6 devices c=0	JESD22 B-100	Verify physical dimensions to the applicable user part packaging specification for dimensions and tolerances			Note 1: For AEC; performed during initial qual or when process change is made
Subgroup 2									
Thermal Shock (liquid to liquid)	1056	25 cycles, condition B	22	6 devices c=0					Not stated in AEC-Q101
Temperature cycling (air-to-air)	1051	Test condition C (-55 to +175°C), or maximum storage temperature, whichever is less. (45 cycles including screening)			JESD22 A-104, Appendix 6	1000 cycles (TA = minimum range of -55°C to maximum rated junction temperature, not to exceed 150°C). Can reduce duration to 400 cycles using TA (max) = 25°C over part maximum rated junction temperature or using TA(max) = 175°C if the maximum rated junction temperature is above 150°C. TEST before and after TC. Note: AEC additional req't is post temp cycle: 125°C TEST after TC, followed by decap and wire pull on all wires from 5 devices per appendix 6 for parts with internal bond wire sizes 5 mil diameter and less. In addition, there is 100% CSAM req't post TC.	77 samples from 3 lots for each test		AEC requires more cycles, along with pre- and post-test inspections.
Terminal strength	2036	As specified			MIL-STD-750, Method 2036	Evaluate lead integrity of leaded parts only			
Surface mount end cap bond integrity	2038	As specified (Condition B for US devices)			AEC-Q101, Appendix 6	Guideline for opening plastic packaged devices for reliable wire pull or bond shear testing.			AEC-Q101 Appendix 6 refers to plastic parts only. No specifics on end cap bond integrity testing.
Hermetic seal 2/									
a. Fine leak	1071	Fine leak not required for double plug diodes.			JESD22 A-109	Fine and gross leak test per individual user specification	1 Lot 30 parts		
b. Gross leak									
Moisture resistance	1021	Omit initial conditioning							AEC has no provision for moisture resistance testing for hermetic package but does perform HAST with preconditioning for plastic
Electrical measurements		Group A, subgroup 2							
Subgroup 3		Not required for disc packages or metallurgically bonded double plug devices or stud packaged devices							
Shock	2016	Nonoperating, 1,500 G's, 0.5 ms, 5 blows in each orientation, X1, Y1, and Z1 (Y1 only for axial glass diodes)	22 devices c=0	6 devices c=0	JESD22 B-104	1500 G's for 0.5 ms, 5 blows, 3 orientations. Test before and after mechanical shock			
Vibration, variable frequency	2056	Peak-to-peak amplitude of 0.06" or peak acceleration of 20 g's over 20 to 2000 Hz; Cycle performed 4 times in each x, y, and z orientations.			JESD22 B-103	Use a constant displacement of 0.06" (double amplitude) over the range of 20 Hz to 100 Hz and a 50 G constant peak acceleration over the range of 100 Hz to 2 KHz. Test before and after VVF			
Constant acceleration 3/	2006	1 minute minimum in each orientation. X1, Y1, and Z1 at 20,000 G's minimum, except at 10,000 G's minimum for devices with power rating of ≥ 10 watts. Tc = +25°C.			MIL-STD-750, Method 2006	Y1 plane only, 15K G-force. Test before and after constant acceleration	30 samples, 1 lot		AEC requires Y1 plane only, 15K g-force
Electrical measurements		Group A, subgroup 2							
Subgroup 4									
Salt atmosphere (corrosion) 1/	1041	Salt atmosphere at +35°C passed thru chamber for 24 +2/-0 h at rates of 10 - 50 g/m^2 per 24 h; examine post test	15 devices c=0	6 devices c=0					Not stated in AEC-Q101
Subgroup 5									
Thermal resistance 4/									
Diodes	4081								
Transistors (bipolar)	3131								
Transistors (power FETs)	3161	As specified	15 devices c=0	6 devices c=0	JESD24-3, 24-4, 24-6 as appropriate	Measure TR to assure specification compliance and provice process change comparison data			Sample size not specified in AEC.
Thyristors	3181								
IGBT	3103								
CaAs FET	3104								
Subgroup 6 5/ 6/		Not required for disc packages							
Steady-state operation life	1026	1,000 hours minimum, bias conditions as specified. 7/ 8/	22 devices c=0	12 devices c=0	Test methods as follows corresponding to each test in column F: HTRB: -STD-750-1 M1038 Method A, AC blocking voltage: MIL-STD-750-1 M1040 Test condition A, HTFB: JESD22 A-108, Steady state: MIL-STD-750-1 M1038 Condition B (Zeners), HTGB: JESD22 A-108	1000 hours for each of the following tests are performed with testing before and after each hrs of each of the following: HTRB (reverse bias), AC blocking voltage, HTFB (forward bias), Steady state operational , HTGB (gate bias)	77 samples from 3 lots for each test		
Electrical measurements or intermittent operation life	1037	6,000 cycles minimum			MIL-STD-750, Method 1037	Intermittent operational life: Tested per duration indicated in Table 2A. Ta=25°C. Parts powered to insure Tj ≥ 100°C (not to exceed absolute maximum ratings). Test before and after IOL as a minimum			Sample size not specified in AEC.
Hermetic seal 2/									
a. Fine leak	1071	Fine leak not required for double plug diodes			JESD22 B-109	Fine and gross leak test per individual user specification			Sample size not specified in AEC.
b. Gross leak									
Electrical measurements		Group A, subgroup 2							
Bond strength 9/	2037	Condition D, .008 inch or larger wire or clip bonded devices only. The sample shall include a minimum of three devices and shall include all wire sizes	11 wires, c=0	11 wires, c=0	MIL-STD-750, Method 2037	Pre- and post-process change comparison to evaluate process change robustness			
or Blocking life 8/	1048	Perform with primary blocking junction reverse biased at elevated T for time period in accordance with life test requirements. Typically +150°C and at 80-85% of rated voltage.							This test methodology is not addressed in AEC document. Alternative method (steady state or intermittent life; may be used with revised biasing scheme)
Electrical measurements		Group A, subgroup 2			Additional AEC-Q101 test include : Unbiased HAST, biased HAST, High humidity High temp forward bias, High humidity, high temp reverse bias,				
Subgroup 7 10/									
Internal gas analysis	1018	To be performed on each structurally identical package family	3 devices c=0	3 devices c=0					This test methodology is not addressed in AEC document. This is an important test and should be performed

1/ Electrical reject devices, from the same inspection lot, may be used for all subgroups when electrical end-point measurements are not required. Other non-catastrophic rejected devices (i.e., PIND, X-ray) may be utilized for all subgroups. For subgroups with end-point measurements, the devices shall be screened to table E-IV through screen 13. Salt atmosphere not required for Laser marked devices when devices from group B, or from group A for small die flow, salt atmosphere have been selected to satisfy group C inspection requirements.

2/ Non-transparent glass encased double plug noncavity diodes only may use test method 2068 of MIL-STD-750, in lieu of 1071. This test may be performed after electrical measurements.

3/ Not applicable to any devices with external and internal pressure contacts (die to electrical contacts), optical coupled isolators, and double plug diodes.

4/ Not required when performed in group B.

5/ If a given inspection lot undergoing group B inspection has been selected to satisfy group C inspection requirements, the 340 hour or 2,000 cycles life tests may be continued on test to 1,000 hours or 6,000 cycles, as applicable, in order to satisfy the group C life test requirements. End-point measurements shall be performed on either table E-VIA, group B, subgroup 4, or table E-VIB group B, subgroup 3 (340 hours or 2,000 cycles, as applicable) to satisfy group B (table E-VIA or table E-VIB) lot acceptance or group C, subgroup 6 (1,000 hours or 6,000 cycles, as applicable) to satisfy group B and C lot acceptance.

6/ Intermittent operation life shall be performed on all case mounted devices.

7/ TJ = 150°C (min) or rated TJ whichever is less (except schottky and power mosfets) for operation life.

8/ The sample size may be increased and the test time decreased so long as the devices are stressed for a total of 22,000 device hours minimum, and the actual time of test is at least 340 hours.

9/ Required for JANS devices with .008 inch or larger bond wires only. Not required when JANS devices from group B bond pull inspection have been selected to satisfy group C inspection requirements.

10/ Internal gas analysis shall be performed on hermetic devices. An engineering evaluation shall be performed if there is a device failure to determine the moisture source (e.g. sealing environment, non hermetic device). The entire lot shall be rescreened in accordance with screen 14 herein (and resubmitted at 6/0.) Corrective action shall be taken as necessary. Subgroup 7 is not required for noncavity double plug devices.

"- I had some time today so I took a look at the Mil-PRF-19500 table comparison. It looks like someone started working on it so I didn't add to the already filled columns. However, I added a column next to automotive test method with sample size. Hope it is okay. I figured it gives an idea on automotive sampling required since their qual methodology is very different from Mil standard.

- I added some req'ts to Table E-VII for steady state life, constant acceleration sample and Temp cycle.
AEC-Q101 adds several types of 1000 hr life testing (not just one per Mil-PRF-19500). See table above.
AEC-Q101 adds several biased HAST and CSAM following temp cycle (I noted them in table).

- Some general notes are same as notes on Mil-PRF-38535.
o Group A and Group B of Mil-PRF-19500 do not have an equivalent AEC-Q101.
o Qualification is performed initially with no repeats unless a process changes.
o A couple of tests, ie. ESD and parametric are required for each new part but other tests called out in AEC-Q101 can be applied to part family.
Thanks
Lilian"

MIL-PRF-123 vs. AEC-Q200
Capacitors, fixed, ceramic dielectric

Table IX. Qualification Inspection

	TM	TM Description	Number of sample units to be inspected	Number of failures 1/	TM	TM Description/Additional Requirements	Sample Size per Lot	Number of lots	Assessment	Rationale
Group I										
Radiographic inspection (leaded devices only)	4.6.5		All	N/A						No requirements in AEC-Q200
Thermal shock	4.6.6.1 (MIL-STD-202, method 107)	a. Test condition A (except step 3): tested at +125°C b. Qual tests: 100 cycles c. Group A: 20 cycles d. Group B: 100 cycles	186 min 2/	See table XVI			30	1		No test descriptions in AEC-Q200
Voltage conditioning	4.6.6.2	All parts to be exposed to test voltage ±5%, for defined time and temperature.			User spec	Electrical characterization – show Min, Max, Mean, and Stdev at RT, Min and Max operating temperatures.	User spec	User spec		Applied voltage depends on user spec. Mostly intended to measure capacitance and Q factor.
Dielectric withstanding voltage	4.6.9 (MIL-STD-202, method 301)	a. 250 – 400% of direct current rated voltage. b. 5±1 seconds; ramp up within 1 second, max. c. Between capacitor-element terminals. d. Surge current 30 – 50 mA e. Examined for evidence of damage and breakdown.								Dielectric withstanding voltage test may be part of electrical characterization. Test conditions set by user spec.
Insulation resistance +25°C	4.6.10 (MIL-STD-202, method 302)	a. Rated voltage test. b. If failure >50% RH, insualtion resistance may be measured again at <50% RH c. Between mutually insulated points.								Room temperature testing to rated voltage. Sample size is determined by user spec.
Insulation resistance +125°C										Max operating temperature testing to rated voltage may be included. Grades 0 and 1 have maximum temperature rating of +150°C and +125°C, respectively. Sample size is determined by user spec.
Capacitance	4.6.7 (MIL-STD-202, method 305)	a. 1 MHz ± 100 kHz when 100 pF or less for BX and BR and 1000 pF or less for BP and BG. 1 kHz ± 100 Hz when capacitance is greater than above. b. RMS voltage of 1.0 ± 0.2 V.								Capacitance is measured at min/room/max temperatures at a minimum.
Dissipation factor	4.6.8	Measured with a capacitance bridge or other suitable method at the frequency and voltage in 4.6.7								Dissipation factor is measured at min/room/max temperatures at a minimum.
Group II										
Visual and mechanical examination; material, design, construction, and workmanship	4.6.3	Visual inspection criteria in 3.25 for leaded capacitor: use 10x magnification. Use Appendix B for non-leaded capacitors.	15	1	MIL-STD-883, method 2009	1.5 to 10x magnification. Inspect device construction, marking, and workmanship.	all qual parts submitted			Sample size undefined.
Destructive physical analysis 3/	4.6.11	See 4.6.11 for details on Group 1 and Group 2 requirements			EIA-469	Only applies to SMD ceramics. Electrical test not required.	10	1		10 samples required vs. 15 in MIL-PRF.
Group IIIa – Leaded devices										
Terminal strength	4.6.12.1 (MIL-STD-202, method 211)	Leaded capcitors: apply 2±.1 kg on terminal	12	1	MIL-STD-202, method 211	Leaded device only. Ceramics: A (454 g), C (227 g), E (1.45 kg-mm); Tantalums: A (2.27 kg), C (227 g), E (1.45 kg-mm)	30	1		Ceramic load requirement less than that required in MIL-PRF.
Solderability	4.6.13.1 (MIL-STD-202, method 208)	Test two terminals			J-STD-002	50x magnification. Leaded method A: @235°C, cat 3. SMD method B, 4 h @155°C dry heat @235°C; method B @215°C cat 3; method D cat 3 @260°C.	15 each condition	1		
Resistance to soldering heat	4.6.14.1 (MIL-STD-202, method 210)				MIL-STD-202, method 210	Test condition D for SMD and condition B for leaded. Pre-heat @150°C for 60-120 s allowed for ceramics	30	1		
Group IIIb – Nonleaded devices										
Terminal strength	4.6.12.2 (MIL-STD-202, method 211)	Attach nail head, apply 1±.1 kg on CKS51 and CSK52; 2±.2 kg on CKS53 and CKS54.	12	1		Terminal strength on leaded devices only				Not required for non-leaded devices
Solderability	4.6.13.2 (MIL-STD-202, method 208)	Immerse in molten solder to a depth of .020 +.010/-.000" or the entire capacitor			J-STD-002	50x magnification. Leaded method A: @235°C, cat 3. SMD method B, 4 h @155°C dry heat @235°C; method B @215°C cat 3; method D cat 3 @260°C.	15 each condition	1		
Resistance to soldering heat	4.6.14.2 (MIL-STD-202, method 210)	Immersed in molten solder. See 4.6.14 for details.			MIL-STD-202, method 210	Test condition D for SMD and condition B for leaded. Pre-heat @150°C for 60-120 s allowed for ceramics	30	1		
Group IV 4/										
Voltage-temperature limits	4.6.15	See Table XVIII for voltage and temperature ranges. Temperature range: -55 to +125°C; rated voltage applied.	12	1	User spec	Electrical characterization – show Min, Max, Mean, and Stdev at RT, Min and Max operating temperatures.	User spec	User spec		User spec may not require voltage-temperature limit measurements.
Moisture resistance	4.6.16.2 (MIL-STD-202, method 106)	20 cycles; first 10 cycles, apply 50V; after final cycle, condition at 25±5°C and 30-60% RH for 18-24 h. See 4.6.16.2 for details.			Not listed	Not listed	77	1		No details listed in Q200. May accept generic data.
Group V										
Humidity, steady state, low voltage	4.6.16.1 (MIL-STD-202, method 103)	+85°C, 85% RH for 240 h, 1.3±0.25 VDC applied through 100 kohm resistance; after testing, dry for 3±0.5 h at +25°C and perform insulation resistance test through 100 kohm resistor at 1.3±0.25 VDC and capacitance. Visual inspection.	12	0	Not listed	Humidity bias	77	1		No details listed in Q200. May accept generic data.
Vibration, high frequency (leaded capacitors only)	4.6.17 (MIL-STD-202, method 204)	Apply 125% of voltage rating. Test condition E (max 50 g's), except freq range of 10 – 3000 Hz.		1	MIL-STD-202, method 204	Z	30	1; when generic family data is provided in lieu of component specific data, 3 lots are required.		No requirements for electrical measurements during vibe test.
Resistance to solvents	4.6.18 (MIL-STD-202, method 215)	Marked portion of body brushed			MIL-STD-202, method 215	Add aqueous wash chemical OKEMCLEAN (6% concentrated Oakite cleaner) or equivalent.	5	1		Less number of samples tested.
Group VI										
Life	4.6.19 (MIL-STD-202, method 108)	See Table XIX for accept/reject criteria; test at 125 +4/-0°C; 4000 h for qual and 1000 h for group B.	123	1						No requirements. May be unnecessary for short-term missions.

1/ A sample unit having one or more defects will be charged as a single defective.
2/ Additional samples over the 186 minimum should be included, based on Table XVI to allow for the percent defective allowable. Twelve additional samples shall be required for nonleaded devices
3/ DPA samples shall be divided with 10 samples subjected to group 1 (see 4.6.11.1) and 5 samples to group 2 (see 4.6.11.2)
4/ Leads may be soldered to chip capacitor to facilitate the tests required in group IV.

Each production lot of parts to be inspected in accordance with Table X.

Table X. In-process Inspection

Inspection	Requirement paragraph	Description	TM	TM Description	Sample Size
Nondestructive internal examination	3.5		4.6.1	Ultrasonic exmination or other non-destructive tests	100%
Pre-termination destructive physical analysis	3.6		4.6.2	See Table XIV	Table XIV
Visual examination	3.7		4.6.3	Leaded devices: use 10x visual inspectic	100%
Pre-encapsulation terminal strength (leaded capacitors only)	3.8		4.6.4		Table XV
Post termination, unencapsulated destructive physical analysis	3.15		4.6.11		Table XVII, group 1

Table XIV. Pre-termination DPA sample size

Lot Size	Minimum sample size	Accept	Reject
1-500	14	0	1
501-10000	32	1	2
10001-35000	50	2	3
35001-500000	80	3	4

Table XV. Pre-encapsulation terminal strength

Lead configuration	Lead pull minimum	Sample size
Radial per lead	1.8 kg (4.0 lbs)	5
Axial per lead	All styles except CKS11 and CKS12 – 1.8 kg (4.0 lbs)	5
	CKS11 and CKS12 styles – 0.9 kg (2.0 lbs)	
Dual in-line package	2.14 kg (4.7 lbs)	5

Table XVII. Destructive physical analysis sample size

Lot size	Minimum sample size 1/	
	Group 1 2/	Group 2 3/
1-500	5	3
501-10000	10	4
10001-35000	25	7
35001-500000	40	10

1/ No failures allowed
2/ Leaded capacitors: After lead attachment and before encapsulation, or after removing encapsulation. Group 1 inspected for lead attachment, other assembly-related defects.
3/ Non-leaded capacitors: Performed after final termination coating application. See Appendix B.