NASA-STD-8739.11 Tutorial

SECTION C1. CAPACITORS

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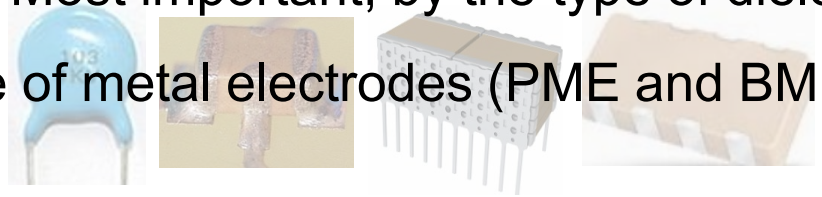
Acronyms

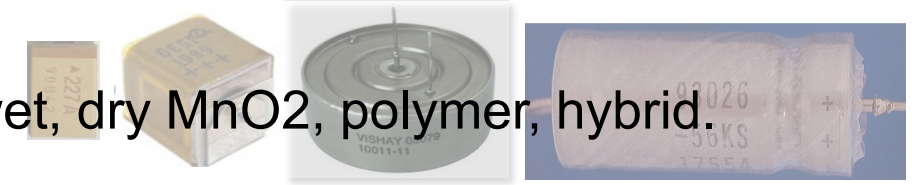
AEC	Automotive Electronics Council	**L1, L2, L3**	progect levels
BI	burn in	**LAT**	lot acceptance testing
BME	base metal electrode	**LT**	life test
CA	Construction analysis	**MEAL**	Mission Environment, Application, and Lifetime
COTS	Commercial-Off-The-Shelf	**MIL-SPEC**	Military Specification
Cpk	Process Capability Index	**PEAL**	Parts Evaluation and Assessment Laboratory
DPA	destructive physical analysis	**PME**	precious metal electrode
DPPM	Defective Parts Per Million	**PPAP**	Production Part Approval Process
EEEE	Electrical, Electronic, Electromechanical, Electro-Optical	**PTC**	polymer tantalum capacitor
FIT	Failure-In-Time	**SCD**	source control drawing
FR	failure rate	**THB**	temperature humidity bias
HSSLV	humidity steady-state low voltage	**UL**	useful life
ILPM	Industry Leading Parts Manufacturer	**WGT**	Weibull grading test

Covered Part Types

- **Classification**: by specifications (MIL, COTS, AEC-Q200, SCD,..), types of application, voltage ranges, design, etc. Most important, by the type of dielectric and electrodes.
- **Ceramic caps**: type of metal electrodes (PME and BME), voltage rating, design,...



- **Tantalum caps**: type of electrolyte/cathode materials: wet, dry MnO2, polymer, hybrid.

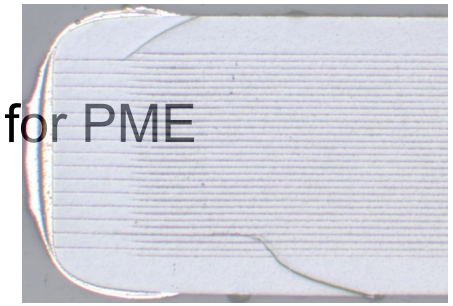


- **Polymer film caps** (hermetic MIL; COTS: variety of polymers and formation processes).

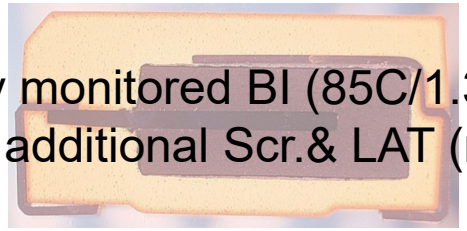
- **Rarely used parts** included in the document: (1) MICA capacitors; (2) Variable capacitors, M81 or M14409; (3) Paper capacitors (AEC-Q200?); (4) Glass capacitors, M23269 (not in Table 1).
- **Not covered**:
  - DLA drawing capacitors (upgraded commercial parts?)
  - New technology aluminum (wet, polymer, hybrid), silicon, supercapacitors, niobium, embedded,…

Key Considerations

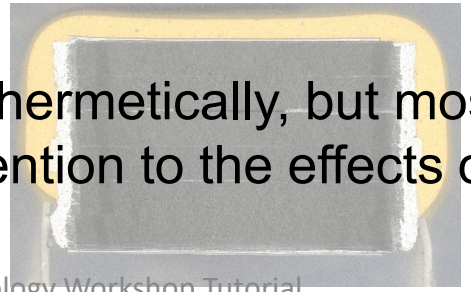
- **General**
  - Most MIL grade capacitors can be used without additional testing (lowest FR for L1 projects)
    => Described Scr.& LAT procedures should be applicable for commercial capacitors.
  - DPA for L1 MIL caps but no CA for AEC-Q200? (Grain size characterization for L1 BME – consult PPE).
  - SCD and AEC-Q200 capacitors can be used for any project levels.
  - Commercial capacitors after Scr.& LAT can be used for L2/L3 projects only.
- **Ceramic capacitors**
  Post-soldering cracking and delamination are major risks of failures, especially for PME capacitors. Requirements for ultrasonic inspection for L1 CDR capacitors only.



- **Tantalum capacitors**
  - WGT can be replaced by monitored BI (85C/1.3VR/160hr)
  - MIL-grade PTCs require additional Scr.& LAT (reference to the guidelines, NASA/TM—20220019033).



- **Polymer film capacitors**
  M83421, M39022, and M19978 caps are sealed hermetically, but most commercial parts are encapsulated in plastic. This requires special attention to the effects of moisture.



Major Changes from EEE-INST-002

- **General**
  - BI and LT can be modified based on application conditions and the required reliability. These modifications might include monitoring of leakage currents, increased sample size, and changes of the stress level.
  - Construction analysis in lieu of DPA is recommended for new technology commercial parts.
  - LAT instead of qualification (required for L1/2 only).
- **Ceramic capacitors**
  - No failures allowed during LT, increased SS for L1.
  - HSSLV test for BME can be replaced with THB.
  - BI and life test for thin dielectric caps can be carried out at $V_{test} < 2VR$.
  - In case of LT failures, the lot can be used at derated conditions if analysis shows that FR and UL are acceptable for the project.
  - Excluded requirements that caps operating at below 10V should be rated to 100V or more.

Major Changes from EEE-INST-002

- **Tantalum capacitors**
  - Moisture resistance per M202 TM106 can be replaced with 85/85/VR/160hr test.
  - Ripple current life test is recommended only for parts operating above 50% of the rated ripple current value.
  - Requirements for series resistance of 0.1ohm (0.3ohm for L1) per 1V (1 ohm max) is excluded. However, surge current associated with power-up of capacitor shall be limited to $I_{max} = V_{rated}/(1+ESR_{spec})$.
- **Polymer film capacitors**
  - Changes might be necessary to reflect specifics of non-hermetic parts.

Use of AEC-Q200 Capacitors

- AEC-Q200 capacitors can be used without additional testing at the following conditions:
  - **For L3**: part is an Established COTS capacitor from an ILPM, or user has verified DPPM, FIT, IATF 16949 certification (QMS), data from Level 3 PPAP, AEC-Q004 Zero Defect Framework related practices, continuous reliability monitoring/testing data, sales volume of parts to date and on orders, design operating life.
  - **For L2**: L3 + verify Cpk for manufacturing processes or yield trend.
  - **For L1**: L2 + on-site visit to get up-to-date Level 2 & 3 required data.
- These requirements should be specified further based on results of PEAL testing and experience of using AEC-Q200 capacitors.

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