

EIA STANDARD

**SMT ALUMINUM
ELECTROLYTIC CAPACITOR
QUALIFICATION
SPECIFICATION**

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April 2000

**ELECTRONIC INDUSTRIES ALLIANCE
ELECTRONIC COMPONENTS, ASSEMBLIES, EQUIPMENT &
SUPPLIES ASSOCIATION**



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Foreword

This specification was prepared by the P-2.4 Subcommittee on Aluminum Electrolytic Capacitors of the Electronic Industries Alliance's sector Electronic Components, Assemblies, Equipment & Supplies Association (EIA/ECA).

1 Scope

1.1 Description

This specification defines the qualification program for SMT aluminum electrolytic capacitors. The qualification program is defined in table 1. Specification sheets can be added, as required, to define specific products or to cover unique/specific requirements.

1.2 Preconditioning

Before starting the qualification program, all capacitors shall be preconditioned by the application of the rated voltage from a direct voltage source having a low internal resistance, such as a regulated power supply. The voltage shall be applied to the capacitor through a resistor. The resistor shall approximately be 100 ohms for rated voltages up to and including 100 V, and 1000 ohms for rated voltages above 100 V.

The voltage shall be maintained for 1 hour. After preconditioning, the capacitors shall be discharged through a resistor of approximately 1ohm per applied volt.

The capacitors shall be allowed to stabilize for a period of 12 hours to 48 hours, without any applied voltage, prior to beginning qualification test program.

1.3 Reference documents

The current revision of the referenced documents will be in effect at the date of agreement to the qualification plan. Subsequent qualification plans will automatically use the latest revisions of these referenced documents.

UL-STD-94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
ASTM D2863-91	Flammability of Plastics Using the Oxygen Index Method
IEC 695	Fire Hazard Testing
IEC 68	Basic Environmental Testing Procedures
ANSI/IPC-SM-786	Recommended Procedures for Handling Moisture Sensitive Devices
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
EIA-469	Standard Test Method for Destructive Physical Analysis of High-Reliability Ceramic Monolithic Capacitors
IEC -68	Environmental Testing
IEC-384-4	Fixed Capacitors for Use in Electronic Equipment

2 General requirements

This specification includes requirements with the intention of developing a single set of robust qualification tests that would enable a supplier to leverage test results to satisfy the requirements of multiple OEM customers.

2.1 Objective

The objective of this qualification program is to insure that components meet a minimum quality and/or reliability level.

2.2 Generic data

2.2.1 The use of generic data to satisfy qualification requirements

Qualification shall be based on specific requirements associated with each characteristic of the device and manufacturing process. These requirements, listed in table 1, are the same for both new processes and re-qualification associated with a process change. For each stress test, two or more qualification families can be combined if reasoning for this is technically sound, supported by data and periodically reviewed for soundness of original assumptions. With proper attention to these qualification guidelines, greater information applicable to other

devices in the family can be accumulated and used to demonstrate their reliability so that qualification testing on new devices entering a family can be minimized. For example, this can be achieved through extensive qualification and monitoring of the most complex device in the reliability family and applied to less complex devices that subsequently joins this family. Sources of generic data shall come from supplier-certified labs, and can include internal supplier's qualification, user-specific qualifications and supplier's in-process monitors, as long as the test conditions and endpoint test temperatures address the worst case temperature extremes and other conditions defined in this specification.

2.2.2 Qualification families

In order to qualify as a family, the qualification samples must represent the same manufacturing process, materials and formulation. The supplier will provide a complete description of each process and material of significance. Samples should represent three different values within the family and separated by one week of date code. The values should represent the low range, middle range and upper range of the family. There must be valid and obvious links between the data and the subject of qualification.

2.2.3 Manufacturing site (fabrication and assembly)

Each manufacturing site and line is to be considered independently for site qualification, meaning that the site is proven to be capable (resources and equipment) of running particular processes. A site cannot be qualified based on the results from a different location. Qualification families do not apply across manufacturing sites.

2.3 Test samples

2.3.1 Lot requirements

Test samples shall consist of representative devices from the qualification family. Multiple lot samples are specified in table 1. Test samples shall be the same values from three non-consecutive lots, with each assembly lot composed of a different date code separated by at least one week.

2.3.2 Production requirements

All test samples shall be processed, tested, screened and inspected on the same production site and with the same production process for which the device in the qualification family to be qualified will be manufactured for production.

2.3.3 Reusability of test samples

Devices that have been used for nondestructive qualification tests may be used to populate other qualification tests.

2.3.4 Pre-stress and post-stress test requirements

All endpoint test temperatures (room, hot and/or cold) are specified in 4.2 to 4.19.

2.4 Definition of electrical test failure after stressing

Electrical test failures are defined as those devices not meeting the individual device requirements called out in section 4 of this document.

2.5 Criteria for passing qualification

Passing all appropriate qualification tests in this specification qualifies the device.

3 Qualification for passing requalification

3.1 Qualification and requalification

The stress test requirements and corresponding test conditions for the qualification of a new device are listed in table 1. For each qualification, the supplier must present data for all of these tests, either specific to the device to be qualified or acceptable reliability family data. Justification for the use of generic data must be demonstrated by the supplier and approved by the user.

3.2 Changes requiring requalification

Changes to a commodity, or the processes used in its fabrication, will require re-testing as agreed upon between the supplier and the user. The supplier and the user should agree upon the appropriate test plan prior to starting the requalification.

3.2.1 Criteria for passing requalification

Passing all appropriate requalification tests specified in this document agreed to between the user and supplier qualifies the change per this document. All requalification failures should be analyzed for root cause, and demonstration of corrective and preventative actions are required.

4 Test requirements

4.1 Sampling plan

Individual samples per test required in table 1 are selected from one manufacturing lot. A minimum of three manufacturing lots separated by at least one week of date code shall be selected, as described in 2.3.1.

**Table 1—SMT aluminum electrolytic capacitor qualification test program
Approval levels and sampling plan**

Test method	Capacitor inspection	Sample Size per lot	Total sample size	Defects permitted
4.2	Electrical characteristics	250	750	0
4.3	Visual and mechanical	5	15	0
4.4	Life test	40	120	0
4.5	Load humidity test	40	120	0
4.6	Thermal shock	40	120	0
4.7	Exposure(storage)	40	120	0
4.8	Surge voltage	20	60	0
4.9	Vibration	5	15	0
4.10	Shock	5	15	0
4.11	Shear(adhesion)	5	15	0
4.12	Terminal Strength	5	15	0
4.13	Seal	5	15	0
4.14	Vent	5	15	0
4.15	Insulation resistance	5	15	0
4.16	Solderability	20	60	0
4.17	Resistance to soldering heat	5	15	0
4.18	DPA	H	H	0
4.19	Flammability	5	15	Present certificate of compliance
* Vibration samples are also used for shock per 4.10f.				
H Visual/mechanical samples are used for DPA per 4.17.				

4.2 Electrical characteristics

Total samples required in table 1 shall be measured initially before subsequent testing. Electrical parameters shall not exceed the values listed in the product specifications.

4.3 Visual mechanical examination

Capacitors shall be examined to verify those visual criteria and mechanical dimensions meet the requirements defined in the product specification sheet, or referenced documents.

4.4 Life test

Capacitors shall be tested per the requirements of MIL-STD-202, Method 108.

- a) preconditioning is required;
- b) the parts shall be subjected to rated voltage for 2000 hours at rated operating temperature (85 °C, 105 °C, or 125 °C); test time may be extended at the prerogative of the user or the supplier;
- c) measurements shall be taken at 0 h, 500 h, 1000 h, and 2000 h; extended testing should have measurements at 1000 hour increments;
- d) capacitance change shall be $\leq 20\%$ from initial limits;
- e) dissipation factor (DF) shall be $\leq 200\%$ of initial limit;
- f) equivalent series resistance (ESR) shall be $\leq 200\%$ of initial limit;
- g) DC leakage current shall meet initial limit.

4.5 Load humidity test

Capacitors shall be tested per MIL-STD-202, Method 103B, except:

- a) preconditioning is required;
- b) apply maximum rated voltage for 500 hours;
- c) measurements shall be taken at 0 hours and 500 hours;
- d) capacitance change shall be $\leq 20\%$ from initial limits;
- e) DF shall be $\leq 200\%$ of initial limit;
- f) ESR shall be $\leq 200\%$ of initial limit;
- g) DC leakage current shall meet initial limit.

4.6 Thermal shock

Capacitors shall be tested per MIL-STD-202, Method 107(air-to-air).

- a) preconditioning is required;
- b) the maximum and minimum temperatures will be per the product specification;
- c) the parts shall be subjected to 300 cycles;
- d) the maximum transfer time shall be 20 seconds;
- e) the dwell time shall be 30 minutes;
- f) capacitance, DF, ESR, and leakage shall be measured after testing and meet initial limits as specified in the detailed specification.

4.7 Exposure (storage)

Capacitors shall be tested per MIL-STD-202, Method 108, with the following exceptions:

- a) preconditioning is required;
- b) twenty samples shall be stored at maximum and twenty samples at minimum temperature per product specification;
- c) exposure time shall be 1000 hours;
- d) capacitors shall be unpowered;
- e) capacitors shall meet the visual requirements per 4.3;
- f) capacitance change shall be $\leq 10\%$ from initial limits.;
- g) DF, ESR and leakage shall meet initial limit.

4.8 Surge voltage

Capacitors shall be tested per the following procedure:

- a) preconditioning is required;
- b) capacitance shall be measured and samples identified;
- c) surge voltage shall be a minimum of 1.15 rated voltage for capacitors rated ≤ 315 V; capacitors rated at > 315 V shall be tested at a minimum of 1.10 rated voltage;
- d) test procedure;

Capacitors, while mounted in the vertical position, shall be subjected to 1000 cycles of DC surge voltage as specified in the table below. Nonpolarized styles shall be subjected to 1000 cycles in each direction. Each cycle shall consist of a 30 second surge voltage application, followed by a 5.5 minute discharge period. Voltage application shall be made through a resistor (1000 ohms \pm 50 ohms for capacitance values of less than 2500 μ F and 100 ohms \pm 5 ohms for capacitance values of 2500 μ F and greater) in series with the capacitor and the voltage source. Each surge voltage cycle shall be performed in such a manner that the capacitor is discharged through the resistor at the end of the 30 second application. The test shall be terminated on the discharge position of the cycle.

- a) capacitance change from initial value shall not exceed $\pm 15\%$;
- b) DF, ESR and DC leakage current must meet initial limits.

4.9 Vibration

Capacitors shall be tested per MIL-STD-202, Method 204, Test Condition D, except:

- a) preconditioning is required;
- b) capacitors shall be mounted on a 203 mm \times 127 mm (8 in \times 5 in) PCB, 0.79 mm(0.031in) thick, with 7 secure points on one 203 mm(8 in) side and 2 secure points on corners of opposite sides. Parts shall be mounted within 51mm(2 in) from any secure point. Capacitors shall be soldered and attached to the board as normally intended. The body of the capacitor shall be rigidly secured to prevent lead breakage;
- c) leaded capacitors shall subjected to 12 cycles in each of three orientations;
- d) the capacitors shall be subjected to a simple harmonic motion having an amplitude of either 1.5 mm (0.06 in) double amplitude (maximum total excursion) or 20.0 g_n (peak) , whichever is less;
- e) frequency shall be varied between 10 Hz and 2000 Hz. The entire frequency range shall be traversed in 20 minutes;
- f) during the last cycle, electrical characteristics (capacitance, DF and ESR) shall be monitored to determine stability;
- g) post-test requirements. Not applicable, since the same parts will be used for shock.

4.10 Shock

Capacitors shall be tested per MIL-STD-202, Method 213, Test Condition C, except:

- a) the mounting shall be the same as specified for vibration;
- b) during the last cycle, electrical characteristics (capacitance, DF, and ESR) shall be monitored to determine stability;
- c) requirements at post-test readouts are:

Maximum capacitance change:	± 5%
Maximum dissipation factor:	same as initial specification limit
Maximum leakage current:	same as initial specification limit
Maximum ESR change:	same as initial specification limit

- d) capacitors shall be visually examined for evidence of loosening or rupturing of the terminals.

4.11 Shear or Adhesion

Test per the requirements of IEC 384-1, subclause 4.34 and IEC 68-2-21, Test U.

4.12 Terminal Strength (Bond Strength of End Face Plating)

Test per the requirements of IEC 384-1, subclause 4.35 and IEC 68-2-1, Test D.

4.13 Seal

Place capacitors in water maintained at +90 °C to +95 °C, or maximum rated temperature, whichever is less for a period of 5 minutes. During the immersion, there shall be no chain or repetitive bubbling from any part of the capacitor.

4.14 Vent

Capacitors shall be mounted using the leads. A reverse DC voltage shall be applied. The voltage shall be of sufficient magnitude to produce a current in accordance with the following:

CV product	Current A
0 to 100k	1 to 3
101k to 500k	10
501k to 1000k	20
1001k and up	30

The vent shall operate without explosion or expulsion of the cover from the container. The container shall not rupture at any place other than the vent. The occurrence of a short or open within the capacitor shall not constitute a vent failure unless there is also an explosive disruption of the capacitor.

4.15 Insulation resistance

Capacitors shall be tested per MIL-STD-202, Method 302.

A metal foil shall be wrapped closely around the full length of the body of the capacitor, protruding by at least 5 mm from each end, provided a distance of not less than 0.5 mm can be maintained between metal foil and the terminations. The ends of the foil shall not be folded over the ends of the capacitor. If the 0.5 mm distance cannot be maintained, the protrusion of the foil shall be reduced as may be necessary to establish the 0.5 mm distance.

A direct voltage of $100\text{ V} \pm 15\text{ V}$ shall be applied between the metal foil and the termination connected to the capacitor body for a minimum of 2 min. At the end of this period, the insulation resistance shall not be less than 100 M Ω .

4.16 Solderability

Capacitors shall be tested as follows:

Setup, materials, 8 hour aging, solder composition, solder temperature, immersion depths and procedures shall be as specified in MIL-STD-202, Method 208H and ANSI/J-STD-002, Test B.

4.17 Resistance to solder heat

Capacitors shall be tested as follows:

- a) samples shall be tested per MIL-STD-202, Method 210, Test condition H or I;
- b) the final capacitance value shall not exceed +2% of the pretest value;
- c) DF, ESR and leakage current must meet the initial product specifications;
- d) no physical or mechanical damage shall be observed.

4.18 Destructive physical analysis (DPA)

Capacitors shall be examined per EIA-469 or MIL-STD-883, Method 5009. The samples shall be subjected to a microsectional evaluation to determine the internal integrity of the device and to gather data for future reference as to current material quality and process control. The supplier shall provide cross-sectional photographs or drawings when requested. DPA will be conducted on the samples used for visual and mechanical inspection per 4.3.

4.19 Flammability

The encapsulating material, when applicable, shall be certified to meet the minimum flammability requirements of UL-94 V-0 or V-1 and an oxygen index of 28% minimum as defined in ASTM-2863-91. The supplier must provide certificates of compliance to both tests upon request. When UL and oxygen-index testing are not feasible, the IEC "needle-flame" test (IEC 695-2-2), may be used. In all cases, appropriate documentation must be maintained.