

EIA/ECA STANDARD

LOW VOLTAGE SUPPLEMENTAL FUSE QUALIFICATION SPECIFICATION

EIA/ECA-962

MARCH 2006



Electronic Components, Assemblies & Materials Association

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(From PN-5073 formulated under the cognizance of the P-14 Committee on Overcurrent Protection Devices).

Published by

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Technology Strategy & Standards Department
2500 Wilson Boulevard
Arlington, VA 22201

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1 Scope

1.1 Description

This specification defines the qualification program for low voltage, supplemental fuses. Fuses covered will be limited to axial-leaded, radial-leaded and surface mount configurations having a current rating of no greater than 60 A, maximum voltage rating of 600 VAC/DC and interrupting rating of 10,000 A maximum. The qualification program is defined in table 1, and the flow diagram. Specification sheets can be added, as required, to define specific products or to cover unique / specific requirements. This document does not relieve the suppliers of their responsibility to maintain their own company's internal qualification program and the fuses shall continue to meet all applicable requirements of UL 248-14 / CSA-C22.2 No. 248.14.

Three types of fuses are covered in this specification. They include:

- | | |
|------------|---|
| Type I - | The type I fuse is designed to operate (open) within a given time period at 200% overload. The remainder of this specification is written with the 200% overload test as the standard. |
| Type II - | The type II fuse is designed to operate (open) within a given time period at 250% overload. For a Type II fuse, the 250% overload shall be substituted throughout this specification where 200% overload is noted. All other requirements shall continue to be met. |
| Type III - | The type III fuse is designed to operate (open) within a given time period at 300% overload. For a Type III fuse, the 300% overload shall be substituted throughout this specification where 200% overload is noted. All other requirements shall continue to be met. |

1.2 Preconditioning

This process is intended to simulate exposure to the thermal and cleaning environments of the assembly process before qualification testing. The component assembly process simulation requirements for different types of processes are described in annex A.

1.3 Reference documents

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

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-HDBK-H53	Military Handbook - Guide for Attribute Lot Sampling Inspection
UL-94	Tests for Flammability of Plastic Materials

UL-248-1/ CSA-C22.2 No. 248.1	Low-Voltage Fuses, Part 1: General Requirements
UL-248-14 / CSA-C22.2 No. 248.14	Low Voltage Fuses, Part 14: Supplemental Fuses
IEC-60695-2-2	Needle-Flame Test
ASTM-2863	Flammability of Plastics Using the Oxygen Index Method
ANSI/J-STD-002	Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires
EIA 554	Method Selection for Assessment of non Conforming Levels in Parts Per Million (PPM)

2 General requirements

This section includes requirements with the intention of developing a set of robust qualification tests that would enable a supplier to leverage test results to satisfy the requirements of multiple original equipment manufacturer (OEM) customers.

2.1 Objective

The objective of this qualification program is to ensure that the device to be qualified meets a minimum set of stress test driven qualification requirements.

2.2 Generic Data

2.2.1 The use of generic data to satisfy qualification requirements

The use of generic data for qualification will be based on specific requirements associated with each characteristic of the fuse and manufacturing process. These requirements, listed in table 1, are the same for both new processes and re-qualification associated with a process change. A maximum negotiable set of qualification tests must be performed for the appropriate changes proposed for the component. 2.2.2 “Qualification families”, defines the criteria by which components are grouped into a qualification family for the purpose of considering all data from one component to another in the family and generically applicable for qualification. 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 fuses in the family can be accumulated and used to demonstrate their reliability so that qualification testing on new fuses entering a family can be minimized. For example, this can be achieved through extensive qualification and monitoring of the most complex fuse in the reliability family and applied to less complex fuses that subsequently join this family. Sources of generic data should come from supplier-certified test labs, and can include internal supplier’s qualification, user qualifications and supplier’s in-process monitors, as long as the test conditions and endpoint test temperatures address the worst case temperature extremes and designed product life for the

application of the user requesting the qualification.

2.2.2 Qualification families

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 shall represent two different current values within the family (where two different values exist) and be separated by at least one week of manufacture. 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 with adequate yields (to be determined by the supplier). In other words, 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 fuses from the qualification family. Multiple lot samples are specified in table 1, and test samples must be composed of approximately equal numbers from three lots, with each assembly lot being manufactured at least one week apart. When applicable, the samples shall include fuses having current ratings representing at least the lowest and highest values. The three lots may each be made up of one of these current ratings.

2.3.2 Production requirements

All test samples shall be processed, production and/or quality control tested, screened and inspected at the same production site and with the same production process for which the fuse in the qualification family to be qualified will be manufactured for production.

2.3.3 Reusability of test samples

Fuses which have been used for nondestructive qualification tests may be used to populate other qualification tests.

2.3.4 Pre- and post-stress test requirements

All endpoint test temperatures (e.g., room, hot and/or cold) are specified in 4.2 to 4.14. The specific temperature must address the worst case temperature extremes and designed product life for the application of the user requesting the qualification.

2.4 Definition of electrical test failure after stressing

Electrical test failures are defined as those fuses not meeting the individual fuse specification, criteria specific to the test, or the supplier's data sheet.

2.5 Criteria for passing qualification

Passing all appropriate qualification tests qualifies the fuse per this document. Any unique reliability tests or conditions requested by the user and not specified in this document shall be negotiated between the supplier and user requesting the test.

2.6 Alternative testing requirements

The user shall approve all deviations from the qualification requirements and conditions. All deviations shall be clearly reported when the results of the qualification are submitted to the user for approval.

2.7 Disqualification

When the number of failures on the fuse for any given test in table 1 exceeds the acceptance criteria using the procedure in 2.5, the device shall be disqualified until the root cause of the failure(s) is (are) determined and corrective and preventive actions are confirmed to be effective. New samples or data may be requested to verify the above.

3 Qualification and requalification

3.1 Qualification of a new fuse

The stress test requirements and corresponding test conditions for the qualification of a new fuse are listed in table 1. For each qualification, the supplier must present data for all of these tests, either specific to the fuse 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. Electrical characteristics information (DC resistance, voltage drop, current overload and interrupting current capability) shall be available from the supplier upon request.

3.2 Changes requiring requalification

Changes to a fuse, or the processes used in its fabrication, will require retesting as agreed upon between the supplier and the user. The supplier and the user shall 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 as agreed to between the user and supplier qualifies the change per this document. All requalification failures shall be analyzed for root cause, and demonstration of corrective and preventative actions are required.

4 Test methods and requirements

4.1 Sampling plan

Sample size per lot in table 1 is selected from one manufacturing lot. Total sample size per family shall be from a minimum of three manufacturing lots separated by at least one week of manufacture. Only the user can authorize any reduction in this sample size. See figure B.5, Test sequence flow chart.

Table 1 - Fuse qualification test program approval levels and sampling plan

Test Method	Fuse inspection	Sample size per lot	Total sample size per family	Defects permitted
4.1	Sampling plan	210	630	N/A
4.2	Visual and mechanical	5	15	0
4.3	Electrical characteristics	-	-	-
4.3.1	DC resistance	175	525	0
4.3.2	DC voltage drop	5	15	0
4.3.3	Current carrying capacity	70	210	0
4.3.4	Overload operation	110	330	0
4.4	Environmental tests	-	-	-
4.4.1	Life test	40	120	0
4.4.2	Load humidity test	40	120	0
4.4.3	Moisture resistance test	40	120	0
4.5	Terminal strength	15	45	0
4.6	Thermal shock	40	120	0
4.7	Case resistance	5	15	0
4.8	Solderability	-	-	-
4.8.1 4.8.2	Solderability after steam aging	5	15	0
4.8.3	Resistance to dissolution of metallization	5	15	0

4.9	Mechanical shock (Specified Pulse)	5	15	0
4.10	Vibration, high frequency	5	15	0
4.11	Resistance to solvents	5	15	0
4.12	Flammability	-	-	C of C
4.13	Agency approval	-	-	C of C
4.14	Interrupting rating	-	-	C of C
Note - C of C = Certification of compliance				

4.1.1 Fuse mounting

Fuses shall be mounted as specified in annex A, based on fuse type, electrical rating and physical size. Each fuse sample, or test fixture position, shall be permanently and clearly identified with a sample number to permit traceability of each fuse. Testing in accordance with performance tests and environmental tests shall be carried out after the fuses have been appropriately mounted to standard test boards, unless otherwise specified.

4.1.2 Test evaluation

The DC resistance shall be measured before, and after, subjecting the samples to tests specified in 4.3 through 4.11. Any permanent change in resistance and/or voltage drop shall not exceed the values as listed when measurements made prior to testing are compared with resistance after the sample that has undergone testing is permitted to return to steady state room conditions. After exposure to the specified tests, the samples shall: a) not exhibit evidence of physical or mechanical damage, b) be within the specified limits for the respective test and c) continue to be capable of meeting all requirements of UL 248-14 / CSA-C22.2 No. 248.14. Where reference is made to initial test requirements, this shall refer to the measurement of parameters after the fuse has been mounted for test per 4.1.1 “Fuse Mounting”, annex A, where applicable.

4.2 Visual and mechanical examination

Fuses shall be examined to verify that mechanical dimensions, specified materials and contact platings are consistent with requirements defined in EIA-PDP-100 and/or the manufacturer’s drawings that have been approved by the user.

4.2.1 Chips and pinholes

Chips, chipouts and pinholes that expose the element are unacceptable.

4.3 Electrical characteristics

Samples for these tests shall represent the lowest and highest current ratings, where applicable. All samples shall be mounted to test boards per 4.1.1 "Fuse Mounting" and preconditioned per annex A prior to initiating the tests. All electrical tests conducted per 4.3 shall be carried out with the mounted fuses placed on a test fuse base, as shown in figure B.4, or a mutually agreed upon test board or base. Electrical parameters listed shall agree with the manufacturer's specified values. These requirements shall continue to be met after completion of specified testing per 4.3 through 4.14, unless specifically exempted by the user. The fuses will be expected to meet the applicable requirements contained in UL 248-14 / CSA-C22.2 No. 248.14 prior to and after testing.

4.3.1 DC resistance

DC resistance using a 4-wire instrument shall be measured and recorded. This test shall be carried out at $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The reference initial DC resistance will be considered to be that resistance measured after mounting of the fuse to the test board as prescribed in Annex A.

NOTE - Accept/Reject: DC resistance measurements shall remain consistent from lot-to-lot for a given current rating within a tolerance of $\pm 15\%$ for fuses rated at 1 A and above, and $\pm 30\%$ for fuses rated below 1 A, or as specified on the manufacturer's data sheet.

4.3.2 DC voltage drop

DC voltage drop using an appropriate voltmeter or millivoltmeter shall be measured at 100% rated current, unless otherwise noted in the manufacturers data sheet, and recorded. This test shall be carried out at $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ambient, with the fuse having attained temperature stabilization. Stabilization shall be considered as reached if no individual temperature rise reading of 4 consecutive readings taken at 5 minute intervals exceeds the average reading of these 4 readings by more than $2\text{ }^{\circ}\text{C}$, and there is no indication of increasing temperature rise. The reference initial DC voltage drop shall be considered that value measured after mounting the fuse to the test board as prescribed in annex A.

NOTE - Accept/Reject: DC voltage drop shall remain consistent from lot-to-lot for a given current rating within a tolerance of $\pm 15\%$ for fuses rated 1 A and above, and $\pm 30\%$ for fuses rated below 1 A, or as specified on the manufacturer's data sheet.

4.3.3 Current carrying capacity

After completion of the appropriate test, the sample shall be subjected to 100% of its rated current for a minimum of 4 hours, or until stabilization (See 4.3.2) has been reached.

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NOTE - Accept/Reject: The fuses shall not operate (open). There shall be no