AEC - Q200 - Rev E
March 20, 2023

STRESS TEST QUALIFICATION FOR PASSIVE COMPONENTS

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Acknowledgement

Any Document involving a complex technology brings together experience and skills from many sources. The Automotive Electronics Council would especially like to recognize the following significant contributors to the revision of this document:

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This document is dedicated in memoriam to:
Bob Knoell (1957-2018)

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Published by the Automotive Electronics Council.

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STRESS TEST QUALIFICATION FOR PASSIVE ELECTRICAL COMPONENTS

Text enhancements and differences made since the last revision of this document are shown as underlined areas. Several figures and tables have also been revised, but changes to these areas have not been underlined.

Unless otherwise stated herein, the date of implementation of this standard for new qualifications and re-qualifications is as of the publish date above.

1.0 SCOPE

1.1 Description

This specification defines the minimum stress test driven qualification requirements and references test conditions for qualification of passive electrical components. This document does not relieve the component Supplier of their responsibility to meet their own company's internal qualification program or meeting any additional requirements needed by their customers. In this document, "User" is defined as all customers using a component qualified per this specification. The User is responsible to confirm and validate all qualification and assessment data that substantiates conformance to this document.

In using this document, the following shall apply:

- New qualifications, including additions to a qualified family (as stated in Section 2.3), shall use Revision E.
- On-going qualifications to Revision D, at the time of release of Revision E, may continue under Revision D.
- Any changes to an already qualified component (to Revisions A through D) must meet the applicable tests (found in Change Tables) of Revision E.
- Components qualified to previous Revisions A through D remain qualified.
- In all cases, the Supplier must clearly indicate which revision of this document a qualification was performed against in all relevant AEC-Q200 data and reports.

1.2 Purpose

The purpose of this specification is to determine that the component is capable of passing the specified tests and thus can be expected to give a certain level of quality/reliability in the application.

1.3 Reference Documents

The current revision of the referenced documents (shown below) 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.

AEC-Q005	Pb-Free Test Requirements
AEC-Q200-001	Flame Retardance Test
AEC-Q200-002	Human Body Model (HBM) Electrostatic Discharge (ESD) Test
AEC-Q200-004	Measurement Procedures for Resettable Fuses
AEC-Q200-005	Board Flex Test
AEC-Q200-006	Terminal Strength (SMD) / Shear Stress Test
AEC-Q200-007	Voltage Surge Test
EIA-469	Standard Test Method for Destructive Physical Analysis (DPA) for Ceramic Monolithic Capacitors

IATF	Quality Management System for Organizations in the Automotive Industry
IEC 60695-11-5	Fire Hazard Testing – Part 11-5: Test Flames – Needle Flame Test Method, Apparatus, Confirmatory Test Arrangement and Guidance
IEC 60127 Series	Miniature Fuses
IEC 60068-2-21	Robustness of terminations and integral mounting devices
ISO-7637-1	Road Vehicles – Electrical Disturbances from Conduction and Coupling – Part 1: Definitions and General Considerations
J-STD-002	Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires
J-STD-020	Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices
JESD22-A104	Temperature Cycling
JESD22-B100	Physical Dimension
JESD22-B106	Resistance to Solder Shock for Through-Hole Mounted Devices
JIS-C-5101-1	Fixed Capacitors for use in Electronic Equipment – Part 1: Generic Specification
MIL-STD-202	Test Method Standard Electronic and Electrical Component Parts
MIL-STD-883	Test Method Standard Microcircuits
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.4 Abbreviations

The following abbreviations are used within the document

AEC	Automotive Electronic Council
CDC	Certificate of Design and Construction
ESD	Electrostatic Discharge
PCB	Printed Circuit Board
PCN	Product/Process Change Notification
SMD	Surface Mount Device
THT	Through-Hole Technology (Axial and Radial THT)

1.5 Definitions

1.5.1 AEC-Q200 Qualification

Successful completion and documentation of the test results to the requirements outlined in this document allows the Supplier to claim that the component is “AEC-Q200 Qualified”.

The Supplier, in agreement with the User, can perform qualification at sample sizes and conditions less stringent than what this document requires. However, that component cannot be considered “AEC-Q200 Qualified” until such time that the unfulfilled requirements have been successfully completed.

1.5.2 AEC Certification

There are no "certifications" for AEC-Q200 qualification and there is no certification board run by AEC to qualify components. Each Supplier performs their qualification to AEC documents, considers customer requirements and submits the data to the customer to verify compliance to AEC-Q200.

1.5.3 Temperature Ranges

The minimum ambient temperature range for a component to be qualified to this document is -40°C to 85°C. The manufacturer shall qualify their components to their specified ambient temperature range and in accordance with the applicable tables (Tables 1 through 16).

Note: Up to Revision D of this document, two different temperature cycling tests were specified: Temperature Cycling (Test No. 4) and Thermal Shock (Test No. 16). The Thermal Shock test was removed in Rev. D as it was considered that the Temperature Cycling test resulted in adequate thermal stresses since (1) the test requires a relatively fast transition time of 1 minute maximum between Low Temperature to Upper Temperature and (2) more cycles when compared to the Thermal Shock test.

1.5.4 Approval for Use in an Application

"Approval" is defined as user approval for use of the part being qualified in the intended application along with any applicable supplements and compliance to any applicable user packaging specification. The user's method of approval is beyond the scope of this document.

1.5.5 Generic Data

Generic data is relevant data, from a qualification family, that the Supplier can use as a substitute for component-specific data for qualification and requalification. See Section 2.3.

1.5.6 Most Sensitive Component

The most sensitive component within a family is the family member that is most affected by a given test.

2.0 GENERAL REQUIREMENTS

2.1 Objective

The objective of this document is to ensure the component to be qualified meets the qualification requirements detailed in Tables 1 through 16.

2.2 Precedence of Requirements

In the event of conflict in the requirements of this specification and those of any other documents, the following order of precedence applies:

a. The purchase order
b. The User's individual component specification
c. This document
d. The reference documents in Section 1.3 of this document
e. The Supplier's data sheet

For the component to be considered a qualified component, the purchase order and/or individual component specification cannot waive or detract from the requirements of this document.

2.3 The Use of Generic Data

As stated in Section 1.5.5, generic data is relevant data from a qualification family that the Supplier can use as a substitute for component-specific data for qualification and requalification. Generic data reduces the number of samples to qualify as testing of certain components can cover others.

Selection of which component to use in generic qualification testing is based on either:

a. Most sensitive family member (see Section 1.5.6) on a test-by-test basis, or
b. Minimum, middle and maximum value of the primary electrical characteristic of the family members in accordance with Appendix 1 (i.e., for a Capacitor family, capacitor value, voltage, etc.).

The Supplier shall provide reasoning as to the selection of the most sensitive members of the family, on a test-by-test basis. Where the most sensitive member(s) of the family for each test/inspection are not clear then the Supplier shall perform testing using the minimum, middle and maximum values of the given family.

Appendix 1 defines the criteria by which components are grouped into a "qualification family".

Sources of generic data can come from certified test labs, internal Supplier's qualifications, User-specific qualifications, and/or Supplier's in-process monitors. The generic data to be submitted must meet or exceed the test conditions specified in Tables 1 through 16. The User(s) will be the final authority on the acceptance of generic data in lieu of component-specific test data.

2.4 Test Samples

2.4.1 Lot Requirements

Lot requirements are in Table C.

2.4.2 Production Requirements

All qualification components shall be produced on tooling and processes at the manufacturing site that will be used to support component deliveries at projected production volumes.

2.4.3 Reusability of Test Samples

Components used for nondestructive qualification tests may be used to populate other qualification tests. Components that have been used for destructive qualification tests may not be used any further except for engineering analysis.

2.4.4 Sample Size Requirements

Sample sizes used for qualification testing and/or generic data submission must be consistent with the specified minimum sample sizes in Table C. Additionally, the number of samples to be tested per lot may vary depending on the physical size of the component as per Table C. Where generic (family) data is provided instead of component-specific data, three (3) lots are required for all the tests that refer to Note B of Table C. If the qualification is performed on a specific component, only one (1) lot of that data is required, except for ESD (see Note E of Table C).

If the Supplier elects to submit generic data for qualification, the specific test conditions and results must be reported. Existing applicable generic data shall first be used to satisfy these requirements and those of Section 2.3 for each test required in Table C. Component-specific qualification testing shall be performed if the generic data does not satisfy these requirements.

For qualifications with a modified sample size (i.e., different than sample size required in Table C) based on the component type being considered, the Supplier and User can come to an agreement to modify the required number of samples per lot for qualification. Such an agreement may not allow for the Supplier to claim that the part is "AEC Qualified".

2.4.5 Pre-stress and Post-stress Test Requirements

To verify that the component to be qualified meets the components' specification, the pre and post stress tests along with External Visual test are conducted. In general, Electrical Tests, Test Number 1 in Table C, and External Visual, Test Number 9, are conducted before the stress test (pre-stress) and after the stress test (post-stress) as shown in Figure 1.

Figure 1: Pre and Post Stress Test Block Diagram

Pre-stress and post-stress electrical tests are performed at nominal (room) temperature only unless otherwise stated in the "Additional Requirements" column of the applicable test of Tables 1 through 16. Any extreme endpoint test temperatures (e.g., minimum and maximum designed operational per Section 1.5.3 or the component datasheet) are specified in the "Additional Requirements" column of Tables 1 through 16 for each test.

2.4.6 Test Failure

Test failures are those components not meeting (in order of significance as defined in Section 2.2):.

a. The User's individual component specification,
b. Post-test criteria specific to the test, or
c. The manufacturer's data sheet

Any component that shows external physical damage attributable to an environmental test is also considered a failed component. If the cause of failure is agreed (by the Supplier and the User) to be due to mishandling or ESD, the failure shall be discounted, but reported as part of the data submission. Suppliers must describe their parametric fail criteria for each stress test as part of the qualification data submission to the User for approval. A listing of suggested parameters for some component types are included after some component type test tables. The complete listing of failure criteria for each component type and parameter in this document is beyond its scope.

2.4.7 Criteria for Passing Qualification

Passing all appropriate qualification tests specified in Tables 1 through 16, either by performing the test (acceptance of zero failures using the specified minimum sample size) on the specific component or demonstrating acceptable family generic data (using the family definition guidelines defined in Appendix 1 and the total required lot and sample sizes), qualifies the component per this document.

Passing the acceptance criteria (if Table xB is available) of all the tests in Tables 1 through 16 qualifies the component per this document. When the number of failures for any given test in Table C exceeds the acceptance criteria using the procedure herein, the component shall not be qualified until the root cause of the failure(s) is (are) determined and the corrective and preventive actions are implemented and confirmed to be effective in an 8D or other acceptable User format. New samples or data may be requested to verify the corrective and prevented action.

Any unique reliability test or conditions requested by the User and not specified in this document shall be agreed upon between the Supplier and User requesting the test, and will not preclude a component from passing stress-test qualification as defined by this document.

2.4.8 Alternative Requirements

Deviation from the requirements herein does not result in AEC Qualification and components cannot claim "AEC Qualified", unless these deviations exceed the test conditions defined within the document.

Any deviation from what is outlined in this document must be approved by the Users through supporting data presented by the Supplier demonstrating equivalency. These deviations will be clearly reported when the results of the qualification are submitted to the User for approval.

3.0 QUALIFICATION AND REQUALIFICATION

3.1 Qualification of a New Component

Requirements for qualification of a new component are listed in Table C, with the corresponding test conditions listed in Tables 1 through 16. Table E summarizes the stress tests for each passive component covered by this document. For each qualification, the Supplier must present data for ALL of these tests, whether it is stress test results on the component to be qualified or acceptable generic family data. A review is to be made of other components in the same generic family to ensure that there are no common failure mechanisms in that family. Upon request, justification for the use of generic data, whenever it is used, must be demonstrated by the Supplier and approved by the User.

For each component qualification, the Supplier must present:

a. Certificate of Design and Construction (CDC) data (see Appendix 2) for the component to be qualified, and
b. The component(s) used for generic data testing.

Test methodology, requirements and results shall be per the specifications and standards detailed under the "Reference" column of Tables 1 through 16. For example, if the referenced specification requires test samples to be PCB mounted (instead of loose component), the testing shall be conducted as such.

3.2 Qualification of Surface Mounted Device (SMD) Components

For SMD lead-free components, added requirements needed to address the special quality and reliability issues that arise when lead-free (Pb-free) processing is utilized are specified in AEC-Q005: Pb-Free Test Requirements. Materials used in lead-free processing include the termination plating and the board attach (solder). These materials usually require higher board attach temperatures to yield acceptable solder joint quality and reliability. These higher temperatures may adversely affect the moisture sensitivity level of plastic packaged components.

If a change is required to provide adequate robustness for Pb-free processing of the component, then the Supplier should refer to the process change qualification requirements (Tables 1A through 16A) in this specification.

For SMD lead-free components, all components which are to be tested to stresses of the below Table A shall be preconditioned with three (3) reflow passes (reference J-STD-020) unless noted otherwise in Table B. The three (3) passes represent top side, bottom side and one (1) rework. When mounting of the components is required (per the stress test), the initial passes may be done with loose components and the final pass can be used to mount the components on the PCB. If agreed upon between User and Supplier, the number of reflows may be reduced and the Supplier shall make note of this in the qualification report and component datasheet. The Peak Temperature (T_{peak}) during reflow shall be measured in accordance with Table B. Figure 2 shows the overall process.

Moisture pre-conditioning (Moisture Soak) per J-STD-020 is not required.

Table A: Stress Tests Requiring Reflow Passes

Test No.	Stress Test
4	Temperature Cycling
7	Humidity Bias
8	High Temperature Operating Life

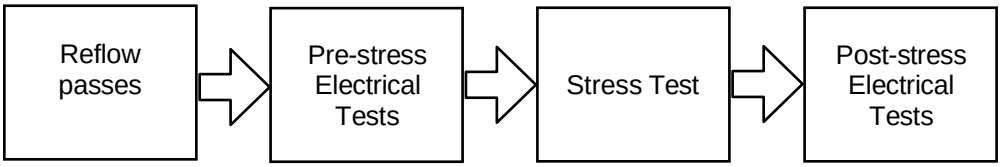

Figure 2: Overall Process for SMD Lead-free Components

High volume components that are > 1cm³ (e.g. film capacitors, aluminum electrolytic capacitors, super capacitors, or inductors etc.) may be preconditioned according to Table B. The Supplier shall make note of this in the qualification report and component datasheet.

Table B: Reflow Passes for High Volume Components

Volume (cm³)	Number of Reflow Pre-Conditioning Passes	Temperature Measurement Location
≤ 1	3 *	Top
>1 to < 2.5	2	Top
≥ 2.5	1	Solder Terminal

* For aluminum electrolytic capacitors, including hybrids and polymers (Table 3) and film capacitors (Table 4) less than 1cm³ shall be preconditioned with two (2) passes as a minimum.

3.3 Requalification of a Component

Requalification of a component or family shall be required when the supplier makes a change to the component or family and/or process that impact the form, fit, function, quality and reliability of the component or family.

3.3.1 Process Change Notification (PCN)

The Supplier shall submit a projection to the Users of all component or process changes influencing the specified data or affecting the processing characteristics, negatively affecting reliability or quality data, changes of materials, manufacturing processes or test methods or each production relocation to another plant. The Supplier shall meet the mutually agreed upon requirements for product/process changes. Information required for submission to the User shall include the following as a minimum or as otherwise agreed upon between Supplier and User:

a. Benefit to the User (value, time and quality).
b. For each User component numbers involved in the change, the following information is required:
   i. Supplier component number
   ii. An estimated date of the last production lot of unchanged components.
   iii. An estimated final order date and final ship date of unchanged components.
   iv. The first projected shipment date and date code of changed components.
c. A detailed description of the change in terms of the materials, processes, visual/electrical/mechanical characteristics, rating, circuit design, internal element layout and size, as applicable.
d. Technical data and rationale to support the proposed changes.

e. If applicable, an electrical characterization comparison (between the new and original component) of all significant electrical parameters over temperature extremes which could be affected by the change. Changes in median and dispersion performances shall be noted even though conformance to specification limits is still guaranteed. This is needed to evaluate any adverse impact on specific end customer applications.

f. The Supplier shall submit an updated Certificate of Design, Construction and Qualification along with information required by this section plus any changes impacting Appendix 2 information as originally submitted.

g. If applicable, the results of completed Supplier requalification tests of the changed component(s).

Items a through e are background information needed up front to evaluate the impact of the change on supply and reliability and to come to agreement on a qualification plan acceptable to the Supplier and User. Items e, f and g must be submitted prior to any final approval to implement any change on the User's product.

3.3.2 Component/Family Changes Requiring Requalification

As a minimum, changes to a component or family shall use Tables 1A through 16A (Process Change Qualification Guidelines) as a guide for determining which tests need to be performed or whether equivalent generic data can be used. These tables are a superset of tests that the Supplier and User should use as a baseline for discussion of tests that are required for the requalification in question. It is the Supplier's responsibility to present rationale for why any of these tests need not be performed or whether any of the tests can be supplemented with generic data. Original test data from the old process (if it exists and is applicable) can be used as a baseline for comparative data analysis. If applicable, Electrical Characterization (Test Number 19) should be performed on a comparative basis. An agreement between the Supplier and the User(s) with justification for performing or not performing any recommended test shall occur before the implementation of a Requalification plan.

3.3.3 Lot/Sample Requirements for Requalification

In case of a single component or family requalification, see Section 2.4.4 “Sample Size Requirements”.

3.3.4 Criteria for Passing Requalification

It is the responsibility of each User to review the data, change notices, and supporting documentation to either approve or reject the change based on the results of the tests performed. All criteria requirements described in Section 2.4.6 apply.

3.3.5 User Approval

A change may not affect a component's qualification status, but may affect its performance in an application. Individual User authorization of a process change will be required for that User's particular application(s), and this method of authorization is outside the scope of this document.

4.0 QUALIFICATION TESTS

4.1 General Tests

Qualification to this specification may be conducted either on a:

a. Family, or
b. Specific (individual) component.

Test details are given in Tables 1 through 16. Not all tests apply to all components. For example, certain tests apply only to hermetically packaged components, while others apply only to SMD large can-components, and so on. The "Additional Requirements" column of Tables 1 through 16 also serves to highlight test requirements that supersede those described in the referenced test.

4.2 Data Submission Format

Data summary shall be submitted similar to the examples given in Appendix 4. Raw data and histograms shall be submitted upon request by the individual User. **All data and documents (e.g., justification for non- performed test, etc.) shall be maintained by the Supplier in accordance with a quality system such as ISO 9001 or IATF 16949.**

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Table C: Qualification Sample Size

Test No.	Stress/Test	Notes	Minimum Sample Size Per Lot Depending on Component Size (cm^3)			Number of Lots		Accept on Number Failed
			< 10	10 ≤ x ≤ 330	> 330	Individual	Family	
1	Pre-and Post-Stress Electrical Test	G	All qualification components unless otherwise specified					0
3	High Temperature Exposure (Storage)	B, D, G, M	77	26	10	1	3	0
4	Temperature Cycling	B, D, G, M	77	26	10	1	3	0
5	Destructive Physical Analysis	B, D, G	10	5	3	1	3	0
7	Humidity Bias	B, D, G, M	77	26	10	1	3	0
8	Operating Life	B, D, G, M	77	26	10	1	3	0
9	External Visual	G, N	All qualification components					0
10	Physical Dimensions	G, N	30	10	4	1	3	0
11	Terminal Strength (THT)	D, G, L	30	10	4	1	3	0
12	Resistance to Solvents	D, G	5	4	3	1	3	0
13	Mechanical Shock	B, D, G	30	10	4	1	3	0
14	Vibration	B, D, G	30	10	4	1	3	0
15	Resistance to Soldering Heat	D, G	30	10	4	1	3	0
17	ESD	D, E	15	6	3	1	3	0
18	Solderability	D, G	15 each condition	6	3	1	3	0
19	Electrical Characterization	G, M, N	30	10	4	3		0
20	Flammability	D	In accordance with Referenced Standards					0
21	Board Flex (SMD)	D, S	30	10	4	1	3	0
22	Terminal Strength (SMD)	D, S	30	10	4	1	3	0
24	Flame Retardance	D, G	30	10	4	1	3	0
25	Rotational Life	D, G	30	10	4	1	3	0
27	Surge Voltage	D, G	30	10	4	1	3	0
30	Electrical Transient Conduction	D, G	30	10	4	1	3	0

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Table C: Qualification Sample Size (continued)

Test No.	Stress/Test	Notes	Minimum Sample Size Per Lot Depending on Component Size (cm^3)			Number of Lots		Accept on Number Failed
			< 10	10 ≤ x ≤ 330	> 330	Individual	Family	
32	Short Circuit Fault Current Durability	D, G	30	10	4	1	3	0
33	Fault Current Durability	D, G	30	10	4	1	3	0
34	End-of-Life Mode Verification	D, G	30	10	4	1	3	0
35	Jump Start Endurance	D, G	30	10	4	1	3	0
36	Load Dump Endurance	D, G	30	10	4	1	3	0

Notes:

B Where generic data is provided instead of component specific data, 3 lots are required for all the tests. Number of allowed failures remains 0 when 3 lots are tested. If the qualification is carried out on the component to be qualified (e.g., expanding an existing product range) only 1 lot of that data is required, which are identified with a specific note.

D Destructive test. Devices are not to be reused for qualification or production.

E For a family qualification, if ESD classification or values are specified by the Supplier, all components within the family (with this ESD value) shall be tested. If no ESD classification or values are specified, generic data may be used.

G Generic data allowed. See Section 2.3.

L Required for through-hole (THT) components only.

M Temperatures specified under “Additional Requirements” shall be understood as ambient chamber temperature rather than component temperature.

N Nondestructive test. Components can be used to populate other tests or they can be used for production.

S Required for surface mount components only.

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Table D: Applicable Stress Qualifications

Test No.	Stress/Test	Component															
		Tantalum and Niobium Capacitors	Ceramic Capacitors	Aluminum Electrolytic Capacitors	Film Capacitors	Magnetics	Networks	Resistors	Thermistors	Trimmer Capacitors/ Resistors	Varistors	Quartz Crystals	Ceramic Resonators	EMI Suppressors / Filters	Polymeric Resettable Fuses	Fuses	Super Capacitors
		Table Number															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pre-and Post-Stress Electrical Test	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	High Temperature Exposure (Storage)	X		X	X	X	X	X	X	X	X	X	X	X		X	X
4	Temperature Cycling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	Destructive Physical Analysis		X											X			
7	Humidity Bias	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	High Temperature Operating Life	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	External Visual	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10	Physical Dimensions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	Terminal Strength (THT)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	Resistance to Solvent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13	Mechanical Shock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	Vibration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	Resistance to Soldering Heat	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
17	ESD		X		X	X	X	X	X	X	X		X	X			
18	Solderability	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Table D: Applicable Stress Qualifications (continued)

Test No.	Stress/Test	Component															
		Tantalum and Niobium Capacitors	Ceramic Capacitors	Aluminum Electrolytic Capacitors	Film Capacitors	Magnetics	Networks	Resistors	Thermistors	Trimmer Capacitors/ Resistor	Varistors	Quartz Crystals	Ceramic Resonators	EMI Suppressors / Filters	Polymeric Resettable Fuses	Fuses	Super Capacitors
		Table Number															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
19	Electrical Characterization	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
20	Flammability			X	X	X	X	X	X	X	X	X		X	X	X	X
21	Board Flex (SMD)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
22	Terminal Strength (SMD)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
24	Flame Retardance							X									
25	Rotational Life									X							
27	Surge Voltage			X													
30	Electrical Transient Conduction										X			X			
32	Short Circuit Fault Current Durability														X		
33	Fault Current Durability														X		
34	End-of-Life Mode Verification														X		
35	Jump Start Endurance														X		
36	Load Dump Endurance														X		

Table 1: Stress Qualifications for Tantalum (MnO_2 and Polymer) and Niobium Capacitors

Stress	No.	Reference	Additional Requirements
Pre-and Post-Stress Electrical Test	1	User Specification	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ 1,000 hours ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temp of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85% RH ▪ Measurement at 24±4 hours after test conclusion. ▪ Rated Voltage Only
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ 2/3 rated voltage ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect component construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 1: Stress Qualifications for Tantalum (MnO2 and Polymer) and Niobium Capacitors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross-sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturers recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 1: Stress Qualifications for Tantalum (MnO_2 and Polymer) and Niobium Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Suppliers' recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount as appropriate to the use-case of the component, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz -2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
Solderability	18	J-STD-002	▪ THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2. ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Pre and Post Electrical Test not required ▪ Magnification 50x ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

Table 1A: Tantalum (MnO2 and Polymer) and Niobium Capacitors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
18. Solderability
19. Electrical Characterization
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

Test # From Table 1	3	4	7	8	9	10	12	13	14	15	18	19	22
MATERIAL													
New / Change Binder Material (anode pressing)	●	●		●					●			B	
New / Change in Anode Powder Category (CV (uC/g))	●	●	●	●								B	
1st usage of Anode powder category (CV (uC/g)) in a voltage range	●	●	●	●								B	
New / Change Cathodic Layer Materials	●	●	●	●								B	
New/ / Change Silver Adhesive	●	●	●	●								B	
New Lead Frame Material	●	●	●	●	●	●		●	●	●	●	B	●
Existing Lead frame - Change External Termination Material/Layers		●	●	●	●	●		●	●	●	●	B	●
PROCESS													
New / Change Anode Pressing technique	●	●		●					●			B	
New Marking							●						
New Assembly Process	●	●	●	●	●	●		●	●	●	●	B	●
DESIGN													
Encapsulation	●	●	●	●	●	●	●				●	B	
Dielectric Thickness	●	●		●						●		B	
Anode Wire Diameter		●		●				●	●				
Existing Lead frame - Change Dimensional / Geometry								●	●	●	●	B	●
MISCELLANEOUS													
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	B	●
Material Suppliers	●	●	●	●			●	●	●	●	●	B	●
New/Modified Mfg. Equipment	●	●	●	●								B	

B = comparative data (unchanged vs. Changed) required

Table 1B: Tantalum (MnO2 and Polymer) and Niobium Capacitors Acceptance Criteria

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

Measured Parameter => AEC-Q200 Test	**Acceptance Criteria** General requirements: 1. Acceptance criteria below apply unless otherwise specified. 2. Supplier spec limits apply, if required parameter is unspecified by the User.			
	Capacitance	**Dissipation factor**	**ESR**	**Leakage current**
1a. Initial limits	Within specified tolerance	Below specified upper limit	Below specified upper limit	Below specified upper limit
1b. Test Conditions	X Hz, y Vrms max. AC, u V max. DC, v C	a Hz, b Vrms max. AC, c V max. DC, d C	m Hz, n C	p% rated DC voltage, q C, 1kohm series resistor, measurement taken after cap is fully charged (typically r minutes)
3. High temp exposure	Change <=x%	Initial limit	Initial limit	Initial limit
4. Temperature cycling	Change <=x%	Initial limit	Initial limit	Initial limit
7. Biased Humidity	Change <=x%	<=a% initial limit	<=m% initial limit	<=p% initial limit
8. Operational Life	Change <=x%	Initial limit	Initial limit	<=p% initial limit
9. External Visual	Per AEC-Q200 – Electrical test not required.			
10. Physical Dimensions	Per AEC-Q200 – Electrical test not required.			
11. Terminal Strength (THT)	Per AEC-Q200 – Electrical test not required.			
12. Resistance to Solvents	Change <=x%	Initial limit	No spec	Initial limit
13. Mechanical Shock	Change <=x%	Initial limit	No spec	Initial limit
14. Vibration	Change <=x%	Initial limit	No spec	Initial limit
15. Resistance to Soldering Heat	Change <=x%	Initial limit	No spec	Initial limit
18. Solderability	Per AEC-Q200 – Electrical test not required.			
19a. Elec. Char. @ 25C	Initial limit	Initial limit	Initial limit	Initial limit
19b. Elec. Char. @ -55C (or specified lower operating temperature limit)	Change <=x%	<=a% Initial limit	No spec	No spec
19c. Elec. Char. @ 85C (or specified upper operating temperature limit)	Change <=x%	Initial limit	No spec	<=p% initial limit
19d. Elec. Char. @ 125C (or specified upper operating temperature limit)	Change <=x%	Initial limit	No spec	<=p% initial limit
20. Flammability	Per AEC-Q200 – Electrical test not required. Present certificate of compliance.			
22. Terminal Strength (SMD)	Per AEC-Q200 – Electrical test not required.			

Table 2: Stress Qualifications for Ceramic Capacitors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Destructive Physical Analysis	5	EIA-469	▪ Pre and Post Electrical Test not required.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85% RH ▪ Measurement at 24±4 hours after test conclusion. ▪ Rated Voltage and 1.3 to 1.5 volts. Add 100Kohm resistor. ▪ For ceramic capacitors that have internal electrodes with no silver content the low voltage portion of this test may be excluded.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Rated voltage ▪ The maximum rated temperature and voltage rating for the dielectric employed in the component shall be used. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect component construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 2: Stress Qualifications for Ceramic Capacitors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross-sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 2: Stress Qualifications for Ceramic Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz.
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Pre and Post Electrical Test not required. ▪ Magnification 50x ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

Table 2A: Ceramic Capacitors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

4. Temperature Cycling
5. Destructive Physical Analysis
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 2	4	5	7	8	9	10	11	12	13	14	15	17	18	19	21	22
MATERIAL																
Binder Material	●	●								●						
Dielectric Change	●	●	●	●			●	●	●	●		●		B	●	
Electrode Attach	●			●							●			B	●	●
Electrode Material	●	●	●	●			●	●		●		●		B		
Encapsulation	●		●		●	●		●								
Lead Material	●	●		●	●		●			●	●		●	B		
PROCESS																
Dicing	●		●		●	●		●	●					B		
Electrode Apply			●											B	●	
Firing Profile	●	●		●								●		B		
Lamination/Press Technique		●	●								●			B	●	
Powder Particle Size	●		●								●	●		B	●	
Screening/Printing				●					●			●		B		
Termination Process	●	●	●	●	●	●	●	●	●	●	●		●	B	●	●
DESIGN																
Electrode Thickness	●	●		●		●			●	●		●		B		
Layer Thickness	●	●	●	●		●	●		●			●		B		
Lead Diameter	●		●	●	●	●	●			●						
Number of Layers	●	●	●	●		●			●			●		B		
Termination Area					●	●				●					●	●
Terminal Interface	●	●	●	●			●		●	●	●			B	●	●
MISCELLANEOUS																
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●
Material Suppliers	●	●	●	●			●	●	●	●	●	●	●	B	●	●
New/Modified Mfg. Equipment	●		●	●		●	a			●		●	●	B		

a = termination equipment only B = comparative data (unchanged vs. Changed) required

Table 2B-1: Ceramic Capacitors – Class I SMD Acceptance Criteria

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

	Acceptance Criteria		
Measured Parameter => AEC-Q200 Test:	**Capacitance**	**Q**	**Insulation Resistance**
1a. Initial limits	Within specified limits	Within specified limits	Within specified limits
4. Temperature cycling	Change <= greater of +/-x% or +/-y pF	Initial limit	Initial limit
5. Destructive physical analysis	Per AEC-Q200 – Electrical test not required.		
7. Biased Humidity	Change <= greater of +/-x% or +/-y pF	<a pF: Q >= b + (c /pf * C) >=a pF: Q >= d% initial	>= m% Initial limit
8. Operational Life	Change <= greater of +/-x% or +/-y pF	<a pF: Q >= b + (c /pf * C) d pF to e pF: Q>= f + (g /pf * C) >= h pF: Q >= i	>= m% Initial limit
9. External Visual	Per AEC-Q200 – Electrical test not required.		
10. Physical Dimensions	Per AEC-Q200 – Electrical test not required.		
12. Resistance to Solvents	Initial limit	Initial limit	Initial limit
13. Mechanical Shock	Initial limit	Initial limit	Initial limit
14. Vibration	Initial limit	Initial limit	Initial limit
15. Resistance to Soldering Heat	Change <= greater of +/-x% or +/-y pF	Initial limit	Initial limit
17. ESD	Initial limit	Initial limit	Initial limit
18. Solderability	Per AEC-Q200 – Electrical test not required.		
19a. Elec. Char. @ 25ºC	Initial limit	Initial limit	Initial limit
	Dielectric Withstanding Voltage: 250% rated voltage		
19b. Elec. Char. @ -55ºC	Change <= +/-x%	No spec	No spec
19c. Elec. Char. @ 125ºC	Change <= +/-x%	No spec	>= m% Initial limit
21. Board Flex	Initial limit	Initial limit	Initial limit
	>=x mm (record deflection at point of electrical failure)		
22. Terminal Strength (SMD)	Initial limit	Initial limit	Initial limit
	0603 and greater: x N 0402 and less: y N		

Table 2B-2: Ceramic Capacitors – Class II/III SMD Acceptance Criteria

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the user and supplier.

	Acceptance Criteria		
Measured Parameter => AEC-Q200 Test	**Capacitance**	**Dissipation Factor**	**Insulation Resistance**
1a. Initial limits	Within specified limits	Within specified limits	Within specified limits
4. Temperature cycling	Change <= +/-x %	Initial limit	Initial limit
5. Destructive physical analysis	Per AEC-Q200 – Electrical test not required.		
7. Biased Humidity	Change <= +/-x%	< a% initial	>= m% Initial limit
8. Operational Life	Change <= +/-x%	< a% initial	>= m% Initial limit
9. External Visual	Per AEC-Q200 – Electrical test not required.		
10. Physical Dimensions	Per AEC-Q200 – Electrical test not required.		
12. Resistance to Solvents	Initial limit	Initial limit	Initial limit
13. Mechanical Shock	Initial limit	Initial limit	Initial limit
14. Vibration	Initial limit	Initial limit	Initial limit
15. Resistance to Soldering Heat	Change <= +/-x%	Initial limit	Initial limit
17. ESD	Initial limit	Initial limit	Initial limit
18. Solderability	Per AEC-Q200 – Electrical test not required.		
19a. Elec. Char. @ 25ºC	Initial limit	Initial limit	Initial limit
	Dielectric Withstanding Voltage: 250% rated voltage		
19b. Elec. Char. @ -55ºC	Change <= +/-x%	No spec	No spec
19c. Elec. Char. @ 125ºC	Change <= +/-x%	No spec	>= m% Initial limit
21. Board Flex	Initial limit	Initial limit	Initial limit
	>= x mm (record deflection at point of electrical failure)		
22. Terminal Strength (SMD)	Initial limit	Initial limit	Initial limit
	0603 and greater: x N 0402 and less: y N		

Table 3: Stress Qualifications for Aluminum Electrolytic (Hybrid, Polymer and Standard) Capacitors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ 1,000 hours ▪ Upper category temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be at least 85°C. ▪ Measurement at 24±4 hours after test conclusion.

Temperature Cycling	4	JESD22-A104	▪ Unpowered
			▪ 1,000 Cycles
			▪ Lower Temperature of the Chamber: -40°C
			▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C.
			▪ Dwell Time (Soak Time):
			  ○ 15 minutes minimum,
			  ○ 30 minutes minimum if component weighs above 28g
			▪ Transition Time: 1 minute maximum
			▪ Measurement at least 24 hours after test conclusion.
			▪ Peeling, flaking, chipping, bubbling or shrinking of insulation sleeve is acceptable.

Humidity Bias	7	MIL-STD-202 Method 103	▪ Rated Voltage ▪ 1,000 hours ▪ 85°C/85%RH for hybrid and standard. ▪ 60°C/90%RH for solid polymers ▪ Measurement at 24±4 hours after test conclusion. ▪ Peeling, flaking, chipping, bubbling or shrinking of insulation sleeve is acceptable.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Rated Voltage ▪ Temperature of the Chamber: the maximum permissible ambient temperature at which the capacitor may be continuously operated at rated conditions. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect component construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component detail specification. Note: User(s) and Suppliers spec. ▪ Pre and Post Electrical Test not required.

Table 3: Stress Qualifications for Aluminum Electrolytic (Hybrid, Polymer and Standard) Capacitors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ Capacitors with sleeve in addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ All others: follow MIL-STD-202, Method 215
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213.
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 3: Stress Qualifications for Aluminum Electrolytic (Hybrid, Polymer and Standard) Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition J or K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
Solderability	18	J-STD-002	▪ THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Pre and Post Electrical Test not required. ▪ Magnification 50x ▪ Applicable to axial/radial THT, SMD and snap-in. ▪ Does not apply to press-fit or screw-in terminal types. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification	▪ Parametrically test per lot and sample size requirements ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 3: Stress Qualifications for Aluminum Electrolytic (Hybrid, Polymer and Standard) Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Surge Voltage	27	JIS-C-5101-1	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

Table 3A: Aluminum Electrolytic (Hybrid, Polymer and Standard) Capacitors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3.	High Temperature Exposure (Storage)	13.	Mechanical Shock	27	Surge Voltage
4.	Temperature Cycling	14.	Vibration		
7.	Biased Humidity	15.	Resistance to Soldering Heat		
8.	Operational Life	18.	Solderability		
9.	External Visual	19.	Electrical Characterization		
10.	Physical Dimension	20.	Flammability		
11.	Terminal Strength (THT)	21.	Board Flex		
12.	Resistance to Solvents	22.	Terminal Strength (SMD)		

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 3	3	4	7	8	9	10	11	12	13	14	15	18	19	20	21	22	27
MATERIAL																	
End Seal		●	●	●	●	●		●						●			
Housing		●				●			●					●			
Sleeving		●		●	●	●		●						●			
Lead/Termination							●			●	●	●	B		●	●	
PROCESS																	
Curing		●	●	●		●							B				●
Impregnation method	●	●		●									B				●
Terminal Attach		●					●		●		●		B		●	●	
Winding		●		●						●			B				
DESIGN																	
Electrolyte Change	●	●		●									B				●
Foil Design		●		●									B				●
Insulation Change		●		●									B				●
MISCELLANEOUS																	
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●	●	●
Material Suppliers	●	●	●				●	●	●	●	●	●	B	●	●	●	
New/Modified Mfg. Equipment		●		●		●	●		●	●			B				●

B = comparative data (unchanged vs. Changed) required

Table 4: Stress Qualifications for Film Capacitors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ 1,000 hours. ▪ Upper Temperature: maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum permissible ambient temperature at which the capacitor may be continuously operated at rated conditions. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ Rated Voltage ▪ 1,000 hours ▪ 40°C/93%RH ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: the maximum permissible ambient temperature at which the capacitor may be continuously operated at rated conditions. ▪ 125% of rated voltage at 85°C. ▪ 100% of rated voltage above 85°C. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 4: Stress Qualifications for Film Capacitors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test)
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 4: Stress Qualifications for Film Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition J or K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	▪ Not applicable for charges V x C (nF) ≥ 100
Solderability	18	J-STD-002	▪ THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 4: Stress Qualifications for Film Capacitors (continued)			
Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

Table 4A: Film Capacitors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 4	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22
MATERIAL																	
Epoxy	●	●	●	●	●	●		●	●	●					●		
Housing		●	●	●	●	●	●		●	●			●				
Lead/Termination						●	●		●		●		●	**B**		●	●
PROCESS																	
Epoxy Fill	●	●	●	●	●			●									
Terminal attach		●		●			●	●						**B**		●	●
Winding	●			●								●		**B**			
DESIGN																	
Foil Design		●		●								●		**B**			
Insulation Change		●		●								●		**B**			
MISCELLANEOUS																	
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	●	**B**	●	●	●
Material Suppliers	●	●		●			●	●		●	●		●		●		●
New/Modified Mfg. Equipment		●		●			●					●		**B**			●

B = comparative data (unchanged vs. Changed) required

Table 5: Stress Qualifications for Magnetics (Inductors/Transformers)

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ 1,000 hours ▪ Upper Temperature: maximum specified operating temperature or maximum specified storage temperature (whichever is higher). ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -40°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ Unpowered ▪ 1,000 hours ▪ 85°C/85%RH ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Upper Temperature of the Chamber: maximum specified operating temperature (not including heat rise) at maximum rated power and shall not exceed 125°C. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component detail specification. ▪ Pre and Post Electrical Test not required.

Table 5: Stress Qualifications for Magnetics (Inductors/Transformers) (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test)
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
▪ Note: the values and formulas are per IEC 60068-2-21, 6th Edition
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213.
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method
</td></tr>
<tr><td>Vibration</td><td>14</td><td>MIL-STD-202 Method 204</td><td>
▪ 5g's for 20 minutes
▪ 12 cycles each of 3 orientations.
▪ Tested per the Supplier's recommended mounting method
▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device.
▪ Test from 10 Hz - 2000 Hz.
</td></tr>
</table>

Table 5: Stress Qualifications for Magnetics (Inductors/Transformers) (continued)

Stress	No.	Reference	Additional Requirements
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements,(inductance only unless otherwise agreed upon) ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

Table 5A: Magnetics (Inductors/Transformers) Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given components under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 5	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22
MATERIAL																	
Bobbin material	●	●	●	●	●				●						●		
Core material		●		●	●				●					B	●		
Insulation material	●	●	●	●	●			●			●	a		B	●		
Lead material				●	●		●			●	●		●			●	●
Mold material	●	●	●	●	●			●	●					B	●		
Solder material		●			●		●		●	●			●			●	●
Wire/foil material			●	●	●							●		B		●	●
PROCESS																	
Insulation strip					●			●			●						
Lead prep/plating		●			●		●			●	●		●			●	●
Terminal Attach		●			●		●		●	●	a		●				
Marking					●			●									
Molding	●	●	●	●	●	●		●	●					B	●		
Soldering		●			●		●			●			●			●	●
Winding - Insulation			●	●				●			●	a		B			
Winding - Wire				●	●									B			
DESIGN																	
Bobbin		●			●	●			●			●		B			
Core		●			●	●			●	●				B			
Insulation system			●	●	●	●		●			●	a		B	●		
Lead					●	●	●			●	●	●	●			●	●
Mold		●			●	●		●	●					B			
Wire/foil		●			●	●								B		●	●
MISCELLANEOUS																	
Mfg. Site Transfer	●	●		●			●				●			B			●
Material Suppliers		●			●	●	●							B			
Process Control Change					●	●											

a = Multilayer only B = comparative data (unchanged vs. Changed) required

Table 6: Stress Qualifications for Networks (R-C/C/R)			
Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ 1,000 hours. ▪ Unpowered ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Capacitor Networks: Rated Voltage ▪ Resistor Networks: 10% Rated Power (for components with specified operating voltages higher or equal to 500V, 10% of operating voltage). ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature at maximum rated voltage ▪ Capacitor Networks: rated voltage ▪ Resistor Networks: Power shall be applied to the component intermittently: 90 minutes ON and 30 minutes OFF. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 6: Stress Qualifications for Networks (R-C/C/R) (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 6: Stress Qualifications for Networks (R-C/C/R) (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: within 1.5mm of component body Condition B C, or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification	▪ Parametrically test per lot and sample size requirements ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 6: Stress Qualifications for Networks (R-C/C/R) (continued)			
Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Flame Retardance	24	AEC-Q200-001	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

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Table 6A: Networks (R-C/C/R) Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
24 Flame Retardance

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 6	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	24
MATERIAL																		
Ink/Wire Material	●	●		●			**W**					**F**		**B**		●	●	**R**
Package	●	●	●		●	●	●	●		●		●			●	●	●	**R**
Passivation	●	●	●	●				●							●			**R**
Substrate Material		●	●	●			●				●		●	**B**		●	●	
PROCESS																		
Ink Fire		●		●			**R**							**B**				
Ink Print	●	●		●			**R**							**B**		**R**	**R**	**R**
Laser Trim			●	●										**B**				
Lead Form			●		●	●	●						●	**B**				
Termination Attach			●				●		●		●			**B**				
Marking					●			●										
Molding	●	●	●		●	●	●	●		●		●			●	●	●	**R**
DESIGN																		
Package	●	●	●		●	●	●	●		●	●	●	●		●	●	●	**R**
Passivation	●	●	●	●				●							●			**R**
Res/Cap Tolerance	●	●		●							●	●		**B**				
Res/Cap Value	●	●		●							●	●		**B**				**R**
MISCELLANEOUS																		
Mfg. Site Transfer	●	●	●	●	●	●	●	●			●	●		**B**		●	●	**R**
Material Suppliers		●				●	●	●			●	●		**B**	●			**R**
New/Modified Mfg. Equipment		●		●								●		**B**				

B = comparative data (unchanged vs. Changed) required F = Film products only
R = Resistors Only W = Wirewound products only

Table 7: Stress Qualifications for Resistors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Upper Temperature: maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ 1,000 hours ▪ Unpowered ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature but shall not exceed 155°C ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ 10% of operating power (for components with specified operating voltages higher or equal to 500V, 10% of operating voltage) ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Power shall be applied to the component intermittently: 90 minutes ON and 30 minutes OFF ▪ Temperature of the Chamber: maximum specified operating temperature at 100% rated power without derating ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 7: Stress Qualifications for Resistors (continued)

Stress	No.	Reference	Additional Requirements
Terminal Strength (for axial and radial THT components)	11	MIL-STD-202 Method 211	▪ Test THT component lead integrity only. ▪ Test Condition A (pull test): Nominal cross- sectional area (mm^2) / Force (N): ≤ 0.05 / 1; 0.06 to 0.10 / 2.5; 0.11 to 0.20 / 5; 0.21 to 0.50 / 10; 0.51 to 1.20 / 20; > 1.20 / 40 ▪ Test Condition C (wire-lead bend test): Section Modulus (Z_X) (mm^3) / Force (N): ≤ $1.5x10^{-3}$ / 0.5; $1.6x10^{-3}$ to $4.2x10^{-3}$ / 1.25; $4.3x10^{-3}$ to $1.2x10^{-2}$ / 2.5; $1.3x10^{-2}$ to $0.5x10^{-1}$ / 5; $0.6x10^{-1}$ to $1.9x10^{-1}$ / 10; > $1.9x10^{-1}$ / 20 For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter. For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip. Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
Resistance to Solvents	12	MIL-STD-202 Method 215	▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time). ▪ Applicable to ink marked components and not laser marked components.
Mechanical Shock	13	MIL-STD-202 Method 213	▪ Figure 1 of Method 213 ▪ THT: Condition C ▪ SMD: Condition C ▪ Tested per the Supplier's recommended mounting method

Table 7: Stress Qualifications for Resistors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: within 1.5mm of device body, Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 7: Stress Qualifications for Resistors (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Flame Retardance	24	AEC-Q200-001	Pre and Post Electrical Test not required.

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

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Table 7A: Resistors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
24 Flame Retardance

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 7	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	24
MATERIAL																		
Ink/Wire Material	●	●		●			W					F		B		●	●	R
Package	●	●	●		●	●	●	●		●		●			●	●	●	R
Passivation	●	●	●	●				●							●			R
Substrate Material		●	●	●			●				●		●	B		●	●	
PROCESS																		
Ink Fire		●		●			R							B				
Ink Print	●	●		●			R							B		R	R	R
Laser Trim			●	●										B				
Lead Form			●		●	●	●						●	B				
Termination Attach			●				●		●		●			B				
Marking					●			●										
Molding	●	●	●		●	●	●	●		●		●			●	●	●	R
DESIGN																		
Package	●	●	●		●	●	●	●		●	●	●	●		●	●	●	R
Passivation	●	●	●	●				●							●			R
Res/Cap Tolerance	●	●		●							●	●		B				
Res/Cap Value	●	●		●							●	●		B				R
MISCELLANEOUS																		
Mfg. Site Transfer	●	●	●	●	●	●	●	●			●	●		B		●	●	R
Material Suppliers		●				●	●	●			●	●		B	●			R
New/Modified Mfg. Equipment		●		●								●		B				

B = comparative data (unchanged vs. Changed) required F = Film products only
R = Resistors Only W = Wirewound products only

Table 7B-1: Acceptance Criteria for Carbon Film THT Fixed Resistors

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

AEC-Q200 Test	Acceptance Criteria
	Resistance
1. Initial Limits	Within specified tolerance
3. High Temperature Exposure (storage)	±x% +yΩ
4. Temperature Cycling	±x% +yΩ
7. Biased Humidity	±x% +yΩ
8. Operational Life	±x% +yΩ
9. External Visual	Per AEC-Q200 - Electrical test not required
10. Physical Dimensions	Per AEC-Q200 - Electrical test not required
11. Terminal Strength (leaded)	±x%
12. Resistance to Solvents	Marking must remain legible
13. Mechanical Shock	±x% +yΩ
14. Vibration	±x% +yΩ
15.Resistance to Soldering Heat	±x% +yΩ
17. ESD	Per AEC-Q200-002
18. Solderability	Per AEC-Q200 - Electrical test not required
19a. Elec. Char. @25ºC	Initial limit
19b. Elec. Char. @Min. operating temp.	Initial limit Ω change allowed over temp. range
19c. Elec. Char. @Max operating temp.	Initial limit Ω change allowed over temp. range
20. Flammability	Per AEC-Q200 - Electrical test not required
24. Flame Retardance	See AEC-Q200-001

Significant characteristics:

1. D.C. Resistance
2. Temperature Coefficient of Resistance

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Table 7B-2: Acceptance Criteria for Metal Film THT Fixed Resistors (Includes molded flat lead SMD)

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

AEC-Q200 Test	Acceptance Criteria
	Resistance
1. Initial Limits	Within specified tolerance
3. High Temperature Exposure (storage)	±x% +yΩ
4. Temperature Cycling	±x% +yΩ
7. Biased Humidity	±x% +yΩ
8. Operational Life	±x% +yΩ
9. External Visual	Per AEC-Q200 - Electrical test not required
10. Physical Dimensions	Per AEC-Q200 - Electrical test not required
11. Terminal Strength (leaded)	±x% +yΩ
12. Resistance to Solvents	Marking must remain legible
13. Mechanical Shock	±x% +yΩ
14. Vibration	±x% +yΩ
15.Resistance to Soldering Heat	±x% +yΩ
17. ESD	Per AEC-Q200-002
18. Solderability	Per AEC-Q200 - Electrical test not required
19a. Elec. Char. @25ºC	Initial limit
19b. Elec. Char. @Min. operating temp.	Initial limit ± change allowed over temp. range
19c. Elec. Char. @Max operating temp.	Initial limit ± change allowed over temp. range
20. Flammability	Per AEC-Q200 - Electrical test not required
21. Board Flex (SMD)	N/A
22. Terminal Strength (SMD)	N/A
24. Flame Retardance	See AEC-Q200-001

Significant characteristics:

1. D.C. Resistance
2. Temperature Coefficient of Resistance

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Table 7B-3: Acceptance Criteria for Metal Oxide THT Fixed Resistors

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

AEC-Q200 Test	Acceptance Criteria
	Resistance
1. Initial Limits	Within specified tolerance
3. High Temperature Exposure (storage)	±x% +yΩ
4. Temperature Cycling	±x% +yΩ
7. Biased Humidity	±x% +yΩ
8. Operational Life	±x% +yΩ
9. External Visual	Per AEC-Q200 - Electrical test not required
10. Physical Dimensions	Per AEC-Q200 - Electrical test not required
11. Terminal Strength (leaded)	±x% +yΩ
12. Resistance to Solvents	Marking must remain legible
13. Mechanical Shock	±x% +yΩ
14. Vibration	±x% +yΩ
15.Resistance to Soldering Heat	±x% +yΩ
17. ESD	Per AEC-Q200-002
18. Solderability	Per AEC-Q200 - Electrical test not required
19a. Elec. Char. @25ºC	Initial limit
19b. Elec. Char. @Min. operating temp.	Initial limit ± change allowed over temp. range
19c. Elec. Char. @Max operating temp.	Initial limit ± change allowed over temp. range
20. Flammability	Per AEC-Q200 - Electrical test not required
24. Flame Retardance	See AEC-Q200-001

Significant characteristics:

1. D.C. Resistance
2. Temperature Coefficient of Resistance

Table 7B-4: Acceptance Criteria for Wire Wound THT Fixed Resistors (Includes molded flat lead SMD)

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

AEC-Q200 Test	Acceptance Criteria
	Resistance
1. Initial Limits	Within specified tolerance
3. High Temperature Exposure (storage)	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±a% +bΩ
4. Temperature Cycling	±x% +yΩ
7. Biased Humidity	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
8. Operational Life	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
9. External Visual	Per AEC-Q200 - Electrical test not required
10. Physical Dimensions	Per AEC-Q200 - Electrical test not required
11. Terminal Strength (leaded)	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
12. Resistance to Solvents	Marking must remain legible
13. Mechanical Shock	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
14. Vibration	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
15.Resistance to Soldering Heat	Technologies J and K (Crimped): ±x% +yΩ Technology H (Welded): ±x% +yΩ
17. ESD	Per AEC-Q200-002
18. Solderability	Per AEC-Q200 - Electrical test not required
19a. Elec. Char. @25ºC	Initial limit
19b. Elec. Char. @Min. operating temp.	Initial limit ± change allowed over temp. range
19c. Elec. Char. @Max operating temp.	Initial limit ± change allowed over temp. range
20. Flammability	Per AEC-Q200 - Electrical test not required
24. Flame Retardance	See AEC-Q200-001

Significant characteristics:

1. D.C. Resistance
2. Temperature Coefficient of Resistance

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Table 7B-5: Acceptance Criteria for SMD Chip Resistors (Does not include molded flat lead SMD, but does include coated metal strip)

Note: The contents in this table are meant to serve as examples of wording or limits for each test and relative parameter to be measured and NOT actual requirements. Variables are denoted by lower-case letters (e.g., x, y). The measured parameters, values and wording of each acceptance criteria for each test should be agreed to between the User and Supplier.

AEC-Q200 Test	Acceptance Criteria
	Resistance
1. Initial Limits	Within specified tolerance
3. High Temperature Exposure (storage)	±x% +yΩ
4. Temperature Cycling	±x% +yΩ
7. Biased Humidity	Technologies L, M, and U: ±x% +yΩ Technologies N, P, R and T : ±x% +yΩ
8. Operational Life	Technologies L, M, N and U: ±x% +yΩ Technologies P, R and T : ±x% +yΩ
9. External Visual	Per AEC-Q200 - Electrical test not required
10. Physical Dimensions	Per AEC-Q200 - Electrical test not required
12. Resistance to Solvents	Marking must remain legible
13. Mechanical Shock	±x% +yΩ
14. Vibration	±x% +yΩ
15.Resistance to Soldering Heat	Technologies L, M, and U: ±x% +yΩ Technology N: ±x% +yΩ Technologies P, R, and T : ±x% +yΩ
17. ESD	Per AEC-Q200-002
18. Solderability	Per AEC-Q200 - Electrical test not required
19a. Elec. Char. @25ºC	Initial limit
19b. Elec. Char. @Min. operating temp.	Initial limit ± change allowed over temp. range
19c. Elec. Char. @Max operating temp.	Initial limit ± change allowed over temp. range
20. Flammability	Per AEC-Q200 - Electrical test not required
21. Board Flex (SMD)	±x% +yΩ
22. Terminal Strength (SMD)	0603 and greater: x N 0402 and less: y N
24. Flame Retardance	See AEC-Q200-001

Significant characteristics:

1. D.C. Resistance
2. Temperature Coefficient of Resistance

Table 8: Stress Qualifications for Thermistors (NTC, Platinum, Ceramic PTC)

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ 1,000 hours ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum, o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Ceramic PTC: Biased at 20% of rated hold current or 10% of rated power or voltage. ▪ All other: 10% rated power, unless the thermistor resistance during the test violates its specified value for the applied test temperature +0.2 K due to self-heating. In this case, the applied power shall be reduced to ensure the resistance limit. ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Heater-type Ceramic PTC: Rated voltage ▪ Non heater-type Ceramic PTC: Rated hold current or 50% of rated voltage. ▪ All other: 10% rated power, unless the thermistor resistance during the test violates its specified value for the applied test temperature +0.2 K due to self-heating. In this case, the applied power shall be reduced to ensure the resistance limit. ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C ▪ Measurement at 24±4 hours after test conclusion.

Table 8: Stress Qualifications for Thermistors (NTC, Platinum, Ceramic PTC) (continued)

Stress	No.	Reference	Additional Requirements
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.
Terminal Strength (for axial and radial THT components)	11	MIL-STD-202 Method 211	▪ Test THT component lead integrity only. ▪ Test Condition A (pull test): Nominal cross- sectional area (mm^2) / Force (N) ≤ 0.05 / 1 0.06 to 0.10 / 2.5 0.11 to 0.20 / 5 0.21 to 0.50 / 10 0.51 to 1.20 / 20 > 1.20 / 40 ▪ Test Condition C (wire-lead bend test): Section Modulus (Z_X) (mm^3) / Force (N) ≤ $1.5x10^{-3}$ / 0.5 $1.6x10^{-3}$ to $4.2x10^{-3}$ / 1.25 $4.3x10^{-3}$ to $1.2x10^{-2}$ / 2.5 $1.3x10^{-2}$ to $0.5x10^{-1}$ / 5 $0.6x10^{-1}$ to $1.9x10^{-1}$ / 10 > $1.9x10^{-1}$ / 20 For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter. For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip. Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
Resistance to Solvents	12	MIL-STD-202 Method 215	▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time). ▪ Applicable to ink marked components and not laser marked components.
Mechanical Shock	13	MIL-STD-202 Method 213	▪ Figure 1 of Method 213 ▪ THT: Condition C ▪ SMD: Condition C ▪ Tested per the Supplier's recommended mounting method.

Table 8: Stress Qualifications for Thermistors (NTC, Platinum, Ceramic PTC) (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz.
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: within 1.5mm of device body, Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s, remove carrier ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room or 0°C, minimum and maximum operating temperatures (or other temperatures as defined by Supplier). ▪ Pre and Post Electrical Test not required.

Table 8: Stress Qualifications for Thermistors (NTC, Platinum, Ceramic PTC) (continued)			
Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
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TABLE 8A: Thermistors (NTC, Platinum, Ceramic PTC) Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

Test # From Table 8	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22
MATERIAL																	
Ink Material	●	●	●	●								●		**B**			
Protective Coat	●	●															
Substrate Material									●		●		●		●		
PROCESS																	
Lead Form					●	●	●							**B**		●	●
Marking					●			●									
Molding	●	●			●	●		●		●	●		●		●		
Termination Attach			●	●			●		●			●	●	**B**		●	●
DESIGN																	
Package	●	●	●	●	●	●	●	●	●	●	●		●		●		
Thermistor Value	●	●		●								●		**B**			
Thermistor Tolerance	●	●		●							●	●		**B**			
MISCELLANEOUS																	
Mfg. Site Transfer	●	●		●	●	●	●		●	●	●	●	●	**B**	●	●	●
Material Suppliers		●		●			●	●			●		●	**B**	●	●	●

B = comparative data (unchanged vs. Changed) required

Table 9: Stress Qualifications for Trimmer Capacitors/Resistors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C ▪ 1,000 hours ▪ Unpowered ▪ Measurement at 24±4 hours after test conclusion.

Temperature Cycling	4	JESD22-A104	▪ Unpowered
			▪ 1,000 Cycles
			▪ Lower Temperature of the Chamber: -55°C
			▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C.
			▪ Dwell Time (Soak Time):
			  ○ 15 minutes minimum,
			  ○ 30 minutes minimum if component weighs above 28g
			▪ Transition Time: 1 minute maximum
			▪ Measurement at least 24 hours after test conclusion.

Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH. ▪ Capacitor Networks: Rated Voltage ▪ Resistor Networks: 10% Rated Power ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C ▪ Trimmer Resistor: de-rated power at temperature ▪ Trimmer Capacitor: Rated Voltage ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 9: Stress Qualifications for Trimmer Capacitors/Resistors (continued)

Stress	No.	Reference	Additional Requirements
Terminal Strength (for axial and radial THT components)	11	MIL-STD-202 Method 211	▪ Test THT component lead integrity only. ▪ Test Condition A (pull test): Nominal cross- sectional area (mm^2) / Force (N): ≤ 0.05 / 1; 0.06 to 0.10 / 2.5; 0.11 to 0.20 / 5; 0.21 to 0.50 / 10; 0.51 to 1.20 / 20; > 1.20 / 40 ▪ Test Condition C (wire-lead bend test): Section Modulus (Z_X) (mm^3) / Force (N): ≤ $1.5x10^{-3}$ / 0.5; $1.6x10^{-3}$ to $4.2x10^{-3}$ / 1.25; $4.3x10^{-3}$ to $1.2x10^{-2}$ / 2.5; $1.3x10^{-2}$ to $0.5x10^{-1}$ / 5; $0.6x10^{-1}$ to $1.9x10^{-1}$ / 10; > $1.9x10^{-1}$ / 20 For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter. For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip. Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
Resistance to Solvents	12	MIL-STD-202 Method 215	▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time). ▪ Applicable to ink marked components and not laser marked components.
Mechanical Shock	13	MIL-STD-202 Method 213	▪ Figure 1 of Method 213 ▪ THT: Condition C ▪ SMD: Condition C ▪ Tested per the Supplier's recommended mounting method.

Table 9: Stress Qualifications for Trimmer Capacitors/Resistors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: within 1.5mm of device body, Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 9: Stress Qualifications for Trimmer Capacitors/Resistors (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Rotational Life	25	MIL-STD-202 Method 206	▪ Condition A

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 9A: Trimmer Capacitors/Resistors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
25 Rotational Life

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 9	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	25
MATERIAL																		
Element Material		●										●		**B**				●
Housing Material		●		●	●	●												
Substrate		●	●						●									
Termination Material		●		●		●	●	●	**C**	●	●		●			●	●	
Washer	●	●						●					●					●
PROCESS																		
Brush Attach		●	●							●				**B**				●
Termination Attach		●		●			●				●					●	●	
DESIGN																		
Element		●										●		**B**				●
Housing	●	●		●	●	●		●							●			
MISCELLANEOUS																		
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	●	**B**	●	●	●	●
Material Suppliers		●				●			**C**				●					

C = Capacitive Trimmers only B = comparative data (unchanged vs. Changed) required

Table 10: Stress Qualifications for Varistors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ 1,000 hours ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C ▪ Measurement at 24±4 hours after test conclusion.

Temperature Cycling	4	JESD22-A104	▪ Unpowered
			▪ 1,000 Cycles
			▪ Lower Temperature of the Chamber: -40°C
			▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C.
			▪ Dwell Time (Soak Time):
			  ○ 15 minutes minimum,
			  ○ 30 minutes minimum if component weighs above 28g
			▪ Transition Time: 1 minute maximum
			▪ Measurement at least 24 hours after test conclusion.

Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH. ▪ Bias at 85% (+5%/-0%) of rated Varistor voltage ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C. ▪ Bias at 85% (+5%/-0%) of rated Varistor voltage ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 10: Stress Qualifications for Varistors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
▪ Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 10: Stress Qualifications for Varistors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes, ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: within 1.5mm of device body, Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s, remove carrier Non-soldered type mounting/attach are not applicable
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 10: Stress Qualifications for Varistors (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Electrical Transient Conduction	30	ISO7637-2	▪ Test pulses 1 to 3

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

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TABLE 10A: Varistors Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
30 Electrical Transient Conduction

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 10	3	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	30
MATERIAL																		
Coating Material	●	●			●			●	●	●					●			
Electrode Attach	●	●		●			●				●			B		●	●	●
Element Material	●	●		●					●			●		B				●
Passivation		●														●		
Termination	●	●		●			●				●		●	B		●	●	●
PROCESS																		
Coating Dip/Cure	●	●			●	●		●							●			
Dicing		●	●		●	●								B		●	●	●
Lead Forming	●		●			●	●			●	●		●	B				
Marking	●				●			●										
Sintering	●	●		●								●		B				●
Termination Attach	●	●		●		●	●			●	●			B		●	●	●
Termination Plating	●	●		●		●	●				●		●	B		●	●	
DESIGN																		
Element Size		●		●					●	●		●		B				●
Grain Boundary Size				●								●		B				●
Grain Size				●										B				●
Layer - Number of		●		●						●								●
Layer - Thickness				●										B		●	●	●
Package Size		●		●	●	●	●		●	●		●				●		●
Passivation Thickness		●		●					●					B				
MISCELLANEOUS																		
Mfg. Site Transfer	●	●	●	●	●	●	●		●	●	●	●	●	B		●	●	●
Material Suppliers	●	●		●			●			●	●	●	●	B		●	●	●
New/Modified Mfg. Equipment		●		●			●			●		●		B				●

B = comparative data (unchanged vs. Changed) required

Table 11: Stress Qualifications for Quartz Crystals

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ 1,000 hours ▪ Unpowered ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 85°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Rated V_{DD} applied with 1MΩ and inverter in parallel, 2X crystal C_L capacitors between each crystal leg and GND. ▪ Measurement at 24±4 hours after test conclusion.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ Note: 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C ▪ Rated V_{DD} applied with 1MΩ and inverter in parallel, 2X crystal C_L capacitors between each crystal leg and GND. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 11: Stress Qualifications for Quartz Crystals (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>$\leq 1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>$> 1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 11: Stress Qualifications for Quartz Crystals (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 11: Stress Qualifications for Quartz Crystals (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 11A: Quartz Crystals Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 11	3	4	7	8	9	10	11	12	13	14	15	18	19	20	21	22
MATERIAL																
Quartz Blank	●	●		●					●	●			B		●	
Base		●	●		●	●		●	●	●					●	●
Lead/Termination		●			●	●	●	●		●	●	●	B		●	●
Glass Seal	●	●	●	●	●		●	●	●	●	●		B		●	●
Can/Cap		●	●		●	●		●	●	●					●	
Blank Support		●		●					●	●			B		●	
Overmold	●	●			●	●		●	●	●	●			●	●	●
Case Sealing	●	●	●		●			●	●	●	●		B	●	●	
Electrode	●	●		●						●						
Insulator	●	●			●	●		●		●	●		B	●	●	
PROCESS																
Quartz Blank		●		●					●	●			B		●	
Base Assembly	●	●	●		●	●	●		●	●	●	●			●	●
Blank Etch/Clean													B			
Electrode Formation		●		●						●			B		●	
Auto Trim									●	●			B		●	
Bond/Anneal Blank	●	●		●					●	●			B		●	
Cap/Can Attach	●	●	●	●	●	●			●	●			B		●	
Overmolding		●			●	●			●	●			B	●	●	●
Marking					●			●								
Aging									●	●			B		●	
DESIGN																
Quartz Blank		●							●	●			B		●	
Base	●	●	●		●	●	●		●	●					●	●
Lead/Termination		●			●	●	●		●	●	●	●	B		●	●
Can/Cap		●	●		●	●			●	●			B		●	
Blank Support		●		●					●	●			B		●	
Package (Molded)		●			●	●	●	●	●	●	●		B	●	●	●
Insulator					●	●		●								
MISCELLANEOUS																
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●	●
Material Suppliers		●		●	●	●	●	●	●	●		●	B	●	●	●
Process Control Change					●	●										

B = comparative data (unchanged vs. Changed) required

Table 12: Stress Qualifications for Ceramic Resonators

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C ▪ 1,000 hours ▪ Measurement at 24±4 hours after test conclusion.

Temperature Cycling	4	JESD22-A104	▪ Unpowered
			▪ 1,000 Cycles
			▪ Lower Temperature of the Chamber: -55°C
			▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 85°C.
			▪ Dwell Time (Soak Time):
			  ○ 15 minutes minimum
			  ○ 30 minutes minimum if component weighs above 28g
			▪ Transition Time: 1 minute maximum
			▪ Measurement at least 24 hours after test conclusion.

Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH. ▪ Measurement at 24±4 hours after test conclusion. ▪ Rated V_{DD} applied with 1MΩ and inverter in parallel, 2X resonator C_L capacitors between each resonator leg and GND.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C ▪ Rated V_{DD} applied with 1MΩ and inverter in parallel, 2X resonator C_L capacitors between each resonator leg and GND. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 12: Stress Qualifications for Ceramic Resonators (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213.
▪ THT: Condition C
▪ SMD: Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 12: Stress Qualifications for Ceramic Resonators (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 12A: Ceramic Resonators Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
18. Solderability
19. Electrical Characterization
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 12	3	4	7	8	9	10	11	12	13	14	15	18	19	21	22
MATERIAL															
Ceramic Element	●	●		●			●		●	●			B		
Inner Electrode	●	●		●			●		●	●					
Epoxy Resin Overcoat	●	●	●	●	●	●	●	●							
Outer Electrode		●			●	●	●	●		●	●	●		●	●
Wax					●								B		
Terminal Solder		●			●							●		●	●
Element/Lead Attach	●	●		●			●		●	●	●		B		
Case	●	●		●	●	●		●	●	●	●			●	●
Case Adhesive/Seal	●	●		●	●	●	●	●	●	●	●			●	●
Capacitor	●	●		●			●		●	●	●		B	●	●
PROCESS															
Ceramic Blank		●		●			●		●	●			B	●	●
Lapping		●					●		●	●			B	●	●
Electroding		●		●			●		●	●			B	●	●
Cutting							●		●	●			B	●	●
Annealing				●			●		●	●			B	●	●
Polarize/Freq. Adjust													B		
Element/Lead Attach		●		●			●		●	●			B	●	●
Adhesive/Epoxy Seal		●	●	●	●				●	●				●	
Epoxy Dip & Cure				●	●	●	●	●							
Wax Application					●	●									
Terminal Solder	●	●		●	●	●	●					●		●	●
Marking					●			●							
DESIGN															
Ceramic Element		●		●		●			●	●			B	●	
Electrode/Capacitor		●		●			●		●	●			B	●	●
Case		●		●	●	●			●	●				●	●
Termination		●		●	●		●		●	●		●		●	●
MISCELLANEOUS															
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●
Material Suppliers		●		●	●	●	●	●	●	●		●	B	●	●
New/Modified Mfg. Equipment					●	●									

B = comparative data (unchanged vs. Changed) required

Table 13: Stress Qualifications for Ferrite EMI Suppressors/Filters

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C ▪ 1,000 hours ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -55°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Destructive Physical Analysis	5	EIA-469	▪ Pre and Post Electrical Test not required.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Measurement at 24±4 hours after test conclusion. ▪ Apply 10% of maximum rated power.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C. ▪ Measurement at 24±4 hours after test conclusion. ▪ Rated I_L applied
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 13: Stress Qualifications for Ferrite EMI Suppressors/Filters (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Test Condition C
▪ SMD: Test Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 13: Stress Qualifications for Ferrite EMI Suppressors/Filters (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device.
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
ESD	17	AEC-Q200-002	
Solderability	18	J-STD-002	▪ Through-hole Technology (THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 13: Stress Qualifications for Ferrite EMI Suppressors/Filters (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL 94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (ex: sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Electrical Transient Conduction	30	ISO7637-2	▪ Test pulses 1 to 3

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 13A: Ferrite EMI Suppressors/Filters Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
5. Destructive Physical Analysis
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
30. Electrical Transient Conduction

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change

Test # From Table 13	3	4	5	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	30
MATERIAL																			
Binder Material		●									●				B				
Dielectric	●	●	●	●				●		●	●		●		B		●		
Terminal Interface	●	●	●	●						●	●		●		B		●		
Conductor Material	●	●	●	●	●			●			●				B		●		
Encapsulation			●			●	●		●			●							
Lead/Termination		●				●	●	●			●	●		●	B			●	
PROCESS																			
Dicing	●	●		●		●	●		●	●					B	●			
Conductor Apply	●			●	●							●	●		B		●		
Electrode Formation		●	●		●								●		B				●
Firing Profile		●	●										●		B		●		●
Lamination Press			●	●								●			B		●		
Powder Particle Size		●		●								●	●		B		●		
Screen Printing		●											●		B				
Termination Process	●	●	●	●		●	●	●		●	●	●		●	B		●	●	
DESIGN																			
Conductor Thickness	●	●	●							●			●		B				
Lead/Term. Thickness		●				●	●	●			●						●	●	
Number of Layers		●	●	●			●						●		B		●		
Termination Area		●				●	●				●						●	●	
Terminal Interface	●	●	●	●					●	●	●	●	●		B		●	●	●
MISCELLANEOUS																			
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●	●	
Material Suppliers	●	●	●	●	●	●	●	●	●	●	●	●	●	●	B	●	●	●	
New/Modified Mfg. Equipment		●		●			●	a			●		●	●	B				

a = termination equipment only B = comparative data (unchanged vs. Changed) required

Table 14: Stress Qualifications for Polymeric Resettable Fuses

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -40°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Tri-temperature Pre and post stress required. ▪ Dwell Time (Soak Time): o 15 minutes minimum o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Measurement at 24±4 hours after test conclusion. ▪ Biased at 10% of hold current.
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify the physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 14: Stress Qualifications for Polymeric Resettable Fuses (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only.
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross- sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>$\leq 1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>$> 1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
▪ Note: the values and formulas are per IEC 60068-2-21, 6th Edition.
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Verify marking permanency.
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Test Condition C
▪ SMD: Test Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 14: Stress Qualifications for Polymeric Resettable Fuses (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
Solderability	18	J-STD-002	▪ Through-hole Technology THT: o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.
Flammability	20	UL 94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (ex: sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.

Table 14: Stress Qualifications for Polymeric Resettable Fuses (continued)

Stress	No.	Reference	Additional Requirements
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	
Short Circuit Fault Current Durability	32	AEC-Q200-004	
Fault Current Durability	33	AEC-Q200-004	
End-of-Life Mode Verification	34	AEC-Q200-004	
Jump Start Endurance	35	AEC-Q200-004	
Load Dump Endurance	36	AEC-Q200-004	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 14A: Polymeric Resetable Fuses Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
17. Electrostatic Discharge (ESD)
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)
32. Short Circuit Current Durability
33. Fault Current Durability
34. End-of-Life Mode Verification
35. Jump Start Endurance
36. Load Dump Endurance

Note: A letter or "● " indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

Test # From Table 14	4	7	8	9	10	11	12	13	14	15	17	18	19	20	21	22	32	33	34	35	36
MATERIAL																					
PTC Core Material		●	●	●						●			B					●	●		
Marking				●			●														
Terminal/Lead				●	●	●		●	●			●			●	●					
Terminal/Lead Attachment				●	●			●	●			●			●	●					
Protective Coating		●	●	●	●									●							
PROCESS																					
PTC Forming		●	●							●				●	●						
Substrate Singulation				●	●																
Terminal/Lead Attachment		●	●	●		●						●			●	●					
Protective Coating		●	●	●	●																
Marking				●			1														
DESIGN																					
Form Factor				●	●								B								
Terminal Configuration (Kink)				●	●	●		●	●												
Characteristics Specification													B								
MISCELLANEOUS																					
Mfg. Site Transfer	●	●	●	●	●	●	1	●	●	●	●	●	B		●	●	●	●	●	●	●

1 = For components marked with ink only. Laser and stamped marked components shall be exempt from this test.
B = comparative data (unchanged vs. Changed) required

Table 15: Stress Qualifications for Fuses

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	UL 248, IEC 60127 or User Specification	Pre-test: ▪ Resistance Measurement o Per AEC-Q200-004 o Mount fuse as per specification. o Measure fuse on-board resistance @ 10% nominal fuse current rating. Post-test: ▪ Resistance Measurement o Per AEC-Q200-004 o Mount fuse as per specification. o Measure fuse on-board resistance @ 10% nominal fuse current rating. o All samples ▪ Current Carrying Capacity o Test methodology per UL 248 Series, IEC 60127 Series or per User spec. o Half of samples o Room Ambient ▪ Overload (Time/Current Characteristic) Test o Lowest specification (maximum fusing time) o Test methodology per UL 248 Series, IEC 60127 Series or per User spec. o Overload specification per User Spec. o Half of samples o Room Ambient
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Mount fuse as per specification. ▪ 1000 hrs @ max. temperature ▪ Fuses not energized
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: Lower operating temp as specified. Minimum -40°C. ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ Biased at 10% of Nominal Fuse Current Rating. ▪ 1,000 hours ▪ 85°C, 85% relative humidity ▪ Measurement at 24±4 hours after test conclusion.

Table 15: Stress Qualifications for Fuses (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>High Temperature Operating Life</td><td>8</td><td>MIL-STD-202 Method 108</td><td>▪ 1,000 hours
▪ Temperature of the Chamber: maximum specified operating temperature up to 150°C.
▪ Biased at the derated nominal fuse current rating.
▪ Measurement at 24±4 hours after test conclusion.</td></tr>
<tr><td>External Visual</td><td>9</td><td>MIL-STD-883 Method 2009</td><td>▪ Inspect component construction, marking and workmanship.
▪ Pre and Post Electrical Test not required.</td></tr>
<tr><td>Physical Dimensions</td><td>10</td><td>JESD22-B100</td><td>▪ Verify physical dimensions to the applicable component specification.
▪ Pre and Post Electrical Test not required.</td></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>▪ Test THT component lead integrity only
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross-sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturers recommended parameters (i.e.,: solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.</td></tr>
</table>

Table 15: Stress Qualifications for Fuses (continued)

Stress	No.	Reference	Additional Requirements
Mechanical Shock	13	MIL-STD-202 Method 213	▪ Figure 1 of Method 213 ▪ THT: Test Condition C ▪ SMD: Test Condition C ▪ Tested per the Supplier's recommended mounting method.
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations ▪ Tested per the Suppliers' s recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz -2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Test Condition B, C or D ▪ SMD: Condition K, time above 217°C, 60s – 150s ▪ Non-soldered type mounting/attach are not applicable.
Solderability	18	J-STD-002	▪ Through-hole Technology (THT): o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.

Table 15: Stress Qualifications for Fuses (continued)

Stress	No.	Reference	Additional Requirements
Electrical Characterization	19	UL 248, IEC 60127 or User Specification	▪ Characteristics shall be measured for the following operating temperature: o minimum o room o maximum ▪ Resistance Measurement o Mount fuse as per specification. o Measure fuse on-board resistance @ 10% nominal fuse current rating. o Conduct at maximum, room, and minimum temperature range. ▪ Current Carrying Capacity o Per UL 248 Series or IEC 60127 Series o Conduct at maximum, room, and minimum temperature range. For minimum and maximum operating temperatures, rerate the fuse current based on Supplier's recommendation. ▪ Overload Test o Test methodology per UL 248 Series or IEC 60127 Series o Overload gates per User Spec. o Conduct at maximum, room, and minimum temperature range. ▪ Short Circuit Tests o Test methodology per UL 248 Series or IEC 60127 Series o Short circuit value per User Spec. o Conduct at maximum, room, and minimum temperature range.
Flammability	20	UL 94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA, testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (ex: sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.

Table 15: Stress Qualifications for Fuses (continued)

Stress	No.	Reference	Additional Requirements
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
Component Technical Committee

TABLE 15A: Fuses Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
12. Resistance to Solvents
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
18. Solderability
19. Electrical Characterization
20. Flammability
21. Board Flex
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

Test # From Table 15	4	7	8	9	10	11	12	13	14	15	18	19	20	21	22
MATERIAL															
Housing	●	●	●	●	●		●	●	●			B	●		
Marking				●			●								
Terminal/Lead				●	●	●		●	●		●		●	●	
Terminal/Lead Attachment				●	●			●	●		●		●	●	
Element	●		●					●	●			B			
Filler	●		●					●	●			B			
PROCESS															
Element Attach			●					●	●						
Terminal/Lead Attachment		●	●	●		●					●			●	●
Molding	●	●	●	●	●		●	●							
Marking				●			●								
DESIGN															
Element size			●		●			●	●			B			
Characteristics Specification												B			
MISCELLANEOUS															
Mfg. Site Transfer	●	●	●	●	●	●		●	●	●	●	B		●	●
Materials Suppliers	●		●			●			●	●	●	B	●	●	●
New/Modified Mfg. Equipment	●		●			●			●			B			

B = comparative data (unchanged vs. Changed) required

Table 16: Stress Qualifications for Super Capacitors

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Specification.	▪ Test is performed at room temperature except as specified in the applicable stress reference and the additional requirements in this Table.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	▪ Unpowered ▪ 1,000 hours ▪ Tested at maximum specified operating temperature or maximum specified storage temperature (whichever is higher). Minimum test temperature shall be 85°C. ▪ Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22-A104	▪ Unpowered ▪ 1,000 Cycles ▪ Lower Temperature of the Chamber: -40°C ▪ Upper Temperature of the Chamber: maximum specified operating temperature and shall not exceed 125°C. ▪ Dwell Time (Soak Time): o 15 minutes minimum o 30 minutes minimum if component weighs above 28g ▪ Transition Time: 1 minute maximum ▪ Measurement at least 24 hours after test conclusion.
Humidity Bias	7	MIL-STD-202 Method 103	▪ 1,000 hours ▪ 85°C/85%RH ▪ Measurement at 24±4 hours after test conclusion. ▪ Rated Voltage
High Temperature Operating Life	8	MIL-STD-202 Method 108	▪ 1,000 hours ▪ Temperature of the Chamber: the maximum permissible ambient temperature at which the component may be continuously operated at rated conditions. ▪ Rated Voltage applied. ▪ Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	▪ Inspect device construction, marking and workmanship. ▪ Pre and Post Electrical Test not required.
Physical Dimensions	10	JESD22-B100	▪ Verify physical dimensions to the applicable component specification. ▪ Pre and Post Electrical Test not required.

Table 16: Stress Qualifications for Super Capacitors (continued)

<table>
<tr><th>Stress</th><th>No.</th><th>Reference</th><th>Additional Requirements</th></tr>
<tr><td>Terminal Strength (for axial and radial THT components)</td><td>11</td><td>MIL-STD-202 Method 211</td><td>
▪ Test THT component lead integrity only
▪ Test Condition A (pull test):
<table>
<tr><th>Nominal cross-sectional area (mm^2)</th><th>Force (N)</th></tr>
<tr><td>≤ 0.05</td><td>1</td></tr>
<tr><td>0.06 to 0.10</td><td>2.5</td></tr>
<tr><td>0.11 to 0.20</td><td>5</td></tr>
<tr><td>0.21 to 0.50</td><td>10</td></tr>
<tr><td>0.51 to 1.20</td><td>20</td></tr>
<tr><td>> 1.20</td><td>40</td></tr>
</table>
▪ Test Condition C (wire-lead bend test):
<table>
<tr><th>Section Modulus (Z_X) (mm^3)</th><th>Force (N)</th></tr>
<tr><td>≤ $1.5x10^{-3}$</td><td>0.5</td></tr>
<tr><td>$1.6x10^{-3}$ to $4.2x10^{-3}$</td><td>1.25</td></tr>
<tr><td>$4.3x10^{-3}$ to $1.2x10^{-2}$</td><td>2.5</td></tr>
<tr><td>$1.3x10^{-2}$ to $0.5x10^{-1}$</td><td>5</td></tr>
<tr><td>$0.6x10^{-1}$ to $1.9x10^{-1}$</td><td>10</td></tr>
<tr><td>> $1.9x10^{-1}$</td><td>20</td></tr>
</table>
For round terminations: $Z_X = (\pi d^3)/32$ where d is the lead diameter.
For strip terminations: $Z_X = (ba^2)/6$ where a is the thickness of the rectangular strip perpendicular to the bending axis, b is the other dimension of the rectangular strip.
Note: the values and formulas are per IEC 60068-2-21, 6th Edition
</td></tr>
<tr><td>Resistance to Solvents</td><td>12</td><td>MIL-STD-202 Method 215</td><td>
▪ In addition to the Method 215 solvents, add an Aqueous wash chemical and follow chemical manufacturer's recommended parameters (i.e., solution temperature and immersion time).
▪ Applicable to ink marked components and not laser marked components.
</td></tr>
<tr><td>Mechanical Shock</td><td>13</td><td>MIL-STD-202 Method 213</td><td>
▪ Figure 1 of Method 213
▪ THT: Test Condition C
▪ SMD: Test Condition C
▪ Tested per the Supplier's recommended mounting method.
</td></tr>
</table>

Table 16: Stress Qualifications for Super Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	▪ 5g's for 20 minutes ▪ 12 cycles each of 3 orientations. ▪ Tested per the Supplier's recommended mounting method. ▪ Verification of transfer load: during setup, verify that with the selected PCB design (size, thickness and secure points), or an alternative mount, that the transferred load onto the component corresponds to the requested load. This verification can be achieved using a laser vibrometer or other adequate measuring device. ▪ Test from 10 Hz - 2000 Hz
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	▪ THT: Conditions B or C ▪ SMD: Condition J or K, time above 217°C, 60s - 150s ▪ Non-soldered type mounting/attach are not applicable.
Solderability	18	J-STD-002	▪ Through-hole Technology (THT): o Method A1, Coating Durability Category 2 ▪ SMD: o Method B1, Coating Durability Category 2 o Method D, Coating Durability Category 2 ▪ Note: in particular circumstances when SnPb reverse compatibility is requested by the User, Method A shall be used for THT and Method B shall be used for SMD. ▪ Magnification 50x ▪ Pre and Post Electrical Test not required. ▪ Non-soldered type mounting/attach are not applicable.
Electrical Characterization	19	User Specification.	▪ Parametrically test per lot and sample size requirements. ▪ Summary to show minimum, maximum, mean and standard deviation at room, minimum and maximum operating temperatures. ▪ Pre and Post Electrical Test not required.

Table 16: Stress Qualifications for Super Capacitors (continued)

Stress	No.	Reference	Additional Requirements
Flammability	20	UL-94 or IEC 60695-11-5	▪ Applicable to components with exposed cured resins or plastic materials. ▪ If exposed resins or plastic materials are V-1, V-0 or 5VA testing is not required. ▪ If exposed resins or plastic materials are not V-1, V-0 or 5VA, components or applicable parts of the component (e.g., sleeve or encapsulant), material shall be tested to the Needle Flame Test per IEC 60695-11-5. Data from previously qualified materials can be supplied in place of conducting test. ▪ Pre and Post Electrical Test not required.
Board Flex (SMD)	21	AEC-Q200-005	
Terminal Strength (SMD)	22	AEC-Q200-006	

Note: For any deviation from the above stresses, refer to Section 2.4.8.

Back to Table C: Qualification Sample Size
Back to Table D: Applicable Stress Qualifications

Automotive Electronics Council
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TABLE 16A: Super Capacitor Process Change Qualification Guidelines for the Selection of Tests

For a given change listed below, the Supplier should justify why a suggested test does not apply for the given component(s) under consideration. Collaboration with their customer base is highly recommended.

3. High Temperature Exposure (Storage)
4. Temperature Cycling
7. Biased Humidity
8. Operational Life
9. External Visual
10. Physical Dimension
11. Terminal Strength (THT)
13. Mechanical Shock
14. Vibration
15. Resistance to Soldering Heat
18. Solderability
19. Electrical Characterization
22. Terminal Strength (SMD)

Note: A letter or "●" indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

Test # From Table 16	3	4	7	8	9	10	11	13	14	15	18	19	22
MATERIAL													
Electrode	●	●	●	●								B	
Electrolyte	●	●	●	●						●		B	
Separator	●	●	●	●				●		●		B	
Lead terminal		●	●	●	●		●	●	●	●	●	B	●
Package		●	●	●	●	●		●	●			B	
Sleeve		●		●	●								
PROCESS													
Element	●	●	●	●								B	
Package		●	●	●	●	●						B	
DESIGN													
Electrode	●	●	●	●								B	
Electrolyte	●	●	●	●						●		B	
Separator	●	●	●	●				●		●		B	
Lead terminal		●	●	●	●		●	●	●	●	●	B	●
Package		●	●	●	●	●		●	●			B	
MISCELLANEOUS													
Mfg. Site Transfer	●	●	●	●	●	●	●	●	●	●	●	B	●
Material Suppliers	●	●	●	●			●	●	●	●	●	B	●

B = comparative data (unchanged vs. Changed) required

APPENDIX 1: Qualification Family

1. General

The qualification of a particular process will be defined within, but not limited to, the categories listed below. The Supplier will provide a complete description of each process, case size and material of significance. There must be valid and obvious links between the data and the subject of qualification.

For components to be categorized in a qualification family, they all must share the same:

a. Major process,
b. Material elements, and
c. Basic design

Basic design qualification family members shall share the same design elements except for the constructional attribute (i.e., layer count for capacitors) that is varied to achieve the different performance values (i.e., Capacitance value) for the family. Examples of attributes are materials, and physical construction.

All members of a qualification family are qualified by association when the most sensitive family members successfully complete qualification testing. Depending on the qualification test, a family's most sensitive component is defined on a test-by-test basis. The most sensitive component might be different for each qualification test.

Extensions to an existing qualified family, if the added components meet the most sensitive definition, these added components shall be subject to qualification. If these added components do not meet the most sensitive definition and therefore fall within the qualified family, testing is not required.

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APPENDIX 2: Certificate of Design and Construction (CDC)

The following information, as applicable, is required to identify a component which has met the requirements of this specification. This page is available as a stand-alone document.

Supplier		Lead/terminal attachment method	
User P/N(s)		Package outline drawing	
Supplier P/N(s)		Flammability rating	
Data sheet		ESD characterization(s)	
Assembly Location		Lead/Termination material	
Process Identifier		Lead plating/coating	
Final QC Facility Location		Construction cross section	
Family number		Package Subcontractor(s)	
Technology description		Element composition	
All dimensions in millimeters		Solvent exposure restriction	
Metallization material		Marking method	
Number of active layers		Exceptions taken to AEC- Q200	
Electrode/Internal element attachment method		Subassembly location	
Thickness range		Insulation material	
Package material		**Temperature Range**	

Attachments:	Requirements
1) Cross section photo 2) Package outline drawing 3) Special test circuits 4) Letter stating exceptions taken to AEC-Q200	1) A separate CDC shall be submitted for each family as defined by Appendix 1 and Appendix 2. 2) Document shall be signed by a responsible individual at the Supplier who can verify that all of the above information is correct.

Type name and sign.

Completed by:	Date:	Certified By:	Title	Date:

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APPENDIX 3: Qualification Test Plan Format

The Supplier is requested to complete and submit the Passive Component Qualification Plan as part of the pre-launch Control Plan whenever production approval submission is required. Acceptance and subsequent sign-off of the plan will establish a qualification agreement between the User and the Supplier determining requirements for both new components and process changes prior to commencement of testing. Where "family" data is being proposed, the plan will document how the reliability testing previously completed fulfills the requirements outlined in this specification. An approved copy of the qualification plan should be included with each production approval submission.

The test plan section of the form should detail ONLY the testing that will be performed on the specific component shown. **Testing MUST include the additional requirements listed in the applicable Tables 1-16.** For process change qualifications, multiple components can be included on the same plan. Supporting generic or family data reports should be noted in the comment section and attached. When requesting use of generic or family data, attach a separate page detailing similarities or differences between components referencing the criteria in Appendix1. There must be valid and obvious links between the data and the subject of qualification.

The example below is provided to demonstrate how the Qualification Plan Form should be used. In this case, a ceramic multilayer capacitor was chosen as being representative of a typical new component qualification requesting reduced component testing by including generic test data. The component comes from a Supplier who previously qualified the package, assembly site, etc. This ***EXAMPLE*** is shown for illustration purposes only and should not limit any requirements from Tables 1 through 16 herein.

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Figure 3: Example of Passive Component Qualification Plan

Page 1 of 1 | Passive Component Qualification Test Plan | Rev: - 2/3/96

User P/N : N611045BF DDAARA
User Component Engineer : John Doe
User Spec. # : ES-N610450FDAARA
General Specification : AEC-Q200
Supplier : Sam's Discunt Capacitor
Supplier Manufacturing Site : Shanghai, Cl ina
Supplier P/N: N611045 BFDDAARA
Required production approval Submission Date 5/1/96

Family Type : X7R1206 Ceramic

Reason for Qualification : New device Qualification

Item	Test	Test conditions	Exceptions	Est. Start	Est. Comp.	# Lots	S. S.	Additional Requirements
1	Electrical Test	@ -55°C, 25°C, 125 °C		4/1/09	4/5/09	all	all	
3	High Temp Exposure	1000 Hours @ 150°C		4/11/09	6/24/09	3	40	
4	Temperatur e Cycling	1000 cycles (-55°C to +125°C)		4/15/09	6/24/09			
5	Destructive Physical Analysis			4/22/09	4/29/09			
6	Moisture Resistance	Cycled 25°C to 65°C, 80-100% RH, 24 hours/cycle 10 Cycles		4/29/09	5/27/09			
7	Biased Humidity	1000 hours 85°C/85RH	Use attached generic data for this package related test. Comment #1	4/28/09	6/24/09			generic data uses +70C/85% (rather than 85C) Rated and 1.3V. Add 100K Ohm resistor.
8	Operating Life	1000 hours 125°C with Full rated Voltage		4/15/09	6/24/09			
9	External Visual	Per Spec.		4/22/09	4/29/09			
10	Physical Dimensions	Per user(s) Spec.		4/22/09	4/28/09			
12	Resistance to Solvents	MIL STD 215 and Aqueous Wash materials		4/22/09	4/26/09			
13	Mechanical Shock	½ Sine Pulse 1500g Peak		5/19/09	5/26/09			

Test summaries are to include mean, std. Deviation, min. & max. Reading for all endpoint tests.

Comments:

1. Supplier requests 1 lot qualification of this device type in addition to attached reliability reports of similar parts.

Prepared by:

(supplier)

Approved by:

(User Engineer)

APPENDIX 4: Data Presentation Format and Content

The Supplier is required to complete and submit an Environmental Test Summary (Figure 4) and Parametric Verification Summary (Figure 5) with each Passive Component production approval submittal. Figure 4 is an ***EXAMPLE*** of a completed Environmental Test Summary. The content of the example shall be followed in a similar format.

Figure 4: Environmental Test Summary

Production Part Approval - Environmental Test Summary

SUPPLIER Sam's Discount Capacitors		USER PART NUMBER N611045BFDAARA			
NAME OF LABORATORY SDS Qual Lab.		PART NAME Ceramic Capacitor			
Test #	Description	Test Conditions	# Lots Tested	Qty Tested	Number Failed
3	High Temp. Exposure	Per Spec.	3	120	0
5	Destructive Physical Analysis	Per Spec.	3	15	0
9	External Visual	Per Spec.	3	260	0
10	Physical Dimensions	Per Spec.	3	30	0
12	Resistance to Solvents	Per Spec.	1	5	0
13	Mechanical Shock	½ Sine Pulse 1500g	3	90	0

Figure 5 is an ***EXAMPLE*** of a completed Parametric Verification Summary. The content of the example shall be followed in a similar format.

Figure 5: Parametric Verification Summary

Production Part Approval - Parametric Verification Summary

Supplier SAM's Discount Passive Components			Part Number N611045BFDAARA				
Lot Number 394A			Temperature -55°C				
Test Name	User Spec. LSL	User Spec. USL	Min.	Max.	Mean	Std. Dev.	Cpk
Capacitance	0.09 µF	0.11 µF	0.0971 µF	0.1086 µF	0.103 µF	0.0013 µF	1.79
DF	------	±2.5%	1.07%	1.98%	1.6%	.092%	3.79
IR	20GΩ	------	40GΩ	100GΩ	70GΩ	30GΩ	7.03
Temperature Coefficient	-15.0%	+15%	-14.83%	-5.97%	-11.4%	1.01%	1.19

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Revision History

Rev #	Date of change	Brief summary listing affected sections
-	April 30, 1996	Initial Release.
A	June 16, 1997	1.1.1 Add Crystals, Resonators, Ferrites 2.1 Changed "qualification program" to "document"; Added "user's" to item #2. 2.3 Changed 2-10, 2A-10A to 2-13,2A-13A 2.4.5 Changed 2-10 to 2-13 2.6 Changed 2-10 to 2-13 2.7 Changed 2-10 to 2-13 3.1 Changed 2-10 to 2-13 3.2.2 Changed 2-10, 2A-10A to 2-13,2A-13A 4.1 Table 1 - Remove N on Test 12; Add S on Test 21-22 Table 2 - Remove Test 24; Add 1.5mm to Test 15 Table 2A - Remove Test 24 Table 4 - Changed temperature on Test 16 Table 9 - Added 230C, term. coverage Test 15; Changed minutes to seconds Test 16 Tables 2-10 - Added 24 Hour meas. Tests3,4,6-8; Add 10-2000 Hz on Test 14 Tables 11-13 - Added Tables 11-13, 11A-13A Appendix 2 - Added resp. Individual to requirement 2
B	March 15, 2000	Removed CDF designation through document. Removed Chrysler, Delco, and Ford logo from each heading. Removed Automotive Grade through document. Added Component Technical Committee to each heading. 1.2.3 Replaced Automotive with AEC Tables 14 –14A Added Tables for Polymetric Resettable Fuses. Changed all references to Tables 2– 13 to 2–14 Changed all references to Tables 2A – 13A to 2A –14A 4.1 Changed reference to Table 1-13 to 1-14 2.4.1 Changed to Lot requirements are designated in Table1, herein Tables 2-13, item 18 – Reversed Method a and b for SMD solderability requirements Table 3, item 16 – Changed Dwell Time (Soak Time) to 15 minutes Table 5, item 16 – Changed Dwell Time (Soak Time) to 15 minutes Table 6, item 21 – Added 3mm board flex for COG devices Table 1, Added Note A and Note B Table 1, item 18 - Changed sample size from 10 to 15 Table 1, item 18 – Added each condition Legend for Table 1- Added Note A and B

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Revision History (continued)

Rev #	Date of change	Brief summary listing affected sections
C	June 17, 2005	Acknowledgements – latest information on members Table of Contents – page number corrections 1.1.1 Temperature Grades – definition of AEC qualified 1.2.1 MIL-PRF-27 reference correction 1.2.3 Addition of AEC subspec test method references 2.3 editorial 2.4.3 editorial 3.2 Added section: Qualification of a Lead (Pb) – Free Device 3.3.2 comparative testing of parts 4.3 Added section: Lead (Pb) – Free Specific Tests 4.4 Data maintenance per TS-16949 Table 1: Solderability note C and legend description Test 21: AEC-Q200-005 reference in Table of Tests Test 22: AEC-Q200-006 reference in Table of Tests Test 19: B reference in Change tables and legend description Test 27: AEC-Q200-007 reference in Table of Tests Test 8: MIL-PRF-27 reference in Table of Tests #5 Appendix 1, family 7 & 8
D	June 1, 2010	Acknowledgements – latest information on members Notice Statement (page 3) Added Table of Contents – page number corrections (1.1.1): Temperature Grades – definition of AEC qualified (1.1.2): Approval for Use in an Application - editorial (1.2.1): JESD201 and JESD22-A121 addition (1.2.2): IEC ISO/DIS10605 and iNEMI addition. (1.2.3): AEC-Q200-005, -006, -007, Q005 clarification/addition. (2.3): editorial (2.4.4): Prohibit – Dip-Fixturing (2.4.5): Pre- and post-stress electrical tests at room temperature. (3.2): Describe new Qualification of Pb–Free Device requirement. (3.3.1): adverse impact on specific end customer applications. Items 1 through 5 are background information. (3.3.2): baseline for comparative data analysis. Table 1: Lot Size – Test Item 5. Added Items 31 – 36 Table 2: Test Items 3,4,7,8,12,15,17,19,21,&22 updated. Table 2A: Collaboration statement added. D added for Tantalums Table 2B: Acceptable Criteria table added. Table 2C: Acceptable Criteria table added. Table 2D: Acceptable Criteria table added. Table 3: Test Items 3,4,7,8,17,20,21,22,&27 updated. Criteria reg Table 3A: Collaboration statement added. Table 3: Test Items 3,4,6,7,8,17,21,&22 updated. Criteria reg

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Revision History (continued)

Rev #	Date of change	Brief summary listing affected sections
D (cont.)	June 1, 2010	Table 3: Test Items 3,4,6,7,8,17,21,&22 updated. Criteria reg Table 3A: Collaboration statement added. Table 4: Test Items 3,4,6,7,8,17,21,&22 updated. Criteria reg Table 4A: Collaboration statement added. Table 5: Test Items 3,4,7,8,17,21,&22 updated. Criteria reg Table 5A: Collaboration statement added. Table 6: Test Items 3,4,7,8,17,21,&22 updated. Criteria reg Table 6A/7A: Collaboration statement added. Table 7: Test Items 3,4,7,8,17,21,&22 updated. Table 7B: Acceptable Criteria table added. Table 7C: Acceptable Criteria table added. Table 7D: Acceptable Criteria table added. Table 7E: Acceptable Criteria table added. Table 7F: Acceptable Criteria table added. Table 8: Test Items 4,17, 21, & 22 updated. Criteria reg Table 8A: Collaboration statement added. Table 9: Test Items 3,4,7,8,17, 21, & 22 updated. Criteria reg Table 9A: Collaboration statement added. Table 10: Test Items 4,7,8,17,21,&22 updated. Criteria reg Table 10A: Collaboration statement added. Table 11: Test Items 3,4,7,8,21,&22 updated. Table 11A: Collaboration statement added. Table 11B: Acceptable Criteria table added. Table 12: Test Items 4,17,21,&22 updated. Table 12A: Collaboration statement added. Table 12B: Acceptable Criteria table added. Table 13: Test Items 4,17,21,&22 updated. Criteria reg Table 13A: Collaboration statement added. Table 14: Test Items 4,17,21,&22 updated. Criteria reg Table 14A: Collaboration statement added
E	March 20, 2023	Revised Sections 1.1, 1.3, 2, 3, 4, Tables 1-14, All Tables xA, All Tables xB, Appendix 1, Appendix 2, Appendix 3, and Appendix 4. Added Sections 1.2, 1.4, 1.5, Figure 1, Table A, Figure 2, Table B, Table C, Table D, Table 15, Table 16, Figure 3, Figure 4, and Figure 5. Deleted Table 1.