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CAPACITORS, FIXED, HIGH RELIABILITY, SPACE USE, GENERAL SPECIFICATION FOR

Japan Aerospace Exploration Agency

This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: 19 August 2025

Revision History

Rev.	Date	Description
NC	31 Mar. 2004	Original
A	24 Aug. 2005	(1) Added requirements (Appendix L) for the newly developed products (chip, fixed, fine ceramic dielectric capacitor) which are converted from for automobile use to for space use. (2) Added non-destructive internal inspection and humidity, steady state, low voltage test to in-process inspection of Appendixes A, B and C. (3) Changed test conditions to be consistent with MIL and JIS specifications.
B	15 Feb. 2008	(1) Added caution for tin whisker growth (paragraphs 6.2.2, K.1.3.3 and L.1.3.6). (2) Reflected the results of re-qualification test for Hot Solder Dip products. · Changed dimensional tolerance (Table L-2). · Changed the test condition for thermal shock and immersion test to -55 to +125°C, 250 cycles (paragraphs C.4.4.9.5.1 and L.4.4.9.5.1). (3) Other changes for clarification and consistency of the requirements. · Changed the test method from axial lead method to radial lead method for terminal strength test (paragraphs A.4.4.7.1 and B.4.4.7.1). · Added “Marking shall be legible” to the requirements for external visual inspection after life test. · Changed the temperature tolerance in step 3 to +4/-0 for thermal shock and voltage aging test (paragraph C.4.4.9.4.1). · Specified glass epoxy substrate as the material for substrate bending test (paragraph L.4.4.8.3). · Changed the duration of voltage application (time to reach the specified voltage) for voltage aging test (paragraph L.4.4.9.4.2).
C	23 Mar. 2012	1) Overall modification of Appendix K (Capacitors, Chip, Solid, Electrolytic, Tantalum) · Changed the definition of part number from “NASDA****” to “JAXA****” (paragraph K. 1.3) · Modified coefficient of derated and surge voltage. · Deleted Tin plate from table K-3, Terminal Finish, and changed the symbol for solder plate from “C” to “H”. · Modified the marking (paragraph K.3.3.1) · Added electrical characteristics requirements in Substrate bending (K.3.7.3) and Resistance to soldering heat (K.3.7.6). · Changed Equivalent series resistance after test in Thermal Shock (II) from “less than specified value in detail specification” to “Not exceeding 125% of the value specified in the detail specification” (K.3.8.7) · Deleted the requirements for electrical characteristics in Resistance to solvents (K.3.8.10) · Deleted Radiation Hardness. · Added “Reflow conditioning”, “Thermal shock”, “Surge current” and “Radiographic inspection” to Qualification test (Table K-6) and Group A test

Rev.	Date	Description
		(Table K-7). Changed the sample size of DPA from 2 to 3 samples. · Moved “Stability at low and high temperature”, “Surge voltage” and “Solderability” in Group B test to Group A test (Table K-7) · Moved “Resistance to soldering heat”, “Detach strength”, “Moisture resistance”, “Life”, “Random vibration” and “Shock” in Group C to Group B (Table K-8) · Changed the temperature condition in normal state from “25±3°C” to “15 to 35°C” (K.4.4.1). · Designated alumina as a material for the substrate on which a test capacitor is mounted in Detach strength (K.4.4.6.2), Shear (K.4.4.6.4) and Resistance to soldering heat (K.4.4.6.6). · Designated glass woven based epoxy resin as a material for the substrate on which a test capacitor is mounted in Substrate bending test. Changed the tip style of the pressing jig from “R230” to “R5” (K.4.4.6.3) · Added the description of pre-treatment before step 3 for “Stability at low and high temperature” (K.4.4.7.8) · Added the description about solderability to “Long-term storage” (K.4.5). · Others: Clarify the requirements, modify to ensure consistency, unify the entire expressions and corrected errors.
D	7 May 2012	(1) Added Appendix M, the requirement specification for Newly developed product (CAPACITORS, MINIATURE, HIGH-CAPACITY, SURFACE MOUNT, FINE CERAMIC DIELECTRIC).
E	1 Dec. 2014	(1) Changed the test method of terminal strength in Capacitors, Chip, Fixed, Fine Ceramic Dielectric, (Temperature Stable and General Purpose) (Appendix L) ・ Paragraph L.3.9.1: Replaced Terminal strength with Shear (Destructive) ・ Paragraph L.4.4.8.1: Replaced Terminal strength with Shear (Destructive)
F	2 Feb. 2018	(1) Added the requirements of fine ceramic dielectric, high-capacity, multilayer, leaded capacitors (Appendix P). (2) Reviewed Shear test for fine ceramic dielectric, fixed, chip capacitors (Appendix L) In the previous revision, both shear and shear (destructive) were required. Deleted shear test since shear (destructive) covers the requirements of shear test. Subdivided the shear mode D in shear (destructive) into D1 (Peeling of the solder surface (part side)) and D2 (Peeling of the solder surface (board side)) (Table L-16 in paragraph L.4.4.8.1) Added the description, “If the capacitors exhibit the detachment of shear modes, “D2” or “E” shown in Table L-16 under the shear strength equal to or less than the minimum shear strength shown in Table L-7, the capacitors may be re-tested” (L.3.9.1) since the detachment from board surface indicates the board problem. Made the above-described changes to M.3.9.1 and M.4.4.8.1. (3) Moved “Voltage-Temperature Characteristics” from Group B to Group C of Quality Conformance Inspection. (Appendix L and M)

Rev.	Date	Description
		(4) In association with the newly established Appendix P, made the changes regarding the requirements of nondestructive internal inspection (describing that the test method shall be specified in the detail specification) to other appendix paragraphs C.3.3, C.4.4.4, L,3.4, L.4.4.4, M.3.4, and M.4.4.4. (5) In association with the newly established Appendix P, added external inspection requirement specified in paragraph P.3.4.1 of Appendix P, “The details of the capacitor exterior other than these above shall be specified in the detail specification” to other appendix paragraphs L.3.5.1 and M.3.5.1. (6) In association with the newly established Appendix P, added DPA requirement specified in paragraph P.3.5.1 of Appendix P, “The items to be verified in DPA shall be specified in the detail specification and the details shall be in accordance with the DPA manual” to other appendix paragraphs C.3.5.1, L,3.6.1, and M.3.6.1. (7) In association with the newly established Appendix P, made the changes regarding unit expression to Appendixes C, L, and M. (8) Others: Corrected errors.
G	22 Mar. 2024	(1) Added the Terms and Definition "Electric field strength (Electrical field intensity)" in c) of paragraph 1.2. (2) Added "JERG-0-040" and "JERG-1-009" in paragraph 2.2, items c) and d) respectively. (3) Changed the referred paragraph number from "4.6.1" to "4.3.5" to justify the latest revision of JAXA-QTS-2000 in paragraph 4.8. (4) Deleted the designation of the number of individual packaging from item a) in paragraph 5.1. (5) Changed to refer to JERG regarding the caution against tin whiskers in paragraph 6.2.2 as follows. - Tin content designation: JERG-1-009 - Conformal coating thickness: JERG-0-040 (6) Changed the revision letter (issue number) of the reference documents in paragraph K.2.2 as follows. - MIL-PRF-55365: revision letter from "K" to "J". - ESCC Generic Specification No. 3012: issue number from "3" to "4". (7) Deleted the requirements and test methods of the vibration and shock in Appendix K as follows. - Paragraph K.3.8.1 (High frequency vibration). - Paragraph K.3.8.2 (Random vibration). - Paragraph K.3.8.3 (Shock). - Group III, test order 1 (High frequency vibration) in Table K-6. - Group IX, test order 1 (Random vibration) in Table K-6. - Group IX, test order 2 (Shock) in Table K-6. - Group B3, test order 1 (Random vibration) in Table K-8. - Group B3, test order 2 (Shock) in Table K-8. - Group C1, test order 1 (High frequency vibration) in Table K-9. - Paragraph K.4.4.7.1 (High frequency vibration). - Paragraph K.4.4.7.2 (Random vibration).

Rev.	Date	Description
		- Paragraph K.4.4.7.3 (Shock). (8) Changed the requirement of resistance to solvents to apply in the case of marked with ink only in appendix K as follows. - Added sentence "This requirement applies only to capacitors indicated by marked with ink." in paragraph K.3.8.10. - Added note (6) "Applies only to capacitors marked with ink." with test item "Resistance to solvents" in Table K-6. - Added note (1) "Applies only to capacitors marked with ink." with inspection item "Resistance to solvents" in Table K-8. (9) Added substitute condition of thermal shock (II) when thermal shock (I) is performed with 1,000 cycles as follows. - Added note (5) "In the test order 1 of group X thermal Shock (II), the test result of the test order 1 of group X thermal Shock (II) may be applied when the test order 2 of group III thermal Shock (I) was performed and passed with 1,000 cycles. In this case, the inspection results may be substituted as the results of test order 1 of subgroup X thermal Shock (II)" in Table K-6. - Added note (1) "In the test order 2 of subgroup C1 thermal shock (I), the test cycle (1000 cycles) of test order 1 of subgroup C2 thermal shock (II) may be applied when thermal shock (I) with 1,000 cycles has performed and passed. In this case, the inspection results may be substituted as the results of test order 1 of subgroup C2 thermal Shock (II)." in Table K-9. (10)Changed the test duration applied to voltage aging specified in Group A of quality conformance inspection from 198^{+5}_{0} hours to 96^{+5}_{0} hours in paragraph K.4.4.5.1. (11)Changed the measurement method from "Bridge method" to "LCR meter or other measuring instrument" in paragraph K.4.4.5.4. (12)Deleted the inspections specified in quality conformance inspection (Group B and C) as follows. - Detach strength of quality conformance inspection (Group B) in Table K-8. - Substrate bending of quality conformance inspection (Group C) in Table K-9. - Shear of quality conformance inspection (Group C) in Table K-9. - Body strength of quality conformance inspection (Group C) in Table K-9. (13)Changed the revision letter of the reference document in paragraphs C.2.2 and L.2.2 respectively as follows. - MIL-PRF-55681: revision letter from "F" to "G" in paragraph C.2.2. - MIL-PRF-123: revision letter from "D" to "E" in paragraph L.2.2. (14)Added "MIL-PRF-32535A" as a reference document in item b) paragraph L.2.2. (15)Changed the unit of insulation resistance from "MΩ·μF" to "Ω·F" in paragraphs C.3.7.3, L.3.8.4 and M.3.8.4. (16)Deleted the requirements and test methods of the random vibration and shock in Appendixes C, L and M as follows. <Appendix C> - Paragraph C.3.9.1 (Random vibration). - Paragraph C.3.9.2 (Shock). - Group VII, test order 1 (Random vibration) in Table C-7.

Rev.	Date	Description
		- Group VII, test order 2 (Shock) in Table C-7. - Group C3, test order 1 (Shock) in Table C-10. - Group C5, test order 1 (Random vibration) in Table C-10. - Paragraph C.4.4.9.1 (Random vibration). - Paragraph C.4.4.9.2 (Shock). <Appendix L> - Paragraph L.3.10.1 (Random vibration). - Paragraph L.3.10.2 (Shock). - Group IX, test order 1 (Random vibration) in Table L-9. - Group IX, test order 2 (Shock) in Table L-9. - Group C4, test order 1 (Random vibration) in Table L-12. - Group C4, test order 2 (Shock) in Table L-12. - Paragraph L.4.4.9.1 (Random vibration). - Paragraph L.4.4.9.2 (Shock). <Appendix M> - Paragraph M.3.10.1 (Random vibration). - Paragraph M.3.10.2 (Shock). - Group IX, test order 1 (Random vibration) in Table M-9. - Group IX, test order 2 (Shock) in Table M-9. - Group C3, test order 1 (Random vibration) in Table M-12. - Group C3, test order 2 (Shock) in Table M-12. - Paragraph M.4.4.9.1 (Random vibration). - Paragraph M.4.4.9.2 (Shock). (17) Changed the requirement of resistance to solvents to apply in the case of marked with ink only in Appendix C as follows. - Added sentence "This requirement applies only to capacitors indicated by marked with ink." in paragraph C.3.9.9. - Added note (6) "Applies only to capacitors marked with ink." with test item "Resistance to solvents" in Table C-7. - Added note (1) "Applies only to capacitors marked with ink." with inspection item "Resistance to solvents" in Table C-9. (18)Delete the requirement for dielectric thickness in Appendixes C, L and M as follows. - Note (1) in Table C-6. - Main body in paragraph L.3.5.2.1. - Main body in paragraph M.3.5.2.1. (19)Clarified the content (weight by mass) of silver in the solder in paragraphs C.4.4.3, C.4.4.8.1, L.4.4.3 and M.4.4.3. (20)Revised the external dimensions (length (L) and width (W)) in Tables L-2 and M-2. (21)Added voltage-temperature characteristic symbol "X7S" in paragraphs L.1.3.2, L.3.8.2, L.3.9.3, L.3.9.5, L.3.10.3, L.3.10.5, L.3.10.6, L.3.10.7, L.3.11.1, L.4.4.2, L.4.4.7.1, and M.1.3.2. (22)Added the requirements to be documented to quality assurance program plan for the production family which consists the combination of materials, structure,

Rev.	Date	Description
		etc., of the specimens to be tested to qualification test in paragraphs L.3.1.1 and M.3.1.1. (23)Clarified the requirement for samples to be subjected to quality conformance inspection (group B and group C) in paragraphs L.4.3.1 and M.4.3.1. (24)Added style "1005" in Table M-2, and paragraph M.3.9.1. (25)Added terminal finish symbol "R" (Resin electrode, Ni plating, Sn plating, and Solder (SnPb) plating on the base metal) in Table M-6.

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CAPACITORS, FIXED, HIGH RELIABILITY, SPACE USE, GENERAL SPECIFICATION FOR

1. GENERAL

1.1 Scope

This specification establishes the general requirements and quality assurance provisions for high reliability, fixed capacitors (hereinafter referred to as "capacitors") used for electronic equipment installed on space systems.

This specification complies with JAXA-QTS-2000 (Common Parts/Materials, Space Use, General Specification for) which was recently established to transition to the qualified manufacturing line system and replaces the following specifications.

a) NASDA-QTS-1002D Capacitors, Fixed, Ceramic, Dielectric, (Temperature Compensating), High Reliability, Space Use, General Specification for

b) NASDA-QTS-39014D Capacitors, Fixed, Ceramic Dielectric, High Reliability, Space Use, General Specification for

c) NASDA-QTS-55681C Capacitors, Chip, Multiple Layer, Fixed, Ceramic Dielectric, High Reliability, Space Use, General Specification for

d) NASDA-QTS-39001E Capacitors, Fixed, Mica, Dielectric, High Reliability, Space Use, General Specification for

e) NASDA-QTS-55514A Capacitors, Fixed, Plastic Film, High Reliability, Space Use, General Specification for

f) NASDA-QTS-39003D Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, High Reliability, Space Use, General Specification for

g) NASDA-QTS-39006C Capacitors, Fixed, Electrolytic (Non-Solid Electrolyte), Tantalum, High Reliability, Space Use, General Specification for

h) NASDA-QTS-55365A Capacitors, Chip, Fixed, Tantalum, Electrolytic High Reliability, Space Use, General Specification for

1.2 Terms and Definitions

The definitions for terms used herein are as specified in JAXA-QTS-2000. In addition the following terms are also used.

a) Rated condition
The rated condition is a condition where the rated voltage is applied at the maximum temperature in the life test.

b) Accelerated condition
The accelerated condition is a condition where a voltage several times higher than the rated voltage is applied at the maximum temperature in the life test.

c) Electric field strength (Electrical field intensity) (E)
If the voltage “V” applied between the external electrodes and “d” be the distance between the internal counter electrodes, the electric field strength (electrical field intensity) "E" is given by the following equation.

E = V/d.

This is an index used to evaluate reliability instead of capacitance which depends on the size of the capacitor.

1.3 Classification

Capacitors covered by this specification shall be classified as specified in Table 1.

1.4 Part Number

The part number shall be as specified in paragraph A.3.1.4 of JAXA-QTS-2000. Details shall be as specified in each appendix.

Table 1. Classification

Capacitor type	Appendix	Previous specifications
Capacitors, fixed, ceramic dielectric (temperature compensating)	A	NASDA-QTS-1002D
Capacitors, fixed, ceramic dielectric	B	NASDA-QTS-39014D
Capacitors, chip, multiple layer, fixed, ceramic dielectric	C	NASDA-QTS-55681C
Capacitors, fixed, mica dielectric	F	NASDA-QTS-39001E
Capacitors, fixed, plastic film	G	NASDA-QTS-55514A
Capacitors, fixed, electrolytic (solid electrolyte), tantalum	H	NASDA-QTS-39003D
Capacitors, fixed, electrolytic (non-solid electrolyte), tantalum	J	NASDA-QTS-39006C
Capacitors, chip, solid, electrolytic, tantalum	K	NASDA-QTS-55365A
Capacitors, chip, fixed, fine ceramic dielectric, (temperature stable and general purpose)	L	N/A
Capacitors, Miniature, High-capacity, Surface Mount, Fine Ceramic Dielectric	M	N/A
Capacitor, Leaded, Multilayer, High-capacity, Fine Ceramic Dielectric	P	N/A

2. APPLICABLE DOCUMENTS

2.1 Applicable Documents

The documents listed below form a part of this specification. These documents are the latest issues available at the time of contract award or application.
If it is necessary to designate an issue, the issue shall be specified in the detail specification.

a) JAXA-QTS-2000 Common Parts/Materials, Space Use, General Specification for

b) MIL-STD-202 Test Method Standard, Electronic and Electrical Component Parts
c) JIS Z 9015-1 Sampling procedures for inspection by attributes -- Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.
d) ASTM E 595 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
e) MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests
f) MIL-STD-883 Test Method Standard, Microcircuits
g) JIS K 1522 Isopropyl alcohol (Isopropanol)
h) JIS K 5902 Colophonium
i) JIS Z 3282 Soft solders -- Chemical compositions and forms

2.2 Reference Document

The following is a list of reference documents.

a) JERG-0-035 NASDA Parts Application Handbook
b) JP002 Current Tin Whiskers Theory and Mitigation Practices Guideline
c) JERG-0-040 Requirements for Bonding Process of Electronic Assemblies of Space Use Staking, Conformal Coating and Potting
d) JERG-1-009 Lead Free Parts application Standard for Rocket Avionics

2.3 Order of Precedence

In the event of a conflict between the text of this specification and the applicable documents, the following order of precedence shall apply.

a) Detail specification
b) This specification
c) JAXA-QTS-2000
d) Applicable documents of this specification (paragraph 2.1, except for JAXA-QTS-2000)

2.4 Detail Specification

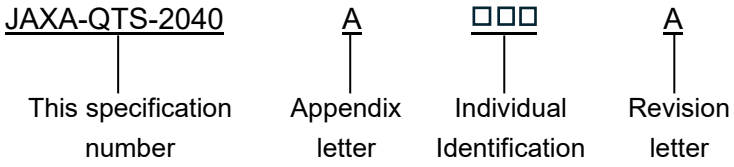
Detailed requirements for the type and performance of capacitors are specified in each detail specification.

The detail specification shall be prepared and established by a manufacturer in accordance with Appendix A, Paragraph A.4 of JAXA-QTS-2000. The detailed specification shall also be registered with the Japan Aerospace Exploration Agency (hereinafter referred to as “JAXA”).

2.4.1 Detail Specification Number

The detail specification number shall be indicated in the following form in accordance with paragraph A.2.2.2 of JAXA-QTS-2000.

(Example)



2.4.2 Revision Letter of Detail Specification

A revision letter in the detail specification number shall be assigned in accordance with paragraph A.2.2.2.4 of JAXA-QTS-2000.

2.4.3 Independency of Detail Specification

The detail specification shall be a stand-alone document with a unique number defined in accordance with paragraph 2.4.1.

2.4.4 Format of Detail Specification

The detail specification format shall be in accordance with paragraph A.6, item b) of JAXA-QTS-2000 and shall specify each requirement in accordance with paragraph A.4 of JAXA-QTS-2000.

3. REQUIREMENTS

3.1 Certification

3.1.1 Qualification Coverage

Qualification coverage shall be as specified in each appendix.

3.1.2 Initial Qualification

To acquire certification of the capacitors in compliance with this specification, a manufacturer shall establish a quality assurance program in accordance with paragraph 3.2.1, perform the qualification tests specified in paragraph 4.4, and acquire a certification status from JAXA as specified in paragraph 3.4.1 of JAXA-QTS-2000. The manufacturer shall be listed on the Qualified Manufacturer List of the Japan Aerospace Exploration Agency (JAXA QML).

3.1.3 Retention of Qualification

To continue supplying capacitors in accordance with this specification, a manufacturer must apply for QML certification retention in accordance with paragraph 3.4.2.1 of JAXA-QTS-2000 commencing between 30 and 60 days prior to the expiration date of the certification period specified in paragraph 3.1.4.

If products were not shipped during the effective period of certification and a quality conformance inspection was not conducted, the manufacturer may apply for retention of certification without conducting the quality conformance inspection.

3.1.4 Effective Period of Certification

The effective period of certification granted in compliance with this specification shall be three years.

3.1.5 Change of Qualification Coverage

To change the qualification coverage, the manufacturer shall perform procedures for re-certification in accordance with paragraph 3.4.3 of JAXA-QTS-2000.

3.2 Quality Assurance Program

3.2.1 Establishment of a Quality Assurance Program

To acquire certification in compliance with this specification, the manufacturer shall be responsible for establishing a quality assurance program that satisfies the requirements specified in paragraph 3.3.1 of JAXA-QTS-2000 and this specification. The manufacturer shall generate a Quality Assurance Program Plan in accordance with paragraph 3.3.2 of JAXA-QTS-2000 and provide the plan to JAXA for review in accordance with paragraph 3.3.6 of JAXA-QTS-2000.

3.2.2 TRB Formation

To acquire a certification status in compliance with this specification, the manufacturer shall form and operate the Technical Review Board (TRB) in accordance with paragraph 3.3.5 of JAXA-QTS-2000.

3.3 Materials

Materials used for manufacturing a capacitor shall be specified in this specification. If a specific material is not specified, a material which enables the capacitors to meet the requirements of this specification shall be used and the material shall be specified in the document defining the manufacturing conditions of the quality assurance program.

3.3.1 Outgassing

Unless otherwise specified, organic materials used for capacitors shall meet the following requirements when tested in accordance with ASTM E 595.

a) Total Mass Loss (TML): 1.0% or less
b) Collected Volatile Condensable Material (CVCM): 0.1% or less

3.4 Design and Construction

Design and construction shall be in accordance with each appendix. Detailed requirements shall be specified in the detail specifications.

3.5 Externals, Dimension, Mass and Marking

The externals, dimensions, mass and markings of the capacitor shall be as specified in each appendix.

3.6 Workmanship

The workmanship of the capacitor shall be as specified in each appendix.

3.7 Rating

The ratings of the capacitor shall be as specified in each appendix.

3.8 Electrical Performance

Requirements for the electrical performance of the capacitor shall be in accordance with each appendix.

3.9 Mechanical Performance

Requirements for the mechanical performance of the capacitor shall be in accordance with each appendix.

3.10 Environmental Performance

Requirements for the environmental performance of the capacitor shall be in accordance with each appendix.

3.11 Durability Performance

Requirements for the durability performance of the capacitor shall be in accordance with each appendix.

4. QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

The manufacturer shall be responsible for implementing the quality assurance program as specified in paragraph 3.2 and operating the TRB.

4.2 Classification of Test and Inspection

The tests and inspections shall be classified into the following three categories in accordance with paragraph 4.3 of JAXA-QTS-2000.

a) In-process inspection
b) Qualification test
c) Quality conformance inspection

4.3 In-Process Inspection

The manufacturer shall perform the in-process inspections during the manufacturing process to detect any failure which could seriously affect the reliability and quality of the products, assure the workmanship, and characterize properties which cannot be measured using the finished products. Some examples are shown below. The manufacturing flowchart in the quality assurance program plan shall define the inspection process.

a) Internal visual inspection of semi-finished products (non-destructive, 100% or sampled inspection).
b) Physical and chemical inspection of semi-finished products (destructive or non-destructive, 100% or sampled inspection).
c) Characterization of semi-finished products (non-destructive, 100% or sampled inspection).

4.4 Qualification Test

4.4.1 Sample

Samples shall be manufactured using the process and control as specified in the quality assurance programs and shall also typify the qualification coverage. The details shall be as specified in each appendix.

4.4.2 Manufacturing Records
The manufacturer, which intends to acquire certification status, shall archive material certification, receiving inspection data or test data of materials used, work records related to sample preparation, and in-process inspection data. These records shall be readily available upon request.

4.4.3 Test Items and Number of Samples
Test items, test sequence, sample size, and sampling method shall be in accordance with each appendix.

4.4.4 Determination of Pass or Fail
A failure of any test in the qualification tests specified in each appendix shall constitute failure of the qualification tests. If the failure mode of the defects is catastrophic such as an open- or short-circuit where the function of the capacitor might be lost, the capacitor fails the qualification test.

4.4.5 Disposition after Inspections
The samples used in the qualification test shall not be delivered.
The products in the same inspection lot that have passed the qualification test may be delivered upon passing the group A inspection of the quality conformance inspection.

4.5 Quality Conformance Inspection

4.5.1 Quality Conformance Inspection (Group A)
Group A inspections shall be performed at the time of production for all products.

4.5.1.1 Sample
Selection of inspection samples for group A inspections lots shall be defined as a part of the manufacturing conditions in the quality assurance program.

4.5.1.2 Inspection Items and Sample Size
Inspection items, inspection order, sample sizes and sampling method in the group A inspection shall be as specified in each appendix.

4.5.1.3 Determination of Pass or Fail
A failure of any inspection specified in the group A inspections shall constitute failure of the quality conformance inspections. If the failure mode of the defects is catastrophic such as an open- or short-circuiting where the function of the capacitor might be lost, the capacitor fails group A of the quality conformance inspections.

4.5.1.4 Disposition after Inspections
The lots rejected in the group A inspection shall not be delivered. Details shall be specified in each appendix.

4.5.2 Quality Conformance Inspection (Groups B and C)
Groups B and C inspections shall be performed in accordance with the following schedule.

a) The group B inspection shall be performed on the first lot manufactured within the certification period.
b) When retention of certification is granted, the group C inspection shall be performed prior to the restart of production when no products were manufactured within the previous certification period and no quality conformance inspection was performed.

4.5.2.1 Sample

Samples for groups B and C inspection lots shall be taken from inspection lots that have passed group A inspections.

4.5.2.2 Inspection Items and Sample Size

Inspection items, inspection order, and the number of samples of the groups B and C inspections shall be as specified in each appendix. The sampling method shall be constant sampling from the capacitors of arbitrary shape and capacitance value or shall be in accordance with JIS Z 9015-1.

4.5.2.3 Determination of Pass or Fail

A failure of any inspection specified in the group B or C inspections shall constitute failure of the quality conformance inspection of each group. If the failure mode of the defects is catastrophic such as an open- or short-circuiting where the function of the capacitor might be lost, the capacitor fails the group B or C inspections.

4.5.2.4 Disposition after Inspections

The samples used for the group B or C inspections shall not be delivered. If the samples fail in the group B or C inspections, the manufacturer shall conduct a failure analysis on the defects and take corrective action. Delivery of the products shall be suspended until JAXA approves the corrective actions.

4.6 Method for Test or Inspection

4.6.1 Externals, Dimension, Mass, and Marking

Test methods for externals, dimensions, mass, and marking of the capacitor shall be as specified in each appendix.

4.6.2 Workmanship

Test methods regarding workmanship of the capacitor shall be as specified in each appendix.

4.6.3 Electrical Performance

Test methods regarding the electrical performance of the capacitor shall be as specified in each appendix.

4.6.4 Mechanical Performance

Test methods regarding the mechanical performance of the capacitor shall be as specified in each appendix.

4.6.5 Environmental Performance
Test methods regarding the environmental performance of the capacitor shall be as specified in each appendix.

4.6.6 Durability Performance
Test methods regarding the durability performance of the capacitor shall be as specified in each appendix.

4.7 Long-Term Storage

4.7.1 Disposition of Lots Stored for a Long-Term at the Manufacturer's Site
When products have been stored at the manufacturer's site for 24 months or longer after the group A of the quality conformance inspection, the manufacturer shall perform 100% inspection for test items specified in each appendix prior to delivery. Only the capacitors which have passed such inspections can be shipped as products.

4.7.2 Storage by Purchasers
Instructions for storage by purchasers shall be in accordance with the detail specifications.

4.8 Change to Tests and Inspections

Any change in the in-process inspection and quality conformance inspection specified in this specification shall be made in accordance with paragraphs 4.3.5 (Changes or Optimization of Test and Inspection) of JAXA-QTS-2000.

5. PREPARATION FOR DELIVERY

Preparation for delivery shall be as follows and as specified in paragraph 5 of JAXA-QTS-2000.

5.1 Packaging

The capacitors shall be appropriately packaged as high reliability parts at time of delivery from the manufacturer to the purchaser.

a) Individual packaging
A group of capacitors shall be individually packaged in a proper manner.
b) Packaging
Individually packaged capacitors shall be placed in a container with cushioning materials to protect the products. Additional requirements for packaging shall be specified in procurement documents, if necessary.

5.2 Marking on Package

Each shipping package shall have the following markings.

a) Part name
b) Part number
c) Applicable specification number
d) Lot identification code
e) Purchaser's name
f) Manufacturer's name
g) Quantity of packages
h) Date of inspection

i) Inspection result

6. NOTES

6.1 Notes for Manufacturer

6.1.1 Preparation and Registration of Application Data Sheet
The manufacturer shall prepare the application data sheet in accordance with appendix G of JAXA-QTS-2000 and register it with JAXA.

6.1.2 Compatibility
To acquire certification of a capacitor that has previously been qualified by other manufacturers, the new capacitor to be qualified shall be fully compatible with the certified capacitor including the packaging specification.

6.2 Notes for Purchaser

Refer to the application data sheet for detailed data of the products and notes.

6.2.1 Items to be Ordered for Procurement
To purchase capacitors manufactured in accordance with this specification, the purchaser shall provide the following information.

a) Part number
b) This specification number
c) Detail specification number
d) Indication of test data or source inspection results to be submitted for delivery
e) Others

For item e), requirements other than those defined in this specification may be specified for special applications. However, if the requirements conflict with the existing requirements in this specification, the purchaser shall not request that the manufacturer indicate that the capacitors comply with this specification.

6.2.2 Tin Whiskers Growth
Capacitors with terminal finish that is made of an alloy with tin content greater than 97wt% may result in tin whisker growth, which may occur in a few years after the capacitors are manufactured and cause adverse effects on electronic equipment. Conformal coating which covers the terminal surface can prevent tin whisker growth. Refer to Table 4-4 (Thickness of Conformal Coating) in JERG-0-040.

In general, 3wt% or more lead in tin alloys may mitigate the growth of tin whisker. For more information on lead content in tin, refer to JERG-1-009. For further information of tin whiskers, refer to JP002.

APPENDIX A

CAPACITORS, FIXED, CERAMIC DIELECTRIC
(TEMPERATURE COMPENSATING)

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: 19 August 2025

APPENDIX A

CAPACITORS, FIXED, CERAMIC DIELECTRIC, (TEMPERATURE COMPENSATING)

A.1 GENERAL

A.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for ceramic dielectric, fixed capacitors for temperature compensation (hereinafter referred to as "capacitors").

A.1.2 Classification

Capacitors shall be classified as specified in Table A-1.

Table A-1. Classification

Structure	Style
Non-metal enclosure, radial lead	1002S/05
	1002S/06

A.1.3 Part Number

The part number shall be indicated as follows. The details shall be as specified in the detail specification.

(Example)

NASDA(1) 1002S/05 CH 100 D

Style	Characteristic	Nominal capacitance	Capacitance tolerance
(A.1.3.1)	(A.1.3.2)	(A.1.3.3)	(A.1.3.4)

Note: (1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

A.1.3.1 Style

Style shall be identified with “1002S”, followed by a slash mark (/) and a two-digit number. “1002S” denotes “high reliability, ceramic dielectric, fixed capacitors for temperature compensating” and the following two digits denote capacitor size.

A.1.3.2 Characteristics

The characteristic shall denote the temperature coefficient and shall be identified by a two-letter symbol as specified in Table A-2. The first letter indicates the nominal capacitance temperature coefficient (hereinafter referred to as “nominal temperature coefficient”), and the second letter indicates the capacitance temperature coefficient tolerance (hereinafter referred to as “temperature coefficient tolerance”).

Table A-2. Temperature Coefficient

(Unit: 10^{-6}/°C)

Symbol	Nominal temperature coefficient
CG	0± 30
CH	0± 60
CJ	0±120
CK	0±250

A.1.3.3 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be identified by a three-digit number. The first two digits represent significant figures and the last digit specifies the number of zeros to follow. When the capacitance includes a decimal point, the letter “R” indicates the point and the succeeding two digits denote significant figures. For example, 102 indicates 1,000pF, R50 indicates 0.50pF, and 1R5 indicates 1.5pF.

A.1.3.4 Capacitance Tolerance

Capacitance tolerance shall be identified by a capital letter as specified in Table A-3.

Table A-3. Capacitance Tolerance

Symbol	Capacitance tolerance
C	±0.25pF
D	±0.5pF
F(1)	±1%
G(2)	±2%
J	±5%
K	±10%

Notes:

(1) The tolerance shall be ±1.0pF when the nominal capacitance is 10pF or less.

(2) The tolerance shall be ±2.0pF when the nominal capacitance is 10pF or less.

A.2 APPLICABLE DOCUMENTS

A.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

A.2.2 Reference Document

The following document is a referenced document for this appendix.

a) MIL-PRF-20 Capacitor, Fixed, Ceramic Dielectric (Temperature Compensating), Established Reliability and Non-Established Reliability, General Specification for

A.3 REQUIREMENTS

A.3.1 Qualificaiton Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs A.3.2 to A.3.10. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

A.3.2 Materials

The materials shall be as specified below and as specified in paragraph 3.3.

A.3.2.1 Construction

Construction shall be as specified below and as specified in the detail specification.

a) Capacitor element
Ceramic shall be used as the dielectric.

b) Lead terminal
Lead terminals shall be appropriately processed to facilitate soldering.

c) Insulating enclosure and impregnating compounds
Insulating enclosure and impregnating compounds shall withstand the maximum operating temperature and shall maintain the required moisture resistance and electrical isolation. They shall not adversely affect the capacitor performance.

A.3.3 Non-Destructive Internal Inspection

All capacitors shall be subjected to an ultrasonic test or a non-destructive internal inspection as specified in the quality assurance program. When tested in accordance with paragraph A.4.4.3, capacitors shall not exhibit any defects such as delamination, voids or cracks.

A.3.4 Externals, Dimension, and Marking

When tested in accordance with paragraph A.4.4.4, capacitors shall meet the following requirements.

A.3.4.1 Externals and Marking

The capacitor surface shall be free of any crack or corrosion. As a minimum the following items shall be marked in a manner which cannot be erased easily.

a) Part number.
b) Lot identification code.
c) Manufacturer name or abbreviation (if possible).

A.3.4.2 Dimension and Mass

Dimension and mass shall be as specified in the detail specification.

A.3.5 Workmanship

Capacitors shall be manufactured based on a good design and in accordance with the quality assurance program defined in paragraph 3.2.1.

Capacitors shall not exhibit cracks, pinholes, flaws or other defects that will affect electrical or mechanical performance. The lead terminals shall not exhibit bends, deformations or other defects.

a) Soldering

Soldering shall not be employed to obtain mechanical strength. Excessive flux or solder shall be removed.

When soldering to establish electrical connection, it is desirable that the mechanical connection is provided before soldering. Electrical connection shall be established after soldering.

Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area, and tin or solder coating for the mechanical connection area which is not intended to create an electrical circuit.

Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.

Regardless of the use of acid or acid salt the post-processing, such as complete neutralization or cleaning, shall be performed immediately after soldering.

b) Finish

The capacitor's finish shall not exhibit any external surface defects such as scars, cracks or corrosion.

c) Terminal and sealing area

There shall be no grease or other foreign objects at any terminal or sealing area.

d) Solder finish

There shall be no bumps or rough surfaces caused by insufficient heating. Soldering shall be performed with the minimum required amount of flux and solder. Excessive flux shall be removed without damaging the capacitor. No dispersed flux particles, brush bristles or other foreign objects shall be left inside or on the external surface of the capacitor.

No damage to insulators or loosening of parts shall be caused by the soldering heat.

A.3.5.1 DPA

When tested in accordance with A.4.4.5.1, capacitors shall meet the requirements specified in the detail specification.

A.3.6 Rating

The following items shall be specified in the detail specification.

a) Nominal capacitance.
b) Characteristic.
c) Rated voltage.
d) Operating temperature range.

A.3.7 Electrical Performance

Capacitors shall meet the following requirements.

A.3.7.1 Voltage Aging

When tested in accordance with A.4.4.6.1, capacitors shall meet the following requirements.

a) Insulation resistance
   1) As specified in paragraph A.3.7.5 at the maximum operating temperature.
   2) As specified in paragraph A.3.7.5 in the standard conditions.

b) Dissipation factor
   The dissipation factor shall be not less than the values specified in Figure A-1 (initial required condition).

c) Capacitance
   As specified in paragraph A.3.7.2.

A.3.7.2 Capacitance

When tested in accordance with paragraph A.4.4.6.2, the capacitance shall meet the requirements in the detail specification.

A.3.7.3 Dissipation Factor

When tested in accordance with paragraph A.4.4.6.3, the dissipation factor shall be not less than the values specified in Figure A-1.

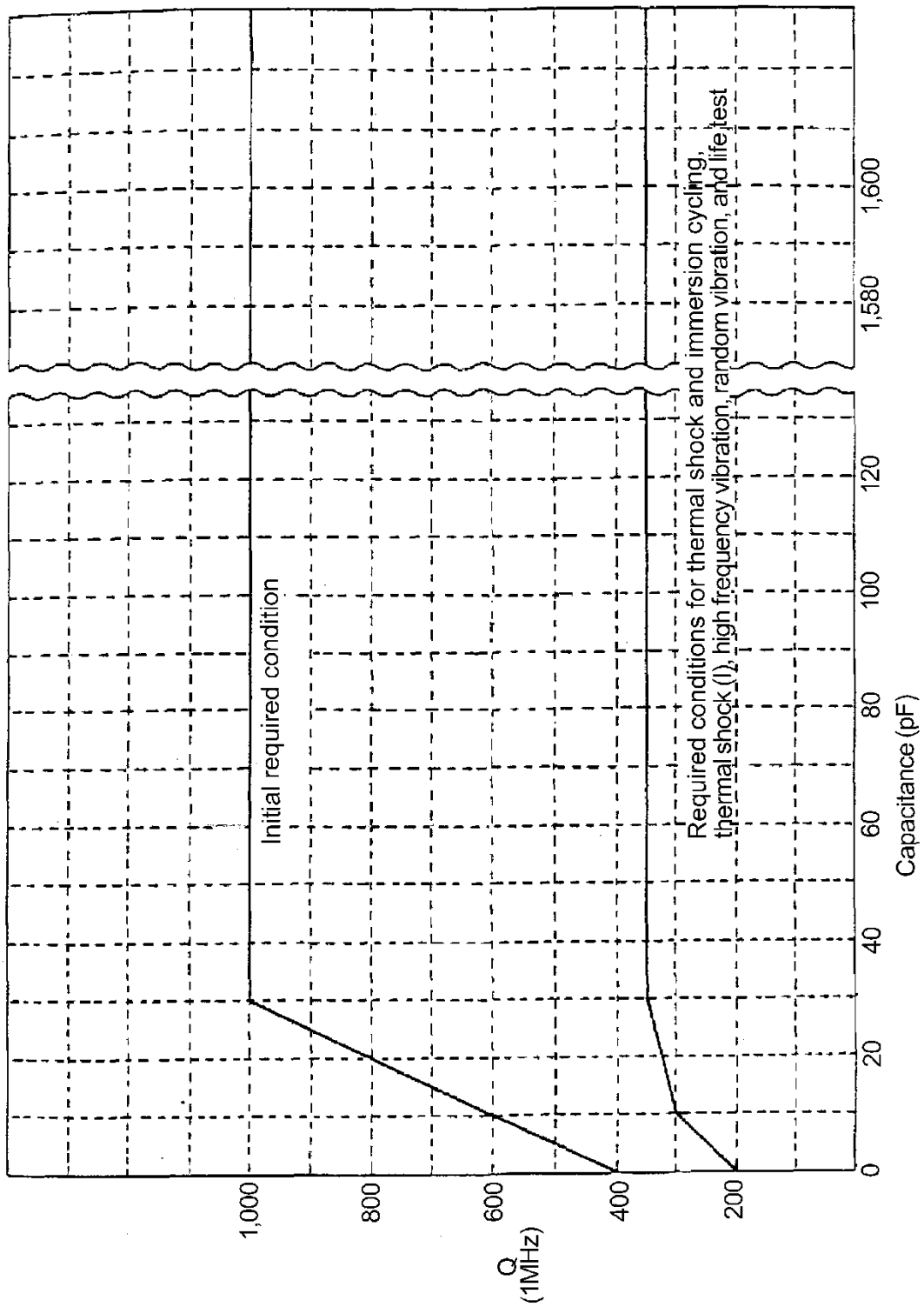

Figure A-1. Minimum Dissipation Factor

A.3.7.4 Dielectric Withstanding Voltage

When tested in accordance with paragraph A.4.4.6.4, capacitors shall meet the following requirements.

a) Between terminals
There shall be no damage or dielectric breakdown between terminals.
b) Between terminals and enclosure
There shall be no damage or dielectric breakdown between terminals and enclosure.

A.3.7.5 Insulation Resistance

When tested in accordance with paragraph A.4.4.6.5, the insulation resistance shall meet the requirements specified in the detail specification.

A.3.7.6 Temperature Coefficient and Capacitance Drift

a) Temperature coefficient
When tested in accordance with paragraph A.4.4.6.6, the capacitance–temperature curve shall lie within the tolerance envelope shown in Figure A-2.
The minimum and maximum values of the envelope are shown in Table A-4.
b) Capacitance drift
When the test frequency is 1MHz, the capacitance drift shall be not greater than 0.2% or 0.05pF, whichever is greater.

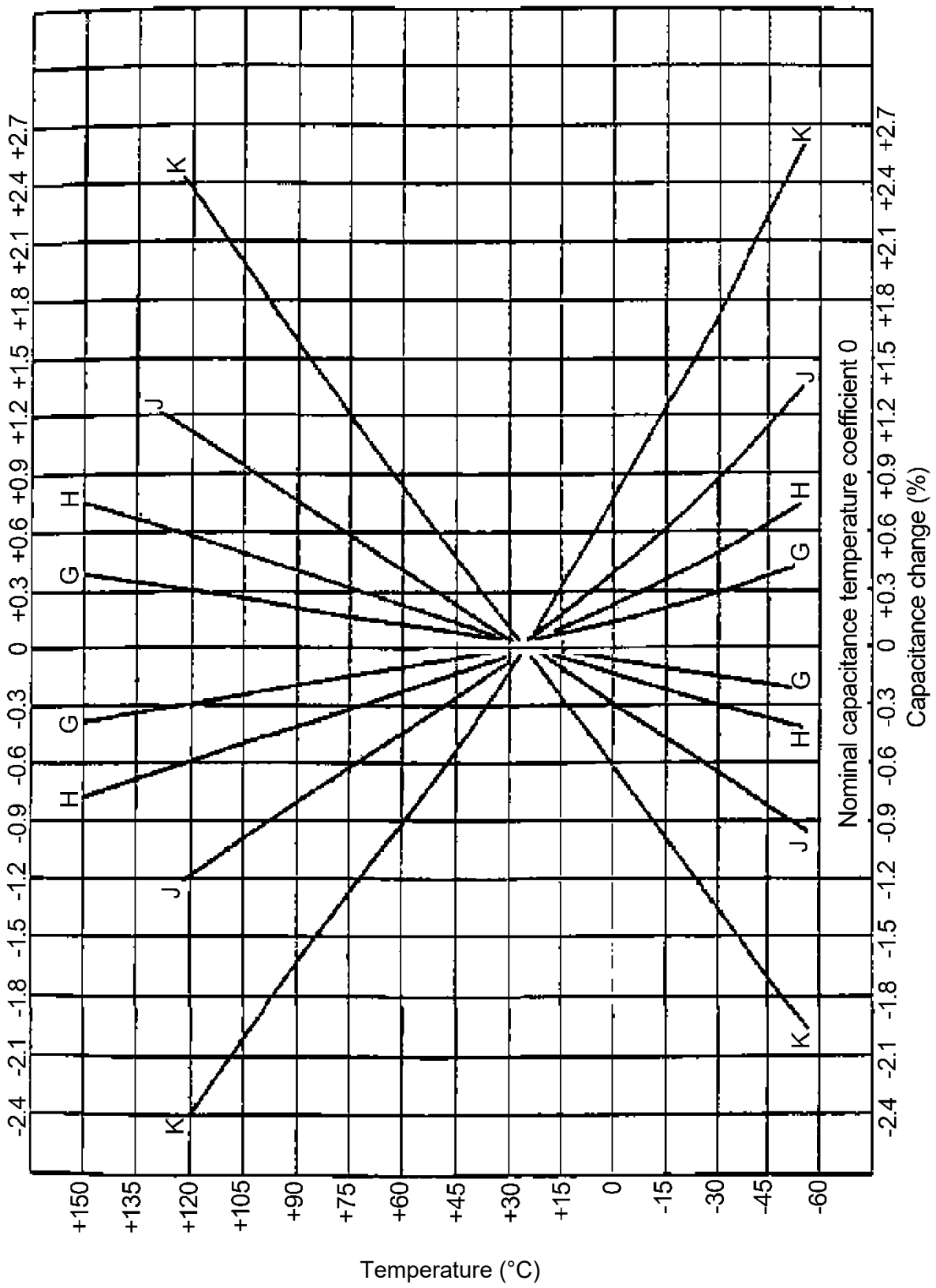

Figure A-2. Allowable Error Envelope for Temperature Coefficient C

Table A-4. Readings Taken from Figure A-2

(Unit: 10^{-6})

Characteristic	Capacitance tolerance change from capacitance at 25°C							
	-55°C		-40°C		-10°C			
	Max.	Min.	Max.	Min.	Max.	Min.		
CG	4,300	-2,200	3,400	-1,900	1,700	-1,100		
CH	7,300	-4,400	5,800	-3,700	2,900	-2,000		
CJ	13,300	-9,300	10,500	-7,600	5,400	-4,200		
CK	26,100	-19,700	20,800	-16,100	10,700	-8,600		
	45°C		65°C		85°C		125°C	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
CG	600	-700	1,100	-1,400	1,700	-1,800	3,000	-3,000
CH	1,300	-1,500	2,400	-2,500	3,600	-3,600	6,000	-6,000
CJ	2,300	-2,700	4,700	-5,100	7,200	-7,200	12,000	-12,000
CK	5,000	-5,500	10,000	-10,400	15,000	-15,000	25,000	-25,000

A.3.8 Mechanical Performance

Capacitors shall meet the following requirements.

A.3.8.1 Terminal Strength

When tested in accordance with A.4.4.7.1, the terminals shall not have defects such as breakage, looseness or extraction.

A.3.8.2 Solderability

When tested in accordance with paragraph A.4.4.7.2, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough surface and shall not be concentrated in one area.

A.3.8.3 Resistance to Soldering Heat

When tested in accordance with A.4.4.7.3, capacitors shall meet the following requirements.

a) Insulation resistance
Capacitors shall meet the requirements in the detail specification.

b) Capacitance
The capacitance change from the initial value shall be up to 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater.

c) Dissipation factor
The dissipation factor shall not be less than the values specified in Figure A-1 (initial requirement).

A.3.9 Environmental Performance

Capacitors shall meet the following requirements.

A.3.9.1 Vibration

A.3.9.1.1 High Frequency Vibraion

When tested in accordance with paragraph A.4.4.8.1.1, there shall be no intermittent contacts of 0.5ms or greater duration or open-circuiting. Capacitors shall meet the following requirements:

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Capacitance
The capacitance shall not change more than 2% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.

c) Dissipation factor
The dissipation factor shall not be less than the values specified in Figure A-1.

d) Dielectric withstanding voltage (between terminals)
There shall be no damage or dielectric breakdown.

e) Insulation resistance
As specified in paragraph A.3.7.5.

A.3.9.1.2 Random Vibraion

When tested in accordance with paragraph A.4.4.8.1.2, there shall be no intermittent contacts of 0.5ms or greater duration, or open-circuiting. In addition, capacitors shall meet the following requirements:

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Capacitance
The capacitance shall not change more than 2% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.

c) Dissipation factor
The dissipation factor shall be not less than the values specified in Figure A-1.

d) Dielectric withstanding voltage (between terminals)
There shall be no damage or dielectric breakdown.

e) Insulation resistance
As specified in paragraph A.3.7.5.

A.3.9.2 Shock

When tested in accordance with paragraph A.4.4.8.2, there shall be no intermittent contacts of 0.5ms or greater duration, open-circuiting, mechanical damage, or breakage.

A.3.9.3 Thermal Shock (I)

When tested in accordance with paragraph A.4.4.8.3, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage. The marking shall remain legible.

b) Capacitance
The capacitance shall not change more than 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.
c) Dissipation factor
The dissipation factor shall be not less than the values specified in Figure A-1.
d) Dielectric withstanding voltage (between terminals)
There shall be no damage or dielectric breakdown.
e) Insulation resistance
The insulation resistance shall meet the requirements in the detail specification.

A.3.9.4 Thermal Shock and Immersion Cycling

When tested in paragraph A.4.4.8.4, capacitors shall meet the following requirements.
a) Externals
There shall be no mechanical damage, and the marking shall remain legible.
b) Capacitance
The capacitance shall not change more than 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.
c) Dissipation factor
The dissipation factor shall be not less than the values specified in Figure A-1.
d) Dielectric withstanding voltage (between terminals)
There shall be no damage or dielectric breakdown.
e) Insulation resistance
The insulation resistance shall meet the requirements in the detail specification.

A.3.9.5 Moisture Resistance

When tested in accordance with paragraph A.4.4.8.55, capacitors shall meet the following requirements.
a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Capacitance
The capacitance shall not change more than 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.
c) Insulation resistance
The insulation resistance shall meet the requirements in the detail specification.

A.3.9.6 Humidity, Steady State, Low Voltage

When tested in accordance with A.4.4.8.6,capacitors shall meet the following requirements.
a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Insulation resistance (+25°C)
The insulation resistance shall meet the requirements specified in paragraph A.3.7.5.
c) Capacitance Change
The capacitance shall not change more than 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.

A.3.9.7 Barometric Pressure (Reduced)

When tested as specified in paragraph A.4.4.8.7, capacitors shall not exhibit short-circuiting or mechanical damage during or after the test.

A.3.9.8 Resistance to Solvents

When tested as specified in paragraph A.4.4.8.8, the marking shall remain legible.

A.3.10 Durability Performance

Capacitors shall meet the following requirements.

A.3.10.1 Life

When tested in accordance with paragraph A.4.4.9.1, capacitors shall not exhibit short-circuiting or mechanical damage during or after the test, and shall meet the following requirements:

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Capacitance
The capacitance shall not change more than 5% or 0.5pF (0.25pF for value less than 10pF), whichever is greater from the initial value.

c) Dissipation factor
The dissipation factor shall not be less than the values specified in Figure A-1.

d) Insulation resistance
The insulation resistance shall meet the requirements specified in the detail specification.

A.4 QUALITY ASSURANCE PROVISIONS

A.4.1 In-Process Inspection

Each manufacturing lot shall be subjected to the in-process inspections specified in Table A-5. Manufacturer may arbitrarily add the inspection items in accordance with paragraph 4.3.

Table A-5. In-Process Inspection

No.	In-process inspection item	Requirement paragraph	Test method paragraph	Quantity of samples
1	Non-destructive internal inspection	A.3.3	A.4.4.3	100%
2	Humidity, steady state, low voltage (1)	A.3.9.6	A.4.4.8.6	12

Note: (1) This inspection is not applicable to capacitors with ceramic dielectric that exceeds 30μm in nominal thickness or that consists of two or more ceramic layers. The details shall be as specified in the detail specification.

A.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

A.4.2.1 Sample

Samples for the qualification test shall be taken from inspection lots that have passed the in-process inspection. Manufacturer shall submit sample units with maximum nominal capacitance from a group that has the same style, characteristics and rated voltage.

A.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table A-6. All samples shall be subjected to groups I, II and III tests before being divided for groups IV through XI tests. Tests in group IV and subsequent groups may be performed in any order regardless of the group number. Tests in each group shall be performed in the order listed.

Table A-6. Qualification Test

Test			Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item			Quantity of samples	Quantity of allowable defectives(1)
I	1	Voltage aging	A.3.7.1	A.4.4.6.1	All samples	0
II	1	Externals, dimensions, mass and marking	A.3.4	A.4.4.4	All samples(2)	1
III(3)	1	Capacitance	A.3.7.2	A.4.4.6.2	280(4)	1
	2	Dissipation factor	A.3.7.3	A.4.4.6.3		
	3	Dielectric withstanding voltage	A.3.7.4	A.4.4.6.4		
	4	Barometric pressure (reduced)	A.3.9.7	A.4.4.8.7		
	5	Insulation resistance	A.3.7.5	A.4.4.6.5		
IV	1	Solderability	A.3.8.2	A.4.4.7.2	6	1
V	1	Temperature coefficient and capacitance drift	A.3.7.6	A.4.4.6.6	18	1
	2	High-frequency vibration	A.3.9.1.1	A.4.4.8.1.1		
	3	Thermal shock and immersion cycling	A.3.9.4	A.4.4.8.4		
VI	1	Shock	A.3.9.2	A.4.4.8.2	18	1
	2	Terminal strength	A.3.8.1	A.4.4.7.1		
	3	Moisture resistance	A.3.9.5	A.4.4.8.5		
						1(5)
VII	1	Resistance to soldering heat	A.3.8.3	A.4.4.7.3	6	1
	2	Resistance to solvents	A.3.9.8	A.4.4.8.8		
VIII	1	Life – Rated condition	A.3.10.1	A.4.4.9.1	159	0
		Life – Accelerated condition	A.3.10.1	A.4.4.9.1	52	0
IX	1	DPA	A.3.5.1	A.4.4.5.1	2	0
X	1	Random vibration	A.3.9.1.2	A.4.4.8.1.2	6	0
XI	1	Thermal shock (I)	A.3.9.3	A.4.4.8.3	12	0
–	–	Materials	A.3.2	–	(6)	

Notes:
(1) A sample having one or more defects in one group shall be counted as a single defect.
(2) For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(3) Non-destructive tests.
(4) One additional sample unit is included in each sample to permit substitution for the failure allowed in group III (280 sample units).

(5) The total allowable defects shall be one in Groups IV through VII.
(6) Documents shall be submitted to prove that the samples meet the design specification.

A.4.3 Quality Conformance Inspection

The quality conformance inspection shall be as follows and as specified in paragraph 4.5.

A.4.3.1 Sample

Sample selection for an inspection lot submitted to group A inspection shall be as specified in paragraph 4.5.1.1
Groups B and C inspections shall be conducted per group of the same style, characteristic and rated voltage. Sample selection for an inspection lot shall be as specified in paragraph 4.5.2.1. If one or more lots from one group were submitted to group A inspection around the same time, samples shall be taken from the lot with the maximum nominal capacitance.

A.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table A-7 for group A, Table A-8 for group B, and Table A-9 for group C. Group A inspection shall be performed in the order of subgroups listed in the table, and each inspection in the subgroup shall be performed in the order listed in each table.

A.4.3.3 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in the order 2 test of subgroup A1 and/or subgroup A2 inspections, 100% inspection shall be conducted for the rejected items and conforming products may be delivered.

Table A-7. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Voltage aging (Insulation resistance) (Dissipation factor) (Capacitance)	A.3.7.1 (A.3.7.5) (A.3.7.3) (A.3.7.2)	A.4.4.6.1 (A.4.4.6.5) (A.4.4.6.3) (A.4.4.6.2)	All samples	0
	2	Externals, dimensions, mass and marking	A.3.4	A.4.4.4	AQL(1) 1.0%	
A2	1	Dielectric withstanding voltage	A.3.7.4	A.4.4.6.4	AQL(1) 0.65%	
A3	1	DPA	A.3.5.1	A.4.4.5.1	2	0

Note: (1) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection as specified in JIS Z 9015-1, Attachment Table 2-A.

Table A-8. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Solderability	A.3.8.2	A.4.4.7.2	6	0
B2	1	Resistance to soldering heat	A.3.8.3	A.4.4.7.3	8	0
	2	Resistance to solvents	A.3.9.8	A.4.4.8.8		

Table A-9. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Barometric pressure (reduced)	A.3.9.7	A.4.4.8.7	6	0
C2	1	Temperature coefficient and capacitance drift	A.3.7.6	A.4.4.6.6	18	0
	2	High-frequency vibration	A.3.9.1.1	A.4.4.8.1.1		
	3	Thermal shock and immersion cycling	A.3.9.4	A.4.4.8.4		
C3	1	Shock	A.3.9.2	A.4.4.8.2	18	0
	2	Terminal strength	A.3.8.1	A.4.4.7.1		
	3	Moisture resistance	A.3.9.5	A.4.4.8.5		
C4	1	Life (accelerated condition)	A.3.10.1	A.4.4.9.1	12	0
C5	1	Random vibration	A.3.9.1.2	A.4.4.8.1.2	6	0
C6	1	Thermal shock (I)	A.3.9.3	A.4.4.8.3	6	0

A.4.4 Methods of Test and Inspection

A.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202. The following details and exceptions shall apply.

a) Standard conditions

The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 to 75%, and atmospheric pressure of 86 to 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute is expected over the results.

b) Test conditions

The decision conditions shall be at a temperature of 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure of 86 to 106kPa.

c) Reference conditions

The reference conditions shall be at a temperature of 25°C, a relative humidity of 50% and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Drift of the power supply voltage for the life test shall be within ±3% of the specified test voltage.

A.4.4.2 Processing of the test capacitor

The following processing shall be completed, if needed.

a) Preprocessing
The test capacitor shall be discharged for 30 minutes or longer at the test temperature prior to tests and measurements.

b) Forced drying
Unless otherwise specified, the test capacitor shall be dried as specified in Table A-10 prior to tests and measurements.

Table A-10. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6±0.5 hours

A.4.4.3 Non-Destructive Internal Inspection

Capacitors shall be examined using ultrasonic test equipment or by a non-destructive internal inspection method which can verify if capacitors meet the requirements specified in paragraph A.3.3. The inspection method shall be defined in the Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

A.4.4.4 Externals, Dimension, Mass and Marking

Capacitors shall be inspected for the externals, construction, dimensions, mass, and markings as specified in paragraph A.3.4. The mass shall be measured in the qualification test and group A inspection conducted prior to group C inspection.

A.4.4.5 Workmanship

A.4.4.5.1 DPA

The DPA shall be conducted in accordance with the DPA manual as specified in the Quality Assurance Program Plan to examine the inner construction and to confirm that the processes such as welding and soldering are properly implemented by disassembling capacitors.

A.4.4.6 Electrical Performance

Electrical performance tests shall be performed as follows:

A.4.4.6.1 Voltage Aging

The following conditions shall apply.

a) Voltage aging conditions
   1) Temperature: Maximum operating temperature $^{+4}_{0}$°C.
   2) Duration of application: 100±4 hours.
   3) Applied test voltage: 200% of rated voltage.

b) Measuring conditions of electrical characteristics
   1) Insulation resistance (1)
      As specified in paragraph A.4.4.6.5 at the maximum operating temperature.
      As specified in paragraph A.4.4.6.5 under the standard conditions.
   2) Dissipation factor
      As specified in paragraph A.4.4.6.3.
   3) Capacitance
      As specified in paragraph A.4.4.6.2.

   Note: (1) The insulation resistance at the maximum operating temperature shall be measured following the voltage aging test. The test capacitor may be displaced to another chamber controlled at the same temperature. In this case, displacing time shall not exceed 15 minutes.

A.4.4.6.2 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Test frequency
   1) When nominal capacitance is up to 1,000pF: 1MHz±100kHz.
   2) When nominal capacitance is over 1,000pF: 1kHz±100Hz.
b) Test voltage: 1.0±0.2Vrms

A.4.4.6.3 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge. The following details and exception shall apply.

a) Test frequency: Paragraph A.4.4.6.2, item a).
b) Test voltage: Paragraph A.4.4.6.2, item b).

A.4.4.6.4 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202 for the two items below.

a) Between terminals
   The following conditions shall apply.
   1) Test voltage: 300% of the rated voltage unless otherwise specified in the detail specification.
   2) Duration of application: 5±1 seconds.
   3) Charged and discharged current: 50mA or less.

b) Between terminals and enclosure
The following conditions shall apply.
1) Test voltage: 150% of the rated voltage unless otherwise specified in the detail specification.
2) Duration of application: 5±1 seconds.
3) Charged and discharged current: 50mA or less.

A.4.4.6.5 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details shall apply.

a) Test conditions
1) Test voltage: Rated voltage.
2) Charged and discharged current: 50mA or less.
3) Duration of charging: 120^{+10}_{0} seconds.

b) Point of measurement: Between the terminals.

c) Test temperature
Unless otherwise specified in the detail specification, the measurement shall be made under standard conditions.

d) Special conditions
If a dispute arises over the measured results in which the relative humidity was greater than 50%, the measurement may be repeated at a relative humidity not greater than 50%.

A.4.4.6.6 Temperature Coefficient and Capacitnace Drift

a) Temperature coefficient
The capacitance shall be measured in accordance with paragraph A.4.4.6.2. The order of measurements and sample temperature shall be as listed in Table A-11.

b) Capacitance drift
Capacitance drift shall be calculated by dividing the greatest single difference between any two of the three capacitance values recorded at 25°C by the capacitance value measured at the reference temperature.

Table A-11. Temperature and Order of Capacitance Measurement

Order	Temperature (°C)
1	25^{0}_{-2}
2	-55^{0}_{-2}
3	-40^{0}_{-2}
4	-10^{0}_{-2}
5	25^{0}_{-2} (1)
6	45^{+2}_{0}
7	65^{+2}_{0}
8	85^{+2}_{0}
9	105^{+2}_{0} (2)
10	125^{+2}_{0} (2)
11	25^{0}_{-2}

Notes:

(1) Reference temperature for calculating temperature coefficient.

(2) Applicable only to capacitors of which the maximum operating temperature is 125°C.

Remarks:

1. At each temperature, when two consecutive measurements taken at 5 minutes intervals at that temperature indicate no change in capacitance, the measurement shall be recorded.
2. Since it is not practical to measure the capacitor characteristic of 20pF or less capacitance and the temperature coefficient tolerance is under the curve specified in Figure A-3, the test may be conducted with capacitors having a temperature coefficient tolerance on or above the curve. In this case, the manufacturer shall verify that the test capacitor has the same materials as those of 20pF or less.

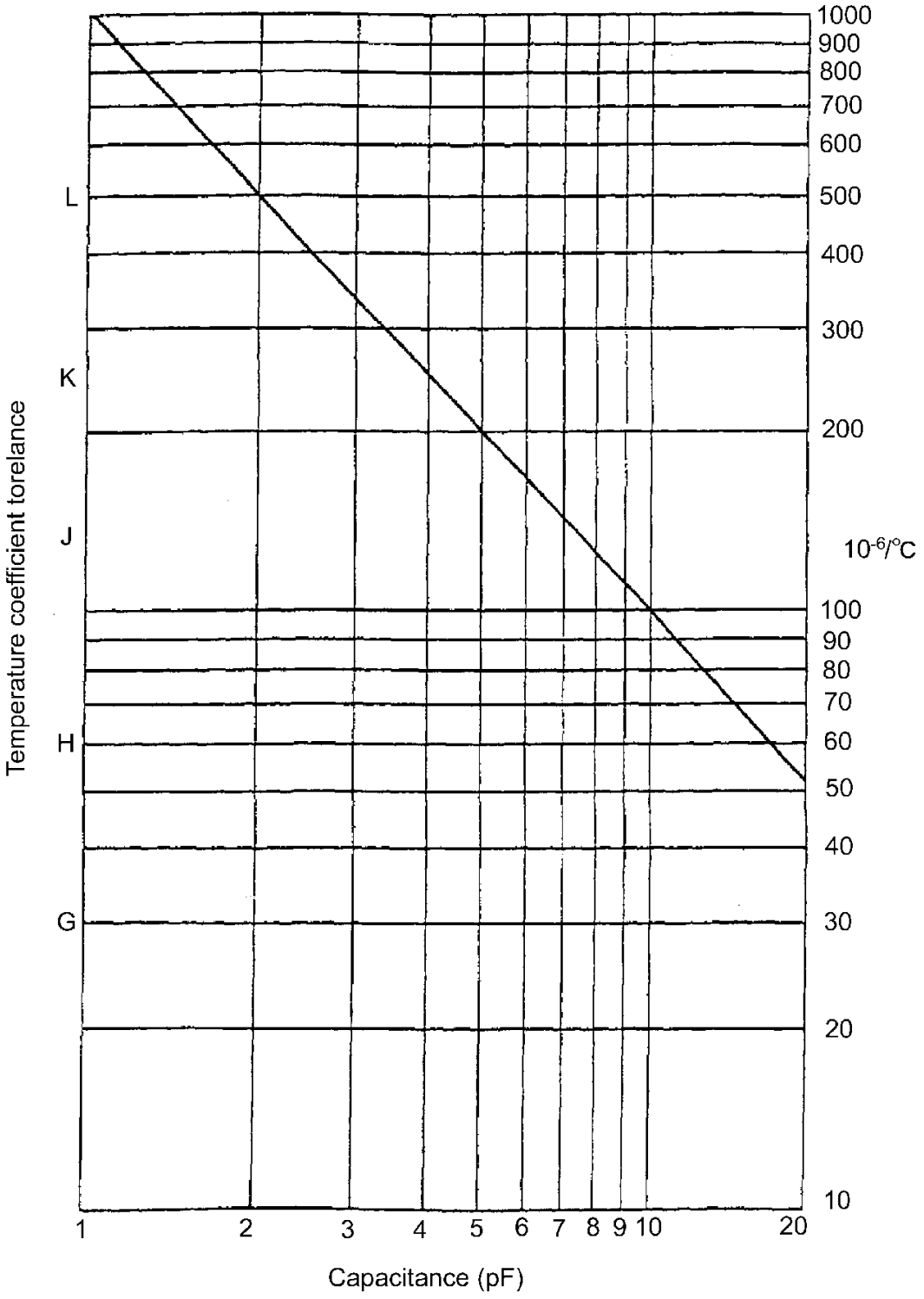

Figure A-3. Capacitance Limit for Characteristics Measurement

A.4.4.7 Mechanical Performance

Mechanical performance tests shall be performed as follows.

A.4.4.7.1 Terminal Strength

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details shall apply.

a) Pull test
   1) Test condition: A.
   2) Applied force: 10N.
   3) Method of applying force:
      Capacitors shall be secured by the body and force shall be gradually applied to one terminal.
b) Bend test
   1) Test condition: C.
   2) Applied force: 10N.

A.4.4.7.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: All terminals.
b) Solder temperature: 230±5°C.
c) Duration of immersion: 5±0.5 seconds.
d) Depth of immersion: Approximately 2mm from the terminal base.

A.4.4.7.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Depth of immersion:
   The lead terminal shall be immersed in molten solder to within 1.0mm from egress of the test capacitor.
b) Solder temperature: 270±5°C.
c) Duration of immersion: 10±1 seconds.
d) Duration of cooling from immersion to measurement: 10±1 minutes.
e) Measurements after test:
   The insulation resistance, capacitance and dissipation factor shall be measured as specified in paragraphs A.4.4.6.5, A.4.4.6.2, and A.4.4.6.3.

A.4.4.8 Environmental Performance

Environmental performance tests shall be performed as follows.

A.4.4.8.1 Vibration

A.4.4.8.1.1 High-Frequency Vibration

Capacitors shall be tested in accordance with test method 204 of MIL-STD-202. The following details shall apply.

a) Mounting method
   Unless otherwise specified in the detail specification, the test capacitor shall be securely mounted on a mounting fixture and the lead wires shall be rigidly connected to the support terminals. The length of lead wire shall be approximately 1cm between the support terminal and the edge of the test

capacitor. To avoid damaging the surface, connect the lead wire by soldering, if possible. The mounting fixture shall be constructed to preclude resonance within the specified test frequency range.

a) Voltage loading condition
Unless otherwise specified in the detail specification, 125% of the rated voltage shall be applied between the terminals of the test capacitor during the test.

b) Test condition:
Condition D (either 196m/s^2 p-p or total amplitude of 1.5mm, whichever is smaller)

c) Directions and duration of vibration
Unless otherwise specified in the detail specification, the capacitor shall be vibrated for an equal amount of time in each of the three directions. The duration of the frequency sweep shall be 20 minutes per cycle and shall be repeated for 8 cycles in each of the three directions (8 hours in total).

d) Inspections during test
Capacitors shall be examined for intermittent contacts or open-circuiting in each direction. A detector shall have the capability to detect a discontinuity of 0.5ms or greater duration.

e) Inspections and measurements after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility. The capacitance, dissipation factor, dielectric withstanding voltage, and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, A.4.4.6.3, item a) of A.4.4.6.4, and A.4.4.6.5.

A.4.4.8.1.2 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be rigidly mounted using a jig or shall be mounted directly to the vibrating table. Adhesives such as resin may be used to secure the test capacitor.

b) Test condition: II-H (20 to 2,000Hz, 334m/s^2 rms).

c) Direction of vibration: Three mutually perpendicular directions.

d) Duration of test: 3 minutes in each direction.

e) Inspections during test
Capacitors shall be examined for intermittent contacts or open-circuiting in each direction. A detector shall have the capability to detect a discontinuity of 0.5ms or greater duration.

f) Inspections and measurements after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility. The capacitance, dissipation factor, dielectric withstanding voltage and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, A.4.4.6.3, item a) of A.4.4.6.4, and A.4.4.6.5.

A.4.4.8.2 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method

The test capacitor shall be secured by the body and at lead wires approximately 10mm from edge of the body.

b) Test condition: I (980m/s^2, 6ms, and saw tooth waveform).

c) Directions of shock application: 3 mutually perpendicular directions.

d) Inspections during test
Capacitors shall be examined for electrical discontinuity of 0.5ms or greater duration during the final cycle in each direction. A detector shall have sensitivity to detect a discontinuity of 0.5ms or greater duration.

e) Inspection after test
Capacitors shall be visually examined for mechanical damage.

A.4.4.8.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: B, except that the temperature shall be -30^{0}_{-3}°C in step 1, and 100^{+3}_{0}°C in step 3.

b) Number of cycles: 1,000 cycles

c) Measurements and inspections.
The following electrical measurements and external inspections shall be performed before the first cycle and during the cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.

1) Electrical measurements
The capacitance, dissipation factor, dielectric withstanding voltage and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, A.4.4.6.3, item a) of A.4.4.6.4, and A.4.4.6.5.

2) Visual inspection
Capacitors shall be visually examined with a magnifying glass of 10-times magnification following the test.

A.4.4.8.4 Thermal Shock and Immersion Cycling

a) Thermal shock
Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

1) Test condition: B (5 cycles), except that the temperature shall be -55^{0}_{-3}°C in step 1, and the value specified in the detail specification $^{+3}_{0}$°C in step 3.

2) Measurements after test: Not applicable.

b) Immersion cycling
Capacitors shall be tested in accordance with test method 104 of MIL-STD-202 after the thermal shock. The following details shall apply.
1) Pre-test measurement: Not applicable.
2) Test condition: B (2 cycles).
3) Inspections and measurements after final cycle:
Capacitors shall be examined for evidence of mechanical damage and marking legibility. The capacitance, dissipation factor, dielectric withstanding voltage and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, A.4.4.6.3, item a) of A.4.4.6.4, and A.4.4.6.5.

A.4.4.8.5 Moisuture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement: Not applicable.
b) Number of cycles: Continuous 20 cycles.
c) Loading condition
For initial 10 cycles, either DC100V or rated voltage, whichever is lower, shall be applied to both edges of terminals. Capacitors shall be inspected for short-circuiting once a day.
d) Inspections and measurements after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility immediately after step 6 of the final cycle. The capacitance and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, and A.4.4.6.5, respectively.

A.4.4.8.6 Humidity, Steady Sate, Low Voltage

Capacitor chips shall be tested in accordance with test method 103, test condition A of MIL-STD-202 before lead attachment. The following details shall apply.
Under no circumstances during the test, shall the voltage applied to test capacitors exceed 1.5V.

a) Initial measurement
The capacitance shall be measured as specified in paragraph A.4.4.6.2.
b) Test
The test capacitor shall be exposed to a temperature of +85°C and a relative humidity of 85% for at least 240 hours. The test shall be performed as a single test not a cycling test. DC voltage of $1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor via a 100kΩ resistor.
c) Final measurement
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes to stabilize. Subsequently the insulation resistance shall be measured as specified in paragraph A.4.4.6.5 except for applying DC voltage of $1.3^{+0.20}_{-0.25}$V via a resistor of 100kΩ and then the capacitance shall be measured as specified in paragraph A.4.4.6.2.
d) Inspection after test

Capacitors shall be visually examined for evidence of mechanical damage and marking legibility after the final measurement.

A.4.4.8.7 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Mounting method
   Capacitors shall be securely fastened in the normal manner.
b) Point of application: Between terminals.
c) Condition of pressure reduction: 2.8±0.4kPa {21.0±3mmHg}.
d) Applied voltage: 150% of the rated voltage, unless otherwise specified in the detail specification.
e) Duration of application: 5±1 seconds.
f) Charged and discharged current: 50mA or less.
g) Inspections during test
   Capacitors shall be monitored for short-circuiting.
h) Inspection after test
   Capacitors shall be visually examined for evidence of mechanical damage.

A.4.4.8.8 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. Isopropyl alcohol shall be used as the solvent.

A.4.4.9 Durability Performance

The durability performance test shall be performed as follows.

A.4.4.9.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Test temperature: Maximum operating temperature specified in the detail specification $^{+4}_{0}$°C.
b) Applied voltage
   1) Rated condition: Rated voltage.
   2) Accelerated condition: 200% of the rated voltage.
c) Charged and discharged current: 50mA or less
d) Duration of voltage application
   1) Rated condition: 4,000$^{+72}_{0}$ hours.
   2) Accelerated condition: 2,000$^{+72}_{0}$ hours.
e) Inspections and measurements during and after test
   Capacitors shall be monitored for short-circuiting. Capacitors shall be visually examined for evidence of mechanical damage and marking legibility 250±8, 1,000$^{+48}_{0}$, 2,000$^{+72}_{0}$, and 4,000$^{+72}_{0}$ hours after the test. The capacitance, dissipation factor, and insulation resistance shall be measured as specified in paragraphs A.4.4.6.2, A.4.4.6.3, and A.4.4.6.5.

A.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.

a) Capacitance (paragraph A.3.7.2)
b) Dissipation factor (paragraph A.3.7.3)
c) Dielectric withstanding voltage (paragraph A.3.7.4)
d) Insulation resistance (paragraph A.3.7.5)
e) Externals and markings (paragraph A.3.4)

A.4.6 Change to Tests and Inspections

Change to tests and inspections shall be processed as specified in paragraph 4.8.

A.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

A.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX B

CAPACITORS, FIXED, CERAMIC DIELECTRIC

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX B

CAPACITORS, FIXED, CERAMIC DIELECTRIC

B.1 GENERAL

B.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for ceramic dielectric, fixed capacitors (hereinafter referred to as "capacitors").

B.1.2 Classification

Capacitors shall be classified as specified in Table B-1.

Table B-1. Classification

Structure	Style
Non-metal enclosure, radial lead	CKS05
	CKS06

B.1.3 Part Number

The part number shall be indicated as follows. The details shall be as specified in the detail specification.

(Example)

NASDA[(1)] CKS05 BX 100 K

Style	Characteristic	Nominal capacitance	Capacitance tolerance
(B.1.3.1)	(B.1.3.2)	(B.1.3.3)	(B.1.3.4)

Note: [(1)] "NASDA" indicates the part is for space use and may be abbreviated “N”.

B.1.3.1 Style

Style shall be identified with “CKS”, followed by a two-digit number. “CKS” denotes “high reliability, ceramic dielectric, fixed capacitors” and the following two digits denote capacitor size.

B.1.3.2 Characteristics

The characteristic shall be identified by a two-letter symbol. The first letter indicates the operating temperature range as specified in Table B-2, and the second letter indicates the voltage–temperature characteristic as shown in Table B-3.

Table B-2. Operating Temperature Range

(Unit: °C)

Symbol	Operating temperature range
A	-55 to +85
B	-55 to +125

Table B-3. Voltage–Temperature Characteristic

(Unit: %)

Symbol	Capacitance change at 25°C		Operating temperature range
	No voltage applied A to D of Table B-11	Rated voltage applied E to G of Table B-11	
W	+22 -56	+22 -60	A
X	±15	+15 -25	A, B
Y	+30 -70	+30 -80	A
R	±15	+15 -40	B

B.1.3.3 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For example, 102 indicates 1,000pF.

B.1.3.4 Capacitance Tolerance

Capacitance tolerance shall be identified by a capital letter as specified in Table B-4.

Table B-4. Capacitance Tolerance

(Unit: %)

Symbol	Capacitance tolerance
J	+5
K	±10
M	±20
Z	+80 -20

B.2 APPLICABLE DOCUMENTS

B.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

B.2.2 Reference Document

The following document is a referenced document for this appendix.

a) MIL-PRF-39014 Capacitor, Fixed, Ceramic Dielectric (General Purpose), Established Reliability and Nonestablished Reliability, General Specification for

B.3 REQUIREMENTS

B.3.1 Qualificaiton Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings, and performance specified in paragraphs B.3.2 to B.3.10. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

B.3.2 Materials

The materials shall be as specified below and as specified in paragraph 3.3.

B.3.2.1 Construction

Construction shall be as specified below and as specified in the detail specification.

a) Capacitor element
Ceramic shall be used as the dielectric.

b) Lead terminal
Lead terminals shall be appropriately processed to facilitate soldering.

c) Insulating enclosure and impregnating compounds
Insulating enclosure and impregnating compounds shall withstand the maximum operating temperature and shall maintain the required moisture resistance and electrical isolation. They shall not adversely affect the capacitor performance.

B.3.3 Non-Destructive Internal Inspection

All capacitors shall be subjected to an ultrasonic test or a non-destructive internal inspection as specified in the quality assurance program. When tested in accordance with paragraph B.4.4.3, capacitors shall not exhibit any defects such as delamination, voids, or cracks.

B.3.4 Externals, Dimension, Mass and Marking

When tested in accordance with paragraph B.4.4.4, capacitors shall meet the following requirements.

B.3.4.1 Externals and Marking

The capacitor surface shall not exhibit cracks, chips, or other defects. At a minimum

the following items shall be marked in a manner which cannot be erased easily.

a) Part number
b) Lot identification code
c) Manufacturer name or abbreviation (if possible)

B.3.4.2 Dimension and Mass

Dimension and mass shall be as specified in the detail specification.

B.3.5 Workmanship

Capacitors shall be manufactured based on a good design and in accordance with the quality assurance program defined in paragraph 3.2.1.
Capacitors shall not exhibit cracks, pinholes, flaws or other defects that will affect electrical or mechanical performance. The lead terminals shall not exhibit bends, deformations, or other defects.

a) Soldering
Soldering shall not be employed to obtain mechanical strength. Excessive flux or solder shall be removed.
When soldering to establish electrical connection, it is desirable that the mechanical connection is provided before soldering. Electrical connection shall be established after soldering.
Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area, and tin or solder coating for the mechanical connection area which is not intended to create an electrical circuit.
Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.
Regardless of the use of acid or acid salt the post-processing, such as complete neutralization or cleaning, shall be performed immediately after soldering.

b) Finish
The capacitor's finish shall not exhibit any external surface defects such as scars, cracks, or corrosion.

c) Terminal and sealing area
There shall be no grease or other foreign objects at any terminal or sealing area.

d) Solder finishing
There shall be no bumps or rough surfaces caused by insufficient heating. Soldering shall be performed with the minimum required amount of flux and solder. Excessive flux shall be removed without damaging the capacitor. No dispersed flux particles, brush bristles or other foreign objects shall be left inside or on the external surface of the capacitor.
No damage to insulators or loosening of parts shall be caused by the soldering heat.

B.3.5.1 DPA

When tested in accordance with paragraph B.4.4.5.1, capacitors shall meet the requirements specified in the detail specification.

B.3.6 Rating

The following items shall be specified in the detail specification.

a) Nominal capacitance

b) Characteristic
c) Rated voltage
d) Operating temperature range

B.3.7 Electrical Performance

Capacitors shall meet the following requirements.

B.3.7.1 Capacitance

When tested in accordance with paragraph B.4.4.6.1, the capacitance shall meet the requirements in the detail specification.

B.3.7.2 Dissipation Factor

When tested in accordance with paragraph B.4.4.6.2, the dissipation factor shall meet the requirements in the detail specification.

B.3.7.3 Dielectric Withstanding Voltage

When tested in accordance with paragraph B.4.4.6.3, the capacitor shall meet the following requirements.

a) Between terminals
There shall be no damage or dielectric breakdown between terminals.
b) Between terminals and enclosure
There shall be no damage or dielectric breakdown between terminals and enclosure.

B.3.7.4 Insulation Resistance

When tested in accordance with paragraph B.4.4.6.4, the insulation resistance shall exceed the values specified in Figure B-1.

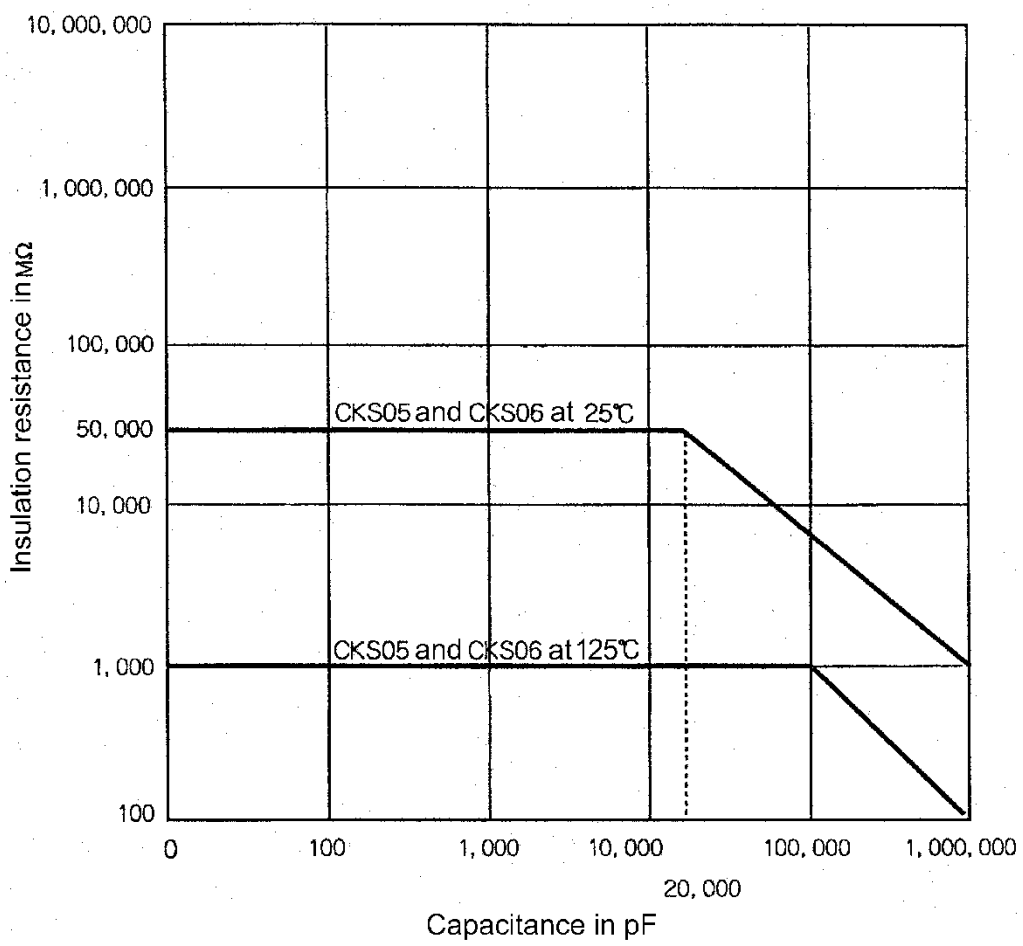

Figure B-1. Capacitance versus Insulation Resistance

B.3.7.5 Voltage–Temperature Characteristics

When tested under the conditions of Table B-11 specified in paragraph B.4.4.6.5, the capacitance change shall not exceed the limit specified in Table B-3.

B.3.8 Mechanical Performance

Capacitors shall meet the following requirements.

B.3.8.1 Terminal Strength

When tested in accordance with paragraph B.4.4.7.1, the terminals shall not have defects such as breakage, looseness, or extraction.

B.3.8.2 Solderability

When tested in accordance with paragraph B.4.4.7.2, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough surfaces and shall not be concentrated in one area.

B.3.8.3 Resistance to Soldering Heat

When tested in accordance paragraph B.4.4.7.3, capacitors shall meet the following requirements.

a) Insulation resistance
Capacitors shall meet the requirements in the detail specification.
b) Capacitance
The capacitance change from the initial measured value shall be up to 5%.
c) Dissipation factor
The dissipation factor shall not exceed 2.5%.

B.3.9 Environmental Performance

Capacitors shall meet the following requirements.

B.3.9.1 Vibration

B.3.9.1.1 High Frequency Vibraion

When tested in accordance with paragraph B.4.4.8.1.1, there shall be no intermittent contacts of 0.5ms or greater duration, open-circuiting, mechanical damage, or breakage.

B.3.9.1.2 Random Vibraion

When tested in accordance with paragraph B.4.4.8.1.2, there shall be no intermittent contacts of 0.5ms or greater duration, open-circuiting, mechanical damage, or breakage.

B.3.9.2 Shock

When tested in accordance with paragraph B.4.4.8.2, there shall be no intermittent contacts of 0.5ms or greater duration, open-circuiting, mechanical damage or breakage.

B.3.9.3 Thermal Shock (I)

When tested in accordance with paragraph B.4.4.8.3, capacitors shall meet the following requirements.
a) Externals
There shall be no significant defects, and the marking shall remain legible.
b) Dielectric withstanding voltage (between terminals)
There shall be no mechanical damage or dielectric breakdown.
c) Insulation resistance
The insulation resistance shall meet the requirements in the detail specification.
d) Capacitance
The capacitance shall be as specified in paragraph B.3.7.1.

B.3.9.4 Thermal Shock and Voltage Aging

When tested in accordance with paragraph B.4.4.8.4, capacitors shall meet the following requirements.
a) Insulation resistance
1) Measurements shall not be less than the values specified in Figure B-1 at the maximum operating temperature.
2) Measurements shall not be less than the values specified in Figure B-1 under the standard conditions.
b) Dissipation factor

The dissipation factor shall meet the requirements specified in the detail specification.

c) Capacitance
The capacitance shall meet the requirements specified in the detail specification.

B.3.9.5 Immersion Cycling

When tested in accordance with paragraph B.4.4.8.5, the capacitor shall meet the following requirements.

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Dielectric withstanding voltage (between terminals)
There shall be no mechanical damage or dielectric breakdown.

c) Insulation resistance
When measured under standard conditions, measurements shall exceed the values specified in Figure B-1.

B.3.9.6 Moisture Resistance

When tested in accordance with paragraph B.4.4.8.6, the capacitor shall meet the following requirements.

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Dielectric withstanding voltage (between terminals)
There shall be no mechanical damage or dielectric breakdown.

c) Insulation resistance
The insulation resistance shall meet the requirements specified in the detail specification.

d) Capacitance
The capacitance shall be as specified in paragraph B.3.7.1.

B.3.9.7 Humidity, Steady State, Low Voltage

When tested in accordance with paragraph B.4.4.8.7, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Insulation resistance (+25°C)
The insulation resistance shall meet the requirements in paragraph B.3.7.4.

c) Capacitance
The capacitance change shall be within ±10% of initial value.

B.3.9.8 Barometric Pressure (Reduced)

When tested as specified in paragraph B.4.4.8.8, capacitors shall not exhibit short-circuiting or mechanical damage during or after the test.

B.3.9.9 Resistance to Solvents

When tested as specified in paragraph B.4.4.8.9, the marking shall remain legible.

B.3.10 Durability Performance

Capacitors shall meet the following requirements.

B.3.10.1 Life

When tested as specified in paragraph B.4.4.9.1, capacitors shall not exhibit short-circuiting or mechanical damage during or after the test, and shall meet the following requirements.

a) Externals
There shall be no mechanical damage, and the marking shall remain legible.

b) Insulation resistance
1) Measurements shall not be less than the values specified in Figure B-1 at the maximum operating temperature.
2) Measurements shall not be less than the values specified in Figure B-1 under standard conditions.

c) Capacitance
The capacitance shall meet the requirements in the detail specification.

d) Dissipation factor
The dissipation factor shall meet the requirements in the detail specification.

B.4 QUALITY ASSURANCE PROVISIONS

B.4.1 In-Process Inspection

Each manufacturing lot shall be subjected to the in-process inspections specified in Table B-5. Manufacturers may arbitrarily add the inspection items in accordance with paragraph 4.3.

Table B-5. In-Process Inspection

No.	In-process inspection item	Requirement paragraph	Test method paragraph	Quantity of samples
1	Non-destructive internal inspection	B.3.3	B.4.4.3	All samples
2	Humidity, steady state, low voltage(1)	B.3.9.7	B.4.4.8.7	12

Note: (1) This inspection is not applicable to capacitors with ceramic dielectric that exceeds 30μm in nominal thickness or that consists of two or more ceramic layers. The details shall be as specified in the detail specification.

B.4.2 Qualification Test

The qualification test shall be as follows and as specified in paragraph 4.4.

B.4.2.1 Sample

Samples for the qualification test shall be taken from the inspection lots that have passed the in-process inspection. Manufacturers shall submit sample units with maximum nominal capacitance and the minimum capacitance tolerance from a group that has the same style, characteristics, and rated voltage.

B.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table B-6. All samples shall be subjected to groups I, II, and III tests before being divided for groups IV through XI tests. Groups IV through XI tests may be performed in any order regardless of the group number. Tests in each group shall be performed in the order listed.

Table B-6. Qualification Test

Test				Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item				Quantity of samples	Quantity of allowable defectives(1)
I	1	Thermal shock and voltage aging		B.3.9.4	B.4.4.8.4	All samples	0
II	1	Externals, dimensions, mass and marking		B.3.4	B.4.4.4	All samples(2)	1
III(3)	1	Capacitance		B.3.7.1	B.4.4.6.1	280(4)	1
	2	Dissipation factor		B.3.7.2	B.4.4.6.2		
	3	Dielectric withstanding voltage		B.3.7.3	B.4.4.6.3		
	4	Barometric pressure (reduced)		B.3.9.8	B.4.4.8.8		
	5	Insulation resistance		B.3.7.4	B.4.4.6.4		
IV	1	Solderability		B.3.8.2	B.4.4.7.2	6	1
V	1	Voltage–temperature characteristics		B.3.7.5	B.4.4.6.5	18	1 (5)
	2	High-frequency vibration		B.3.9.1.1	B.4.4.8.1.1		
	3	Immersion cycling		B.3.9.5	B.4.4.8.5		
VI	1	Shock		B.3.9.2	B.4.4.8.2	18	1
	2	Terminal strength		B.3.8.1	B.4.4.7.1		
	3	Moisture resistance		B.3.9.6	B.4.4.8.6		
VII	1	Resistance to soldering heat		B.3.8.3	B.4.4.7.3	6	1
	2	Resistance to solvents		B.3.9.9	B.4.4.8.9		
VIII	1	Life	Rated condition	B.3.10.1	B.4.4.9.1	159	0
			Accelerated condition	B.3.10.1	B.4.4.9.1	52	0
IX	1	DPA		B.3.5.1	B.4.4.5.1	2	0
X	1	Random vibration		B.3.9.1.2	B.4.4.8.1.2	6	0
XI	1	Thermal shock (I)		B.3.9.3	B.4.4.8.3	12	0
–	–	Materials		B.3.2	–	(6)	

Notes:

(1) A sample having one or more defects in one group shall be counted as a single defect.

(2) For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.

(3) Non-destructive tests.

(4) One additional sample unit is included in each sample to permit substitution for the failure allowed in group III (280 sample units).

(5) The total allowable defects shall be one in groups IV through VII.

(6) Documents shall be submitted to prove that the samples meet the design specification.

B.4.3 Quality Conformance Inspection

The quality conformance inspection shall be as follows and as specified in paragraph 4.5.

B.4.3.1 Sample

Sample selection for an inspection lot submitted to group A inspection shall be as specified in paragraph 4.5.1.1
Groups B and C inspections shall be conducted per group of the same style, characteristic, and rated voltage. Sample selection for an inspection lot shall be as specified in paragraph 4.5.2.1. If one or more lots from one group were submitted to group A inspection around the same time, samples shall be taken from the lot with the maximum nominal capacitance.

B.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table B-7 for group A, Table B-8 for group B, and Table B-9 for group C. All group A subgroup inspections shall be performed in the order and as specified in each table. Each inspection in the subgroup shall be performed in the order listed in each table

B.4.3.3 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in the order 2 and/or order 3 test of subgroup A1 inspections, 100% inspection shall be conducted for the rejected items and conforming products may be delivered.

Table B-7. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Thermal shock and voltage aging (Insulation resistance) (Dissipation factor) (Capacitance)	B.3.9.4 (B.3.7.4) (B.3.7.2) (B.3.7.1)	B.4.4.8.4 (B.4.4.6.4) (B.4.4.6.2) (B.4.4.6.1)	All samples	0
	2	Externals, dimensions, mass and marking	B.3.4	B.4.4.4	AQL(1) 1.0%	
	3	Dielectric withstanding voltage	B.3.7.3 a)	B.4.4.6.3 a)	AQL(1) 0.65%	
A2	1	DPA	B.3.5.1	B.4.4.5.1	2	0

Note: (1) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection as specified in JIS Z 9015-1, Attachment Table 2-A.

Table B-8. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Solderability	B.3.8.2	B.4.4.7.2	6	0
B2	1	Resistance to soldering heat	B.3.8.3	B.4.4.7.3	8	0
	2	Resistance to solvents	B.3.9.9	B.4.4.8.9		

Table B-9. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Barometric pressure (reduced)	B.3.9.8	B.4.4.8.8	6	0
C2	1	Voltage–temperature characteristics	B.3.7.5	B.4.4.6.5	18	0
	2	High-frequency vibration	B.3.9.1.1	B.4.4.8.1.1		
	3	Immersion cycling	B.3.9.5	B.4.4.8.5		
C3	1	Shock	B.3.9.2	B.4.4.8.2	18	0
	2	Terminal strength	B.3.8.1	B.4.4.7.1		
	3	Moisture resistance	B.3.9.6	B.4.4.8.6		
C4	1	Life (accelerated condition)	B.3.10.1	B.4.4.9.1	12	0
C5	1	Random vibration	B.3.9.1.2	B.4.4.8.1.2	6	0
C6	1	Thermal shock (I)	B.3.9.3	B.4.4.8.3	6	0

B.4.4 Methods of Test and Inspection

B.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202. The following details shall apply.

a) Standard conditions
The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 to 75%, and atmospheric pressure of 86 to 106kPa . Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute is expected over the results.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at a temperature of 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure of 86 to 106kPa.

c) Reference conditions
Reference conditions shall be used when converting the measurements to the

values under the reference conditions. The reference conditions shall be at a temperature of 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage.

B.4.4.2 Processing of the test capacitor

The following processing shall be completed prior to tests and measurements, if required.

a) Preprocessing
The test capacitor shall be discharged for 30 minutes or longer at the test temperature prior to tests and measurements.

b) Forced drying
Unless otherwise specified, the test capacitor shall be dried in accordance with Table B-10 prior to tests and measurements.

c) Voltage conditioning
If a dispute arises over the results of the capacitance measurements, following all other electrical measurements, capacitance re-measurement may be made after which the test capacitor shall be heated 150°C for one hour and maintained in standard conditions between 24 and 48 hours.

Table B-10. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6±0.5 hours

B.4.4.3 Non-Destructive Internal Inspection

Capacitors shall be examined using ultrasonic test equipment or by a non-destructive internal inspection method which can verify that capacitors meet the requirements specified in paragraph B.3.3. The inspection method shall be defined in the Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

B.4.4.4 Externals, Dimension, Mass and Marking

Capacitors shall be inspected for the externals, construction, dimensions, mass, and markings as specified in paragraph B.3.4. The mass shall be measured in the qualification test and group A inspection conducted prior to group C inspection.

B.4.4.5 Workmanship

B.4.4.5.1 DPA

The DPA shall be conducted in accordance with the DPA manual as specified in the Quality Assurance Program Plan to examine the inner construction and to confirm that the processes, such as welding and soldering, are properly implemented by disassembling capacitors.

B.4.4.6 Electrical Performance

Electrical performance tests shall be performed as follows.

B.4.4.6.1 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Test frequency
   1) When nominal capacitance is lower than 100pF: 1MHz±100kHz.
   2) When nominal capacitance is not less than 100pF: 1kHz±100Hz.
b) Test voltage: 1.0±0.2Vrms.

B.4.4.6.2 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge. The following details shall apply.

a) Test frequency: Paragraph B.4.4.6.1, item a).
b) Test voltage: Paragraph B.4.4.6.1, item b).

B.4.4.6.3 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202 for the two items below.

a) Between terminals
   The following conditions shall apply.
   1) Test voltage: 250% of the rated voltage unless otherwise specified in the detail specification.
   2) Duration of application: 5±1 seconds.
   3) Charged and discharged current: 50mA or less.
b) Between terminals and enclosure
   The following conditions shall apply.
   1) Test voltage: 150% of the rated voltage unless otherwise specified in the detail specification.
   2) Duration of application: 5±1 seconds.
   3) Charged and discharged current: 50mA or less.

B.4.4.6.4 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details shall apply.

a) Test conditions
   1) Test voltage: Rated voltage.

2) Charged and discharged current: 50mA or less.
3) Duration of charging: 120^{+10}_{0} seconds.

b) Point of measurement: Between the terminals

c) Test temperature
Unless otherwise specified in the detail specification, the measurement shall be made under standard conditions.

d) Special conditions
If a dispute arises over the measured results in which the relative humidity was greater than 50%, the measurement may be repeated at a relative humidity not greater than 50%.

B.4.4.6.5 Voltage–Temperature Characteristic

Capacitors shall be tested under the following conditions.

a) Qualification test
The temperature of each test capacitor shall be varied as specified in Table B-11. DC rated voltage shall be applied to the test capacitor in each step of E through G as specified in Table B-11.
The capacitance shall be measured in accordance with paragraph B.4.4.6.1 in each step shown in Table B-11 and at a sufficient number of points between steps B and G to obtain a characteristic curve. The measurement shall be made after reaching temperature equilibrium in each step. The capacitance measured in step C shall be a reference value.

b) Quality conformance inspection
The measurement of capacitance shall be made at steps C, D, E, F, and G of Table B-11. The other conditions shall be as specified in item a) above.

Table B-11. Voltage–Temperature Cycling

Symbol	DC voltage applied	Temperature (°C)
A	N/A	25±2
B	N/A	-55±2
C(1)	N/A	25±2
D	N/A	Maximum operating temperature ±2
E	Rated voltage	Maximum operating temperature ±2
F	Rated voltage	25±2
G	Rated voltage	-55±2

Note: (1) Reference point.

B.4.4.7 Mechanical Performance

Mechanical performance tests shall be performed as follows.

B.4.4.7.1 Terminal Strength

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details shall apply.

a) Pull test
   1) Test condition: A.
   2) Applied force: 10N.
   3) Mounting method:
      Capacitors shall be secured by the body and force shall be gradually applied to one terminal.
b) Bend test
   1) Test condition: C.
   2) Applied force: 10N.

B.4.4.7.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: All terminals.
b) Solder temperature: 230±5°C.
c) Duration of immersion: 5±0.5 seconds.
d) Depth of immersion: Approximately 2mm from the terminal base.

B.4.4.7.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Depth of immersion:
   The lead terminal shall be immersed in molten solder to within 1.0mm from egress of the test capacitor.
b) Solder temperature: 270±5°C.
c) Duration of immersion: 10±1 seconds.
d) Duration of cooling from immersion to measurement: 10±1 minutes.
e) Measurements after test:
   The insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs B.4.4.6.4, B.4.4.6.1, and B.4.4.6.2.

B.4.4.8 Environmental Performance

Environmental performance tests shall be performed as follows.

B.4.4.8.1 Vibration

B.4.4.8.1.1 High-Frequency Vibration

Capacitors shall be tested in accordance with test method 204 of MIL-STD-202. The following details shall apply.

a) Mounting method
   Unless otherwise specified in the detail specification, the test capacitor shall be securely mounted on a mounting fixture and the lead wires shall be rigidly connected to the support terminals. The length of lead wire shall be approximately 1cm between the support terminal and the edge of the test

capacitor. To avoid damaging the surface, connect the lead wire by soldering, if possible. The mounting fixture shall be constructed to preclude resonance within the specified frequency range.

b) Voltage loading condition
Unless otherwise specified in the detail specification, 125% of the rated voltage shall be applied between the terminals of the test capacitor during the test.

c) Test condition:
Condition D (either 196m/s^2 p-p or total amplitude of 1.5mm, whichever is smaller)

d) Directions and duration of vibration:
Unless otherwise specified in the detail specification, the capacitor shall be vibrated for an equal amount of time in each of the three directions. The duration of the frequency sweep shall be 20 minutes per cycle and shall be repeated for 8 cycles in each of the three directions (8 hours in total).

e) Inspections during test:
Capacitors shall be examined for evidence of electrical discontinuity of 0.5ms or greater duration during the last cycle in each direction. A detector shall have the capability to detect a discontinuity of 0.5ms or greater duration.

f) Inspection after test:
Capacitors shall be visually examined for mechanical damage.

B.4.4.8.1.2 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method:
The test capacitor shall be rigidly mounted using a jig or shall be mounted directly to the vibrating table. Adhesives such as resin may be used to secure the test capacitor.

b) Test condition: II-H (20 to 2,000Hz, 334m/s^2 rms).

c) Direction of vibration: Three mutually perpendicular directions.

d) Duration of test: 3 minutes in each direction.

e) Inspections during test:
Capacitors shall be examined for intermittent contacts or open-circuiting in each direction. A detector shall have the capability to detect a discontinuity of 0.5ms or greater duration.

f) Inspection after test:
Capacitors shall be visually examined for mechanical damage.

B.4.4.8.2 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method:
The test capacitor shall be secured by the body and at lead wires approximately 10mm from the edge of the body.

b) Test condition: I (980m/s^2, 6ms, and saw tooth waveform).

c) Direction of shock application: 3 mutually perpendicular directions.

d) Inspections during test:

Capacitors shall be examined for electrical discontinuity of 0.5ms or greater duration during the last cycle in each direction. A detector shall have the capability to detect a discontinuity of 0.5ms or greater duration.

e) Inspection after test:
Capacitors shall be visually examined for mechanical damage.

B.4.4.8.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: B, except that the temperature shall be -30^{0}_{-3}°C in step 1, 100^{+3}_{0}°C in step 3
b) Number of cycles: 1,000 cycles.
c) Measurements and inspections.
The following measurements and inspections shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.
   1) Electrical measurements
   The capacitance, dielectric withstanding voltage, and insulation resistance shall be measured as specified in paragraphs B.4.4.6.1, item a) of B.4.4.6.3, and B.4.4.6.4, respectively.
   2) Visual inspection
   Capacitors shall be visually examined with a magnifying glass of 10-times magnification following the test.

B.4.4.8.4 Thermal Shock and Voltage Aging

Capacitors shall be tested in the following order.

a) Thermal shock
The thermal shock shall be performed in accordance with test method 107 of MIL-STD-202. The following details shall apply.
   1) Test condition: B. The minimum temperature shall be -55°C. The maximum temperature shall be 85°C when the operating temperature range is A.
   2) Electrical measurement: Not applicable.
b) Voltage aging
   1) Temperature: Maximum operating temperature $^{+4}_{0}$°C.
   2) Duration of application of test voltage: 100±4 hours.
   3) Applied voltage: 200% of the rated voltage.
c) Electrical measurements
   1) Insulation resistance(1):
   As specified in paragraph B.4.4.6.4 at the maximum operating temperature
   As specified in paragraph B.4.4.6.4 under the standard conditions
   2) Dissipation factor: As specified in paragraph B.4.4.6.2.
   3) Capacitance (2): As specified in paragraph B.4.4.6.1.
   Notes:
   (1) The insulation resistance at the maximum operating temperature shall be measured following the voltage aging test. When measuring the insulation resistance, the test capacitor may be transferred to another

chamber controlled to the same temperature. In this case, the transfer time shall not exceed 15 minutes.

(2) Measurements may be made after the capacitor is kept for a minimum of 24 hours in consideration of capacitor aging characteristics.

B.4.4.8.5 Immersion Cycling

Capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles)
b) Pre-test measurement: Not applicable.
c) Inspections and measurements following the final cycle:
The test capacitor shall be removed from a test chamber, wiped, and air-blasted with room temperature air. After 30 minutes, the following inspection and measurements shall be performed.
1) Visual inspection
The test capacitor shall be examined for mechanical damage.
2) Electrical measurements
The dielectric withstanding voltage and insulation resistance shall be measured as specified in item a) of paragraph B.4.4.6.3, and paragraph B.4.4.6.4, respectively.

B.4.4.8.6 Moisuture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement: Not applicable.
b) Number of cycles: Continuous 20 cycles.
c) Loading condition:
For the initial 10 cycles, either DC100V or the rated voltage, whichever is smaller, shall be applied to both edges of the capacitor terminals. Capacitors shall be inspected for short-circuiting once a day.
d) Inspection and measurements following the test:
Capacitors shall be visually examined for mechanical damage and marking legibility immediately after step 6 of the final cycle. The dielectric withstanding voltage, insulation resistance, and capacitance shall be measured as specified in item a) of paragraph B.4.4.6.3, and paragraphs B.4.4.6.4, and B.4.4.6.1.

B.4.4.8.7 Humidity, Steady Sate, Low Voltage

Capacitor chips shall be tested in accordance with test method 103, test condition A of MIL-STD-202 before lead attachment. The following details shall apply.
Under no circumstances during the test shall the voltage applied to test capacitors exceed 1.5V.

a) Initial measurement
The capacitance shall be measured as specified in paragraph B.4.4.6.1.
b) Test
The test capacitor shall be exposed to a temperature of +85°C and a relative

humidity of 85% for at least 240 hours. The test shall be performed as a single test not a cycling test. DC voltage of $1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor via a 100kΩ resistor.

c) Final measurement
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes to stabilize. Subsequently the insulation resistance shall be measured as specified in paragraph B.4.4.6.4 except for applying a DC voltage of $1.3^{+0.20}_{-0.25}$V via a resistor of 100kΩ and the capacitance shall be measured as specified in paragraph B.4.4.6.1.

d) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility after the final measurement.

B.4.4.8.8 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Mounting method: Capacitors shall be securely fastened in the normal manner.
b) Point of application: Between terminals.
c) Condition of pressure reduction: 2.8±0.4kPa {21.0±3mmHg}.
d) Applied voltage: 150% of the rated voltage, unless otherwise specified in the detail specification.
e) Duration of application: 5±1 seconds.
f) Charged and discharged current: 50mA or less.
g) Inspections during test: Capacitors shall be monitored for short-circuiting.
h) Inspection after test: Capacitors shall be visually examined for mechanical damage.

B.4.4.8.9 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. Isopropyl alcohol shall be used as the solvent.

B.4.4.9 Durability Performance

The durability performance test shall be performed as follows.

B.4.4.9.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Test temperature: Maximum operating temperature specified in the detail specification $^{+4}_{0}$ °C.
b) Applied voltage
   1) Rated condition: Rated voltage.
   2) Accelerated condition: 200% of the rated voltage.
c) Charged and discharged current: 50mA or less.
d) Duration of voltage application
   1) Rated condition: 4,000$^{+72}_{0}$ hours.
   2) Accelerated condition: 2,000$^{+72}_{0}$ hours.
e) Inspections and measurements during and after test:

The insulation resistance shall be measured as specified in paragraph B.4.4.6.4 during the test capacitor is kept at the test temperature after 250±8, $1{,}000^{+48}_{0}$, $2{,}000^{+72}_{0}$, and $4{,}000^{+72}_{0}$ hours. The test capacitor shall subsequently be reset to the standard conditions specified in paragraph B.4.4.1 and examined for mechanical damage. The insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs B.4.4.6.44, B.4.4.6.1, and B.4.4.6.2.

B.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.

a) Capacitance (paragraph B.3.7.1)
b) Dissipation factor (paragraph B.3.7.2)
c) Dielectric withstanding voltage (paragraph B.3.7.3)
d) Insulation resistance (paragraph B.3.7.4)
e) Externals and markings (paragraph B.3.4)

B.4.6 Change to Tests and Inspections

Change to tests and inspections shall be processed as specified in paragraph 4.8.

B.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

B.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX C

CAPACITORS, CHIP, MULTIPLE LAYER,
FIXED, CERAMIC DIELECTRIC

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX C

CAPACITORS, CHIP, MULTIPLE LAYER, FIXED, CERAMIC DIELECTRIC

C.1 GENERAL

C.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for ceramic dielectric, fixed, multiple layer, chip, capacitors (hereinafter referred to as "capacitors").

C.1.2 Classification

Capacitors shall be classified as specified in Table C-1.

Table C-1. Classification

Structure	Style
Rectangular, electrode in both directions	CDS50, CDS51, CDS52, CDS53, CDS54, CDS56

C.1.3 Part Number

The part number shall be indicated as follows. The details shall be as specified in the detail specification.

(Example)

NASDA(1) CDS51 BX 392 A K S

CDS51	BX	392	A	K	S
Style (C.1.3.1)	Characteristic (C.1.3.2)	Nominal Capacitance (C.1.3.3)	Rated voltage (C.1.3.4)	Capacitance tolerance (C.1.3.5)	Terminal finish (C.1.3.6)

Note: (1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

C.1.3.1 Style

The style shall be identified by “CDS”, followed by a two-digit number. “CDS” denotes “high reliability, ceramic dielectric, fixed, multiple layer, chip capacitors” and the following two digits denote capacitor size.

C.1.3.2 Characteristic

The characteristic shall be identified by a single or two-letter symbol as specified in Table C-2. When identified by a two-letter symbol, the first letter “B” indicates the operating temperature range of -55 to +125°C, and the second letter indicates the voltage–temperature characteristic as specified in Table C-2. When identified by a single letter, it indicates the voltage–temperature characteristic.

The operating temperature range for R and U characteristics shall be as specified in the detail specification.

Table C-2. Voltage–Temperature Characteristic

Symbol	Capacitance change from temperature 25°C			
	No voltage applied A to F of Table C-12	Specified voltage applied G to K of Table C-12	No voltage applied A to B and D to E of Table C-12	Specified voltage applied H to J of Table C-12
BP	0±30ppm/°C	0±30ppm/°C	–	–
BX	±15%	+15% -25%	–	–
R	±15%	+15% -40%	–	–
U	+15% -85%	+15% -90%	+15% -60%	+15% -70%

C.1.3.3 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For nominal capacitance under 10pF, the letter “R” represents the decimal point and the other two digits shall denote the most significant figures. For example, 102 indicates 1,000pF, 1R0 indicates 1.0pF, 0R5 indicates 0.5pF, and R75 indicates 0.75pF.

C.1.3.4 Rated Voltage

The rated voltage shall be identified by a capital letter as specified in Table C-3.

Table C-3. Rated Voltage

(Unit: V_{DC})

Symbol	Rated voltage
Y	25
A	50
B	100

C.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a capital letter as specified in Table C-4.

Table C-4. Capacitance Tolerance

Nominal capacitance	Symbol	Capacitance tolerance
10pF or less	C	±0.25pF
	D	±0.50pF
	F	±1.00pF
Over 10pF	J	± 5%
	K	±10%
	M	±20%
	Z	+80% -20%

C.1.3.6 Terminal Finish

The terminal finish shall be identified by a capital letter as specified in Table C-5.

Table C-5. Terminal Finish

Symbol	Terminal Finish
M	Silver–palladium
Q	Gold
S	Solder coating over silver–palladium
Z	Solder coating consists of indium, lead, and silver over silver–palladium

C.2 APPLICABLE DOCUMENTS

C.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

C.2.2 Reference Document

The following document is a referenced document for this appendix.

a) MIL-PRF-55681G Capacitor, Chip, Multiple Layer, Fixed, Ceramic Dielectric, Established Reliability and Non-Established Reliability, General Specification for

C.3 REQUIREMENTS

C.3.1 Qualificaiton Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs C.3.2 to C.3.10. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacture is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

C.3.2 Materials

The materials shall be as specified below and as specified in paragraph 3.3.

C.3.2.1 External Electrode Material

The materials for external electrodes shall be as specified in Table C-5.

C.3.2.2 Construction

Construction of capacitors shall be as specified below and as specified in the detail specification.

a) Capacitor element
Ceramic shall be used as the dielectric.

b) Terminal
Terminals other than gold electrodes shall be properly processed to facilitate soldering, and the gold electrodes shall also be properly processed to facilitate wire bonding.

C.3.3 Non-Destructive Internal Inspection

Before finishing the terminals, all capacitors shall be subjected to an ultrasonic test or a non-destructive internal inspection as specified in the detail specification to verify the functionality. When tested in accordance with paragraph C.4.4.4, capacitors shall not exhibit any defects such as delamination, voids or cracks.

C.3.4 Externals, Dimension, Mass and Marking

When tested in accordance with paragraph C.4.4.5, capacitors shall meet the following requirements.

C.3.4.1 Externals and Marking

The capacitor surface shall not exhibit cracks or corrosions. The markings shall be legible. The other marking requirements shall be as specified in the detail specification.

C.3.4.2 Dimension and Mass

Dimension and mass of capacitors shall be as specified in the detail specification.

C.3.5 Workmanship

Capacitors shall be manufactured based on a good design and in accordance with the quality assurance program defined in paragraph 3.2.1.
Capacitors shall not exhibit cracks, pinholes, flaws or other defects that will affect electrical or mechanical performance.

C.3.5.1 DPA

When tested in accordance with paragraph C.4.4.6.1, capacitors shall meet the requirements specified in the detail specification. The details shall be in accordance with DPA manual.

C.3.6 Rating

The following items shall be specified in the detail specification.

a) Nominal capacitance
b) Characteristic
c) Rated voltage
d) Operating temperature range
e) Capacitance tolerance

C.3.7 Electrical Performance

Capacitors shall meet the following requirements.

C.3.7.1 Capacitance

When tested in accordance with paragraph C.4.4.7.1, the capacitance shall meet the requirements in the detail specification.

C.3.7.2 Dissipation Factor

When tested in accordance with paragraph C.4.4.7.2, the dissipation factor shall meet the following requirements:

a) BP characteristic: 0.15% or less.
b) BX characteristic: 2.5% or less.
c) R characteristic: 2.5% or less.
d) U characteristic: 5% or less.

C.3.7.3 Insulation Resistance

When tested in accordance with paragraph C.4.4.7.3, the insulation resistance shall meet the following requirements:

a) At the maximum operating temperature
    1) BP characteristic:
       Greater than 1,000MΩ or 10Ω·F, whichever is smaller.
    2) BX characteristic:
       Greater than 10,000MΩ or 100Ω·F, whichever is smaller.
    3) R characteristic:
       Greater than 10,000MΩ or 100Ω·F, whichever is smaller.
    4) U characteristic:
       Greater than 10,000MΩ or 100Ω·F, whichever is smaller.
b) Under the standard conditions
   Greater than 100,000MΩ or 1,000Ω·F, whichever is smaller.

C.3.7.4 Dielectric Withstanding Voltage

When tested in accordance with paragraph C.4.4.7.4, there shall be no visible damage, instantaneous/intermittent arcing, or open-/short-circuiting.

C.3.7.5 Voltage–Temperature Characteristic

When tested in accordance with paragraph C.4.4.7.5, the capacitance change shall not exceed the limit specified in Table C-2.

C.3.8 Mechanical Performance

Capacitors shall meet the following requirements.

C.3.8.1 Connection Strenght of Terminal Electrode

When tested in accordance with paragraph C.4.4.8.1, terminal electrodes shall not exhibit any sign of peeling. This test is not applicable to terminal finish “Q”.

C.3.8.2 Bond Strength

When tested the external terminals of capacitors in accordance with paragraph C.4.4.8.2, the wire bonded gold wire (50μmφ) shall withstand the force of 0.1N or greater for 30 seconds. This test is applicable to terminal finish “Q”.

C.3.8.3 Solderability

When tested in accordance with paragraph C.4.4.8.3, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining surface of 5% or less may contain only small pinholes or rough surfaces and shall not be concentrated in one area. This test is not applicable to terminal finish “Q”.

C.3.8.4 Resistance to Soldering Heat

Capacitors shall meet the following requirements when tested in accordance with paragraph C.4.4.8.4. This test is not applicable to terminal finish “Q”.

a) Externals
   There shall be no evidence of mechanical damage, crack or exposed internal electrodes. Leaching shall be a maximum of 25% on each edge of the mounting area (see Figure C-1.).
b) Capacitance change
   1) BP characteristic: -1.0 to +2.0% of the initial measured value.
   2) BX and R characteristics: -1.0 to +6.0% of the initial measured value.
   3) U characteristic: ±20% of the initial measured value.

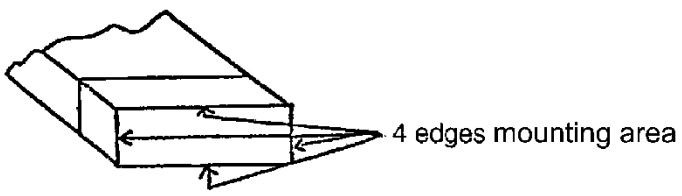

Figure C-1. Mounting Area

C.3.9 Environmental Performance

Capacitors shall meet the following requirements.

C.3.9.1 Random Vibraion

Deleted.

C.3.9.2 Shock

Deleted.

C.3.9.3 Thermal Shock (I)

When tested in accordance with paragraph C.4.4.9.3, capacitors shall meet the following requirements.

a) Externals
   There shall be no mechanical damage.
b) Dielectric withstanding voltage
   As specified in paragraph C.3.7.4.
c) Insulation resistance
   30% or greater of the specified value under the standard conditions.
d) Capacitance change
   1) BP characteristic: ±0.5% or ±0.5pF of the initial measured value, whichever the absolute value is greater
   2) BX and R characteristics: ±10% of the initial measured value.
   3) U characteristic: ±30% of the initial measured value.
e) Dissipation factor
   As specified in paragraph C.3.7.2.

C.3.9.4 Thermal Shock and Voltage Aging

When tested in accordance with paragraph C.4.4.9.4, capacitors shall have no mechanical damage.

C.3.9.5 Thermal Shock and Immersion Cycling

When tested in accordance with paragraph C.4.4.9.5, capacitors shall meet the following requirements.

a) Externals
   There shall be no mechanical damage or terminal corrosion.
b) Dielectric withstand voltage
   As specified in paragraph C.3.7.4.
c) Insulation resistance
   30% or greater of the specified value under the standard conditions.
d) Capacitance change
   1) BP characteristic: ±0.5% or ±0.5pF of the initial measured value, whichever the absolute value is greater.
   2) BX characteristics and R: ±10% of the initial measured value.
   3) U characteristic: ±20% of the initial measured value.
e) Dissipation factor
   As specified in paragraph C.3.7.2.

C.3.9.6 Moisture Resistance

When tested in accordance with paragraph C.4.4.9.6, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage or terminal corrosion.
b) Dielectric withstand voltage
As specified in paragraph C.3.7.4.
c) Insulation resistance
30% or greater of the specified value under the standard conditions.
d) Capacitance change
1) BP characteristic: ±0.5% or ±0.5pF of the initial measured value, whichever the absolute value is greater.
2) BX and R characteristics: ±10% of the initial measured value.
3) U characteristic: ±30% of the initial measured value.

C.3.9.7 Humidity, Steady State, Low Voltage

When tested in accordance with paragraph C.4.4.9.7, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Insulation resistance (+25°C)
As specified in item b) of paragraph C.3.7.3.
c) Capacitance change
1) BP characteristic: ±0.5% or ±0.5pF of the initial measured value, whichever the absolute value is greater.
2) BX and R characteristics: ±10% of the initial measured value.
3) U characteristic: ±30% of the initial measured value.

C.3.9.8 Barometric Pressure (Reduced)

When tested in accordance with paragraph C.4.4.9.8, capacitors shall not exhibit mechanical damage, instantaneous/intermittent arcing, or open-/short-circuiting.

C.3.9.9 Resistance to Solvents

When tested in accordance with C.4.4.9.9, the marking shall be legible. This requirement applies only to capacitors marked with ink.

C.3.10 Durability Performance

Capacitors shall meet the following requirements.

C.3.10.1 Life

When tested in accordance with paragraph C.4.4.10.1, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage.
b) Insulation resistance
1) At the maximum operating temperature: 30% or greater of the specified value.
2) Under the standard conditions: 30% or greater of the specified value.
c) Capacitance change
1) BP characteristic: ±2% or ±0.5pF of the initial measured value, whichever the absolute value is greater.

2) BX and R characteristics: ±10% of the initial measured value.
3) U characteristic: ±30% of the initial measured value.

d) Dissipation factor
1) BP characteristic: 2.0% or less.
2) BX and R characteristics: 3.0% or less.
3) U characteristic: 7.5% or less.

C.4 QUALITY ASSURANCE PROVISIONS

C.4.1 In-Process Inspection

Each manufacturing lot shall be subjected to the in-process inspections specified in Table C-6. At the option of the manufacturer, in-process inspections other than those specified in Table C-6 may be performed in accordance with paragraph 4.3.

Table C-6. In-Process Inspection

No.	In-process inspection item	Requirement paragraph	Test method paragraph	Quantity of samples
1	Non-destructive internal inspection	C.3.3	C.4.4.4	All samples
2	Humidity, steady state, low voltage	C.3.9.7	C.4.4.9.7	12

C.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

C.4.2.1 Sample

Samples for the qualification test shall be taken from the inspection lots that have passed the in-process inspection. Manufacturer shall submit sample units with the maximum nominal capacitance from a group that have the same characteristics, rated voltage, and terminal finish.

C.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table C-7. All samples shall be subjected to groups I and II tests before being divided for groups III through X tests. Tests in group III and subsequent groups may be performed in any order regardless of the group number. Tests in each group shall be performed in the order listed.

Table C-7. Qualification Test

Test				Requirement paragraph	Test method paragraph	Pass/fail				
						Quantity of samples per terminal finish (1)				Quantity of allowable defectives
Group	Order	Item				S	Q	M	Z	
I	1	Externals, dimensions, mass and marking (2)		C.3.4	C.4.4.5	323	46	69	69	0
II	1	Thermal shock and voltage aging		C.3.9.4	C.4.4.9.4	323	46	69	69	0
	2	Dielectric withstanding voltage (3)		C.3.7.4	C.4.4.7.4					
	3	Insulation resistance (at high temperature)		C.3.7.3	C.4.4.7.3					
	4	Capacitance		C.3.7.1	C.4.4.7.1					
	5	Dissipation factor		C.3.7.2	C.4.4.7.2					
	6	Insulation resistance		C.3.7.3	C.4.4.7.3					
	7	Dielectric withstanding voltage (4)		C.3.7.4	C.4.4.7.4					
III	1	Solderability		C.3.8.3	C.4.4.8.3	6	N/A	6	6	0
	2	Barometric pressure (reduced)		C.3.9.8	C.4.4.9.8	6	–	–	–	0
	3	Resistance to solvents (6)		C.3.9.9	C.4.4.9.9	6	–	–	–	0
IV	1	Voltage-temperature characteristics		C.3.7.5	C.4.4.7.5	18	18	18	18	0
	2	Thermal shock and immersion cycling		C.3.9.5	C.4.4.9.5					
V	1	Resistance to soldering heat		C.3.8.4	C.4.4.8.4	9	N/A	9	9	0
	2	Moisture resistance		C.3.9.6	C.4.4.9.6	9	–	–	–	
VI	1	Life	Rated condition	C.3.10.1	C.4.4.10.1	159	–	–	–	0
			Accelerated condition	C.3.10.1	C.4.4.10.1	52	–	–	–	0
VII	1	Connection strength of terminal electrode		C.3.8.1	C.4.4.8.1	18	N/A	18	18	0
VIII	1	Deleted		-	-	-	–	–	–	-
	2	Deleted		-	-	-	-	-	-	-
	3	Thermal shock (I)		C.3.9.3	C.4.4.9.3	18	18	18	18	0
IX	1	Bond strength		C.3.8.2	C.4.4.8.2	N/A	10	N/A	N/A	0
X	1	DPA		C.3.5.1	C.4.4.6.1	2	–	–	–	0
–	–	Material		C.3.2	N/A	(5)				N/A

Notes:

(1) The tests indicating "–" in the quantity of samples columns may be exempted when they have been performed with other terminal finish. If not, the tests shall be conducted with a sample size specified in terminal finish S. Groups I and II tests shall be performed for all terminal finishes.

(2) For dimension and mass, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.

(3) Applicable to BX, R and U characteristics.
(4) Applicable to BP characteristic.
(5) Documents shall be submitted to prove that the samples meet the design specification.
(6) This requirement applies only to capacitors marked with ink.

C.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

C.4.3.1 Sample

Sample selection for an inspection lot submitted to group A inspection shall be as specified in paragraph 4.5.1.1
Groups B and C inspections shall be conducted per group of the same characteristic, rated voltage and terminal finish. Sample selection for an inspection lot shall be as specified in paragraph 4.5.2.1. If one or more lots from one group were submitted to group A inspection around the same time, samples shall be taken from the lot with the maximum nominal capacitance.

C.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table C-8 for group A, Table C-9 for group B, and Table C-10 for group C, respectively. All group A subgroup inspections shall be performed in the order of and as specified in each table.

C.4.3.3 Disposition after Inspections

The lots rejected in the group A inspection shall not be delivered. If the samples fail in the dimensions of group A1 inspection, 100% inspection shall be conducted for the dimensions and conforming products may be delivered.
The samples used in subgroups A4 and A5 shall not be delivered.

Table C-8. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Externals, dimensions, mass and marking	C.3.4	C.4.4.5	All samples	0(1)
A2	1	Thermal shock and voltage aging	C.3.9.4	C.4.4.9.4	All samples	0
A3	1	Dielectric withstanding voltage	C.3.7.4	C.4.4.7.4	All samples	0
	2	Insulation resistance (at high temperature)	C.3.7.3	C.4.4.7.3		
	3	Capacitance	C.3.7.1	C.4.4.7.1		
	4	Dissipation factor	C.3.7.2	C.4.4.7.2		
	5	Insulation resistance (standard conditions)	C.3.7.3	C.4.4.7.3		
A4(2)	1	DPA	C.3.5.1	C.4.4.6.1	2	0
A5(2)	1	Bond strength	C.3.8.2	C.4.4.8.2	10	0

Notes:
(1) For dimension, pass/fail shall be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(2) Subgroups A4 and A5 inspections shall be performed after completion of subgroups A1 through A3 inspections.

Table C-9. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Solderability	C.3.8.3	C.4.4.8.3	6	0
B2	1	Resistance to soldering heat	C.3.8.4	C.4.4.8.4	18	0
	2	Resistance to solvents (1)	C.3.9.9	C.4.4.9.9		

Note: (1) This inspection applies only to capacitors marked with ink.

Table C-10. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Barometric pressure (reduced)	C.3.9.8	C.4.4.9.8	6	0
C2	1	Voltage-temperature characteristics	C.3.7.5	C.4.4.7.5	18	0
	2	Thermal shock and immersion cycling	C.3.9.5	C.4.4.9.5		
C3	1	Deleted	-	-	18	0
	2	Connection strength of terminal electrode	C.3.8.1	C.4.4.8.1		
	3	Moisture resistance	C.3.9.6	C.4.4.9.6		
C4	1	Life (accelerated condition)	C.3.10.1	C.4.4.10.1	12	0
C5	1	Deleted	-	-	-	-
C6	1	Thermal shock (I)	C.3.9.3	C.4.4.9.3	6	0

C.4.4 Methods of Test and Inspection

C.4.4.1 Test and Inspection Conditions

Test or inspection conditions shall be in accordance with section 4 of MIL-STD-202. The following details shall apply.

a) Standard conditions
The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 to 75%, and atmospheric pressure of 86 to 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b)

Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the results is expected.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at a temperature of 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure of 86 to 106kPa.

c) Reference conditions
Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at a temperature of 25°C, a relative humidity of 50% and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage.

C.4.4.2 Processing of the test capacitor

The following processing shall be completed prior to tests and measurements, if required.

a) Preprocessing
The test capacitor shall be discharged for 30 minutes or longer at the test temperature prior to tests and measurements.

b) Forced drying
Unless otherwise specified, the test capacitor shall be dried as specified in Table C-11 prior to tests and measurements.

c) Voltage conditioning (applicable to BX, R and U characteristics)
If a dispute arises over the results of the capacitance measurements, following all other electrical measurements, capacitance re-measurement may be made after which the test capacitor shall be heated150°C for one hour and maintained in standard conditions between 24 and 48 hours.

Table C-11. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6±0.5 hours

C.4.4.3 Mounting Test Samples

a) Terminal finish M, S, and Z
The test capacitor shall be soldered on a test jig (95 to 99% alumina substrate) as shown in Figure C-2. The soldering shall be uniformly performed using a soldering iron or in a reflow process using the solder containing 3wt% or less silver (1). Avoid heat shock during soldering.

b) Terminal finish Q
The test capacitor shall be mounted to a test jig (95 to 99% alumina substrate) as shown in Figure C-2 with an adhesive, and wire bonded with a gold wire of 50μmφ.

Note: (1) The reason for using silver-contained solder is to reduce the silver diffusion rate from the terminal electrodes of the capacitors into the solder when soldered to the test board (test jig), and to prevent "silver leaching".

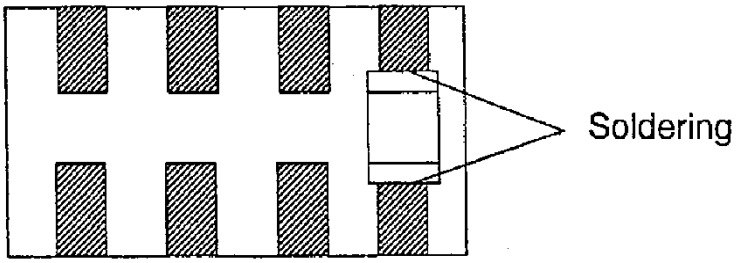

Figure C-2. Test Jig (Example)

C.4.4.4 Non-Destructive Internal Inspection

Capacitors shall be examined using ultrasonic test equipment or by a non-destructive internal inspection method which can verify that capacitors meet the requirements specified in paragraph C.3.3. The inspection method shall be defined in the detail specification. The details shall be clearly specified in Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

C.4.4.5 Externals, Dimension, Mass and Marking

Capacitors shall be inspected for the externals, construction, dimensions, mass, and markings. The mass shall be measured only in the qualification test.

C.4.4.6 Workmanship

C.4.4.6.1 DPA

The DPA shall be conducted in accordance with the DPA manual as specified in the Quality Assurance Program Plan to examine the inner construction and to verify that each process is properly implemented by disassembling capacitors.

C.4.4.7 Electrical Performance

Electrical performance test shall be performed as follows.

C.4.4.7.1 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Test frequencies
   1) BX, R and U characteristics, and BP characteristic of 1,000pF or greater capacitance: 1kHz±100Hz.
   2) BP characteristic of less than 1,000pF capacitance: 1MHz±100kHz.
b) Test voltage: 1.0±0.2Vrms

   For BX, R and U characteristics, the capacitance measurement may be made within 12 hours after measuring the dielectric withstanding voltage or insulation resistance.

C.4.4.7.2 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge. The following details shall apply.

a) Test frequency: As specified in item a) of paragraph C.4.4.7.1.
b) Test voltage: As specified in item b) of paragraph C.4.4.7.1.

C.4.4.7.3 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.
Capacitors shall be carefully cleaned to remove any contamination including fingerprints prior to the test.

a) Test conditions
   1) Test voltage: Rated voltage.
   2) Charged and discharged current: 50mA or less.
   3) Duration of charging: 120^{+10}_{0} seconds.
b) Points of measurement: Between terminals.
c) Special conditions
   If a dispute arises over the measured results in which the relative humidity was greater than 50%, the measurements may be repeated at a relative humidity not greater than 50%.

C.4.4.7.4 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Test voltage: 250% of the rated voltage unless otherwise specified in the detail specification.
b) Duration of application: 5±1 seconds.
c) Point of application: Between terminals of the test capacitor unless otherwise specified in the detail specification.
d) Charged and discharged current: 50mA or less.
e) Inspections after test:
   The test capacitor shall be examined for evidence of damage, arcing, open-circuiting, and short-circuiting.

C.4.4.7.5 Voltage–Temperature Characteristic

Capacitors shall be tested under the following conditions. These measurements shall be performed only for capacitors of 10pF or grater capacitance. Capacitors of smaller than 10pF capacitance shall be characterized as having the same voltage-temperature limits as those of 10pF or greater capacitance manufactured from the same lot.

a) Qualification test

The temperature of each test capacitor shall be varied as specified in Table C-12. DC rated voltage shall be applied to the test capacitor in each step of G through K as shown in Table C-12.

The capacitance shall be measured in accordance with paragraph C.4.4.7.1 in each step shown in Table C-12 and at a sufficient number of points between steps B and K to obtain a characteristic curve. The measurement shall be made after reaching temperature equilibrium in each step. The capacitance measured in step D shall be a reference value.

b) Quality conformance inspection

The measurement of capacitance shall be made at steps D, F, G, I, and K of Table C-12. The other conditions shall be as specified in item a) above.

Table C-12. Voltage-Temperature Cycling

Symbol	DC voltage applied	Temperature (°C)
A	N/A	+25±2
B (1) (3)	N/A	-20±2
C	N/A	-55±2
D (1)	N/A	+25±2
E (1) (3)	N/A	+60±2
F	N/A	Maximum operating temperature ±2
G	Rated voltage (2)	Maximum operating temperature ±2
H (1) (3)	Rated voltage (2)	+60±2
I	Rated voltage (2)	+25±2
J (1) (3)	Rated voltage (2)	-20±2
K	Rated voltage (2)	-55±2

Notes:
(1) Reference point.
(2) The rated voltage shall be as specified in the detail specification (a half of rated voltage for R and U characteristics).
(3) Applicable only to U characteristics.

C.4.4.8 Mechanical Performance

Mechanical performance tests shall be performed as follows.

C.4.4.8.1 Connection Strength of Teminal Electrode

Capacitors shall be soldered on a test jig (alumina substrate) shown in Figure C-3. The soldering shall be uniformly performed using a soldering iron or in a reflow process using solder containing 3wt% silver (1) or less. Avoid heat shock during soldering.

Apply 10N {1kgf} (5N for CDS50) in the direction of an arrow in the figure and in a horizontal position with the jig.

Note: (1) The reason for using silver-contained solder is to reduce the silver diffusion rate from the terminal electrodes of the capacitors into the solder when soldered to the test board (test jig), and to prevent "silver leaching".

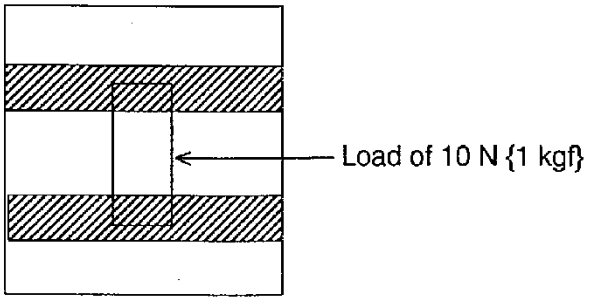

Figure C-3. Test Jig (Example)

C.4.4.8.2 Bonding Strength

Capacitors shall be tested in accordance with test method 2011 of MIL-STD-883. The following details shall apply.

a) Mounting method: Not applicable.
b) Bonding method: Thermocompression
   1) Wire ·····Gold wire of 50μmφ
   2) Stage temperature ·····140°C
   3) Capillary temperature ·····340°C
   4) Applied load ·····230g
   5) Duration ·····1 second
c) Number of bonding: A single point on either side of electrodes
d) Bonding position: At center on the top
e) Bonding strength: Apply load in the direction of an arrow shown in Figure C-4.

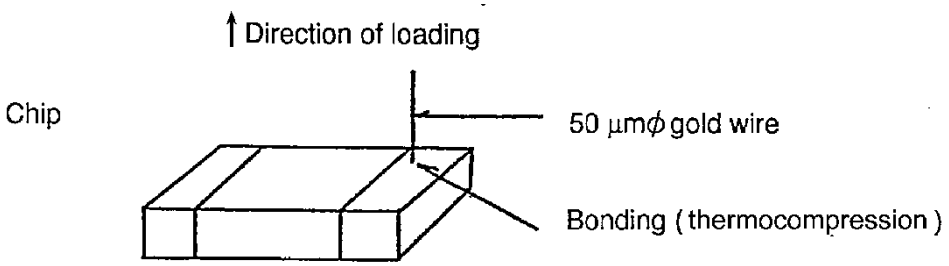

Figure C-4. Test Method (Example)

C.4.4.8.3 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: All terminals
b) Solder temperature: 230±5°C

c) Duration of immersion: 5.0±0.5 seconds

d) Depth of immersion: Each terminal shall be immersed to the depth of $0.50^{+0.25}_{0}$ mm.

e) Inspections after test
The test capacitor shall be visually examined. If a dispute arises over the measured results, the percentage of pinhole and rough surfaces with regard to the total surface shall be determined by measurement.

C.4.4.8.4 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Mounting method: As specified in paragraph C.4.4.3.

b) Test condition: B

c) Duration of cooling after immersion to measurement: 10 minutes to 24 hours.

d) Inspection and measurement after test:
The test capacitor shall be visually examined and the capacitance shall be measured as specified in paragraph C.4.4.7.1.

C.4.4.9 Environmental Performance

The environmental performance of the capacitors shall be performed as follows.

C.4.4.9.1 Random Vibration

Deleted.

C.4.4.9.2 Shock

Deleted.

C.4.4.9.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method:
As specified in paragraph C.4.4.3. The solder thickness shall be less than a half of the ceramic thickness for the terminal finish of M, S, and Z.

b) Test condition: A, except that the temperature shall be -30^{0}_{-3}°C in step 1 and 100^{+3}_{0}°C in step 3.

c) Number of cycles: 1,000 cycles

d) Measurements and inspections
The following measurements and inspections shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.

1) Electrical measurements
The dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs C.4.4.7.4, C.4.4.7.3, C.4.4.7.1, and C.4.4.7.2, respectively.

2) Visual inspection
Capacitors shall be visually examined under 10X minimum magnification after the measurements.

C.4.4.9.4 Thermal Shock and Voltage Aging

C.4.4.9.4.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3 and the number of cycles shall be 20 cycles.
b) Measurement after test: Not applicable.

C.4.4.9.4.2 Voltage Aging

Capacitors shall be tested under the following conditions.

a) Temperature: Maximum operating temperature $^{+4}_{0}$
b) Duration of application: 100±4 hours
c) Applied voltage: 200% of the rated voltage
d) Inspection after test
Capacitors shall be examined for mechanical damage.

C.4.4.9.5 Thermal Shock and Immersion Cycling

C.4.4.9.5.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method:
As specified in paragraph C.4.4.3. The solder thickness shall be less than a half of the ceramic thickness for the termination finish M, S, and Z.
b) Test conditions:
1) BP, BX, and R characteristics: A; except that the temperature shall be $+125^{+4}_{0}$ °C in step 3 and the number of cycles shall be 250 cycles.
2) U characteristics: A-3.
c) Post-test measurement: Not applicable.

C.4.4.9.5.2 Immersion Cycling

Capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles).
b) Pre-test measurement: Not applicable.
c) Measurements and inspections after the final cycle:
The test capacitor shall be removed from a chamber, wiped, and air-blasted with room temperature air. After 30 minutes the following measurements and inspections shall be performed.
1) Electrical measurements
The dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs C.4.4.7.4, C.4.4.7.3, C.4.4.7.1, and C.4.4.7.2, respectively.
2) Visual inspection
Capacitors shall be visually examined with a magnifying glass of 10-times or greater magnification after the measurements.

C.4.4.9.6 Moisuture Resistance

The moisture resistance shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement: The capacitance shall be measured as specified in paragraph C.4.4.7.1.
b) Number of cycles: 20 continuous cycles, except for omission of steps 7a and 7b.
c) Applied voltage: $50V_{DC}$ or the rated voltage, whichever is smaller.
d) Final measurements
After step 6 of the final cycle, the test capacitor shall be visually examined and the dielectric withstanding voltage, insulation resistance, and capacitance shall be measured as specified in paragraphs C.4.4.7.4, C.4.4.7.3, and C.4.4.7.1, respectively.

C.4.4.9.7 Humidity, Steady State, Low Voltage

Capacitors shall be tested in accordance with test method 103, test condition A of MIL-STD-202. The following details shall apply.
Under no circumstances during the test, shall the voltage applied to test capacitors exceed 1.5V.

a) Initial measurement
The capacitance shall be measured as specified in paragraph C.4.4.7.1.
b) Test
The test capacitor shall be exposed at a temperature of +85°C and relative humidity of 85% for at least 240 hours. The test shall be performed as a single test not as a cycling test. DC voltage of $1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor through a 100kΩ resistor.
c) Final measurements
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes to stabilize. Subsequently the insulation resistance shall be measured as specified in paragraph C.4.4.7.3 except applying a DC voltage of $1.3^{+0.20}_{-0.25}$V through a 100kΩ resistor and the capacitance shall be measured as specified in paragraph C.4.4.7.1.
d) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility after the final measurement.

C.4.4.9.8 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Mounting method: As specified in paragraph C.4.4.3.
b) Test condition: D (1.1kPa).
c) Applied voltage: 150% of the rated voltage.
d) Duration of application: 5±1 seconds.
e) Charged and discharged current: 50mA or less.
f) Inspections after test
Capacitors shall be examined for evidence of damage, arcing, open-circuiting, and short-circuiting.

C.4.4.9.9 Resistance to Solvents

The moisture resistance shall be tested in accordance with test method 215 of MIL-STD-202. The following details shall apply.

a) Solvent: Isopropyl alcohol.
b) Inspections after test:
The test capacitor shall be visually examined for evidence of obliteration of marking.

C.4.4.10 Durability Performance

The durability performance test shall be performed as follows.

C.4.4.10.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Mounting method: As specified in paragraph C.4.4.3.
b) Test temperature: Maximum operating temperature specified in the detail specification $^{+4}_{0}$ °C.
c) Applied voltage
   1) Rated condition: Rated voltage.
   2) Accelerated condition: 200% of the rated voltage.
d) Charged and discharged current: 50mA or less.
e) Duration of voltage application
   1) Rated condition: 4,000$^{+72}_{0}$ hours.
   2) Accelerated condition: 2,000$^{+48}_{0}$ hours.
f) Inspections and measurements during and after test
The insulation resistance shall be measured as specified in paragraph C.4.4.7.3 during the test capacitor is maintained at the test temperature after 1,000 hours and at the point of test completion. The test capacitor shall subsequently be reset to the standard conditions specified in paragraph C.4.4.1 and examined for evidence of mechanical damage with a magnifying glass of 10-times or greater magnification. Then the capacitance, dissipation factor, and insulation resistance shall be measured as specified in paragraphs C.4.4.7.1, C.4.4.7.2, and C.4.4.7.3, respectively.

C.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.

a) Capacitance (paragraph C.3.7.1).
b) Dissipation factor (paragraph C.3.7.2).
c) Insulation resistance (paragraph C.3.7.3).
d) Dielectric withstanding voltage (paragraph C.3.7.4).

For capacitors other than gold terminal finish, the solderability and resistance to soldering heat shall be performed as shown in Table C-9 per each terminal finish.
The date of re-inspection shall be marked on the packages or storage containers. The rejected lot shall not be delivered.

C.4.6 Change to Tests and Inspections

Change to tests and inspections shall be processed as specified in paragraph 4.8.

C.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

C.6 NOTES

Notes shall be as specified in paragraph 6.

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CAPACITORS, FIXED, MICA DIELECTRIC

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX F

CAPACITORS, FIXED, MICA DIELECTRIC

F.1 GENERAL

F.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for mica dielectric, fixed capacitors (hereinafter referred to as "capacitors").

F.1.2 Classification

Capacitors shall be classified as specified in Table F-1.

Table F-1. Classification

Structure	Style
Non-metal enclosure, rectangular, radial plate terminal	CMS16
	CMS17
	CMS18
	CMS19
	CMS21
	CMS22

F.1.3 Part Number

The part number shall be indicated as follows. See the detail specification for details.
(Example)

NASDA(1)	CMS16	C	010	D	O	A
	Style	Characteristic	Nominal Capacitance	Capacitance tolerance	Operating temperature range	Rated voltage
	(F.1.3.1)	(F.1.3.2)	(F.1.3.3)	(F.1.3.4)	(F.1.3.5)	(F.1.3.6)

Note (1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

F.1.3.1 Style

The style shall be identified by “CMS”, followed by a two-digit number. “CMS” denotes “high reliability, mica dielectric, fixed capacitors” and the following two digits denote capacitor size.

F.1.3.2 Characteristic

The characteristic shall be identified by a single capital letter as specified in Table F-2 indicating relative stability of capacitors with respect to temperature changes.

Table F-2. Voltage–Temperature Characteristic

Symbol	Temperature coefficient (ppm/°C)	Capacitance drift
C	-200 to +200	± (0.5%+0.1pF)
E	-20 to +100	± (0.1%+0.1pF)
F	0 to +70	± (0.05%+0.1pF)

F.1.3.3 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For example, 010 indicates 1pF, 101 indicates 100pF, 102 indicates 1,000pF.

F.1.3.4 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table F-3.

Table F-3. Capacitance Tolerance

Symbol	Capacitance tolerance
D	±0.5pF(when the nominal capacitance is 100pF or smaller) ±0.5% (when the nominal capacitance is over 100pF)
F	±1%
G	±2%
J	±5%

F.1.3.5 Operating Temperature Range

The operating temperature range shall be identified by a single capital letter as specified in Table F-4.

Table F-4. Operating Temperature Range

(Unit: °C)

Symbol	Capacitance tolerance
O	-55 to +125
P	-55 to +150

F.1.3.6 Rated Voltage

The rated voltage shall be identified by a single capital letter as specified in Table F-5.

Table F-5. Rated Voltage

(Unit: V_{DC})

Symbol	Rated voltage
A	100
C	300
D	500
F	1,000

F.2 APPLICABLE DOCUMENTS

F.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

F.2.2 Reference Document

The following document is a referenced document of this appendix.

a) MIL-PRF-39001 Capacitors, Fixed, Mica Dielectric, Established Reliability and Non-established Reliability, General Specification for

F.3 REQUIREMENTS

F.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings, and performance specified in paragraphs F.3.2 to F.3.9. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

F.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

F.3.2.1 Enclosure

Organic enclosure materials shall withstand the maximum operating temperature and shall maintain the required moisture resistance and electrical isolation. The enclosure material shall not adversely affect the capacitor performance.

F.3.2.2 Soldering Flux

Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area, and tin or solder coating on the mechanical connection area that is not intended to create an electrical circuit.
Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.

F.3.3 Externals, Dimension, Mass and Marking

When tested in accordance with paragraph F.4.4.2, capacitors shall meet the following requirements.

F.3.3.1 Externals and Marking

The capacitor surface shall not exhibit any cracks, corrosions, or other defects. The following items shall be marked in a manner to ensure legibility.

a) Part number
”NASDA” may be excluded, and for small geometry capacitors, style may also be excluded.

b) Lot identification code
Lot identification code shall be assigned as specified by the manufacturer.

c) Manufacturer name or abbreviation
These markings may be excluded for small geometry capacitors.

F.3.3.2 Construction, Dimension and Mass

Construction, dimension, and mass shall be as follows and as specified in the detail specification.

a) Construction
Capacitors shall be completely coated by enclosure materials which will protect the capacitor element from moisture and mechanical damage.

b) Terminal
The terminals shall be soldered by immersion in molten solder or electroplating.

F.3.4 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.

a) Enclosure
The capacitor enclosure shall be free of cracks, pinhole, flaws, or other defects which will adversely affect the electrical or mechanical performance.

b) Terminals
The terminals shall not exhibit bends, deformation or other defects. The terminals shall be securely connected internally and externally to prevent breakage and excessive force applied to the capacitor body or enclosure when the terminals are manipulated. The terminals and capacitor elements shall be securely soldered or welded.

c) Soldering
Soldering shall not be employed to obtain mechanical strength. If soldering to establish electrical connection, it is desirable that the mechanical connection is provided before soldering. Electrical connection shall be certainly established and excessive flux or solder shall be removed after soldering. Whether or not acid or acid salt is used, the post-processing, such as complete neutralization or cleaning, shall be performed immediately after soldering.

d) Finish
The finish shall not exhibit any defects such as chip off, cracks, or corrosion on the external surface of the enclosure.

e) Solder finishing
There shall be no bumps or rough areas caused by insufficient heating. Soldering shall be performed with the minimum required amount of flux and solder.

Excessive flux shall be removed without damaging the capacitor. No dispersed flux particles, brush bristles, or other foreign objects shall remain inside or on the external surface of the capacitor.
No damage to insulators or loosening of parts shall be caused by the soldering heat.

F.3.4.1 DPA

When examined in accordance with paragraph F.4.4.3.1, soldering of the capacitor element and terminals and other processes shall be verified to meet the requirements. Dimensions of mica films and their spacing, and other internal construction and materials shall be verified to meet the requirements specified in the quality assurance program.

F.3.5 Rating

The following items shall be specified in the detail specification.

a) Nominal capacitance
b) Capacitance tolerance
c) Characteristic
d) Operating temperature range
e) Rated voltage

F.3.6 Electrical Performance

Capacitors shall meet the following requirements.

F.3.6.1 Insulation Resistance

When tested in accordance with paragraph F.4.4.4.1, the insulation resistance shall be not less than the values specified in Table F-6.

Table F-6. Insulation Resistance

Temperature (°C)	Capacitance (pF)	Minimum insulation resistance
25	Less than 10,000	100,000 MΩ
	10,000 or greater	1,000 MΩ·μF (1)
125	Less than 3,300	10,000 MΩ
	3,300 or greater	33 MΩ·μF (1)
150	Less than 1,500	5,000 MΩ
	1,500 or greater	7.5 MΩ·μF (1)

Note (1) Insulation resistance (MΩ) x capacitance (μF) = minimum insulation resistance (specified value), therefore, insulation resistance (MΩ) ≥ minimum insulation resistance / capacitance (μF)

F.3.6.2 Capacitance

When tested in accordance with paragraph F.4.4.4.2, the capacitance shall meet the requirements in the detail specification.

F.3.6.3 Dissipation Factor

When tested in accordance with paragraph F.4.4.4.3, the dissipation factor (tan δ) shall not exceed the values specified in Figure F-1.

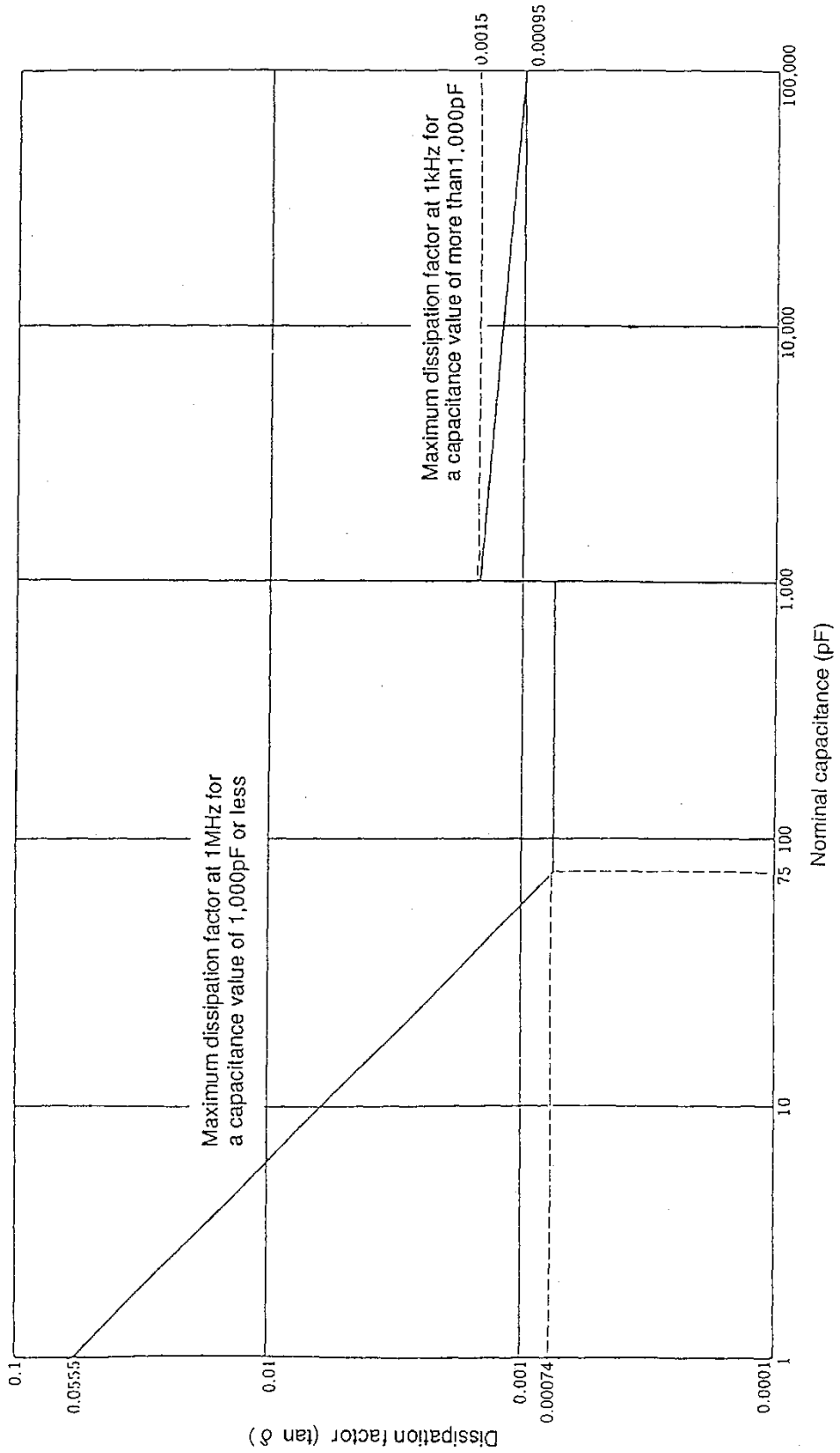

Figure F-1. Dissipation Factor

F.3.6.4 Temperature Coefficient and Capacitance Drift

When tested in accordance with paragraph F.4.4.4.4, the temperature coefficient and capacitance drift shall be within the range specified in Table F-2.

F.3.6.5 Dielectric Withstanding Voltage

When tested in accordance with paragraph F.4.4.4.5, there shall be no evidence of arcing, dielectric breakdown, or mechanical damage.

F.3.6.6 Voltage Aging

When tested in accordance with paragraph F.4.4.4.6, there shall be no evidence of arcing, dielectric breakdown, or mechanical damage.

F.3.7 Mechanical Performance

Capacitors shall meet the following requirements.

F.3.7.1 Terminal Strength

F.3.7.1.1 Pull Test

When tested in accordance with paragraph F.4.4.5.1.1, the terminals shall not exhibit loosening or rupture, and no other mechanical damage shall be detected.

F.3.7.1.2 Flat Terminal Bend Test

When tested in accordance with paragraph F.4.4.5.1.2, the terminals shall not exhibit loosening or rupture, and no other mechanical damage shall be detected.

F.3.7.2 Solderability

When tested in accordance with paragraph F.4.4.5.2, the dipped surface of the terminals shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough spots and shall not be concentrated in one area.

F.3.7.3 Resistance to Soldering Heat

When tested in accordance with paragraph F.4.4.5.3, capacitors shall meet the following requirements.

a) Insulation resistance
   As specified in paragraph F.3.6.1.
b) Capacitance
   The capacitance change before and after the test shall be within ±5pF or ±5%, whichever is greater.
c) Dissipation factor (tan δ)
   As specified in paragraph F.3.6.3.

F.3.8 Environmental Performance

Capacitors shall meet the following requirements.

F.3.8.1 High-Frequency Vibration

When tested in accordance with paragraph F.4.4.6.1, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, open-circuiting, or mechanical damage.

F.3.8.2 Random Vibraion

When tested in accordance with paragraph F.4.4.6.2, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, open-circuiting, or mechanical damage. In addition, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
As specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
As specified in paragraph F.3.6.3.

e) Externals
There shall be no mechanical damage and the marking shall remain legible.

F.3.8.3 Shock

When tested in accordance with paragraph F.4.4.6.3, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, open-circuiting, or mechanical damage.

F.3.8.4 Thermal Shock (I)

When tested in accordance with paragraph F.4.4.6.4, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
30% or greater of the values specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
The dissipation factor shall not exceed 150% of the values specified in paragraph F.3.6.3.

e) Externals
There shall be no corrosion (1) or mechanical damage and the markings shall remain legible.
Note: (1) Corrosion which adversely affects mechanical and electrical performance of capacitors.

F.3.8.5 Thermal Shock and Immersion Cycling

When tested in accordance with paragraph F.4.4.6.5, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
30% or greater of the values specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
The dissipation factor shall not exceed 150% of the values specified in paragraph F.3.6.3.

e) Externals
There shall be no corrosion (1) or mechanical damage and the markings shall remain legible.
Note: (1) Corrosion which adversely affects mechanical and electrical performance of capacitors.

F.3.8.6 Moisture Resistance
When tested in accordance with paragraph F.4.4.6.6, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
25% or greater of the values specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
The dissipation factor shall not exceed 150% of the values specified in paragraph F.3.6.3.

e) Externals
There shall be no corrosion (1) or mechanical damage and the markings shall remain legible.
Note: (1) Corrosion which adversely affects mechanical and electrical performance of capacitors.

F.3.8.7 Barometric Pressure (Reduced)
When tested as specified in paragraph F.4.4.6.7, there shall be no evidence of arcing, dielectric breakdown, or mechanical damage.

F.3.8.8 Resistance to Solvents
When tested in accordance with paragraph F.4.4.6.8, the marking shall remain legible.

F.3.9 Durability Performance
Capacitors shall meet the following requirements.

F.3.9.1 Life

F.3.9.1.1 Rated Condition
When tested in accordance with paragraph F.4.4.7.1.1, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
As specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
The dissipation factor shall not exceed 150% of the values specified in paragraph F.3.6.3.

e) Externals
There shall be no corrosion (1) or mechanical damage and the markings shall remain legible.
Note: (1) Corrosion which adversely affects mechanical and electrical performance of capacitors.

F.3.9.1.2 Acceralated Condition
When tested in accordance with paragraph F.4.4.7.1.2, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage
As specified in paragraph F.3.6.5.

b) Insulation resistance
As specified in paragraph F.3.6.1.

c) Capacitance
The capacitance change before and after the test shall be within ±1pF or ±1%, whichever is greater.

d) Dissipation factor (tan δ)
The dissipation factor shall not exceed 150% of the values specified in paragraph F.3.6.3.

e) Externals
There shall be no corrosion (1) or mechanical damage and the markings shall remain legible.
Note; (1) Corrosion which adversely affects mechanical and electrical performance of capacitors.

F.4 QUALITY ASSURANCE PROVISIONS

F.4.1 In-Process Inespction

In-process inspection shall be as specified in paragraph 4.3.

F.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

F.4.2.1 Sample

Sample selection for qualification test shall be as follows and as specified in paragraph 4.4.1.

a) Individual qualification
The manufacturer shall submit 229 sample units that represent the style, characteristic, nominal capacitance, capacitance tolerance, operating temperature range, and rated voltage of capacitors to be qualified.

b) Group qualification

The manufacturer shall submit 229 sample units grouped under the following conditions. The number of sample units of different styles shall be almost equal. For each style, the number of sample units that represent the maximum nominal capacitance shall be almost equal to the number of sample units that represent the minimum nominal capacitance. If the minimum nominal capacitance is 47pF or less, the manufacturer may submit sample units of 47pF

1) CMS16 and CMS17 may be combined but shall not be combined with any other styles.
2) CMS18, CMS19, CMS21, and CMS22 with rated voltage of $500V_{DC}$ may be combined but shall not be combined with any other style or CMS22 with rated voltage of $1,000V_{DC}$.
3) CMS22 with rated voltage of $1,000V_{DC}$ shall not be combined with any other styles or CMS22 with rated voltage of $500V_{DC}$.

F.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table F-7. All samples shall be subjected to groups I and II tests before being divided for groups III through IX. Tests in group III and subsequent groups may be performed in any order regardless of group number. Tests in each group shall be performed in the order listed.

Table F-7. Qualification Test

Test				Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item				Quantity of samples	Quantity of allowable defects(1)
I(2)	1	Dielectric withstanding voltage		F.3.6.5	F.4.4.4.5	229(4)	0
	2	Voltage aging		F.3.6.6	F.4.4.4.6		
	3	Externals, dimensions, mass and marking (3)		F.3.3	F.4.4.2		
II(2)	1	Barometric pressure (reduced)		F.3.8.7	F.4.4.6.7	229(4)	0
	2	Insulation resistance		F.3.6.1	F.4.4.4.1		
	3	Capacitance		F.3.6.2	F.4.4.4.2		
	4	Dissipation factor		F.3.6.3	F.4.4.4.3		
III	1	Solderability		F.3.7.2	F.4.4.5.2	18	1
	2	High-frequency vibration		F.3.8.1	F.4.4.6.1		
	3	Temperature coefficient and capacitance drift		F.3.6.4	F.4.4.4.4		
	4	Thermal shock and immersion cycling		F.3.8.5	F.4.4.6.5		
IV	1	Shock		F.3.8.3	F.4.4.6.3	18	1
	2	Terminal strength	Pull	F.3.7.1.1	F.4.4.5.1.1		
	3		Flat terminal bend	F.3.7.1.2	F.4.4.5.1.2		
	4	Moisture resistance		F.3.8.6	F.4.4.6.6		
V	1	Life	Rated condition	F.3.9.1.1	F.4.4.7.1.1	150	0
	2		Accelerated condition	F.3.9.1.2	F.4.4.7.1.2	17	0
VI	1	Resistance to solvents		F.3.8.8	F.4.4.6.8	6	0
	2	Resistance to soldering heat		F.3.7.3	F.4.4.5.3		
VII	1	DPA		F.3.4.1	F.4.4.3.1	2(4)	0
VIII	1	Random vibration		F.3.8.2	F.4.4.6.2	6	0
IX	1	Thermal shock (I)		F.3.8.4	F.4.4.6.4	12	0
–	–	Materials		F.3.2	–	(5)	

Notes:
(1) A sample having one or more defects in one group shall be charged as a single defect.
(2) Non-destructive tests.
(3) For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(4) In the case of group qualification, DPA shall be conducted for at least a single sample per style. Additional sample(s) for this purpose shall be submitted.
(5) Documents shall be submitted to prove that the samples meet the design specification.

F.4.3 Quality Conformance Inspection

The quality conformance inspection shall be as follows and as specified in paragraph 4.5.

F.4.3.1 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table F-8 for group A, Table F-9 for group B and Table F-10 for group C. Tests in each group shall be performed in the order listed in each table.

F.4.3.2 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered.

Table F-8. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defects
A1	1	Dielectric withstanding voltage	F.3.6.5	F.4.4.4.5	All samples	0
	2	Voltage aging	F.3.6.6	F.4.4.4.6		
	3	Insulation resistance	F.3.6.1	F.4.4.4.1		
	4	Capacitance	F.3.6.2	F.4.4.4.2		
	5	Dissipation factor	F.3.6.3	F.4.4.4.3		
	6	Externals, dimensions, mass and marking(1)	F.3.3	F.4.4.2		
A2	1	DPA	F.3.4.1	F.4.4.3.1	2(2)	0

Notes:

(1) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.

(2) DPA shall be conducted for at least a single sample per style. Additional sample(s) for this purpose shall be submitted.

Table F-9. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples(1)	Quantity of allowable defects
B1	1	Resistance to solvents	F.3.8.8	F.4.4.6.8	6	0
	2	Resistance to soldering heat	F.3.7.3	F.4.4.5.3		

Note: (1) The samples shall be taken in proportion to the quantity of capacitors per style.

Table F-10. Quality Conformance Inspection (Group C)

Inspection				Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item				Quantity of samples(1)	Quantity of allowable defects
C1	1	Solderability		F.3.7.2	F.4.4.5.2	18	0
	2	High-frequency vibration		F.3.8.1	F.4.4.6.1		
	3	Temperature coefficient and capacitance drift		F.3.6.4	F.4.4.4.4		
	4	Thermal shock and immersion cycling		F.3.8.5	F.4.4.6.5		
C2	1	Barometric pressure (reduced)		F.3.8.7	F.4.4.6.7	18	0
	2	Shock		F.3.8.3	F.4.4.6.3		
	3	Terminal strength	Pull	F.3.7.1.1	F.4.4.5.1.1		
	4		Flat terminal bend	F.3.7.1.2	F.4.4.5.1.2		
	5	Moisture resistance		F.3.8.6	F.4.4.6.6		
C3	1	Life (accelerated condition)		F.3.9.1.2	F.4.4.7.1.2	12	0
C4	1	Random vibration		F.3.8.2	F.4.4.6.2	6	0
C5	1	Thermal shock (I)		F.3.8.4	F.4.4.6.4	6	0

Note: (1) The samples shall be taken in proportion to the quantity of capacitors per style.

F.4.4 Method of Test and Inspection

F.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202 and the following details and exceptions shall apply.

a) Standard conditions

The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 and 75%, and atmospheric pressure of 86 and 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the results is expected.

b) Test conditions

Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at a temperature of 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure 86 to 106kPa.

c) Reference conditions
Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at a temperature of 25°C, a relative humidity of 50% and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, or are considerable to be affected by measuring jigs, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage. For measuring leakage current, the fluctuation of power supply voltage shall be within ±100ppm.

F.4.4.2 Externals, Dimension, Mass and Marking

Capacitors shall be inspected for the externals, construction, dimensions, mass, and markings specified in paragraph F.3.3. The mass shall be measured only in the qualification test and Group A inspections performed prior to Group C inspections.

F.4.4.3 Workmanship

F.4.4.3.1 DPA

The DPA shall be conducted in accordance with the DPA manual cited in Quality Assurance Program Plan to examine soldering of the capacitor element and terminals, other processes, inner construction, and materials, and to measure the dimensions of mica films and their spacing by disassembling capacitors.

F.4.4.4 Electrical Performance

Electrical performance test shall be performed as follows.

F.4.4.4.1 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.

a) Test condition
   1) When the rated voltage is less than $500V_{DC}$: A ($100V_{DC}$).
   2) When the rated voltage is $500V_{DC}$ or greater : B ($500V_{DC}$).

b) Point of measurement: Between terminals.

c) Duration of application: 10 to 120 seconds.

d) Test temperature:
   1) Qualification test and group A inspections performed prior to group C inspections: 25±5°C and the maximum operating temperature $^{+5}_{0}$ °C.
   2) Group A inspections other than stated above: 25±5°C.

F.4.4.4.2 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Test frequency(1)
   1) When the nominal capacitance is 1,000pF or less: 1MHz±0.1%.
   2) When the nominal capacitance exceeds 1,000pF: 1kHz±10%.
b) Measuring accuracy: Not greater than ±0.2pF or 0.2% of the nominal capacitance, whichever is greater.
c) Test voltage: Effective voltage of 10V or smaller.

Note: (1) When the manufacturer used a frequency in between 1kHz and 1MHz at its option, it is assumed that the test frequency specified in items 1) or 2) of a) above was applied.

F.4.4.4.3 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge. The following details shall apply.

a) Test frequency(1)
   1) When the nominal capacitance is 1,000pF or less: 1MHz±0.1%.
   2) When the nominal capacitance exceeds 1,000pF: 1kHz±10%.
b) Measuring accuracy: Within ±2%.
c) Test voltage: Effective voltage of 10V or less.

Note (1) When the manufacturer used a frequency between1kHz and 1MHz at its option, it is assumed that the test frequency specified in items 1) or 2) of a) above was applied.

F.4.4.4.4 Temperature Coefficient and Capacitance Drift

The capacitance shall be measured as specified in paragraph F.4.4.4.2 at each step in Table F-11 in the order listed. The temperature coefficient and capacitance drift shall be calculated from the measurements.

Measuring accuracy shall be within ±(nominal capacitance x 0.025%+0.05pF). The capacitor shall be brought to thermal stability before the measurements. Thermal stability will have been reached when no further change in capacitance is observed between two successive measurements taken at 5-minute intervals.

a) Temperature coefficient

   The temperature coefficient shall be calculated as follows.

$$\text{Temperature coefficient (ppm/°C)} = \frac{(C_x - C_5)}{C_5(T_x - T_5)} \times 10^6$$

   Where, C_x: Capacitance at test temperature (pF)
   C_5: Capacitance at step 5 (pF)
   T_x: Test temperature at step X (°C)
   T_5: Test temperature at step 5 (25°C)

b) Capacitance drift

   The capacitance drift shall be calculated by dividing the difference between the maximum and minimum measurements obtained in steps 1, 5, and 11 by the measured value at step 5.

Table F-11. Test Temperature

(Unit: °C)

Step(1)	Temperature	Step(1)	Temperature
1	25±2	6	45±2
2	-55±2	7	65±2
3	-40±2	8	85^{+2}_{0}
4	-10±2	9	125^{+2}_{0}
5	25±2	10(2)	150^{+2}_{0}
–	–	11	25±2

Notes:

(1) Measurements in steps 3, 4, 6, 7, and 8 may be exempted for Group C inspections.

(2) Applicable to capacitors with the operating temperature range “P”.

F.4.4.4.5 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Test voltage: 200% of rated voltage.
b) Duration of application: 1 to 5 seconds.
c) Point of measurement: Between terminals.
d) Charged and discharged current: 50mA or less.
e) Inspections after test:
The test capacitor shall be examined for evidence of arcing, insulation breakdown, and mechanical damage.

F.4.4.4.6 Voltage Aging

The voltage aging shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Test temperature: Maximum operating temperature specified in the detail specification.
b) Test voltage: 200% of rated voltage.
c) Duration of application: 48^{+4}_{0} hours.
d) Point of measurement: Between terminals.
e) Inspections after test:
The test capacitor shall be examined for evidence of arcing, insulation breakdown and mechanical damage.

F.4.4.5 Mechanical Performance

Mechanical performance test shall be performed as follows.

F.4.4.5.1 Terminal Strength

F.4.4.5.1.1 Pull Test

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exception shall apply.

a) Test method: A (pull test).
b) Holding method: The test capacitor shall be held by the body.
c) Applied force: As specified in Table F-12.
d) Test duration: 5±1 seconds.
e) Inspection after test
   Capacitors shall be visually examined for looseness, rupture, and other mechanical damage of the terminals.

Table F-12. Applied Force for Terminal Strength Test

(Unit: N)

Nominal cross-section area (mm^2)	Applied force	
	Pull test	Bend test
0.07 to 0.2	4.9	2.45
Over 0.2 to 0.5	9.8	4.9
Over 0.5 to 1.0	24.5	9.8
Over 1.0	44.1	14.7

F.4.4.5.1.2 Bend Test

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exception shall apply.

a) Test method: B (flat terminal bend).
b) Applied force: As specified in Table F-12.
c) Test procedure:
   The terminals shall be bent at the right angle in two mutually perpendicular directions with respect to the direction to where the terminals are pulled out with the force shown in Table F-12, returned to original position, and these shall be repeated for 2 times. One of examples for bending directions is shown below. For CMS22, the bending direction No.1 in the figure shall only be applied.
d) Inspections after test
   Capacitors shall be visually examined for looseness, rupture, and other mechanical damage of the terminals.

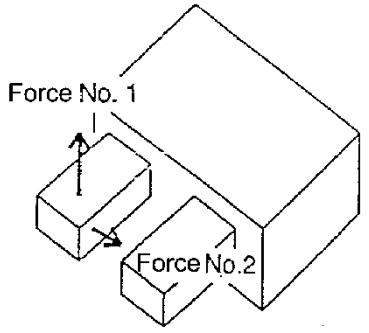

Figure F-2. Bending Directions of Flat Terminals

F.4.4.5.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: 2 terminals per test sample.
b) Solder temperature: 230±5°C.
c) Depth of immersion: Approximately within 1.5mm from the terminal base.
d) Inspection after test
   The test capacitor shall be visually examined for soldered connections.

F.4.4.5.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Pre-test measurement
   The capacitance shall be measured as specified in paragraph F.4.4.4.2.
b) Test conditions
   Test condition: B (260°C, 10±1 seconds), except that the duration of immersion shall be 3±0.5 seconds for CMS16.
c) Depth of immersion: 4±0.8mm from the terminal base.
d) Duration from immersion to measurement: 60±10 seconds.
e) Post-test measurements.
   The insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

F.4.4.6 Environmental Performance

Environmental performance test shall be performed as follows.

F.4.4.6.1 High-Frequency Vibration

Capacitors shall be tested in accordance with test method 204 of MIL-STD-202. The following details and exception shall apply.

a) Mounting method
   The test capacitor shall be secured using a jig or shall be directly mounted on a vibration apparatus. Adhesives such as resin may be used to fasten the test capacitor.
b) Test condition: D (196m/s^2).
c) Measurement during test
   Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting.
d) Inspection after test
   Capacitors shall be visually examined for mechanical damage.

F.4.4.6.2 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Measurement before test
   The capacitance shall be measured as specified in paragraph F.4.4.4.2.
b) Mounting method

The test capacitor shall be secured using a jig or shall be directly mounted on a vibration apparatus. Adhesives such as resin may be used to fasten the test capacitor.

c) Test condition: II-H (333m/s^{2}rms).

d) Direction and duration of vibration
Three mutually perpendicular directions, 3 minutes each (9 minutes in total).

e) Measurement during test
Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, short-circuiting and open-circuiting.

f) Measurement after test
After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

g) Inspection after test
Capacitors shall be visually examined for evidence of mechanical damage and marking legibility.

F.4.4.6.3 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply:

a) Mounting method
The test capacitor shall be secured using a jig or shall be directly mounted on a vibration apparatus. Adhesives such as resin may be used to fasten the test capacitor.

b) Test condition: I (980m/s^2 and saw tooth waveform).

c) Measurement during test
Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting at final cycle of each direction.

d) Inspection after test
Capacitors shall be visually examined for evidence of mechanical damage.

F.4.4.6.4 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: B, except that the number of cycles shall be 1,000 cycles, the temperature shall be -30^{0}_{-3}°C in step 1 and 100^{+3}_{0} °C in step 3, and holding time in these temperatures shall be 15^{+5}_{0} munites.

b) Measurements and inspections
The following measurements and inspections shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.

1) Measurements
After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

2) Inspections
Capacitors shall be visually examined for evidence of corrosion, mechanical damage, and marking legibility with a magnifying glass of 10-times magnification.

F.4.4.6.5 Thermal Shock and Immesion Cycling

a) Thermal Shock
Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply:
1) Pore-test measurements
After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.
2) Test condition
B (5 cycles), except that the temperature shall be -55^{0}_{-3}°C in step 1 and the maximum operating temperature $^{+3}_{0}$ °C in step 3.
3) Duration of test
The test capacitor shall be exposed for 30 minutes as a minimum in steps 1 and 3.

b) Immersion cycling:
Immediately after testing the thermal shock of item a) aforesaid, the immersion cycling shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.
1) Test method: B (2 cycles in saturated saline)
2) Post-test measurements
After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.
3) Inspections after test
Capacitors shall be visually examined for corrosion, mechanical damage, and marking legibility.

F.4.4.6.6 Moisture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be mounted by terminals in a manner that will keep the capacitor body from touching the mounting jig during test or measurement.

b) Measurement before test
After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

c) Thermal shock before test
The thermal shock shall be performed before the test under the following conditions.
1) Test condition: B (5 cycles), except that the temperature shall be -55^{0}_{-3}°C in step 1, and the maximum operating temperature $^{+3}_{0}$ °C in step 3.
2) Duration of test
The test capacitor shall be exposed for a minimum of 30 minutes in steps 1 and 3.

d) Number of cycles
The number of cycles shall be 20 continuous cycles except that the vibration in step 7b shall not apply.

e) Loading during test
DC voltage of $100V_{DC}$ shall be applied to half of the test capacitors with no voltage applied to the other half.

f) Measurements after test
After step 6 of the final cycle, the test capacitor shall be maintained between 4 and 24 hours at 25±5°C and a relative humidity of 50±5%. After measuring the dielectric withstanding voltage as specified in paragraph F.4.4.4.5, the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

g) Inspection after test
Capacitors shall be visually examined for corrosion, mechanical damage, and marking legibility.

F.4.4.6.7 Barometric Pressure (Reduced)
Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Test condition: D (1.1kPa, 30,480m).
b) Applied voltage
1) Capacitors with the rated voltage of $1,000V_{DC}$: Rated voltage.
2) Capacitors with rated voltage other than $1,000V_{DC}$: 150% of the rated voltage.
c) Point of measurement: Between terminals.
d) Duration of application during decompression: 60^{+15}_{0} seconds.
e) Charged and discharged current: 50mA or less.
f) Inspections after test
Capacitors shall be examined for evidence of arcing, dielectric breakdown, and mechanical damage.

F.4.4.6.8 Resistance to Solvents
The moisture resistance shall be tested in accordance with test method 215 of MIL-STD-202. Isopropyl alcohol shall be used as solvent.

F.4.4.7 Durability Performance
Durability performance test shall be performed as follows.

F.4.4.7.1 Life

F.4.4.7.1.1 Rated Condition

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Preparation for test
The test capacitor shall be maintained at -55^{0}_{-2}°C for 48^{+4}_{0} hours.

b) Pre-test measurement
The capacitance shall be measured as specified in paragraph F.4.4.4.2.

c) Test temperature: Maximum operating temperature±3°C.

d) Applied voltage: Rated voltage.

e) Charged and discharged current: 50mA or less.

f) Duration of test: $4{,}000^{+72}_{0}$ hours.

g) Post-test measurements
At $2{,}000^{+72}_{0}$ and $4{,}000^{+72}_{0}$ hours, the dielectric withstanding voltage shall be measured as specified in paragraph F.4.4.4.5, then the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

h) Inspections after test
Capacitors shall be visually examined for corrosion, mechanical damage, and marking legibility.

F.4.4.7.1.2 Accelerated Condition

The life test shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall be applied.

a) Preparation for test
The test capacitor shall be maintained at -55^{0}_{-2}°C for 48^{+4}_{0} hours.

b) Pre-test measurement
The capacitance shall be measured as specified in paragraph F.4.4.4.2.

c) Test temperature: Maximum operating temperature±3°C.

d) Applied voltage: 150% of the rated voltage.

e) Charged and discharged current: 50mA or less.

f) Duration of test: $2{,}000^{+72}_{0}$ hours.

g) Post-test measurements
After measuring dielectric withstanding voltage as specified in paragraph F.4.4.4.5, then the insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured in accordance with paragraphs F.4.4.4.1, F.4.4.4.2, and F.4.4.4.3.

h) Inspections after test
Capacitors shall be visually examined for corrosion, mechanical damage, and marking legibility.

F.4.5 Long-Term Storage

When Capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for following items in the order shown.

a) Dielectric withstanding voltage (paragraph F.3.6.5)

b) Insulation resistance (paragraph F.3.6.1)

c) Capacitance (paragraph F.3.6.2)
d) Dissipation factor (paragraph F.3.6.3)
e) Externals and markings (paragraph F.3.3)

F.4.6 Change to Tests and Inspections

Change to tests and inspections shall be as specified in paragraph 4.8.

F.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

F.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX G

CAPACITORS, FIXED, PLASTIC FILM

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX G

CAPACITORS, FIXED, PLASTIC FILM

G.1 GENERAL

G.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for plastic film, fixed capacitors (hereinafter referred to as "capacitors").

G.1.2 Classification

Capacitors shall be classified as specified in Table G-1.

Table G-1. Classification

Structure	Application	Style
Cylindrical type, nonmetal case, radial lead, metallized plastic film	For filter (10 to 68μF)	CFS061
Rectangular type, nonmetal case, radial lead, metallized plastic film	For filter (0.01 to 6.8μF)	CFS991
	For resonance (0.01 to 0.22μF)	CFS992

G.1.3 Part Number

The part number shall be indicated as follows. Refer to the detail specification for details.

(Example)

NASDA[(1)] CFS991 N K 105 K

Style	Characteristic	Rated voltage	Nominal Capacitance	Capacitance tolerance
(G.1.3.1)	(G.1.3.2)	(G.1.3.3)	(G.1.3.4)	(G.1.3.5)

Note: [(1)] "NASDA" indicates the part is for space use and may be abbreviated “N”.

G.1.3.1 Style

The style shall be identified by “CFS”, followed by a three-digit number. “CFS” denotes “high reliability, plastic film, fixed capacitors”. The first two digits of the following 3-digit number denote capacitor type and the last digit denotes application, as specified in Table G-2.

Table G-2. Type and Application

Symbol	Type	Symbol	Application
06	Cylindrical type, nonmetal case, radial lead	1	For filter
99	Rectangular type, nonmetal case, radial lead	1	For filter
		2	For resonance

G.1.3.2 Characteristic

The characteristic shall be identified by a single capital letter as given in Table G-3.

Table G-3. Characteristic

Symbol	Operating temperature range (°C)	Dielectric
N	-55 to +105	Polyethylene terephthalate film
L	-55 to +105	Polypropylene firm
R	-55 to +125	Polycarbonate film
T	-55 to +150	Polysulfone film

G.1.3.3 Rated Voltage

The rated voltage shall be indicated by a single capital letter as specified in Table G-4.

Table G-4. Rated Voltage

(Unit: V)

Symbol	A	B	C	D	E	F	G	H	J	K	L
Rated voltage	50	100	200	300	400	600	75	150	25	250	500

G.1.3.4 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For example, 103 indicates 0.010μF, 105 indicates 1.0μF, 686 indicates 68μF.

G.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table G-5.

Table G-5. Capacitance Tolerance

(Unit: %)

Symbol	H	J	K
Capacitance tolerance	±3	±5	±10

G.2 APPLICABLE DOCUMENTS

G.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

G.2.2 Reference Document

The following document is a referenced document of this appendix.

a) MIL-PRF-55514 Capacitors, Fixed, Plastic (or Metallized Plastic), Dielectric, DC or DC-AC, in Nonmetal Cases, Non-Established and Established Reliability, General Specification for

G.3 REQUIREMENTS

G.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs G.3.2 to G.3.10. The qualification coverage shall be represented by samples that have passed the qualification test. Within this coverage, the manufacture is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

G.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

G.3.2.1 Dielectric Film

Dielectric films of capacitors shall be selected from the following materials and shall be specified in the detail specification.

a) Polyethylene terephthalate film
b) Polypropylene film
c) Polycarbonate film
d) Polysulfone film

G.3.2.2 Impregnant and Filling Materials

Impregnant and filling materials shall be chemically inactive with respect to the capacitor element or its case, and shall have no adverse effect on the capacitor performance under the operating or non-operating conditions.

G.3.3 Design and Construction

G.3.3.1 Construction

Capacitors shall be constructed as follows and as specified in the detail specification.

a) Enclosure
Capacitors shall be encapsulated by a resin case or resin tapes to prevent leakage of impregnant and filling materials and to protect the capacitor element from moisture and mechanical damage.

b) Lead terminals
Copper or copper alloy shall be used for the lead terminals. Capacitors shall be securely connected internally and externally to avoid excessive forces applied to capacitor element or its case when the lead wires are manipulated. The lead wires shall be soldered by immersing into molten solder or electroplating.

c) Capacitor element
The capacitor elements shall consist of plastic films or metallized plastic films. The plastic films and metallized plastic films may be used together as dielectrics. Capacitor elements shall have non-inductive structure to reduce inductance.

G.3.4 Externals, Dimension, Mass and Marking

G.3.4.1 Externals and Marking

The surface of capacitor shall not exhibit any damages. The following items shall be marked on capacitors as a minimum in a manner to ensure legibility.

a) Part number
b) Lot identification code
c) Manufacturer name or abbreviation

G.3.4.2 Dimenstion and Mass

Dimension and mass shall be as specified in the detail specification.

G.3.5 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.

G.3.5.1 Radiograph

When tested in accordance with paragraph G.4.4.3.1, there shall be no structural defects such as insufficient connection, insufficient soldering, or adhesion of solder particles.

G.3.5.2 DPA

When examined in accordance with paragraph G.4.4.3.2, soldering of capacitor element and terminals and other processes shall be verified to be properly implemented. Dimensions of dielectrics, their spacing, and other internal construction shall be verified to meet the requirements specified in the quality assurance program.

G.3.6 Rating

The following items shall be specified in the detail specification.

a) Nominal capacitance
b) Capacitance tolerance
c) Operating temperature range
d) Rated voltage

G.3.7 Electrical Performance

Capacitors shall meet the following requirements.

G.3.7.1 Insulation Resistance

When tested in accordance with paragraph G.4.4.4.1, the insulation resistance shall meet the requirements specified in the detail specification.

G.3.7.2 Dielectric Withstanding Voltage

When tested in accordance with paragraph G.4.4.4.2, there shall be no instantaneous or intermittent arcing or short-circuiting other than instantaneous one.

G.3.7.3 Capacitance

When tested in accordance with paragraph G.4.4.4.3, the capacitance shall meet the requirements in the detail specification.

G.3.7.4 Dissipation Factor

When tested in accordance with paragraph G.4.4.4.4, the dissipation factor shall meet the requirements in the detail specification.

G.3.7.5 Equivalent Series Resisntance

When tested in accordance with paragraph G.4.4.4.5, the equivalent series resistance shall meet the requirements specified in the detail specification.

G.3.7.6 Frequency Characteristic

When tested in accordance with paragraph G.4.4.4.9, the resonant frequency shall be not less than the value calculated as follows.

$$f_0 = \frac{1}{1.5\sqrt{C}} \text{ (MHz)}$$

f_0: Resonant frequency (MHz)

C: Rated capacitance (μF)

G.3.7.7 Low-Temperature Conditioning and Capacitance Change withTempearture

When tested as specified in G.4.4.4.6, capacitors shall have no evidence of dielectric breakdown, arcing, disconnection, short-circuiting, or mechanical damage.
The capacitance change, insulation resistance, and dissipation factor at specified temperature shall meet the requirements specified in the detail specification.

G.3.7.8 Current Loading

When tested in accordance with paragraph G.4.4.4.7, capacitors shall meet the following requirements.

a) Insulation resistance between terminals (25°C): 50% or higher than the specified value.
b) Capacitance change rate: Within ±5%.

c) Dissipation factor (25°C): 120% or lower than the specified value.
d) Equivalent series resistance: 120% or lower than the specified value.
e) Externals
Capacitors shall have no external defects which will adversely affect the capacitor performance.
f) DPA
Capacitors shall have no significant defects which are not observed with capacitors that have not been tested.

G.3.7.9 Charged or Discharged Current

When tested in accordance with paragraph G.4.4.4.8, capacitors shall meet the following requirements.
a) Insulation resistance between terminals (25°C): 50% or higher than the specified value.
b) Capacitance change rate: Within ±5%.
c) Dissipation factor (25°C): 120% or lower than the specified value.
d) Equivalent series resistance: 120% or lower than the specified value.
e) Externals
Capacitors shall have no external defects which will adversely affect the capacitor performance.
f) DPA
Capacitors shall have no significant defects which are not observed with capacitors that have not been tested.

G.3.8 Mechanical Performance

Capacitors shall meet the following requirements.

G.3.8.1 Terminal Strength

When tested in accordance with paragraph G.4.4.5.1, the lead terminals shall have no loosening, cracks, or other damages.

G.3.8.2 Solderability

When tested in accordance with paragraph G.4.4.5.2, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough spots and shall not be concentrated in one area.

G.3.8.3 Resistance to Soldering Heat

When tested in accordance with paragraph G.4.4.5.3, capacitors shall meet the following requirements.
a) Capacitance change rate: Within ±3%.
b) Dissipation factor (25°C)
The dissipation factor shall meet the requirements specified in the detail specification.
c) Equivalent series resistance: Specified value or smaller.

G.3.9 Environmental Performance

Capacitors shall meet the following requirements.

G.3.9.1 Random Vibraion

When tested in accordance with paragraph G.4.4.6.1, capacitors shall meet the following requirements.

a) Capacitors shall not exhibit mechanical damage, intermittent contact of 0.5ms or greater duration, open-circuiting, or short-circuiting.
b) Insulation resistance between terminals (25°C): Specified value or greater.
c) Capacitance change rate: Within ±3%.
d) Dissipation factor (25°C): Specified value or smaller.
e) Equivalent series resistance: Specified value or smaller.
f) Externals
Capacitors shall have no external defects which will adversely affect the capacitor performance.

G.3.9.2 Shock

When tested in accordance with paragraph G.4.4.6.2, capacitors shall not exhibit mechanical damage, intermittent contact of 0.5ms or greater duration, open-circuiting, or short-circuiting.

G.3.9.3 Thermal Shock (I)

When tested in accordance with paragraph G.4.4.6.3, capacitors shall meet the following requirements.

a) Insulation resistance between terminals (25°C): 50% or higher than the specified value.
b) Capacitance change rate: Within ±5%.
c) Dissipation factor (25°C): 120% or lower than the specified value.
d) Equivalent series resistance: 120% or lower than the specified value.
e) Externals
Capacitors shall have no external defects which will adversely affect the capacitor performance.

G.3.9.4 Thermal Shock and Voltage Aging

When tested in accordance with paragraph G.4.4.6.4, capacitors shall not exhibit mechanical damages.

G.3.9.5 Thermal Shock and Immersion Cycling

When tested in accordance with paragraph G.4.4.6.5, capacitors shall meet the following requirements.

a) Dielectric withstanding voltage: As specified in paragraph G.3.7.2.
b) Insulation resistance between terminals (25°C): 50% or higher than the specified value.
c) Capacitance change rate: Within ±5%.
d) Dissipation factor (25°C): 120% or lower than the specified value.
e) Equivalent series resistance: 120% or lower than the specified value.
f) Externals
The case shall have no damage and the terminals shall have no damage or corrosion.

G.3.9.6 Moisture Resistance

When tested in accordance with paragraph G.4.4.6.6, capacitors shall meet the requirements given below.

a) Dielectric withstanding voltage: As specified in paragraph G.3.7.2.
b) Insulation resistance between terminals (25°C): 50% or higher than the specified value.
c) Capacitance change rate: Within ±5%.
d) Dissipation factor (25°C): Specified value or smaller.
e) Equivalent series resistance: Specified value or smaller.
f) Externals
The case shall have no damage and the terminals shall have no damage or corrosion.

G.3.9.7 Barometric Pressure (Reduced)

When tested in accordance with paragraph G.4.4.6.7, capacitors shall have no visual damage, external arcing, open-circuiting, or short-circuiting.

G.3.9.8 Resistance to Solvents

When tested in accordance with paragraph G.4.4.6.8, markings shall remain legible and shall not smear.

G.3.9.9 Radiation Hardness

When tested in accordance with paragraph G.4.4.6.9, capacitors shall meet the following requirements.
a) Insulation resistance between terminals (25°C): 30% or higher than the specified value.
b) Capacitance change rate: Within ±5%.
c) Dissipation factor (25°C): 120% or lower than the specified value.
d) Equivalent series resistance: 120% or lower than the specified value.
e) Externals
Capacitors shall have no mechanical damage which will adversely affect the capacitor performance or obliteration of markings.

G.3.10 Durability Performance

Capacitors shall meet the following requirements.

G.3.10.1 Life

When tested in accordance with paragraph G.4.4.7.1, capacitors shall meet the following requirements.
a) Insulation resistance between terminals (25°C): 30% or higher than the specified value.
b) Capacitance change rate: Within ±5%.
c) Dissipation factor (25°C): 120% or lower than the specified value.
d) Equivalent series resistance: 120% or lower than the specified value.
e) Externals
There shall be no deformation, obliteration of markings, or leakage of filling materials.

G.4 QUALITY ASSURANCE PROVISIONS

G.4.1 In-Process Inespction

In-process inspection shall be as specified in paragraph 4.3.

G.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

G.4.2.1 Sample

Sample selection for qualification test shall be as follows and as specified in paragraph 4.4.1.

a) Individual qualification
The manufacturer shall submit 300 sample units that represent the style, characteristic, rated voltage, nominal capacitance, and capacitance tolerance of capacitors to be qualified.

b) Group qualification
From the voltage group to be qualified, the manufacturer shall submit 151 sample units that represent the maximum rated voltage, the maximum nominal capacitance and the minimum case size, and shall submit 151 sample units that represent the maximum rated voltage, the maximum nominal capacitance and the maximum case size. The sample units shall have the same style and characteristics.

G.4.2.2 Test Items and Sample Size

Test items and sample size of qualification test shall be as specified in Table G-6. All samples shall be subjected to group I and II tests before being divided for group III through XI tests. Tests in group III and subsequent groups may be performed in any order regardless of group number. Tests in each group shall be performed in the order listed.

Table G-6. Qualification Test

Test			Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item			Quantity of samples per terminal finish	Quantity of allowable defectives
I	1	Externals, dimensions, mass and marking (1)	G.3.4	G.4.4.2	All samples	0
	2	Thermal shock and voltage aging	G.3.9.4	G.4.4.6.4		
	3	Radiograph	G.3.5.1	G.4.4.3.1		
II	1	Dielectric withstanding voltage	G.3.7.2	G.4.4.4.2	302 (2)	0
	2	Insulation resistance	G.3.7.1	G.4.4.4.1		
	3	Capacitance	G.3.7.3	G.4.4.4.3		
	4	Dissipation factor	G.3.7.4	G.4.4.4.4		
	5	Equivalent series resistance	G.3.7.5	G.4.4.4.5		
	6	Frequency characteristics	G.3.7.6	G.4.4.4.9		
III	1	Resistance to soldering heart	G.3.8.3	G.4.4.5.3	12	0
	2	Random vibration	G.3.9.1	G.4.4.6.1		
	3	Shock	G.3.9.2	G.4.4.6.2		
	4	Terminal strength	G.3.8.1	G.4.4.5.1		
IV	1	Solderability	G.3.8.2	G.4.4.5.2	8	0
	2	Barometric pressure (reduced)	G.3.9.7	G.4.4.6.7		
	3	Resistance to solvents	G.3.9.8	G.4.4.6.8		
V	1	Low-temperature conditioning and capacitance change with temperature	G.3.7.7	G.4.4.4.6	12	0
	2	Thermal shock and immersion cycling	G.3.9.5	G.4.4.6.5		
VI	1	Current loading	G.3.7.8	G.4.4.4.7	6	0
VII	1	Charged and discharged current	G.3.7.9	G.4.4.4.8	6	0
VIII	1	Moisture resistance	G.3.9.6	G.4.4.6.6	236	0
	2	Life (rated condition)	G.3.10.1	G.4.4.7.1	150	
	3	Life (accelerated condition)			86	
IX	1	DPA	G.3.5.2	G.4.4.3.2	4 (3)	0
X	1	Thermal shock (I)	G.3.9.3	G.4.4.6.3	12	0
XI	1	Radiation hardness	G.3.9.9	G.4.4.6.9	6	0
–	–	Materials	G.3.2	–	–	(4)

Notes:
(1) For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(2) The number of samples shall be 300 for individual qualification.
(3) The number of samples shall be 2 for individual qualification.
(4) Documents shall be submitted to prove that the samples meet the design specification.

G.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

G.4.3.1 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table G-7 for group A, Table G-8 for group B, and

Table G-9 for group C. Group A inspection shall be performed in the order of subgroups listed in the table, and each inspection in the subgroup shall be performed in the order listed in each table.

G.4.3.2 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in the dimensions of subgroup A1, 100% inspection shall be conducted for the dimensions and conforming products may be delivered.

Table G-7. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Externals, dimensions, mass and marking (1)	G.3.4	G.4.4.2	All samples	0
A2	1	Thermal shock and voltage aging	G.3.9.4	G.4.4.6.4	All samples	0
	2	Radiograph	G.3.5.1	G.4.4.3.1		
A3	1	Dielectric withstanding voltage	G.3.7.2	G.4.4.4.2	All samples	0
	2	Insulation resistance	G.3.7.1	G.4.4.4.1		
	3	Capacitance	G.3.7.3	G.4.4.4.3		
	4	Dissipation factor	G.3.7.4	G.4.4.4.4		
	5	Equivalent series resistance	G.3.7.5	G.4.4.4.5		
A4	1	DPA	G.3.5.2	G.4.4.3.2	2 (2)	0

Notes:
(1) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(2) If the nominal capacitance varies, a capacitor with the maximum nominal capacitance and that with the minimum nominal capacitance shall be submitted.

Table G-8. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples(1)	Quantity of allowable defectives
B1	1	Current loading	G.3.7.8	G.4.4.4.7	6	0
B2	1	Charged and discharged current	G.3.7.9	G.4.4.4.8	6	0
B3	1	Moisture resistance	G.3.9.6	G.4.4.6.6	12	0
	2	Life (accelerated condition)	G.3.10.1	G.4.4.7.1		

Table G-9. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Resistance to soldering heat	G.3.8.3	G.4.4.5.3	12	0
	2	Shock	G.3.9.2	G.4.4.6.2		
	3	Terminal strength	G.3.8.1	G.4.4.5.1		
C2	1	Solderability	G.3.8.2	G.4.4.5.2	8	0
	2	Barometric pressure (reduced)	G.3.9.7	G.4.4.6.7		
	3	Resistance to solvents	G.3.9.8	G.4.4.6.8		
C3	1	Low-temperature conditioning and capacitance change with temperature	G.3.7.7	G.4.4.4.6	12	0
	2	Thermal shock and immersion cycling	G.3.9.5	G.4.4.6.5		
C4	1	Random vibration	G.3.9.1	G.4.4.6.1	12	0
C5	1	Thermal shock (I)	G.3.9.3	G.4.4.6.3	6	0

G.4.4 Methods for Test and Inspection

G.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202 and the following details and exceptions shall apply.

a) Standard conditions
The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 and 75%, and atmospheric pressure of 86 and 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the results is expected.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at a temperature of 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure 86 to 106kPa.

c) Reference conditions
Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, or are considerable to be affected by measuring jigs, they shall be repeated.
e) Measuring accuracy of test voltage shall be ±3.0% of the specified test voltage.
f) Fluctuation in power supply voltage for the life test shall be ±3% of the specified test voltage.

G.4.4.2 Externals, Dimension, Mass, and Marking

Capacitors shall be tested for the externals, construction, dimensions, mass, and markings specified in paragraph G.3.4.

G.4.4.3 Workmanship

G.4.4.3.1 Radiograph

Capacitors shall be tested in accordance with test method 209 of MIL-STD-202. The following details and exceptions shall apply.

a) Judgment
The judgment shall be made using negative or positive films and applicable recording paper.
b) Radiographic quality
The radiographic shall have sufficient definition to determine if the test capacitor satisfies the requirements specified in paragraph G.3.5.1 and renders a clear sharp image of the penetrameter.
c) Penetrameter
Definition of the penetrameter appropriate for sample shall be specified.
d) Observation
Capacitors shall be inspected visually or with 2x enlarged images.
e) Direction of radiography
Radiography shall be performed from a direction perpendicular to the capacitor surface containing two lead wires.
f) Radiographic condition
The radiographic equipment shall be set to produce the required radiographic specified in item b) above.

G.4.4.3.2 DPA

DPA shall be conducted in accordance with the DPA manual established in the Quality Assurance Program Plan to examine inner construction and to verify that processes such as welding and soldering are properly implemented by disassembling capacitors.

G.4.4.4 Electrical Performance

Electrical performance tests shall be performed as follows.

G.4.4.4.1 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.

a) Test voltage
   $100V_{DC}$ when the rated voltage is $100V_{DC}$ or over and under $500V_{DC}$, and $500V_{DC}$ when the rated voltage is $500V_{DC}$ or over.
b) Maximum charged and discharged current: 50mA.
c) Points of measurement
   1) Between terminals.
   2) Between terminals and case (if required) (with metal foils or metal pellets).
d) Duration of measurement
   2 minutes maximum. If the measured values are stable or still increasing above the required value, the measurements may be terminated.

G.4.4.4.2 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Test voltage and duration of application.
   Unless otherwise specified, condition B below shall apply.
   1) Condition A: 200% of the rated voltage for 10 to 60 seconds.
   2) Condition B: 250% of the rated voltage for 1 to 5 seconds.
b) DC or AC of applied voltage: DC voltage.
c) Point of measurement: Between terminals.
d) Maximum charged and discharged current: 50mA.
e) Inspections after test
   The test capacitor shall be examined for evidence of arcing and short-circuiting.

G.4.4.4.3 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Measuring frequency: 1±0.1kHz.
b) Measuring accuracy: ±0.5%.
c) Measuring voltage
   AC voltage not exceeding 20% of the rated voltage or 10V, whichever is lower.

G.4.4.4.4 Dissipation Factor

Capacitors shall be tested using appropriate equipment under following conditions.

a) Measuring frequency: 1±0.1kHz.
b) Measuring accuracy: ±2%.
c) Measuring voltage
   AC voltage not exceeding 20% of the rated voltage or 10V, whichever is lower.

G.4.4.4.5 Equivalemt Series Resistance

Capacitors shall be tested using appropriate equipment under following conditions.

a) Measuring frequency: 100±0.1kHz.
b) Measuring accuracy: ±5%.
c) Measuring voltage
   AC voltage of 20% or lower than the rated voltage or 10V, whichever is lower.
d) Measuring method: Shielded four-terminal method.

e) Point of measurement
Approximately 5mm from the test capacitor's body.

f) Shield
If the test is interfered with incoming noises, a shield box/room shall be used.

G.4.4.4.6 Low-Temperature Conditioning and Capacitance Change with Temperature

G.4.4.4.6.1 Low-Temperature Conditoning

The test capacitor shall be placed in an air circulation chamber controlled at -55±3°C for 48±4 hours with the rated voltage applied during this period.

G.4.4.4.6.2 Capacitance Change wtih Termperature

Following the low-temperature conditioning, the temperature of test capacitor shall be changed as specified in Table G-10 エラー! 参照元が見つかりません。 and the capacitance shall be measured at each temperature. The measurements shall be recorded when the test capacitor reaches thermal stability, which is no change in capacitance is observed between two successive readings taken at 5-minute intervals.
For the qualification test, the insulation resistance and dissipation factor shall be measured at step 3. After the test, the test capacitor shall be examined for evidence of dielectric breakdown, arcing, disconnection, short-circuiting, and mechanical damage.

Table G-10. Capacitance Measuring Temperature

(Unit: °C)

Step	Temperature
1	-55±3
2	+25±5
3	Maximum operating temperature ±3
4	+25±5

[Calculating capacitance change rate]

Capacitance change rate (%) = $\frac{C_2-C_X}{C_2}$ x 100

C_2: Capacitance in step 2
C_X: Capacitance in step 1 or 3

G.4.4.4.7 Current Loading

The current loading shall be performed with a current specified in the detail specification under the following conditions.

a) Frequency: 100±10kHz.
b) Duration of test: $2{,}000^{+48}_{0}$ hours.
c) Test temperature: Ambient temperature.
d) Measurements and inspection before and after test.

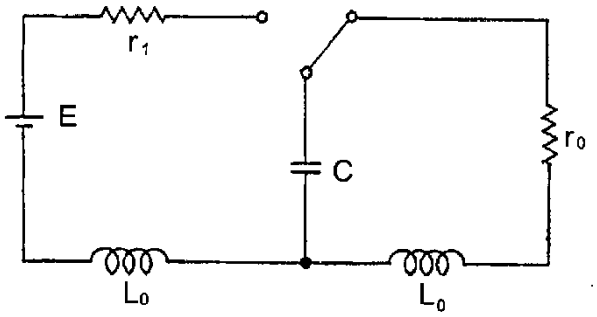
The insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The external surface shall be visually examined.

e) DPA
DPA shall be conducted on two samples as specified in paragraph G.4.4.3.2. The pre-test and post-test results shall be compared.

G.4.4.4.8 Charged and Discharged Current

Capacitors shall be tested with a circuit shown in Figure G-1 under the following conditions.

a) Number of charged and discharged: 10,000.
b) Charged and discharged cycle: 1 second.
c) Applied voltage: 150% of the rated voltage.
d) r_0
The resistor value shall be set to produce allowable pulse current specified in the detail specification.
e) Measurements and inspection before and after test
The insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The external surface shall be visually examined.
f) DPA
DPA shall be conducted on two samples as specified in paragraph G.4.4.3.2. The pre-test and post-test results shall be compared.



C: Test capacitor
E: Power supply
r_0: Resistor for pulse current control
r_1: Resistor for power supply protection
L_0: Inductor to prevent surge voltage

Figure G-1. Charged and Discharged Current Circuit

G.4.4.4.9 Frequency Characteristics

Resonance frequency shall be measured under the following conditions.

a) Measuring voltage: $1\pm0.2V_{AC.}$
b) Measuring device: Impedance analyzer (YHP4192A) or better than equivalent.
c) Measuring method: Shielded four-terminal method.
d) Point of measurement
Approximately 5mm from the test capacitor's body.

e) Shield
If the test is interfered by incoming noises, a shield box/room shall be used.

G.4.4.5 Mechanical Performance

Mechanical performance tests shall be performed as follows.

G.4.4.5.1 Terminal Strength

The terminal strength shall be performed in accordance with test method 211 of MIL-STD-202. The following details and exception shall apply.

a) Test method

1) Test condition A (pull test)

Terminal style	Terminal condition		Load
Lead terminal	Nominal wire dia. (mm) (Circular cross section)	0.5< d ≤ 0.8	9.8N
		0.8< d ≤ 1.25	19.6N

2) Test condition C (bend test)

Terminal style	Terminal condition		Load
Lead terminal	Nominal wire dia. (mm) (Circular cross section)	0.5< d ≤ 0.8	4.9N
		0.8< d ≤ 1.25	9.8N

b) Inspections after test
The test capacitor shall be visually examined for looseness, rupture, and other damage of the terminals.

G.4.4.5.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: 2 terminals per test sample.
b) Depth of immersion: Approximately 3mm from edge of the test capacitor's body.
c) Inspections after test
The test capacitor shall be visually examined for solder wettability.

G.4.4.5.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Depth of immersion: Within 3.0mm from the case or sealing section.
b) Test condition: B (at 260±5°C for 10±1 seconds).
c) Duration from test completion to measurement: 10±1 minutes.
d) Measurements after test
The capacitance, dissipation factor, and equivalent series resistance shall be measured.

G.4.4.6 Environmental Performance

Environmental performance tests shall be performed as follows.

G.4.4.6.1 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be secured by the body and the terminals shall be supported at 12.7±3mm from the body.

b) Loading during test
The rated voltage shall be applied between the terminals.

c) Test condition: II-H (at frequency range of 20 to 2,000Hz and total effective acceleration of 334m/s^2 rms).

d) Directions and duration of vibration
   1) Cylindrical type: 3 minutes in each of two perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis (6 minutes in total).
   2) Rectangular type: 3 mutually perpendicular directions for 3 minutes in each direction (9 minutes in total).

e) Inspections during test
Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, open-circuiting, and short-circuiting during the test of each direction.

f) Measurements and inspection after test
The insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The external surface shall be visually examined.

G.4.4.6.2 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be firmly mounted by the body.

b) Test condition: I (980m/s^2, 6ms, and saw tooth waveform).

c) Directions of shock
   1) Cylindrical type: 2 perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis.
   2) Rectangular type: 3 mutually perpendicular directions.

d) Loading during test: 125% of the rated voltage shall be applied between the terminals.

e) Inspections during test
Capacitors shall be examined for evidence of intermittent contact of 0.5ms or greater duration, open-circuiting, and short-circuiting during the test of each direction.

f) Inspection after test
Capacitors shall be examined for evidence of arcing and mechanical damage.

G.4.4.6.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be -30^{0}_{-3}°C at step 1, and 100^{+3}_{0} °C at step 3.
b) Number of cycles: $1{,}000^{+10}_{0}$ cycles.
c) Measuring cycles during test
The measurements shall be made during cycles of 0, 50±10, 100±10, 250±20, and 500±20.
d) Measurements and inspection before and after test
The insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The external surface shall be examined with a 10x magnifier.

G.4.4.6.4 Thermal Shock and Voltage Aging

G.4.4.6.4.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be the maximum operating temperature $^{+3}_{0}$°C in step 3.
b) Number of cycles: 5 cycles.

G.4.4.6.4.2 Voltage Aging

a) Test temperature: 85^{+4}_{0}°C.
b) Applied voltage: 125% of the rated voltage.
c) Duration of application: 48^{+5}_{0} hours.
d) Series resistance
A resistor shall be used to control the surge current to be 1A or smaller. Verify that the voltage is applied to the test capacitor through the current limiting resistor.
e) Inspections after test
Capacitors shall be examined for mechanical damage.

G.4.4.6.5 Thermal Shock and Immesion Cycling

G.4.4.6.5.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be the maximum operating temperature $^{+3}_{0}$°C in step 3.
b) Number of cycles: 20 cycles.

G.4.4.6.5.2 Immersion Cycling

Following the thermal shock, the test capacitor shall be maintained at ambient temperature for 4 to 24 hours, and shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles).

b) Measurements and inspections after test
The dielectric withstanding voltage, insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The external surface shall be visually examined.

G.4.4.6.6 Moisture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be mounted in its normal manner and shall be attached to a jig at 12.7±3mm of lead terminals except during measurement periods.
b) Number of cycles: 20 cycles (except for step 7b).
c) Polarization potential
DC 100V or the rated voltage, whichever is lower, shall be applied to a half of the sample units in steps 1 through 6 with no load applied to the other half.
d) Measurements and inspection after test
The test capacitor shall be removed from a test chamber and maintained at 25±5°C and a relative humidity of 50±5% for between 22 and 24 hours. The dielectric withstanding voltage, insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured. The externals shall be visually examined.

G.4.4.6.7 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Test condition: D (1.1kPa).
b) Test during reduction
140% of the rated voltage shall be applied between the terminals for 1 minute.
c) Inspections after test
Capacitors shall be examined for evidence of arcing and mechanical damage.

G.4.4.6.8 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. The following details shall apply.

a) Solvent: Isopropyl alcohol.
b) Inspections after test
The test capacitor shall be visually examined for obliteration of marking.

G.4.4.6.9 Radiation Hardness

Capacitors shall be tested as follows.

a) Radiation source: Cobalt 60.
b) Exposure rate: 1×10^4Gy/h (silicon basis).
c) Duration of exposure: 1 hour.
d) Measurements and inspection before and after test
The insulation resistance, capacitance, dissipation factor and equivalent series resistance shall be measured, and the externals shall be visually examined.

G.4.4.7 Durability Performance

Durability performance tests shall be performed as follows.

G.4.4.7.1 Life

The life test shall be performed in accordance with test method 108 of MIL-STD-202. The following details and exceptions shall apply.

a) Mounting method
The test capacitors shall be firmly mounted with a minimum spacing of 25.4 mm.

b) Test temperature: 85^{+4}_{0}°C.

c) Test conditions

1) Applied voltage
Rated voltage under rated condition, and 125% of the rated voltage under accelerated condition.

2) Application method
A resistor shall be inserted to control the surge current to be 1A or smaller. Verify that voltage is applied to the test capacitor through the current limiting resistor.

d) Duration of test

1) Rated condition: $4{,}000^{+72}_{0}$ hours.

2) Accelerated condition: $2{,}000^{+48}_{0}$ hours.

e) Measuring time during test: At 0, 250^{+12}_{0}, $1{,}000^{+48}_{0}$, and $2{,}000^{+48}_{0}$ hours.

f) Measurements and inspections after test
Capacitors shall be returned to the standard conditions specified in paragraph G.4.4.1, and shall be visually examined for evidence of deformation, obliteration of marking, and leakage of filling materials. Then the insulation resistance, capacitance, dissipation factor, and equivalent series resistance shall be measured.

G.4.5 Long-Term Storage

When Capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for following items.

a) Externals (paragraph G.3.4)
b) Dielectric withstanding voltage (paragraph G.3.7.2)
c) Insulation resistance (paragraph G.3.7.1)
d) Capacitance (paragraph G.3.7.3)
e) Dissipation factor (paragraph G.3.7.4)

G.4.6 Changes to Tests and Inspections

Change to tests and inspections shall be as specified in paragraph 4.8.

G.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

G.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX H

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX H

CAPACITORS, FIXED, ELECTROLYTIC (SOLID ELECTROLYTE), TANTALUM

H.1 GENERAL

H.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for tantalum, electrolytic (solid electrolyte), fixed capacitors (hereinafter referred to as "capacitors").

H.1.2 Classification

Capacitors shall be classified as specified in Table H-1.

Table H-1. Classification

Structure	Style
Metal case, sleeved, hermetic seal, cylindrical, axial lead	CSS13

H.1.3 Part Number

The part number shall be indicated as follows. Refer to the detail specification for details.

(Example)

NASDA[(1)] CSS13 B 565 K

CSS13	B	565	K
Style (H.1.3.1)	Rated voltage (H.1.3.2)	Nominal capacitance (H.1.3.3)	Capacitance tolerance (H.1.3.4)

Note: [(1)] "NASDA" indicates the part is for space use and may be abbreviated “N”.

H.1.3.1 Style

The style shall be identified by “CSS”, followed by a two-digit number. “CSS” denotes “high reliability, tantalum, electrolytic (solid electrolyte), fixed capacitors” and the following two digits denote capacitor size.

H.1.3.2 Rated Voltage

The rated voltage shall be identified by a single capital letter as specified in Table H-2.

Table H-2. Rated Voltage

(Unit: V_{DC})

Symbol	Rated voltage (-55 to +85°C)
B	6
C	10
D	15
E	20
F	35
G	50
H	75
J	100

H.1.3.3 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zero to follow. For example, 103 indicates 0.010μF, 104 indicates 0.10μF, and 337 indicates 330μF.

H.1.3.4 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table H-3.

Table H-3. Capacitance Tolerance

(Unit: %)

Symbol	Capacitance tolerance
J	+5
K	±10
M	±20

H.2 APPLICABLE DOCUMENTS

H.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

H.2.2 Reference Document

The following document is a referenced document of this appendix.

a) MIL-PRF-39003 Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for

H.3 REQUIREMENTS

H.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs H.3.2 to H.3.9. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

H.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

H.3.2.1 Case

The case shall be of a corrosion-resisting material or shall be plated or treated to resist corrosion.

H.3.2.2 Insulating sleeving

Insulating sleeving shall not deform or discolor at the maximum operating temperature of capacitors. Cardboard sleeving shall not be used as an insulator.

H.3.2.3 Solder

Solder shall not melt below 168°C or at a temperature that specified in the detail specification.

H.3.2.4 Soldering Flux

Soldering flux shall be rosin or rosin dissolved in alcohol. Other equivalent anticorrosion flux may be used provided that it meets the requirements specified in this specification.
Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area and tin or solder coating on the mechanical connection area that is not intended to create an electrical circuit.
Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.

H.3.3 Externals, Dimension, Mass and Marking

H.3.3.1 Externals and Marking

The surface of capacitor shall not exhibit any cracks, corrosions, strains, or other defects. The following items shall be marked in a manner to ensure legibility.

a) Part number
”NASDA” may be excluded, and for small geometry capacitors, style may also be excluded.
b) Lot identification code
Lot identification code shall be assigned as specified by the manufacturer.
c) Polarity
Marking method for polarity mark shall be as specified in the detail specification.
d) Manufacturer name or abbreviation

These markings may be excluded for small geometry capacitors.

H.3.3.2 Construction, Dimenston and Mass

Construction, dimension, and mass shall be as follows and as specified in the detail specification.

a) Construction
Capacitors shall be enclosed in a hermetically-sealed metal case which will protect the capacitor element from moisture and mechanical damage.

b) Terminal
The terminals shall be soldered by immersion in molten solder or electroplating.

H.3.4 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.
Capacitors shall not exhibit any cracks, pinholes, flaws, or other defects that will adversely affect the electrical or mechanical performance.

a) Soldering
Soldering shall not be employed to obtain mechanical strength. If soldering to establish electrical connection, it is desirable that the mechanical connection is provided before soldering. Electrical connection shall be certainly established and excessive flux or solder shall be removed after soldering. Whether or not acid or acid salt is used, the post-processing, such as complete neutralization or cleaning, shall be performed immediately after soldering.

b) Finish
The capacitor's finish shall not exhibit any external surface defects such as chip off, cracks, or corrosion.

c) Terminal and sealing area
All terminals and sealing areas shall be free of grease or other foreign matter. Lead wires shall be free of bend, deformation, or other defects. The terminals shall be securely connected internally and externally to prevent breakage and excessive forces applied to the capacitor element or its case when the lead wires are manipulated.

d) Case
There shall be no burrs or barbs on the metal case.

e) Insulating sleeving
Insulating sleeving shall fit the case.

f) Solder finishing
There shall be no pinholes or rough areas caused by insufficient heating. Soldering shall be performed with the minimum required amount of flux and solder. Excessive flux shall be removed without damaging the capacitor. No dispersed flux particles, brush bristles, or other foreign objects shall remain inside or on the external surface of the capacitor.
No damage to insulators or loosening of parts shall be caused by the soldering heat.

g) Welding
Welded areas shall be free of burning, strain, breakage, non-metal residue, and unwelded areas.

H.3.4.1 Radiography
When tested as specified in paragraph H.4.4.3.1, there shall be no structural defects such as insufficient connection, displacement of capacitor element and sealed area, insufficient soldering, or residual solder balls.

H.3.4.2 DPA
When tested as specified in paragraph H.4.4.3.2, the processes such as welding and soldering shall be verified to be properly implemented. The inner construction and materials shall be verified to meet the requirements specified in the quality assurance program.

H.3.5 Rating

H.3.5.1 Nominal Capacitance and Capacitance Tolerance
The nominal capacitance and capacitance tolerance shall be specified in the detail specification.

H.3.5.2 Operating Tempearture Range
The operating temperature range shall be -55 to +125°C. Unless otherwise specified, the operating temperature range at the rated voltage shall be -55 to +85°C. If the ambient temperature exceeds this range, derated voltage specified in the detail specification shall be applied.

H.3.5.3 Rated Voltage
The rated voltage shall be as specified in Table H-2, and shall be specified in the detail specification.

H.3.6 Electrical Performance
Capacitors shall meet the following requirements.

H.3.6.1 Leakage Current
When tested as specified in paragraph H.4.4.4.1, the leakage current shall meet the requirements in the detail specification.

H.3.6.2 Capacitance
When tested as specified in paragraph H.4.4.4.2, the capacitance shall meet the requirements in the detail specification.

H.3.6.3 Dissipation Factor (tan δ)
When tested as specified in paragraph H.4.4.4.3, the dissipation factor (tan δ) shall meet the requirements in the detail specification.

H.3.6.4 Insulating sleeving

H.3.6.4.1 Dielectric Withstainding Voltage
When tested as specified in paragraph H.4.4.4.4.1, there shall be no dielectric breakdown.

H.3.6.4.2 Insulation Resistance
When tested as specified in paragraph H.4.4.4.4.2, the insulation resistance shall be 1,000Ω or greater.

H.3.6.5 Surge Voltage
When tested as specified in paragraph H.4.4.4.5, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.
b) Capacitance
Capacitance change rate from pre-test shall be within ±2%.
c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.
d) Externals
There shall be no evidence of spark discharge, dielectric breakdown, or mechanical damage.

H.3.7 Mechanical Performance
Capacitors shall meet the following requirements.

H.3.7.1 Terminal Strength

H.3.7.1.1 Pull Test
When tested as specified in paragraph H.4.4.5.1.1, the terminals shall not exhibit looseness. There shall be no mechanical damage at the terminals, and welded, soldered, or sealed area of the terminals which will adversely affect the capacitor performance.

H.3.7.1.2 Twist Test
When tested as specified in paragraph H.4.4.5.1.2, the terminals shall not exhibit looseness. There shall be no mechanical damage at the terminals, and welded, soldered, or sealed area of the terminals which will adversely affect the capacitor performance.

H.3.7.2 Solderability
When tested as specified in paragraph H.4.4.5.2, the dipped surface of the terminals shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough shots; these shall not be concentrated in one area.

H.3.7.3 Resistance to Soldering Heat
When tested as specified in paragraph H.4.4.5.3, capacitors shall meet the requirements given below.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.
b) Capacitance
Capacitance change rate from pre-test shall be within ±2%.
c) Dissipation Factor (tan δ)

The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no mechanical damage which will adversely affect the capacitor performance at terminals, and welded, soldered, or sealed area of the terminals.

H.3.8 Environmental Performance

Capacitors shall meet the following requirements.

H.3.8.1 High Frequency Vibraion

When tested as specified in paragraph H.4.4.6.1, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, open-circuiting, spark discharge, dielectric breakdown, or mechanical damage.

H.3.8.2 Random Vibraion

When tested as specified in paragraph H.4.4.6.2, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting or open-circuiting. In addition, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±2%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no evidence of spark discharge, dielectric breakdown, or mechanical damage.

H.3.8.3 Shock

When tested as specified in paragraph H.4.4.6.3, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, open-circuiting, spark discharge, dielectric breakdown, or mechanical damage.

H.3.8.4 Thermal Shock (I)

When tested as specified in paragraph H.4.4.6.4, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 200% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±2%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

d) Dielectric withstanding voltage of insulating sleeving
There shall be no dielectric breakdown.

e) Externals
There shall be no mechanical damage which will adversely affect the capacitor performance.

H.3.8.5 Thermal Shock and Voltage Aging

H.3.8.5.1 Thermal Shock

When tested as specified in paragraph H.4.4.6.5.1, there shall be no mechanical damage which will adversely affect the capacitor performance.

H.3.8.5.2 Voltage Aging

When tested as specified in paragraph H.4.4.6.5.2, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
The capacitance shall be within capacitance tolerance specified in the detail specification.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

H.3.8.6 Thermal Shock and Immersion Cycling

When tested as specified in paragraph H.4.4.6.6, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±3%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no corrosion (1) or mechanical damage and the marking shall remain legible.
Note: (1) The corrosion which will affect mechanical or electrical performance of capacitors.

H.3.8.7 Stability at Low and High Temperatures

When tested as specified in paragraph H.4.4.6.7, capacitors shall meet the following requirements.

a) Step 1 (25°C)
1) Leakage current
The leakage current shall not exceed the value (at 25°C) specified in the detail specification.
2) Capacitance
The capacitance shall be within capacitance tolerance specified in the detail specification.
3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

b) Step 2 (-55°C)

1) Capacitance
The capacitance change rate from step 1 shall be as specified in the detail specification.
2) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at -55°C) specified in the detail specification.

c) Step 3 (25°C)
1) Leakage current
The leakage current shall not exceed the value (at 25°C) specified in the detail specification.
2) Capacitance
Capacitance change rate from step 1 shall be within ±2%.
3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

d) Step 4 (85°C)
1) Leakage current
The leakage current shall not exceed the value (at 85°C) specified in the detail specification.
2) Capacitance
The capacitance change rate from step 1 shall be as specified in the detail specification.
3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the specified value at 85°C in the detail specification.

e) Step 5 (125°C)
1) Leakage current
The leakage current shall not exceed the value (at 125°C) specified in the detail specification.
2) Capacitance
Capacitance change rate from step 1 shall be as specified in the detail specification.
3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 125°C) specified in the detail specification.

f) Step 6 (25°C)
1) Leakage current
The leakage current shall not exceed the value (at 25°C) specified in the detail specification.
2) Capacitance
Capacitance change rate from step 1 shall be within ±2%.
3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

H.3.8.8 Moisture Resistance

When tested as specified in paragraph H.4.4.6.8, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±2%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no corrosion (1) or mechanical damage and the marking shall remain legible.
Note: (1) The corrosion which will affect mechanical or electrical performance of capacitors.

H.3.8.9 Salt Atmosphere

When tested as specified in paragraph H.4.4.6.9, there shall be no corrosion (1), and the finish shall protect at least 90% of any exposed metal surface. There shall be no unwrapping of, or mechanical damage to the insulating sleeving. In addition, the marking shall remain legible.

Note: (1) The corrosion which will affect mechanical or electrical performance of capacitors.

H.3.8.10 Resistance to Solvents

When tested as specified in paragraph H.4.4.6.10, there shall be no unwrapping of, or mechanical damage to the insulating sleeving, and the marking shall remain legible.

H.3.8.11 Seal

When tested as specified in paragraph H.4.4.6.11, there shall be no evidence of air leakage.

H.3.9 Durability Performance

Capacitors shall meet the following requirements.

H.3.9.1 Life (85°C)

When tested as specified in paragraph H.4.4.7.1, capacitors shall meet the following requirements.

a) Leakage current (at 25°C)
The leakage current shall not exceed 200% of the value (at 25°C) specified in the detail specification.

b) Leakage current (at 85°C)
The leakage current shall not exceed the value (at 85°C) specified in the detail specification.

c) Capacitance
Capacitance change rate from pre-test shall be within ±2%.

d) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

e) Dielectric withstanding voltage of insulating sleeving

There shall be no dielectric breakdown.

f) Externals
There shall be no spark discharge, dielectric breakdown, or mechanical damage.

H.3.9.2 Life (125°C)
When tested as specified in paragraph H.4.4.7.2, capacitors shall meet the following requirements.

a) Leakage current (at 25°C)
The leakage current shall not exceed 200% of the value (at 25°C) specified in the detail specification.

b) Leakage current (at 125°C)
The leakage current shall not exceed the value (at 125°C) specified in the detail specification.

c) Capacitance
Capacitance change rate from pre-test shall be within ±2%.

d) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value (at 25°C) specified in the detail specification.

e) Dielectric withstanding voltage of insulating sleeving
There shall be no dielectric breakdown.

f) Externals
There shall be no spark discharge, dielectric breakdown, or mechanical damage.

H.4 QUALITY ASSURANCE PROVISIONS

H.4.1 In-Process Inespction
In-process inspection shall be as specified in paragraph 4.3.

H.4.2 Qualification Test
Qualification test shall be as follows and as specified in paragraph 4.4.

H.4.2.1 Sample
Sample selection for the qualification test shall be as follows and as specified in paragraph 4.4.1.

a) Single voltage group qualification
The manufacturer seeking certification of a single voltage group selected from Table H-4 shall submit 293(1) sample units to represent the maximum rated voltage in the voltage group and the maximum nominal capacitance in the case sizes for which the certification is sought.
When including case sizes smaller than those of sample units to the qualification coverage, two sample units of the highest voltage and the maximum nominal capacitance in the voltage group shall be subjected to group IX of Table H-5 per case sizes. These sample units shall be subjected to groups I and II tests prior to group IX examination.
Note: (1) One of these sample units shall be a replacement sample for an allowable defective for groups III through V tests.

b) Combined-voltage group qualification

The manufacturer seeking certification of combined voltage groups specified in Table H-4 shall submit 147 sample units to represent the minimum rated voltage in the lower voltage group and the maximum nominal capacitance of the case sizes for which the certification is sought, and shall submit 147 sample units to represent the maximum rated voltage in the higher voltage group and the maximum nominal capacitance of the case sizes for which the certification is sought for a total of 294 [(1)] units. The voltage group E5 shall be treated as an independent group and shall not be combined with other groups.

When including the case sizes smaller than those of sample units to the qualification coverage, two sample units per each case size shall be subjected to group IX of Table H-5, one sample unit of the lowest rated voltage and the maximum nominal capacitance in the lower voltage group, and one sample unit of the highest rated voltage and the maximum nominal capacitance in the higher voltage group. These sample units shall be subjected to groups I and II tests prior to group IX examination.

Note: [(1)] One of these sample units shall be a replacement sample for an allowable defective for groups III through V tests.

Table H-4. Voltage Group

(Unit: V_{DC})

Voltage group	Rated voltage range
E1	6 to 10
E2	11 to 20
E3	21 to 35
E4	36 to 50
E5	51 to 100

H.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table H-5. All samples shall be subjected to groups I and II tests before being divided for groups III through XI tests. Tests in group III and subsequent groups may be performed in any order regardless of group number. Tests in each group shall be performed in the order listed.

Table H-5. Qualification Test

Test				Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item				Quantity of samples	Quantity of allowable defectives(1)
I(2)	1	Thermal shock and voltage aging		H.3.8.5	H.4.4.6.5	All samples	0
	2	Seal		H.3.8.11	H.4.4.6.11		
	3	Radiograph		H.3.4.1	H.4.4.3.1		
II(3)	1	Externals, constructions, dimensions, mass and marking(4)		H.3.3	H.4.4.2	All samples	0
III	1	Shock		H.3.8.3	H.4.4.6.3	12	1
	2	High-frequency vibration		H.3.8.1	H.4.4.6.1		
	3	Salt atmosphere		H.3.8.9	H.4.4.6.9		
	4	Thermal shock and immersion cycling		H.3.8.6	H.4.4.6.6		
IV	1	Solderability		H.3.7.2	H.4.4.5.2	12	
	2	Terminal strength	Pull	H.3.7.1.1	H.4.4.5.1.1		
	3		Twist	H.3.7.1.2	H.4.4.5.1.2		
	4	Moisture resistance		H.3.8.8	H.4.4.6.8		
	5	Insulating sleeving	Dielectric withstanding voltage	H.3.6.4.1	H.4.4.4.4.1		
	6		Insulation resistance	H.3.6.4.2	H.4.4.4.4.2		
V	1	Stability at low and high temperatures		H.3.8.7	H.4.4.6.7	12	
	2	Surge voltage		H.3.6.5	H.4.4.4.5		
VI	1	Life (85°C)		H.3.9.1	H.4.4.7.1	190	0
VII	1	Life (125°C)		H.3.9.2	H.4.4.7.2	40	0
VIII	1	Resistance to solvents		H.3.8.10	H.4.4.6.10	6	0
	2	Resistance to soldering heat		H.3.7.3	H.4.4.5.3		
IX	1	DPA		H.3.4.2	H.4.4.3.2	2(5)	0
X	1	Random vibration		H.3.8.2	H.4.4.6.2	6	0
XI	1	Thermal shock (I)		H.3.8.4	H.4.4.6.4	12	0
–	–	Materials		H.3.2	–	(6)	

Notes:
(1) A sample having one or more defects in one group shall be charged as a single defect.
(2) The insulating sleeving shall be wrapped after the seal test is completed.
(3) Non-destructive tests.
(4) For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(5) Additional samples of different case size shall be submitted as needed.
(6) Documents shall be submitted to prove that the samples meet the design specification.

H.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

H.4.3.1 Inspection Items and Sample Size

Inspection items and sample size of quality conformance inspection shall be as specified in Table H-6 for group A, Table H-7 for group B and Table H-8 for group C. Group A inspection shall be performed in the order of subgroup numbers listed in Table H-6. Subgroups of groups B and C inspections may be performed in any order. Inspections in each subgroup shall be performed in the order listed in each table.

H.4.3.2 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in subgroup A2, 100% inspection shall be conducted for the rejected test items and conforming products may be delivered.

Table H-6. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1(1)	1	Thermal shock and voltage aging	H.3.8.5	H.4.4.6.5	All samples	0
	2	Seal	H.3.8.11	H.4.4.6.11		
	3	Radiograph	H.3.4.1	H.4.4.3.1		
A2	1	Externals, constructions, dimensions, mass and marking	H.3.3	H.4.4.2	AQL = 4.0%(2)	
A3	1	DPA	H.3.4.2	H.4.4.3.2	1(3)	0

Notes:
(1) The insulating sleeving shall be wrapped after the seal test is completed.
(2) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(3) One sample with the maximum capacitance shall be inspected per each case size.

Table H-7. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Stability at low and high temperature	H.3.8.7	H.4.4.6.7	12	0
	2	Surge voltage	H.3.6.5	H.4.4.4.5		
B2	1	Resistance to solvents	H.3.8.10	H.4.4.6.10	8	0
	2	Resistance to soldering heat	H.3.7.3	H.4.4.5.3		

Table H-8. Quality Conformance Inspection (Group C)

Inspection				Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item				Quantity of samples	Quantity of allowable defectives
C1	1	Shock		H.3.8.3	H.4.4.6.3	12	0
	2	High-frequency vibration		H.3.8.1	H.4.4.6.1		
	3	Salt atmosphere		H.3.8.9	H.4.4.6.9		
	4	Thermal shock and immersion cycling		H.3.8.6	H.4.4.6.6		
C2	1	Solderability		H.3.7.2	H.4.4.5.2	12	0
	2	Terminal strength	Pull	H.3.7.1.1	H.4.4.5.1.1		
	3		Twist	H.3.7.1.2	H.4.4.5.1.2		
	4	Moisture resistance		H.3.8.8	H.4.4.6.8		
	5	Insulating sleeving	Dielectric withstanding voltage	H.3.6.4.1	H.4.4.4.4.1		
	6		Insulation resistance	H.3.6.4.2	H.4.4.4.4.2		
C3	1	Life (85°C)		H.3.9.1	H.4.4.7.1	12	0
C4	1	Random vibration		H.3.8.2	H.4.4.6.2	6	0
C5	1	Thermal shock (I)		H.3.8.4	H.4.4.6.4	12	0

H.4.4 Methods for Test and Inspection

H.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202 and under the following conditions.

a) Standard conditions

The standard conditions shall be at 25±3°C, between 25 and 75% for relative humidity and between 86 and 106kPa for atmospheric pressure. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions

Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure between 86 and 106kPa.

c) Reference conditions

Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If the reference measurements were made no earlier than 30 days prior to the beginning of the aging test, or are considerable to be affected by measuring jigs, they shall be repeated.

e) Measuring accuracy of test voltage shall be ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be ±3% of the specified test voltage. For measuring leakage current, the fluctuation of power supply voltage shall be within ±100ppm.

H.4.4.2 Externals, Constructions, Dimension, Mass and Marking
Capacitors shall be tested for the externals, constructions, dimensions, mass, and markings as specified in paragraph H.3.3.

H.4.4.3 Workmanship

H.4.4.3.1 Radiograph
Capacitors shall be tested in accordance with test method 209 of MIL-STD-202. The following details and exceptions shall apply.

a) Judgment
The judgment shall be made using negative or positive films.

b) Radiographic quality
The radiographic shall have sufficient definition to determine if the test capacitor meets the requirements specified in paragraph H.3.4.1 and renders a clear sharp image of the penetrameter.

c) Penetrameter
Definition of the penetrameter appropriate for sample shall be specified.

d) Observation
Capacitors shall be inspected visually or with double enlarged image.

e) Direction of radiography
Radiography shall be performed from two directions mutually perpendicular and perpendicular to the axis where the terminals are pulled out.

f) Radiographic condition
The radiographic equipment shall be set to produce the required radiographic specified in item b) aforesaid.

H.4.4.3.2 DPA
DPA shall be conducted in accordance with the DPA manual cited in the Quality Assurance Program Plan to examine the inner construction and to verify that the processes such as welding and soldering are properly implemented by disassembling capacitors.

H.4.4.4 Electrical Performance
Electrical performance tests shall be performed as follows.

H.4.4.4.1 Leakage Current

Capacitors shall be tested under following conditions.

a) Series protective resistance: 1,000Ω.
b) Applied voltage
   The rated voltage shall be applied. If the temperature is designated, the derated voltage specified in the detail specification shall be applied.
c) Duration of application: Up to 5 minutes.

H.4.4.4.2 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Measuring frequency: 120±5Hz.
b) Measuring accuracy: Within ±0.5%.
c) Measuring voltage
   2.2V_{DC} or lower, superimposed with 1V_{AC} rms or a smaller voltage.

H.4.4.4.3 Dissipation Factor (tan δ)

Capacitors shall be tested under following conditions.

a) Measuring frequency: 120±5Hz.
b) Measuring voltage
   2.2V_{DC} or lower, superimposed with 1V_{AC} rms or a smaller voltage.

H.4.4.4.4 Insulating sleeving

H.4.4.4.4.1 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Point of measurement: Between the capacitors case and a V-block.
b) Applied voltage: 2,000V_{DC}.
c) Duration of application: 60±5 seconds.
d) Inspections after test
   Capacitors shall be examined for evidence of dielectric breakdown.

H.4.4.4.4.2 Insulation resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details shall apply.

a) Point of measurement: Between the capacitor case and a V-block
b) Test condition: B (500V_{DC}).
c) Duration of application: 60^{0}_{-15} seconds.
d) Inspections after test: Capacitors shall be rotated on a V-block, and the insulation resistance shall be measured at 5 points.

H.4.4.4.5 Surge Voltage

Capacitors shall be tested under the following conditions:

a) Pre-test measurement
   The capacitance shall be measured as specified in paragraph H.4.4.4.2.
b) Test temperature: 85±5°C.
c) Applied voltage
   The surge voltage specified in Table H-9 shall be applied.

d) Series protective resistance: 33Ω±5%.
e) Charged and discharged condition
The test capacitor shall be charged and discharged through a series protection resistor of 33Ω.
f) Duration and interval of application
30 seconds application and 30 seconds discharge (1 minute interval).
g) Number of cycles: 1,000 cycles.
h) Post-test measurements
After the final cycle completion, the test capacitor shall be stabilized at ambient temperature and humidity for 12 to 24 hours, and the leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.
i) Inspections after test
The capacitance shall be examined for evidence of spark discharge, dielectric breakdown, and mechanical damage.

Table H-9. Surge Voltage

(Unit: V_{DC})

Rated voltage (V_{DC})	Surge voltage
6	8
10	13
15	20
20	26
35	46
50	65
75	98
100	130

H.4.4.5 Mechanical Performance
Mechanical performance tests shall be performed as follows.

H.4.4.5.1 Terminal Strength

H.4.4.5.1.1 Pull Test
Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exceptions shall apply.
a) Test condition: A (pull test).
b) Test terminals: Anode and cathode lead wires.
c) Holding method: The test capacitor shall be secured by the body.
d) Applied force: 13.24N.

e) Inspections after test
The test capacitor shall be visually examined for evidence of loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed portion of the terminals.

H.4.4.5.1.2 Twist Test
Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exception shall apply.
a) Test condition: D (twist test).
b) Test terminals: Anode and cathode lead wires.
c) Number of torsions: 3 times.
d) Inspections after test
The test capacitor shall be visually examined for evidence of loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed portion of the terminals.

H.4.4.5.2 Solderability
Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.
a) Number of test terminals: 2 terminals per sample.
b) Depth of immersion: 1.2 to 3.2mm from the capacitor body.
c) Inspections after test: Solder connections shall be visually examined.

H.4.4.5.3 Resistance to Soldering Heat
Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.
a) Pre-test measurement
The capacitance shall be measured in accordance with paragraph H.4.4.4.2.
b) Test condition: B (260°C), except that the duration of immersion shall be 20±2 secs.
c) Depth of immersion
1) Cathode lead wire: 3.2±0.6mm from the edge of capacitor case.
2) Anode lead wire: 3.2±0.6mm from sealing solder edge.
d) Duration from immersion to measurement: 30 minutes or longer.
e) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.
f) Inspections after test
The test capacitor shall be visually examined for evidence of loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed portion of the terminals.

H.4.4.6 Environmental Performance
Environmental performance tests shall be performed as follows.

H.4.4.6.1 High-Frequency Vibration
Capacitors shall be tested in accordance with test method 204 of MIL-STD-202. The following details and exception shall apply.
a) Mounting method

The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

b) Test condition: D (196m/s^2 p-p or total amplitude of 1.5mm, whichever is smaller).

c) Applied voltage: Rated voltage.

d) Duration and directions of vibration
Four hours in each of two perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis (8 hours in total).

e) Inspections during test
Capacitors shall be examined for evidence of intermittent contact of 0.5ms or greater duration, short-circuiting, and open-circuiting at the last cycle in each direction.

f) Inspections after test
Capacitors shall be examined for evidence of spark discharge, dielectric breakdown, and mechanical damage.

H.4.4.6.2 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

b) Test condition: II-H (20 to 2,000Hz, 334m/s^2 rms).

c) Applied voltage: Rated voltage.

d) Duration and direction of vibration
Three minutes in each of two perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis (6 minutes in total).

e) Inspections during test
Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, short-circuiting and open-circuiting during the test in each direction.

f) Measurements after test
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.

g) Inspections after test
Capacitors shall be examined for evidence of spark discharge, dielectric breakdown, and mechanical damage.

H.4.4.6.3 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

b) Test condition: I (980m/s^2, 6ms, and saw tooth waveform).

c) Applied voltage: Rated voltage.

d) Inspections during test
Capacitors shall be examined for evidence of intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting.

e) Inspections after test
Capacitors shall be examined for evidence of spark discharge, dielectric breakdown, and mechanical damage.

H.4.4.6.4 Thermal Shock (I)
Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: B, except that the number of cycles shall be 1,000, and the temperature shall be -30^{0}_{-3}°C in step 1 and 100^{+3}_{0}°C in step 3.
b) Measurements and inspection
The following measurements and inspection shall be performed before test and at cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$. For group C inspections, the measurements and inspections shall be performed before the test and during $1{,}000^{+10}_{0}$ cycles.
1) Measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.
2) Inspection
Capacitors shall be examined for mechanical damage with a magnifying glass of 10-times magnification.

H.4.4.6.5 Thermal Shock and Voltage Aging

H.4.4.6.5.1 Thermal Shock
Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Test condition: B (at -65 to +125°C for 5 cycles).
b) Inspections after test
The test capacitor shall be visually examined for mechanical damage.

H.4.4.6.5.2 Voltage aging
Capacitors shall be tested under following conditions.

a) Test temperature: 85±5°C.
b) Applied voltage: Rated voltage.
c) Duration of test: Minimum of 168 hours.
d) Series resistance: 3Ω max. including the internal impedance of power supply.
e) Post-test measurements
The test capacitor shall be removed from a test chamber and maintained at ambient temperature and humidity for 12 to 24 hours. Then the leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.

H.4.4.6.6 Thermal Shock and Immersion Cycling

a) Thermal shock
Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.
1) Pre-test measurement
The capacitance shall be measured as specified in paragraph H.4.4.4.2.
2) Test condition: B (at -65 to +125°C for 5 cycles).

b) Immersion cycling
Following the thermal shock above, capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.
1) Test condition: B (2 cycles using saturated saline).
2) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3, within 30 minutes after the final cycle completion.
3) Inspections after test
The test capacitor shall be visually examined for evidence of corrosion and mechanical damage, and for marking legibility.

H.4.4.6.7 Stability at Low and High Temepratures
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in Table H-10. The measurements shall be made after the test capacitor has reached thermal equilibrium, which no further change in capacitance is observed between two successive measurements taken at 15-minute intervals.

Table H-10. Stability at Low and High Temperature

Step	Temperature (°C)	Measuring item	Test method paragraph
1	25±2	Leakage current	H.4.4.4.1
		Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3
2	-55^{0}_{-3}	Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3
3	25±2	Leakage current	H.4.4.4.1
		Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3
4	85^{+3}_{0}	Leakage current	H.4.4.4.1
		Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3
5	125^{+3}_{0}	Leakage current (1)	H.4.4.4.1
		Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3
6	25±2	Leakage current	H.4.4.4.1
		Capacitance	H.4.4.4.2
		Dissipation factor (tan δ)	H.4.4.4.3

Note: (1) Derated voltage specified in Table H-11 shall be applied.

H.4.4.6.8 Moisuture Resistance
Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.
a) Pre-test measurement
The capacitance shall be measured as specified in paragraph H.4.4.4.2.

b) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3, within 2 to 6 hours after the final cycle completion.

c) Inspections after test
The test capacitor shall be visually examined for evidence of corrosion and mechanical damage, and for marking legibility.

H.4.4.6.9 Salt Atmosphere
Capacitors shall be tested in accordance with test method 101 of MIL-STD-202. The following details shall apply.

a) Test method: B (48 hours).
b) Salt solution: 5%.
c) Inspections after test
The test capacitor shall be visually examined for evidence of corrosion and mechanical damage, and for marking legibility.

H.4.4.6.10 Resistance to Solvents
Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. Isopropyl alcohol shall be used as solvent.

H.4.4.6.11 Seal
Capacitors shall be tested in accordance with test method 112 of MIL-STD-202. The following details shall apply.

a) Test method: A or D (bubble test).
b) Post-test treatment
The test capacitor shall be washed with suitable degreasing agent and thoroughly dried at ambient temperature and humidity.

H.4.4.7 Durability Performance
Durability performance tests shall be performed as follows.

H.4.4.7.1 Life (85°C)
Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Measurement before test
The capacitance shall be measured as specified in paragraph H.4.4.4.2.
b) Mounting method
The test capacitor shall be mounted by lead terminals.
c) Test temperature: 85^{+3}_{0} °C.
d) Applied voltage: Rated voltage.
e) Voltage application method
The rated voltage shall be applied gradually (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes). The voltage shall be applied continuously, except for measurement periods.
f) DC power supply

Storage batteries or an electronic power supply, which is capable of supplying at least 1A when a capacitor is shorted out, shall be used.
The impedance of voltage source shall not exceed 3Ω as seen from the terminals of each capacitor.

g) Duration of test
   1) Qualification test: $4{,}000^{+72}_{0}$ hours.
   2) Quality conformance inspection (group C): $2{,}000^{+72}_{0}$ hours.

h) Measurements during test
The leakage current at the test temperature shall be measured as specified in paragraph H.4.4.4.1 at the beginning of the test, and at 240^{+48}_{0}, $1{,}000^{+48}_{0}$, $2{,}000^{+72}_{0}$ and $4{,}000^{+72}_{0}$ hours.

i) Measurements after test
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs H.4.4.4.1, H.4.4.4.2, and H.4.4.4.3.
In addition, the dielectric withstanding voltage of the insulating sleeving shall be tested as specified in paragraph H.4.4.4.4.1.

j) Inspections after test
The test capacitor shall be examined for evidence of spark discharge, dielectric breakdown, and mechanical damage.

H.4.4.7.2 Life (125°C)

Capacitors shall be tested as specified in paragraph H.4.4.7.1 above and under the following conditions.

a) Test temperature: 125^{+3}_{0}°C.
b) Applied voltage: Derated voltage specified in Table H-11.
c) Duration of test: $4{,}000^{+72}_{0}$ hours.

Table H-11. Derated Voltage

(Unit: V_{DC})

Rated voltage (V_{DC})	Derated voltage (125°C)
6	4
10	7
15	10
20	13
35	23
50	33
75	50
100	67

H.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.

a) Leakage current (paragraph H.3.6.1)
b) Capacitance (paragraph H.3.6.2)
c) Dissipation factor (paragraph H.3.6.3)
d) Externals and markings (paragraph H.3.3)

H.4.6 Changes to Tests and Inspections

Change to tests and inspections shall be as specified in paragraph 4.8.

H.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

H.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX J

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPENDIX J

CAPACITORS, FIXED, ELECTROLYTIC (NON-SOLID ELECTROLYTE), TANTALUM

J.1 GENERAL

J.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for tantalum, electrolytic (non-solid electrolyte), fixed capacitors (hereinafter referred to as "capacitors").

J.1.2 Classification

Capacitors shall be classified as specified in Table J-1.

Table J-1. Classification

Structure	Style
Metal case, sleeved, hermetic seal, cylindrical, axial lead	CLS79

J.1.3 Part Number

The part number shall be indicated as follows. Refer to the detail specification for details.

(Example)

NASDA(1) CLS79 B H 117 U P

Style	Characteristic	Rated voltage	Nominal capacitance	Capacitance tolerance	Polarity
(J.1.3.1)	(J.1.3.2)	(J.1.3.3)	(J.1.3.4)	(J.1.3.5)	(J.1.3.6)

Note:(1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

J.1.3.1 Style

The style shall be identified with “CLS”, followed by a two-digit number. “CLS” denotes “high reliability, tantalum, electrolytic (non-solid electrolyte), fixed capacitors” and the following two digits denote capacitor size.

J.1.3.2 Chracteristic

The characteristic shall be identified by a capital letter as specified in Table J-2 indicating the operating temperature range when the rated voltage is applied.

Table J-2. Characteristics

(Unit: °C)

Symbol	Operating temperature range at rated voltage
B	-55 to +85

J.1.3.3 Rated Voltage

The rated voltage shall be identified by a capital letter as specified in Table J-3.

Table J-3. Rated Voltage and Surge Voltage

(Unit: V_{DC})

Symbol	Rated voltage (85°C)	Derated voltage (125°C)	Surge voltage (85°C)	Symbol	Rated voltage (85°C)	Derated voltage (125°C)	Surge voltage (85°C)
A	3	2	3.4	N	100	65	115.0
B	6	4	6.9	O	250	165	287.0
C	8	5	9.2	P	125	85	144.0
D	10	7	11.5	Q	150	100	172.0
E	15	10	17.2	R	180	120	207.0
F	20	13	23.0	S	270	180	310.0
G	25	15	28.8	T	360	240	414.0
H	30	20	34.5	U	450	300	518.0
I	112	75	129.0	V	540	360	621.0
J	50	30	57.5	W	630	420	724.0
K	60	40	69.0	X	300	200	345.0
L	75	50	86.2	Y	375	250	431.0
M	90	60	103.0	Z	225	150	259.0

J.1.3.4 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For example, 175 indicates 1.7μF, 106 indicates 10μF, and 128 indicates 1,200μF.

J.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table J-4.

Table J-4. Capacitance Tolerance

(Unit: %)

Symbol	Capacitance tolerance	Symbol	Capacitance tolerance
J	±5	S	+30 -15
K	±10	T	+50 -15
L	±15	U	+75 -15
M	±20	–	–

J.1.3.6 Polarity

The polarity shall be identified by a single capital letter as specified in Table J-5.

Table J-5. Polarity

Symbol	Polarity
P	Polarized
N	Non-polarized

J.2 APPLICABLE DOCUMENTS

J.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1.

J.2.2 Reference Document

The following document is a referenced document of this appendix.

a) MIL-PRF-39006 Capacitor, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability, General Specification for

J.3 REQUIREMENTS

J.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings, and performance specified in paragraphs J.3.2 to J.3.9. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacture is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

J.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

J.3.2.1 Case

The case shall be of a corrosion-resisting material or shall be plated or treaded to resist corrosion.

J.3.2.2 Insulating Sleeving

Insulating sleeving shall not deform or discolor at the maximum operating temperature of capacitors. Cardboard sleeving shall not be used as an insulator.

J.3.2.3 Solder

Solder shall not melt below 168°C or at a temperature that specified in the detail specification.

J.3.2.4 Soldering Flux

Soldering flux shall be rosin or rosin dissolved in alcohol. Other equivalent anticorrosion flux may be used provided that it satisfies the requirements specified in this specification.
Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area and tin or solder coating on the mechanical connection area that is not intended to create an electrical circuit.
Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.

J.3.3 Externals, Dimension, Mass and Marking

J.3.3.1 Externals and Marking

The surface of capacitor shall not exhibit any cracks, corrosions, strains, or other defects. The following items shall be marked in a manner to ensure legibility.

a) Part number
   As specified in the detail specification.
b) Lot identification code
   Lot identification code shall be assigned as specified by the manufacturer.
c) Polarity
   Marking method for polarity mark shall be as specified in the detail specification.
d) Manufacturer name or abbreviation.

J.3.3.2 Construction, Dimenstion and Mass

Construction, dimension and mass shall be as follows and as specified in the detail specification.

a) Construction
   Capacitors shall be enclosed in a hermetically-sealed metal case which will protect capacitor element from moisture and mechanical damage.
b) Terminal
   Terminals shall be soldered by immersion into molten solder or electroplating.

J.3.4 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.

Capacitors shall not exhibit any cracks, pinholes, flaws, or other defects that will adversely affect the electrical or mechanical performance.

a) Soldering
Soldering shall not be employed to obtain mechanical strength. If soldering to establish electrical connection, it is desirable that the mechanical connection is provided before soldering. Electrical connection shall be certainly established and excessive flux or solder shall be removed after soldering. Whether or not acid or acid salt is used, the post-processing, such as complete neutralization or cleaning, shall be performed immediately after soldering.

b) Finish
The capacitor's finish shall not exhibit any external surface defects such as chip off, cracks, or corrosion.

c) Terminal and sealing area
All terminals and sealing areas shall not exhibit grease or other foreign matter. Lead wires shall not exhibit bend, deformation, or other defects. The terminals shall be securely connected internally and externally to prevent breakage and excessive forces applied to the capacitor element or its case when the lead wires are manipulated.

d) Case
Burrs and barbs on the metal case shall be 0.02mm or less. If an insulator is used, burrs and barbs shall be one-tenth or smaller than the insulator thickness.

e) Insulating sleeving
The insulating sleeving shall fit the case without loose seams or ragged edges. When a shrinkage type is used, the overhang shall not exceed 1.5mm from the capacitor edge. The lead wires and sealing areas shall not exhibit residual adhesive materials such as resin or cement used to cover the insulating sleeving.

f) Solder finishing
There shall be no pinholes or rough areas caused by insufficient heating. Soldering shall be performed with the minimum required amount of flux and solder. Excessive flux shall be removed without damaging the capacitor. No dispersed flux particles, brush bristles, or other foreign objects shall remain inside or on the external surface of the capacitor.
No damage to insulators or loosening of parts shall be caused by the soldering heat.

g) Welding
Welded areas shall not exhibit burning, strain, breakage, non-metal residue, and unwelded areas.

J.3.4.1 DPA

When tested in accordance with paragraph J.4.4.3.1, the processes such as welding and hermetic seal of glass and metal shall be verified to be properly implemented. The materials, inner construction, and anode surface of capacitor element shall be verified to satisfy the requirements specified in the quality assurance program.

J.3.5 Rating

J.3.5.1 Nominal Capacitance and Capacitance Tolerance

The nominal capacitance and capacitance tolerance shall be specified in the detail specification.

J.3.5.2 Operating Tempearture Range

The operating temperature range shall be -55 to +125°C. Unless otherwise specified, the operating temperature range at rated voltage shall be -55 to +85°C. If the ambient temperature exceeds the range, derated voltage specified in the detail specification shall be applied.

J.3.5.3 Rated Voltage

The rated voltage shall be as shown in Table J-3, and shall be specified in the detail specification.

J.3.6 Electrical Performance

Capacitors shall meet the following requirements.

J.3.6.1 Leakage Current

When tested in accordance with paragraph J.4.4.4.1, the leakage current shall meet the requirements in the detail specification.

J.3.6.2 Capacitance

When tested in accordance with paragraph J.4.4.4.2, the capacitance shall meet the requirements in the detail specification.

J.3.6.3 Dissipation Factor (tan δ)

When tested in accordance with paragraph J.4.4.4.3, the dissipation factor (tan δ) shall meet the requirements in the detail specification.

J.3.6.4 Insulating sleeving

J.3.6.4.1 Dielectric Withstainding Voltage

When tested in accordance with paragraph J.4.4.4.5.1, there shall be no dielectric breakdown.

J.3.6.4.2 Insulation Resistance

When tested in accordance with paragraph J.4.4.4.5.2, the insulation resistance shall be 100MΩ or greater.

J.3.6.5 Reverse Voltage

When tested in accordance with paragraph J.4.4.4.6, capacitors shall meet the following requirements.

a) Leakage current

The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be as specified in the detail specification.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

J.3.6.6 Surge Voltage

When tested in accordance with paragraph J.4.4.4.4, there shall be no unstable connections, short-circuiting, or open-circuiting. Capacitors shall exhibit no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.7 Mechanical Performance

Capacitors shall meet the following requirements.

J.3.7.1 Terminal Strength

J.3.7.1.1 Pull Test

When tested in accordance with paragraph J.4.4.5.1.1, the terminals shall not exhibit looseness. There shall be no mechanical damage at the terminals, or welded, soldered, or sealed area of the terminal which will adversely affect the capacitor performances.

J.3.7.1.2 Wire-Lead Bend Test

When tested in accordance with paragraph J.4.4.5.1.2, the terminals shall not exhibit looseness. There shall be no mechanical damage at the terminals, or welded, soldered, or sealed area of the terminals which will adversely affect the capacitor performance.

J.3.7.1.3 Wire-Lead Bend Test at Welded Spot

When tested in accordance with paragraph J.4.4.5.1.3, the terminals shall not exhibit looseness. There shall be no mechanical damage at the terminals, or welded, soldered, or sealed area of the terminals which will adversely affect the capacitor performance.

J.3.7.2 Solderability

When tested in accordance with paragraph J.4.4.5.2, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5 % may contain only small pinholes or rough spots, these shall not be concentrated in one area.

J.3.7.3 Resistance to Soldering Heat

When tested in accordance with paragraph J.4.4.5.3, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)

The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no mechanical damage which will adversely affect capacitors performance at terminals, or welded, soldered, or sealed area of the terminals.

J.3.8 Environmental Performance

Capacitors shall meet the following requirements.

J.3.8.1 High Frequency Vibraion

When tested in accordance with paragraph J.4.4.6.1, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, or open-circuiting. In addition, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 125% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed 115% of the value specified in the detail specification.

d) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.2 Random Vibraion

When tested in accordance with paragraph J.4.4.6.2, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, or open-circuiting. In addition, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 125% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed 115% of the value specified in the detail specification.

d) Equivalent series resistance
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.3 Shock

When tested in accordance with paragraph J.4.4.6.3, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, or open-circuiting. In addition, there shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.4 Thermal Shock (I)

When tested in accordance with paragraph J.4.4.6.4, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 200% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±10%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed 115% of the value specified in the detail specification.

d) Externals
There shall be no evidence of mechanical damage detrimental to capacitor performance or electrolyte leakage.

J.3.8.5 Thermal Shock (II)

When tested in accordance with paragraph J.4.4.6.5, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed 115% of the value specified in the detail specification.

d) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.6 Thermal Shock and Voltage Aging

J.3.8.6.1 Thermal Shock

When tested in accordance with paragraph J.4.4.6.6.1, the capacitance shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 125% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed 115% of the value specified in the detail specification.

d) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.6.2 Voltage Aging

When tested in accordance with paragraph J.4.4.6.6.2, there shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage.

J.3.8.7 Stability at Low and High Temperatures

When tested in accordance with J.4.4.6.7, capacitors shall meet the following requirements.

a) Step 1 (25°C)
   1) Leakage current
      The leakage current shall not exceed the value (at 25°C) specified in the detail specification.
   2) Capacitance
      The capacitance shall be within capacitance tolerance specified in the detail specification.
   3) Dissipation Factor (tan δ)
      The dissipation factor shall not exceed the value specified in the detail specification.

b) Step 2 (-55°C)
   1) Capacitance
      The capacitance change rate from step 1 shall be as specified in the detail specification.
   2) Impedance
      The dissipation factor shall not exceed the value specified in the detail specification.

c) Step 3 (25°C)
   1) Leakage current
      The leakage current shall not exceed the value (at 25°C) specified in the detail specification.
   2) Capacitance
      Capacitance change rate from step 1 shall be within ±5%.
   3) Dissipation Factor (tan δ)
      The dissipation factor shall not exceed the value specified in the detail specification.

d) Step 4 (85°C)
   1) Leakage current
      The leakage current shall not exceed the value (at 85°C) specified in the detail specification.
   2) Capacitance
      The capacitance change rate from step 1 shall be as specified in the detail specification.
   3) Dissipation Factor (tan δ)
      The dissipation factor shall not exceed the value specified in the detail specification.

e) Step 5 (125°C)
   1) Leakage current
      The leakage current shall not exceed the value (at 125°C) specified in the detail specification.
   2) Capacitance
      The capacitance change rate from step 1 shall be as specified in the detail

specification.

3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

f) Step 6 (25°C)

1) Leakage current
The leakage current shall not exceed the value (at 25°C) specified in the detail specification.

2) Capacitance
The capacitance shall be within capacitance tolerance specified in the detail specification.

3) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

J.3.8.8 Low Temperature Storage

When tested in accordance with paragraph J.4.4.6.8, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±5%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no evidence of electrolyte leakage.

J.3.8.9 Moisture Resistance

When tested in accordance with paragraph J.4.4.6.9, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed 125% of the value (at 25°C) specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be as specified in the detail specification.

c) Dissipation Factor (tan δ)
The dissipation factor shall be within 115% of the value specified in the detail specification.

d) Externals
There shall be no evidence of corrosion [(1)], mechanical damage harmful to the capacitor performance, or electrolyte leakage. The marking shall remain legible.
Note: [(1)] The corrosion which will adversely affect mechanical or electrical performance of the capacitor.

J.3.8.10 Salt Atmosphere

When tested in accordance with paragraph J.4.4.6.10, there shall be no corrosion [(1)], and the finish shall protect at least 90% of any exposed metal surface. Corrosion on

the terminal surface shall not exceed 10% of the total terminal surface. The insulating sleeving shall not exhibit signs of unraveling, mechanical damage, or electrolyte leakage. The marking shall remain legible.

Note: (1) The corrosion which will adversely affect mechanical or electrical performance of the capacitor.

J.3.8.11 Barometric Pressure (Reduced)

When tested in accordance with paragraph J.4.4.6.11, capacitors shall have no flashover, deformation of case, mechanical damage harmful to the capacitor performance, or electrolyte leakage. The marking shall remain legible.

J.3.8.12 Resistance to Solvents

When tested in accordance with paragraph J.4.4.6.12, there shall be no unwrapping of, or mechanical damage to the insulating sleeving. The marking shall remain legible.

J.3.8.13 Seal

When tested in accordance with paragraph J.4.4.6.13, capacitors shall be free of air leakage.

J.3.9 Durability Performance

Capacitors shall meet the following requirements.

J.3.9.1 Life (85°C)

When tested in accordance with paragraph J.4.4.7.1, capacitors shall meet the following requirements.

a) Leakage current (at 25°C)
The leakage current shall not exceed the value (at 25°C) specified in the detail specification.

b) Leakage current (at 85°C)
The leakage current shall not exceed the value (at 85°C) specified in the detail specification.

c) Capacitance
Capacitance change rate from pre-test shall be within ±10%.

d) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

e) Insulating sleeving
The insulating sleeving shall meet the requirements in paragraph J.3.6.4.

f) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage. The marking shall remain legible.

J.3.9.2 Life (125°C)

When tested in accordance with paragraph J.4.4.7.2, capacitors shall meet the following requirements.

a) Leakage current (at 25°C)

The leakage current shall not exceed the value (at 25°C) specified in the detail specification.

b) Leakage current (at 125°C)
The leakage current shall not exceed the value (at 125°C) specified in the detail specification.

c) Capacitance
Capacitance change rate from pre-test shall be as specified in the detail specification.

d) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

e) Insulating sleeving
The insulating sleeving shall meet the requirements in paragraph J.3.6.4.

f) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage. The marking shall remain legible.

J.3.9.3 AC Ripple Life

When tested in accordance with paragraph J.4.4.7.3, capacitors shall meet the following requirements.

a) Leakage current
The leakage current shall not exceed the value specified in the detail specification.

b) Capacitance
Capacitance change rate from pre-test shall be within ±10%.

c) Dissipation Factor (tan δ)
The dissipation factor shall not exceed the value specified in the detail specification.

d) Externals
There shall be no evidence of mechanical damage harmful to the capacitor performance or electrolyte leakage. The marking shall remain legible.

J.4 QUALITY ASSURANCE PROVISIONS

J.4.1 In-Process Inespction

In-process inspection shall be as specified in paragraph 4.3.

J.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

J.4.2.1 Sample

a) Individual qualification
The manufacturer shall submit 295 sample units that represent the case size, rated voltage, nominal capacitance, and capacitance tolerance of capacitors to be qualified.

b) Group qualification
For the rated voltage specified in the detail specification to be qualified, the manufacturer shall submit 139 sample units that represent the maximum rated voltage and the maximum nominal capacitance, and shall submit 139 sample units

that represent the minimum rated voltage and the maximum nominal capacitance for a total of 278 units. The manufacturer shall separately submit additional sample units which represent the maximum allowable ripple current 6 sample units for group III tests, 8 sample units for group VI tests, and 3 sample units for group X tests per each case size (See Table J-6.). These samples shall be subjected to group I and II tests before subjected to group III, VI or X tests specified in Table J-6.

J.4.2.2 Test Items and Sample Size

Test items and sample size of the qualification test shall be as specified in Table J-6. All samples shall be subjected to groups I and II tests before being divided for groups III through XII tests. Tests in group III and subsequent groups may be performed in any order regardless of group numbers. Tests in each group shall be performed in the order listed.

Table J-6. Qualification Test

Test				Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item				Quantity of samples	Quantity of allowable defectives[1]
I[2]	1	Voltage aging		J.3.8.6.2	J.4.4.6.6.2	All samples	0
	2	Leakage current		J.3.6.1	J.4.4.4.1		
	3	Capacitance		J.3.6.2	J.4.4.4.2		
	4	Dissipation factor (tan δ)		J.3.6.3	J.4.4.4.3		
	5	Seal		J.3.8.13	J.4.4.6.13		
II[3]	1	Externals, constructions, dimensions, mass and marking[4]		J.3.3	J.4.4.2	All samples	0
III[5]	1	Shock		J.3.8.3	J.4.4.6.3	6[6]	1
	2	High-frequency vibration		J.3.8.1	J.4.4.6.1		
	3	Thermal shock (II)		J.3.8.5	J.4.4.6.5		
	4	Salt atmosphere		J.3.8.10	J.4.4.6.10		
IV	1	Solderability		J.3.7.2	J.4.4.5.2	12	
	2	Terminal strength	Pull	J.3.7.1.1	J.4.4.5.1.1		
	3		Wire-lead bend	J.3.7.1.2	J.4.4.5.1.2		
	4		Wire-lead bend at welded spot	J.3.7.1.3	J.4.4.5.1.3		
	5	Surge voltage		J.3.6.6	J.4.4.4.4		
	6	Moisture resistance		J.3.8.9	J.4.4.6.9		
	7	Insulating sleeving	Dielectric withstanding voltage	J.3.6.4.1	J.4.4.4.5.1		
	8		Insulation resistance	J.3.6.4.2	J.4.4.4.5.2		
	9	Low temperature storage		J.3.8.8	J.4.4.6.8		
	10	Seal		J.3.8.13	J.4.4.6.13		
V	1	Stability at low and high temperature		J.3.8.7	J.4.4.6.7	12	
	2	Reverse voltage		J.3.6.5	J.4.4.4.6		
VI	1	AC ripple life		J.3.9.3	J.4.4.7.3	8[6]	0
VII	1	Life (85°C)		J.3.9.1	J.4.4.7.1	190	0
VIII	1	Life (125°C)		J.3.9.2	J.4.4.7.2	40	0
	2	Barometric pressure (reduced)		J.3.8.11	J.4.4.6.11		
IX	1	Resistance to solvents		J.3.8.12	J.4.4.6.12	6	0
	2	Resistance to soldering heat		J.3.7.3	J.4.4.5.3		
X	1	DPA		J.3.4.1	J.4.4.3.1	3[6]	0
XI	1	Random vibration		J.3.8.2	J.4.4.6.2	6	0
XII	1	Thermal shock (I)		J.3.8.4	J.4.4.6.4	12	0
–	–	Materials		J.3.2	–	[7]	

Notes:
[1] A sample having one or more defects in one group shall be charged as a single defect.
[2] The insulating sleeving shall be wrapped after the seal test is completed.
[3] Non-destructive tests.
[4] For dimension, pass/fail may be judged by 1.0% of acceptance quality level (AQL) based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
[5] The test shall be performed unwrapping the insulating sleeving.
[6] In the case of group qualification, the samples shall be submitted as specified in paragraph J.4.2.1 per each case size.
[7] Documents shall be submitted to prove that the samples meet the design specification.

J.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

J.4.3.1 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table J-7 for group A, Table J-8 for group B, and Table J-9 for group C. Group A inspection shall be performed in the order of subgroup numbers listed in Table J-7. Subgroups of groups B and C inspections may be performed in any order. Inspections in each subgroup shall be performed in the order listed in each table.

J.4.3.2 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in subgroup A2, 100% inspection shall be conducted for the rejected test items and conforming products may be delivered.

Table J-7. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defects
A1(1)	1	Thermal shock	J.3.8.6.1	J.4.4.6.6.1	All samples	0
	2	Voltage aging	J.3.8.6.2	J.4.4.6.6.2		
	3	Leakage current	J.3.6.1	J.4.4.4.1		
	4	Capacitance	J.3.6.2	J.4.4.4.2		
	5	Dissipation factor (tan δ)	J.3.6.3	J.4.4.4.3		
	6	Seal	J.3.8.13	J.4.4.6.13		
A2	1	Externals, constructions, dimensions, mass and marking	J.3.3	J.4.4.2	AQL = 1.0%(2)	
A3	1	DPA(3)	J.3.4.1	J.4.4.3.1	3	0

Notes:
(1) The insulating sleeving shall be wrapped after the seal test is completed.
(2) The acceptance quality level (AQL) is based on a single sampling plan for normal inspection, specified in JIS Z 9015-1, Attachment Table 2-A.
(3) Samples with the maximum allowable ripple current shall be selected per each case size.

Table J-8. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defects
B1	1	Stability at low and high temperature	J.3.8.7	J.4.4.6.7	12	0
	2	Surge voltage	J.3.6.6.	J.4.4.4.4		
B2	1	Resistance to solvents	J.3.8.12	J.4.4.6.12	4	0
	2	Resistance to soldering heat	J.3.7.3	J.4.4.5.3		

Table J-9. Quality Conformance Inspection (Group C)

Inspection				Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item				Quantity of samples	Quantity of allowable defects
C1	1	Shock		J.3.8.3	J.4.4.6.3	12	0
	2	High frequency vibration		J.3.8.1	J.4.4.6.1		
	3	Salt atmosphere		J.3.8.10	J.4.4.6.10		
C2	1	Solderability		J.3.7.2	J.4.4.5.2	12	0
	2	Terminal strength	Pull	J.3.7.1.1	J.4.4.5.1.1		
	3		Wire-lead bend	J.3.7.1.2	J.4.4.5.1.2		
	4		Wire-lead bend at welded spot	J.3.7.1.3	J.4.4.5.1.3		
	5	Moisture resistance		J.3.8.9	J.4.4.6.9		
	6	Insulating sleeving	Dielectric withstanding voltage	J.3.6.4.1	J.4.4.4.5.1		
	7		Insulation resistance	J.3.6.4.2	J.4.4.4.5.2		
C3	1	Low temperature storage		J.3.8.8	J.4.4.6.8	12	0
	2	Seal		J.3.8.13	J.4.4.6.13		
C4	1	Reverse voltage		J.3.6.5	J.4.4.4.6	12	0
C5	1	AC ripple life		J.3.9.3	J.4.4.7.3	12	0
C6	1	Life (85°C)		J.3.9.1	J.4.4.7.1	12	0
C7	1	Barometric pressure (reduced)		J.3.8.11	J.4.4.6.11	12	0
C8	1	Random vibration		J.3.8.2	J.4.4.6.2	6	0
C9	1	Thermal shock (I)		J.3.8.4	J.4.4.6.4	6	0

J.4.4 Methods of Test and Inspection

J.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202 and under the following conditions.

a) Standard conditions
The standard conditions shall be at a temperature of 25±3°C, relative humidity of 25 to 75%, and atmospheric pressure of 86 to 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at 25^{0}_{-2}°C, a relative humidity of 50±2% and an atmospheric pressure of 86 to 106kPa.

c) Reference conditions

Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at 25°C, a relative humidity of 50% and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If reference measurements have been made 30 days prior to the beginning of the aging test, or are considerable to be affected by measuring jigs, they shall be repeated.

e) Measuring accuracy of test voltage shall be ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be ±3% of the specified test voltage. For measuring leakage current, the fluctuation of power supply voltage shall be within ±100ppm.

J.4.4.2 Externals, Constructions, Dimension, Mass, and Marking

Capacitors shall be tested for the externals, constructions, dimensions, mass, and markings as specified in paragraph J.3.3. The mass shall be measured only in the qualification test and group A inspection performed prior to group C inspection.

J.4.4.3 Workmanship

J.4.4.3.1 DPA

DPA shall be conducted by disassembling the test capacitor to examine welding, hermetic seal between the glass and metal, materials, inner construction, and anode surface of the capacitor element. The anode surface shall also be inspected using a scanning electron microscope (SEM).

J.4.4.4 Electrical Performance

Electrical performance tests shall be performed as follows.

J.4.4.4.1 Leakage Current

Capacitors shall be tested under the following conditions.

a) Applied voltage
The rated voltage shall be applied. If the temperature is designated, the derated voltage specified in the detail specification shall be applied.

b) Duration of application
1) Qualification test and quality conformance inspection (groups B and C): 5±0.5 minutes.
2) Quality conformance inspection (group A): Within 5 minutes.

J.4.4.4.2 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Measuring frequency: 120±5Hz.

b) Measuring accuracy: Within ±2%.

c) Measuring voltage: $1V_{AC}$ rms or lower, superimposed with the DC voltage specified in Table J-10.

Table J-10. Superimposed DC Voltage

(Unit: V_{DC})

Style	Rated voltage (V_{DC})	Superimposed DC voltage
CLS79	6 to 75	2^{0}_{-1}
	100 to 125	10^{0}_{-1}

J.4.4.4.3 Dissipation Factor (tan δ)

Capacitors shall be tested with a polarized bridge under the following conditions.

a) Measuring frequency: 120±5Hz.
b) Measuring accuracy: Within ±2%.
c) Measuring voltage: $1V_{AC}$ rms or lower, superimposed with the DC voltage specified in Table J-10.

J.4.4.4.4 Surge Voltage

The surge voltage shall be tested under the following conditions.

a) Test temperature: 85^{+3}_{0}°C.
b) Applied voltage: The surge voltage specified in Table J-3.
c) Series protection resistance: 1,000±100Ω.
d) Charged and discharged condition
   The test capacitor shall be charged and discharged through a series protection resistor (1,000Ω).
e) Duration and interval of application
   0.5 minutes application and 5.5 minutes discharge (6-minute intervals).
f) Number of cycles: 1,000 cycles
g) Inspections during test
   The test capacitor shall be examined for evidence of unstable connection, short-circuiting, and open-circuiting.
h) Measurements after test
   The test capacitor shall be examined for evidence of mechanical damage and electrolyte leakage.

J.4.4.4.5 Insulating sleeving

J.4.4.4.5.1 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Point of measurement: Between the capacitor case and a V-block.
b) Applied voltage: $2,000V_{DC}$.
c) Duration of application: 60±5 seconds.
d) Inspections after test
   Capacitors shall be examined for evidence of dielectric breakdown.

J.4.4.4.5.2 Insulation resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details shall apply.

a) Point of measurement: Between the capacitor case and a V-block.

b) Test condition: B ($500V_{DC}$).
c) Duration of application: 60^{0}_{-15} seconds.
d) Post-test measurements
Capacitors shall be rotated on a V-block, and the insulation resistance shall be measured at 5 points.

J.4.4.4.6 Reverse Voltage

Capacitors shall be tested under the following conditions.

a) Pre-test measurement
The capacitance shall be measured as specified in paragraph J.4.4.4.2.
b) Test temperature: 85^{+3}_{0}°C.
c) Applied voltage and duration of application.
Capacitors shall be subjected to a $3V_{DC}$ applied in the reverse polarity direction for 125±10 hours. Subsequently the rated voltage shall be applied in the forward polarity direction for additional 125±10 hours, and the test capacitor shall be removed from a test chamber.
d) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.

J.4.4.5 Mechanical Performance

Mechanical performance tests shall be performed as follows.

J.4.4.5.1 Terminal Strength

J.4.4.5.1.1 Pull Test

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exceptions shall apply.

a) Test condition: A (pull test).
b) Test terminals: Anode and cathode lead wires.
c) Holding method: The test capacitor shall be secured by the body.
d) Applied force: 14.71N.
e) Duration of application: 30^{+5}_{0} seconds.
f) Inspections after test
The test capacitor shall be visually examined for loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed area of the terminals.

J.4.4.5.1.2 Wire-Lead Bend Test

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details and exceptions shall apply.

a) Test condition: C (wire-lead bend test).
b) Holding method
The test capacitor shall be held at the body so that the axis where the terminals are pulled out shall be perpendicular.
c) Test terminals: As specified in the detail specification.
d) Applied force

Specified force in the detail specification shall be applied to the tip of lead wire.

e) Bending method
The body of test capacitor shall be bent 90° with respect to the lead wire and returned to the starting position. This motion is counted as one bend. The second bend shall be performed in the same manner in the reverse direction.

f) Bending speed: 2 to 3 seconds per bend.

g) Number of bends: 4 times.

h) Inspections after test
The test capacitor shall be visually examined loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed area of the terminals.

J.4.4.5.1.3 Wire-Lead Bend Test at Welded Area

This test shall be performed for capacitors which have terminals welded on the external surface. The following details shall apply.

a) Holding method
The terminals shall be inserted into the hole of test jig till the lower end of welded spot contacts the surface of jig, and a wingnut shall be tightened.

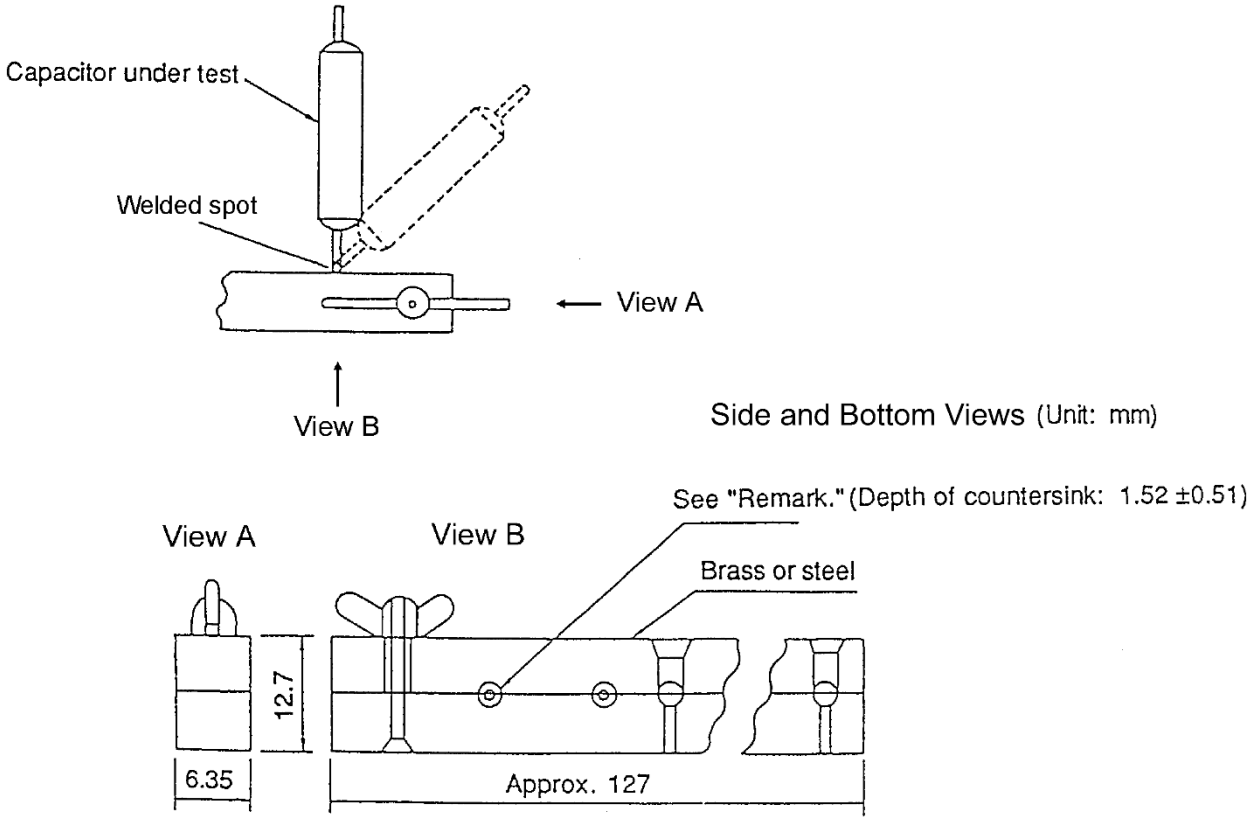
b) Test terminals
Applicable to capacitors which have the lead wires welded on the external surface.

c) Bending method
The lead wire shall be maintained in its axial position while bending the terminal until the end of the case contacts the top surface of the jig. When the lead wire is returned to the starting position, one bend is completed. Then the second bend shall be performed in the same manner but in the reverse direction.

d) Bending speed: Approximately 5 seconds per bend.

e) Number of bends: 4 times.

f) Inspections after test
The test capacitor shall be visually examined for evidence of loosened terminals, and mechanical damage at the terminals and welded, soldered, and sealed portion of the terminals.



Remarks: The hole diameter shall be smaller than the lead diameter by 0.03mm.
The countersink shall be tapered up to a depth of 1.52 ± 0.51mm.

Figure J-1. Wire-Lead Bend Test at Welded Point

J.4.4.5.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: 2 terminals per sample.
b) Depth of immersion: 1.6mm from the welded point.
c) Inspections after test: Solder connections shall be visually examined.

J.4.4.5.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Post-test measurement
The capacitance shall be measured in accordance with paragraph J.4.4.4.2.
b) Test condition: B (at 260±5°C for 10±1 seconds).
c) Depth of immersion: 1.6mm from the welded point
d) Duration from immersion to measurement: 10±1 minutes.
e) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.
f) Inspections after test
The test capacitor shall be visually examined for evidence of mechanical damage at the terminals and welded, soldered, and sealed portion of the terminals.

J.4.4.6 Environmental Performance

Environmental performance tests shall be performed as follows.

J.4.4.6.1 High-Frequency Vibration

Capacitors shall be tested in accordance with test method 204 of MIL-STD-202. The following details and exception shall apply.

a) Mounting method
The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

b) Test condition
D (196m/s^2 p-p or the total amplitude of 1.5mm, whichever is smaller).

c) Applied voltage: Rated voltage.

d) Duration and directions of vibration
Four hours in each of two perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis (8 hours in total).

e) Division of frequency range
The frequency range may be divided into a total amplitude range of 1.5mm and a range to produce 196m/s^2 p-p. The latter may be further divided into two or more ranges.

f) Inspections during test
During the last 30 minutes of vibration in each direction, capacitors shall be examined for intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting.

g) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.

h) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and electrolyte leakage.

J.4.4.6.2 Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Post-test measurement
The capacitance shall be measured in accordance with paragraph J.4.4.4.2.

b) Mounting method
The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

c) Test condition
Test condition II-H (20 to 2,000Hz, 334m/s^2 rms).

d) Applied voltage: Rated voltage.

e) Duration and directions of vibration
Three minutes in each of two perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis (6 minutes in total).

f) Inspections during test
Capacitors shall be examined for intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting during the test in each direction.

g) Measurements after test
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.

h) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and electrolyte leakage.

J.4.4.6.3 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor shall be secured by the body and lead terminals at the point of approximately 10mm from the body.

b) Test condition: I (980m/s^2, 6ms and saw tooth waveform).

c) Applied voltage: Rated voltage.

d) Inspections during test
Capacitors shall be examined for intermittent contacts of 0.5ms or greater duration, short-circuiting, and open-circuiting.

e) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and electrolyte leakage.

J.4.4.6.4 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Conditioning prior to first cycle
Capacitors shall be maintained at normal temperature and humidity for 15 minutes.

b) Test condition: B, except that the number of cycles shall be 1,000, and the temperature shall be -30^{0}_{-3} °C in step 1 and 100^{+3}_{0} °C in step 3.

c) Measurements and inspection
The following measurements and inspections shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and 1000^{+10}_{0}. For Group C inspection of the quality conformance inspection, the measurements shall be made before the first cycle and during cycles of $1{,}000^{+10}_{0}$.

1) Measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.

2) Inspections
Capacitors shall be visually examined for mechanical damage, and for electrolyte leakage with Thymol blue or other suitable chemical indicator solution.
If appropriate chemical indicator solutions are not available, the electrolyte leakage shall be examined under test condition A specified in paragraph J.4.4.6.13 after examined the external surface using a 10x magnifier.

J.4.4.6.5 Thermal Shock (II)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Conditioning prior to first cycle
Capacitors shall be maintained at a normal temperature for 15 minutes.
b) Pre-test measurement
The capacitance shall be measured as specified in paragraph J.4.4.4.2.
c) Test condition: A, except that the number of cycles shall be 300, and the temperature shall be 125^{+4}_{0}°C in step 3.
d) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.
e) Inspections after test
Capacitors shall be visually examined for mechanical damage, and for electrolyte leakage with Thymol blue or other suitable chemical indicator solution.
If appropriate chemical indicator solutions are not available, the electrolyte leakage shall be examined under test condition A specified in paragraph J.4.4.6.13 after examined the external surface using a 10x magnifier.

J.4.4.6.6 Thermal Shock and Voltage Aging

J.4.4.6.6.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202 and the following details and exceptions shall apply. This test shall not be applied for the qualification test.

a) Conditioning prior to first cycle
Capacitors shall be maintained at normal temperature for 15 minutes.
b) Pre-test measurement
The capacitance shall be measured as specified in paragraph J.4.4.4.2.
c) Test condition: A, except that the number of cycles shall be 30, and the temperature shall be 125^{+4}_{0}°C in step 3.
d) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.
e) Inspections after test
Capacitors shall be visually examined for mechanical damage, and for electrolyte leakage with Thymol blue or other suitable chemical indicator solution.
If appropriate chemical indicator solutions are not available, the electrolyte leakage shall be examined under test condition A specified in paragraph J.4.4.6.13 after examined the external surface using a 10x magnifier.

J.4.4.6.6.2 Voltage aging

Capacitors shall be tested under the following conditions.

a) Test temperature: 85^{+3}_{0}°C.
b) Applied voltage: Rated voltage.
c) Duration of test: 168^{+5}_{0} hours.
d) Series resistance: 1,000±100Ω.
e) Inspections after test
Capacitors shall be visually examined for evidence of mechanical damage and electrolyte leakage.

J.4.4.6.7 Stability at Low and High Temeprature

The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in Table J-11. The measurements shall be made after the test capacitor has reached thermal equilibrium, which is defined when no further change in capacitance is observed between two successive measurements taken at 15-minute intervals. In addition, the impedance at step 2 shall be measured under the following conditions.

a) Conditioning before measurement
   Capacitors shall be maintained at -55^{0}_{-3}°C for 30 minutes or longer.
b) Measuring circuit: Bridge or other appropriate circuit.
c) Measuring frequency: 120±5Hz.
d) Measuring accuracy: Within ±5%.

Table J-11. Stability at Low and High Temperature

Step	Temperature (°C)	Measuring item	Test method paragraph
1	25±2	Leakage current	J.4.4.4.1
		Capacitance	J.4.4.4.2
		Dissipation factor (tan δ)	J.4.4.4.3
2	-55^{0}_{-3}	Impedance	J.4.4.6.7
		Capacitance	J.4.4.4.2
3	25±2	Leakage current	J.4.4.4.1
		Capacitance	J.4.4.4.2
		Dissipation factor (tan δ)	J.4.4.4.3
4	85^{+3}_{0}	Leakage current	J.4.4.4.1
		Capacitance	J.4.4.4.2
		Dissipation factor (tan δ)	J.4.4.4.3
5	125^{+3}_{0}	Leakage current(1)	J.4.4.4.1
		Capacitance	J.4.4.4.2
		Dissipation factor (tan δ)	J.4.4.4.3
6	25±2	Leakage current	J.4.4.4.1
		Capacitance	J.4.4.4.2
		Dissipation factor (tan δ)	J.4.4.4.3

Note: (1) Derated voltage specified in Table J-3 shall be applied.

J.4.4.6.8 Low Temeprature Storage

Capacitors shall be tested in accordance with test method 502 of MIL-STD-810. The following details shall apply.

a) Pre-test measurement
   The capacitance shall be measured as specified in paragraph J.4.4.4.2.
b) Storage temperature: -62^{0}_{-3}°C.
c) Duration of storage: 72±4 hours.
d) Post-storage conditioning

The test capacitor shall be maintained at 125^{+4}_{0}°C for one hour within 24 hours after the storage completion.

e) Post-test measurements
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.

f) Inspections after test
Capacitors shall be examined for electrolyte leakage with Thymol blue or other suitable chemical indicator solutions.
If appropriate chemical indicator solutions are not available, the electrolyte leakage shall be examined under test condition A specified in paragraph J.4.4.6.13 after examined the external surface using a 10x magnifier.

J.4.4.6.9 Moisture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Mounting method
The test capacitor may be secured by the body except for the time of measurements.

b) Measurement before test
The capacitance shall be measured as specified in paragraph J.4.4.4.2.

c) Loading during test: $6V_{DC}$.

d) Measurements after test
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3 within 2 to 6 hours after the final cycle completion [(1)].
Note: [(1)] The test capacitor may be removed from a test chamber within 8 hours after step 6 of the final cycle is completed.

e) Inspections after test
The test capacitor shall be visually examined for corrosion, mechanical damage, electrolyte leakage, and marking legibility.

J.4.4.6.10 Salt Atmosphere

Capacitors shall be tested in accordance with test method 101 of MIL-STD-202. The following details shall apply.

a) Test method: B (48 hours).

b) Inspections after test
The test capacitor shall be removed from a test chamber and cleaned. After drying at normal temperature for 24 hours, the test capacitor shall be visually examined for corrosion, mechanical damage, electrolyte leakage, and marking legibility.

J.4.4.6.11 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Test condition: E (0.15kPa, 45,720m).

b) Applied voltage: Rated voltage.

c) Duration of application: 60±5 seconds.

d) Duration of exposure after test: 5 minutes minimum.

e) Measurements after test

The test capacitor shall be visually examined for flashover, deformation of the case, mechanical damage, electrolyte leakage, and marking legibility.

J.4.4.6.12 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. Isopropyl alcohol shall be used as solvent.

J.4.4.6.13 Seal

Capacitors shall be tested in accordance with test method 112 of MIL-STD-202 with the insulating sleeving unwrapped. The following details shall apply.

a) Test conditions
   1) Qualification test (group I): A (bubble test).
   2) Qualification test (group IV):
      C-III (tracer gas test, 10^{-9}Pa·m^3/s) and A (bubble test).
   3) Quality conformance inspection (group A):
      C-III (tracer gas test, 10^{-9}Pa·m^3/s) and A (bubble test).

J.4.4.7 Durability Performance

Durability performance tests shall be performed as follows.

J.4.4.7.1 Life (85°C)

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Measurement before test
   The capacitance shall be measured as specified in paragraph J.4.4.4.2.
b) Test temperature: 85^{+3}_{0}°C.
c) Applied voltage: Rated voltage
d) Voltage application method
   DC rated voltage shall be applied gradually (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes). The voltage shall be continuously applied except for measurement periods.
e) DC power supply
   Storage batteries or an electronic power supply, which is capable of supplying at least 100mA when a capacitor is shorted out, shall be used. The impedance of voltage source shall not exceed 10Ω as seen from the terminals of each capacitor.
f) Duration of test
   1) Qualification test: $4{,}000^{+72}_{0}$ hours.
   2) Quality conformance inspection (Group C): $2{,}000^{+72}_{0}$ hours.
g) Measurements during test
   The leakage current at the test temperature shall be measured as specified in paragraph J.4.4.4.1 at beginning of the test, and at 240^{+48}_{0}, $1{,}000^{+48}_{0}$, $2{,}000^{+72}_{0}$, and $4{,}000^{+72}_{0}$ hours.
h) Measurements after test
   The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3. The

insulating sleeving test shall also be performed as specified in paragraph J.4.4.4.5.

i) Inspections after test
The test capacitor shall be visually examined for mechanical damage, electrolyte leakage, and marking legibility.

J.4.4.7.2 Life (125°C)

Capacitors shall be tested as specified in paragraph J.4.4.7.1 above. The following exceptions shall apply.

a) Test temperature: 125^{+3}_{0}°C.
b) Applied voltage: Derated voltage specified in Table J-3.
c) Duration of test: $4{,}000^{+72}_{0}$ hours.

J.4.4.7.3 AC Ripple Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Measurement before test
The capacitance shall be measured as specified in paragraph J.4.4.4.2.
b) Test temperature: 85^{+3}_{0}°C.
c) Applied voltage: 66.67% of the rated voltage.
d) Voltage application method
The specified voltage shall be applied gradually (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes).
e) DC power supply
Storage batteries or an electronic power supply, which is capable of supplying at least 100mA when a capacitor is shorted out, shall be used. The impedance of voltage source shall not exceed 10Ω as seen from the terminals of each capacitor.
f) Ripple current
After applying the voltage as aforesaid, the maximum ripple current specified in the detail specification shall be applied.
g) Duration of test: $2{,}000^{+72}_{0}$ hours.
h) Measurements after test
The leakage current, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs J.4.4.4.1, J.4.4.4.2, and J.4.4.4.3.
i) Inspections after test:
The test capacitor shall be visually examined for mechanical damage, electrolyte leakage, and marking legibility.

J.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items in the order shown.

a) Leakage current (paragraph J.3.6.1)
b) Capacitance (paragraph J.3.6.2)
c) Dissipation factor (paragraph J.3.6.3)
d) Externals and markings (paragraph J.3.3)

J.4.6 Changes to Tests and Inspections

Changes to tests and inspections shall be as specified in paragraph 4.8.

J.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

J.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX K

CAPACITORS, CHIP, SOLID, ELECTROLYTIC, TANTALUM

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

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APPNEDIX K

CAPACITORS, CHIP, SOLID, ELECTROLYTIC, TANTALUM

K.1 GENERAL

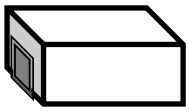
K.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for tantalum, electrolytic, solid, chip capacitors (hereinafter referred to as "capacitors").

K.1.2 Classification

Capacitors shall be classified as specified in Table K-1.

Table K-1. Classification

Structure	Shape	Style
Rectangular resin molded, metal terminal		CWS11

K.1.3 Part Number

The part number shall be indicated as follows. Refer to the detail specification for details.
(Example)

JAXA([1]) CWS11 C H 335 K

CWS11	C	H	335	K
Style (K.1.3.1)	Voltage (K.1.3.2)	Terminal finish (K.1.3.3)	Nominal capacitance (K.1.3.4)	Capacitance tolerance (K.1.3.5)

Note: [(1)] "JAXA" indicates the part is for space use and may be abbreviated “J”.

K.1.3.1 Style

The style shall be identified with “CWS”, followed by two-digit number. “CWS” denotes “high reliability, tantalum, electrolytic, solid, chip capacitors” and the following two digits denote capacitor structure and shape.

K.1.3.2 Voltage

The rated voltage, derated voltage and surge voltage shall be identified by a single capital letter as specified in Table K-2.

Table K-2. Rated Voltage, Derated Voltage and Surge Voltage

(Unit: V_{DC})

Symbol	Rated voltage (+85°C)	Derated voltage (+125°C)	Surge voltage (+85°C)
A	02	01.3	02.7
B	03	02.0	04.0
C	04	02.7	05.2
D	06	04.0	08.0
E	08	05.3	10.7
F	10	06.7	13.0
G	12	08.0	16.0
H	15	10.0	20.0
J	20	13.3	26.0
K	25	16.7	32.5
L	30	20.0	40.0
M	35	23.3	46.0
N	50	33.3	65.0

K.1.3.3 Terminal Finish

The terminal finish shall be identified by a single capital letter as specified in Table K-3.

Table K-3. Terminal Finish

Symbol	Terminal finish
H	Solder plate including a minimum of 4wt% Pb

K.1.3.4 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zero to follow. For example, 104 indicates 0.10μF, 105 indicates 1.0μF, and 107 indicates 100μF.

K.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table K-4.

Table K-4. Capacitance Tolerance

(Unit: %)

Symbol	Capacitance tolerance
J	± 5
K	±10
M	±20

K.2 APPLICABLE DOCUMENTS

K.2.1 Applicable Documents

Applicable documents for this appendix shall be as specified in paragraph 2.1 and as follows

a) ANSI/J-STD-005 Requirements for Soldering Pastes
b) JIS Z 3284 Solder pastes

K.2.2 Reference Documents

The following documents are the referenced documents of this appendix.

a) MIL-PRF-55365J Capacitor, Fixed, Electrolytic (Tantalum), Chip, Established Reliability, None-established Reliability, and High Reliability, General Specification for
b) ESCC Generic Specification No.3012, ISSUE 4
Capacitor, Leadless Surface Mounted, Tantalum, Solid Electrolyte, Enclosed Anode Connection
c) JIS C 5101-3 Fixed Capacitors for Use in Electronic Equipment- Part 3: Sectional Specification-Surface Mount Fixed Tantalum Electrolytic Capacitors with MnO_2 Solid Electrolyte

K.3 REQUIREMENTS

K.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs K.3.2 to K.3.9. The qualification coverage shall be represented by samples that have passed the qualification test. Within this coverage, the manufacture is allowed to supply qualified products in accordance with the detail specification. If necessary, additional qualification coverage shall be specified in the detail specification.

K.3.1.1 Limitation for Qualification

The nominal capacitance to be qualified shall be the same or lower than the nominal capacitance of the capacitor provided for qualification test. The qualification coverage for capacitance tolerance shall be specified in Table K-5. The rated voltage to be qualified shall limit to the rated voltage range of the capacitor provided for qualification test.

Table K-5. Capacitance Tolerance to be qualified

Capacitance tolerance of sample	Capacitance tolerance to be qualified
J	J, K, M
K	K, M
M	M

K.3.2 Materials

The materials used for capacitor shall be in accordance with paragraph 3.3 and as follows.

K.3.2.1 Solder

Solder shall not melt at 168°C or below or at a temperature specified in the detail specification.

K.3.2.2 Soldering Flux

Soldering flux shall be rosin or rosin dissolved in alcohol. Other equivalent anticorrosion flux may be used when it satisfies the requirements specified in this specification.
Acid or acid salt shall not be used except for pre-tin-coating on the electrical connection area and for tin or solder coating on the mechanical connection area that is not intended to create an electrical circuit.
Acid or acid salt shall not be used near insulating materials unless it is thoroughly removed after soldering.

K.3.3 Externals, Dimension, Mass and Marking

K.3.3.1 Externals and Marking

The surface of capacitor shall not exhibit cracks, corrosions, strains, or other defects.
The following items shall be marked in a manner to ensure legibility. Marking details shall be specified in detail specification.

a) Rated voltage
b) Nominal capacitance
c) Polarity

K.3.3.2 Construction, Dimenstion and Mass

Construction, dimension and mass of the capacitor shall be as follows and as specified in the detail specification.

a) Construction
   Capacitors shall be molded by resin to protect capacitor elements from moisture and mechanical damage.
b) Terminals
   All terminals shall be free of any foreign object which interferes with soldering.

K.3.4 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.
Capacitors shall not exhibit any cracks, pinholes, flaws, or other defects that will adversely affect the electrical or mechanical performance.

a) Finish
   The capacitor’s finish shall not exhibit any external surface defects such as scars, cracks, or corrosion.
b) Welding
   Welded areas shall be free of burning, strain, breakage, non-metal residue, and unwelded areas.

K.3.4.1 Radiographic Inspection

When inspected as specified in paragraph K.4.4.4.1, the capacitors shall meet the following requirements.

a) 25% or more cathodes shall be connected to the external leads with silver epoxy resin which cannot have any detachments or cracks.
b) Position gap between tantalum wire and lead terminal due to welding shall be within 15 degrees.
c) Tantalum wire shall be embedded entirely in molded resin.
d) The case shall not have any cracks or chips.
e) The external leads shall not have any stress cracks.

K.3.4.2 DPA

When tested as specified in paragraph K.4.4.4.2, the processes such as welding or bonding shall be verified to be properly implemented.
The inner construction and materials shall be verified to meet the requirements specified in the quality assurance program.

K.3.5 Rating

K.3.5.1 Nominal Capacitance and Capacitance Tolerance

Unless otherwise specified, the preferred number series E6 shall be used as the nominal capacitance values in relation to the capacitance tolerance. The specified values shall be specified in the detail specification.

K.3.5.2 Operating Tempearture Range

The operating temperature range shall be -55 to +125°C. Unless otherwise specified, the operating temperature range at rated voltage shall be -55 to +85°C. If the ambient temperature exceeds this range, derated voltage shall be applied as specified in the detail specification.

K.3.5.3 Rated Voltage

The rated voltage shall be specified in the detail specification within the range as specified in Table K-2.

K.3.6 Electrical Performance

Capacitor shall meet the following requirements.

K.3.6.1 Votalge Aging

When tested as specified in paragraph K.4.4.5.1, the capacitors shall meet the following requirements.
a) Leakage current: Requirements in paragraph K.3.6.2 shall be met.
b) Capacitance: Requirements in paragraph K.3.6.3 shall be met.
c) Dissipation factor (tan δ): Requirements in paragraph K.3.6.4 shall be met.
d) Equivalent series resistance (if specified): Requirements in paragraph K.3.6.5 shall be met.
e) External: Capacitors shall not have any mechanical damages.

K.3.6.2 Leakage Current

When tested as specified in paragraph K.4.4.5.2, the leakage current shall meet the requirements in the detail specification.

K.3.6.3 Capacitance

When tested as specified in paragraph K.4.4.5.3, the capacitance shall be within the specified capacitance tolerance.

K.3.6.4 Dissipation Factor (tan δ)

When tested as specified in paragraph K.4.4.5.4, the dissipation factor (tan δ) shall meet the requirements in the detail specification.

K.3.6.5 Equivalent Series Resistance (if specified)

When tested as specified in paragraph K.4.4.5.5 the equivalent series resistance shall meet the requirements in the detail specification.

K.3.6.6 Surge Voltage

When tested as specified in paragraph K.4.4.5.6, the capacitor shall meet the following requirements.

a) Leakage current: Not exceeding the value specified in the detail specification.
b) Capacitance change rate from pre-test: Within ±5%.
c) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
d) Equivalent series resistance: Not exceeding the value specified in the detail specification.

K.3.6.7 Surge Current

When tested as specified in paragraph K.4.4.5.7, the capacitor shall meet the following requirements.

a) Leakage current: Requirements in paragraph K.3.6.2 shall be met.
b) Capacitance: Requirements in paragraph K.3.6.3 shall be met.
c) Dissipation factor (tan δ): Requirements in paragraph K.3.6.4 shall be met.
d) Equivalent series resistance (if specified): Requirements in paragraph K.3.6.5 shall be met.
e) External: Capacitors shall not have any mechanical damages.

K.3.7 Mechanical Performance

Capacitors shall meet the following requirements.

K.3.7.1 Body Strength

When tested as specified in paragraph K.4.4.6.1, there shall be no intermittent contacts of 0.5ms or greater duration, short-circuiting, or open-circuiting. The capacitor shall not have any defects such as cracks, chipping, crazing and detachment.

K.3.7.2 Detach Strength

When tested as specified in paragraph K.4.4.6.2, capacitor shall not have any defects such as cracks, chipping, crazing and detachment in the soldered area.

K.3.7.3 Substrate Bending

When tested as specified in paragraph K.4.4.6.3, the capacitor shall meet the following requirements.

a) Capacitance change rate from pre-test: Within ±2%
b) External: Capacitor shall not have any defects such as cracks, chipping, crazing and detachment.

K.3.7.4 Shear

When tested as specified in paragraph K.4.4.6.4, capacitor shall not have any defects such as cracks, chipping, crazing and detachment in the soldered area.

K.3.7.5 Solderability

When tested as specified in paragraph K.4.4.6.5, at least 95% of the surface of the terminals shall be covered with a new, smooth, solder coating. The remaining surface may contain only small pinholes or rough areas without solder but they shall not be concentrated in one area. Such surface shall be less than 5% of entire terminal surface.

K.3.7.6 Resistance to Soldering Heat

When tested as specified in paragraph K.4.4.6.6, capacitor shall meet the following requirements.

a) Leakage current: Not exceeding the value specified in the detail specification.
b) Capacitance change rate from pre-test: Within ±5%
c) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
d) External: Capacitors shall not have any mechanical damages.

K.3.8 Environmental Performance

The capacitor shall meet the following requirements.

K.3.8.1 High Frequency Vibraion

Deleted.

K.3.8.2 Random Vibraion

Deleted.

K.3.8.3 Shock

Deleted.

K.3.8.4 Reflow Conditioning

When tested as specified in paragraph K.4.4.7.4, capacitor shall not have any mechanical damages.

K.3.8.5 Thermal Shock

When tested as specified in paragraph K.4.4.7.5, capacitor shall not have any mechanical damages.

K.3.8.6 Thermal Shock (I)

When tested as specified in paragraph K.4.4.7.6, capacitors shall meet the following requirements.

a) Leakage current: Not exceeding the value specified in the detail specification.

b) Capacitance change rate from pre-test: Within ±5%.
c) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
d) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.
e) External:
There shall be no corrosion, which will adversely affect mechanical or electrical performance of the capacitor, or mechanical damage and the marking shall remain legible.

K.3.8.7 Thermal Shock (II)

When tested as specified in paragraph K.4.4.7.7, capacitors shall meet the following requirements.

a) Leakage current: Not exceeding 125% of the value specified in the detail specification.
b) Capacitance change rate from pre-test: Within ±5%.
c) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
d) Equivalent series resistance (if specified): Not exceeding 125% of the value specified in the detail specification.
e) External:
There shall be no mechanical damage which will adversely affect the capacitor performance, and the marking shall remain legible.

K.3.8.8 Stability at Low and High Temperatures

When tested as specified in paragraph K.4.4.7.8, capacitors shall meet the following requirements.

a) Step 1 (+25°C)
    1) Leakage current: Not exceeding the value specified in the detail specification.
    2) Capacitance: Within capacitance tolerance specified in the detail specification.
    3) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
    4) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.
b) Step 2 (-55°C)
    1) Capacitance change rate from step 1: Between -10% min and +0% max.
    2) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
c) Step 3 (+25°C)
    1) Leakage current: Not exceeding the value specified in the detail specification.
    2) Capacitance change rate from step 1: Within ±2%
    3) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
d) Step 4 (+85°C)
    1) Leakage current: Not exceeding the value specified in the detail specification.
    2) Capacitance change rate from step 1: Between -0% min and +10% max.

3) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.

e) Step 5 (+125°C)
   1) Leakage current: Not exceeding the value specified in the detail specification.
   2) Capacitance change rate from step 1: Between -0% min and +15% max.
   3) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.

f) Step 6 (+25°C)
   1) Leakage current: Not exceeding the value specified in the detail specification.
   2) Capacitance change rate from step 1: Within ±2%
   3) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.
   4) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.

K.3.8.9 Moisture Resistance

When tested as specified in paragraph K.4.4.7.9, capacitors shall meet the following requirements.

a) Leakage current: Not exceeding 200% of the value specified in the detail specification.
b) Capacitance change rate from pre-test: Within ±15%.
c) Dissipation Factor (tan δ): Not exceeding 150% of the value specified in the detail specification.
d) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.
e) External:
   There shall be no corrosion, which will adversely affect mechanical or electrical performance of the capacitor, or mechanical damage and the marking shall remain legible.

K.3.8.10 Resistance to Solvents

When tested as specified in paragraph K.4.4.7.10, the marking shall remain legible. This requirement applies only to capacitors marked with ink.

K.3.9 Durability Performance

Capacitors shall meet the following requirements.

K.3.9.1 Life (+85°C)

When tested as specified in paragraph K.4.4.8.1, capacitors shall meet the following requirements.

a) Leakage current (at +25°C): Not exceeding the value specified in the detail specification.
b) Leakage current (at +85°C): Not exceeding the value specified in the detail specification.
c) Capacitance change rate from pre-test: Within ±10%.
d) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.

e) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.

f) External:
There shall be no corrosion, which will adversely affect mechanical or electrical performance of the capacitor, or mechanical damage and the marking shall remain legible. There shall not be any short-circuiting or open-circuiting either intermittently or permanently.

K.3.9.2 Life (+125°C)

When tested as specified in paragraph K.4.4.8.2, capacitors shall meet the following requirements.

a) Leakage current (at +25°C): Not exceeding the value specified in the detail specification.

b) Leakage current (at +125°C): Not exceeding the value specified in the detail specification.

c) Capacitance change rate from pre-test: Within ±10%.

d) Dissipation Factor (tan δ): Not exceeding the value specified in the detail specification.

e) Equivalent series resistance (if specified): Not exceeding the value specified in the detail specification.

f) Externals
There shall be no corrosion, which will adversely affect mechanical or electrical performance of the capacitor, or mechanical damage and the marking shall remain legible. There shall not be any short-circuiting or open-circuiting either intermittently or permanently.

K.4 QUALITY ASSURANCE PROVISIONS

K.4.1 In-Process Inspection

In-process inspection shall be as specified in paragraph 4.3.

K.4.2 Qualification Test

Qualification test shall be in accordance with paragraph 4.4 and as follows.

K.4.2.1 Sample

Sample selection for the qualification test shall be in accordance with paragraph 4.4.1 and as follows.

a) Individual qualification
The manufacturer shall provide with 335 sample units that represent the maximum nominal capacitance for each rated voltage of the capacitor style to be qualified. The capacitance tolerance of the sample shall be selected in consideration of Table K-5.

b) Group qualification
For the minimum and maximum rated voltages to be qualified, the manufacturer shall submit sample units to represent the maximum nominal capacitance for maximum case size and minimum case size. In addition, the capacitance tolerance of the sample shall be selected in consideration of Table K-5.

K.4.2.2 Test Items and Sample Size

Test items and sample size for the qualification test shall be as specified in Table K-6. For group qualification, samples shall be split equally to each group so that the number of the sample units in each group would be at least the specified quantity. After samples are tested for group I and group II tests in this order, they are divided for group III through XV tests. Tests in group III and subsequent groups may be performed in any order regardless of group number. Tests in each group shall be performed in the order listed.

Table K-6. Qualification Test

Test			Requirement Paragraph	Test method Paragraph	Pass/fail	
Group	Order	Item			Quantity of samples	Quantity of allowable defectives
I	1	Reflow conditioning	K.3.8.4	K.4.4.7.4	All samples(2)	0
	2	Thermal Shock	K.3.8.5	K.4.4.7.5		
	3	Surge current(1)	K.3.6.7	K.4.4.5.7		
	4	Voltage aging	K.3.6.1	K.4.4.5.1		
	5	Leakage current	K.3.6.2	K.4.4.5.2		
	6	Capacitance	K.3.6.3	K.4.4.5.3		
	7	Dissipation factor (tan δ)	K.3.6.4	K.4.4.5.4		
	8	Equivalent series resistance	K.3.6.5	K.4.4.5.5		
	9	Externals, constructions, dimensions, mass and marking	K.3.3	K.4.4.3		
II	1	Radiographic inspection	K.3.4.1	K.4.4.4.1	All samples	0
	2	DPA	K.3.4.2	K.4.4.4.2	3(3)	0
III	1	Deleted	-	-	12	0
	2	Thermal shock (I)(5)	K.3.8.6	K.4.4.7.6		
IV	1	Resistance to soldering heat	K.3.7.6	K.4.4.6.6	18	0
	2	Detach strength	K.3.7.2	K.4.4.6.2		
	3	Moisture resistance	K.3.8.9	K.4.4.7.9		
V	1	Stability at low and high temperatures	K.3.8.8	K.4.4.7.8	12	0
	2	Surge voltage	K.3.6.6	K.4.4.5.6		
VI	1	Life (+125°C)	K.3.9.2	K.4.4.8.2	24	0
VII	1	Life (+85°C)	K.3.9.1	K.4.4.8.1	206	0
VIII	1	Solderability	K.3.7.5	K.4.4.6.5	18	0
	2	Resistance to solvents(6)	K.3.8.10	K.4.4.7.10		
IX	1	Deleted	-	-	-	-
	2	Deleted	-	-		
X	1	Thermal shock (II)(5)	K.3.8.7	K.4.4.7.7	12	0
XI	1	Substrate bending	K.3.7.3	K.4.4.6.3	6	0
XII	1	Shear	K.3.7.4	K.4.4.6.4	6	0
XIII	1	Body strength	K.3.7.1	K.4.4.6.1	6	0
–	–	Materials	K.3.2	–	(4)	

Notes:
(1) This test can be performed after voltage aging test.
(2) For dimensions and mass, the acceptance quality level (AQL) 1.0% is based on a single sampling plans for normal inspection specified in Attachment Table 2-A of JIS Z 9015-1.
(3) In the case of group qualification, the number of samples shall be three per case size.
(4) Documents shall be submitted to prove that the samples meet the design specification.
(5) In the test order 1 of group X thermal shock (II), the test result of the test order 1 of group X thermal shock (II) may be applied when the test order 2 of group III thermal shock (I) was performed and passed with 1,000 cycles. In this case, the inspection results may be substituted as the results of test order 1 of subgroup X thermal Shock (II).
(6) Applies only to capacitors marked with ink.

K.4.3 Quality Conformance Inspection

Quality conformance inspection shall be in accordance with paragraph 4.5 and as follows.

K.4.3.1 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table K-7 for group A, Table K-8 for group B, and Table K-9 for group C. Subgroups A4 through A6 shall be performed after subgroups A1, A2 and A3 are performed in the order of subgroup numbers listed in Table K-7. Inspections specified

in Table K-8 and Table K-9 may be performed in any order of subgroup numbers. Inspections in each subgroup shall be performed in the order listed in each table.

K.4.3.2 Disposition after tests

The lots rejected in group A inspection shall not be shipped. If the samples fail Dimension inspection in subgroup A2 of group A inspection, 100% inspection shall be conducted for the rejected test items in accordance with paragraph H.3.3 of JAXA-QTS-2000 and conforming products may be shipped.
Any samples which have been subjected to subgroups A4, A5 and A6 shall not be shipped.

Table K-7. Quality Conformance Inspection (Group A)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Radiographic inspection	K.3.4.1	K.4.4.4.1	All samples	N/A
A2	1	Reflow conditioning	K.3.8.4	K.4.4.7.4	All samples	0
	2	Thermal Shock	K.3.8.5	K.4.4.7.5		
	3	Surge current(1)	K.3.6.7	K.4.4.5.7		
	4	Voltage aging	K.3.6.1	K.4.4.5.1		
	5	Leakage current	K.3.6.2	K.4.4.5.2		
	6	Capacitance	K.3.6.3	K.4.4.5.3		
	7	Dissipation factor (tan δ)	K.3.6.4	K.4.4.5.4		
	8	Equivalent series resistance	K.3.6.5	K.4.4.5.5		
A3	1	Externals, constructions, dimensions, mass and marking	K.3.3	K.4.4.3	All samples (2)	0
A4	1	DPA	K.3.4.2	K.4.4.4.2	3	0
A5	1	Stability at low and high temperature	K.3.8.8	K.4.4.7.8	6	0
	2	Surge voltage	K.3.6.6	K.4.4.5.6		
A6	1	Solderability	K.3.7.5	K.4.4.6.5	4	0

Notes:
(1) This inspection may be performed after voltage aging test.
(2) The acceptance quality level (AQL) 1.0% is based on a single sampling plan for normal inspection specified in Attachment Table 2-A of JIS Z 9015-1.

Table K-8. Quality Conformance Inspection (Group B)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Resistance to soldering heat	K.3.7.6	K.4.4.6.6	18	0
	2	Deleted	-	-		
	3	Resistance to solvents(1)	K.3.8.10	K.4.4.7.10		
	4	Moisture resistance	K.3.8.9	K.4.4.7.9		
B2	1	Life (+85°C)	K.3.9.1	K.4.4.8.1	24	0
B3	1	Deleted	-	-	-	-
	2	Deleted	-	-		

Note: (1) This inspection applies only to capacitors marked with ink.

Table K-9. Quality Conformance Inspection (Group C)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Deleted	-	-	12	0
	2	Thermal shock (I)(1)	K.3.8.6	K.4.4.7.6		
C2	1	Thermal shock (II)(1)	K.3.8.7	K.4.4.7.7	12	0
C3	1	Deleted	-	-	-	-
C4	1	Deleted	-	-	-	-
C5	1	Deleted	-	-	-	-

Note: (1) In the test order 2 of subgroup C1 thermal shock (I), the test cycle (1000 cycles) of test order 1 of subgroup C2 thermal shock (II) may be applied when thermal shock (I) with 1,000 cycles has performed and passed. In this case, the inspection results may be substituted as the results of test order 1 of subgroup C2 thermal Shock (II). In this case, the inspection results may be substituted as the results of test order 1 of subgroup C2 thermal Shock (II).

K.4.4 Methods for Test and Inspection

K.4.4.1 Test and Inspection Conditions

Test and inspection conditions shall be in accordance with section 4 of MIL-STD-202 and under the following conditions.

a) Standard conditions
The standard conditions shall be at a temperature of 15 to 35°C, relative humidity of 25 to 75%, and atmospheric pressure of 86 to 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure of between 86 and 106kPa.

c) Reference conditions
Reference conditions shall be used when converting the measurements to the values under the reference conditions. The reference conditions shall be at 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If reference measurements have been made 30 days prior to the beginning of the aging test, or are considerable to be affected by measuring jigs, they shall be repeated.

e) Measuring accuracy of test voltage shall be ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be ±2% of the specified test voltage. For measuring leakage current, the fluctuation of power supply voltage shall be within ±100ppm. During the measurement, the leakage current displayed in the measuring device shall not be fluctuated greatly.

K.4.4.2 Mounting Method

When specified in this specification, the test capacitor shall be mounted on a testing printed wiring board (PWB) (96% min. alumina) under the following conditions. If not specified, the capacitor can be tested in an appropriate manner without being mounted on the printed wiring board.

a) Thickness of PWB: 0.635±0.05mm or greater.

b) Test land: A maximum of 10 pairs of lands shall be provided to mount the test capacitors by soldering the terminals.

c) Solder paste: Sn63Pb37 or Sn60Pb40 solder paste which is conforming to ANSI/J-STD-005 or JIS Z 3284 shall be used. Flux type shall be non-corrosive rosin flux (R or RMA).

d) Pre-heating: At +135±15°C for 60±10 seconds.

e) Temperature and duration of soldering: At +245±5°C for 60^{+30}_{0} seconds.

f) Soldering method: Reflow (with a solder bath or hot plate).

g) Post-treatment: Excessive flux or solder shall be removed.

K.4.4.3 Externals, Constructions, Dimension, Mass and Marking

Capacitors shall be tested for the externals, constructions, dimensions, mass, and markings as specified in paragraph K.3.3. The mass shall be measured only in the qualification test and group A inspection performed prior to group C inspection. In addition, the following conditions shall apply.

a) Visual examination shall be performed using a minimum of 10x magnifier.

b) Marking shall be visually examined.

c) The dimensions shall be measured using a caliper specified in JIS B 7507 or a micrometer specified in JIS B 7502. Other instruments may be used provided that no dispute would arise on the measured values.

d) Mass shall be measured using an instrument of sufficient accuracy.

K.4.4.4 Workmanship

K.4.4.4.1 Radiographic Inspection

The test shall be conducted in accordance with test method 209 of MIL-STD-202 and under the following conditions.

a) Radiographic quality
   The radiograph shall be indicated to meet the quality requirements specified in paragraph K.3.4.1 and shall have the sufficient resolution to project clear and sharpen images of penetrometer.
b) Penetrometer
   A specimen shall be defined according to the sample.
c) Filming conditions
   The filming conditions shall be defined so that the radiographic quality as specified in a) above will be acquired. The images from the penetrometer shall be included in each film.
d) Direction of filming samples
   Samples shall be filmed from the direction where the connection status of the cathode can be observed.
e) When Non-film techniques are used, the following conditions shall be satisfied.
   1) The record shall have equivalent or greater resolution than the radiographic film and shall be stored in the reproducible electronic medium.
   2) The device shall be able to gain results of same quality as using radiographic film. The digital images shall be inspected by the display monitor with the capability of displaying in the same or greater magnification than by the film inspection. The quality of the radiographs shall meet the requirement as specified in a) above and the image shall not be magnified to the point where the defective characteristics become blurred.
f) Observation
   The images shall be observed under a minimum of 10X magnification.

K.4.4.4.2 DPA

DPA shall be conducted in accordance with the DPA manual established in the Quality Assurance Program Plan to examine the inner construction and to verify that the process such as welding and soldering are properly implemented by disassembling the capacitor using the following methods a) through c).

a) A sample shall be buried in the transparent epoxy resin and cut in the vertical surface along the parallel line of a long side of the capacitor. Then the cut surface shall be polished until the welding area of the tantalum wire and the mounted area to the tantalum element appear.
b) A sample shall be buried in the transparent epoxy resin and cut in the vertical surface along the vertical line of a long side of the capacitor. Then the cut surface shall be polished until cathode and external lead connection appear.
c) Molded resin shall be dissolved with chemicals.

Pictures and records shall be taken using a different sample for each a), b) and c) above.

K.4.4.5 Electrical Performance

Electrical performance tests shall be performed as follows.

K.4.4.5.1 Voltage Aging

The voltage aging shall be tested under the following conditions.

a) Test temperature: +85±5°C.
b) Applied voltage: Rated voltage.
c) Test duration:
   Qualification Test: 168^{+5}_{0} hours.
   Quality conformance inspection (group A): 96^{+5}_{0} hours.
d) Series resistance of test circuit: 3Ω as a maximum.
e) Post-test measurement and inspection
   The test capacitor shall be removed from a test chamber, maintained for 12 to 24 hours in accordance with paragraph item a) of paragraph K.4.4.1, and then measured and inspected.
   1) Measurement
      Leakage current, capacitance, dissipation factor (tan δ) and equivalent series resistance shall be measured in accordance with paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.
   2) Inspection
      The capacitor shall be inspected for any mechanical damages under a minimum of 10X magnification.

K.4.4.5.2 Leakage Current

The leakage current shall be tested under the following conditions.

a) Series protective resistance: 1,000Ω.
b) Measuring condition
   Within ±2% of the rated voltage (if temperature is specified, the derated voltage specified in the detail specification) is applied and then measured within 5 minutes after reaching the targeted voltage.
c) Power supply: Stable supply such as stabilized power supply shall be used.
d) Accuracy of measuring device: Within ±2% or up to 0.02μA, whichever is greater.

K.4.4.5.3 Capacitance

Capacitance shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Measuring frequency: 120±5Hz.
b) Accuracy of measuring device: Within ±2% of capacitance tolerance.
c) Measuring voltage:
   $2.2V_{DC}$ or smaller, superimposed with $1.0V_{AC}$ rms or a smaller voltage.

K.4.4.5.4 Dissipation Factor (tan δ)

The following conditions shall be tested using an LCR meter or other measuring instrument.

a) Measuring frequency: 120±5Hz.
b) Accuracy of measuring device: Within ±(2+0.1%) of measuring dissipation factor.
c) Measuring voltage
   2.2V_{DC} or smaller, superimposed with 1.0V_{AC} rms or a smaller voltage.

K.4.4.5.5 Equivalent Series Resistance

The equivalent series resistance shall be directly measured at the specified temperature, or shall be calculated from measured values obtained using a capacitance bridge. The following details shall apply.

a) Test temperature: +25±5°C.
b) Measuring frequency: 100±5kHz.
c) Accuracy of measuring device: Within ±5.0% of the specified value.
d) Measuring voltage
   2.2V_{DC} or smaller, superimposed 0.5V_{AC} rms or a smaller voltage.

K.4.4.5.6 Surge Voltage

The surge voltage shall be tested under the following conditions.

a) Pre-test measurement
   The capacitance shall be measured as specified in paragraph K.4.4.5.3.
b) Test temperature: +85±5°C.
c) Applied voltage: The surge voltage specified in Table K-2.
d) Series protection resistance: 33Ω±5%.
e) Charged and discharged condition
   The test capacitor shall be charged and discharged through a series protection resistor.
f) Duration and interval of application
   30^{+2}_{0} seconds application and 30^{+2}_{0} seconds discharge (1 minute interval).
g) Number of cycles: 1,000 cycles.
h) Post-test measurements
   After the final cycle completion, the test capacitor shall be stabilized for 12 to 24 hours in accordance with paragraph item a) of paragraph K.4.4.1, and the leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured as specified in paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.

K.4.4.5.7 Surge Current

The surge current shall be tested under the following conditions.

a) Test temperature: -55^{0}_{-5} °C and +85±5°C.
b) A test circuit (see Figure K-1) for each capacitor shall be tested individually.
c) Charge cycle
   The bank capacitor with 20-folds or more capacitance than the test capacitor shall be connected between output terminals of the stabilized power supply. With charging continuously, the test capacitor shall be charged for 0.5 seconds

by the bank capacitor and applied ±2% of rated voltage by the stabilized power supply.

d) Discharge cycle
The test capacitor shall be discharged through the circuit with the resistance of 0.2Ω or less for 0.5 seconds as a minimum until the voltage becomes 1% or less of the rated voltage.

e) Number of cycle
10 times for each test temperature.

f) The sum of the internal resistance and external series resistance of the power supply shall be 0.5Ω as a maximum.

g) The peak value of charge and discharge current shall be verified to be the same as or larger than the calculated value using the formula below for each test circuit.

$$\frac{V_r}{0.5 + ESR_{CAP}}$$

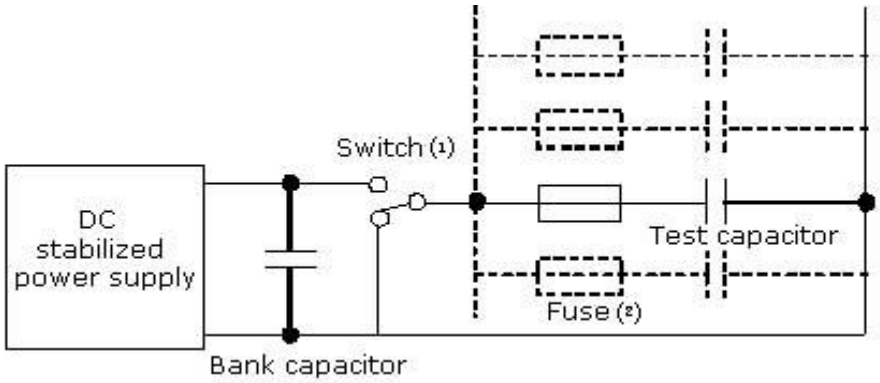
where Vr: Test voltage
ESR_{CAP}: Equivalent series resistance specified in detail specification for +85°C
:200% of Equivalent series resistance specified in detail specification for -55°C

h) When the applied voltage of the capacitor with the rated voltage of 35V and capacitance of 47μF±10% placed on the test position is measured, each test circuit shall be verified that the applied peak voltage reaches within ±5% of rated voltage at charging, and reaches 90% of rated voltage within 100μs after the switch is off.

i) The capacitor is considered a defect if the fuse melts during the test or the test capacitor has 1A or larger pull after charging for 1ms.

j) Post-test measurement
At the completion of the final cycle, leakage current, capacitance, dissipation factor (tan δ) and equivalent series resistance shall be measured in accordance with paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.

k) Post-test inspection
The capacitor shall be inspected for any mechanical damages under a minimum of 10X magnification.



(1) Use a switch for high current without contact bouncing
(2) Use the fuse which is designed to melt at the current of 0.5 to 2.0A.

Figure K-1. Test Circuit for Surge Current

K.4.4.6 Mechanical Performance

Mechanical performance tests shall be performed as follows.

K.4.4.6.1 Body Strength

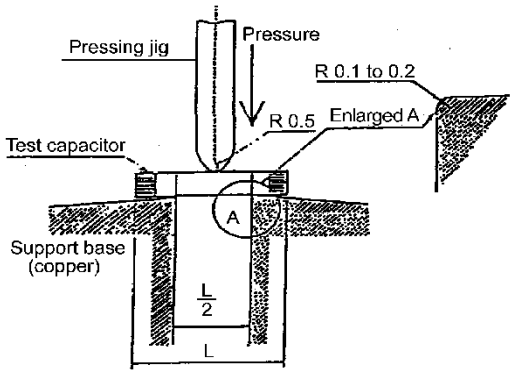
The strength of capacitor body shall be tested as follows.

a) Test devices
A support base shown in Figure K-2 and a pressing jig shown in Figure K-3 shall be used to apply a specified pressure.

b) Preparation
The test capacitor shall be positioned on the support base shown in Figure K-2 so that both edges are even. The support base shall be placed on a flat and sturdy test bench.

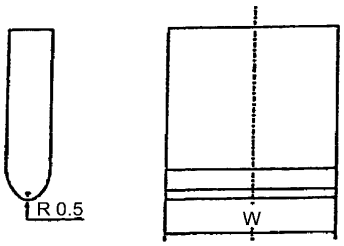
c) Test procedure
A pressure of 10±1N shall be applied to the center of test capacitor for 10±1 seconds using the pressing jig shown in Figure K-3. Intermittent contact of 0.5ms or greater duration, short-circuiting, and open-circuiting shall be examined during the pressure test.

d) Inspection after test
The test capacitor shall be examined for evidence of defects such as cracks, chipping, crazing, or detachment under a minimum of 10X magnification.



Taping angle at portion A shall be 70° as a minimum and less than 90°

Figure K-2. Pressure Application



The pressing jig shall be made of hardening steel or cemented carbide and the dimension W shall be greater than the width of test capacitor.

Figure K-3. Pressing Jig

K.4.4.6.2 Detach Strength

Capacitors shall be tested for detachment strength when mounted on a printed wiring board. The test procedures shall be as follows.

a) Test devices
Pressing jig with R0.5 projection shall be used to apply pressure as shown in Figure K-4.

b) Mounting a test capacitor

A test capacitor shall be mounted on the test printed wiring board in accordance with paragraph K.4.4.2 and shall contain a rectangular hole (W x 20mm) as shown in Figure K-5. The condition of the mounting capacitor shall be shown in Figure K-6.

c) Test procedure
Press the back of test capacitor at its center using the jig as shown in Figure K-4 with 5±0.5N for 10±1 seconds.

d) Inspection after test
The test capacitor shall be examined at the soldered section for evidence of defects such as crack, chipping, crazing, or detachment under a minimum of 10X magnification.

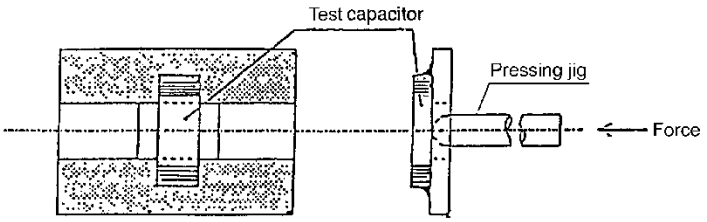


Figure K-4. Pressurization

(Unit: mm)

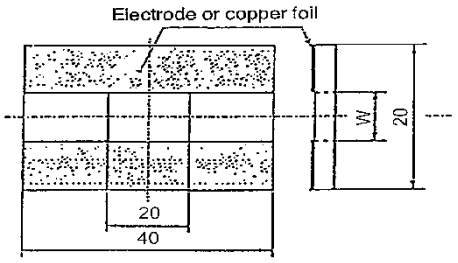


Figure K-5. Printed Wiring Board

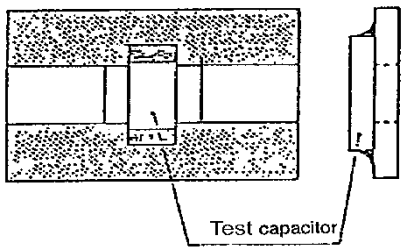


Figure K-6. Mounting Test Capacitor (Example)

K.4.4.6.3 Substrate Bending

The capacitor shall be tested for resistance to substrate bending when mounted on a printed wiring board. The test shall be performed as follows.

a) Test devices
Support rods and test bench shown in Figure K-7, a pressing jig shown in Figure K-8 shall be used.

b) Mounting a test capacitor
As specified in paragraph K.4.4.2. The printed wiring board on which the test capacitor is mounted shall be made of glass woven based epoxy resin with the thickness of 1.6±0.2mm and shall not affect test or measurement.

c) Pre-test measurement
Capacitance shall be measured in accordance with paragraph K.4.4.5.3.

d) Preparation
A test printed wiring board on which the test capacitor is mounted shall be positioned on support rods shown in Figure K-7. The support rods shall be placed on a flat and sturdy test bench.

e) Test procedure

Pressure shall be applied as shown in Figure K-9 using the jig shown in Figure K-8 to deflect the test printed wiring board. The extent of flexure shall be $3^{+0.2}_{0}$ mm. The pressure shall be applied once at a speed of 1mm/s, and the pressure shall be maintained for 5±1 seconds after reaching specified flexure.

f) Measurement during test
Capacitance with the test printed wiring boards bent shall be measured in accordance with paragraph K.4.4.5.3.

g) Inspection after test
The test capacitor shall be examined for evidence of defects such as cracks, chipping, crazing, or detachment under a minimum of 10X magnification.

(Unit: mm)

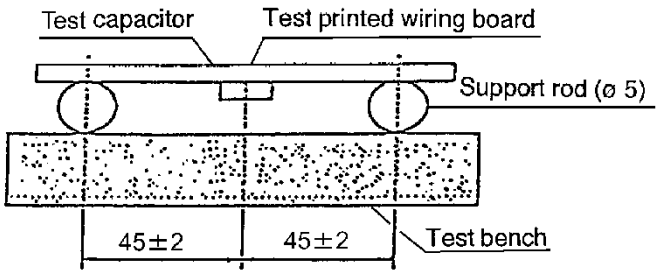
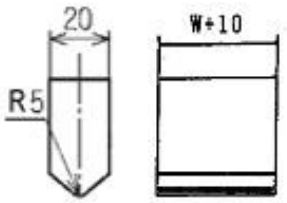


Figure K-7. Layout

(Unit: mm)



Remark:
W denotes the width of test printed wiring board.

Figure K-8. Pressing Jig

(Unit: mm)

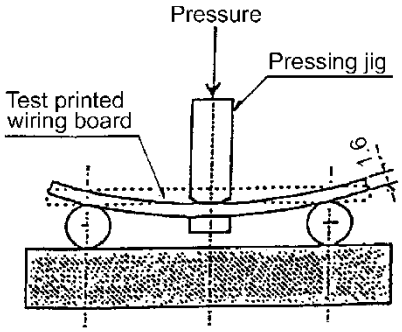


Figure K-9. Pressurization

K.4.4.6.4 Shear

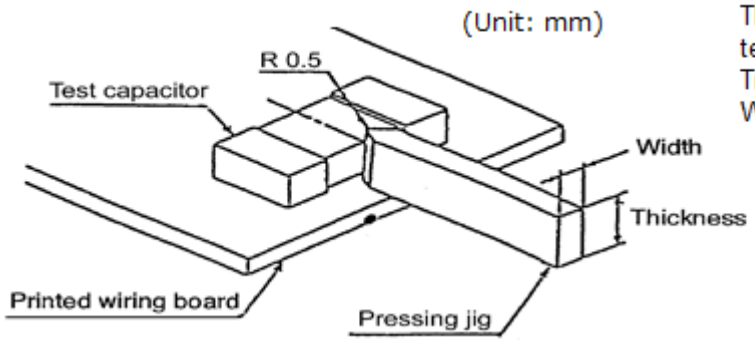
The capacitor shall be tested for shear strength against lateral stress when mounted on a printed wiring board. The test shall be performed as follows.

a) Test devices
The test device shall be pressured as specified with a pressing jig as shown in Figure K-10.

b) Mounting a test capacitor
As specified in paragraph K.4.4.2.

c) Test procedure
The pressure shall be gradually applied to the jig in a horizontal direction to test the printed wiring board by bringing the tip of the jig into contact with the test capacitor at the center of the longitudinal side as shown in Figure K-10. Unless otherwise specified, the applied pressure shall be 5±0.5N and the duration of application shall be 10±1 seconds.

d) Inspection after test
The test capacitor shall be examined at the soldered section for evidence of defects such as crack, chipping, crazing, or detachment under a minimum of 10X magnification.



Thickness of Jig: Thicker than the height of tested surface of the test capacitor.
Tip of Jig: Chamfered to R0.5
Width of Jig: Not Specified.

Figure K-10. Pressing Jig

K.4.4.6.5 Solderability

The solderability shall be tested as follows.

a) Test devices

The solder bath shall have a minimum depth of 40mm to hold sufficient volume of solder (not less than 300ml or 0.9 kg) and shall be adjustable and maintainable at the specified temperature.

The temperature shall be measured at the depth of 25 mm from the top surface of the liquid.

b) Materials

1) Solder

H60A, H60S, or H63A defined in JIS Z 3282 (Soft Solders).

2) Flux

Rosin (JIS K 5902) dissolved in isopropyl alcohol (JIS K 1522) with a mass ratio of 25% concentration.

c) Test procedure

1) Preparing terminals

Avoid touching the tested surface with fingers or dirty tools. The test capacitor shall not be cleaned prior to the test.

2) Immersion in flux

Entire test capacitor shall be immersed into flux at normal temperature.
The test capacitor shall be held and immersed as shown in Figure K-11 and Figure K-12 and the duration of immersion shall be 2±0.5 seconds.
No part of the tweezers shall contact the terminals (electrodes) while holding the test capacitor.

3) Pre-heating

The test capacitor shall be heated between +80 and +120°C for 10 to 30 seconds.

4) Cleaning solder bath

Any oxidized solder or flux cinder on the liquid surface shall be removed before every test.

5) Immersion in solder bath

The test capacitor shall be immersed into the molten solder bath at +235±5°C at a speed of +25±2.5mm/s immediately after the pre-heating.
When the depth specified in Figure K-13 is reached, the test capacitor shall

be maintained for 2±0.5 seconds, and shall then be removed at a speed of 25±2.5mm/s.

d) Inspection after test
Within 60 minutes after test completion, the residual flux shall be removed and the test capacitor shall be visually examined under a minimum of 10X magnification for solder wettability.

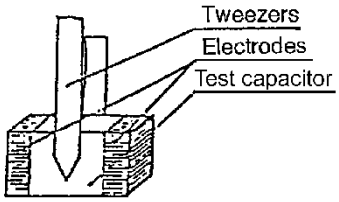


Figure K-11. Holding Test Capacitor

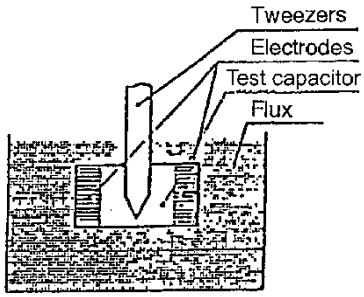


Figure K-12. Immersion into Flux

(Unit: mm)

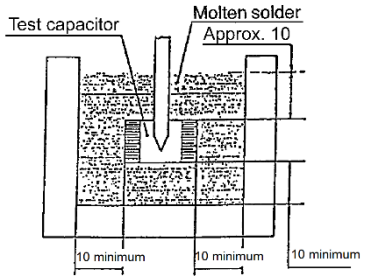


Figure K-13. Immersion into Solder Bath

K.4.4.6.6 Resistance to Soldering Heat

Capacitors shall be tested as follows for resistance to solder heat using a reflow bath.

a) Pre-test measurement
Capacitance shall be measured in accordance with paragraph K.4.4.5.3.

b) Test devices
A reflow bath which satisfies the test conditions, such as for infrared reflow or vapor phase soldering, shall be used.

c) Test printed wiring boards
A printed wiring board on which the test capacitor is mounted shall be as specified in paragraph K.4.4.2 and contain a rectangular opening (W x 20mm) as shown in Figure K-5.

d) Solder paste
Solder paste specified in item c) of paragraph K.4.4.2 shall be used.

e) Test procedure
1) Mounting a test capacitor
Apply the solder paste to the printed wiring board with lands and the test capacitor shall be placed on it. The solder paste applied shall be a thickness of between 150 and 250μm.
2) Pre-heating
The test capacitor shall be heated in the reflow bath at +150±10°C for 60 to 120 seconds.

3) Heating
Immediately after pre-heating, the temperature of the reflow bath shall be increased. When the temperature of the test capacitor reaches +240±5°C, the temperature shall be maintained for 30±1 seconds (see Figure K-14). The temperature of the test capacitor denotes the temperature at the terminals (electrodes).

f) Post-test measurement
Within 60 minutes after test completion, residual flux shall be removed, and the leakage current, capacitance and dissipation factor (tan δ) shall be measured in accordance with paragraphs K.4.4.5.2, K.4.4.5.3, and K.4.4.5.4, respectively.

g) Inspection after test
The capacitor shall be inspected for any mechanical damages under a minimum of 10X magnification.

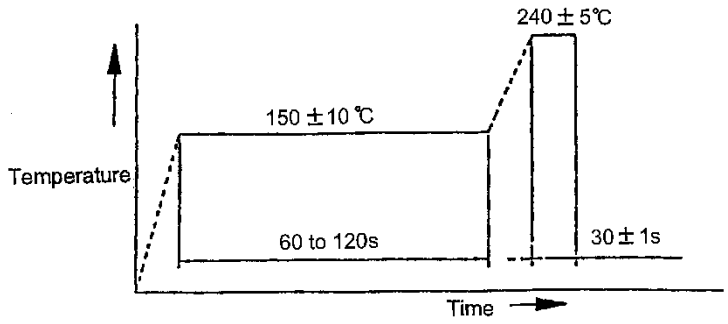


Figure K-14. Temperature Profile of Reflow Bath

K.4.4.7 Environmental Performance

Environmental performance tests shall be performed as follows.

K.4.4.7.1 High-Frequency Vibration

Deleted.

K.4.4.7.2 Random Vibration

Deleted.

K.4.4.7.3 Shock

Deleted.

K.4.4.7.4 Reflow Conditioning

Capacitor shall be tested for integrity of the internal connection in accordance with the following conditions.

a) Test capacitor shall not be mounted.
b) Pre- or post-test Measurements: Not conducted.
c) Number of cycles: one cycle.
d) Temperature profile of reflow tank: as specified in Figure K-15.
e) Inspection after test:
The capacitor shall be examined for evidence of mechanical damage under a minimum of 10X magnification.

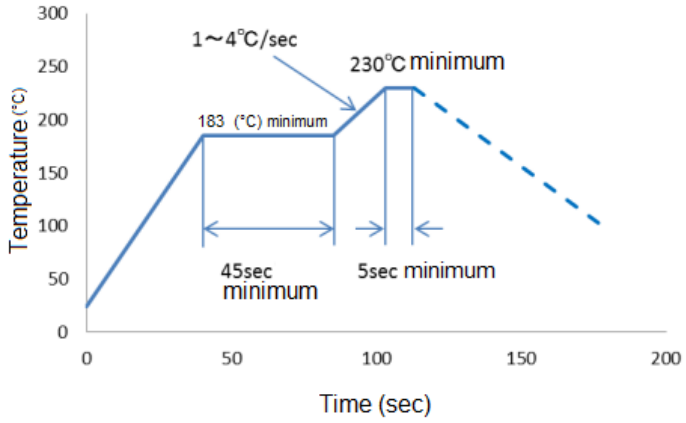


Figure K-15. Temperature Profile of Reflow Conditioning

K.4.4.7.5 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Test conditions: B (5 cycles), except that the temperature shall be -55^{0}_{-3}°C in step 1.
b) Pre- and Post- test measurements: Not conducted.
c) Inspection after test:
The capacitor shall be examined for evidence of mechanical damage under a minimum of 10X magnification.

K.4.4.7.6 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Mounting a test capacitor: As specified in paragraph K.4.4.2.
b) Pre-test measurement: Capacitance shall be measured in accordance with paragraph K.4.4.5.3.
c) Test condition: B-1 (25 cycles), except that the temperature shall be -55^{0}_{-3}°C in step 1.
Post-test measurements
The leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured as specified in paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.
d) Inspection after test
The capacitor shall be examined for evidence of corrosion and mechanical damage and for marking legibility under a minimum of 10X magnification.

K.4.4.7.7 Thermal Shock (II)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details and exceptions shall apply.

a) Mounting a test capacitor: As specified in paragraph K.4.4.2.
b) Pre-test measurement: Capacitance shall be measured as specified in paragraph K.4.4.5.3.

c) Test condition: B, except that the number of cycles shall be 1,000, and the temperature shall be -30^{0}_{-3}°C in step 1, 100^{+3}_{0}°C in step 3.

d) Measurements and inspection
The following measurements and inspection shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and 1000^{+10}_{0}.

1) Measurements
The leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured as specified in paragraphs. K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.

2) Inspection
The capacitor shall be examined for evidence of mechanical damage under a minimum of 10X magnification.

K.4.4.7.8 Stability at Low and High Temepratures

After having maintained at $+125^{+3}_{0}$°C for 30^{+4}_{0} minutes before the test, the leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured at each step specified in Table K-10. The capacitor shall be brought to thermal equilibrium, which no further change in capacitance is observed between two successive measurements taken at 15-minute intervals.
After measuring capacitance and dissipation factor (tan δ) at -55°C (in step 2), the rated voltage shall be applied to the capacitor through 33Ω resistor for 5 minutes.

Table K-10. Stability at Low and High Temperature

Step	Temperature (°C)	Measuring item	Test method Paragraph
1	+25±2	Leakage current	K.4.4.5.2
		Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
		Equivalent series resistance	K.4.4.5.5
2	-55^{0}_{-3}	Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
3	+25±2	Leakage current	K.4.4.5.2
		Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
4	$+85^{+3}_{0}$	Leakage current	K.4.4.5.2
		Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
5	$+125^{+3}_{0}$	Leakage current (1)	K.4.4.5.2
		Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
6	+25±2	Leakage current	K.4.4.5.2
		Capacitance	K.4.4.5.3
		Dissipation factor (tan δ)	K.4.4.5.4
		Equivalent series resistance	K.4.4.5.5

Note: (1) Derated voltage specified in Table K-2 shall be applied.

K.4.4.7.9 Moisture Resistance

Capacitors shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Mounting a test capacitor: As specified in paragraph K.4.4.2.
b) Pre-test measurement
The capacitance shall be measured as specified in paragraph K.4.4.5.3.
c) Number of cycles: 20 cycles in a row (except for steps 7a and 7b).
d) Post-test measurements
After the final cycle completion, the test capacitor shall be maintained under the conditions specified in item a) of paragraph K.4.4.1 for one hour. The leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured as specified in paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.
e) Inspection after test
The capacitor shall be examined for evidence of corrosion and mechanical damage and for marking legibility under a minimum of 10X magnification.

K.4.4.7.10 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. The following details shall apply.

a) Brushing area: Marked area
b) Solvent: Isopropyl alcohol
c) Inspection after test
The capacitor shall be visually examined for marking legibility.

K.4.4.8 Durability Performance

Durability performance tests shall be performed as follows.

K.4.4.8.1 Life (+85°C)

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Mounting a test capacitor: As specified in paragraph K.4.4.2.
b) Pre-test Measurements
The capacitance shall be measured as specified in paragraph K.4.4.5.3.
c) Test temperature: $+85^{+3}_{0}$°C.
d) Applied voltage: Rated voltage.
e) Voltage application method
Voltage shall be applied to the capacitor (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes) so that it will reach the specific voltage within 5 minutes. The voltage shall be applied continuously except for measurement periods.
f) DC power supply
Storage batteries or an electronic power supply, which is capable of supplying at least 1A when a capacitor is shorted out, shall be used. The impedance of voltage source shall not exceed 3Ω as seen from the terminals of each capacitor.

g) Duration of test
   1) Qualification test: $4{,}000^{+72}_{0}$ hours.
   2) Quality conformance inspection (group B): $2{,}000^{+72}_{0}$ hours.

h) Measurements during test
   The leakage current at the test temperature shall be measured as specified in paragraph K.4.4.5.2 at beginning of the test, and at 240^{+48}_{0}, $1{,}000^{+48}_{0}$, $2{,}000^{+72}_{0}$, and $4{,}000^{+72}_{0}$ hours.

i) Post-test measurements
   After restoring the capacitor to the specified state as specified in item a) of paragraph K.4.4.1, the leakage current, capacitance, dissipation factor (tan δ), and equivalent series resistance shall be measured as specified in paragraphs K.4.4.5.2, K.4.4.5.3, K.4.4.5.4, and K.4.4.5.5, respectively.

j) Inspections after test
   The capacitor shall be examined for evidence of corrosion and mechanical damage and for marking legibility under a minimum of 10X magnification.

K.4.4.8.2 Life (+125°C)

Capacitors shall be tested as specified in paragraph K.4.4.8.1. The following exceptions shall apply.

a) Test temperature: $+125^{+3}_{0}$°C.
b) Applied voltage: Derated voltage specified in Table K-2.
c) Duration of test: $4{,}000^{+72}_{0}$ hours.

K.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items:

a) Leakage current (paragraph K.3.6.2)
b) Capacitance (paragraph K.3.6.3)
c) Dissipation factor (paragraph K.3.6.4)
d) Equivalent series resistance (paragraph K.3.6.5)
e) Externals and marking (paragraph K.3.3)

For solderability, the sampling inspection shall be conducted in accordance with Table K-7. The re-inspection date shall be marked on either the package or storing box. Any lot which has failed the solderability test shall not be shipped.

K.4.6 Changes to Tests and Inspections

Changes to tests and inspections shall be as specified in paragraph 4.8.

K.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

K.6 NOTES

Notes shall be as specified in paragraph 6.

APPENDIX L

CAPACITORS, CHIP, FIXED, FINE CERAMIC DELECTRIC,
(TEMPERATURE STABLE AND GENERAL PURPOSE)

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: 19 August 2025

APPENDIX L

CAPACITORS, CHIP, FIXED, FINE CERAMIC DIELECTRIC, (TEMPERATURE STABLE AND GENERAL PURPOSE)

L.1 GENERAL

L.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for fine ceramic dielectric, fixed, chip capacitors (temperature stable and general purpose) (hereinafter referred to as "capacitors").

L.1.2 Classification

Capacitors shall be classified as specified in Table L-1.

Table L-1. Classification

Structure	Style
Rectangular, electrode in both directions	1005, 1608, 2012, 3216, 3225, 4532, 5750

L.1.3 Part Number

The part number shall be indicated as follows. See the detail specification for details.
(Example)

NASDA(1) 2040/L 104 1608 X7R 1H 103 K Y

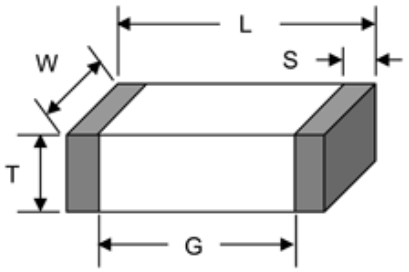
104	1608	X7R	1H	103	K	Y
Individual Identification	Style (L.1.3.1)	Characteristic (L.1.3.2)	Rated voltage (L.1.3.3)	Nominal Capacitance (L.1.3.4)	Capacitance tolerance (L.1.3.5)	Terminal finish (L.1.3.6)

Note: (1) "NASDA" indicates the common part for space use and may be abbreviated to “N”.

L.1.3.1 Style

The style indicates the external size of capacitor and shall be identified with a four-digit number as shown in Table L-2.The detailed dimensions shall be as specified in the detail specification. The detail specification shall specify at least length, width, thickness, electrode gap, and band width of capacitors.

Table L-2. Style



(Unit: mm)

Style	Physical Dimensions						
	Length (L)		Width (W)		Thickness (T)	Electrode Gap (G)	Band Width (S)
	Max.	Min.	Max.	Min			
1608	1.80	1.50	1.00	0.70	As specified in the detail specification	As specified in the detail specification	As specified in the detail specification
2012	2.25	1.85	1.50	1.10			
3216	3.60	3.05	1.90	1.45			
3225	3.60	2.90	2.80	2.30			
4352	5.00	4.10	3.55	2.90			
5750	6.20	5.30	5.45	4.60			

L.1.3.2 Characteristic

The characteristic shall be identified in accordance with paragraph 1.3.2 of EIA-198-1 as shown in Table L-3.

Table L-3. Voltage–Temperature Characteristic

Symbol	Operating temperature range (°C)	Capacitance change from temperature +25°C	
		Steps A to D of Table L-5 (no voltage applied)	Steps E to G of Table L-5 (rated voltage applied)
C0G	-55 to +125	0±30ppm/°C	0±30ppm/°C
X7R	-55 to +125	±15%	– (1)
X7S	-55 to +125	±22%	– (1)

Note: (1) Detailed information shall be provided in the application data sheet.

L.1.3.3 Rated Voltage

The rated voltage shall be identified in accordance with Appendix 1, paragraph 2.3.4 of JIS C 5101-1 as specified in Table L-4.

Table L-4. Rated Voltage

(Unit: V)

First symbol	Second symbol									
	A	B	C	D	E	F	G	H	J	K
0	–	–	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00
1	10.00	12.50	16.0	20.00	25.00	31.50	40.00	50.00	63.00	80.00
2	100.00	125.00	160.00	200.00	250.00	315.00	400.00	500.00	–	–

L.1.3.4 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow. For nominal capacitance under 10pF, the letter “R” represents the decimal point and the other two digits shall denote significant figures. For example, 1R0 indicates 1.0pF, R75 indicates 0.75pF, 0R5 indicates 0.5pF, and 102 indicates 1,000pF.

L.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table L-5.

Table L-5. Capacitance Tolerance

Nominal capacitance	Symbol	Capacitance tolerance
10pF or less	B	±0.10pF
	C	±0.25pF
	D	±0.50pF
	F	±1.00pF
Over 10pF	F	±1%
	G	±2%
	J	±5%
	K	±10%
	M	±20%

L.1.3.6 Terminal Finish

The terminal finish shall be identified by a single capital letter as specified in Table L-6. Tin whisker may grow because 100% tin is used for the terminal finish “Y.”

Table L-6. Terminal Finish

Symbol	Terminal finish
G	Ag-Ni-Au
M	Pd/Ag alloy
S	Solder coated over layer to prevent solder dissolution
Y	100% Sn plated over base Ni barrier
Z	Solder plated over base metallization barrier (Sn/Pb alloy with a minimum of 4wt% Pb)

L.2 APPLICABLE DOCUMENTS

L.2.1 Applicable Document

Applicable documents for this appendix shall be as follows and as specified in paragraph 2.1.

a) EIA-198-1 Ceramic Dielectric Capacitors Classes I, II, III and IV
Part I: Characteristics and Requirements

b) EIA 469 Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors

c) JIS C 5101-1 Fixed Capacitors for Use in Electronic Equipment
Part 1: Generic Specification

d) JIS Z 3198-7 Test methods for lead-free solders-Part 7:Method for shear strength of solder joints on chip components

L.2.2 Reference Document

The following documents are the referenced documents of this appendix.

a) MIL-PRF-123E Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification for

b) MIL-PRF-32535A Capacitor, Chip, Fixed, Ceramic Dielectric (Temperature Stable and General purpose), Extended Range, High Reliability and Standard Reliability, General Specification for

L.3 REQUIREMENTS

L.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs L.3.2 to L.3.11. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

L.3.1.1 Restriction of Qualification

The qualification of nominal capacitance and rated voltage shall be restricted to values equal to and less than the nominal capacitance and rated voltage of capacitors, respectively, subjected to the qualification test. Qualification of characteristics, ceramic materials, and terminal finish shall be also restricted to those of capacitors subjected to

the qualification test. For the product family, the combination of materials, structure, etc. of the samples to be tested shall be specified in the quality assurance program plan.

L.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

a) Materials of capacitor element
Ceramic shall be used as the dielectric.

b) Terminal finish
The terminal finish shall be any of those shown in Table L-6 and as specified in the detail specification. The finish shall be properly processed to facilitate soldering.

L.3.3 Design and Constructions

The design and constructions of capacitors shall be as specified in the detail specification.

L.3.4 Non-Destructive Internal Inspection

All capacitors shall be subjected to an ultrasonic inspection or non-destructive internal inspection as specified in the detail specification to verify the functionality. When tested as specified in paragraph L.4.4.4, capacitors shall not exhibit any defects such as delamination, voids, and cracks.

L.3.5 Externals, Dimension, Mass and Marking

When tested as specified in paragraph L.4.4.5, capacitors shall meet the following requirements.

L.3.5.1 Externals

The externals of the capacitors shall meet the following requirements. Any other requirements regarding the externals shall be specified in the detail specification.

a) Terminals
   1) End surfaces of terminals shall be thoroughly covered with terminal finish. Pinholes of ϕ0.13mm or greater shall not be allowed. The maximum number of pinholes in per surface shall be three.
   2) Edge chip-out shall be less than 10%.
   3) There shall be no visible foreign matters or voids that expose base metal 10% or greater.

b) Ceramic surface
   1) There shall be no cracks.
   2) There shall be no delamination.
   3) There shall be no striation.
   4) Edge chip-out shall be less than 0.08mm in depth with respect to each plane.
   5) Edges shall not have irregular shapes.
   6) There shall be no fused dusts or excess ceramic materials that prevent a chip from lying flat, or protrude of 0.08mm or greater out of a surface.
   7) There shall be no blisters or bubbles of 0.05mm or greater on a surface.
   8) The clearance (warpage) at the center of the chip shall be less than 5% of the length of capacitor (L) (see Table L-2) when compared to a flat surface.
   9) There shall be no pinholes or dents of φ0.05mm or greater.

10) There shall be no holes or voids that expose the internal electrodes.

L.3.5.2 Dimenstions

Dimensions of capacitors shall meet the values specified in the detail specification.

L.3.5.2.1 Dielectirc

Voids shall not reduce the total thickness of ceramic dielectric by more than 50% (see Figure L-1).

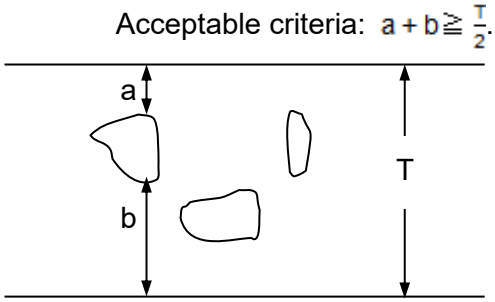


Figure L-1. Criteria for Dielectric Thickness (Example)

L.3.5.3 Marking

The marking shall be provided not on a capacitor body but on individual package or packaging. Marked items shall be as specified in paragraph 5.2.

L.3.6 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.

L.3.6.1 DPA

When tested as specified in paragraph L.4.4.6.1, capacitors shall meet the requirements specified in EIA-469. The items to be verified in DPA shall be specified in the detail specification and the details shall be in accordance with the DPA manual. In addition, capacitors shall meet the requirements for materials, design, and construction specified in the detail specification and also the requirements specified in paragraph L.3.5.2.1.

L.3.7 Rating

The following items shall be specified in the detail specification.

a) Voltage–temperature characteristics
b) Rated voltage
c) Nominal capacitance
d) Capacitance tolerance

L.3.8 Electrical Performance

Capacitors shall meet the following requirements.

L.3.8.1 Capacitance

When tested as specified in paragraph L.4.4.7.1, the capacitance shall be within the tolerance specified in the detail specification.

L.3.8.2 Dissipation Factor

When tested as specified in paragraph L.4.4.7.2, the dissipation factor shall meet the following requirements.

a) C0G characteristic
   1) For nominal capacitance of 30pF or greater: Q ≥ 1,000.
   2) For nominal capacitance less than 30pF: Q ≥ 400+20C.
      (C: nominal capacitance expressed in pF).
b) X7R and X7S characteristics: tanδ ≤ 2.5%.

L.3.8.3 Dielectric Withstanding Voltage

When tested as specified in paragraph L.4.4.7.3, there shall be no damage or insulation breakdown.

L.3.8.4 Insulation Resistance

When tested as specified in paragraph L.4.4.7.4, the insulation resistance shall meet the following requirements.

a) At +25°C: Not less than 100,000MΩ or 1,000Ω·F, whichever is smaller.
b) At +125°C: Not less than 10,000MΩ or 100Ω·F, whichever is smaller.

L.3.8.5 Voltage–Temperature Characteristic

When tested as specified in paragraph L.4.4.7.5, the capacitance change shall not exceed the limit specified in Table L-3. The capacitance obtained at step C in Table L-15 shall be the reference value.

L.3.9 Mechanical Performance

Capacitors shall meet the following requirements.

L.3.9.1 Shear (Destructive)

When tested as specified in paragraph L.4.4.8.1, the shear strength shall not fall below the value specified in Table L-7 and shall have no separation between ceramic and terminal electrodes (symbol "B" of Table L-16) or detachment of the solder (symbol "D1" of Table L-16).

If the capacitors exhibit the detachment of shear modes, symbols “D2” or “E” shown in Table L-16 under the shear strength equal to or less than the minimum shear strength shown in Table L-7, the capacitors may be re-tested.

Table L-7. Minimum Shear Strength

Unit: N

Style	Minimum shear strength
1608	15
2012	30
3216	30
3225	60
4532	100
5750	100

L.3.9.2 Shear

Deleted.

L.3.9.3 Substrate Bending

When tested as specified in paragraph L.4.4.8.3, capacitors shall meet the following requirements.

a) Externals
There shall be no crack or other damage.

b) Capacitance change
1) C0G characteristic: Within ±0.5% or ±0.5pF of initial measured value, whichever the absolute value is greater.
2) X7R and X7S characteristics: Within ±10% of initial measured value.

L.3.9.4 Solderability

When tested as specified in paragraph L.4.4.8.4, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough spots and shall not be concentrated in one area.

L.3.9.5 Resistance to Soldering Heat

When tested as specified in paragraph L.4.4.8.5, capacitors shall meet the following requirements.

a) Externals
There shall be no evidence of mechanical damage, peeling or exposed internal electrodes. Dissolution of electrodes shall be a maximum of 25% on each edge of the mounting area (see Figure L-2.).

b) Insulation resistance (at +25°C)
The insulation resistance shall meet the requirements specified in item a) of paragraph L.3.8.4.

c) Capacitance change
1) C0G characteristic: Within -1.0 to +2.0% or ±0.5pF of initial measured value, whichever the absolute value is greater.
2) X7R and X7S characteristics: Within -1.0 to +6.0% of initial measured value.

d) Dissipation factor
As specified in paragraph L.3.8.2.

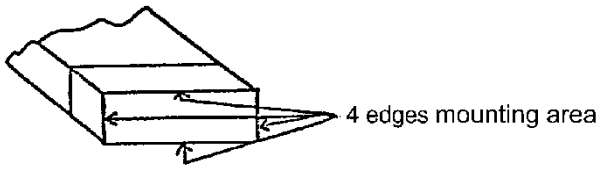


Figure L-2. Mounting Area

L.3.10 Environmental Performance

Capacitors shall meet the following requirements.

L.3.10.1 Random Vibraion

Deleted.

L.3.10.2 Shock

Deleted.

L.3.10.3 Thermal Shock (I)

When tested as specified in paragraph L.4.4.9.3, capacitors shall meet the following requirements.

a) Externals
   There shall be no mechanical damage.
b) Dielectric withstanding voltage
   As specified in paragraph L.3.8.3.
c) Insulation resistance (+25°C)
   30% or greater than the value specified in item a) of paragraph L.3.8.4.
d) Capacitance change
   1) C0G characteristic: Within ±0.5% or ±0.5pF of initial measured value, whichever the absolute value is greater.
   2) X7R and X7S characteristics: Within ±10% of initial measured value.
e) Dissipation factor
   As specified in paragraph L.3.8.2.

L.3.10.4 Thermal Shock and Voltage Aging

When tested as specified in paragraph L.4.4.9.4, capacitors shall meet the following requirements.

a) Insulation resistance (+125°C)
   As specified in item b) of paragraph L.3.8.4.
b) Externals
   There shall be no mechanical damage.
c) Dielectric withstanding voltage
   As specified in paragraph L.3.8.3.
d) Insulation resistance (+25°C)
   As specified in item a) of paragraph L.3.8.4.
e) Capacitance
   As specified in paragraph L.3.8.1.
f) Dissipation factor
   As specified in paragraph L.3.8.2.

L.3.10.5 Thermal Shock and Immersion Cycling

When tested as specified in paragraph L.4.4.9.5, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage.
b) Dielectric withstanding voltage
As specified in paragraph L.3.8.3.
c) Insulation resistance (+25°C)
50% or higher than the value specified in item a) of paragraph L.3.8.4.
d) Capacitance change
1) C0G characteristic: ±0.5% or ±0.5pF of initial measured value, whichever the absolute value is greater.
2) X7R and X7S characteristics: Within ±10% of initial measured value.
e) Dissipation factor
As specified in paragraph L.3.8.2.

L.3.10.6 Moisture Resistance

When tested as specified in paragraph L.4.4.9.6, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage.
b) Dielectric withstanding voltage
As specified in paragraph L.3.8.3.
c) Insulation resistance (+25°)
50% or higher than the value specified in item a) of paragraph L.3.8.4.
d) Capacitance change
1) C0G characteristic: ±0.3% or ±0.3pF of initial measured value, whichever is the absolute value is greater.
2) X7R and X7S characteristics: Within ±10% of initial measured value.

L.3.10.7 Humidity, Steady State, Low Voltage

When tested as specified in paragraph L.4.4.9.7, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage.
b) Insulation resistance (+25°)
As specified in item a) of paragraph L.3.8.4.
c) Capacitance change
1) C0G characteristic: ±0.3% or ±0.3pF of initial measured value, whichever the absolute value is greater.
2) X7R and X7S characteristics: Within ±10% of initial measured value.

L.3.10.8 Barometric Pressure (Reduced)

When tested as specified in L.4.4.9.8, capacitors shall not exhibit damage, instantaneous/intermittent arcing, open-circuiting, or short-circuiting.

L.3.11 Durability Performance

Capacitors shall meet the following requirements.

L.3.11.1 Life

When tested as specified in paragraph L.4.4.10.1, capacitors shall meet the following requirements.

a) 250-hour limits
   1) Insulation resistance (+125°C)
      50% or higher than the value specified in item b) of paragraph L.3.8.4.
   2) Externals
      There shall be no mechanical damage.
   3) Insulation resistance (+25°C)
      50% or higher than the value specified in item a) of paragraph L.3.8.4.
   4) Capacitance change
      4.1) C0G characteristic: ±0.3% or ±0.3pF of initial measured value, whichever the absolute value is greater.
      4.2) X7R and X7S characteristics: Within ±15% of initial measured value.
   5) Dissipation factor
      As specified in paragraph L.3.8.2.

b) 1,000, 2,000, and 4,000-hour limits
   1) Insulation resistance (+125°C)
      30% or higher than the value specified in item b) of paragraph L.3.8.4.
   2) Externals
      There shall be no mechanical damage.
   3) Insulation resistance (+25°C)
      30% or higher than the value specified in item a) of paragraph L.3.8.4.
   4) Capacitance change
      4.1) C0G characteristic: ±0.5% or ±0.5pF of initial measured value, whichever the absolute value is greater.
      4.2) X7R and X7S characteristics: Within ±20% of initial measured value.
   5) Dissipation factor
      5.1) C0G characteristic: As specified in paragraph L.3.8.2.
      5.2) X7R and X7S characteristics: 3.0% maximum.

L.4 QUALITY ASSURANCE PROVISIONS

L.4.1 In-Process Inspection

Each manufacturing lot shall be subjected to the in-process inspections specified in Table L-8.Manufacturers may arbitrarily add the in-process inspection item in accordance with paragraph 4.3.

Table L-8. In-Process Inspection

Item no.	In-process inspection item	Requirement paragraph	Test method paragraph	Quantity of samples
1	Non-destructive internal inspection	L.3.4	L.4.4.4	All samples
2	Visual inspection	L.3.5.1	L.4.4.5	All samples

L.4.1.1 Rework

Rework shall not be conducted on any operations subsequent to the formation of slurry. Rework denotes reattempting processes such as re-firing ceramic or terminal electrodes, re-plating, or barrel polishing of finished products.

L.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4 and as follows.

L.4.2.1 Sample

Samples for the qualification test shall be taken from the inspection lot that has passed the in-process inspection. Manufacturers shall submit the sample units of the maximum nominal capacitance from a group that have the same characteristics, rated voltage, and terminal finish.

L.4.2.2 Test Items and Sample Size

Test items and sample size of qualification test shall be as specified in Table L-9. All samples shall be subjected to group I test before being divided for groups II through XI tests. Tests in group II and subsequent groups may be performed in the order listed regardless of group number. Tests in each group shall be performed in the order listed.

Table L-9. Qualification Test

Test			Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item			Quantity of samples	Quantity of allowable defectives
I	1	Thermal shock and voltage aging	L.3.10.4	L.4.4.9.4	241	0
	2	Insulation resistance (+125°C)	L.3.8.4	L.4.4.7.4		
	3	Dielectric withstanding voltage	L.3.8.3	L.4.4.7.3		
	4	Insulation resistance (+25°C)	L.3.8.4	L.4.4.7.4		
	5	Capacitance	L.3.8.1	L.4.4.7.1		
	6	Dissipation factor	L.3.8.2	L.4.4.7.2		
II	1	Externals, dimensions, mass and marking	L.3.5	L.4.4.5	15	0
	2	DPA	L.3.6.1	L.4.4.6.1		
III	1	Solderability	L.3.9.4	L.4.4.8.4	4	0
	2	Resistance to soldering heat	L.3.9.5	L.4.4.8.5	4	
IV	1	Voltage-temperature characteristics	L.3.8.5	L.4.4.7.5	12	0
	2	Moisture resistance	L.3.10.6	L.4.4.9.6		
V	1	Humidity, steady state, low voltage	L.3.10.7	L.4.4.9.7	12	0
VI	1	Life	L.3.11.1	L.4.4.10.1	123	0
VII	1	Barometric pressure (reduced)	L.3.10.8	L.4.4.9.8	6	0
VIII	1	Thermal shock and immersion cycling	L.3.10.5	L.4.4.9.5	18	0
IX	1	Deleted	-	-	-	-
	2	Deleted	-	-	-	
X	1	Thermal shock (I)	L.3.10.3	L.4.4.9.3	18	0
XI	1	Shear (Destructive)	L.3.9.1	L.4.4.8.1	6	0
	2	Substrate bending	L.3.9.3	L.4.4.8.3	3	
–	–	Material	L.3.2	–	(1)	

Note: (1) Documents shall be submitted to prove that the samples meet the design specification.

L.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

L.4.3.1 Sample

Sample selection for an inspection lot submitted to group A shall be as specified in paragraph 4.5.1.1.

The combination of materials, construction, etc. of the samples to be submitted for group B and group C inspections shall be specified in the quality assurance program plan. The composition of the inspection lot shall be in accordance with paragraph 4.5.2.1. If there is more than one lot in a combination submitted for group A inspection at the same time, the lot shall be composed by extracting a sample from the lot with the highest field strength among the lots.

L.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of quality conformance inspection shall be as specified in Table L-10 for group A, Table L-11 for group B, and table L-12 for group C. Group A inspection shall be performed in the order of subgroups listed in the table. Each inspection in each subgroup shall be performed in the order listed.

L.4.3.3 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in subgroup A2, 100% inspection shall be conducted for the rejected items as specified in paragraph H.3.3 of JAXA-QTS-2000, and conforming products may be delivered. The samples subjected to subgroups A3 and A4 shall not be delivered.

Table L-10. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Thermal shock and voltage aging	L.3.10.4	L.4.4.9.4	All samples	0
	2	Insulation resistance (+125°C)	L.3.8.4	L.4.4.7.4		
	3	Dielectric withstanding voltage	L.3.8.3	L.4.4.7.3		
	4	Insulation resistance (+25°C)	L.3.8.4	L.4.4.7.4		
	5	Capacitance	L.3.8.1	L.4.4.7.1		
	6	Dissipation factor	L.3.8.2	L.4.4.7.2		
A2	1	Externals, dimensions, mass and marking	L.3.5	L.4.4.5	20	0
A3	1	Humidity, steady state, low voltage	L.3.10.7	L.4.4.9.7	2	0
A4	1	DPA	L.3.6.1	L.4.4.6.1	Table L-14	

Table L-11. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Thermal shock	L.3.11.1	L.4.4.9.4.1	25	0
	2	Life		L.4.4.10.1		
B2	1	Moisture resistance	L.3.10.6	L.4.4.9.6	12	0
B3	1	Shear (Destructive)	L.3.9.1	L.4.4.8.1	6	0
	2	Solderability	L.3.9.4	L.4.4.8.4	6	
	3	Resistance to soldering heat	L.3.9.5	L.4.4.8.5	6	

Table L-12. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Barometric pressure (reduced)	L.3.10.8	L.4.4.9.8	6	0
C2	1	Thermal shock and immersion cycling	L.3.10.5	L.4.4.9.5	18	0
C3	1	Voltage-temperature characteristics	L.3.8.5	L.4.4.7.5	12	0
C4	1	Deleted	-	-	-	-
	2	Deleted	-	-	-	
C5	1	Thermal shock (I)	L.3.10.3	L.4.4.9.3	6	0
C6	1	Substrate bending	L.3.9.3	L.4.4.8.3	3	0

L.4.4 Methods for Test and Inspection

L.4.4.1 Test and Inspection Conditions

Test or inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202. The following details shall apply.

a) Standard conditions
The standard conditions shall be at 25±3°C, relative humidity between 25 and 75%, and atmospheric pressure between 86 and 106kPa. Unless otherwise specified, the tests and measurements shall be performed under standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions
Test conditions, which are the measurement conditions with narrowed tolerance, shall be used when high repeatability is required. The test conditions shall be at 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure between 86 and 106kPa.

c) Reference conditions
Reference conditions shall be used when conversion is required. The reference conditions shall be at 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If reference measurements have been made 30 days prior to the beginning of the aging test, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage.

L.4.4.2 Processing of the test capacitor

The following processing shall be conducted, if needed.

a) Preprocessing
The test capacitor shall be discharged for one hour or longer at the test temperature prior to tests and measurements.

b) Forced drying
Unless otherwise specified, the test capacitor shall be dried in accordance with Table L-13 prior to tests and measurements.

c) Heat conditioning (applicable to X7R and X7S characteristics)
If a dispute arises about the results of the capacitance measurements, capacitance re-measurement may be made after measuring other electrical characteristics. Prior to the re-measurement, the test capacitor shall be heated at 150°C for one hour and maintained under the standard conditions between 24 and 48 hours.

Table L-13. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6.0±0.5 hours

L.4.4.3 Mounting of Test Samples

The test capacitor shall be soldered on a test jig (95 to 99% alumina substrate) as shown in Figure L-3. The soldering shall be uniformly performed with a soldering iron or in a reflow process using tin-lead eutectic solder containing 3wt% or less silver (1). Avoid heat shock during soldering. For capacitors of terminal finishes “S”, “Y”, and “Z”, tin-lead solder of Sn/Pb = 60/40 or 63/37 may be used.

Note (1): The reason for using silver-contained solder is to reduce the silver diffusion rate from the terminal electrodes of the capacitors into the solder when soldered to the test board, and to prevent "silver leaching".

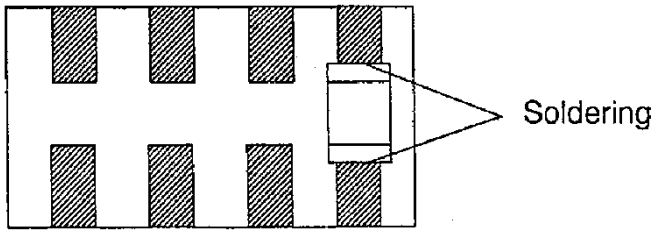


Figure L-3. Test Jig (Example)

L.4.4.4 Non-Destructive Internal Inspection

Capacitors shall be examined using ultrasonic test equipment or by a non-destructive internal inspection method which can verify that capacitors meet the requirements specified in paragraph L.3.4. The inspection method shall be defined in the detail specification and the details shall be documented to Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

L.4.4.5 Externals, Dimensions, Mass and Marking

Capacitors shall be tested for the externals and dimensions. The externals shall be examined under 10X magnification.

L.4.4.6 Workmanship

L.4.4.6.1 DPA

DPA shall be conducted in accordance with the DPA manual cited in Quality Assurance Program Plan after final terminal finish process. The DPA manual shall contain test procedures specified in EIA-469 or procedures which can verify that capacitors meet the requirements specified in EIA-469. The number of samples shall be as specified in Table L-14.

Table L-14. Sample Size of DPA

Lot size	Minimum no. of samples	Allowable no. of defects
1 to 500	5	0
501 to 10,000	10	0
10,001 to 35,000	25	0

L.4.4.7 Electrical Performance

Electrical performance tests shall be performed as follows.

L.4.4.7.1 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) Test frequency
   1) When the nominal capacitance is 100pF or smaller for X7R and X7S characteristics, and 1,000pF or smaller for C0G characteristic: 1MHz±100kHz.
   2) When the nominal capacitance exceeds 1) above: 1kHz±100Hz.

b) Test voltage: 1.0±0.2Vrms.

L.4.4.7.2 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge at the frequency and voltage specified in paragraph L.4.4.7.1. Measurement accuracy shall be sufficient for the requirement of dissipation factor. Suitable measuring techniques shall be used to minimize errors due to the connections between the measuring apparatus and the test capacitor.

L.4.4.7.3 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Test voltage
   250 to 400% of the DC rated voltage and as specified in the detail specification.

b) Duration of application of test voltage
5±1 seconds, and the test voltage shall be raised from 0V to the specified value within 1 second.
c) Point of application: Between terminals of the test capacitor.
d) Charged and discharged current: 50mA or less.
e) Inspections after test
The test capacitor shall be examined for evidence of damage and dielectric breakdown.

L.4.4.7.4 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.

a) Test conditions
1) Test voltage: Rated voltage.
2) Charged and discharged current: 50mA or less.
3) Duration of charging: 120^{+10}_{0} seconds.
b) Point of measurement: Between terminals.
c) Special condition
If a dispute arises about the determination at a relative humidity of over 50%, measurements may be repeated at a relative humidity of 50% or less.

L.4.4.7.5 Voltage–Temperature Characteristic

Capacitors shall be tested under the following conditions. As it is practically impossible to make measurement for C0G characteristic of smaller than 10pF capacitance, capacitors of 10pF or grater capacitance manufactured using the same materials shall be used.

a) For qualification test
The temperature of each test capacitor shall be varied as specified in Table L-15 and the capacitance shall be measured as specified in paragraph L.4.4.7.1. DC rated voltage shall be applied to the test capacitor in each step of E through G as shown in Table L-15 until the voltage is stabilized and capacitance measurement is made.
The measurement shall be made as specified in each step shown in Table L-15 and at sufficient number of points between steps B and G to obtain a characteristic curve. The measurement shall be made after reaching temperature equilibrium in each step.
b) For quality conformance inspection
The capacitance shall be measured as specified in paragraph L.4.4.7.1 at steps C, D, E, and G of Table L-15. The other conditions shall be as specified in item a) above.

Table L-15. Voltage-Temperature Cycling

Step	DC voltage applied	Temperature (°C)
A	N/A	+25±2
B	N/A	-55±2
C (1)	N/A	+25±2
D	N/A	+125±2
E	Rated voltage	+125±2
F	Rated voltage	+25±2
G	Rated voltage	-55±2

Note: (1) Reference point.

L.4.4.8 Mechanical Performance

Mechanical performance tests shall be performed as follows.

L.4.4.8.1 Shear (Destructive)

The shear test shall be performed in accordance with JIS Z 3198-7. The following details shall apply.

a) Mounting method:
   As specified in paragraph L.4.4.3.
b) Moving speed of shear test jig: 30±6mm/min.
c) Measurement and recording
   The maximum load shall be measured when sheared. The condition of the sheared area shall be visually examined under 10X magnification and the shear mode shall be selected from the Table L-16 and recorded.

Table L-16. Shear Mode

Symbol	Shear mode
A	Sheared ceramic
B	Separation between ceramic and terminal electrodes
C	Sheared solder
D1	Detachment of solder (from part surface)
D2	Detachment of solder (from board surface)
E	Peeling of the land on test board
F	Others

L.4.4.8.2 Shear

Deleted.

L.4.4.8.3 Substrate Bending

The capacitor shall be tested in accordance with paragraph 4.35 of JIS C 5101-1. The following details shall apply.

a) Mounting method
As specified in paragraph L.4.4.3. The material for the printed wiring board shall be 1.6mm thick glass epoxy resin copper clad laminate for printed wiring board and shall not affect the tests and measurements.
b) Measurement before test
The capacitance shall be measured and recorded as specified in paragraph L.4.4.7.1.
c) Flexure extent: 1mm.
d) Duration of pressure application: 5±1 seconds.
e) Measurement during test
The capacitance shall be measured and recorded as specified in paragraph L.4.4.7.1 applying pressure to the test printed wiring board.
f) Inspection after test
The test capacitor shall be visually examined for cracks and other damages under 10X magnification.

L.4.4.8.4 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.
a) Number of test terminals: All terminals.
b) Solder temperature: 230±5°C.
c) Duration of immersion: 5.0±0.5 seconds.
d) Depth of immersion
Each terminal shall be immersed into molten solder to the depth of $0.50^{+0.25}_{0}$ mm.
e) Inspections after test
The test capacitor shall be visually examined if it meets the requirements specified in paragraph L.3.9.4. If a dispute arises about the determination, the percent coverage with pinholes or rough spots shall be determined by actual measurement in these areas, as compared to the total area

L.4.4.8.5 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.
a) Mounting method
As specified in paragraph L.4.4.3.
b) Test condition: B.
c) Duration of cooling from immersion to measurement
10 minutes min. to 24 hours max.
d) Measurements before test
The capacitance, dissipation factor and insulation resistance at +25°C shall be measured and recorded as specified in paragraphs L.4.4.7.1, L.4.4.7.2, and L.4.4.7.4.
e) Inspections and measurements after test
The test capacitor shall be visually examined if it satisfies the requirements given in item a) of paragraph L.3.9.5 under 10X magnification. The capacitance,

dissipation factor, and insulation resistance at +25°C shall be measured as specified in paragraphs L.4.4.7.1, L.4.4.7.2, and L.4.4.7.4.

L.4.4.9 Environmental Performance

Environmental performance test shall be performed as follows.

L.4.4.9.1 Random Vibration

Deleted.

L.4.4.9.2 Shock

Deleted.

L.4.4.9.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in paragraph L.4.4.3. The solder thickness (filet height) shall be less than a half of the capacitor thickness (T) (see Table L-2)

b) Test condition: A, except that the temperature shall be -30^{0}_{-3}°C in step 1 and 100^{+3}_{0}°C in step 3.

c) Number of cycles: 1,000 cycles.

d) Measurements and inspection
The following measurements and inspection shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.

1) Electrical measurements
The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor shall be measured as specified in paragraphs L.4.4.7.3, L.4.4.7.4, L.4.4.7.1, and L.4.4.7.2.

2) Visual inspection
Capacitors shall be visually examined for mechanical damage under 10X magnification.

L.4.4.9.4 Thermal Shock and Voltage Aging

L.4.4.9.4.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ in step 3.

b) Number of cycles
1) Qualification test: 100 cycles.
2) Group A of quality conformance inspection: 20 cycles.
3) Group B of quality conformance inspection: 100 cycles.

L.4.4.9.4.2 Voltage Aging

Following the thermal shock specified in paragraph L.4.4.9.4.1, capacitors shall be tested as follows. A circuit shown in Figure L-4 shall be used to maintain at least

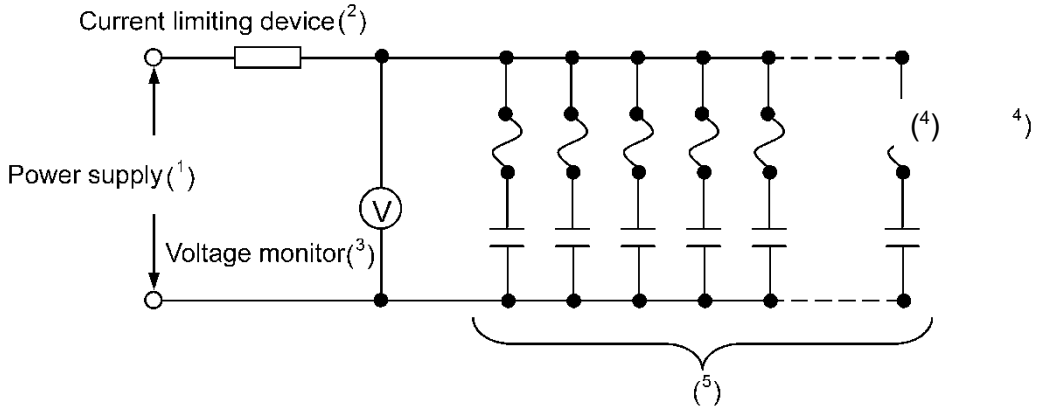
95% of the test voltage during the test. Blown fuses or the voltage drop to 95% of the specified voltage shall constitute failure of the test.

a) Temperature: $+125^{+4}_{0}$°C.

b) Applied voltage: 200±5% of the rated voltage.

c) Duration of application
168 hours or longer, and the test voltage shall be increased from 0 to the specified value within 2 minutes.

d) Inspection after test
After the test completion, the insulation resistance shall be measured as specified in paragraph L.4.4.7.4. The test capacitor may be transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall be made after the test capacitor is stabilized and during maintained at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph L.4.4.1 to visually examine for mechanical damage under 10X magnification. Then the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs L.4.4.7.3, L.4.4.7.4, L.4.4.7.1, and L.4.4.7.2.



Notes:

(1) The power supply shall be capable of providing at least twice the rated voltage of the capacitors at a leakage current of 30mA as a minimum.

(2) The current limiting device shall be a resistor and/or a fuse. The current shall be limited between 30mA and 10A.

(3) There shall be a voltage monitor that will trigger an alarm and shut off the test if the applied voltage drops by more than 5 percent.

(4) At the option of the manufacturer, a fuse or a resistor may be used. The value of the resistors and fuses shall be such that they do not restrict the power supply's ability to provide the required test voltage to the capacitor under test.

(5) The number of test capacitors per circuit shall be 10 or more.

Figure L-4. Test Circuit for Voltage Aging

L.4.4.9.5 Thermal Shock and Immersion Cycling

L.4.4.9.5.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in paragraph L.4.4.3. The solder thickness (filet height) shall be less than a half of the capacitor thickness (T) (see Table L-2)

b) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3.

c) Number of cycles: 250 cycles.

L.4.4.9.5.2 Immersion Cycling

Capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles).

b) Measurements and inspection after final cycle
The test capacitor shall be removed from a chamber, wiped, and air-blasted with room temperature air. After waiting 30 minutes, the following measurements and inspection shall be performed.

1) Electrical measurements
The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor shall be measured as specified in paragraphs L.4.4.7.3, L.4.4.7.4, L.4.4.7.1, and L.4.4.7.2.

2) Visual inspection
Capacitors shall be visually examined for mechanical damage under 10X magnification.

L.4.4.9.6 Moisuture Resistance

The moisture resistance shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement
The capacitance shall be measured as specified in paragraph L.4.4.7.1.

b) Number of cycles: Continuous 20 cycles.

c) Test procedure
For first 10 cycles, DC 50V or the rated voltage, whichever is smaller shall be applied to the both terminals. Occurrence of short-circuiting shall be checked once a day. Vibration cycle at step 7b shall not be performed.

d) Final measurements
After step 6 of the final cycle, the test capacitor shall be exposed at 25±5°C, 30 to 60%RH for 18 to 24 hours, and visually examined for mechanical damage under 10X magnification. Then the capacitance, dielectric withstanding voltage, and insulation resistance at +25°C shall be measured as specified in paragraphs L.4.4.7.1, L.4.4.7.3, and L.4.4.7.4.

L.4.4.9.7 Humidity, Steady State, Low Voltage

Capacitors shall be tested in accordance with test method 103, test condition A of MIL-STD-202. The following details shall apply.

Under no circumstances during the test, shall the voltage applied to test capacitors exceed 1.5V.

a) Mounting method
As specified in paragraph L.4.4.3.

b) Initial measurement
The capacitance shall be measured as specified in paragraph L.4.4.7.1.

c) Test procedure
The test capacitor shall be exposed at +85°C and 85%RH for at least 240 hours. The test shall be performed as a single test not as a cycling test. DC voltage of $1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor through a 100kΩ resistor.

d) Final measurements
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes. After stabilizing, the insulation resistance shall be measured as specified in paragraph L.4.4.7.4 except for applying a DC voltage of $1.3^{+0.20}_{-0.25}$V via a 100kΩ resistor, then the capacitance shall be measured as specified in paragraph L.4.4.7.1.

e) Post-test inspection
After the final measurements, capacitors shall be visually examined for evidence of mechanical damage under 10X magnification.

L.4.4.9.8 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in paragraph L.4.4.3.
Other appropriate measures may be taken provided that no dispute will arise about the determination.

b) Test condition: D (1.1kPa).

c) Applied voltage
1) When the rated voltage is 200V or lower: 150% of the rated voltage.
2) When the rated voltage is over 200V: 300V.

d) Duration of application: 5±1 seconds.

e) Charged and discharged current: 50mA or less.

f) Post-test inspections
Capacitors shall be examined for evidence of damage, arcing, open-circuiting, and short-circuiting.

L.4.4.10 Durability Performance

Durability performance test shall be performed as follows.

L.4.4.10.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Distance between the test capacitor and temperature measuring position: Not applicable.

b) Test temperature: $+125^{+4}_{0}$°C.

c) Test voltage and test circuit shall be as specified in paragraph L.4.4.9.4.2. In case of blown fuse, the determination shall also be as specified in L.4.4.9.4.2.
d) Charged and discharged current: 50mA or less.
e) Duration of voltage application
   1) Qualification test: $4{,}000^{+72}_{0}$ hours.
   2) Quality conformance inspection (Group B): $1{,}000^{+48}_{0}$ hours.
f) Measurements and inspection during and after test
   At each completion of 250 hours, 1,000 hours, 2,000 hours, and 4,000 hours of life test, the insulation resistance shall be measured as specified in paragraph L.4.4.7.4 while the capacitor is maintained at the test temperature. The test capacitor may be transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall be made after the test capacitor is stabilized and during maintained at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph L.4.4.1 to visually examine for mechanical damage under 10X magnification. Then the capacitance, dissipation factor, and insulation resistance shall be measured as specified in paragraphs L.4.4.7.1, L.4.4.7.2, and L.4.4.7.4.

L.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.
a) Capacitance (paragraph L.3.8.1)
b) Dissipation factor (paragraph L.3.8.2)
c) Insulation resistance (paragraph L.3.8.4)
d) Dielectric withstanding voltage (paragraph L.3.8.3)

Inspection for the solderability and resistance to soldering heat shall be performed using samples as shown in Table L-11 for each terminal finish. The date of re-inspection shall be marked on the packages or storage containers. The rejected lot shall not be shipped.

L.4.6 Changes to Tests and Inspections

Changes to tests and inspections shall be as specified in paragraph 4.8.

L.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

L.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX M

CAPACITORS, MINIATURE, HIGH-CAPACITY,
SURFACE MOUNT, FINE CERAMIC DIELECTRIC

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: 19 August 2025

APPENDIX M

CAPACITORS, MINIATURE, HIGH-CAPACITY, SURFACE MOUNT, FINE CERAMIC DIELECTRIC

M.1 GENERAL

M.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for fine ceramic dielectric, high-capacity, miniature, surface mount capacitors (hereinafter referred to as "capacitors") with dielectric of less than 12μm in thickness.

M.1.2 Classification

Capacitors shall be classified as specified in Table M-1.

Table M-1. Classification

Structure	Style
Rectangular, electrode in both directions	1005, 1608, 3216, 3225

M.1.3 Part Number

The part number shall be indicated as follows. See the detail specification for details.
(Example)

JAXA([1]) 2040/M 105 3216 X7R A 226 K S

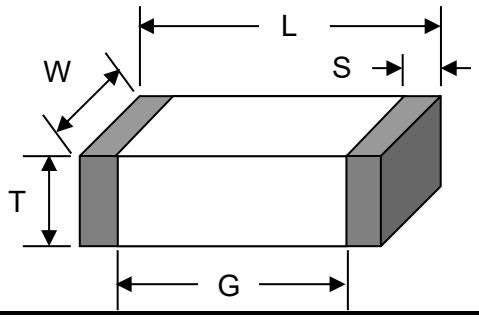
105	3216	X7R	A	226	K	S
Individual Identification	Style (M.1.3.1)	Characteristic (M.1.3.2)	Rated voltage (M.1.3.3)	Nominal Capacitance (M.1.3.4)	Capacitance tolerance (M.1.3.5)	Terminal finish (M.1.3.6)

Note: ([1]) "JAXA" indicates the part is for space use and may be abbreviated “J”.

M.1.3.1 Style

The style indicates the outline dimensions of the capacitor and shall be identified with a four-digit number as shown in Table M-2. The detailed dimensions shall be as specified in the detail specification. The detail specification shall specify at least length, width, thickness, electrode gap, and band width of capacitors.

Table M-2. Style



(Unit: mm)

Style	Physical Dimension						
	Length (L)		Width (W)		Thickness (T)	Electrode Gap (G)	Band width (S)
	Max.	Min.	Max.	Min.			
1005	1.10	0.90	0.60	0.40	As specified in the detail specification	As specified in the detail specification	As specified in the detail specification
1608	1.80	1.50	1.00	0.70			
3216	3.60	3.05	1.90	1.45			
3225	3.60	2.90	2.80	2.30			

M.1.3.2 Characteristics

The characteristic shall be identified in accordance with paragraph 1.3.2 of EIA-198-1 as shown in Table M-3.

Table M-3. Voltage–Temperature Characteristics

Symbol	Operating temperature range (°C)	Capacitance change from temperature +25°C	
		Steps A to D of Table M-15 (no voltage applied)	Steps E to G of Table M-15 (rated voltage applied)
X7R	-55 to +125	±15%	– (1)
X7S	-55 to +125	±22%	– (1)

Note: (1) Detailed information shall be provided in application data sheet.

M.1.3.3 Rated Voltage

The rated voltage shall be identified by a single capital letter as specified in Table M-4.

Table M-4. Rated Voltage

(Unit: V_{DC})

Symbol	Rated voltage
A	3.5
B	8.0
C	25.0

M.1.3.4 Nominal Capacitance

The nominal capacitance value expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit

denotes the number of zeros to follow. For example, 104 indicates 0.1μF, 105 indicates 1.0μF, and 226 indicates 22μF.

M.1.3.5 Capacitance Tolerance

The capacitance tolerance shall be identified by a single capital letter as specified in Table M-5.

Table M-5. Capacitance Tolerance

Symbol	Capacitance tolerance
J	±5%
K	±10%
M	±20%

M.1.3.6 Terminal Finish

The terminal finish shall be identified by a single capital letter as specified in Table M-6. Tin whisker may grow because 100% tin is used for the terminal finish “Y.” (see paragraph 6.2.2).

Table M-6. Terminal Finish

Symbol	Terminal finish
S	Solder coated over layer to prevent solder dissolution
Y	100% Sn plated over base Ni barrier
Z	Solder plated over base metallization barrier (Sn/Pb alloy with a minimum of 4% (in weight) Pb)
R	Resin electrode, Ni plating, Sn plating and Solder (SnPb) plating on the base metal

M.2 APPLICABLE DOCUMENTS

M.2.1 Applicable Documents

The applicable documents for this appendix are as follows and as specified in paragraph 2.1.

a) EIA-198-1 Ceramic Dielectric Capacitors Classes I, II, III and IV
Part I: Characteristics and Requirements

b) EIA 469 Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors

c) JIS C 5101-1 Fixed Capacitors for Use in Electronic Equipment
Part 1: Generic Specification

d) JIS Z 3098-7 Test methods for lead-free solders-Part 7: Method for shear strength of solder joints on chip components

M.3 REQUIREMENTS

M.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs M.3.2 to M.3.11. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

M.3.1.1 Restriction of Qualification

Nominal capacitance qualification shall be restricted to values equal to and less than the nominal capacitance of capacitors submitted to the qualification test. Qualification of characteristics, rated voltage, and terminal finish shall be also restricted to those of capacitors submitted to the qualification test. For the product family, the combination of materials, construction, etc. of the specimens to be tested shall be specified in the quality assurance program plan.

M.3.2 Materials

The materials shall be specified as follows and as specified in paragraph 3.3.

a) Materials of capacitor element
Ceramic shall be used as the dielectric.

b) Terminal finish
The terminal finish shall be any of those shown in Table M-6 and as specified in the detail specification. The finish shall be properly processed to facilitate soldering.

M.3.3 Design and Constructions

The design and constructions of capacitors shall be as specified in the detail specification.

M.3.4 Non-Destructive Internal Inspection

All capacitors shall be subjected to an ultrasonic inspection or non-destructive internal inspection specified in the detail specification to verify the functionality. When tested as specified in paragraph M.4.4.4, capacitors shall not exhibit any defects such as delamination, voids, and cracks.

M.3.5 Externals, Dimension, Mass and Marking

When tested as specified in paragraph M.4.4.5, capacitors shall meet the following requirements.

M.3.5.1 Externals

The externals shall meet the following requirements. Other details shall be specified in the detail specification.

a) Terminals
   1) End surfaces of terminals shall be thoroughly covered with terminal finish. Pinholes of φ0.13mm or greater shall not be allowed. The maximum number of pinholes per surface shall be less than four.
   2) Edge chip-out shall be less than 10%.

3) There shall not be visible foreign matters or voids that expose base metal 5% or more.

b) Ceramic surface

1) There shall be no cracks.
2) There shall be no delamination.
3) Edge chip-out shall be less than 0.08mm in depth with respect to each plane.
4) Edges shall not have irregular shapes.
5) There shall be no fused dusts or excess ceramic materials that prevent a chip from lying flat, or protrude of 0.08mm or greater out of a surface.
6) There shall be no blisters or bubbles of 0.05mm or greater on a surface.
7) The clearance (warpage) at the center of the chip shall be less than 5% of the length of capacitor (L) (see Table M-2) when compared to a flat surface.
8) There shall be no pinholes or dents of φ0.05mm or greater.
9) There shall be no holes or voids that expose the internal electrodes.

M.3.5.2 Dimenstions

Dimensions of capacitors shall meet the values specified in the detail specification.

M.3.5.2.1 Dielectirc

Voids shall not reduce the total thickness of ceramic dielectric by more than 50% (see Figure M-1).

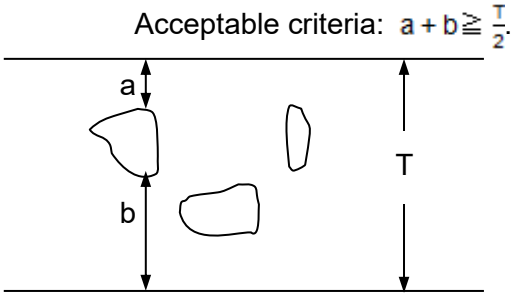


Figure M-1. Criteria for Dielectric Thickness (Example)

M.3.5.3 Marking

The marking shall be provided not on a capacitor body but on individual package or packaging. Marked items shall be as specified in paragraph 5.2.

M.3.6 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.

M.3.6.1 DPA

When tested as specified in paragraph M.4.4.6.1, capacitors shall meet the requirements specified in EIA-469 and paragraph M.3.5.2.1. The items to be verified in DPA shall be specified in the detail specification and the details shall be in accordance with the DPA manual. In addition, capacitors shall also meet the requirements for materials, design, and construction specified in the detail specification.

M.3.7 Rating

The following items shall be specified in the detail specification.

a) Voltage–temperature characteristics
b) Rated voltage
c) Nominal capacitance
d) Capacitance tolerance

M.3.8 Electrical Performance

Capacitors shall meet the following requirements.

M.3.8.1 Capacitance

When tested as specified in paragraph M.4.4.7.1, the capacitance shall be within the tolerance specified in the detail specification.

M.3.8.2 Dissipation Factor (tan δ)

When tested as specified in paragraph M.4.4.7.2, the dissipation factor (tan δ) shall be 15% or less.

M.3.8.3 Dielectric Withstanding Voltage

When tested as specified in paragraph M.4.4.7.3, there shall be no damage or insulation breakdown.

M.3.8.4 Insulation Resistance

When tested as specified in paragraph M.4.4.7.4, the insulation resistance shall meet the following requirements.

a) At +25°C: 100Ω·F or more.
b) At +125°C: 10Ω·F or more.

M.3.8.5 Voltage–Temperature Characteristics

When tested as specified in paragraph M.4.4.7.5, the capacitance change shall not exceed the limit specified in Table M-3. The capacitance obtained at step C in Table M-15 shall be the reference value.

M.3.9 Mechanical Performance

Capacitors shall meet the following requirements.

M.3.9.1 Shear (Destructive)

When tested as specified in paragraph M.4.4.8.1, the shear strength shall not fall below the value specified in Table M-7 and shall have no separation between ceramic and terminal electrodes (symbol "B" of Table M-16) or detachment of the solder (symbol "D1" of Table M-16).
If the capacitors exhibit the detachment of shear modes, symbols “D2” or “E” shown in Table M-16 under the shear strength equal to or less than the minimum shear strength shown in Table M-7, the capacitors may be re-tested.

Table M-7. Minimum Shear Strength

Unit: N

Style	Minimum shear strength
1005	5N
1608	15N
3216	30N
3225	60N

M.3.9.2 Substrate Bending

When tested as specified in paragraph M.4.4.8.2, capacitors shall meet the following requirements.

a) Externals: There shall be no crack or other damages.
b) Capacitance change: Within ±10% of initial measured value.

M.3.9.3 Solderability

When tested as specified in paragraph M.4.4.8.3, the dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain only small pinholes or rough spots and shall not be concentrated in one area.

M.3.9.4 Resistance to Soldering Heat

When tested as specified in paragraph M.4.4.8.4, capacitors shall meet the following requirements.

a) Externals
   There shall be no evidence of mechanical damage, peeling or exposed internal electrodes. Dissolution of electrodes shall be a maximum of 25% on each edge of the mounting area (see Figure M-2).
b) Insulation resistance (at +25°C): The insulation resistance shall meet the requirements specified in item a) of paragraph M.3.8.4.
c) Capacitance change: Within ±7.5% of initial measured value.
d) Dissipation factor (tan δ): As specified in paragraph M.3.8.2.

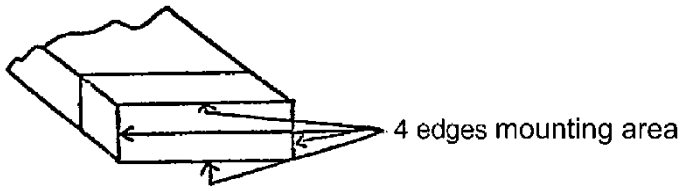


Figure M-2. Mounting Area

M.3.10 Environmental Performance

Capacitors shall meet the following requirements.

M.3.10.1 Random Vibraion

Deleted.

M.3.10.2 Shock

Deleted.

M.3.10.3 Thermal Shock (I)

When tested as specified in paragraph M.4.4.9.3, capacitors shall meet the following requirements.

a) Externals: There shall be no mechanical damage.
b) Dielectric withstanding voltage: As specified in paragraph M.3.8.3.
c) Insulation resistance (+25°C)
   30% or greater than the value specified in item a) of paragraph M.3.8.4.
d) Capacitance change: Within ±10% of initial measured value.
e) Dissipation factor (tan δ): As specified in paragraph M.3.8.2.

M.3.10.4 Thermal Shock and Voltage Aging

When tested as specified in paragraph M.4.4.9.4, capacitors shall meet the following requirements.

a) Insulation resistance (+125°C): As specified in item b) of paragraph M.3.8.4.
b) Externals: There shall be no mechanical damage.
c) Dielectric withstanding voltage: As specified in paragraph M.3.8.3.
d) Insulation resistance (+25°C): As specified in item a) of paragraph M.3.8.4.
e) Capacitance: As specified in paragraph M.3.8.1.
f) Dissipation factor (tan δ): As specified in paragraph M.3.8.2..

M.3.10.5 Thermal Shock and Immersion Cycling

When tested as specified in paragraph M.4.4.9.5, capacitors shall meet the following requirements.

a) Externals: There shall be no mechanical damage.
b) Dielectric withstanding voltage: As specified in paragraph M.3.8.3.
c) Insulation resistance (+25°C): 50% or higher than the value specified in item a) of paragraph M.3.8.4.
d) Capacitance change: Within ±10% of initial measured value.
e) Dissipation factor (tan δ): As specified in M.3.8.2.

M.3.10.6 Moisture Resistance

When tested as specified in paragraph M.4.4.9.6, capacitors shall meet the following requirements.

a) Externals: There shall be no mechanical damage.
b) Dielectric withstanding voltage: As specified in M.3.8.3.
c) Insulation resistance (+25°C): 50% or higher than the value specified in item a) of paragraph M.3.8.4.
d) Capacitance change: Within ±10% of initial measured value.

M.3.10.7 Humidity, Steady State, Low Voltage

When tested as specified in paragraph M.4.4.9.7, capacitors shall meet the following requirements.

a) Externals: There shall be no mechanical damage.
b) Insulation resistance (+25°C): As specified in item a) of paragraph M.3.8.4.
c) Capacitance change: Within ±10% of initial measured value.

M.3.10.8 Barometric Pressure (Reduced)

When tested as specified in M.4.4.9.8, capacitors shall not exhibit damage, instantaneous/intermittent arcing, open-circuiting, or short-circuiting.

M.3.11 Durability Performance

Capacitors shall meet the following requirements.

M.3.11.1 Life

When tested as specified in paragraph M.4.4.10.1, capacitors shall meet the following requirements.

a) 250-hour limits
   1) Insulation resistance (+125°C): 50% or higher than the value specified in item b) of paragraph M.3.8.4.
   2) Externals: There shall be no mechanical damage.
   3) Insulation resistance (+25°C): 50% or higher than the value specified in item a) of paragraph M.3.8.4.
   4) Capacitance change: Within ±15% of initial measured value
   5) Dissipation factor (tan δ): As specified in paragraph M.3.8.2.

b) 1,000, 2,000, and 4,000-hour limits
   1) Insulation resistance (+125°C): 30% or higher than the value specified in item b) of paragraph M.3.8.4.
   2) Externals: There shall be no mechanical damage.
   3) Insulation resistance (+25°C): 30% or higher than the value specified in item a) of paragraph M.3.8.4.
   4) Capacitance change: Within ±20% of initial measured value.
   5) Dissipation factor (tan δ): As specified in paragraph M.3.8.2.

M.4 QUALITY ASSURANCE PROVISIONS

M.4.1 In-Process Inspection

Each manufacturing lot shall be subjected to the in-process inspections specified in Table M-8.

At the manufacturer's option, in-process inspections other than those specified in Table M-8 may be performed in accordance with paragraph 4.3.

Table M-8. In-Process Inspection

Item no.	In-process inspection item	Requirement Paragraph	Test method Paragraph	Quantity of samples
1	Non-destructive internal inspection	M.3.4	M.4.4.4	All samples
2	Visual inspection	M.3.5.1	M.4.4.5	All samples

M.4.1.1 Rework

Rework shall not be conducted on any operations subsequent to the formation of slurry. Rework denotes reattempting processes such as re-firing ceramic or terminal electrodes, re-plating, or barrel polishing of finished products.

M.4.2 Qualification Test

Qualification test shall be as follows and as specified in paragraph 4.4.

M.4.2.1 Sample

Samples for the qualification test shall be taken from the inspection lot that has passed the in-process inspection. Manufacturer shall submit the sample units of the maximum nominal capacitance from a group that have the same characteristics, rated voltage, and terminal finish.

M.4.2.2 Test Items and Sample Size

Test items and sample size of qualification test shall be as specified in Table M-9. All samples shall be subjected to group I test before being divided for groups II through XI tests. Tests in group II and subsequent groups may be performed in the order listed regardless of group number. Tests in each group shall be performed in the order listed.

Table M-9. Qualification Test

Test			Requirement Paragraph	Test method Paragraph	Pass/fail	
Group	Order	Item			Quantity of samples	Quantity of allowable defectives
I	1	Thermal shock and voltage aging	M.3.10.4	M.4.4.9.4	241	0
	2	Insulation resistance (+125°C)	M.3.8.4	M.4.4.7.4		
	3	Dielectric withstanding voltage	M.3.8.3	M.4.4.7.3		
	4	Insulation resistance (+25°C)	M.3.8.4	M.4.4.7.4		
	5	Capacitance	M.3.8.1	M.4.4.7.1		
	6	Dissipation factor (tan δ)	M.3.8.2	M.4.4.7.2		
II	1	Externals, dimensions, mass and marking	M.3.5	M.4.4.5	15	0
	2	DPA	M.3.6.1	M.4.4.6.1		
III	1	Solderability	M.3.9.3	M.4.4.8.3	4	
	2	Resistance to soldering heat	M.3.9.4	M.4.4.8.4	4	
IV	1	Voltage-temperature characteristics	M.3.8.5	M.4.4.7.5	12	0
	2	Moisture resistance	M.3.10.6	M.4.4.9.6		
V	1	Humidity, steady state, low voltage	M.3.10.7	M.4.4.9.7	12	0
VI	1	Life	M.3.11.1	M.4.4.10.1	123	0
VII	1	Barometric pressure (reduced)	M.3.10.8	M.4.4.9.8	6	0
VIII	1	Thermal shock and immersion cycling	M.3.10.5	M.4.4.9.5	18	0
IX	1	Deleted	-	-	-	-
	2	Deleted	-	-	-	
X	1	Thermal shock (I)	M.3.10.3	M.4.4.9.3	18	0
XI	1	Shear (destructive)	M.3.9.1	M.4.4.8.1	6	0
	2	Substrate bending	M.3.9.2	M.4.4.8.2	3	
–	–	Material	M.3.2	–	(1)	

Note: (1) Documents shall be submitted to prove that the samples meet the design specification.

M.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as follows and as specified in paragraph 4.5.

M.4.3.1 Sample

Sample selection for an inspection lot submitted to group A shall be as specified in paragraph 4.5.1.1. The combination of materials, construction, etc. of the samples subjected to group B and group C inspections shall be specified in the quality assurance program plan. The composition of the inspection lot shall be in accordance with paragraph 4.5.2.1. If there is more than one lot in a combination submitted for group A inspection at the same time, the lot shall be composed by extracting a sample from the lot with the highest electrical field strength among the lots.

M.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of quality conformance inspection shall be as specified in Table M-10 for group A, Table M-11 for group B, and Table M-12 for group C. Group A inspection shall be performed in the order of subgroups listed in the table. Each inspection in each subgroup shall be performed in the order listed.

M.4.3.3 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in subgroup A2, 100% inspection shall be conducted for the rejected items as specified in paragraph H.3.3 of JAXA-QTS-2000, and conforming products may be delivered. The samples used in subgroups A3 and A4 shall not be delivered.

Table M-10. Quality Conformance Inspection (Group A)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Thermal shock and voltage aging	M.3.10.4	M.4.4.9.4	All samples	0
	2	Insulation resistance (+125°C)	M.3.8.4	M.4.4.7.4		
	3	Dielectric withstanding voltage	M.3.8.3	M.4.4.7.3		
	4	Insulation resistance (+25°C)	M.3.8.4	M.4.4.7.4		
	5	Capacitance	M.3.8.1	M.4.4.7.1		
	6	Dissipation factor (tan δ)	M.3.8.2	M.4.4.7.2		
A2	1	Externals, dimensions, mass and marking	M.3.5	M.4.4.5	20	0
A3	1	Humidity, steady state, low voltage	M.3.10.7	M.4.4.9.7	12	0
A4	1	DPA	M.3.6.1	M.4.4.6.1	Table M-14	

Table M-11. Quality Conformance Inspection (Group B)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Thermal shock	M.3.11.1	M.4.4.9.4.1	25	0
	2	Life		M.4.4.10.1		
B2	1	Moisture resistance	M.3.10.6	M.4.4.9.6	12	0
B3	1	Shear (Destructive)	M.3.9.1	M.4.4.8.1	6	0
	2	Solderability	M.3.9.3	M.4.4.8.3	6	0
	3	Resistance to soldering heat	M.3.9.4	M.4.4.8.4	6	0

Table M-12. Quality Conformance Inspection (Group C)

Inspection			Requirement Paragraph	Test method Paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Thermal shock and immersion cycling	M.3.10.5	M.4.4.9.5	18	0
C2	1	Voltage-temperature characteristics	M.3.8.5	M.4.4.7.5	12	0
C3	1	Deleted	-	-	-	-
	2	Deleted	-	-		
C4	1	Substrate bending	M.3.9.2	M.4.4.8.2	3	0

M.4.4 Methods for Test and Inspection

M.4.4.1 Test and Inspection Conditions

Test or inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202. The following details shall apply.

a) Standard conditions
The standard conditions shall be at 15 to 35°C, relative humidity between 25 and 75%, and atmospheric pressure between 86 and 106kPa. Unless otherwise specified, the tests and measurements shall be performed under standard conditions. If the conditions are needed to be tightly controlled for repeatability, b) Test conditions shall apply. If conversion is needed, c) Reference condition shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions
The test conditions shall be at 25^{0}_{-2}°C, a relative humidity of 50±2%, and an atmospheric pressure between 86 and 106kPa.

c) Reference conditions
The reference conditions shall be at 25°C, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If reference measurements have been made 30 days prior to the beginning of the aging test, they shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.

f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage.

M.4.4.2 Processing of the test capacitor

The following processing shall be conducted, if needed.

a) Preprocessing
The test capacitor shall be discharged for one hour or longer at the test temperature before tests and measurements.

b) Forced drying
Unless otherwise specified, the test capacitor shall be dried in accordance with Table M-13 before tests and measurements.

c) Heat conditioning
Capacitance measurement shall be made after measuring other electrical characteristics. Prior to the measurement, the test capacitor shall be heated at 150°C for one hour and maintained under the standard conditions between 24 and 48 hours.

Table M-13. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6.0±0.5 hours

M.4.4.3 Mounting of Test Samples

The test capacitor shall be soldered on a test jig (thickness of 0.635±0.05mm and 95% or more alumina substrate) as shown in Figure M-3. The soldering shall be uniformly performed with a soldering iron or in a reflow process using tin-lead eutectic solder containing 3wt% silver [(1)]. Avoid heat shock during soldering. Tin-lead solder of Sn/Pb = 60/40 or 63/37 may be used.

Note: [(1)] The reason for using silver-contained solder is to reduce the silver diffusion rate from the terminal electrodes of the capacitors into the solder when soldered to the test board, and to prevent "silver leaching".

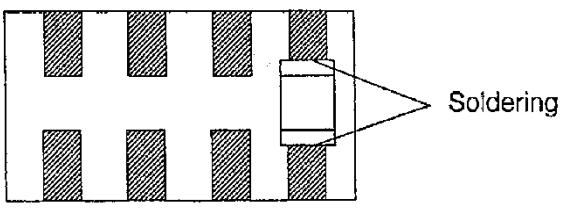


Figure M-3. Test Jig (Example)

M.4.4.4 Non-Destructive Internal Inspection

Capacitors shall be examined using ultrasonic test equipment or by a non-destructive internal inspection method which can verify that capacitors meet the requirements specified in paragraph M.3.4. The inspection method shall be defined in the detail specification. The details shall be documented to Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

M.4.4.5 Externals, Dimensions, Mass and Marking

Capacitors shall be tested for the externals and dimensions. The externals shall be examined under 10X magnification.

M.4.4.6 Workmanship

M.4.4.6.1 DPA

DPA shall be conducted in accordance with the DPA manual cited in the Quality Assurance Program Plan after final terminal finish process. The DPA manual shall contain test procedures specified in EIA-469 or procedures which can verify that capacitors meet the requirements specified in EIA-469. The number of samples shall be as specified in Table M-14.

Table M-14. Sample Size of DPA

Lot size	Minimum no. of samples	Allowable no. of defects
1 to 500	5	0
501 to 10,000	10	0
10,001 to 35,000	25	0

M.4.4.7 Electrical Performance

Electrical performance test shall be performed as follows.

M.4.4.7.1 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following details shall apply.

a) For a capacitor with capacitance of 10μF or less.
   1) Test frequency: 1.0kHz±100Hz.
   2) Test voltage:
      For rated voltage of 3.15V or less: 0.5±0.1Vrms.
      For rated voltage exceeding 3.15V: 1.0±0.2Vrms.

b) For a capacitor with capacitance exceeding 10μF
   1) Test frequency: 120±24Hz.
   2) Test voltage: 0.5±0.1Vrms.

M.4.4.7.2 Dissipation Factor (tan δ)

Capacitors shall be tested using appropriate equipment such as a capacitance bridge at the frequency and voltage specified in paragraph M.4.4.7.1. Measurement accuracy shall be sufficient for the requirement of dissipation factor (tan δ). Suitable measuring techniques shall be used to minimize errors due to the

connections between the measuring apparatus and the test capacitor.

M.4.4.7.3 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Test voltage: 250% of the DC rated voltage.
b) Duration of application of test voltage: 5±1 seconds, and the test voltage shall be raised from 0 to the specified value within 1 second.
c) Point of application: Between terminals of the test capacitor.
d) Charged and discharged current: 50mA or less.
e) Inspections after test: The test capacitor shall be examined for evidence of damage and dielectric breakdown.

M.4.4.7.4 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.

a) Test conditions
   1) Test voltage: Rated voltage.
   2) Charged and discharged current: 50mA or less.
   3) Duration of charging: 120^{+10}_{0} seconds.
b) Point of measurement: Between terminals.
c) Special condition:
   If a dispute arises about the determination at a relative humidity of over 50%, measurements may be repeated at a relative humidity of 50% or less.

M.4.4.7.5 Voltage–Temperature Characteristic

a) For qualification test
   The temperature of each test capacitor shall be varied as specified in Table M-15 and the capacitance shall be measured as specified in paragraph M.4.4.7.1. DC rated voltage shall be applied to the test capacitor in each step of E through G until the voltage is stabilized and capacitance measurement is made.
   The measurement shall be made as specified in each step shown in Table M-15 and at sufficient number of points between steps B and G to obtain a characteristic curve. The measurement shall be made after reaching temperature equilibrium in each step.
b) For quality conformance inspection
   The capacitance shall be measured as specified in paragraph M.4.4.7.1 at steps C, D, E, and G of Table M-15. The other conditions shall be as specified in item a) above.

Table M-15. Voltage-Temperature Cycling

Step	DC voltage applied	Temperature (°C)
A	N/A	+25±2
B	N/A	-55±2
C (1)	N/A	+25±2
D	N/A	+125±2
E	Rated voltage	+125±2
F	Rated voltage	+25±2
G	Rated voltage	-55±2

Note: (1) Reference point.

M.4.4.8 Mechanical Performance

Mechanical performance tests shall be performed as follows.

M.4.4.8.1 Shear (Destructive)

The shear test shall be performed in accordance with JIS Z 3198-7. The following details shall apply.

a) Mounting method:
As specified in paragraph M.4.4.3.

b) Moving speed of shear test jig: 30±6mm/min.

c) Measurement and recording
The maximum load shall be measured when sheared. The condition of the sheared area shall be visually examined under 10X magnification and the shear mode shall be selected from Table M-16 and recorded.

Table M-16. Shear Mode

Symbol	Shear mode
A	Sheared ceramic
B	Separation between ceramic and terminal electrodes
C	Sheared solder
D1	Detachment of solder (from part surface)
D2	Detachment of solder (from board surface)
E	Peeling of the land on test board
F	Others

M.4.4.8.2 Substrate Bending

The capacitor shall be tested in accordance with paragraph 4.35 of JIS C 5101-1. The following details shall apply.

a) Mounting method
As specified in paragraph M.4.4.3. The material for the printed wiring board shall be 1.6±0.2mm thick glass epoxy resin copper clad laminate for printed wiring board and shall not affect the tests and measurements.

b) Pre-test measurement
The capacitance shall be measured and recorded as specified in paragraph M.4.4.7.1.

c) Flexure extent: 1mm.

d) Duration of pressure application: 5±1 seconds.
e) Measurement during test
The capacitance shall be measured and recorded as specified in paragraph M.4.4.7.1 applying pressure to the test printed wiring board.
f) Inspection after test
The test capacitor shall be visually examined for cracks and other damages under 10X magnification.

M.4.4.8.3 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.
a) Number of test terminals: All terminals.
b) Solder temperature: 230±5°C.
c) Duration of immersion: 5.0±0.5 seconds.
d) Depth of immersion
Each terminal shall be immersed into molten solder to the depth of $0.50^{+0.25}_{0}$ mm.
e) Inspections after test
The test capacitor shall be visually examined if it meets the requirements specified in paragraph M.3.9.3. If a dispute arises about the determination, the percent coverage with pinholes or rough spots shall be determined by actual measurement in these areas, as compared to the total area.

M.4.4.8.4 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.
a) Mounting method
As specified in paragraph M.4.4.3.
b) Test condition: B
c) Duration of cooling from immersion to measurement
10 minutes min. to 24 hours max.
d) Measurements before test
The capacitance, dissipation factor (tan δ) and insulation resistance at +25°C shall be measured and recorded as specified in paragraphs M.4.4.7.1, M.4.4.7.2, and M.4.4.7.4.
e) Inspections and measurements after test.
The test capacitor shall be visually examined if it satisfies the requirements given in item a) of paragraph M.3.9.4 under 10X magnification. The capacitance, dissipation factor (tan δ), and insulation resistance at +25°C shall be measured as specified in paragraphs M.4.4.7.1, M.4.4.7.2, and M.4.4.7.4.

M.4.4.9 Environmental Performance

Environmental performance tests shall be performed as follows.

M.4.4.9.1 Random Vibration

Deleted.

M.4.4.9.2 Shock

Deleted.

M.4.4.9.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method: As specified in paragraph M.4.4.3.
b) Test condition: A, except that the temperature shall be -30^{0}_{-3}°C in step 1 and 100^{+3}_{0}°C in step 3.
c) Number of cycles: 1,000 cycles.
d) Measurements and inspection
   The following measurements and inspection shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.
   1) Electrical measurements:
      The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs M.4.4.7.3, M.4.4.7.4, M.4.4.7.1, and M.4.4.7.2.
   2) Visual inspection:
      Capacitors shall be visually examined for mechanical damage under 10X magnification.

M.4.4.9.4 Thermal Shock and Voltage Aging

M.4.4.9.4.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

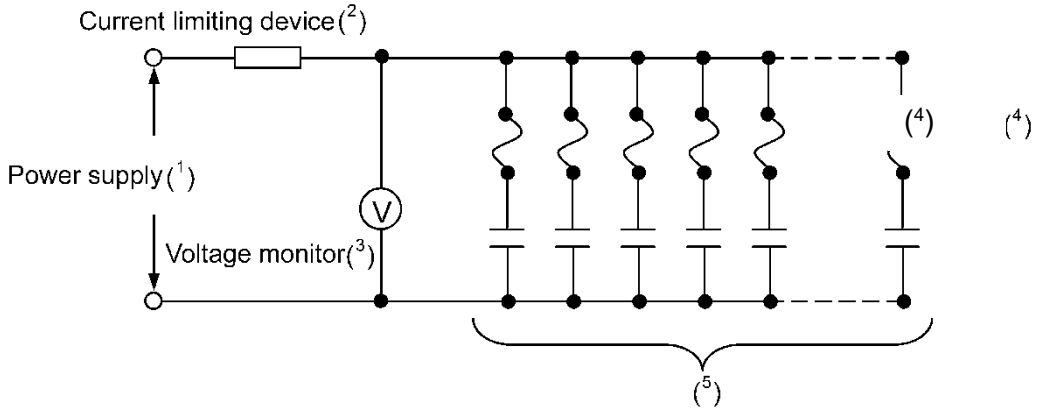
a) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3.
b) Number of cycles
   1) Qualification test: 100 cycles.
   2) Group A of quality conformance inspection: 20 cycles.
   3) Group B of quality conformance inspection: 100 cycles.

M.4.4.9.4.2 Voltage Aging

After completion of the thermal shock test specified in paragraph M.4.4.9.4.1, capacitors shall be tested under the followings.
A circuit shown in Figure M-4 shall be used to maintain at least 95% of the test voltage during the test. Blown fuses or the voltage drop to 95% of the specified voltage shall constitute failure of the test.

a) Temperature: $+125^{+4}_{0}$°C.
b) Applied voltage: 150±5% of the rated voltage.
c) Duration of application
   168 hours or longer, and the test voltage shall be increased from 0 to the specified value within 2 minutes.
d) Inspection and measurement after test
   After the test completion, the insulation resistance shall be measured as specified in paragraph M.4.4.7.4 while the capacitor is maintained at the test

temperature. The test capacitor may be transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall be made only after the test capacitor is stabilized and at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph M.4.4.1 to visually examine for mechanical damage under 10X magnification. Then the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs M.4.4.7.3, M.4.4.7.4, M.4.4.7.1, and M.4.4.7.2.



Notes:

(1) The power supply shall be capable of providing at least twice the rated voltage of the capacitors at a leakage current of 30mA as a minimum.

(2) The current limiting device shall be a resistor and/or a fuse. The current shall be limited between 30mA and 10A.

(3) There shall be a voltage monitor that will trigger an alarm and shut off the test if the applied voltage drops by more than 5 percent.

(4) At the option of the manufacturer, a fuse or a resistor may be used. The value of the resistors and fuses shall be such that they do not restrict the power supply's ability to provide the required test voltage to the capacitor under test.

(5) The number of test capacitors per circuit shall be 10 or more.

Figure M-4. Test Circuit for Voltage Aging

M.4.4.9.5 Thermal Shock and Immersion Cycling

M.4.4.9.5.1 Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in paragraph M.4.4.3. The solder filet height shall be between 1/7 and 1/4 of the capacitor thickness (T) (see Table M-2).

b) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3.

c) Number of cycles: 250 cycles.

M.4.4.9.5.2 Immersion Cycling

Capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles).

b) Measurements and inspection after final cycle
The test capacitor shall be removed from a chamber, wiped, and air-blasted with room temperature air. After waiting 30 minutes, the following measurements and inspection shall be performed.

1) Electrical measurements
The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor (tan δ) shall be measured as specified in paragraphs M.4.4.7.3, M.4.4.7.4, M.4.4.7.1, and M.4.4.7.2.

2) Visual inspection
Capacitors shall be visually examined for mechanical damage under 10X magnification.

M.4.4.9.6 Moisuture Resistance

The moisture resistance shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement
The capacitance shall be measured as specified in paragraph M.4.4.7.1.

b) Number of cycles: Continuous 20 cycles.

c) Test procedure
For the first 10 cycles, DC 50V or the rated voltage, whichever is smaller, shall be applied to both terminals. Occurrence of short-circuiting shall be checked once a day. Vibration cycle at step 7b shall not be performed.

d) Final measurements
After step 6 of the final cycle, the test capacitor shall be exposed at 25±5°C, 30 to 60%RH for 18 to 24 hours, and visually examined for mechanical damage under 10X magnification. Then the capacitance, dielectric withstanding voltage, and insulation resistance at +25°C shall be measured as specified in paragraphs M.4.4.7.1, M.4.4.7.3, and M.4.4.7.4.

M.4.4.9.7 Humidity, Steady State, Low Voltage

Capacitors shall be tested in accordance with test method 103, test condition A of MIL-STD-202. The following details shall apply.
Under no circumstances during the test, shall the voltage applied to test capacitors exceed 1.5V.

a) Mounting method
As specified in paragraph M.4.4.3.

b) Initial measurement
The capacitance shall be measured as specified in paragraph M.4.4.7.1.

c) Test procedure
The test capacitor shall be exposed at +85°C and 85%RH for at least 240 hours. The test shall be performed as a single test not as a cycling test. DC voltage of

$1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor through a 100kΩ resistor.

d) Final measurements
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes. After stabilizing, the insulation resistance shall be measured as specified in paragraph M.4.4.7.4 except for applying a DC voltage of $1.3^{+0.20}_{-0.25}$V via a 100kΩ resistor, then the capacitance shall be measured as specified in paragraph M.4.4.7.1.

e) Post-test inspection
After the final measurements, capacitors shall be visually examined for evidence of mechanical damage under 10X magnification.

M.4.4.9.8 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in paragraph M.4.4.3.
Other appropriate measures may be taken provided that no dispute will arise about the determination.
b) Test condition: D (1.1kPa).
c) Applied voltage: 150% of the rated voltage.
d) Duration of application: 5±1 seconds.
e) Charged and discharged current: 50mA or less.
f) Post-test inspections
Capacitors shall be examined for evidence of damage, arcing, open-circuiting, and short-circuiting.

M.4.4.10 Durability Performance

Durability performance tests shall be performed as follows.

M.4.4.10.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.

a) Distance between the test capacitor and temperature measuring position: N/A
b) Test temperature: $+125^{+4}_{0}$°C
c) Test voltage and test circuit shall be as specified in paragraph M.4.4.9.4.2. In case of blown fuse, the determination shall also be as specified in paragraph M.4.4.9.4.2.
d) Charged and discharged current: 50mA or less
e) Duration of voltage application
1) Qualification test: $4{,}000^{+72}_{0}$ hours
2) Quality conformance inspection (Group B): $1{,}000^{+48}_{0}$ hours
f) Measurements and inspection during and after test
At each test completion of 250, 1,000, 2,000 and 4,000 hours, the insulation resistance shall be measured with the capacitor maintained at the test temperature as specified in paragraph M.4.4.7.4. The test capacitor may be

transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall only be made when the test capacitor is stabilized at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph M.4.4.1 to visually examine for mechanical damage under 10X magnification. Then the capacitance, dissipation factor (tan δ), and insulation resistance shall be measured as specified in paragraphs M.4.4.7.1, M.4.4.7.2, and M.4.4.7.4.

M.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following test items.

a) Capacitance (paragraph M.3.8.1)
b) Dissipation factor (tan δ) (paragraph M.3.8.2)
c) Insulation resistance (paragraph M.3.8.4)
d) Dielectric withstanding voltage (paragraph M.3.8.3)

Sampling inspection for the solderability and resistance to soldering heat shall be performed as specified in Table M-11 for each terminal finish. The date of re-inspection shall be marked on the packages or storage containers. The rejected lot of solderability and resistance to soldering heat shall not be shipped.

M.4.6 Changes to Tests and Inspections

Changes to tests and inspections shall be as specified in paragraph 4.8.

M.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

M.6 NOTE

Notes shall be as specified in paragraph 6.

APPENDIX P

CAPACITORS, LEADED, MULTILAYER, HIGH-CAPACITY,
FINE CERAMIC DIELECTRIC

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: 19 August 2025

APPENDIX P

CAPACITORS, LEADED, MULTILAYER, HIGH-CAPACITY, FINE CERAMIC DIELECTRIC

P.1 GENERAL

P.1.1 Scope

This appendix establishes the general requirements and quality assurance provisions for fine ceramic dielectric, high-capacity, multilayer, leaded capacitors (hereinafter referred to as "capacitors").

P.1.2 Classification

Capacitors shall be classified as specified in Table P-1.

Table P-1. Classification

Structure	Style
Non-metal enclosure, radial lead	As specified in detail specification

P.1.3 Part Number

The part number shall be indicated as follows. See the detail specification for details.

(Example)

JAXA[1] 2040/P 301 **[2] X7R 1E 105 M W

301	**[2]	X7R	1E	105	M	W
Individual Identification	Style (P.1.3.1)	Characteristic (P.1.3.2)	Rated voltage (P.1.3.3)	Nominal Capacitance (P.1.3.4)	Capacitance tolerance (P.1.3.4)	Terminal finish (P.1.3.5)

Notes: [1] "JAXA" indicates the common part is for space use and may be abbreviated to “J”.

[2] As specified in detail specification.

P.1.3.1 Style

The style indicates the outline dimensions of the capacitor and the detailed dimensions shall be specified in the detail specification. The lead diameter, length, and spacing between leads of the capacitor, etc. shall be specified in the detail specification.

P.1.3.2 Characteristic

The characteristic shall be identified in accordance with paragraph 1.3.2 of EIA-198-1 as shown in Figure P-2.

Table P-2. Voltage–Temperature Characteristic

Symbol	Operating temperature range (°C)	Capacitance change from temperature +25°C	
		Steps A to D of Table P-13. (no voltage applied)	Steps E to G of Table P-13. (rated voltage applied)
X7R	-55 to +125	±15%	– (1)

Note: (1) Detailed information shall be provided in application data sheet.

P.1.3.3 Rated Voltage

The rated voltage shall be identified in accordance with Appendix 1, paragraph 2.3.4 of JIS C 5101-1 as specified in Table P-3.

Table P-3. Rated Voltage

(Unit: V)

First symbol	Second symbol									
	A	B	C	D	E	F	G	H	J	K
0	–	–	1.6	2.0	2.5	3.15	4.0	5.0	6.3	8.0
1	10	12.5	16	20	25	31.5	40	50	63	80
2	100	125	160	200	250	315	400	500	–	–

P.1.3.4 Capacitance and Tolerance

The nominal capacitance expressed in picofarads (pF) shall be indicated by a three-digit number. The first two digits denote significant figures and the last digit denotes the number of zeros to follow.
Example: 102: 1,000pF, 105: 1,000,000pF.
The capacitance tolerance is specified in Table P-4.

Table P-4. Capacitance Tolerance

Symbol	Capacitance tolerance
K	±10%
M	±20%

P.1.3.5 Terminal Finish

The terminal finish shall be identified by a single capital letter as specified in Table P-5.

Table P-5. Terminal Finish

Symbol	Terminal finish
W	Solder coating over copper plated iron core wire

P.2 APPLICABLE DOCUMENTS

P.2.1 Applicable Documents

The applicable documents for this appendix are as follows and as specified in paragraph 2.1.

a) EIA-198-1 Ceramic Dielectric Capacitors Classes I, II, III and IV
Part I: Characteristics and Requirements

b) EIA 469 Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors

c) JIS 5101-1 Fixed Capacitors for Use in Electronic Equipment
Part 1: Generic Specification

P.2.2 Reference Documents

The following documents are the reference documents of this appendix.

a) MIL-PRF-123 Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification for

b) MIL-PRF-39014 Capacitor, Fixed Ceramic Dielectric (General Purpose), Established Reliability and Non-Established Reliability, General Specification For

c) ESCC Generic Specification No. 3001
Capacitors, Fixed, Ceramic Dielectric, Types I and II

d) ESCC Detail Specification No. 3001/030
Capacitors, Fixed, Ceramic Dielectric, Types I and II, High Capacitance, 50V To 500V, Based On Types BR, CV and CH

P.3 REQUIREMENTS

P.3.1 Qualification Coverage

Qualification shall be valid for capacitors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs P.3.2 to P.3.10. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacturer is allowed to supply qualified products in accordance with the detail specification.
If necessary, additional qualification coverage shall be specified in the detail specification.

P.3.1.1 Restriction of Qualification

The qualification of the nominal capacitance and rated voltage shall limit to the values equal to or less than the values of each capacitor submitted to the qualification test. Qualification of characteristics, ceramic materials, and terminal finish shall be also restricted to those of capacitors submitted to the qualification test.

P.3.2 Design and Constructions

The material, design and constructions of capacitors shall be as specified in the detail specification and as follows.

P.3.2.1 Materials

The materials used in the capacitors shall be specified in paragraph 3.3 and as follows.

a) Capacitor element
Ceramic shall be used as the dielectric.
b) Lead terminal
The lead terminals shall be copper plated on the iron wire and the surface shall be coated with solder.
c) Exterior resin
The exterior resin shall withstand the maximum operating temperature and sustain the moisture resistance and electrical insulation property. The exterior resin shall not affect the performance of the capacitors.

P.3.3 Non-Destructive Internal Inspection

Before and after lead attachment, all capacitors and capacitor elements shall be subjected to non-destructive internal inspection as specified in the detail specification and integrity of the capacitor shall be verified. When tested as specified in paragraph P.4.4.3, capacitors shall not exhibit any defects such as delamination, voids, and cracks.

P.3.4 Externals, Dimension, Mass and Marking

When tested as specified in paragraph P.4.4.4, capacitors shall meet the following requirements.

P.3.4.1 Externals and Marking

The exterior of the capacitors shall not exhibit any external anomalies which would affect the functions and performances of the capacitors such as cracks, surface roughness, pinholes, and blisters. The lead terminals shall not exhibit excess solder, solder ball, any scratches exposing base metal, or pinholes. The details of the capacitor exterior other than these above shall be specified in the detail specification. The following items shall be marked on the capacitors in such a manner that the marking will not easily be faded. The details of marking shall be specified in the detail specification.

a) Rated voltage, capacitance
b) Lot identification code
c) QML manufacturer's name or its abbreviation (only when there is the area to mark).

P.3.4.2 Dimensions and Mass

Dimensions and mass of capacitors shall meet the requirements specified in the detail specification.

P.3.4.2.1 Dielectirc

When the thickness of the fired ceramic dielectric layer is measured, the dielectric thickness of the capacitor element shall meet the value specified in the detail specification.
The total thickness of ceramic dielectric excluding voids shall be equal to or more than 50% of the counter electrode distance (see the following equation and Figure P-1).

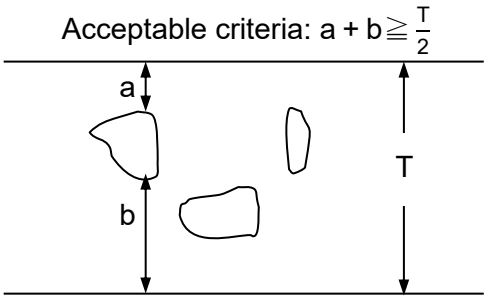


Figure P-1. Criteria for Dielectric Thickness (Example)

P.3.5 Workmanship

Capacitors shall be manufactured based on good design practices and in accordance with the quality assurance program defined in paragraph 3.2.1.
The capacitor elements shall not exhibit any anomalies that affect electrical or mechanical performances of the capacitor such as cracks, pinholes, and scratches. The lead terminals shall not exhibit any fractures, crushed areas, or other scratches exposing base metal.

P.3.5.1 DPA

When tested as specified in paragraph P.4.4.5.1, capacitors shall meet the requirements specified in EIA-469 and paragraph P.3.4.2.1 in this appendix. The items to be verified in DPA shall be specified in the detail specification and the details shall be in accordance with the DPA manual. In addition, capacitors shall meet the requirements for materials, design, and construction specified in the detail specification.

P.3.5.2 Pre-encapsulation Visual Inspection

When tested as specified in paragraph P.4.4.5.2, pre-encapsulation capacitors shall meet the following requirements.
The capacitor elements shall not exhibit any anomalies that affect electrical or mechanical performances of the capacitor such as cracks, pinholes, and scratches.
The solder junction between capacitor element and lead terminal shall not exhibit any anomalies that affect electrical and mechanical connections. The lead terminal shall not exhibit any chipping more than 10% of lead diameter, or any scratches exposed the base metal.

P.3.6 Rating

The following items shall be specified in the detail specification.

a) Voltage–temperature characteristics
b) Rated voltage
c) Nominal capacitance
d) Capacitance tolerance
e) Operating temperature range

P.3.7 Electrical Performance

Capacitors shall meet the following requirements.

P.3.7.1 Capacitance

When tested as specified in paragraph P.4.4.6.1, the capacitance shall fall within the tolerance specified in the detail specification.

P.3.7.2 Dissipation Factor

When tested as specified in paragraph P.4.4.6.2, the dissipation factor (tanδ) shall meet the requirements specified in the detail specification.

P.3.7.3 Dielectric Withstanding Voltage

When tested as specified in paragraph P.4.4.6.3, there shall be no damage or insulation breakdown.

P.3.7.4 Insulation Resistance

When tested as specified in paragraph P.4.4.6.4, the insulation resistance shall meet the following requirements.

a) At +25°C: Not less than 4,000MΩ or 100MΩ·μF, whichever is smaller.
b) At +125°C: Not less than 400MΩ or 10MΩ·μF, whichever is smaller.

P.3.7.5 Voltage–Temperature Characteristic

When tested as specified in paragraph P.4.4.6.5, the capacitance change shall not exceed the limit specified in Table P-2.. The capacitance obtained at step C in Table P-13. shall be the reference value.

P.3.8 Mechanical Performance

Capacitors shall meet the following requirements.

P.3.8.1 Terminal Strength

When tested as specified in paragraph P.4.4.7.1, The terminals shall not have defects such as breakage, looseness, extraction, and base metal exposure.

P.3.8.2 Solderability

When tested as specified in paragraph P.4.4.7.2, no base metal exposure is allowed on the lead surface. The dipped surface of the leads shall be at least 95% covered with a new, smooth, solder coating. The remaining 5% may contain small pinholes or rough spots, however, these shall not be concentrated in one area.

P.3.8.3 Resistance to Soldering Heat

When tested as specified in paragraph P.4.4.7.3, capacitors shall meet the following requirements.

a) Externals
   There shall be no evidence of mechanical damages.
b) Insulation resistance (at +25°C)
   The insulation resistance shall meet the requirements specified in item a) of paragraph P.3.7.4.
c) Capacitance change
   1) Within ±10% of the initial measured value
d) Dissipation factor
   As specified in paragraph P.3.7.2.

P.3.9 Environmental Performance

Capacitors shall meet the following requirements.

P.3.9.1 Vibration Resistance

P.3.9.1.1 High Frequency Vibration

When tested as specified in paragraph P.4.4.8.1.1, there shall be no intermittent contacts of 0.5ms or longer duration, or disconnection. In addition, there shall be no mechanical damage or breakdown.

P.3.9.1.2 Random Vibraion

When tested as specified in paragraph P.4.4.8.1.2, there shall be no intermittent contacts of 0.5ms or longer duration, open-circuiting, or short-circuiting. In addition, there shall be no evidence of insulation breakdown, arcing, or mechanical damage.

P.3.9.2 Shock

When tested as specified in paragraph P.4.4.8.2, there shall be no intermittent contacts of 0.5ms or longer duration, open-circuiting, or short-circuiting. In addition, there shall be no evidence of mechanical damage.

P.3.9.3 Thermal Shock (I)

When tested as specified in paragraph P.4.4.8.3, capacitors shall meet the following requirements.

a) Externals
   There shall be no mechanical damage. The marking shall remain legible.
b) Dielectric withstanding voltage
   As specified in paragraph P.3.7.3.
c) Insulation resistance (+25°C)
   30% or greater than the value specified in item a) of paragraph P.3.7.4.
d) Capacitance change
   Within ±10% of initial measured value.
e) Dissipation factor
   As specified in paragraph P.3.7.2.

P.3.9.4 Thermal Shock and Voltage Aging

When tested as specified in paragraph P.4.4.8.4, capacitors shall meet the following requirements.

a) Insulation resistance (+125°C)
   As specified in item b) of paragraph P.3.7.4.
b) Externals
   There shall be no mechanical damage. The marking shall remain legible.
c) Dielectric withstanding voltage
   As specified in paragraph P.3.7.3.
d) Insulation resistance (+25°C)
   As specified in item a) of paragraph P.3.7.4.
e) Capacitance
   As specified in paragraph P.3.7.1.
f) Dissipation factor
   As specified in paragraph P.3.7.2.

P.3.9.5 Thermal Shock and Immersion Cycling

When tested as specified in paragraph P.4.4.8.5, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Dielectric withstanding voltage
As specified in paragraph P.3.7.3.
c) Insulation resistance (+25°C)
50% or higher than the value specified in item a) of paragraph P.3.7.4.
d) Capacitance change
Within ±10% of initial measured value.
e) Dissipation factor
As specified in paragraph P.3.7.2.

P.3.9.6 Moisture Resistance

When tested as specified in paragraph P.4.4.8.6, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Dielectric withstanding voltage
As specified in paragraph P.3.7.3.
c) Insulation resistance (+25°C)
50% or higher than the value specified in item a) of paragraph P.3.7.4.
d) Capacitance change
e) Within ±10% of initial measured value.

P.3.9.7 Humidity, Steady State, Low Voltage

When tested as specified in paragraph P.4.4.8.7, capacitors shall meet the following requirements.

a) Externals
There shall be no mechanical damage. The marking shall remain legible.
b) Insulation resistance (+25°C)
As specified in item a) of paragraph P.3.7.4.
c) Capacitance change
Within ±10% of initial measured value.

P.3.9.8 Barometric Pressure (Reduced)

When tested as specified in P.4.4.8.8, capacitors shall not exhibit damage, momentary or intermittent arcing, open-circuiting, or short-circuiting either during or after the test.

P.3.9.9 Resistance to Solvents

When tested as specified in P.4.4.8.9, the marking shall remain legible.

P.3.10 Durability Performance

Capacitors shall meet the following requirements.

P.3.10.1 Life

When tested as specified in paragraph P.4.4.9.1, capacitors shall meet the following requirements.

a) 250-hour limits
   1) Insulation resistance (+125°C)
      50% or higher than the value specified in item b) of paragraph P.3.7.4.
   2) Externals
      There shall be no mechanical damage. The marking shall remain legible.
   3) Insulation resistance (+25°C)
      50% or higher than the value specified in item a) of paragraph P.3.7.4.
   4) Capacitance change
      Within ±15% of initial measured value.
   5) Dissipation factor
      As specified in paragraph P.3.7.2.

b) 1,000, 2,000, and 4,000-hour limits
   1) Insulation resistance (+125°C)
      30% or higher than the value specified in item b) of paragraph P.3.7.4.
   2) Externals
      There shall be no mechanical damage. The marking shall remain legible.
   3) Insulation resistance (+25°C)
      30% or higher than the value specified in item a) of paragraph P.3.7.4.
   4) Capacitance change
      Within ±20% of initial measured value.
   5) Dissipation factor
      As specified in paragraph P.3.7.2.

P.4 QUALITY ASSURANCE PROVISIONS

P.4.1 In-Process Inspection

Each manufacturing lot of the capacitors shall be subjected to the in-process inspections specified in Table P-6. Manufacturer may arbitrarily add the in-process inspection item other than the items listed in Table P-6 in accordance with paragraph 4.3.

Table P-6. In-Process Inspection

Item no.	In-process inspection item	Inspection timing	Requirement paragraph	Test method paragraph	Quantity of samples
1	Non-destructive internal inspection	Capacitor element	P.3.3	P.4.4.3	All samples
2	Pre-encapsulation visual inspection	Pre-encapsulation	P.3.5.2	P.4.4.5.2	All samples
3	Visual inspection	Post- encapsulation	P.3.4.1	P.4.4.4	All samples

P.4.1.1 Rework

Rework shall not be conducted on any operations subsequent to the formation of slurry. Rework denotes reattempting processes such as re-firing ceramic or terminal electrodes, re-plating, mounting of leads, or reapplication of exterior resin.

P.4.1.2 Elimination of Initial Failure

The inspections or screening process to eliminate the initial failure shall be clearly specified in the detail specification.

P.4.2 Qualification Test

Qualification test shall be as specified in paragraph 4.4 and as follows.

P.4.2.1 Samples

The inspection lot for qualification test shall consist of the sample taken from the inspection lot that has passed the in-process inspection. Manufacturer shall submit the sample units of the maximum nominal capacitance from a group that have the same materials, characteristics, rated voltage, and terminal finish of the capacitor element.

P.4.2.2 Test Items and Sample Size

Test items and sample size of qualification test shall be as specified in Table P-7. All samples shall be subjected to group I test before being divided for groups II through X tests. Tests in group II and subsequent groups need not be performed in the order listed regardless of group number. The detailed qualification test flow is as specified in Figure P-2.

Table P-7. Qualification Test

Test			Requirement paragraph	Test method paragraph	Pass/fail	
Group	Order	Item			Quantity of samples	Quantity of allowable defectives
I	1	Thermal shock and voltage aging	P.3.9.4	P.4.4.8.4	240	0
	2	Insulation resistance (+125°C)	P.3.7.4	P.4.4.6.4		
	3	Dielectric withstanding voltage	P.3.7.3	P.4.4.6.3		
	4	Insulation resistance (+25°C)	P.3.7.4	P.4.4.6.4		
	5	Capacitance	P.3.7.1	P.4.4.6.1		
	6	Dissipation factor	P.3.7.2	P.4.4.6.2		
II	1	Externals, dimensions, mass and marking	P.3.4	P.4.4.4	15	0
	2	DPA	P.3.5.1	P.4.4.5.1		
III	1	Terminal strength	P.3.8.1	P.4.4.7.1	4	0
	2	Solderability	P.3.8.2	P.4.4.7.2	4	
	3	Resistance to soldering heat	P.3.8.3	P.4.4.7.3	4	
	4	Resistance to solvents	P.3.9.9	P.4.4.8.9	4	
IV	1	Voltage-temperature characteristics	P.3.7.5	P.4.4.6.5	12	0
	2	High frequency vibration	P.3.9.1.1	P.4.4.8.1.1		
	3	Moisture resistance	P.3.9.6	P.4.4.8.6		
V	1	Humidity, steady state, low voltage	P.3.9.7	P.4.4.8.7	12	0
VI	1	Life	P.3.10.1	P.4.4.9.1	123	0
VII	1	Barometric pressure (reduced)	P.3.9.8	P.4.4.8.8	6	0
VIII	1	Thermal shock and immersion cycling	P.3.9.5	P.4.4.8.5	18	0
IX	1	Random vibration	P.3.9.1.2	P.4.4.8.1.2	10	0
	2	Shock	P.3.9.2	P.4.4.8.2	10	
X	1	Thermal shock (I)	P.3.9.3	P.4.4.8.3	18	0
–	–	Material	P.3.2	–	(1)	

Note: (1) Documents shall be submitted to prove that the samples meet the design specification.

P.4.3 Quality Conformance Inspection

Quality conformance inspection shall be as specified in paragraph 4.5 and as follows.

P.4.3.1 Sample

Sample selection for an inspection lot submitted to group A shall be as specified in paragraph 4.5.1.1.

Groups B and C inspections shall be conducted per group of the same characteristics, rated voltage, and terminal finish. Sample selection for an inspection lot shall be as specified in paragraph 4.5.2.1. If one or more lots from one group were submitted to group A inspection around the same time, samples shall be taken from the lot with the maximum nominal capacitance.

P.4.3.2 Inspection Items and Sample Size

Inspection items and sample size of the quality conformance inspection shall be as specified in Table P-8 for group A, Table P-9 for group B, and Table P-10 for group C. The detailed flows for group A, group B, and group C inspections shall be as shown in Figure P-3, Figure P-4, and Figure P-5.

P.4.3.3 Disposition after Inspections

The lots rejected in group A inspection shall not be delivered. If the samples fail in subgroup A2, 100% inspection shall be conducted for the rejected items as specified in paragraph H.3.3 of JAXA-QTS-2000, and conforming products may be delivered. The samples used in subgroups A3 and A4 shall not be delivered.

Table P-8. Quality Conformance Inspection (Group A)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
A1	1	Thermal shock and voltage aging	P.3.9.4	P.4.4.8.4	All samples	0
	2	Insulation resistance (+125°C)	P.3.7.4	P.4.4.6.4		
	3	Dielectric withstanding voltage	P.3.7.3	P.4.4.6.3		
	4	Insulation resistance (+25°C)	P.3.7.4	P.4.4.6.4		
	5	Capacitance	P.3.7.1	P.4.4.6.1		
	6	Dissipation factor	P.3.7.2	P.4.4.6.2		
A2	1	Externals, dimensions, mass and marking	P.3.4	P.4.4.4	20	0
A3	1	Humidity, steady state, low voltage	P.3.9.7	P.4.4.8.7	2	0
A4	1	DPA	P.3.5.1	P.4.4.5.1	Table P-12.	

Table P-9. Quality Conformance Inspection (Group B)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
B1	1	Thermal shock	P.3.10.1	P.4.4.8.4.1	25	0
	2	Life		P.4.4.9.1		
B2	1	Terminal strength	P.3.8.1	P.4.4.7.1	6	0
	2	Solderability	P.3.8.2	P.4.4.7.2	6	0
	3	Resistance to soldering heat	P.3.8.3	P.4.4.7.3	6	0
	4	Resistance to solvents	P.3.9.9	P.4.4.8.9	6	0

Table P-10. Quality Conformance Inspection (Group C)

Inspection			Requirement paragraph	Test method paragraph	Pass/fail	
Subgroup	Order	Item			Quantity of samples	Quantity of allowable defectives
C1	1	Barometric pressure (reduced)	P.3.9.8	P.4.4.8.8	6	0
C2	1	Thermal shock and immersion cycling	P.3.9.5	P.4.4.8.5	18	0
C3	1	Voltage-temperature characteristics	P.3.7.5	P.4.4.6.5	12	0
	2	High frequency vibration	P.3.9.1.1	P.4.4.8.1.1		
	3	Moisture resistance	P.3.9.6	P.4.4.8.6		
C4	1	Random vibration	P.3.9.1.2	P.4.4.8.1.2	6	0
	2	Shock	P.3.9.2	P.4.4.8.2	6	0
C5	1	Thermal shock (I)	P.3.9.3	P.4.4.8.3	6	0

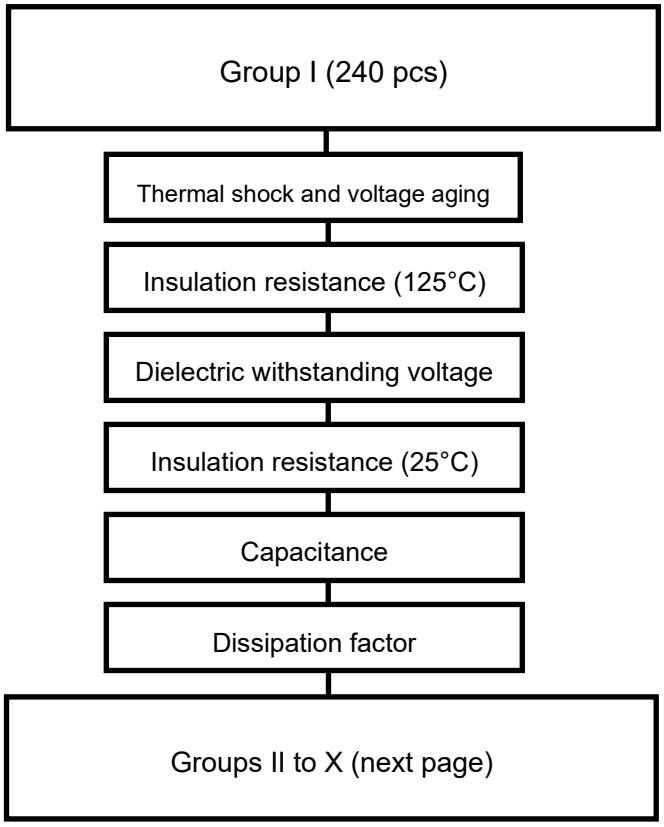


Figure P-2. Flow Chart for Qualification Test

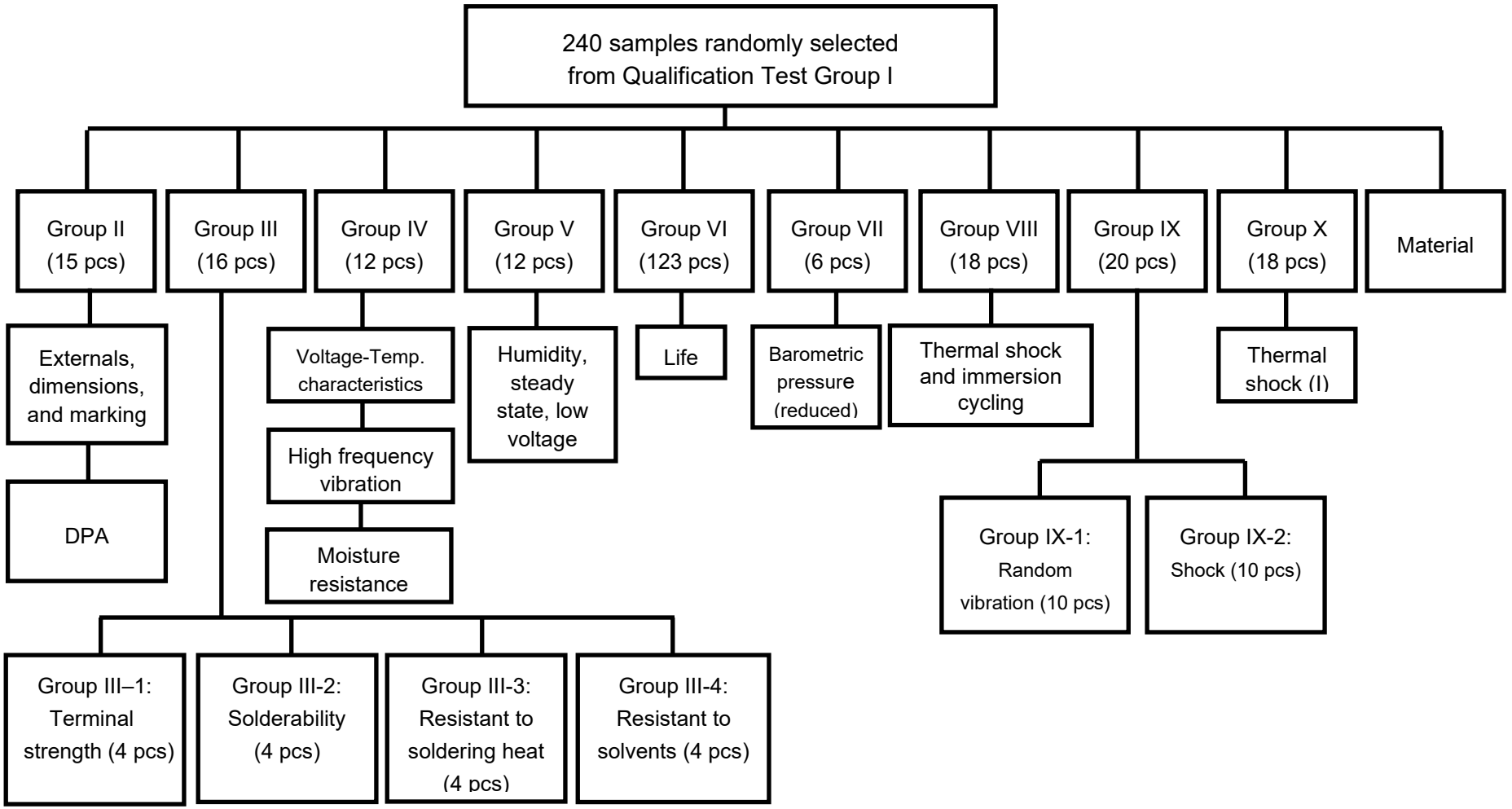


Figure P-2. Flow Chart for Qualification Test (cont.)

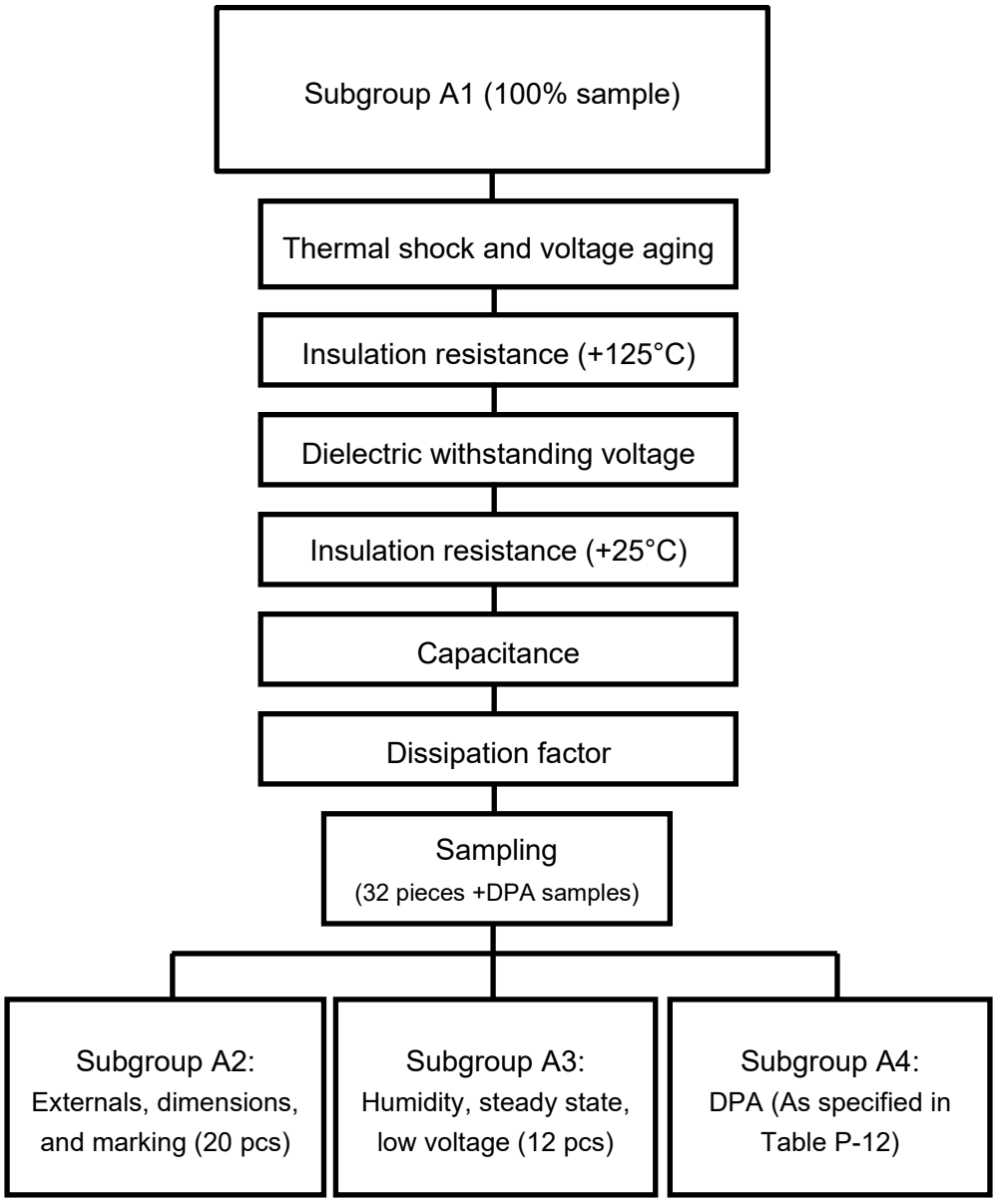


Figure P-3. Flow Chart for Group A Inspection

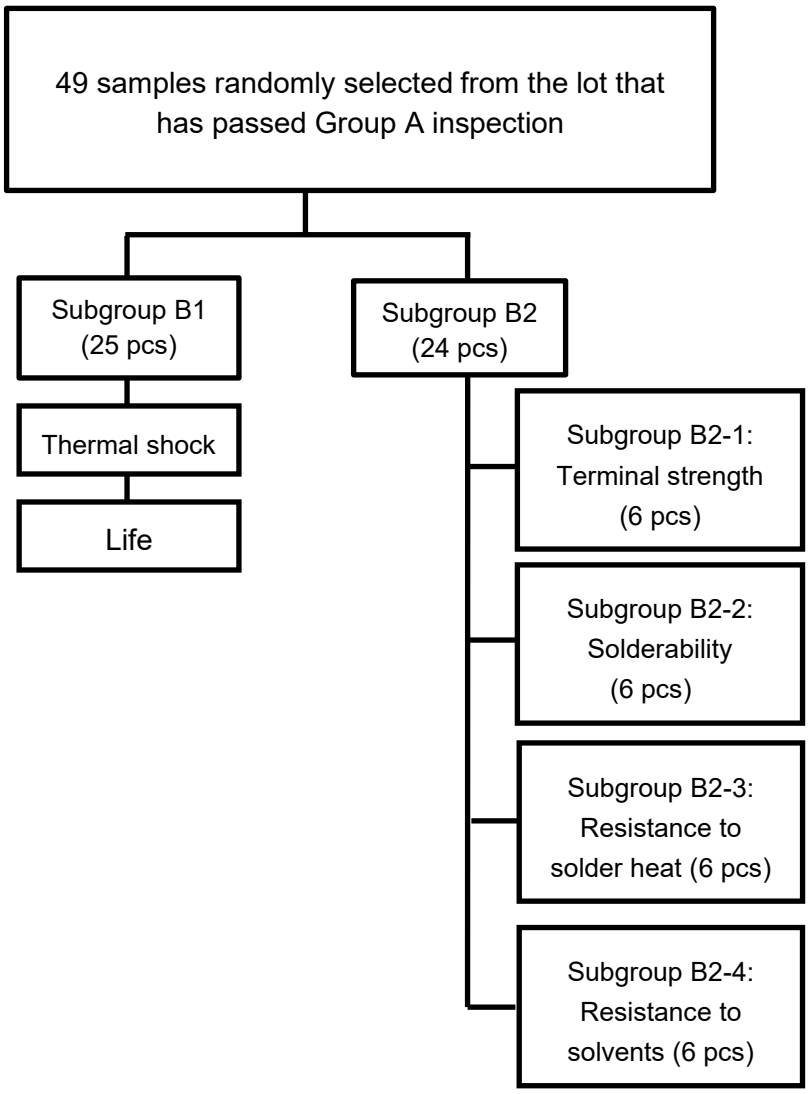


Figure P-4. Flow Chart for Group B Inspection

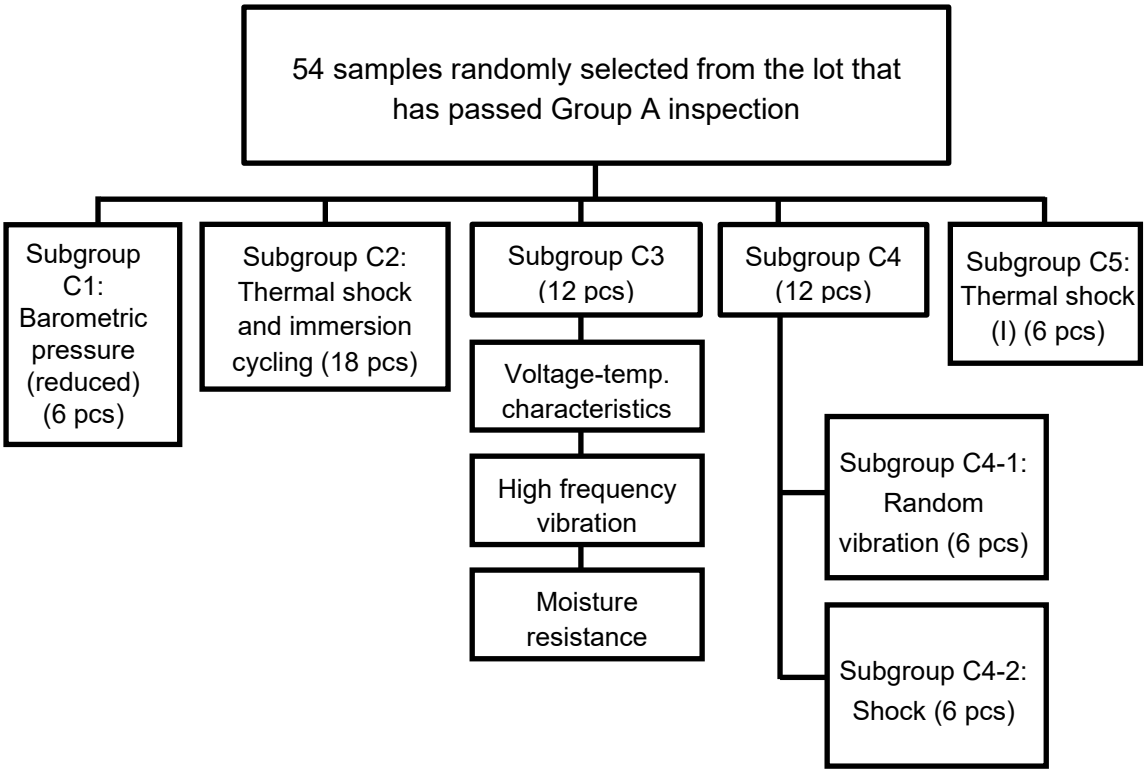


Figure P-5. Flow Chart for Group C Inspection

P.4.4 Methods for Test and Inspection

P.4.4.1 Test and Inspection Conditions

Test or inspection conditions shall be in accordance with paragraph 4 of MIL-STD-202. The following details shall apply.

a) Standard conditions
The standard conditions shall be at 25±3°C, relative humidity between 25 and 75%, and atmospheric pressure between 86 and 106kPa. Unless otherwise specified, the tests and measurements shall be performed under the standard conditions. Whenever the conditions must be closely controlled in order to obtain reproducible results, the Test conditions in b) shall apply. If conversion is needed, Reference condition in c) shall apply. Tests or measurements may be performed under environmental conditions other than the standard conditions provided that no dispute over the measurements is expected.

b) Test conditions
Test conditions shall be 25^{0}_{-2}°C for temperature, a relative humidity of 50±2%, and an atmospheric pressure between 86 and 106kPa.

c) Reference conditions
Reference conditions as a base for calculations shall be 25°C for temperature, a relative humidity of 50%, and an atmospheric pressure of 101.3kPa.

d) Reference measurement
When comparison is required between pre and post aging test measurements, measurements made at 25±3°C prior to the aging test shall be used as the reference values. If reference measurements have been made more than 30 days prior to the beginning of the aging test, measurement shall be repeated.

e) Measuring accuracy of test voltage shall be within ±3.0% of the specified test voltage.
f) Fluctuation in power supply voltage for the life test shall be within ±3% of the specified test voltage.

P.4.4.2 Processing of the test capacitor

The following processing shall be conducted, if needed.

a) Preprocessing
The test capacitor shall be discharged for one hour or longer at the test temperature prior to tests and measurements.
b) Forced drying
Unless otherwise specified, the test capacitor shall be dried in accordance with Table P-11 prior to tests and measurements.
c) Heat conditioning
If a dispute arises about the results of the capacitance measurements, capacitance re-measurement may be made after measuring other electrical characteristics. Prior to the re-measurement, the test capacitor shall be heated at 150°C for one hour and maintained under the standard conditions between 24 and 48 hours.

Table P-11. Drying Conditions

Temperature	55±2°C
Relative humidity	20% or less
Atmospheric pressure	Normal
Drying time	6±0.5 hours

P.4.4.3 Non-Destructive Internal Inspection

Capacitors shall be examined by a non-destructive internal inspection method which can verify that capacitors meet the requirements specified in paragraph P.3.3. The inspection methods shall be specified in the detail specification. The details shall be documented to Quality Assurance Program Plan and reviewed by JAXA as specified in paragraph 3.2.1.

P.4.4.4 Externals, Dimensions and Marking

Capacitors shall be tested for the externals and dimensions. The externals shall be examined with a 10x magnifier. Marking shall be visually verified that it remains legible.

P.4.4.5 Workmanship

P.4.4.5.1 DPA

DPA shall be conducted in accordance with the DPA manual cited in the Quality Assurance Program Plan after final terminal finish process. The DPA manual shall contain test procedures specified in EIA-469 or procedures which can verify that

capacitors meet the requirements specified in EIA-469. The number of samples shall be as specified in Table P-12.

Table P-12. Sample Size of DPA

Lot size	Minimum no. of samples	Allowable no. of defects
1 to 500	5	0
501 to 10,000	10	0
10,001 to 35,000	25	0

P.4.4.5.2 Pre-encapsulation Visual Inspection

When the visual inspection is conducted under 10X magnification, the capacitors shall meet the requirements specified in P.3.5.2. The details shall be as specified in the detail specification.

P.4.4.6 Electrical Performance

Electrical performance test shall be performed as follows.

P.4.4.6.1 Capacitance

Capacitors shall be tested in accordance with test method 305 of MIL-STD-202. The following conditions shall apply.

a) Test frequency: 1.0MHz±100kHz.
b) Test voltage: 1.0±0.2Vrms.

P.4.4.6.2 Dissipation Factor

Capacitors shall be tested using appropriate equipment such as a capacitance bridge at the frequency and voltage specified in paragraph P.4.4.6.1. Measurement accuracy shall be sufficient for the requirement of dissipation factor. Suitable measuring techniques shall be used to minimize errors due to the connections between the measuring apparatus and the test capacitor.

P.4.4.6.3 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with test method 301 of MIL-STD-202. The following details shall apply.

a) Between leads

The following details shall apply.

1) Test voltage: 250 to 400% of the DC rated voltage and as specified in the detail specification.
2) Duration of application of test voltage: 5±1 seconds, and the test voltage shall be raised from 0 to the specified value within 1 second.
3) Point of application: Between leads of the test capacitor.
4) Charged and discharged current: 50mA or less.
5) Inspections after test: The test capacitor shall be examined for evidence of damage and dielectric breakdown.

b) Between lead and exterior
The following details shall apply.
1) Test voltage: 150% of the DC rated voltage unless otherwise specified in the detail specification.
2) Duration of application of test voltage: 5±1 seconds, and the test voltage shall be raised from 0 to the specified value within 1 second.
3) Point of application: Between leads and package of the test capacitor.
4) Charged and discharged current: 50mA or less.
5) Inspections after test: The test capacitor shall be examined for evidence of damage and dielectric breakdown.

P.4.4.6.4 Insulation Resistance

Capacitors shall be tested in accordance with test method 302 of MIL-STD-202. The following details and exception shall apply.

a) Test conditions
1) Test voltage: Rated voltage.
2) Charged and discharged current: 50mA or less.
3) Duration of charging: 120^{+10}_{0} seconds.

b) Point of measurement: Between leads.

c) Special condition
If a dispute arises about the determination at a relative humidity of over 50%, measurements may be repeated at a relative humidity of 50% or less.

P.4.4.6.5 Voltage–Temperature Characteristic

a) For qualification test
The temperature of each test capacitor shall be altered as specified in Table P-13 and the capacitance shall be measured at the specified frequency and voltage specified in paragraph P.4.4.6.1. DC rated voltage shall be applied to the test capacitor in each step of E through G as shown in Table P-13 until the voltage is stabilized and capacitance measurements are completed.
The measurement shall be made in each step shown in Table P-13 and at sufficient number of points between steps B and G to obtain a characteristic curve. The measurement shall be made after reaching temperature equilibrium in each step.

b) For quality conformance inspection
The capacitance shall be measured as specified in paragraph P.4.4.6.1 at steps C, D, E, and G of Table P-13. The other conditions shall be as specified in item a) above.

Table P-13. Voltage-Temperature Cycling

Step	DC voltage applied	Temperature (°C)
A	N/A	+25±2
B	N/A	-55±2
C(1)	N/A	+25±2
D	N/A	+125±2
E	Rated voltage	+125±2
F	Rated voltage	+25±2
G	Rated voltage	-55±2

Note: (1) Reference point.

P.4.4.7 Mechanical Performance

Mechanical performance tests shall be performed as follows.

P.4.4.7.1 Terminal Strength

Capacitors shall be tested in accordance with test method 211 of MIL-STD-202. The following details shall apply.

a) Pull test
   1) Test condition: A.
   2) Applied force: 5N for nominal lead diameter of 0.5mm or less.
      10N for nominal lead diameter between 0.5mm and 0.8mm (excl.0.5mm).
      20N for nominal lead diameter of more than 0.8mm.
   3) Method of applying force:
      Capacitors shall be fixed by the body and force shall be gradually applied to one terminal.

b) Bend test for lead
   1) Test condition: C.
   2) Applied force: 2.5N for nominal lead diameter of 0.5mm or less.
      5N for nominal lead diameter between 0.5mm and 0.8mm (excl. 0.5mm).
      10N for nominal diameter of more than 0.8mm.

c) Inspection after test
   The test capacitor shall be visually examined under 10X magnification if it meets the requirements specified in paragraph P.3.8.1.

P.4.4.7.2 Solderability

Capacitors shall be tested in accordance with test method 208 of MIL-STD-202. The following details shall apply.

a) Number of test terminals: All leads.
b) Solder temperature: 230±5°C.
c) Duration of immersion: 5.0±0.5 seconds.
d) Depth of immersion
   Each lead shall be immersed into molten solder to the depth of 2 mm from the base of the lead.

e) Inspections after test
The test capacitor shall be visually examined under 10X magnification if it meets the requirements specified in paragraph P.3.8.2. In case of dispute, the percent coverage with pinholes or rough spots shall be determined by actual measurement in these areas, as compared to the total area.

P.4.4.7.3 Resistance to Soldering Heat

Capacitors shall be tested in accordance with test method 210 of MIL-STD-202. The following details shall apply.

a) Depth of immersion
Each lead shall be immersed into molten solder within the depth of 1.0 mm from the lowermost line of the outer perimeter or outer border.
b) Solder temperature: 270±5°C.
c) Duration of immersion: 10±1 seconds.
d) Cooling time after test to measurement: 10±1 minutes.
e) Measurements before and after test
The capacitance, dissipation factor and insulation resistance at +25°C shall be measured and recorded as specified in paragraphs P.4.4.6.1, P.4.4.6.2, and P.4.4.6.4.

P.4.4.8 Environmental Performance

Environmental performance tests shall be performed as follows.

P.4.4.8.1 Vibration

P.4.4.8.1.1. High Frequency Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method
Unless otherwise specified in the detail specification, the lead of the capacitor shall be firmly fixed onto the support terminal in such a way that the distance between the outer border and support terminal of the capacitor is about 10mm. when mounting the lead, the lead surface shall not be damaged. For this reason, mounting by solder is desirable. The mounting table is made to assure that it is free from resonances over the specified test frequency range.
b) Electrical loading condition
Unless otherwise specified in the detail specification, 125% of the rated voltage shall be applied between the leads of test capacitor.
c) Test conditions: D: 196m/s^{2}p-p or total amplitude of 1.5mm, whichever is smaller.
d) Direction and duration of vibration
Unless otherwise specified in the detail specification, the capacitor shall be vibrated for an equal amount of time in each of the three directions. The duration of the frequency sweep shall be 20 minutes per direction and shall be repeated for 8 cycles in each of the three directions (8 hours in total).

e) Inspections during test
Capacitors shall be examined for intermittent contact of 0.5ms or longer during the final cycle of each direction. The detector used for measurement shall be capable of detecting intermittent contact of 0.5ms or longer.

f) Inspections after test
Capacitors shall be visually examined for any mechanical damage.

P.4.4.8.1.2. Random Vibration

Capacitors shall be tested in accordance with test method 214 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in item a) of paragraph P.4.4.8.1.1.

b) Electrical loading condition
Unless otherwise specified in the detail specification, 125% of the rated voltage shall be applied between the leads of test capacitor.

c) Test conditions: II-H: 20 to 2,000Hz, 334m/s^2 rms.

d) Direction of vibration: Three mutually perpendicular directions.

e) Test duration: Three minutes for each direction.

f) Inspections during test
Capacitors shall be examined for intermittent contact or open circuits for each direction. The detector used for measurement shall be capable of detecting intermittent contact of 0.5ms or longer.

g) Inspections after test
Capacitors shall be visually examined for any mechanical damage.

P.4.4.8.2 Shock

Capacitors shall be tested in accordance with test method 213 of MIL-STD-202. The following details shall apply.

a) Mounting method
As specified in item a) of paragraph P.4.4.8.1.1.

b) Test condition: C.

Maximum acceleration	980m/s^2
Normal duration ……	6ms
Waveform……	Half sine wave
Speed variation…….	3.75m/s

c) Inspections during test
Capacitors shall be electrically monitored for intermittent contact of 0.5ms or longer, open-circuiting, and short-circuiting. The detector used for measurement shall be capable of detecting intermittent contact of 0.5ms or longer.

d) Inspection after test
The externals of capacitors shall be examined for mechanical damage under 10X magnification.

P.4.4.8.3 Thermal Shock (I)

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be -30^{0}_{-3}°C in step 1 and $+100^{+3}_{0}$°C in step 3.
b) Number of cycles: 1,000 cycles.
c) Measurements and inspection
The following measurements and inspection shall be performed before the first cycle and during cycles of 50±10, 100±10, 250±20, 500±20, and $1{,}000^{+10}_{0}$.
   1) Electrical measurements
   The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor shall be measured as specified in paragraphs P.4.4.6.3, P.4.4.6.4, P.4.4.6.1, and P.4.4.6.2.
   2) Visual inspection
   The externals of capacitors shall be examined for mechanical damage under 10X magnification.

P.4.4.8.4 Thermal Shock and Voltage Aging

P.4.4.8.4.1. Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

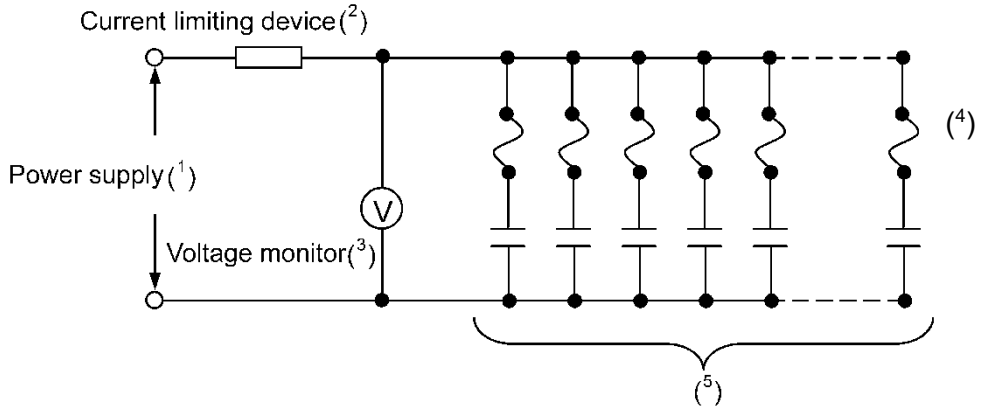
a) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3.
b) Number of cycles
   1) Qualification test: 100 cycles.
   2) Group A of quality conformance inspection: 20 cycles.
   3) Group B of quality conformance inspection: 100 cycles.

P.4.4.8.4.2. Voltage Aging

Following the thermal shock test specified in paragraph P.4.4.8.4.1, capacitors shall be tested as follows. A circuit shown in Figure P-6 shall be used to maintain at least 95% of the test voltage during the test. Blown fuses or the voltage drop below 95% of the specified voltage shall constitute failure of the test.

a) Temperature: $+125^{+4}_{0}$°C.
b) Applied voltage: 200±5% of the rated voltage.
c) Duration of application
   168 hours or longer, and the test voltage shall be increased from 0 to the specified value within 2 minutes.
d) Inspection and measurement after test
   After the test completion, the insulation resistance shall be measured as specified in paragraph P.4.4.6.4. The test capacitor may be transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall be made after the test capacitor is stabilized and during maintained at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph

P.4.4.1 to examine the externals for mechanical damage under 10X magnification. Then the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall be measured as specified in paragraphs P.4.4.6.3, P.4.4.6.4, P.4.4.6.1, and P.4.4.6.2.



Notes:
(1) The power supply shall be capable of providing at least twice the rated voltage of the capacitors at a leakage current of 30mA as a minimum.
(2) The current limiting device shall be a resistor and/or a fuse. The current shall be limited between 30mA and 10A.
(3) There shall be a voltage monitor that will trigger an alarm and shut off the test if the applied voltage drops by more than 5 percent.
(4) At the option of the manufacturer, a fuse or a resistor may be used. The value of the resistors and fuses shall be such that they do not restrict the power supply's ability to provide the required test voltage to the capacitor under test.
(5) The number of test capacitors per circuit shall be 10 or more.

Figure P-6. Test Circuit for Voltage Aging

P.4.4.8.5 Thermal Shock and Immersion Cycling

P.4.4.8.5.1. Thermal Shock

Capacitors shall be tested in accordance with test method 107 of MIL-STD-202. The following details shall apply.

a) Test condition: A, except that the temperature shall be $+125^{+4}_{0}$ °C in step 3.
b) Number of cycles: 250 cycles.

P.4.4.8.5.2. Immersion Cycling

Capacitors shall be tested in accordance with test method 104 of MIL-STD-202. The following details shall apply.

a) Test condition: B (2 cycles).
b) Measurements and inspection after final cycle
The test capacitor shall be removed from a chamber, wiped, and air-blasted with room temperature air. After waiting 30 minutes, the following measurements and inspection shall be performed.
1) Electrical measurements
The dielectric withstanding voltage, insulation resistance at +25°C, capacitance, and dissipation factor shall be measured as specified in paragraphs P.4.4.6.3, P.4.4.6.4, P.4.4.6.1, and P.4.4.6.2.
2) Visual inspection

Capacitors shall be visually examined for mechanical damage under 10X magnification.

P.4.4.8.6 Moisuture Resistance

The moisture resistance shall be tested in accordance with test method 106 of MIL-STD-202. The following details shall apply.

a) Initial measurement
The capacitance shall be measured as specified in paragraph P.4.4.6.1.
b) Number of cycles: Continuous 20 cycles.
c) Test procedure
For first 10 cycles, DC 50V or the rated voltage, whichever is smaller shall be applied to the ends of both leads. Occurrence of short-circuiting shall be checked once a day. Vibration cycle at step 7b shall not be performed.
d) Final measurements and inspection
After the final cycle of step 6, the test capacitor shall be subjected to an environment of 25±5°C, 30 to 60%RH for a minimum of 18 hours and a maximum of 24 hours, and visually examined for any evidence of mechanical damage under 10X magnification. Then the capacitance, dielectric withstanding voltage, and insulation resistance at +25°C shall be measured as specified in paragraphs P.4.4.6.1, P.4.4.6.3, and P.4.4.6.4.

P.4.4.8.7 Humidity, Steady State, Low Voltage

Capacitors shall be tested in accordance with test method 103, test condition A of MIL-STD-202. The following details shall apply.
Under no circumstances during the test, shall the voltage applied to test capacitors exceed 1.5V.

a) Initial measurement
The capacitance shall be measured as specified in paragraph P.4.4.6.1.
b) Test procedure
The test capacitor shall be subjected to an environment of +85°C and 85%RH for 240 hours minimum. The test shall be performed as a single test not as a cycling test. DC voltage of $1.3^{+0.20}_{-0.25}$V shall be continuously applied to each test capacitor via a 100kΩ resistor.
c) Final measurements
After test completion, the test capacitor shall be removed from the test chamber and dried at +25°C for 210±30 minutes. After stabilizing, the insulation resistance shall be measured as specified in paragraph P.4.4.6.4 except for applying a DC voltage of $1.3^{+0.20}_{-0.25}$V through a 100kΩ resistor, then the capacitance shall be measured as specified in paragraph P.4.4.6.1.
d) Visual inspection
After the final measurements, capacitors shall be visually examined for evidence of mechanical damage under 10X magnification.

P.4.4.8.8 Barometric Pressure (Reduced)

Capacitors shall be tested in accordance with test method 105 of MIL-STD-202. The following details shall apply.

a) Test condition: D (1.1kPa).

b) Applied voltage: Unless otherwise specified in the detail specification, 150% of the rated voltage.
c) Duration of application: 5±1 seconds.
d) Charged and discharged current: 50mA or less.
e) Measurement during test
Capacitors shall be monitored for short-circuiting.
f) Post-test inspections
Capacitors shall be examined for evidence of damage, arcing, open-circuiting, and short-circuiting.

P.4.4.8.9 Resistance to Solvents

Capacitors shall be tested in accordance with test method 215 of MIL-STD-202. The following details shall apply.
a) Applied area: Marked area.
b) Solvents solutions: A mixture consisting of the following:
1) Three parts by volume of mineral spirits, or three parts by volume of a mixture of 80 percent by volume of kerosene and 20 percent by volume ethylbenzene. One part by volume of isopropyl alcohol.
2) A terpene defluxer consisting of 90 percent d-limonene and 10 percent surfactant.
3) Forty-two parts by volume pure water, which is a minimum of 1 megohm-cm minimum resistivity. One part by volume of propylene glycol monomethyl ether. One part by volume of monoethanolamine.
c) Post-test inspection
Capacitors shall be examined visually for marking legibility.

P.4.4.9 Durability Performance

Durability performance test shall be performed as follows.

P.4.4.9.1 Life

Capacitors shall be tested in accordance with test method 108 of MIL-STD-202. The following details shall apply.
a) Distance between the test capacitor and temperature measuring position: N/A
b) Test temperature: $+125^{+4}_{0}$°C.
c) Test voltage and test circuit shall be as specified in paragraph P.4.4.8.4.2. In case of blown fuse, the determination shall also be as specified in P.4.4.8.4.2.
d) Charged and discharged current: 50mA or less.
e) Duration of voltage application
1) Qualification test: $4{,}000^{+72}_{0}$ hours.
2) Quality conformance inspection (Group B): $1{,}000^{+48}_{0}$ hours.
f) Measurements and inspection during and after test
At each completion of 250 hours, 1,000 hours, 2,000 hours, and 4,000 hours of life test, the insulation resistance shall be measured as specified in paragraph P.4.4.6.4 while the capacitor is maintained at the test temperature. The test capacitor may be transferred to another chamber maintained at the same temperature to measure the insulation resistance. The transfer time shall not exceed 15 minutes. The measurement shall be made after the test capacitor is stabilized at the test temperature. After the measurement, the test capacitor shall be brought to the standard conditions specified in paragraph P.4.4.1 to

visually examine for mechanical damage under 10X magnification. Then the capacitance, dissipation factor, and insulation resistance shall be measured as

g) specified in paragraphs P.4.4.6.1, P.4.4.6.2, and P.4.4.6.4.

P.4.5 Long-Term Storage

When capacitors have been stored for a long term in accordance with paragraph 4.7.1, 100% inspection shall be conducted for the following items.

a) Capacitance (paragraph P.3.7.1)
b) Dissipation factor (paragraph P.3.7.2)
c) Insulation resistance (paragraph P.3.7.4)
d) Dielectric withstanding voltage (paragraph P.3.7.3)
e) Externals (paragraph P.3.4)

Inspection for the solderability and resistance to soldering heat shall be performed using samples as shown in Table P-9. for each lead finish.

The date of re-inspection shall be marked on the packages or storage containers. The rejected lot for solderability and resistance to soldering heat shall not be shipped.

P.4.6 Changes to Tests and Inspections

Changes to tests and inspections shall be as specified in paragraph 4.8.

P.5 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in paragraph 5.

P.6 NOTE

Notes shall be as specified in paragraph 6.