INCH-POUND
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SUPERSEDING
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15 December 2003

MILITARY SPECIFICATION

CAPACITORS, FIXED, MICA DIELECTRIC, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

INACTIVE FOR NEW DESIGN
after 31 March 1999

1. SCOPE

1.1 Scope. This specification covers the general requirements for molded and dipped mica dielectric, fixed capacitors intended primarily for use in high-stability, low-loss radio-frequency applications such as tuned circuits (see 6.1). This is a graded specification covering ranges in temperature coefficient, capacitance, tolerance, temperature, and vibration.

1.2 Classification.

1.2.1 Type designation. The type designation is in the following form, and as specified (see 3.1 and 6.2):

CM15	C	D	010	D	N	3
Style (1.2.1.1)	Characteristic (1.2.1.2)	Voltage rating (1.2.1.3)	Capacitance (1.2.1.4)	Capacitance tolerance (1.2.1.5)	Temperature range (1.2.1.6)	Vibration grade (1.2.1.7)

1.2.1.1 Style. The style is identified by the two-letter symbol “CM” followed by a two-digit number; the letters identify mica dielectric, fixed capacitors, and the number identifies the shape and dimensions of the capacitor.

1.2.1.2 Characteristic. The characteristic is identified by a single letter which indicates the relative stability of the capacitor with temperature change, in accordance with table I.

TABLE I. Characteristic.

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

Comments, suggestions, or questions on this document should be addressed to: DLA Land and Maritime ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990 or e-mailed to capacitorfilter@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.daps.dla.mil/quicksearch or https://assist.daps.dla.mil

1.2.1.3 Voltage rating. The voltage rating is identified by a single letter in accordance with table II.

TABLE II. Voltage rating.

Symbol	Voltage rating (volts, dc)
A	100
C	300
D	500

1.2.1.4 Capacitance. The nominal capacitance value expressed in picofarads (pF) is identified by a three-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow.

1.2.1.5 Capacitance tolerance. The capacitance tolerance is identified by a single letter in accordance with table III.

TABLE III. Capacitance tolerance.

Symbol	Capacitance tolerance
D	± .5 pF
F	± 1%
G	± 2%
J	± 5%

1.2.1.6 Temperature range. The temperature range is identified by a single letter in accordance with table IV.

TABLE IV. Operating temperature range.

Symbol	Operating temperature range
N	-55° to +85°C
O	-55° to +125°C
P	-55° to +150°C

1.2.1.7 Vibration grade. The only vibration grade still available is grade 3, 10 to 2,000 Hz.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications. standards. and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (See 6.2).

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-C-5/1	-	Capacitors, Fixed, Mica Dielectric, Style CM15.
MIL-C-5/18	-	Capacitors, Fixed, Mica Dielectric, Styles CM04, CM05, CM06, CM07, CM08, CM09, CM10, CM11, CM12, and CM13.
MIL-PRF-39001	-	Capacitors, Fixed, Mica Dielectric, Established Reliability and Nonestablished Reliability, General Specification For.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	-	Test Method Standard Electronic and Electrical Component Parts.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch/ or https://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL Z540.3	-	Calibration and Measuring and Test Equipment - General Requirements (Replaces MIL-STD-45662.)

(Copies of this document may be ordered online at www.ncsli.org or from NCSL International, 1800 30th Street, Suite 305, Boulder, CO 80701-1026)

THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS INC. (IPC)

J-STD-004	-	Requirements for Soldering Fluxes.
J-STD-006	-	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications.

(Copies of these documents can be ordered online at www.ipc.org or from the Institute for Interconnecting and Packaging Electronic Circuits (IPC, INC.), 2215 Sanders Road, Suite 200 South, Northbrook, IL 60062.)

INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)

ISO-10012-1	-	Quality Assurance Requirements for Measuring Equipment - Part I: Metrological Confirmation System for Measuring Equipment - First Edition.

(Copies of this document may be ordered online at http://webstore.ansi.org/ or from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036-0350)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification. Capacitors furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.4 and 6.3).

3.3 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Insulating, impregnating, and sealing compounds. Insulating, impregnating, and sealing compounds, including varnishes, waxes, and the like, shall be suitable for each particular application. Compounds shall preserve the electrical characteristics of the insulation to which applied. The compound, either in the state of its original application or as a result of cracking or aging, shall have no adverse effect on the performance of the capacitor. The compound shall not leak from the capacitor when it is mounted in any position under the conditions specified herein.

3.4 Interface and physical dimensions. Capacitors shall meet the interface and physical dimensions specified (see 3.1).

3.4.1 Case. Capacitors shall be effectively sealed against the entry of moisture, and the elements shall be mounted so as to prevent injurious movement in the capacitor cases. The capacitor elements shall be completely enclosed by the cases except where terminals or leads project.

3.4.2 Terminal leads. Leads shall be made of a solid conductor of the length and diameter specified (see 3.1) and shall be coated with solder, and shall meet the solderability requirements of 3.13.

3.4.3 Tin plated finishes. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of capacitor components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.7).

3.5 Dielectric withstanding voltage. When tested as specified in 4.6.2, capacitors shall withstand the direct current (dc) potential specified without damage, arcing, or breakdown.

3.6 Barometric pressure (Qualification inspection only). When tested as specified in 4.6.3, capacitors shall withstand the potential specified (see 3.1) without damage, arcing, or breakdown.

3.7 Insulation resistance. Unless otherwise specified (see 3.1), when capacitors are tested as specified in 4.6.4, the insulation resistance shall be not less than the applicable requirement specified in table V.

TABLE V. Insulation resistance.

Capacitance value	Minimum insulation resistance
At 25°C	
0 to 10,000 picofarads	100,000 megohms
10,000 picofarads and greater	1,000 megohm-microfarads 1/
At 85°C	
0 to 5,000 picofarads	15,000 megohms
5,000 picofarads and greater	75 megohm-microfarads
At 125°C	
0 to 3,300 picofarads	10,000 megohms
3,300 picofarads and greater	33 megohm-microfarads
At 150°C	
0 to 1,500 picofarads	5,000 megohms
1,500 picofarads and greater	7.5 megohm-microfarads

1/ Product obtained by multiplying the capacitance in microfarads by the insulation resistance in megohms.

3.8 Dissipation factor. When measured as specified in 4.6.5, the dissipation factor shall not exceed the applicable value shown in figure 1 (see 6.1.3).

3.9 Capacitance. When measured as specified in 4.6.6, the capacitance shall be within the tolerance shown in the type designation (see 3.1).

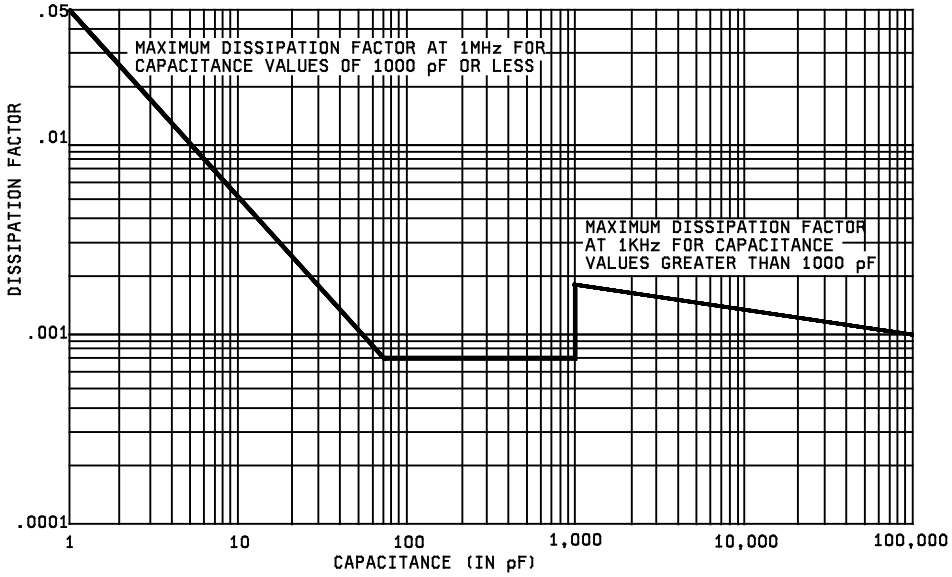

FIGURE 1. Dissipation factor.

3.10 High frequency vibration. When capacitors are tested as specified in 4.6.7, there shall be no mechanical damage, intermittent contacts, nor open-circuiting or short-circuiting.

3.11 Thermal shock and immersion. When tested as specified in 4.6.8, capacitors shall meet the following requirements:

Dielectric withstanding voltage	As specified in 3.5
Insulation resistance	At least 30 percent of initial requirement.
Dissipation factor	Not greater than 150 percent of initial requirement.
Capacitance	Change from the value obtained when measured as specified in 4.6.6 shall not exceed the value specified (see 3.1).

3.12 Shock (specified pulse). When capacitors are tested as specified in 4.6.9, there shall be no visible mechanical damage, intermittent contacts of 0.5 millisecond (ms) or greater duration, nor open-circuiting or short-circuiting.

3.13 Solderability. When capacitors are tested as specified in 4.6.10, the dipped surface of the capacitor lead to be inspected shall be limited to a one-inch area extending outward from .050 inch of the capacitor body for molded units and from the epoxy coating or from the bottom of the crimp, as applicable, for dipped units. Of this area, at least 95 percent shall be covered with a new smooth, solder coating. The remaining 5 percent of the surface to be inspected shall show only small pinholes or voids; these shall not be concentrated in one area. Bare base metal and areas where the solder dip failed to cover the original coating are indications of poor solderability, and shall be cause for failure when their total area exceeds 5 percent of the surface to be inspected. In case of dispute, the percent coverage with pinholes or voids, shall be determined by actual measurements of these areas, as compared to the total area.

3.14 Terminal strength. When capacitors are tested as specified in 4.6.11, no part of the terminals shall loosen or rupture and no other damage shall result. For dipped capacitors, minor chipping of the resinous coating of the meniscus only, will not be considered a failure, provided that the sample unit passes all subsequent environmental tests.

3.15 Moisture resistance. When tested as specified in 4.6.12, capacitors shall meet the following requirements:

Dielectric withstanding voltage	As specified in 3.5
Insulation resistance	At least 30 percent of initial requirement.
Dissipation factor	Not greater than 150 percent of initial requirement.
Capacitance	Change from initial value obtained when measured as specified in 4.6.6 shall not exceed the value specified (see 3.1).

3.16 Temperature coefficient and capacitance drift. When measured as specified in 4.6.13, the temperature coefficient and capacitance drift shall be within the limits specified in table I for each characteristic.

3.17 Low-temperature storage and life. When tested as specified in 4.6.14, capacitors shall meet the following requirements:

Visual examination	No mechanical damage and marking shall remain legible.
Dielectric withstanding voltage	As specified in 3.5.
Dissipation factor	Not greater than 150 percent of initial requirement.
Insulation resistance	Shall meet initial requirement.
Capacitance	Change from initial value obtained when measured as specified in 4.6.6 shall not exceed the value specified (see 3.1).

3.17.1 Performance check. When tested as specified in 4.6.14.2.1, capacitors shall meet the following requirements:

Visual examination	No mechanical damage and marking shall remain legible.
Dielectric withstanding voltage	As specified in 3.5.
Dissipation factor	Not greater than 150 percent of initial requirement.
Insulation resistance	Shall meet initial requirement.
Capacitance	Change from initial value obtained when measured as specified in 4.6.6 shall not exceed the value specified (see 3.1).

3.17.2 Continuation test. When tested as specified in 4.6.14.2.2, capacitors shall meet the requirements specified in 3.17.

3.18 Marking. Capacitors shall be marked in accordance with one of the methods specified in 3.18.1 and 3.18.2. The marking methods are given in the order preferred. Other markings that in any way interfere with, obscure, or confuse those specified herein, are prohibited. Each capacitor shall be legibly marked with smear-resistant ink that will withstand the environmental tests specified herein. The marking shall remain legible after all tests.

3.18.1 Full marking. The capacitors shall be marked with the type designation, manufacturer's name or symbol, working voltage, and where applicable (see 3.1), the current rating at 1 megahertz (MHz). There shall be no space between the symbols that comprise the type designation.

3.18.2 Partial marking. When space or existing molds do not permit the marking specified in 3.18.1, the type designation, manufacturer's name or symbol, and where applicable (see 3.1), the current rating at 1 MHz, shall be marked on the capacitor. If lack of space requires it, the type designation may appear on two lines. In this event, the type designation shall be divided as shown in the following example:

CM15CD
010DN3

An abbreviated type designation marking will be permitted for styles CM04 and CM09 as follows:

CM4ED
101JO

3.18.3 Established reliability (ER) marking. An ER part manufactured in accordance with MIL-PRF-39001 may be marked and furnished as a non-ER part to this specification, if produced on the same assembly line or lines, and provided it is subjected to and meets all the inspection requirements of the ER part. This is applicable only to group 1 of 4.5.1.1.

3.19 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality and shall be free from pits, corrosion, cracks, rough edges, and other defects that will affect life, serviceability, or appearance. All traces of corrosive flux shall be removed.

4. VERIFICATION

4.1 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with ANSI/NCSL Z540-1, ISO-10012-1, or equivalent, as approved by the qualifying activity.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. Qualification inspection (see 4.4).

b. Conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in "GENERAL REQUIREMENTS" of MIL-STD-202.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3).

4.4.1 Sample size. The number of capacitors to be submitted for qualification inspection shall be as specified in the appendix to this specification. The sample shall be taken from a production run and shall be produced with equipment and procedures normally used in production.

4.4.2 Inspection routine.

4.4.2.1 Single-type submission. The specimens (see A.2.1.1) shall be subjected to the examinations and tests specified in table VII, in the order shown. All specimens shall be subjected to the examinations and tests of group I. The specimens shall then be divided into the remaining groups as shown in table VII, and subjected to the tests for their particular group.

4.4.2.2 Single-style submission. The specimens (see A.2.1.2) shall be subjected to the electrical tests of group I and the temperature-coefficient and capacitance-drift test of table VII only. Only one defective shall be allowed.

4.4.3 Defectives. Defectives in excess of those allowed in table VII and 4.4.2.2 shall be cause for refusal to grant qualification.

TABLE VII. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of defectives allowed
Group I				
Visual and mechanical examination	3.1, 3.3 to 3.4.3, 3.18 to 3.19	4.6.1		
Dielectric withstanding voltage	3.5	4.6.2	1/ 43	1
Barometric pressure	3.6	4.6.3		
Insulation resistance	3.7	4.6.4		
Dissipation factor	3.8	4.6.5		
Capacitance	3.9	4.6.6		
Group II				
High frequency vibration	3.10	4.6.7	12	1
Thermal shock and immersion	3.11	4.6.8.1 to 4.6.8.1.3		
Group III				
Shock (specified pulse)	3.12	4.6.9		
Solderability	3.13	4.6.10	12	1
Terminal strength	3.14	4.6.11		
Moisture resistance	3.15	4.6.12		
Group IV				
Temperature coefficient and capacitance drift	3.16	4.6.13.1 to 4.6.13.1.3	2/ 18	1
Low-temperature storage and life	3.17	4.6.14 and 4.6.14.1		

1/ One additional specimen is included to permit substitution for the allowable defective in group I.
2/ Only 12 specimens are to be subjected to the temperature-coefficient and capacitance-drift test, 6 of which shall be of the low capacitance sample units when single style qualification is sought.

4.5 Conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A and group B inspection.

4.5.1.1 Inspection lot. An inspection lot shall consist of capacitors in one or more styles. The sample selected from the lot shall be representative of the styles in the lot. Styles may be grouped as follows:

Group	Styles
1	CM04, CM05, CM06, CM07, CM08, CM09, CM10, CM11, CM12, and CM13
2	CM15

4.5.2 Rejected lots. If an inspection lot is rejected, the supplier may withdraw the lot, rework it to correct the defects, or screen out defectives and resubmit for re-inspection. Such lots shall be kept separate from new lots and shall be clearly identified as re-inspected lots. Rejected lots shall be inspected, using tightened inspection.

4.5.3 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table VIII, in the order shown.

4.5.3.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table IX. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table IX. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this inspection.

TABLE VIII. Group A inspection.

Inspection	Requirement paragraph	Test Method paragraph	Sample procedure
Visual and mechanical examination:			
Material	3.1, 3.3 to 3.3.1	4.6.1	
Body dimensions	3.4		13 samples
Interface and physical dimensions			0 failures
(other than dimensions)	3.4 to 3.4.4		
Marking 1/	3.18 to 3.18.3		
Workmanship	3.19		
Dielectric withstanding voltage	3.5	4.6.2	
Insulation resistance (at room ambient temperature)	3.7	4.6.4.1	See 4.5.3.1
Dissipation factor	3.8	4.6.5	
Capacitance	3.9	4.6.6	

1/ Marking defects are based on visual examination only. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

Table IX. Sampling plans for group A electrical inspection.

Lot size	Sample size
2 to 12	100 percent
13 to 150	13
151 to 280	20
281 to 500	29
501 to 1,200	34
1,201 to 3,200	42
3,201 to 10,000	50
10,001 to 35,000	60
35,001 to 150,000	74
150,001 to 500,000	90
500,001 and over	102

4.5.4 Group B inspection. Group B inspection shall consist of the tests specified in table X, in the order shown. Shipment of capacitor lots shall not be accomplished until representative samples of the lot have successfully completed the group B tests.

4.5.4.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table X. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table X. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.4.2 Disposition of sample units. Sample units that have been subjected to group B inspection shall not be delivered on the contract or order.

4.5.5 Retention of qualification. Every 6 months, the manufacturer shall verify the retention of qualification to the qualifying activity. The supplier shall also notify the qualification activity at any time during the 6-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification.

In the event that there is no production of a single style device during a reporting period and the manufacturer is listed for more than one style on the QPL, the manufacturer shall verify they still have the capabilities and facilities necessary to produce that product. If during three consecutive reporting periods there has been no production of a given style, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of that style to testing.

TABLE X. Group B inspection.

Test	Requirement paragraph	Method paragraph	Sample procedure
Insulation resistance (at high ambient temperature) 1/ Temperature coefficient and capacitance drift 1/ Low-temperature storage and life (performance check) 1/	3.7 3.16 3.17.1	4.6.4.2 4.6.13.2 thru 4.6.13.2.2 4.6.14.2.1	5 samples 0 failures

1/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failures, the frequency of this test, with the approval of the qualifying activity, can be performed every two years. If the design, material, construction, or processing of the part is changed, or if there are any quality problems or failures, the qualifying activity may require resumption of the original test frequency.

4.6 Methods of examination and test.

4.6.1 Visual and mechanical examination. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.4.3, and 3.18 to 3.19).

4.6.2 Dielectric withstanding voltage (see 3.5). Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

a. Magnitude and nature of test voltage: 200 percent of the dc working voltage (see 3.1).

b. Duration of application of test voltage: Not less than 1 second nor more than 5 seconds. The duration of the test shall begin when 95 percent of the test potential is reached.

c. Points of application of test voltage: Between terminals.

d. Limiting value of surge current: Shall not exceed 5 milliamperes (mA).

e. Examinations after test: Capacitors shall be examined for evidence of damage, arcing, and breakdown.

4.6.3 Barometric pressure (Qualification only) (see 3.6). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

a. Method of mounting: Not applicable.

b. Test condition: Reduced pressure as specified (see 3.1).

c. Tests during subjection to reduced pressure: A test potential as specified (see 3.1) shall be applied between the terminals for not less than 1 second nor more than 5 seconds.

d. Examinations after test: Capacitors shall be examined for evidence of damage, arcing, and breakdown.

4.6.4 Insulation resistance (see 3.7).

4.6.4.1 At room ambient temperature. Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

a. Test-condition letter: A.

b. Points of measurement: From terminal to terminal. (Condensed moisture may be removed by a blast of air.)

4.6.4.2 At high ambient temperature. Capacitors shall be subjected to the applicable high ambient temperature (see 3.1 and table IV) for a period of time sufficient to reach thermal stability and shall then be measured as specified in 4.6.4.1.

4.6.5 Dissipation factor (see 3.8). Dissipation factor shall be measured at a frequency of 1 MHz ± 1,000 Hz when the nominal capacitance is 1,000 pF or less, and 1 kHz ± 100 Hz when the nominal capacitance is greater than 1,000 pF. Measurement accuracy for direct reading methods shall be within ±2 percent of the readout or ±0.0005 dissipation factor, whichever is greater. If obtaining dissipation factor measurements by an indirect method, an analysis should be made to show that the calculated value is within the specified limits when considering the worst-case error stated by the measurement accuracy of the measurement instrument. Frequency accuracy shall be ± 1 percent.

4.6.6 Capacitance (see 3.9). Capacitance shall be measured in accordance with method 305 of MIL-STD-202 at a frequency of 1 MHz ± 10 percent when the capacitance is 1,000 pF or less, and at a frequency of 1 kHz when the capacitance is greater than 1,000 pF. Capacitance measurements shall be made at 25°C and need not be more accurate than ±(0.2 percent +0.5 pF).

4.6.7 High frequency vibration (grade 3) (see 3.10). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Capacitors shall be rigidly mounted by the body to a vibration-test apparatus.

b. Test-condition letter: D (20G).

c. Measurements during vibration: During the last cycle in each direction, an electrical measurement shall be made to determine intermittent contacts of 0.5 ms or greater duration, or open-circuiting or short-circuiting.

d. Examination after test: Capacitors shall be visually examined for evidence of mechanical damage.

4.6.8 Thermal shock and immersion (see 3.11).

4.6.8.1 For qualification inspection.

4.6.8.1.1 Thermal shock. Capacitors shall be tested in accordance with test condition A, method 107, of MIL-STD-202, except that at step 3, the maximum temperature shall be 85° +3° -0°C, 125° +3° -0°C, and 150 +3° -0°C, as applicable.

4.6.8.1.2 Immersion. Thermal shock shall be followed by immersion in accordance test with condition B, method 104, of MIL-STD-202. At the end of the immersion, surface moisture shall be removed by circulating air at room temperature, or wiping with a clean dry cloth, or both. The elapsed time between the removal of the capacitors from the immersion tank and the measurements shall not exceed 30 minutes.

4.6.8.1.3 Measurements. After thermal shock and immersion, the dielectric withstanding voltage, insulation resistance, dissipation factor, and capacitance shall be measured as specified in 4.6.2, 4.6.4.1, 4.6.5, and 4.6.6, respectively.

4.6.8.2 For conformance inspection. Capacitors shall be tested as specified in 4.6.8.1, except that only three of the five thermal shock cycles shall be required; however, at the option of the manufacturer, the temperature within the cold chamber may be lower than -55°C, and the temperature within the hot chamber may be higher than the applicable maximum temperature of 4.6.8.1.1; and the temperature of the water may be higher than 65°C, or lower than 20°C.

4.6.9 Shock (specified pulse) (see 3.12). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

a. Mounting: Capacitors shall be rigidly mounted by the body.

b. Test condition: Letter I (100G (pk)).

c. Measurements and electrical loading during shock: DC rated voltage shall be applied to the capacitor during test. Observations shall be made to determine intermittent contact or arcing or open-circuiting or short-circuiting. Detection equipment shall be sufficiently sensitive to detect any interruption of 0.5 ms or greater duration.

d. Measurements after shock: Capacitors shall be visually examined for evidence of arcing, breakdown, and mechanical damage.

4.6.10 Solderability (see 3.13). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

a. The number of terminations of each capacitor to be tested: 2.

b. Special preparation of terminations: None; to be tested in an “as received” condition.

c. Depth of immersion in flux and solder: Both leads to be immersed to within 0.05 inch of the capacitor body.

4.6.11 Terminal strength (see 3.14)

4.6.11.1 Pull test. Capacitors shall be held by one terminal and a load gradually applied to the other terminal (the capacitor shall not be supported by its body) until the applied load reaches 5 pounds, unless otherwise specified (see 3.1). The maximum pull shall be applied for at least 5 seconds. The capacitors shall then be examined for evidence of loose or ruptured terminals.

4.6.11.2 Twist test (straight leads only) (see 3.1). All straight lead terminals shall be bent through 90 degrees at a point 1/4 inch from the body of the capacitor, with the radius of curvature at the bend approximately 1/32 inch. The terminals shall be clamped to within 3/64 $\pm$ 1/64 inch of the bend on the side between the bend and the remaining portion of the lead, away from the body. The body of the capacitor shall then be rotated about the original axis of the bent terminal through 360 degrees in alternating directions for five such 360-degree rotations, at the rate of approximately 5 seconds per rotation.

4.6.11.3 Bend test (crimped leads only) (see 3.1). Capacitors with crimped leads shall be clamped at the first bend at the bottom of the crimp. The body of the capacitor shall then be bent 90 degrees from the vertical in one direction, then back to the vertical, then bent 90 degrees in the opposite direction and then back to the vertical. This sequence shall be performed one time. After the test, capacitors shall be examined for loose or ruptured terminals or other damage.

4.6.12 Moisture resistance (see 3.15). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Except during measurements, capacitors shall be securely fastened by normal mounting means to rigidly supported terminals, so spaced that the length of each lead between support and capacitor body shall be 5/8 inch.

b. Initial measurements: Not applicable.

c. Polarization and load: Not applicable.

d. Final measurements: Upon completion of step 6 of the final cycle, capacitors shall be maintained at a temperature of 25° +10° -5°C and a relative humidity of 20 to 80 percent for a period of 4 to 24 hours; the dielectric withstanding voltage, insulation resistance, dissipation factor, and capacitance shall then be measured as specified in 4.6.2, 4.6.4.1, 4.6.5, and 4.6.6, respectively.

4.6.13 Temperature coefficient and capacitance drift (see 3.16).

4.6.13.1 For qualification inspection. Capacitance measurements shall be made in accordance with 4.6.6 (a frequency of 100 kHz ± 1 percent may be used as an alternate) at the following temperatures, in the order listed:

Temperature, °C	Temperature, °C
+25 ± 2	+65 ± 2
-55 +0, -2	+85 +2, -0 (For temperature ranges N, O, and P)
-40 ± 2	+125 +2, -0 (For temperature ranges O and P)
-10 ± 2	+150 +2, -0 (For temperature range P)
+25 ± 2	+25 ± 2
+45 ± 2	

The measurement at each temperature shall be recorded when two successive readings taken at 5 minute intervals are within ±(0.025 percent of nominal capacitance ±0.05 pF) of each other. The second reading is then taken as the capacitance at the specified test temperature.

4.6.13.1.1 Temperature coefficient. The temperature coefficient shall be computed as follows:

$$TC = \frac{(C_2 - C_1) \times 10^6}{(T_2 - T_1) \times C_1}$$

Where: TC = Temperature coefficient (in parts per million per degree C).
C_1 = Capacitance (in pF) at the middle 25°C (reference) temperature.
C_2 = Capacitance (in pF) at test temperature.
T_1 = 25°C.
T_2 = Test temperature (in degrees C).

4.6.13.1.2 Capacitance drift. Capacitance drift shall be computed by dividing the greatest single difference between any two of the three values recorded at 25°C by the second value recorded at 25°C.

4.6.13.1.3 Continuous-curve temperature coefficient. As an alternate to the measurements specified in 4.6.13.1, a continuous curve of capacitance versus temperature may be produced by subjecting the capacitors to a slowly varying temperature. The temperature shall be varied from +25°C, to -55°C, to the applicable elevated temperature (see 3.1 and table IV), to +25°C. A temperature-sensing device shall be embedded in a dummy capacitor in a manner to assure accurate internal reading in the capacitor under test. The temperature shall be varied slowly enough to produce a smooth, uniform curve with no loops at -55°C or the applicable elevated temperature (see 3.1 and table IV). Measurements shall be made at a frequency of 100 ± 10 kHz. Accuracy shall be as specified in 4.6.13.1.

4.6.13.2 For conformance inspection. Capacitance measurements shall be made as specified in 4.6.13.1, or 4.6.13.1.3, except that only five temperature exposures at +25°C, -55°C, +25°C, the applicable elevated temperature (see 3.1 and table IV), and +25°C need be made.

4.6.13.2.1 Temperature coefficient. The temperature coefficient shall be computed as specified in 4.6.13.1.1.

4.6.13.2.2 Capacitance drift. Capacitance drift shall be computed as specified in 4.6.13.1.2.

4.6.14 Low-temperature storage and life (see 3.17). Capacitors shall be subjected to a temperature of -55°C +0°C, -2°C for a period of 48 hours. Capacitors shall then be subjected to the tests specified in 4.6.14.1 or 4.6.14.2.1, as applicable.

4.6.14.1 For qualification inspection. Capacitors shall be subjected to 150 percent of dc working voltage (see 3.1) and high operating temperature (see 3.1) ±3°C for 2,000 hours. During the test, the surge current shall be limited to 50 mA. At the conclusion of the test, capacitors shall be returned to the inspection conditions specified in 4.3, and shall be visually examined for evidence of mechanical damage and obliteration of marking; the dielectric withstanding voltage, insulation resistance, dissipation factor, and capacitance shall then be measured as specified in 4.6.2, 4.6.4.1, 4.6.5, and 4.6.6, respectively.

4.6.14.2 For conformance inspection.

4.6.14.2.1 Performance check. Capacitors shall be tested as specified in 4.6.14 and 4.6.14.1, except that the duration of the potential shall be 250 hours (see 3.17.1 and 4.5.4).

4.6.14.2.2 Continuation test. Capacitors that have been subjected to the 250-hour performance check (see 4.6.14.2.1) shall be tested for an additional period of 1,750 hours in accordance with 4.6.14.1 (see 3.17.2).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

6.1 Intended use. These mica capacitors, because of their low-power factor, high-breakdown voltage, low-dielectric absorption, and high-insulation resistance, are intended for use in high-frequency circuits where good stability is required for temperature, frequency, and aging, such as in timing and frequency-determining circuits. Capacitors covered by this specification are unique due to the fact that these devices must be able to operate satisfactorily under the following demanding conditions: 20 Gs of high frequency vibration, 100 Gs of shock (specified pulse), and wide temperature fluctuations. These capacitors also receive 2,000 hours of life testing. Commercial components are not designed to withstand these military environmental conditions.

6.1.1 Safe operating voltages. The voltage ratings specified (see 3.1) apply over the operating temperature range of the capacitor, and under the following conditions:

a. Barometric pressure: As specified in the associated specification sheet for altitudes up to 50,000 feet for the larger transmitting styles and 100,000 feet for the remaining styles.

b. Relative humidity: Up to 80 percent.

6.1.2 Flammability. It should be noted that this specification contains no requirements concerning the flammability of the materials used in the construction of the capacitors. Users should take this into consideration when a particular application involves this requirement.

6.1.3 Dissipation factor. For dissipation factor measurement purposes Q = 1/DF (see 3.8).

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Title, number, and date of the applicable specification sheet, and the complete type designation (see 1.2.1 and 3.1).

c. Levels of preservation and packaging and packing, and applicable marking (see section 5).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products that are, at the time of award of contract, qualified for inclusion in Qualified Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the DLA Land and Maritime ATTN: VAT, PO Box 3990, Columbus, OH 43216-5000, or by e-mail to vqp.chief@dla.mil.

6.3.1 Copies of SD-6. Copies of SD-6, "Provisions Governing Qualification". A copy of this document is available online at https://assist.daps.dla.mil/quicksearch/ or https://assist.daps.dla.mil or from the Standardization Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

6.4 PIN. This specification requires a PIN that describes codification or classification and appropriate references to associated documents (see 1.2.1 and 3.1).

6.5. Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmentally Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm. Further information is available at the following EPA site: http://www.epa.gov/epaoswer/hazwaste/minimize/. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

6.6 Subject term (key word) listing.

Capacitance
Vibration

6.7 Tin whisker growth. The use of alloys with a tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacturer and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have been shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

6.8 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX A

PROCEDURE FOR QUALIFICATION INSPECTION

A.1. SCOPE

A.1.1 This appendix details the procedure for submission of samples for qualification inspection of capacitors covered by this specification. The procedure for extending qualification of the required sample to other capacitors covered by this specification is also outlined herein. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2. SUBMISSION

A.2.1 Sample.

A.2.1.1 Single-type submission. Sets of 43 capacitors shall be submitted for each type for which qualification is sought. Each sample set shall be submitted in the J (± 5 percent) or closer capacitance tolerance.

A.2.1.2 Single-style submission. An additional sample set of 12 capacitors shall be submitted with each sample set of 43 capacitors. The specimens of this additional sample set shall be in the same capacitance tolerance and temperature range, and shall be of the same design, construction, and materials as the corresponding specimens selected in accordance with A.2.1.1, and shall have the lowest capacitance value listed for the particular style, characteristic, and capacitance tolerance. Where the lowest capacitance value listed for a particular style is below 45pF, specimens of the 47pF value, or preferably lower, may be submitted. The additional sample units shall be subjected to the group I tests of table A-I and shall represent 50 percent of those units subjected to the temperature coefficient and capacitance drift tests of group IV.

A.2.2 Qualification-group submission. Table A-I shows the number and types of specimens to be submitted for the styles constituting a qualification-group submission. The characteristics submitted shall be of the narrowest temperature coefficient for which qualification is desired, and shall be in either foil or silvered-mica construction. The temperature range of the specimens submitted shall be the same.

A.3. EXTENT OF QUALIFICATION

A.3.1 Submission and qualification of a particular style in one of characteristics C, E, or F and in one of temperature ranges N, O, or P automatically carries with it broader requirements, provided the units are of the same style, material, and construction (e.g., qualification of characteristic F includes qualification and characteristics C and E of the same design; qualification of temperature range P includes qualification of temperature ranges N and O of the same design). Qualification of the ± 5 percent or closer capacitance tolerances automatically qualifies all other applicable capacitance tolerances. Qualification of a style is limited to the maximum watt-second rating and the highest voltage submitted. Qualification of either straight lead style or crimp lead style allows qualification of the other lead style.

A.3.2 Qualification groups. Qualification of all the types submitted as a complete qualification group (see table A-I) automatically carries with it qualification of all types for the styles included in the group which have characteristics of equal or broader requirements than the types submitted, and of temperature ranges equal to and narrower than the type submitted. This extension of qualification is contingent on the use of the same materials, design, and construction for all types qualified in the qualification group. Wherever material, design, or construction differences exist, submission shall be made in accordance with A.2.1.1 and A.2.1.2, as applicable.

APPENDIX A

TABLE A-I. Samples for qualification inspection. 1/

Styles CM04, CM05, CM06, CM07, CM08, CM09, CM10, CM11, CM12, CM13	
Number of specimens	Type designation
12	CM09FD910JP3
43	CM09FD241JP3
12	CM09FA331JP3
43	CM09FA391JP3
12	CM10FD910JP3
43	CM10FD391JP3
12	CM11FD431JP3
43	CM11FD472JP3
12	CM12FD512JP3
43	CM12FD203JP3
12	CM13FD223JP3
43	CM13FD473JP3

1/ Since these specimens may be submitted in either foil or silvered-mica constructions, qualification will be limited to the construction submitted. If qualification of both constructions is desired, duplicate submissions are required (see A.3.2).

Custodians:
Army - CR
Navy - EC
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 5910-2011-026)

Review activities:
Army - MI
Navy - AS, MC, OS
Air Force - 19, 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using ASSIST Online database at https://assist.daps.dla.mil .