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PERFORMANCE SPECIFICATION

CAPACITORS, FIXED, ELECTROLYTIC (SOLID ELECTROLYTE), TANTALUM, MOLDED, CONFORMAL COATED AND METAL CASED WITH PLASTIC END-FILL, NONHERMETICALLY SEALED, GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for fixed, electrolytic (solid electrolyte), tantalum, molded, conformal coated and metal cased with plastic end-fill nonhermetically sealed capacitors, primarily intended for filter, bypass, coupling, and other applications where the alternating current (ac) component is small compared to the direct current (dc) rated voltage. These capacitors are intended to be used only where supplemental moisture protection is provided or for noncritical applications where hermetic moisture protection is not required.

1.2 Classification. Capacitors covered by this specification are classified by the style, as specified (see 3.1).

1.2.1 Part or Identifying Number (PIN). The PIN is in the following form and as specified (see 3.1).

CX01	D	225	K
Style (see 1.2.1.1)	Voltage (see 1.2.1.2)	Capacitance (see 1.2.1.3)	Capacitance tolerance (see 1.2.1.4)

1.2.1.1 Style. The style is identified by the two-letter symbol CX, followed by a two-digit number; the letters identify fixed, electrolytic (solid electrolyte) tantalum, molded, conformal coated and metal cased with plastic end-fill, nonhermetically sealed capacitors, and the number identifies the design of the capacitor.

1.2.1.2 Voltage. The voltage (rated and surge) is identified by a single letter as shown in table I.

1.2.1.3 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.

Comments, suggestions, or questions on this document should be addressed to: Communications-Electronics Research Development and Engineering Center (CERDEC), ATTN: RDER-PRO, Aberdeen Proving Ground, MD 21005, or emailed to usarmy.APG.cerdec.mbx.standardization-crx@mail.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.dla.mil

TABLE I. Voltage.

Symbol	Rated (+85°C) Volts, dc	Surge (+85°C) Volts, dc
A	2	2.6
B	3	4.0
C	4	5.0
D	6	8.0
F	10	13.0
H	15	20.0
J	20	26.0
K	25	32.0
M	35	46.0
N	50	65.0

1.2.1.4 Capacitance tolerance. The capacitance tolerance is identified by a single letter as shown in table II.

TABLE II. Capacitance tolerance.

Symbol	Capacitance tolerance (±)
K	10 percent
M	20 percent

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-PRF-49137/1 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polar, Molded, Nonhermetically Sealed, Style CX01
MIL-PRF-49137/2 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polar, Conformal Coated, Nonhermetically Sealed, Styles CX02 and CX12
MIL-PRF-49137/5 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polar, Molded, Nonhermetically Sealed, Style CX05
MIL-PRF-49137/6 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polar, Nonhermetically Sealed, Styles CX06 and CX16

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	-	Electronics and Electrical Component Parts, Test Methods for
MIL-STD-1276	-	Leads For Electronic Component Parts
MIL-STD-1285	-	Marking of Electrical and Electronic Parts

(Copies of these documents are available online at http://quicksearch.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.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 17025	-	General Requirements for the Competence of Testing and Calibration Laboratories
ISO 10012	-	Measurement Management Systems – Requirements for Measurement Processes and Measuring Equipment

(Copies of these documents are available online at http://www.iso.org or from ISO, 1, ch. de la Voie-Creuse, Case postale 56 – CH-1211 Geneva 20, Switzerland.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 the 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 qualified for listing on the applicable Qualified Products List (QPL) before contract award (see 4.4 and 6.4).

3.3 Materials. Materials 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. The use of paper products is not acceptable.

3.3.1 Solder and soldering flux. Solder and soldering flux shall be of such quality as to enable the capacitors to meet all of the requirements of this specification.

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

3.4.1 Body structure. The body structure shall be of encapsulated form (see 3.1).

3.4.2 Terminals. Terminals shall be of a solid conductor, of the dimensions specified (see 3.1), and shall be suitably treated to facilitate soldering.

3.4.2.1 Solder dip (retinning). Only the manufacturer may solder dip/retin the lead of the capacitors supplied to this specification, provided the solder dip process has been approved by the qualifying activity.

3.4.2.1.1 Qualifying activity approval. Approval of the solder dip process shall be based on one of the following options:

a. When the original lead finish qualified was hot solder dip lead finish 52 in accordance with MIL-STD-1276 (NOTE: The 200 microinch maximum thickness is not applicable). The manufacturer shall use the same solder dip process for retinning as was used in the original manufacture of the capacitor.

b. When the lead originally qualified was not solder dip lead finish 52 of MIL-STD-1276 as prescribed in 3.4.2.1.1a, approval for the process to be used for solder dip shall be based on the following procedure:

(1) Thirty samples of any capacitance value for each style and lead finish shall be subjected to the manufacturer's solder dip process. The capacitors shall be subjected to all prescreen electrical tests, with no defects allowed.

(2) Ten of the 30 samples shall be subjected to the solderability test, with no defects allowed.

(3) The remaining 20 samples shall be subjected to the resistance to soldering heat test, followed by the moisture resistance test, with no defects allowed.

3.4.2.1.2 Solder dip/retinning options. The capacitor manufacturer may solder dip/retin after the prescreen tests or as a corrective action. After solder dip/retinning, the following inspection and tests shall be performed on 100 percent of the lot:

a. DC leakage: Shall not exceed the requirement specified in 3.7.

b. Capacitance: Shall be within the tolerance specified (see 3.1).

c. Dissipation factor: Shall not exceed the requirement specified in 3.9.

3.4.2.2 Pure tin. 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 6.3).

3.5 Voltage aging. When tested as specified in 4.8.2, capacitors shall withstand the application of voltage at high temperature without visible mechanical damage.

3.6 Construction analysis (metal cased units only). When capacitors are inspected as specified in 4.8.3, construction analysis shall disclose no evidence of voids of the plastic end-fill exceeding 20 percent of the total case volume.

3.7 DC leakage. When measured as specified in 4.8.4, the dc leakage shall not exceed the applicable value specified (see 3.1).

3.8 Capacitance. When measured as specified in 4.8.5, the capacitance shall be within the applicable tolerance specified (see 3.1).

3.9 Dissipation factor. When measured as specified in 4.8.6, the dissipation factor shall not exceed the value specified (see 3.1).

3.10 Shock (specified pulse). When capacitors are tested as specified in 4.8.7, there shall be no intermittent contacts of 0.5 millisecond (ms) or greater duration, or arcing or other indication of breakdown, nor shall there be any open-circuiting or short-circuiting or evidence of mechanical damage.

3.11 Vibration, high frequency. When capacitors are tested as specified in 4.8.8, there shall be no intermittent contacts of 0.5 ms or greater duration, or arcing or other indication of breakdown, nor shall there be any open-circuiting or short-circuiting or evidence of mechanical damage.

3.12 Thermal shock. When tested as specified in 4.8.9, capacitors shall meet the following requirements:

a. DC leakage: Shall not exceed the requirement specified in 3.7.

b. Capacitance: Shall not change more than ±10 percent from the initial measured value (see 3.8).

c. Dissipation factor: Shall not exceed the requirement specified in 3.9.

d. Visual examination: There shall be no evidence of harmful corrosion, mechanical damage, and obliteration of marking wherever applicable.

3.13 Resistance to soldering heat. When capacitors are tested as specified in 4.8.10, there shall be no evidence of mechanical damage.

3.14 Terminal strength. When capacitors are tested as specified in 4.8.11, there shall be no loosening of the terminals or permanent damage to the terminals.

3.15 Moisture resistance. When tested as specified in 4.8.12, capacitors shall meet the following requirements:

a. DC leakage: Shall not exceed 300 percent of the requirement specified in 3.7.

b. Capacitance: Shall not change more than ±15 percent from the initial measured value (see 3.1 and 3.8).

c. Dissipation factor: Shall not exceed 150 percent of the requirement specified in 3.9.

d. Visual examination: There shall be no evidence of harmful corrosion, mechanical damage, or obliteration of marking wherever applicable.

3.16 Stability at low and high temperatures. When tested as specified in 4.8.13, capacitors shall meet the following requirements:

a. Step 1 (+25°C):

(1) DC leakage: Shall not exceed the applicable value specified (see 3.1).

(2) Capacitance: Shall be within tolerance of the nominal value specified (see 3.1).

(3) Dissipation factor: Shall not exceed the applicable value specified (see 3.1).

b. Step 2 (-55°C):

(1) Capacitance: Shall not change more than the applicable value specified (see 3.1) from the step 1 measured value.

(2) Dissipation factor: Shall not exceed the applicable value specified (see 3.1).

c. Step 3 (+25°C):

(1) DC leakage: Shall not exceed the applicable value specified (see 3.1).

(2) Capacitance: Shall not change more than 10 percent from the step 1 measured value.

(3) Dissipation factor: Shall not exceed the requirement specified in 3.9.

d. Step 4 (+85°C):

(1) DC leakage: Shall not exceed the applicable value specified (see 3.1)

(2) Capacitance: Shall not change more than the applicable value specified (see 3.1) from the step 1 measured value.

(3) Dissipation factor: Shall not exceed the requirement specified in 3.9.

e. Step 5 (+25°C):

(1) DC leakage: Shall not exceed the applicable value specified (see 3.1).

(2) Capacitance: Shall not change more than the applicable value specified (see 3.1) from the step 1 measured value.

(3) Dissipation factor: Shall not exceed the applicable value specified (see 3.1).

3.17 Surge voltage. When tested as specified in 4.8.14, capacitors shall meet the following requirements.

a. DC leakage: Shall not exceed the requirement specified in 3.7.

b. Capacitance: Shall not change more than the applicable value specified (see 3.1) from the initial measured value.

c. Dissipation factor: Shall not exceed the requirement specified in 3.9.

3.18 Life. When tested as specified in 4.8.15 there shall be no evidence of harmful corrosion, mechanical damage, or obliteration of marking (if applicable) and capacitors shall meet the following requirements:

a. DC leakage (at +25°C): Shall not exceed the applicable value specified (see 3.1).

b. Capacitance (at +25°C): Shall not change more than the applicable value specified (see 3.1) from the initial measured value.

c. Dissipation factor (at +25°C): Shall not exceed the applicable value specified (see 3.1).

3.19 Solderability. When capacitors are tested as specified in 4.8.16, the criteria for evaluation shall be as specified in method 208 of MIL-STD-202.

3.20 Resistance to solvents. When tested as specified in 4.8.17, marking shall remain legible and shall not smear, and capacitors shall meet the following requirements:

a. DC leakage: Shall not exceed the requirement specified in 3.7

b. Capacitance: Shall not change more than ±2 percent from the initial measured value.

c. Dissipation factor: Shall not exceed the requirement specified in 3.9.

3.21 Marking. Capacitors shall be marked in accordance with method I of MIL-STD-1285. Polarity for polarized units shall be indicated by a plus (+) symbol near the positive terminal. At the option of the manufacturer, a contrasting color may also be used to indicate polarity. Paper labels shall not be used. Marking shall remain legible after all tests. Capacitor marking shall include the specified information, in the sequence shown in the following example.

105K - Coded capacitance (in picofarads); capacitance tolerance.

+50T - Polarity, voltage, and manufacturers trade mark. 1/

1412A – Date code and lot symbol 2/

1/ Polarity symbol shall be near the positive terminal and may be placed on either end of the last line of type, depending on the marking orientation with respect to the polarity.
2/ Date code and lot symbol marking are at the option of the manufacturer.

3.22 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.23 Workmanship. Capacitors shall be processed in such a manner that when examined under 3X magnification, they shall be uniform in quality and shall be free from pits, cracks, rough edges, and other defects that will affect life, serviceability, or appearance.

3.23.1 Soldering. All excess flux or solder shall be removed. Electrical connections shall be electrically continuous after soldering.

4. VERIFICATION

4.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ISO/IEC 17025, ISO 10012 or approved equivalent.

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

a. Qualification inspection (see 4.4).

b. Verification of qualification (see 4.5).

c. Conformance inspection (see 4.6).

d. Periodic group C inspection (see 4.7).

4.3 Inspection conditions.

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

4.3.2 AC measurements. AC measurements shall be made at the frequency specified. The magnitude of the ac voltage shall be equal to or less than 1.0 volt root mean square (rms). The maximum dc bias voltage shall be equal to or less than 2.2 volts for all ac measurements of polarized capacitors.

4.3.3 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at +25°C ±5°C prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.4 Power supply. The power supply used for life testing shall have a regulation of ±2 percent or less of the rated voltage. The power source employed for dc leakage current measurements shall be stabilized to at least ±100 parts per million. During measurements, there must be no voltage fluctuations of sufficient amplitude to produce a variation in the current measurement as read with any dc leakage current tester used to test capacitors.

4.4 Qualification inspection. Qualification inspection shall he performed at a laboratory acceptable to the Government (see 6.4) on sample units produced with equipment and procedures normally used in production.

4.4.1 Sample size. The number and style combinations of capacitors to be subjected to qualification inspection shall be as specified in appendix A.

4.4.2 Inspection routine. The sample units shall be subjected to the inspections specified in table III, in the order shown.

4.4.3 Failures. Failures in excess of those allowed in table III shall be cause for refusal to grant qualification approval.

4.5 Verification of qualification. The manufacturer shall provide verification to the qualifying activity. Continuation of qualification shall be based on meeting the following requirements:

a. The capacitor design has not been modified.

b. Lot rejection for group A inspection does not exceed 10 percent or one lot, whichever is greater.

c. Periodic group C inspection.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A and group B inspections.

4.6.1.1 Inspection lot. An inspection lot shall consist of all capacitors of the same style (see 3.1), produced under essentially the same conditions with the same basic materials, and offered for inspection during a single month. The capacitance values and voltages produced shall be represented in the lot in approximately the ratio of production. Voltage groups shall be as follows:

I - - - - - - - - - - - - - - - - - - - 6 through 20 volts.
II - - - - - - - - - - - - - - - - - - - 25 through 50 volts.

TABLE III. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of failures allowed
Group I				
Voltage aging	3.5	4.8.2	154 or 1/ 160	0
Construction analysis (metal cased units only)	3.6	4.8.3		
DC leakage	3.7	4.8.4		
Capacitance	3.8	4.8.5		
Dissipation factor	3.9	4.8.6		
Visual and mechanical inspection	3.1, 3.3, 3.3.1, 3.4, 3.4.1, 3.4.2, 3.21 and 3.23	4.8.1		
Group II				
Shock (specified pulse) (polarized capacitors only)	3.10	4.8.7	12	1
Vibration, high frequency	3.11	4.8.8		
Thermal shock	3.12	4.8.9		
Group III				
Resistance to soldering heat	3.13	4.8.10	18	
Terminal strength	3.14	4.8.11		
Moisture resistance	3.15	4.8.12		
Group IV				
Stability at low and high temperatures	3.16	4.8.13	12	
Surge voltage	3.17	4.8.14		
Group V				
Life (1,000 hours at +85° C)	3.18	4.8.15	102	1
Group VI				
Solderability	3.19	4.8.16	10	1
Resistance to solvents	3.20	4.8.17		

1/ For metal cased units.

4.6.1.2 Prescreen inspection. All capacitors submitted for group A inspection shall be 100 percent prescreened for the inspections specified in table IV, in the order shown.

TABLE IV. Prescreen inspection.

Inspection	Requirement paragraph	Test method paragraph
Voltage aging	3.5	4.8.2
DC leakage	3.7	4.8.4
Capacitance	3.8	4.8.5
Dissipation factor	3.9	4.8.6

4.6.1.3 Group A inspection. Group A inspection shall consist of the inspections specified in table V, in the order shown.

TABLE V. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
Subgroup 1			
DC leakage	3.7	4.8.4	20 samples
Capacitance	3.8	4.8.5	0 failures
Dissipation factor	3.9	4.8.6	
Subgroup 2			
Visual and mechanical inspection	3.1, 3.3, 3.3.1, 3.4, 3.4.1, 3.4.2, 3.21 and 3.23	4.8.1	13 samples 0 failures
Construction analysis (metal cased units only)	3.6	4.8.3	
Subgroup 3			
Solderability	3.19	4.8.16	13 samples 0 failures

4.6.1.3.1 Subgroup 1 and subgroup 2.

4.6.1.3.1.1 Sampling plan. The sampling plan for subgroup 1 and subgroup 2 shall be as specified in table V.

4.6.1.3.1.2 Rejected lots. The rejected lot shall be segregated from new lots and those lots that have passed inspection. The rejected lot shall be 100 percent inspected for those quality characteristics found defective in the sample and any defective found shall be removed from the lot. A new sample of parts shall then be randomly selected in accordance with table V. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.3.2 Subgroup 3 (solderability).

4.6.1.3.2.1 Sampling plan. Thirteen samples shall be selected randomly from every inspection lot and subjected to the subgroup 3 solderability test. The manufacturer may use electrical rejects from the subgroup 1 screening test for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed.

4.6.1.3.2.2 Rejected lots. In the event of one or more defects, the inspection lot shall be rejected. The manufacturer may use one of the following options to rework the lot:

a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.1.3.2.1. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in item 4.6.1.3.2.2b.

b. The manufacturer shall submit the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.4.2.1. Following the solder dip, the electrical measurements required in group A, subgroup 1 tests shall be repeated on another 125 samples with no defects allowed. Thirteen additional samples shall then be selected and subjected to the solderability test with no defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.6.1.3.2.3 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

4.6.1.4 Group B inspection. Group B inspection shall consist of the inspections specified in table VI in the order shown, and shall be made on sample units which have been subjected to and have passed the group A inspection.

TABLE VI. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
Subgroup 1 Stability at low and high temperatures	3.16	4.8.13	8 samples 0 failures
Subgroup 2 Surge voltage	3.17	4.8.14	8 samples 0 failures

4.6.1.4.1 Sampling plan. The sampling plan shall be as specified in table VI.

4.6.1.4.2 Rejected lots. The rejected lot shall be segregated from new lots which have passed inspection. The contractor may rework the lot to correct the defects, or screen out the defective units, and resubmit for inspection in accordance with table VI. A new sample of parts shall then be randomly selected in accordance with table VI. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.4.3 Disposition of sample units. Sample units which have been subjected to group B, subgroup 2 inspection shall not be delivered on the contract.

4.7 Periodic group C inspection. Group C inspection shall consist of the tests specified in table VII, in the order shown. Group C inspection shall be made on sample units selected from lots which have passed group A and group B inspection. Group C samples shall be representative of production. The allowable number of defectives shall be as indicated in table VII. Except where the results of periodic inspection show noncompliance with the applicable requirements (see 4.7.2), delivery of products which have passed group A and group B inspections shall not be delayed pending the results of this periodic inspection

4.7.1 Sampling plan. Sixty-seven sample units of each style shall be selected from the first lot produced, and thereafter from each production of 500,000 units or once every 3 months, whichever occurs first. The 67 sample units shall be subdivided as specified for each subgroup in table VII.

4.7.1.1 Disposition of sample units. Sample units that have been subjected to group C inspection shall not be delivered on the contract.

TABLE VII. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph	Units to be inspected	No. of defectives allowed
Subgroup 1				
Shock (specified pulse) (polarized capacitors only) 1/	3.10	4.8.7	12	
Vibration, high frequency 1/	3.11	4.8.8		
Thermal shock 1/	3.12	4.8.9		
Subgroup 2				
Resistance to soldering heat 2/	3.13	4.8.10	18	1
Terminal strength 2/	3.14	4.8.11		
Moisture resistance 2/	3.15	4.8.12		
Subgroup 3			10	
Resistance to solvents 1/	3.20	4.8.17		
Subgroup 4				
Life (1,000 hours at +85°C) 1/	3.18	4.8.15	25	1

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 on an annual basis. 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.

2/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failures, this test, with the approval of the qualifying activity, can be deleted. The manufacturer, however, shall perform this test every three years after the deletion as part of long term design verification. If the design, material, construction or processing of the part is changed or, if there are any quality problems, the qualifying activity may require resumption of the specified testing. Deletion of testing does not relieve the manufacturer from meeting the test requirement in case of dispute.

4.7.2 Noncompliance. If a sample fails to pass group C inspection the manufacturer shall immediately notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections or the inspection which the original sample failed, at the option of the qualifying activity). Group A and group B inspection may be reinstituted, however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.8 Methods of inspection.

4.8.1 Visual and mechanical inspection. Capacitors shall be inspected to verify that the materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.4.1, 3.4.2, 3.21, and 3.23).

4.8.2 Voltage aging (see 3.5). Capacitors shall be subjected to a minimum of 125 percent of dc rated voltage for 2 hours minimum, at a temperature of +85°C ±5°C. The voltage aging circuit shall have a series resistance of 3.0 ohms maximum. Power source shall not be less than 5 amperes. Capacitors shall then be stabilized at room temperature and examined for evidence of mechanical damage.

4.8.3 Construction analysis (metal cased units only) (see 3.6). Six pieces from each inspection lot shall be dissected in such a way that the plastic end-fill can be inspected to determine the extent of the filling.

4.8.4 DC leakage (see 3.7). DC leakage shall be measured using the dc rated voltage ±2 percent at the applicable test temperature (see 3.1), after a maximum electrification period of 5 minutes. A 1,000 ohm resistor shall be placed in series with the capacitor to limit the charging current. A steady source of power, such as a regulated power supply, shall be used. Unless otherwise specified (see 3.1), measurement accuracy shall be within ±2 percent or 0.02 microamp (μA), whichever is greater (see 4.3.4).

4.8.5 Capacitance (see 3.8). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. Unless otherwise specified (see 3.1), the following details shall apply.

a. Test frequency: 120 Hz ±5 Hz.

b. Limit of accuracy: Measurement accuracy shall be within ±2 percent of the reading.

c. Magnitude of polarizing voltage: Maximum dc bias shall be 2.2 volts for all ac measurements. The magnitude of the ac voltage shall be limited to 1.0 volt rms.

4.8.6 Dissipation factor (see 3.9). The dissipation factor shall be measured by means of a polarized capacitance bridge. The bridge shall provide a dial reading accuracy of 0.1 percent dissipation factor and measuring accuracy of ± (2 percent of the measured dissipation factor plus 0.1 percent). Unless otherwise specified (see 3.1), the test frequency and the magnitude of the polarizing voltage shall be as specified in 4.8.5.

4.8.7 Shock (specified pulse) (see 3.10). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

a. Special mounting means: Capacitors shall be rigidly mounted on a mounting fixture by the body. Potting compounds may be used to secure the capacitor body as long as the compound does not support the leads. Leads shall be secured to rigidly supported terminals, spaced so that the length of each lead from the capacitor is approximately .375 inch (9.53 mm) when measured from the edge of the supporting terminal. Leads shall be within 30 degrees of being parallel. When securing leads, care shall be taken to avoid pinching the leads.

b. Test condition letter I (100 g's peak).

c. Measurements and electrical loading during shock: During the test, observations shall be made to determine intermittent contact or arcing or open-circuiting or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms. The dc rated voltage (see 3.1) shall be applied to the capacitors during the test.

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

4.8.8 Vibration, high frequency (see 3.11). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting of specimens: Capacitors shall be mounted on a fixture by the body. Leads shall be supported by rigidly supported terminals.

b. Electrical load conditions: During the test, the specified dc rated voltage (see 3.1) shall be applied to the capacitors.

c. Test condition letter D (20 g's).

d. Duration and direction of motion: Four hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the axis.

e. Measurements during vibration: During the last cycle, an electrical measurement shall be made to determine intermittent operation or open-circuiting or short-circuiting. Observations shall also be made to determine intermittent contact or arcing or open-circuiting or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms or greater.

f. Measurements after vibration: Not applicable.

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

4.8.9 Thermal shock (see 3.12). Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter A.

b. Measurements after thermal shock: DC leakage, capacitance, and dissipation factor shall be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively.

c. Examination after test: Capacitors shall be visually examined for evidence of harmful corrosion, mechanical damage, and obliteration of marking (wherever applicable).

4.8.10 Resistance to soldering heat (see 3.13). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter B: Leads shall be immersed to within .025 inch (0.64 mm) of the end seal or capacitor body.

b. Cooling time prior to final examinations and measurements after test: Not applicable.

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

4.8.11 Terminal strength (see 3.14). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. Unless otherwise specified (see 3.1), the following details shall apply:

a. Test condition letter A: The body of the capacitor shall be secured; 2-pound applied force.

b. Test condition letter C: One pound applied force, three bends.

c. Measurements after test: After the test, capacitors shall be visually examined for loosening of the terminals and permanent damage to the terminals.

4.8.12 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: Special mounting not required.

b. Initial measurements: Capacitance as specified in 4.8.5.

c. Number of cycles: Ten continuous cycles except steps 7a and 7b are not required.

d. Loading voltage: Not applicable.

e. Final measurements: After removal from chamber, capacitors shall be dried for 1 hour at room temperature. Within 2 hours to 6 hours after the drying period, dc leakage, capacitance, and dissipation factor shall be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively.

f. Examination after test: Capacitors shall be visually examined for evidence of harmful corrosion, mechanical damage, and obliteration of marking (wherever applicable).

4.8.13 Stability at low and high temperatures (see 3.16). DC leakage, capacitance, and dissipation factor shall be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively, at each of the temperatures specified in table VIII except that dc leakage measurements at -55°C (step 2) are not required. The capacitors shall be brought to thermal stability at each test temperature. Thermal stability will have been reached when no further change in capacitance is observed between two successive measurements taken at intervals of 15 minutes +2 minutes, -0 minute. Capacitors may be dried at +85°C for 30 minutes +4 minutes, -0 minute prior to start of tests, however, the decision to reject the parts shall be made on those parts that have been dried.

TABLE VIII. Temperature for stability test.

Step	Test temperature (°C)
1	+25 ±2
2	-55 +0, -3
3	+25 ±2
4	+85 +4, -0
5	+25 ±2

4.8.14 Surge voltage (see 3.17). Capacitors shall be subjected to 1,000 cycles of the applicable surge voltage specified in table I. The ambient temperature during cycling (see 3.1), shall be +85°C ±5°C. Each cycle shall consist of a 30 second +2 second, -0 second surge voltage application followed by a 30 second +2 second, -0 second discharge period. Voltage application shall be made through a resistor of 33 ohms. The tolerance of the resistor shall be ±5 percent. Each surge voltage cycle shall be performed in such a manner that the capacitor is shorted terminal to terminal through a copper bar, or an equivalent low resistance at the end of the 30 second +2 second, -0 second application. An alternate method of shorting the capacitors is discharged through the same resistance that is utilized for charging. After the final cycle, the capacitors shall be stabilized at the inspection conditions specified in 4.3, and the dc leakage, capacitance, and dissipation factor shall be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively.

4.8.15 Life (see 3.18). Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Test temperature and tolerance: +85°C +4°C, -0°C.

b. Operating conditions: DC rated voltage (see 3.1), shall be applied gradually (not to exceed 5 minutes either by a slow buildup of the voltage or through a resistor which shall be shorted out within 5 minutes). Voltage shall be applied continuously, except for measurement periods. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed 3 ohms. Storage batteries or an electronic power supply capable of supplying at least 1 ampere when a capacitor is shorted shall be used.

c. Test condition letter D (1,000 hours).

d. Measurements during exposure: DC leakage shall be measured as specified in 4.8.4 at 0 hour; 240 hours +48 hours -0 hour; 1,000 hours +48 hours, -0 hour. The manufacturer may option to measure dc leakage at +85°C; however, if the capacitors fail to meet the dc leakage requirement in 3.18 the measurement shall be made at +25°C.

e. Measurements after exposure: Capacitors shall be returned to the inspection conditions specified in 4.3 and visually examined for evidence of harmful corrosion, mechanical damage, or obliteration of marking (if applicable); dc leakage, capacitance and dissipation factor shall then be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively.

4.8.16 Solderability (see 3.19). 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. Depth of immersion in flux and solder: All terminals shall be immersed to within .125 inch (3.18 mm) of the capacitor body.

4.8.17 Resistance to solvents (see 3.20). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following exceptions shall apply:

a. Brushing is required.

b. Measurements and examination after test: DC leakage, capacitance, and dissipation factor shall be measured as specified in 4.8.4, 4.8.5 and 4.8.6, respectively. The marking shall remain legible and shall not smear.

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

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Capacitors covered by this specification are intended mainly for use in filter, bypass, coupling, blocking, and other low-voltage applications (such as transistor circuits) where stability, size, weight, and shelf life are important factors. These capacitors are intended to be used only where supplemental moisture protection is provided or for noncritical applications where hermetic moisture protection is not required. These capacitors also are verified under a qualification system. Commercial components are not designed to withstand these military environmental conditions.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number and date of the specification, the applicable specification sheet, and the complete PIN (see 1.2.1).

b. Packaging requirements (see 5.1).

6.3 Tin whisker growth. The use of alloys with tin content greater than 97 percent by mass, may exhibit tin whisker growth problems after manufacturer. Tin whiskers may occur anytime from a day to years after manufacture 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 shown to inhibit the growth of tin whiskers. For additional information of this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in the 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. The activity responsible for the Qualified Products List is the U.S. Army Communications-Electronics Command, ATTN: RDER-PRQ-QE, Aberdeen Proving Ground, MD 21015; however, information pertaining to qualification of products may be obtained from the DLA Land and Maritime, ATTN: VQP, PO Box 3990, Columbus, OH 43218-3990, or by e-mail to vqp.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.5 Verification of qualification. For the purposes of verification of qualification (see 4.5) and conformance inspection (see 4.6), the manufacturer may use verification of qualification data from MIL-PRF-39003 provided the internal parts are manufactured using the same process as MIL-PRF-39003.

6.6 Subject term (key word) listing.

Capacitance
Dissipation factor
Polarized

6.7 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. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is and additional information is available on their website http://www.epa.gov/osw/hazard/wastemin/priority.htm. Included in the list of 31 priority chemicals are cadmium, lead, and mercury. Use of these materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

6.8 Changes from previous issues. The margins of this specification are marked with vertical lines to indicate where changes from 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 Scope. 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 APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

A.3. SUBMISSION

A.3.1 Sample.

A.3.1.1 Single-style submission. A sample consisting of 154 (160 for metal-cased units) units of the highest capacitance value in each voltage rating in each style for which qualification is sought shall be submitted.

A.3.1.2 Combined-voltage submission. A sample consisting of sample units of the highest capacitance value in each voltage group in each style for which qualification is sought shall be submitted (see table A-I).

APPENDIX A

TABLE A-I. Combined voltage submission.

Style	Type designation	Number of units	Rated volts
CX01	CX01D686-	77	6
	CX01J186-	77	20
	CX01K126-	77	25
	CX01N565-	77	50
CX02	CX02D337-	77	6
	CX02J107-	77	20
	CX02K686-	77	25
	CX02N226-	77	50
CX05	CX05D476-	77	6
	CX05J156-	77	20
	CX05K106-	77	25
	CX05N475-	77	50
CX06	CX06A106-	77	2
	CX06F107-	77	10
	CX06H686-	77	15
	CX06M226-	77	35
CX12	CX12D686-	77	6
	CX12J156-	77	20
	CX12K106-	77	25
	CX12N475-	77	50
CX16	CX16A106-	77	2
	CX16F107-	77	10
	CX16H686-	77	15
	CX16M226-	77	35

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

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

Preparing activity:
Army - CR

Agent:
DLA - CC

(Project 5910-2014-012)

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.dla.mil.