INCH-POUND

MIL-C-11015F
5 November 2008
SUPERSEDING
MIL-C-11015E
14 May 2001

MILITARY SPECIFICATION

CAPACITORS, FIXED, CERAMIC DIELECTRIC (GENERAL PURPOSE), GENERAL SPECIFICATION FOR

INACTIVE FOR NEW DESIGN
after 31 March 1999

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 general purpose, ceramic dielectric, insulated, fixed capacitors for use in applications where variations in capacitance with respect to temperature, voltage, frequency, and life can be tolerated.

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).

CK05	BX	100	K
Style (1.2.1.1)	Rated temperature and voltage temperature limits (1.2.1.2)	Capacitance (1.2.1.3)	Capacitance tolerance (1.2.1.4)

1.2.1.1 Style. The style is identified by the two-letter symbol "CK" followed by a two-digit number; the letters identify general purpose, ceramic dielectric, fixed capacitors, and the number identifies the shape and dimensions of the capacitor.

1.2.1.2 Rated temperature and voltage-temperature limits. The rated temperature and voltage-temperature limits are identified by a two-letter symbol. The first letter indicates the rated temperature as shown in table I; the second letter indicates the voltage-temperature limits as shown in table II.

TABLE I. Rated temperature.

Symbol	Temperature (range)
	°C
A	-55 to +85
B	-55 to +125
C	-55 to +150

Comments, suggestions or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990), or emailed 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 assist.daps.dla.mil.

TABLE II. Voltage-temperature limits.

Symbol	Capacitance change with reference to 25°C		Rated temperature symbol (see table I)
	Steps A to D incl of table VIII	Steps E to G incl of table VIII	
	Percent	Percent	
R	+15, -15	+15, -40	B
W	+22, -56	+22, -66	A,B
X	+15, -15	+15, -25	A,B
Y	+30, -70	+30, -80	A
Z	+20, -20	+20, -30	C

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. When fractional values of a pf are required, the letter "R" is used to indicate the decimal point and the succeeding digits of the group represent significant figures. Example: 2R2 indicates 2.2 pf.

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

TABLE III. Capacitance tolerance.

Symbol	Capacitance tolerance
	Percent (±)
K	10
M	20

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.

FEDERAL STANDARDS

FED-STD-H28 - Screw-Thread Standards for Federal Services.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-39014 - Capacitors, Fixed, Ceramic Dielectric (General Purpose), Established Reliability and Non-Established Reliability, General Specification for.

(See supplement 1 for list of associated specification sheets.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	-	Electronic and Electrical Component Parts, Test Methods for.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://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 the documents are those cited in the solicitation or contract.

NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCSL)

NCSL Z540.3	-	Requirements for the Calibration of Measuring and Test Equipment.

(Copies of these documents are available from http://global.ihs.com or Global Engineering Documents, Attn: Customer Service Department, 15 Inverness Way East, Englewood, CO 80112-5776.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 10012	-	Measurement Management Systems Requirements for Measurement Processes and Measuring Equipment.

(Copies of these documents are available from http://global.ihs.com or Global Engineering Documents, Attn: Customer Service Department, 15 Inverness Way East, Englewood, CO 80112-5776.)

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 sheets. In the event of any conflict between requirements of this specification and the specification sheets, the latter shall govern.

3.2 Qualification. Capacitors furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.3).

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.

3.3.1 Insulating and impregnating compounds. Insulating and impregnating compounds, including resins, varnishes, waxes, and the like, shall be suitable for each particular application. Compounds shall preserve the electrical characteristics of the insulation to which they are applied.

3.3.2 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 6.4). Use of lead-free, tin alloy high temperature solders for internal connections requires approval by the qualifying activity. The tin content of lead-free high temperature solders shall not exceed 97 percent by mass.

3.4 Design and construction. Capacitors shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Threaded parts. All threaded parts (see 3.1) shall be in accordance with FED-STD-H28.

3.4.2 Solder-type terminals. Solder-type terminals shall be coated with solder having a 40 to 70 percent tin content.

3.4.3 Mounting hardware (when specified, see 3.1). Capacitors shall be furnished with the mounting hardware specified (see 3.1).

3.5 Dielectric withstanding voltage. When capacitors are tested as specified in 4.7.2, there shall be no breakdown or evidence of damage.

3.6 Barometric pressure (reduced) (qualification only). When tested as specified in 4.7.3, capacitors shall withstand the dc potential specified (see 3.1) without flashover.

3.7 Insulation resistance. When measured as specified in 4.7.4, the insulation resistance shall be not less than the value specified (see 3.1).

3.8 Capacitance. When measured as specified in 4.7.5, the capacitance shall be within the applicable tolerance specified (see 3.1).

3.9 Dissipation factor. When measured as specified in 4.7.6, the dissipation factor shall not exceed the value specified (see 3.1).

3.10 Shock, specified pulse (all styles except CK22 and CK27). When capacitors are tested as specified in 4.7.7, there shall be no momentary or intermittent contacts of 0.5 millisecond (ms) or greater duration, open or short-circuiting, or other indication of breakdown or arcing, nor shall there be any evidence of mechanical damage.

3.11 Vibration, high frequency. When capacitors are tested as specified in 4.7.8, there shall be no intermittent contacts of 0.5 ms or greater duration, open or short-circuiting, or evidence of mechanical damage.

3.12 Thermal shock and immersion. When tested as specified in 4.7.9, capacitors shall meet the following requirements:

Visual examination----------No mechanical damage. Marking shall remain legible.

Dielectric withstanding voltage
(when specified; see 3.1)----------As specified in 3.5.

Insulation resistance----------Not less than value specified (see 3.1).

Capacitance
(when specified; see 3.1)----------Capacitance change shall not exceed ±10 percent of the initial measured value.

Dissipation factor
(when specified; see 3.1)----------As specified in 3.9.

3.13 Salt spray (corrosion) (styles CK70 and CK72). When capacitors are tested as specified in 4.7.10, there shall be no harmful or extensive corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be protected by the finish. There shall be no mechanical damage to insulating surfaces. In addition, corrosion of the mounting hardware or of the terminals shall not exceed 10 percent of the surface area.

3.14 Terminal strength (when specified; see 3.1). When capacitors are tested as specified in 4.7.11, the terminals shall not loosen or rupture.

3.15 Moisture resistance. When tested as specified in 4.7.12, capacitors shall meet the following requirements:

Visual examination---------- No mechanical damage. Marking shall remain legible.

Dielectric withstanding voltage
(when specified; see 3.1)---------- As specified in 3.5.

Insulation resistance---------- Unless otherwise specified (see 3.1), not less than 10 percent of the initial 25°C requirement.

Capacitance
(when specified; see 3.1)---------- Unless otherwise specified (see 3.1), capacitance change shall not exceed ±10 percent of the initial measured value.

3.16 Solderability. When capacitors are tested as specified in 4.7.13, the dipped surface shall be at least 95 percent covered with a new, smooth, solder coating. The remaining 5 percent may contain only small pinholes or rough spots; these shall not be concentrated in one area. Bare base metal where the solder dip failed to cover the original coating is an indication of poor solderability, and shall be cause for failure. In case of dispute, the percent of coverage with pinholes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.

3.17 Resistance to soldering heat (all styles except CK22, CK27, CK74, CK75, CK78, CK79, and CK85,). When tested as specified in 4.7.14, capacitors shall meet the following requirements:

Insulation resistance----------Not less than the initial 25°C requirement (see 3.1).

Capacitance----------Change not more than +15, -5 percent from the initial 25°C measured value.

Dissipation factor----------Shall not exceed initial limit.

3.18 Voltage-temperature limits. When capacitors are tested as specified in 4.7.15, the capacitance change shall not exceed the applicable limits specified in table II. The capacitance value obtained in step C of table VIII shall be considered as the reference point.

3.19 Life (at elevated ambient temperature). When tested as specified in 4.7.16, capacitors shall meet the following requirements:

Visual examination----------No mechanical damage.

Insulation resistance----------Shall be not less than the value specified (see 3.1).

Capacitance
(when specified; see 3.1)----------Change shall not exceed ±20 percent from the initial measured value.

Dissipation factor----------Shall not exceed the value specified (see 3.1).

3.20 Marking. Unless otherwise specified (see 3.1), capacitors shall be permanently and legibly marked with the PIN, the manufacturer's name or symbol, and the date code. Paper labels shall not be used. Other markings which in any way interfere with, obscure, or confuse those specified herein are prohibited. The marking shall remain legible after all tests.

3.20.1 PIN. There shall be no space between the symbols which comprise the PIN. When the size of the capacitor does not permit the PIN to be marked on one line, it may be divided into two or three lines as shown in the following examples:

Examples:

CK60BX		CK05
2R2K	or	BX
		100K

3.20.2 Date code. The date code shall be in accordance with MIL-STD-1285 and, unless otherwise specified (see 3.1), shall be marked on the capacitor wherever capacitor size permits.

3.20.3 Marking of established reliability (ER) parts. An ER part manufactured in accordance with MIL-PRF-39014 may be marked and furnished as the 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.

3.21 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable 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.

3.22 Marking legibility (laser marking only). When tested as specified in 4.7.17, the marking shall remain legible.

3.23 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality when examined using 2x minimum to 4x maximum magnification and shall be free from pits, cracks, rough edges, and other defects that will affect life, serviceability, or appearance. Capacitors with round external leads; within .050 inch (1.27 mm) of the component body, 10 percent of the surface area of the leads may exhibit bare base metal. These capacitors are not expected to be solderable within .050 inch (1.27 mm) of the case.

3.23.1 Soldering. All excess flux or solder shall be removed. Electrical connections shall be mechanically secured before soldering, where possible, and electrically continuous after soldering.

4. VERIFICATION

4.1 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with NCSL Z540.3, ISO 10012, 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 4.6).

c. Periodic group C inspection (see 4.6.2).

4.3 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 except relative humidity shall not exceed 75 percent. Accuracy of all test voltage measurements shall be within ±2.0 percent of the specified voltage.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

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

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table IV, in the order shown. All sample units shall be subjected to the inspections of group I. The sample shall then be divided as specified in table IV for groups II to VI inclusive and subjected to the inspection for their particular group.

TABLE IV. Qualification Inspection.

Examination or test	Requirement paragraph	Test paragraph	Number of sample units to be inspected	Number of Failures Allowed 1/	
Group I 2/					
Visual and mechanical examination		4.7.1			
Materials, design, construction, and workmanship	3.3, 3.4, and 3.23	---			
Physical dimensions and marking 3/	3.1, 3.22	---			
Dielectric withstanding voltage	3.5	4.7.2	(51 or 63) 4/	1	
Barometric pressure (reduced)	3.6	4.7.3			
Insulation resistance	3.7	4.7.4			
Capacitance	3.8	4.7.5			
Dissipation factor	3.9	4.7.6			
Group II					
Shock, specified pulse, (all styles except CK22 and CK27)	3.10	4.7.7			
Vibration, high frequency	3.11	4.7.8			
Thermal shock and immersion	3.12	4.7.9	12	1	
Salt spray (corrosion) (styles CK70 and CK72)	3.13	4.7.10			
Group III					
Terminal strength (when specified, see 3.1)	3.14	4.7.11	12	1	
Moisture resistance	3.15	4.7.12			
Group IV					
Solderability	3.16	4.7.13	10	1	
Marking legibility (laser marking only)	3.22	4.7.17			1
Group V					
Resistance to soldering heat (all styles except CK22, CK27, CK74, CK75, CK78, CK79, and CK85)	3.17	4.7.14	4	0	
Group VI					
Voltage-temperature limits	3.18	4.7.15.1	12 or 24 5/	1	
Life (at elevated ambient temperature)	3.19	4.7.16.1			

1/ A sample unit having one or more defects shall be considered as a single failure.
2/ Nondestructive examinations and tests (see A3.2).
3/ Marking defects shall be based on visual examination only and shall be charged only for illegible, incomplete, or incorrect marking.
4/ One additional sample unit is included in each sample size to permit substitution for the failure allowed in group I.
5/ For styles CK05 and CK06 capacitors with dual temperature ratings (see 3.1), 12 sample units shall be subjected to the group VI tests at 125°C; the remaining 12 sample units shall be subjected to the group VI tests at 150°C.

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

4.5 Verification of qualification. Every 6 months, the manufacturer shall verify the retention of qualification to the qualifying activity. In addition, the manufacturer shall immediately notify the qualifying activity whenever group C inspection results indicate failure of the qualified product to meet the requirements of the specification. Verification 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 the group A sampling plan.

c. Periodic group C inspection requirements have been met.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection. Except as specified in 4.6.2.4, delivery of products which have passed group A inspection shall not be delayed pending the results of group C inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all capacitors in one or more styles, produced under essentially the same conditions, and offered for inspection at the same time. The sample from the lot shall be representative of the styles in the lot. The capacitance values and voltages produced shall also be represented in the lot in approximately the same ratio of production. Styles may be grouped as follows:

Group	Style
1	CK22,CK27, CK60, CK61, CK62, CK63, CK64 CK65, CK66, CK67, CK68, and CK69
2	CK31 and CK32
3	CK12, CK13, CK14, CK15 and CK16
4	CK05 and CK06
5	CK74, CK75, CK78, CK79, CK85, and CK99
6	CK70 and CK72

4.6.1.2 Group A inspection. Group A inspection shall consist of the examination and tests specified in table V, in the order shown.

4.6.1.2 1 Sampling plan. The sampling plan shall be as specified in table V. In the event of one or more failures, the lot shall be rejected.

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. A new sample of parts shall be randomly selected in accordance with table V. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE V. Group A inspection.

Examination or test	Requirement paragraph	Test paragraph	Sampling procedure
Visual and mechanical examination		4.7.1	
Materials	3.3		
Body dimensions	3.1		See table VI
Design construction (other than body dimensions)	3.4		
Marking 1/	3.20		
Workmanship	3.23		
Dielectric withstanding voltage	3.5	4.7.2	
Insulation resistance	3.7	4.7.4	See table VI
Capacitance	3.8	4.7.5	
Dissipation factor	3.9	4.7.6	
Solderability	3.16	4.7.13	13 samples 0 failures

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

TABLE VI. Sampling plans for Group A tests.

Lot size	Sample size
1- 13	100%
14- 150	13
151- 280	20
281- 500	29
501- 1,200	34
1,201- 3,200	42
3,201- 10,000	50
10,001- 35,000	60
35,001- 150,000	74
150,001- 500,000	90
500,001- Up	102

4.6.2 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 inspection lots which have passed group A inspection.

4.6.2.1 Sampling plan. Sample units shall be selected in accordance with 4.6.2.1.1 and 4.6.2.1.2. The number of sample units to be inspected for each sampling period shall be as specified in table VII. A different sample shall be selected for each subgroup.

4.6.2.1.1 Every 4 months (Subgroups 1 through 3). Every 4 months sample units shall be selected and subjected to the tests of subgroups 1 through 3 of table VII. Subgroups 1 and 2 may be checked during alternate bimonthly periods.

4.6.2.1.2 Every 4 months (Subgroup 4). Every 4 months (every 6 months for styles CK60 through CK69), sample units shall be selected and subjected to the test of subgroup 4 of table VII.

4.6.2.2 Failures. If the number of failures exceeds the number allowed in table VII, the sample shall be considered to have failed.

4.6.2.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or purchase order.

TABLE VII. Group C inspection.

Test	Requirement paragraph	Test paragraph	Number of sample units to be inspected	Number of failures allowed 1/
Every 4 months (subgroup 1)				
Voltage-temperature limits	3.18	4.7.15		
Vibration, high frequency	3.11	4.7.8		
Thermal shock and immersion	3.12	4.7.9	12	1
Salt spray (corrosion) (styles CK70 and CK72)	3.13	4.7.10		
Every 4 months (subgroup 2)				
Shock, specified pulse (all styles (except CK22 and CK27)	3.10	4.7.7		
Terminal strength (when specified, see 3.1)	3.14	4.7.11	12	1
Resistance to soldering heat (all styles except CK22, CK27, CK74, CK75, CK78, CK79, and CK85)	3.17	4.7.14		
Moisture resistance	3.15	4.7.12		
Every 4 months (subgroup 3)				
Marking legibility (laser marking only)	3.22	4.7.17	10	1
Every 4 months (subgroup 4) (every 6 months for styles CK60 through CK69)				
Life (at elevated temperature)	3.19	4.7.16.2	12	1

1/ A sample unit having one or more defects shall be charged as a single failure.

4.6.2.4 Noncompliance. If a sample fails to pass group C inspection, the supplier shall 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 of the product shall be discontinued until corrective action, acceptable to the Government, 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 Government). Group A inspection may be re-instituted; however, final acceptance shall be withheld until the group C re-inspection has shown that the corrective action was successful. In the event of failure after re-inspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7 Methods of examination and test.

4.7.1 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, 3.4, 3.20, and 3.23).

4.7.2 Dielectric withstanding voltage (see 3.5).

4.7.2.1 Dielectric. Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:

(a) Magnitude and nature of test voltage - As specified (see 3.1).

(b) Duration of application of test voltage - 5 ±1 second. The test voltage shall be raised from 0 to the specified value within 1 second, maximum.

(c) Points of application of test voltage - Unless otherwise specified (see 3.1), between the capacitor-element terminals.

(d) Limiting value of surge current - Shall be limited between 30 milliamperes (ma) and 50 milliamperes (ma).

(e) Examination after test - Capacitors shall be examined for evidence of damage and breakdown.

4.7.2.2 Body insulation (when applicable, see 3.1) (Qualification only). Unless otherwise specified (see 3.1), capacitors shall be wrapped with conductive tape or foil not less than .065 inch and not more than .125 inch away from the lead wires. A dc potential (see 3.1) shall be applied between the two leads connected together and the conductive tape or foil for a period of 5 ±1 second. The circuit shall be so arranged that surge current will not exceed 50 mA. Following the test, capacitors shall be examined for evidence of damage and breakdown.

4.7.3 Barometric pressure (reduced) (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 - Securely fastened by their normal mounting means.

(b) Test conditions - As specified (see 3.1).

(c) Test during subjection to reduced pressure - A dc potential as specified (see 3.1) shall be applied for a period of 5 ±1 second.

(d) Points of application of test voltage - Unless otherwise specified (see 3.1), between the capacitor-element terminals.

(e) Surge current - Shall not exceed 50 ma.

(f) Examination during and after test - Capacitors shall be visually monitored for evidence of flashover or damage.

4.7.4 Insulation resistance (see 3.7). Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

(a) Test conditions - As specified (see 3.1).

(b) Special conditions - If a failure occurs at a relative humidity over 50 percent, the insulation resistance may be measured again at any relative humidity less than 50 percent.

(c) Points of measurement - Unless otherwise specified (see 3.1), between the capacitor-element terminals.

4.7.5 Capacitance (see 3.8). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details and exceptions shall apply:

(a) Test frequency - 100pF or less - 1MHz ±100kHz.
Over 100pF - 1kHz ±100 Hz.

(b) Test voltage - 1.0 ±0.2 volt rms.

Note: Following a dielectric withstanding voltage or insulation resistance test, capacitance measurement may be delayed for a period of time up to 24 hours.

4.7.6 Dissipation factor (see 3.9). Dissipation factor shall be measured with a bridge or other suitable equipment at the frequency and voltage specified in 4.7.5. The inherent accuracy of the measurement shall be ±2 percent of the reading plus 0.1 percent DF (absolute) unless otherwise specified. Suitable measurement techniques shall be used to minimize errors due to the connections between the measuring apparatus and the capacitor.

4.7.7 Shock, specified pulse (all styles except CK22, and CK27) (see 3.10). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting - Capacitors shall be rigidly mounted by the body.

(b) Test-condition letter - I (100 G's).

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

(d) Examination after shock - Capacitors shall be visually examined for evidence of breakdown, arcing, and mechanical damage.

4.7.8 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 - Unless otherwise specified (see 3.1), capacitors shall be rigidly mounted on a mounting fixture by the body. For styles other than feed-through, leads shall be secured to rigidly supported terminals, so spaced that the length of each lead from the capacitor is approximately .375 inch (22.22mm) when measured from the edge of the supporting terminal. Leads shall be within 15 degrees of being parallel; each lead in disk types shall be in the plane of the flat surface from which it extends. When securing leads, care should be taken to avoid pinching the leads. The mounting fixture shall be so constructed as to preclude any resonance within the test range. An examination of the mounting fixture shall be made on a vibrator. If any resonant frequencies are observed, adequate steps shall be taken to dampen the structure.

(b) Electrical-load conditions - During the test, a dc potential equal to 125 percent of the rated voltage (see 3.1) shall be applied between the terminals of the capacitor.

(c) Test-condition letter - B (15 G's) or D (20 G's) (see 3.1).

(d) Duration and direction of motion - 2 hours in each of three mutually perpendicular directions (total of 6 hours).

(e) Measurement 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-circuit or short-circuiting.

(f) Examination after vibration - After the test capacitors shall be visually examined for evidence of mechanical damage.

4.7.9 Thermal shock and immersion (see 3.12).

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

(a) Test-condition letter - A, except that in step 3, sample units shall be tested at the maximum rated temperature (see table I and 3.1).

(b) Measurements before and after test - Not applicable.

4.7.9.2 Immersion. Following thermal shock, capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

(a) Test-condition letter - B.

(b) Examinations and measurements after final cycle - Capacitors shall be visually examined for evidence of mechanical damage; dielectric withstanding voltage (when specified, see 3.1), insulation resistance, capacitance (when specified, see 3.1), and dissipation factor (when specified, see 3.1) shall then be measured as specified in 4.7.2.1, 4.7.4, 4.7.5, and 4.7.6, respectively.

4.7.10 Salt spray (corrosion) (styles CK70 and CK72) (see 3.13). Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details and exceptions shall apply:

(a) Applicable salt solution - 5 percent.

(b) Test-condition letter - B (48 hours).

(d) Measurements after exposure - Not applicable.

(e) Examinations after test - Capacitors shall be visually examined for evidence of harmful and extensive corrosion.

4.7.11 Terminal strength (when specified; see 3.1) (see 3.14). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

(a) Test condition A (applicable to all styles) - Applied force: 5 pounds, unless otherwise specified.

(b) Test condition C (applicable to radial lead units only) - Applied force: 1.0 pound, +0.1 pound, -0 pound.

(c) Test condition D (applicable to axial lead units only).

(d) Examination after test - Capacitors shall be visually examined for evidence of loosening or rupturing of terminals.

4.7.12 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) Initial measurements - Not applicable.

(b) Number of cycles - 20 continuous cycles.

(c) Step 7b - Not applicable.

(d) Loading voltage - During the first 10 cycles, a dc potential of 100 volts or rated voltage, whichever is less, shall be applied across the capacitor terminals. Once each day, a check shall be performed to determine whether a capacitor has shorted.

(e) Final measurements - After the final cycle, capacitors shall be conditioned at 25°C ±5°C and a relative humidity of 30 percent to 60 percent for a period of 18 hours minimum, 24 hours maximum, and shall be visually examined for mechanical damage. Dielectric withstanding voltage (when specified, see 3.1), insulation resistance, and capacitance (when specified, see 3.1) shall be measured as specified in 4.7.2.1, 4.7.4, and 4.7.5, respectively.

4.7.13 Solderability (see 3.16). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following detail shall apply:

(a) Number of terminations of each part to be tested - As specified (see 3.1).

4.7.14 Resistance to soldering heat (all styles except CK22, CK27, CK74, CK75, CK78, CK79, and CK85,) (see 3.17). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

(a) Surface oxides and dross shall be skimmed off the solder pot immediately before lead immersion to ensure full and complete heat flow through the leads.

(b) Depth of immersion in molten solder - To a minimum of .050 inch, +.020, -0 inch (1.27mm, +0.51, -0mm) from the capacitor body (the example shown in figure 1 is applicable to all terminal types).

(c) Test condition letter - B, except that the immersion duration shall be 20 seconds ±1 second.

(d) Cooling time prior to measurement after test - 10 minutes ±1 minute, unless otherwise specified (see 3.1).

(e) Measurements after test - Capacitance, dissipation factor, and insulation resistance at 25°C shall be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

(f) Internal examination after test - Not required.

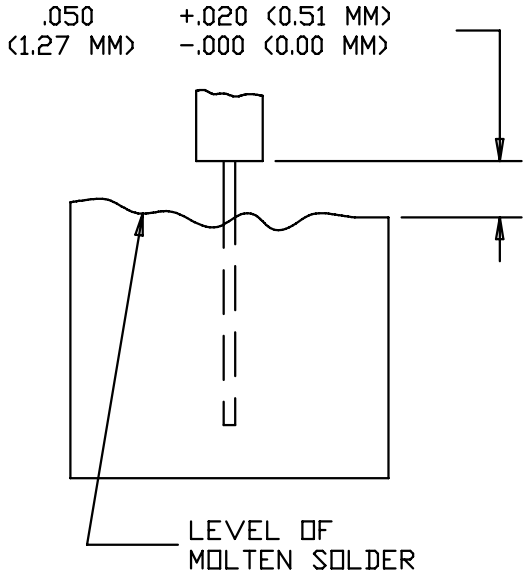

FIGURE 1. Example of axial wire-lead depth of immersion in molten solder.

4.7.15 Voltage-temperature limits (see 3.18).

4.7.15.1 For qualification inspection. Capacitors shall be tested as specified in 4.7.5, except that the capacitance measurements shall be made at the steps shown in table VIII and at a sufficient number of intermediate points between steps B and G of table VIII to establish a true characteristic curve. The capacitance value obtained in step C of table VIII shall be considered as the reference point. The capacitance measurement at each temperature shall be recorded when two successive readings taken at 5-minute intervals at that temperature indicate a capacitance change of less than 1 percent.

TABLE VIII. Voltage-temperature-limit cycle.

Step 1/	Voltage	Temperature
	volts, dc	°C
A	None	+25 ±2
B	None	-55 ±2
C 3/	None	+25 ±2
D	None	Max rated temp ±2°C
E	500 2/	Max rated temp ±2°C
F	500 2/	+25 ±2
G	500 2/	-55 ±2

1/ For styles CK05 and CK06 capacitors with dual temperature ratings (see 3.1), steps D and E shall be performed at each maximum rated temperature.
2/ For capacitors with voltage ratings of less than 500 volts, rated voltage (see 3.1) shall be applied.
3/ Reference point.

4.7.15.2 For conformance inspection. Capacitors shall be tested as specified in 4.7.15.1, except that measurements shall be made only for steps C, D, E, and G of table VIII.

4.7.16 Life (at elevated ambient temperature) (see 3.19).

4.7.16.1 For qualification inspection. Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

(a) Distance of temperature measurements from specimens, in inches - Not applicable.

(b) Test temperature and tolerance - At the applicable maximum rated temperature, +4°, -0°C (see 3.1). For styles CK05 and CK06 capacitors with dual temperature ratings (see 3.1), this test shall be performed at each maximum rated temperature.

(c) Operating conditions - Capacitors shall be subjected to the specified voltage ±2 percent (see 3.1).

(d) Test conditions – 1000 hours.

(e) Measurements during and after exposure - At the conclusion of this test and while the capacitors are at the applicable high test temperature, the insulation resistance shall be measured as specified in 4.7.4. At the option of the manufacturer, the units may be immediately transferred (period of transfer not to exceed 15 minutes) to another chamber maintained at the same temperature for the purpose of measuring IR. The IR measurement shall be made only after the units have stabilized at the test temperature. The capacitors shall then be returned to the inspection conditions specified in 4.3 and shall be visually examined for evidence of mechanical damage and obliteration of marking. Insulation resistance, capacitance (when specified, see 3.1) and dissipation factor shall be measured as specified in 4.7.4, 4.7.5 and 4.7.6 respectively.

4.7.16.2 For conformance inspection. Capacitors shall be tested as specified in 4.7.16.1.

4.7.17 Marking legibility (laser marking only). Capacitors shall be coated with .005 inch minimum of silicone resin insulating compound. After curing, coated capacitors shall be examined for legibility under normal production room lighting by an inspector with normal or corrected 20/20 vision.

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 services 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. These capacitors are primarily designed for use where a small physical size with comparatively large electrical capacitance and high insulation resistance is required. General purpose ceramic capacitors are suitable for use as by-pass, filter, and non-critical coupling elements in high frequency circuits. All of these applications are of the type where dissipation factor is not critical and moderate changes due to temperature, voltage, and frequency variations do not affect the proper functioning of the circuit.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification, the applicable specification sheet, and the complete PIN (see 1.2.1 and 3.1).

(b) Packaging requirements (see section 5).

(c) Lead length, if different from that specified (applicable to specification sheets MIL-C-11015/19 and MIL-C-11015/20). Lead length may be a minimum of .625 inch (15.88 mm) long or 1.00 inch (25.4 mm) long, as applicable (see 3.1), for use in tape & reel automatic insertion equipment.

6.3 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 applicable Qualified Products List QPL, 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 Defense Supply Center, Columbus, ATTN: DSCC/VQP, PO Box 3990, Columbus, OH 43218-3990, or by email to vqp.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at http://assist.daps.dla.mil.

6.4 Tin whisker growth. The use of alloys with 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 manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of whisker-prone surface will not prevent the formation of whiskers. Alloys of 3 percent lead, by mass, have 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).

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

6.6 Ambient operating conditions. Designers are cautioned to give consideration to the change in dielectric constant with temperature, shelf aging, and electric-field intensity, and should recognize that the apparent insulation resistance may vary with humidity and surface conditions.

6.7 Canceled styles. Several styles formerly covered by this specification have been canceled. Recommended substitute items and applicable specification sheets are as listed in table IX.

6.7.1 Verification based upon established reliability parts. For the purpose of verification of qualification (see 4.5) and conformance inspection (see 4.6), test data on identical items covered by MIL-PRF-39014 may be used.

TABLE IX. Cross-reference of substitute items.

Canceled style		Recommended substitute style	
Style	Spec sheet	Style	Spec sheet
CK17	MIL-C-11015/20	CK15	MIL-C-11015/20
CK18 and CK19	MIL-C-11015/26		No Replacement
CK21	MIL-C-11015/1		No Replacement
CK26	MIL-C-11015/3		No Replacement
CK33	MIL-C-11015/5	CK22	MIL-C-11015/2
CK36	MIL-C-11015/6		No Replacement
CK37	MIL-C-11015/7		No Replacement
CK41, CK42, CK43, CK50, CK51, CK52, CK53, CK54, and CK55	MIL-C-11015/24		No Replacement
CK47	MIL-C-11015/8	CK27	MIL-C-11015/4
CK50	MIL-C-11015/16	CK61	MIL-C-11015/10
CK51	MIL-C-11015/17	CK63	MIL-C-11015/12
CK76 and CK77	MIL-C-11015/30		No Replacement
CK80	MIL-C-11015/14		No Replacement
CK81	MIL-C-11015/15		No Replacement
CK90 and CK91	MIL-C-11015/22		No Replacement
CK95	MIL-C-11015/31		No Replacement

6.8 Standard capacitor types. Equipment designers should refer to MIL-HDBK-198, "Capacitors, Selection and Use of," for a selection of standard capacitor types and values for new equipment design. Application information concerning these capacitors is also provided in MIL-HDBK-198.

6.9 Subject term (key word) listing.

Capacitance

6.10 Changes from previous issue. The margins of this specification are marked with vertical lines 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, with related data, 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 this 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 51 sample units (63 sample units are required for styles CK05 and CK06) of the highest capacitance value in each voltage rating, in each rated temperature and voltage-temperature limits, in each style for which qualification is sought shall be submitted.

A.3.1.2 Combined-voltage submission (styles CK60, CK63, and CK70). A sample consisting of 26 sample units of the highest capacitance value in each voltage rating, in each rated temperature and voltage-temperature limits, in each style for which qualification is sought shall be submitted (see table A-1).

TABLE A-I. Combined-voltage submission.

Style	No. of sample units to submitted	PIN	Rated voltage
CK60	26	CK60AW152M	500
	26	CK60AW102M	1,000
	26	CK60AX471K	500
	26	CK60AX221K	1,000
	26	CK60BX151K	500
	26	CK60BX101K	1,000
CK63	26	CK63AW103M	500
	26	CK63AW472M	1,000
CK70	26	CK70AX681K	500
	26	CK70AX101K	1,000

A.3.1.3 Group submission. A sample consisting of the number of sample units with type designations as shown in table A-II shall be submitted. Failure of one style in a group will fail the complete group.

A.3.2 Test data. When examinations and tests are to be performed at a Government laboratory, prior to submission all sample units shall be subjected to all of the examinations and tests indicated as nondestructive in table IV. Each submission shall be accompanied by the test data obtained from these examinations and tests. The performance of the destructive tests by the supplier on a duplicate set of sample units is encouraged, although not required. All test data shall be submitted in duplicate.

TABLE A-II. Group submission.

Group	Part or Identifying Number (PIN)	Number of sample units to be submitted	Rated temperature and voltage-temperature limits	Rated voltage	Will qualify style(s)
I	CK05BX102K	63	BX	200	CK05
	CK05BX103K	26	BX	100	
	CK05BX104K	26	BX	50	
II	CK06BX103K	63	BX	200	CK06
	CK06BX104K	26	BX	100	
	CK06BX105K	26	BX	50	
III	CK13BX223K	51	BX	50	CK12, 13, 14, 15 and 16
	CK15BX104K	51	BX	100	
	CK16BR105K	51	BR	100	
	CK16BR335K	51	BR	50	
IV	CK22AX681K	26	AX	500	CK22 and 27
	CK27AX152K	26	AX	500	
V	CK31BT103K	26	BT	50	CK31 and 32
	CK32BT203K	26	BT	50	
	CK31BU203K	26	BU	50	
	CK32BU393K	26	BU	50	
	CK31BV513K	26	BV	50	
	CK32BV104K	26	BV	50	
VI	CK63BX332K	26	BX	500	CK60, 61, 62 and 63
	CK60BX101K	26	BX	1,000	
	CK63AW103M	26	AW	500	
	CK63AW472M	26	AW	1,000	
	CK63AY103M	26	AY	1,000	
	CK62AY471M	26	AY	1,500	
	CK60AX221M	26	AX	1,000	
	CK63CZ332K	26	CZ	500	
VII	CK69AW153M	51	AW	1,600	CK64, 65, 66, 67, 68 and 69
	CK67AW752M	51	AW	1,600	
VIII	CK70AX681K	26	AX	500	CK70
	CK70AX101K	26	AX	1,000	
IX	CK72AX102M	51	AX	1,500	CK72
X	CK99BW122M	26	BW	200	CK99
	CK99BW502M	26	BW	50	

A.4 EXTENT OF QUALIFICATION

A.4.1 Single-style submission. Capacitance-range qualification will be restricted to values equal to and less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. Voltage rating qualification will be restricted to that submitted. Rated temperature and voltage-temperature-limit qualification will be restricted to that submitted. Qualification of one style may be the basis for qualification of another style, as shown in table A-III, provided that the dielectric material, rated temperature and voltage-temperature limits, and dielectric thickness are essentially the same.

TABLE A-III. Style qualification.

Style	May also qualify
CK13	CK12
CK14	CK13, CK12
CK15	CK14, CK13, CK12
CK16	CK15, CK14, CK13, CK12
CK61	CK60
CK62	CK61, CK60
CK63	CK62, CK61, CK60
CK65	CK64
CK66	CK65, CK64
CK67	CK66, CK65, CK64
CK69	CK68

A.4.2 Combined-voltage submission (styles CK60, CK63, and CK70). Capacitance-range qualification will be restricted to values equal to and less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. Voltage rating qualification will be restricted to those submitted. Rated temperature (range) qualification will be restricted to ranges equal to and narrower than the widest range submitted. Voltage-temperature-limit qualification will be restricted to limits equal to and wider than the narrowest limit submitted.

A.4.3 Group submission. Qualification of the PIN(s) within the group will be the basis for qualifying the style(s) as shown in table A-II.

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

Preparing activity:
DLA-CC

(Project 5910-2008-020)

Review activities:
Army – AR, MI
Navy - AS, MC, OS, SH
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 the ASSIST Online database at http://assist.daps.dla.mil/.