INCH-POUND
MIL-PRF-14409J
29 August 2014
SUPERSEDING
MIL-PRF-14409H
7 April 2008

PERFORMANCE SPECIFICATION
CAPACITORS, VARIABLE (PISTON TYPE, TUBULAR TRIMMER)
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 tubular-trimmer, piston-type, variable capacitors intended primarily for use in high-frequency trimming applications where relatively few adjustments are required during the effective life of the equipment.

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). Capacitors specified herein are identified by a PIN. The term “Part or Identifying Number (PIN)” is equivalent to the term “type designation” that was previously used in this specification. The PIN is in the following form and as specified (see 3.1 and 6.1):

PC51	H	380
Style	Characteristic	Capacitance
(1.2.1.1)	(1.2.1.2)	(1.2.1.3)

1.2.1.1 Style. The style is identified by the two-letter symbol "PC" followed by a two-digit number; the letters identify tubular-trimmer, piston-type, variable capacitors, and the number identifies the shape or differentiating electrical characteristics of the capacitor.

1.2.1.2 Characteristic. The characteristic is identified by a single letter in accordance with table I.

1.2.1.3 Capacitance. The nominal maximum rated 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 are required, the letter "R" should be used to indicate the decimal point. For example: 8R5 indicates 8.5 pF.

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

TABLE I. Characteristic.

Symbol	Operating temperature range (°C)	Temperature coefficient referred to an ambient temperature of +25°C (Parts/million/°C)	Capacitance drift
G	-55 to +125	±150	±.5 percent maximum rated value
H	-55 to +125	±100	±.2 percent of maximum rated value or .04 pF (whichever is greater)
J	-55 to +125	±50	±.15 percent of maximum rated value or .02 pF (whichever is greater)
K	-55 to +125	0 ± 75	±.18 percent of maximum rated value or .03 pF (whichever is greater)
Q	-55 to +150	+50, -0	±.1 percent of maximum rated value or .01 pF (whichever is greater)
T	-65 to +125	±20	±.1 percent of maximum rated value or .01 pF (whichever is greater)
L	-55 to +125	50 ±50	±.1 percent of maximum rated value or .01 pF (whichever is greater)

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 SPECIFICATONS

(See supplement 1 for a full list of associated specification sheets)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202 - Test Method Standard Electronic and Electrical 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 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, 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 (see 6.1).

3.2 Qualification. Capacitors furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.3 and 6.2).

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

3.3.1 Pure tin prohibition. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.5).

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 shall be in accordance with FED-STD-H28, and shall be as specified (see 3.1).

3.4.2 Locking of screw-thread assemblies. All screw-thread mounting assemblies shall be rendered resistant to loosening under vibration. If needed, lockwashers and nuts compatible with assembly finish, shall be provided.

3.4.3 Terminals. All terminals shall be coated, electro-tin plated, or hot tin dipped with a solder having a minimum tin content of 40 percent (pure tin is prohibited (see 3.3.1)) or shall be gold plated.

3.4.4 Connections. Electrical connections shall not depend upon wires, lugs, terminals, and the like clamped between a metallic member and an insulating material. Such connections shall be soldered.

3.5 Thermal shock. When capacitors are tested as specified in 4.5.1, there shall be no evidence of fracture or loosening of mechanical connections. In addition, corrosion of exposed metallic surfaces shall not exceed 10 percent. (Discoloration and tarnishing alone shall not be cause for rejection.)

3.6 Capacitance. When measured as specified in 4.5.3, the minimum capacitance shall be not more and the maximum not less than the value specified (see 3.1). The capacitance range may be broader than that specified, provided it encompasses the specified range.

3.7 Change of capacitance. When capacitors are tested as specified in 4.5.4, the rate of change of capacitance as a function of the change of adjustment shall not change sign over the entire range of adjustment.

3.8 Insulation resistance. When capacitors are tested as specified in 4.5.5, the insulation resistance shall be not less than the value specified (see 3.1).

3.9 Dielectric withstanding voltage. When capacitors are tested as specified in 4.5.6, there shall be no evidence of damage, arcing, or breakdown.

3.10 Quality factor (Q). When capacitors are tested as specified in 4.5.7, the Q shall exceed the value specified (see 3.1).

3.11 Torque.

3.11.1 Driving torque. Unless otherwise specified (see 3.1), when measured as specified in 4.5.8.1, the torque required to start and maintain rotation of the rotor shall be greater than or equal to 1 and less than or equal to 10 inch-ounces at all temperatures.

3.11.2 Torque bushing strength (panel mount units only). When capacitors are tested as specified in 4.5.8.2, there shall be no evidence of bushing breakage, thread stripping, or other visible mechanical damage.

3.12 Temperature coefficient and capacitance drift. Unless otherwise specified (see 3.1), when capacitors are tested as specified in 4.5.9, the temperature coefficient and capacitance drift shall be within the limits specified in table I.

3.13 Immersion (sealed units only) (see 3.1). When capacitors are tested as specified in 4.5.10, the following requirements shall be met:

a. Capacitance (maximum): Shall change not more than .5 pF or 5 percent, whichever is greater.

b. Insulation resistance at room ambient temperature: Shall be not less than 100,000 megohms.

c. Dielectric withstanding voltage: As specified in 3.9.

3.14 Salt atmosphere (corrosion).

3.14.1 Salt atmosphere (corrosion) (sealed units only) (see 3.1). When capacitors are tested as specified in 4.5.11.1, the following requirements shall be met:

a. Insulation resistance at room ambient temperature: Shall not be less than 100,000 megohms.

b. Dielectric withstanding voltage: As specified in 3.9.

c. Driving torque at room ambient temperature: As specified in 3.11.1.

d. Corrosion of exposed metallic surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection.

3.14.2 Salt atmosphere (corrosion) (unsealed units only). When capacitors are tested as specified in 4.5.11.2, corrosion of exposed metallic surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection.

3.15 Low-temperature storage. When capacitors are tested as specified in 4.5.12, there shall be no visible mechanical damage to the capacitors.

3.16 Shock (specified pulse). When capacitors are tested as specified in 4.5.13, there shall be no intermittent contacts of 0.5 milliseconds (ms) or greater duration, or momentary arcing, open-circuiting or short-circuiting, or any evidence of fractures, loosening of parts, or other visible mechanical damage.

3.17 Vibration, high frequency. When capacitors are tested as specified in 4.5.14, there shall be no intermittent contacts of 0.5 ms or greater duration, or momentary arcing, open-circuiting or short-circuiting, or any evidence of fracture, loosening of parts, or other mechanical damage visible under 10 power magnification. The capacitance change shall be not more than 1 percent or 0.05 pF, whichever is greater, from the initial value obtained when measured as specified in 4.5.14.

3.18 Barometric pressure (reduced, qualification only). Unless otherwise specified (see 3.1), when capacitors are tested as specified in 4.5.15, they shall withstand a potential of 50 percent of the dc rated voltage or 500 volts, whichever is less without damage, arcing, or breakdown.

3.19 Moisture resistance. When capacitors are tested as specified in 4.5.16, the following requirements shall be met:

a. Insulation resistance at room ambient temperature: Shall not be less than 100,000 megohms.

b. Dielectric withstanding voltage: As specified in 3.9.

c. Driving torque at room ambient temperature: As specified in 3.11.1.

d. Corrosion of exposed metallic surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection.

3.20 Terminal strength. When capacitors are tested as specified in 4.5.17, there shall be no loosening or rupturing of the terminals or other damage to the terminals or capacitor body. A slight separation (not exceeding .063 inch (1.60 mm)) of wire leads from the cylindrical body at the point the lead leaves the cylinder is acceptable.

3.21 Resistance to soldering heat (printed circuit mount types only, see 3.1). When capacitors are tested as specified in 4.5.18, they shall meet the following requirements after resistance to soldering heat:

a. Capacitance: Shall be as specified in 3.6.

b. Dielectric withstanding voltage: Shall be as specified in 3.9.

c. Quality factor: Shall be as specified in 3.10.

d. Visual examination: There shall be no evidence of mechanical damage.

3.22 Seal (sealed units only) (see 3.1). When capacitors are tested as specified in 4.5.19, there shall be no evidence of dye penetration and they shall meet the following requirements:

a. Capacitance (maximum): Shall change not more than .5 pF or 5 percent, whichever is greater.

b. Insulation resistance at room ambient temperature: Shall be not less than 100,000 megohms.

c. Dielectric withstanding voltage: As specified in 3.9.

3.23 Rotational life. When capacitors are tested as specified in 4.5.20, the following requirements shall be met:

a. Dielectric withstanding voltage: As specified in 3.9.

b. Contact resistance: Shall not exceed 0.01 ohm after test.

c. Capacitance change versus rotation: Unless otherwise specified (see 3.1), capacitance change versus rotation of the rotor shall not deviate from a straight line by more than 10 percent and shall show no reversals in direction.

d. Driving torque at room ambient temperature: As specified in 3.11.1.

3.24 Solderability (all solderable terminals). When capacitors are tested as specified in 4.5.21, the dipped surface of the leads shall be at least 95 percent covered with a new, smooth, solder coating. The remaining 5 percent of the lead surface shall show only small pinholes or rough spots; these shall not be concentrated in one area. Bare base metal and areas where the solder dip failed to cover the original coating are indications of poor solderability, and shall be cause for failure. 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.

3.25 Marking. Marking of capacitors shall conform to method I of MIL-STD-1285 and shall include the PIN, date code and lot symbol, and manufacturer's symbol or trademark. There shall be no space between symbols which comprise the PIN. If space limitation requires it, the PIN may appear on two lines. In this event, the PIN shall be divided between the style and the characteristic symbols and shall appear on two lines as shown in the following example:

PC51
H380

Marking shall remain legible after all tests.

3.25.1 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, or 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.

3.26 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality and shall be free from corrosion, cracks, rough edges, chips, or other defects that will affect life, serviceability, or appearance.

3.26.1 Soldering All excess flux and solder shall be removed. Electrical connections shall be mechanically secure before soldering, when possible, and electrically continuous after soldering.

4. VERIFICATION

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

a. Qualification inspection (see 4.3).

b. Verification of Qualification (see 4.3.4)

c. Conformance inspection (see 4.4).

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

4.3 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2) on sample units produced with equipment and procedures normally used in production.

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

4.3.2 Inspection routine. The sample shall be subjected to the qualification inspection specified in table II, in the order shown. All sample units shall be subjected to the inspections of group I. The sample shall then be divided equally into the remaining groups shown in table II and shall be subjected to the inspection for their particular group.

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

TABLE II. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of failures 1/	
Group I					
Thermal shock (styles PC21, PC22, PC23, PC24, PC26, PC27, PC28, PC29, PC30, PC32, and PC34)	3.5	4.5.1			
Visual and mechanical examination 2/ 3/	3.1, 3.3 to 3.4.4 and 3.25 to 3.26.1	4.5.2	49 4/	1	
Capacitance 3/	3.6	4.5.3			
Change of capacitance	3.7	4.5.4			
Insulation resistance 3/	3.8	4.5.5			
Dielectric withstanding voltage 3/	3.9	4.5.6			
Quality factor (Q) 3/	3.10	4.5.7			
Driving torque 3/	3.11.1	4.5.8.1.1			
Group II					
Temperature coefficient and capacitance drift	3.12	4.5.9			
Thermal shock	3.5	4.5.1	12	1	
Immersion 5/	3.13	4.5.10			
Salt atmosphere (corrosion)	3.14	4.5.11			
Group III					
Torque, bushing strength 6/	3.11.2	4.5.8.2			
Low-temperature storage	3.15	4.5.12	12	1	
Shock (specified pulse)	3.16	4.5.13			
Vibration, high frequency	3.17	4.5.14			
Group IV					2
Barometric pressured (reduced) (when applicable)	3.18	4.5.15			
Moisture resistance	3.19	4.5.16	12	1	
Terminal strength	3.20	4.5.17			
Resistance to soldering heat (printed circuit mount types only, see 3.1)	3.21	4.5.18			
Group V					
Seal 5/	3.22	4.5.19	12	1	
Rotational life	3.23	4.5.20			
Solderability 7/	3.24	4.5.21			

1/ A sample unit having one or more defects will be charged as a single failure.
2/ Marking will be considered defective if found to be illegible during visual inspection.
3/ Nondestructive test.
4/ One additional sample unit is included in each sample of 49 capacitors to permit substitution for the allowable failure in group I.
5/ Sealed units only.
6/ Panel-mount units only.
7/ All solderable terminals.

4.3.4 Verification of qualification. Every 12 months the manufacturer shall provide verification of qualification to the qualifying activity. Continuation of qualification shall be based on meeting the following requirements.

a. Group A inspection.

b. Group B inspection.

c. Periodic group C inspection.

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

4.4 Conformance inspection.

4.4.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspection. Except as specified in 4.4.2.1.4, delivery of products that have passed the groups A and B inspection shall not be delayed pending the results of group C inspection.

4.4.1.1 Inspection lot. An inspection lot, shall consist of all capacitors of the same style and characteristic, produced under essentially the same conditions, and offered for inspection at one time, except combinations of the styles represented by individual groups of table A-I may be grouped and considered an inspection lot provided the capacitors are of the same characteristic, produced under essentially the same conditions, and offered for inspection at one time. This definition shall apply to group A and group B tests only.

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

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Test paragraph	Sampling procedure
Thermal shock (styles PC21, PC22, PC23, PC24, PC26, PC27, PC28, PC29, PC30, PC32, and PC34)	3.5	4.5.1	100 percent inspection
Visual and mechanical examination:			
Material	3.3	4.5.2	13 samples 0 failures
Body dimensions	3.4		
Design and construction (other than body dimensions)	3.1, 3.4 through 3.4.4		
Marking 1/	3.25		
Workmanship	3.26 and 3.26.1		
Capacitance	3.6	4.5.3	13 samples 0 failures
Change of capacitance	3.7	4.5.4	
Insulation resistance (at 25°C)	3.8	4.5.5	
Dielectric withstanding voltage 2/	3.9	4.5.6	
Quality factor (Q)	3.10	4.5.7	
Driving torque (room ambient temperature)	3.11.1	4.5.8.1.2.1	

1/ Marking defects are based on visual examination only, and will be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects will not be used as a basis for determining marking defects.
2/ Dielectric withstanding voltage will be during capacitor cycle.

4.4.1.2.1 Sampling plan. The sampling plan shall be as specified in table III.

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

4.4.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table IV, in the order shown.

TABLE IV. Group B inspection.

Test	Requirement paragraph	Test paragraph	Sampling procedure
Seal (sealed units only) Torque, bushing strength (panel-mount units only) Solderability (all solderable terminals)	3.22 3.11.2 3.24	4.5.19 4.5.8.2 4.5.21	5 samples 0 failures

4.4.1.3.1 Sampling plan. The sampling plan shall be as specified in table IV.

4.4.1.3.2 Rejected lots. If one or more defects are found, the lot shall be screened or reworked and defects removed. After screening or rework, and the removal of defects, a new sample of parts shall be randomly selected in accordance with table IV. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

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

4.4.2 Periodic inspection. Periodic inspection shall consist of group C inspection.

4.4.2.1 Group C inspection. Group C inspection shall consist of the tests specified in table V, in the order shown. Group C inspection shall be made on sample units selected from inspection lots which have passed groups A and B inspection.

4.4.2.1.1 Sampling plan. Sample units shall be tested in accordance with table V. A separate sample shall be selected for each subgroup. Sample units shall be selected without regard to their quality. The samples shall be representative of production during the period.

4.4.2.1.2 Defectives. If the number of defectives exceeds the number allowed in table V, the sample shall be considered to have failed.

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

4.4.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall 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 inspection, or the inspection that the original sample failed, at the option of the qualifying activity). Groups A and B inspections 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 and corrective action taken shall be furnished to the qualifying activity and the contracting officer or purchaser.

TABLE V. Group C inspection.

Test	Requirement paragraph	Test method paragraph	Sampling procedure
Subgroup I (semiannually)			
Insulation resistance (at high temperature)	3.8	4.5.5	12 samples per characteristic 1 failure
Temperature coefficient and capacitance drift	3.12	4.5.9	
Thermal shock 1/	3.5	4.5.1	
Subgroup II (semiannually)			
Driving torque 2/	3.11.1	4.5.8.1.2.2	12 samples per characteristic 1 failure
Terminal strength	3.20	4.5.17	
Resistance to soldering heat 1/	3.21	4.5.18	
Subgroup III (semiannually) 3/			
Immersion (sealed units only)	3.13	4.5.10	12 samples per characteristic 1 failure
Salt atmosphere (corrosion)	3.14	4.5.11	
Subgroup IV (annually)			
Moisture resistance 1/	3.19	4.5.16	12 samples per characteristic 1 failure
Subgroup V (annually)			
Shock (specified pulse)	3.16	4.5.13	12 samples per characteristic 1 failure
Vibration, high frequency	3.17	4.5.14	

1/ Capacitance, insulation resistance, and quality factor will follow last test of subgroups I, II, and IV.
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 3 years after the deletion as part of long term design verification. If the design, material, construction 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 requirements in case of dispute.
3/ Electrical tests are not required on unsealed units.

4.5 Methods of examination and test.

4.5.1 Thermal shock (see 3.5). Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

a. Test condition: B (styles PC26 (characteristic T), PC32, and PC34) or A (all other styles), except that in step 3, capacitors shall be tested at the high test temperature, ±5°C (see 3.1).

b. Measurements before and after cycling: Not applicable.

After the test, capacitors shall be visually examined for evidence of fracture, corrosion, or loosening of mechanical connections.

4.5.2 Visual and mechanical examination. Capacitors shall be examined to verify that the material, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.3 to 3.4.4 inclusive, and 3.25 to 3.26.1, inclusive).

4.5.3 Capacitance (see 3.6). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. Measurements shall be made using a test jig incorporating a guard provision. The following details and exception shall apply:

a. Test frequency: Minimum and maximum rated capacitance shall be measured at a frequency of 1 megahertz (MHz) ±100 kilohertz (kHz).

b. Limit of accuracy: Shall be within ±1 percent or 0.05 pF, whichever is greater.

4.5.4 Change of capacitance (see 3.7). The rate of change of capacitance shall be monitored by any suitable method while the capacitance is adjusted from the minimum rated value to the maximum rated value and back to the minimum rated value. The rate of change of capacitance as a function of the change of adjustment shall be monitored for change of sign.

4.5.5 Insulation resistance (see 3.8). Capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition: As specified (see 3.1).

b. Special conditions: Measurements shall be made at room ambient temperature and at the applicable high test temperature. The relative humidity shall be between 20 and 50 percent; however, at the manufacturer's option, measurements may be made at a relative humidity up to 80 percent.

c. Points of measurement: Insulation resistance shall be measured at the maximum rated capacitance setting between the mutually insulated points.

d. Electrification time: 1 minute.

4.5.6 Dielectric withstanding voltage (see 3.9). Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

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

b. Points of application of test voltage: Capacitors shall be set at maximum rated capacitance and the potential applied between the terminals.

4.5.7 Quality factor (Q) (see 3.10). Capacitors shall be tested in accordance with method 306 of MIL-STD-202. The following details and exceptions shall apply:

a. Test frequency: Unless otherwise specified (see 3.1), capacitors shall be set at maximum rated capacitance as specified in 4.5.3 and Q shall be measured at a frequency of 20 MHz ±200 kHz.

b. Condition: The mounting means shall be snugly fitted against the capacitor when making measurements.

c. Measurements: Shall be made using a test jig designed for minimum stray capacitance effects.

d. Measurement accuracy: Shall be sufficient to guarantee the minimum Q specified.

4.5.8 Torque.

4.5.8.1 Driving torque (see 3.11.1). The torque required to start and maintain rotation of the rotor shall be measured by a gradually applied force sufficient to turn the rotor through at least 50 percent of the total number of rotations.

4.5.8.1.1 For qualification inspection. The test specified in 4.5.8.1 shall be performed at room ambient temperature, -55°C +0°C -3°C, and at the applicable high test temperature, +5°C -0°C.

4.5.8.1.2 Conformance inspection.

4.5.8.1.2.1 Group A inspection. The test specified in 4.5.8.1 shall be performed at room ambient temperature.

4.5.8.1.2.2 Group C inspection. The test specified in 4.5.8.1 shall be performed at -55°C +0°C, -3°C, and at the applicable high test temperature, +5°C, -0°C.

4.5.8.2 Torque, bushing strength (panel mounts only) (see 3.11.2). The capacitor shall be mounted through the suggested hole (see 3.1) in a metal panel of .125 inch (3.18 mm) maximum thickness, while the applicable torque specified in table VI is applied to the nut. The torque shall be applied in the direction which will tighten the nut and shall be held at its specified value for a period of not less than 3 seconds. It shall be applied repeatedly to the nut until a total of five twists have been applied. After the test, the capacitor shall be visually examined for evidence of bushing breakage, thread stripping, or other visible mechanical damage.

TABLE VI. Torque.

Bushing size	Torque ±0.1 (inch-pounds)
.120	1.2
.190-64	3.0
.234	5.0
.190-32	6.0
.250	8.0

4.5.9 Temperature coefficient and capacitance drift (see 3.12).

4.5.9.1 For qualification inspection.

4.5.9.1.1 Temperature coefficient. With capacitors set at approximately 75 percent of maximum rated capacitance, capacitance measurements shall be made at a frequency of 1 MHz ±100 kHz and at the temperatures specified in table VII. Each measurement shall be made after thermal stability has been reached. (Thermal stability has been reached when no further change in capacitance is obtained between two successive measurements taken at 5 minute intervals.) Accuracy of measurements shall be within ±0.01 pF.

TABLE VII. Temperature coefficient and capacitance-drift cycle.

Steps	Qualification inspection temperature (°C)	Conformance inspection temperature (°C)
a	25 +2, -2	25 ±2
b	-55 +0, -2	-55 +0, -2
c	-10 +2, -2	25 ±2 1/
d	25 +2, -2 1/	125 +2, -0
e	85 +2, -0	150 +2, -0 2/
f	125 +2, -0	25 ±2
g	150 +2, -0 2/	
h	25 +2, -2	

1/ This temperature shall be considered as the reference temperature.
2/ For characteristic Q only.

4.5.9.1.1.1 Computation of temperature coefficient. The temperature coefficient shall be computed as follows:

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

Where: TC = Temperature coefficient in parts per million per °C.
C_1 = Capacitance at +25°C in pF.
C_2 = Capacitance at test temperature in pF.
T_1 = +25°C.
T_2 = Test temperature in °C.

4.5.9.1.2 Capacitance drift. Capacitance drift shall be the greatest difference between any two of the three values recorded at +25°C (see table VII).

4.5.9.2 For conformance inspection.

4.5.9.2.1 Temperature coefficient. Capacitance measurements shall be made as specified in 4.5.9.1.1 and table VII.

4.5.9.2.2 Capacitance drift. Capacitance drift shall be computed as specified in 4.5.9.1.2.

4.5.10 Immersion (sealed units only) (see 3.14). Capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

a. Test condition: A.

b. Measurements after final cycle: Maximum rated capacitance, insulation resistance, and dielectric withstanding voltage shall be measured as specified in 4.5.3, 4.5.5, and 4.5.6, respectively.

4.5.11 Salt atmosphere (corrosion).

4.5.11.1 Salt atmosphere (corrosion) (sealed units only) (see 3.14.1). Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

a. Test condition: B.

b. Measurements between 4 and 24 hours after exposure: Insulation resistance, dielectric withstanding voltage, and driving torque at room ambient temperature shall be measured as specified in 4.5.5, 4.5.6, and 4.5.8.1.2.1, respectively.

Capacitors shall be examined for evidence of corrosion.

4.5.11.2 Salt atmosphere (corrosion) (unsealed units only) (see 3.14.2). Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

a. Test condition: B

b. Measurement after test not required.

c. Capacitors shall be examined for evidence of corrosion.

4.5.12 Low-temperature storage (see 3.15). Capacitors shall be subjected to storage at -62°C ±5°C for a period of 48 ±4 hours. Capacitors shall then be examined for evidence of mechanical damage.

4.5.13 Shock (specified pulse) (see 3.16). 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 mounted by their normal mounting means.

b. Number and direction of applied shocks: Twenty; ten in each of two mutually perpendicular directions (five blows in each of two directions). One of the test planes shall be parallel and the other perpendicular to the cylindrical axis of the rotor.

c. Test condition: I.

d. Electrical load during shock: A potential of 125 percent of the specified dc rated voltage (see 3.1) shall be applied between rotor and stator with the capacitor set at approximately 75 percent of maximum rated capacitance.

e. Examination during and after shock: During the test, observation shall be made for momentary arcing or intermittent contacts of 0.5 ms or greater duration. After test capacitors shall be visually examined for evidence of breakdown, arcing, fractures, loosening of parts, or other visible mechanical damage.

4.5.14 Vibration, high frequency (see 3.17). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Capacitors shall be mounted by their normal mounting means. Lead-mounted capacitors designed for printed-circuit mounting shall be seated firmly against a printed-wiring board or comparable support to withstand forces encountered in service. Leads shall pass through mounting holes in the board and shall be soldered on the opposite side of the printed-wiring board.

b. Measurements prior to vibration: Capacitors shall be set at approximately 75 percent of maximum rated capacitance and capacitance shall then be measured as specified in 4.5.4.

c. Electrical-load conditions: During the test while capacitors are set as specified in (b) above, a potential of 125 percent of the dc rated voltage shall be applied between rotor and stator. Observation shall be made for intermittent contacts of 0.5 ms or greater duration, momentary arcing, open-circuiting or short circuiting.

d. Test condition: B.

e. Direction of motion: In two directions; one perpendicular and one parallel to the axis of the rotor shaft.

f. Final measurements: After vibration, capacitance shall again be measured as specified in 4.5.4.

After completion of test, capacitors shall be examined for evidence of fracture, loosening of parts, or other mechanical damage visible under 10 power magnification.

4.5.15 Barometric pressure (reduced, qualification only) (see 3.18). Unless otherwise specified (see 3.1), capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

a. Method of mounting: Capacitors shall be mounted by their normal mounting means.

b. Test condition: D.

c. Test during subjection to reduced pressure: A dc potential equal to 50 percent of the dc rated voltage or 500 volts, whichever is less, shall be applied, for not less than 1 second nor more than 5 seconds, between the terminals.

Capacitors shall be visually examined for evidence of damage, arcing, or breakdown.

4.5.16 Moisture resistance (see 3.19). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Capacitors shall be mounted by their normal mounting means and set at approximately 75 percent of maximum rated capacitance.

b. Polarization and loading voltage: Not applicable.

c. Final measurements: Upon completion of step 6 of the final cycle, capacitors shall be maintained at a temperature of +25°C +10°C, -5°C and a relative humidity of 50 ±5 percent for a period of 4 to 24 hours. Insulation resistance, dielectric withstanding voltage, and driving torque at room ambient temperature shall then be measured as specified in 4.5.5, 4.5.6, and 4.5.8.1.2, respectively.

After completion of test, capacitors shall be examined for evidence of corrosion.

4.5.17 Terminal strength (see 3.20). A load shall be gradually applied perpendicular to the initial position of the wire lead in the opposite direction of the winding (or perpendicular to the center line for flat and printed circuit terminals) until the applied load reaches 2 pounds. The 2-pound load shall be applied for at least 5 seconds at a point within .25 inch (6.35 mm) of the open end of the wire lead and printed circuit terminals and from the lead hole itself in the flat terminals. The capacitors shall then be examined for evidence of lead separation, loosening or rupturing of the terminal, and any other damage to terminals and the capacitor body.

4.5.17.1 Bend test (wire leads only). Leads shall be clamped .25 inch (6.35 mm) from the body of the capacitor and shall be bent at an angle 90° each side of the center (total -180°) 3 times. The radius of curvature at the 90° bend shall be approximately .031 inch (0.79 mm).

4.5.17.2 Bend test (flat terminals only). Capacitors with flat terminals shall be tested in accordance with method 211 of MIL-STD-202. The following details shall apply:

a. Test condition: B

b. Number of bends: 2.

4.5.18 Resistance to soldering heat (printed circuit mount types only, see 3.1) (see 3.21). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

a. Depth of immersion in molten solder: Leads shall be immersed to within .125 inch (3.18 mm) of the body of the capacitor.

b. Test condition: B.

c. Cooling time prior to measurement after test: Sufficient time to allow the capacitor temperature to return to +25°C ±5°C.

d. Measurements after test: Capacitance, dielectric withstanding voltage, and quality factor shall be measured as specified in 4.5.3, 4.5.6, and 4.5.7, respectively.

Capacitors shall then be examined for evidence of mechanical damage.

4.5.19 Seal (see 3.22). Capacitors shall be placed in a sealed enclosure filled with water with sufficient noncorrosive dye, Rhodamine B (tetraethylrhodamine). Air pressure shall be applied inside the sealed enclosure to a pressure level of 40 pounds per square inch gauge for a total period of 15 minutes. After completion of this period of time, the capacitors shall be removed from the sealed enclosure, cleaned, dried, thoroughly, and then examined for presence of dye. Maximum rated capacitance, insulation resistance, and dielectric withstanding voltage shall then be measured as specified in 4.5.3, 4.5.5, and 4.5.6, respectively. (If necessary to determine the presence of dye internally, the units may be disassembled after performing the rotational life test) (see 4.5.20).

4.5.20 Rotational life (see 3.23). Capacitors shall be mounted by their normal mounting means with the adjusting screw set at approximately 20 percent of maximum rated capacitance. The screw shall be rotated four complete revolutions in the direction of increasing capacitance, then four complete revolutions in the direction of decreasing capacitance. This cycle shall be repeated 75 times at a rate of 5 cycles per minute. Following the final cycle, dielectric withstanding voltage shall be measured as specified in 4.5.6. Then capacitors shall be set at approximately 10 percent of the maximum rated capacitance value above the minimum rated capacitance value or 1.0 pF, whichever is greater, and then the rotor shall be rotated in steps of two turns until 90 percent of maximum rated capacitance is reached. Capacitance measurements at a minimum of three steps shall be recorded. Capacitance shall be measured after each step at a frequency of .001 or 1.0 MHz ±10 percent and shall be continuously monitored for reversals. The accuracy of the rotation shall be within ±5° per revolution. Reproducibility of the measurements shall be within ±0.1 percent or 0.01 pF, whichever is greater. Following measurements of capacitance change versus rotation, driving torque at room ambient temperature shall be measured as specified in 4.5.8.1. Without further rotation after the driving torque measurement contact resistance shall be measured between the rotor screw and the mounting base. Disassembly may be necessary for this measurement.

4.5.21 Solderability (see 3.24). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. All solderable terminations of each part shall be tested.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.1). 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 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).

b. Packaging requirements (see 5.1).

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

6.2.1 Copies of SD-6, "Provisions Governing Qualification" may be obtained upon application to Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094

6.3 Substitutability data. For a cross reference of the substitutability relationship of superseded styles PC38, PC40, PC41, PC42, PC46, and PC47 characteristics J and H only, see the applicable specification sheet (see 3.1).

6.4 Mounting. It is recommended that the capacitor bodies have adequate heat sink during mounting operation with high temperature solder.

6.5 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 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 on this matter, refer to ASTM B545, Standard Specification for Electrodeposited Coating of Tin.

6.6 Subject term (key word) listing.

Dielectric withstanding voltage
Insulation resistance
Capacitance drift
Rotational life

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

6.8 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 Scope. This appendix details the qualification-submittal plans for capacitors to be subjected to the qualification inspection specified in this specification. These plans specify the sample size, sampling criteria, and limits of coverage for the type of qualification sought. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

A.2 SUBMITTAL PLANS

A.2.1 Single part. The following details apply:

a. Sample size: As specified in table II (49 sample units).

b. Sampling criteria: Sample units of a single PIN for which qualification is sought.

c. Limits of coverage: Qualification coverage will be restricted to the PIN submitted.

A.2.2 Single style, single characteristic submission. The following details shall apply:

a. Sample size: As specified in table II (49 sample units).

b. Sampling criteria: 25 samples of the highest capacitance value of a characteristic (or the highest capacitance to which qualification is sought) in a style and 24 samples of the lowest capacitance value (or lowest capacitance value to which qualification is sought) in the same characteristic and style.

c. Limits of coverage: Qualification coverage will extend to all intermediate capacitance ratings in the characteristic and style for which qualification is sought.

A.2.3 Combined-style submission.

a. Sample size: As specified in table A-I.

b. Sampling criteria: As specified in table A-I.

c. Extent of qualification: Qualification will be extended to all intermediate capacitance ratings of all styles within the group when submitted in accordance with table A-I.

APPENDIX A

TABLE A-I. Combined style qualification.

Group	Style	Characteristic	PIN(s) submitted 1/	Number of samples to be submitted	PIN(s) qualified
I	PC21, PC22 PC23, PC24	J	PC2*J1R2 PC2*J4R5	24 25	PC21J*** PC22J*** PC23J*** PC24J***
		K	PC2*K080	49	PC21K080 PC22K080 PC23K080 PC24K080
II	PC25, PC26 PC31	J	PC**J060 PC26J300	24 25	PC25J*** PC26J*** PC31J***
III	PC27, PC28, PC29, PC30	J	PC**J3R5 PC29J100	24 25	PC27J*** PC28J*** PC29J*** PC30J***
IV	PC32, PC34	T	PC32T140 PC34T100	24 25	PC32T140 PC34T100
V	PC38, PC42	Q	PC**Q1R8 PC**Q160	24 25	PC38Q*** PC42Q***
VI	PC39, PC43	G, J 2/	PC**G160 PC**J121 2/	24 25	PC39G*** PC43G*** PC39J121 PC43J121
VII	PC40, PC41	Q	PC4*Q1R8 PC4*Q160	24 25	PC40Q*** PC41Q***
VIII	PC48, PC52	J	PC**J5R5 PC**J110	24 25	PC48J*** PC52J*** PC48H*** PC52H***
		H	PC**H160 PC**H380	24 25	
IX	PC50, PC51	J	PC5*J5R5 PC5*J110	24 25	PC50J*** PC51J*** PC50H*** PC51H***
		H	PC5*H160 PC5*H380	24 25	
X	PC18, PC19 PC46, PC47	L	PC**L100 PC**L140	25 24	PC**L100 PC**L140

1/ When applicable, the high and low capacitance value parts submitted shall not be of the same style.
2/ If qualifying only characteristic G, substitute PC**G121 for PC**J121.

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

Reviewing activities:
Navy - MC

Preparing activity:
DLA - CC

(Project 5910-2014-014)

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.