

INCH-POUND
MIL-PRF-49464C
24 June 2009
SUPERSEDING
MIL-PRF-49464B
3 June 2004

PERFORMANCE SPECIFICATION

CAPACITORS, CHIP, SINGLE LAYER, FIXED, PARALLEL PLATE,
CERAMIC DIELECTRIC, ESTABLISHED RELIABILITY,
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 ceramic plate, single layer capacitors. These capacitors are intended for stripline or microstrip applications, usually at frequencies of 1 GHz and higher. Capacitors covered by this specification have failure rate levels (FRL) ranging from 1.0 to 0.001 percent per 1,000 hours. These failure rate levels are established at a 90-percent confidence level and maintained at a 10-percent producer's risk. They are based on life tests performed at a maximum rated voltage at maximum rated temperature. An acceleration factor of 8:1 has been used to relate life test data obtained at 200 percent of rated voltage at maximum rated temperature, to rated voltage at rated temperature. Statistical Process Control (SPC) techniques are required in the manufacturing process to minimize variation in production of capacitors supplied to the requirements of this specification.

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). Capacitors specified herein (see 3.1) are identified by a PIN which consists of the basic number of the performance specification and a series of coded characters. The coded characters provide information concerning the capacitors temperature coefficient, specification sheet number, capacitance value, capacitance tolerance, voltage, case code, termination finish, and failure rate level. The PIN is in the following form:

<u>M49464</u>	<u>F</u>	<u>01</u>	<u>1R0</u>	<u>B</u>	<u>B</u>	<u>J</u>	<u>A</u>	<u>H</u>	<u>M</u>
Performance specification number	Temperature coefficient (1.2.1.1)	Specification sheet number	Capacitance value (1.2.1.2)	Capacitance tolerance (1.2.1.3)	Voltage (1.2.1.4)	Case code (1.2.1.5)	Termination configuration code (1.2.1.6)	Termination finish (1.2.1.7)	FRL (1.2.1.8)

1.2.1.1 Temperature coefficient limits. The rated temperature and temperature coefficient limits are identified by a single letter. The rated temperature of these parts is -55°C to +125°C. The letter indicates the temperature coefficient limits as shown in [table I](#).

<p>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 http://assist.daps.dla.mil.</p>
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TABLE I. Temperature coefficient limits.

Symbol	Capacitance change with temperature	Class
F	0 \pm 25 ppm/ $^{\circ}$ C	1A
G	0 \pm 30 ppm/ $^{\circ}$ C	1A
W	\pm 20 percent	2

1.2.1.2 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 the nominal value is less than 10 pF, the letter "R" is used to indicate the decimal point and the succeeding digit(s) of the group represent significant figure(s). For example, 1R0 indicates 1.0 pF and 0R5 indicates 0.5 pF.

1.2.1.3 Capacitance tolerance. The capacitance tolerance is identified by a single letter in accordance with table II.

TABLE II. Capacitance tolerance.

Symbol	Capacitance tolerance
A	\pm .05 pF
B	\pm .10 pF
C	\pm .25 pF
D	\pm .50 pF
J	\pm 5 percent
K	\pm 10 percent
M	\pm 20 percent

1.2.1.4 Rated voltage. The rated voltage for continuous operation at +125 $^{\circ}$ C is identified by a single letter as shown in table III.

TABLE III. Rated voltage.

Symbol	Rated voltage
A	16
B	25
C	50
D	100

1.2.1.5 Case code. The case code is identified by a single letter (see 3.1).

1.2.1.6 Termination configuration code. There are three termination configurations available (see 3.1):

- A - Borders on top and bottom,
- B - Border on top and full metallization on bottom, and
- C - Full metallization on top and bottom.

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1.2.1.7 Termination finish. The termination finish is identified by the letter H.

H: A minimum of 100 microinches of 99.99 percent gold, on both sides. This is suitable for gold wire bonding and conductive epoxy or AuSn eutectic die attachment.

1.2.1.8 Failure rate level (FRL). The FRL is identified by a single letter as shown in table IV.

TABLE IV. FRL.

Symbol	FRL (percent per 1,000 hours)
M	1.0
P	0.1
R	0.01
S	0.001

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 of the documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-49464/1](#) - Capacitors, Chip, Single Layer, Fixed Unencapsulated, Ceramic Dielectric, Established Reliability, Style CPCRO1 (High Frequency).

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-202](#) - Electronic and Electrical Component Parts, Test Methods for.
[MIL-STD-690](#) - Failure Rate Sampling Plans and Procedures.
[MIL-STD-790](#) - Standard Practice for Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications.
[MIL-STD-810](#) - Environmental Engineering Considerations and Laboratory Tests.
[MIL-STD-883](#) - Test Methods and Procedures for Microelectronics.

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

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

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

[EIA-557](#) - Statistical Process Control Systems. (DoD Adopted).

(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.)

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

3. REQUIREMENTS

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

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 (QPL) before contract award. In addition, the manufacturer shall obtain certification from the qualifying activity that the QPL system requirements of 3.3 and 4.2 have been met and are being maintained. Authorized distributors who are approved to MIL-STD-790 distributor requirements by the QPL manufacturer are listed in the QPL.

3.3 QPL system. The manufacturer shall establish and maintain a QPL system for parts covered by this specification. Requirements for this system are specified in MIL-STD-690 and MIL-STD-790. In addition, the manufacturer shall establish a Statistical Process Control (SPC) system that meets the requirements of 3.3.1.

3.3.1 SPC system. As part of the overall MIL-STD-790 QPL system, the manufacturer shall establish an SPC system which meets the requirements of EIA-557. Typical manufacturing processes for application of SPC include raw material mixing and blending, dielectric sheet manufacturing, metallization, cutting, and firing.

3.4 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 guarantee of the acceptance of the finished product.

3.4.1 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 6.8).

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

3.5.1 Body structure. The body shall be a single ceramic plate or a single ceramic plate with buried electrodes and multiple via connections that meets the requirements specified herein (see 3.1).

3.6 Thermal shock and voltage conditioning. When tested as specified in 4.8.3, capacitors shall withstand the extremes of high and low temperature without visible damage and meet the following requirements:

- a. Capacitance (at +25°C): Shall be within the tolerance as specified in 3.7.
- b. Dissipation factor (at +25°C): Shall not exceed the value as specified in 3.8.
- c. Insulation resistance (at +25°C): Shall not be less than the value specified in 3.9.
- d. Dielectric withstanding voltage (at +25°C): Shall be as specified in 3.10. Not applicable if optional voltage conditioning was performed at or above 250 percent of rated voltage.

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3.7 Capacitance. When measured as specified in 4.8.4, the capacitance shall be within the specified tolerance (see 3.1).

3.8 Dissipation factor. When determined as specified in 4.8.5, the dissipation factor for capacitors of 4.7 pF or greater shall not exceed:

Symbol F and G characteristics:	0.15 percent
Symbol W: 50 and 100 volts	2.5 percent
Symbol W: 16 and 25 volts	3.5 percent

3.9 Insulation resistance. When measured as specified in 4.8.6, the insulation resistance at +25°C shall be not less than 10^5 megohms. At +125°C it should not be less than 10^4 megohms.

3.10 Dielectric withstanding voltage. When capacitors are tested as specified in 4.8.7, there shall be no evidence of breakdown or visible evidence of arcing or damage.

3.11 Bond strength. When tested as specified in 4.8.8, bond strength shall be at least 3.0 grams force, and there shall be no fracturing of the bond at the wire to electrode interface or separation of the electrode from the dielectric.

3.12 Die shear strength. When tested as specified in 4.8.9, parts shall not shear from their mountings within the gram force limits specified.

3.13 Temperature coefficient limits. When capacitors are tested as specified in 4.8.10, the capacitance change shall not exceed the limits specified in table I.

3.14 Immersion. When tested as specified in 4.8.11, capacitors shall meet the following requirements:

- a. Visual examination: No mechanical damage.
- b. Dielectric withstanding voltage: As specified in 3.10.
- c. Insulation resistance (+25°C): Not less than 30 percent of the initial requirement (see 3.9).
- d. Capacitance change:
 - (1) Symbols F and G: Shall change not more than 0.5 percent of the nominal value or 0.5 pF, whichever is greater, from the initial value.
 - (2) Symbol W: Shall change not more than ± 10 percent from the initial measured value.
- e. Dissipation factor: Shall be as specified in 3.8.

3.15 Humidity, steady state, low voltage. When tested as specified in 4.8.12, capacitors shall meet the following requirements:

- a. Visual examination: No mechanical damage.
- b. Insulation resistance (+25°C): Shall meet the initial +25°C requirement (see 3.9).
- c. Capacitance change:
 - (1) Symbols F and G: Shall change not more than 0.5 percent of the nominal value or 0.5 pF from the initial value, whichever is greater.
 - (2) Symbol W: Shall change not more than ± 10 percent from the initial measured value.

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3.16 Life (at +125°C). When tested as specified in 4.8.13, capacitors shall meet the following requirements:

- a. Visual examination: No mechanical damage.
- b. Insulation resistance (at +125°C): Shall not be less than 30 percent of initial requirement (see 3.9).
- c. Insulation resistance (at +25°C): Shall not be less than 30 percent of initial requirement (see 3.9).
- d. Capacitance change:
 - (1) Symbols F and G: Shall change not more than 2.0 percent of the nominal value or 0.5 pF from the initial value, whichever is greater.
 - (2) Symbol W: Shall change not more than ± 10 percent from the initial measured value.
- e. Dissipation factor: Shall be as specified in 3.8.

3.17 Fungus. The manufacturer shall certify that all materials are fungus resistant or shall perform the test as specified in 4.8.14. When capacitors are tested as specified in 4.8.14, there shall be no evidence of fungus growth on the external surface.

3.18 Marking. There shall be no marking on the capacitors. Capacitor packaging containers shall be marked with the PIN, capacitance, capacitance tolerance, voltage, date code and lot symbol, "JAN" brand, and the Commercial and Government Entity (CAGE) code.

3.18.1 JAN and J marking. The United States Government has adopted and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of specifications. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" and "J" shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the part number. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein on in applicable specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets, the manufacturer shall remove completely the military part number and the "JAN" or the "J" from the sample tested and also from all items represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration Number 504,860 for the certification mark "JAN" and Registration Number 1,586,261 for the certification mark "J".

3.18.2 Substitutability of FRL. A manufacturer may supply to all higher FRLs than to which they are qualified. Items of an exponential FRL as shown below and marked to lower FRL's with procuring agency approval, are substitutable for higher FRL's, and shall not be remarked unless specified in the contract or order (see 6.2), the lot date codes on the parts are unchanged, and the workmanship criteria is met.

Parts qualified to product level	Are substitutable for product level
S R P M	R, P, and M P, and M M

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3.18.3 Substitution of capacitance tolerance and rated voltage. Parts qualified and marked to tighter capacitance tolerance or higher rated voltage are, with acquiring agency approval, substitutable for parts marked to looser capacitance tolerance or lower rated voltage, provided all other values, such as case size, characteristic, and leads are the same. Unless specified in the contract or order (see 6.2), the substitutable parts shall not be remarked.

3.19 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.

3.20 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality when using 7x minimum to 30x maximum magnification. All capacitors shall not exhibit pits, cracks, rough edges, adhered foreign material or other defects that will affect life or serviceability. The capacitors shall exhibit no demetalization (lift-off, blisters, or roll back) or voids or scratches on the electrodes that expose the dielectric over more than 5 percent of the area.

4. VERIFICATION

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

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (see 4.5).
- c. Conformance inspection (see 4.6).
- d. Periodic group B inspection (see 4.7).

4.2 QPL system. The manufacturer shall establish and maintain a QPL system in accordance with 3.3. Evidence of such compliance is a prerequisite for qualification and retention of qualification.

4.3 Inspection conditions and methods.

4.3.1 Inspection conditions. Unless otherwise specified herein, all inspections shall be made in accordance with 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.

4.3.2 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.3 Power supply. The power supply used for life testing shall have a regulation of ± 2 percent or less of the specified test voltage. The power supply used for insulation resistance measurements shall be stabilized to at least ± 100 parts per million. Voltage fluctuations shall not occur during measurements that would produce a variation in the current measurement.

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. Samples shall be selected in accordance with 4.6.1.1.1 and shall be representative of the highest capacitance value.

4.4.1 Sample size. The number of capacitors to be submitted for qualification inspection shall be as specified in table V and in appendix A to this specification. Each separate capacitor class shall be qualified separately.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection as specified in table V, 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 V for groups II through VI inclusive, and subjected to the tests for their particular group.

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

4.4.4 FRL and quality level verification.

4.4.4.1 FR qualification and lot conformance FR inspection. FR qualification and lot conformance FR inspection shall be in accordance with the general and detailed requirements of [MIL-STD-690](#) and the following details:

- a. Procedure I: Qualification at the initial FR level. Level M (1.0 percent) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group I, table V prior to being tested as specified in group IV, table V (see [4.4.2](#)).
- b. Procedure II: Extension of qualification to lower FR levels. To extend qualification to the P (0.1 percent), R (0.01 percent), and S (0.001 percent) FR levels, two or more voltages within a temperature coefficient limit may be combined. For FR levels R and S, two or more voltage temperature characteristics may be combined.
- c. Procedure III: Maintenance of FR level qualification. Maintenance period B of FRSP-10 shall apply. Regardless of the number of production lots produced during this period, the specified number of unit hours shall be accumulated to maintain qualification.

4.4.4.2 Quality level verification. The contractor is responsible for establishing a quality system to verify the ppm defect level of lots. The ppm defect level shall be based on a 6-month moving average.

TABLE V. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted	
<u>Group I</u>					
Thermal shock and voltage conditioning	3.6	4.8.3	67 ^{2/}	0	
Insulation resistance (+125°C) ^{1/}	3.9	4.8.6			
Capacitance ^{1/}	3.7	4.8.4			
Dissipation factor ^{1/}	3.8	4.8.5			
Insulation resistance ^{1/}	3.9	4.8.6			
Dielectric withstanding voltage ^{1/}	3.10	4.8.7			
Visual and mechanical inspection	3.1, 3.4, 3.5, 3.20	4.8.1			
<u>Group II</u>					
Bond strength	3.11	4.8.8	6	1	1
Die shear strength	3.12	4.8.9			
<u>Group III</u>					
Temperature coefficient limits	3.13	4.8.10	18	1	
Immersion	3.14	4.8.11			
<u>Group IV</u>					
Life	3.16	4.8.13	25	1	
<u>Group V</u>					
Fungus ^{2/}	3.17	4.8.14	6	0	
<u>Group VI</u>					
Humidity, steady state, low voltage	3.15	4.8.12	12	0	

^{1/} Performed as part of voltage conditioning.

^{2/} Certification of fungus resistance may be substituted for testing. If certification is given for fungus (see [3.17](#)), only 61 samples are needed.

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4.5 Verification of qualification. Every 6 months, the manufacturer shall provide verification of qualification to the qualifying activity. Continuation of qualification shall be based on meeting the following requirements:

- a. MIL-STD-790 program.
- b. The capacitor design has not been modified.
- c. Lot rejection for group A inspection does not exceed 10 percent or one lot, whichever is greater.
- d. Periodic group B inspection.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection.

4.6.1.1 Inspection and production lot.

4.6.1.1.1 Inspection lot. An inspection lot shall consist of all capacitors of the same voltage-temperature characteristics, produced under essentially the same conditions and offered for inspection during a single work month. Each inspection lot shall be kept separate from every other inspection lot. The capacitance values and voltages produced shall be represented in the lot in approximately the ratio of production.

4.6.1.1.2 Production lot. A production lot shall consist of all capacitors of the same voltage rating, nominal capacitance value, voltage-temperature characteristic, and termination finish. The manufacture of all parts in the production lot shall have been started, processed, assembled, and tested as a group. Lot identity shall be maintained throughout the manufacturing cycle.

4.6.2 Group A inspection. Group A inspection shall consist of the inspections specified in [table VI](#) in the order shown.

4.6.2.1 Subgroup 1.

4.6.2.1.1 Sampling plan. Subgroup 1 shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Capacitors failing the tests of this subgroup shall be removed from the lot. If, during the 100 percent inspection, screening requires that more than 8 percent of the capacitors be discarded (8 percent defective allowable (PDA)), the entire lot shall be rejected.

4.6.2.1.2 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 1, [table VI](#) as the final step of their production process, group A, subgroup 1 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 1 inspections shall be granted by the qualifying activity only. The following criteria must be complied with:

- a. Tests conducted by the manufacturer during production shall be clearly identical to, or more stringent than, that specified for subgroup 1.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to their production tests.
- c. The parameters measured and the failure criteria shall be the same as, or more stringent than, those specified herein.
- d. The lot rejection criteria is the same as, or more stringent than, that specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in their production tests.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification of, and concurrence by, the qualifying activity.

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4.6.2.1.3 Rejected lots. Production lots exceeding the PDA of group A, subgroup 1 inspection, shall be rejected and shall not be resubmitted.

4.6.2.2 Subgroup 2.

4.6.2.2.1 Sampling plan. Subgroup 2 shall be performed on an inspection lot basis. In the event of one or more failures the lot shall be rejected.

4.6.2.2.2 Rejected lots. The rejected lots shall be segregated from new lots and those that have passed inspection. Rejected lots shall be 100 percent reworked or scrapped. The rejected lot may be rescreened and the defects removed. The lot may then be resubmitted to the sample plan. If one or more defects of the same type are found in this second sample, the lot is rejected and shall not be supplied to this specification. If another defect of a different type is found in the second sample, a rescreen for that defect is also permitted.

4.6.2.3 Subgroup 3. Subgroup 3 shall be performed on an inspection lot basis. The sampling procedure shall be as specified in table VI. If there are one or more defects, the inspection lot shall be rejected.

4.6.2.4 Subgroup 4.

4.6.2.4.1 Sampling plan. Subgroup 4 shall be performed on a production lot basis. In the event of one or more failures the lot shall be rejected.

4.6.2.4.2 Disposition of sample units. Sample units that have been subjected to subgroup 4 shall not be delivered on the contract or purchase order.

TABLE VI. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
<u>Subgroup 1</u> Thermal shock and voltage conditioning Capacitance <u>1/</u> Dissipation factor <u>1/</u> Insulation resistance <u>1/</u> Dielectric withstanding voltage <u>1/</u>	3.6 3.7 3.8 3.9 3.10	4.8.3 4.8.4 4.8.5 4.8.6 4.8.7	100% inspection
<u>Subgroup 2</u> Visual and mechanical examination: <u>2/</u> Material Physical dimensions Interface requirements (other than physical dimensions) <u>2/</u> Workmanship	3.4 3.1 3.5 3.20	4.8.1	13 samples 0 failures
<u>Subgroup 3</u> Bond strength Die shear strength	3.11 3.12	4.8.8 4.8.9	13 samples 0 failures
<u>Subgroup 4</u> Temperature coefficient limits	3.13	4.8.10	13 samples 0 failures

1/ Performed as part of voltage conditioning tests.

2/ The manufacturer may request the deletion of the visual and mechanical examination provided an in-line or process control system to assure the visual and mechanical requirements are met can be validated and approved by the qualifying activity. Deletion of these examinations does not relieve the manufacturer from meeting these requirements in case of dispute. If the design, material, construction, or processing of the part is changed or if there are any quality problems, the qualifying activity may require resumption of these examinations.

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4.7 Periodic group B inspection. Periodic group B inspection shall consist of the tests specified in table VII in the order shown, and shall be performed on sample units selected from lots that have passed group A inspection. Capacitor styles manufactured during each 3-month or 6-month period, as applicable, shall be represented, as far as practical, in at least the approximate ratio of production. Except where the results of this inspection show noncompliance with the applicable requirements (see 4.7.3), delivery of products that have passed group A inspection shall not be delayed pending the results of this periodic inspection.

4.7.1 Sampling plan.

4.7.1.1 Subgroups 1 and 2. 24 sample units shall be taken from production every 6 months and subjected to the applicable tests for their particular subgroup. Permitted failures shall be as specified in table VII.

4.7.1.2 Subgroup 3. A minimum of 25 sample units per style of the highest capacitance value produced shall be selected from the first inspection lot produced during a 6-month period. Permitted failures shall be as specified in MIL-STD-690. The accumulated data shall be used for maintenance and extension of FR qualification.

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

4.7.3 Noncompliance. If a sample unit fails to pass group B inspection, the manufacturer shall notify the qualifying activity and 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 and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed), at the option of the qualifying activity. Group A inspection may be reinstated; however, final acceptance shall be withheld until the group B inspection has shown that corrective action was successful.

TABLE VII. Periodic group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted ^{1/}
<u>Subgroup 1</u> Temperature coefficient limits ^{2/} Immersion	3.13 3.14	4.8.10 4.8.11	12	0
<u>Subgroup 2</u> Humidity, steady state, low voltage	3.15	4.8.12	12	0
<u>Subgroup 3</u> Life	3.16	4.8.13	25	See 4.7.1.2

^{1/} A sample unit having one or more defects shall be charged as a single defective.

^{2/} Need not be repeated if performed on same samples as group A inspection.

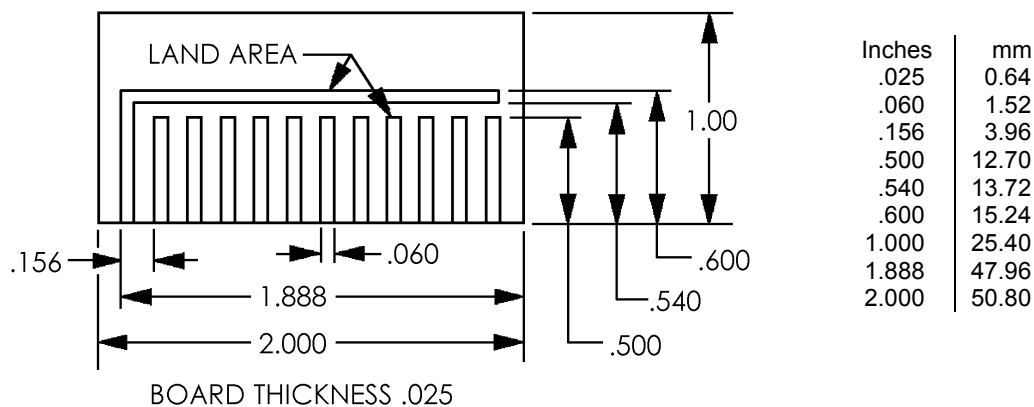
4.8 Methods of examination and test.

4.8.1 Visual and mechanical examination. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, and 3.20).

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4.8.2 Mounting for testing. When it is specified in the test procedure that the capacitors shall be mounted, they shall be mounted on a suitable substrate (for example, 99 percent alumina). The substrate material shall be such that it will not be the cause of, nor contribute to, the failure of any test for which it may be used. The capacitors shall be mounted on the substrate as follows:

- a. A substrate shall be prepared with metallized surface land areas. A typical "tests card" is shown in figure 1.
- b. The capacitors to be tested shall each be attached to one land area by any convenient method (see 1.2.1.6).
- c. The connection to the common land area shall begin with a thermosonic ball bond of a one mil gold wire to the exposed capacitor terminal and end with a stitch bond on the common land area of the substrate.



NOTES:

1. Dimensions are in inches. Metric equivalents are given for general information only.
2. The metallized land areas of the "test card" selected to facilitate testing of the chips shall be of the proper spacing to accommodate the attachment of the applicable chips to the card.

FIGURE 1. Typical "test card".

4.8.3 Thermal shock and voltage conditioning (see 3.6). Capacitors shall be subjected to the tests of 4.8.3.1 and 4.8.3.2.

4.8.3.1 Thermal shock. Capacitors shall be tested in accordance with [method 107 of MIL-STD-202](#). The following details shall apply:

- a. Test condition A, except that in step 3, units shall be tested at 125°C +3°C, -0°C.
- b. Number of cycles: 5 cycles

4.8.3.2 Voltage conditioning (see 3.6). The intent of voltage conditioning is that all parts be exposed to a predetermined test voltage ± 5 percent, for a defined time and temperature. Voltage conditioning is done to help eliminate infant mortality capacitors from the production lot. All parts offered for electrical testing shall be subjected to the voltage conditioning test in 4.8.3.2.1 or 4.8.3.2.2. It shall be verifiable that all parts offered for electrical tests have been exposed to the required voltage conditioning for the required time duration. See [figure 2](#) for a suggested test circuit. An alternate test circuit can be used, provided the notes of [figure 2](#) are followed.

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4.8.3.2.1 Standard voltage conditioning. Voltage conditioning shall consist of applying a minimum of twice the rated voltage to the unit at the maximum rated temperature +4°C, -0°C for 100 +20, -4 hours. After testing, perform measurements of 4.8.3.3.

4.8.3.2.2 Optional voltage conditioning. The manufacturer, with approval from the qualifying activity, may perform an optional voltage conditioning test instead of the standard voltage conditioning tests of 4.8.3.2.1. All conditions of 4.8.3.2.1 apply, with the exception of the voltage applied and the test time. The accelerated condition selected for the optional voltage conditioning shall be used for the duration of the test. At no time shall a combination of standard and optional voltage conditioning be allowed on the same samples. The minimum time duration, T(test) minimum, shall be calculated as follows:

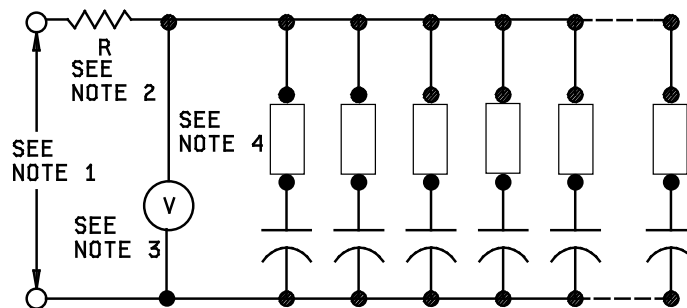
$$T_{\text{test}} (\text{min.}) = \frac{800}{(E_{\text{test}} / E_{\text{rated}})^3}$$

Where: $2 \times E_{\text{rated}} \leq E_{\text{test}} \leq 4 \times E_{\text{rated}}$

E_{test} = Applied voltage

E_{rated} = Rated voltage of the capacitor

4.8.3.3 Measurements after testing. After completion of the test, the units shall be allowed to stabilize at room temperature (+25°C) for a period up to 24 hours. After stabilization at room temperature, the capacitance, dissipation factor, insulation resistance and dielectric withstanding voltage shall be measured as specified in 4.8.4, 4.8.5, 4.8.6, and 4.8.7, respectively.



NOTES:

1. The power supply shall be capable of supplying the required test voltage.
2. The current limiting device shall be a resistor or a fuse. The current shall be limited to no less than 30 milliamperes (mA) and no more than 10 A.
3. There shall be a voltage monitor that will indicate when the applied voltage drops or increases by more than 5 percent, and shut off the test. The resistance of the voltage monitor shall be a minimum of 10X the equivalent resistance of the series resistor and the device under test.
4. Each device under test must have a resistor or fuse in series with it. The value of the resistor shall be such that it does not restrict the power supply's ability to provide the required test voltage to the device under test (± 5 percent).

FIGURE 2. Suggested test circuit.

4.8.4 Capacitance (see 3.7). Unmounted capacitors shall be tested in accordance with [method 305 of MIL-STD-202](#). The following detail and exception shall apply:

- a. Test frequencies: 1 MHz ± 50 Hz for all capacitors less than or equal to 100 pF.
1 kHz ± 50 Hz for all other capacitors.
- b. Test voltage: A root-mean-square potential of 1.0 ± 0.2 volts, when no polarizing voltage is applied.

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4.8.5 Dissipation factor (see 3.8). The dissipation factor shall be measured with a capacitance bridge or other suitable method at the frequency and voltage as specified in 4.8.4. The capacitors shall be unmounted.

4.8.6 Insulation resistance (see 3.9). Unmounted capacitors shall be tested in accordance with [method 302 of MIL-STD-202](#). The following details and exceptions shall apply:

Prior to performing this test, capacitors shall be carefully cleaned to remove any contamination including fingerprints. Care must be taken to maintain cleanliness in test chamber and while making measurements.

- a. Test conditions: Rated voltage as specified (see 3.1) applied through a series resistor sufficient to limit the charging current to a minimum of 30 mA and a maximum of 50 mA.
- b. Special conditions: If a failure occurs at a relative humidity of 50 percent or higher, the insulation resistance may be measured again at a relative humidity of less than 50 percent.
- c. Points of measurement: Between the terminations.

4.8.7 Dielectric withstanding voltage (see 3.10). Unmounted 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: 250 percent of dc rated voltage for 5 seconds ± 1 second.
- b. Points of application of test voltage: Between the capacitor-element terminals.
- c. Limiting value of surge current: 50 mA maximum.
- d. Examination after test: Capacitors shall be examined for evidence of damage and breakdown.

4.8.8 Bond strength (see 3.11). Capacitors shall be tested as specified in [method 2011 of MIL-STD-883](#). The following details shall apply:

- a. Capacitors shall be mounted as specified in 4.8.2.
- b. Test condition D.

4.8.9 Die sheer strength (see 3.12). Capacitors shall be mounted as specified in 4.8.2 and tested as specified in [method 2019 of MIL-STD-883](#), except AuSn eutectic or conductive epoxy shall be used to attach the capacitor.

4.8.10 Temperature coefficient limits (see 3.13). Capacitors shall be tested as specified in 4.8.4 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 D 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. Capacitors shall be kept at each temperature until a temperature equilibrium is attained. These measurements need be performed only on capacitors having a value of 10 pF or greater. Capacitors of less than 10 pF shall be characterized as having the same temperature coefficient limits as those of 10 pF or more manufactured in the same lot.

TABLE VIII. Temperature coefficient limit cycle.

Step	Voltage, dc	Temperature, °C
A	None	+25 \pm 2
B	None	-55 \pm 2
C (reference)	None	+25 \pm 2
D	None	+125 +4, -0

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4.8.11 Immersion (see [3.14](#)). Capacitors shall be tested in accordance with [method 104 of MIL-STD-202](#). The following details shall apply:

- a. Test condition: B.
- b. Examinations and measurements after final cycle: Capacitors shall meet the requirements of [3.14](#).

4.8.12 Humidity, steady state, low voltage (see [3.15](#)). Capacitors shall be tested in accordance with [method 103 of MIL-STD-202](#), condition A. The following details and exceptions shall apply:

NOTE: At no time during test shall voltage greater than 1.55 volts be applied to any capacitor under test.

- a. Initial measurements: Capacitance shall be measured in accordance with [4.8.4](#).
- b. Tests: Capacitors shall be subjected to an environment of +85°C with 85 percent relative humidity for 240 hours minimum. Cycling shall not be performed. A dc potential of 1.3 volts \pm 0.25 volts shall be applied continuously through a 100 kilohm resistor.
- c. Final measurements: On completion of test, remove the capacitors from the chamber and allow 3 hours, 30 minutes, \pm 30 minutes for drying and stabilization at 25°C before performing IR (through a 100 kilohm resistor at 1.3 \pm 0.25 volts) and capacitance in accordance with [4.8.6](#) and [4.8.4](#), respectively. The capacitors shall then be examined for evidence of mechanical damage and obliteration of marking.
- d. Leads may be attached to chip capacitors for mounting and loading purposes. Mechanical loading is acceptable.

4.8.13 Life (at +125°C) (see [3.16](#)). Capacitors shall be tested in accordance with [method 108 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Capacitors shall be mounted as specified in [4.8.2](#).
- b. Test temperature and tolerance: +125°C, +4°C, -0°C.
- c. Operating conditions: Capacitors shall be subjected to 200 percent of rated voltage (see [3.1](#)). The surge current shall not exceed 50 mA. When necessary, a suitable current-limiting resistor may be inserted into the circuit.
- d. Test condition: F (2,000 hours).
- e. Measurements during and after exposure: After 1,000 hours and at the conclusion of this test and while capacitors are still held at +125°C, insulation resistance shall be measured as specified in [4.8.6](#). The capacitors shall then be returned to the inspection conditions specified in 4.3 and shall be visually inspected for evidence of mechanical damage, and capacitance, dissipation factor, and insulation resistance shall be measured as specified in [4.8.4](#), [4.8.5](#), and [4.8.6](#), respectively.
- f. Final measurement: Capacitors shall meet the requirements of [3.16](#).

4.8.14 Fungus (see [3.17](#)). Capacitors shall be tested in accordance with [method 508 of MIL-STD-810](#).

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5. PACKAGING

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

6. NOTES

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

6.1 **Intended use.** These capacitors are primarily designed for use in stripline or microstripline applications, usually at frequencies of 1 GHz and higher. Capacitors covered by this specification are unique due to the fact that they must be able to operate satisfactorily in military systems under the following demanding conditions: Extreme temperatures (-55°C to +125°C) and damp environments. These capacitors also offer established reliability that is verified under a qualification system. Commercial components are not designed to withstand these military conditions.

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. Capacitor marking requirements (see [3.18.2](#) and [3.18.3](#)).
- c. Packaging requirements.

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 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 Defense Supply Center, Columbus, ATTN: DSCC-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 <http://assist.daps.dla.mil>

6.3.1 **Copies of SD-6.** Copies of SD-6, "Provisions Governing Qualification", are available online at <http://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

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

6.5 **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 insulation resistance may vary with humidity and organic contamination of the ceramic chip surfaces. Care should be taken to assure that the capacitors are properly and thoroughly cleaned of organic contamination especially before the insulation resistance test.

6.6 **Barometric pressure test.** These units are not subjected to the barometric pressure test since the likelihood of failure is remote.

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6.7 Subject term (key word) listing.

Capacitance
Microstrip
Stripline

6.8 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 Coatings of Tin).

6.9 Environmentally preferable material. 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 at <http://www.epa.gov/osw/hazard/wastemin/priority.htm>. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see [Section 3](#))."

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.

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APPENDIX A

PROCEDURE FOR QUALIFICATION INSPECTION

A.1 SCOPE

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

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 of the size required in the qualification inspection table, of the largest case size, highest capacitance value in each voltage rating, in each temperature coefficient limits for which qualification is sought shall be submitted.

A.4 EXTENT OF QUALIFICATION

A.4.1 Qualification of capacitance range. 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. Temperature coefficient qualification will be limited to that submitted. The PINs in table A-I are the highest capacitance values in each temperature coefficient and each voltage.

TABLE A-I. Combined submission.

Style	PIN ^{1/}	Number of units ^{2/}	Rated voltage
CPCR01	M49464F01100JAKAHM	67	16
CPCR01	M49464F019R1BBKAHM	67	25
CPCR01	M49464F016R2BCKAHM	67	50
CPCR01	M49464F013R0BDKAHM	67	100
CPCR01	M49464G01360JAKAHM	67	16
CPCR01	M49464G01300JBKAHM	67	25
CPCR01	M49464G01200JCKAHM	67	50
CPCR01	M49464G01100JDKAHM	67	100
CPCR01	M49464W01102KAKAHM	67	16
CPCR01	M49464W01681KBKAHM	67	25
CPCR01	M49464W01621KCKAHM	67	50
CPCR01	M49464W01301KDKAHM	67	100

^{1/} 61 units will be submitted for qualification if certification is given for fungus resistance.

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Custodians:

Army - CR
Navy - EC
Air Force - 85
DLA - CC
NASA - NA

Preparing activity:

DLA - CC

(Project 5910-2009-029)

Review activities:

Army - AT, AV, MI
Navy - AS, MC
Air Force - 19, 99

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