

MILITARY SPECIFICATION

CAPACITORS, CHIP, SINGLE LAYER, FIXED, PARALLEL PLATE,
CERAMIC DIELECTRIC, ESTABLISHED RELIABILITY, GENERAL SPECIFICATION FOR

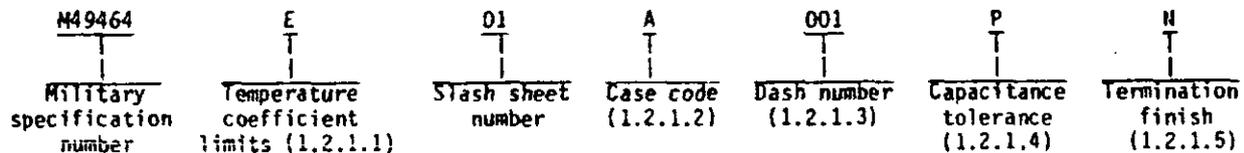
This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers established reliability, 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 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 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.

1.2 Classification.

1.2.1 Military part number. Capacitors specified herein (see 3.1) shall be identified by a military part number which shall consist of the basic number of the military specification sheet followed by a series of coded characters. Each military specification sheet covers a different capacitor style. The coded number shall provide information concerning the capacitor's temperature coefficient, slash sheet number, case code, dash number, capacitance tolerance and termination material. The military part number shall be in the following form as indicated:



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.

TABLE I. Temperature coefficient limits.

Symbol	ppm/°C	Class	Symbol	ppm/°C	Class
E	+90 ±30	1A	P	-1500 ±500	1B
F	0 ±15	1A	R	-2200 ±600	1B
G	0 ±30	1A	T	-3300 ±1000	1C
H	-80 ±60	1A	U	-3900 ±1000	1C
J	-150 ±60	1B	V	-4700 ±1000	1C
K	-220 ±60	1B	W	-5600 ±1000	1C
L	-330 ±150	1B	X	±15%	2
M	-470 ±150	1B	Y	±25%	2
N	-750 ±250	1B	Z	+22 -82%	3 <u>1/</u>

1/ Temperature coefficient measured between +10°C and +85°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Laboratory Command, ATTN: SLCET-R-S, Fort Monmouth, NJ 07703-5302 by using the self addressed Standardization Document Improvement proposal (DD Form 1426) appearing at the end of this document or by letter.

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

1.2.1.3 Dash number. The dash number shall represent a specific capacitance value, voltage and failure rate level (see table II and 3.1).

TABLE II. Failure rate level (established at 90 percent confidence).

Symbol	Failure rate level (% per 1,000 hours)
M	1.0
P	0.1
R	0.01
S	0.001

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

TABLE III. Capacitance tolerance.

Symbol	Capacitance tolerance
P	±.01 pF
A	±.05 pF
B	±.10 pF
C	±.25 pF
D	±.50 pF
F	± 1 percent
G	± 2 percent
J	± 5 percent
K	± 10 percent
M	± 20 percent
V	-0 +100 percent
Z	-20 +80 percent

1.2.1.5 Termination finish. The nickel-gold termination finish is identified by the single letter "M", see 3.5.2.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder, Tin Alloy, Tin-Lead Alloy, and Lead Alloy.

MILITARY

MIL-C-39028 - Capacitors, Packaging of.
MIL-C-49464/1 - Capacitors, Chip, Single Layer, Fixed Unencapsulated, Ceramic Dielectric, Established Reliability, Style CPCRO1 (High Frequency).

STANDARDS

MILITARY

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-690	-	Failure Rate Sampling Plans and Procedures.
MIL-STD-790	-	Reliability Assurance Program for Electronic Parts Specifications.
MIL-STD-810	-	Environmental Test Methods.
MIL-STD-883	-	Test Methods and Procedures for Microelectronics.

(Copies of the specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede 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 sheet, the latter shall govern.

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

3.3 Reliability. Reliability of capacitors furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790 and MIL-STD-690 with details specified in 4.1.1, 4.4.4, and 4.5.

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 guaranty of the acceptance of the finished product.

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

3.5.1 Body structure. The body shall be a single ceramic plate which shall meet the requirements specified herein (see 3.1).

3.5.2 Terminations. The terminations shall be a minimum of 50 microinches of gold over a suitable barrier base metal.

3.6 Voltage conditioning. When tested as specified in 4.7.2, capacitors shall meet the requirements of 3.6.1 through 3.6.5 inclusive.

3.6.1 Insulation resistance. Insulation resistance at 125°C shall be as specified in 3.9.

3.6.2 Capacitance. Capacitance at 25°C shall be as specified in 3.7.

3.6.3 Dissipation factor. Dissipation factor at 25°C shall be as specified in 3.8.

3.6.4 Insulation resistance. Insulation resistance at 25°C shall be as specified in 3.9.

3.6.5 Dielectric withstanding voltage. Dielectric withstanding voltage at 25°C shall be as specified in 3.10.

3.7 Capacitance. When measured as specified in 4.7.3, the capacitance shall be within the applicable tolerance specified, see 3.1.

3.8 Dissipation factor. When measured as specified in 4.7.4, the dissipation factor for capacitors of 4.7 pF or greater shall not exceed:

- .15 percent for class 1A characteristics
- .25 percent for class 1B characteristics
- 1.5 percent for class 1C characteristics
- 2.5 percent for class 2 characteristics
- 4.0 percent for class 3 characteristics

3.9 Insulation resistance. When measured as specified in 4.7.5, the insulation resistance at 25°C shall be not less than:

- 10⁶ megohms for classes 1A, 1B, and 1C
- 10⁵ megohms for classes 2 and 3

At 125°C it shall be not less than:

- 10⁵ megohms for classes 1A, 1B, and 1C
- 10⁴ megohms for classes 2 and 3

3.10 Dielectric withstanding voltage. When capacitors are tested as specified in 4.7.6, there shall be no evidence of breakdown or visible evidence of arcing or damage.

3.11 Solderability. Capacitors shall be tested as specified in 4.7.8, except Sn62 solder, in accordance with QQ-S-571, shall be used in lieu of Sn60. The immersed metallized surface shall be 95 percent covered with a smooth solder coating. The remaining 5 percent of the surface may contain small pinholes or rough spots; however, these shall not be concentrated in one area.

3.12 Bond strength. When tested as specified in 4.7.9, 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.

3.13 Die shear strength. When tested as specified in 4.7.10, parts shall not shear from their mountings within the gram force limits specified.

3.14 Temperature coefficient limits. When capacitors are tested as specified in 4.7.11, the capacitance change shall not exceed the applicable limits specified in table I.

NOTE: For negative temperature characteristics P, R, T, U, V, and W, the negative tolerance from +25°C to -55°C shall be calculated according to the formula: Negative tolerance (ppm/°C) = -36 - (1.22 x specified positive tolerance) + (0.22 x nominal temperature coefficient).

3.15 Thermal shock and immersion. When tested as specified in 4.7.12, capacitors shall meet the following requirements of 3.15.1 through 3.15.5 inclusive.

3.15.1 Visual inspection. There shall be no mechanical damage.

3.15.2 Dielectric withstanding voltage. Dielectric withstanding voltage shall be as specified in 3.10.

3.15.3 Insulation resistance. Insulation resistance at 25°C shall be not less than 30 percent of the initial requirement (see 3.9).

3.15.4 Capacitance change.

- a. Class 1A and 1B characteristics shall change not more than 0.5 percent of the nominal value or 0.5 pF, whichever is greater, from the initial measured value.
- b. Class 1C, 2, and 3 shall change not more than ± 10 percent from the initial measured value.

3.15.5 Dissipation factor. Dissipation factor shall be as specified in 3.8.

3.16 Resistance to soldering heat. When tested as specified in 4.7.13, capacitors shall meet the following requirements of 3.16.1 and 3.16.2.

3.16.1 Visual inspection. There shall be no evidence of mechanical damage.

3.16.2 Capacitance change.

- a. Classes 1A and 1B characteristics shall change not more than 0.5 percent of the nominal value or 0.5 pF, whichever is greater, from the initial measured value.
- b. Classes 1C, 2, and 3 shall change not more than ± 10 percent from the initial measured value.

3.17 Low voltage humidity. When tested as specified in 4.7.14, capacitors shall meet the following requirements of 3.17.1 through 3.17.4 inclusive.

3.17.1 Visual inspection. There shall be no mechanical damage.

3.17.2 Dielectric withstanding voltage. Dielectric withstanding voltage shall be as specified in 3.10.

3.17.3 Insulation resistance. Insulation resistance at 25°C shall be not less than 30 percent of initial requirement (see 3.9).

3.17.4 Capacitance change.

- a. Classes 1A and 1B characteristics shall change not more than 0.5 percent of the nominal value or 0.5 pF, whichever is greater, from the initial measured value.
- b. Classes 1C, 2, and 3 shall change not more than ± 10 percent from the initial measured value.

3.18 Life (at 125°C). When tested as specified in 4.7.15, capacitors shall meet the following requirements of 3.18.1 through 3.18.4 inclusive.

3.18.1 Visual inspection. There shall be no mechanical damage.

3.18.2 Insulation resistance. Insulation resistance at 25°C and 125°C shall be not less than 30 percent of initial requirement.

3.18.3 Capacitance change.

- a. Classes 1A and 1B characteristics shall change not more than 2.0 percent of the nominal value or 0.5 pF, whichever is greater, from the initial measured value.
- b. Classes 1C, 2, and 3 shall change not more than ± 10 percent from the initial measured value.

3.18.4 Dissipation factor. Dissipation factor shall be as specified in 3.8.

3.19 Fungus. The manufacturer shall certify that all materials are fungus resistant or shall perform the test specified in 4.7.16. When capacitors are tested as specified in 4.7.16, inspection shall not disclose evidence of fungus growth or damage.

3.20 Marking (all styles). There shall be no marking on the capacitors. Capacitor packaging containers shall be marked with the part number, capacitance, capacitance tolerance, voltage, 'JAN' brand, and the Commercial and Government Entity (CAGE) code.

3.20.1 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 military 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" or "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 or 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 or associated detail specifications, the manufacturer shall remove 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 No. 504,860 for the certification mark "JAN".

3.21 Workmanship. Capacitors shall be so processed that when inspected under 20X to 40X magnification, they shall be uniform in quality and shall be free from pits, cracks, rough edges, adhered foreign material and other defects which will affect life or serviceability. The capacitors shall exhibit no demetalization (lift-off, blisters, or roll back) or voids or scratches on the electrodes which expose the dielectric over more than 5 percent of the area.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Reliability assurance program. A reliability assurance program shall be established and maintained in accordance with MIL-STD-790. Evidence of such compliances shall be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification.

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

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (see 4.5).
- c. Quality conformance inspection (see 4.6).

4.3 Inspection conditions.

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

4.3.2 Method.

4.3.2.1 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at 25 C 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 applicable applied 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, on sample units produced with equipment and procedures normally used in production.

4.4.1 Sample size. The number of sample units comprising a sample of capacitors to be submitted for qualification inspection shall be as specified in table IV. The sample shall be taken from a production run and shall be produced with equipment and procedures normally used in production. Each separate class shall be qualified separately e.g., 1A, 1B, etc.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in table IV, in the order shown. All sample units shall be subjected to the group I tests. These sample units shall then be divided as shown in table IV for groups II to VI inclusive, and subjected to the tests for their particular group.

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

4.4.4 Failure rate (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 Failure Rate Sampling Plan-90 (FRSP) shall apply. Sample units shall be subjected to the qualification inspection specified in group I, table IV prior to being tested as specified in group V, table IV (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, data from 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 (see 4.5f.).

4.5 Verification of qualification. Every 6 months the manufacturer shall compile a summary of the results of quality conformance inspections and extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity within 30 days after the end of the reporting period as the basis of continued qualification approval. In addition, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain the qualified FR level, or the group C inspection data indicates failure of the qualified product to meet the requirements of this specification. Continuation shall be based on evidence that over the 6 month period the following has been met:

- a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item.
- c. The specification requirements for the item have not been amended so as to affect the character of the item.
- d. Lot rejection for group A or B inspection does not exceed 10 percent or one lot, whichever is greater.
- e. The requirements of group C inspection are met.
- f. The records of all tests combined substantiate the "M" (1.0 percent) or "P" (0.1 percent) FR level has been maintained or that the manufacturer continued to meet the "R" (0.01 percent) or "S" (0.001 percent) FR level for which qualified, although the total component hours of testing does not, as yet, meet the requirements of 4.4.4c.

If group C test requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, the manufacturer shall submit a verification of qualification report within 30 days after completion of the group C testing. In this case, the qualifying activity shall be notified within the time the original verification of qualification report was due. All reports shall be certified by the responsible company official. The qualifying activity shall be contacted for a report format.

4.5.1 Records. Maintenance of life test and FR level records shall be as specified in MIL-STD-690.

4.6 Quality conformance inspection.

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

4.6.1.1 Inspection lot. An inspection lot shall consist of all capacitors of the same voltage-temperature characteristics, produced under essentially the same conditions with the same basic materials, and offered for inspection at one time. The capacitance values and voltages produced shall be represented in the lot in approximately the ratio of production.

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

4.6.1.2.1 Sampling plan. Subgroup 1 tests (except insulation resistance at elevated temperature) shall be performed on each capacitor offered for acceptance. If during the 100 percent inspection of subgroup 1, screening requires that over 8 percent of the capacitors be discarded, the entire lot shall be rejected. Subgroup 1 conditioning shall not be repeated for the purpose of reinspection. Statistical sampling and inspection for subgroup 1, insulation resistance at 125°C, and subgroup 2 shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality levels (AQL) and limiting quality (LQ) where $P_a = 10$ percent, shall be as specified in table V. Major and minor defects shall be as defined in MIL-STD-105.

4.6.1.2.1.1 Manufacturer's production inspection. If the manufacturer performs tests equal to or more stringent than those specified in subgroup 1, table V, as the final step of the 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 inspection shall be granted by the qualifying activity only. The following criteria shall be met:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1. Test conditions shall be equal to or more stringent than those specified for subgroup 1 tests.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.
- c. The parameters measured and the failure criteria shall be the same or more stringent than those specified herein.
- d. The lot rejection criteria is the same or more stringent than that specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in his production tests which are a substitute for subgroup 1 tests. This data shall be provided as part of the evaluation required for MIL-STD-790. The manufacturer shall also make available to the Government all records of all detail test data resulting from production test, which are a substitute for subgroup 1 tests.
- f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

4.6.1.2.2 Rejected lots. Lots rejected by the group A inspection shall be segregated from new lots and those lots that have passed inspection. Lots rejected because of failures in subgroup 2 may be offered for acceptance only if the manufacturer inspects all units in the lot for those quality characteristics found defective in the sample and, after removing all defective units found, reinspects the lot using the tightened inspection procedure of MIL-STD-105. Resubmitted lots shall be kept separate from new lots, and shall be clearly identified as resubmitted lots.

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

TABLE IV. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted
<u>Group I</u>				
Voltage conditioning	3.6	4.7.2	85 <u>2/</u>	0
Insulation resistance (125°C) <u>1/</u>	3.9	4.7.5		
Capacitance <u>1/</u>	3.7	4.7.3		
Dissipation factor <u>1/</u>	3.8	4.7.4		
Insulation resistance <u>1/</u>	3.9	4.7.5		
Dielectric withstanding voltage <u>1/</u>	3.10	4.7.6		
Visual and mechanical inspection	3.1, 3.4, 3.5, 3.21	4.7.7		
<u>Group II</u>				
Solderability	3.11	4.7.8	6	} 1 1 } 1
Bond strength	3.12	4.7.9	6	
Die shear strength	3.13	4.7.10	6	
<u>Group III</u>				
Temperature coefficient limits	3.14	4.7.11	} 18	} 1 } 1
Thermal shock and immersion	3.15	4.7.12		
<u>Group IV</u>				
Resistance to soldering heat	3.16	4.7.13	} 18	} 1
Low voltage humidity	3.17	4.7.14		
<u>Group V</u>				
Life	3.18	4.7.15	25	1
<u>Group VI</u>				
Fungus <u>2/</u>	3.19	4.7.16	6	0

1/ Performed as part of the voltage conditioning test.

2/ Only 79 samples are needed if certification is given for fungus (see 3.19).

TABLE V. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	AQL (percent defective) and LQ (limiting quality percent defective)	
<u>Subgroup 1</u>				
Voltage conditioning	3.6	4.7.2	Not applicable (100% sample)	
Insulation resistance ^{1/} (125°C)	3.9	4.7.5	0.65 (AQL), 4.8 (LQ)	
Capacitance ^{1/}	3.7	4.7.3	Not applicable (100% sample)	
Dissipation factor ^{1/}	3.8	4.7.4		
Insulation resistance ^{1/}	3.9	4.7.5		
Dielectric withstanding voltage ^{1/}	3.10	4.7.6		
<u>Subgroup 2</u>				
Visual and mechanical inspection	3.1, 3.4, 3.5, 3.21	4.7.7	Major	Minor
			1.0 (AQL) 7.6 (LQ)	4.0 (AQL) 18.0 (LQ)

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

TABLE VI. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
<u>Subgroup 1</u>		
Solderability	3.11	4.7.8
Bond strength	3.12	4.7.9
Die shear strength	3.13	4.7.10
<u>Subgroup 2</u>		
Temperature coefficient limits	3.14	4.7.11

4.6.1.3.1 Sampling plan. The sampling plan for subgroup 1 shall be in accordance with MIL-STD-105 for special inspection level S-4. The AQL shall be 1.0 percent defective. For subgroup 2, 18 sample units shall be subjected to the test; there shall be no failures.

4.6.1.3.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

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

4.6.2 Periodic inspection. Periodic inspection shall consist of group C inspection. Except where the results of this inspection show noncompliance with the applicable requirements (see 4.6.2.1.3), delivery of products which have passed groups A and B inspections shall not be delayed pending the results of these periodic inspections.

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

4.6.2.1.1 Sampling plan (subgroups 1 through 3 (all FR levels)). Sixty one sample units of each temperature coefficient limit shall be selected from the first lot produced and thereafter from each production of 500,000 units, or once every 6 months, whichever occurs first.

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

4.6.2.1.3 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 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 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 which the original sample failed, at the option of the qualifying activity). Groups A and B inspection may be reinstated; however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

TABLE VII. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted
<u>Subgroup 1</u>				
Temperature coefficient limits 1/	3.14	4.7.11	} 18	} 1
Thermal shock and immersion	3.15	4.7.12		
<u>Subgroup 2</u>				
Resistance to soldering heat	3.16	4.7.13	} 18	} 1
Low voltage humidity	3.17	4.7.14		
<u>Subgroup 3</u>				
Life	3.18	4.7.15	25	1

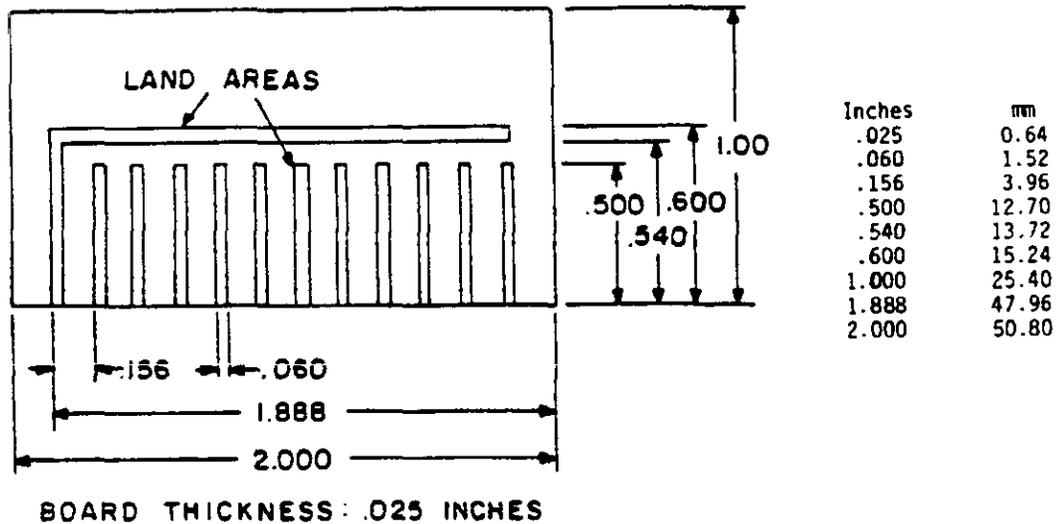
1/ Need not be repeated if performed on same samples as group B inspection.

4.6.3 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-C-39028.

4.7 Methods of inspection.

4.7.1 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 (e.g., 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 substrate shall be prepared with metallized surface land areas. A typical "test card" is shown on figure 1.
- The capacitors to be tested shall each be soldered to one land area by any convenient method.
- 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:

- Dimensions are in inches.
- Metric equivalents are given for general information only.
- The metallized land areas of the "test card" selected, to facilitate the 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".

4.7.1.1 Test rack. When specified, the substrate shall be mounted on a test rack which shall be so designed as to permit readout for electrical parameters at 25°C and 125°C and to monitor each chip under test for failure. This will insure uniform and uninterrupted voltage and heat stresses.

4.7.2 Voltage conditioning (see 3.6). Twice the rated voltage shall be applied to the unit at the maximum rated temperature +4°C -0°C for 100 ±4 hours. After completion of the exposure period, the insulation resistance shall be measured at 125°C as specified in 4.7.5. After allowing the unit to stabilize at room temperature, the capacitance, dissipation factor, insulation resistance, and dielectric withstanding voltage shall be measured as specified in 4.7.3, 4.7.4, 4.7.5, and 4.7.6 respectively.

4.7.3 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 frequency: 1 MHz \pm 50 kHz.
- b. Test voltage: 1.0 \pm 0.2 volt rms.

NOTE (for classes 2 and 3 characteristics only): Following a dielectric withstanding voltage or insulation resistance test, capacitance may be measured after holding the capacitor for a period of time not to exceed 24 hours.

4.7.4 Dissipation factor (see 3.8). Dissipation factor shall be measured with a bridge or other suitable equipment at the frequency and voltage specified in 4.7.3. The capacitors shall be unmounted.

4.7.5 Insulation resistance (see 3.9). Unmounted capacitors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

PRECAUTIONARY NOTE: 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 maximum of 50 milliamperes.
- b. Special conditions: If a failure occurs at a relative humidity above 50 percent, the insulation resistance may be measured again at any relative humidity less than 50 percent.
- c. Points of measurement: Between the terminations.

4.7.6 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 rated voltage.
- b. Duration of application of test voltage: 2 seconds minimum.
- c. Points of application of test voltage: Between the capacitor element terminals.
- d. Limiting value of the surge current shall not exceed 50 mA.
- e. Inspection after test: Capacitors shall be inspected for evidence of damage and breakdown.

4.7.7 Visual and mechanical inspection. Capacitors shall be inspected 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 3.21).

4.7.8 Solderability (see 3.11). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details and exceptions shall apply:

- a. The terminals shall be immersed to a depth of .020 \pm .010, -.000 inch (0.51 \pm 0.25, -0.00 mm).
- b. Inspections of terminations shall be in accordance with 3.11. In case of dispute, the percent coverage with pinholes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.

4.7.9 Bond strength (see 3.12). 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 4.7.1.
- b. Test condition D.

4.7.10 Die shear strength (see 3.13). Capacitors shall be mounted as specified in 4.7.1 and tested as specified in method 2019 of MIL-STD-883.

4.7.11 Temperature coefficient limits (see 3.14). Capacitors shall be tested as specified in 4.7.3 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	Temperature
	Volts, dc	°C
A	None	+25 ±2
B	None	-55 ±2
C (reference)	None	+25 ±2
D	None	+125 ±4 -0

4.7.12 Thermal shock and immersion (see 3.15).

4.7.12.1 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, sample units shall be tested at 125°C.
- b. Minimum time (for steps 1 and 3) shall be 1/4 hour.
- c. Measurements before and after cycling: not applicable.

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

- a. Test condition B.
- b. Inspections and measurements after final cycle: Capacitors shall meet the requirements of 3.15.

4.7.13 Resistance to soldering heat (see 3.16). Capacitors shall be mounted as specified in 4.7.1 and tested in accordance with method 210 of MIL-STD-202, test Condition C. Capacitors shall be allowed to cool 10 minutes minimum and up to 24 hours maximum prior to measurement. After mounting, capacitors shall meet the requirements of 3.16.

4.7.14 Low voltage humidity (see 3.17). Capacitors shall be mounted as specified in 4.7.1 and 4.7.1.1 and placed in a test chamber at 85°C ±2°C and 85 percent ±5 percent relative humidity for 240 hours. During the entire test, a bias voltage of 1.5 volts dc ±10 percent will be applied to the capacitors.

4.7.15 Life (at 125°C) (see 3.18). 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 4.7.1 and 4.7.1.1.
- 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 shall 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 the capacitors are still held at 125°C, insulation resistance shall be measured as specified in 4.7.5. The capacitors shall then be returned to the inspection conditions specified in 4.3 and shall be visually inspected for evidence of mechanical damage; capacitance, dissipation factor, and insulation resistance shall be measured as specified in 4.7.3, 4.7.4, and 4.7.5, respectively.

f. Final measurement: Capacitors shall meet the requirements of 3.18.

4.7.16 Fungus, when applicable (see 3.19). Capacitors shall be tested in accordance with method 508 of MIL-STD-810.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-39028.

6. NOTES

6.1 Intended use. Single plate ceramic capacitors are intended for stripline or microstrip applications, usually at frequencies of 1 GHz and higher.

6.2 Ordering data. Acquisition documents should specify the following:

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

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List (QPL 49464), 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the US Army Laboratory Command, ATTN: SLCET-R-S, Fort Monmouth, New Jersey 07703-5302; however information pertaining to qualification of products may be obtained from Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45444.

6.4 Miscellaneous notes.

6.4.1 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.

6.4.2 Barometric pressure test. These units are not subject to the barometric pressure test since the likelihood of their failure is remote.

6.5 Subject term (key word) listing.

Capacitor
Ceramic dielectric
Chip
Microstrip
Parallel plate
Single layer
Stripline

6.6 Substitutability by failure rate levels. Substitutability for failure rate levels shall be as follows:

<u>Failure rate level</u>	<u>Will replace failure rate level</u>
S	R, P, M
R	P, M
P	M
M	

6.7 Substitutability by capacitance tolerance. Substitutability for capacitance tolerance shall be as follows:

<u>Temperature coefficient</u>	<u>Capacitance tolerance</u>	<u>Will replace capacitance tolerance</u>
E F G H	< 5 pF	P
		A
		B
		C
J K L M N P R	≥ 5 pF	D
		F
		G
		J
T U V W	< 10 pF	K
		C
		D
X Y	≥ 10 pF	G
		J
		K
		M
Z		H
		J
		K
		M
		A, B, C, D
		B, C, D
		C, D
		D
		G, J, K
		J, K
		K
		D
		J, K, M
		K, M
		M
		D
		K, M
		M
		K, M
		M
		V, Z
		Z

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

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

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. SUBMISSION

30.1 Samples. A sample of 85 units consisting of the smallest and largest case sizes, highest capacitance value in each voltage rating, in each rated temperature coefficient limits for which qualification is sought, shall be submitted (see table IX).

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

30.3 Certification of material. When submitting samples for qualification, the contractor shall submit certification, in duplicate, that the materials used in the components are in accordance with the applicable specification requirements.

30.4 Description of items. The supplier shall submit a detailed description of the capacitors being submitted for inspection, including body, electrode material, terminals, etc.

40. EXTENT OF QUALIFICATION

40.1 Qualification of voltage rating. Voltage rating qualification will be restricted to those submitted. Each temperature coefficient limit shall be qualified at the highest standard capacitance value listed.

TABLE IX. Combined submission.

Style	Part number M49464	Number of units	Rated voltage
CPCRO1	E01A007PN	85	50
"	F01A006PN	"	"
"	G01A009PN	"	"
"	H01A007PN	"	"
"	J01A008CN	"	"
"	K01A008CN	"	"
"	L01A009CN	"	"
"	M01A009CN	"	"
"	N01A012CN	"	"
"	P01A015CN	"	"
"	R01A021CN	"	"
"	T01A029CN	"	"
"	U01A037CN	"	"
"	V01A031CN	"	"
"	W01A039CN	"	"
"	X01A047JN	"	"
"	Y01A049JN	"	"
"	Z01A061MN	"	"

APPENDIX

TABLE IX. Combined submission - Continued.

Style	Part number M49464	Number of units	Rated voltage
CPCR01	E01J039JN	85	50
"	F01J037JN	"	"
"	G01J051JN	"	"
"	H01J045JN	"	"
"	J01J047JN	"	"
"	K01J049JN	"	"
"	L01J051JN	"	"
"	M01J053JN	"	"
"	N01J057JN	"	"
"	P01J061JN	"	"
"	R01J064JN	"	"
"	T01J066JN	"	"
"	U01J070JN	"	"
"	V01J068JN	"	"
"	W01J072JN	"	"
"	X01J072JN	"	"
"	Y01J072JN	"	"
"	Z01J072JN	"	"
"	E01A079PN	"	100
"	F01A078PN	"	"
"	G01A081PN	"	"
"	H01A079PN	"	"
"	J01A080CN	"	"
"	K01A080CN	"	"
"	L01A081CN	"	"
"	M01A081CN	"	"
"	N01A084CN	"	"
"	P01A087CN	"	"
"	R01A093CN	"	"
"	T01A101CN	"	"
"	U01A108CN	"	"
"	V01A103CN	"	"
"	W01A111CN	"	"
"	X01A119JN	"	"
"	Y01A121JN	"	"
"	Z01A133JN	"	"
"	E01J111JN	"	"
"	F01J109JN	"	"
"	G01J123JN	"	"
"	H01J117JN	"	"
"	J01J119JN	"	"
"	K01J121JN	"	"
"	L01J123JN	"	"
"	M01J125JN	"	"
"	N01J128JN	"	"
"	P01-133JN	"	"
"	R01J137JN	"	"
"	T01J141JN	"	"
"	U01J148JN	"	"
"	V01J145JN	"	"
"	W01J152JN	"	"
"	X01J155JN	"	"
"	Y01J156JN	"	"
"	Z01A158JN	"	"

CONCLUDING MATERIAL

Custodians:

Army - ER
Navy - EC
Air Force - 85
NASA - NA

Review activities:

Navy - AS
Air Force - 17, 99
DLA - ES

User activities:

Navy - MC, SH
Air Force - 11, 19

Preparing activity:

Army - ER

Agent:

DLA - ES

(Project 5910-1558)

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1. DOCUMENT NUMBER

MIL-C-49464

2. DOCUMENT TITLE CAPACITORS, CHIP, SINGLE LAYER, FIXED, PARALLEL
PLATE, CERAMIC DIELECTRIC, ER, GENERAL SPECIFICATION FOR

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

VENDOR

USER

MANUFACTURER

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a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

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7a. NAME OF SUBMITTER (Last, First, MI) - Optional

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