

INCH-POUND

MIL-PRF-11693D
w/Amendment 1
18 May 2004
SUPERSEDING
MIL-PRF-11693D
9 August 2001

PERFORMANCE SPECIFICATION

CAPACITORS, FEED THROUGH, RADIO-INTERFERENCE REDUCTION,
DC (HERMETICALLY SEALED IN METAL CASES),
ESTABLISHED AND NON-ESTABLISHED RELIABILITY
GENERAL SPECIFICATION FOR

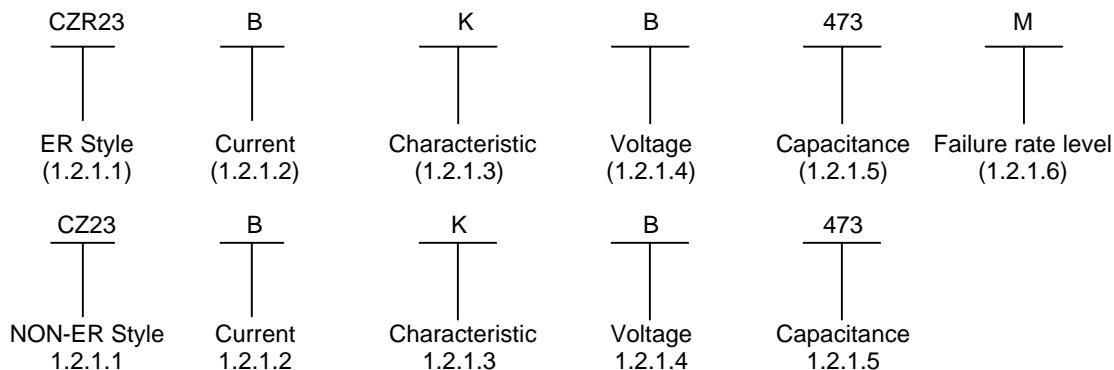
This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability (ER) and non-ER capacitors designed for operation with direct current (dc), paper, paper plastic, and plastic (extended foil) dielectric, radio-interference-reduction, feed-through capacitors, hermetically sealed in metal cases (see 6.6.2), for use primarily in broadband, radio-interference suppression application. Capacitors meeting the established reliability requirements specified herein have a maximum failure rate of 1.0 percent per 1,000 hours. This failure rate is established with a 90-percent confidence limit based on the life test parameters specified and are maintained at a 10-percent producer's risk. An acceleration factor of 5:1 has been used to relate the life test data obtained at 140 percent of rated dc voltage at the applicable high test temperature to the rated voltage at the applicable high test temperature.

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). The PIN is in the following form, and as specified (see 3.1 and 6.2):



*

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, DSCC-VAT, Post Office Box 3990, Columbus, OH 43216-5000 or e-mailed to capacitorfilter@dsc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

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1.2.1.1 Style. The style is identified by either the three-letter symbol "CZR" or the two-letter symbol "CZ" followed by a two-digit number. The letters identify dc, radio-interference reduction feed through capacitors, hermetically sealed in metal cases. The symbol "CZR" identifies established reliability (ER) capacitors; the symbol "CZ" identifies capacitors for which no specific reliability requirements are specified (non-ER). The first digit following the letter symbols identifies the general shape of the case, and the second digit identifies specific details other than case size. Each style designation may include a family of case sizes.

1.2.1.2 Current. The current rating is identified by a single letter in accordance with table I.

TABLE I. Current rating.

| Symbol | Current rating (dc amperes) |
|--------|-----------------------------|
| B | 10 |

1.2.1.3 Characteristic. The characteristic is identified by a single letter in accordance with table II.

TABLE II. Characteristic.

| | Values for characteristics | |
|--|----------------------------|----------|
| | K | E |
| High ambient test temperature, degrees Celsius $\pm 3^{\circ}\text{C}$ | 125 | 85 |
| Low ambient test temperature, degrees Celsius $\pm 3^{\circ}\text{C}$ | -55 | -55 |
| Life-test voltage (see 4.7.19), in percent of rated dc voltage rating | 140 | 140 |
| Capacitance tolerance (percent) | ± 10 | ± 10 |

1.2.1.4 Voltage. The voltage rating is identified by a single letter in accordance with table III.

TABLE III. Voltage rating.

| Symbol | Voltage rating (Volts, dc) |
|--------|----------------------------|
| B | 100 |
| C | 200 |
| E | 400 |
| F | 600 |

1.2.1.5 Capacitance. The nominal capacitance value expressed in picofarad (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.

1.2.1.6 Failure rate level. The failure rate level of 1.0 percent per 1,000 hours is identified by a symbol M, and is based on operation at rated working voltage and maximum rated temperature.

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

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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-11693/7 - Capacitors, Feed Through, Radio-Interference Reduction, DC (Hermetically Sealed in Metal Cases), Established and Non-Established Reliability, Styles CZ23, CZ24, CZR23 and CZR24.

FEDERAL STANDARDS

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

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202 - Test Method Standard Electronic and Electrical Component Parts.
MIL-STD-220 - Method of Insertion Loss Measurement.
MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
MIL-STD-790 - Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.

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

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL Z540.1 - Calibration Laboratories and Measuring and Test Equipment, General Requirements for.

- * (Copies of this document may be ordered online at www.ncsli.org or from NCSL International, 1800 30th Street, Suite 305, Boulder, CO 80701-1026)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D92 - Flash and Fire Points by Cleveland Open Cup. (DoD adopted).

- * (Copies of this document may be ordered online at www.astm.org or from the American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103.)

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA-554-1 - Assessment of Average Outgoing Quality Levels in Parts Per Million (ppm). (DoD adopted).
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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INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)

ISO 10012-1 - Quality Assurance Requirements for Measuring Equipment, Part 1: Meteorological Confirmation System for Measuring Equipment.

* (Copies of this document may be ordered online at <http://webstore.ansi.org/> or from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036-0350)

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

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern. (see 6.2)

3.2 Qualification. Capacitors furnished under this specification shall be products that are 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 4.4 have been met and are being maintained. Authorized distributors that are approved to MIL-STD-790 distributor requirements by the QPL manufacturers are listed in the QPL.

3.3 QPL system. The manufacturer shall establish and maintain an internal documentation system for qualified products 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) and Part Per Million (PPM) system that meets the requirements of 3.3.1 and 3.3.2, respectively. The following MIL-STD-790 exceptions are allowed:

a. Under 'Description of production processes and controls', the procedure for identification of each production lot shall include only 'the manufacturer shall as a minimum be able to identify the time period during which the final production operation was performed on each item of product prior to final test. The date or lot code marked on each part shall be identified to a production lot.'

b. 'Traceability' of materials shall not apply.

3.3.1 SPC system. As part of the overall MIL-STD-790 QPL system, the manufacturer shall establish a SPC system which meets the requirements of EIA-557. Typical manufacturing processes for application of a SPC include pre-assembly, assembly, encapsulation, and packaging.

3.3.2 PPM system. As part of the overall MIL-STD-790 QPL system, the manufacturer shall establish a PPM system for assessing the average outgoing quality of lots in accordance with EIA-554-1. Data exclusion, in accordance with EIA-554-1, may be used with approval of the qualifying activity. The PPM system shall identify the PPM rate at the end of each month and shall be based on a six month moving average.

3.4 Materials. The 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.

3.4.1 Impregnating and filling compounds. Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor element and the case (see 3.5.1). The compound either in the state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitor. For liquid-filled capacitors, the same material shall be used for impregnating as is used for filling.

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

3.5.1 Case. Each capacitor shall be enclosed in a hermetically sealed metal case that will prevent leakage of the impregnant or filling compound, and will protect the capacitor element from moisture and mechanical damage under all test conditions specified herein.

3.5.2 Finish. All exposed metal surfaces shall be suitably protected against corrosion by plating, or other means (see 3.15). The resultant finish shall form a good electrical conductor and shall be free from defects that may affect its protective value.

* 3.5.2.1 Tin plated finishes. Tin plating is prohibited as a final finish or as an undercoat. Tin-lead (Sn-Pb) finishes are acceptable provided that the minimum lead content is three percent (see 6.9). This prohibition applies to all external surfaces of the capacitor, including nuts and washers.

3.5.3 Threaded parts. All threaded parts shall be as specified (see 3.1) and in accordance with FED-STD-H28. Aluminum nuts shall not be used.

3.5.3.1 Engagement of threaded parts. All threaded parts shall engage by at least two full threads.

3.6 Seal. When capacitors are tested as specified in 4.7.2, there shall be no continuous visible stream of bubbles or other evidence of leakage.

3.7 Terminal strength. When capacitors are tested as specified in 4.7.3, no part of the terminal shall loosen or rupture, and there shall be no other damage. Stud-type terminals shall exhibit no perceptible movement relative to the case, under the applied torque.

3.8 Dielectric withstanding voltage. When capacitors are tested as specified in 4.7.4, there shall be no visible damage, flashover, breakdown, open-circuiting or short-circuiting (see 6.6.3).

3.9 Insulation resistance. When measured as specified in 4.7.5, the insulation resistance, shall be not less than the applicable value specified in table IV and shown on figure 1. For measurements made at temperatures between 20° and 35°C, the applicable correction factor specified in table V shall be applied.

TABLE IV. Insulation resistance measurements.

| Capacitance rating | Minimum insulation resistance |
|--|--|
| Characteristic K 0 to 0.33 microfarads Greater than 0.33 microfarads | <u>At 25°C</u> A 18,000 megohms 6,000 megohm-microfarads <u>1/</u> |
| | <u>At 125°C</u> 150 megohms 10 megohm-microfarads <u>1/</u> |
| Characteristic E 0 to 0.33 microfarads Greater than 0.33 microfarads | <u>At 25°C</u> 6,000 megohms 2,000 megohm-microfarads <u>1/</u> |
| | <u>At 85°C</u> 600 megohms 20 megohm-microfarads <u>1/</u> |

1/ Product obtained by multiplying the capacitance in microfarads (μF) by the insulation resistance.

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TABLE V. Insulation-resistance correction factors.

| Temperature (Degrees C) | Correction factor <u>1/</u> | Temperature (Degrees C) | Correction factor <u>1/</u> | Temperature (Degrees C) | Correction factor <u>1/</u> | Temperature (Degrees C) | Correction factor <u>1/</u> |
|-------------------------|-----------------------------|-------------------------|-----------------------------|-------------------------|-----------------------------|-------------------------|-----------------------------|
| 20 | 1.42 | 24 | 1.08 | 28 | 0.82 | 32 | 0.63 |
| 21 | 1.33 | 25 | 1.00 | 29 | 0.76 | 33 | 0.59 |
| 22 | 1.24 | 26 | 0.94 | 30 | 0.71 | 34 | 0.55 |
| 23 | 1.16 | 27 | 0.87 | 31 | 0.67 | 35 | 0.51 |

1/ These correction factors are to be applied to the required values, not to the measured values.

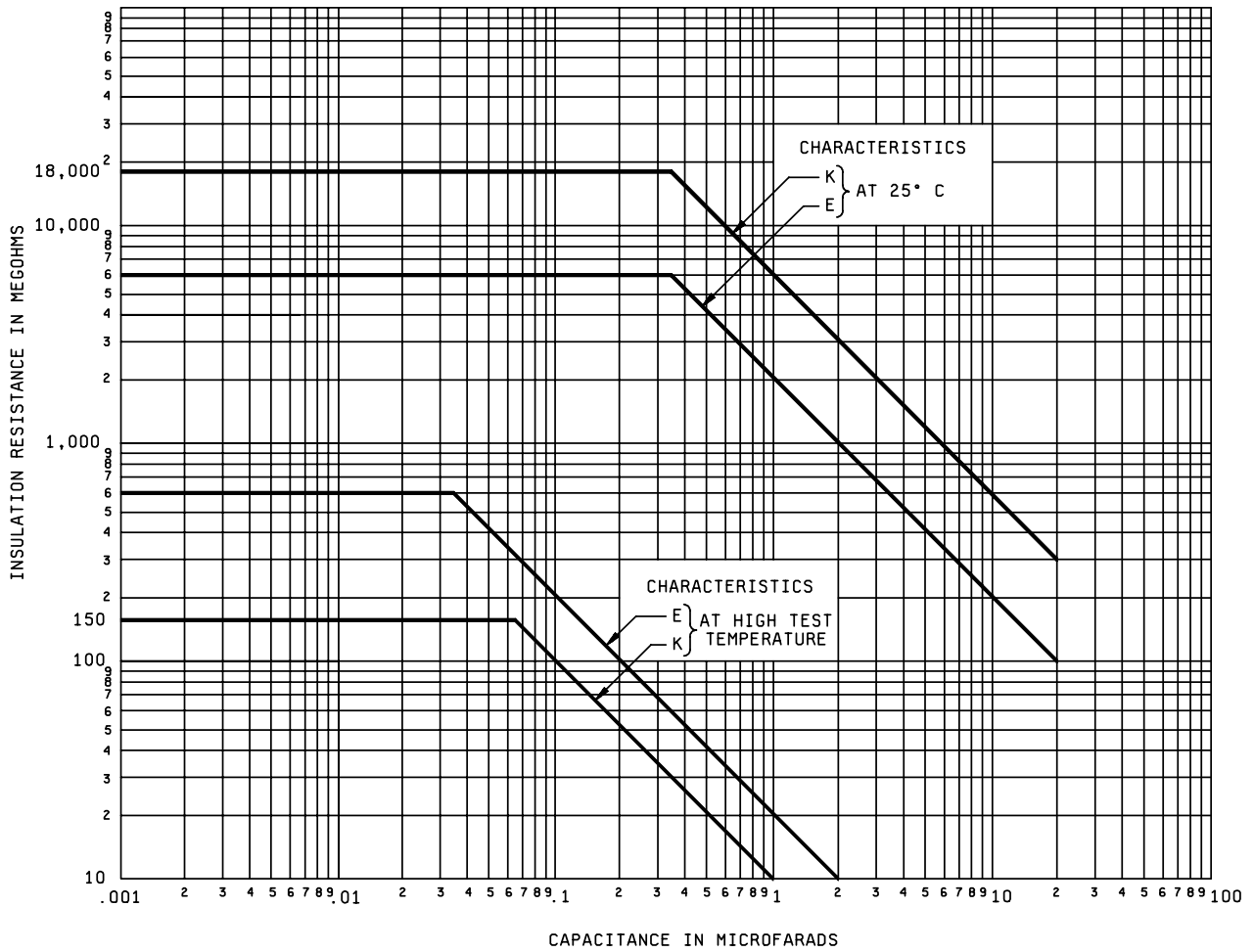


FIGURE 1. Insulation-resistance curve for characteristics K and E.

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3.10 Capacitance. When measured as specified in 4.7.6, the capacitance shall be not less than 90 percent nor greater than 110 percent of the specified nominal value (see 3.1).

3.11 Dissipation factor. When measured as specified in 4.7.7, the dissipation factor shall be not more than 1.0 percent.

3.12 Insertion loss. When measured as specified in 4.7.8, the insertion loss shall be not more than 6 decibels (dB) below the value shown on figure 2 (unless otherwise specified, see 3.1) for an ideal capacitor of the same nominal capacitance value. Dips are permissible when tested at frequencies from 0.15 megahertz (MHz) up to that frequency at which the insertion loss of the capacitor under test becomes 60 dB; however, at higher frequencies up to 1,000 MHz the insertion loss shall not fall below 60 dB. Deviations in the nature of dips in the curve will be permitted. Such dips indicate a drop in insertion loss below that of an ideal capacitor followed by a rise in insertion loss, as frequency is increased faster than the rise that is characteristic of an ideal capacitor. Such dips are also characteristic of all extended-foil capacitors.

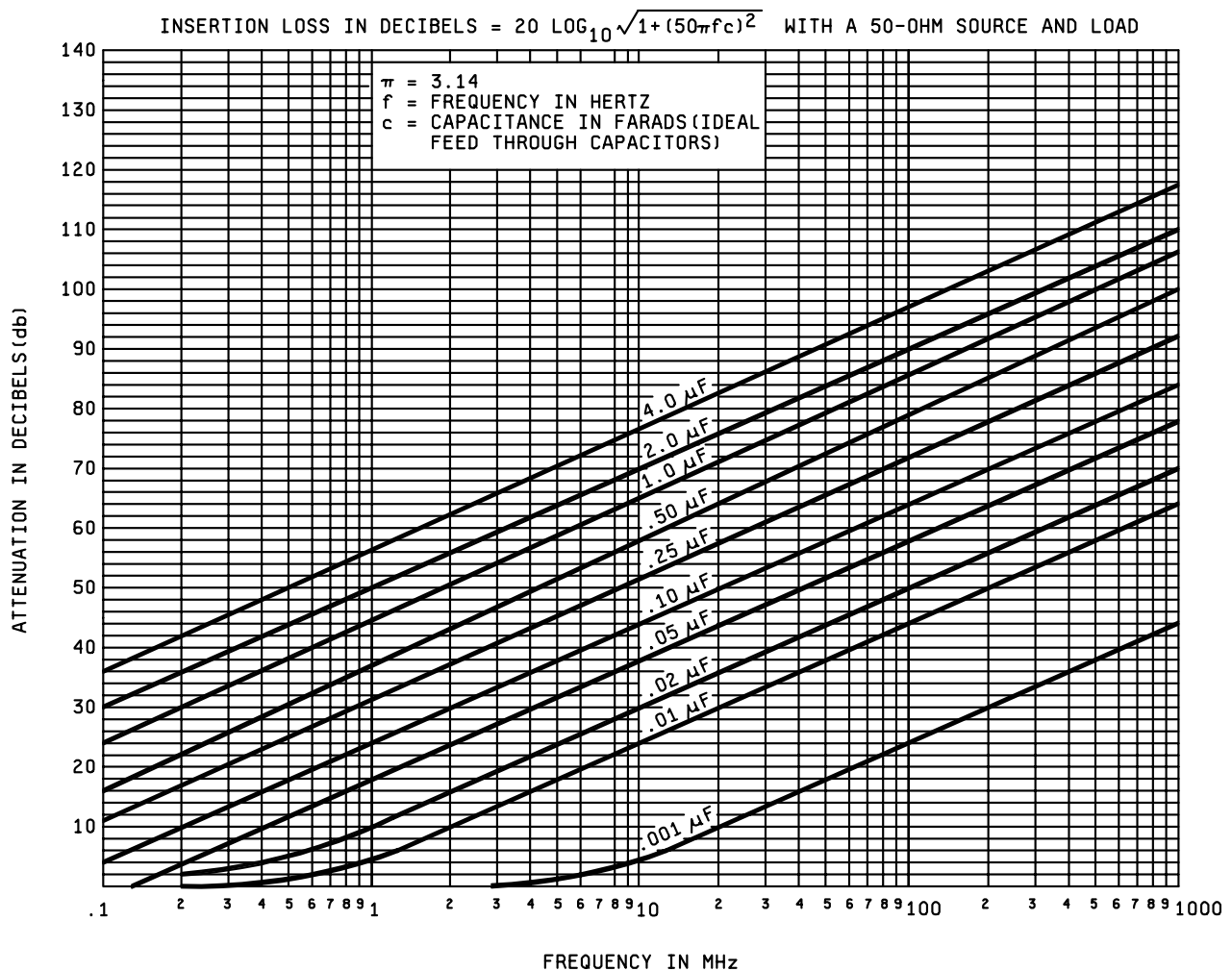


FIGURE 2. Insertion-loss versus frequency for an ideal capacitor.

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3.13 DC resistance. When measured as specified in 4.7.9, the dc resistance shall not exceed the value specified (see 3.1).

3.14 Resistance to soldering heat. When tested as specified in 4.7.10, there shall be no damage to the capacitors or the terminal insulators that will cause electrical failure of the capacitors, or which will cause hermetically sealed capacitors to leak. Unless the chipping extends to the outer periphery, chipping of terminal insulators alone shall not be cause for failure. Capacitors shall also meet the following requirements:

Insulation resistance.....Not less than the value specified (see 3.1).
CapacitanceChange not more than the value specified (see 3.1).
Dissipation factor.....Shall not exceed 1.5 percent.

* 3.15 Salt atmosphere (corrosion). When capacitors are tested as specified in 4.7.11, there shall be no harmful or extensive corrosion and at least 90 percent of any exposed metallic surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

3.16 Thermal shock and immersion. When tested as specified in 4.7.12, capacitors shall meet the following requirements:

Dielectric withstanding voltageAs specified in 3.8.
Insulation resistance (at 25°C)Not less than the value specified (see 3.1).
CapacitanceChange not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.6.
Dissipation factor.....Shall not exceed 1.5 percent.
Insertion lossChange at any frequency not more than 3 dB from the initial value obtained when measured as specified in 4.7.8 except that for those frequencies at which the initial value is 60 dB or greater, the change may exceed 3 dB provided the insertion loss does not drop below 60 dB.
Visual examinationThere shall be no harmful or extensive corrosion and at least 90 percent of any exposed metal surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

3.17 Shock (specified pulse). When capacitors are tested as specified in 4.7.13, there shall be no intermittent contacts of 0.5 millisecond (ms) or greater duration, open or short-circuiting and no mechanical damage to the capacitors. After completion of the shock test, the units shall be subjected to the insertion loss test (see 4.7.8). The change at any frequency shall be not more than 3 dB from the initial value obtained when measured as specified (see 3.1), except for those frequencies at which the initial value is 60 dB or greater, which may exceed 3 dB provided the insertion loss does not drop below 60 dB.

3.18 Vibration, high frequency. When capacitors are tested as specified in 4.7.14 there shall be no intermittent contacts of 0.5 ms or greater duration, open-circuiting, short-circuiting and no mechanical damage to the capacitors.

3.19 Moisture resistance. When tested as specified in 4.7.15, capacitors shall meet the following requirements:

Dielectric withstanding voltageAs specified in 3.8.
Insulation resistance (at 25°C)Not less than the value specified (see 3.1).
CapacitanceChange not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.6.
Dissipation factor.....Shall not exceed 1.5 percent.
Visual examinationThere shall be no harmful or extensive corrosion and at least 90 percent of any exposed metal surfaces of the capacitor shall be protected by the finish. In addition, there shall be not more than 10-percent corrosion of the terminal hardware or mounting surface. Marking shall remain legible after the test.

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3.20 Solderability. When capacitors are tested as specified in 4.7.16, the dipped surface of the capacitor leads shall be at least 95 percent covered with a new continuous solder coating, free from pinholes or voids. The remaining 5 percent of the lead surface shall show only small pinholes or voids. These shall not be concentrated in one area. Bare base material and areas where the solder dip failed to cover the original coating are indications of poor solderability and shall be cause for failure. In case of dispute, the percentage covered by pinholes or voids shall be determined by actual measurement of those areas, as compared to the total area.

3.21 Resistance to solvents. When capacitors are tested as specified in 4.7.17, there shall be no evidence of mechanical damage, and the marking shall remain legible.

3.22 Low temperature and capacitance change at reduced temperature. When capacitors are tested as specified in 4.7.18, there shall be no evidence of breakdown, flashover, or fracture. The capacitance change at $-55^{\circ} \pm 3^{\circ}\text{C}$ shall not exceed 15 percent of the value measured at 25°C .

3.23 Life. When tested as specified in 4.7.19, there shall be no mechanical failure or leakage of impregnant or filling compound and capacitors shall meet the following requirements:

| | |
|--|---|
| Insulation resistance (at 25°C) | Not less than the value specified (see 3.1). |
| Capacitance | Change not more than the value specified (see 3.1) from the initial value obtained when measured as specified in 4.7.6. |
| Dissipation factor | Shall not exceed 1.5 percent. |
| Insertion loss | Unless otherwise specified (see 3.1), change at any frequency not more than 3 dB from the initial value obtained when measured as specified in 4.7.8, except that for those frequencies at which the initial value is 60 dB or greater, the change may exceed 3 dB provided the insertion loss does not drop below 60 dB. |

3.24 Flashpoint of impregnant or filling compound. When measured as specified in 4.7.20, the flashpoint of the impregnant or filling compound shall be not lower than 145°C for characteristic K, and 135°C for characteristics E.

* 3.25 Marking. Capacitors shall be marked with the PIN (JAN brand when applicable (see 3.25.2) trade mark TM and the Commercial and Government Entity (CAGE) code, date code, voltage and current ratings. The marking shall be placed on the exposed cylindrical surface of the case and shall remain legible after all environmental tests. Labels shall not be used. Other markings that in any way interfere with, obscure, or confuse those specified herein are prohibited. There shall be no space between the symbols that comprise the type designation. If space limitation requires it, the type designation may appear on two lines. In this event, the type designation shall be divided between the current symbol and the characteristic symbol as shown in the following examples:

| | | | |
|-------------------|----|-------------------|-----------|
| CZ23B | | CZR23B | |
| KB473 | | KB473M | |
| JAN TM | | JAN TM | |
| 12345 | or | 12345 | CAGE code |
| 0411 | | 0411 | Date code |
| 100 Volt | | 100 Volt | |
| 20 Amps | | 20 Amps | |

NOTE: The trademark may appear anyplace on the capacitor. Successful qualification is a prerequisite for "JAN" branding.

3.25.1 Date code. The date code shall be in accordance with MIL-STD-1285.

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3.25.2 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 specification, 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 and 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 specifications, 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".

3.26 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.

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

3.27.1 Soldering. Flux for soldering shall be rosin, rosin and alcohol, or rosin and turpentine. No acid or acid salts shall be used in preparation for or during soldering. All excess flux and solder shall be removed. Electrical connections shall be mechanically secured before soldering, where possible, and electrically continuous after soldering.

3.27.2 Terminal. Solder lugs and solder lug terminals may be of any shape provided dimensional limits are met. All terminals shall be coated with solder having a tin content of 40 to 70 percent.

4. VERIFICATION

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

- a. Qualification inspection (see 4.4).
- b. Verification of qualification (ER styles: See 4.5); (non-ER: See 4.5.1).
- c. Conformance inspection (see 4.6).

4.2 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with ANSI/NCSL Z540-1, ISO10012-1, or equivalent, as approved by the qualifying activity.

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202 except relative humidity shall not exceed 75 percent. Accuracy of all test voltage measurements shall be within ± 2.0 percent of the specified voltage.

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

4.4.1 Sample size. The number of capacitors to be subjected to qualification inspection shall be as specified in table VI and the appendix to this specification.

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table VI, in the order shown. Two specimens will be subjected to the subsequent examinations and tests in group 1. The specimens will then be divided into the remaining groups specified in table VI, 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 VI shall be cause for refusal to grant qualification approval.

*

TABLE VI. Qualification Inspection.

| Inspection | Requirement paragraph | Test method paragraph | NON-ER | | ER | |
|---|---|---|--|---------------------------------------|--|-----------------------------|
| | | | Number of sample units to be inspected | Number of defects permitted <u>1/</u> | Number of sample units to be inspected | Number of defects permitted |
| Group I Visual and mechanical examination (internal): Material and workmanship | 3.1, 3.4 to 3.5.3.1, and 3.25 to 3.27.2 | 4.7.1 | 2 | 0 | 2 | 0 |
| Visual and mechanical examination (external): Physical dimensions, marking, and workmanship <u>2/</u> Seal Terminal strength Dielectric withstanding voltage Insulation resistance Capacitance Dissipation factor Insertion loss DC resistance | 3.1, 3.5, and 3.25 and 3.27 3.6 3.7 3.8 3.9 3.10 3.11 3.12 3.13 | 4.7.1 4.7.2 4.7.3 4.7.4 4.7.5 4.7.6 4.7.7 4.7.8 4.7.9 | 29 <u>3/</u> | 1 | 57 <u>3/</u> | 1 |
| Group II Resistance to soldering heat Salt atmosphere (corrosion) Thermal shock and immersion | 3.14 3.15 3.16 | 4.7.10 4.7.11 4.7.12 | 6 | 1 | 6 | 1 |
| Group III Shock (specified pulse) Vibration, high frequency Moisture resistance | 3.17 3.18 3.19 | 4.7.13 4.7.14 4.7.15 | 6 | 1 | 6 | 1 |
| Group IV Solderability Resistance to solvents <u>5/</u> | 3.20 3.21 | 4.7.16 4.7.17 | 4 | 1 | 4 | 1 |
| Group V Low temperature and capacitance change at reduced temperature Life (accelerated) <u>4/</u> | 3.22 3.23 | 4.7.18 4.7.19 | 12 | 1 | 40 | 1 |

1/ A specimen having one or more defects will be considered as a single defective.

2/ Marking will be considered as a defect only if it becomes illegible as a result of any of the tests of the specification.

3/ One additional specimen is included in each sample of 31 or 59 specimens as applicable to permit substitution for the allowable defective in group I.

4/ The decision as to whether or not the NON-ER product is to be included on the qualified products list shall be made at the end of the 240 hour life test and at the conclusion of the 2,000-hour life test for the ER parts.

5/ Two capacitors with sleeves and two unsleeved.

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4.4.4 Failure rate (FR) qualification (applicable to ER parts only). FR qualification for capacitors shall be in accordance with the general and detailed requirements of MIL-STD-690 and as follows.

- a. Procedure I: Qualification at the initial FRL. Level "M" (1.0 percent) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group V, table VI (see 4.4.2).
- b. Procedure III: Maintenance of FRL 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.

4.4.5 Quality level verification (ER styles only). The manufacturer is responsible for establishing a quality system to assess the ppm defect level of lots that are subjected to subgroup 2 tests of the group A inspections. The ppm defect level shall be based on a 6-month moving average.

4.5 Verification of qualification (ER styles). Every 6 months the manufacturer shall compile a summary of the results of qualification conformance inspections and extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain the qualified FR level, or the group B 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. MIL-STD-790 program.
- b. The capacitor design has not been modified.
- c. Lot rejection for group A inspection does not exceed 5 percent or one lot, whichever is greater.
- d. The requirements for group B inspection are met.
- e. Verification of FRLs.
- f. PPM assessment.

When group B requirements were not met and the manufacturer has taken corrective action satisfactory to the qualifying activity, group B retesting shall be instituted. A summary of the retesting shall be forwarded to the qualifying activity within 30 days after completion of the retest.

In the event that there is no production of a single style device during a maintenance period and the manufacturer is listed for more than one style on the QPL, the manufacturer shall certify that they retain the capabilities and facilities necessary to produce that product. However, the manufacturer shall still maintain the required number of unit hours in the maintenance period using those styles produced in order to remain qualified to the applicable failure rate levels. Styles need not be manufactured for testing only but the manufacturer must certify that the capability and facilities needed to produce that style are still in place. In the event that units must be built for the purpose of maintaining the required hours, they shall also undergo all required testing prior to being placed on life test and be subjected to all group B requirements.

- * 4.5.1 Verification of qualification (non-ER styles). Every 6 months the manufacturer shall compile a summary of the results of qualification conformance inspections in the form of a verification of qualification report, and forward it to the qualifying activity whenever the group B inspection data indicates failure of the qualified product to meet the requirements of this specification. Retention of qualification of an ER style will also retain qualification of corresponding non-ER style (e.g., CZR23 and CZ23).

Failure to submit the report within 30 days after the end of each 6 month period may result in loss of qualification for the product. In addition to the periodic report, the supplier shall immediately notify the qualifying activity at any time during the 6 month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification.

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In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during 3 consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit (the products, a representative product of each type, grade, class, etc.) to testing in accordance with the qualification inspection requirements.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection. Except as specified in 4.6.2.3, delivery of products which have passed group A inspection shall not be delayed pending the results of group B inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all capacitors of the same style, current and voltage ratings produced under essentially the same conditions, and offered for inspection at the same time. ER parts shall be kept separate from non-ER parts.

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

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

4.6.1.2.2 Manufacturers production inspection for ER parts only. If the manufacturer performs tests similar to those specified in subgroup 1, table VII, as the final step of his 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 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 or more stringent than those specified herein.
- d. The lot rejection criteria is the same or more stringent than that specified herein.

4.6.1.2.3 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. If during the 100 percent inspection of subgroup 1 (ER parts only), screening requires that over 5 percent of the capacitors be discarded, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.4 PPM calculations (ER and non-ER). The manufacturer shall establish and maintain a system for assessing and calculating average outgoing quality of capacitors. A PPM rate combining IR, capacitance, and DF shall be assessed for lots that have passed the group A inspection. The manufacturer's PPM system shall also address rectification procedures for lots failing PPM assessment. Data from the rectification process shall not be used to calculate PPM.

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| Examination or test | Requirement paragraph | Method paragraph | Sampling procedure | |
|--|-----------------------|------------------|--------------------------|--------------------------------------|
| | | | NON-ER | ER |
| <u>Subgroup 1</u> | | | | |
| Seal | 3.6 | 4.7.2 | See table VIII | Not applicable. (100% inspection) |
| Dielectric withstanding voltage | 3.8 | 4.7.4 | | |
| Insulation resistance | 3.9 | 4.7.5 | | |
| Capacitance | 3.10 | 4.7.6 | | |
| Dissipation factor | 3.11 | 4.7.7 | | |
| Insertion loss | 3.12 | 4.7.8 | | |
| DC resistance | 3.13 | 4.7.9 | | |
| <u>Subgroup 2</u> | | | | |
| Visual and mechanical examination (external): | | | 13 samples 0 failures | See table VIII |
| Materials | 3.4 and 3.4.1 | 4.7.1 | | |
| Physical dimensions | 3.5 | | | |
| Design construction (other than physical dimensions) | 3.5 to 3.5.3.1 | | | |
| Marking ^{1/} | 3.25 | | | |
| Workmanship | 3.28 | | | |

^{1/} Marking defects are based on visual examination only and shall be charged only for illegible, incomplete, or incorrect markings. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

TABLE VIII. Sampling plans for Group A tests.

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

4.6.2 Periodic group B inspection. Periodic group B inspection shall consist of the tests specified in table IX, in the order shown, and shall be performed on sample units selected from lots that have passed group A inspection. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.3), delivery of products that have passed group A shall not be delayed pending the results of this periodic inspection.

4.6.2.1 Sampling plan. Sample units shall be representative of capacitors produced.

4.6.2.1.1 Subgroups 1, 2, 3, and 4 (ER and non-ER). Six sample units shall be taken from production every 2 months and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table IX.

4.6.2.1.2 Subgroup 5 (non-ER parts only). Six sample units shall be taken from production every 2 months and subjected to the applicable tests for their particular subgroup. Allowable failures shall be as specified in table IX.

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4.6.2.1.3 Subgroup 6 (ER parts only). Six sample units shall be selected from lots produced during a 6-month period. Allowable failures shall be as specified in table IX. The accumulated life test data shall be used for maintenance of FR qualification, and shall be verified for failure rate level maintenance with 90 percent confidence level, at 2-year intervals.

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

*

TABLE IX. Group B inspection.

| Inspection | Requirement paragraph | Method paragraph | Number of sample units to be inspected | Number of defects permitted | |
|---|-----------------------|-------------------------------|--|-----------------------------|-------------|
| | | | | NON-ER | ER |
| <u>Subgroup 1</u> Terminal strength <u>1/</u> Insertion loss | 3.7 3.12 | 4.7.3 4.7.8 | 6 | 1 | 1 |
| <u>Subgroup 2</u> Resistance to soldering heat <u>1/</u> Salt atmosphere (corrosion) <u>1/</u> Thermal shock and immersion <u>1/</u> | 3.14 3.15 3.16 | 4.7.10 4.7.11 4.7.12 | 6 | 1 | 1 |
| <u>Subgroup 3</u> Shock (specified pulse) <u>2/</u> Vibration (high frequency) <u>2/</u> Moisture resistance <u>1/</u> | 3.17 3.18 3.19 | 4.7.13 4.7.14 4.7.15 | 6 | 1 | 1 |
| <u>Subgroup 4</u> <u>3/</u> Solderability Resistance to solvents <u>1/</u> | 3.20 3.21 | 4.7.16 4.7.17 | 3 | 1 | 1 |
| <u>Subgroup 5 (NON-ER parts only)</u> Low temperature and capacitance change at reduced temperature Insulation resistance (at the high ambient temperature) Life (240 hours) | 3.22 3.9 3.23 | 4.7.18 4.7.5 4.7.19.2.1 | 6 | 1 | N/A |
| <u>Subgroup 6 (ER parts only)</u> Low temperature and capacitance change at reduced temperature Insulation resistance (at the high ambient temperature) Life (2,000 hours) | 3.22 3.9 3.23 | 4.7.18 4.7.5 4.7.19.2.2 | 6 | N/A | 1 <u>4/</u> |

1/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failure, this test, with the approval of the qualifying activity, can be deleted. The manufacturer, however, shall perform this test every 3 years after the deletion as part of long term design verification. If the design, material, construction processing of the part is changed, or if there are any quality problems, the qualifying activity may require resumption of the specified testing. Deletion of testing does not relieve the manufacturer from meeting the test requirements in case of dispute.

2/ The time requirement for shock and vibration tests is a minimum of once every 24 months.

3/ Two capacitors with sleeve and one unsleeved.

4/ The number of defects is also governed by the requirement of 4.5, wherein the qualified product must meet the 90 percent failure rate plan on an annual basis.

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

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4 to 3.5.3.1, 3.25 and 3.27).

4.7.2 Seal (see 3.6).

4.7.2.1 Solid-filled and liquid-impregnated capacitors. While at room temperature, capacitors whose filling material will be solid at the high ambient test temperature, and liquid-impregnated capacitors in which no filling compound is used, shall be immersed for at least 1 minute in oil or water maintained at a temperature of 5°C +5°C, -0°C above the high ambient test temperature.

4.7.2.2 Liquid-filled capacitors. Capacitors whose filling material will be liquid at the high ambient test temperature, shall be placed with the terminals facing horizontal and brought to a case temperature of 5°C, +5°C, -0°C above the high ambient test temperature. After 10 minutes at this case temperature, the capacitors shall be turned through 180° onto another surface with the terminals still horizontal and kept in this position for 10 minutes with the case temperature maintained within the same limits. An oil spot or spots appearing on the paper or any oil impregnant appearing on the outside of the case is considered evidence of leakage.

* 4.7.3 Terminal strength (pull test) (see 3.7). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition letter: A.
- b. Method of holding: normal mounting means.
- c. Applied force: 5 pounds +3, -0, ounces.
- d. Duration of applied force: 30 +5, -0 seconds.

4.7.4 Dielectric withstanding voltage (see 3.8).

4.7.4.1 For qualification inspection. Capacitors shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

- a. Magnitude and nature of test voltage: 200 percent of the rated dc voltage. The ac ripple shall not exceed 2 percent.
- b. Duration of application of test voltage: 1 minute ±5 seconds.
- c. Points of application of test voltage: Between the case and either terminal.
- d. Limiting value of surge current: Between 5 milliamperes and 1 ampere.

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- e. Measurement during and after dielectric withstanding voltage: after the test, capacitors shall be visually examined for external evidence of damage, arcing, or breakdown.

4.7.4.2 For acceptance inspection. Capacitors shall be tested as specified in 4.7.4.1, except that, at the option of the manufacturer, a test voltage of 250 percent of the rated dc voltage may be applied for a period of not less than 1 second.

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

- a. Test potential: A potential equal to the rated voltage (see 3.1) or 500 volts dc, whichever is less.
- b. Special conditions: Capacitors shall be tested at the applicable high ambient test temperature (see table II), and at 25°C or corrected thereto.
- c. Points of measurement: Between either terminal and the case.

4.7.6 Capacitance (see 3.10). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details shall apply:

- a. Test frequency: 1 kHz \pm 100 Hz for capacitors whose nominal capacitance is 1 μ F or less, and 60 \pm 6 Hz for capacitors whose nominal capacitance is more than 1 μ F.
- b. Limit of accuracy: Within \pm 2 percent.

4.7.7 Dissipation factor (see 3.11). The dissipation factor of each capacitor shall be measured at a root-mean-square (rms) voltage not greater than 20 percent of the rated dc voltage. Measurement shall be made at a frequency of 1 kHz \pm 100 Hz for capacitors whose nominal capacitance is more than 1 μ F. Measurement accuracy shall be within \pm 0.1 percent absolute.

4.7.8 Insertion loss (see 3.12). Capacitors shall be tested in accordance with MIL-STD-220. Measurements shall be taken at the frequencies specified (see 3.1).

4.7.9 DC resistance (see 3.13). The dc resistance shall be measured directly using a Kelvin bridge or indirectly using the voltmeter-ammeter method, ammeter-potentiometer method, or other suitable means. The point of contact shall be along the lead, where the lead is normally connected in an actual circuit, except that for axial-wire leads, the contact shall be made 5/8 \pm 1/8 inch from the insulator. The maximum allowable measurement error shall be 5 percent.

4.7.10 Resistance to soldering heat (see 3.14).

- a. Depth of immersion in molten solder: Within .062 \pm .031 inch of the seal or case.
- b. Test condition: B.
- c. Cooling time prior to measurement after test: 1 hour.
- d. Measurement after test: capacitance to ground and coil continuity.

* 4.7.11 Salt atmosphere (corrosion) (see 3.15). Capacitors shall be tested in accordance with method 101, test condition B, of MIL-STD-202. The salt solution concentration shall be 5 percent. After this test, capacitors shall be visually examined for corrosion and obliteration of marking.

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w/Amendment 14.7.12 Thermal shock and immersion (see 3.16).

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 letter: A, except that in step 3, capacitors shall be tested at the applicable high ambient test temperature (see table II).

(b) Measurements before and after cycling: Not applicable.

4.7.12.2 Immersion. Within 4 to 24 hours after completion of thermal shock, capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

a. Test condition letter: B.

b. Measurements after final cycle: Dielectric withstanding voltage, insulation resistance at 25°C, capacitance, dissipation factor, and insertion loss shall be measured as specified in 4.7.4, 4.7.5, 4.7.6, 4.7.7 and 4.7.8, respectively. These measurements shall be made within 2 hours after capacitors are removed from the immersion tank, except that no time limit is specified for the insertion-loss measurement. If the capacitors fail the insulation-resistance test, they may be retested for insulation resistance after a total maximum drying period of 24 hours.

c. Visual examination: Capacitors shall be examined for corrosion and obliteration of marking.

4.7.13 Shock (specified pulse) (see 3.17). Capacitors shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

a. Mounting: securely fastened by normal mounting means. When applicable, leads and connecting wires must be supported to prevent damage to the capacitor.

b. Test condition: Non ER: G (50g, peak);
ER: I (100g, peak).

c. Electrical loading during shock: During the test, a potential of 125 percent of dc rated voltage (see 3.1) shall be applied to the capacitor.

d. Measurements during shock: During the test, observations shall be made to determine intermittent contact or arcing or open-circuiting or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms duration or greater.

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

4.7.14 Vibration, high frequency (ER only) (see 3.18). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

a. Mounting: securely fastened by normal mounting means. When applicable, leads and connecting wires must be so supported to exclude spurious resonance.

b. Electrical load conditions: during the test, a potential of 125 percent of rated voltage (see 3.1) shall be applied between the terminal and case of the capacitor.

c. Test condition letter: B (15g).

d. Direction and duration of motion: 4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.

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- e. Measurements during vibration: during the last half hour of vibration in each direction, a signal of 1 ± 0.2 kHz at a level of 1 ± 0.2 volts shall be placed across the capacitor and measured with a suitable device to determine open-circuiting or short-circuiting or intermittent of 0.5 ms or greater duration.
- f. Examination after test: Capacitors shall be visually examined for evidence of mechanical damage.

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

- a. Initial measurements: Not applicable.
- b. Polarization voltage: The dc potential shall be applied to either terminal and the case of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.
- c. Final measurements: Upon completion of step 6 of the final cycle, the dielectric withstanding voltage, insulation resistance at 25°C, capacitance, and dissipation factor shall be measured as specified in 4.7.4, 4.7.5, 4.7.6 and 4.7.7, respectively, at a relative humidity of 50 ± 5 percent.
- d. Visual examination: Capacitors shall be examined for corrosion and obliteration of marking.

* 4.7.16 Solderability (see 3.20). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

- a. The number of terminations of each capacitor to be tested: 2.

* b. Depth of immersion in flux and solder: Both leads/terminals shall be immersed to within 0.05 inches from the solder seal.

4.7.17 Resistance to solvents (see 3.21). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- a. Portion of specimen to be brushed: That portion on which marking is present.
- b. Number of specimens to be tested: As specified in applicable inspection tables.
- c. Permissible extent of damage: As specified in 3.21.

4.7.18 Low temperature and capacitance change at reduced temperature (see 3.22).

4.7.18.1 Low temperature. Capacitors shall be placed in a chamber maintained at $-55^\circ \pm 3^\circ\text{C}$, and rated voltage at the rated frequency (when applicable) shall be applied at this condition for 48 ± 4 hours (see 3.1). The air within the conditioning chamber shall be circulated.

4.7.18.2 Capacitance change at reduced temperature. At the conclusion of the test specified in 4.7.18.1 but before the capacitors are removed from the conditioning chamber, the capacitance shall be measured as specified in 4.7.6 except that the measurement shall be made at $-55^\circ \pm 3^\circ\text{C}$. This measurement shall be compared with a measurement made at room ambient temperature. After exposure, capacitors shall be visually examined for evidence of breakdown, flashover, or fractures.

4.7.19 Life (see 3.23).

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

- a. Method of mounting and distance between specimens: Suspended by their terminals with a distance of not less than 1.5 inches separation between units.
- b. Test temperature and tolerance: The applicable high temperature specified in table II (see 3.1).

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- c. Operating conditions: A potential of 140 percent of the rated dc voltage shall be applied between the terminal and the case. Rated current shall be flowing through the feed through conductors (see 3.1).
- d. Test condition: F (2,000 +96, -0 hours) for ER parts and 240 +48, -0 for non-ER parts.
- e. Measurements after exposure: Capacitors shall be returned to the inspection conditions specified in 4.3, and shall be visually examined for leakage of impregnant or filling compound and deformation of case. Insulation resistance at 25°C, capacitance, dissipation factor, and insertion loss shall then be measured as specified in 4.7.5, 4.7.6, 4.7.7 and 4.7.8, respectively, (see 3.23).

4.7.19.2 Life (Conformance inspection).

4.7.19.2.1 240 hour (group B inspection) (see 3.23). Capacitors shall be tested as specified in 4.7.19.1, except that the duration of the test shall be 240 +48, 0 hours.

4.7.19.2.2 2,000 hour (group B inspection) (ER parts only) (see 3.23). Capacitors shall be tested as specified in 4.7.19.1, except the duration of the test shall be 2,000 +96, -0 hours.

4.7.20 Flashpoint of impregnant or filling compound (see 3.24). This test is applicable only to liquid impregnants and filling compounds and to solid impregnants having a melting point of less than 135°C. The flashpoint of the impregnant or filling compound shall be measured as specified in ASTM D92, except that fire point and precision do not apply. "Impregnant or filling compound" shall be substituted for the word "oil" throughout the test method.

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. The capacitors covered by this specification are primarily designed for use in broadband, radio-interference suppression applications. They are military unique due to the fact that they must be able to operate satisfactorily in military systems under the following demanding conditions: -55°C to +85°C or +125°C operating temperature range, 15 Gs of vibration, 50 - 100 Gs of shock, 48 hours of salt spray, 2,000 hours of use at the maximum temperature and 140 percent of rated voltage. In addition these military requirements are verified under a qualification system. Commercial components are not designed to withstand these military environmental conditions.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. Packaging requirements (see section 5.1).
- c. Direct Governmental purchases should specify machine nuts and washers.

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* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products that are, at the time of award of contract, qualified for inclusion in Qualified Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Defense Supply Center, Columbus, ATTN: DSCC-VQP, PO Box 3990, Columbus, OH 43216-5000, or by e-mail to vqp.chief@dla.mil.

6.4 Insertion loss for ideal capacitors. The insertion loss of ideal capacitors for capacitance values from 0.001 to 100 μ F, inclusive, and frequency range from 0.01 to 1,000 megahertz, inclusive, may be determined from figure 3 (see 4.7.8).

6.5 Lockwasher. External tooth-type lockwashers should be used for all applications (see 3.1), except where space limitations, appearance, or other special conditions necessitate the use of internal tooth-type or split-type lockwashers. Internal tooth-type lockwashers should not be used with binder head screws. Screws or nuts with captive lockwashers will be permitted, provided that replacement with common-type screws and lockwashers or nuts and lockwashers may be readily effected. Soldering lug and lockwasher combinations should not be used.

6.6 Definitions.

6.6.1 Radio interference. Radio interference is defined as undesired conducted or radiated electrical disturbances, including transients, within the range of frequencies covered by this specification, which may interfere with the operation of electrical or electronic communication equipment or other electronic equipment.

6.6.2 Hermetic sealing. For the purpose of this specification, a hermetically sealed capacitor is one in which the capacitance element is contained within a sealed enclosure of ceramic, glass or metal, or combinations thereof, where sealing is accomplished by material fusion, welding, brazing or soldering.

6.7 Supersession data. ER capacitors of this specification supersede similar non ER items (CZR23 for CZ23, and CZR24 for CZ24) of this specification and similar items from MIL-C-39011, (Capacitors, Feed Through, Radio-Interference Reduction, ER).

6.8 Required construction.

Extended foil: Aluminum foil electrodes separated by paper or plastic or paper-plastic dielectric and noninductively wound.

* 6.9 Tin plated finishes. Tin plating is prohibited (see 3.5.2.1) because it may result in tin whisker growth. Tin whisker growth could adversely affect the operation of electronic equipment systems. For additional information, see ASTM B545, "Standard Specification for Electrodeposited Coating of Tin."

6.10 Subject term (key word) listing.

Dielectric withstanding voltage
Dissipation factor
Insulation resistance

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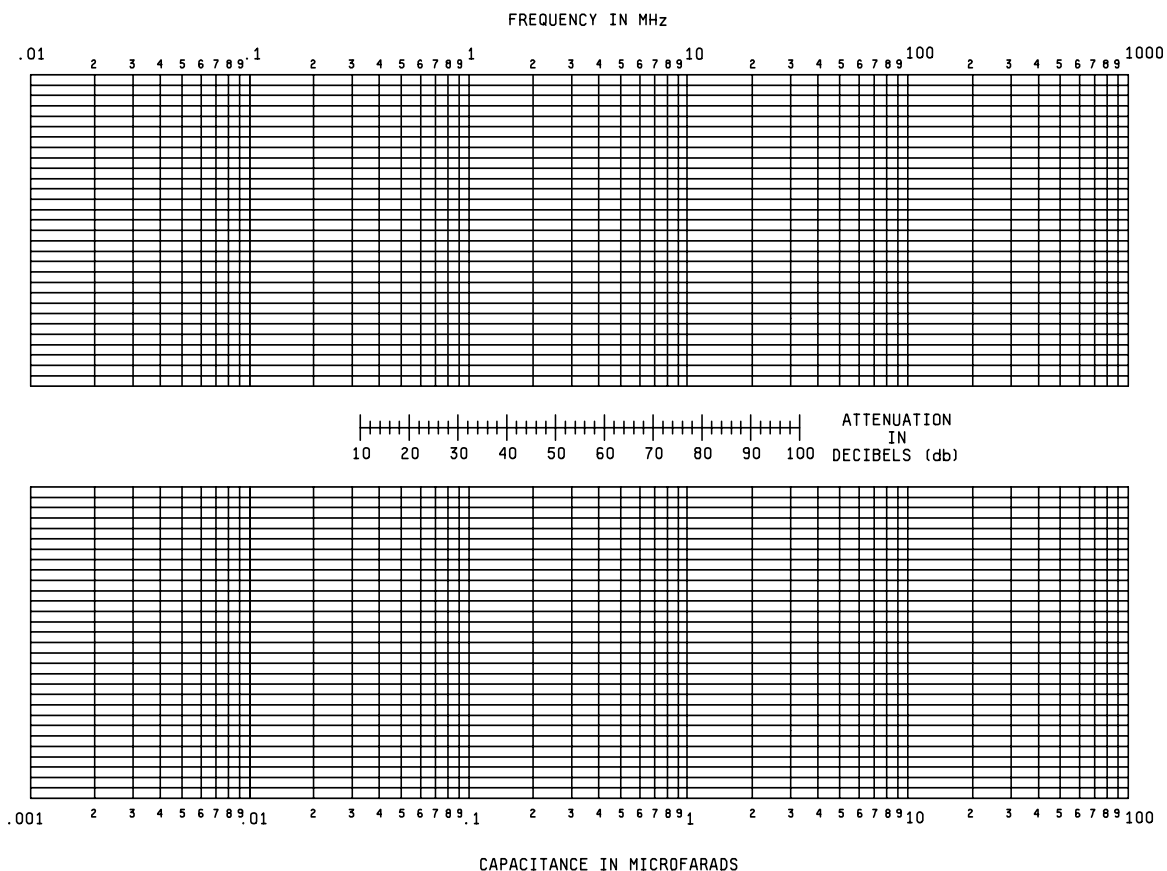


FIGURE 3. Insertion-loss chart for ideal capacitors.

* 6.11 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. Table X lists the Environmental Protection Agency (EPA) top seventeen hazardous materials targeted for major usage reduction. Unless needed to meet the requirements specified herein (see 3.1), use of these materials should be minimized or eliminated.

* TABLE X. EPA top seventeen hazardous materials.

| | | |
|------------------------|------------------------|-------------------------|
| Benzene | Dichloromethane | Tetrachloroethylene |
| Cadmium and Compounds | Lead and Compounds | Toluene |
| Carbon Tetrachloride | Mercury and Compounds | 1,1,1 - Trichloroethane |
| Chloroform | Methyl Ethyl Ketone | Trichloroethylene |
| Chromium and Compounds | Methyl Isobutyl Ketone | Xylene |
| Cyanide and Compounds | Nickel and Compounds | |

* 6.12 Changes from previous issue. The margins of this specification are marked with asterisks 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 This appendix details the procedure for submission of samples for qualification inspection of capacitors covered by this specification. The procedure for extending qualification of the required sample to other capacitors covered by this specification is also outlined herein.

A.2. SUBMISSION

A.2.1 Sample.

A.2.1.1 Single-style submission. A sample consisting of 36 specimens of the type for which qualification is sought shall be submitted (see A.3.1).

A.2.1.2 Combined-type submission. A maximum of two types in each style for which qualification is sought, consisting of 18 specimens of the highest watt-second rating or volt-ampere reactive, as applicable in the highest voltage rating and 18 specimens of the lowest capacitance value in any voltage rating, shall be submitted. Table A-I is an example of a combined-type submission (see A.3.2).

TABLE A-I. Example of combined-type submission.

| Style | Type to be submitted | Number of samples to be submitted | Watt-second rating ^{1/} | Voltage, volts |
|-------|----------------------|-----------------------------------|----------------------------------|----------------|
| CZ23 | CZ23BKF103 | 18 | 0.0018 | 600 DC |
| CZ23 | CZ23BKF474 | 18 | 0.0846 | 600 DC |
| CZ24 | CZ24BKF103 | 18 | 0.0018 | 600 DC |
| CZ24 | CZ24BKF474 | 18 | 0.0846 | 600 DC |
| CZR23 | CZR23BKF474M | 32 | 0.0846 | 600 DC |
| CZR24 | CZR24BKF103M | 32 | 0.0018 | 600 DC |

^{1/} The watt-second rating will be determined by the following formula:

$$W = \frac{CE^2}{2}$$

Where: W = energy content in watt-seconds.
C = nominal capacitance in farads.
E = dc voltage rating in volts.

A.3. EXTENT OF QUALIFICATION

A.3.1 Single-type submission. Qualification will be restricted to the type submitted.

A.3.2 Combined-type submission. Qualification of the types submitted will be extended to types whose watt-second and voltage ratings are not greater than the highest watt-second and voltage ratings submitted, and whose capacitance values are not less than the lowest capacitance value submitted. In addition, submission and qualification of a type or types in one characteristic automatically carries with it qualification of the lower characteristics, provided the units are of the same style, material, impregnant or filling compound and construction (e.g. qualification of characteristic K provided the basis for qualification of characteristics K and E). Qualification of ER parts will give qualification of non-ER parts of the same dielectric, construction, voltage ratings, current ratings and capacitance values.

MIL-PRF-11693D
w/Amendment 1

Custodians:

Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

(Project 5910-2259)

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