INCH-POUND

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23 August 1990
SUPERSEDING
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MILITARY SPECIFICATION

# CAPACITOR, FIXED, ELECTROLYTIC (TANTALUM), CHIP, ESTABLISHED RELIABILITY, GENERAL SPECIFICATION FOR

**FAILURE RATE LEVELS "M", "P", "R", AND "S" ARE INACTIVE FOR NEW DESIGN AFTER 23 August 1990.**

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, tantalum, fixed chip capacitors, primarily intended for use in thick and thin film hybrid circuits or surface mount applications for filter, bypass, coupling, and other applications where the alternating current (ac) component is small compared to the direct current (dc) rated voltage and where supplemental moisture protection is available (see 6.1). These capacitors have reliability ratings established on the basis of life tests performed at specified voltage at +85°C for failure rate (FR) levels ranging from:

a. 1.0 percent per 1,000 hours to 0.001 percent per 1,000 hours in accordance with MIL-STD-690. These FR levels are established at a 60-percent confidence level and are maintained at a 10-percent producer's risk (exponential distribution).

b. 0.1 percent per 1,000 hours to 0.0001 percent per 1,000 hours (1 FIT) 1/ at a 90-percent confidence level (Weibull distribution).

A part per million (PPM) quality system is used for documenting and reporting the average outgoing quality of capacitors supplied to this specification. Statistical process control (SPC) techniques are required in the manufacturing process to minimize variation in production of capacitors supplied to this specification.

1/ FIT = failure unit = one failure per $10^9$ device hours.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. 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 document or by letter.

AMSC N/A FSC 5910

1.2 Classification. Capacitors covered by this specification are classified by the style, as specified (see 3.1).

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

| CWR06 | B | A | 225 | J | M |
|---|---|---|---|---|---|
| Style (1.2.1.1) | Voltage (1.2.1.2) | Termination finish (1.2.1.3) | Capacitance (1.2.1.4) | Capacitance tolerance (1.2.1.5) | FR Level (1.2.1.6) |

1.2.1.1 Style. The style is identified by the three-letter symbol "CWR", followed by the two digit number; the letters identify established reliability, tantalum, fixed chip capacitors, and the number identifies the design of the capacitor.

1.2.1.2 Voltage. The voltage (rated, derated, and surge) is identified by a single letter as shown in table I.

TABLE I. Voltage.

| Symbol | Voltage | | |
|---|---|---|---|
| | Rated (85°C) | Derated (+125°C) | Surge (+85°C) |
| | Volts, dc | Volts, dc | Volts, dc |
| A | 2 | 1.3 | 2.6 |
| B | 3 | 2.0 | 4.0 |
| C | 4 | 2.7 | 5.0 |
| D | 6 | 4.0 | 8.0 |
| E | 8 | 5.4 | 10.0 |
| F | 10 | 7.0 | 13.0 |
| G | 12 | 8.0 | 16.0 |
| H | 15 | 10.0 | 20.0 |
| J | 20 | 13.0 | 26.0 |
| K | 25 | 17.0 | 32.0 |
| L | 30 | 20.0 | 39.0 |
| M | 35 | 23.0 | 46.0 |
| N | 50 | 33.0 | 65.0 |

1.2.1.3 Termination finish. The termination finish is identified by a single letter, as follows:

B - Gold plated (50 microinch minimum).
C - Hot solder dipped (60 microinch minimum).
E - Tin plated (100 microinch minimum).
H - Solder plated (100 microinch minimum).
J - Tin fused (60 microinch minimum).
K - Solder fused (60 microinch minimum).

See 6.8 for conversion from previous termination finishes.

1.2.1.4 Capacitance. The nominal capacitance value, expressed in picofarads (pF), is identified by a three-digit number; the first two digits represent significant figures and the third digit specifies the number of zeros to follow.

1.2.1.5 Capacitance tolerance. The capacitance tolerance is identified by a single letter as shown in table II.

TABLE II. Capacitance tolerance.

| Symbol | Capacitance tolerance |
|---|---|
| | Percent (±) |
| J | 5 |
| K | 10 |
| M | 20 |

1.2.1.6 Failure rate (FR) level. The FR level (based on life tests performed at specified voltage) is identified by a single letter as shown in table III.

TABLE III. FR level.

| Symbol | Exponential FR level |
|---|---|
| | % per 1,000 hours |
| M | 1.0 |
| P | 0.1 |
| R | 0.01 |
| S | 0.001 |
| | Weibull FR level |
| | % per 1,000 hours |
| B | 0.1 |
| C | 0.01 |
| D | 0.001 |
| E | 0.0001 |

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

2.1.1 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

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

MILITARY

MIL-C-39003 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification For.
MIL-C-39028 - Capacitors, Packaging of.
MIL-C-55365/2 - Capacitors, Chip, Fixed, Tantalum, Established Reliability, Styles CWR03 and CWR04.
MIL-C-55365/4 - Capacitors, Chip, Fixed, Tantalum, Established Reliability, Styles CWR06 and CWR09.
MIL-C-55365/7 - Capacitors, Chip, Fixed, Tantalum, Established Reliability, Style CWR10.
MIL-C-55365/8 - Capacitors, Chip, Fixed, Tantalum, Established Reliability, Style CWR11.
MIL-C-55365/9 - Capacitors, Chip, Fixed, Tantalum, Established Reliability, Style CWR12.

STANDARDS

MILITARY

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-1285 - Marking of Electrical and Electronic Parts.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-554 - Assessment of Outgoing Nonconforming Levels in Parts Per Million (PPM).
EIA-557 - Statistical Process Control Systems.

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

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

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 of award of contract (see 4.4 and 6.4). Authorized distributors which are approved to MIL-STD-790 distributor requirements by the qualified products list (QPL) manufacturers are listed in the QPL.

3.3 Reliability and quality.

3.3.1 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 4.1.2, 4.4.4, and 4.5. The reliability rating is identified by the following FR level symbols:

| Symbol | Exponential FR level (% per 1,000 hrs) | Symbol | Weibull FR level (% per 1,000 hrs) |
|---|---|---|---|
| M | 1.0 | B | 0.1 |
| P | 0.1 | C | 0.01 |
| R | 0.01 | D | 0.001 |
| S | 0.001 | E | 0.0001 (1 FIT) |

3.3.2 Quality.

3.3.2.1 Statistical process control (SPC). The contractor shall implement and use statistical process control techniques in the manufacturing process for parts covered by this specification. The SPC program shall be developed and maintained in accordance with EIA-557. The SPC program shall be documented and maintained as a part of the overall reliability assurance program as specified in MIL-STD-790. The implementation date for statistical process control shall be 12 months from the date of this specification. Processes for application of SPC techniques should include but are not limited to:

a. Pressing

b. Sintering

c. Electrochemical processing

d. Encapsulation

e. Packaging

3.3.2.2 Quality levels. The quality of lots that have been subjected to and have passed the subgroup 1 100 percent screening inspections of the group A inspection shall be established and maintained in accordance with 4.6.1.2.2 and EIA-554, method B. Individual PPM levels (i.e., PPM-2 and PPM-3) and an overall PPM defect level (i.e., PPM-5) shall be established based on the test prescribed in the subgroup 2 tests of the group A inspections. The defect level for PPM-2 shall be less than 100 PPM. Data shall not be excluded from the appropriate PPM calculation unless specifically authorized by the qualifying activity. Guidance for exclusion of data is specified in EIA-554.

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 structure shall be either of the conformally coated or molded form (see 3.1).

3.5.2 Terminals. Terminals shall be of a solid conductor, of the dimensions specified (see 3.1), and shall be suitably treated to facilitate soldering.

3.5.2.1 Reprocessing of terminations. The manufacturer (or his authorized category C distributor) may reprocess the terminations of capacitors supplied to this specification, provided the termination process has been approved by the qualifying activity.

3.5.2.1.1 Reprocessing option. If the manufacturer (or his authorized category C distributor) reprocesses the terminations of the capacitors as a part of normal production, or as a corrective action for solderability failure, the following shall apply:

a. Following any reprocessing, the electrical measurements as specified in group A, subgroup 2, shall be performed on a 200 piece sample for each 8 hours of manufacturing. If there are one of more defects, the individual inspection lot, or lots, from which the defect originated shall be subjected to 100 percent testing of the electrical measurements of group A, subgroup 2, and must meet the DPA requirements as specified in 4.6.1.2.1.

b. PPM-2 data following the reprocessing shall be reported every six months. The calculation method shall be in accordance with method B of EIA-554.

3.6 Voltage aging (exponential only). When tested as specified in 4.7.3, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall be within the tolerance specified (see 3.1). |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| Equivalent series resistance (ESR) (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

3.7 DC leakage. When measured as specified in 4.7.4, the dc leakage shall not exceed the applicable value specified (see 3.1).

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

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

3.10 Vibration, high frequency. When capacitors are tested as specified in 4.7.7, there shall be no intermittent contacts of 0.5 millisecond (ms) or greater duration, or arcing or other indication of breakdown, nor shall there be any open- or short-circuiting or evidence of mechanical damage.

3.11 Thermal shock. When tested as specified in 4.7.8, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall change not more than ±5 percent from the initial measured value. |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |
| Visual Examination | There shall be no evidence of harmful corrosion, mechanical damage, or obliteration of marking (if applicable). |

3.12 Resistance to soldering heat. When tested as specified in 4.7.9, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall change not more than ±5 percent from the initial measured value. |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| Visual examination | There shall be no evidence of mechanical damage. |

3.13 Equivalent series resistance (ESR) (when specified, see 3.1). When measured as specified in 4.7.10, the ESR shall not exceed the value specified (see 3.1).

3.14 Moisture resistance. When tested as specified in 4.7.11, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed 200 percent of the requirement specified in 3.7. |
| Capacitance | Shall change not more than ±15 percent from the initial measured value. |
| Dissipation factor | Shall not exceed 150 percent of the requirement specified in 3.9. |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |
| Visual examination | There shall be no evidence of harmful corrosion, mechanical damage, or obliteration of marking (if applicable). |

3.15 Stability at low and high temperatures. When tested as specified in 4.7.12, capacitors shall meet the following requirements:

Step 1 (+25°C):

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall be within tolerance of the nominal value specified (see 3.1). |
| Dissipation factor | Shall not exceed the applicable value specified (see 3.1). |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

Step 2 (-55°C):

| | |
|---|---|
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the step 1 measured value. |
| Dissipation factor | Shall not exceed the applicable value specified (see 3.1). |

Step 3 (+25°C):

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than ±5 percent from the step 1 measured value. |
| Dissipation factor | Shall not exceed the requirement specified (see 3.1). |

Step 4 (+85°C):

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the step 1 measured value. |
| Dissipation factor | Shall not exceed the requirement specified (see 3.1). |

Step 5 (+125°C):

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the step 1 measured value. |
| Dissipation factor | Shall not exceed the requirement specified (see 3.1). |

Step 6 (+25°C):

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the step 1 measured value. |
| Dissipation factor | Shall not exceed the requirement specified (see 3.1). |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

3.16 Surge voltage (exponential only, see 3.1). When tested as specified in 4.7.13, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the initial measured value. |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

3.17 Life (exponential only, see 3.1). When capacitors are tested as specified in 4.7.14, there shall be no evidence of harmful corrosion or obliteration of marking (if applicable), mechanical damage, intermittent shorts, or permanent shorts or opens.

3.17.1 Qualification inspection. When tested as specified in 4.7.14, capacitors shall meet the following requirements:

At +25°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than the applicable value specified (see 3.1) from the value obtained when measured as specified in 4.7.5. |
| Dissipation factor | Shall not exceed the applicable value specified (see 3.1). |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

At +85°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |

At +125°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |

3.17.2 Quality conformance inspection.

3.17.2.1 For group A inspection. When tested as specified in 4.7.3 or 4.7.17, exponential or Weibull as applicable, capacitors shall meet the requirements specified in 3.6 or 3.20. Weibull FR level grading data from the inspection lot that meets the requirements of 4.7.17 and 3.20 shall be accepted in lieu of 4.7.3 and 3.6.

3.17.2.2 For group C life or extended life (see 4.7.14.1). When tested as specified in 4.7.14, capacitors shall meet the following requirements:

At +25°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |
| Capacitance | Shall change not more than ±10 percent from the value obtained when measured as specified in 4.7.5. |
| Dissipation factor | Shall not exceed the applicable value specified (see 3.1). |

At +85°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |

At +125°C:

| | |
|---|---|
| DC leakage | Shall not exceed the applicable value specified (see 3.1). |

3.18 Solderability. When capacitors are tested as specified in 4.7.15, the dipped portion of the terminations shall conform to the solid-wire termination criteria of method 208 of MIL-STD-202. Solderable surfaces shall be as specified (see 3.1).

3.19 Resistance to solvents. When tested as specified in 4.7.16, marking shall remain legible and shall not smear, and capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall change not more than ±2 percent from the initial measured value. |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

3.20 Weibull FR level grading (in lieu of 3.6). When tested as specified in 4.7.17, capacitors shall exhibit decreasing failure rate with respect to time as evidenced by a value of beta (β) which is less than 0.9; and the instantaneous failure rate in the last interval shall be no more than the failure rate specified. After grading, capacitors shall meet the following requirements:

| | |
|---|---|
| DC leakage | Shall not exceed the requirement specified in 3.7. |
| Capacitance | Shall be within the tolerance specified (see 3.1). |
| Dissipation factor | Shall not exceed the requirement specified in 3.9. |
| ESR (when specified, see 3.1) | Shall not exceed the applicable value specified in 3.13. |

Capacitors tested as specified in 4.7.17 shall be exempt from group A percent defective allowable (PDA) provisions (see 4.6.1.2) and exempt from 3.17.2.2 extended life (see 4.7.14.1).

3.21 Marking. Molded style capacitors shall be marked in accordance with method 1 of MIL-STD-1285, and shall be as specified (see 3.1). Polarity marking shall be as specified (see 3.1). All styles shall have the following information marked on the package.

a. "JAN" brand.

b. Rated capacitance.

c. Rated voltage.

d. Capacitance tolerance.

e. Failure rate level symbol.

f. Part or Identifying Number (PIN).

g. Manufacturer's source code in accordance with MIL-STD-1285.

h. Lot date code.

3.21.1 "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 PIN 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 PIN. 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 Number 504,860 for the certification mark "JAN".

3.21.2 Substitution of failure rate levels. A manufacturer may substitute, with procuring agency approval, failure rate levels in accordance with table IV. Qualified manufacturers may mark exponential failure rate level symbols on parts that have been Weibull graded to level B, C, D, or E. Items having a Weibull failure rate level (FRL) may be substituted, with procuring agency approval, for items of an exponential FRL as shown in table IV. Parts qualified and marked to lower FRL's, with procuring agency approval, are substitutable for higher FRL's, and shall not be remarked unless specified in the contract or purchase order (see 6.2). In the event the failure rate levels are remarked, the date lot codes on the parts shall not be changed and the workmanship criteria shall be met.

TABLE IV. Failure rate level substitutability.

| Parts qualified to failure rate level | Are substitutable for failure rate level |
|---|---|
| D | M, P, R, S, B, and C |
| C | M, P, R, S, and B |
| B | M, P, R, and S |
| S | M, P, and R |
| R | M and P |
| P | M |

3.21.3 Substitution of capacitance tolerance and rated voltage. Parts qualified and marked to tighter capacitance tolerance or higher rated voltage, with procuring agency approval, are substitutable for parts marked to looser capacitance or lower rated voltage, provided all other values, such as case size, characteristic, and terminations remain the same. The substitutable parts shall not be remarked unless specified in the contact or purchase order (see 6.2). In the event the capacitance tolerances or rated voltages are remarked, the lot date codes on the parts shall not be changed and the workmanship criteria shall be met.

3.22 Workmanship. Capacitors shall be processed in such a manner that, when examined under 10X magnification, they shall be uniform in quality and shall be free from pits, cracks, rough edges, and other defects that will affect life, serviceability, or function. The capacitors shall exhibit no demetallization (lift-off) on the terminations.

3.22.1 Soldering. All excess flux or solder shall be removed. Electrical connections shall be electrically continuous after soldering.

3.23 Termination finish code substitutability. Termination finish codes may be substituted for other termination finish codes, with procuring agency approval, in the following manner:

| Termination finish code | May be substituted for termination finish code |
|---|---|
| K | C |
| J | E |
| C, K | H |
| C | K |

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier 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 inspections 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 this 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 contact. 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.

4.1.3 Statistical process control (SPC). An SPC program shall be established and maintained in accordance with EIA-557. Evidence of such compliance shall be verified by the qualifying activity as a prerequisite for qualification and retention of 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 and methods.

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 Methods.

4.3.2.1 AC measurements. AC measurements shall be made at the frequency specified. The magnitude of the ac voltage shall be equal to or less than 1.0 volt root mean square (rms). The maximum dc bias voltage shall be equal to or less than 2.2 volts.

4.3.2.2 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at 25°C ±5°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 rated voltage. The power supply employed for dc leakage current measurements shall be stabilized to at least ±100 parts per million. During measurements there must be no voltage fluctuations of sufficient amplitude to produce a variation in the current measurement as read with any dc leakage current tester used to test capacitors.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.4) on sample units produced with equipment and procedures normally used in production. Qualification approval will be based on the successful completion of the tests specified in table V, and will not be withheld pending completion of the extended life test of 4.4.4.1.1a.

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

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table V, in the order shown. All sample units shall be subjected to the inspections of group I. The units successfully completing group I inspection shall then be divided as specified in table V for groups II through VI (or VII) inclusive, and subjected to the inspections for their particular group; for combined voltage group submissions, each type shall be equally represented in each group (see 4.6.1.1).

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

4.4.4 Failure rate level and quality level verification.

4.4.4.1 Failure rate level qualification.

4.4.4.1.1 Exponential. Exponential FR qualification shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

a. Procedure I - Qualification at the initial FR level. Level "M" (1.0 percent) of FRSP-60 shall apply. Sample units shall be subjected to the qualification inspection specified in group VI, table V (see 4.4.2). The entire life test sample shall be continued on test to 10,000 hours, as specified in 4.7.14.1, on completion of the 2,000 hour qualification test.

b. Procedure II - Extension of qualification to lower FR levels. To extend qualification to the "P" FR level, data from two or more voltages within a style may be combined. For FR levels "R" and "S", the following styles of similar construction (see 4.6.1.1) may be combined: CWR03 and CWR04; CWR09 and CWR11; CWR06, CWR10, and CWR12.

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).

TABLE V. Qualification inspection.

| Inspection 1/ | Requirement paragraph | Method paragraph | Number of sample units to be inspected | Number of failures allowed |
|---|---|---|---|---|
| Group I | | | | |
| Voltage aging (exponential only, see 3.1) | 3.6 | 4.7.3 | 178 | N/A |
| DC leakage | 3.7 | 4.7.4 | | |
| Capacitance | 3.8 | 4.7.5 | | |
| Dissipation factor | 3.9 | 4.7.6 | | |
| Equivalent series resistance (when specified, see 3.1) | 3.13 | 4.7.10 | | |
| Visual and mechanical examination | 3.4, 3.5, 3.21, and 3.22 | 4.7.2 | | |
| Group II | | | | |
| Vibration, high frequency | 3.10 | 4.7.7 | 12 | 1 |
| Thermal shock | 3.11 | 4.7.8 | | |
| Group III | | | | |
| Resistance to soldering heat | 3.12 | 4.7.9 | 18 | |
| Moisture resistance | 3.14 | 4.7.11 | | |
| Group IV | | | | |
| Stability at low and high temperatures | 3.15 | 4.7.12 | 12 | |
| Surge voltage (exponential only, see 3.1) | 3.16 | 4.7.13 | | |
| Group V | | | | |
| Life (at +125°C) | 3.17 | 4.7.14 | 24 | |
| Group VI | | | | |
| Life (at +85°C) | 3.17 | 4.7.14 | 102 | 1 |
| Group VII | | | | |
| Solderability | 3.18 | 4.7.15 | 10 | 0 |
| Resistance to solvents (when specified, see 3.1) | 3.19 | 4.7.16 | | |

1/ For qualification of design changes only, manufacturers may submit Weibull data instead of groups V and VI test data.

4.4.4.1.2 Weibull. Weibull FR qualification will be granted only to manufacturers who have achieved FR level P for any capacitor style covered by this specification or by MIL-C-39003 in accordance with 4.4.4.1.1. To extend qualification to include Weibull FR levels, the manufacturer shall demonstrate the capability of Weibull FR grading (see 4.7.17) to the qualifying activity.

If, during two consecutive reporting periods there has been no production of the lowest Weibull failure rate level for which the manufacturer is qualified, the manufacturer may be required, at the discretion of the qualifying activity, to submit a product of each style to testing in accordance with the qualification inspection requirements. Failure to meet this requirement shall result in a loss of the manufacturer's failure rate to the lowest failure rate last demonstrated.

4.4.4.2 Quality level verification. The contractor is responsible for establishing a quality system to verify the PPM defect level of lots that are subjected to subgroup 2 tests of the group A inspections. The PPM defect level shall be maintained for each specification sheet. The PPM defect level shall be based on a 6 month moving average. The contractor shall verify and report individual PPM categories (i.e., PPM-2, and -3) and an overall PPM defect level (i.e., PPM-5).

4.4.4.3 Noncompliance. The contractor shall notify the qualifying activity when the 100 PPM level is reached or exceeded for PPM-2. The contractor shall provide sufficient information to the qualifying activity documenting the causes of the problem and what corrective action is being taken. Failure to correct this problem shall be the basis for removal of the affected product from the QPL.

4.5 Verification of qualification. Every 6 months, the manufacturer shall compile a summary of the results of quality conformance inspections and, where applicable, extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity as the basis of continued qualification approval. In addition to the periodic submission of FR test data, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain his qualified FR level. Continuation shall be based on the evidence that, over a 6-month period, the following has been met:

a. Verification by the qualifying activity that the manufacturer has met the requirements of MIL-STD-790.

b. The manufacturer has not modified the design of the item. Change in design includes, but is not limited to, any change of materials or processes.

c. The specification requirements of the item have not been amended so as to affect the character of the item.

d. Lot rejection for group A does not exceed 5 percent or one lot, whichever is greater; not applicable to table VIII.

e. Requirements for group C are met.

f. The records of all FR tests combined per style substantiate that the M, P, R, or S level has been maintained.

g. The records of all Weibull life FR tests are summarized for each specification sheet, stress level, and acceleration factor (see table VI).

TABLE VI. Weibull grading failure rate summary.

Burn-in test voltage _____ Manufacturer _____
Voltage stress level _____ Location _____
Acceleration factor _____ Military style _____

| Weibull inspection lot number | Nominal capacitance value | Rated dc volts | Quantity started | Date placed on test | Quantity of 2 hours initial failures | Quantity of end of test falures | Duration (real time test hours) | Beta | Z rate %/K hours | FRL being tested to |
|---|---|---|---|---|---|---|---|---|---|---|
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h. The contractor shall provide documentation to the qualifying activity pertaining to PPM calculations, including numbers of part types tested, individual PPM defect categories (i.e., PPM-2 and -3) and the overall PPM defect rate (PPM-5). This information shall be submitted on a specification sheet basis.

If group C requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, the forwarding of the verification of qualification report may be delayed until 30 days after completion of retesting of the periodic quality conformance tests. In this case, the qualifying activity shall be notified of this condition within the time that the original version of the verification of qualification report was due. All reports shall be certified by a responsible company official. The qualifying activity shall be contacted for the report format.

If a group C test requires a comparison of "post-test" readings with initial readings (delta measurements), the verification of qualification summary shall include the maximum and minimum delta changes for each inspection lot. For life testing, delta C readings shall be reported at each interval in which readings are taken.

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 submission of inspection data, 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 the specification.

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 three consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of each style to testing in accordance with the qualification inspection requirements.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and C inspections. However, shipment need not be held pending the results of group C tests.

4.6.1.1 Inspection and production lot.

4.6.1.1.1 Inspection lot (exponential distribution). An inspection lot shall consist of capacitors of the same specification sheet (see 3.1), from the same production line or lines, of the same basic design, produced under essentially the same conditions, and offered for inspection during a single month. Capacitors of the same specification sheet must be maintained to at least the P level. The capacitance values and voltages produced shall be represented in the lot in approximately the ratio of production. Voltage groups shall be as follows:

| | |
|---|---|
| I - - - - - - - - - - - - - - - - - - - - | 2 to 20 volts inclusive |
| II - - - - - - - - - - - - - - - - - - - - | 25 to 50 volts inclusive |

4.6.1.1.2 Inspection lot (Weibull distribution). An inspection lot shall consist of capacitors of the same specification sheet (see 3.1), voltage rating, design, and nominal capacitance rating produced in the same case size. Manufacture of all parts in the lot shall have been started, processed, assembled, and tested as a group. Lot identity shall be maintained throughout the manufacturing cycle. All anodes shall be fabricated from a single identifiable powder lot.

4.6.1.1.3 Production lot. A production lot shall consist of all capacitors of the same style (note: styles CWR03 and CWR04 may be combined), voltage rating, nominal capacitance value, and termination finish. Manufacture of all parts in the lot shall have been started, processed, assembled, and tested as a group. Lot identity shall be maintained throughout the manufacturing cycle. All anodes shall be fabricated from a single identifiable powder lot.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table VII or VIII, and shall be made on the same set of sample units, in the order shown.

4.6.1.2.1 Subgroup 1 tests.

4.6.1.2.1.1 Exponential. Subgroup 1 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Capacitors failing the tests of subgroup 1 shall be removed from the lot. If, during the 100 percent inspection, screening requires that more than 5 percent of the capacitors be discarded due to catastrophic or dc leakage failures, the entire lot shall be rejected.

4.6.1.2.1.2 Weibull. Subgroup 1 tests shall be performed on an inspection lot basis (see 4.6.1.1.2) on 100 percent of the product supplied under this specification. Requirements for the infant mortal period and Weibull failure rate level grading shall be in accordance with 4.7.17.

4.6.1.2.1.3 Manufacturer's production inspection. If the manufacturer performs tests equal to or more stringent than those specified in subgroup 1 of table VII or VIII, subgroup 1 of group A inspection may be waived and the data resulting from the manufacturer's production tests may be used instead as the final step of this production process. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria shall 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. Test conditions shall be equal to or more stringent than those specified for subgroup 1.

b. Manufacturer subjects 100 percent of the products 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 shall be 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. 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 the production tests.

f. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification and concurrence by the qualifying activity.

TABLE VII. Group A inspection (exponential distribution).

| Inspection 1/ | Requirement paragraph | Test method paragraph | Sampling procedure |
|---|---|---|---|
| Subgroup 1 | | | |
| Voltage aging | 3.6 | 4.7.3 | 100% inspection |
| Subgroup 2 (PPM) | | | |
| DC leakage (PPM-2) | 3.7 | 4.7.4 | See table IX |
| Capacitance (PPM-2) | 3.8 | 4.7.5 | |
| Dissipation factor (PPM-2) | 3.9 | 4.7.6 | |
| Equivalent series resistance (ESR) (when specified, see 3.1) (PPM-2) | 3.13 | 4.7.10 | |
| Mechanical examination (PPM-3) | 3.5 | 4.7.2 | |
| Subgroup 3 | | | |
| Visual examination Materials | 3.4 | 4.7.2 | 13 samples 0 failures |
| Physical dimensions | 3.1 | | |
| Marking | 3.21 | | |
| Workmanship | 3.22 | | |
| Subgroup 4 | | | |
| Stability at low and high temperatures | 3.15 | 4.7.12 | 13 samples 0 failures |
| Subgroup 5 | | | |
| Surge voltage | 3.16 | 4.7.13 | 13 samples 0 failures |
| Subgroup 6 | | | |
| Solderability 2/ | 3.18 | 4.7.15 | 13 samples 0 failures |

1/ Sampling need only conform to the requirements of 4.6.1.1.1 (exponential distribution).
2/ Not applicable to gold plated termination finishes.

TABLE VIII. Group A inspection (Weibull distribution).

| Inspection | Requirement paragraph | Test method paragraph | Sampling procedure |
|---|---|---|---|
| Subgroup 1 | | | |
| Life (accelerated failure rate) 1/ | 3.20 | 4.7.17 | 100% inspection |
| Subgroup 2 (PPM) | | | |
| DC leakage (PPM-2) | 3.7 | 4.7.4 | See table IX |
| Capacitance (PPM-2) | 3.8 | 4.7.5 | |
| Dissipation factor (PPM-2) | 3.9 | 4.7.6 | |
| Equivalent series resistance (ESR) (when specified, see 3.1) (PPM-2) | 3.13 | 4.7.10 | |
| Mechanical examination (PPM-3) | 3.5 | 4.7.2 | |
| Subgroup 3 | | | |
| Visual examination | | | |
| Materials | 3.4 | 4.7.2 | 13 samples 0 failures |
| Physical dimensions | 3.1 | | |
| Marking | 3.21 | | |
| Workmanship | 3.22 | | |
| Subgroup 4 | | | |
| Stability at low and high temperatures | 3.15 | 4.7.12 | 13 samples 0 failures |
| Subgroup 5 | | | |
| Solderability 2/ | 3.18 | 4.7.15 | 13 samples 0 failures |

1/ Exempt from 5 percent PDA; rejects shall not be delivered on the contract or purchase order.
2/ Not applicable to gold plated termination finishes.

TABLE IX. Sampling plans for PPM categories.

| Lot size | Sample size |
|---|---|
| 1 - 125 | 100 percent |
| 126 - 3,200 | 125 |
| 3,201 - 10,000 | 200 |
| 10,001 - 35,000 | 315 |
| 35,001 - 150,000 | 500 |
| 150,001 - 500,000 | 800 |
| 500,001 - up | 1,250 |

4.6.1.2.2 Subgroup 2 tests (PPM categories).

4.6.1.2.2.1 Sampling plans. Subgroup 2 tests shall be performed on an inspection lot basis. Samples subjected to subgroup 2 shall be selected in accordance with table IX based on the size of the inspection lot. In the event of 1 or more failures the lot shall be rejected. Equipment and operators used to perform the subgroup 2 tests shall not be the same as those used in the subgroup 1 100 percent tests.

4.6.1.2.2.2 Rejected lots. The rejected lot shall be segregated from new lots and those lots that have passed inspection. The rejected lot shall be 100 percent inspected by those quality characteristics found defective in the sample and any defectives found removed from the lot. A new sample of parts shall then be randomly selected in accordance with table IX. If 1 or more defects are found in this second sample the lot shall be rejected and shall not be supplied to the specification.

4.6.1.2.2.3 PPM calculations. PPM calculations shall be based on the results of the first sample check as prescribed in 4.6.1.2.2.1. Calculations and data inclusion shall be in accordance with EIA-554. (Note: PPM calculations shall not use data on the second sample submission).

4.6.1.2.3 Subgroups 3 and 4 tests. Subgroups 3 and 4 shall be performed on an inspection lot basis. Sampling inspection shall be in accordance with table VII or table VIII.

4.6.1.2.3.1 Rejected lots. The rejected lot from either subgroup shall be segregated from new lots and those lots which have passed inspection. If a lot is rejected, another 13 samples shall be inspected. If the second sample lot has one or more failures, the entire production lot shall be rejected and shall not be delivered on the contract or purchase order.

4.6.1.2.4 Subgroup 5 test (exponential only). Subgroup 5 test shall be performed with 13 units from the subgroup 3 or 4 tests, with no failures allowed.

4.6.1.2.4.1 Rejected lots. The rejected lot shall be segregated from new lots and those lots which have passed inspection. If a lot is rejected, another 13 samples shall be inspected. If the second sample lot has one or more failures, the entire production lot shall be rejected and shall not be delivered on the contract or purchase order.

4.6.1.2.4.2 Disposition of sample units. Sample units which have been subjected to subgroup 5 shall not be delivered on the contract or purchase order.

4.6.1.2.5 Subgroup 6 (exponential only) or subgroup 5 (Weibull only) (solderability).

4.6.1.2.5.1 Sampling plan. Thirteen samples shall be selected randomly from each inspection lot, as defined in 4.6.1.1, and subjected to the solderability test. The manufacturer may use electrical rejects from the subgroup 1 screening tests for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed.

4.6.1.2.5.2 Rejected lots. If there are one or more defects, the inspection lot shall be rejected. The manufacturer may use one or more of the following options to rework the lot:

a. The individual production lot, or lots, from which the defect originated shall be individually subjected to the solderability test as required in 4.6.1.2.5.1. Production lots that pass the solderability test are available for shipment. Production lots that fail the solderability test may be reworked only if they are subjected to solder dip procedure in "b".

b. The manufacturer shall submit the failed lot to a 100 percent reprocessing of the termination finish in accordance with 3.5.2.1.1. Thirteen additional samples shall then be selected and subjected to the solderability test with no defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.6.1.2.5.3 Disposition of samples. The solderability test is considered a destructive test and samples subjected to the solderability test shall not be supplied on the contract.

4.6.1.3 Group C inspection. Group C inspection shall consist of the tests specified in table X, in the order shown. Group C inspection shall be made on sample units selected from inspection lots which have passed group A inspection; however, sample units subjected to surge voltage shall not be used.

4.6.1.3.1 Sampling plan. There shall be 89 sample units of each specification sheet taken from production every 2 months and subdivided as specified for the subgroups listed in table X and subjected to the tests specified in those subgroups, in the order shown. The maximum and minimum case sizes manufactured during that month shall be represented in the sample in at least the approximate ratio of production. Allowable failures shall be as specified in table X.

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

4.6.1.3.3 Noncompliance. If a sample unit fails to pass group C inspection, the supplier shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections or the inspection that the original sample failed, at the option of the Government). Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown 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.

4.6.2 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.

TABLE X. Group C inspection.

| Inspection | Requirement paragraph | Method paragraph | Number of sample units to be inspected | Number of failures allowed |
|---|---|---|---|---|
| Subgroup I | | | | |
| Vibration, high frequency | 3.10 | 4.7.7 | 12 | 1 |
| Thermal shock | 3.11 | 4.7.8 | | |
| Subgroup II | | | | |
| Resistance to soldering heat | 3.12 | 4.7.9 | 18 | |
| Moisture resistance | 3.14 | 4.7.11 | | |
| Subgroup III | | | | |
| Life (2,000 hrs at +125°C) | 3.17 | 4.7.14 | 24 | 1 |
| Subgroup IV | | | | |
| Life (10,00 hrs at +85°C) FR (exponential only) | 3.17 | 4.7.14.1 | 25 minimum per style | See 4.4.4.1 |
| Subgroup V | | | | |
| Resistance to solvents (when specified, see 3.1) | 3.19 | 4.7.16 | 10 | 0 |

4.7 Methods of inspection and test.

4.7.1 Mounting for testing. Mounting is optional for test environments; however, when specified in the test procedures, the chip capacitors shall be mounted on a suitable substrate (e.g., 96 percent alumina or FR4 glass epoxy). The substrate material shall be such that it shall not be the cause of, nor contribute to, failure of any test for which it may be used. The capacitors shall be mounted on the substrate as follows:

a. A substrate shall be prepared with metallized surface land areas of proper spacing to permit mounting of chips by soldering the terminations of the chips to the "test card" land areas.

b. Solder paste, type "R" or "RMA", in accordance with QQ-S-571, shall be applied to terminals and substrates as applicable.

c. The chip shall then be placed across the metallized land areas of the test substrate so as to make contact between chip and substrate land areas.

d. The substrate shall then be placed in or on a suitable heat transfer unit at a temperature of 135 ±15°C for 1.0 ±0.1 minute. The substrate shall then be placed upon or enter the 245 ±5°C hot-plate or tunnel oven. The substrate shall remain on the hot-plate or tunnel oven at 245 ±5°C until the solder paste melts and reflows forming a homogeneous solder bond to the metallized substrate.

e. All excess flux or solder shall be removed.

4.7.2 Visual and mechanical inspection. Capacitors shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.4, 3.5, 3.21, and 3.22).

4.7.3 Voltage aging (exponential only) (see 3.6). Capacitors shall be subjected to a minimum of 100 percent of dc rated voltage for 40 hours, minimum, at a temperature of 85°C ±5°C. The voltage aging circuit shall have a series resistance of 3.0 ohms, maximum. Capacitors shall then be stabilized at room temperature and the dc leakage, capacitance, and dissipation factor shall then be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

4.7.4 DC leakage (see 3.7). DC leakage shall be measured using the dc rated voltage ±2 percent at the applicable test temperature (see 3.1), after a maximum electrification period of 5 minutes. A 1,000 ohm resistor shall be placed in series with the capacitor to limit the charging current. A steady source of power, such as a regulated power supply, shall be used. Unless otherwise specified (see 3.1), measurement accuracy shall be within ±2 percent or 0.02 microampere (μA), whichever is greater (see 4.3.3).

4.7.5 Capacitance (see 3.8). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. Unless otherwise specified (see 3.1), the following details shall apply:

a. Test frequency: 120 ±5 hertz (Hz).

b. Limit of accuracy: Measurement accuracy shall be within ±2 percent of the reading.

c. Magnitude of polarizing voltage: Maximum dc bias shall be 2.2 volts for all ac measurements. The magnitude of the ac voltage shall be limited to 1.0 volt root mean square (rms).

4.7.6 Dissipation factor (see 3.9). The dissipation factor shall be measured at a frequency of 120 ±5 Hz (unless otherwise specified, see 3.1) by means of a polarized capacitance bridge. The bridge shall provide a dial reading of 0.1 percent dissipation factor and a measuring accuracy of ±(2 percent of the measured dissipation factor plus 0.1 percent).

4.7.7 Vibration, high frequency (see 3.10). Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting of specimens: Capacitors shall be mounted on a substrate as specified in 4.7.1.

b. Electrical-load conditions: During the test, the specified dc rated voltage (see 3.1) shall be applied to the capacitors.

c. Test condition letter: D(20 g).

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

e. Measurements during vibration: During the last cycle, electrical measurements shall be made to determine intermittent open or short circuits. Intermittent contact and arcing shall also be determined. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 millisecond (ms), or greater.

f. Measurements after vibration: Not applicable.

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

4.7.8 Thermal shock (see 3.11). Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting of specimens: Capacitors shall be mounted on a substrate as specified in 4.7.1.

b. Test condition letter: B.

c. Measurements after thermal shock: DC leakage, capacitance, dissipation factor, and ESR (when specified, see 3.1) shall be measured as specified in 4.7.4, 4.7.5, 4.7.6, and 4.7.10, respectively.

d. Examination after test: Capacitors shall be visually examined for evidence of harmful corrosion, mechanical damage, and obliteration of marking (if applicable).

4.7.9 Resistance to soldering heat (see 3.12). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exception shall apply:

a. Mounting of specimens: Capacitors shall be mounted on a substrate using the methods of 4.7.1, except the post pre-heat hot-plate temperatures shall be 260°C ±5°C for a duration of 5 seconds ±0.5 second.

b. Measurements prior to test: DC leakage, capacitance, and dissipation factor shall be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

c. Test condition letter: C.

d. Post test conditioning: The capacitors shall be inserted in a vapor degreasing apparatus containing boiling 1-1-1 trichloroethane for 1.5 +0.5, -0 minutes. The parts shall then be cleaned with isopropyl alcohol.

e. Measurements after test: After completion of the cleaning process and following a minimum 3-hour cooling period, the dc leakage, capacitance, and dissipation factor shall be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

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

4.7.10 Equivalent series resistance (ESR) (when specified, see 3.1)(see 3.13). The ESR at the applicable temperature shall be measured directly or determined from measurements obtained from a bridge. The following details shall apply:

a. Test temperature and tolerance: +25°C ±5°C.

b. Test frequency: 100 kHz ±5 kHz.

c. Limit of accuracy: Measurement accuracy shall be within ±5.0 percent of the reading.

d. Magnitude of polarizing voltage: Unless otherwise specified (see 3.1), the maximum dc bias shall be 2.2 volts for all ac measurements. The magnitude of the ac voltage shall be limited to 0.5 volt rms maximum.

4.7.11 Moisture resistance (see 3.14). Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting of specimens: Capacitors shall be mounted on a substrate as specified in 4.7.1.

b. Initial measurements: Capacitance as specified in 4.7.5.

c. Number of cycles: 20 continuous cycles except that steps 7a and 7b shall be omitted.

d. Loading voltage: Not applicable.

e. Final measurements: After removal from chamber, capacitors shall be dried for 1 hour at room temperature and, within the next hour, dc leakage, capacitance, dissipation factor, and ESR (when specified, see 3.1) shall be measured as specified in 4.7.4, 4.7.5, 4.7.6, and 4.7.10, respectively.

f. Examination after test: Capacitors shall be visually examined for evidence of harmful corrosion, mechanical damage, and obliteration of marking (if applicable).

4.7.12 Stability at low and high temperatures (see 3.15). Capacitors shall be dried at +125°C for 30 +4, -0 minutes, prior to start of test. DC leakage, capacitance, and dissipation factor shall then be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively, at each of the temperatures specified in table XI, except that dc leakage measurements at -55°C (step 2) are not required. ESR (when applicable, see 3.1) shall be measured at steps 1 and 6 as specified in 4.7.10. The capacitors shall be brought to thermal stability at each temperature. Thermal stability will have been reached when no further change in capacitance is observed between two successive measurements taken at 15 +2, -0 minute intervals.

TABLE XI. Temperature for stability test.

| Step | Test temperature (°C) |
|---|---|
| 1 | +25 ±2 |
| 2 | -55 +0, -3 |
| 3 | +25 ±2 |
| 4 | +85 +4, -0 |
| 5 | +125 +4, -0 |
| 6 | +25 ±2 |

4.7.13 Surge voltage (see 3.16). Capacitors shall be subjected to 1,000 cycles of the applicable surge voltage specified in table I. The ambient temperature during cycling shall be +85°C ±5°C. Each cycle shall consist of a 30 +2, -0 second surge voltage application followed by a 30 +2, -0 second discharge period. Voltage application shall be made through a resistor of 33 ohms. The tolerance of the resistor shall be ±5 percent. Each surge voltage cycle shall be performed in such a manner so that the capacitor is shorted terminal to terminal through a copper bar, or an equivalent low resistance at the end of the 30 +2, -0 second application. An alternate method of shorting the capacitor is to discharge through the same resistance that is utilized for charging. After the final cycle, the capacitors shall be stabilized at the inspection conditions specified in 4.3, and the dc leakage, capacitance, dissipation factor, and ESR (when specified, see 3.1) shall be measured as specified in 4.7.4, 4.7.5, 4.7.6, and 4.7.10, respectively.

4.7.14 Life (see 3.17). Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Method of mounting: As specified in 4.7.1.

b. Test temperature and tolerance:

(1) For qualification: Capacitors being subjected to the test of group V of table V shall be tested at +125°C +4, -0°C. Capacitors being subjected to the test of group VI of table V shall be tested at +85°C +4, -0°C.

(2) For group C (2,000 hours proof): Capacitors shall be tested at +125°C +4, -0°C.

c. Operating conditions: A minimum of dc rated voltage (see 3.1) or a minimum of derated voltage at +125°C (see table I), as applicable, shall be applied gradually (not to exceed 5 minutes either by a slow buildup of the voltage or through a resistor which shall be shorted out within 5 minutes). Voltage shall be applied continuously, except for measurement periods. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed 3 ohms. Storage batteries or an electronic power supply capable of suppling at least 1 ampere when a capacitor is shorted shall be used.

d. Test condition letter: F (2,000 hours).

e. Measurements during exposure: DC leakage at the applicable high test temperature shall be measured as specified in 4.7.4 at 0; 240 +48, -0 hours; 1,000 +48, -0 hours; and 2,000 +72, -0 hours.

f. Measurements after exposure: Capacitors shall be returned to the inspection conditions specified in 4.3, and visually examined for evidence of mechanical damage; dc leakage, capacitance, and dissipation factor shall be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

4.7.14.1 Extended life (exponential only). Capacitors shall be tested as specified in 4.7.14, except the test temperature shall be +85°C +4, -0°C, and the duration of the test shall be 10,000 hours. DC leakage shall be measured as specified in 4.7.4 at +85°C at 0; 240 +48, -0 hours; 1,000 +48,-0 hours; 2,000 +72, -0 hours; and every 2,000 hours thereafter until 10,000 +96, -0 hours have elapsed. Final measurements shall be in accordance with 4.7.14f.

4.7.15 Solderability (see 3.18). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. Mounting surfaces shall be dipped to cover the normal mounting surfaces. After the test, the solderable surfaces shall be examined.

4.7.16 Resistance to solvents (when specified, see 3.1) (see 3.19). Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following exceptions shall apply:

a. Brushing is not required.

b. Measurements after test: DC leakage, capacitance, dissipation factor, and ESR (when specified, see 3.1) shall be measured as specified in 4.7.4, 4.7.5, 4.7.6, and 4.7.10, respectively.

4.7.17 Weibull FR level grading (see 3.20). Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Distance of temperature from specimens, in inches: Not applicable.

b. Method of mounting: Capacitors shall be mounted by their terminations.

c. Test temperature and tolerance: +85°C +4°C, -0°C.

d. Operating conditions: Accelerated dc voltage as applicable (see table XII), shall be applied gradually (not to exceed 5 minutes by a slow buildup of the voltage). Maximum acceleration shall be 20,000:1. Voltage shall be applied continuously except for failure count periods. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed one ohm. An electronic power supply capable of supplying at least 5 amperes when a capacitor is shorted shall be used.

e. Minimum sample size for monitoring at the beginning of test prior to infant mortal period: 300 pieces, or 100 percent, whichever is less.

f. Duration of test: 40 hours minimum.

Timing: Infant mortal period $X_1$ $X_2$

| 0 | 15 minutes maximum | 2 hours minimum | 40 hours minimum |
|---|---|---|---|

g. Failure definition: A failure is defined as a blown fuse or equivalent.

h. Failure count during test: The lot size (see 4.6.1.1.2) to be graded is established after removal of gross defectives (infant mortality) (15 minutes maximum). The first failure count shall be performed at least 2 hours after the test was started. The number of blown fuses and the time under test shall be recorded to within ±0.1 hour. Calculate the fraction failed, $p_1$, at time $x_1$, see equation 4 (6.7.2). Optionally, MIL-STD-690, table II FRSP-90 may be used to compute the failure rate based on accelerated part hours generated when C = 0 (see examples A and B, and 6.7.2).

i. Failure count after test: A failure count shall be performed after 40 hours minimum after the test was started. The number of blown fuses and the time under test shall be recorded to within ±0.1 hour. Calculate the cumulative fraction failed, $p_2$, at time $x_2$, see equation 4 (6.7.2).

j. Lot failure rate: Determine Z(t) from equation 3 (6.7.1). If the desired failure rate has been achieved, the lot may be removed from test.

k. Continuation grading: If the desired failure rate has not been reached, the lot may be continued on test. The time to reach the failure rate goal may be determined from equation 5 (6.7.2). If the time calculated to reach the goal failure rate is excessive, the lot may be discarded in favor of a new lot.

l. Measurements after exposure: Capacitors shall be removed from the test, be stabilized at room ambient conditions specified in 4.3, and the dc leakage, capacitance, and dissipation factor shall be measured as specified in 4.7.4, 4.7.5, and 4.7.6, respectively.

TABLE XII. Normal acceleration factors.

| Grading stress $V_a/V_r$ 1/ | Acceleration factor |
|---|---|
| 1.0000 | 1.0000 |
| 1.1000 | 6.5355 |
| 1.2000 | 42.7128 |
| 1.3000 | 279.1496 |
| 1.4000 | 1,824.3823 |
| 1.5000 | 11,923.2626 |
| 1.5276 | 20,000.0000 |

1/ $V_a$ = accelerated voltage.
$V_r$ = rated voltage.

## 5. PACKAGING

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

## 6. NOTES

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

6.1 Intended use. Tantalum chip capacitors are intended to be used in thin or thick film hybrid circuits or surface mount applications where microcircuitry is indicated.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Title, number, and date of the applicable specification sheet, and the complete type designation (see 3.1).

6.3 Supplying for logistic support. Chip components require use of sophisticated equipment to remove from and install on printed wiring boards. Only requistioners with in-house or contracted capability to replace surface mounted components should be supplied with chip components, per their specification.

6.4 Qualification. 1/ 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 the applicable qualified products list, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, 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. The activity responsible for the qualified products list is U.S. Army Laboratory Command; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45444.

6.5 Standard capacitor types. Equipment designers should refer to MIL-STD-198, "Capacitors, Selection and Use of", for standard capacitor types and selected values chosen from this specification. MIL-STD-198 provides a selection of standard capacitors for new equipment design.

6.6 Soldering heat. Caution should be exercised when subjecting these units to soldering heat. Preheat and soldering exposure times and temperatures should be held to a minimum.

6.7 Weibull FR level determination. Weibull FR level determination is based on lot by lot 100 percent quality conformance accelerated failure rate life testing. For example:

| | |
|---|---|
| 2500 | Capacitors have a voltage rating ($V_r$) of 50 V dc; |
| X40 | hours Weibull life test at 65 V dc voltage applied ($V_a$); |
| X279.1496 | accelerated factor for $V_a/V_r$ = 1.3000. |
| 27,914,960 | Accelerated part hours. |

Weibull FRLs are determined from actual lot performance data. Exponential FRL determination starts with several production lots which may be included in the same inspection lot. For example, 4 production lots of 2,500 capacitors having a voltage rating of 50 V dc are offered for inspection in the same inspection lot.

| | |
|---|---|
| 10,000 | Capacitors having a voltage rating ($V_r$) of 50 V dc; |
| X40 | hours voltage conditioning at 50 V dc minimum; |
| 400,000 | part hours, however, exponential lot voltage conditioning performance data are not used to determine FRLs. |
| 110 | Samples are drawn from the inspection lot of 10,000 capacitors; |
| X2000 hours | group C life test at 50 V dc voltage applied; |
| 220,000 | part hours, however, data accumulated and used to determine FRLs. |
| 10 | Samples selected on completing each group C inspection; |
| X9760 | hours continuation life testing to 10,000 hours; |
| 97,600 | rated condition part hours for FRL maintenance. |

Exponential FRLs are based on the aggregate averages of a few samples drawn from many lots maintained in accordance with MIL-STD-690.

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1/ SD-6, Provisions Governing Qualification, is issued for the information of applicants requesting qualification of products. Copies of this publication may be obtained from the Commanding Officer, Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

Time ordered distribution of failures for solid tantalum capacitors is described by the Weibull equation:

Equation 1

$$F(x) = 1 - \exp\left[-\frac{x^{\beta}}{\alpha}\right]$$

Where: F(x) = cumulative fraction failed (p) at time x
x = actual test time
$\beta$ = Weibull "shape parameter" (beta)
$\alpha$ = Weibull "scale parameter

This relationship may be plotted on graph paper which is constructed with ln x as abscissae and ln ln 1/(1-p) as ordinates. Auxiliary scales allow plotting x and p directly. A straight line is obtained. The slope of this line is $\beta$, and the y-intercept is $-\ln\alpha$. Figure 1 illustrates a typical Weibull plot.

At any time x, values for $\beta$ and p can be obtained and the lot failure rate Z (x) may be calculated from equation 3. A second plot of failure rate versus time may be drafted as indicated on figure 2. The slope of this line is $\beta$-1. Acceptable capacitor lots always exhibit decreasing failure rate with respect to time as evidenced by a value of $\beta$ which is less than unity.

6.7.1 Acceleration factors. In order to provide the equivalent of several thousand hours of testing within a practical time frame, voltage acceleration is employed. It has been determined that the application of voltage in excess of rated voltage produces a higher failure rate than that observed when the devices are operated at the nominal voltage rating. On the Weibull plot, a straight line, parallel to the line representing rated voltage is obtained. The increased number of failures indicated by the line representing the higher voltage results from increased dielectric stress. The slopes ($\beta$) of both lines are essentially the same, but the time (x) required to produce any specified p is reduced as voltage is increased. As a result, acceleration factors may be specified which define the relationship between operation at rated voltage and operation at higher-than-rated voltages. For example, a lot of capacitors having a voltage rating of 50 V dc might be tested at 65 V dc. In this case, the ratio of applied voltage to rated voltage is 1.30, resulting in an acceleration factor (A) of 279. In practical terms, operation of these capacitors for 1 hour at 65 V dc is equivalent to operation at 50 V dc for 279 hours. This relationship may be mathematically represented as:

Equation 2

$$Z(t) = Z(Ax) = \frac{\beta}{\alpha} x^{\beta-1} \cdot \frac{1}{A}$$

In conjunction with equation 1, this function may be restated as:

Equation 3

$$Z(t) = F = \frac{-\beta \ln (1-p)}{x} \cdot \frac{10^5}{A}$$

The $10^5$ factor allows for expression of Z(t) in terms of percent per 1,000 hours when x denotes hours. Table XII illustrates a range of acceleration factors normally used for Weibull FR determination.

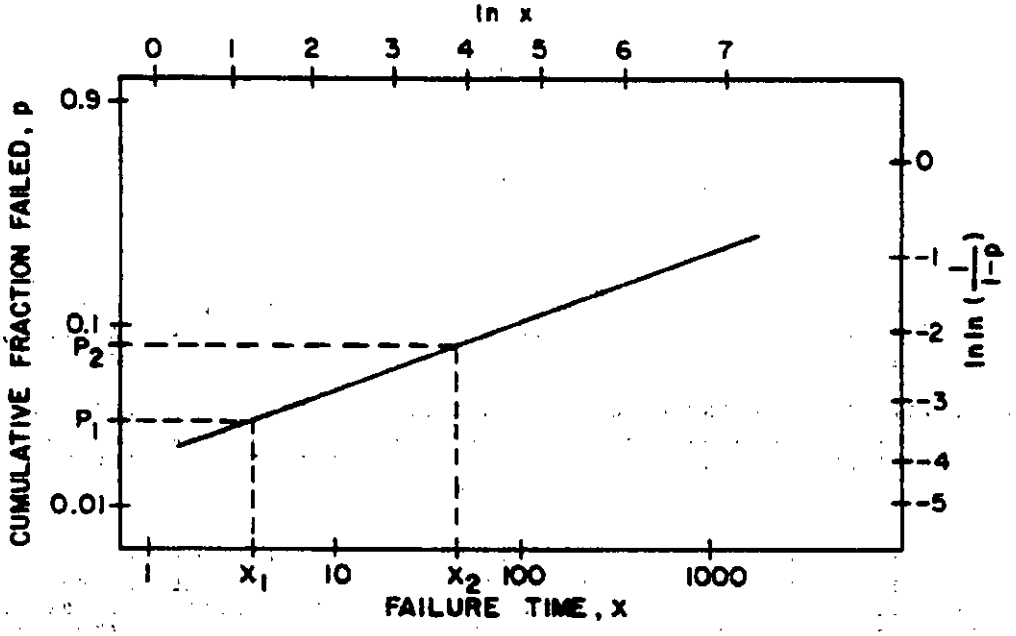


FIGURE 1. Typical weibull plot.

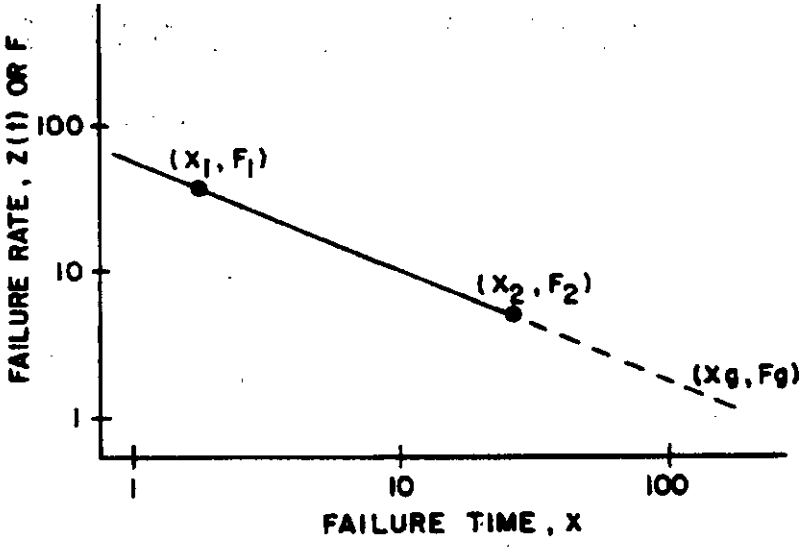


FIGURE 2. Failure rate versus time.

6.7.2 Grading calculations. On the basis of failure counts at $x_1$ and $x_2$ as specified in 4.7.1.1, the slope between these points is calculated as follows:

Equation 4

$$s = \frac{\ln\ln(1/(1-p_2)) - \ln\ln(1/(1-p_1))}{\ln x_2 - \ln x_1}$$

The failure rate at time $x_2$ is then determined from equation 3:

$$F_2 = \frac{-s \ln(1-p_2) \times 10^5}{x_2 A}$$

If additional grading time is required to reach the desired failure rate, the required time $x_g$ may be determined as follows:

Equation 5

$$\ln x_g = \frac{\ln F_g - \ln F_2}{s - 1} + \ln x_2$$

Equation 6

$$A = 7.03412025 \times 10^{-9} \, e^{\left(18.77249321 \times \frac{V_a}{V_r}\right)}$$

A = Acceleration factor
e = Natural logarithm
$V_a$ = Accelerated voltage
$V_r$ = Rated voltage

Examples: A. 880 capacitors tested at a grading stress level of 1.2300 (75.0139 acceleration factor) for 40 hours resulted in zero failures.

880 (75.0139 x 40) = 2,640,489 hours
C = 0
FR = B level (MIL-STD-690 FRSP-90)

B. 1,350 capacitors tested at a grading stress level of 1.3300 (490.2535 acceleration factor) for 40 hours resulted in zero failures.

1,350 (490.2535 x 40) = 26,473,689 hours
C = 0
FR = C level (MIL-STD-690 FRSP-90)

C. 400 capacitors tested at a grading stress level of 1.4000 (1824.3823 acceleration factor) for 40 hours resulted in 1 failure at $x_1$; no additional failures at $x_2$.

400 (1824.3823 x 40) = 29,190,117 hours
C = 1
FR = B level (MIL-STD-690 FRSP-90)

D. 100 capacitors tested at a grading stress level of 1.4000 (1824.3823 acceleration factor) for 41 hours resulted in 3 failures at $x_1$; no additional failures at $x_2$.

100 (1824.3823 x 41) = 7,479,967.430
C = 3
FR = B level (MIL-STD-690 FRSP-90)

OR assume one additional failure at $x_2$
$x_1$ = 2 hours
$x_2$ = 41 hours
$p_1$ = .03
$p_2$ = .04
A = 1824.3823

$$\beta = \frac{\ln \ln \frac{1}{1-p_2} - \ln \ln \frac{1}{1-p_1}}{\ln x_2 - \ln x_1}$$

$$= \frac{\ln \ln \frac{1}{1 - .04} - \ln \ln \frac{1}{1 - .03}}{\ln 41 - \ln 2}$$

$$= \frac{\ln \ln 1.041666 - \ln \ln 1.030928}{3.713572 - 0.693147}$$

$$= \frac{-3.1985499 - (-3.4913617)}{3.02042425}$$

$$= \frac{0.2928118}{3.02042425} = 0.096944$$

$$FRL = \frac{-\beta \ln (1 - p_2)10^5}{x_2 A} = \frac{-0.096944 \ln (.96)10^5}{41\ (1824.3823)}$$

$$= \frac{-0.096944\ (-0.040822)10^5}{74799.67} = 0.000000053 \times 10^5$$

$$= \frac{0.053\%}{1{,}000 \text{ hours}}$$

To compute hours needed to verify 0.001% per 1,000 hours FRL:

$$\ln x_g = \frac{\ln F_g - \ln F_2}{\beta - 1} + \ln x_2$$

$x_2$ = hours at point 2

$x_g$ = hours to test (goal)

$F_2$ = observed FRL at $x_2$

$F_g$ = Failure rate level (goal)

$$\ln x_g = \frac{\ln (0.001) - \ln (0.0053)}{-0.903056} + \ln 41$$

$$= \frac{-6.9077553 - (-5.2400485)}{-0.903056} + 3.713572$$

$$= \frac{-1.6677068}{-0.903056} + 3.713572$$

$$= 1.8467369 + 3.713572 = 5.5503089$$

$$x_g = 259.90 \text{ hours}$$

6.7.3 Weibull grading method. After determining the lot failure rate per 4.7.17, the balance of the lot (when applicable) should be tested to the same voltage acceleration conditions as the monitored test samples. These units shall then be subjected to the 100-percent electrical tests shown in table VIII.

6.8 Termination finish code conversion. Termination finish codes in this revision (see 1.2.1.3) replace those from previous revisions in the following manner:

| Revision C Termination Finish Codes | Replace Previous Revisions Termination Finish Codes |
|---|---|
| B (gold plated) | B (gold) |
| C (hot solder dipped)<br>H (solder plated)<br>K (solder fused) | A (solder-coated nickel)<br>C (solder-coated gold)<br>D (solder-coated alloy 725)<br>F (solder-coated alloy 752) |
| E (tin plated)<br>J (tin fused) | E (tin) |

6.9 Subject term (key word) listing.

Capacitor
Chip
Established reliability
Tantalum
Weibull

6.10 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

APPENDIX

PROCEDURES FOR QUALIFICATION INSPECTION

10 SCOPE

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

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

30 SUBMISSION

30.1 Sample.

30.1.1 Single-style submission. A sample of the size required in table V, of the highest capacitance value in each voltage rating in each style for which qualification is sought shall be submitted.

30.1.2 Combined-voltage submission (exponential). A sample of 89 units of the highest capacitance value of the lowest voltage and 89 units of the highest capacitance value of the highest voltage in each voltage group for each style for which qualification is sought shall be submitted (see table XIII).

TABLE XIII. Combined-Voltage Submission.

| Style | PIN 1/ | Number of units 2/ | Rated voltage | Voltage group |
|---|---|---|---|---|
| CWR03 and CWR04 | CWR0-B-107-M | 89 | 3 | I |
| | CWR0-J-226-M | 89 | 20 | I |
| | CWR0-M-106-M | 89 | 35 | II |
| | CWR0-N-335-M | 89 | 50 | II |
| CWR06 and CWR09 | CWR0-C-107-M | 89 | 4 | I |
| | CWR0-J-226-M | 89 | 20 | I |
| | CWR0-K-156-M | 89 | 25 | II |
| | CWR0-N-475-M | 89 | 50 | II |
| CWR10 | CWR10C-337-M | 89 | 4 | I |
| | CWR10J-476-M | 89 | 20 | I |
| | CWR10K-336-M | 89 | 25 | II |
| | CWR10M-226-M | 89 | 35 | II |
| CWR11 | CWR11D-476-M | 89 | 6 | I |
| | CWR11J-156-M | 89 | 20 | I |
| | CWR11K-106-M | 89 | 25 | II |
| | CWR11N-225-M | 89 | 50 | II |
| CWR12 | CWR12C-227-M | 89 | 4 | I |
| | CWR12J-476-M | 89 | 20 | I |
| | CWR12K-336-M | 89 | 25 | II |
| | CWR12N-106-M | 89 | 50 | II |

1/ The complete PIN shall include additional symbols to indicate style, where applicable, termination finish, and capacitance tolerance.
2/ 300 units for Weibull (see 30.1.3).

30.1.3 Combined-voltage submission (Weibull). A sample of 300 units of the highest capacitance value of the lowest voltage and 300 units of the highest capacitance value of the highest voltage in each voltage group for each style for which qualification is sought shall be submitted (see table XIII). Weibull FR level grading shall be performed in accordance with 3.20 and 4.7.17 instead of voltage aging (exponential only) in group I of table V. DC leakage, capacitance, dissipation factor, and ESR (when specified, see 3.1) shall be performed only once. All other exponential tests in table V shall not apply.

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

30.3 Description of items. The contractor shall submit a detailed description of the capacitors being submitted for inspection, including body, coating, electrode material, terminations, etc.

40. EXTENT OF QUALIFICATION

40.1 Single-style submission. Capacitance-range qualification will be restricted to values equal to or less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. Voltage rating qualification shall be restricted to those submitted.

40.2 Combined-voltage submission. Capacitance-range qualification will be restricted to values equal to or less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. Voltage rating qualification shall be restricted to those submitted.

40.3 Weibull qualification via similiarity. Capacitance-range qualification will be restricted to values equal to or less than the capacitance value submitted. Capacitance-tolerance qualification will be restricted to tolerances equal to and wider than the tolerance submitted. Voltage rating qualification shall be restricted to those submitted.

## CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 85

Review activities:
Army - MI
Navy - SH
Air Force - 17, 99
NASA - NA
DLA - ES

User activities:
Army - AR
Navy - AS, CG, MC, OS
Air Force - 19

Preparing activity:
Army - ER

Agent:
DLA - ES

(Project 5910-1636)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

| I RECOMMEND A CHANGE: | 1. DOCUMENT NUMBER | 2. DOCUMENT DATE (YYMMDD) |
|---|---|---|
| | MIL-C-55365C | 900823 |

3. DOCUMENT TITLE: Capacitor, Fixed, Electrolytic (Tantalum), Chip, Established Reliability, General Specification For

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

| a. NAME (Last, First, Middle Initial) | b. ORGANIZATION |
|---|---|
| c. ADDRESS (Include Zip Code) | d. TELEPHONE (Include Area Code)<br>(1) Commercial<br>(2) AUTOVON<br>(If applicable) |

e. DATE SUBMITTED (YYMMDD)

7. PREPARING ACTIVITY

| a. NAME | b. TELEPHONE (Include Area Code)<br>(1) Commercial | (2) AUTOVON |
|---|---|---|
| LABCOM | (201) 544-3148 | 995-3148 |
| c. ADDRESS (Include Zip Code)<br>ATTN: SLCET-RS<br>Fort Monmouth, NJ 07703 | IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:<br>Defense Quality and Standardization Office<br>5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466<br>Telephone (703) 756-2340 AUTOVON 289-2340 | |

DD Form 1426, OCT 89 — Previous editions are obsolete. — 198/290