

PERFORMANCE SPECIFICATION

CAPACITORS, FIXED, METALLIZED, PLASTIC FILM DIELECTRIC,
 (DC, AC, OR DC AND AC), HERMETICALLY SEALED IN METAL CASES OR CERAMIC CASES,
 ESTABLISHED RELIABILITY, GENERAL SPECIFICATION FOR

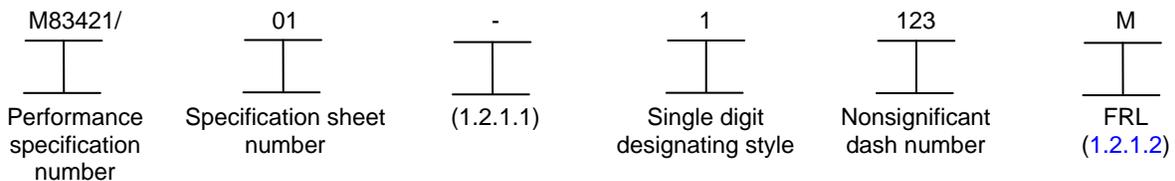
This specification is approved for use by all Departments
 and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability (ER), metallized plastic film dielectric, fixed capacitors, hermetically sealed in metal or ceramic cases. Capacitors covered by this specification have failure rate levels (FRL) established in accordance with MIL-STD-690. The reliability for each level is identified by a symbol in accordance with table I. These FRLs are established at a 90 percent confidence level and maintained at a 10 percent producer's risk and, unless otherwise specified (see 3.1), are based on life tests performed at maximum rated voltage at maximum rated temperature. Unless otherwise specified (see 3.1), an acceleration factor of 5:1 has been used to relate life-test data obtained at 140 percent of rated voltage at maximum rated temperature, to rated voltage at maximum rated temperature (see 6.1). 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 the requirements of this specification.

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

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



1.2.1.1 Dash. Use "-" for standard product or "H" for random vibration option.

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

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

TABLE I. FRL.

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

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-PRF-83421/1 - Capacitors, Fixed, Metallized Plastic Film, Dielectric, DC and AC, Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH01, CRH02, CRH03, CRH04, CRH05, CRH06, CRH07, CRH08, CRH09, and CRH00.
- MIL-PRF-83421/2 - Capacitors, Fixed, Metallized Plastic Film, Dielectric, (DC, AC, or DC and AC), Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH11, CRH12, and CRH13 (Insulated).
- MIL-PRF-83421/6 - Capacitors, Fixed, Metallized Plastic Film Dielectric, DC and AC, Hermetically Sealed in Metal Cases, Established Reliability, Styles CRH31, CRH32, CRH33, CRH34, and CRH35.

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-202 - Test Methods Standard Electronic and Electrical Component Parts.
- MIL-STD-690 - Failure Rate Sampling Plans and Procedures.
- MIL-STD-790 - Standard Practice for Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications.
- MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- [ASTM D92](#) - Standard Test Method for Flash and Fire Points by Cleveland Open Cup. (DoD adopted).

(Copies of this document is available from <http://www.astm.org> or American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

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.)

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

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification 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 (QPL) before contract award. In addition, the manufacturer shall obtain certification from the qualifying activity that the QPL system requirements of 3.3 and 4.2 have been met and are being maintained. Authorized distributors 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 a QPL system for parts covered by this specification. Requirements for this system are specified in [MIL-STD-690](#) and [MIL-STD-790](#). In addition, the manufacturer shall establish a Statistical Process Control (SPC) and Part Per Million (PPM) system which meets the requirements of 3.3.1 and 3.3.2, respectively. The following [MIL-STD-790](#) exception is 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 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4.1 Impregnant. The impregnant shall be chemically inactive with respect to the capacitor element and the case. The impregnant, 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-impregnated capacitors, the same material shall be used for impregnating as is used for filling.

3.4.2 Metals. Metals shall be of a corrosion-resistant type or shall be plated or treated to resist corrosion. Silver plating shall not be used in any external portions of these capacitors.

3.4.2.1 Dissimilar metals. Where dissimilar metals are used in intimate contact with each other, provision shall be made to provide protection against electrolysis and corrosion. The use of dissimilar metals in contact, which may tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy), shall not be acceptable. However, metal plating or metal spraying of dissimilar metals to base metals to provide similar or suitable abutting surfaces will be permitted (for example, the spraying of copper on aluminum for soldering operations will be permitted). The use of dissimilar metals separated by insulating material will also be permitted.

3.4.3 Pure tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of capacitor components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.7). Lead-free, tin alloy high temperature solders may be used where high temperature solder is necessary with the approval of the qualifying activity. The tin content of lead-free high temperature solders shall not exceed 97 percent, by mass.

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

3.5.1 Case. Each capacitor shall be enclosed in a hermetically-sealed case (see 3.1) which will protect the capacitor element from moisture, impregnant or filling compound leakage, and mechanical damage under all test conditions specified herein.

3.5.2 Sleeving. The sleeving material shall not soften, creep, or shrink to a point where any part of the cylindrical portion of the case is left uncovered at any test temperature specified herein. The sleeving shall not obscure the part marking.

3.5.3 Leads. Leads shall be solderable and meet the requirements of 3.19.

3.5.3.1 Solder dip (retinning) leads. Only the manufacturer (or his authorized category B or C distributor) may solder dip/retin the leads of product supplied to this specification provided the solder dip process (see appendix A) has been approved by the qualifying activity.

3.6 Burn-in (when specified, see 3.1). When tested as specified in 4.7.2, capacitors shall withstand the exposure to high temperature and voltage without visible damage.

3.7 Dielectric absorption (when specified, see 3.1). When measured as specified in 4.7.3, the dielectric absorption shall not exceed the value specified.

3.8 Thermal shock. When tested as specified in 4.7.4, capacitors shall withstand the extremes of high and low temperatures without visible damage.

3.9 Seal.

3.9.1 Liquid-impregnated or solid-impregnated capacitors. When capacitors are tested as specified in 4.7.5, there shall be no evidence of leakage of impregnant or repetitive bubbling.

3.9.2 Liquid-filled capacitors. When capacitors are tested as specified in 4.7.5, there shall be no evidence of liquid leakage.

3.10 Dielectric withstanding voltage. When tested as specified in 4.7.6, capacitors shall be capable of withstanding the potentials specified (see 3.1) without permanent damage, open-circuiting or short-circuiting.

3.11 Insulation resistance. When capacitors are tested as specified in 4.7.7, the following shall apply.

3.11.1 Terminal to terminal. When measured as specified in 4.7.7b(1), the insulation resistance shall be not less than the values specified (see 3.1).

3.11.2 Terminals to case (when case is not a terminal). When measured as specified in 4.7.7b(2), the insulation resistance between terminals and case shall be not less than the value specified (see 3.1).

3.12 Capacitance. When measured as specified in 4.7.8, the capacitance shall be within the applicable tolerance specified (see 3.1).

3.13 Dissipation factor. When measured as specified in 4.7.9, the dissipation factor shall not exceed the value specified (see 3.1).

3.14 Equivalent series resistance (ESR) (applicable to styles CRH11, CRH12, and CRH13). When measured as specified in 4.7.10, the ESR (in ohms) shall not exceed the value specified (see 3.1).

3.15 Barometric pressure (reduced) for qualification only. When tested as specified in 4.7.11, capacitors shall withstand the specified potential (see 3.1) without visible damage, external flashover, open-circuiting or short-circuiting.

3.16 Vibration, high frequency and random. When capacitors are tested as specified in 4.7.12, there shall be no evidence of mechanical damage, intermittent contacts of 0.5 millisecond (ms) or greater duration, open-circuiting or short-circuiting.

3.17 Salt atmosphere (corrosion). When capacitors are tested as specified in 4.7.13, there shall be no harmful or extensive corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be protected by the finish. Harmful corrosion shall be construed as being any type of corrosion which in any way interferes with mechanical or electrical performance. In addition, there shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable. Marking shall remain legible.

3.18 Immersion. When tested as specified in 4.7.14, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Insulating sleeves-----	Shall be greater than 4,000 volts, dc.
Terminal to terminal -----	Shall be as specified (see 3.1).
Terminals to case (when case is not a terminal) -----	Shall be as specified (see 3.1).

Insulation resistance:

Insulating sleeves-----	Shall be 10,000 megohms, minimum.
Terminal to terminal -----	Shall be not less than the specified percent of the initial requirement (see 3.1).

Terminals to case (when case is not a terminal) ----- Shall be not less than the value specified (see 3.1).

Capacitance ----- Shall change not more than the specified percent (see 3.1) of the initial measured value.

Dissipation factor----- Shall not be more than the specified percent (see 3.1).

As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, when applicable, or obliteration of markings.

3.19 Solderability. When capacitors are tested as specified in 4.7.15, the terminals shall conform to the criteria of method 208 of MIL-STD-202.

3.20 Shock (specified pulse). When capacitors are tested as specified in 4.7.16, there shall be no mechanical damage, no evidence of intermittent contacts of 0.5 ms or greater duration, open-circuiting or short-circuiting.

3.21 Resistance to soldering heat. When tested as specified in 4.7.17, capacitors shall meet the following requirements:

Insulation resistance ----- Shall be as specified in 3.11.
 Capacitance ----- Shall change not more than the specified percent of the initial measured value (see 3.1).
 Dissipation factor----- Shall be not greater than initial limit.

3.22 Moisture resistance. When tested as specified in 4.7.18, capacitors shall meet the following requirements:

Dielectric withstanding voltage:
 Insulating sleeves----- Shall be greater than 4,000 volts, dc.
 Terminal to terminal ----- Shall be as specified (see 3.1).
 Terminals to case (when case is not a terminal) ----- Shall be as specified (see 3.1).

Insulation resistance:
 Insulating sleeves----- Shall be 10,000 megohms, minimum.
 Terminal to terminal ----- Shall be not less than the specified percent of the initial requirement (see 3.1).

Terminals to case (when case is not a terminal) ----- Shall be not less than the value specified (see 3.1).
 Capacitance ----- Shall change not more than the specified percent (see 3.1) of the initial measured value.
 Dissipation factor----- Shall be not more than the specified percent (see 3.1).

As a result of the test, corrosion of exposed metal surfaces shall not exceed 10 percent. Discoloration and tarnishing alone shall not be cause for rejection. There shall be no unwrapping of, or mechanical damage to the insulating sleeves, or obliteration of markings.

3.23 Terminal strength. When capacitors are tested as specified in 4.7.19, there shall be no permanent damage to the terminals or seal.

3.24 Low-temperature life. When capacitors are tested as specified in 4.7.20, there shall be no evidence of mechanical damage.

3.25 Fungus. The manufacturer shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.21. When capacitors are tested as specified in 4.7.21, inspection shall disclose no evidence of fungus growth.

3.26 Resistance to solvents. When capacitors are tested as specified in 4.7.22, marking shall remain legible and shall not smear or rub off. In addition, there shall be no visible indication of damage or deterioration of the capacitor body.

3.27 Temperature coefficient. When capacitors are tested as specified in 4.7.23, the capacitance changes at the specified temperatures shall not exceed the applicable limits (see 3.1).

3.28 Life. When tested as specified in 4.7.24, capacitors shall meet the following requirements:

Insulation resistance:	
Terminal to terminal -----	Shall be not less than the specified percent of the initial requirement (see 3.1).
Terminals to case (when case is not a terminal) -----	Shall be not less than the value specified (see 3.1).
Capacitance -----	Shall change not more than the specified percent of the initial measured value (see 3.1).
Dissipation factor-----	Shall be not greater than the limit specified (see 3.1).
Visual inspection -----	There shall be no corrosion, leakage of impregnant, or mechanical damage either during or after the test.

3.29 AC conditioning (when specified, see 3.1). When tested as specified in 4.7.25, capacitors shall withstand the ac voltage exposure without visible damage.

3.30 Flash point of impregnant (when specified, see 3.1). When tested as specified in 4.7.26, the flash point of impregnant shall be not lower than 145°C.

3.31 Marking. Marking of capacitors shall conform to method I of MIL-STD-1285, and shall include the Part Number or Identifying Number (PIN) (see 6.6), "JAN" marking, date code, lot symbol, manufacturer's source code, capacitance (in μF), capacitance tolerance, and rated voltage (see 4.7.1). The manufacturer shall provide for lot traceability by date code and lot symbol. Manufacturing records shall include these same date codes and lot symbols.

Example of marking:

M83421/01	-	PIN (may be on one line if space permits).
2107M		
.018 μF 5% 50 V	-	Capacitance, capacitance tolerance, and rated voltage (dc or ac, as applicable).
JAN 0533A 12345	-	"JAN" marking, date code, lot symbol, and source code (manufacturer's item serial number may be included if space permits).

3.31.1 JAN and J marking. The United States Government has adopted and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of specifications. Accordingly, items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" and "J" shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the part number. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein 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, 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".

3.31.2 Supplying to higher failure rate levels. A manufacturer may supply to all higher failure rate levels than to which he is qualified. Parts qualified and marked to lower failure rate levels, with acquiring agency approval, are substitutable for higher failure rate levels, and shall not be remarked unless specified in the contract or acquisition document (see 6.2).

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

3.32 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.

3.33 Workmanship. Capacitors shall be processed in such a manner as to be uniform in quality when using a magnification between 5X and 7X. External leads shall not exhibit cold solder, pits, cuts, nicks, or scrapes exceeding 10% of the length of the leads. Separation of the solder between the lead and the eyelet seal due to lead forming is not rejectable. These capacitors are not required to be solderable within .125 inch of the eyelet, seal or case.

4. VERIFICATION

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

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

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

4.3 Inspection conditions. Unless otherwise specified, 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. Unless otherwise specified (see 3.1), accuracy of all test voltage measurements shall be within ± 2.0 percent of the specified voltage.

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4.3.1 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at +25°C ±3°C prior to beginning of conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.3.2 Power supply. The power supply used for life testing shall have a regulation of ±2 percent or less of the specified test voltage.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the qualifying activity (see 6.4) 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 appendix A of this specification.

4.4.2 Inspection routine. Sample units shall be subjected to the qualification inspection specified in table II, in the order shown. All sample units, including those sample units required for group X testing (when applicable), shall be subjected to the inspections of group I (when applicable) and group II. The sample units, with the exception of group X samples (when applicable) shall then be divided into the eight remaining groups as specified in table II, and subjected to the tests for their particular group.

Sample units which have been selected to be submitted to the life test shall be divided into two groups; one group shall be subjected to the accelerated condition and the other group to the rated condition. The decision as to whether or not the product is to be included on the qualified products list shall be made at the conclusion of the 2,000-hour life test.

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

TABLE II. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defects permitted <u>1/</u>
<u>Group I</u>				
Burn-in (when specified, see 3.1)	3.6	4.7.2	<u>2/ 3/</u> 89 min	NA
Dielectric absorption (when specified, see 3.1)	3.7	4.7.3		
<u>Group II 4/</u>				
Visual and mechanical examination	3.1, 3.4, 3.5	4.7.1		
Marking <u>5/</u>	3.31	4.7.1		
Workmanship (external)	3.33	4.7.1		
Thermal shock	3.8	4.7.4		
Seal	3.9	4.7.5		
Dielectric withstanding voltage	3.10	4.7.6	<u>2/ 3/</u> 89 min	NA
Insulation resistance	3.11	4.7.7		
Capacitance	3.12	4.7.8		
Dissipation factor	3.13	4.7.9		
Equivalent series resistance <u>6/</u>	3.14	4.7.10		
Barometric pressure (reduced)	3.15	4.7.11		

See footnotes at end of table.

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TABLE II. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defects permitted <u>1/</u>
<u>Group III</u> Vibration, high frequency Salt atmosphere (corrosion) <u>7/</u> Immersion <u>7/</u>	<u>3.16</u> <u>3.17</u> <u>3.18</u>	<u>4.7.12.1</u> <u>4.7.13</u> <u>4.7.14</u>	6	
<u>Group IV</u> Solderability Shock (specified pulse) Resistance to soldering heat Moisture resistance	<u>3.19</u> <u>3.20</u> <u>3.21</u> <u>3.22</u>	<u>4.7.15</u> <u>4.7.16</u> <u>4.7.17</u> <u>4.7.18</u>	6	1
<u>Group V</u> Terminal strength Low temperature life	<u>3.23</u> <u>3.24</u>	<u>4.7.19</u> <u>4.7.20</u>	6	
<u>Group VI</u> Fungus <u>8/</u> Resistance to solvents	<u>3.25</u> <u>3.26</u>	<u>4.7.21</u> <u>4.7.22</u>	4 4	1
<u>Group VII</u> Temperature coefficient Life (accelerated conditions) Life (rated conditions)	<u>3.27</u> <u>3.28</u> <u>3.28</u>	<u>4.7.23</u> <u>4.7.24</u> <u>4.7.24</u>	33 30	1
<u>Group VIII</u> <u>2/</u> AC conditioning	<u>3.29</u>	<u>4.7.25</u>	24	1
<u>Group IX</u> Flash point of impregnant (when specified, see <u>3.1</u>)	<u>3.30</u>	<u>4.7.26</u>	1	0
<u>Group X</u> (when applicable) Vibration, random <u>9/</u>	<u>3.16</u>	<u>4.7.12.2</u>	<u>10/</u>	0

1/ A sample unit having one or more defects shall be considered as a single defect.

2/ Group VIII for styles CRH11, CRH12, and CRH13 only. Group I and group II samples shall be 113 minimum.

3/ This total shall be determined by the number of capacitors tested for random vibration in group X. Additional samples over the minimum should be included to allow for any failures.

4/ Nondestructive tests.

5/ Marking defects are based on visual inspection only and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

6/ Equivalent series resistance applicable to styles CHR11, CHR12, and CHR13.

7/ One-half of the sample units shall be tested with the insulating sleeves removed.

8/ Certification of fungus resistance may be substituted for testing.

9/ Unless otherwise specified, random vibration is optional (see 3.1).

10/ When applicable, an additional three sample units of the longest case length of each diameter for which qualification is sought shall be required for group X testing.

4.4.4 Failure rate (FR) qualification. 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 FRL. Level "M" (1.0 percent) of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group VII, [table II](#) (see [4.4.2](#)). The entire life test sample shall be continued on test to 10,000 hours as specified in [4.7.24.2.2](#), upon completion of the 2,000 hour qualification.
- b. Procedure II - Extension of qualification to lower FRLs. To extend qualification to the "R" (0.01 percent) and "S" to (0.001 percent) FRLs, data from two or more styles within a specification sheet may be combined.
- c. 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. See [4.6.2.1.1](#) for maintenance of [MIL-PRF-83421/2](#) styles.

4.4.5 Quality level verification. The manufacturer is responsible for establishing a quality system to assess the ppm defect level of lots that are subjected to the 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.

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

- a. [MIL-STD-790](#) program.
- b. The capacitor design has not been modified.
- c. Lot rejection for group A inspection does not exceed 5 percent or one lot, whichever is greater.
- d. The requirements for group B inspection are met.
- e. Verification of FRLs.
- f. PPM assessment.

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. In the case where the lowest failure rate for an un-produced style is M, 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. If during three consecutive reporting periods there has been no production of a given style, the manufacturer may be required, at the discretion of the qualifying activity, to submit a newly-produced (not from stock) representative product of that style to testing.

4.6 Conformance inspection.

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

4.6.1.1 Inspection and production lot.

4.6.1.1.1 Inspection lot. An inspection lot shall consist of all capacitors from the same production line or lines, of one or more styles from the same specification sheet, not less than the minimum number of dielectric layers, and offered for inspection during a single work month. The minimum number of dielectric layers is the number of layers used in the sample units submitted for qualification. Each lot shall be kept separate from every other lot. The sample selected from the lot shall be representative of the capacitance values and case sizes in the lot. All sample units belonging to a lot shall be identified by means of a code symbol (either letters or numbers, at the option of the manufacturer).

4.6.1.1.2 Production lot. A production lot shall consist of capacitors of the same style, voltage rating, and nominal capacitance value. 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.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examination and tests specified in [table III](#).

4.6.1.2.1 Subgroup 1 tests. Subgroup 1 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification. Lots having more than 5 percent total rejects shall not be furnished on contracts. A failure is defined as capacitance value exceeding ± 20 percent of its nominal value, insulation resistance (IR) less than 100 megohms, or dissipation factor (DF) exceeding the limits specified after 10,000-hour life.

4.6.1.2.1.1 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 1, [table III](#), as the final step of the production process, group A, subgroup 1 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria shall be 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 tests.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to the 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 are the same or more stringent than those specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in the production tests. The manufacturer shall also make available to the Government all records of all detail test data resulting from 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 III. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sampling procedure
<u>Subgroup 1</u>			
Thermal shock	3.8	4.7.4	100% inspection
Burn-in	3.6	4.7.2	
Seal	3.9	4.7.5	
Dielectric withstanding voltage	3.10	4.7.6	
Insulation resistance (at +25°C)	3.11	4.7.7	
Capacitance	3.12	4.7.8	
Dissipation factor	3.13	4.7.9	
Equivalent series resistance <u>1/</u>	3.14	4.7.10	
<u>Subgroup 2</u> <u>2/</u>			
Visual inspection, external	3.1	4.7.1	See table IV
Physical dimensions	3.4, 3.5	4.7.1	
Marking <u>3/</u>	3.31	4.7.1	
Workmanship	3.33	4.7.1	
<u>Subgroup 3</u>			
Solderability <u>4/</u> <u>5/</u>	3.19	4.7.15	5 samples 0 failures

1/ For styles CRH11, CRH12, and CRH13 only.

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

3/ Marking defects are based on visual inspection and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as a basis for determining marking defects.

4/ The manufacturer may request the deletion of the subgroup 3 solderability test, provided an inline or process control system for assessing and assuring the solderability of leads can be validated and approved by the qualifying activity. Deletion of the test does not relieve the manufacturer from meeting this test requirement.

5/ Electrical rejects from subgroup 1 may be used for solderability.

4.6.1.2.2 Subgroup 2 tests. Subgroup 2 tests shall be performed on an inspection lot basis. The sampling procedure shall be as specified in [table IV](#). If one or more defects are found, the lot shall be rescreened and defects removed. A new sample shall then randomly be selected. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE IV. Sampling plans for subgroup 2.

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

4.6.1.2.3 Subgroup 3 tests (solderability).

4.6.1.2.3.1 Inspection lot. An inspection lot for the purpose of subgroup 3 (solderability) testing shall consist of all lots manufactured with the same diameter lead wire and offered for inspection within the same work week. Each production lot shall be kept separate from every other lot. All samples belonging to a production lot shall be identified to that lot. Means of identification is at the option of the manufacturer. Test samples may be selected from subgroup 1 electrical failures.

4.6.1.2.3.2 Sampling plan. A minimum of 5 pieces shall be selected randomly from each inspection lot; however, each production lot shall be represented in the sample. If the inspection lot consists of more than 5 production lots, then a minimum of one sample shall be selected from each production lot. If there are one or more failures, the inspection lot shall be considered to have failed.

4.6.1.2.3.3 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer may use one of the following options to rework the lot:

- a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.1.2.3.2. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in 4.6.1.2.3.3b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with [appendix A](#). Following the solder dip, the electrical measurements required in group A, subgroup 1 tests (dielectric withstanding voltage, insulation resistance at +25°C, capacitance, dissipation factor and equivalent series resistance, if applicable) shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests. (Note: If hermetic seal is required in the group A, subgroup 1 tests, this test shall be repeated.) Thirteen additional samples shall be then selected and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot may be reworked a second time and retested. If the lot fails this second rework, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

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

4.6.1.2.4 PPM calculations. The manufacturer shall establish a PPM system in accordance with 3.3.2 for assessing and calculating average outgoing quality of capacitors. A PPM rate combining capacitance, DF, IR (+25°C), and ESR 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.

4.6.2 Periodic group B inspection. Periodic group B inspection shall consist of the tests specified in table V, in the order shown, and shall be performed on sample units selected from inspection 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 periodic inspection.

4.6.2.1 Sampling plan.

4.6.2.1.1 Subgroup 1. Every 2 months, 12 sample units from production shall be inspected as shown in table V.

4.6.2.1.2 Subgroup 2. A minimum of 10 sample units shall be selected from each group A inspection lot as defined in 4.6.1.1.1. The actual number of sample units required to maintain the required FRL may be more.

If qualification has been granted at the "R" or "S" FRL for MIL-PRF-83421/2 styles (CRH11, CRH12, and CRH13), and production is not sufficient to maintain the FRL, qualification may be maintained by similarity with MIL-PRF-83421/1 styles. However, a minimum number of hours shall be generated from MIL-PRF-83421/2 styles to maintain "P" FRL. This may require more than the minimum number of 10 sample units. Similarity may only be used for FRL maintenance and not for initial qualification.

4.6.2.1.3 Subgroup 3. Sample units of the same style shall be inspected (see 3.1). Testing need only be done in January and July (30 V dc units); February and August (50 V dc units); March and September (100 V dc units); April and October (200 V dc units); May and November (400 V dc units); and June and December (300 V dc and 600 V dc units).

4.6.2.1.4 Subgroup 4. Every 6 months, 2 sample units of each case diameter produced shall be inspected as shown in table V. The maximum and minimum case sizes manufactured shall be represented in the sample in at least the approximate ratio of production.

4.6.2.1.5 Subgroup 5. Every 6 months, 18 sample units from production shall be divided and inspected as shown in table V. The maximum and minimum case sizes manufactured shall be represented in the sample in at least the approximate ratio of production.

4.6.2.2 Disposition of sample units. Subgroup 2 through subgroup 5 inspections are considered destructive. Sample units that have been subjected to these inspections shall not be delivered on the contract.

4.6.2.3 Noncompliance. If a sample unit fails to pass group B inspection, the manufacturer shall notify the qualifying activity and cognizant activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, and so forth, and which are considered subject to the same failure.

4.7 Methods of inspection and test.

4.7.1 Visual and mechanical inspection. All capacitors shall be examined using 5X to 7X magnification to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.31, and 3.33).

4.7.2 Burn-in (see 3.1 and 3.6). Capacitors shall be tested under accelerated voltage conditions as specified in 4.7.24, with the following exceptions:

- a. AC burn-in, when applicable: Details are specified in specification sheet (see 3.1).
- b. DC burn-in: Shall be exposed to a temperature of +125°C with 140 percent, minimum of dc derated voltage for 16 hours, minimum.

TABLE V. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defects permitted
<u>Subgroup 1</u> Insulation resistance (at applicable maximum rated temperature) Temperature coefficient	3.11 3.27	4.7.7 4.7.23	12 samples every 2 months	1
<u>Subgroup 2</u> Life	3.28	4.7.24.2.1	10 per inspection lot minimum	1/
<u>Subgroup 3</u> AC conditioning (when specified, see 3.1) Equivalent series resistance 2/ Dissipation factor Insulation resistance	3.29 3.14 3.13 3.11	4.7.25 4.7.10 4.7.9 4.7.7	10 per inspection lot minimum, unless otherwise specified (see 3.1)	1
<u>Subgroup 4</u> Vibration, high frequency Vibration, random 3/	3.16 3.16	4.7.12.1 4.7.12.2	2 samples per each case diameter	1
<u>Subgroup 5</u> Salt spray (corrosion) 4/ 5/ Immersion 4/ 5/ Shock (specified pulse) Resistance to soldering heat 5/ Moisture resistance 5/ Dielectric absorption (when specified, see 3.1) 5/ Terminal strength 5/ Resistance to solvents 5/	3.17 3.18 3.20 3.21 3.22 3.7 3.23 3.26	4.7.13 4.7.14 4.7.16 4.7.17 4.7.18 4.7.3 4.7.19 4.7.22	6 6 6	1

1/ See MIL-STD-690 for number of defectives permitted.

2/ For styles CRH11, CRH12, and CRH13 only.

3/ Unless otherwise specified, random vibration is optional (see 3.1).

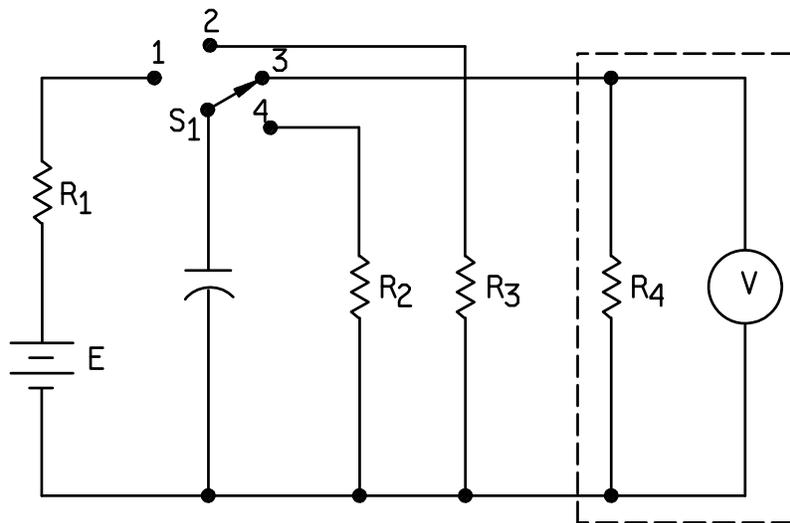
4/ One-half of the sample units shall be tested with the insulating sleeve removed.

5/ 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.

4.7.3 Dielectric absorption (when specified, see 3.1 and 3.7). The capacitor shall be charged at dc rated voltage or 100 volts dc (whichever is less) for a minimum period of 5 minutes. The initial surge current shall not exceed 50 milliamperes. A typical test schematic is shown in figure 1. At the end of this period, the capacitor shall be disconnected from the power source and discharged through a 5 ohm ± 1 percent resistor for 5 ± 0.5 seconds. The discharge resistor shall be disconnected from the capacitor at the end of the 5 second discharge period; and after 1 minute, the voltage remaining on the capacitor (recovery voltage) shall be measured with an electrometer, or other suitable device having an input resistance of 10,000 megohms, or greater. The dielectric absorption shall be computed from the following formula:

$$d = \frac{V_1}{V_2} \times 100$$

Where: d = Dielectric absorption (percent).
 V_1 = Maximum recovery voltage.
 V_2 = Charging voltage.



E = DC rated voltage or 100 volts dc, whichever is less (± 2 percent)
 R_1 and R_2 = 1000 ohms ± 20 percent (this value not critical).
 R_3 = 5 ohms ± 1 percent.
 R_4 = 10,000 megohms, minimum.

Suggest use of $\pm 1230A$ GR electrometer or equivalent with 10,000 megohms, minimum, input resistance.

NOTES:

1. Charge for 5 minutes ± 10 seconds with switch in position 1.
2. Switch in position 2 for 5 seconds ± 0.5 seconds.
3. Switch in position 3.
4. After 1 minute read recovery voltage and compute as a percentage of charge voltage.
5. Switch to position 4, discharge and remove.

FIGURE 1. Typical dielectric absorption test schematic.

4.7.4 Thermal shock (see 3.8). Capacitors shall be tested in accordance with [method 107 of MIL-STD-202](#). The following details and exception shall apply:

- a. Test condition letter B.
- b. Measurements before and after cycling: Not applicable.
- c. Number of cycles: 10 or 5, as specified (see 3.1).

4.7.5 Seal (see 3.9). Capacitors shall be tested in accordance with [method 112 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Test condition letters: As specified (see 3.1).
- b. Measurements after test: Not applicable.

4.7.5.1 Seal - alternative test (see 3.9). For capacitors with a liquid impregnant, the following seal test may be substituted: Capacitors shall be placed with the terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature within +3°C, -0°C of the applicable maximum rated temperature (see 3.1) for a period of 4 hours, minimum. The capacitor and absorbent paper shall then be visually examined for evidence of leakage of impregnant or filling compounds or bubbles from the seal.

4.7.6 Dielectric withstanding voltage (see 3.10). Capacitors shall be tested in accordance with [method 301 of MIL-STD-202](#). The following details and exception shall apply:

- a. Magnitude and nature of test voltage: As specified (see 3.1).
- b. Duration of application of test voltage: Unless otherwise specified (see 3.1), 1 minute.
- c. Points of application of test voltage: Between terminals.
- d. Power supply voltage regulation: ± 2 percent or better.
- e. Current resistor: Sufficient to limit charging current 1.0 ampere, maximum.

4.7.7 Insulation resistance (see 3.11). Capacitors shall be tested in accordance with [method 302 of MIL-STD-202](#). The following details shall apply:

- a. Test potential: Unless otherwise specified (see 3.1), rated voltage,.
- b. Points of measurement:
 - (1) Terminal to terminal: Between terminals at the applicable specified temperatures (see 3.1), and at +25°C ± 3 °C.
 - (2) Terminals to case (when case is not a terminal): Between each terminal and the case at +25°C ± 3 °C.

4.7.8 Capacitance (see 3.12). 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: 1,000 ± 100 Hz.
- b. Limit of accuracy: Within ± 0.05 percent.

4.7.9 Dissipation factor (see 3.13). Unless otherwise specified (see 3.1), the dissipation factor shall be measured at 1,000 ±100 Hz (for capacitors having a nominal capacitance of 1 µF or less) or 100 ±10 Hz (for capacitors having a nominal capacitance greater than 1 µF).

4.7.10 ESR applicable to styles CRH11, CRH12, and CRH13 (see 3.14). ESR shall be determined by a suitable measuring device. Instrument measurement accuracy shall be within ±2 percent. AC measurements shall be made at a frequency of 100 kHz ±10 percent. ESR is to be measured within .250 inch to .500 inch of case.

4.7.11 Barometric pressure (reduced) for qualification only (see 3.15). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- a. Method of mounting: By normal mounting means.
- b. Unless otherwise specified (see 3.1), test condition letter D (100,000 feet),.
- c. Tests during subjection to reduced pressure: The specified potential (see 3.1) shall be applied for at least 1 minute between each terminal and the case when the terminal is not connected to the case, or between the insulated terminal and the case when the case is a terminal. However, at no time shall the potential exceed those limits specified (by altitude and case diameter) on figure 2. A suitable means shall be used to detect momentary or permanent breakdown.

After the test, capacitors shall be visually inspected for evidence of damage.

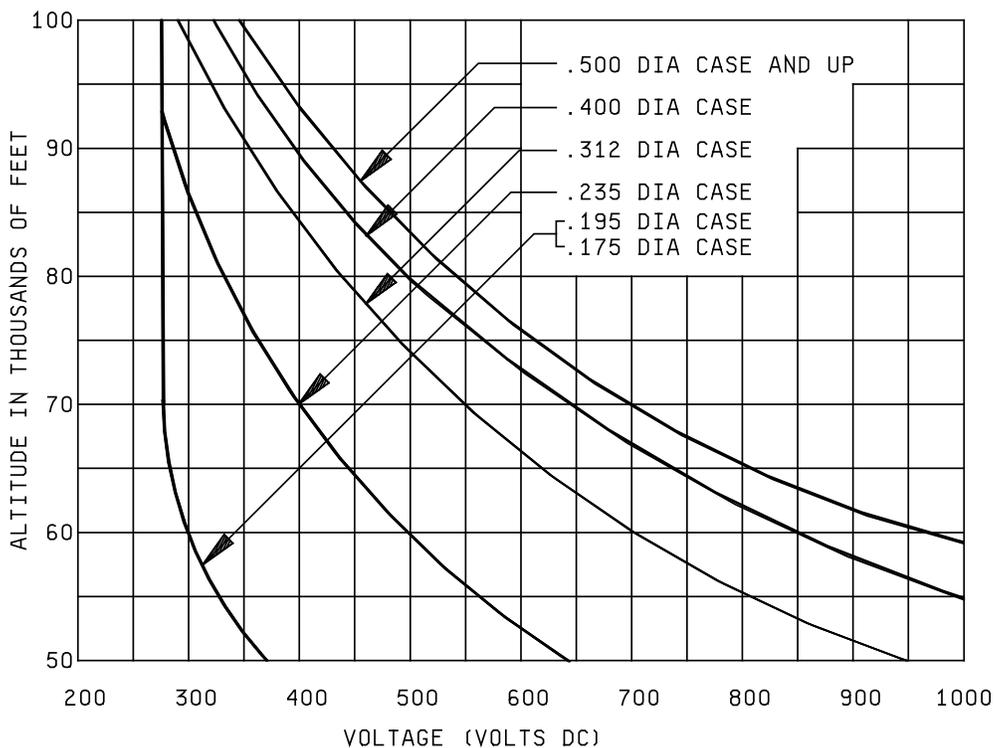


FIGURE 2. Breakdown voltage versus altitude.

4.7.12 Vibration (see [3.16](#)).

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

- a. Mounting of specimens: Rigidly mounted by the body to the vibration-test apparatus; terminals shall be secured .500 ±.125 inch from the case.
- b. Electrical-load conditions: During the test, a dc potential equal to 50 percent of the rated voltage (see [3.1](#)) shall be applied between the terminals of the capacitor.
- c. Test condition letter E (50 g's), unless otherwise specified (see [3.1](#)).
- 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 cylindrical axis.
- e. Measurements: During the last cycle in each direction, a signal of 1 ±0.2 kHz at a level of 1 ±.05 volt shall be placed across the capacitor and measured with a suitable ac recording device (a permanent record is not necessary for this test) to determine intermittent contacts of 0.5 ms or greater duration, open-circuits or short-circuits. The accuracy of the detecting equipment shall be sufficient to detect any interruption of 0.5 ms or greater duration.
- f. Measurements after vibration: Dissipation factor shall be measured as specified in [4.7.9](#) and shall be within initial limits.

After the test, capacitors shall be visually inspected for evidence of mechanical damage, open-circuiting or short-circuiting.

4.7.12.2 Vibration, random. Capacitors shall be tested in accordance with [method 214 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Mounting of specimens: Rigidly mounted by the body to the vibration-test apparatus; terminals shall be secured .500 ±.125 inch from the case.
- b. Electrical load conditions: Not applicable.
- c. Test condition II, letter K.
- d. Duration and direction of motion, 15 minutes in each of two mutually perpendicular directions (total of 30 minutes), one parallel and the other perpendicular to the cylindrical axis.
- e. During the test, a signal of 1 ±0.2 kHz at a level of 1 volt minimum shall be placed across the capacitor and measured with a suitable ac recording device (a permanent record is not necessary for this test) to determine intermittent contacts of 0.5 ms or greater duration, open-circuits or short-circuits. The accuracy of the detecting equipment shall be sufficient to detect any interruption of 0.5 ms or greater duration.
- f. Measurements after vibration: Dissipation factor shall be measured as specified in [4.7.9](#) and shall be within initial limits.

4.7.13 Salt atmosphere (corrosion) (see 3.17). Capacitors shall be tested in accordance with [method 101 of MIL-STD-202](#). The following details shall apply:

- a. Test condition letter B (48 hours).
- b. Measurements after exposure: Not applicable.

After the test, capacitors shall be visually inspected for evidence of harmful corrosion and unwrapping of, or mechanical damage to the insulating sleeves, when applicable.

4.7.14 Immersion (see 3.18). Capacitors shall be tested in accordance with [method 104 of MIL-STD-202](#). The following details and exception shall apply:

- a. Test condition letter C, with the following exceptions:
 - (1) Both hot and cold baths shall be a saturated solution of sodium chloride and water.
 - (2) For quality conformance inspection only, two immersion cycles and 30 minute exposure shall be required.
- b. Inspections after final cycle: Capacitors shall be inspected for evidence of extensive corrosion, obliteration of markings, and unwrapping of or mechanical damage to the insulating sleeves, when applicable.
- c. Measurements after final cycle: Dielectric withstanding voltage and insulation resistance shall be measured only on the insulating sleeves of case sizes .400 inch diameter x 1.063 inch long and larger at +25°C ±3°C as specified in 4.7.6 and 4.7.7, respectively, except the measurements shall be made between two wire windings placed around the sleeve of the capacitor .500 inch apart; each winding shall consist of three close turns of .040 inch (18 AWG) bare copper wire. The insulating sleeves of all sizes shall be removed, and the dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at +25°C ±3°C as specified in 4.7.6 to 4.7.9, inclusive.

4.7.15 Solderability (see 3.19). Capacitors shall be tested in accordance with [method 208 of MIL-STD-202](#). The following details shall apply:

- a. Number of terminations of each capacitor to be tested: 2.
- b. Depth of immersion in flux and solder: Both terminals shall be immersed to within .125 inch of the capacitor body or eyelet closure.
- c. No physical damage after test.

4.7.16 Shock (specified pulse) (see 3.20). Capacitors shall be tested in accordance with [method 213 of MIL-STD-202](#). The following details shall apply:

- a. Special mounting means: Rigidly mounted by the body.
- b. Test condition letter I.
- c. Electrical loading during shock: During the test, a potential of 50 percent of rated voltage shall be applied between the terminals of the capacitor.

- d. Measurements during and after shock: During the test, a cathode-ray oscilloscope (or other comparable means) shall be used as an indicating device in determining any electrical failures and intermittent contacts of 0.5 ms or greater duration, open-circuiting or short-circuiting. Dissipation factor shall be measured as specified in 4.7.9 and shall be within initial limits.

After the test, capacitors shall be visually inspected for evidence of breakdown, arcing, fractures, and other visible mechanical damage.

4.7.17 Resistance to soldering heat (see 3.21). Capacitors shall be tested in accordance with [method 210 of MIL-STD-202](#). The following details shall apply:

- a. Depth of immersion in molten solder: To a minimum of .250 inch from the capacitor body.
- b. Test condition letter C, except test time shall be 10 ± 1 seconds.
- c. Cooling time prior to final measurement: Sufficient time to stabilize at room temperature.
- d. Measurements after test: Insulation resistance, capacitance, and dissipation factor shall be measured at $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ as specified in 4.7.7, 4.7.8, and 4.7.9, respectively.

4.7.18 Moisture resistance (see 3.22). Capacitors shall be tested in accordance with [method 106 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Mounting: As specified in 4.7.11a. Capacitors which are normally supported by their wire leads shall be mounted to rigidly supported terminals so spaced that the length of each lead from the capacitor body shall be approximately .625 inch. Tubular capacitors greater than .562 inch nominal diameter and 1.562 inches in length shall have a supplementary mounting means, and the leads shall be supported at the ends during vibration.
- b. Subcycle: A total of five subcycles shall be performed. The vibration required in step 7 shall be in any direction.
- c. Loading (polarization): During steps 1 to 6 inclusive, a dc potential of 100 volts or rated voltage (see 3.1), whichever is less, shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.
- d. Final measurements: After the final cycle, capacitors shall be conditioned at $+25^{\circ}\text{C} +10^{\circ}\text{C}$, -5°C at a relative humidity of less than 80 percent, and a barometric pressure between 28 and 32 inches of mercury. After a maximum of 24 hours, capacitors shall be inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves.

Dielectric withstanding voltage and insulation resistance shall be measured only on the insulating sleeves of case sizes .400 inch diameter x 1.063 inch long and larger at $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ as specified in 4.7.6 and 4.7.7, respectively, except the measurements shall be made between two wire windings placed around the sleeve of the capacitor .500 inch apart; each winding shall consist of three close turns of .040 inch (18 AWG) bare copper wire.

All capacitors shall have dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor shall then be measured at $+25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ as specified in 4.7.6 through 4.7.9. These tests shall be done with insulating sleeves removed.

After the test, capacitors shall be visually inspected for evidence of extensive corrosion, and unwrapping of, or mechanical damage to the insulating sleeves.

4.7.19 Terminal strength (see 3.23). Capacitors shall be tested in accordance with [method 211 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Test condition letters A (pull test) and C (bend test).
- b. Test condition A:
 - (1) Method of holding: Capacitors shall be clamped by one terminal, and pull test load applied to the other terminal.
 - (2) Applied force: 5 pounds.

4.7.20 Low temperature life (see 3.24). Unless otherwise specified (see 3.1), capacitors shall be placed in a chamber maintained at -65°C $+0^{\circ}\text{C}$, -3°C and a potential equal to dc rated voltage shall be applied at this temperature for 48 ± 4 hours. After the test, capacitors shall be visually inspected for evidence of breakdown, arcing, open-circuiting, short-circuiting, and other visible mechanical damage.

4.7.21 Fungus (see 3.25). Capacitors shall be tested in accordance with [method 508 of MIL-STD-810](#).

4.7.22 Resistance to solvents (see 3.26). 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, see [table II](#) and [table V](#).
- c. Permissible extent of damage: As specified in 3.26.

Following each immersion, capacitors shall be brushed with a common hard-bristle toothbrush for 10 strokes with a brushing force of 1 pound.

4.7.23 Temperature coefficient (see 3.27). Capacitance shall be measured as specified in 4.7.8 at the temperatures specified (see 3.1). The measurement at each temperature shall be recorded when two successive readings taken at 5 minute intervals indicate no change in capacitance.

4.7.24 Life (see 3.28).

4.7.24.1 Qualification inspection. Capacitors shall be tested in accordance with [method 108 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Distance of temperature measurements from specimens: Measured on the body of the capacitor.
- b. Test temperature and tolerance: Applicable maximum rated temperature, $+4^{\circ}\text{C}$, -0°C (see 3.1). Radiation shall not be used as a means of heating the chamber.
- c. Operating conditions: Those capacitors being tested at the accelerated condition shall be subjected to the specified percent of rated voltage (see 3.1); those capacitors being tested at the rated condition shall be subjected to rated voltage. The power supply shall be capable of providing the required voltage to all capacitors under test. Suitable metering devices shall be provided to verify that the correct voltage is being applied to all capacitors.
- d. Test condition letter F (2,000 +72, -0 hours).
- e. Measurements during test: Not applicable.

- f. Measurements after life test: Capacitors shall be returned to the inspection conditions specified in 4.3. The insulating sleeves shall be removed and the insulation resistance, capacitance, and dissipation factor shall be measured as specified in 4.7.7, 4.7.8, and 4.7.9, respectively.

After the test, capacitors shall be visually inspected for evidence of corrosion, leakage of impregnant, and mechanical damage.

4.7.24.2 Conformance inspection.

4.7.24.2.1 Accelerated condition. Capacitors shall be tested as specified in 4.7.24.1, except at the accelerated condition only, measurements shall be accomplished after 1,000 hours +48 hours, -0 hours; and 2,000 hours +72 hours, -0 hours.

4.7.24.2.2 Rated condition. Upon completion of the 2,000-hour test and related inspections, those capacitors which were tested under the rated condition shall be tested for an additional 8,000 hours; measurements shall be accomplished after 2,000 hours +72 hours, -0 hours; and every 2,000 hours +72 hours, -0 hours thereafter, until 10,000 hours +96 hours, -0 hours have elapsed.

4.7.25 AC conditioning (when specified, see 3.1 and 3.29). Capacitors shall be exposed to the voltages and frequencies specified at +100°C for 240 hours +48 hours, -0 hours.

4.7.26 Flash point of impregnant (see 3.30). The flash point of impregnant shall be measured as specified in ASTM-D92, except that fire point and precision do not apply. The word "impregnant" 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. Capacitors covered by this specification are primarily intended for use in power supply filter circuits, by-pass applications, and other applications where the ac component of voltage is known or a significant factor. Styles covered by this specification may be used for applications requiring a tight capacitance tolerance, excellent capacitance stability, very high-insulation resistance, and low-loss factors where the ac component of voltage is large with respect to the applied dc voltage. These devices also must be able to operate satisfactorily in high reliability military systems under demanding conditions such as 50 Gs of high frequency vibration and 100 Gs of shock (specified pulse). Commercial components are not designed to withstand these military environmental conditions. These capacitors can exhibit momentary breakdowns. If sufficient energy is available from the circuit and stored in the capacitor, clearing will occur. Minimum stored energy in the range 100 to 500 microjoules is recommended to insure clearing. Applications for these capacitors should be limited to circuits that will provide sufficient energy to insure clearing and are insensitive to momentary breakdown/clearing actions.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification, the applicable specification sheet, and the complete PIN (see 3.1).
- b. Packaging requirements (see 5.1).

6.3 Solder dip (retinning). If retinning (hot solder dip) of the leads is required, see 3.5.3.1.

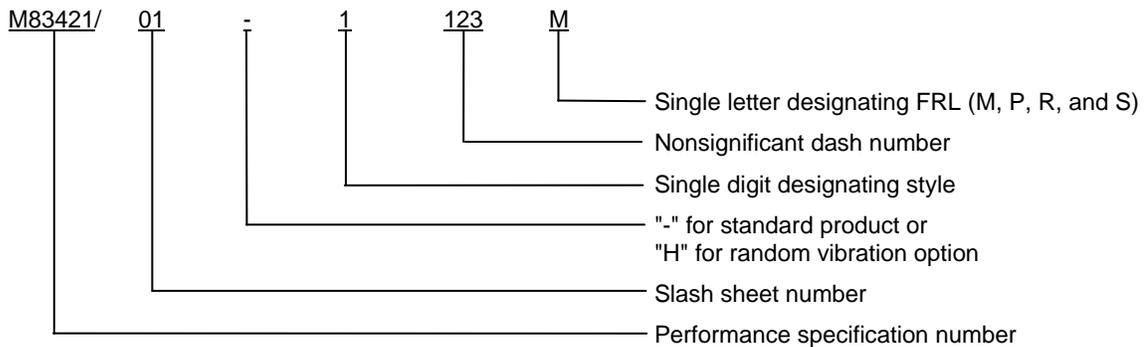
6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in the Qualified Products List QPL whether or not such products have actually been so listed by that date. The attention of the 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 DLA Land and Maritime, ATTN: VQP, PO Box 3990, Columbus, OH 43218-3990, or by e-mail to vqp.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.daps.dla.mil>.

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

6.5 Subject term (key word) listing.

- Capacitance
- Dissipation factor
- Insulation resistance

6.6 PIN example. See 1.2.1 for details.



6.7 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to [ASTM-B545](#) (Standard Specification for Electrodeposited Coatings of Tin).

6.8 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals and additional information is available on their website at <http://www.epa.gov/osw/hazard/wastemin/priority.htm>. Included in the list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see [section 3](#)).

6.9 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX A

PROCEDURE FOR QUALIFICATION INSPECTION

A.1 SCOPE

A.1.1 Scope. This appendix details the 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. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.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.

A.2.2 Government documents.

A.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.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-1276](#) - Leads for Electronic Component Parts.

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

A.2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (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.

A.3 SUBMISSION

A.3.1 Sample. For qualification to "M" level (see 3.1) as in accordance with [table II](#).

A.3.1.1 Single type submission. A sample consisting of 89 1/ 2/ sample units of the same style, dielectric material, rated voltage, capacitance value, and capacitance tolerance for which qualification is sought shall be submitted.

A.3.1.2 Single style submission. A sample consisting of 45 2/ 3/ sample units of the highest capacitance value in the smallest case size and 45 2/ 3/ sample units of the highest capacitance value in the largest case size, within a single style, shall be submitted. The dielectric material and FRL of the sample units shall be the same.

A.3.1.3 Complete qualification group submission. The types and number of samples which shall be submitted for qualification approval are those shown in [table A-1](#) and shall be grouped in accordance with that table.

1/ For styles CRH11, CRH12 and CRH13, 113 sample units.

2/ This total shall be determined by the number of capacitors tested for random vibration in group X.

3/ For styles CRH11, CRH12 and CRH13, 57 sample units.

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A.3.1.4 Impregnant. Two-hundred cubic centimeters of each impregnant used in the specimens for which approval is sought shall be submitted. On subsequent submissions, an impregnant that has successfully withstood the flash point of impregnant test (see 4.7.26) need not be submitted.

A.3.2 Description of items. The manufacturer shall submit a detailed statement of the materials and constructional features of the capacitors being submitted for test, including information on whether they are liquid-impregnated; the type and quantity of the impregnant; the type, thickness, and number of layers of the capacitor tissue; and material, thickness, and applied finish of the case.

A.4 EXTENT OF QUALIFICATION

A.4.1 Single type submission. Qualification of a capacitance type will be restricted to the dielectric material, rated voltage, and capacitance value submitted. Capacitance-tolerance qualification will be restricted to the capacitance tolerances equal to and wider than the tolerance submitted. Extent of FRL qualification shall be as specified in A.4.4.

TABLE A-I. Samples for complete qualification submission.

Style	Qualification group	Types to be submitted	Quantity for complete qualification groups ^{1/}
CRH01	30 V	Maximum capacitance value	45
CRH02	50 V	Maximum capacitance value	45
CRH03	100 V	Maximum capacitance value	45
CRH04	200 V	Maximum capacitance value	45
CRH05	400 V	Maximum capacitance value	45
CRH11	100 V	Maximum capacitance value	45
CRH12	200 V	Maximum capacitance value	45
CRH13	400 V	Maximum capacitance value	45
CRH31	30 V	Maximum capacitance value	45
CRH32	50 V	Maximum capacitance value	45
CRH33	100 V	Maximum capacitance value	45
CRH34	200 V	Maximum capacitance value	45
CRH35	400 V	Maximum capacitance value	45

^{1/} This total shall be determined by the number of capacitors tested for random vibration in group X.

A.4.2 Single style submission. Qualification of the capacitance types submitted will be a basis for qualification for all capacitance values and case sizes in the style. If the tightest capacitance tolerance is included, complete capacitance range qualification may be granted. Extent of FRL qualification shall be as specified in A.4.4.

A.4.3 Complete qualification group submission. Qualification of the complete qualification group submission will be the basis for qualification for all styles within a specification sheet, dielectric materials, rated voltages, capacitance values, and capacitance tolerances; if the tightest capacitance tolerance is included in at least one style, complete capacitance range, qualification may be granted. Extent of FRL qualification shall be as specified in A.4.4.

A.4.4 FRL qualification. The extent of qualification between FRLs shall be as specified in table A-II.

TABLE A-II. Extent of FRL qualification.

Qualification for FRL	Will qualify FRL(s)
S	S, R, P, M
R	R, P, M
P	P, M
M	M

APPENDIX A

A.5 QUALIFICATION APPROVAL FOR LOWER FRL

A.5.1 FR qualification. Extension of qualification to lower FRLs shall be in accordance with 4.4.4 of this specification.

A.6 SOLDER DIP (RETIMMING) LEADS

A.6.1 Solder dip (retinning) leads. Only the manufacturer (or his authorized category B or C distributor) may solder dip/retin the leads of product supplied to this specification provided the solder dip process has been approved by the qualifying activity.

A.6.2 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

- a. When the original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276, the manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product. (Note: The 200 microinch maximum thickness is not applicable)
- b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in A.6.2a, approval for the process to be used for solder dip shall be based on the following test procedure:
 - (1) Thirty samples of any capacitance value for each style and lead finish are subjected to the manufacturing's solder dip process. Following the solder dip process, the capacitors are subject to the capacitance, DF, and IR measurements. No defects are allowed. (Note: If hermetic seal testing is required in group A, this test shall be repeated.) No defects are allowed.
 - (2) Ten of the 30 samples are then subjected to the solderability test. No defects are allowed.
 - (3) The remaining 20 samples are subjected to the resistance to solder heat test followed by the seal test. No defects are allowed. (Note: Solder dip of gold plated leads is not allowed.)

A.6.3 Solder dip/retinning options. The manufacturer (or authorized category C distributor) may solder dip/retin as follows:

- a. As a corrective action if the lot fails the group A solderability test.
- b. After the group A inspection has been completed, following the solder dip/retinning process, the capacitance, DF, and IR measurements shall be performed on 100 percent of the lot. The percent defective allowable (PDA) for the electrical measurements shall be as for the subgroup 1 tests. (Note: If hermetic seal is required in the group A, subgroup 1 tests, this test shall be repeated.) Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.7.15.

Custodians:

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

Preparing activity:
DLA - CC

(Project 5910-2010-017)

Review activities:

Army - AR
Navy - AS, MC, OS, SH
Air Force - 19, 99

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