INCH-POUND
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PERFORMANCE SPECIFICATION

FUSE, CARTRIDGE, INSTRUMENT TYPE, GENERAL SPECIFICATION FOR

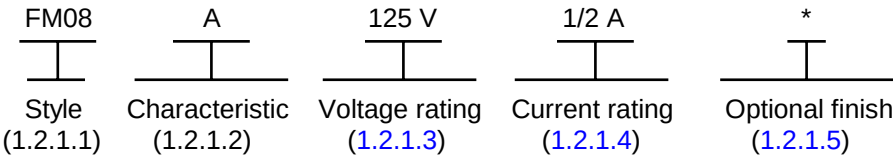
This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers instrument type fuses designed for the protection of electrical, electronic, and communication equipment on direct current (dc) and alternating current (ac) (up to 400 hertz (Hz)) circuits.

1.2 Classification.

1.2.1 Type designation. The type designation of fuses is in the following form and as specified (see 3.1 and 6.2).



1.2.1.1 Style. The style is identified by the letters "FM" followed by a two-digit number denoting a fuse of a given construction and dimensions.

1.2.1.2 Characteristic. The characteristic is identified by a one-letter symbol which indicates the relative overload interrupt time (see 6.5) in accordance with table I.

TABLE I. Characteristics.

Symbol	Relative overload interrupt time
A	Normal
B	Time delay

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAT, Post Office Box 3990, Columbus, Ohio 43218-3990 or by email CircuitProtect@dla.mil Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

1.2.1.3 Voltage rating. The voltage rating is the maximum dc or ac root mean square (rms) voltage for which a fuse is designed (see 3.1). The voltage rating is identified by a numerical value followed by the letter "V".

(See paragraph 6.1.3 concerning use of FM08 style fuses in vacuum applications.)

1.2.1.4 Current rating. The current rating is the amount of current a fuse will carry indefinitely without interruption (see 3.1). The current rating in amperes and fractions of an ampere is identified by a numerical value followed by the letter "A".

1.2.1.5 Optional finish. When specified, a suffix letter is added to the type designation covered by selected specification sheets to denote optional finish (see 3.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 or 5 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, 4 or 5 of this specification, whether or not they are listed.

2.2 Government documents.

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

SPECIFICATIONS

DEPARTMENT OF DEFENSE

(See supplement 1 for list of associated specification sheets.)

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-202 - Test Methods Standard Electronics and Electrical Component Parts.
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-1285 - Marking of Electrical and Electronic Parts.

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

2.2.2 Other Government documents, drawings and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation or contract.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA Reference Publication 1124 - Outgassing Data for Selected Spacecraft Materials.

(Hard copies of this document are no longer available from the NASA Goddard Materials Branch or the Document Automation and Production Service Detachment Office (DAPS). This information is only available at http://outgassing.nasa.gov.

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(see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E595 - Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

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

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-557 - Statistical Process Control Systems.

(Copies of this document are available online at http://www.eia.org/new_policy/availability.phtml or from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201).

UNDERWRITERS LABORATORIES, INC. (UL)

UL 248-1 - Standard for Low-Voltage Fuses, Part 1: General Requirements.

(Copies of this document are available online at http://www.ul.com or from the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2002).

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

3. REQUIREMENTS

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

3.1.1 Fuses with ratings not covered by a specification sheet. The requirements of this specification shall apply to fuses with other voltage and current ratings, provided the fuse has the same dimensions and falls within the minimum and maximum current and voltage rating of an existing specification sheet, and conforms to all other requirements of that specification sheet. The Qualified Products List (QPL) shall be applicable to these fuses

3.2 Qualification. Fuses furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable QPL before contract award (see 4.4 and 6.3).

3.3 QPL system. The manufacturer shall establish and maintain a QPL system for fuses covered by this specification. Requirements for this system are specified in MIL-STD-790 with details as specified in 4.2.

3.3.1 Statistical Process Control (SPC) system. As part of the overall MIL-STD-790 QPL system, the manufacturer shall establish a SPC system that meets the requirements of EIA-557.

3.4. Material. The material for each part shall be as specified herein. When a definite material is not specified, a material shall be used which will enable the fuses to meet the performance requirements of this specification. Note, however, that the tin content of fuse components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 3.5.5). Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.5 Interface and physical dimensions. Fuses shall be of the interface and physical dimensions as specified (see 3.1).

3.5.1 Mounting. Fuses parameters shall allow for convenient insertion and removal from printed wiring boards, fuseclips, or holders as specified (see 3.1).

3.5.2 Terminal mounting. Terminals shall be secured to the fuse body so that they shall not loosen. The fuse wire shall be so attached to the terminals that there shall be no danger of breaking the fuse wire or connections when installing the fuse. Terminals other than the ends to which the fusible elements are attached shall be free from solder.

3.5.3 Ferrule alignment. Fuses with ferrule terminals shall pass through a tubular gauge having a length equal to that of the fuse. The tubular gauge shall have an internal diameter of .005 inch (0.13 mm) greater than the maximum ferrule diameter for fuse lengths up to and including 1.750 inches (44.45 mm). For fuse lengths greater than 1.750 inches (44.45 mm), the tubular gauge shall have an internal diameter .010 inch (0.25 mm) greater than the maximum ferrule diameter.

3.5.4 Indication. When specified (see 3.1), the fuse shall be such that it is possible to determine that the fuse is open, without removing the fuse from the circuit.

3.5.5 Terminal finish or plating. Ferrules or other terminals shall be finished (plated, dipped, coated) or shall be natural (no finishing process), as specified (see 3.1). When silver plating is specified (see 1.2.1.5), the letter "S" shall be added as a suffix to the type designation. Finish shall be optional when not specifically designated and shall enable the fuses to meet the performance requirements of this specification. However, the use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.7).

3.6 Continuity. Fuses shall have electrical continuity (see 4.7.2).

3.7 Resistance (when applicable (see 3.1). Fuses shall have electrical resistance as specified (see 3.1 and 4.7.3).

3.7.1 Voltage drop (when applicable (see 3.1). Fuses shall have the voltage drop as specified (see 3.1 and 4.7.3.1).

3.8 Current-carrying capacity. Fuses shall show no evidence of mechanical damage and shall carry current as specified (see 3.1) without electrical failure. Unless otherwise specified, the temperature of the case, body, or terminals shall not rise more than 70°C above room ambient temperature (see 3.1 and 4.7.4).

3.9 Terminal strength. Fuse terminals shall not become damaged when subjected to the specified force (see 3.1 and 4.7.5).

3.10 Overcurrent.

3.10.1 Overload interrupt. Fuses shall open the circuit within the time limits specified (see 3.1) without causing the case or body to char or fracture. The circuit shall remain open without the circuit closing again during the one-minute period after interrupt. There shall be no mechanical failure (see 4.7.6.1).

3.10.2 Maximum current clearing I^2t (when specified, (see 3.1). When fuses are tested as specified in 4.7.6.2, the amount of ampere-squared seconds passed by the fuse during melting, arcing, or clearing time shall not exceed the value specified (see 3.1).

3.10.3 Short circuit interrupt. Fuses shall remain intact and shall open the circuit. The fuse shall remain in the energized circuit for 30 seconds minimum without any indication of the circuit closing again. The insulation shall not puncture, the terminals or body shall not rupture or separate, and the terminals shall not be shunted (see 4.7.6.3).

3.11 Outgassing (when specified, (see 3.1). When the fuses or the fuse materials are tested as specified in 4.7.7, the materials shall meet the following requirements:

Total mass loss (TML) ---------- Shall not exceed 1.0 percent.
Collected volatile condensable material (CVCM) -- Shall not exceed 0.1 percent.

Materials data listed in the latest revision of the NASA Reference Publication 1124 which meet these TML and CVCM requirements may be substituted in lieu of testing.

3.12 Vibration.

3.12.1 Vibration, high frequency. When tested as specified in 4.7.8.1, there shall be no electrical or mechanical damage to the fuse.

3.12.2 Vibration, random (when specified, (see 3.1). When tested as specified in 4.7.8.2, there shall be no electrical or mechanical damage to the fuse.

3.13 Shock. When tested as specified in 4.7.9, there shall be no electrical or mechanical damage to the fuse.

3.14 Salt atmosphere (corrosion). When tested as specified 4.7.10, there shall be no evidence of excessive corrosion. Excessive corrosion is defined as that which interferes with the electrical or mechanical performance, or in the case of plated metals, corrosion which has passed through the plating and attacked the base metal. There shall be no warping, cracking, or other electrical or mechanical damage to the fuse.

3.15 Moisture resistance. When tested as specified in 4.7.11, there shall be no cracking, peeling, loosening of terminals or evidence of electrolytic corrosion. When labels are used there shall be no evidence of peeling, wrinkling, ends lifting or illegible ink markings.

3.16 Thermal shock. When tested as specified in 4.7.12, the fuses shall show no mechanical or electrical damage and there shall be no loosening of the terminals or other parts.

3.17 Solderability (when specified, (see 3.1). When fuses are tested as specified in 4.7.13, the dipped portion of the leads shall conform to the solid-wire termination criteria in accordance with method 208 of MIL-STD-202.

3.18 Resistance to soldering heat (when specified, (see 3.1). When tested as specified in 4.7.14, the fuses shall show no evidence of external damage.

3.19 Marking. Unless otherwise specified (see 3.1), each fuse shall be marked in accordance with method I of MIL-STD-1285.

3.19.1 Ferrule and end cap marking. When fuse ferrules and end caps are marked, the marking shall include the following:

a. Type designation (see 1.2.1).

b. Manufacturer's name, trademark, or code symbol.

3.20 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.

3.21 Workmanship. Fuses shall be manufactured and processed in such a manner as to be uniform in quality and shall be free from loose terminals, cracked, or displaced parts, sharp edges, burrs, and other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

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

a. Qualification inspection (see 4.4).

b. Verification of qualification (see 4.4.4).

c. Conformance inspection (see 4.6).

d. Periodic inspection (see 4.6.2)

4.2 QPL system. The manufacturer shall establish and maintain a QPL system as described in 3.3. Evidence of such compliance shall be verified by the qualifying activity of this specification as prerequisite for qualification and retention of qualification.

4.2.1 SPC system. A SPC system 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.

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

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

4.4.1 Sample size. Unless otherwise specified (see 3.1) the number of samples submitted for qualification shall be 22 each of the maximum and minimum current ratings for which qualification is desired. Four additional samples each of the maximum and minimum ratings shall be forwarded to the qualifying activity.

4.4.2 Inspection routine. The sample shall be subjected to the qualification inspection shown in table II, in the order shown. All sample units shall be subjected to the inspection of group I. The sample shall then be divided as specified in table II for group II to group VI inclusive.

4.4.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4.4.4 Verification of qualification. To retain qualification, the manufacturer shall provide verification to the qualifying activity for the following items at 36-month intervals:

a. Design of the fuseholders has not changed.

b. Verification that the conformance inspections have been performed on inspection lots supplied to the requirements of this specification (group A and group B).

c. Verification that the periodic inspection (group C) has been performed as applicable. If there is an indication of nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the QPL.

4.4.4.1 Failure to provide verification of the product within 30 days after the end of each 36-month period may result in loss of qualification for the product. The contractor shall immediately notify the qualifying activity at any time during the 36-month period that verification indicates failure of the qualified product to meet the requirements of this specification.

4.4.4.2 In the event that no production occurred during the reporting period, the contractor shall verify to the qualifying activity that the capability to manufacture and test QPL fuses still exists and that the contractor wants to remain of the QPL. If during two 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, voltage rating, and current rating to testing in accordance with the qualification inspection requirements.

4.5 Extent of qualification. Qualification between performance specifications shall be in accordance with the applicable performance specifications (see 3.1).

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A and group B inspection. Except as specified in 4.6.2, delivery of products which have passed the group A and group B inspections shall not be delayed pending the results of the group C inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all fuses of the same style and current rating produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table III, in the order shown.

TABLE II. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units per current rating
Group I			
Visual and mechanical examination	3.5, 3.19, 3.21	4.7.1	All
Continuity	3.6	4.7.2	
Resistance (when specified, see 3.1)	3.7	4.7.3	
Voltage drop (when specified, see 3.1)	3.7.1	4.7.3.1	
Current-carrying capacity	3.8	4.7.4	
Group II (see 3.1)			
Terminal strength	3.9	4.7.5	6
Overload interrupt	3.10.1	4.7.6.1	
Solderability (when specified)	3.17	4.7.13	
Group III (see 3.1)			
Short circuit	3.10.3	4.7.6.3	4
Maximum clearing current I^2t (when specified)	3.10.2	4.7.6.2	
Group IV			
Vibration, high frequency	3.12.1	4.7.8.1	4
Vibration, random (when specified, see 3.1)	3.12.2	4.7.8.2	
Continuity	3.6	4.7.2	
Shock	3.13	4.7.9	
Continuity	3.6	4.7.2	
Group V			
Salt atmosphere (corrosion)	3.14	4.7.10	4
Overload interrupt (at room ambient temperature and maximum voltage rating)	3.10.1	4.7.6.1	
Group VI			
Outgassing (when specified, see 3.1)	3.11	4.7.7	4
Moisture resistance	3.15	4.7.11	
Thermal shock	3.16	4.7.12	
Current carrying capacity (at room ambient temperature)	3.8	4.7.4	
Overload interrupt (at room ambient temperature and maximum voltage rating)	3.10.1	4.7.6.1	

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph
Subgroup 1		
Continuity 1/	3.6	4.7.2
Resistance 2/	3.7	4.7.3
Voltage drop 2/	3.7.1	4.7.3.1
Subgroup 2		
Visual and mechanical examination	3.5, 3.19, and 3.21	4.7.1

1/ Not required when resistance or voltage drop test is conducted.
2/ When applicable (see 3.1).

4.6.1.2.1 Subgroup 1 tests. Subgroup 1 tests shall be performed on 100 percent of the product supplied under this specification. All rejected parts shall be removed from the lot and shall not be furnished on the contract. Lots having more than 5 percent total rejects shall not be furnished on the contract.

4.6.1.2.1.1 Manufacturers production inspection. If the manufacturer performs tests equal to or more stringent than those specified in subgroup 1, table III as the final step of this production process, group A, subgroup 1 inspection may be waived and the information resulting from the manufacturers production tests may be used instead. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria must be complied with:

a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1. Test conditions shall be equal to or more stringent than those specified for subgroup 1.

b. Manufacturer subjects 100 percent of the product supplied under this specification to their production tests.

c. The parameters measured and the failure criteria shall be the same as or more stringent than those specified herein.

d. The lot rejection criteria is the same as or more stringent than that specified herein.

e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in his production tests. The manufacturer shall also make available to the qualifying activity all test information resulting from production tests.

4.6.1.2.2 Subgroup 2 . Subgroup 2 tests shall be performed on an inspection lot basis in accordance with 4.6.1.2.2.1.

4.6.1.2.2.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table IV. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table IV. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE IV. Group A and Group B, zero defect sampling plan. 1/

Lot size	Sample size	
	Group A, subgroup 2	Group B
1 to 13	100 percent	5
14 to 50	13	5
51 to 90	13	7
91 to 150	13	11
151 to 280	20	13
281 to 500	29	16
501 to 1,200	34	19
1,201 to 3,200	42	23
3,201 to 10,000	50	29

1/ If sample size equals, or exceeds lot size, 100 percent inspection is required.

4.6.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table V, in the order shown, and the sample shall be selected from inspection lots that have passed the group A inspection.

4.6.1.3.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table IV. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table IV. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE V. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Current-carrying capacity (at room ambient temperature)	3.8	4.7.4
Terminal strength 1/	3.9	4.7.5
Overload interrupt (at room ambient temperature)	3.10.1	4.7.6.1
Solderability (when specified, see 3.1)	3.17	4.7.13

1/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failures, this test, with approval of the qualifying activity, can be deleted. The manufacturer, however, shall still perform this test as part of the group C inspection test. 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 the specified testing. Deletion of testing does not relieve the manufacturer from meeting the test requirement in case of dispute.

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

4.6.2 Periodic inspection. Periodic inspection shall consist of group C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.1.4), delivery of products which have passed group A and group B shall not be delayed pending the results of these periodic inspections.

4.6.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in table VI, in the order shown for each subgroup. Group C inspection shall be made on sample units selected from inspection lots which have passed the group A and group B inspections, unless the Government considers it more practical to select a sample from current production. A manufacturer's normal quality control tests, production tests, environmental tests, and so forth, may be used to fulfill all or part of group C inspection; however, all of group C inspection shall be completed as specified.

TABLE VI. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units per current rating
Subgroup I			
Short circuit	3.10.3	4.7.6.3	4
Maximum clearing current I^2t (when specified, see 3.1)	3.10.2	4.7.6.2	at maximum voltage rating
Subgroup 2 (see 3.1)			
Terminal strength	3.9	4.7.5	6
Overload interrupt	3.10.1	4.7.6.1	at maximum voltage rating
Subgroup 3			
Vibration, high frequency	3.12.1	4.7.8.1	4
Vibration, random (when specified, see 3.1)	3.12.2	4.7.8.2	
Continuity	3.6	4.7.2	
Shock	3.13	4.7.9	
Continuity	3.6	4.7.2	
Resistance to soldering heat (when specified)	3.18	4.7.14	
Subgroup 4			
Salt atmosphere (corrosion)	3.14	4.7.10	4
Overload interrupt (at room ambient temperature and maximum voltage rating)	3.10.1	4.7.6.1	
Maximum clearing current I^2t (when specified, see 3.1)	3.10.2	4.7.6.2	
Subgroup 5			
Moisture resistance	3.15	4.7.11	4
Thermal shock	3.16	4.7.12	
Current carrying capacity (at room ambient temperature)	3.8	4.7.4	

4.6.2.1.1 Sampling plan. Unless otherwise specified, 22 sample units each of the maximum and minimum current ratings shall be selected, from those covered by a single specification sheet, 36 months after the date of notification of qualification; except for subgroup 3, which shall be selected on a 48-month basis. The sample units shall be subdivided into subgroups shown in table VI. When production of a particular type of fuse has been suspended for 36 months or more, sample units shall be selected from the first lot of the new production presented for acceptance, and after each subsequent 36-month period; except for subgroup 3, which shall be on a 48-month basis.

4.6.2.1.2 Failures. If one or more sample units fail to pass group C inspection, the sample shall be considered to have failed.

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

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

4.7 Methods of examination and test.

4.7.1 Visual and mechanical examination. Fuses shall be examined to verify that the materials, interface, and physical dimensions, marking and workmanship are in accordance with the applicable requirements (see 3.1 through 3.5 inclusive, 3.19, and 3.21).

4.7.2 Continuity (see 3.6). Continuity of each fuse shall be determined by use of a low voltage ohmmeter or other suitable method.

4.7.3 Resistance (see 3.7). Resistance shall be measured with a Wheatstone bridge, Kelvin bridge, or equivalent sensitive instrument or calculated from the voltage drop (see 4.7.3.1). Measurements shall be taken at room ambient temperature and as close to the fuse element as practicable.

4.7.3.1 Voltage drop (see 3.7.1). Voltage drop shall be measured using a dc voltmeter having a minimum input impedance of 11 megohms with measurements taken at room ambient temperature and as close to the fuse element as practicable.

4.7.4 Current-carrying capacity (see 3.8). Unless otherwise specified (see 3.1), fuses shall be subjected to an ac or dc of 100 percent of rated current and shall be mounted in a fuseholder as specified (see 3.1).

4.7.4.1 For qualification inspection (group I), the samples shall be apportioned and submitted to the test at -55°C to -60°C, at +20°C to +35°C (room ambient temperature), and at the maximum rated temperature for the fuse (see 3.1). The tolerance at the maximum rated temperature shall be -0°C and +5°C.

4.7.4.2 For group B, the inspection shall be done only at +20°C to +35°C (room ambient temperature). The test current shall be as specified (see 3.1). The current shall be maintained for 30 minutes after the temperature of each fuse has stabilized. Stabilization shall be considered to have occurred when no individual fuse temperature rise reading of 4 consecutive readings taken at 5 minute intervals exceeds the average reading of these 4 readings by more than 2°C and no indication of increasing temperature rise is observed. This average temperature rise reading shall be deemed to be the temperature rise of the fuse.

4.7.4.3 When two or more fuses are tested in series, the fuseholders shall be located so that there will be a spacing, as specified in table VII, between any two fuses under test. The wire connecting the fuseholders together and connecting the fuseholders to the ammeter and the source of supply shall be as specified in table VII, (unless otherwise specified). The length of wire between fuseholders shall be as specified in table VII. The temperature of the fuse case or body and of the terminals shall be measured by thermocouples (wire size 28 to 32 AWG).

TABLE VII. Current-carrying capacity test set-up.

Fuse current rating	Spacing (mm)	Wire size	Length (mm)
> 15 amperes	> 6 inches (152.4) (unless otherwise specified)	8 AWG	2 feet (609.6)
≤ 15 amperes	> 1 inch (25.4)	14 AWG	6 inches (152.4)

4.7.5 Terminal strength (see 3.9). Unless otherwise specified, terminals shall be tested in accordance with method 211 of MIL-STD-202, test condition A or E, as applicable. Forces shall be as specified (see 3.1) and shall be applied to individual terminals as follows:

a. Plug or lead type terminals.

(1) Along terminal axis.

(2) Perpendicular to terminal axis.

b. Ferrule type terminals. Torque.

4.7.6 Overcurrent.

4.7.6.1 Overload interrupt (see 3.10.1). Fuses shall be subjected to the percentage of rated current and voltage specified (see 3.1); for qualification (group II) and group C inspection (subgroup 2) the sample fuses shall be apportioned and submitted to the tests as specified (see 3.1), at -55°C to -60°C, at +20°C to +25°C (room ambient temperature) and at maximum rated temperature. The tolerance at the maximum rated temperature shall be -0°C, +5°C. The fuses shall be maintained at the test temperature for a minimum of 30 minutes, prior to the actual application of the test current. For qualification and group C inspections, the power supply shall have an open-circuit voltage of not less than that of the specified voltage rating of the fuse under test. For group B, the inspection shall be done only at room ambient temperature and the power supply may be of any value which is not less than 6 volts. For the qualification and group C inspections, the fuses shall be left in the circuit for 1 minute after opening without any indication of the circuit reclosing. Opening time measurements shall be made with an oscillograph for periods shorter than 1 second; a synchronous timer may be used for measurements longer than 1 second; a stop watch is suitable for measurements of longer than 10 seconds.

4.7.6.2 Maximum current clearing (I^2t)(see 3.10.2). The maximum clearing I^2t shall be determined from an oscillogram showing the current trace or by other equivalent means. It is suggested that UL Standard 248-1 be used for guidance only in determining I^2t but is not intended for compliance. Fuses shall be subjected to rms symmetrical currents with a tolerance of +20, -0 percent. The power factor shall be 95 to 100 percent. The closing angle shall be essentially at zero of the voltage wave (maximum offset) or later, so as to produce start of arcing within 30 electrical degrees prior to system peak voltage. The test voltage shall be not less than the rated voltage of the fuse (see 3.1). The maximum peak voltage occurring during the interruption shall be not more than 3,000 volts. This voltage shall be measured with an instrument having a frequency response that is linear from 50 Hz to 300 Hz.

4.7.6.3 Short circuit (see 3.10.3). Fuses shall be subjected to the tests at the current and voltage specified (see 3.1). The dc tests shall be made using appropriate generating equipment as a source of power and with the rate of current rise for the test circuit adjusted for at least 3.25×10^6 amperes per second. The ac tests shall be conducted using an ac supply of adequate capacity and shall be on a single phase basis. Unless otherwise specified (see 3.1), the current shall be applied within $\pm$10 degrees of zero point of the voltage wave and the circuit power factor shall be 0.85 to 0.95. Short circuit currents shall be determined by means of an oscillograph. Test circuits shall be calibrated for the specified current with the applicable fuseholder (see 3.1) short-circuited.

4.7.7 Outgassing (see 3.11). The fuses or fuse materials shall be tested as specified in ASTM E595.

4.7.8 Vibration (see 3.12).

4.7.8.1 Vibration, high frequency (see 3.12.1). The fuses shall be subjected to vibration tests in accordance with method 204 of MIL-STD-202. The following details shall apply:

a. Mounting: In applicable fuseholder (see 3.1).

b. Test condition C.

c. One-half of the sample units shall be tested while carrying 100 percent of rated current and the balance tested with no current. All sample units shall be tested for continuity as specified in 4.7.2 at the end of test.

4.7.8.2 Vibration, random (see 3.12.2). The fuses shall be subjected to vibration tests in accordance with method 214 of MIL-STD-202. The following details shall apply:

a. Mounting: In applicable fuseholder (see 3.1).

b. Test condition I, letter E.

c. Duration shall be as specified (see 3.1).

d. One-half of the sample units shall be tested while carrying 100 percent of rated current and the balance tested with no current. All sample units shall be tested for continuity as specified in 4.7.2 at the end of test.

4.7.9 Shock (see 3.13). Fuses shall be tested in accordance with 4.7.9.1 or 4.7.9.2, as specified (see 3.1).

4.7.9.1 Method I. Fuses shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting method and accessories: Fuses shall be mounted in or on applicable fuseholder (see 3.1).

b. Test condition I, unless otherwise specified (see 3.1).

c. Measurements before and after test: One-half of the sample units shall be tested while carrying 100 percent of rated current (see 3.1), and the remainder with no current. All fuses shall be tested before and after test for continuity as specified in 4.7.2.

4.7.9.2 Method II. Fuses shall be tested in accordance with method 207 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting fixtures: Fuses shall be tested in or on applicable fuseholder, mounted on fixture 207-4A, or equivalent, of MIL-STD-202.

b. Electrical load on operating conditions: One-half of the sample units shall be tested while carrying 100 percent of rated current (see 3.1), the remainder with no current.

c. Measurement: All fuses shall be tested before and after test for continuity as specified in 4.7.2.

4.7.10 Salt atmosphere (corrosion) (see 3.14). Fuses shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

a. Five percent salt solution.

b. Test condition B.

c. Following the drying period, the fuses shall be subjected to 100 percent of rated current for 1 hour.

d. Following the test, fuses shall be examined for compliance with 3.14.

4.7.11 Moisture resistance (see 3.15). Fuses shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Normal mounting means on a noncorrosive metal panel positioned 15 degrees from the vertical with the terminal down.

b. Polarizing voltage shall be 100 volts dc.

c. Steps 7a and 7b are not applicable.

d. Following the test, the fuses shall be examined for compliance with 3.15.

4.7.12 Thermal shock (see 3.16). The fuses shall be subjected to thermal shock tests in accordance with method 107 of MIL-STD-202. The following details shall apply:

a. Test condition A or B as specified (see 3.1).

b. Examination after test: Fuses shall be examined for compliance with 3.16.

4.7.13 Solderability (see 3.17). Fuses shall be tested in accordance with method 208 of MIL-STD-202 (both leads on each fuse shall be tested).

4.7.14 Resistance to soldering heat (see 3.18). Fuses shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

a. Measurement before test: Continuity shall be measured as specified in 4.7.2.

b. Special preparation of the specimen: Gold plated leads shall have the gold removed by single or double dipping into a flowing or nonflowing hot solder of sufficient volume to assure complete gold removal. Both leads shall be dipped in a suitable noncorrosive flux for a period of 5 seconds ±2 seconds, after which they shall be pre-tinned by immersion into solder for 3 seconds to 5 seconds. The solder shall be maintained at +260°C ±5°C. The leads shall be immersed to within .150 inch ±.025 inch (3.81 mm ±0.64 mm) of the body of the fuse. The fuses shall then be assembled onto the mount board. The mount board shall not be metal clad.

c. Test condition C, except time duration shall be 5 seconds, ± 2 seconds.

d. Cooling time: 5 minutes minimum.

e. Measurements after test: Continuity shall be measured as specified in 4.7.2.

f. Examination after test: Fuses shall be examined for evidence of mechanical damage when visually inspected at 7X.

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.

6.1.1 Fuses. Fuses covered by this specification are intended for use in electronic and low power electrical equipment where relatively low values of short circuit currents are encountered. The fuse primarily provides protection and isolation for the equipment itself. These fuses are designed to endure environmental requirements not specified in MIL-PRF-15160. The fuses covered by this specification are unique due to the fact that these devices must be able to operate satisfactorily under the following demanding conditions: 10 g's vibration, 100 g's of shock, thermal shock from -65°C to +125°C and 48 hours of salt atmosphere. In addition, these requirements are verified under a qualification system. Commercial components are not designed to withstand these environmental conditions.

6.1.2 CAUTION. Application of fuses must be made within the short circuit current and voltage ratings shown on the applicable specification sheet. The available short circuit current of the system in which the fuse is applied shall not exceed the short circuit current rating of the fuse. Use of fuses beyond these requirements may be dangerous to personnel and cause damage to the equipment.

6.1.2.1 Fuses covered by this specification may be safely applied in circuits having a lower voltage than shown as the maximum for the particular fuse provided the short circuit current rating of the fuse is not exceeded. Fuses should never be applied in circuits having voltages greater than the specified maximum fuse voltage rating.

6.1.3 WARNING. FM08 style cartridge fuses are susceptible to plasma arcing once the internal pressure falls near 50 torr or below. If used in a vacuum, the fuse will eventually leak down to critical pressure. If the fuse encounters over-limit currents with sufficient source current, a plasma arc can ensue that will consume the fuse and possibly damage the hardware. Therefore, it is recommended these style fuses not be used in vacuum applications with voltages greater than 36 volts.

6.2 Acquisition requirements. Acquisition documents must specify the following:

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

b. Packaging requirements (see 5.1).

c. Special marking, if required.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Defense Supply Center Columbus, ATTN: DSCC-VQP, 3990 E. Broad Street, Columbus, OH 43213, online at http://www.dscc.dla.mil/programs/qmlqpl/.

6.3.1 Provisions governing qualification. Copies of SD-6, “Provisions Governing Qualification” may be obtained upon application to Defense Automated Printing Service, Building 4D, (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.), online at http://assist.daps.dla.mil.

6.4 Supersession data. This specification includes the essential requirements of previous revisions and supersedes previous type designations (see 3.1).

6.4.1 Background. Previous requirements for fuse style FM03 and FM06 included a current-carrying capacity rating at 100 percent of the nominal current rating. This prevented a direct correlation between style F03 fuses of MIL-PRF-15160, which were rated at 110 percent, and the FM03 and FM06. In an attempt to provide this highly desirable correlation, the style FM09 has been developed. FM09A will have normal interrupt characteristics and the FM09B will have an intentional time delay (see 1.2.1.2 and 6.5). This will provide a direct correlation between the F03A and the FM09A, and between the F03B and the FM09B. The main difference between the style F03 and style FM09 is the known environmental capability of fuses furnished under MIL-PRF-23419.

6.4.2 Cross reference. Specific cross-reference will be provided on the specification sheet.

6.5 Characteristics. The term characteristic refers to the relative overload interrupt capability of a fuse:

6.5.1 Characteristic A: Commonly referred to as "normal" or "instantaneous". This fuse contains a single element with no intentional time delay designed into the element, only maximum opening time is specified.

6.5.2 Characteristic B: Commonly referred to as "time delay". This is a dual element fuse, each element with a different time/current characteristic; maximum and minimum time is specified.

6.6 Finishes.

6.6.1 Tin-plated finish. Pure tin plating is prohibited (see 3.5.5) since it may result in tin whisker growth. Tin whisker growth could adversely affect the operation of electronic equipment systems (see 6.7).

6.6.2 Silver-plated finish. Users may want to consult ASTM B700, Standard Specification for Electrodeposited Coatings of Silver for Engineering Use, as an aid to meeting the performance requirements of this specification.

6.6.3 Gold plated finish. Users may want to consult the appropriate portions of AMS 2422, Plating, Gold and ASTM B488, Electrodeposited Coatings of Gold for Engineering Uses as an aid to meeting the performance requirements of this specification.

6.6.4 Nickel plated finish. Based on past experience, nickel plating .00008 inch (0.0020 mm) thick over brass and .0002 inch (0.0051 mm) thick over copper, has been used successfully to meet the performance requirements of this specification.

6.6.5 Bright alloy plated finish. Based on past experience, bright alloy plating .00008 inch (0.0020 mm) thick for brass terminals and .0002 inch (0.0051 mm) thick for copper terminals with the following compositions, has been used successfully to meet the performance requirements of this specification:

Copper	-	50 to 60 percent
Tin	-	25 to 28 percent
Zinc	-	14 to 18 percent

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. Table VIII lists the Environmental Protection Agency (EPA) top seventeen hazardous materials targeted for major usage reduction. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see section 3).

TABLE VIII. EPA top seventeen hazardous materials.

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

6.9 Subject term (key word) listing.

Amperes
Circuit protection
Continuity
Current-carrying capacity
Current limiting
Maximum current clearing (I^2t)
Overload interrupt
Overload protection
Short circuit
Time delay

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.

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

Review activities:
Army - AR, CR4, MI
Navy - OS, SH
Air Force - 19, 99
NSA - NS

Preparing activity:
DLA - CC

(Project 5920-2007-025)

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