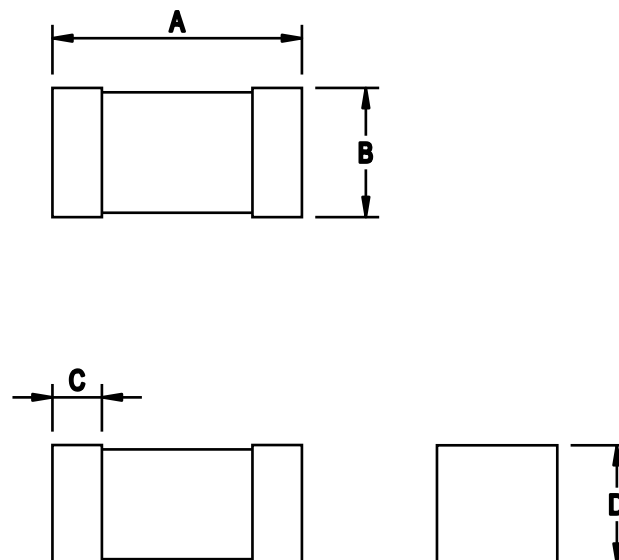


PERFORMANCE SPECIFICATION SHEET

FUSES, INSTRUMENT TYPE, STYLE FM14
(CHIP (SURFACE MOUNT) - HIGH PERFORMANCE)

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

The requirements for acquiring the product described herein
shall consist of this specification sheet and [MIL-PRF-23419](#).



Ltr	Inches		mm	
	Min.	Max.	Min.	Max.
A	.118	.134	3.00	3.40
B	.052	.068	1.32	1.73
C (TYP)	.015	.035	.38	.89
D	---	.062	---	1.57

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Thick film construction (Au element).

FIGURE 1. Style FM14 fuse.

REQUIREMENTS:

Interface and physical dimensions: See [table I](#). and [figure 1](#).

Materials, design and construction: The materials, design and construction of the fuses shall be as specified herein. Marking color (if applicable) and arc suppressant glass color are noted in [table I](#).

Terminals: The base film terminations shall be Silver (Ag) with plated Nickel (Ni) and a final finish of Tin/Lead (Sn/Pb) solder coating. The Tin (Sn) percentage of the solder coating shall not exceed 97 percent, by mass.

Voltage rating: The voltage ratings for fuses specified herein are 24 and 32 volts DC. The applicable voltage ratings are specified in [table I](#).

Current rating: The current rating is the maximum amperes that the fuse will carry at a case/substrate temperature of +25°C without degradation. The applicable current ratings are specified in [table I](#).

Temperature rating: The temperature rating for fuses specified herein shall be -55°C through +150°C nonoperating. The maximum operating temperature shall not exceed a substrate temperature of +125°C. The temperature derating curve is given in [figure 3](#).

Resistance rating: The DC resistance of the fuses shall be as specified in [table I](#). The resistance of the fuse shall be measured using a constant current DC source having an open circuit voltage not greater than the voltage rating of the fuse. The resistance of the fuse shall be measured using one of the following two methods:

Method I. The resistance shall be measured using a constant current DC source having an open circuit voltage not greater than the voltage rating of the fuse. The measurement current shall be from 0.1 to 10 milliamperes and provide a measurement accuracy of +/- 1 percent.

Method II. The fuses shall be electrically connected to a constant DC source supplying 10 percent of the rated current of the fuse and having an open circuit voltage not greater than the voltage rating of the fuse. The voltage drop of each fuse shall be measured and the resistance calculated from the measured voltage drop.

Thermal shock: Fuses shall be tested in accordance with [MIL-PRF-23419](#), test condition B shall apply. A total of five cycles shall be run without interruption. The DC resistance value of the fuse shall not change by more than 10 percent.

Radiographic inspection (X-ray): Fuses shall be subjected to radiographic inspection in accordance with [MIL-STD-202-209](#). The following details shall apply:

- a) The radiograph shall be of sufficient quality to render a clear, sharp image of the penetrometer.
- b) The source-object distance shall ensure a sharply defined image.
- c) Two views of each fuse (0° and 90°) shall be provided.
- d) A radiograph penetrometer shall be included on each radiographic film.
- e) Radiographs shall be examined at 10X magnification for the following defects specified below.
 - i) The internal thick film Ag terminations shall be in contact with the external end Ag termination end caps.
 - ii) The Au fusible element shall be completely encapsulated with arc suppressive cover glass. There shall be no exposed Au fusible element material at the sides of the component.
 - iii) There shall be no cracks in the arc suppressive cover glass or in the 96 percent alumina substrate.
 - iv) There shall be no voids in the arc suppressive glass greater than 0.010 inches (.25 mm) in diameter.
 - v) There shall be no voids in the end terminations greater than 0.005 inches (.13 mm) in diameter.
 - vi) There shall be no foreign material in the fuse greater than 0.005 inches (.13 mm) in diameter.
 - vii) The internal Ag terminations shall be in contact with the Au fusible element.

Note: inspection of the fusible element (and the corresponding interface with the internal terminations) is not always possible for low amperage fuses, and in these cases shall not be required.

Current-carrying capacity: Fuse samples shall be apportioned and submitted to the following DC test currents at -55 °C to -60 °C, at +20 °C to +35 °C (room ambient temperature), and at +125 °C to +130 °C:

<u>Test temperature</u>	<u>DC test current</u>
-55 °C	110 percent of rated
+25 °C	100 percent of rated
+125 °C	80 percent of rated

The test current shall be maintained for 30 minutes after the temperature of each fuse has stabilized, but shall not be applied for less than 1.5 hours. It may be assumed that the temperature has stabilized when four consecutive temperature readings taken at 5 minute intervals show no rise in temperature. The temperature of the fuse body shall be measured by thermocouples (wire 28 to 32 AWG). Group C current-carrying capacity testing shall be conducted at room temperature conditions only.

Termination strength: When fuses are tested in accordance with [MIL-PRF-23419](#), the end terminations shall not break or loosen. The DC resistance value of the fuse shall not change by more than 10 percent. The following exceptions shall apply:

- Test condition A (5-lb pull for fuses rated at 1.0 ampere and higher; 4-lb pull for fuses rated at less than 1.0 ampere) applying the force axially to each lead wire individually (solder .017 inch (.43 mm) to .020 inch (.51 mm) diameter wires to terminations prior to testing).
- Method of holding - The fuse body shall be held by means other than rigid clamping to prevent stresses from being transferred to the fuse element.
- Measurements - DC resistance measurements shall be taken before and after exposure in accordance with the resistance rating requirements of this specification sheet.

Thermal vacuum (qualification only): When fuses are tested herein, they shall show no open circuit during the application of derated DC current nor shall there be evidence of arcing or mechanical damage after the test. Fuses that are subjected to the 400 percent overload current test shall "blow" within the time period specified (see [table I](#)). The DC resistance values of those fuses not subjected to the overload current shall not change by more than 10 percent. Fuses shall be solder mounted onto a suitable test circuit board. The fuses shall then be placed in a vacuum chamber and the chamber evacuated to a pressure of 5×10^{-5} torr maximum. The temperature of the fuse mount shall be controlled such that the temperature of the fuses, measured with a thermocouple mounted on the fuse body, is maintained at +125 °C $\pm$ 3 °C for a period of 48 $\pm$ 4, -0 hours, while 90 percent of the +25 °C rated current is flowing through each fuse. At the end of the 48 hour exposure and while the fuses are at the test temperature and pressure, half of the samples shall be given an overload current at 400 percent of their rated current using the procedure specified in the overload current requirements of this specification sheet. The fuses shall then be removed from the chamber and the remaining fuses (not blown) measured for DC resistance in accordance with the resistance requirement of this specification sheet.

Overload current:

Overload interrupt characterization: Each fuse lot shall be sampled to assure that the blow times fall within the limits of [table I](#). Each lot shall be truncated to form an inspection lot based upon the DC resistance measured after thermal shock. Fuses samples shall be blown (a minimum of 20 samples total) selected from the extremes of the truncated population to ensure that their blow times are within the specification.

Overload interrupt: Fuses selected from a truncated distribution shall be tested herein. The clearing times and the maximum i^2t shall be as specified in [table I](#). After clearing, the circuit shall remain open without closing again during a one-minute period. The let through energy during the one-minute period shall be included in the calculation of i^2t . The blown fuses shall meet the resistance after firing test specified herein. There shall be no evidence of mechanical damage. Fuses shall be subjected to the applicable percent of DC current (250%, 400% or 600%) as specified in [table I](#). For Group A and B, the fuses shall be tested while at case temperatures of +25 °C to +35 °C. For Qualification inspection (Subgroup II, [table II](#)) and Group C inspection (Subgroup II, [table V](#)) the fuses shall be divided equally and tested at 250% (+25 °C and +125 °C), at 400 % (-55 °C and +125 °C) and at 600 % (-55 °C and +125 °C). The low impedance source shall be adjusted to supply an open circuit voltage equal to the rating of the fuse. The time to "blow" (the interval measured from the application of the current to the time the current drops below the rating of the fuse) shall be measured for each fuse.

Each fuse shall remain in the test circuit for 1 minute after the fuse opens to check for restrike conditions. The maximum clearing I^2t shall be determined using an oscillogram showing the current trace. A recommended test circuit is shown in [figure 2](#).

Resistance after firing: The open resistance of the “blown” fuse shall be measured by applying rated DC voltage across the terminals or the fuse. The resistance value shall be taken after a one-minute application of the test voltage. The minimum DC resistance shall be 1 megohm when blown fuses are tested herein.

Moisture resistance (Group C/Qualification only): Fuses shall be tested in accordance with [MIL-STD-202-106](#), there shall be no evidence of mechanical damage or excessive corrosion of the terminations. The DC resistance shall not change by more than 15 percent as a result of the moisture exposure. The following details and exceptions shall apply:

- a) Mounting – Normal mounting means by soldering onto a printed circuit board.
- b) No polarizing voltage shall be applied.
- c) Steps 7a and 7b are not applicable.
- d) Measurements – DC resistance measurements shall be taken before and after the exposure in accordance with the resistance requirements of this specification sheet.

Shock (Group C/Qualification only): Fuses shall be tested in accordance with [MIL-STD-202-213](#). There shall be no evidence of mechanical damage and the DC resistance shall not change by more than 10 percent. The following details and exceptions shall apply:

- a) Mounting – Fuses shall be securely fastened to the table of the shock machine to prevent relative motion between the fuses and the table. Fuses shall be solder mounted onto a test circuit board prior to fastening to vibration machine table.
- b) Test condition F (1500Gs, 0.5 milliseconds, half-sine).
- c) Loading during test – rated DC current on half of the samples tested.
- d) Number of shocks – Three shocks in each direction of three mutually perpendicular axes (18 shocks total).
- e) Measurements – DC resistance measurements shall be taken before and after the shock exposure in accordance with the resistance requirements of this specification sheet.

Vibration (Group C/Qualification only): Fuses shall be tested in accordance with [MIL-STD-202-204](#). There shall be no evidence of mechanical damage and the DC resistance shall not change by more than 10 percent. The following details and exceptions shall apply:

- a) Mounting – Fuses shall be securely fastened to the table of the vibration machine to prevent relative motion between the fuses and the table. Fuses shall be solder mounted onto a test circuit board prior to fastening to vibration machine table.
- b) Test level – Sinusoidal vibration from 5 to 3000 hertz, 0.4-inch (10.16 mm) double amplitude or 30G's peak, whichever is less.
- c) Sweep rate – Approximately 1/2 octave per minute.
- d) Test Duration – 12 hours total (4 hours in each of three major axes).
- e) Loading during testing – Rated DC current on half of the samples tested.
- f) Measurements – DC resistance measurements shall be taken before and after the vibration exposure in accordance with the resistance requirements of this specification sheet.

Low temperature operation (Group C/Qualification only): When fuses are tested herein, there shall be no open circuit and the DC resistance shall not change by more than 10 percent. There shall be no mechanical damage. Fuses shall be solder mounted onto a suitable test circuit board and placed in a low temperature chamber. The chamber temperature shall be lowered gradually to -55 °C +0/-3°C within a period of 1 hour. After stabilizing at the low temperature for a period of 1 hour, rated DC current shall be applied to the fuses for a period of 4 +1/-0 hours while at the low temperature. The chamber shall then be gradually raised to room temperature within a 4 hour period and maintained at room temperature for a period of 8 hours minimum. After this time, the DC current shall be removed from the fuses and the fuses removed from the chamber. The DC resistance of the fuses shall be measured before and after the test in accordance with the resistance requirements of this specification sheet.

Life (2000 hours, Group C/Qualification only): When fuses are tested herein, there shall be no open circuit and the DC resistance shall not change by more than 10 percent. There shall be no mechanical damage. Fuses shall be solder mounted onto a suitable test circuit board and placed in a chamber at $+125^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ambient. The fuses shall be electrically connected to a DC source supplying 64 percent of the $+25^{\circ}\text{C}$ rated current. The fuses shall remain in the chamber at the specified current for 2000 ± 8 hours. The electrical circuit shall provide a suitable indicator, which shall be monitored daily during the length of the life test, to identify failure (blowing) of any fuse. The time of failure shall be recorded to the nearest ± 12 hours and the blown fuse replaced with a short circuit for the remainder of the test. The DC resistance of the fuses shall be measured before and after the test in accordance with the resistance requirements of this specification sheet.

Resistance to soldering heat: Fuses shall be tested in accordance with [MIL-STD-202-210](#), test condition B. The following details and exceptions shall apply:

- a) Solder temperature: $260^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- b) Immersion time: 10 ± 1 seconds.
- c) DC resistance shall be measured before and after the test in accordance with the resistance requirement of this specification sheet.

Solderability: Fuses shall meet the solderability requirements of [MIL-PRF-23419](#).

Salt atmosphere ((corrosion) Group C/Qualification only): Fuses shall meet the salt atmosphere (corrosion) requirements of [MIL-PRF-23419](#). The DC resistance shall not change by more than 10 percent.

Outgassing: Material shall meet the outgassing requirements specified in [MIL-PRF-23419](#).

Short circuit interrupt (Group C/Qualification only): Fuses shall be placed in a DC test circuit capable of supplying a minimum of 35 to 50 amperes (as applicable to the fuse under test). The test circuit 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 open circuit voltage of the test circuit shall be adjusted to a value equal to the maximum rating of the fuse to be tested. The DC resistance after short circuit testing shall be at least 1 megohm.

168-hour burn-in (Group B): When fuses are tested herein, the voltage drop (as measured at 10 percent rated current) shall not have changed by more than 10 percent of the pre thermally shocked value. There shall be no evidence of mechanical damage. Fuses shall be solder mounted onto suitable test boards and connected in an electrically series circuit. Prior to testing, the voltage drop (at 10 percent rated current) of each fuse shall be measured and recorded. Voltage drop measurements shall be accomplished by probing the fuse end terminations. The mounted fuses shall be subjected to 5 cycles of thermal shock testing of this specification sheet. Following the thermal shock exposure, the fuses shall be subjected to 168 hours ($+4/-0$ hours) of rated current testing. During burn-in testing, the ambient room temperature shall be maintained at from $+25^{\circ}\text{C}$ to $+28^{\circ}\text{C}$, fuse case temperature shall not be controlled during the burn-in test. Following the 168-hour exposure, the fuse voltage drops at 10 percent rated current shall be measured.

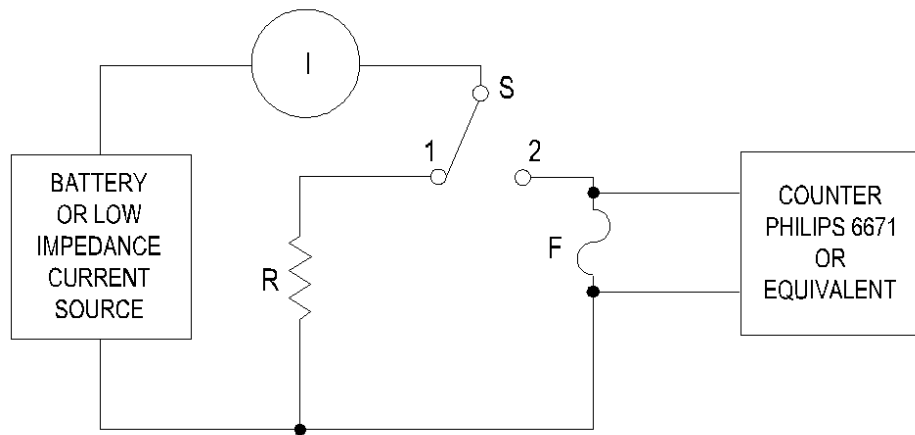
Workmanship: Fuses shall meet the workmanship requirements in [MIL-PRF-23419](#).

Traceability requirements: Traceability requirements shall conform to [MIL-STD-790](#).

Part or Identifying Number (PIN): The PIN shall be derived from [table I](#). An example of a complete PIN designation: FM14A32V1/2A.

Marking: Fuses shall be marked with the PIN designation in accordance with [MIL-PRF-23419](#), manufacturer's name or logo, date code, and serialized label. Manufacturer's lot may be marked optionally.

Current derating limits: The recommended derating limits for fuses covered in this specification sheet are listed on [figure 3](#). This figure relates current to case temperature, regardless of vacuum conditions.



NOTES:

R = Non-inductive resistor equal to the ohmic value of the fuse being tested.

S = Non-bounce high current switch.

I = Current adjusted to percent overload with switch in position 1.

F = Current limiting fuse under test.

FIGURE 2. Overload current test circuit.

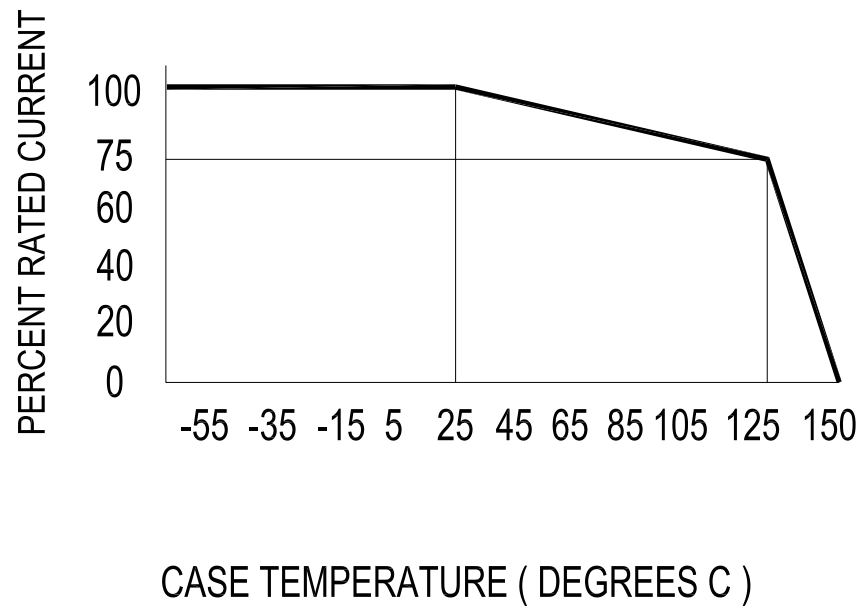


FIGURE 3. Current derating limits.

Table I. PIN designation identification

PIN designation			DC resistance (ohms) ^{1/}		Overload interrupt time (seconds) ^{2/} , ^{3/} , ^{5/}			Max. I^2t (A ² -Sec.) ^{4/}	Arc Suppressant Glass Color	Marking Design ation Bars/D ots	Marking Ink Color
Style	Characteristic	Max. voltage (V dc)	Current rating (A)	Min.	Max.	250%	Nominal rating	400%	600%		
FM14	A	32V	0.250	1.463	3.038	.005-60.0	.0005-.015	.0005-.003	Note 4	2 Bars	White
		32V	0.375	0.975	2.030	.005-60.0	.0005-.015	.0005-.003	Note 4	2 Bars	Red
		32V	0.500	0.390	0.810	.005-10.0	.0005-.015	.0005-.003	Note 4	2 Bars	Blue
		32V	0.750	0.172	0.358	.005-10.0	.0005-.015	.0005-.003	Note 4	2 Bars	Black
		32V	1.000	0.090	0.190	.005-8.0	.0005-.010	.0001-.003	Note 4	2 Dots	White
		32V	1.500	0.075	0.155	.005-8.0	.0005-.010	.0001-.003	Note 4	2 Dots	Blue
		32V	2.000	0.0360	0.0760	.005-3.0	.0005-.010	.0001-.003	Note 4	2 Dots	Green
		32V	3.000	0.0208	0.0432	.005-1.0	.0005-.010	.0001-.003	Note 4	2 Dots	Brown
		24V	4.000	0.0150	0.0311	.005-1.0	.0005-.010	.0001-.003	Note 4	2 Dots	Yellow
		24V	5.000	0.0104	0.0216	.005-1.0	.0005-.010	.0001-.003	Note 4	None	None
		24V	6.000	0.0091	0.0189	.010-1.0	.0005-.010	.0001-.003	Note 4	2 Dots	Red
		24V	7.000	0.0078	0.0162	.010-1.0	.0005-.010	.0001-.003	Note 4	2 Dots	Orange

^{1/} DC resistance is measured in accordance with the resistance requirements of this specification sheet.

^{2/} Overload interrupt clearing times at -25°C. Clearing times at 250 percent overloads and -55°C may be longer than those noted. PCB trace geometry may also affect clearing times below 400 percent overload levels.

^{3/} 200 percent and 1000 percent overload interrupt clearing times also supplied for Group A data.

^{4/} Maximum I^2t (let-thru energy) can be calculated by squaring the given overload current and multiplying by the maximum clearing time specified.

^{5/} The short circuit interrupt rating: 50 amperes for ¼ to 3.0 ampere rating at rated voltage: 35 amperes for 4.0 to 7.0 ampere ratings at rated voltage.

Qualification inspection: Qualification inspection shall be in accordance with MIL-PRF-23419, except qualification inspection shall consist of the tests listed in table II.

Qualification samples: Samples submitted to qualification inspection shall be representative of the normal production. A sample of 44 fuses representing the lowest, middle, and highest DC resistance values within the truncated distribution shall be submitted for qualification inspection. At the completion of Subgroup I inspection, the 44 samples shall be divided into the subgroups and quantities shown in table II. Each subgroup shall have approximately equal representation of the fuse DC resistance values.

TABLE II Qualification inspection.

Examination or test	Number of Units specified	PDA (Max)
Subgroup I (44 Units)		
Visual and mechanical examination	44	0
Material analysis ^{1/}	5	0
DC resistance	44	0
Subgroup II (6 units)		
Solderability	6	
Overload interrupt @ high/low temperatures and maximum clearing at 600 percent.	6	0
Resistance after firing	6	0
Subgroup III (20 units)		
Low temperature operation	12	0
Life (2000 hours)	12	0
Overload interrupt (+25 °C)	12	0
Resistance after firing	12	0
Thermal vacuum	4 (separate sample)	0
Overload interrupt (400 percent)	2	0
Resistance after firing	2	0
Short circuit interrupt	4 (separate sample)	0
Resistance after firing	4	0
Subgroup IV (4 units)		
Vibration	4	0
Shock	4	0
Subgroup V (4 units)		
Salt atmosphere	4	0
Overload interrupt @ +25 °C (maximum clearing at 600 percent.	4	0
Resistance after firing	4	0
Subgroup VI (4 units)		
Outgassing ^{2/}	(as required)	0
Moisture resistance	4	0
Thermal shock	4	0
Resistance to soldering heat	4	0
Current carrying capacity (+25 °C)	4	0
Overload interrupt (+25 °C)	4	0
Resistance after firing	4	0
Subgroup VII (6 units)		
Termination strength	6	0

^{1/} Material analysis shall be as specified in MIL-PRF-23419.

^{2/} Outgassing sample size dependent on testing laboratory.

Conformance inspection. Inspection of product for delivery shall consist of group A and group B inspection. Non-conforming units shall be removed from the lot.

Group A inspection. Group A inspection shall consist of the inspections specified in [table III](#), shall be conducted on 100 percent of the units, in the order shown.

TABLE III. Group A inspection.

Examination or test	Number of Units specified	PDA (Max) <u>1/</u>
DC resistance	100 percent	N/A
Thermal shock	100 percent	<u>2/</u>
DC resistance	100 percent	N/A
Overload Current characterization	As required (20 pcs. Minimum)	N/A
Radiograph inspection (X-Ray)	100 percent	N/A
Visual and mechanical inspection	100 percent	N/A

1/ Overall PDA shall not exceed 5 percent.

2/ The maximum PDA for Thermal Shock is 5 percent.

Group B inspection: Group B inspection shall consist of the tests listed in [table IV](#), in the order indicated. The sample size shall be 58 units. All fuses submitted to Group B inspection shall have successfully met all electrical requirements of Group A inspection (visual rejects and Radiographic inspection (X-ray) rejects may be utilized for Group B inspection).

TABLE IV Group B inspections.

Examination or test	Number of Units specified	PDA (Max)
Subgroup I (20 Units)		
Overload interrupt (+25°C)	20	0
Resistance after firing	20	0
Subgroup II (8 units)		
Solderability	8	0
Subgroup III (4 units)		
Resistance to soldering heat	4	0
Subgroup IV (4 units)		
Termination strength	4	0
Subgroup V (22 units)		
Thermal shock	22	0
168-Hour burn-in	22	0

Group C inspection: Periodic inspection shall consist of group C inspection and shall consist of the tests listed in [table V](#). The sample size shall be 34 units. The fuses submitted for Group C inspection shall have met Group A and Group B inspection requirements as part of the inspection lot from which they were taken.

TABLE V Group C inspections.

Examination or test	Number of Units specified	PDA (Max)
Subgroup I (16 Units)		
Low temperature operation	12	0
Life (2000 hours)	12	0
Overload interrupt (+25 °C)	12	0
Resistance after firing	12	0
Short circuit interrupt	4	0
Resistance after firing	4	0
Subgroup II (6 units)		
Overload interrupt	6	0
Resistance after firing	6	0
Subgroup III (4 units)		
Vibration	4	0
Shock	4	0
Resistance to soldering heat	4	0
Subgroup IV (4 units)		
Salt atmosphere	4	0
Overload interrupt (+25 °C)	4	0
Resistance after firing	4	0
Subgroup V (4 units)		
Moisture resistance	4	0
Thermal shock	4	0
Current-carrying capacity (+25 °C)	4	0

Referenced documents. In addition to [MIL-PRF-23419](#), this document references the following:

[MIL-STD-790](#)
[MIL-STD-202-106](#)
[MIL-STD-202-204](#)
[MIL-STD-202-209](#)
[MIL-STD-202-210](#)
[MIL-STD-202-213](#)

Custodians:

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

Preparing activity:

DLA - CC

(Project 5920-2018-011)

Review activities:

Army - AR, CR4, MI
 Navy - OS, SH
 Air Force - 19
 NSA - NS
 Other - MDA

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 <https://assist.dla.mil>.