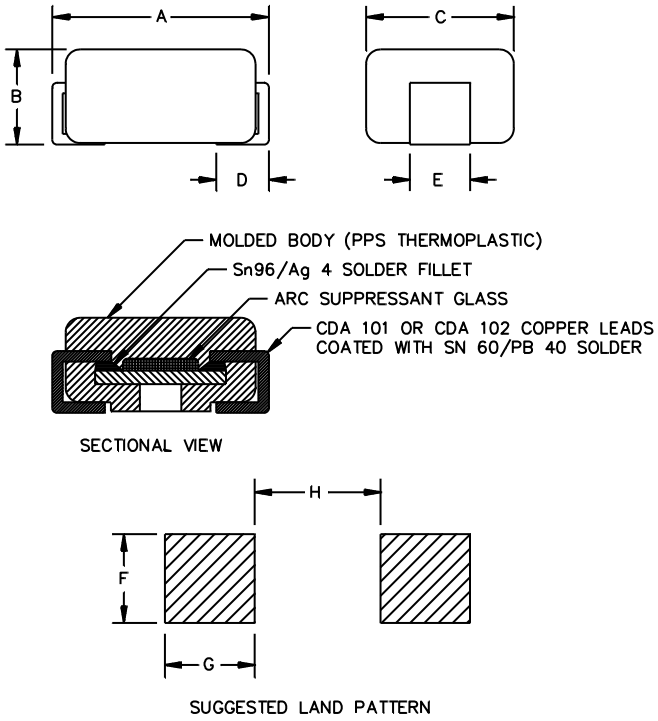
PERFORMANCE SPECIFICATION SHEET

FUSES, INSTRUMENT TYPE, STYLE FM13
(SUBMINIATURE - 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.



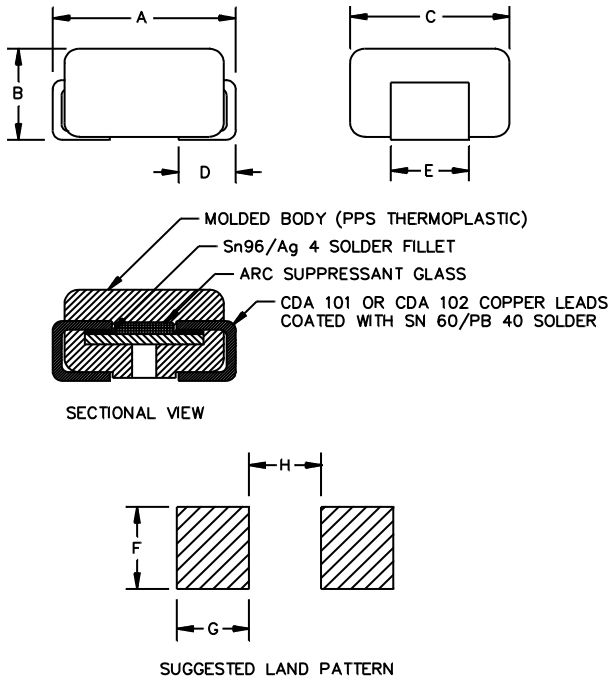
Ltr	Inches		mm		Ltr	Inches		mm	
	Min	Max	Min	Max		Min	Max	Min	Max
A	.320	.340	8.13	8.64	E	.090	.098	2.29	2.49
B	---	.160	---	4.06	F	.090	.110	2.29	2.79
C	.225	.245	5.72	6.22	G	.100	.120	2.54	3.05
D	.065	.085	1.65	2.16	H	.150	.170	3.81	4.32

FIGURE 1. Style FM13 fuse (72 and 125 VDC).

NOTES:

1. Dimensions are in inches.
2. Contour optional within dimensional limits.
3. Lead terminals shall be copper.
4. Maximum weight shall be 0.5 grams.
5. Metric equivalents are given for general information only.
6. Unless otherwise specified, tolerance is ±.01 (0.3 mm).

FIGURE 1. Style FM13 fuse (72 and 125 VDC) - continued.



Ltr	Inches		mm		Ltr	Inches		mm	
	Min	Max	Min	Max		Min	Max	Min	Max
A	.450	.500	11.43	12.70	E	.199	.207	5.05	5.26
B	---	.250	---	6.35	F	.200	.220	5.08	5.59
C	.410	.450	10.41	11.43	G	.170	.190	4.32	4.83
D	.135	.155	3.43	3.94	H	.170	.190	4.32	4.83

NOTES:

1. Contour optional within dimensional limits.
2. Lead terminals shall be copper.
3. Maximum weight shall be 1.85 grams.
4. Minimum marking shall be abbreviated:
5. Dimensions are in inches.
6. Metric equivalents are given for general information only.
7. Unless otherwise specified, tolerance is ±.01 (0.3 mm).

FIGURE 2. Style FM13 fuse (50, 72 and 125 VDC).

REQUIREMENTS:

Interface and physical dimensions: See table I and figures 1 or 2.

Case material: Polyphenylene sulfide (PPS) or equivalent. The PPS material shall be insert molded to form the body of the fuse.

Internal construction: The fuse element shall be a thick film material printed on a thermally insulated substrate and sealed with a thick film arc suppressive glass.

Terminals:

Material: The lead material shall be copper, electro tin-lead plated per SAE-AMS-P-81728 or solder coated with Sn60/Pb40 solder. Exposed base material may be present but shall not exceed 2 percent of the total lead surface. Terminal thickness reduction in bend areas shall be at least 60 percent of nominal terminal thickness.

Strength: Five pounds applying force axially to each fuse terminal.

Pure tin: Pure tin shall be as specified in MIL-PRF-23419 except lead-free, tin alloy high temperature solders may be used internally 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.

Outgassing: Material shall meet the outgassing requirements specified in MIL-PRF-23419.

Current rating: See table I.

Voltage rating: See table I.

Temperature rating: The temperature rating for fuses specified is -55°C to +150°C nonoperating. The maximum operating temperature shall not exceed a case temperature of +125°C. The temperature derating curve is given in figure 4.

Current carrying capacity: 100 percent at +25°C; 110 percent at -55°C; 80 percent at +125°C. Current carrying capacity is independent of vacuum conditions. The temperature of the case, body or terminals shall, at no point, rise more than +85°C above the ambient air temperature. The maximum temperature rise for 6.0, 7.5, 10, 15, and 20 ampere fuses shall be +120°C.

Resistance rating: See table I.

Overload interrupt (as applicable to 250 percent overload and -55°C ambient): Interrupt time from -55°C through +125°C shall be as specified in table I. The following exception shall apply for interrupt times at -55°C and 250 percent overload current:

a. Fuse ratings greater than 1.5 amperes shall open in 5 seconds maximum.

b. Fuse ratings of 1.5 amperes and less shall meet the minimum required clearing time and the maximum clearing time will depend upon fuse mount conditions and fuse mount heat sinking efficiency.

For group B, group C, and qualification 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. Opening times (the interval measured from the application of current to the time the current drops below the rating of the fuse) shall be made with an oscillogram for periods shorter than 1 second.

Short circuit interrupt: 1,000 amperes at maximum voltage dc.
Maximum current clearing I^2t: The maximum current clearing I^2t shall be in accordance with MIL-PRF-23419 and shall be as specified in table I.

Vibration, high frequency: Fuses shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Fuses shall be mounted with their bodies restrained from movement, on an appropriate mounting fixture.

b. Test level: Sinusoidal vibration from 5 to 3,000 hertz, 0.4 inch double amplitude or 30 g's peak, whichever is less. (Method 201 of MIL-STD-202 is not applicable).

c. Sweep rate: Approximately one-half octave per minute.

d. Test duration: 12 hours total (4 hours in each of three major axis).

e. Loading during testing: Rated dc current on 50 percent of fuse samples tested.

f. Measurements: DC resistance measurements shall be taken before and after the vibration exposure.

Shock: In accordance with method I of MIL-PRF-23419, except test condition F. Fuses shall be mounted by their normal mounting means, with their bodies restrained from movement, on an appropriate mounting fixture.

Thermal shock: In accordance with MIL-PRF-23419, except test condition B shall apply.

Burn-in (168 hours - group B): Fuses shall be mounted onto suitable test boards and connected in an electrically series circuit. Spacing between adjacent fuses shall not be less than 0.25 inches and not greater than 3.0 inches. 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 leads in the lead egress area. The mounted fuses shall then be subjected to 5 cycles of thermal shock testing. Following the thermal shock exposure, the fuses shall be subjected to 168 +4, -0 hours of rated current testing. During burn-in testing, the ambient room temperature shall be maintained at from +25°C to +28°C. Fuse case temperature will not be controlled during the burn-in test. Following the 168-hour burn-in exposure, the fuse voltage-drop at 10 percent rated current shall be measured.

Terminal strength: Method 211 of MIL-STD-202, test condition A (5 pounds pull) applying the force axially to each terminal (solder .026 inch diameter wires to fuse terminals prior to testing). The DC resistance of each fuse shall be measured before and after testing in accordance with MIL-PRF-23419. The change in resistance shall not exceed ±10 percent from the initial value.

Resistance to soldering heat: Fuses shall be tested in a vapor phase test device and the boiling liquid shall be FC-70 or equivalent. A thermocouple (wire size 28 to 32 AWG) shall be attached to the body of one fuse for the purpose of monitoring case temperature during testing. The test samples shall be placed in the vapor for a period of 180 +/- 10 seconds after the case temperature has reached a temperature of +215°C. After the vapor exposure, the fuses shall be allowed to cool for 10 minutes at room temperature. The DC resistance of each fuse shall be measured before and after the test in accordance with MIL-PRF-23419. The change in resistance shall not exceed ±10 percent from the initial value.

Low temperature operation: Fuses shall be soldered to test boards and placed in a low temperature chamber. The chamber temperature shall be lowered gradually to -55°C +0°C, -3°C within a period of 1 hour. After stabilizing at the low temperature for 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 over 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 each fuse shall be measured before and after testing in accordance with MIL-PRF-23419. The change in resistance shall not exceed ±10 percent from the initial value.

Life (2,000 hours): Fuses shall be soldered on a suitable test board and placed in a chamber at +125°C +3°C, -0°C ambient. The fuses shall be electrically connected to a dc source supplying each fuse with 64 percent of the +25°C rated value of current. The fuses shall remain in the chamber at specified current for 2,000 ±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 each fuse shall be measured before and after testing as specified in MIL-PRF-23419 and shall not have changed by more than ±10 percent.

Solderability: Fuses shall be tested in accordance with method 208 of MIL-STD-202.

Moisture resistance: Fuses shall be tested as specified in MIL-PRF-23419. The DC resistance of each fuse shall be measured before and after testing and shall not have changed by more than ±15 percent. Normal mounting means on a non-corrosive metal panel positioned 15 degrees from the vertical with the terminals facing up.

Dielectric withstanding voltage: Fuses shall be tested in accordance with method 301 of MIL-STD-202. Fuses shall be mounted in a test fixture capable of exposing all major surfaces of the fuse body and the leads to the test voltage. The test voltage shall be applied to the terminals electrically tied together and to the test fixture. The following details shall apply:

a. Test voltage: 500 V rms.

b. Duration: 5 seconds for group A inspections.
60 seconds for qualification inspections.

c. Leakage current: 1 milliampere maximum.
d. Measurements: DC resistance of the fuse after the dielectric withstanding exposure in accordance with MIL-PRF-23419.

This test shall become part of the group I test under qualification and group A inspections.

Thermal vacuum: Fuses shall be solder mounted on suitable test boards. The fuses shall then be placed in a vacuum chamber and the chamber evacuated to a pressure of 5 x 10^{-5} torr maximum. The temperature of the fuse mount shall be controlled such that the temperature of the fuses, as measured with a thermocouple mounted on the fuse body, is maintained at +125°C ±3°C for a period of 48 +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, one-half of the samples shall be given an overload interrupt test at 400 percent of their rated current. The fuses shall then be removed from the chamber and the remaining fuses (not blown) measured for DC resistance as specified in MIL-PRF-23419. The change in resistance shall not exceed ±10 percent of the initial value.

Conformance: With the exception of the overload characterization test and dielectric withstanding voltage test, the following tests shall be conducted on 100 percent of the units, in the order shown, and shall replace the group A tests referenced in MIL-PRF-23419. Nonconforming units shall be removed from the lot. The lot shall be considered rejected if it exceeds the allowable PDA of 5 percent for the thermal shock and burn-in tests combined.

a. Precap inspection performed at 10X magnification as specified herein.

b. Visual and mechanical inspection; screen for the following defects:

   (1) Cracks in the molded housing.

   (2) Insufficient plastic fill (Note: Molding gaps in terminal egress areas are normal as long as the fuse meets the radiographic inspection requirements).

   (3) Exc--essive plastic flash (part out of dimensional tolerance).

c. Thermal shock as specified herein.

d. DC resistance in accordance with MIL-PRF-23419.

e. Overload characterization: Each fuse lot shall be sampled to assure that overload interrupt times shall fall within the limits as specified in table I. Each lot shall be truncated to form an inspection lot based upon the final DC resistance as measured after the completion of thermal shock. The manufacturer shall subject samples selected from the extremes of the truncated population to overload interrupt testing to ensure that overload interrupt times are as specified in table I. A minimum of 20 fuses shall be selected from the extremes of the population and subjected to 250 percent, 400 percent, and 600 percent overload interrupt testing.

f. Radiographic inspection in accordance with method 209, MIL-STD-202, two views (0° and 90°). Inspection criteria shall be as specified herein.

g. Visual and mechanical inspection in accordance with MIL-PRF-23419 at 10X magnification.

h. Dielectric withstanding voltage shall be performed as specified herein. A sample of fuses shall be randomly selected in accordance with the zero defect sampling plan of MIL-PRF-23419 (group B column). If one or more defects are found, the lot shall be rejected.

Part or Identifying Number (PIN): The PIN shall be derived from table I. An example of a complete PIN designation: FM13A72V1/2A.

Marking: Fuses shall be marked with the PIN designation in accordance with MIL-PRF-23419, and the manufacturer's lot number.

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.

Precap inspection: Prior to molding, all fuses shall be visually inspected at 10X magnification for the following defects:

Arc suppressant glass:

a. Obvious foreign materials in the arc suppressant glass are cause for rejection only if they are greater than .010 inches in diameter.

b. Pits and small chips in the arc suppressant glass shall be cause for rejection only if they are greater than .010 inches in diameter.

c. Scratches on the surface of the arc suppressant glass are not cause for rejection.

d. Micro-cracks on the surface of the arc suppressant glass are not cause for rejection. If the inspector suspects a fracture may exist below the surface of the glass, a sample of five fuses shall be cross-sectioned and inspected at a minimum of 30X magnification.

e. Areas of discoloration in the arc suppressant glass are acceptable.

f. Holes in the arc suppressant that are greater than .010 inches in diameter are cause for rejection.

Lead attachment:

a. Parts shall be visually free of flux and other foreign material after cleaning.

b. The solder must make a continuous fillet between the silver termination pad and the lead (fillet required on each side of lead – not required at the arc suppressant end of lead).

c. Voids in the solder fillet shall not exceed .015 inches in diameter.

d. The leads must lay approximately parallel with the edge of the alumina substrate (place in assembly mold if lead position is in question – should drop into mold cavity without resistance).

e. A sample of five fuses shall be subjected to lead peel testing. Minimum acceptable force at lead pullout is 250 grams.

Radiographic Inspection: The following examinations of radiographic film will be performed under a microscope at a minimum of 10X magnification.

Molding voids (plastic body):

a. Voids in the molded body are rejectable if they are greater than .020 inches in diameter. Excluded are voids in the terminal egress area that do not extend into terminal attachment areas.
b. Any voids adjacent to the arc suppressant glass are rejectable.

c. Delaminations between the element substrate/lead subassembly and molded body are rejectable (except when delamination is on non-active side of substrate/lead subassembly and does not run the full length of the substrate).

d. Cracks in the molded case are rejectable.

Arc Suppressant glass:

a. Pin holes in the arc suppressant are rejectable if they are greater than .010 inches in diameter.

b. Cracks in the arc suppressant glass are rejectable.

Alumina substrate:

a. Cracks in the alumina substrate are rejectable.

Solder fillet criteria:

a. Voids in the solder fillet are rejectable if they are greater than .015 inches in diameter (fillet is defined as soldered area on sides of lead – not area under lead or at arc suppressant glass end of lead). Solder voids under the lead shall not exceed 50 percent of the total soldered area (excludes solder fillet areas previously defined).

b. Cracks in the solder fillet are rejectable.

c. The leads shall lay parallel with the edge of the alumina substrate and there shall be no evidence of disturbed solder fillets.

Foreign material:

a. Any foreign material greater than .015 inches in diameter is rejectable (includes solder balls).

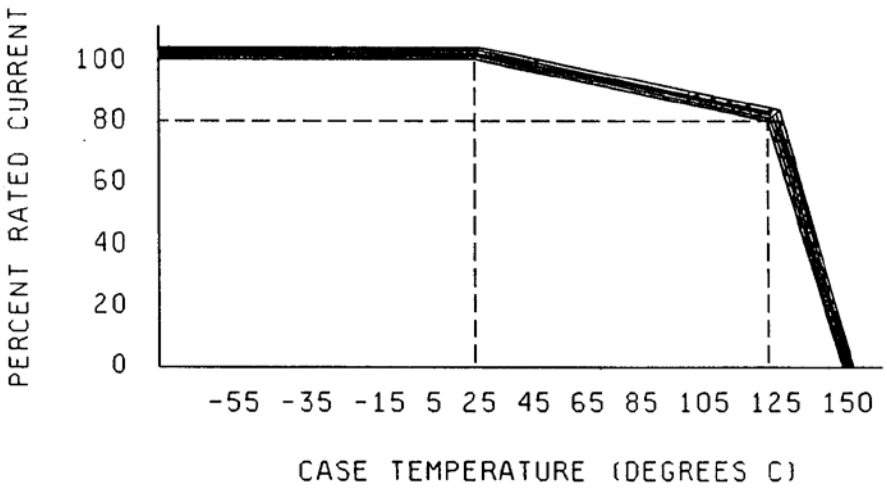


FIGURE 3. Current derating limits.

TABLE I. PIN designation identification.

PIN designation				DC resistance (ohms) 1/		Figure (1, or 2)	Overload interrupt time (seconds) 2/			Maximum current clearing I^2t (ampere^2 seconds) 3/		
Style	Charac-teristic	Maximum voltage (V dc)	Current rating (A)	Minimum	Maximum		250% nominal rating	400% nominal rating	600% nominal rating	250% nominal rating	400% nominal rating	600% nominal rating
FM13	A	72V	1/8A	6.375	10.625	1	.005-30.0	.0005-.015	.000075-.003	2.930	0.004	0.002
FM13	A	72V	1/4A	1.875	3.125	1	.005-30.0	.0005-.015	.000075-.003	11.719	0.015	0.007
FM13	A	72V	3/8A	1.125	1.875	1	.005-.5	.0005-.015	.000075-.003	0.439	0.034	0.015
FM13	A	72V	1/2A	0.675	1.125	1	.005-.5	.0005-.015	.000075-.003	0.781	0.060	0.027
FM13	A	72V	3/4A	0.225	0.375	1	.005-.5	.0005-.015	.000075-.003	1.758	0.135	0.061
FM13	A	72V	1A	0.135	0.225	1	.005-.5	.0005-.015	.000075-.003	3.125	0.240	0.108
FM13	A	72V	1.5A	0.097	0.163	1	.005-.5	.0005-.015	.000075-.003	7.031	0.540	0.243
FM13	A	72V	2.0A	0.045	0.075	1	.005-.5	.0005-.015	.000075-.003	12.500	0.960	0.432
FM13	A	72V	3.0A	0.0262	0.0438	1	.005-.5	.0005-.015	.000075-.003	28.125	2.160	0.972
FM13	A	72V	4.0A	0.0195	0.0325	1	.005-.5	.0005-.015	.000075-.003	50.000	3.840	1.728
FM13	A	72V	5.0A	0.0135	0.0225	1	.005-.5	.0005-.015	.000075-.003	78.125	6.000	2.700
FM13	A	72V	6.0A	0.0100	0.0180	1	.005-.5	.0005-.015	.000075-.003	112.500	8.640	3.888
FM13	A	72V	7.5A	0.0070	0.0110	1	.005-.5	.0005-.015	.000075-.003	175.781	13.500	6.075
FM13	A	72V	10A	0.0046	0.0079	1	.005-.5	.0005-.015	.000075-.003	312.500	24.000	10.800
FM13	A	72V	15A	0.0040	0.0075	2	.005-.5	.0005-.015	.000075-.003	703.125	54.000	24.300
FM13	A	50V	20A	0.0020	0.0056	2	.005-.5	.0005-.015	.000075-.003	1250.000	96.000	43.200
FM13	A	125V	1/8A	6.375	10.625	1	.005-30.0	.0005-.015	.000075-.003	2.930	0.004	0.002
FM13	A	125V	1/4A	1.875	3.125	1	.005-30.0	.0005-.015	.000075-.003	11.719	0.015	0.007
FM13	A	125V	3/8A	1.125	1.875	1	.005-.5	.0005-.015	.000075-.003	0.439	0.034	0.015
FM13	A	125V	1/2A	0.675	1.125	2	.005-.5	.0005-.015	.000075-.003	0.781	0.060	0.027
FM13	A	125V	3/4A	0.225	0.375	2	.005-.5	.0005-.015	.000075-.003	1.758	0.135	0.061
FM13	A	125V	1A	0.090	0.270	2	.005-.5	.0005-.015	.000075-.003	3.125	0.240	0.108
FM13	A	125V	1.5A	0.0850	0.2250	2	.005-.5	.0005-.015	.000075-.003	7.031	0.540	0.243
FM13	A	125V	2.0A	0.0450	0.1350	2	.005-.5	.0005-.015	.000075-.003	12.500	0.960	0.432
FM13	A	125V	3.0A	0.0350	0.1050	2	.005-.5	.0005-.015	.000075-.003	28.125	2.160	0.972
FM13	A	125V	4.0A	0.0300	0.0900	2	.005-.5	.0005-.015	.000075-.003	50.000	3.840	1.728
FM13	A	125V	5.0A	0.0220	0.0680	2	.005-.5	.0005-.015	.000075-.003	78.125	6.000	2.700

1/ DC resistance is measured with a test current less than 10 milliamperes of current, or shall be calculated from the measured voltage drop at a current not exceeding 10 percent of the rated current of the fuse.

2/ Overloads interrupt times at -55°C and 250 percent overload current shall be as follows:

a. Fuse ratings greater than 1.5 amperes shall open in 5 seconds maximum.

b. Fuse ratings of 1.5 amperes and less shall meet the minimum required clearing time and the maximum clearing time will depend upon fuse mount conditions and heat mount heat sinking efficiency.

3/ Maximum current clearing I^2t at -55°C and 250 percent overload current may be greater than indicated. To calculate maximum I^2t at case temperature of -55°C and 250 percent overload current, multiply the I^2 product by the maximum blow times indicated in note 2 above.

Group B inspection:

Inspection routine: Group B inspection shall be in accordance with MIL-PRF-23419, except the number of samples shall be 42 samples, and the inspection order shall be as indicated in table II. If the inspection lot exceeds 1,200 fuses, the zero defect sampling plan of MIL-PRF-23419 shall apply.

TABLE II Group B samples.

Inspection	Number of sample fuses
Subgroup I	
Solderability	ALL
Terminal strength	ALL
Overload interrupt at +25°C	
250% overload current	12 of 20
400% overload current	4 of 20
600% overload current	4 of 20
Subgroup II	
Thermal shock	22
168-hour burn-in	22

Qualification inspection: Qualification inspection shall be in accordance with MIL-PRF-23419, except the group II and group III inspections shall be as follows:

Group II inspection routine: Six samples shall be subjected to the group II inspection routine as specified in table III. Maximum clearing I^2t shall be measured when group II samples are subjected to 600 percent overload interrupt testing.

TABLE III Group II samples.

Inspection	Number of sample fuses
Group II	
Terminal strength	ALL
Overload interrupt	
250% at -55°C	1 of 6
250% at +125°C	1 of 6
400% at -55°C	1 of 6
400% at +125°C	1 of 6
600% at -55°C	1 of 6
600% at +125°C	1 of 6
Solderability	ALL

Group III inspection routine: Fourteen samples shall be subjected to the group III inspection routine as specified in table IV. Group III samples shall be taken as indicated. DC resistance measurements shall be taken before and after each test. DC resistance values for each fuse shall not change by more than ±10 percent.

TABLE IV. Group III samples.

Inspection	Sample number. 'X' indicates test to be performed.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Group III														
Low temp. operation	X	X	X	X	X	X								
Life (2,000 hours)	X	X	X	X	X	X								
Overload interrupt														
250% at +25°C	X	X												
400% at +25°C			X	X										
600% at +25°C					X	X								
Thermal vacuum							X	X	X	X				
Overload interrupt at 400%							X	X						
Short circuit											X	X	X	X

Group C inspection: Group C inspection shall be in accordance with MIL-PRF-23419, except 16 samples shall be subjected to the subgroup I inspections as specified in table V. Maximum clearing I^2t for subgroups II and IV shall be performed at 600 percent of the +25°C rated current.

TABLE V. Subgroup I samples.

Inspection	Sample number. 'X' indicates test to be performed.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group I																
Low temp. operation	X	X	X	X	X	X	X	X	X	X	X	X				
Life (2,000 hours)	X	X	X	X	X	X	X	X	X	X	X	X				
Overload interrupt																
250% at +25°C	X	X	X	X												
400% at +25°C					X	X	X	X								
600% at +25°C									X	X	X	X				
Short circuit													X	X	X	X

Referenced documents. In addition to MIL-PRF-23419, this document references the following:

MIL-STD-202 SAE-AMS-P-81728

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

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

Preparing activity:
DLA - CC

(Project 5920-2014-002)

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.