INCH-POUND
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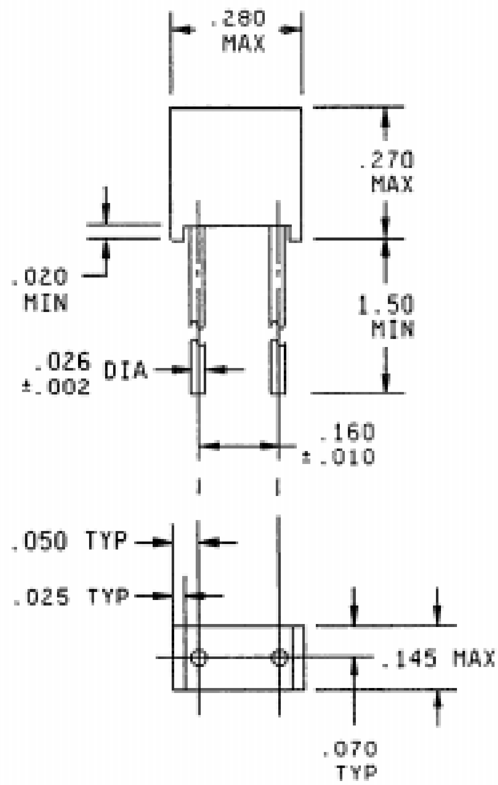
PERFORMANCE SPECIFICATION SHEET

FUSES, CARTRIDGE, INSTRUMENT TYPE, STYLE FM12
(SUBMINIATURE - HIGH PERFORMANCE)

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

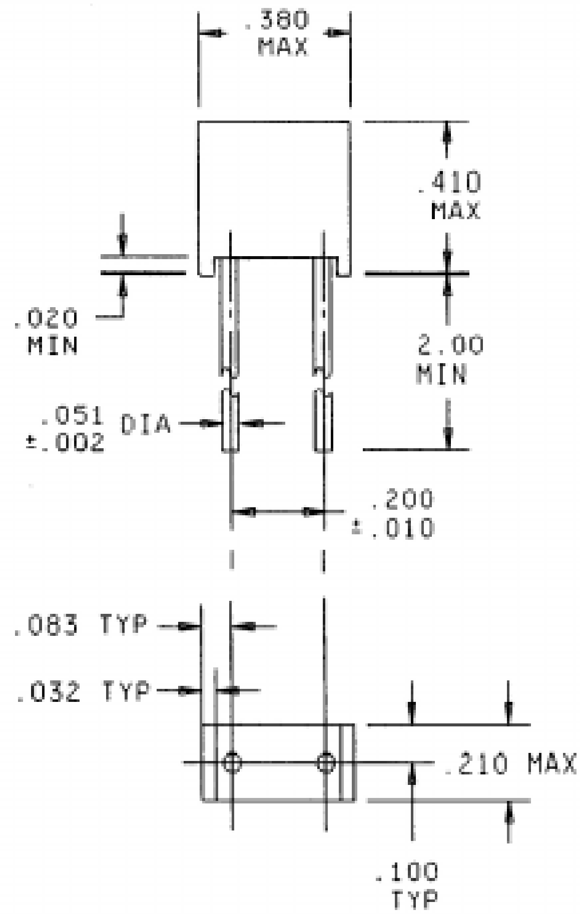
The requirements for acquiring the product described herein shall consist of this specification and MIL-PRF-23419.

Inches	mm
.002	0.05
.010	0.25
.020	0.51
.025	0.64
.026	0.66
.050	1.27
.070	1.78
.145	3.68
.160	4.06
.270	6.86
.280	7.11
1.50	38.1



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.01 (0.3 mm).

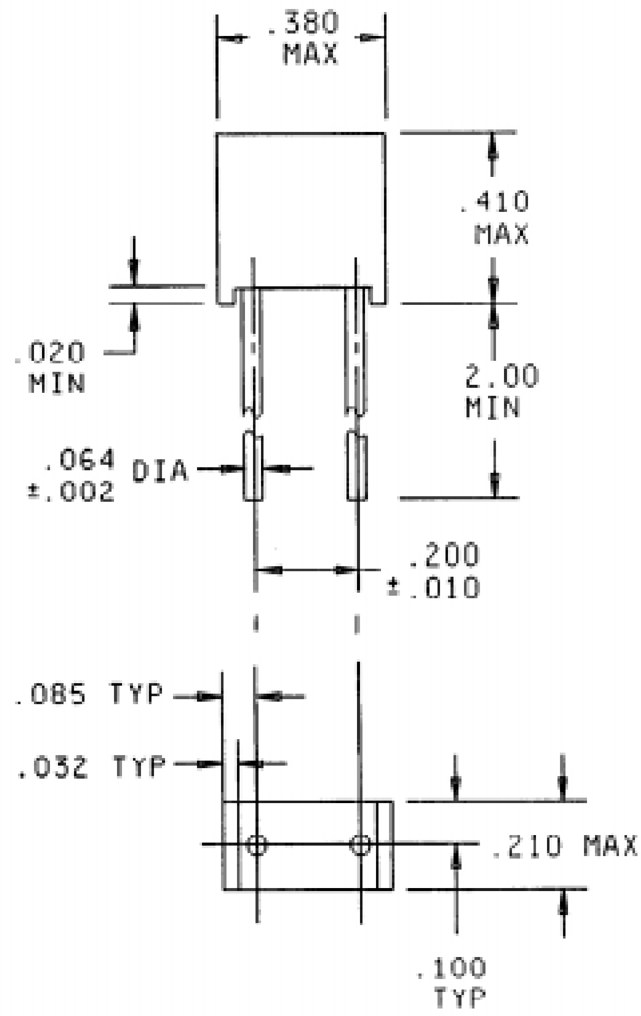
FIGURE 1. Style FM12 fuse (.026 inch diameter leads).



Inches	mm
.002	0.05
.010	0.25
.020	0.51
.032	0.81
.051	1.30
.083	2.11
.100	2.54
.200	5.08
.210	5.33
.380	9.65
.410	10.41
2.00	50.8

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.01 (0.3 mm).

FIGURE 2. Style FM12 fuse (.051 inch diameter leads).



Inches	mm
.002	0.05
.010	0.25
.020	0.51
.032	0.81
.064	1.63
.085	2.16
.100	2.54
.200	5.08
.210	5.33
.380	9.65
.410	10.41
2.00	50.8

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.01 (0.3 mm).

FIGURE 3. Style FM12 fuse (.064 inch diameter leads).

REQUIREMENTS:

Interface and physical dimensions: See table I and figures 1, 2, or 3.

Case material: Polyphenlene sulfide (PPS) Ryton R-4 or equivalent.

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: CDA-102 Copper.

Finish: Gold plate in accordance with MIL-G-45204, type II, grade C, class 1 with nickel underplate of 50 microinches.

Strength: Five pounds applying force axially to each fuse, and one pound applying three bends to each terminal.

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

Current rating: See table I.

Voltage rating: See table I.

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 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: See table I.

Overload interrupt: 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 of 1.0 ampere and less shall open in 10 seconds maximum.

b. Fuse rating greater than 1.0 ampere shall open in 5 seconds maximum.

c. Fuse ratings less than 3/8 ampere shall open in 60 seconds maximum.

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): Fuses shall be mounted by their terminals in sockets. Spacing between each fuse shall not be less than .250 inch (6.35 mm) or greater than 1.00 inch (25.4 mm). Fuses shall be electrically connected to a constant dc source supplying rated current to each fuse. Initial voltage drop measurements shall be taken after current has been applied for a minimum of 2 hours but not longer than 4 hours. Current shall be applied for 168 +4, -0 hours while at room ambient conditions. Forced air shall not flow over the fuses during the burn-in period. The voltage drop of each fuse shall be measured after the burn-in period with the voltage drop change determined from measurements taken before the thermal shock test. The voltage drop change for each fuse shall be less than ±10 percent.

Terminal strength: Method 211 of MIL-STD-202, test condition A (5 pounds pull) applying the force axially to each wire individually, then test condition C (1 pound force) applying three bends to each wire terminal. The cold 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: Method 210, test condition B, MIL-STD-202. Depth of immersion to be between .020 and .050 inch (0.51 and 1.27 mm) from the base for the fuse case. The cold 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.

Low temperature operation: Fuses shall be mounted by their terminals in sockets 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 cold 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 (2000 hours): Fuses shall be mounted by their terminals in sockets and mounted 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 current source shall supply an open circuit voltage equal to the voltage rating of the fuse. The fuses shall remain in the chamber at 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 cold 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. 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.

Moisture resistance: Fuses shall be tested as specified in MIL-PRF-23419. The cold resistance of each fuse shall be measured before and after testing and shall not have changed by more than ±15 percent.

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 mounted in suitable mount sockets. 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, 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 cold resistance as specified in MIL-PRF-23419. The change in resistance shall not exceed ±10 percent of the initial value.

Quality 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 plastic molded housing (critical at lead egress area).

   (2) Insufficient plastic fill (critical at lead egress area).

   (3) Excessive plastic flash (part out of dimensional tolerance).

c. Thermal shock as specified herein.

d. Burn-in: 168 hours at rated current and ambient air at +25°C +3°C, -0°C.

e. Cold resistance in accordance with MIL-PRF-23419.

f. 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 voltage drop as measured after the completion of burn-in. 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 truncated population and subjected to 250 percent, 400 percent, and 600 percent overload interrupt testing.

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

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

i. 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.

Marking: Fuses shall be marked with the type designation in accordance with MIL-PRF-23419, manufacturer's name or logo, date code, and serialized label. Manufacturer's lot may be marked optionally. Marking ink color shall be white.

Current derating limits: The recommended derating limits for fuses covered in this specification sheet are listed on figure 4 below. 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:

a. Obvious foreign inclusions or pits greater than .005 inch (0.13 mm) diameter in the arc suppressant glass shall be cause for rejection if they fall within the dashed line as indicated on figure 5.

b. Parts shall be visually free of flux or other foreign material after cleaning.

c. Solder must make a continuous fillet between the silver termination pad and lead.

d. Voids, or the sum of voids in the solder fillet shall not exceed .015 inch (0.38 mm) in diameter.

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

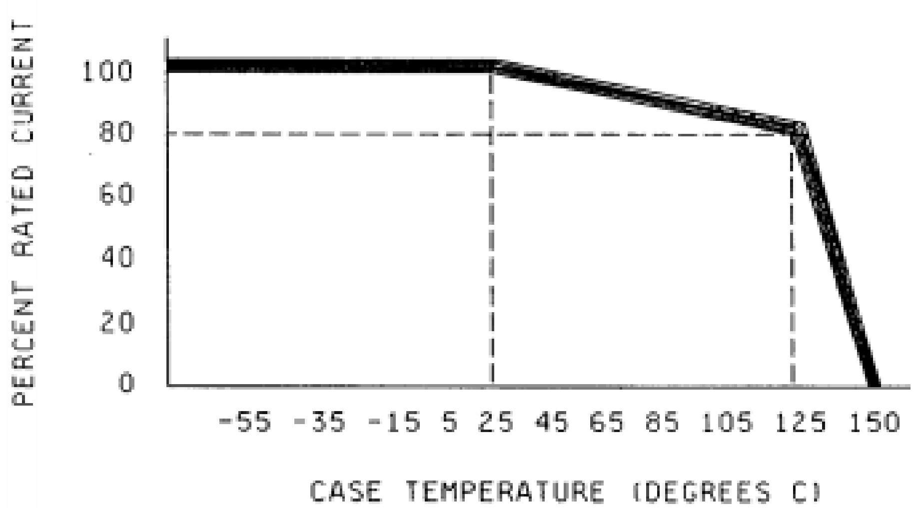


FIGURE 4. Current derating limits.

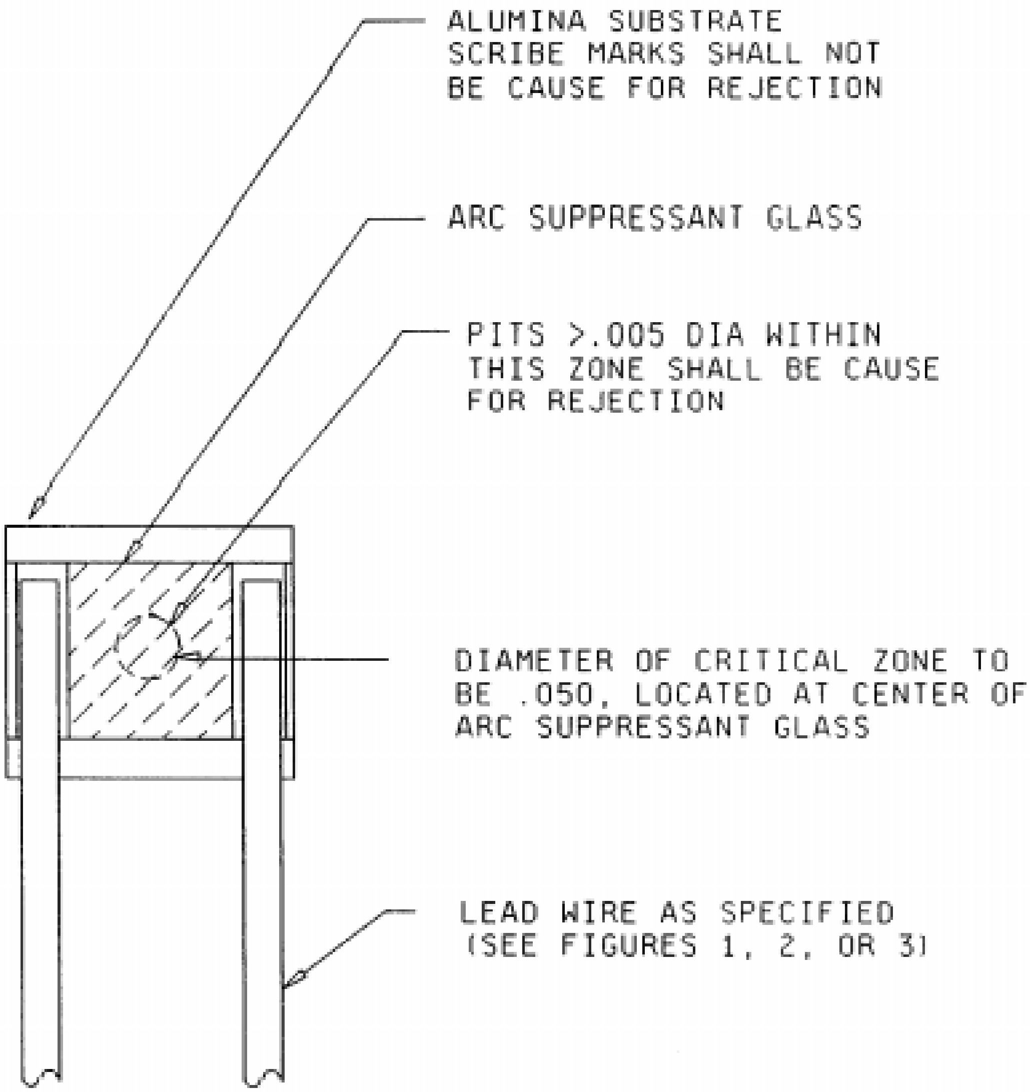
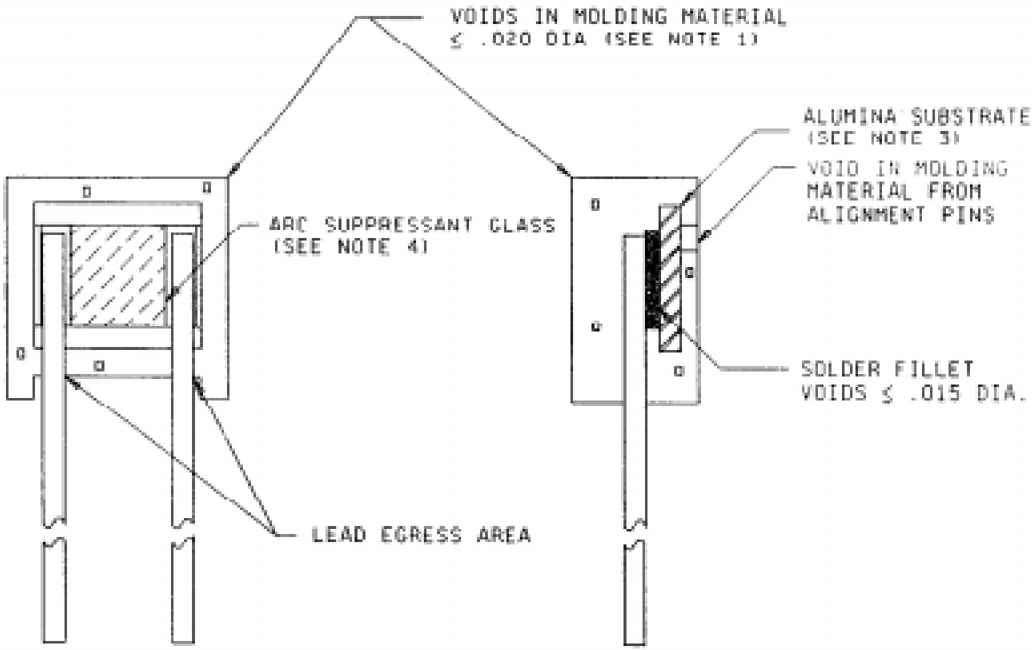


FIGURE 5. Precap inspection.

Radiographic inspection: The radiographic examination shall include, but not be limited to, inspection for loose or foreign particles, solder splash, excessive solder on leads, voids in molded material >.020 inch (0.51 mm) in diameter, any void at lead egress, adequate clearance between the alumina substrate and the molded body and fractures or cracks in the alumina substrate or arc suppressant glass. Figures 6 and 7 define accept and reject criteria.

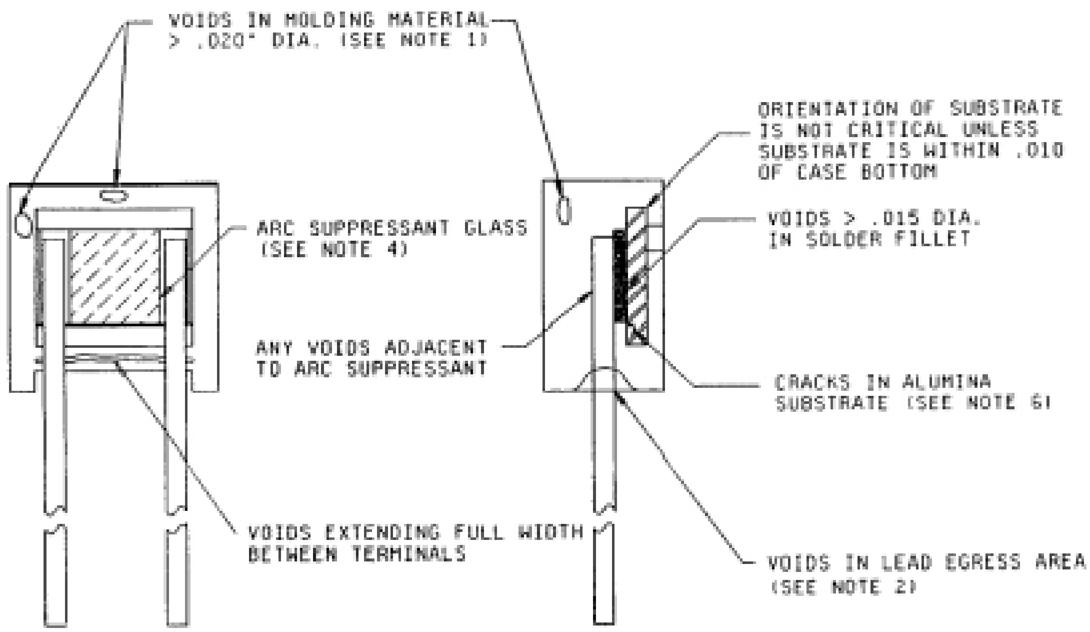
a. Two views are required. View 1 shall show the plan view of the part. View 2 shall show a side view of the part on an edge that does not contain external leads.

b. The sensitivity of the radiograph must be such that a lead particle .004 inch (0.10 mm) in diameter shall be visible. Use of double emulsion film is optional.



NOTES:
1. Voids less than or equal to .020 inch (0.51 mm) diameter are acceptable provided they are not adjacent to the arc suppressant glass.
2. Voids in the lead egress area which are less than or equal to 50 percent of the distance between case bottom and the bottom of the alumina substrate are acceptable.
3. Scribe mark at the perimeter of the alumina substrate are acceptable.
4. Pin holes less than or equal to .010 inch (0.25 mm) diameter in the arc suppressant glass are acceptable.
5. Foreign material less than or equal to .015 inch (0.38 mm) diameter between the terminals or bordering edge of the alumina substrate are acceptable.

FIGURE 6. Accept criteria (radiographic inspection).



NOTES:
1. Voids less than .020 inch (0.51 mm) diameter are rejectable.
2. Voids in the lead egress area which are less than or equal to 50 percent of the distance between the case bottom and the bottom of the alumina substrate are rejectable.
3. Voids extending the full length between the terminals are rejectable.
4. Pin holes greater than .010 inch (0.25 mm) diameter in the arc suppressant glass are rejectable.
5. Foreign material greater than .015 inch (0.38 mm) diameter between terminals or bordering edge of the alumina substrate are rejectable.
6. Cracks in the alumina substrate are rejectable.
7. Cracks in the molded case are rejectable.

FIGURE 7. Reject criteria (radiographic inspection).

TABLE I. Type designation identification.

Type designation 1/				Cold resistance (ohms) 2/		Figure (1, 2, or 3)	Overload interrupt time (seconds) 3/			Maximum current clearing I^2t (ampere^2 seconds) 4/		
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
FM12	A	72V	1/8A	6.375	10.625	1	0-30.0	0-.015	0-.003	2.930	0.004	0.002
FM12	A	72V	1/4A	1.875	3.125	1	0-30.0	0-.015	0-.003	11.719	0.015	0.007
FM12	A	72V	3/8A	1.125	1.875	1	.01-.300	.001-.015	.00015-.003	0.264	0.034	0.015
FM12	A	72V	1/2A	0.675	1.125	1	.01-.300	.001-.015	.00015-.003	0.469	0.060	0.027
FM12	A	72V	3/4A	0.225	0.375	1	.01-.300	.001-.015	.00015-.003	1.055	0.135	0.061
FM12	A	72V	1A	0.135	0.225	1	.01-.300	.001-.015	.00015-.003	1.875	0.240	0.108
FM12	A	72V	1.5A	0.097	0.163	1	.01-.300	.001-.015	.00015-.003	4.219	0.540	0.243
FM12	A	72V	2.0A	0.045	0.075	1	.01-.300	.001-.015	.00015-.003	7.500	0.960	0.432
FM12	A	72V	3.0A	0.0262	0.0438	1	.01-.300	.001-.015	.00015-.003	16.875	2.160	0.972
FM12	A	72V	4.0A	0.0195	0.0325	1	.01-.300	.001-.015	.00015-.003	30.000	3.840	1.728
FM12	A	72V	5.0A	0.0135	0.0225	1	.01-.300	.001-.015	.00015-.003	46.875	6.000	2.700
FM12	A	72V	6.0A	0.0112	0.0188	1	.01-.300	.001-.015	.00015-.003	67.500	8.640	3.888
FM12	A	72V	7.5A	0.0082	0.0138	1	.01-.300	.001-.015	.00015-.003	105.469	13.500	6.075
FM12	A	72V	10A	0.0063	0.0107	2	.01-.300	.001-.015	.00015-.003	187.500	24.000	10.800
FM12	A	72V	15A	0.0038	0.0070	2	.01-.300	.001-.015	.00015-.003	421.875	54.000	24.300
FM12	A	125V	1/8A	6.375	10.625	1	0-30.0	0-.015	0-.003	2.930	0.004	0.002
FM12	A	125V	1/4A	1.875	3.125	1	0-30.0	0-.015	0-.003	11.719	0.015	0.007
FM12	A	125V	3/8A	1.125	1.875	1	.01-.300	.0005-.015	.00005-.003	0.264	0.034	0.015
FM12	A	125V	1/2A	0.675	1.125	2	.01-.300	.0005-.015	.00005-.003	0.469	0.060	0.027
FM12	A	125V	3/4A	0.225	0.375	2	.01-.300	.0005-.015	.00005-.003	1.055	0.135	0.061
FM12	A	125V	1A	0.090	0.270	2	.01-.300	.0005-.015	.00005-.003	1.875	0.240	0.108
FM12	A	125V	1.5A	0.0850	0.2250	2	.01-.300	.0005-.015	.00005-.003	4.219	0.540	0.243
FM12	A	125V	2.0A	0.0450	0.1350	2	.01-.300	.0005-.015	.00005-.003	7.500	0.960	0.432
FM12	A	125V	3.0A	0.0350	0.1050	2	.01-.300	.0005-.015	.00005-.003	16.875	2.160	0.972
FM12	A	125V	4.0A	0.0300	0.0900	2	.01-.300	.0005-.015	.00005-.003	30.000	3.840	1.728
FM12	A	125V	5.0A	0.0220	0.0680	2	.01-.300	.0005-.015	.00005-.003	46.875	6.000	2.700
FM12	A	50V	20A	0.0025	0.0050	3	.01-.300	.001-.015	.00015-.003	750.000	96.000	43.200

1/ Add “T” suffix to type designation if optional solder coated leads are required. Solder coating shall extend up the leads to a point between the fuse stand-off and the lead egress point.

2/ Cold resistance is measured with a test current of 0.1 to 10 milliamperes.

3/ Overloads interrupt times at -55°C and 250 percent overload current shall be as follows:
a. Fuse ratings of 1.0 ampere and less shall open in 10 seconds maximum.
b. Fuse ratings greater than 1.0 ampere shall open in 5 seconds maximum.
c. Fuse ratings less than 3/8 ampere shall open in 60 seconds maximum.

4/ 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 20 and the inspections shall be as shown 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
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
Solderability	ALL

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. Cold resistance measurements shall be taken before and after each test. Cold 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

Custodians:
Navy - EC
DLA - CC

Preparing activity:
DLA - CC

(Project 5920-0730)