Bourns® SinglFuse™ SMD Fuses

Product Selection Guide

A properly selected fuse is widely regarded as the most effective way to safeguard a circuit against potentially catastrophic short circuit events. To this end, Bourns® SinglFuse™ SMD Fuses represent a robust and reliable solution that provides effective overcurrent protection to circuits. These fuses are available in a range of standard SMD packages that accommodate a variety of application needs, with sizes spanning from 0402 to 3812. The fuses are engineered using seven distinct technologies that incorporate board voltage and current ratings, operating temperature ranges, and fusing characteristics, making them an attractive option for designers seeking a versatile and customizable solution. A comprehensive overview of Bourns® SinglFuse™ SMD Fuses portfolio is outlined in the SinglFuse™ SMD Fuse Product Line Chart below. To facilitate the selection of the most appropriate fuse from this range, this article presents key considerations to guide the selection process. To enhance the value of these considerations, a practical example is presented to illustrate their application in real-world scenarios.

SINGLFUSE™ SMD FUSE PRODUCT LINE CHART

Technology	Series	General Purpose						Automotive Grade*		
		0402	0603	1206	2410	3812	2923	0603	1206	2410
Thin Film (PCB)	SF-xxxx-F	0.15 A – 5 A								
Thin Film (Ceramic)	SF-xxxx	0.315 A	– 7 A							
Metal Foil	SF-xxxx-R SF-xxxx-A-R		1 A – 30 A					1 A – 30 A		
Multilayer (Ceramic)	SF-xxxx-M SF-xxxx-A-M	0.5 A – 40 A						0.5 A – 8 A		
Wire Core (PCB)	SF-xxxx-W SF-xxxx-A-W				0.5 A – 20 A				1 A – 20 A	
Wire Core (Ceramic)	SF-xxxx-T					0.62 A – 60 A				
Ceramic Tube	SF-xxxx-C						20 A – 50 A			

*Meets Bourns' internal AEC-Q200 equivalent test plan.

When selecting a SinglFuse™ SMD Fuse, several factors must be considered, including the normal operating current in the circuit, the maximum operating voltage (AC or DC) in the circuit, the ambient temperature during normal operation, the overload current and fusing time required for the fuse to open, the maximum interrupting current, surge currents, inrush currents, and start-up currents, physical dimension limitations, and safety agency approvals such as UL, CSA, TÜV, or PSE.

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NORMAL OPERATING CURRENT AND RATED CURRENT

Fuses are devices that are sensitive to temperature, and their ratings for current, voltage, and interrupting capability are commonly tested under ambient temperature conditions of 25 °C. In order to prevent nuisance tripping, it is recommended that fuses be operated at a maximum of 75 % of their rated current under these conditions.

For instance, SF-0603SP200R-2 is rated at 2 A at 25 °C, and it is advised not to exceed an operating current of 1.5A.

Electrical Characteristics

Model	Rated Current (A)	Resistance (Ω) Typ.[1]	Rated Voltage[1]	Interrupting Rating	Typical I^2t (A^2s)[2]	Agency Recognition cUL: E198545
SF-0603SP100R-2	1.0	0.115	63 VDC	50 A @ 63 VDC	0.059	✓
SF-0603SP150R-2	1.5	0.059			0.13	✓
SF-0603SP200R-2	2.0	0.033			0.21	✓
SF-0603SP300R-2	3.0	0.0159			0.71	✓
SF-0603SP400R-2	4.0	0.01			0.96	✓
SF-0603SP500R-2	5.0	0.00677			2.05	✓
SF-0603SP600R-2	6.0	0.0063			3.47	✓
SF-0603SP700R-2	7.0	0.0047			5.04	✓
SF-0603SP800R-2	8.0	0.0043			6.5	✓

Notes:
1. Resistance value measured with ≤10 % rated current at 25 °C ambient. Tolerance ±25 %.
2. Melting I^2t calculated at 0.001 second pre-arcing time.

RATED VOLTAGE AND APPLICATION VOLTAGE

The rated voltage of a fuse is the maximum voltage at which it can safely interrupt a short circuit current within its rated current. It must be greater than the maximum operating voltage of the circuit. Therefore, the SF-0603SP200R-2 fuse, with a rated voltage of 63 VDC, can be utilized in circuits where the maximum operating voltage is below 63 VDC.

Electrical Characteristics

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Notes:
1. Resistance value measured with ≤10 % rated current at 25 °C ambient. Tolerance ±25 %.
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AMBIENT TEMPERATURE AND TEMPERATURE DERATING

The current carrying capability of a fuse is determined by its performance during testing conducted at a specific ambient temperature of 25 °C. However, the operating life of a fuse is known to be significantly affected by changes in ambient temperature. As temperature increases, a fuse's operating life is reduced, making the derating curve an essential consideration when selecting a fuse.

To compare the derating curves of five SinglFuse™ SMD Fuses, please refer to Figure 1.

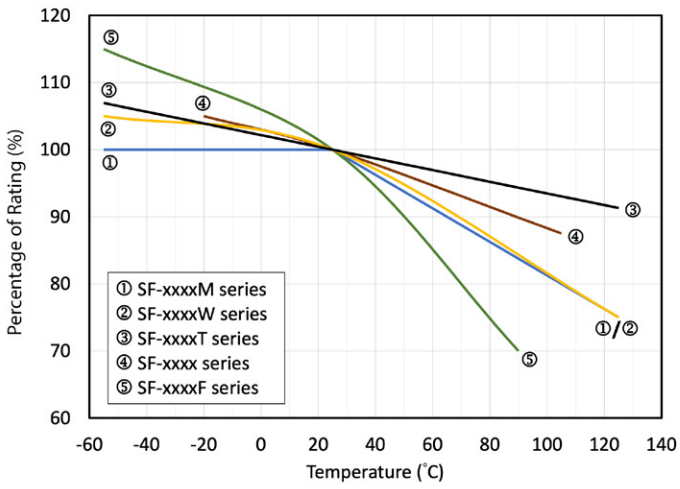

Figure 1 - Temperature derating curves of SinglFuse™ SMD Fuses

MELTING INTEGRAL (I^2t) AND INRUSH CURRENT

Melting Integral (I^2t) and Inrush Current is influenced by various factors such as construction, material, pattern design and cross-sectional area. Bourns SinglFuse™ SMD Fuses incorporate seven distinct technologies, each featuring a unique construction and corresponding I^2t value. As an illustration, SF-0603SPA200R-2 exhibits a typical I^2t value of 0.21 (at 1 ms pre-arcing time) as specified in the datasheet.

Electrical Characteristics

Model	Rated Current (A)	Resistance (Ω) Typ.[1]	Rated Voltage[1]	Interrupting Rating	Typical I^2t (A^2s)[2]	Agency Recognition cUL: E198545
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Notes:
1. Resistance value measured with ≤10 % rated current at 25 °C ambient. Tolerance ±25 %.
2. Melting I^2t calculated at 0.001 second pre-arcing time.

MELTING INTEGRAL (I^2t) AND INRUSH CURRENT

When an overcurrent event occurs, it generates thermal energy. If the duration of this event is brief, it can be likened to an inrush current, and the energy produced can be estimated by the area of the waveform displayed in Figure 2.

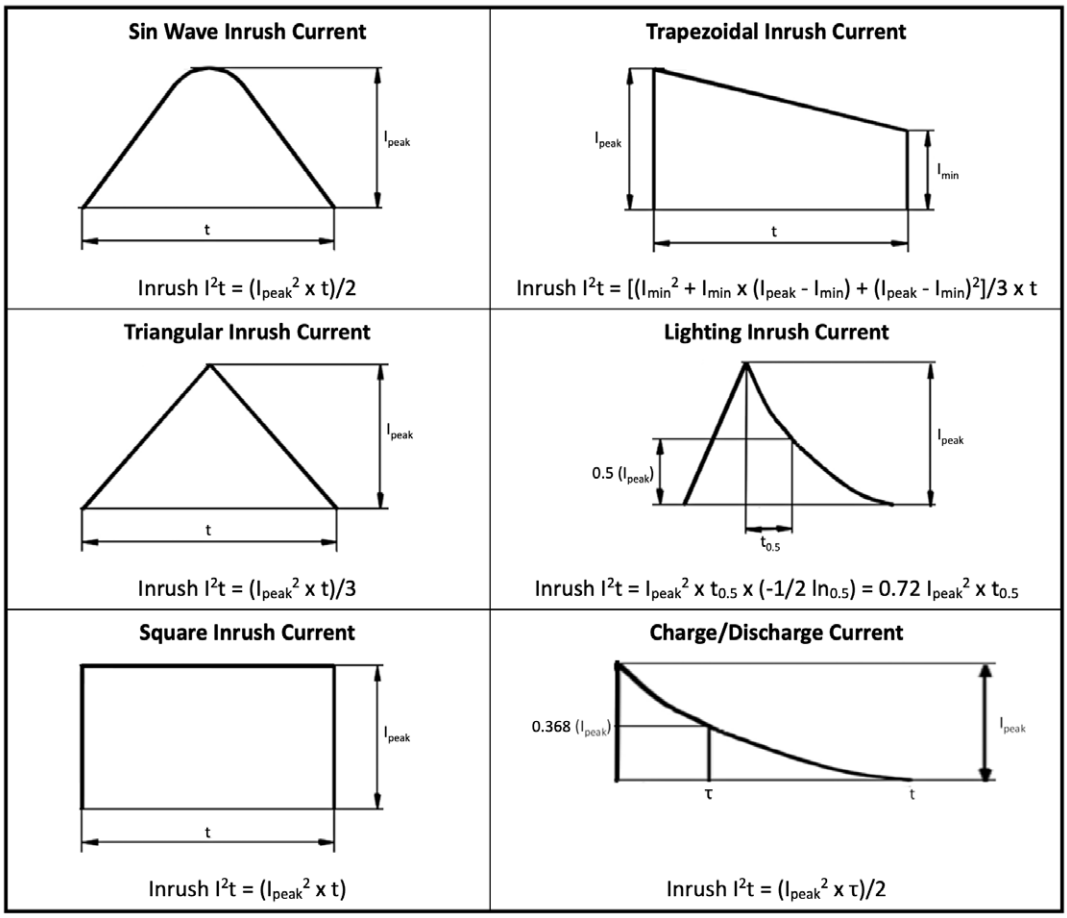

Figure 2 - Inrush waveforms and I^2t calculations

To prevent premature failure of a fuse element, it is important to consider the effect of inrush current even when it does not cause melting of the fuse. In order to select a fuse with appropriate inrush withstand capability, it is necessary to calculate the circuit's inrush energy and compare it with the melting time and I^2t curve of the fuse.

The fuse's melting I^2t value must be equal to or greater than the product of the inrush I^2t and a fuse derating factor (as shown in Figure 3) to ensure proper sizing and to avoid early failure.

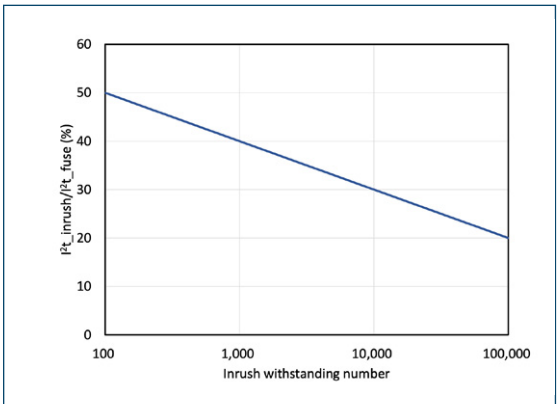

Figure 3 - I^2t derating vs. inrush current withstanding number

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FUSING CHARACTERISTICS AND TIME-CURRENT CURVE

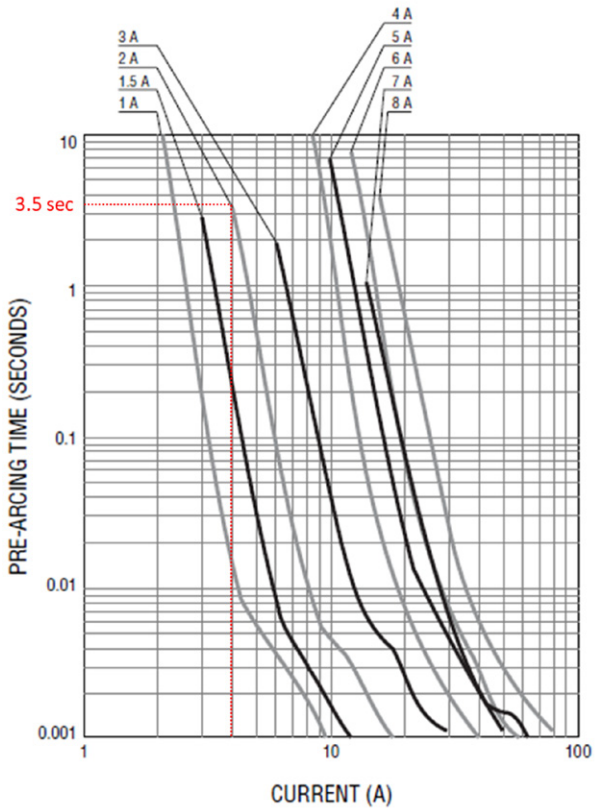
The DC time-current characteristic of a fuse depicts the relationship between its pre-arcing time and the current flowing through it. This characteristic is instrumental in selecting a fuse with the desired fusing time, as fuses with the same current rating can have different time-current characteristics.

In the case of SF-0603SP200R-2, which falls under the category of 1 second to 120 seconds fusing characteristics, applying 4 A current would result in an average pre-arcing time of approximately 3.5 seconds.

Clearing Time Characteristics for Series

% of Current Rating	Clearing Time at 25 °C	
	Min.	Max.
100 %	4 hours	—
200 %	1 second	120 seconds

Average Pre-Arcing Time vs. Current Curves



PARAMETRIC SEARCH TOOL

The Parametric Search tool available online simplifies the selection process. To access more details about these products, please refer to the Bourns® SinglFuse™ SMD Fuse Technical Library.

Circuit Protection - SinglFuse™

Rated Current (A)	0.062 MIN 0.062	60.000 MAX 60.000			
Length (mm)	1.0 MIN 1.0	10.1 MAX 10.1			
Width (mm)	0.51 MIN 0.51	5.80 MAX 5.80			
Height (mm)	0.30 MIN 0.30	4.00 MAX 4.00			
Resistance (Ω)	0.0007 MIN 0.0007	6.6530 MAX 6.6530			
Typical I^2t (A^2s)	0.0006 MIN 0.0006	4224.00 MAX 4224.0000			
Rated Voltage (AC)	☐ 32	☐ 86	☐ 280		
	☐ 35	☐ 125	☐ 600		
	☐ 65	☐ 250			
Rated Voltage (DC)	☐ 24	☐ 60	☐ 100		
	☐ 32	☐ 63	☐ 110		
	☐ 35	☐ 65	☐ 125		
	☐ 48	☐ 80	☐ 250		
	☐ 50	☐ 86			
Min. Rated Temperature (°C)	☐ -20	☐ -55			
Max. Rated Temperature (°C)	☐ 90	☐ 125			
	☐ 105	☐ 150			
Footprint (EIA)	☐ 0402	☐ 1206	☐ 2923		
	☐ 0603	☐ 2410	☐ 3812		
Certification	☐ cUL	☐ TÜV	☐ VDE		
Automotive Compliance	☐ AEC-Q200				

CALCULATE NOW RESET

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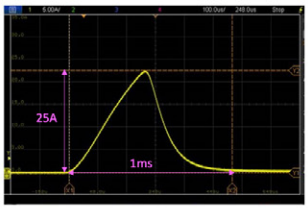
PRACTICAL EXAMPLE:

When the inrush is present, follow Step A to B to C

When the inrush is negligible or absent, follow Step A to C

Step A	**Working conditions in circuit**			
	Continuous operating current (I_o) ①	2 A		
	Max. operating voltage	48 VDC		
	Ambient operating temp.	@ 60 °C		
	Prefer physical size	1206 (EIA)		
	Fuse selection calculation			
	Current derating factor ②	75 %		
	Temperature derating factor @ 60°C (ref to Figure 1) ③	**SF-1206 series**	**SF-1206-M series**	**SF-1206-W series**
		94.6 %	91.25 %	92.5 %
	Recommend fuse current calculation = ①/②/③	≥ 2.82 A → **3 A**	≥ 2.92 A → **3 A**	≥ 2.88 A → **3 A**
	Candidate fuse part number	~~SF-1206F300-2 (32 V)~~ ~~SF-1206FP300-2 (32 V)~~ ~~SF-1206S300-2 (32 V)~~ ~~SF-1206SP300-2 (32 V)~~	**SF-1206F300M-2 (65 V)** ~~SF-1206HI300M-2 (32 V)~~ ~~SF-1206S300M-2 (32 V)~~ ~~SF-1206SP300M-2 (32 V)~~	**SF-1206S300W-2 (65 V)**
Step B	**Inrush current conditions**			
	Peak current	25 A		
	Duration time	1 msec.		
	Waveform	Triangular		
	I^2t of inrush current ④	25^2 * 0.001/3 = **0.208** A^2S		
	I^2t ratio calculation			
	Candidate fuse part number	**SF-1206F300M-2**	**SF-1206S300W-2**	
	I^2t of fuse @ 1ms (Figure 4) ⑤	1.12 A^2S	1.92 A^2S	
	I^2t (inrush current)/I^2t (fuse) = ④/⑤	0.208/1.12 = **18.6 %** < 20 % → withstand over 100,000 times	0.208/1.92 = **10.8 %** < 20 % → withstand over 100,000 times	
Step C	**Fusing characteristic**	60 sec. max. @ 200 % In	5 sec. max. @ 250 % In	
	Interrupting rating	60 A @ 65 VDC 80 A @ 48 VDC	50 A @ 65 VDC	
	Agency Recognition	c RU us	c RU us	

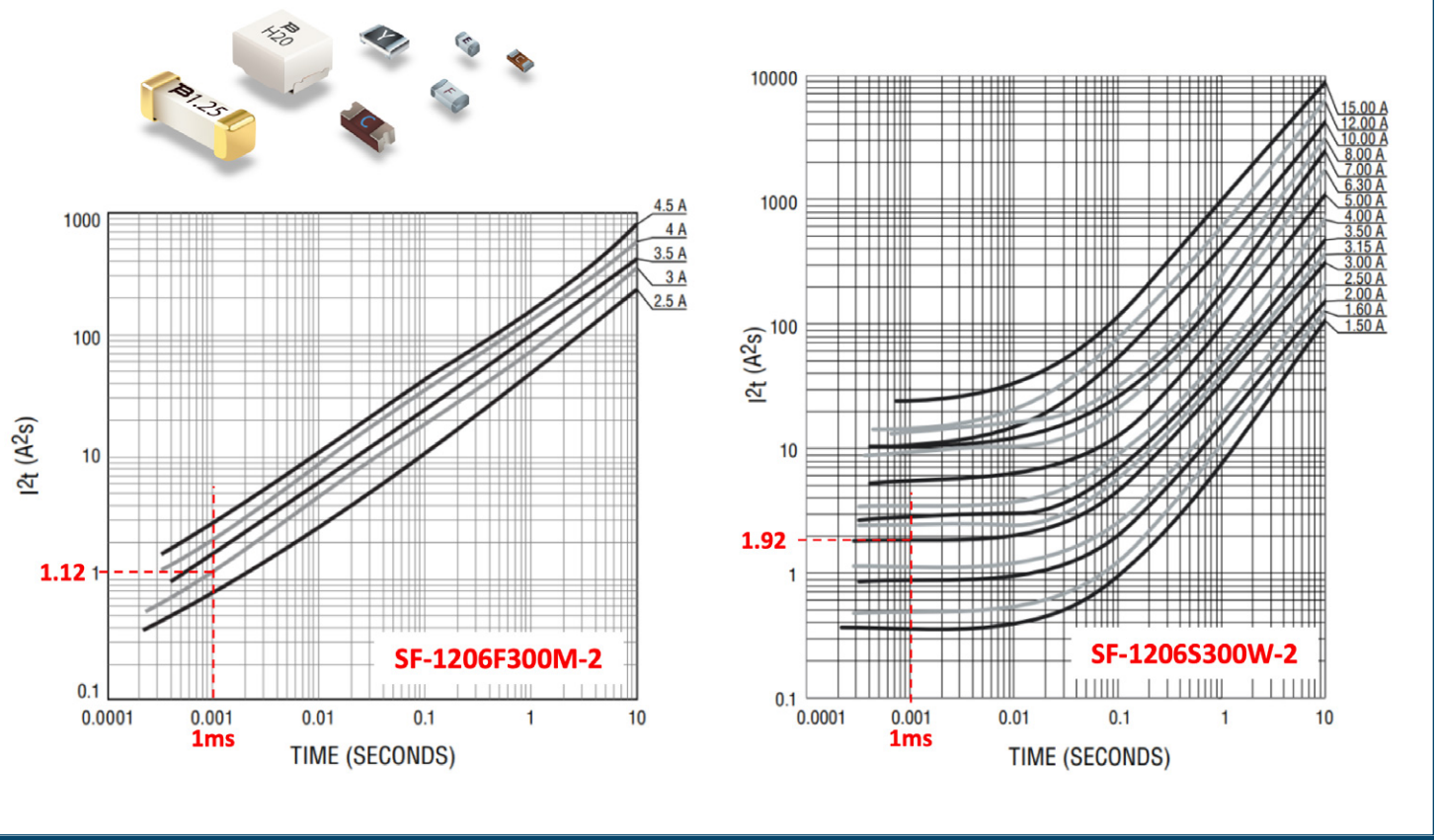


Figure 4 - Time-current curves