Surface-mount Fuses
Fundamentals

Overview

TE Circuit Protection offers the widest selection of surface-mount fuses available for addressing a broad range of overcurrent protection applications. Helping to prevent costly damage and promote a safe environment for electronic and electrical equipment, our single-use chip fuses provide performance stability to support applications with current ratings from .5A up to 20A.

TE Circuit Protection also offers the telecom FT600 fuse for telecommunications applications. This telecom fuse helps comply with North American overcurrent protection requirements, including Telcordia, GR-1089, TIA-968-A (formerly FCC Part 68), and UL60950 3rd edition.

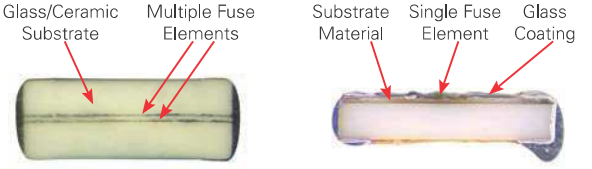
Multi-layer Design for Chip Fuses

The multi-layer design has the benefit of exposing more fuse element surface area to the glass-ceramic absorption material. When the fuse elements open, there is more material for the vaporizing fuse metals to absorb into, resulting in a very efficient and effective quenching of the fuse arc.

Figure 1 compared the multi-layer design of our SFF fuses with standard glass coated designs. The glass coated designs rely on the coating on only one side of the fuse element to absorb the vaporizing fuse material when it opens. Therefore, there is much less absorption material available to absorb the fuse metals. The result can be prolonged arcing and possible coating breach.

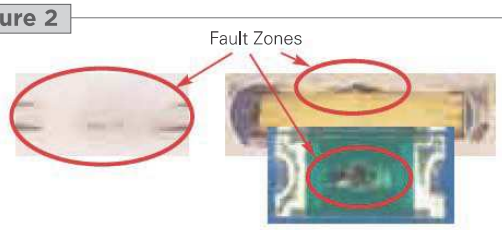
Figure 2 shows how the absorption characteristics of the two designs differ. The multi-layer design indicates a clean separation with the fuse element evenly diffusing into the surrounding ceramic substrate. In the glass coated design, the element diffusion takes place in a small portion of the device and is only absorbed by the glass material directly above the area of failure.

Figure 1



Multi-layer Design | Single-layer Glass Coated Design

Figure 2



Multi-layer Design | Single-layer Glass Coated Design

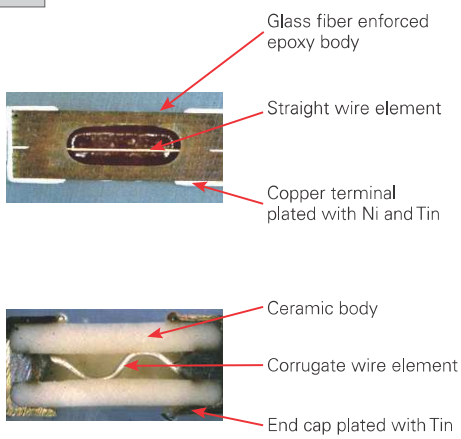
Wire-In-Air Design for 2410SFV Fuses

The 2410(6125) is a Wire-In-Air SMD Fuse which is very suitable for secondary level over current protection applications.

Figure 3 compared our straight wire element design 2410SFV fuses with normal corrugating wire design fuse. The straight wire element in air performs consistent fusing and cutting characteristics together with excellent inrush current withstanding capability.

Introduced PCB assembly technology into 2410SFV fuses design and manufacture, we achieved on lead free completely and no end cap falling off risk comparing with traditional ceramic body with end cap fuse.

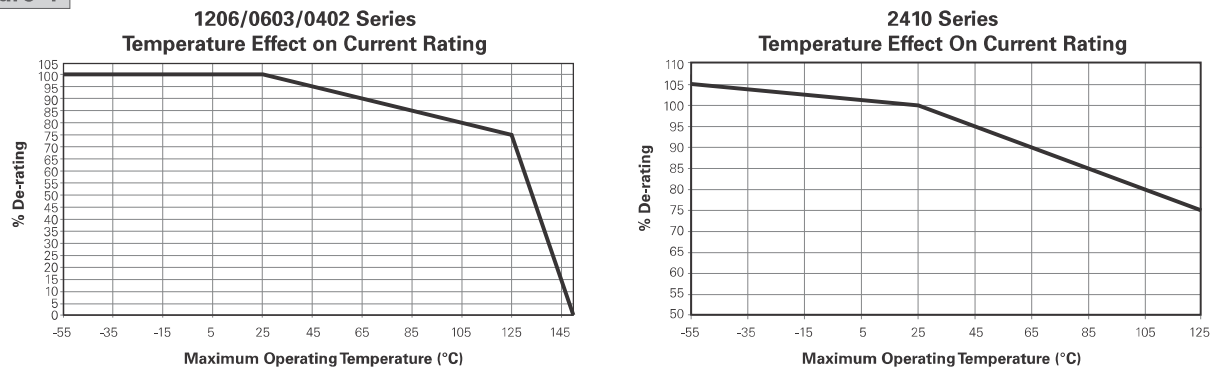
Figure 3



Temperature Derating

A fuse is a temperature sensitive device. Therefore, operating temperature will have an effect on fuse performance and lifetime. Operating temperature should be taken into consideration when selecting the fuse current rating. The Thermal Derating Curve for surface mount fuses is presented in Figure 4. Use it to determine the derating percentage based on operating temperature and apply it to the derated system current.

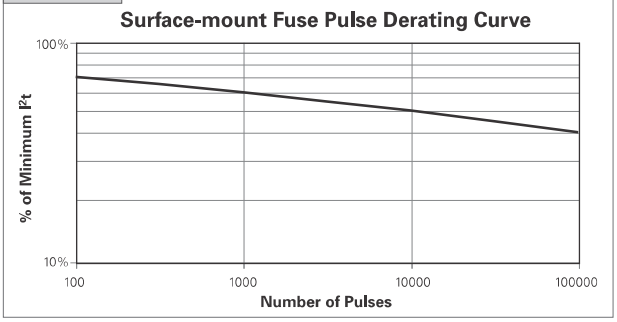
Figure 4



Pulse Cycle Derating

Once the I^2t value for the application waveform has been determined, it must be derated based on the number of cycles expected over the system lifetime. Since the stress induced by the current pulse is mechanical in nature, the number of times the stress is applied has significant bearing on how much derating must be applied to the fuse rating. Figure 5 presents the current pulse derating curve for our surface-mount chip fuses up to 100,000 cycles.

Figure 5



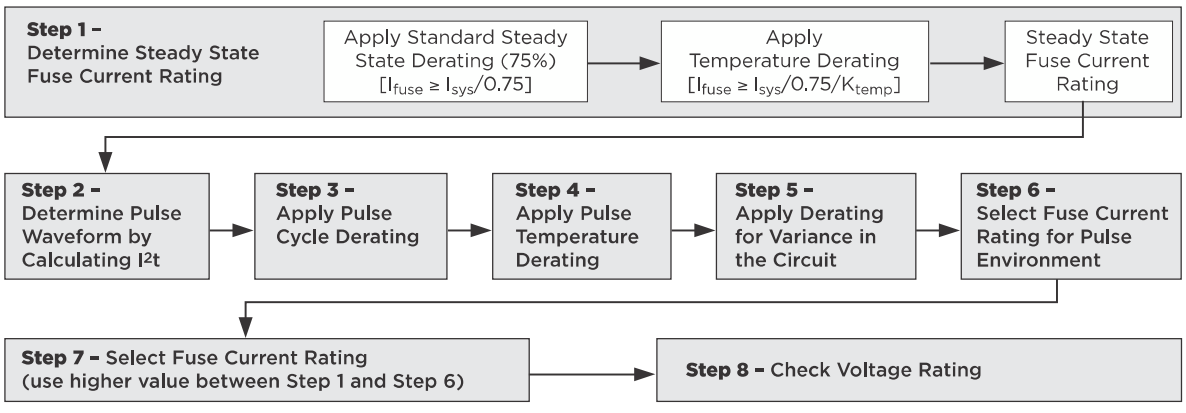
Selecting Surface-mount Fuses

Fuse selection seems straightforward, in that, you pick one which has a current rating just a bit higher than your worstcase system operating current. Unfortunately, it's not that simple. There are derating considerations for operating current and application temperature. Turn-on and other system operations (like processor speed changes or motor start up) cause current surges or spikes that also require consideration when selecting a fuse. So selecting the right fuse for your application is not as simple as knowing the nominal current drawn by the system.

Fuse Selection Flowchart

However, the basic considerations for fuse selection are shown in the flowchart presented in Figure 6. Following this flow chart will help you select a fuse best suited for your application conditions.

Figure 6



Surface-mount Fuses
2410 Very Fast-Acting Fuses

NEW

The 2410(6125) is Wire-in Air SMD Fuse which is very suitable for secondary level overcurrent protection applications.

These lead-free surface mount devices offer more reliability and have no end cap falling off risk. Straight wire element in air performs consistent fusing and cutting characteristics.

Benefits

- Very fast acting at 200% overload current level
- Excellent inrush current withstanding capability
- High reliability and resilience
- Strong arc suppression characteristics
- Copper terminal with nickel and tin plated

Features

- Halogen free, RoHS compliant and 100% lead-free
- Copper or copper alloy composite fuse link
- Fiberglass enforced epoxy fuse body
- Wide range of current rating
- -55°C to +125°C operating temperature range (with de-rating)

Applications

- Industrial equipment
- LCD/PDP TV
- Backlight inverter
- Power supplier
- Telecom system
- Networking
- Game systems
- White goods
- Automotive

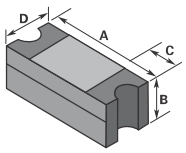
Table SFV1 Clear Time Characteristics for 2410 Very Fast-Acting Fuses

% of rated current	Clear time at 25°C	
100%	4 hours (min.)	
200% (0.5A-10.0A)	0.01 second (min.)	5 seconds (max.)
200% (12.0A-20.0A)	0.01 second (min.)	20 seconds (max.)

Table SFV2 Typical Electrical Characteristics, Dimensions and Recommended Pad Layout for 2410 Very Fast-Acting Fuses

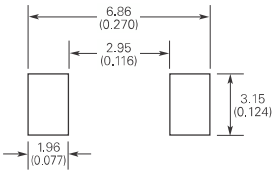
2410 (6125 mm) Very Fast-Acting Fuse

Shape and Dimensions
mm (Inch)



	A		B		C		D	
	Min	Max	Min	Max	Min	Max	Min	Max
mm	5.95	6.25	1.96	2.36	0.97	1.73	2.34	2.64
in	(0.234)	(0.246)	(0.077)	(0.093)	(0.038)	(0.068)	(0.092)	(0.104)

Recommended Pad Layout
mm (Inch)



Part Number	Marking Code	Typical Electrical Characteristics: Rated Current (A)	Typical Electrical Characteristics: Nominal Cold DCR (Ω)*	Typical Electrical Characteristics: Nominal I^2t (A^2sec)	Max. Interrupt Ratings: Voltage (V_{AC})	Max. Interrupt Ratings: Voltage (V_{DC})	Max. Interrupt Ratings: Current (A)
2410SFV0.50FM/125-2	C	0.5	0.2310	0.10	250	125	
2410SFV0.63FM/125-2	S	0.6	0.1740	0.16	250	125	
2410SFV0.75FM/125-2	D	0.8	0.1480	0.23	250	125	50A @ $250V_{AC}$ 50A @ $125V_{DC}$ 300A @ $32V_{DC}$
2410SFV1.00FM/125-2	E	1.0	0.0930	0.59	250	125	
2410SFV1.25FM/125-2	F	1.3	0.0700	0.96	250	125	
2410SFV1.50FM/125-2	G	1.5	0.0620	1.19	125	125	
2410SFV2.00FM/125-2	I	2.0	0.0420	2.75	125	125	
2410SFV2.50FM/125-2	J	2.5	0.0310	1.21	125	125	
2410SFV3.00FM/125-2	K	3.0	0.0249	1.73	125	125	
2410SFV3.15FM/125-2	V	3.2	0.0232	2.20	125	125	
2410SFV3.50FM/125-2	L	3.5	0.0220	2.50	125	125	50A @ $125V_{AC}$ 50A @ $125V_{DC}$ 300A @ $32V_{DC}$
2410SFV4.00FM/125-2	M	4.0	0.0172	4.10	125	125	
2410SFV5.00FM/125-2	N	5.0	0.0143	5.90	125	125	
2410SFV6.30FM/125-2	O	6.3	0.0100	12.50	125	125	
2410SFV7.00FM/125-2	P	7.0	0.0094	14.20	125	125	
2410SFV8.00FM/125-2	R	8.0	0.0086	20.30	125	125	
2410SFV10.0FM/125-2	Q	10.0	0.0066	29.20	125	125	35A @ $125V_{AC}$ 50A @ $125V_{DC}$ 300A @ $32V_{DC}$
2410SFV12.0FM/065-2	X	12.0	0.0053	49.20	65	65	50A @ $65V_{AC}$ 50A @ $65V_{DC}$ 300A @ $32V_{DC}$
2410SFV15.0FM/065-2	Y	15.0	0.0038	102.50	65	65	
2410SFV20.0FM/065-2	Z	20.0	0.0034	126.20	65	65	50A @ $65V_{AC}$ 50A @ $65V_{DC}$ 300A @ $32V_{DC}$

* Measured at ≤10% of rated current and 25°C ambient temperature.

RoHS Compliant, ELV Compliant HF Halogen Free

Figure SFV1-SFV2 Family Performance Curves for 2410 Very Fast-Acting Fuses

Figure SFV1

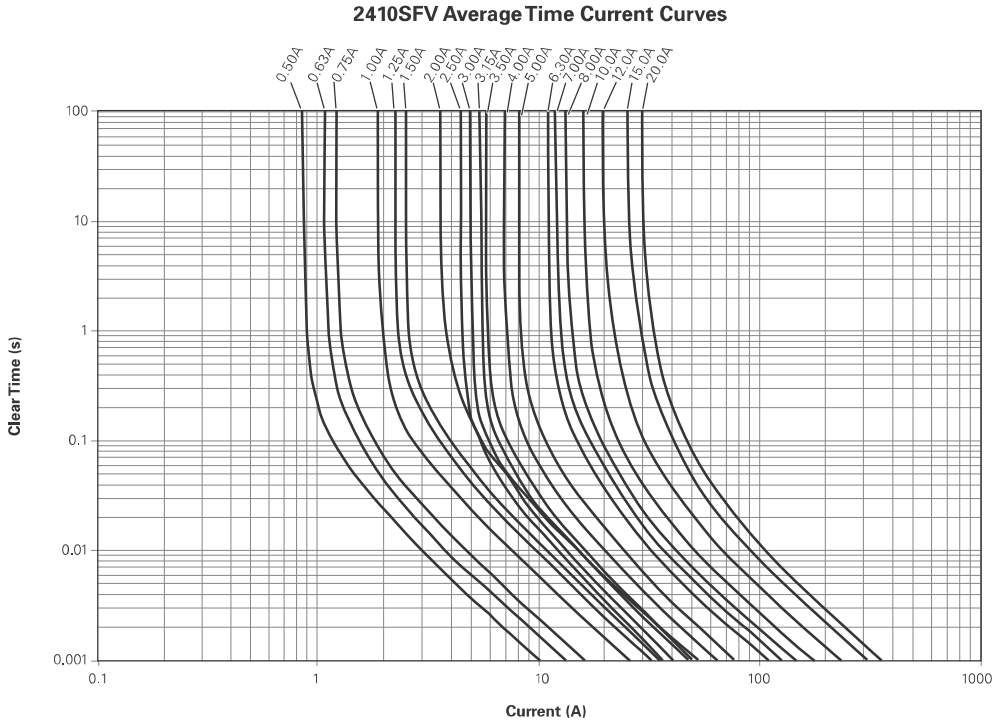
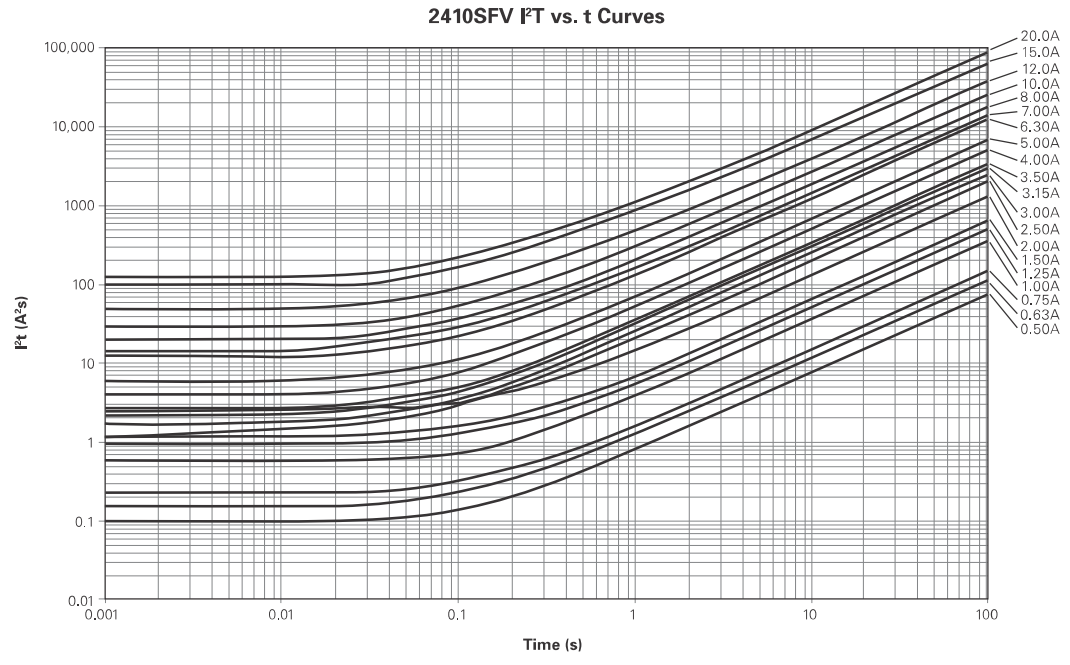


Figure SFV2



Note: Curves are nominal

➔ **Please go to page 97 for more information for 2410 Fast-Acting Fuses.**

Specifications, Packaging Information, Agency Approvals and Part Numbering Systems for All Fuses

Table F1 Environmental Specifications for All Fuses

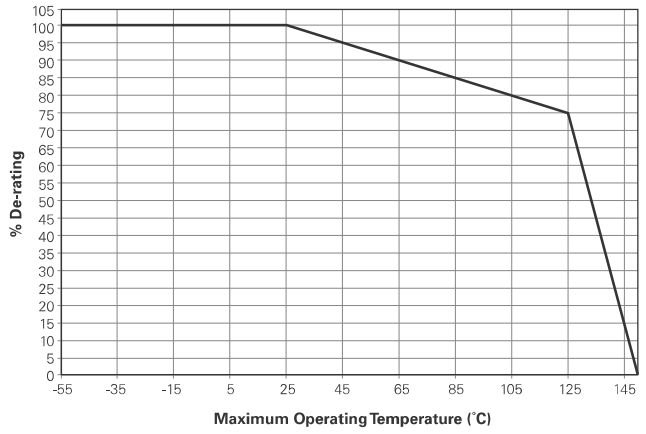
Operating temperature	-55°C to +125°C
Mechanical vibration	Withstands 5-3000 Hz at 30 Gs when evaluated per Method 204 of MIL-STD-202
Mechanical shock	Withstands 1500 Gs, 0.5 millisecond half-sine pulses when evaluated per Method 213 of MIL-STD-202
Thermal shock	Withstands 100 cycles from -65°C to +125°C when evaluated per Method 107 of MIL-STD-202
Resistance to soldering heat	Withstands 60 seconds at +260°C when evaluated per Method 210 of MIL-STD-202
Solderability	Meets 95% minimum coverage requirement when evaluated per Method 208 of MIL-STD-202
Moisture resistance	Withstands 10 cycles when evaluated per Method 106 of MIL-STD-202
Salt spray	Withstands 48-hour exposure when evaluated per Method 101 of MIL-STD-202
Storage temperature	≤30°C/ 85% RH
Storage humidity	Per MIL-STD-202F, Method 106F

Table F2 Material Specifications for All Fuses

Construction body material	Ceramic (1206/0603/0402); Fiberglass/Epoxy (2410)
Termination material	Silver, Nickel, Tin
Fuse element	Silver(1206/0603/0402); Copper/Copper Alloy (2410)

Figure F1 Thermal Derating Current for All Fuses

1206/0603/0402 Series
Temperature Effect on Current Rating



2410 Series
Temperature Effect on Current Rating

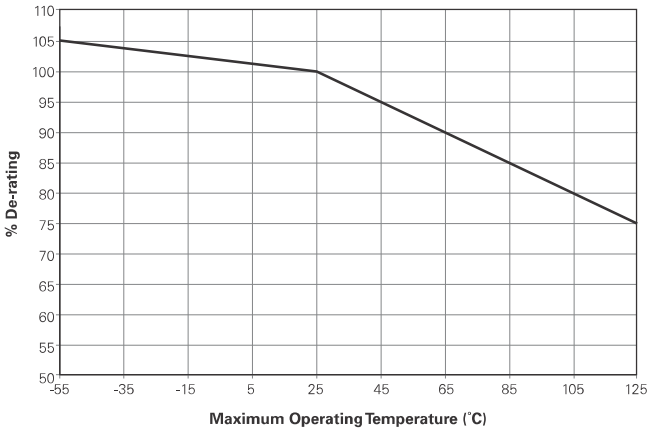


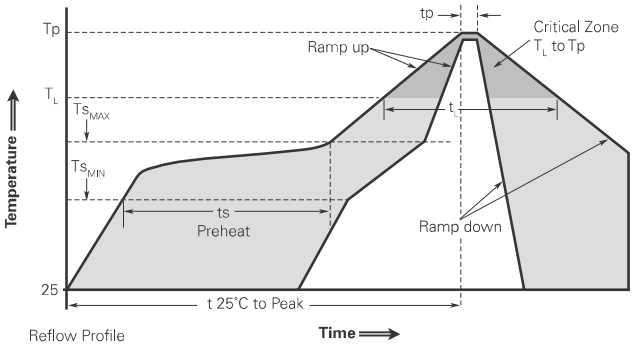
Table F3 Electrical Specifications for All Fuses

Insulation resistance after opening	20,000Ω minimum @ rated voltage. Fuse clearing under low voltage conditions may result in lower - post-clearing insulation values. Under normal fault conditions TE Circuit Protection fuses provide sufficient insulation resistance for circuit protection.
Current carrying capacity	Withstands 100% rated current at +25°C ambient for 4 hours when evaluated per MIL-PRF-23419.

Table F4 Packaging Information for All Fuses

Size	Reel Quantity (pcs)	Reel Diameter	Reel Width	Carrier Tape Size	Tape Type	Reels per Outside Shipment Box	Outside Shipment Boxes per Overpack
0402(1005)	10,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Paper	5	1 to 10
0603(1608)	4,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Paper	5	1 to 10
0603SFV(1608)	6,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Paper	5	1 to 10
1206(3216)	3,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Plastic	5	1 to 10
2410(6125)	2,000	178mm white plastic	13.4 ± 0.5mm	12.00 ± 0.10mm	Plastic	4	1 to 10

Figure F2 Recommended Soldering Temperature Profile for All Fuses



Classification Reflow Profiles

Profile Feature	1206/0603/0402	2410
Average ramp up rate (Ts_{MAX} to Tp)	3°C/second max.	3°C/second max.
Preheat		
• Temperature min. (Ts_{MIN})	150°C	150°C
• Temperature max. (Ts_{MAX})	200°C	200°C
• Time (ts_{MIN} to ts_{MAX})	60-180 seconds	40-100 seconds
Time maintained above:		
• Temperature (T_L)	217°C	200°C
• Time (t_L)	60-150 seconds	30-90 seconds
Peak/Classification temperature (Tp)	260°C max.	250°C max.
Time within 5°C of actual peak temperature		
Time (tp)	20-40 seconds	30-40 seconds
From 25°C to preheating (150°C)	8 minutes max.	40-100 seconds
Ramp down rate	4°C/second max.	Natural cooling

Recommended conditions for hand soldering:

1. Using hot air rework station that can reflow the solder on both terminations at the same time is strongly recommended, do not directly contact the chip termination with the tip of soldering iron.
2. Preheating: 150°C, 60s (min).
   Appropriate temperature (max) of soldering iron tip/soldering time (max): 280°C /10s or 350°C / 3s.

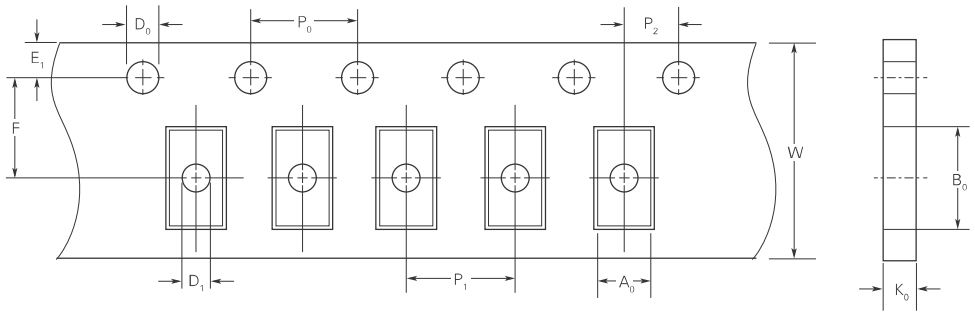
RoHS Compliant, ELV Compliant HF Halogen Free

Table F5 Tape and Reel Specifications for All Fuses

	Dimension in inches (mm)				
Mark	**0402 (1005)**	**0603 (1608)**	**1206 (3216)**	**0603SFV (1608)**	**2410 (6125)**
E_1	0.069 ± 0.004	0.069 ± 0.004	0.069 ± 0.004	0.069 ± 0.004	0.069 ± 0.004
	(1.75 ± 0.10)	(1.75 ± 0.10)	(1.75 ± 0.10)	(1.75 ± 0.10)	(1.75 ± 0.10)
F	0.138 ± 0.002	0.138 ± 0.002	0.138 ± 0.002	0.138 ± 0.002	0.217 ± 0.004
	(3.50 ± 0.05)	(3.50 ± 0.05)	(3.50 ± 0.05)	(3.50 ± 0.05)	(5.50 ± 0.10)
W	0.315 ± 0.004	0.315 ± 0.004	0.315 ± 0.004	0.315 ± 0.004	0.472 ± 0.004
	(8.00 ± 0.10)	(8.00 ± 0.10)	(8.00 ± 0.10)	(8.00 ± 0.10)	(12.00 ± 0.10)
P_1	0.079 ± 0.004	0.157 ± 0.004	0.157 ± 0.004	0.157 ± 0.004	0.157 ± 0.004
	(2.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)
P_0	0.157 ± 0.004	0.157 ± 0.004	0.157 ± 0.004	0.157 ± 0.004	0.157 ± 0.004
	(4.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)	(4.00 ± 0.10)
P_2	0.079 ± 0.002	0.079 ± 0.002	0.079 ± 0.002	0.079 ± 0.002	0.079 ± 0.004
	(2.00 ± 0.05)	(2.00 ± 0.05)	(2.00 ± 0.05)	(2.00 ± 0.05)	(2.00 ± 0.10)
D_0	0.059 ± 0.004	0.059 ± 0.004	0.059 ± 0.004	0.059 ± 0.004	0.059 ± 0.004
	(1.50+0.10/-0.00)	(1.50+0.10/-0.00)	(1.50+0.10/-0.00)	(1.50+0.10/-0.00)	(1.50+0.10/-0.00)
D_1	—	—	0.039 max	—	0.61 ± 0.004
			(1.00 max)		(1.55 ± 0.10)
t	—	—	0.009 ± 0.001	—	0.010 ± 0.002
			(0.23 ± 0.02)		(0.25 ± 0.05)
A_0	0.026 ± 0.004	0.039 ± 0.004	0.071 ± 0.004	0.039 ± 0.004	0.112 ± 0.004
	(0.67 ± 0.10)	(0.98 ± 0.10)	(1.80 ± 0.10)	(0.98 ± 0.10)	(2.85 ± 0.10)
B_0	0.046 ± 0.004	0.071 ± 0.004	0.138 ± 0.004	0.071 ± 0.004	0.252 ± 0.004
	(1.17 ± 0.10)	(1.80 ± 0.10)	(3.50 ± 0.10)	(1.80 ± 0.10)	(6.40 ± 0.10)
K_0	0.025 ± 0.004	0.037 ± 0.003	0.050 ± 0.004	0.024 ± 0.003	0.093 ± 0.004
	(0.63 ± 0.10)	(0.95 ± 0.08)	(1.27 ± 0.10)	(0.60 ± 0.08)	(2.35 ± 0.10)

Figure F3 Component Tape Dimensions for All Fuses

Paper Carrier Tape Specifications



Plastic Carrier Tape Specifications

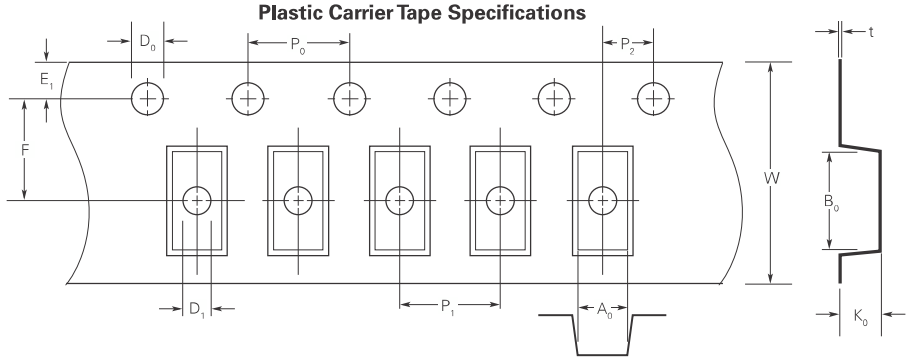
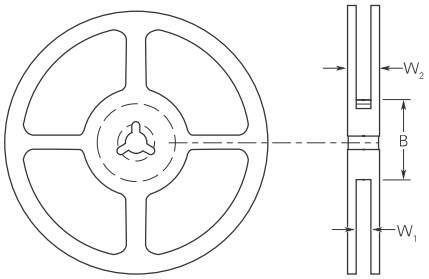


Figure F4 Reel Dimensions for All Fuses

Dimension Description	Mark	Dimension (mm) 1206/0603/0402	2410
Hub outer diameter	B	60	60.2
Reel inside width	W_1	9	13.4
Reel outside width	W_2	11.4	16
Tape width		8	



Agency Approvals for All Fuses

UL File # E197536

Part Numbering System for Fast-Acting, Slow-Blow And 0603 Very Fast-Acting Chip Fuses

1206 SF F 400 F / 24 -2

Packaging
-2 = Tape and Reel

Voltage Rating
24 = $24V_{DC}$

Special Code
F = RoHS Compliant
FM = RoHS Compliant + Marked Part

Rated Current
050 = 0.50 Amps
400 = 4 Amps

Fuse Blow Type
F = Fast Acting
S = Slow Blow

SF = Surface Mount Fuse

Size (1206, 0603, 0402)

Part Numbering System for High-Current-Rated Chip Fuses

1206 SF H 100 F / 24 -2

Packaging
-2 = Tape and Reel

Voltage Rating
24 = $24V_{DC}$

Special Code
F = RoHS Compliant
FM = RoHS Compliant + Marked Part

Rated Current
100 = 10 Amps

Fuse Blow Type
H = High Current

SF = Surface Mount Fuse

Size (1206)

RoHS Compliant, ELV Compliant HF Halogen Free

Part Numbering System for 2410 Very Fast-Acting Fuses