FUSE SELECTION FACTORS

The application guidance and product data in this paper are only part of the auxiliary parameters. In order to quickly select the correct fusion, it is strongly recommended that the application test be carried out to verify the performance of the circuit/application.

1、Approval standards

Cartridge/subminiature fuse normal electrical characteristics standard:

▲UL248-1/UL248-14 American UL standard

- Applied country: USA/Canada
- Approval logo: UL or UR, given by UL

▲IEC60127-1/2/3/4 International electrical commission standard

- Applied country: European and Asian countries
- Approval logo: VDE, SEMKO, PSE, CCC, FIMKO, TUV, IMQ and so on, given by related country institute

▲BS British standard

- Applied country: British and British colonies
- Approval logo: ASTA, BSI

2、Voltage Rating

- Indicates that the fuse will operate at any voltage level below its rating voltage
- Must be equal to or higher than the operating voltage of the device
- May labeled on the fuse body if possible

3、Rated Current

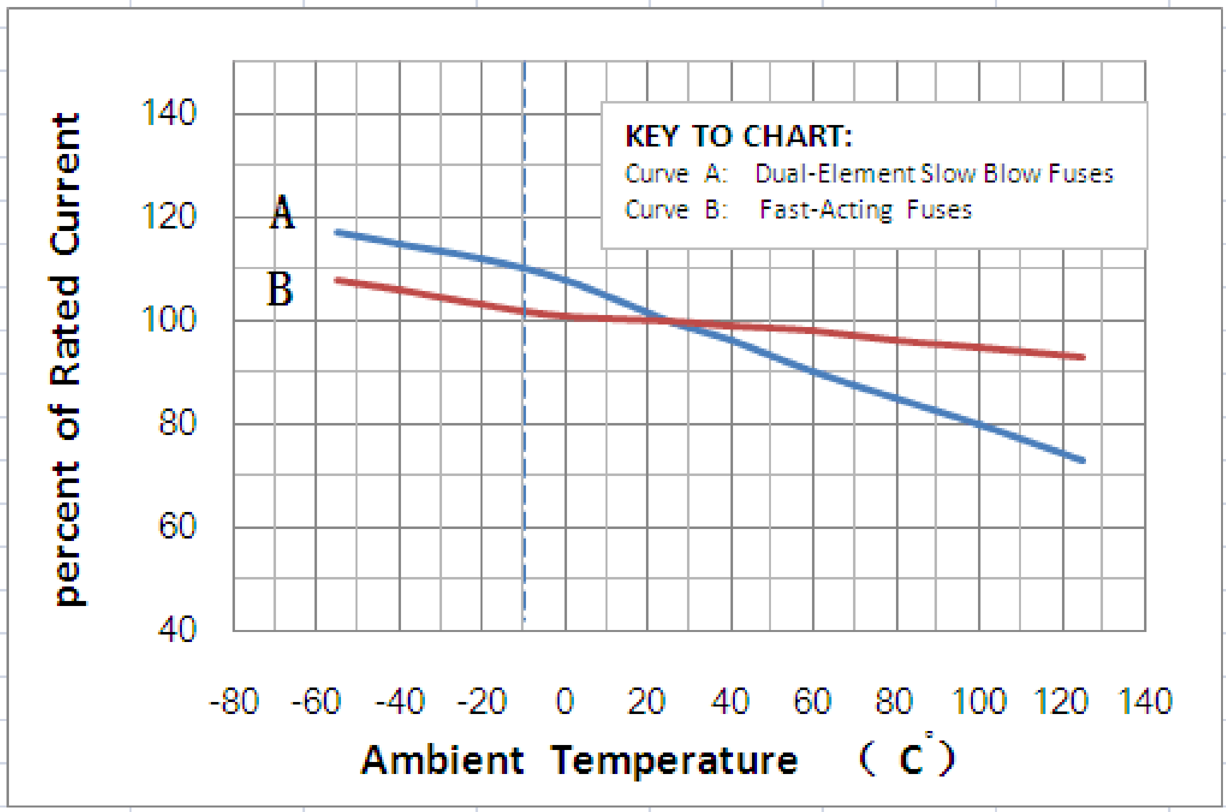
- Identify the current - carrying capacity of the fuse
- Is labeled on the fuse body
- Must be equal to or greater than the maximum operating current
- An operating current of 80% or less than rated current (of device) is recommended for operation at 25° C to avoid nuisance openings.
- Definition of Rated Current is different for UL and IEC

4、Temperature Derating

> Fuse current ratings are measured at 25degC.

> Fuses are temperature dependant so higher the ambient temperature the quicker the fuse will blow.

> Ambient temperature of the application must be considered when choosing the current rating of the fuse.



5、Breaking Capacity

Breaking capacity is the maximum short circuit current a fuse can safely blow without a catastrophic failure such as a fire, breakage or explosion.

Low and high breaking capacity ratings typically range from 35A up to 10kA.

The short circuit condition in the final product determines what fuse breaking capacity is needed.

- Identify the maximum fault current which the fuse will safety interrupt without exploding, rupturing or causing fire
- Is different by AC and DC
- The value is depends on the fuse construction, circuit operation voltage, Current type (AC or DC) and circuit power factor
- Must be greater than maximum fault current (short circuit current)
- Definition of Breaking Capacity is different for UL and IEC

6、In-rush Current Characteristic –I^2t

Many applications will have inrush or peak currents at start-up and sometimes during normal operation.

The inrush current in the application should be measured and used to calculate the proper fuse I2t value.

I^2t is the amount of heat energy, in terms of current and time, required to melt the fuse link

Identify the energy required to melt a specific fuse element

Is constant if, (1) there is no heat dissipation from the surface of the element to surrounding elements. (2) no heat within the fuse casing is conducted away by the fuse contacts or terminals

For fast acting fuses, usually the maximum (Typical) value is given in the datasheet.

For time delay fuses, usually the minimum value is given.

> Many applications will have inrush or peak currents at start-up and sometimes during normal operation.

> The inrush current in the application should be measured and used to calculate the proper fuse I^2t value.

> I^2t is the amount of heat energy, in terms of current and time, required to melt the fuse link

> There are two ways I^2t is used to properly select a fuse in a specific application.

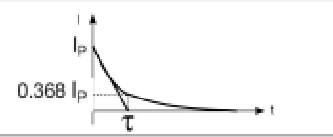
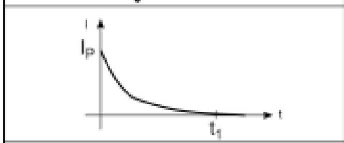
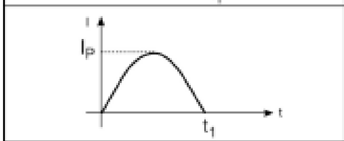
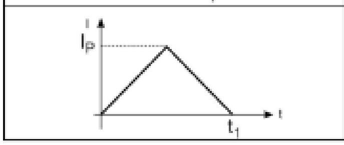
- Components downstream often have a thermal withstand capability. Therefore, the I^2t of the fuse must be lower than the I^2t withstand of the downstream component.

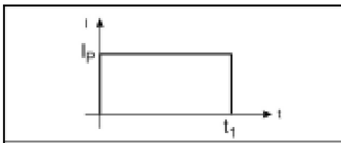
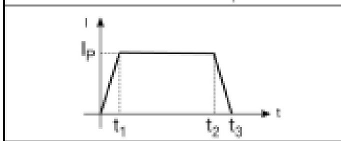
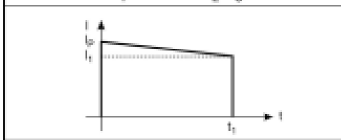
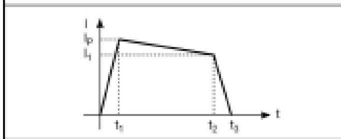
$$I^2t_{fuse} < I^2t_{s.c}\ \text{(components downstream)}$$

- Surge or pulse currents are often normal in an application. The fuse must be able to withstand the thermal energy generated by the pulses and not cause nuisance openings.

$$I^2t_{fuse} > I^2t_{in\text{-}rush}$$

Wave forms Inrush Current Peak

Wave shapes	Formulas
	$I^2t = \frac{1}{2} I_p^2 \tau$
	$I^2t = \frac{1}{5} I_p^2 t_1$
	$I^2t = \frac{1}{2} I_p^2 t_1$
	$I^2t = \frac{1}{3} I_p^2 t_1$

Wave shapes	Formulas
	$I^2t = I_p^2 t_1$
	$I^2t = \frac{1}{3} I_p^2 t_1 I_p^2 (t_2 - t_1) + \frac{1}{3} I_p^2 (t_3 - t_2)$
	$I^2t = I_1 I_p t_1 + \frac{1}{3} (I_p - I_1)^2 t_1$
	$I^2t = \frac{1}{3} I_p^2 t_1 + (I_p I_1 + \frac{1}{3} (I_p - I_1)^2)(t_2 - t_1) + \frac{1}{3} I_1^2 (t_3 - t_2)$

Step 1: Calculation of the I^2t-value of the application

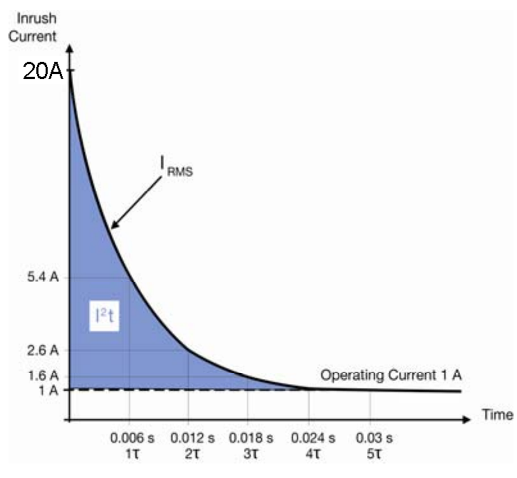
Application example:

Inrush current peak: $I_p = 20$ A, $\tau = 0.008$ s

Type of waveform: Typical discharge curve

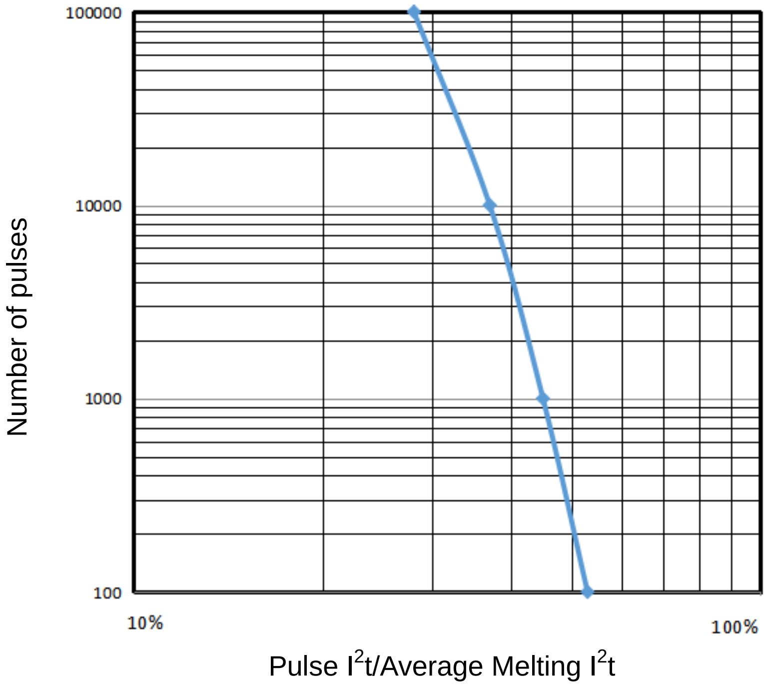
Calculation of the I^2t-value

$$I^2t_{Application} = \frac{1}{2} I_p^2 * \tau = \frac{1}{2} (20\ \text{A})^2 * 0.008\ \text{s} = 1.6\ \text{A}^2\text{s}$$



7、Pulse Factor – Fp

PULSE CYCLE WITHSTAND CAPABILITY	
100000 Pulses	Pulse I^2t=28% of Nominal Melting I^2t
10000 Pulses	Pulse I^2t=37% of Nominal Melting I^2t
1000 Pulses	Pulse I^2t=45% of Nominal Melting I^2t
100 Pulses	Pulse I^2t=53% of Nominal Melting I^2t



保险丝选型

本文中的应用指导和产品数据只是部分辅助性参数，为了快速选择正确的融合，强烈建议进行应用测试，以验证电路/应用的性能

一、安规标准选择

管状/超小型保险丝常规电特性的标准

UL248-1/UL248-14 美国 UL 标准

- 适应的国家：美国，加拿大
- 应用标示：UL or UR,

- IEC60127-1/2/3/4 国际电工委员会标准
- 申请国家:欧洲和亚洲国家
- 应用标示：VDE，SEMKO，PSE，CCC，FIMKO，TUV，IMQ 等等，均由相关国家研究所批准执行

- BSI 英国标准
- 适应国家：英国及英国殖民地
- 应用标示：ASTA，BSI

二、额定电压

- 保险丝可以被使用的最大系统电压，在这个电压下不会对人造成伤害.
- 保险丝的额定电压必须等于或高于设备的工作电压
- 最小标签一定要标示其内电压水平

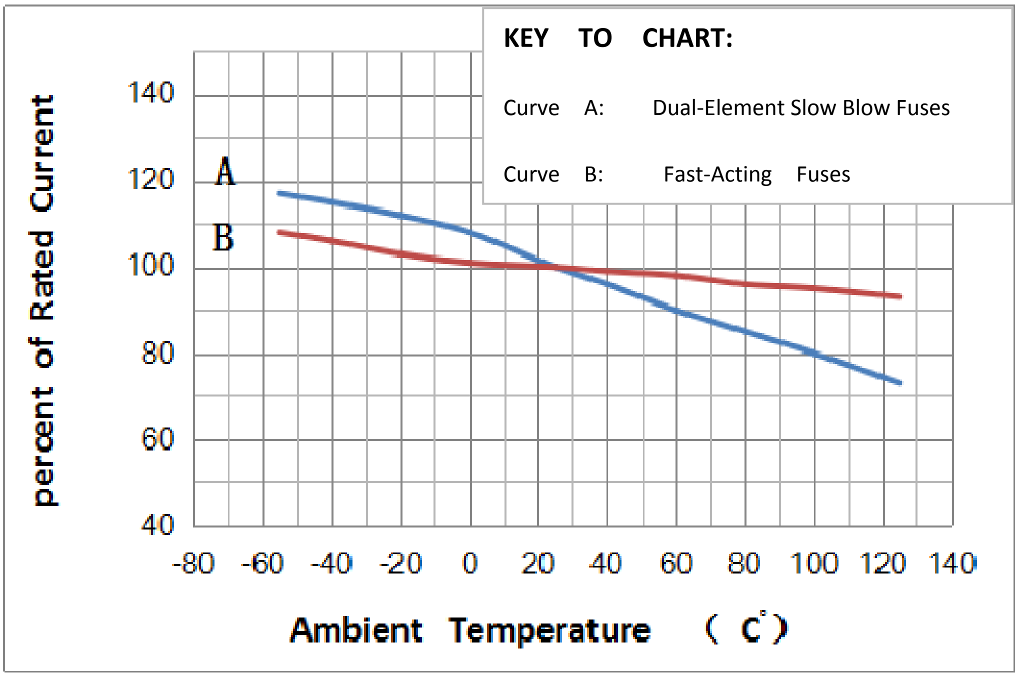
三、额定电流

- 额定电流是表明保险丝的负载能力
- 额定电流必须标示在熔断体本体上
- 必须大于或等于电路的工作电流
- UL 和 IEC 对额定电流的定义是不同的

四、温度降额

> 保险丝的额定电流是在 25 度环境温度定义

> 保险丝的熔断保护是依赖于环境温度，当环境温度越高时其保险丝动作时间将越快。
保险丝选择额定电流时必段考虑其环境温度详细见下表



五、分断能力

分断能力是在额定电压下可以安全断开的最大预期电流。低和高的分断能力评级通常范围从 35A∽10kA。
最终产品的断路条件决定了保险丝断开容量

- 识别保险丝最大故障电流将安全断路没有爆炸，断裂或引起火灾
- 交流直流与分断等级不同
- 分断能力值取决于熔丝、产品结构、电路操作电压、电流类型（交流或直流）和电路功率因数
- 分断能力的选择必须大于预估其故障电流及电压。
- UL 与 IEC 的分断能力定义是不同的。

六、脉冲能量值 I^2t

脉冲是用来描述浪涌电流、起动电流、高起动电流和瞬态中所描述的各种类型的波形。在不同的应用中，电子脉冲也大不同。对于给定的脉冲，不同的保险丝反应也是不一样的。

电子脉冲会产品热循环，从而产品机械结构性疲劳，从而影响保险丝的寿命。在一些应用中通常会有起动脉冲，需要用慢断的保险丝。慢断的保险丝是热延时设计，可以承受正常启动脉冲并可以持续提供过载保护功能。

应用中的侵入电流应测量和用于计算合适的保险丝 I^2t 价值。I^2t 的热量是电流的平方与时间的积。保险丝的 I^2T 值是指其本身的属性，除非你改变其结构形态。

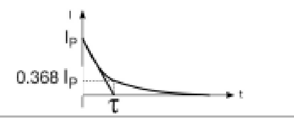
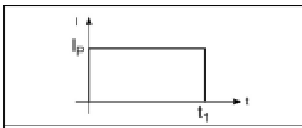
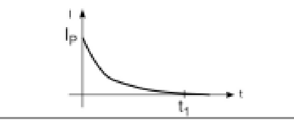
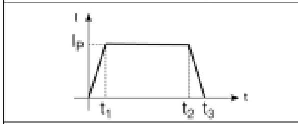
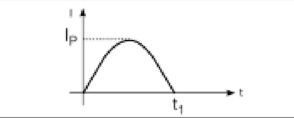
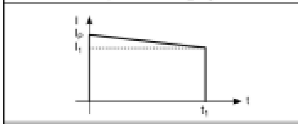
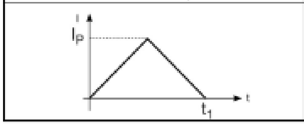
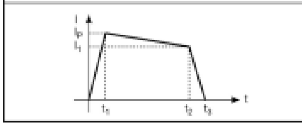
(1)保险丝在熔断瞬间其热量未能扩散。

(2)保险线通常快断保险丝标示最大值，慢断保险丝标示的最小值。

> 许多的应用在产品正常启动时都会产品其峰值冲击。

> 根据其应用的峰值进行计算最后选择合适的保险丝 I^2T 值

> I^2t 的热量是保险丝熔化所需的能量。

波形	公式	波形	公式
	$I^2t=\frac{1}{2}I_p^2\tau$		$I^2t=I_p^2t_1$
	$I^2t=\frac{1}{5}I_p^2t_1$		$I^2t=\frac{1}{3}I_p^2t_1I_p^2(t_2-t_1)+\frac{1}{3}I_p^2(t_3-t_2)$
	$I^2t=\frac{1}{2}I_p^2t_1$		$I^2t=I_1I_pt_1+\frac{1}{3}(I_p-I_1)^2t_1$
	$I^2t=\frac{1}{3}I_p^2t_1$		$I^2t=\frac{1}{3}I_p^2t_1+(I_pI_1+\frac{1}{3}(I_p-I_1)^2)(t_2-t_1)+\frac{1}{3}I_1^2(t_3-t_2)$

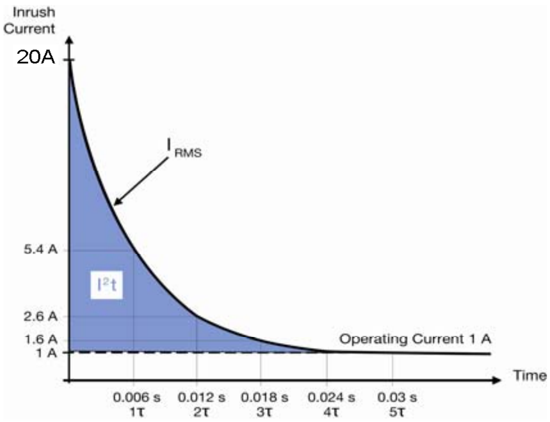
案例:

如何计算涌冲能量例子:

脉冲峰值:I_p = 20 A, τ = 0.008 s

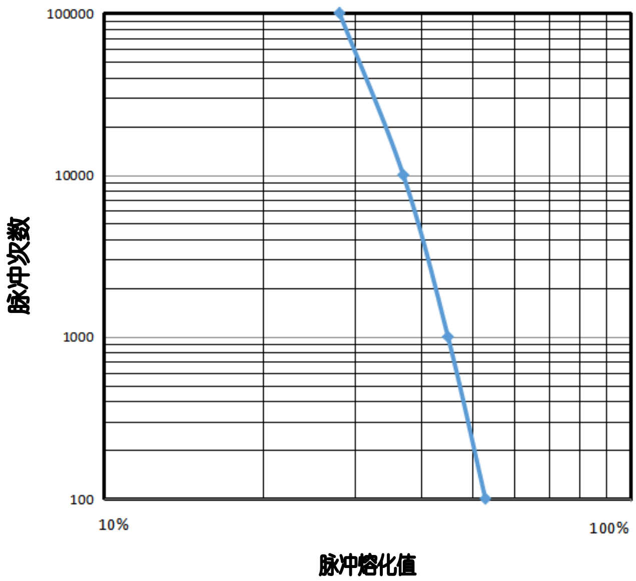
波形:典型的放电曲线

$$I^2t_{Application}=\frac{1}{2}I_p^2*\tau=\frac{1}{2}(20\ A)^2*0.008\ s=1.6\ A^2s$$



七、脉冲系数- Fp

脉冲周期折减参数	
100000 脉冲	10 万次后脉冲值为原 I^2t 值的 0.28 倍
10000 脉冲	1 万次后脉冲值为原 I^2t 值的 0.37 倍
1000 脉冲	10 万次后脉冲值为原 I^2t 值的 0.45 倍
100 脉冲	10 万次后脉冲值为原 I^2t 值的 0.53 倍



资料来源:上海福佑斯电器有限公司 研发部