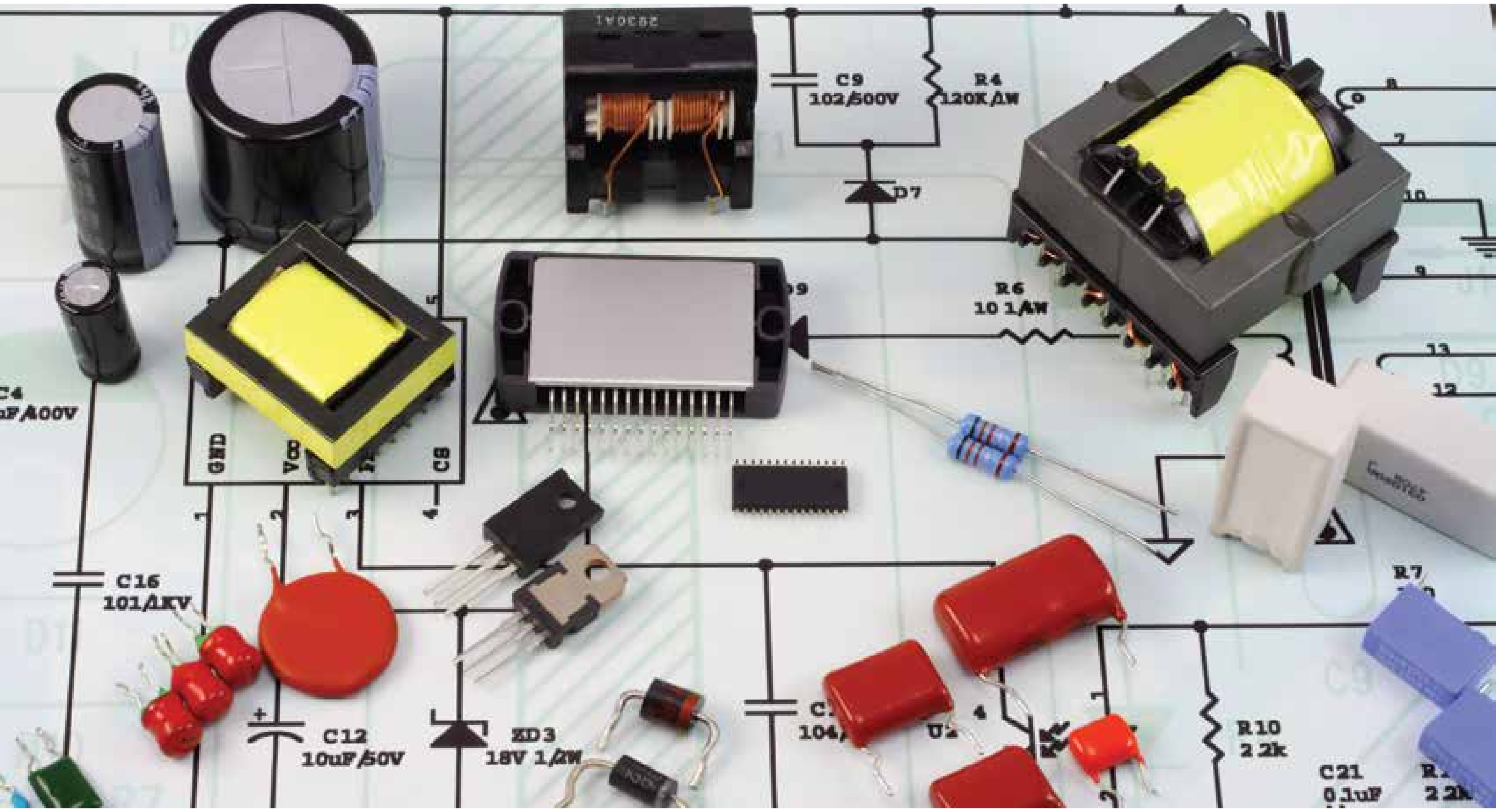
Device Fuse Selection Guide AN-G005



PURPOSE

This article demonstrates how to select the main fuse for a system that has two or more power supplies installed. It also provides insight to discern the implication of the inrush current peak-time factor versus the product operating RMS current.

DESCRIPTION

Fuses are overcurrent devices that protect electrical and electronic devices by melting and opening a circuit. Selecting the right fuse will prevent excessive current from causing damage or starting a fire and prevent a nuisance fuse clearing during a temporary heavy current draw upon initial power-ups. Fuses are designed and specified to be a circuit 's weakest link.

FUSE SELECTION

Things consider when selecting a fuse:

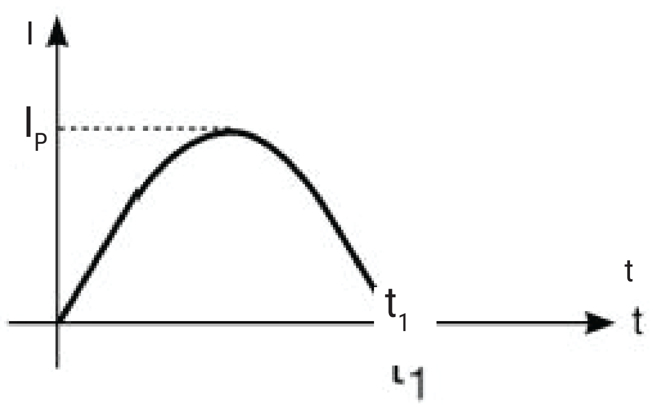
1. Voltage rating: The voltage rating of a fuse must be equal to or greater than the maximum operating voltage of the power supplies.
2. Current rating: The fuse's minimum current rating is determined by the maximum current consumption that occurs at the maximum output load and the minimum input voltage.
3. Melting integral I2t: The peak inrush current is usually significantly greater than the steady-state current. The inrush current if large enough can melt the element or cause significant thermal stress to the element leading to premature failure. The I2t is the
amount of energy needed, in terms of current and time, to melt the fuse link.
4. Temperature derating: The fuse current rating should be derated in an applied ambient temperature exceeding the standard 23°C.

Steps to select a system or device fuse:

1. Obtain I2t from the power supply datasheet if available. If not, calculate the I^2t from the inrush current either from the datasheet or the actual measurement.

Calculate from the datasheet: $I^2t = (1/2)(Iinrush\_pk)^2(t\_inrush)$

Calculate from the actual measurement:



Figue 1. Typical Inrush Current Waveshape $I^2t = (1/2)I^2p * t_1$

2. Determine the required minimum value of the I^2t: The number of inrush current pulses the fuse would be exposed to in the application should be considered. Find the pulse derating factor from the fuse manufacture graph. A sample is shown below. The required minimum I^2t is I^2t / F.

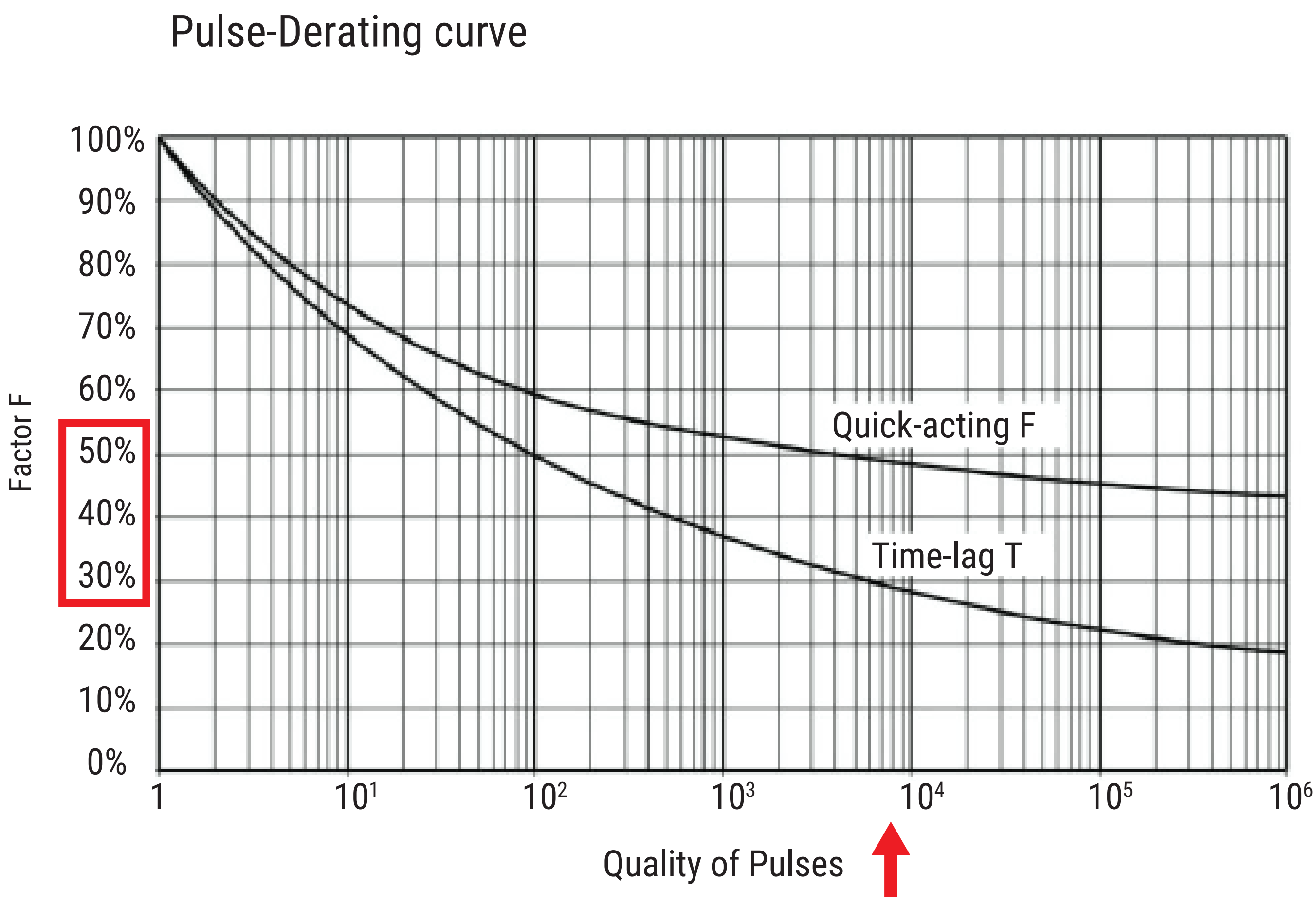


Figure 2. Fuse Derating Curve Sample

3. A selected whole device fuse must meet the following:
a. Fuse current rating: (FN1+FN2+...+FNn)*1.5
b. Fuse melting integral rating: (I2tN1+ I2tN2+...+ I2t Nn)*1.5
Where:
FN1: fuse rating of power supply 1.
FNn: fuse rating of power supply n.
I2tN1: the required minimum I2t of power supply 1.
I2t Nn: the required minimum I2t of power supply n.

CIRCUIT BREAKER TRIP CHARACTERISTICS

Similar to fuses, circuit breakers offer circuit protection and are widely used. They come in various forms and trip behavior. They offer either or both thermal and magnetic or electronic trip mechanisms. The magnetic and electronic type circuit breakers offer fast reaction time so shorter duration, but high peak currents may trip these types of circuit breakers.

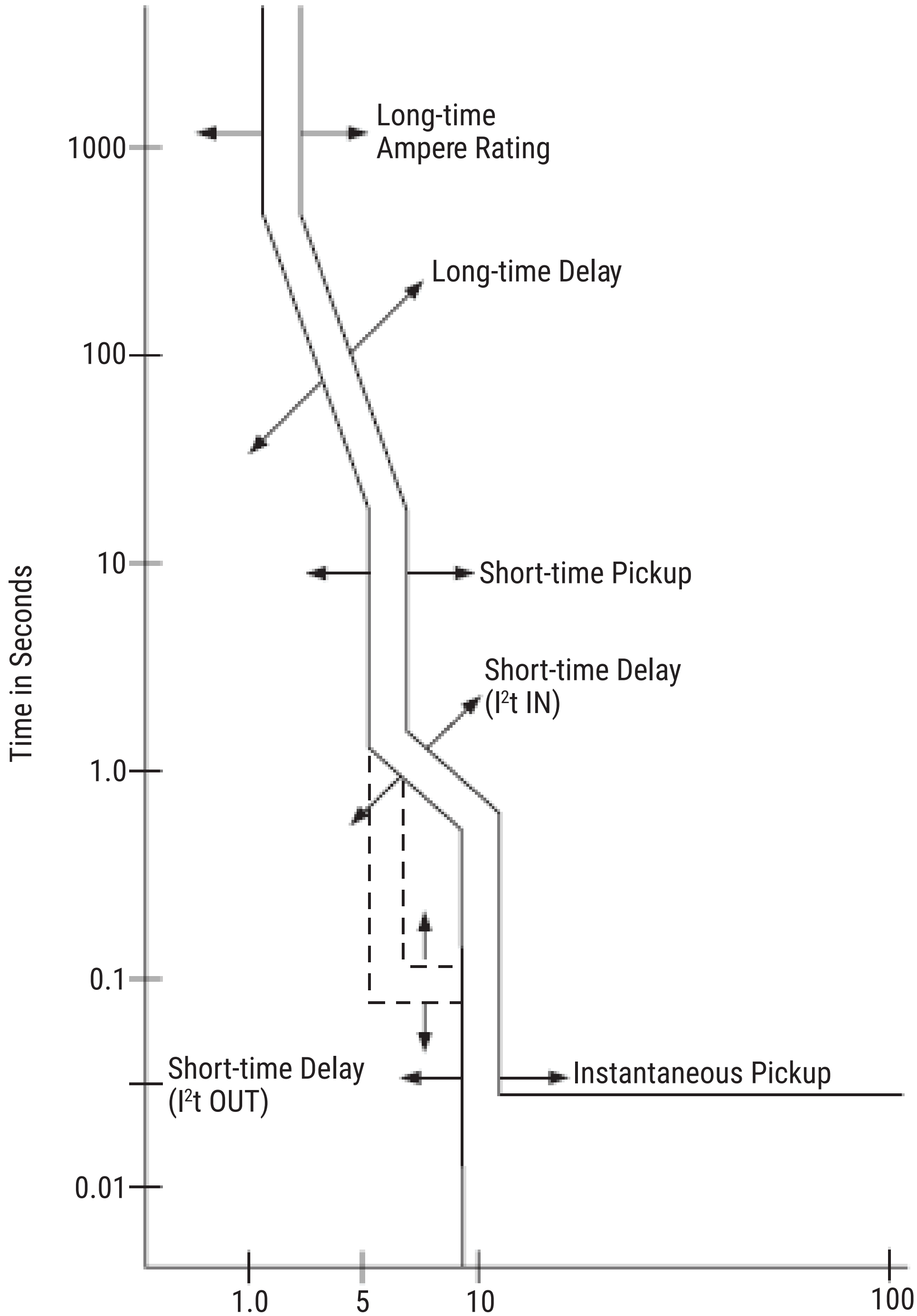


Figure 3. Electronic Trip Characteristics. Square D - Schneider Electric

CHART I

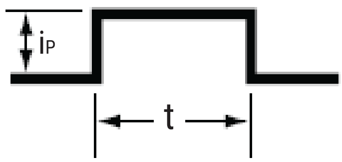
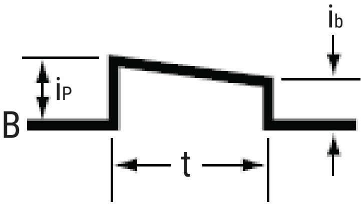
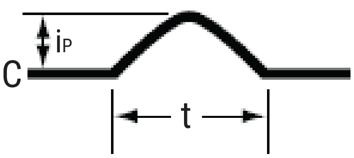
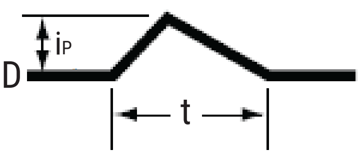
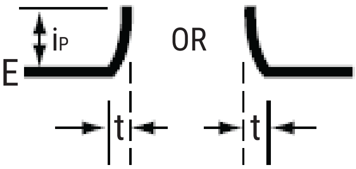
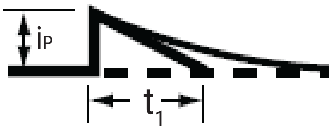
WAVESHAPES	FORMULAS
A 	$i = k$ $I^2t = i_p^2t$
B 	$i = i_P - kt$ $I^2t = (1/3)\,(i_P^2 + i_P i_b + i_b^2)t$
C 	$i = i_P \sin t$ $I^2t = (1/2)\, i_P^2 t$
D 	$I^2t = (1/3)\, i_P^2 t$
E 	$i = kt^2$ OR $i = i_P(1-kt)^2$ $I^2t = (1/5)\, i_P^2 t$
F 	$i = i_P e^{-kt}$ $I^2t = (1/2)\, i_P^2 t^1$

Figure 4. From Littlefuse Fuse Selection Guide

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