

## Multi-layer Slow Blow Fuses Help Protect Automotive Infotainment

Automotive infotainment designs must provide adequate power protection over an increasingly broad range of voltages, currents and temperatures. While the manufacturer's primary design goal may be to improve and expand product functionality, a good design will also focus on product survivability across all definable environments. Many automotive-centric devices, such as navigation systems, DVD players and Bluetooth® enabled devices, must be able to function in a harsh environment where voltage transients and temperature extremes are common, yet unpredictable.

Infotainment devices may control multiple functions with integrated modules controlling audio, video, communications and power distribution. These modular designs are usually predicated on form constraints as well as cost-to-repair concerns. An intelligent power distribution design that protects each module with a current limiting device can help improve customer satisfaction and reduce warranty costs.

High inrush currents and elevated temperatures are two of the major threats to equipment powered by the automotive bus. When selecting a fuse for vehicle infotainment systems, the designer must make derating considerations for operating current, pulse withstand, and application temperature.

Power-on and other system operations, such as processor speed changes, or motor start-up, may cause voltage or current spikes, resulting in nuisance blows. Over time, repeated surges may result in fuse fatigue. Extreme temperatures can cause degradation of the circuit protection device's performance.

Many devices, once exposed to repeated overtemperature conditions, may no longer perform to specification and may begin to draw higher and higher currents in order to maintain functionality. With enough of these degraded components incorporated into a system design, the inrush currents may begin to exceed even the most conservative design criteria.

Selecting a fuse with slow blow characteristics, high current carrying capability, and high pulse withstand is critical in such designs.



### Multi-layer Fuse Design

Tyco Electronics' Slow Blow surface-mount fuses are designed to help protect electronic systems with very dynamic current requirements. We offer a fuse line with small size, high reliability, strong arc suppression characteristics, and some of the highest current ratings available in the 1206 and 0603 form factors.

Slow Blow Fuses help provide overcurrent protection on systems that experience large and frequent current surges as part of their normal operation, and feature clear time characteristics of:

- 4 hours minimum at 100% of rated current;
- 120 seconds maximum and 1 second minimum at 200% of rated current;
- 3 seconds maximum and 0.1 second minimum at 300% rated current; and
- ranges from 0.0005 seconds minimum to 0.05 second maximum at 800% of rated current.

The multi-layer design of these devices allows fuse elements to be stacked in parallel within a single device. The elements are embedded within the fuse body and surrounded on all sides by arc suppression material. Figure 1 compares the multi-layer design of Tyco Electronics' Slow Blow Fuses with a typical single layer, glass coated design.

The ability to stack fuse elements in parallel allows greater current handling capacity within a given package size. The multi-layer design also has the benefit of exposing more fuse element surface area to the glass-ceramic arc suppression material. When the fuse elements open, there is more material to absorb the vaporized fuse element, resulting in a very efficient and effective quenching of the fuse arc.

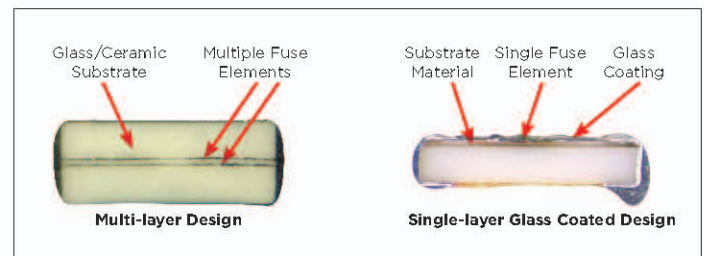


Figure 1. Multi-layer fuse vs. single-layer, glass coated fuse design

## 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.

Thermal derating curves can be used to determine the derating percentage based on operating temperature. Figure 2 shows the thermal derating curve for Tyco Electronics' Slow Blow Fuses.

The minimum fuse current rating selection is determined by the following formula:

$$I_{\text{fuse}} \geq (I_{\text{sys}}/0.75)/K_{\text{temp}}$$

Where:

$K_{\text{temp}}$  is the temperature derating factor

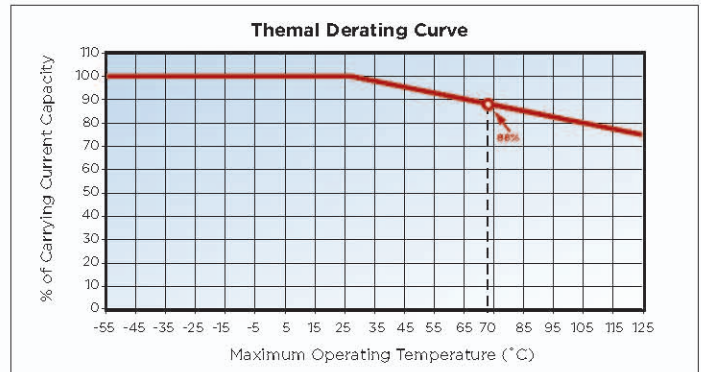


Figure 2. Tyco Electronics' Slow Blow Fuse Thermal Derating Curve

## Transient State or Pulse Derating

The term "pulse" is used to describe any type of transient current that may be applied to the fuse. Common examples of pulses are inrush currents observed at system power-on, motor start-up currents and more extended duration peak currents observed during high-speed processing activity in computing systems.

These pulses have an effect on the fuse element because the transient heating they induce causes thermal cycling within the device. Pulses can affect the life of the fuse. Therefore, the pulse energy and the number of times the fuse may be subjected to the pulses must be considered.

The  $I^2t$  parameter provides a measure of the fuse's ability to withstand the energy of a pulse. By determining the  $I^2t$  energy of the pulse, it can be compared to the fuse's  $I^2t$  curve to determine what the rated current of the fuse must be to help ensure reliable fuse performance.

Once the  $I^2t$  value for the application waveform has been determined, the device must be derated based on the thermal environment and the number of cycles expected over the system lifetime. Since the stress induced by the current pulse is cumulative 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 3 presents the current pulse-derating curve for Tyco Electronics' surface mount chip fuses up to 100,000 cycles.

Tyco Electronics' Slow Blow Fuse provides some of the highest current ratings available in the 1206 and 0603 footprints and enhances high-temperature performance in a wide range of circuit protection designs. Each power circuit within a modular automotive infotainment system can be individually protected with a single device. The RoHS-compliant device is designed for operating temperatures between -55°C and +125°C, and withstands soldering temperatures of up to 260°C for 60 seconds maximum.

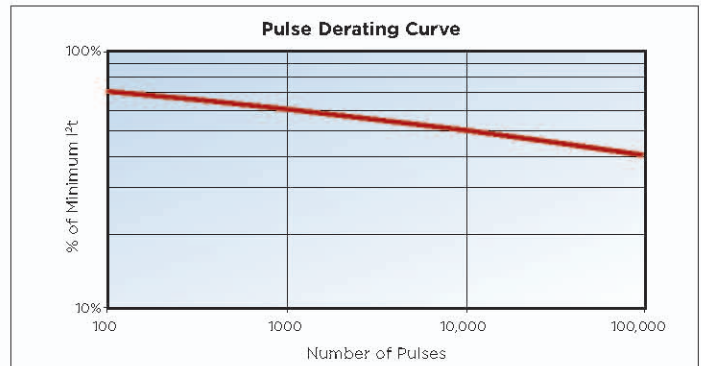


Figure 3. Tyco Electronics' Slow Blow Fuse Pulse Derating Curve

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