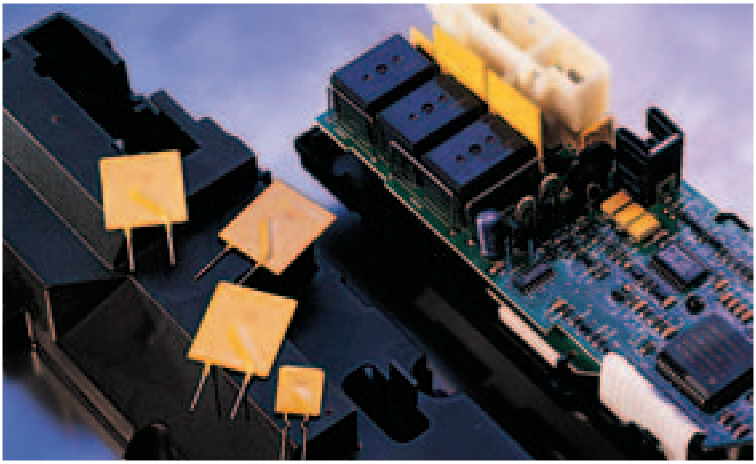
Printed Circuit Board Trace Protection
Application Overview

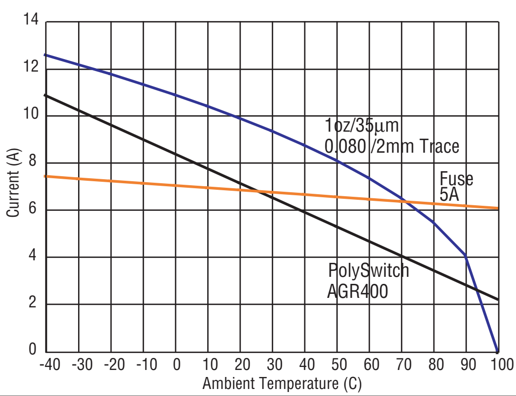


Problem/Solution

As the use of electronics in automobiles increases, automakers are faced with market demands for more interior room and must squeeze more circuitry into smaller packages. To provide an increasing number of functions and interconnections on the surface area of tighter-packed and smaller printed circuit boards, the width of the copper traces must be reduced. However, these “black box” control modules are now controlling a greater number of high-powered accessories, such as power windows, power seat adjusters, remotely controlled door locks, and radio & GPS antennas. Because these accessories are powered from high amperage circuits, there is increased potential for the narrow printed circuit board traces to sustain damage as a result of carrying excessive currents. This may happen, for example, if a power ground becomes detached from a load and the current reroutes through a narrow circuit board trace.

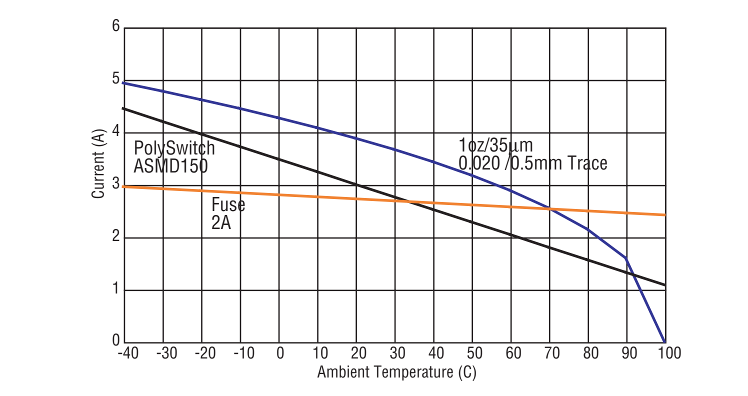
To help protect these delicate printed circuit board traces against damage from overcurrent conditions, PolySwitch resettable devices may be used. Printed circuit board traces function as wires carrying current from one point to another. Depending on its cross-sectional area, each trace can carry only so much current before the heat generated by I^2R losses causes it to fuse open. Even before it melts, a trace may get hot enough to damage the printed circuit board or some of the components mounted on it. For this reason, a protection device is necessary to limit overcurrent and help prevent damage to PCB traces.

Figure 1.



In Figures 1 & 2, it has been assumed that the circuit board designer has chosen to limit the maximum trace temperature to 100°C. Therefore, as the trace approaches this temperature it can carry less and less current. For the example in Figure 1 of a 1oz (35µm), 100mils (2.5mm) trace, a through-hole PolySwitch AGR500 device has been selected. In Figure 2 the trace width has been reduced to 20mils (0.5mm) and is protected by a

Figure 2.



surface-mount ASMD150. Note how the trip current of the PolySwitch device tracks the trace current-to-damage over the temperature range. Even if a fuse could be used here, the nearest size fails to protect above a useful and standard automotive temperature in either case.

Typical Protection Requirements

Electronic modules typically require protection from overcurrent situations that may result from a short-circuit or high stall/inrush current on a module output or from the failure of some other portion of the system, such as a diode short or loss of a power ground. Typical requirements are 1A to 14A of hold current at system voltages of 14V.

Technology Comparison

Fuses are one-use devices that must be replaced when they blow and are not available in a closely incremented range of values needed to protect many trace permutations. Plug-in fuses can be replaced by the incorrect value, while soldered-in fuses are usually not replaceable for practical purposes, resulting in the necessity to replace a whole module. Electronic modules containing fuses would have to be removed from inaccessible areas for servicing in the event of a transient fault. Other solutions for protecting electronic modules include multi-component circuits to sense and switch (which require careful design, consume valuable board space, and may be expensive) or SmartFETs (which may be expensive and may have unacceptable failure modes).

Device Selection

Particular device selection must be based on the maximum current that the trace to be protected can safely carry. PolySwitch AGR and ASMD devices can help provide protection for the copper traces shown in Table 1. However, the table provides only general recommendations. Each specific application should be evaluated independently. Table 1 and Figures 1 & 2 illustrate steady-state conditions for uncoated surface traces. Whatever trace protection system is used, consideration should also be given to the time-to-activate. Empirical selection is then preferred because so many variables are in play, many of which may be unknown. Also typically used in these applications are the AHR and AHS series of PolySwitch resettable devices.

Table 1. Copper Trace Thickness

Width Inches (mm)	1/2 oz. (18µm)	1 oz. (35µm)	2 oz. (70µm)	3 oz. (100µm)
0.020 (0.5)	ASMD100	ASMD150	ASMD250	AGR400
0.040 (1.0)	ASMD150	ASMD200	AGR400	AGR600
0.060 (1.5)	ASMD200	ASMD250	AGR500	AGR800
0.080 (2.0)	ASMD250	AGR400	AGR600	AGR900
0.100 (2.5)	ASMD250	AGR500	AGR800	AGR1100