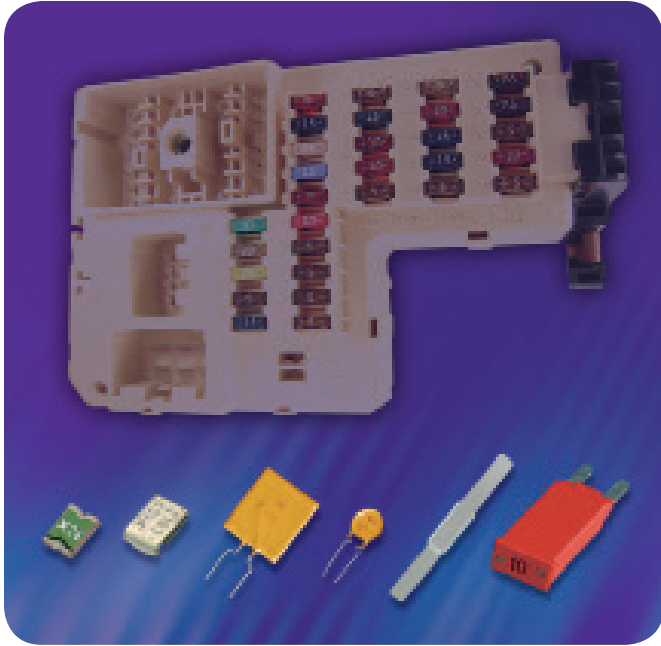


## Automobile Harness Protection



In order to reduce warranty repair costs and improve user satisfaction, vehicle manufacturers must find increasingly efficient solutions to help protect many power functions against damage from high-current fault conditions. At the same time, the wiring harness architecture of automobiles has to constantly adapt as vehicle electrical and electronic content continues to increase.

A vehicle's ideal harness scheme has a hierarchal, tree-like structure with main power "trunks" dividing into smaller "branches," with overcurrent protection at each node. This architecture allows the use of smaller, space-saving wires that can reduce weight and cost. It also optimizes system protection while providing fault isolation, which ultimately improves reliability.

Figure 1 shows a greatly simplified version of a partially distributed architecture, with each junction box either directly feeding a module or another nodal module that supplies peripheral loads. Although this harness scheme offers many advantages, the sheer number of circuits being employed in today's automotive applications makes this approach difficult to realize in actual practice. With so many circuits emanating

from an electrical center, it has become almost impossible to route all the wires in and out of a single box and place it in a driver-accessible location.

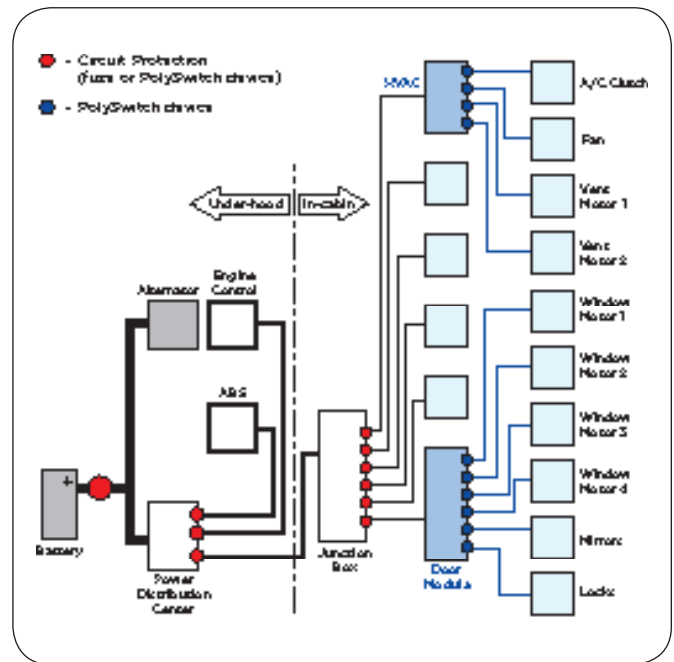


Figure 1. A partially distributed automotive harness architecture.

As a result, system designers have resorted to harness design solutions that negate some of the desired end-benefits, such as:

1. sacrificing wire size optimization and fault isolation by combining loads in one circuit;
2. locating electrical centers where they are only accessible by trained service personnel, at increased cost; and
3. routing back and forth between various functional systems, increasing wiring length, size and cost. For example, due to the necessity for fuse accessibility, a conventional door module would have separate power feeds for windows, locks, LEDs and mirror functions; each protected by a separate fuse in the junction box. By incorporating PolySwitch resettable PPTC (Polymeric Positive Temperature Coefficient) devices in the door module itself, a single power feed can be used, saving wire and reducing the cost and size of the junction box.

## Automobile Harness Protection

Using resettable circuit protection devices that do not need to be driver accessible offers designers a number of solutions that may be used separately or in combination. A single junction box located in the instrument panel may still be employed. However, rather than being positioned close to the conventional fuses, resettable PolySwitch devices can be located inside the box or on another face, which can save frontal area (as shown in Figure 2). Moreover, placing them closer to the connectors allows the trace's length to be reduced. As a result, the overall junction box can be downsized.

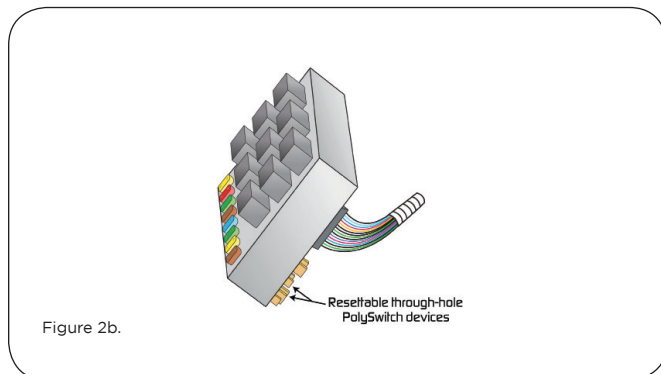
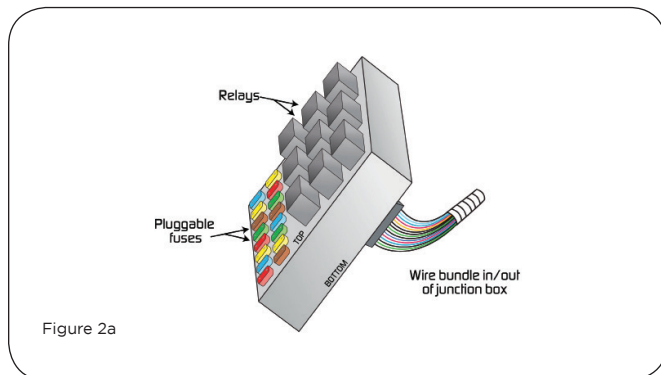


Figure 2. Comparison of a conventional junction box design (shown in 2a) and a reduced size junction box design (shown in 2b).

Alternatively, the junction boxes can be divided into smaller units and relocated around the vehicle with no need to consider accessibility. With the availability of resettable circuit protection and the reliability that can now be expected from relays, modules can switch and protect their own output loads and still be positioned without consideration for any user access.

In these ways, the use of PolySwitch devices allows the electrical architecture to more closely reflect the ideal tree structure with its intended benefits.

PolySwitch devices come in a variety of form factors. Through-hole and surface mount devices lend themselves to be installed in fuse boxes or modules using printed circuit boards. Strap devices can easily be used in metal fret boxes.

Additionally, a new generation of PolySwitch bladed devices can be inserted like a bladed fuse or bi-metal breaker in the junction box. Even though these devices are resettable and do not need to be user accessible, the bladed form factor allows designers to replace a fuse or a bi-metal device without modifying their existing junction box design.

PolySwitch devices are also available in a large number of current ratings, commencing at much lower values and increasing in much smaller increments than conventional fuses. Therefore they are more appropriate for protecting command functions and allow for greater design flexibility.

### Typical Protection Requirements

Automotive wiring harnesses must be protected from damage caused by catastrophic thermal events, such as when a short circuit occurs in the vehicle wiring. Circuits typically require 0.10A to 30A of current at system voltages of 14V for 12V battery systems (28V for 24V battery systems found in most trucks and busses).

Industry standards also play an important role in the design of a vehicle's electrical/electronic system. AEC-Q200, a stress test qualification for passive components, includes test requirements for PPTC devices used in the automotive environment. The test plan includes a series of electrical and environmental stress tests that require electrical verification prior to and after each stress.

The electrical verification tests are designed to check that parts meet performance specifications for resistance, time-to-trip (TtT), and hold current at three different temperatures (-40°C, 25°C and max T).

## Automobile Harness Protection

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Littelfuse has developed test procedures that define performance limits prior to and after the qualification stress tests and has included them in an internal specification. The PS400 specification encompasses the AEC-Q200 standard for PolySwitch devices. It incorporates relevant physical, functional, environmental, electrical, and mechanical requirements specified in a variety of ANSI, ISO, JEDEC, UL and military standards.

### Technology Comparison

Fuses are single-use devices that must be replaced when they blow. This characteristic requires that fuses be mounted in accessible fuse boxes — a requirement that dictates system architecture and forces packaging and system layout compromises. In contrast, PolySwitch devices latch into a high-resistance state when a fault occurs. Once the fault is removed and the power is cycled, the device automatically resets and the protected system is restored to normal operation.

Fuses have nominal current ratings from 2A to 30A in the same form factor and are often substituted for ones that are larger than the design value or are jumped out of circuit when used in delocalized modules. In comparison, PolySwitch devices offer the added benefit of not being readily accessible and cannot be easily changed or substituted by the user.

When compared to bi-metal circuit protection devices, which typically cycle several times before latching, PolySwitch bladed devices use a resistance switching action to interrupt current. In addition to resettable functionality, the PolySwitch bladed device offers high resistance to shock, vibration and rough handling, lower surface temperature and power dissipation, and flatter thermal derating.

### Device Selection

PolySwitch devices typically used for automotive wiring protection applications include the through-hole families AGRF, AHRF and AHEF; surface mount families ASMD, AHS and miniSMD, microSMD, and nanoSMD; and the bladed family BD280/BD540. Strap devices shall be customized upon request.

Refer to the Littelfuse PolySwitch product catalog for detailed information regarding each of these PolySwitch device families.

### Notice:

Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Littelfuse products are not designed for, and shall not be used for, any purpose (including, without limitation, military, aerospace, medical, life-saving, life-sustaining or nuclear facility applications, devices intended for surgical implant into the body, or any other application in which the failure or lack of desired operation of the product may result in personal injury, death, or property damage) other than those expressly set forth in applicable Littelfuse product documentation. Warranties granted by Littelfuse shall be deemed void for products used for any purpose not expressly set forth in applicable Littelfuse documentation. Littelfuse shall not be liable for any claims or damages arising out of products used in applications not expressly intended by Littelfuse as set forth in applicable Littelfuse documentation. The sale and use of Littelfuse products is subject to Littelfuse Terms and Conditions of Sale, unless otherwise agreed by Littelfuse.