PolySwitch Mini-terminal Bladed Device Helps Protect Automotive Wire Harnesses, Motors and Actuators

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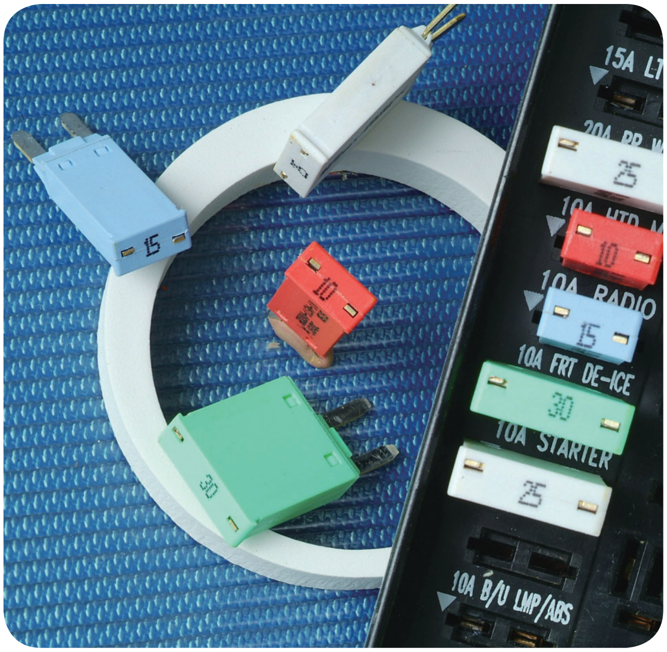

The PolySwitch BD280 and BD540 mini-terminal bladed devices are suitable for one-to-one replacement of plug-in automotive mini fuses and bimetal circuit breakers. The device offers a no-moving-parts design, and a resistance switching action that immediately latches following an overcurrent event.

The solid-state design of the PolySwitch device, as opposed to the multi-part mechanical design of the bimetal device, provides significant advantages in automotive applications. The device's resettable functionality, high resistance to shock, vibration and rough handling, lower surface temperature and power dissipation, and flatter thermal derating can help vehicle manufacturers reduce warranty repair costs and improve user satisfaction. Suitable for use in North American trucks, utility or off-road vehicles and worldwide passenger cars utilizing 12V battery systems, the resettable device helps prevent damage caused by overloads and short circuits.

PolySwitch Device's Latching Behavior Helps Reduce Circuit Damage

Unlike Type II bimetal circuit breakers – which typically cycle several times before latching – the PolySwitch bladed device uses a resistance switching action to interrupt current. Under normal operating conditions the device remains in a low resistance state, but switches to a high resistance state in the event of an overcurrent condition.

PolySwitch circuit protection devices are made from a composite of semi-crystalline polymer and conductive particles. In the normal operating temperature range, the conductive particles form low resistance networks in the polymer. However, if the temperature rises above the device's switching temperature (Tsw) either from high current through the part or from an increase in the ambient temperature, the crystallites in the polymer melt and become amorphous. The increase in volume during melting of the crystalline phase separates the conductive particles resulting in a large non-linear increase in the resistance of the device.

The resistance typically increases by three or more orders of magnitude. This increased resistance helps protect the equipment in the circuit by reducing the amount of current that can flow under the fault condition to a low, steady state level. The device remains in its latched (high resistance) state until the fault is cleared and power to the circuit is cycled – restoring the PolySwitch device to a low resistance state in the circuit and the affected equipment to normal operating conditions.

Because it has no contacts that might arc, weld together or erode, the PolySwitch bladed device typically offers a longer lifespan than bimetal breakers and can help provide more reliable performance.

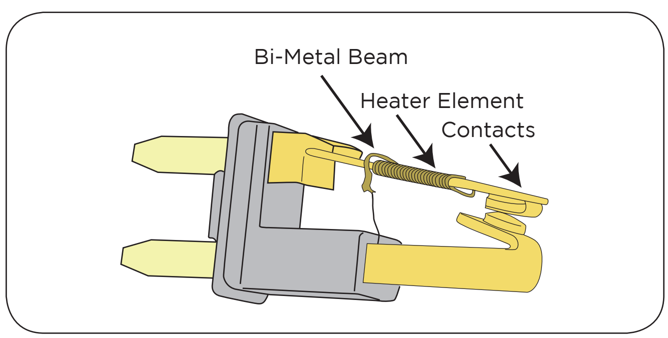

Figure 1. A Type II bimetal circuit breaker utilizes a heating resistor element to prevent cycling.

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The breaker's contacts are normally closed and shunt the heater element out of the circuit. As current flows the bimetal beam is heated. A fault current will heat it to the point at which it bends and separates the contacts. When the contacts are separated the heater element is switched into the circuit and heats the beam to prevent cycling.

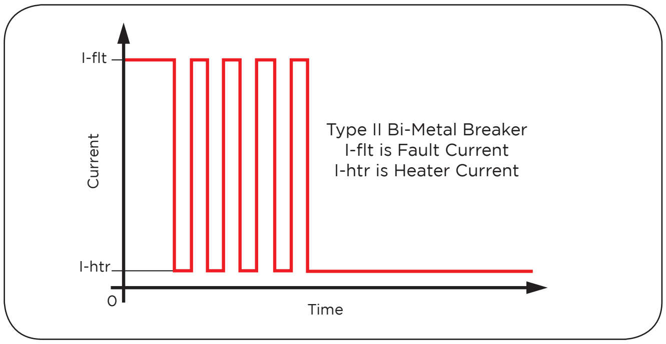

Figure 2. The Type II bimetal breaker typically cycles several times before the heater element reaches a temperature high enough to latch the device.

However, it may take several cycles for the heater element to reach a temperature where it will latch the circuit breaker, as shown in Figure 2. This cycling behavior increases the device's surface temperature, raises power dissipation levels, and can impact the lifespan of the bimetal device.

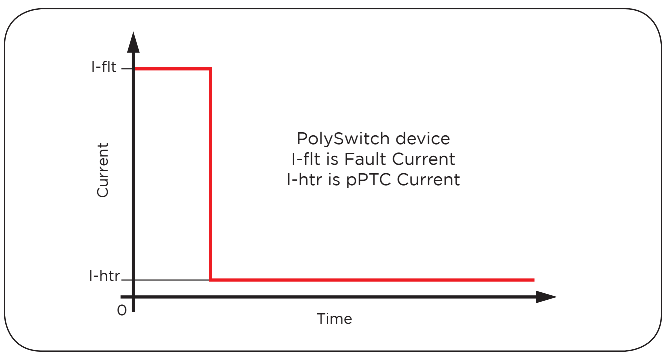

Figure 3. The PolySwitch device latches without pre-cycling.

As shown in Figure 3, the PolySwitch bladed device trips and remains in the latched position without cycling. Although the trip time of the first activation could be slightly longer, the total fault current let-through is lower. The PolySwitch device will exhibit a lower surface temperature and pass less fault energy to the load and its wiring while in this latched state.

Thermal Derating Considerations

When designing in a bimetal circuit breaker, the thermal derating of the device must be evaluated in terms of the application's temperature range. As shown in Figure 4, PolySwitch bladed devices exhibit current carrying derating characteristics similar to those of bimetal circuit breakers, but with much less roll-off at high temperatures. This allows for their use in higher temperature vehicle zones, such as under hood applications.

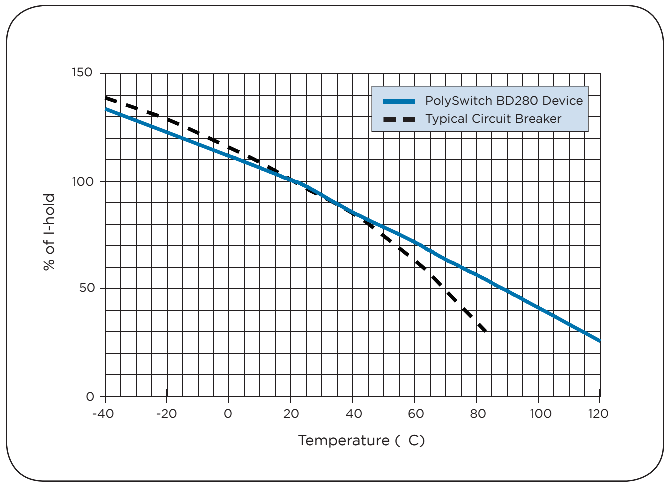

Figure 4. Temperature derating comparison of PolySwitch BD device and Type II bimetal breaker.

Performance Comparison: PolySwitch BD280 Device vs. Type II Bimetal Breakers

Recent testing by Littelfuse compared the performance of several Type II bimetal circuit breakers to the PolySwitch BD280 device under high current and high voltage fault conditions.

In a high fault current test – simulating a condition of a device directly shorted across the battery – ten devices each of 10A, 15A, 20A and 25A Type II bimetal breakers were tested. A maximum 200A at 12V was applied to all devices. Ten trip cycles of 6 seconds on and 120 seconds off were then applied to all devices. Two of the 10A bimetal breakers, two of the 15A breakers, and four of the 25A breakers failed short, indicating that under continuous high current conditions, repeated cycling may damage the Type II bimetal breaker, as shown in Figure 5.

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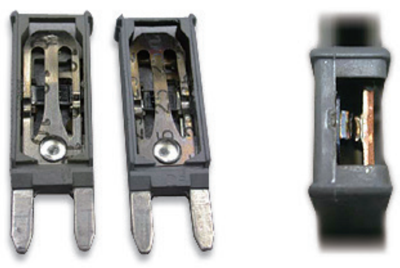

Figure 5. Type II bimetal breakers may be damaged after several high-current level cycles.

Voltage performance testing illustrated that the constant wattage nature of the PolySwitch device results in a constant surface temperature when tripped under various voltage conditions and consistent performance over the entire 12V vehicle system's voltage range. The Type II bimetal breaker's surface temperature varies with voltage as shown in Figure 6. The bimetal heater element dissipates four times as much power at 16V than as at 8V. The testing showed that the bimetal heating element might fail at voltages above 14V.

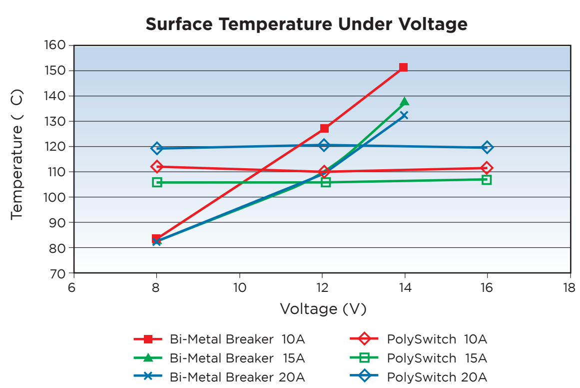

Figure 6. Surface temperature comparison of PolySwitch devices vs. Type II bimetal breakers.

A battery run-down test was also performed with an 80Ah leadacid battery. Ten PolySwitch devices and ten Type II bimetal devices (all 10A) were tested. The battery was fully charged at the beginning of the test (12V) and the voltage

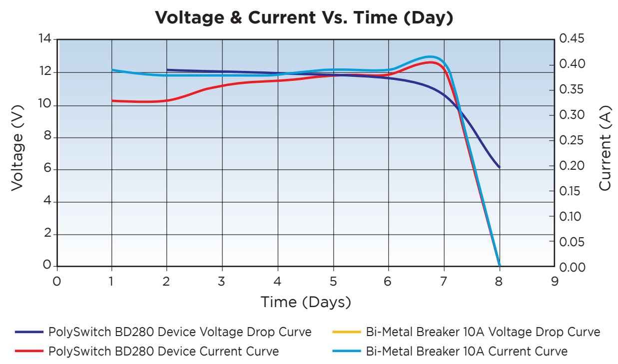

Figure 7. Battery run-down comparison of Type II bimetal breaker and PolySwitch BD280 device

was recorded throughout the test period. As shown in Figure 7, the higher power dissipation of the bimetal breakers caused the battery voltage to run down faster. Moreover, in the battery run-down test, the PolySwitch device remained functional (latched) across the entire voltage span, whereas after the voltage dropped below 8-10V the bimetal breakers did not remain latched and began cycling like Type I bimetals, eventually failing. The heater resistor element of the devices remained functional when measured separately, confirming that its integrity was not the cause of the device failure.

PolySwitch Bladed Device Applications

The BD280 and BD540 mini-terminal bladed devices are useful in helping to provide resettable overcurrent protection for passenger vehicle and North American heavy truck wire harnesses using 12V battery systems. The PolySwitch bladed device features a 2.8 mm form factor to facilitate easy, one-to-one replacement of mini-sized fuses and bimetal circuit protection devices.

Bright color-coded housing and rated current values printed on the top of the device makes replacement easy and helps prevent installation errors. The device also incorporates two exposed probe points to facilitate inspection and troubleshooting.

Useful in helping provide resettable overcurrent protection for power window, power seat, power outlet and other human interface functions, the devices are available in current ratings of 10A, 15A, 20A, 25A and 30A, with additional current ratings and device form factors available upon request. The PolySwitch BD280 and BD540 mini-terminal bladed devices meet all applicable SAE and ISO standards and samples can be requested from local distributors.

PolySwitch Bladed Device Benefits:

- Directly replaces mini-sized automotive fuses and Type I or Type II bimetal breakers
- No cycling into short or overload conditions
- No contacts to arc, erode or weld together improves reliability
- Virtually constant performance across voltage range of 4V to 14V
- Probe points facilitate diagnostics and faultfinding
- Color-coded housing and current rating marks facilitate replacement
- Low thermal derating permits use in under hood applications