Protecting Automotive Battery Chargers from Fault Failures
Application Overview

3

Service station and "do-it-yourself" battery chargers provide a low cost means of charging a flat or heavily discharged battery. However, when battery cables are attached incorrectly, or the clamps or clips touch each other accidentally, the resulting fault condition may cause a blown fuse or equipment damage. Because fuses are typically mounted inside the unit and are not user accessible, and since these kinds of faults can occur easily, a simple and low cost solution would eliminate the time lost to replace the fuse, avoiding equipment downtime for the user. This type of solution could also help avoid customer complaints and costly warranty returns for the manufacturer.

Problem/Solution

A typical battery charger schematic is shown in Figure 1. The fuse protecting the secondary side is typically mounted inside the charger housing and in some cases may be soldered into the wiring or printed circuit board making it more difficult to replace. High current faults that can blow the fuse may also result in damaging high voltage spikes due to the leakage inductance of the transformer. The protection element on the primary can be a current fuse, thermal fuse, circuit breaker, or a positive temperature coefficient (PPTC) resettable component.

A PolySwitch PPTC device is an obvious choice to address an overcurrent situation on the secondary side. The resettable PPTC device is a series element in a circuit. The PPTC device goes from a low-resistance to a high-resistance state in response to internal heating generated by an overcurrent condition, or in response to external heating. When a PPTC device transitions to the high resistance state, it is said to have "tripped." It stays in the tripped state until the circuit is de-energized and the fault is removed, at which point the device "resets" and returns to its low resistance state. This can be an ideal approach for high current protection that avoids replacing a blown fuse.

A device such as the PolySwitch RGE1200 from Raychem Circuit Protection, a unit of Tyco Electronics, can limit current that would otherwise be as high as 100A in the fault condition. However, in some cases, the voltage rise from the secondary side of the transformer can generate very high voltages (e.g., >150V) for several microseconds across a tripped overcurrent device such as a PPTC device, which can far exceed the device's voltage rating, as well as that of the other components. These high voltage conditions most commonly occur during short circuit or reverse

Figure 1. Typical Schematic for Battery Charger

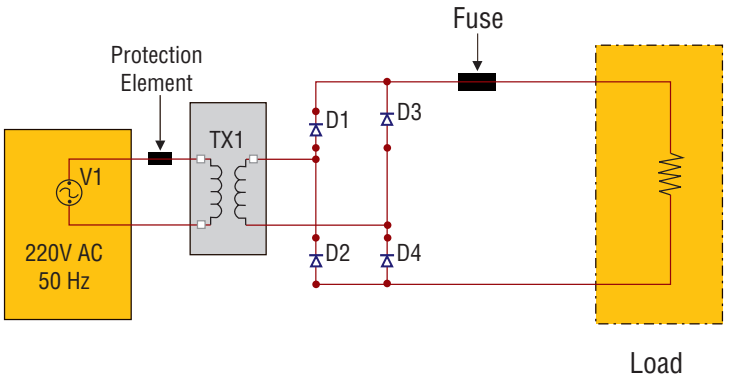
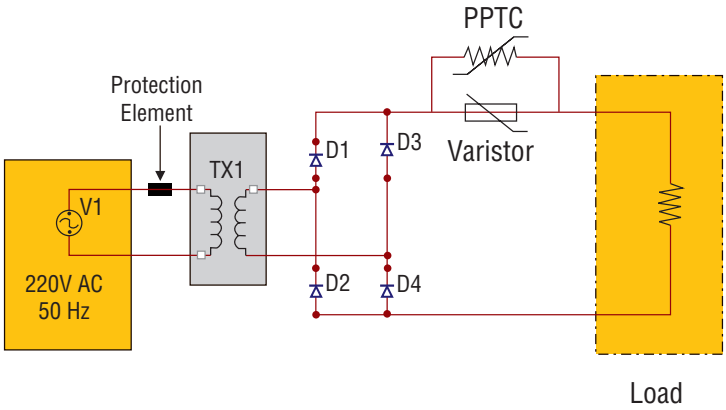


Figure 1. Battery Charger Schematic with PPTC and Varistor to Help Provide Overcurrent and Overvoltage Protection and Eliminate the Need for Secondary Side Fuse Replacement



connection of the output, and if the transformer is a lower cost unit operating in partial saturation. A metal oxide varistor (MOV) in parallel with the PPTC device will clamp the voltage, thereby helping to protect the PPTC device from the overvoltage condition and allowing time for the PPTC device to trip due to the excessive current. The MOV used in combination with the PolySwitch device provides a resettable solution. Figure 2 shows the PPTC and varistor added to the secondary side of the battery charger circuit.

Raychem Circuit Protection's ROV series of MOVs are used in parallel with an electronic device or circuit that has to be protected, in this case the PPTC device. In the normal operating mode, the resistance of the ROV varistor is very high, so the bulk of the current goes through the PPTC, and there is very little leakage current through the varistor. However, when there is a fault that produces a high voltage across the PPTC the varistor "clamps" it to a value that is safe for the PPTC in parallel with it, and protects it from being damaged by the voltage spike.

Selecting the ROV Varistor

The maximum voltage in the secondary of the 12V battery charger can be as high as 17V under normal operating conditions, so a varistor with a VDC rating greater than 17V is required. The ROV20-220M has a maximum DC operating voltage rating of 18V and a clamping voltage of 43V at 100A. The diameter of this device is 20mm to provide sufficient energy absorbing capability.

With the proper selection of a PolySwitch device and ROV varistor, protection against damage from both the overcurrent and overvoltage condition in short circuit or reverse battery connection in the battery charger can be accomplished. This resettable solution is typically much less than $1.00—versus a warranty return costing $10.00 to $50.00 per occurrence—reducing the potential for costly repairs. If the transformer in the battery charger has a small leakage inductance, the overshoot will be significantly lower and the PPTC device alone may be sufficient to solve the problem making the solution even lower cost.

Other Applications for the Combined Overcurrent and Overvoltage Solution

The combination of a PPTC device and a varistor to address both overcurrent and overvoltage conditions has other potential applications. For example, this solution will also work in other heavy inductive load situations, such as motor controls, where a simple means of providing protection can avoid warranty problems.