## **Trouble Shooter**



**Karl Seyfert** 

Engineers place diodes in electrical circuits to control the orderly flow of electrons. They didn't plan for the misguided efforts of a pair of DIYers, however.

#### **DIY Mop-Up**

The son of a long-time customer called to tell us the floor shifter on his 1996 Pontiac Grand Am was stuck in Park. He also said the ERLS fuse blew every time he started the car. And, by the way, a replacement alternator was on the back seat of the car.

The car was towed in and we began what we thought would be a routine electrical diagnosis and repair. We confirmed that the ERLS fuse (located in the engine compartment fuse center near the battery) did indeed blow each time the car was started. We hooked up an ammeter and noticed a substantial current spike on startup. We continued by isolating each circuit routed through the ERLS fuse. This included the backup lamp switch, the electronic brake control relay and module, the neutral switch, the transaxle 2-3 control solenoid, the evaporative

emissions canister vent and purge solenoids, the digital EGR assembly, the powertrain control module and the a/c clutch relay.

Isolating circuits protected by the ERLS fuse caused no change until we got to the a/c clutch relay. With no power to the relay, the fuse would hold while the engine was cranked. The a/c relay checked out fine, leaving only the a/c compressor clutch (we thought). But when we disconnected the compressor clutch wiring, the short was still present.

After reviewing the diagram, we identified an a/c clutch diode in the clutch circuit. We

spent several hours unraveling and inspecting various looms before locating the suspect diode packaged in an oblong, cream-colored plastic enclosure that was hard-wired within the harness. When we removed and opened the container, we found the diode had blown apart and was split along its entire length. We installed a new diode, which solved the problem.

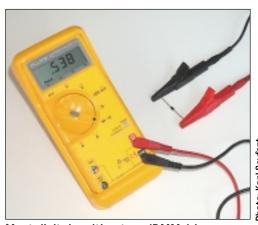
When our customer arrived to pick up his car, he confessed that he and his "mechanic friend" had diagnosed a bad alternator when his battery went dead and the car wouldn't start. Their first attempt at replacing the alternator was unsuccessful, but they got it right the second time and the new alternator charged normally. However, they traded one problem for another, as the "stuck in Park" problem appeared immediately afterward. Do you have any idea how replacing an alternator could have damaged the a/c compressor clutch diode?

Marvin Tow Chula Vista, CA

Well, Marvin, to state the obvious, it appears that someone did something he wasn't supposed to do. If you look in any automotive service manual, nearly every R&R procedure begins with the words "Disconnect the negative battery cable." It would seem that your customer and his friend skipped right over this step, and possibly grounded one or more of the alternator's wires. Other wires may also have been handled improperly, and it's anyone's guess what position the ignition key might have been in at that time.

The damaged diode you found in the a/c clutch circuit is a spike-suppression diode, attached to the compressor clutch terminals to eliminate the potentially damaging voltage spikes that occur each time power is removed from the compressor clutch and the clutch opens. If there were no diode in the circuit, these voltage spikes could travel through the circuit, possibly damaging other components and introducing "noise" into the vehicle's electrical system, at the very least.

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Most digital multimeters (DMMs) have a Diode Check function that ups the voltage flow through the test leads to force the diode to "open." The DMM then displays the voltage drop necessary to open the diode in the forward direction. When the test leads are reversed, the DMM should indicate "OL," or out of limits. If the diode is shorted, the DMM indicates "O" in both directions. If the diode is open, the DMM indicates "OL" in both directions.

#### **Trouble Shooter**

A diode is the electrical equivalent of a one-way check valve. It allows the flow of electrons in one direction but not the other. A certain amount of electricity (usually less than .7 volt) must be flowing in the proper (forward) direction before the diode will open and allow the circuit to operate. Electrical flow in the wrong (reverse) direction is blocked by the diode.

The diode terminals are called the *anode* and *cathode*. The ring marking at one end of the diode body identifies the cathode. Under normal conditions, current is allowed to flow through the diode only when the voltage at the anode is more positive than at the cathode.

A diode can become damaged in a couple of different ways. If the forward current exceeds the diode's design specifications, the diode's internal parts may crack or melt and the contacts may separate. If it melts, the diode may suddenly allow electrical flow in both directions.

The diode is a one-way check valve, but it's designed to hold back only a certain amount of electron flow. So if an excessive amount of electron flow occurs in the reverse direction, the diode will also fail and conduct in the wrong direction.

You didn't mention whether you had electrically tested the diode before replacing it. Since the ERLS fuse blew whenever the a/c clutch relay circuit was powered up, it would appear that the a/c compressor clutch spike-suppression diode was providing a short circuit bypassing the compressor clutch windings. Although it appeared blown apart, it would seem that your customer's electrical shenanigans damaged the diode in such a way that it allowed current flow at all times. So whenever the a/c clutch relay circuit was powered up, the diode provided a direct connection between ground and the a/c relay supply voltage. With no load in the circuit, the ERLS fuse had no choice but to blow. If it hadn't, the rest of the circuit would have melted down, too.

#### Tough Problem?

Write to Trouble Shooter, Motor Magazine, 645 Stewart Ave., Garden City, NY 11530. Or fax to 216-651-3016. Include your work number and email address.

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