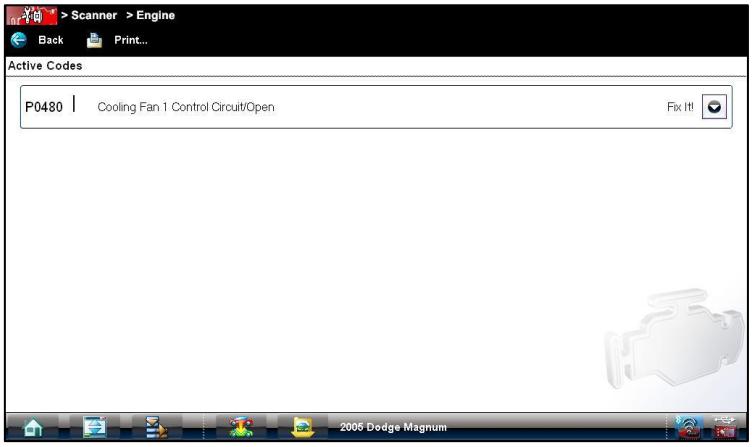
That's One Hot Magnum!



A 2005 Dodge Magnum with a 5.7L V8 came in with an overheating complaint. Normally you'd want to verify the condition before testing, but who wants to overheat the customer's engine on purpose? Luckily the PCM had a stored P0480 for an open cooling fan control circuit. It's important to note here that a code like this could indicate an open or a short. The code is for an open, but a short would blow a fuse and create an open circuit anyway.

The wiring diagram (at the end of this article) shows that 2 fuses are used to control the dual fan system. The diagram is a little hard to understand, but basically this Dodge uses a series/parallel fan design you'll occasionally see on other vehicles as well. At low speed, the 40 Amp fuse feeds both fans in series, so they both drop 6 Volts. Two relays are used for high speed operation to switch the fans from series to parallel, with the 50 Amp fuse feeding one fan and the 40 Amp fuse feeding the other. On this Magnum, the 40 Amp fuse was blown.

Why Simple Tests Won't Work

There are plenty of great strategies for finding a short without blowing lots of test fuses. A test light can be connected across the fuse cavities. With the key on the test light will illuminate if a short is present. An LED test light only flows about 40 mA, so this is a great way to find shorts without flowing too much current through the system. However, this blown fuse controlled a brushed DC motor. These types of motors are a dead-short at rest so the test light will always light up. You can also spin the fans by hand to see if they feel like they're mechanically binding (these fans both spun freely).

To get around the brushed-motor problem, a 40-Amp fuse was risked. However, it was installed using jumper leads to provide test access for current a probe, as shown to the left.

With the fuse and current probe in place, the Scan Tool was used to command fan operation KOEO. This is a great way to test the fans without risking engine overheating. The photo on the previous page shows that the current through the fans is 4.1 Amps on the current probe. The Scan Tool control doesn't say it, but it forces only low speed fan operation. Therefore, this is the current through both fans in series. Clearly there isn't a problem with the fans or circuits during this test.

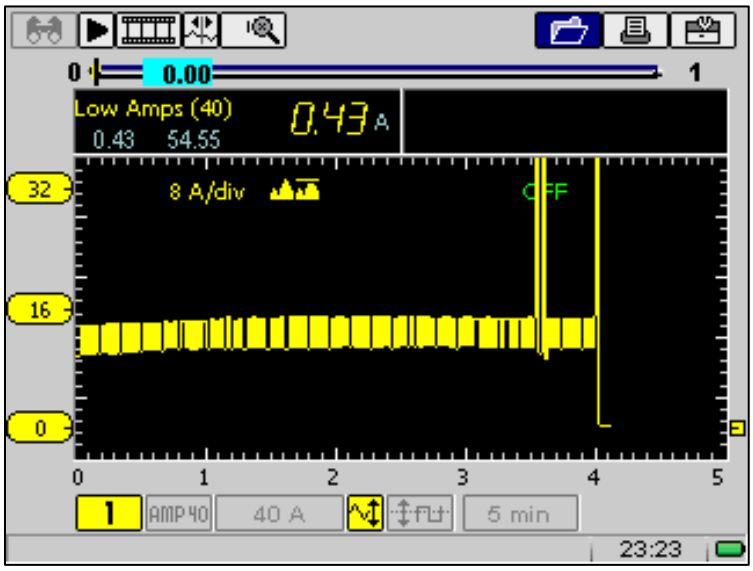
A Diagnostic Regroup

Since this isn't a hard fault, there are 3 options:

1) Return the vehicle to the customer with a new fuse and risk their anger when they melt their engine.
2) Monitor the current while manipulating harnesses and shifting (to check motor mounts) to flush out a short in the harness.
3) Monitor the current while waiting for the fan motors to heat up (many actuators only fail hot).

The first option isn't good for customer loyalty, so both of the other options were used. The first probe had a display for instantaneous readings, but for monitoring current over time, the technician selected the PDI 60 Amp probe and connected it to a Snap-on Vantage Pro. The screen was set to 5 minutes. While the fans were on and heating up, the harness was manipulated and the transmission was shifted repeatedly into all gears to stretch the harness.

The capture to the right shows that the current slowly ramped up during the first minute, which is typical of brushed motors. Then one of the fans either shorted or seized up momentarily at about 3.5 minutes, and then again at about 4 minutes. The current then went to 0 Amps because the 40 Amp test fuse blew. The MIN/MAX tracking on the Vantage shows that the peak current was 54.55 Amps during the fault.

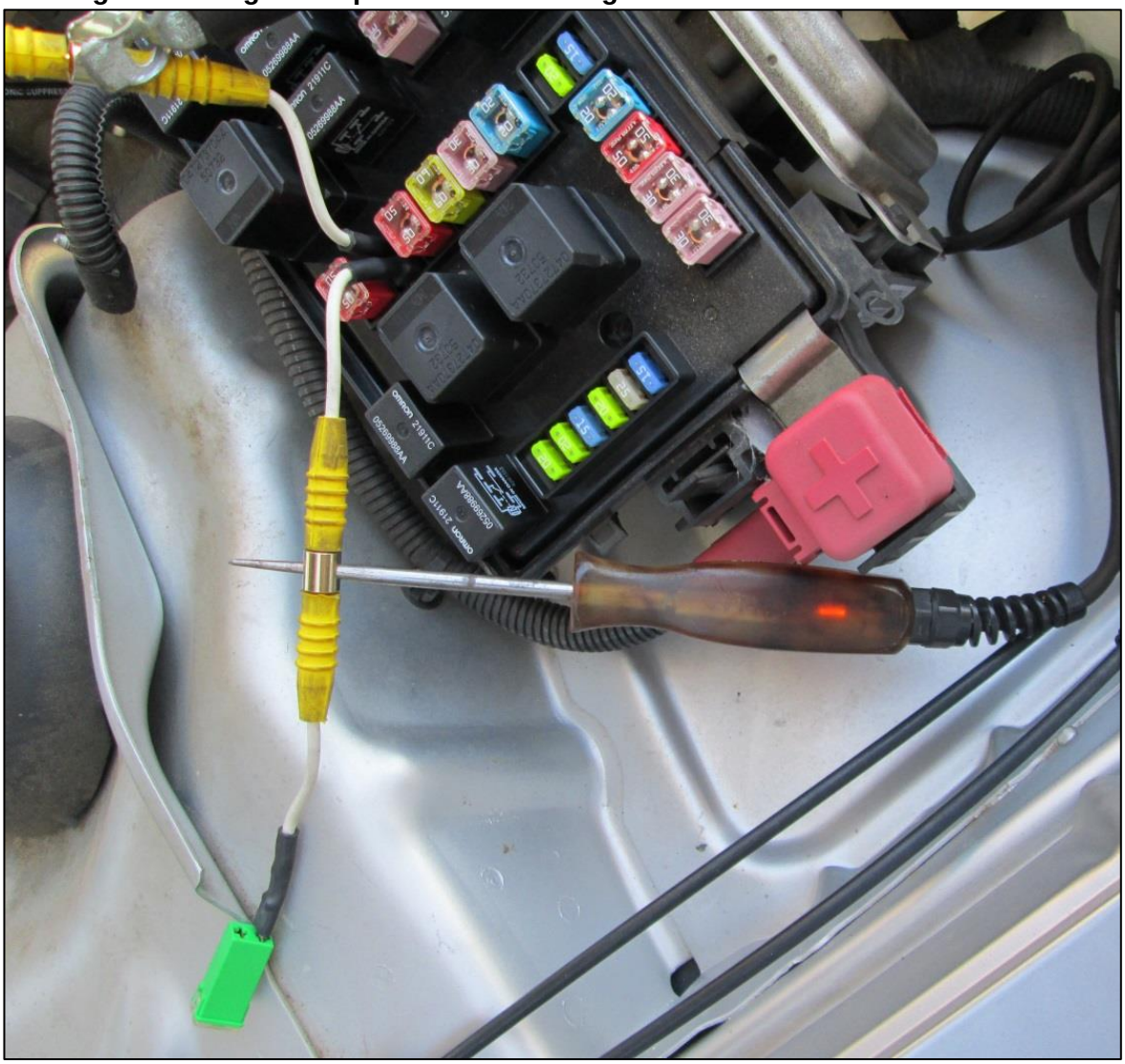


There's a Short, but Where?

It was clear at this point that there was a short, but it still hadn't been decided if the problem was in the harness or in one of the fan motors. Without an endless supply of fuses, you need to be strategic about isolating the fault. Speaking of isolating…

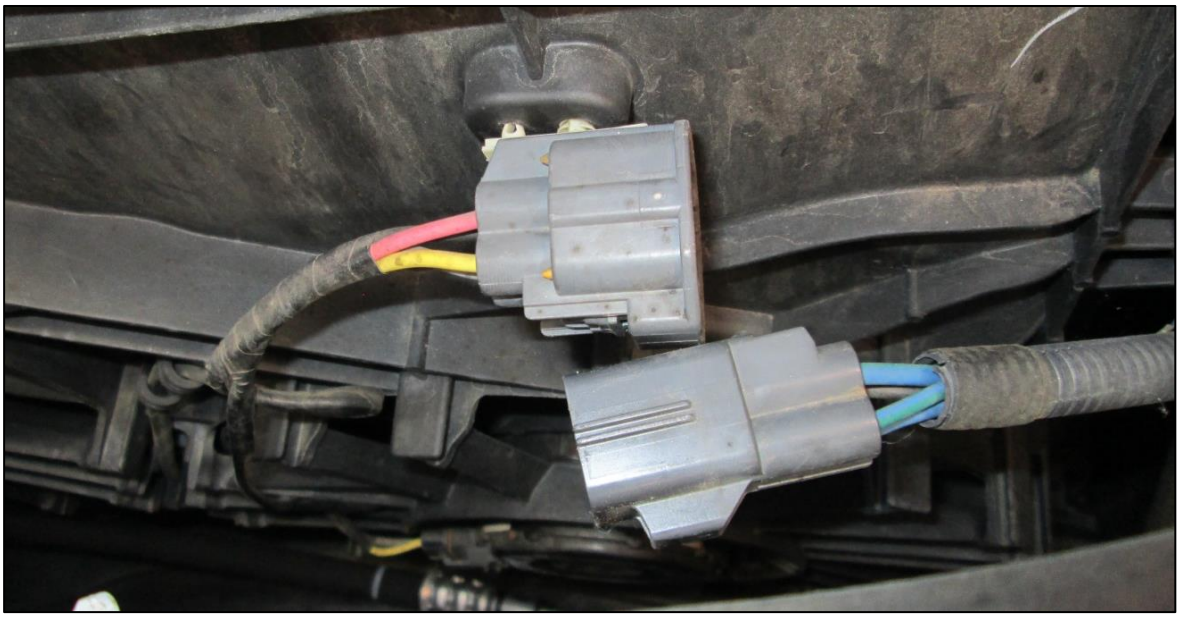
To decide between a circuit, left fan, or right fan short, the technician chose to isolate sections of the fan and control system. To set up this test, a test light was connected across the cavity from which the now-blown 40 Amp fuse was removed (as shown below). This connection effectively completes the circuit, but with only the 40 mA that flow through the test light. As stated before, brushed DC motors are a dead short at rest, so of course the test light illuminated.

Test Light Showing a Complete Circuit Through the Fans



The fan connector was disconnected (top photo on the next page) to see if the test light went out. The test light did go out, which indicated that there was not a short in the harness. These fans are available separately, so it was still important to determine which one shorted. Individual fan circuits share a connector, so it's difficult to isolate them one at a time. It's possible to use jumpers to complete the connection to one fan at a time. However, it takes time and requires the sacrifice of another 40 Amp fuse. Furthermore, the Scan Tool can only control these fans in series, so to test only one of them you'd also need to connect fused leads to directly power the suspect fan.

Fans Disconnected @ Shroud Connector



A Better Test

In this case, the technician had a Raytech infrared thermometer, which saved a lot of time (and a 40 Amp fuse). The idea is that if a fan is flowing too much current, then it's also getting very hot.

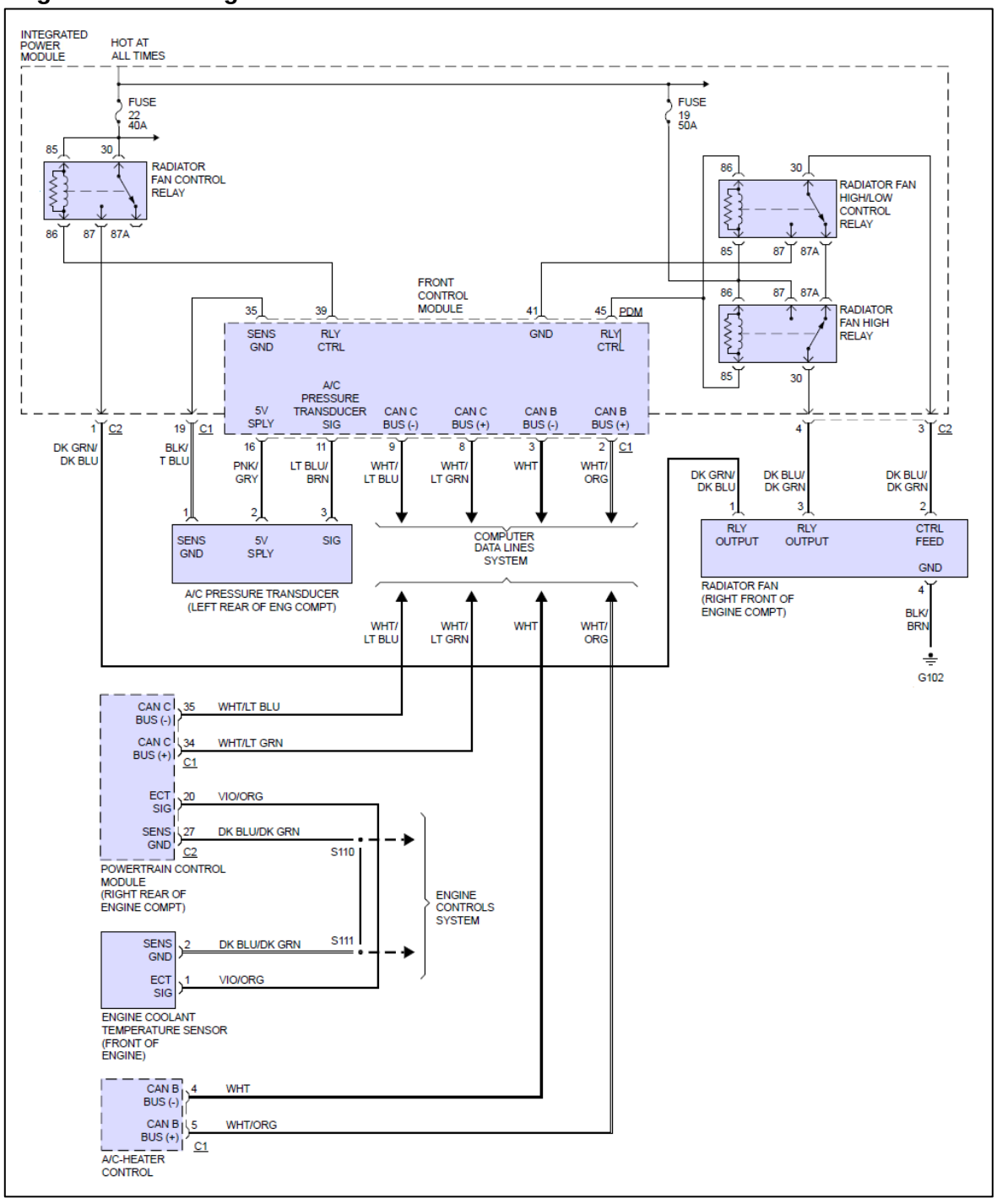
- The left fan was showed 104 ºF
- The right fan showed 234 ºF

The Fix!

The right fan was ordered and replaced, and the vehicle was returned to the customer. In the end, this wasn't a difficult diagnosis, but it's a great example of a faster way to zero in on the root cause without wasting a lot of time (or 40 Amp fuses). Using a graphing meter like the Vantage Pro and an infrared heat gun helped pinpoint the actual shorting condition, and then the offending fan motor. If the short had been in the harness, the infrared gun may have been useful in finding the exact location of the short, although in today's tightly packed engine compartments that's a hit-and-miss strategy.

On a side note, if the fans had run a significant amount of time without the fault showing up, the best strategy would have been to run them at high speed to stress them. Since the Scan Tool doesn't have the ability to force high speed operation, you can remove the FAN HIGH and FAN HIGH/LOW CONTROL relays and jumper cavities 30 and 87 at each socket. This puts the fans in parallel and uses both the 40 Amp and 50 Amp current paths. An alternative strategy is to ground the Front Control Module terminal 45, which should pull both relays to the terminal 87 position and accomplish the same thing. Both workarounds are only possible if you can trace a current path through a circuit, so that's a great skill to practice.

Magnum Fan Wiring – Trimmed to Fit



Courtesy of Mitchell1