FAULT CLASSIFICATION & TEST SELECTION

Resisted Short to Ground

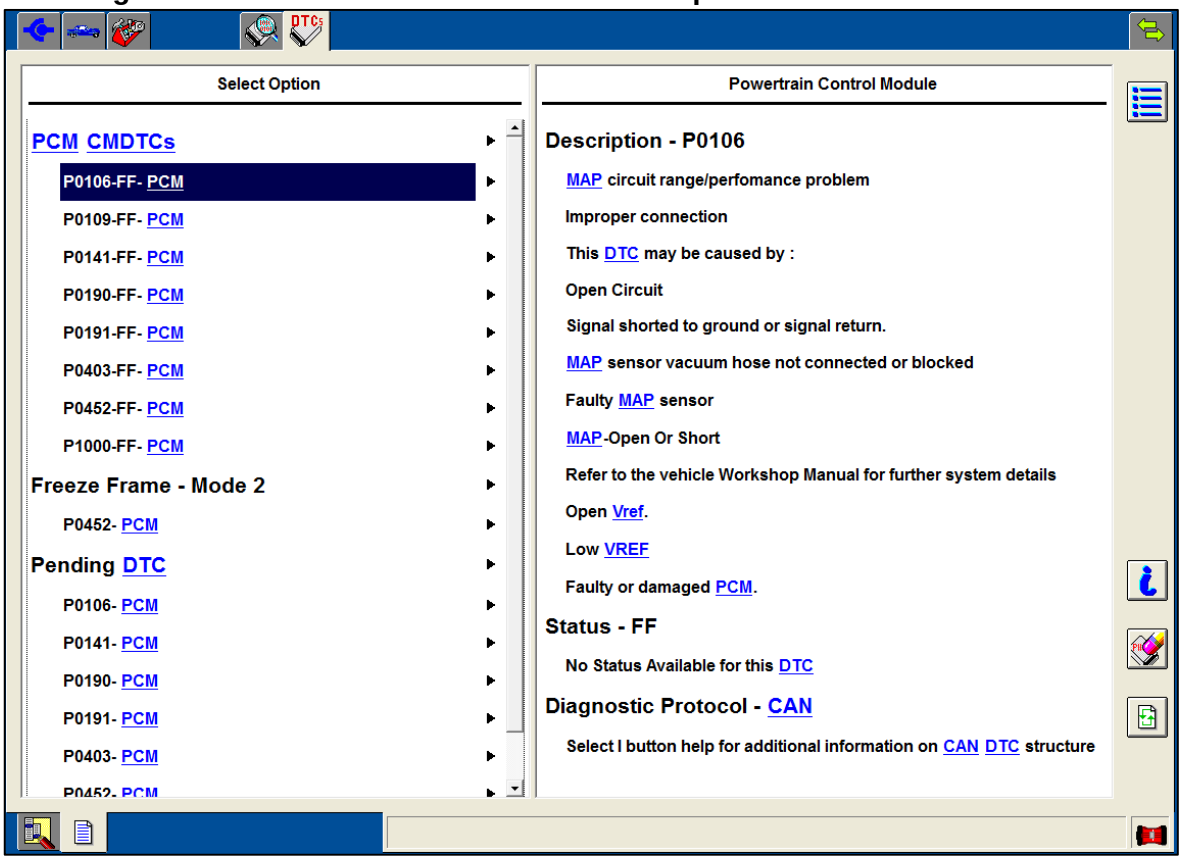
Ford Five Hundred No HVAC & Lack of Power

A 2005 Ford Five Hundred came in to a shop with complaints of no A/C system operation and low engine power. The technician noted low refrigerant high side pressure (Scan Tool PID), so the system was evacuated, leak checked, and recharged. When done, the A/C system still did not work and a similar low PID value was seen in the high side pressure PID. The system was again evacuated to change the sensor, and after recharging the PID was unchanged and the system still did not work.

A diagnostic technician was called in to take over, which resulted in the retrieval of the codes shown below. Besides the P0106 for MAP sensor range/performance, the following codes were found:

- **P0109:** MAP sensor intermittent
- **P0141:** HO_2S circuit malfunction (B1S2)
- **P0190:** Fuel Rail Pressure (FRP) sensor circuit malfunction
- **P0191:** Fuel Rail Pressure (FRP) sensor circuit performance
- **P0403:** EGR control circuit
- **P0452:** FTP sensor low voltage detected
- **P1000:** All Monitors not complete

Scanning All Modules – Ford IDS Scan Tool Example



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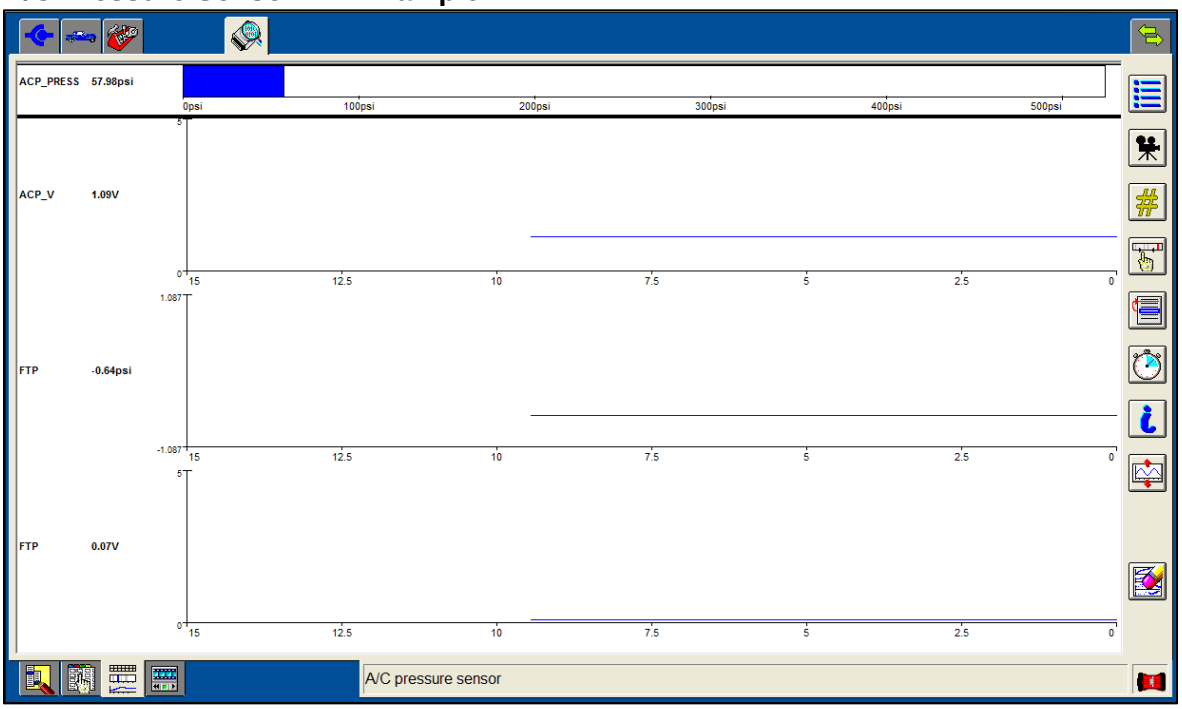
Since the first thing to do is verify that a fault is current, a quick check of a few PIDs indicated that there were unexpected values for the sensors related to most of the codes. In the example below, the A/C Pressure (ACP) sensor showed only 58 PSI (1.09 Volts), which is far less than the actual pressure shown during the recharge.

A/C Pressure Sensor PID Example



Fault Classification – Reference Voltage Short

The A/C pressure sensor PID showed a lower pressure than the actual system pressure. And thanks to the first technician's 2 mistakes, we really knew that the pressure was correct and that the pressure sensor was not the problem (because both the old and new showed the same low pressure).

And thanks to the many codes, it was easy to also check simple PIDs relating to other faults. For example, the FTP sensor showed -0.64 PSI. That FTP PID doesn't seem too far off at first, but the system is supposed to show a very narrow range of In H_2O, so PSI is a strange unit for Ford to have chosen. In fact, -0.64 PSI = -424 In H_2O! That's way more vacuum than the EVAP system is ever designed to be exposed to. The EGR position sensor (integrated into electric EGR) and the Fuel Rail Pressure (FRP) sensors also showed low values.

Key Point: ***Most of the codes could be explained by a 5 Volt reference or sensor ground fault, so these codes are very likely all related to the same root cause. Of course, sensor ground faults would cause higher sensor values, so that was also ruled out without any actual testing. This was classified as a short in reference voltage without a single circuit measurement!***

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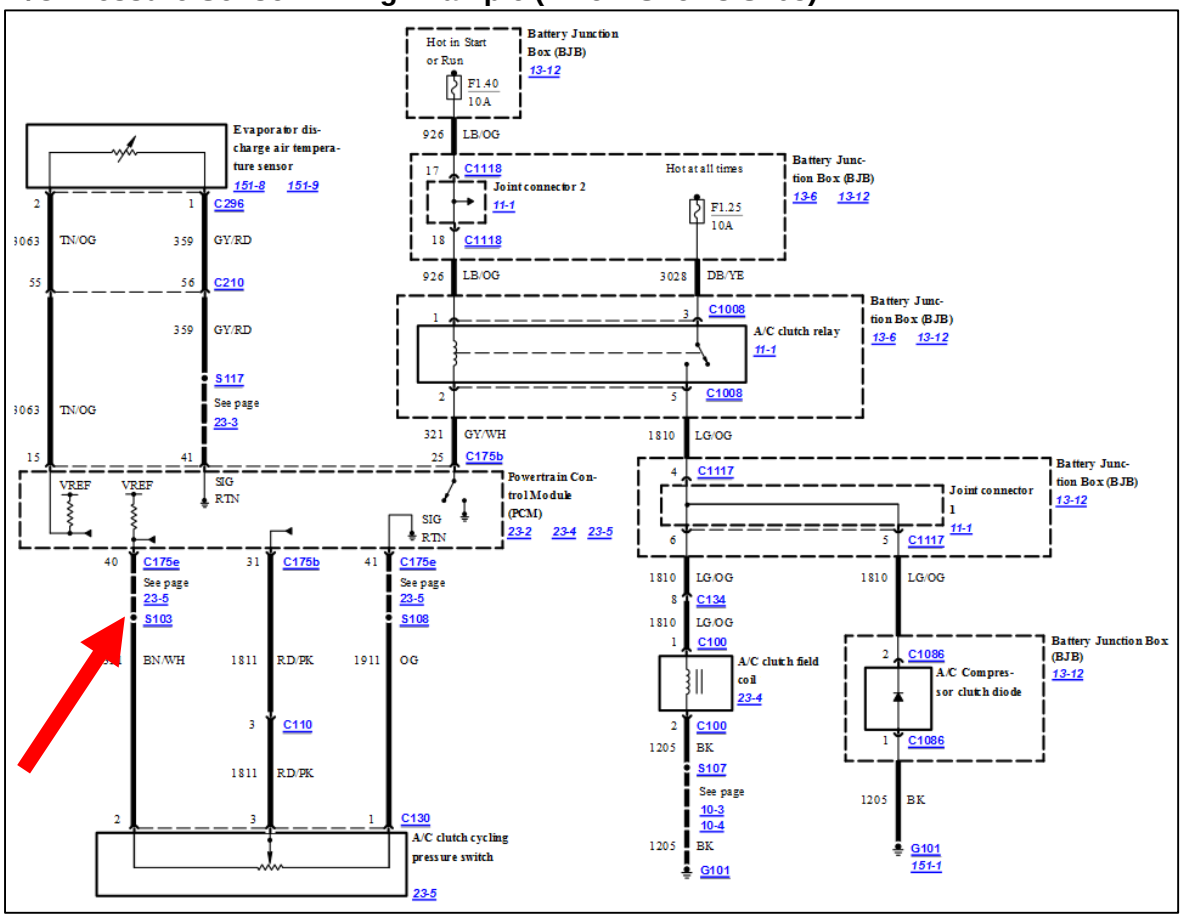
Time to test reference voltage. The wiring diagrams were checked to see if there was a splice or other junction that connected many or all of the 5 Volt circuits. S103 in the diagram below indicates that the VREF is shared with something else. Since the source of the VREF was the PCM, the PCM wiring diagrams were also checked to find the rest of the S103 circuits. The diagrams on the next page show that this same Brown/White wire powers the EGR valve (position sensor), A/C pressure sensor, and FRP sensor via S103.

The diagrams don't prove that this 5 Volt VREF circuit powers the MAP sensor or FTP sensor, which also have codes, but it's possible that all VREF circuits are connected inside of the PCM. During this diagnosis, we already had 3 codes relating to 3 sensors that absolutely shared a VREF circuit, so that's was a good place to start…

A/C Pressure Sensor Wiring Example (Arrow Shows S103)



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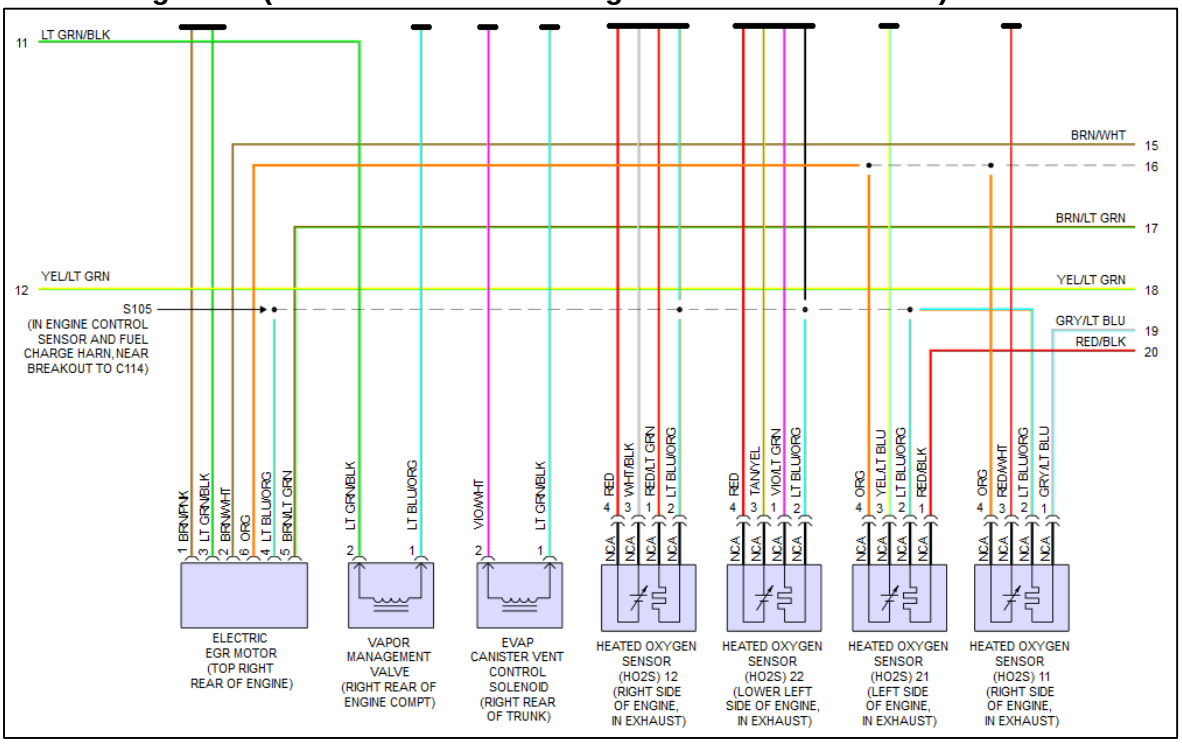
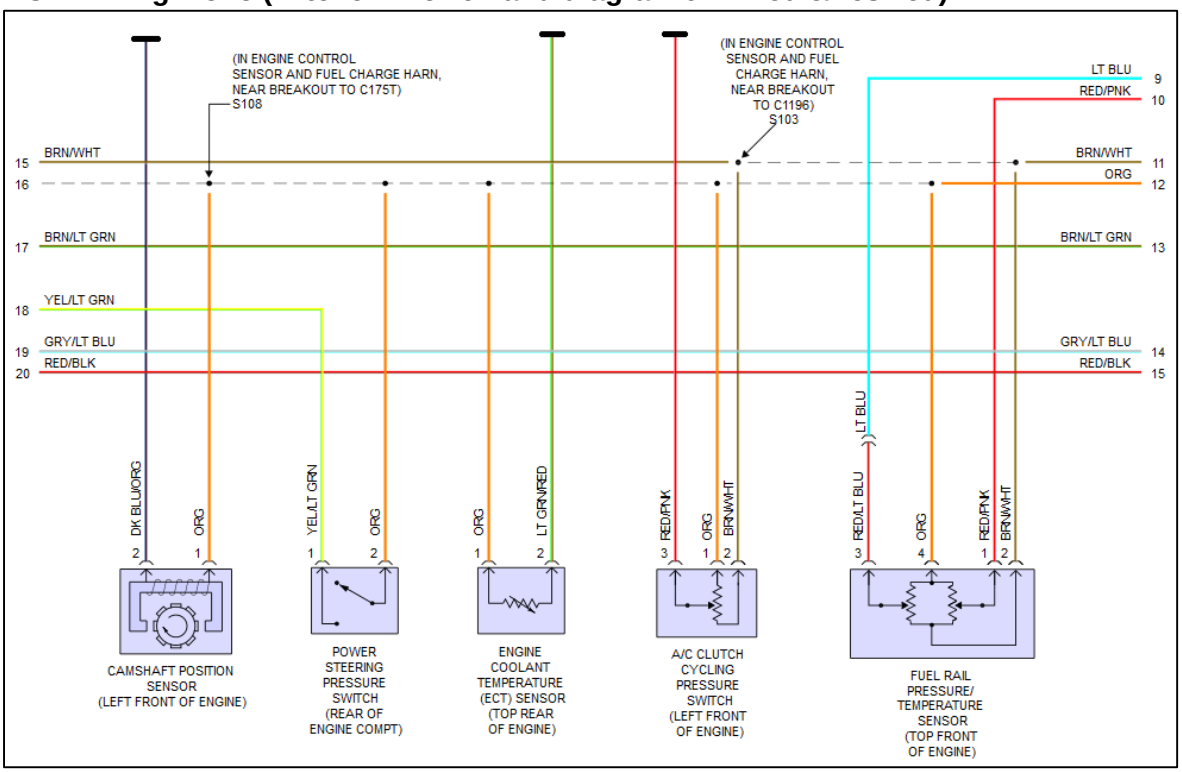
PCM Wiring 3 of 5 (Mitchell ProDemand diagram trimmed & resized)



PCM Wiring 4 of 5 (Mitchell ProDemand diagram trimmed & resized)



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The preceding diagrams show that the VREF circuits are parallel.

Testing VREF

The best test for VREF is to pick the easiest sensor to access and simply unplug it and measure VREF. The A/C pressure sensor was unplugged, and the VREF terminal showed 3.7 Volts instead of 5 Volts. With that 1.3 Volt error, all 5 Volt reference sensors would still be in range, but would return an incorrect value for the give conditions. With the DVOM still connected, the EGR valve connector and FRP sensor connector were disconnected. VREF remained at 3.7 Volts.

Now What?

The wiring diagrams do not indicate whether or not the VREF to other sensors is shared inside of the PCM. However, there were also codes for the FTP sensor and MAP sensor, so those sensors were disconnected too. There's no MAP sensor, but tracing the MAP terminal from the PCM indicated that it was integrated into the EGR assembly. When disconnected, the VREF at the A/C pressure sensor was still 3.7 Volts. Many FTP sensors are hard to access, and this is one of the worst – it's part of a plastic tube and can only be accessed with the fuel tank removed (or at least dropped a bit). With the fuel tank lowered, the FTP sensor and tube were 'flopped' over near the fuel pump access hole under the rear seat, and the sensor was back probed. No surprise…3.7 Volts.

Faulty VREF Test @ FTP Sensor Connector

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The FTP sensor was disconnected, and the VREF jumped to 5 Volts at the FTP connector as well as at the A/C pressure sensor and every other sensor tested. All other sensors were reconnected, and all sensor signal PIDs (including A/C pressure) returned to normal. The FTP sensor was replaced and the vehicle was returned to the customer.

Conclusion

This diagnosis correctly classified the fault as a short in VREF circuit. Diagrams showed the VREF circuits to be in parallel, and while they didn't prove that all VREF circuits in the PCM were shared, the codes made the connections for us. Since VREF wasn't pulled all the way to ground, it was more likely a sensor fault than a wiring fault, but the best tools and tests were the same: Use a DVOM to measure VREF while disconnecting components and harnesses that share it, starting with the most accessible sensors. While the eventual repair included dropping the tank, the diagnostic process worked, so the tank R&R could be sold as a solution, and not an unbillable guess.

Key Point: ***Efficient diagnostics often involves testing circuits or components that don't seem directly related to the symptoms or codes. In this case there was a code for the FTP sensor, but the original technician had gotten distracted by the only two complaints of no A/C operation and low power. Only by finding the relationships between codes could the proper diagnostic path be found.***

VREF Restored!