Clickin' Vickie

Odd noises come from under the hood with the key switched off.

When the 4.6L first appeared under the hood of brand new Crown Victorias back in 1992 (Town Car got it a year earlier), those of us who pounded the concrete and pulled steel in Ford dealership service departments expected a host of new problems. You know, those weak links in the chain that the engineers didn't catch before they released the new platform?

Puddn' - Where the Proof Is

VEHICLE
1998 Ford Crown Victoria

MILEAGE
201,200 miles

ENGINE
4.6L Engine, 4R70W Transmission

COMPLAINT
A clicking noise in the engine compartment was heard when the key was in the OFF position.

We had seen an awful lot of newly designed power plants, and they seldom disappointed us on that front. But as I remember, it was a long time before we saw a 4.6L come through the shop in need of any significant repairs, overhead cam notwithstanding. A multitude of those units have more than 200,000 miles on their clocks, worth more than a few trips around the planet.

This big car had a frame as heavy as a full-size pickup, and with the 4.6L spinning its torque through the tried-and-true automatic over-drive (AOD) transmission, the Crown Victoria lived up to and surpassed the hopes of police agencies and taxi companies everywhere.

There were, however, some weak links in the engine controls — differential pressure feedback EGR (DPFE) sensors were a hot item for years, and the exhaust gas recirculation (EGR) passages on the 4.6L were some of the most clog-prone in the industry. But they weren't hard to clean, and the job paid well.

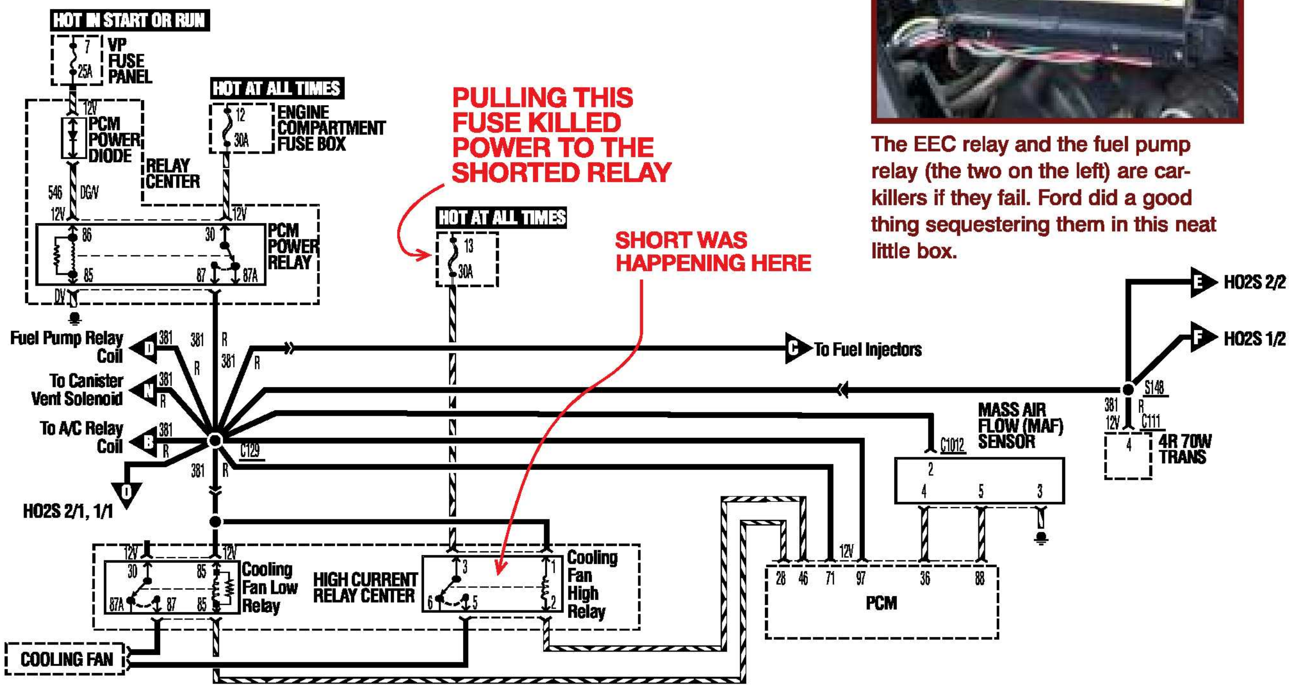
No 4.6L ever had a distributor, and in my mind, that was a good thing. But the early spark plug wires Ford used on this platform were prone to spark punch-through that resulted in annoying misfires. We made good money replacing those wires for a while.

The electronic direct ignition system (EDIS) with its smart little stand-alone module lasted one year past the on-board diagnostics (OBDI) compliant EEC IV system. Crown Vics went OBDII in 1995, which was the only year that EDIS and OBDII were married on Crown Vics. Those models and their Town Car coun-

This housing protects high-current relays for the EEC, fuel pump and A/C. The PCM ground is visible on the inner fender.

All photos and graphics: Richard McCuistian

The EEC relay and the fuel pump relay (the two on the left) are car-killers if they fail. Ford did a good thing sequestering them in this neat little box.



The Cooling Fan High Relay was internally shorted, a condition that back-fed 12 volts to the EEC circuit, which powers everything. It wasn't a connection sufficient to carry all the loads usually handled by the EEC relay, so whenever the PCM attempted to come online (pins 71 and 97 feed EEC power to the PCM), the voltage would drop across the imperfect connection in the relay and the PCM would shut down, causing the cyclic condition I was seeing on the scope. It was sort of like a really elaborate turn signal flasher.

terparts sometimes developed odd little under-load engine misfires on random cylinders that nobody anywhere knew how to fix. The Ford hotline tech finally admitted that to me after I fiddled with one for about a week.

It's beyond dispute that Crown Vics are tough; when I travel to a large city like Chicago, Orlando or Indianapolis, I see a lot of taxicabs. To their credit, taxi companies know which cars will last the longest while needing the least amount of unscheduled maintenance. And if Toyotas and Hondas are the best vehicles, why are the vast majority of taxicabs and police cars Crown Victorias?

Don't get me wrong here; I don't have a vendetta against our Asian buddies. They make some really fine cars, but the proof's in the pudding, so to speak.

This month's Motor Age Garage focuses on a Crown Vic that happens to be one of my very best friends. Every faculty and staff member on our campus uses it. I've maintained it for the past seven years, and it has never complained — until recently. This one is a zinger with a capital Z.

Mysterious Noises

Each member of our staff who drives this old blue Crown Vic has to log their miles and make note of any abnormal conditions. One of my supervisors wrote on the form that she heard a humming noise after switching the key to the OFF position, but that the noise had stopped after she re-cycled the key. I read the ticket and dialed her four-digit extension.

"Was the humming coming from the rear?" I asked her, because I figured the fuel pump relay contacts might be intermittently sticking.

"No," she told me. "This noise was coming from the front, but it stopped when I switched the key on and then off again." That shot the fuel pump theory in the foot.

The car needed an oil change anyway (I make sure it gets one every 3,000 miles), so I secured the key from the dispatcher and put the car on one of my lifts to change the oil.

The first thing I noticed was a noise coming from the engine compartment — nothing that even remotely resembled a hum. This noise was a distinct cyclic clicking at the rate of about 4 hertz (cycles per second). The clicking was as regular as clockwork and only happened with the key OFF.

It could be a typical computer glitch, what with the clocks and stuff in that silver box we call the powertrain control module (PCM). I went right to work on finding the source of the clicking, which turned out to be the fuel pump relay (sequestered in a special weatherproof box with two other relays near the master cylinder). But why was the PCM flipping the fuel pump relay off and on?

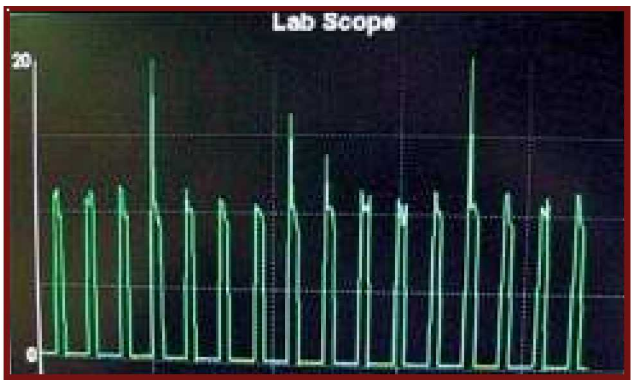
I've seen bad PCMs do that kind of thing. Some readers might remember the bad PCM in my "Under the Shade Tree" story about a 1991 F-150 that was buzzing a lot of solenoids and backfiring the coil via a renegade signal on the profile ignition pickup (PIP) line. Was this a ground problem, too? I checked the battery ground cable connection at the engine block and the PCM ground on the fender near the master cylinder, but everything looked fine there. It was time to peek in the Parameter IDs (PID) window for clues.

With the New Generation STAR (NGS) tool plugged in and diagnostic trouble codes (DTCs) checked (the clicking always stopped with the key switched on), I found nothing save a P1288 trouble code telling me the cylinder head temperature (CHT) sensor had at some point recorded a reading that was too hot. But a peek into the data stream showed me a normal reading for the CHT — about 3.6 volts.

Incidentally, if you nose around in the PIDs and select the Engine Coolant Temp (ECT) sensor, you might be startled by an ECT reading of 4.6 volts (-40 degrees). But the Crown Victoria's PCM doesn't use the ECT sensor — it relies on CHT.

Well, the CHT memory code derailed my scan tool; I should have done a Key On Engine Off (KOEO) test. However, I got sidetracked when I decided to check the coolant, which was, it turned out, mysteriously low. But there was no coolant in the oil and nothing leaking on the ground. Perhaps it was an intake or head gasket leaking? The plastic intake on these cars is a legendary leaker, but I saw no evidence of that in this case. If coolant was migrating through the chambers and out the exhaust pipe, how fast was it happening?

With the breakout box connected, I moved from pin to pin, observing the oscilloscope as it drew the pattern.



Using the breakout box, I found 30 different pins on the PCM that were giving different variations of this signal. Of the 104 pins on this control unit, only 80 are used.

When I pulled this fuse, the clicking stopped. The schematic led me from this fuse to the High Current Fan Relay, which, by this time, I could smell.

This was troubling. I added about a gallon of coolant and made a mental note that I needed to keep track of the coolant level over the next few days, if I could get the car to sit still long enough for me to pop the hood. I ran the engine for a little while and monitored the CHT, but didn't see any alarming numbers and no compression in the coolant. I switched the key off. There was that ticking again.

Ticking Like A Bomb

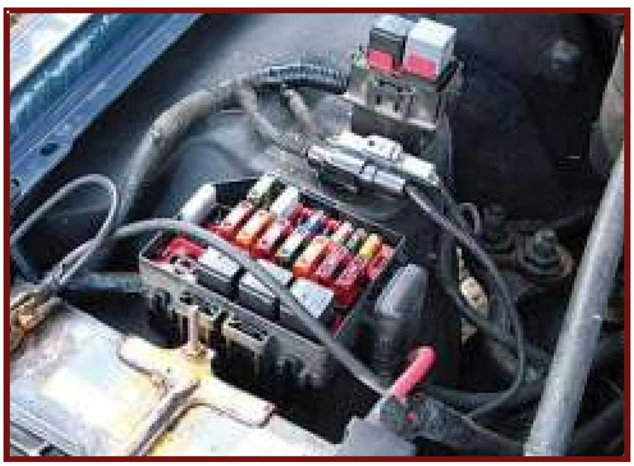
The ticking of the relays had slowed to about half its original cadence, which was another interesting development that sent me scurrying for my Snap-On/Sun Dynamic Data Collector (DDC). As I brought the DDC online and checked to see which cable the Crown Vic would require, I found that the Ford PCM adapter I had was not the right one, and I opted for the breakout box. I'd check this baby one pin at a time and find out what was going on.

With my Interro PDA scope tracing across a flat panel monitor, I checked each pin and found 30 of them (mostly outputs) showing various different signals that all seemed to correspond with the clicking. And it was a study in cadence — perfect rhythm. I should have taken the time to sort out the pins and separate inputs from outputs, then analyze the data to determine which input was causing the screwball signals. But I was under the gun and on a tight schedule.

The result was that I found myself gathering data too fast and with too little time to sort it out, so I managed to plug in another PCM my parts supplier had on hand only to find that the clicking was still there. It wasn't surprising, but it wasn't a good feeling either. Oh well. How many times have you felt that sinking feeling?

As I reflected on my scope readings and the pins at which I had taken those readings, I realized that pins 71 and 97 (power to the PCM from the EEC power relay) were showing some unusual voltage activity that would explain why all the other pins were so lively. Now it was time to get serious.

(LEFT) I smelled this before I actually saw it, because the cover hid the damage. My temperature gun measured the relay at a blistering 230 degrees and climbing. The internal short was feeding power from the common circuit on the relay back through the coil, which, in turn, fed back through the EEC circuit to the PCM and all the PCM-controlled solenoids on the same circuit. It was enough voltage to wake up the PCM, but the voltage dropped as soon as the fuel pump ran. This caused the cyclic ticking noise. (RIGHT) Here's the relay without its gray shell. Notice the scorching between the heavy primary terminal and the coil.



Here's the location of the high current relay center with the new relay installed after it came in. I took this photo 2,000 miles later, and when I checked the coolant level, it was full. I have no idea why the coolant went low previously.

The Plot Thickens

Moving to the underhood fuse panel Ford calls the Power Distribution Box (PDC), I began snatching fuses until the clicking stopped. While I was in that general area, I noticed a burning smell. About eight inches behind the PDC is a high current relay center whose only function is to operate the cooling fans. There are two relays in this lithe box, and as I removed the cover, I saw the heavy-duty relay that drives the high-speed fan was totally destroyed. The fuse I had pulled was the one that supplies this relay with power. So how did that factor into the clicking? Here we go.

When the key is switched to the ON position, the EEC power relay wakes up and fires a good strong 12 volts out to pins 71 and 97 on the PCM, which then wakes up and turns on the fuel pump relay. The hot side of every relay and solenoid operated by the PCM (except the ignition coils) is energized by the EEC relay via a red wire. That includes all the transmission solenoids, the fuel injectors, the Idle Air Control, the fuel pump relay coil and a host of other PCM controlled actuators.

The red wire that originates at the EEC power relay feeds both fan relays. The burned up high-speed fan relay was internally shorted, feeding just enough voltage to the PCM to awaken it. However, when the PCM tried to bring the fuel pump online, the resulting current load was more than the poor connection in the shorted relay could handle. The short circuit in the relay would drop voltage and the PCM would shut down, dropping the fuel pump relay in the process. At this point, the voltage would return and the same thing would happen again. My temperature gun showed that the high-speed fan relay was roasting at 223 degrees.

Conclusions

So what burned up the fan relay? Well, it was a combination of things. First, the relay had more than 200,000 miles on it. Second, the engine was low on coolant and the CHT reading caused the PCM to run the fan on high for a long time. It appears to have saved the engine, but the relay was a casualty.

I'm still watching for the coolant to go low again; haven't seen it yet and don't know how long it'll be before I do. As it was, I replaced the relay and its socket, and our trusty old Crown Vic is back in the wind.

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MOTOR AGE GARAGE TEST 528 6/2008

"Clickin' Vickie"

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Have you ever taken a *Motor Age* Garage test prior to this one? ☐ Yes ☐ No

1. The ignition coils on a Ford are powered by:
A. the ignition switch. **B.** the EEC Power Relay. **C.** the ASD Relay. **D.** the Fuel Pump Relay.

2. The PCM on a late '90s Crown Victoria has how many pins?
A. 104 **B.** 160 **C.** 60 **D.** 120

3. In an OBDII Data Link Connector, pin 16 is B+ power. Which pin(s) provide ground?
A. 1 **B.** 2 and 5 **C.** 4 and 5 **D.** 3

4. Technician A says the evaporative emissions system canister purge valve on OBDII vehicles only operates when the EGR is flowing. Technician B says the canister purge system can cause rough or irregular idle problems if the fuel tank has been overfilled. Who is correct?
A. Tech A **B.** Tech B **C.** Both **D.** Neither

5. A vehicle (like the ASE L1 composite vehicle) comes in on the hook, has no fuel pressure, no injector pulse, no spark and there is no reference voltage available at the TP sensor connector. Technician A says the PCM must be replaced before further diagnosis can be performed. Technician B says a single faulty sensor might be causing this condition. Who is correct?
A. Tech A **B.** Tech B **C.** Both **D.** Neither

6. Which one of the following components provides an input to the PCM?
A. Idle Air Control Valve **B.** Coolant Fan Relays **C.** Service Engine Soon MIL **D.** Vehicle Speed Sensor

7. Which of the following did OBDI regulations require after 1988?
A. A misfire monitor **B.** An oxygen sensor **C.** A dash-mounted warning light **D.** None of the above

8. A friend of yours tells you that the interior lights on his second car, a 1998 Mercury Sable, were inadvertently left on for two full weeks and that the battery, which was practically new, went completely dead. He says that he removed the battery and trickle charged it for a whole day. When he reconnected the battery, there was a spark at the terminals, and then the car wouldn't start and the starter sounded strange, so he bought a replacement battery. With the new battery installed, the engine cranks over normally, but it won't start and a local shop is telling him he needs an ECM, a fuel gauge, a GEM module and possibly an alternator. What do you think happened?
A. The interior light current drain overheated the ignition module and the ECM.
B. He charged the battery backwards.
C. The starter has a very serious intermittent short.
D. The wire harness has deteriorated and needs to be replaced.

9. A lean O_2 signal will cause fuel trim readings to:
A. Increase. **B.** Decrease **C.** Default **D.** None of the above

10. Technician A says a catalyst-damaging misfire is referred to as a Type B and is an event where the percentage of misfire within a 200-rpm sample has exceeded the programmed threshold. Technician B says most oxygen sensors generate their own voltage. Who is correct?
A. Tech A **B.** Tech B **C.** Both **D.** Neither

THIS SHEET WILL NOT BE PROCESSED FOR SCORING IF RECEIVED AFTER AUGUST 1, 2008.