Dorman Training Center Presents

"Computer Diagnosis" Part 2: Applying Logic Diagnosing DTCs

L & L | 2026

Your Instructor For This Class

- National Trainer, ASE World Class, Master Auto, Truck, School Bus, L1, L3, CNG
- ATTP Master Instructor, New York State, CT and New Jersey
- STS (Service Technician Society) 2003 President
- TST (Technicians Service Training) Founder and President
- Author / Co Author/ Technical adviser on 25 plus books including
- OBD II and Mode 6, and Understanding and Diagnosing Hybrid Vehicles
- Published articles for multiple newsletters, and magazines
- Picked as one of the Top Instructors in the country by EPA & SAE
- Numerous Radio, TV, Internet, and SAE Video appearances
- PTEN, Motor Age and TST Webcast Instructor - Dorman Training Director
- Motor Magazine Top 20 award winner
- Provider of OBD II Training for 14 states, Ontario Canada and the US EPA
- Guest speaker at SAE Congress, IM Solutions and Clean Air Conference

"G" Jerry Truglia

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What Will Be Covered

Instructions for this seminar:

- **This seminar will be approximately 1+ hour long**
- **All slides that are presented are in your handout and are numbered**
- **Have a pen or pencil and paper for notes**
- **Questions can be asked at anytime**

- **Sensors**
- **Checking Sensors & Graphing**
- **Checking Actuators & Graphing**
- **Bi-directional Control**
- **Case Studies**

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Sensors

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Sensors

Sensors do two things: they generate a voltage signal, or they modify a voltage they receive from the computer. Voltage levels represent different vehicle operating conditions.

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Sensors

The most important sensors:

1. **Engine Speed (rpm)**
2. **Temperature of engine coolant, intake air and battery in some cases**
3. **Engine load - MAP or MAF sensor**
4. **Throttle Position/Accelerator Pedal Position**
5. **Oxygen Sensor/Air Fuel Sensor**

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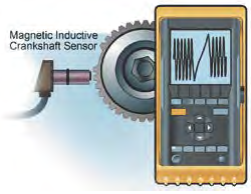
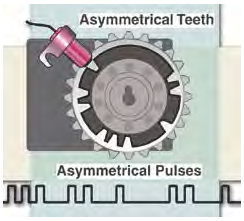
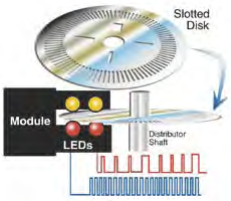
Engine Speed Sensor

The engine speed sensor is the single most important signal input. Without engine speed information, the computer doesn't know how often to fire the spark plugs or squirt the fuel injectors. The engine will not run.

Crank = ?
Cam = ?







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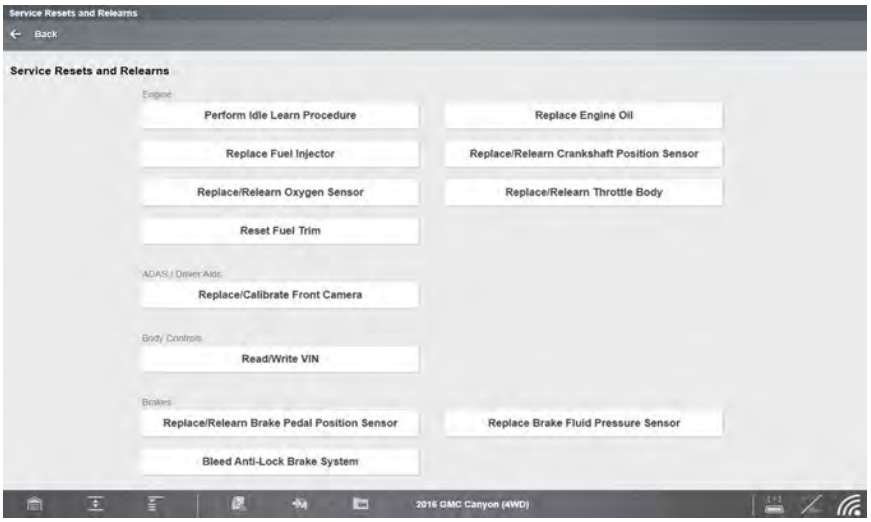
Resets & Relearns



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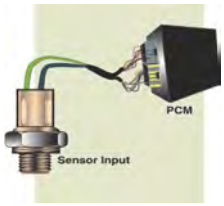
Temperature Sensors - ECT

Temperature sensors and sensor circuits can fail electrically. When they do, they usually store a trouble code in the computer and turn on the dashboard warning light.



Dual Range Temperature Chart

Temperature ° F	Resistance	Voltage
-40° F	100,700Ω	5.00 V
+33° F	9,600Ω	3.50 V
+57° F	4095Ω	2.70 V
+78° F	2,975Ω	2.00 V
+100° F	1,800Ω	1.50 V
+120° F	1350Ω	3.85 V
+143° F	835Ω	3.20. V
+163° F	432Ω	2.75 V
+186° F	305Ω	2.15 V
+210° F	185Ω	1.70 V
+234° F	60Ω	1.25 V

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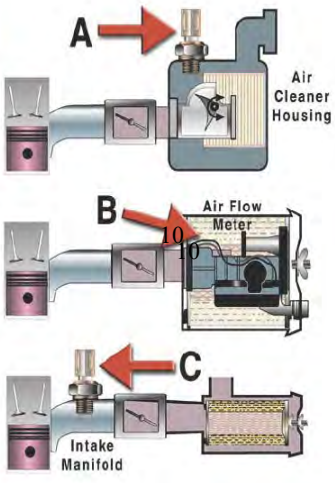
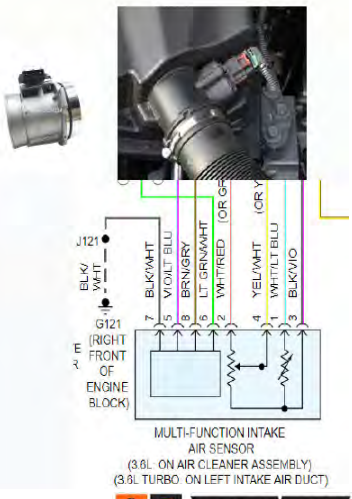
Temperature Sensors - IAT

IAT information is factored into PCM fuel calculations: air density depends in part on air temperature (air pressure is also important as we'll see shortly). Since air density affects the oxygen in a given volume of air, the powertrain uses the IAT input to help it adjust fuel delivery to maintain a target air/fuel ratio.





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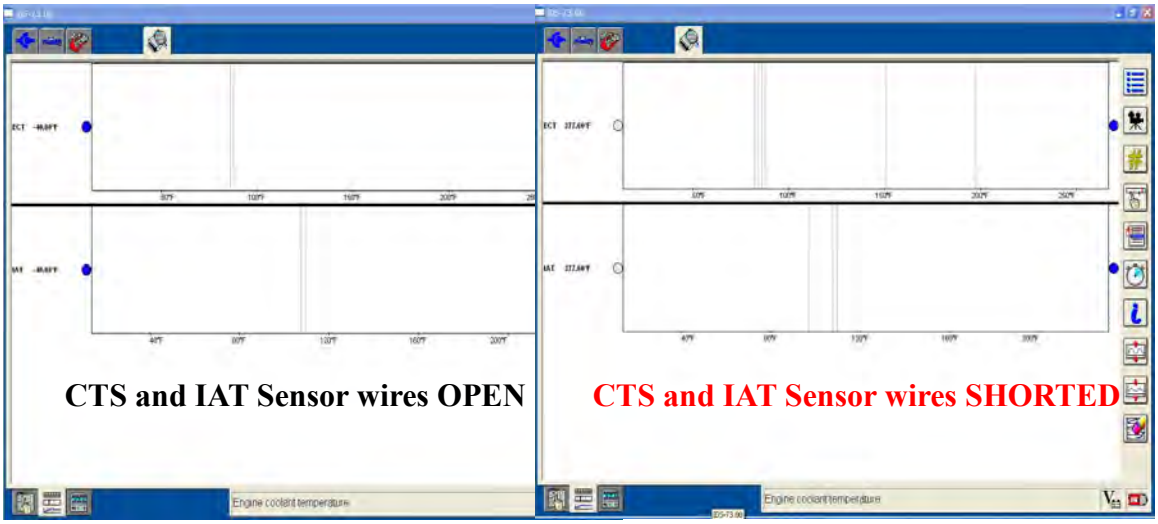
Time Out Real World CTA & IAT Testing



CTS and IAT Sensor wires OPEN

CTS and IAT Sensor wires SHORTED

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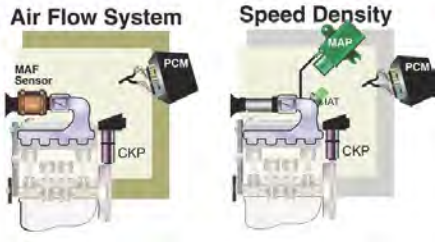
Engine Load & Air Flow Sensors

There are two ways to determine available oxygen:

- **Measure the volume or mass of the air as it enters the engine. This process is used in Air Flow fuel control systems.**
- **Measure the air pressure inside the intake manifold and calculate the amount of oxygen available, based on engine size, speed, efficiency, and the temperature of the air in the manifold. This method is used in Speed/Density fuel control systems.**



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Sensors

Manifold Absolute Pressure Sensor - MAP

- **Measure's engine manifold vacuum**
- **Produces an analog DC voltage or digital**
- **Hertz signal indicating engine load**
- **Input used for line pressure control (replaces TV cable or vacuum modulator)**

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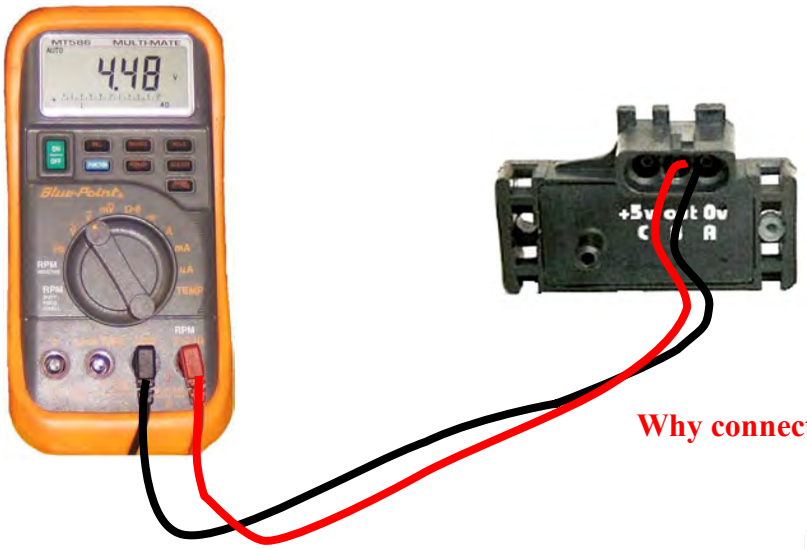
Checking A MAP Sensor



Why connect the meter like this?

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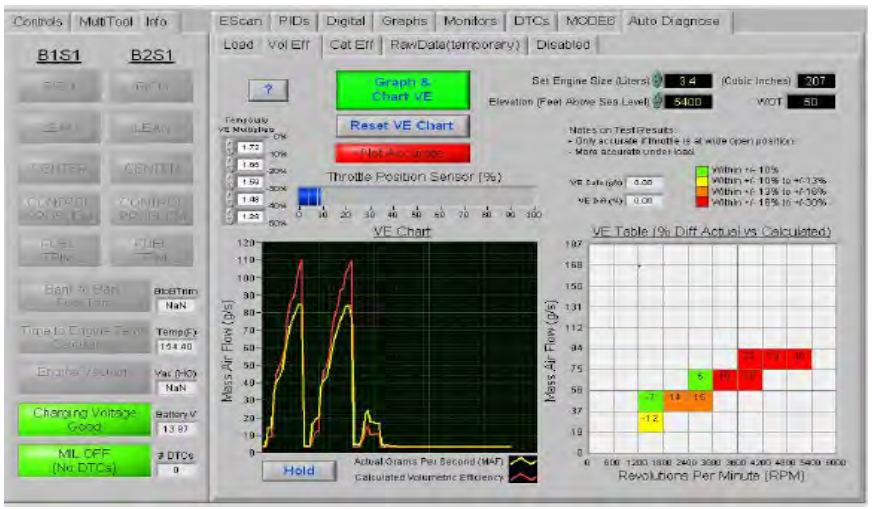
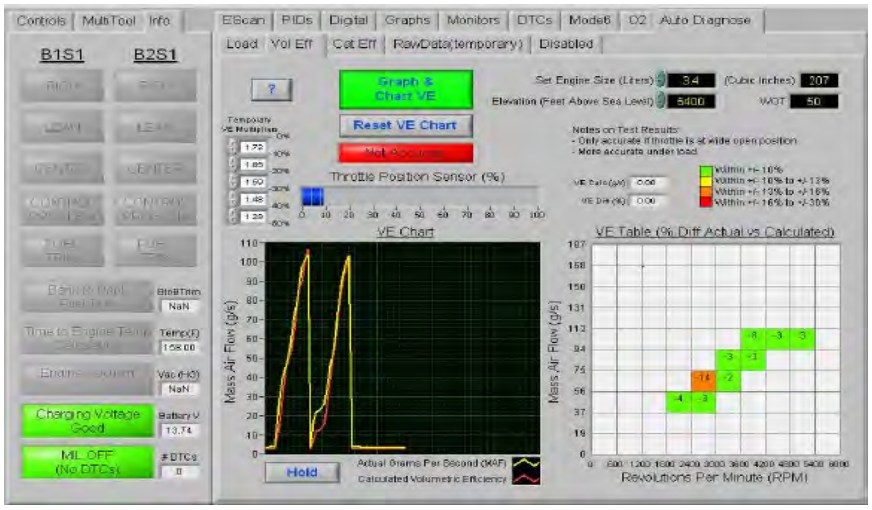
Mass Air Flow Sensors & Volumetric Efficiency



Mass Air Flow Sensors & Volumetric Efficiency



Throttle Position Sensor

Throttle Position Sensor - TPS

- **Measures throttle lever position**
- **Produces an analog DC voltage indicating engine load**
- **Input used for line pressure control for the transmission (replaces throttle cable or vacuum modulator)**

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Checking An APPS Sensor

The Accelerator Pedal Position Sensor (APP) is a drive-by-wire system that has replaced a mechanical connection from the gas pedal to the throttle plate. The sensor outputs a redundant signal at different voltage levels.

APP 1 Sensor 0.98 off to 4.25 full throttle
APP2 Sensor 0.49 off to 2.14 full throttle

Example on GM - Always refer to OE specifications

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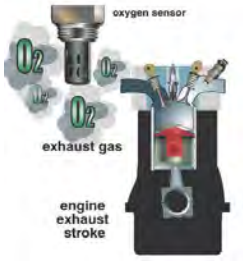
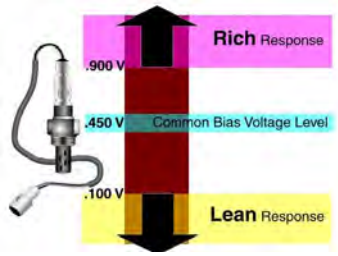
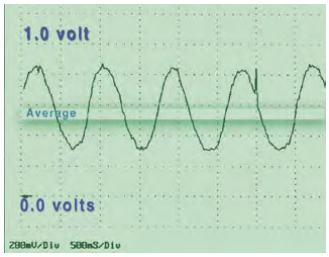
HO2S Oxygen Sensor

The HO2S senses the amount of oxygen in the exhaust that is used in the combustion process. Less oxygen in the exhaust results in a signal voltage over 450mv (RICH CONDITION), more oxygen in the exhaust results in a signal voltage under 450mv (LEAN CONDITION).







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Air Fuel / Wide Range

- **Generic / Global scan tools may not display the true voltage.**
- **OBD II standards requiring O2 sensor PID voltage to be displayed in a range between zero and 1 volt.**
- **Instead, what you'll see is a *percentage* of true voltage. To display the *actual* PCM PID voltage, you'll need a scan tool with enhanced/factory software.**

It's pretty tough to accurately display voltage levels that start at 3.3 volts using a 0-1 volt scale. Some scan tools may display a Toyota 3.3 voltage at approximately 0.685 volts.

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KS & VSS Sensors

KS (Knock Sensor) consists of a piezoelectric element attached to the cylinder block to detect engine knocking conditions. Knocking in the cylinder block is converted to an AC varying voltage signal which is sent to the PCM and used for timing adjustment.

VSS (Vehicle Speed Sensor) is an AC or DC voltage depending on the sensor installed. This sensor informs the PCM of the rate of acceleration and how fast the vehicle is moving. VSS is a major input to the TCM (Transmission Controller Computer).

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Actuators

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Actuators

Fuel injectors

The modern fuel injector is a solenoid-operated fuel metering valve.

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Actuators

Coil-on-Plug ignitions have one coil per plug. The coil is connected directly to the plug, eliminating the secondary ignition cable entirely. Each coil is individually triggered by the main powertrain computer.

The coil power transistor may be integral or located inside the PCM or in a separate ignition module.

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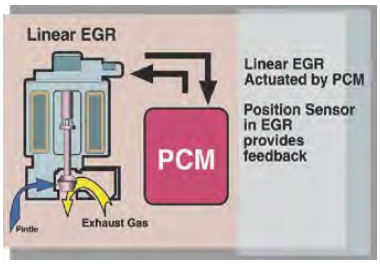
Actuators

EGR

Exhaust Linear EGR valves are operated by a small electrical stepper motor that drives the EGR pintle open and closed on command from the PCM.

The valve also contains a position sensor that signals a change in pintle position as the valve operates.



What should the position sensor read at idle?

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Actuators

Variable Intake Runner Control

P0171 / P0174 (Lean Codes)

Vacuum leaks at the shaft

- **Honda - Toyota (pictured) and other intakes**
- **Smoke testing works well most of the time. If a leak cannot be located due to excessive oil or fuel molecules in the intake, use CO2.**

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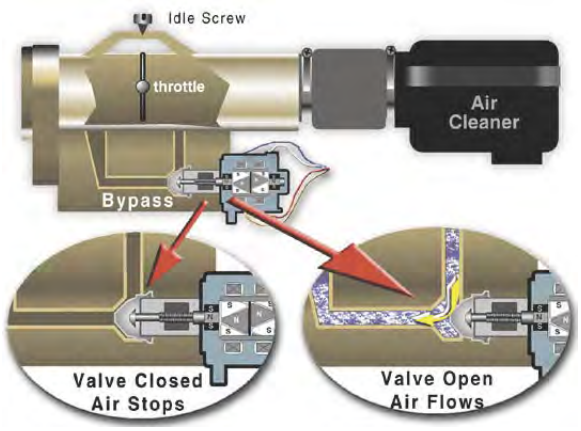
Actuators

Idle Air Control - IAC

On command from the computer, a small IAC motor drives the control pintle in and out. The pintle can be positioned to block the passageway and stop all bypass air, or to open it wide, allowing maximum bypass air. This is not simply and on-off valve, however.



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Actuators

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Output Controls

Use **CAUTION** when replacing PCMs, they just don't happen to burn out. **The sensitive circuits inside the PCM are easily damaged by actuators that have shorted out.** Use proper diagnostic procedures to test all solenoids before replacing a PCM.

Damage to PCMs is commonly caused by shorted solenoids.

Low Resistance = High Amperage

Most Expensive Fuse

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Test & Testing

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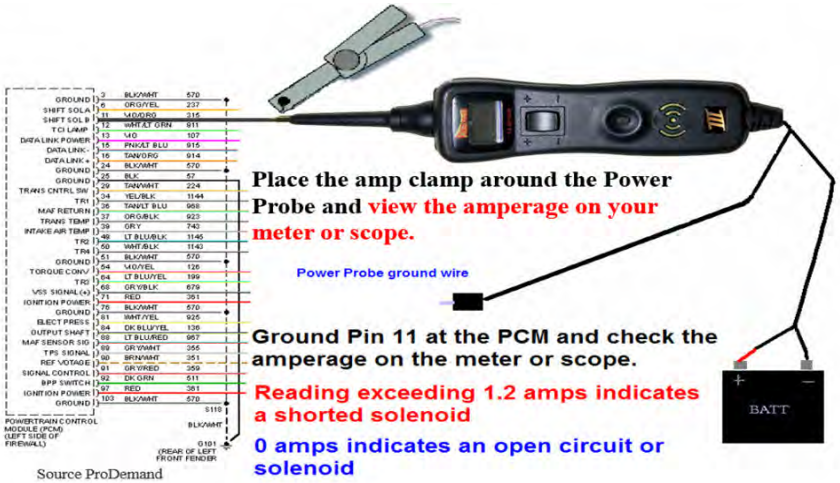
Testing Current With Power Probe & Amp Clamp

The wire harness is DISCONNECTED from the Computer



Source ProDemand

Example using Pin 11 - different on other computers

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Indexing

Before every applying any power or ground to a solenoid you need to perform the following:

1. Turn the power off - Key or Button OFF
2. Disconnect the connector plug from actuator.
3. Turn the power on and check what side of the connector has 12 volts and ground.
4. Apply power and ground to the correct terminal ends of the actuator to activate it.

Actuator plug wire disconnected.

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On To Testing

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Case Studies

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2009 Toyota Camry 2.4 L With 120561

This vehicle came in with a complaint of a slow cranking engine, dash light illuminated and dim lights. We connected our Midtronics tester to check the battery that failed along with the alternator output test. The next step was to connect our Associated smart battery charger to get the battery back up to specification making sure it was good before condemning the alternator. Everything starts with the battery so if the battery failed the test again, we would suggest that it be replaced along with a bad alternator. The battery passed the test, so we moved on to rechecking the charging system confirming a bad alternator. Since the alternator was not able to output a proper voltage there was no doubt it had to be replaced. We ordered a replacement alternator, installed it, and rechecked the charging system that once again was not outputting a proper charging voltage. We replaced the alternator only to come up with the same results.

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2009 Toyota Camry 2.4 L with 120561

We used Identifix and RTFI (read the frickin information) to find this issue can occur on high mileage Toyota vehicles. The problem can be caused by the engine not idling properly (our vehicle had no such problem) preventing the alternator from charging as designed. Identifix had a diagnostic procedure listed by performing a voltage drop on the white sensing terminal wire, followed by checking the voltage level. On our sick Camry the voltage was only at 11.6 volts followed by the next step of running a jumper wire between the battery and the white wire at the alternator then rechecking to see if the alternator will output proper voltage.

The information went on stating that a dirty throttle body could cause the issue as well. We removed the throttle body boot and found a dirty throttle body then proceeded to clean it followed by performing an idle relearn.

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2009 Toyota Camry 2.4 L With 120561

The idle system is controlled by the ETCS (electronic throttle control system) that checks the throttle actuator that operates the throttle valve and is monitored by throttle position sensor. The TP sensor detects the opening angle of the throttle valve along with the accelerator pedal position sensor. It in turn detects the accelerator pedal position that sends its signal to the PCM to control the throttle valve opening angle. This is why after cleaning the throttle body it is important to relearn the throttle. Next step was to restart the engine along with rechecking the alternator output making sure the system is working as designed. Out of curiosity and since it is an easy alternator to remove, we replaced the new alternator and installed the old alternator. The results displayed after the switch back to the old alternator confirmed it was in fact defective. Since we had not returned the first replacement alternator, we installed it and retested, finding that the first replacement alternator was not defective, so we left it in the vehicle and returned the other one. Bill and I had a learning lesson since we did not know what we did not know, but thanks to Identifix we now knew.

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Questions?

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