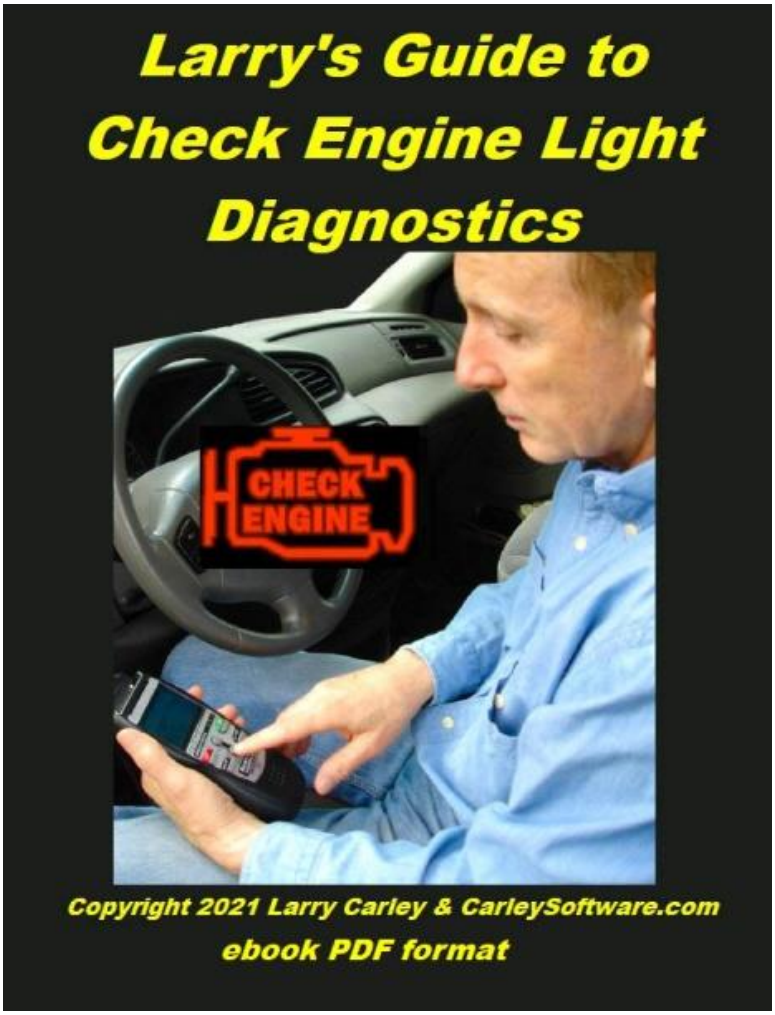


## Uh Oh,  Your Check Engine Light is On

Your Check Engine Light is on, yet your vehicle seems to be running fine. Or, maybe your vehicle isn't running quite the same as before. Maybe you've noticed a drop in fuel economy, or maybe the engine feels a little rough or just doesn't have the zip it once had.  In any event, something has triggered the Check Engine Light.

The "Malfunction Indicator Lamp" (or "MIL")  is on because your vehicle's OnBoard Diagnostic (OBD II) system has self-diagnosed a fault that may cause your vehicle's emissions to increase. It doesn't necessarily mean your vehicle is polluting or has a serious problem—but it might. So the MIL lamp is on to let you know something is amiss and that the problem needs your attention.

Trouble is, you don't know WHAT the trouble might be. It might be something that could lead to a breakdown or cause expensive engine damage, or it might be something minor like a loose gas cap (yes, the onboard diagnostics on 1996 and newer cars can even detect a loose, missing or leaking gas cap!). There's no way to know what the problem is without talking to your vehicle's computer with a scan tool.

By plugging a code reader or scan tool into your vehicles diagnostic connector (which is usually located under the dash near the steering column), you can read the code(s) that caused your Check Engine Light to come on.

**How Trouble Codes Turn On the Check Engine Light**

When a fault is detected, the OBD II system records a "Diagnostic Trouble Code" (DTC) in the computer's memory. The code number corresponds to a particular type of fault. The code might not tell you which component has failed or why, but it will tell you which emission control system or sensor circuit the fault is in, or that your engine is misfiring or running rich (too much fuel) or lean (not enough fuel).

**How To Read Trouble Codes**

When a basic code reader or scan tool is plugged into your vehicle's diagnostic connector, it will display any trouble codes that are found. Codes are usually displayed in numeric order if there is more than one code present.

The least expensive code readers will display the code number but no definition (you have to look up the definition online or in a manual). So buy a code reader, scan tool or download an app that also gives you the code definition with the code number so you'll have an idea of what the code means. Even then, the code definition may be an abbreviation that makes no sense unless you know what the letters mean. This may require doing some research on line to find a complete definition for the code.

**IMPORTANT:** *A trouble code is NOT a final diagnosis but only an indication that a problem has occurred in a given sensor, circuit or system. The code by itself will NOT tell you which part needs to be replaced. Remember that! This bit of advice will save you a lot of money!*


*Scan tool says there are 2 codes present. One happens to be a P0171 lean code. Now what?*

Example: Take a code P0171 or P0174. These are codes that indicate your engine is running lean. A lean air/fuel mixture can be caused by any number of things, and may cause symptoms such as a rough idle, hesitation or stumble when accelerating, hard starting, a loss of power or an emissions failure. Ok, so

your engine is running lean. Now what? The next step up the diagnostic ladder is to use your scan tool or scanner app to look at some of the additional system outputs, voltages or other information that your scan tool can access and display.

## Taking a Look at PIDs

What kind of additional system information are we talking about? **PIDs**. Performance Information Data.

This is the meat and potatoes of onboard diagnostics and is the grist that real technicians rely on to diagnose and repair today's vehicles. The diagnostic connector on your vehicle can provide a wealth of information, such as engine speed, engine load, air flow, ignition timing, coolant temperature, inlet air temperature, throttle position, sensor voltages, what's going on with your engine's fuel management system, the status of various switches and devices, and more.

Up to several HUNDRED different PIDS may be available on some cars depending on the make, model year and engine control system, and the capabilities of your particular scan tool or scanner software. Being able to look at all this data allows you to see what's actually going on inside your engine control system. You see what your engine computer sees, and if you know what to look for, you can find the kind of faults that turn on the MIL lamp.


*Vehicle PIDs are displayed on your scan tool. Knows what to look at can help you figure out what's causing a problem.*


*The OBD II diagnostic connector is usually located under the instrument panel near the steering column. Refer to your owner's manual for its exact location.*

**One of the most useful PIDs to look when diagnosing fuel, ignition or engine problems is Fuel Trim**

There are two types of fuel trim values you can read on your scan tool:

Short Term Fuel Trim (STFT) is what the engine computer is doing to the fuel mixture right now. This value changes rapidly and can bounce around quite a bit depending on engine load, speed, temperature and other operating conditions). Values normally range from negative 10 percent to positive 10 percent, though the readings may jump as much as 25 percent or more in either direction.

**Long Term Fuel Trim (LTFT)** is a longer term average of what the engine computer has been doing to balance the fuel mixture over a predetermined interval of time. This value is a more accurate indicator of how the fuel mixture is being corrected to compensate for changes in the air/fuel ratio that are occurring inside the engine.

STFT B1 is Short Term Fuel Trim engine cylinder Bank 1

STFT B2 is Short Term Fuel Trim engine cylinder Bank 2

LTFT B1 is Long Term Fuel Trim engine cylinder Bank 1

LTFT B2 is Long Term Fuel Trim engine cylinder Bank 2

How do you know which cylinder bank is 1 or 2 on a V6 or V8 engine? Bank 1 will be the cylinder bank that has cylinder number one in the engine firing order. F

**What Fuel Trim Values Mean:**

**POSITIVE (+) fuel trim** values mean the engine computer is adding fuel (increasing the pulse width or on-time of the fuel injectors) to add more fuel to the engine. In other words, it is attempting to RICHEN the fuel mixture because it thinks the engine's air/fuel mixture is running too lean.

**NEGATIVE (-) fuel trim** values mean the engine computer is subtracting fuel (decreasing the pulse width or on-time of the fuel injectors) to reduce the amount of fuel injected into the engine. This is done to LEAN out the fuel mixture to compensate for what it perceives as a rich running condition.

Fuel trim readings are based on what the oxygen sensors are telling the engine computer. If the O2 sensors indicate LEAN, the computer adds fuel and generates a POSITIVE fuel trim value. If the O2 sensors are reading RICH, the computer compensates by subtracting fuel and generates a NEGATIVE fuel trim value.

By reading the STFT and LTFT fuel trim values on a scan tool while your engine is running, you can tell if the air/fuel mixture is running rich (negative fuel trim percentages) or lean (positive fuel trim percentages).

Ideally, the STFT and LTFT should be within a few percentage points (+ or – 5 to 8 points) of zero when the engine is idling or being held at a steady RPM. Remember, STFT can bounce around quite a bit as when you suddenly snap open the throttle or decelerate. But LTFT can tell you if the average

fuel/mixture is running rich or lean. Good LTFT values should be as close to zero as possible, though they can range from 5 to 8 percent depending on the condition of the engine.

If the LTFT is getting up around 10 percent or higher, it usually indicates a problem that needs to be diagnosed. LTFT values that get up around 20 to 25 percent will usually set a P0171 or P0174 lean code. LTFT values that drop down to negative 20 to 25 will usually set a P0172 or P0175 rich code.

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**Section 2**

# How To Diagnose & Repair Common Problems

**Don't Throw Parts At A Problem. Diagnose What's Wrong, Then Replace the Bad Part**

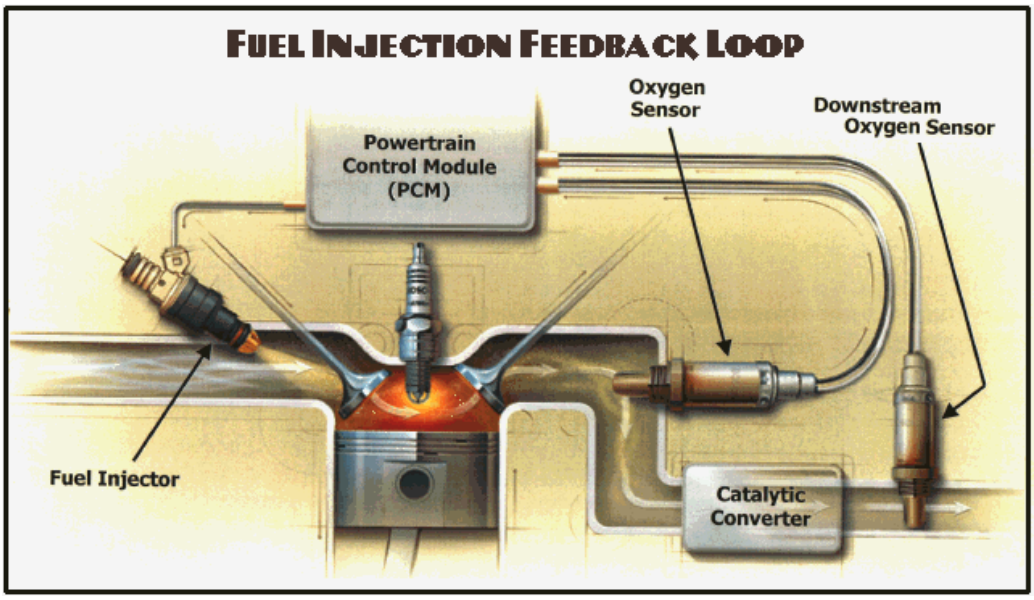
Some sensors are relatively inexpensive and well within the abilities of a do-it-yourself to replace (most coolant sensors, for example). Some sensors, on the other hand, are quite expensive. A mass airflow sensor might cost a couple hundred dollars or more. You want to be sure of your diagnosis before you replace any parts.

## PROBLEM #1: CHECK ENGINE LIGHT ON (Everything else seems to be fine)

First, you need to read out the code(s) that caused the MIL lamp to come on.

Depending on the type of code, your next step would be to look at any PIDs that might shed some light on why the code was set.

For example, say you find an oxygen sensor code (any code from P0130 to P0167). The oxygen sensor is a key sensor because it is part of the fuel feedback control system. The engine computer (called the "Powertrain Control Module" or "PCM") looks at the oxygen sensor signal to see if the engine is running rich or lean. If the engine is running rich (too much fuel), it shortens the control signal to the fuel injectors to reduce the volume of fuel delivered. This adjusts Air/Fuel mixture to the right ratio for optimum fuel economy, performance and emissions.



If the oxygen sensor has crapped out and is not sending a good signal to the PCM, it usually has the effect of making the engine run rich. This wastes fuel and increases emissions. Consequently, the onboard diagnostic system detects the fault, sets a code and turns on the MIL lamp.

Okay, now what?

Now you use the diagnostic power of your scan tool or PC software to look at some important data. You look at the output voltage of the oxygen sensor to see if it is behaving normally. A good oxygen sensor should produce a low voltage signal (0.2 volts or less) when the engine (exhaust, actually) is lean, and a higher voltage signal (0.8 volts or more) when the engine (exhaust) is rich. What's more, the sensor's output voltage should be bouncing up and down as the PCM constantly corrects the Air/Fuel mixture.

The best way to look at this particular signal is to graph it. Graphing the oxygen sensor's output signal makes it easier to see the up and down changes in the voltage (much easier than a simple numeric readout). Some scantools can do this as can some PC software. The key here is using a scantool or software that allows you to display and graph this kind of information in an easy-to-use format.

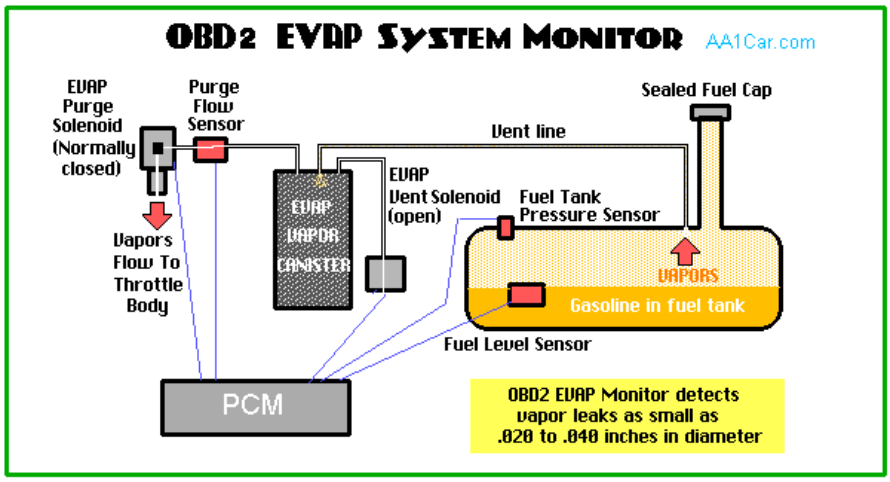
PC, laptop or tablet software if often better in this respect because the display area on a monitor is much larger than that on a small handheld tool or a Smart phone. Most vehicles today have anywhere from two to as many as six separate oxygen sensors, so you need a lot of real estate to graph that many sensors at the same time.

What's more, sometimes you want to look at several different sensor outputs simultaneously to see how they compare or react to changing engine loads or speeds. You might want to look at a whole list of PIDS while monitoring engine rpm and load. The larger the display area you have to work with, the easier it is to view multiple PIDs. And, with the right software you can display the values as numbers, graphs or customized gauges. Cool, huh?

Once the fault has been found, you can now do any additional tests that might be needed to isolate the fault. Often times, a fault in a sensor circuit is a bad connector and not a bad sensor. Simply cleaning the connector may be all that's necessary to bring the sensor back to life.

Other times, you may have to use a simple ohmmeter to check a resistance value, or a voltmeter to check a circuit voltage or ground connection to isolate a fault.

The trick is to NOT jump to conclusions. Make sure you've identified and isolated the fault BEFORE you replace any parts. You'll save yourself a lot of time, money and aggravation if you remember and practice this simple rule.




## PROBLEM #2: CHECK ENGINE LIGHT ON & CODE P0445

Example: the Check Engine light is on and you find a code P0445. This is an evaporative emissions control system (EVAP) code indicating a large vapor leak. The fuel system on late model vehicles is

sealed so fuel vapors cannot escape into the atmosphere. The EVAP system captures and stores fuel vapors so they can be purged later into the engine and burned. If the onboard diagnostic system detects a leak in the EVAP system, it will set a code and turn on the MIL lamp.

In this case, the code P0445 may be due to nothing more than a loose, missing or leaky gas gap. If you recently filled up your vehicle with fuel, check the gas cap to see if it is tight. If the cap is loose, retighten it and the EVAP code will eventually go away without having to clear the code. This will happen the next time the onboard diagnostic system runs a self-check on the EVAP system. This usually occurs after the vehicle has sit overnight and the fuel tank is between ¼ and ¾ full.

## PROBLEM #3: FUEL ECONOMY IS DOWN (Check Engine light may also be on)

Possible causes and codes:

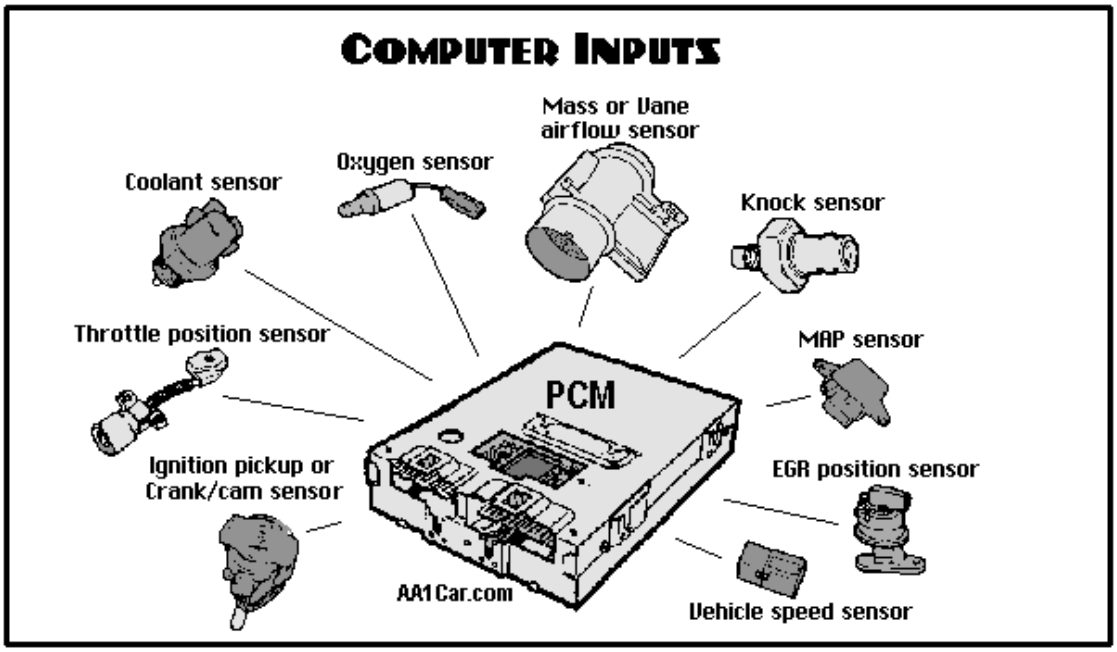
- **P0172 and/or P0175 are rich codes and indicate a general rich air/fuel condition.** The underlying cause may be anything that increases fuel delivery (excessive fuel pressure, a defective fuel pressure regulator or plugged return line, or a leaky injector), decreases airflow (dirty air filter or restricted air intake), or misleads the mass airflow sensor or engine management system into believing the engine is using more air or is under more load than it really is.
- **Misfire codes P030X**, where X indicates the cylinder number that is misfiring.

Misfire codes are bad because they mean a whole cylinder full of air/fuel mixture is wasted every time a cylinder fails to fire. The cause may be a worn or dirty spark plug, a bad plug wire, a weak ignition coil in a distributorless ignition system (DIS) or coil-on-plug (COP) ignition system, or a dirty or dead fuel injector. Misfires can make an engine run rough and reduce horsepower every time it happens. Worse yet, the unburned fuel that passes right through the engine will go into the exhaust. When the fuel reaches the catalytic converter, it will ignite and may cause the converter to overheat and suffer damage. That's why misfires are one of the two leading causes of converter failures (the other is leaky exhaust valves).

**Oxygen sensor codes (P0130 to P0167),** or oxygen sensor heater code (P0036 to P0064) indicating a fault with that sensor. If the O2 sensor fails, is usually causes the engine to run rich.

- **P0115 to P0119 indicating a problem with the coolant sensor**. The coolant sensor is also a key sensor in that it tells the engine computer the temperature of the coolant. The engine computer needs this information so it knows when to adjust the fuel mixture and ignition timing (these things change as the engine warms up). If the coolant sensor is faulty and tells the computer the engine is cold (when it really is hot), the fuel mixture will be too rich. Fuel economy will drop like a rock and the engine will pollute.
- **P0100 to P0104 Mass airflow sensor codes**. The mass airflow sensor monitors airflow into the engine. If it is not reading correctly, the air/fuel mixture won't be right. This is an expensive sensor to replace, so in many instances cleaning the sensor wire with aerosol electronics cleaner can return it to normal operation.
- **P0105 to P0109 Manifold Absolute Pressure sensor codes**. The MAP sensor monitors engine load by reacting to changes in intake vacuum. If the sensor reads incorrectly, the computer may think the engine is under more load than it actually is and give it more fuel than it needs.
- **P0070 to P0074 Inlet Air Temperature sensor**. On fuel injected engines that do not use a mass airflow sensor, air flow is estimated by the computer using inputs from this sensor, throttle position and the MAP sensor. If the air temp sensor is reading colder than it should, the computer will give the engine too much fuel.

Today's engine management systems are very complex and rely on many different sensor inputs to regulate fuel economy, performance and emissions. The key to solving a fuel economy problem is figuring out which of these inputs is feeding the PCM bad information. Garbage in, garbage out. If the computer receives bad sensor data, it will make the wrong adjustments and waste gas.




## PROBLEM #4: YOUR VEHICLE FAILED AN EMISSIONS TEST (or was rejected).

Most states that require emission tests now use a simple Onboard Diagnostics (OBD II) plug-in check instead of a lengthy tailpipe emissions test to verify emissions compliance. The OBD II tests are only used on 1996 and newer vehicles, and may be used in conjunction with a separate tailpipe test in certain situations (the rules vary from state to state).

The OBD II onboard diagnostic system that is used on all 1996 and newer passenger cars and light trucks (as well as a few 1994 and 1995 models) will set a fault code and turn on the MIL lamp if it detects ANY problem that MIGHT cause emissions to exceed federal limits by 1.5 times. Notice we said MIGHT cause emissions to exceed limits. The actual point at which a code is set is determined by the vehicle manufacturer based on extensive dyno testing and how conservative (or liberal) they are with respect to the rules. So in many instances, the MIL lamp may be on even if the vehicle is not really creating a menace to the environment. In fact, in many instances vehicles with a MIL lamp on will easily pass a tailpipe emissions test, even a "loaded mode" test that simulates actual driving conditions on a dyno. But hey, we don't make the rules. Each state makes their own testing rules, and the rules have to conform more or less to what the U.S Environmental Protection Agency requires.

As a rule (pardon the pun), to pass a plug-in OBD II test, a vehicle must:

- Have a functional MIL lamp and diagnostic connector (no tampering or funny business allowed).
- All (with a couple of exceptions) of the OBD II system monitors must have run and been completed before the vehicle is considered "ready" for testing.

The OBD II system runs a number of self-checks (called "monitors") to check the health of the engine management system and emission controls. Some of these tests run every time the engine is started and driven, but others (notably the catalyst and EVAP monitors) only run under certain conditions. Getting the catalyst monitor to run may require driving the vehicle for a number of miles under various speeds and loads. The EVAP monitor won't run unless the vehicle has sit overnight and the fuel tank is between ¼ and ¾ full. It also may not run in extremely hot or extremely cold weather.

Some code readers and most scan tools will show you the status of the OBD II monitors. If the monitor has run, it may say "COMPLETE" or "READY" or "OK."


On OBD II vehicles before model year 2000, the rules may allow one monitor not to have run before the vehicle can be accepted for testing. On some vehicles, there are also "monitor issues" that essentially mean some monitors NEVER run or set (whoops!). So special allowances are made for these vehicles, or they may have to take a regular tailpipe test.

- The MIL lamp must NOT be on (no DTCs in the computer's memory) to pass the test, all monitors must have completed (All Monitors Ready) and the test computer must be able to communicate with your vehicle computer to verify all of the above.

If you failed the emissions test, therefore, you probably had a MIL lamp on and one or more DTCs in your computer. Clearing the codes or resetting the OBD II monitors just before a test won't help you sneak through because the catalyst and EVAP monitors need time to run.

You have to diagnose and repair the fault before the vehicle will pass.

**If your vehicle was rejected for testing**, it means all of the required OBD II monitors had not completed their self-tests. Drive the vehicle for a few days around town and on the highway, and try again.

**If your vehicle failed a tailpipe test** (either a simple idle emissions check or a loaded mode test on a dyno), and the Check Engine is NOT on, chances are you have a problem with the OBD II system, a burned out MIL lamp, or a faulty catalytic converter. The converter is essentially an afterburner that cleans up the exhaust after it exits the engine. The OBD II system uses a "downstream" oxygen sensor to monitor the efficiency of the converter, and it should detect a drop in converter efficiency if the converter has been contaminated or is failing (ignition misfiring, leaky exhaust valves and oil burning can all damage the converter).

**What you want to look for:** Any conditions that might cause ignition misfire, an overly rich or lean fuel condition, or loss of compression. Use your scan tool to look at the oxygen sensor outputs, coolant temperature, airflow, calculated engine load, and inlet air temperature. Look for anything that isn't "normal" (this requires some understanding of these sensors as well as their normal outputs).

## PROBLEM #5: ENGINE HESITATES, STUMBLES, LACKS NORMAL POWER

Nothing is more humbling than to stomp down on the accelerator pedal to blow past some idiot in the right lane and have your engine stumble and cough. Or, to accelerate from a stop like a drunken sailor stumbling out of a bar.

An engine that hesitates, stumbles or misfires when accelerating or when it is under load is an engine that is either sucking too much air, not getting enough fuel or misfiring. If the Check Engine light comes on, you may find any of the following codes:

- P0171, P0174 Lean fuel condition codes
- P0120 to P0124 Throttle position sensor codes
- P0222 to P0229 Throttle position sensor codes
- P0400 to P0409 EGR related codes

**If there are no misfire codes**, a common cause of acceleration stumble is a **bad throttle position sensor.** The TPS sensor tells the computer how far the throttle is open. The PCM uses this information to determine how much fuel is needed to maintain the correct air/fuel mixture, and when extra fuel is needed if the throttle suddenly opens wide.

**Another common cause is dirty fuel injectors**. If varnish deposits have built up in the tips of the injectors, they won't spray as much fuel as they normally do. This creates a lean fuel mixture and conditions that are ripe for stumble and hesitation (also misfire).

Look at short term fuel trim (STFT) and long term fuel trim (LTFT) with you scan tool or scanner software. If the numbers are high, it tells you the engine is running lean and the injectors need cleaning.

**Other problems that may contribute to acceleration stumble** include vacuum leaks, low fuel pressure, a weak spark (low coil voltage or bad coil(s), retarded ignition timing, and bad gas (water or other contamination).

Look at the following with your scan tool or PC scanner software:

Throttle position, mass airflow, short term fuel trim (STFT) and long term furl trim (LTFT), ignition timing, and fuel pressure (if a PID is available).

TPS sensors typically show the most wear in the idle and just above idle positions, but they may also have dead spots at any point in their range of travel. A good way to spot a faulty TPS sensor is to graph the sensors output while slowly opening the throttle all the way. The graph should look like a relatively smooth ramp, with no suddenly drops or flat spots.

## PROBLEM #6: ENGINE CRANKS BUT WON'T START

Definitely not good. Chances are the Check Engine light may not come on with a no-start problem, but it if does you may find any of the following codes:

- P0230 to P0233 Fuel pump codes
- P0600 to P0606 PCM related codes
- P0335 to P0339 Crank sensor codes
- P0190 to P0194 Fuel pressure sensor codes
- Might be No Codes in Memory

Okay, so what's causing the no-start? All engines require three things to start and run: spark, fuel and compression. If any one of these isn't there, you aren't going anywhere. Here's a list of possible causes:

- **No spark** due to a bad crank position sensor, a faulty ignition module or PCM, a problem in the ignition circuit (ignition switch, anti-theft system, wiring, etc.), a faulty park/neutral safety switch, a bad ignition coil (only on engines with a single coil ignition), or wet plugs or plug wires (did it rain last night?).

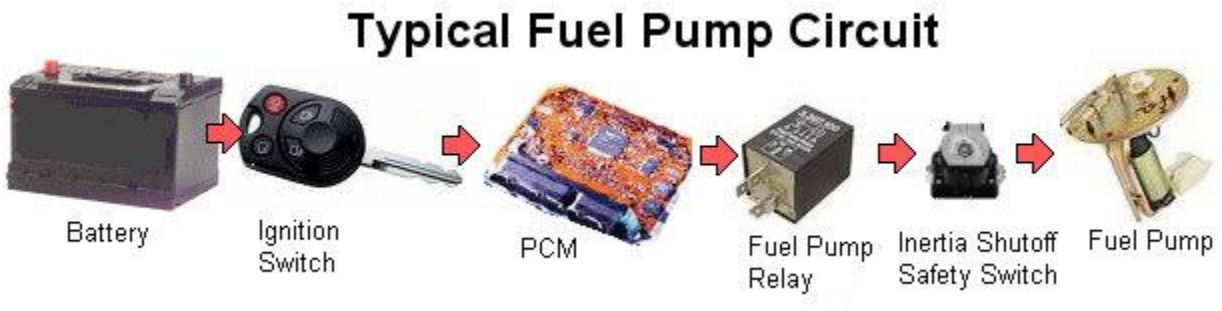
A less common cause is a worn starter that sucks so many amps while cranking the engine that there's not enough juice left to adequately power the ignition system and fuel injectors. Contributing factors might be a weak battery and/or loose or corroded battery cables.

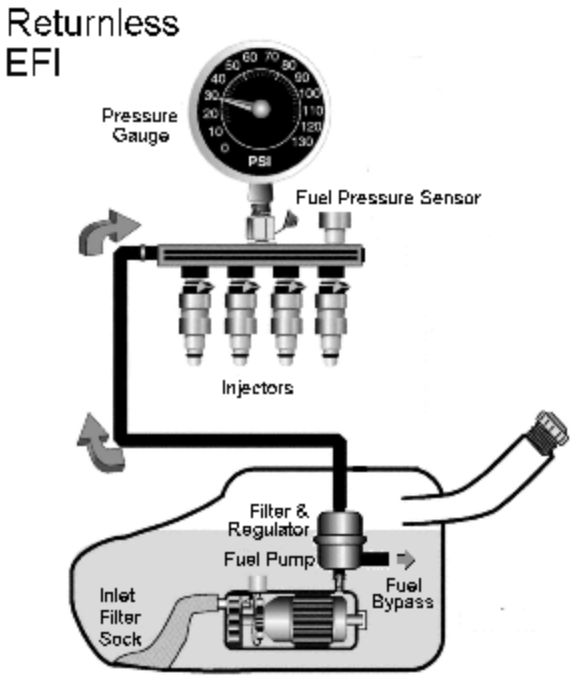
- **No fuel** because of a dead fuel pump, bad fuel pump relay, blown fuel pump fuse, plugged fuel filter or line, or failed PCM injector driver circuit or injector power supply relay. Or, the fuel tank might be empty (don't believe what the gauge is telling you), or the fuel tank might contain contaminated fuel (water or too much alcohol) or the wrong type of fuel (whoops, somebody put in diesel instead of gasoline).
- **No compression** because the timing belt or chain is broken, the timing belt or chain is loose and jumped out of time, or the overhead camshaft has snapped.

Here's a quick way to check for spark IF your engine has individual spark plug wires (this trick doesn't work on engines with coil-on-plug ignition systems). Remove a plug wire, insert a Phillips screwdriver or piece of bare wire into the plug wire boot and place the end near the engine block. If your engine has a coil-on-plug ignition, remove one of the coils, insert a Phillips screwdriver or piece of wire into the coil boot that fits down over the spark plug and place the screwdriver or wire so it is near the engine block.

**CAUTION: DO NOT** hold the plug wire, screwdriver or coil while cranking the engine unless you want a shocking experience!. If you see a spark when the engine is cranked, it has ignition. The problem is either fuel or compression.

If the engine has an overhead cam with a timing belt, loosen the cover over the timing belt and check the belt. If the belt is okay, the problem is no fuel. Listen for the electric fuel pump in the fuel tank to make a buzzing noise when the ignition is turned on (you may have to open the gas cap to hear it). You won't hear anything if the pump has died.






Diagnostics can now be focused on the fuel pump circuit to determine if the pump, relay or wiring is causing the no start. If the relay has voltage but the pump isn't running, you'll probably have to drop the fuel tank to check the wiring connector at the pump. Oh well, you'll have to drop the tank anyway to replace the pump.

**HINT:** A fuel tank full of fuel is very heavy—and dangerous (gasoline explodes, remember?). So drain the tank first into an approved container and keep all sources of flame or sparks far, far away from the tank and fuel lines. No smoking. No running anything that makes sparks (electric motors, drills, grinders, etc.). No space heaters or other possible sources of ignition. And don't sue us if you blow yourself up!

If the problem is no spark, anything in the ignition circuit that creates the spark may be at fault. Start by using your scan tool or PC scanner software to look for an rpm signal while cranking the engine. A bad crankshaft position sensor is a common cause of no-starts. The signal from the crank sensor goes to the PCM or ignition module that switches the ignition coil(s) on and off.

If you have an rpm signal, a bad ignition module or PCM may not be switching the coil(s) on an off. Check for voltage at the coils with the key on and while cranking the engine. The voltage should be switching on and off (you can check this with a voltmeter or dwell meter).

In ignition systems with a single coil and distributor, a bad coil or a cracked distributor cap or rotor can prevent the spark plugs from firing. On multi-coil distributorless ignition systems and coil-on-plug systems, one coil failure may cause an engine to misfire, but it usually won't prevent it from starting.

Coil primary and secondary resistance can be checked with an ohm meter. If the reading is out of specifications, replace the coil.

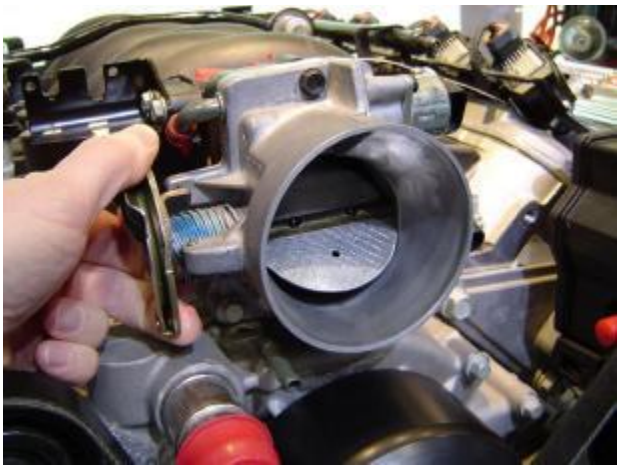
## PROBLEM #7: ENGINE STALLS (Check Engine light may or may not be on)

Nothing is more aggravating than an engine that stalls—especially when some jerk behind you lays on the horn like its your fault. Stalls typically occur when the engine is idling or slowing.

If the Check Engine light comes on, you may find any of the following codes:

- P0505 to P0509 idle control circuit codes
- P0335, P0336, P0337, P0338, P0339 crank sensor codes
- P0171, P0174 lean fuel condition codes
- P0400 to P0409 EGR related codes

**The engine may be stalling because it isn't getting enough throttle opening.** The cause is often a problem in the idle air control system. Other possibilities include a dirty throttle body, Vacuum leak, incorrect ignition timing (retarded), bad gas (water or other contamination), an A/C compressor that is dragging, or an EVAP purge valve that is stuck open and is flooding the engine with fuel vapor.



**What to Check:** The throttle body hose connections and idle controls, also intake vacuum (check the throttle body, manifold and hose connections for leaks, also the PCV valve and hose, too).

With your scan tool or PC scanner software, look at engine rpm, calculated engine load, mass air flow rate, throttle position angle, short term fuel trim (STFT), and ignition timing for possible clues as to what's going on. On some vehicles, you can also look at the idle control motor duty cycle or position, and/or idle tracking sensor (if the vehicle has one).

In many instances, stalling ends up being an idle control motor at its limit or a failed motor. A vacuum leak can cause this, so don't replace the idle control motor until you've found and fixed the vacuum leak.

## PROBLEM #8: CHECK ENGINE LIGHT ON, P0300 RANDOM MISFIRE CODE

What the heck does random misfire mean? **It means your engine is misfiring**, but that the problem is not isolated to one or two cylinders. It is jumping around in a random way from one cylinder to another.

**A random misfire P0300 code usually means the air/fuel mixture is running lean**. But the cause might be anything from a hard-to-find vacuum leak to dirty fuel injectors, low fuel pressure, a weak ignition coil, bad plug wires or compression problems. Even a dirty MAF sensor can cause a lean code and/or misfire to occur.

**First, check intake vacuum with a vacuum gauge**. On most vehicles a normal reading is 17 to 21 inches Hg. If the needle is lower, is jumping up and down or steadily drop, you have a problem. Look for possible vacuum leaks by checking vacuum hose connections, the throttle body and manifold, and PVC valve and plumbing.

**An EGR valve that is leaking** can also act like a vacuum leak and cause a random misfire.

**Check fuel pressure with a gauge**. If it is not within specifications (refer to a service manual for specifics because fuel pressure is critical for proper engine performance), the problem may be a weak

fuel pump, low voltage to the pump (check the relay and wiring), or obstructions in the fuel line (like a plugged filter). A bad fuel pressure relay can also leak pressure and prevent an otherwise good fuel pump from delivering full pressure to the injectors.

**Dirty injectors** can also restrict fuel delivery and cause a lean fuel condition. Many regular grades of gasoline do not contain adequate levels of detergent to keep the injectors clean. Frequent short trip driving accelerates the buildup of injector deposits. Cleaning the injectors with a good quality fuel tank additive (or having them professionally cleaned) can solve this problem.

Look at short term fuel trim (STFT) and long term fuel trim (LTFT) with you scan tool or scanner software. If the numbers are high, it tells you the engine is running lean.

## PROBLEM #9: A CYLINDER SPECIFIC MISFIRE CODE (P030x)

A steady misfire, on the other hand, is isolated to a single cylinder and will set a code that indicates the cylinder (Example: a P0302 code would tell you the #2 cylinder is misfiring). The last digit in the P code is the number of the cylinder (in its firing order) that is misfiring.

Common causes of a single cylinder misfire include a bad spark plug or ignition fault, a clogged or bad fuel injector, or loss of compression in the cylinder (burned exhaust valve, bent valve or blown head gasket).

## PROBLEM #10: OTHER WARNING LIGHT(S) ON (Check Engine light also be on)

Uh oh. This is not good news. Depending on what other warning lights are on, you may have a serious problem.

**TEMP WARNING LIGHT ON**—Your engine is overheating. Stop driving immediately and turn the engine off. Continuing to drive risks causing expensive engine damage such as a blown head gasket, or cracked or warped cylinder head.

Allow the engine to cool down for several hours before you attempt any further diagnosis. A hot engine can be very dangerous because of steam pressure inside the radiator and coolant reservoir. Do NOT attempt to add coolant until the engine has cooled down and the radiator cap or reservoir cap can be safely opened.

Overheating can be caused by a low coolant level (check the radiator, water pump and hoses for leaks), coolant leaks inside the engine (leaky head gasket or cracks in the head or block), a stuck thermostat, or a cooling fan that isn't working (bad fan clutch, fan motor or fan relay).

**OIL PRESSURE WARNING LIGHT ON**—Oil pressure is dangerously low. Stop driving immediately and turn the engine off. Continuing to drive risks ruining the bearings and camshaft in your engine.

Low oil pressure or loss of oil pressure can be caused by a low oil level in the crankcase, a worn or damaged oil pump, or worn engine bearings. In older high mileage vehicles, it is not uncommon to see the oil warning light flicker at idle because of internal engine wear.

Check the oil level before restarting the engine. If low, check the engine for leaky gaskets and seals, or a loose oil filter. If no leaks are seen, the engine may be burning oil because of worn valve guides, rings and/or cylinders. Add oil to bring the level on the dipstick up to the full mark, then start the engine to see if the light goes out.

If the light does not go out and the engine is making noise (ticking, rattling, clicking, rapping sounds), it may not be getting normal oil pressure—or it may have suffered damage because of the loss of oil pressure. So sad, too bad. You're looking at an overhaul or buying another engine.

**CHARGING, ALT OR GEN LIGHT ON**—Your charging system is not putting out its normal voltage or current. This means one of two things: either the alternator (generator) has died, or the belt that drive it is slipping or has broken.

On vehicles with serpentine belts, losing a belt means you lose everything that the belt drives: the water pump, alternator, power steering pump and A/C compressor. The A/C compressor you can live without, and with sufficient upper body strength you can still steer without the PS pump. But your engine isn't going to stay cool for long without the water pump. So stop, turn the engine off and take a look under the hood to see if the belt is still intact.

If the belt is still on and appears to have normal tension, the alternator has probably crapped out on you. You can probably drive your car a few miles or up to 30 minutes or so on the juice that's left in the battery, but don't count on going to far because without the alternator the battery will run down very quickly. And once voltage drops below a certain level, things will start shutting down (fuel pump, injectors, ignition system, etc.).

The fix? Check the charging system's output at the battery terminals with a volt meter. Normal charging voltage should be about 13.5 to 14.5 volts (it varies some with temperature and load). If you see 12.6 volts or less (which is base voltage for a fully charged battery), you need to have the alternator tested (many parts stores can do this for you).

**ABS OR BRAKE LIGHT ON**—Whoe Nelly, you may have lost your binders! If the ABS light only is on, your vehicle should still have normal braking (possibly without power assist, though, depending on what type of ABS system it has). But if the brake light is on (with or without the ABS light), it may indicate a serious hydraulic problem in your brake system.

On most vehicles, the brake warning light will come on if a safety switch detects a difference in pressure between the brake circuits when the brakes are applied. This may indicate a leak and loss of pressure in one of the circuits.

On some vehicles, there is also a brake fluid level sensor in the brake fluid reservoir on the master brake cylinder. If the fluid level drops, it may turn on the warning light.

Either way, the first order of business is to stop the vehicle (assuming the brakes still work) and check the fluid level in the master cylinder. The fluid level will drop somewhat as the brake linings wear, but a sudden drop in the level usually means there's a leak in a brake line, hose, caliper or wheel cylinder. Do NOT drive the vehicle until the problem has been diagnosed and repaired. Dragging your foot is not a very effective way of slowing a 4,000 lb. or heavier vehicle.

## TURNING THE CHECK ENGINE LAMP OFF

As a rule, the Check Engine Light will remain on as long as a fault persists. If an intermittent fault does not reoccur after three consecutive trips, the MIL lamp will go out but the code will remain in memory. If the fault does not reoccur for 40 trips, the code will be erased.

So how do you turn it off?

The only safe way to clear fault codes and turn the MIL lamp off is to use a scan tool or scanner software.

On many pre-OBD II vehicles, all you had to do was disconnect the battery or pull the PCM fuse to clear the memory and turn the Check Engine light off. If the problem had not been fixed, the Check Engine light would eventually come back on. But this procedure should NOT be used on OBD II cars for the following reason:

***WARNING:*** On many OBD II cars, pulling the PCM fuse or disconnecting the battery may NOT clear the codes—and may cause a loss of important information the PCM needs to function correctly. On some vehicles, loss of power to the PCM may cause it to forget transmission settings, climate control functions and other essential data. This, in turn, may require the use of a scan tool and a special relearning procedure to reset the PCM.

Here's another thought: Are you sure you want to erase the codes? Codes contain important diagnostic information you or somebody else might need to troubleshoot the system. If the codes are cleared, it may take some time for the codes to reset - -which will delay diagnosing and repairing the fault.

The best approach to turning off the light, therefore, is to read out the codes, write them down, then clear the codes with your scan tool or scanner software.

Also note: Clearing fault codes may or may not allow you to pass a plug-in OBD II test. Remember, all the OBD monitors must have run and completed BEFORE you can pass the test. That means you may have to drive you car for a few hours or days to get all of the monitors to complete (especially the EVAP monitor). If a fault still exists, the OBD system will detect it and reset the code. On the other hand, if the fault is no longer present, they you should be able to pass the test.

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**Section 3:**

# OBD II DIAGNOSTICS BY TYPE OF CODE

In this section, we list common trouble codes, the symptoms that may be causing the code, possible faults that may have caused the code to set, and what PIDs and/or additional checks you should examine to diagnose the fault.

## O2 SENSOR CODES

**O2 sensor related codes:**

P0030....HO2S Heater Control Circuit Bank 1 Sensor 1

P0031....HO2S Heater Control Circuit Low Bank 1 Sensor 1

P0032....HO2S Heater Control Circuit High Bank 1 Sensor 1

P0033....Turbo Charger Bypass Valve Control Circuit

P0034....Turbo Charger Bypass Valve Control Circuit Low

P0035....Turbo Charger Bypass Valve Control Circuit High

P0036....HO2S Heater Control Circuit Bank 1 Sensor 2

P0037....HO2S Heater Control Circuit Low Bank 1 Sensor 2

P0038....HO2S Heater Control Circuit High Bank 1 Sensor 2

P0042....HO2S Heater Control Circuit Bank 1 Sensor 3

P0043....HO2S Heater Control Circuit Low Bank 1 Sensor 3

P0044....HO2S Heater Control Circuit High Bank 1 Sensor 3

P0050....HO2S Heater Control Circuit Bank 2 Sensor 1

P0051....HO2S Heater Control Circuit Low Bank 2 Sensor 1

P0052....HO2S Heater Control Circuit High Bank 2 Sensor 1

P0056....HO2S Heater Control Circuit Bank 2 Sensor 2

P0057....HO2S Heater Control Circuit Low Bank 2 Sensor 2

P0058....HO2S Heater Control Circuit High Bank 2 Sensor 2

P0062....HO2S Heater Control Circuit Bank 2 Sensor 3

P0063....HO2S Heater Control Circuit Low Bank 2 Sensor 3

P0064....HO2S Heater Control Circuit High Bank 2 Sensor 3

P0130....O2 Sensor Circuit Bank 1 Sensor 1

P0131....O2 Sensor Circuit Low Voltage Bank 1 Sensor 1

P0133....O2 Sensor Circuit Slow Response Bank 1 Sensor 1

P0134....O2 Sensor Circuit No Activity Detected Bank 1 Sensor 1

P0135....O2 Sensor Heater Circuit Bank 1 Sensor 1

P0136....O2 Sensor Circuit Malfunction Bank 1 Sensor 2

P0137....O2 Sensor Circuit Low Voltage Bank 1 Sensor 2

P0138....O2 Sensor Circuit High Voltage Bank 1 Sensor 2

P0139....O2 Sensor Circuit Slow Response Bank 1 Sensor 2

P0140....O2 Sensor Circuit No Activity Detected Bank 1 Sensor 2

P0141....O2 Sensor Heater Circuit Bank 1 Sensor 2

P0142....O2 Sensor Circuit Malfunction Bank 1 Sensor 3

P0143....O2 Sensor Circuit Low Voltage Bank 1 Sensor 3

P0144....O2 Sensor Circuit High Voltage Bank 1 Sensor 3

P0145....O2 Sensor Circuit Slow Response Bank 1 Sensor 3

P0146....O2 Sensor Circuit No Activity Detected Bank 1 Sensor 3

P0147....O2 Sensor Heater Circuit Bank 1 Sensor 3

**Symptoms:**

- Engine running rich (lazy or sluggish O2 sensors)
- Poor fuel economy
- Emission failure (high CO)

**Possible causes:**

- Heater codes: bad connection, wiring or heater voltage supply

- Sensor codes: sensor is old or contaminated, or connector or wiring fault

**Other possible causes:**

- Sensor codes: Air leak in exhaust manifold or gasket

**What to Check:**

- O2 sensor switching activity - look for cyclic voltage change from 0.2 v to 0.8 v in upstream O2 sensor (sensor 1)
- Downstream O2 sensor (sensor 2) -- should see less switching activity once exhaust is hot (flatline around 0.4 to 0.5 volts)

**Generic PIDS to display when diagnosing an O2 sensor code:**

Comprehensive component monitor status
All O2 sensor voltages (graph if possible)
O2 sensor monitor status
O2 heater monitor status
Loop status (should be Closed Loop (CL) when engine is hot & running)
Short term fuel trim (STFT)
Long term fuel trim (LTFT)
Coolant temperature

**Repair Tips:**

Check O2 sensor wiring harness for loose, corroded or damaged wires or connectors.

Apply a SMALL dab of anti seize compound to O2 sensor threads before installation. Be very careful not to contaminate the sensor tip.

# LEAN CODES

## P0171 & P0174

**Symptoms:**

- Engine running lean (not enough fuel/too much air)
- Engine may have random misfire
- Engine may hesitate or stumble under load

**Possible causes:**

Dirty fuel injectors
Low fuel pressure
Vacuum leak
Dirty or defective mass airflow sensor
Bad air temperature sensor

**What to Check:**

- Intake vacuum (typically 18 to 22 in. –Hg at idle, if low may indicate vacuum leak or bad intake valve)
- Fuel pressure (should be within specifications)
- Fuel pressure regulator (leaky regulator valve can reduce fuel pressure)

**Generic PIDS to display when diagnosing a lean code:**

Comprehensive component monitor status
All O2 sensor voltages (graph)
O2 sensor monitor status
O2 heater monitor status
Loop status
Short term fuel trim (STFT)
Long term fuel trim (LTFT)
Coolant temperature
Mass airflow (MAF)
Intake air temperature

**Enhanced PIDS to display (if available):**

Fuel pressure
Fuel injection pulse width (graph)

**Repair Tips:**

Most common causes of lean codes are vacuum leaks (intake manifold, throttle body, vacuum hoses), dirty fuel injectors, low fuel pressure, or using the wrong fuel (E85 in a vehicle that is not designed to use flex fuel), or a dirty MAF sensor.

Cleaning fuel injectors may solve problem if fuel pressure is okay, and there are no vacuum leaks.

Cleaning dirty MAF sensor wire with electronic cleaner may restore proper MAF operation and eliminate lean codes.

If the MAF sensor is dirty, the fuel trim at idle will probably be close to normal (plus or minus 3 to 5 range), but as engine speed increases up to 2500 RPM, you will see the fuel trim value go positive (5 or higher). If the MAF is dirty, the fix is easy enough: just clean or replace the MAF sensor. In many instances, the MAF sensor can be successfully cleaned by spraying the sensor element with electronics cleaner. Do not use any other type of cleaner as this may damage the MAF sensor

# RICH CODES

## P0172, P0175

**Symptoms:**

- Engine running rich (too much fuel, not enough air)
- Poor fuel economy
- Engine may have rough idle or surge

**Possible causes:**

### Bad O2 sensor

Excessive fuel pressure (bad regulator or plugged return line)
Leaky fuel injectors
Dirty air filter or restricted air inlet

**What to Check:**

- O2 sensors (bad sensor may prevent engine from going into Closed Loop)
- Bad coolant sensor (may prevent engine from going into Closed Loop when warm)
- Bad engine thermostat (may prevent engine from reaching normal temperature)
- Excessive Fuel pressure
- Bad fuel pressure regulator or plugged fuel return line to fuel tank

**Generic PIDS to display when diagnosing a rich code:**

Comprehensive component monitor status
All O2 sensor voltages (graph)
O2 sensor monitor status
O2 heater monitor status
Loop status
Short term fuel trim (STFT)
Long term fuel trim (LTFT)
Coolant temperature
Mass airflow
Intake air temperature

**Enhanced PIDS to display (if available):**

Fuel pressure
Fuel injection pulse width (graph)

**Repair Tips:**

A quick way to check the coolant sensor with your scan too is to compare the reading of the coolant temp sensor and intake temp sensor when the engine is cold. Both should read the same. If the two temp sensors read differently, one may be bad.

A rich condition may cause the catalytic converter to run hot, overheat and suffer damage.

# MISFIRE CODES

## P0300 to P0312 Misfire codes

**Symptoms:**

- Engine has steady misfire in one or more cylinders
- P0300 only - Engine has random misfire (no specific cylinder)
- Idle may also be rough, noticeable engine shake
- Loss of power
- Loss of fuel economy
- Emissions failure

**Possible causes:**

Ignition misfire (worn/dirty spark plugs)
Ignition misfire (bad plug wires)
Ignition misfire (weak DIS/COP ignition coil)
Lean misfire (dirty or dead fuel injector(s))
Lean misfire (weak fuel pump)
Lean misfire (bad fuel pressure regulator)
Lean misfire (vacuum leak)
Compression loss (leaky valve)
Compression loss (leaky head gasket)
Compression loss (worn cam lobe)

**What to Check:**

- Spark plugs, plug wires, ignition coils
- Fuel injectors (dirty, weak or dead injectors)

- Fuel pressure (should be within specifications)
- Cylinder Compression

**Generic PIDS to display:**

Comprehensive component monitor status
Misfire monitor status
Calculated engine load
Short Term Fuel Trim (STFT)
Long Term Fuel Trim (LTFT)

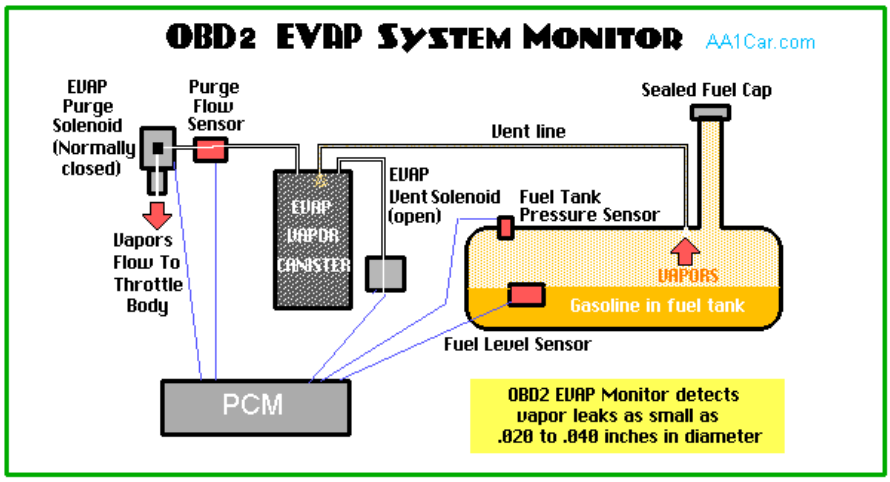
Enhanced PIDS to display (if available):

Mode 06 misfire counts for each cylinder
Fuel injection pulse width (graph)

**Repair Tips:**

If you have a cylinder specific misfire code (such as a P0302 – the last digit is the cylinder number), focus your investigation on that cylinder (#2 in this example).

Check the spark plug, plug wire, DIS/COP ignition coil & compression in the affected cylinder. If the spark plug, coil and compression are all okay, the fuel injector may be dirty or dead. If the fuel injector is not buzzing when the engine is running, the wiring harness or connector may be loose, damaged or corroded.




# EVAP CODES

## P0440 to P0457 Evaporative emission control system codes

**Symptoms:**

- Loose, missing or damaged gas cap
- Engine may have a rich fuel condition
- May be gasoline smell
- Emissions failure

**Possible causes:**

EVAP system leak
Missing, loose or leaking gas cap
Faulty EVAP purge valve

**What to Check:**

- Gas cap (loose, missing or damaged seal)
- EVAP system plumbing (vapor leaks)

**Generic PIDS to display:**

EVAP monitor status
Short term fuel trim (STFT)
Long term fuel trim (LTFT)

**Enhanced PIDS to display (if available):**

EVAP purge command status
Any other EVAP related PIDS
Professional bi-directional scan tool can run EVAP purge test to check for leaks

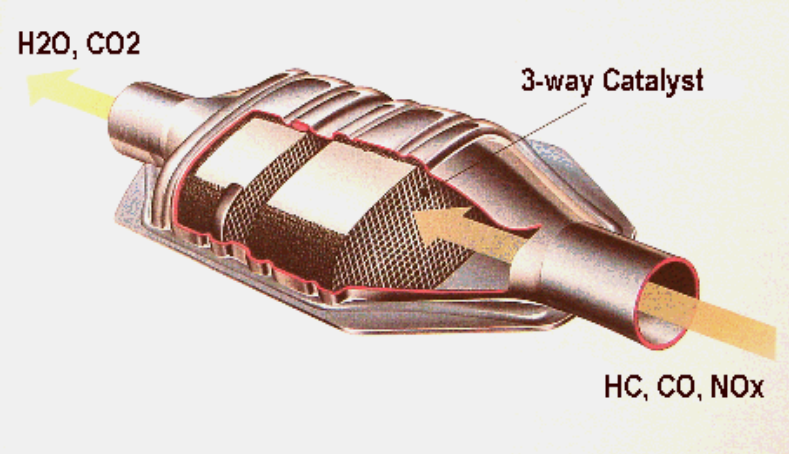
**Repair Tips:**

A loose gas cap or damaged cap seal can set an EVAP code and turn on the MIL lamp.

The EVAP monitor won't run unless the fuel tank is between ¼ and ¾ full. Vehicle must also sit overnight.

EVAP purge solenoid faults are also common.

EVAP vapor leaks can be very difficult to find. May require spraying soapy water on hoses, or using a smoke machine to pressurize EVAP system so leaks will be visible.




# CATALYTIC CONVERTER CODES

### P0420 to P0439 Catalytic converter codes

**Symptoms:**

- Engine starts but quickly stalls (if converter is plugged or severely restricted)
- Loss of engine power at high speed (if restricted)

- Emissions failure (if converter is not working properly)
- Strong sulfur odor (may indicate weak converter)

**Possible causes:**

Converter damaged or plugged (or exhaust restriction aft of converter)
Rich fuel condition underlying cause of converter damage
Faulty secondary air system (if equipped)

**What to Check:**

- Catalytic converter (inspect for physical damage, also converter efficiency PID)
- Exhaust system behind converter for damaged/crushed pipe, restricted muffler)
- Secondary air system (if equipped)

**Generic PIDS to display:**

Catalytic converter OBD II monitor status Enhanced PIDS to display (if available):

Catalyst Efficiency

Barometric Presure (BARO): A lower than normal barometric pressure (BARO) value. If your engine has a Mass Airflow (MAF) sensor, and the engine computer uses the signal from the MAF sensor to calculate a barometric pressure (BARO) value, the calculated value may be lower than normal is the exhaust is restricted.

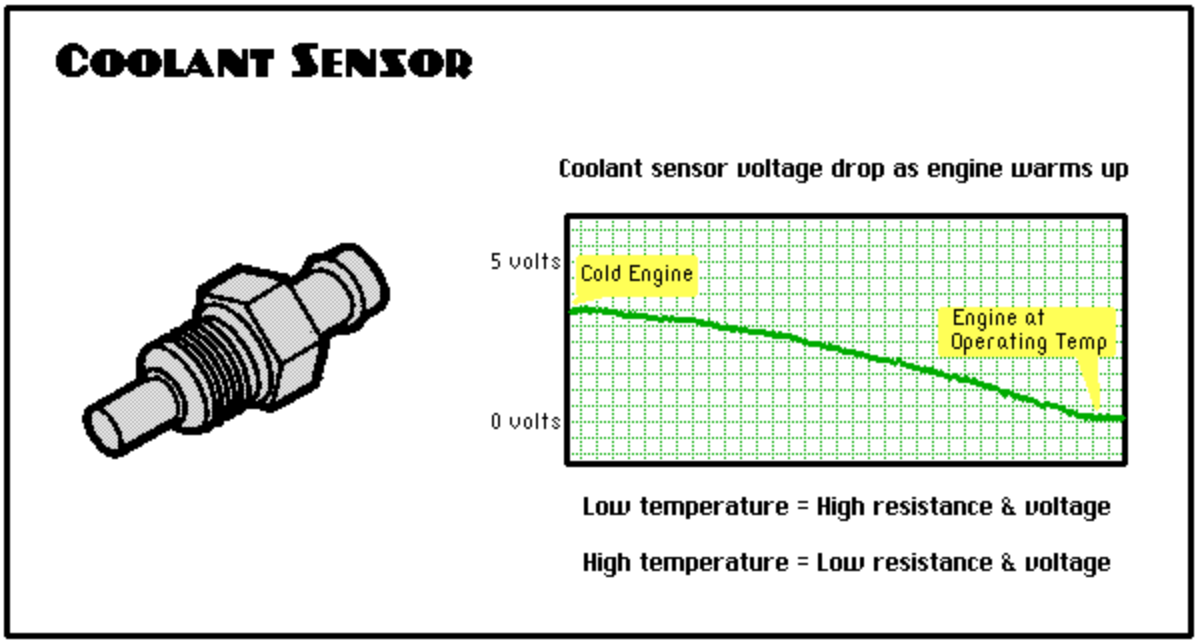
MAP value: A lower than normal Manifold Absolute Pressure (MAP) sensor value would indicate a restricted converter. Any increase in exhaust backpressure can reduce intake vacuum.

Calculated Load: Thel Calculated Load value PID (percentage or grams/second) displayed on a scan tool is a measure of the engine's volumetric efficiency. A low calculated load value means the engine is not breathing normally because of an exhaust restriction.

**Repair Tips:**

Converter damage may result if unburned fuel enters the exhaust. This may be due to a misfiring spark plug or leaky exhaust valve.

Converters are covered by a 7/70 or longer emissions warranty.




# COOLANT SENSOR CODES

## P0115 to P0119 Coolant sensor codes

**Symptoms:**

- Engine may not be going into closed loop (CL) when warm
- Engine may be running rich
- Engine may experience overheating problems because cooling fan not coming on.

**Possible causes:**

Bad coolant sensor
Low coolant level

**What to Check:**

- Coolant sensor
- Coolant level
- Operation of thermostat

**Generic PIDS to display:**

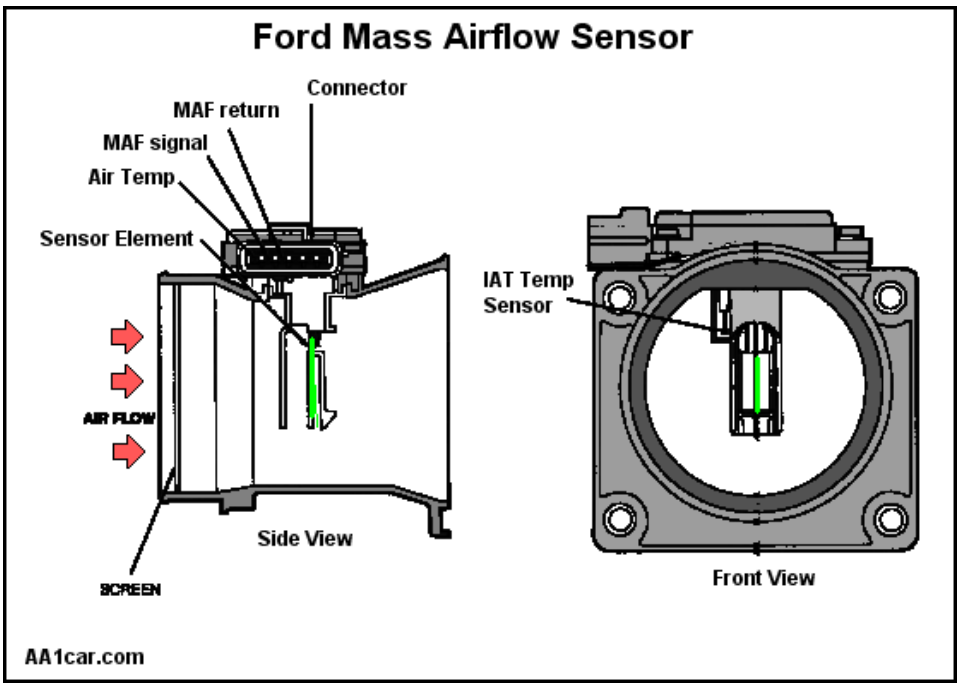
Comprehensive component monitor status
Coolant temperature (graph)
Loop status

**Enhanced PIDS to display (if available)**
Cooling fan command status

**Repair Tips:**

Coolant sensor can be checked with an ohmmeter. Resistance should change according to specs as temperature changes. No change in the reading would tell you the coolant sensor is bad.

Also, compare the coolant sensor reading to the intake temperature reading. Both should be the same when the engine is cold. A difference in redings would indicate a bad sensor.




# MAF SENSOR CODES

## P0100 to P0104 Mass airflow sensor codes

**Symptoms:**

- Engine may be running lean
- Engine may hesitate or stumble under load

**Possible causes:**

Bad mass airflow sensor
Dirty mass airflow sensor element
Air/vacuum leak between MAF sensor and throttle body

**What to Check:**

- MAF sensor (inspect for dirty/varnish inside, loose/damaged wiring connectors)
- Intake plumbing between MAF sensor and throttle body (loose hoses/clamps)

**Generic PIDS to display:**

Mass airflow value
Calculated Load
**Enhanced PIDS to display (if available)**
MAF sensor output (graph voltage output)

**Repair Tips:**

Cleaning dirty MAF sensor wire with electronic cleaner may restore proper MAF operation and eliminate need to replace sensor.

If air duct hose between MAF sensor and throttle is damaged or loose, replace it along with new clamps.

# TPS (Throttle Position Sensor) CODES

P0120 to P0124 Throttle position sensor codes
P0222 to P0229 Throttle position sensor codes

**Symptoms:**

- Engine may hesitate or stumble when accelerating

**Possible causes:**

Bad TPS sensor or sensor wiring circuit
Air/vacuum leak
Bad MAP sensor

**What to Check:**

- TPS sensor (look at indicated throttle opening on your scan tool. Does it change when throttle is opened?)
- MAP sensor
- Intake vacuum (should be 18 to 22 mm Hg at idle, if low check for vacuum leaks)

**Generic PIDS to display:**

Calculated engine load (if low, may indicate bad TPS input)
Mass Airflow (MAF)
Engine RPM

**Enhanced PIDS to display (if available)**
TPS sensor output (graph)

**Repair Tips:**

Watch graph of TPS output for sudden drops while gradually opening and closing throttle (engine off).

On vehicles with electronic throttle by wire, the TPS sensor works with the gas pedal position sensors to control throttle opening. A bad TPS sensor or pedal position sensor may prevent normal throttle operation.

## ELECTRONIC THROTTLE CONTROL DIAGNOSTICS

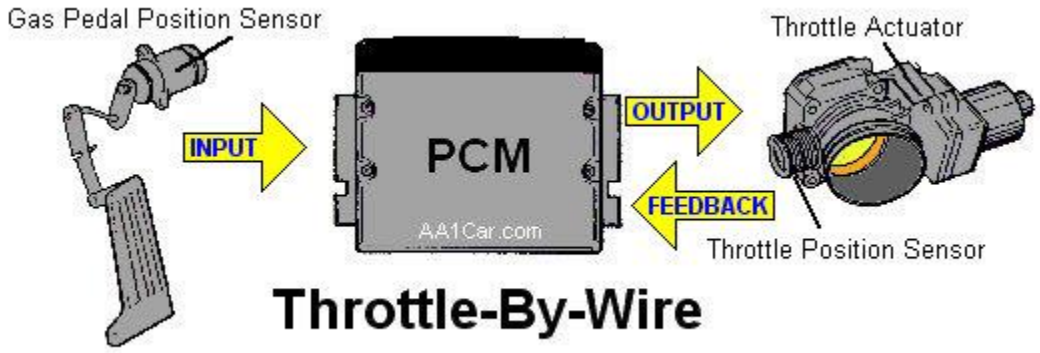
Most of the faults that occur in a Throttle-By-Wire control systems are things you would expect, like pedal or throttle position sensors that wear out and skip or produce erratic signals, motor failures in the throttle body, and electrical problems like loose or corroded wiring connectors.

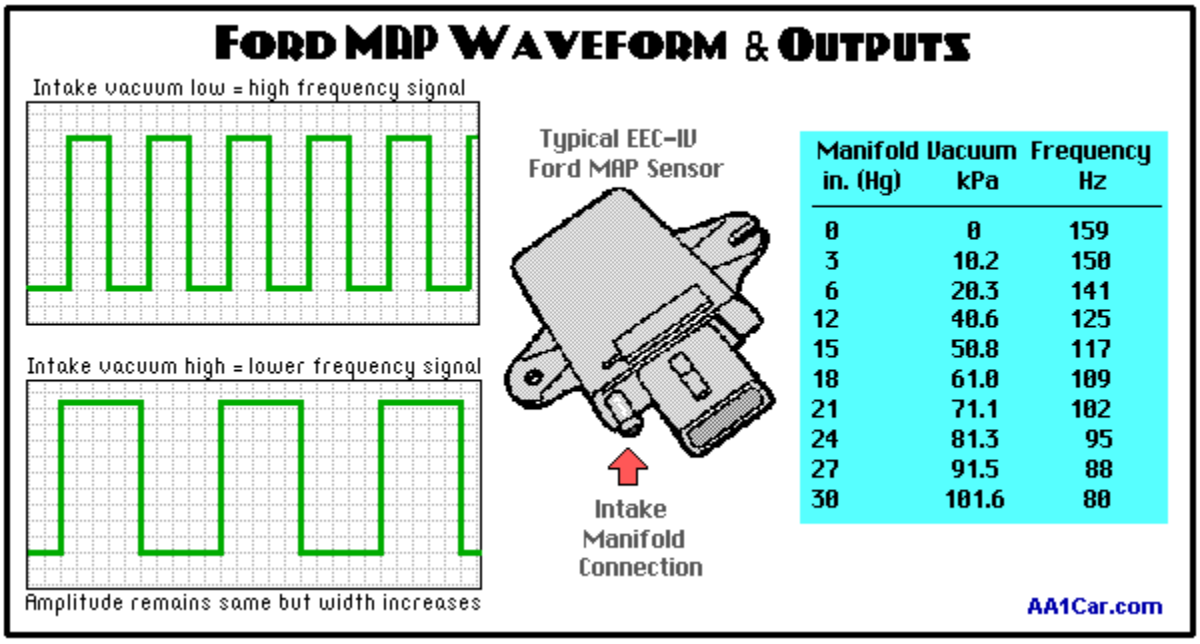
A code reader or scan tool is required for diagnostics. Codes for possible pedal position sensor faults include P0120 through P0124, P0220 through P0229, plus any OEM enhanced P1 or P2 series codes for that specific vehicle.

If a fault occurs in the motor on the throttle body, it will be detected by the feedback signals from the throttle position sensors. Generic OBD II codes for this kind of problem include P0638 & P0639, plus any OEM enhanced P1 or P2 series codes for that specific vehicle.

The Throttle-By-Wire system also monitors the TPS sensors on the throttle body. A fault here may set any of the same OBD II codes just listed for the pedal position sensor, or OEM enhanced P1 or P2 series codes for that specific vehicle.

Diagnosis involves reading the fault code(s) to determine the circuit that is experiencing the problem, then checking the voltage or resistance of the pedal or throttle position sensors with a DVOM, or checking the operation of the throttle control motor (visual observation of the throttle when the motor is commanded to move, and/or checking the duty cycle commanded by the control module using your scan tool.






# MAP (Manifold Absolute Pressure) CODES

## P0105 to P0109 Manifold absolute pressure sensor codes

**Symptoms:**

- Engine may run rich or lean
- Engine may hesitate or stumble when accelerating

**Possible causes:**

Bad MAP sensor
Leaky vacuum connection to MAP sensor
Air/vacuum leak

**What to Check:**

- MAP sensor output
- Intake vacuum
- Catalytic converter & exhaust system for restriction/excessive backpressure

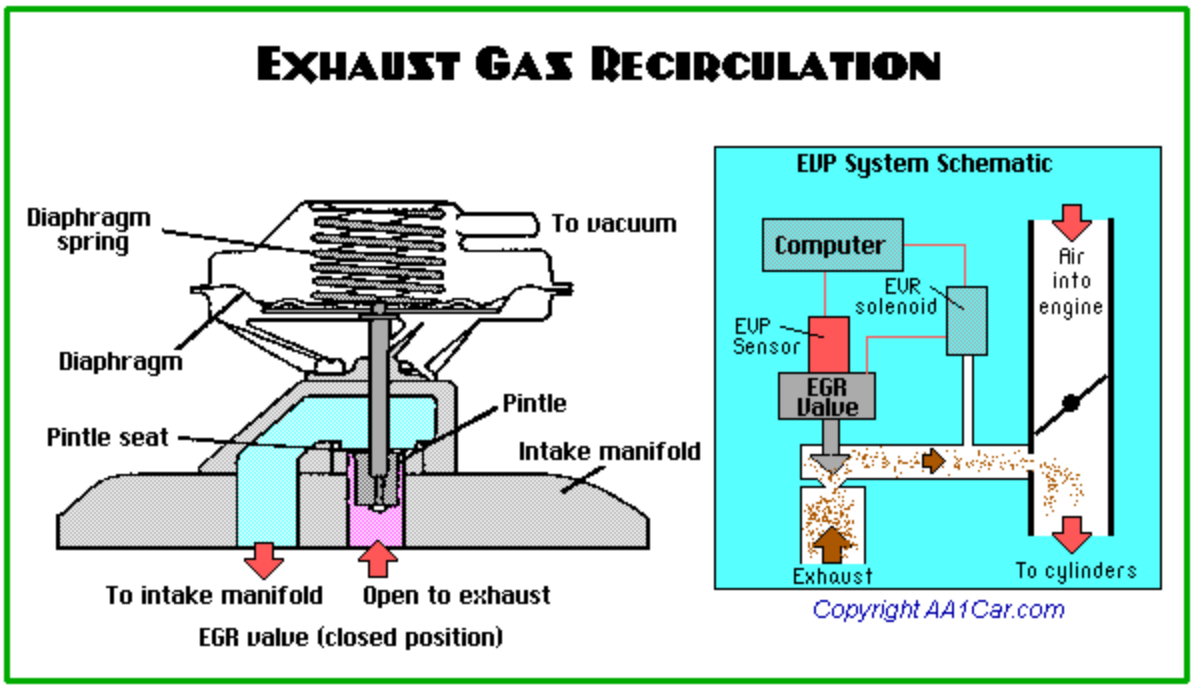
**Generic PIDS to display:**
Calculated engine load (should change with engine speed & throttle position)
Mass airflow (MAF)
ignition timing (retarded timing can reduce intake vacuum & MAP reading)
engine RPM

**Enhanced PIDS to display (if available)**
MAP sensor output (graph voltage output)

**Repair Tips:**

MAP sensor measures engine load, which the PCM uses to adjust the fuel mixture and spark timing.

If the MAP sensor is reading out of range and there are no intake vacuum leaks or exhaust restrictions, replace the sensor.




## EGR (Exhaust Gas Recirculation) CODES

P0400 to P0409 Exhaust gas recirculation codes
P0486 to P0488 Exhaust gas recirculation codes

**Symptoms:**

- Engine may knock or ping (detonate) under load
- Emissions failure due to high NOX

**Possible causes:**

Bad EGR valve
Bad EGR valve control solenoid
Leaky EGR valve vacuum supply
Carbon clogged EGR valve or port in manifold

**What to Check:**

- Operation of EGR valve
- Intake vacuum (if low, EGR valve may be leaking exhaust into manifold at idle)

**Generic PIDS to display:**

EGR OBD II monitor status
Calculated engine load
Engine RPM

**Enhanced PIDS to display (if available)**
EGR commands
EGR valve position

Repair Tips:

EGR recirculates exhaust into the intake manifold to dilute the air/fuel mixture. This lowers combustion temperatures and the formation of oxides of nitrogen (NOX).

If the EGR valve is stuck open, it acts like a vacuum leak and causes a lean fuel condition.

If the EGR valve is fails to open or the port is clogged with carbon, the engine may knock or ping (detonate) under load. NOX emissions will also be higher than normal.

Cleaning the EGR valve & port may restore normal operation.


## CKP/CMP (Crankshaft Position Sensor & Camshaft sensor) CODES

P0335....Crankshaft Position Sensor A Circuit

P0336....Crankshaft Position Sensor A Circuit Range/Performance

P0337....Crankshaft Position Sensor A Circuit Low Input

P0338....Crankshaft Position Sensor A Circuit High Input

P0339....Crankshaft Position Sensor A Circuit Intermittent

P0340....Camshaft Position Sensor 'A' Circuit (Bank 1 or Single Sensor)

P0341....Camshaft Position Sensor 'A' Circuit Range/Performance (Bank 1)

P0342....Camshaft Position Sensor 'A' Circuit Low Input (Bank 1)

P0343....Camshaft Position Sensor 'A' Circuit High Input (Bank 1)

P0344....Camshaft Position Sensor 'A' Circuit Intermittent (Bank 1)

P0345....Camshaft Position Sensor 'A' Circuit (Bank 2)

P0346....Camshaft Position Sensor 'A' Circuit Range/Performance (Bank 2)

P0347....Camshaft Position Sensor 'A' Circuit Low Input (Bank 2)

P0348....Camshaft Position Sensor 'A' Circuit High Input (Bank 2)

P0349....Camshaft Position Sensor 'A' Circuit Intermittent (Bank 2)

**Symptoms:**

- No-Start, Engine cranks but will not start due to lack of crank position signal
- Engine may suddenly die if sensor fails while driving

**Possible causes:**

Bad CKP sensor or loose/cracked sensor ring on crankshaft or crank pulley
Bad CMP sensor
Loss of voltage to hall effect CKP/CMP (loose/corroded or damaged wiring or connector)
Loose sensor or sensor not positioned correctly

**What to Check**:

- Spark when cranking engine (if spark, sensor is working)
- CKP/CMP sensor wiring
-

**Generic PIDS to display:**

Engine rpm (no RPM reading when cranking could indicate crank sensor or wiring fault)

**Repair Tips:**

Two types of crank sensors: magnetic and hall effect. Loss of voltage to hall effect will prevent it from generating a signal pulse. Magnetic sensors make their own voltage, but can be affected by debris on the sensor tip and spacing between the sensor tip and the notches in the crankshaft, flywheel or balancer.

If there is no signal from the crank sensor and you replace it, and the engine still will not start, the problem may be a cracked or loose sensor wheel on the crankshaft or crank balancer/pulley.

# IGNITION RELATED CODES

P0350 to P0362 ignition coil codes
P0300 to P0312 Misfire codes

**Symptoms:**

- Engine may have steady misfire in one or more cylinders
- Engine may crank but not start
- Engine may misfire, stall or die suddenly

**Possible causes:**

Loss of CKP/CMP signal (bad crank sensor or cam sensor)
Bad ignition module or PCM
Bad ignition coil(s)
Bad ignition power relay
Fault in ignition circuit

**What to Check:**

- Ignition coils (check primary & secondary resistance with ohmmeter,check for cracks/carbon arcing)
- Spark when cranking engine (if spark, coils & module are working)
- CKP/CMP sensor wiring (if no spark when cranking)
-

**Generic PIDS to display:**

Misfire monitor status
Engine RPM (no rpm value would indicate bad crank sensor)

**Enhanced PIDS to display (if available):**

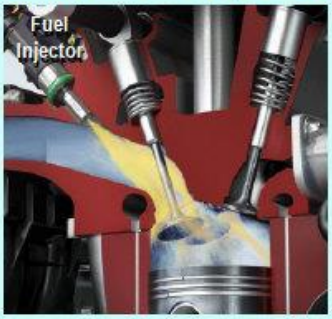
Mode 06 misfire counts for each cylinder (if a count is high, indicates a problem)

**Repair Tips:**

Remove and inspect spark plugs for fouling/wear/gap. Inspect ignition coils for cracks/carbon arcing. Measure ignition coil primary and secondary resistance with ohmmeter. If out of specifications, replace coil(s). If engine has spark plug wires, measure wire resistance end to end. Replace is out of specifications).

## Gasoline Direct Injection vs Port Fuel Injection


AA1Car.com




| | |
|---|---|
| **Where Fuel Is Injected:** Combustion Chamber | Intake Port |
| **When Fuel Is Injected:** Intake Stroke and/or Compession Stroke Depending on Mode | Intake Stroke Only |
| **Fuel Injection Pressure:** Very HIGH: Up to 2200 PSI | Moderate: 40 to 60+ PSI |
| **How Many Injections Per Stroke:** Can Be Multiple Injections | One Injection Per Stroke |

# FUEL RELATED CODES

See RICH CODES, LEAN CODES, MISFIRE CODES

**Symptoms:**

- Engine running rich or lean
- Engine cranks but won't start (no fuel)
- Engine hard to start
-

**Possible causes:**

Low fuel pressure (weak pump or bad regulator)
No fuel (bad fuel pump)
No fuel (bad fuel pump relay)
No fuel (fuel tank empty)
No fuel (plugged fuel filter or line)
No fuel (failed PCM injector driver circuit)
No fuel (bad injector relay or power supply)
Bad gas (water or other contamination, or wrong type of fuel)

**What to Check:**

- Fuel pressure
- Fuel pressure regulator
- Fuel pump relay and voltage supply
- Fuel pump safety shutoff switch
- Fuel gauge reading (no fuel in tank?)

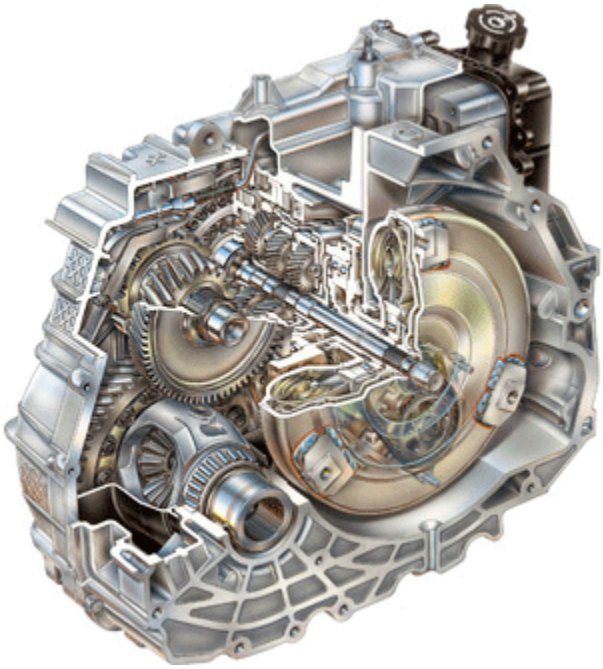
**Generic PIDS to display:**

Fuel system OBD II monitor status
Fuel pressure
Short Term Fuel Trim (STFT)
Long Term Fuel Trim (LTFT)

**Repair Tips:**

If no start, listen for pump to run when ignition is turned on (pump is located inside fuel tank on most vehicles). No pump noise would indicate a dead pump, pump wiring problem, bad pump relay, blown fuel pump fuse, PCM fault or anti-theft system fault preventing pump from running.

If engine has spark and compression but won't start when cranked, problem is no fuel or low fuel pressure.



# TRANSMISSION CODES

### P0800 to P0998 Transmission codes

**Symptoms:**

- Transmission may not be shifting properly or slipping
- Torque converter may not be locking and releasing properly

**Possible causes:**

Internal transmission problem
PCM/TCM module problem
Vehicle speed sensor problem
Wrong type of fluid in transmission

**What to Check:**

- Transmission fluid level
- Vehicle speed sensor

**Generic PIDS to display:**

Engine RPM
Vehicle speed (VSS)

**Enhanced PIDS to display (if available):**

Any transmission related PIDS

Transmission speed sensors & solenoids (if available)

Compare vehicle speed and engine rpm to see if transmission is slipping. Slippage is often caused by a low fluid level.

**Repair Tips:**

If codes are present for transmission shift control solenoids, speed sensors or pressure sensors, these parts can usually be replaced. So can the transmission valve body assembly and torque converter.
If code is present for transmission module, check module wiring connections and ground. If connections are good, module is bad and needs to be replaced.
If transmission has internal mechanical problem (failed pump piston, clutches, etc.), transmission will need to be rebuilt or replaced.

**VERY IMPORTANT:** *If transmission fluid level is low, or fluid is being changed/refilled, make sure you use the type of ATF specified for the application. Using the wrong type of ATF may cause transmission problems or failure.*

# CONTROLLER AREA NETWORK (CAN) CODES

Most late model vehicles (2008 and newer) have a data bus that connects all the onboard modules so they can communicate and share information. A problem here can affect multiple systems and cause various kinds of symptoms. Problems are usually due to wiring faults such as loose, corroded or broken wires, or wires shorted to one another. Controller Area Network (CAN) bus faults will set "U" codes:

**CAN codes**

U0001 High Speed CAN Communication Bus

U0002 High Speed CAN Communication Bus Performance

U0003 High Speed CAN Communication Bus (+) open

U0004 High Speed CAN Communication Bus (+) low

U0005 High Speed CAN Communication Bus (+) high

U0006 High Speed CAN Communication Bus (-) open

U0007 High Speed CAN Communication Bus (-) low

U0008 High Speed CAN Communication Bus (-) high

U0009 High Speed CAN Communication Bus (-) shorted to Bus (+)

U0010 Medium Speed CAN Communication Bus

U0011 Medium Speed CAN Communication Bus Performance

U0012 Medium Speed CAN Communication Bus (+) open

U0013 Medium Speed CAN Communication Bus (+) low

U0014 Medium Speed CAN Communication Bus (+) high

U0015 Medium Speed CAN Communication Bus (-) open

U0016 Medium Speed CAN Communication Bus (-) low

U0017 Medium Speed CAN Communication Bus (-) high

U0018 Medium Speed CAN Communication Bus (-) shorted to Bus (+)

U0019 Low Speed CAN Communication Bus

U0020 Low Speed CAN Communication Bus Performance

U0021 Low Speed CAN Communication Bus (+) open

U0022 Low Speed CAN Communication Bus (+) low

U0023 Low Speed CAN Communication Bus (+) high

U0024 Low Speed CAN Communication Bus (-) open

U0025 Low Speed CAN Communication Bus (-) low

U0026 Low Speed CAN Communication Bus (-) high

U0027 Low Speed CAN Communication Bus (-) shorted to Bus (+)

U0028 Vehicle Communication Bus A

U0029 Vehicle Communication Bus A Performance

U0030 Vehicle Communication Bus A (+) open

U0031 Vehicle Communication Bus A (+) low

U0032 Vehicle Communication Bus A (+) high

U0033 Vehicle Communication Bus A (-) open

U0034 Vehicle Communication Bus A (-) low

U0035 Vehicle Communication Bus A (-) high

U0036 Vehicle Communication Bus A (-) shorted to Bus (+)

U0037 Vehicle Communication Bus B

U0038 Vehicle Communication Bus B Performance

U0039 Vehicle Communication Bus B (+) open

U0040 Vehicle Communication Bus B (+) low

U0041 Vehicle Communication Bus B (+) high

U0042 Vehicle Communication Bus B (-) open

U0043 Vehicle Communication Bus B (-) low

U0044 Vehicle Communication Bus B (-) high

U0045 Vehicle Communication Bus B (-) shorted to Bus (+)

U0046 Vehicle Communication Bus C

U0047 Vehicle Communication Bus C Performance

U0048 Vehicle Communication Bus C (+) open

U0049 Vehicle Communication Bus C (+) low

U0050 Vehicle Communication Bus C (+) high

U0051 Vehicle Communication Bus C (-) open

U0052 Vehicle Communication Bus C (-) low

U0053 Vehicle Communication Bus C (-) high

U0054 Vehicle Communication Bus C (-) shorted to Bus (+)

U0055 Vehicle Communication Bus D

U0056 Vehicle Communication Bus D Performance

U0057 Vehicle Communication Bus D (+) open

U0058 Vehicle Communication Bus D (+) low

U0059 Vehicle Communication Bus D (+) high

U0060 Vehicle Communication Bus D (-) open

U0061 Vehicle Communication Bus D (-) low

U0062 Vehicle Communication Bus D (-) high

U0063 Vehicle Communication Bus D (-) shorted to Bus (+)

U0064 Vehicle Communication Bus E

U0065 Vehicle Communication Bus E Performance

U0066 Vehicle Communication Bus E (+) open

U0067 Vehicle Communication Bus E (+) low

U0068 Vehicle Communication Bus E (+) high

U0069 Vehicle Communication Bus E (-) open

U0070 Vehicle Communication Bus E (-) low

U0071 Vehicle Communication Bus E (-) high

U0072 Vehicle Communication Bus E (-) shorted to Bus (+)

U0073 Control Module Communications Bus Off

U0100 Lost Communication with ECM/PCM A

U0101 Lost Communication with TCM

U0102 Lost Communication with Transfer Case Control Module

U0103 Lost Communication with Gear Shift Module

U0104 Lost Communication with Cruise Control Module

U0105 Lost Communication with Fuel Injector Control Module

U0192 Lost Communication with Television

U0197 Lost Communication with Telephone Control Module

U0198 Lost Communication with Telematic Control Module

U0222 Lost Communication with Door Window Motor A

U0235 Lost Communications with Cruise Control Front Distance Range Sensor

U0301 Software Incompatibility with ECM/PCM

U0302 Software Incompatibility with TCM (Transmission Control Module)

U0303 Software Incompatibility with Transfer Case Control Module

U0321 Software Incompatibility with Ride Level Control Module

U0326 Software Incompatibility with Vehicle Immobilizer Control Module

U0327 Software Incompatibility with Vehicle Security Control Module

**What to Check:**

Refer to wiring schematic for vehicle and check wiring continuity and connections.

Check all ground connections.

Check voltages at modules on data bus.

Check wiring for excessive resistance, shorts or opens.

Repair Tips:

If wiring faults are found, replace wiring as needed.

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