

Oxygen Sensor Information

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>From Terrill_Yuhas@smtpsc1.sc.pima.gov Fri Nov 4 12:42:39 1994

In response to several requests for more information about Oxygen (O2) sensors, perhaps the following information will help. Comment:

These procedures are only for self powered conventional sensors. Some very new cars are using a different style sensor that is powered. *Many* Oxygen sensors are replaced that are good to excellent. *Many* people don't know how to test them. They routinely last 50,000 or more miles, and if the engine is in good shape, can last the life of the car.

What does the O2 sensor do?

It is the primary measurement device for the fuel control computer in your car to know if the engine is too rich or too lean. The O2 sensor is active anytime it is hot enough, but the computer only uses this information in the closed loop mode. Closed loop is the operating mode where all engine control sensors including the Oxygen sensor are used to get best fuel economy, lowest emissions, and good power.

Should the O2 sensor be replaced when the sensor light comes on in your car?

Probably not, but you should test it to make sure it is alive and well. This assumes that the light you see is simply an emissions service reminder light and not a failure light. A reminder light is triggered by a mileage event (20-40,000 miles usually) or something like 2000 key start cycles. EGR dash lights usually fall into the reminder category. Consult your owners manual, auto repair manual, dealer, or repair shop for help on what your light means.

How do I know if my O2 sensor may be bad?

If your car has lost several miles per gallon of fuel economy and the usual tune up steps do not improve it. This *is not* a pointer to O2 failure, it just brings up the possibility. Vacuum leaks and ignition problems are common fuel economy destroyers. As mentioned by others, the on board computer may also set one of several failure "codes". If the computer has issued a code pertaining to the O2 sensor, the sensor and it's wiring should be tested. Usually when the sensor is bad, the engine will show some loss of power, and will not seem to respond quickly.

What will damage my O2 sensor?

Home or professional auto repairs that have used silicone gasket sealer that is not specifically labeled "Oxygen sensor safe",

"Sensor safe", or something similar, if used in an area that is connected to the crankcase. This includes valve covers, oil pan, or nearly any other gasket or seal that controls engine oil. Leaded fuel will ruin the O2 sensor in a short time. If a car is running rich over a long period, the sensor may become plugged up or even destroyed. Just shorting out the sensor output wire will not usually hurt the sensor. This simply grounds the output voltage to zero. Once the wiring is repaired, the circuit operates normally. Undercoating, antifreeze or oil on the *outside* surface of the sensor can kill it. See how does an Oxygen sensor work.

Will testing the O2 sensor hurt it?

Almost always, the answer is no. You must be careful to not *apply* voltage to the sensor, but measuring it's output voltage is not harmful. As noted by other posters, a cheap voltmeter will not be accurate, but will cause no damage. This is *not* true if you try to measure the resistance of the sensor. Resistance measurements send voltage into a circuit and check the amount returning.

How does an O2 sensor work?

An Oxygen sensor is a chemical generator. It is constantly making a comparison between the Oxygen inside the exhaust manifold and air outside the engine. If this comparison shows little or no Oxygen in the exhaust manifold, a voltage is generated. The output of the sensor is usually between 0 and 1.1 volts. All spark combustion engines need the proper air fuel ratio to operate correctly. For gasoline this is 14.7 parts of air to one part of fuel. When the engine has more fuel than needed, all available Oxygen is consumed in the cylinder and gasses leaving through the exhaust contain almost no Oxygen. This sends out a voltage greater than 0.45 volts. If the engine is running lean, all fuel is burned, and the extra Oxygen leaves the cylinder and flows into the exhaust. In this case, the sensor voltage goes lower than 0.45 volts. Usually the output range seen is 0.2 to 0.7 volts.

The sensor does not begin to generate it's full output until it reaches about 600 degrees F. Prior to this time the sensor is not conductive. It is as if the circuit between the sensor and computer is not complete. The mid point is about 0.45 volts. This is neither rich nor lean. A fully warm O2 sensor *will not spend any time at 0.45 volts*. In many cars, the computer sends out a bias voltage of 0.45 through the O2 sensor wire. If the sensor is not warm, or if the circuit is not complete, the computer picks up a steady 0.45 volts. Since the computer knows this is an "illegal" value, it judges the sensor to not be ready. It remains in open loop operation, and uses all sensors except the O2 to determine fuel delivery. Any time an engine is operated in open loop, it runs somewhat rich and makes more exhaust emissions. This translates into lost power, poor fuel economy and air pollution.

The O2 sensor is constantly in a state of transition between high and low voltage. Manufacturers call this crossing of the 0.45 volt mark O2 cross counts. The higher the number of O2 cross counts, the better the sensor and other parts of the computer

control system are working. It is important to remember that the O2 sensor is comparing the amount of Oxygen inside and outside the engine. If the outside of the sensor should become blocked, or coated with oil, sound insulation, undercoating or antifreeze, (among other things), this comparison is not possible.

How can I test my O2 sensor?

They can be tested both in the car and out. If you have a high impedance volt meter, the procedure is fairly simple. It will help you to have some background on the way the sensor does it's job. Read how does an O2 sensor work first.

Testing O2 sensors that are installed

The engine must first be fully warm. If you have a defective thermostat, this test may not be possible due to a minimum temperature required for closed loop operation. Attach the positive lead of a high impedance DC voltmeter to the Oxygen sensor output wire. This wire should remain attached to the computer. You will have to back probe the connection or use a jumper wire to get access. The negative lead should be attached to a good clean ground on the engine block or accessory bracket. Cheap voltmeters will not give accurate results because they load down the circuit and absorb the voltage that they are attempting to measure. A acceptable value is 1,000,000 ohms/volt or more on the DC voltage. Most (if not all) digital voltmeters meet this need. Few (if any) non-powered analog (needle style) voltmeters do. Check the specs for your meter to find out. Set your meter to look for 1 volt DC. Many late model cars use a heated O2 sensor. These have either two or three wires instead of one. Heated sensors will have 12 volts on one lead, ground on the other, and the sensor signal on the third. If you have two or three wires, use a 15 or higher volt scale on the meter until you know which is the sensor output wire.

When you turn the key on, do not start the engine. You should see a change in voltage on the meter in most late model cars. If not, check your connections. Next, check your leads to make sure you won't wrap up any wires in the belts, etc. then start the engine. You should run the engine above 2000 rpm for two minutes to warm the O2 sensor and try to get into closed loop. Closed loop operation is indicated by the sensor showing several cross counts per second. It may help to rev the engine between idle and about 3000 rpm several times. The computer recognizes the sensor as hot and active once there are several cross counts.

You are looking for voltage to go above and below 0.45 volts. If you see less than 0.2 and more than 0.7 volts and the value changes rapidly, you are through, your sensor is good. If not, is it steady high (> 0.45) near 0.45 or steady low.

Testing O2 sensors on the workbench.

Use a high impedance DC voltmeter as above. Clamp the sensor in a vice, or use a plier or vice-grip to hold it. Clamp your negative voltmeter lead to the case, and the positive to the output wire. Use a propane torch set to high and the inner blue flame tip to heat the fluted or perforated area of the sensor.

You should see a DC voltage of at least 0.6 within 20 seconds. If not, most likely cause is open circuit internally or lead fouling. If OK so far, remove from flame. You should see a drop to under 0.1 volt within 4 seconds. If not likely silicone fouled. If still OK, heat for two full minutes and watch for drops in voltage. Sometimes, the internal connections will open up under heat. This is the same as a loose wire and is a failure. If the sensor is OK at this point, and will switch from high to low quickly as you move the flame, the sensor is good. Bear in mind that good or bad is relative, with port fuel injection needing faster information than carbureted systems.

ANY O2 sensor that will generate 0.9 volts or more when heated, show 0.1 volts or less within one second of flame removal, AND pass the two minute heat test is good regardless of age. When replacing a sensor, don't miss the opportunity to use the test above on the replacement. This will calibrate your evaluation skills and save you money in the future. There is almost always **no** benefit in replacing an oxygen sensor that will pass the test in the first line of this paragraph.