

Electrical: Engine Sensors

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Abbreviations:

AMM	Air Mass Meter
ECT	Engine Coolant Temperature sensor
ECU	Engine Control Unit computer (either fuel injection or ignition)
FI	Fuel Injection
FPR	Fuel Pressure Regulator
IAC	Idle Air Control solenoid valve
TB	Throttle Body
TPS	Throttle Position Sensor
VSS	Vehicle Speed Sensor

Air Mass Meter. See [FAQ section](#) in Engine: Fuel Injection for AMM information.

Hall Sensor. See [Electrical: Ignition](#) for more details on Hall sensors in LH 2.2 and earlier distributors.

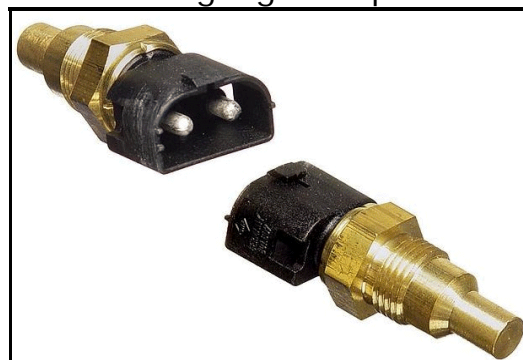
Engine Temperature Sensors. The B230F of the vintage discussed, 1989-1995 have in effect three temp sensors. The **Temperature Gauge Sensor** is at the front under intake manifold runner number two, just ahead of the knock sensor which is bolted in at an angle. It has two round pin connectors, one signal, one ground. For resistance ratings, see the link noted. Behind the knock sensor under manifold runner three is the **Engine Coolant Temperature Sensor - ECT** - which is in effect two sensors in one housing. Two NTC thermistors are combined in one ECT sensor housing with two flat connectors and ground through the housing into the manifold. One of the temp sensor signals goes to the LH fuel injection computer, the other to the EZK ignition computer. When you remove any of the sensors, disconnect the battery negative cable.

Removing the Sensors.

Do I Need to Drain the Coolant? [John McRaven] Release any residual pressure in the system by opening the cap, then close it again. Get the old ECT loose, get the new one ready to go, then just pop the old one out and put the new one in as quickly as possible. You really won't lose very much coolant at all. The sealed system will glug out a little bit, then build a slight vacuum and stop. Put the new one in, tighten, then rinse away the slight leakage with a hose and top off the missing pint or less.

Gauge Temperature Sensor. [Inquiry] How do I remove the gauge temperature

sensor? [Mark Duval] This is the front sensor under intake manifold runner number two with the two round pins. A 19mm socket will not work because of the width of the wiring connector. I bought the stubby 19mm combination wrench and a 19mm crow foot socket. First tried the open end side of the stubby and although I could get it squarely on the hex head, I could not put enough force on the wrench to turn the sensor. Then used the crow foot socket with a long extension. This



rotated off the hex and cracked the electrical connection at the top of the sensor. The answer all along was to remove the sensor's molded-on electrical connector (destroying the sensor) and gain access to the hex with an offset 19mm box wrench or a 3/4 inch socket. [Jay Simkin] Remove the old sensor and prep the new sensor by applying a thin coat of grease on the threads. Then apply grey pipe joint compound (not the white, teflon-loaded joint compound) in a collar of compound on the underside of the sensor's lip, above the threads. Keep the joint compound away from the threads. To reinstall, gently screw the prepped sensor into the opening in the block. Tighten snug using a 3/4" open end wrench. A 3/4" socket will not work, as the electrical connector housing is wider than the brass hex fitting used to secure the sensor. Check for leaks. Tighten gently if required to stop any leaks. Replace the knock sensor using a 12mm wrench to tighten it securely

against the engine block. Replace both electrical connectors and reconnect the battery negative.

[Editor] It helps to first remove assorted tubes and pipes, including the IAC valve and the **knock sensor** nearby, which is merely bolted into the block.

Engine Coolant Temperature Sensor. Removing the Engine Coolant Temperature Sensor (the rear-most of the three sensors, Volvo p/n 1346030 or Bosch 0280130032) is a little tougher, since it is buried under intake manifold runner number three. Two contrary removal tips: [Tip from John Sargent] [Removing the intake manifold](#) makes it less than a 30 minute job. Trying to R&R without removing the intake manifold can lead to a broken sensor. The brass hex of the ECT is 19mm. The electrical connector is larger than the 19mm hex and a socket or box end wrench will not fit over the electrical connector, so you can only use an open end wrench to remove the ECT. The wiring harness connector can be very difficult to disconnect without removing the intake manifold. Save yourself on both aggravations, just get an intake manifold gasket if the sensor needs to be replaced. [Jay Simkin]



This sensor's wiring connector housing fits inside a 19mm deep socket, which then engages the sensor's brass hex fitting. I recently did this job, and used a 3/8" 19mm deep socket to remove the sensor from the head. There was just enough work room between the manifold's runners (I have small hands). I put the socket on the sensor, and then inserted the ratchet's square protrusion into the socket. By contrast, the temperature gauge's coolant sensor (towards the front of the head) has a wiring connector housing wider than is the sensor's brass hex fitting. Therefore, some may need to remove the connector housing, before removing the sensor.

Installing the Sensors. [Editor] Do NOT use Teflon tape or Teflon pipe sealer on the threads when reinstalling since they may interfere with temperature readings and with grounding against the block. Better to use thin coat of a conductive grease such as OxGard or apply pipe joint compound above the threaded area.

Diagnosing ECT Failures. [Response: Don Foster, adapted to 700/900 series by Editor] Your engine has two temp sensors -- one for the gauge (it's mounted in the head about under intake header #2, and one for the FI (it's mounted in the head about under intake header #3). The latter is the ECT sensor.

The sensor is an NTC thermistor -- negative temperature coefficient. As the temp drops, the resistance rises, and as the temperature rises, the resistance drops. Thus, if you have a broken wire, defective sensor, or bad connection (I've seen it happen) the resistance measured by the ecu will be very high or infinite. The ECU interprets this as minus a zillion degrees and pours in the gas

The car I saw filled the oil with gas and certainly wouldn't run. And the problem was only a displaced spade lug in the plastic connector housing. According to

Chilton's (you may choose to disregard this):

The coolant temperature signal to the control unit has a great influence on the computed injection period... For example, when the engine is being started and is cold, the amount of injected fuel must be relatively large. [Editor:] Too rich a mixture because of a failing ECT may lead to idle surges, high idle, poor warm running, or other symptoms of too much fuel. See [Engine Tune and Performance: Symptoms](#) for more examples.

If the control unit receives a signal higher than 302F (150C) or lower than -40F (-40C), it will interpret the signal as a fault...the control unit will assume a substitute value corresponding to 32F (0C) on starting and 68F (20C) when the engine has started.

With the control unit connected, connect a voltmeter across LH ECU terminals 13 and 5 (ground) for Bosch LH 2.4 systems or terminals 2 and 5 (ground) for LH 2.2 systems. This unit is in the passenger side footwell, under the plastic cover. Remove the cover of the large electrical connector to access the backs of the pins for the test. Turn the ignition switch ON.

- At 68F (20C) the voltage should be 2.0 +/- .5v volts.
- At 104F(40C) the voltage should be 1.2 +/- .3volts
- At 176F (80C) the voltage should be .5 +/- .2volts.

The resistance values between ECU pins 13 and 5, or between each of the pins on the sensor and ground, are (by eye from the chart):

- 32F (0C)-- about 6000 ohms within a range of +/- 10%
- 68F(20C) -- about 2300 ohms
- 104F(40C) -- about 1300 ohms
- 140F(60C) -- about 600 ohms
- 176F(80C) -- about 300 ohms
- 212F -- about 190 ohms

[Response: Steve Ringlee] ECT resistance cold for LH2.4 systems should be around 6k ohms at 32 degrees F (0 deg C), 2300-2700 ohms at 68 degrees F (20 C), and 200 at 212 F (100 C). However, try checking your ECT wiring: Between pins 13 and 5 at the LH ECU (with sensor DISconnected) resistance should be infinite. Voltage with the ignition ON and sensor connected, measured between pins 13 and 5, should be:

- 0 C=around 3 volts +/- .5v
- 20C=around 2 volts +/- .5v
- 100C=around .3 volt +/- .1v

If these aren't correct, check the connections in the ECT wiring harness. Check engine ground connections at the intake manifold. If the voltage is zero, your ECU is at fault.

ECT Wiring/Connector Failure. [JonP] my 1990 LH2.4 still ran rich, smoked, stumbled, and set codes 1-1-3, 2-1-3, and others referring to rich mixture. However, during disassembly I discovered the female connector for the ECT was

damaged by one of the sensors spade pins when someone pressed the connector on incorrectly. The pin missed one of the female clips and mashed it. The local Volvo dealer parts manager has been very helpful: I described the ECT connector problem and he gave a new connector to me with a couple of insulated pinch connectors and his tips for how to make the splice....no charge. He did say if this splice didn't fix it then he thought it was a failed ground in the ECU (ECM) for the fuel injection. He said the bad connector could also cause a bad ground problem at the ECU.

960 B6304 ECT Sensor Failure.

[Tip from Tom Haywood] '95 960 B6304 with Motronic 1.8: the symptoms, in my case, were sudden very high idle surges (2500-3000 RPMs) while sitting at idle and hot-start problems. This engine has two coolant sensors; the rear coolant temperature sensor is Volvo#68 49 350 (SWF#602.101) and apparently plays a role in fuel injection and various timing functions. It is similar to the front one (FRONT Volvo#35 45 031), but without the 5-inch connector wire. Testing the sensor in heated water indicated normal operating ranges until reaching 180deg.(220 ohms)at which point the circuit would open completely (infinite ohms). When the brass housing would heat up it would pull the connector pin away from the thermistor leg. I have further learned that these symptoms can also point to the wiring to this sensor, because of the location between the fire-wall and hot engine parts. I could suggest to anyone with this engine to keep a new sensor handy, because it looks like the car will be dead-in-the-water when it fails. This sensor is at the rear of the head and requires a mirror taped to the firewall and a 19mm open-end wrench for removal (drain the antifreeze and remove the heater hoses first). Work from the top of the engine, standing on a stepstool and using a pillow on which to kneel. It has a 2-pin D-type connector mounted right on the brass housing. The large size of the connector keeps you from being able to get a good box-end wrench on it, but mine was not very tight anyhow (just very hard to get to).

[Tom Irwin] Those rear ECT's are a pain in the ass. The harness (surprise!) allows very little slack. As the insulation degrades, the tension on the wires just pops it off. Then the epoxy potting around the sensor starts to go.

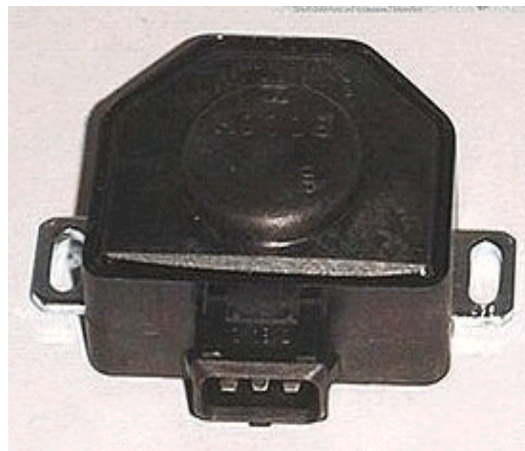
Throttle Position Switch. [Editor] This applies to both Bosch LH2.4 and Regina systems.

Symptoms of Failure:

High idle at startup or uncontrolled idle above 750 rpm.

Diagnosis:

This switch is a simple device: at either extreme of motion, an internal switch is closed and you will see continuity between one outer connector and the middle ground connector. Disconnect the

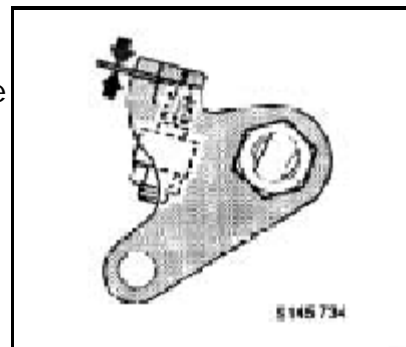


switch connector and jump from one side connector to the middle ground connector. If idle returns to normal, then the switch is at fault. The switch is not repairable.

Adjusting the TPS:

To adjust the TPS:

1. Remove the throttle body from the car and loosen the TPS adjustment screws
2. Hold the throttle plate and keep it from moving. Rotate the TPS clockwise, then counterclockwise until a click is heard. Continue rotating until it stops but does not cause the throttle plate to move. This can best be done by inserting a .25mm feeler gauge between the lever and the adjustment screw. Secure the screws.
3. Proper adjustment is obtained when you open the throttle plate and insert a feeler gauge at the throttle stop screw:
 - When you close the throttle against a .45mm feeler gauge, no click is heard from the TPS
 - When you close the throttle against a .15mm feeler gauge, a click is heard.



Oxygen Sensor

Theory and Operation

1. Oxygen sensors should last over 100k miles under ideal conditions; various contaminants will shorten that considerably.
2. [Excerpts from Underhood Service magazine, Nov 2000, et al]

The O₂ sensor is mounted in the exhaust manifold to monitor how much unburned oxygen is in the exhaust as it exits the engine. Monitoring oxygen levels in the exhaust is a way it gauges the fuel mixture. The sensor tells the computer if the fuel mixture is burning rich (less oxygen) or lean (more oxygen).

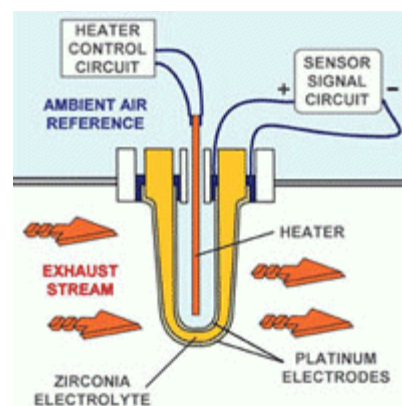


Although O₂ sensors are amazingly rugged considering the operating environment they live in, they do wear out and eventually have to be replaced. The performance of the O₂ sensor diminishes with age as contaminants accumulate on the sensor tip and gradually reduce its ability to produce voltage. The aging process is caused by a buildup of contaminants on the sensor's zirconium sensing element. If the engine burns oil, phosphorus deposits may contaminate the sensor and catalytic converter over time. If the engine has an internal coolant leak (cracked combustion chamber or leaky head gasket), silicone additives in the antifreeze can become a source of contamination. **Contamination Caution:** If you use silicone-based RTV gasket

material anywhere on the engine, especially in manifolds or valve covers, make sure the tube says "sensor-safe RTV compound". Silicone from the gasket can contaminate your oxygen sensor. According to the Robert Bosch Corp., replacing a degraded oxygen sensor with a new one will increase fuel efficiency by 10% to 15%. Don't use silicone sprays anywhere near the intake system. And Airtex Automotive reports replacing degraded oxygen sensors has the potential to reduce a vehicle's emissions of hydrocarbons (HC) by 23% and carbon monoxide (CO) by 33%. In fact, an EPA study found that 70% of the vehicles that failed an I/M 240 emissions test needed a new O₂ sensor. Bosch recommends a professional service technician check a customer's oxygen sensor on a regular basis: every 60,000 to 100,000 miles for a heated three- or four-wire sensor.

The O₂ sensor works like a miniature generator and produces its own voltage when it gets hot. Inside the vented cover on the end of the sensor that screws into the exhaust manifold is a zirconium ceramic bulb. The bulb is coated on the outside with a porous layer of platinum.

Inside the bulb are two strips of platinum that serve as electrodes or contacts. Between the electrodes is a solid-state electrolyte made up of a zirconic ceramic material that acts like a galvanic battery electrolyte under certain conditions. When the sensing element is cold, the zirconia material behaves similar to an insulator. At elevated temperatures, the zirconia material performs more like a semiconductor, and can generate a characteristic voltage output on the sensor connections.



The outside of the bulb is exposed to the hot gases in the exhaust while the inside of the bulb is vented internally through the sensor body to the outside atmosphere. Newer-style O₂ sensors breathe through their wire connectors and have no vent hole. This is why grease should never be used on O₂ sensor connectors because it can block the flow of air.

The difference in oxygen levels between the outside air and the exhaust within the sensor is what causes voltage to flow through the ceramic bulb. The greater the difference, the higher the voltage reading. Typically, an oxygen sensor will generate up to about 0.9 volts when the fuel mixture is rich and there is little unburned oxygen in the exhaust. When the mixture is lean, the sensor's output voltage will drop down to about 0.1 volts. When the air/fuel mixture is balanced or at the equilibrium point of about 14.7 to 1, the sensor will read around .45 volts. When the computer receives a rich signal (high voltage) from the O₂ sensor, it leans the fuel mixture to reduce the sensor's reading. When the O₂ sensor reading goes lean (low voltage), the computer reverses again, making the fuel mixture go rich. This constant flip-flopping back and forth of the fuel mixture occurs at different speeds depending on the fuel system. Engines with multiport injection do this five to seven times per second at 2,500 rpm. The O₂ sensor must react quickly to these changing fuel conditions in order for the computer to maintain the best average air/fuel ratio. As sensors age, they become sluggish and respond more slowly to changes in the air/fuel ratio. This may cause emissions and fuel consumption to rise.

Before it will start to generate a voltage signal, the oxygen sensor must be hot - usually from about 450d F to 600d F or even higher. The sensor incorporates an internal electric heating element to bring the O₂ sensor up to operating

temperature quickly (under 35 seconds). Internal heating elements usually operate continuously while the engine is running to maintain an operating temperature of approximately 1292 degrees Fahrenheit to 1472 degrees Fahrenheit. Heated O2 sensors operate at a more consistent temperature and allow greater flexibility of placement locations in the exhaust system. Three and four wire sensors have this heater installed: two wires for the heating element, one signal wire and possibly a ground wire. Oxygen sensors that are not equipped with a ground wire must have a well-grounded exhaust system to complete the sensing circuit. Basic electrical wiring circuit checks should be made to determine if the vehicle's wiring harness has good continuity and is free from short circuits.

The ECU will set an O2 sensor diagnostic code if the sensor does not produce a voltage signal, stays rich too long, stays lean too long, does not switch rich/lean (center too long), or does not switch rich/lean fast enough. If the sensor dies altogether, the result can be a fixed rich fuel mixture. The rich mixture therefore can cause the converter to overheat, resulting in severe damage and higher repair costs for the driver. As one aftermarket manufacturer points out, sensor checks come down to paying a little now or a lot later. One way technicians can test oxygen sensors is to see if the sensor's output voltage changes when the fuel mixture changes. When the mixture is lean, the sensor's output voltage should be low (down around 0.1 volts), and when the mixture is rich the sensor's output should be high (up around 0.9 volts). A steady low voltage reading or no voltage reading would indicate a bad sensor.

Making the fuel mixture artificially rich by adding propane into the intake manifold should cause the sensor to respond almost immediately (within 100 milliseconds) and go to maximum (0.9v) output. On the other hand, creating a lean mixture by opening a vacuum line should cause the sensor's output to drop to its minimum (0.1v) value.

Although a technician can read the O2 sensor's output with a scan tool or digital voltmeter, the transitions are hard to see because the numbers jump around so much. An analog voltmeter is better for viewing transitions, but may not respond quickly enough on systems with higher transition rates. So the recommended instrument for observing the O2 sensor's voltage output is a digital storage oscilloscope (DSO). A scope will display the sensor's voltage output as a wavy line that shows its amplitude (minimum and maximum voltage) as well as its frequency (transition rate from rich to lean).

A good O2 sensor should produce an oscillating waveform at idle that makes voltage transitions from near minimum to near maximum. If the sensor doesn't flip-flop back and forth quickly enough, it may indicate a need for replacement. If the O2 sensor circuit opens, shorts or goes out of range, it may set a fault code and illuminate the Check Engine or Malfunction Indicator Lamp. If additional diagnosis reveals the sensor is defective, replacement is required.

Specific Diagnostics and Tests

See the specific diagnostic procedures in the [FAQ Fuel Injection](#) section on [Oxygen Sensor Diagnosis](#).

[Inquiry:] Anybody know what the resistance of the O2 sensor heater should be?

mine says 2.2 ohms. With only the green wire connected to the ECU I get a pretty stable .52 volts, which I have read in the archives to be the ECU reference voltage. Hopefully all is well at that end. If I connect the heater (there is ~13.5v on the harness side, btw) the sensor voltage decays over about 30 seconds to .01 volts. At no time does voltage sweep from .3 to .7 v. Also, can you replace the heated one with non-heated? A Bosch Ford 5 litre sensor is \$97.80 (cdn) at a local import autoparts store, the Volvo sensor is \$280 something.

[Response 1: Abe Crombie] That is the right resistance on the heater. Use a digital voltmeter with impedance at least 10 megohm. Before you replace the sensor warm up engine and attach the voltmeter positive probe to O2 sensor lead (the green wire into pin 24 on the Fuel Injection ECU, or using a sharp probe tip into the black sensor wire at the firewall connector), the negative probe to a convenient chassis ground, and leave the oxygen sensor connected. Then turn on the engine and momentarily pinch the rubber return line behind fuel pressure regulator. If the voltage of sensor goes to .7-.9 V then look for something other than the sensor causing a lean condition. A faulty sensor can give you the low V reading but an air leak or defective MAF sensor can do the same. With regard to heated (three wire), versus non-heated (two wire), yes and no. The heated sensors are used to keep the signal active while idling. Idling in cold weather primarily, the sensor will fall below its 600F temp at which the reaction that makes it output voltage begins to work. If it were to stay above this temp the non-heated would be okay. There are different sensors out there also. Most all the Bosch up to 92 have the same output voltage at the same O2 gradient. After 92 there are differences in some of the applications in this respect.

Regina vs. Bosch Oxygen Sensors

The Bendix/Siemens Regina fuel injection systems use a titania-type sensor which varies resistance and is **not** interchangeable with the Bosch zirconia units which create a varying voltage signal. This sensor does not work with a .5 V reference out of the ECM as do the Bosch versions. The Regina unit uses the heater power supply to feed a sensor circuit which responds to O2-level variations. The Bosch zirconia unit measures an electrochemical reaction and the heater merely maintains the temperature stability of the sensor and does not supply current to be modified and used as output signal.



Compared to the more common zirconia O2 sensors, titania sensors have three advantages: (1) they don't need an air reference (there is no internal venting to the outside atmosphere to plug up); (2) they have a fast warm-up time (about 15 seconds); and (3) they work at lower exhaust temperatures (they won't cool off at idle and they can be located further downstream from the engine or used with turbochargers). See the [notes below](#) regarding the use of generic sensors in Regina cars. A direct replacement for the Regina sensor is an NGK 25002: [Amazon](#) has a good price on these.

When is Replacement Recommended? [Tip from Import Car Magazine, Apr 2003] Replace if:

- Antifreeze contaminates oxygen sensors. Oxygen sensor replacement is highly recommended after replacing cracked cylinder heads, leaking intake gaskets or

leaking cylinder head gaskets.

- Oil contamination also ruins oxygen sensors. Oil ash accumulating on the sensor thimble or wicking through the sensor wire may cause erroneous air/fuel ratio readings.

Other Conditions Causing Oxygen Sensor Malfunctions:

- Leaking exhaust manifolds and air injection systems contribute to faulty air/fuel measurements by the oxygen sensor because they dilute the exhaust gas stream with atmospheric oxygen.
- Leaking fuel pressure regulators or leaking vacuum hoses and intake gaskets often will cause a no-switching condition at the oxygen sensor.

Replacement Procedures:

Opening Caution. [JohnO] If doing it yourself, do it with a cold engine as many O2 sensors are more likely to cross-thread if done hot (although not so much so with Volvos). If you doubt your skills with this, just take it to dealer and pay them to replace it as it won't be that much for the labor (about 1 hour).

Tool Notes. Which tool do I use to remove the O2 sensor? [Paul Seminara] Use a crows foot or special slotted O2 sensor socket or adapted open/closed end wrench.

Replacement Procedure. [Editor: Tom's notes apply to a 960 but the procedure is similar for 740/940] [query] I'm planning to change my O2 sensor on my 960 wagon. Where is that thing? How tough of a time will I have in removing it because of heat-related seizing. [Response: Tom Irwin] OK, if you are w/o a shop and hydraulic lift, I recommend the following... FOUR JACKSTANDS Rated to 3,000 pounds apiece or better. I've been lifting the car under it's mid-chassis reinforcement with a large wide-saddle jack. A skinny jack will damage the underside of your car... Lifting the whole side, place 1 jackstand each under the corner lifting points, at FULL-EXTENSION... do the drivers side first... Ditto the passenger side, BUT LEAVE the jack in place and lower it maybe 0.5" so it is a back-up, in case the jackstands fail, but it is NOT bearing any load... (could cause they whole deal to shift.) Lay down a HEAVY piece of corrugated cardboard... Let's you SLIDE in and out from under the car real nice.

The O2 sensor is screwed in to the CAT, up on top, there are four wires. FIRST! Go open the hood and locate the O2 connector... it's kinda near the oil dipstick tube, about half-way down. It should be clipped to a metal standard...release it...there is enough slack to lift the whole assembly up higher for a better look. It is a BLUE plastic connector with a RED slide-Lock passing through it's mid section. Use a small thin screwdriver under the looped bail of the red slide lock and pry it gently to the side, extend it as far as it will go. Separate the 2 blue plastic halves make sure that the end of the harness that goes down below to the O2 sensor is not wire tied anywhere.

Go back Down Under the car, pull the wire down and cut any cable ties holding it to the dipstick or elsewhere. Now on the left side of the transmission there are 3 plastic snap-lock clips holding the wires to the transmission pan. Squeeze them from the inside with a thin nosed plier and release all three. On the UPPER, TRAILING EDGE of the transmission tail bracket, there are 3 10mm headed bolts

holding the wire to the bracket. Remove all three. A small 1/4" drive ratchet is great for this. Then remove the ONE speed nut holding the wire up on a heatshield in front of the CAT. Follow the wire... THAR she IS... sticking out of the top of the CAT, in front of the honeycomb. It is a 22mm facet on the base of the sensor. Get a 22mm socket with the sidewall slotted out for the wire to pass thru (Editor: known as an oxygen sensor wrench)... if you can... but I just squirted a bit of PB Blaster on the base and let it sit for a few minutes.

I ended up using a 22mm spanner wrench open end to the sensor.. It cracked free quite easily... you may be so lucky.. Then you just un-screw it. I know this is trite....but....Re-Assembly IS reverse order. REALLY! [Tip] In truly corroded cases, heating the pipe or converter bung with an oxyacetylene torch should loosen the screwed-in sensor. [Note from WBain] Use an anti-seize compound on the threads (if the sensor did not come with any.) It will make any future disassembly easier. [Caution from David Hunter] Also make sure you are not cross threading it - easy to do on the O2 sensor.

Replacement: Use of Generic Sensors.

Generics. [Editor] You can install a generic Bosch or other three-wire heated sensor instead of the more expensive Volvo OEM sensor in Bosch LH systems, but you will have to splice in the connector. The separate [FAQ File](#) on sensor replacements shows some wire length and splice information. Bosch model numbers 13953, 13942, and 13913 are reputed to work depending on your year and engine (same sensor listed as for Ford 5.0 V8 Mustang engine but different harness lengths: check the [Bosch](#) site for applications and see the [FAQ File](#) on sensor replacements).

Note: See the [table](#) of generic replacements compiled by Brickboard members. Note that several correspondents have noticed [hesitation](#) on acceleration after installing generic sensors due to peak voltages of 1.3 instead of 0.9. Replacing the sensor solved the problem.

OEM in 93+ Bosch. [Frank] In March of 1993 Volvo switched from a three wire O2 sensor to a four wire sensor. The three-wire generic sensors are **not** interchangeable with the newer four-wire applications.

Regina. If you have a Regina-equipped car, **use a sensor specifically engineered for Regina** systems. Regina cars through 1993 use a Volvo -394 sensor which is the same as NGK OTA4F-B. The Walker catalog lists 250-23811 as a direct fit replacement for Regina systems. **Note: many aftermarket sites, including FCPGroton, do not distinguish between Bosch and Regina and claim that the Bosch unit "fits all". Not true.** To be sure, buy the NGK unit for Regina which is listed at their [website](#) (they confuse 8 and 16 valve cars, but the correct Regina sensor is shown.)

Installation. [Ken] To install the generic sensor, you will need to cut the wires on your harness and splice them to the sensor wire. Crimping is recommended, instead of soldering, because solder weakens stranded wire subject to heat and vibration by decreasing its fatigue life. The NGK website also recommends crimping using heat shrink tubing to protect the crimp. Buy 3M crimp connectors with integral heat shrink tubing (Walmart has these). Do not use silicone dielectric grease on the connection since silicone contaminates the sensor.

Code 2-1-2 "Faulty Oxygen Sensor" in 960 Cars. [Rafael Riverol] If the check

engine light on the dashboard lights up and you read OBD I diagnostic code 2 1 2 (faulty oxygen sensor (O2) signal) in your 960, undo the red and blue four way O2 connector near the oil dipstick and check inside. The metal spades in the male connector are surrounded by silicone like material which crumbles, particularly after you apply electronic connection cleaner or the like. The particles can fall within the male and female connection, even inside the female connector contacts, and cause a faulty O2 sensor signal. Take out the loose material with sharp tweezers. Make sure all contacts are clean and undistorted and connect back together **WITHOUT** using silicone dielectric grease because of low signal voltages. Clear the codes. This procedure should eliminate the faulty signal.

Crank Position or RPM Sensor.

B2XX Series Engines. Symptoms of Failure: No Hot Restart. Suppose the car already has the upgraded silver-terminal fuel pump relay but won't restart promptly after a hot soak. Take an educated guess on a weak crank position (RPM) sensor. If you have Bosch LH2.4, then replacing this permanent-magnet sensor located in the top of the bellhousing fixes many hot restart complaints on 700/900s. [Tip from HansW] Check the lead to the sensor: it can rub against engine components or fray from flexing and expose the wiring. Newer sensors come with plastic cable holders to prevent this. [Editor] Many Regin-equipped cars use the same sensor.



Testing Bellhousing RPM Sensor. [Inquiry:] I decided to find and remove my flywheel sensor. Externally it's in perfect condition. The cable and ends are pristine-looking. Is there a way to test it with a multimeter?

[Response: Ivan K] To find the sensor, stand at the left or drivers' side front fender and look behind the rear of the cylinder head down towards the bell housing . The crank sensor sits in a hole at the very top of the bell housing and has a black 1/4 inch diameter wiring harness leading into it down from the firewall harness. Often these rpm sensors fail intermittently, usually when hot. This makes them hard to test. Since the sensor is cheap enough, just replace it. With high mileage cars, it's only a matter of time before they fail.

[Response] Measure the signal while the sensor is still installed by unplugging the sensor at the cable connections at the firewall to the drivers side of the engine. Measure voltage here as the engine is being cranked. Use a low voltage setting on a digital volt meter, preferably in an alternating current setting if available in a low voltage setting. If no signal is detected, the unit is suspect. The other simple measurement is to unplug the unit (without removing it from its location behind the engine on top of the transmission housing). Check all 3 terminals for resistance or an open circuit. The new sensor measured about 160 ohms between the center lug and a side lug (red and blue wires). The black wire is the grounded shielding wire. My old defective unit had no continuity and no measurable resistance.

Removal of Bellhousing RPM Sensor. [Tips from Jay Simkin, George Campbell and others] The rpm sensor is awkward to access as it is below the cylinder head on top of bell housing. It can be removed by using 21" of 1/4" or 3/8" extensions, then a universal joint, a 3" extension, and a 10mm standard depth socket to turn the retaining 10mm hex head screw. OR you can use a 10mm combination wrench with a ratcheting box end ("GearWrench"). Note that some cars use an 8mm bolt head.

Use a flashlight to locate the sensor and the bolt. You'll have to peer at the thing from the passenger side fender, looking over the air conditioning pipes. It's below the distributor, on the top of the bell housing. Carefully put your left hand between the engine block and firewall, and locate the retaining bolt head and the wire from the sensor with your fingers. The reason for this is so you can orient yourself to its exact location. While you're removing and replacing it, you won't be able to see what you're doing, so you'll need to visualize it in your mind. Then clean the area around the sensor using brake cleaner and spray it with penetrating oil.

[*Using the Socket and Extensions to Loosen*] Without inserting the ratchet in the extension end, pass the tools between the firewall and the aluminum-colored air-conditioning pipe. Once the tools enter the space beside the engine, bend the universal at 60 degree angle. Pass the tool string behind the engine block. There is a black cable that can be pushed out of the way. The 3" extension and 10mm socket will align pretty easily with the top of the hex head machine screw. Set the socket on the machine screw head. Gently, insert the ratchet into the extension string. Turn gently to remove the machine screw. Remove the tools. Use your left hand to grip the sensor.

[*Using the Ratcheting Wrench*] Orient the wrench so that it will loosen the bolt, and then using your left hand, with your index finger placed over the ratcheting box, insert your hand and the wrench carefully behind the engine block and place the ratcheting box end over the retaining bolt head. The reason for putting your index finger over the box end is to make it easier to find that bolt head, since you won't be able to see. Carefully re-orient your hand on the wrench, trying not to pop the box end off the bolt head and then loosen the retaining bolt. You'll be able to move the wrench only about 10 degrees, so keep going until the ratchet won't loosen the retaining bolt any further, then remove the wrench and your left hand. Insert your right hand behind the engine block, thumb down, and use thumb and index finger to finish removing the retaining bolt. Keep one finger on the bolt at all times. You'll only be able to manage a partial turn each time. When the bolt is free, carefully remove it and take it out from the narrow space. Put it somewhere safe.

[*Removing the Sensor*] The sensor usually will come free as soon as the screw is removed. If it does not, grip it close to where it enters the housing - not at the top, into which the wire enters - and pull straight up. Do not pull on the wire. If the sensor will not come out, you may need to break any seal between the sensor base and the bell housing. Use penetrating oil. Turn the sensor gently about 1/16" turn, in either direction. You may rock the sensor gently, but no more than 1/16", side-to-side. Do not use any tool or brute force and DO NOT PRY since the housing is plastic (see the Cautionary Note below). The sensor goes only about 3/4" into the bell housing. The sensor has smooth sides and no locking lugs, so it is removed by pulling straight up. Do not use brute force: if the sensor snaps and plastic fragments fall into the bell housing, the transmission will have to be removed to allow removal of the fragments. Disconnect the sensor at the connector near the driver's side firewall. Pry the spring clip loose and put it safely somewhere. It's

small and easily lost. You can fish the plug through the zip tie on the firewall, but it's not all that easy. Move the other wires, etc. until you get it out.

Caution: Some Cars Have a Flimsy Sensor Mounting Bracket. [Another Tip]

Trouble started when I couldn't get the old sensor out of the hole into which it fits over the flywheel. Where it's located makes it hard to get much of a grip on it. I tried rotating it in the hole to free it and then prying it up with a screwdriver. To make a long-story short, it's not mounted in the beefy Volvo bell housing like I thought, but in a flimsy, Fiat-like, aluminum casting that bolts into the back of the block. And very easy to break, I've discovered. And designed so you need to separate the bell housing from the engine to R&R it!!! Moral of the story is go easy on a stuck sensor



[Chris Herbst] NEVER PRY the RPM sensor out of the bracket. The poor quality bracket that they use to hold the sensor is SO weak that can break if you force the sensor around. Prying side to side on the sensor can break either the bracket or the sensor, leaving you helpless to do anything but pull the trans back to replace the bracket. When you really pry that thing is usually when it breaks. But because those brackets are so flimsy, it can still get you when you don't expect it. Usually (99 out of 100) is a piece of cake. But when you're the one who has #100... it sucks. Just be careful and you'll be fine.

Turn it lightly back and forth to remove it, but don't force it at all. Wait until it moves. On a standard trans cars use a tiny bit of silicone spray to get the thing out, and work it gently back and forth until it gradually loosens. If it is an automatic, get an Easy Out screw extractor into it, then douse the thing with PBlaster penetrating oil and wait for it to work its magic. The penetrant won't hurt anything like the clutch on the standard trans car. On the other hand, you want to avoid harming the timing ring on the automatic, because it is not very strong. You still run the risk of demolishing the bracket if you pry at it too hard, so make sure you are patient and let any penetrant or silicone get in there before you pull it. Once they move side to side, they can gently be removed. This sometimes takes a while, but the rewards are that you don't have to pull the transmission. On installation, put a light coating of grease on the perimeter of the sensor where it contacts the bracket. That will make your life a lot easier when you go to get it out of there next time. And if you have the trans out for any reason, take the RPM sensor out--whether or not you reuse it--and coat it LIGHTLY with a film of grease. That will avoid the problem, should the sensor need replacement in the future. [Editor]

Reinstallation. [George Campbell] Don't bother trying to fish the new sensor's plug through there. It's a waste of time. Just zip tie the wire to the other wires after installation. After plugging in and securing the new sensor, carefully route it and let it drop behind the distributor, near where it will go. Coat the 10mm bolt threads and face with antiseize. Insert the retaining bolt in the sensor's extension. Using your left hand, put your index finger on the top of the

retaining bolt, grasp the sensor with your thumb and second finger and carefully maneuver the sensor into position, lowering the sensor into the hole in the bell housing. You may have to fiddle a bit, but if you oriented yourself well before starting, you'll find the hole easily with the part by feel. Keep your index finger on the top of the retaining bolt as it rises when the sensor enters the bell-housing. Gently turn the assembly until you feel the retaining bolt find its threaded hole. It's hard to describe, but you'll feel it. Very carefully, move your hand, and work with thumb and forefinger to start the bolt in the threads. If you don't have lots of experience, this will be the most difficult part of the job, since the quarters are so tight and since you can't rotate the bolt much. Don't rush and don't accidentally pull the bolt out and drop it. The bracket is deep enough to keep the bolt from falling out on its own. Just don't raise the bolt. Once you've started the threads with your left hand, switch to your right hand, thumb down, and continue turning the bolt head to tighten it. When you can no longer move it with your fingers, use the ratchet box end of the wrench to finish the tightening job.

Broken Sensor Bracket Removal. [Editor] The usual solution to a broken crank sensor bracket is to pull the transmission and replace it. However, I have seen reports of using a Dremel or drill along with a shop vac to suck up metal chips, to enlarge the bellhousing opening and remove the bracket screws before installing a new sensor bracket. This is done without pulling the transmission. [Robert] Drill and a dremel worked fine. Tried to pull tranny out but got stuck on one pesky bolt. So I had to abort and went for a drill. Was done in 2 hours and back on the road today. I only had to trim about half an inch on each side. The bracket itself is only about \$30.

Bent Flywheel Sensor Plate. The sensor uses a toothed plate mounted on the flywheel to sense revolutions; if this is bent, it will not record the pulse. Odd symptoms, including difficult starting and poor power, may result. Bending commonly occurs when working around the flywheel or when jamming the ring gear to change the timing belt, so be VERY careful when working in that area.

B6XXX Series Six Cylinder Engines

[Tip: Rob Bareiss] The 960 (B6304) engine uses a sensor mounted at the back end of one of the camshafts. It's in the same position as the distributor on an 850/S/V70 5cylinder. Since the 960 has no distributor, it uses this thing instead. Also saves a bunch of space at the back of the engine. Probably should consider it a regular service item, as with the 4-cylinder models. Replacing it is probably cheaper than having the car towed one time... Removing it is similar to the B23X engines except for the wiring clip on the firewall.

[DanR] To get the connector off the bracket, all you need is a fairly small flat bladed screw driver. Pry away the metal collar that surrounds the connector; it has a clip that snaps in place. The part that snaps in is on the underside of the clip. If you break the plastic shells holding it together, they are replaceable from the dealer. On reinstallation, make sure you insert correctly the two wires from the trans oil temp sensor.

Knock Sensor.

Symptoms of Failure. [Tips from Marc] The car starts fine and will run for 2 miles and then lose power. It never stalls just won't move. If I shut it off and immediately restart it, it will run fine again for another 2 miles and so on and so on. When it runs fine, with a timing light hooked up on acceleration the timing will retard 1 or 2 degrees before it advances. If I check it when the problem is occurring it will retard 6 or 8 degrees before it tries to advance. Solution: new knock sensor. [Other symptoms] Retarded timing, acting as though no fuel is reaching the engine.

Sensor Styles. [John Sargent] The knock sensor is located on the cylinder head under the junction between number two and three intake manifold runners. It is next to the two coolant temperature sensors also bolted to the head. LH 2.1, LH 2.2, and LH 2.4 all use the same knock sensor, offered in two interchangeable styles that may be used on the red engines. Type 1 is on the left in the photo on the right, and Type 2 on the right. The only difference in the parts is the torque for the bolt holding the sensor to the block. Type 1 has the flat top, and the fastening bolt is torqued to 8 ft-lbs (11Nm), and Type 2 has the domed top and the fastening bolt is torqued to 15 ft-lbs (20Nm). If you use anti-seize paste, reduce the torque setting by 30-40% to account for the lubrication by the paste.



Operation. [Inquiry:] How do I test the knock sensor? [Response: Abe Crombie] If there is not a fault code for it then it is okay. The ignition control unit tests it every time you exceed some thing around 3000 rpm with moderate to high throttle. If it is not torqued properly it might not be as sensitive as it should or be overly sensitive. Torque is 8-11 ft-lbs. It produces a high voltage pulse when it senses the shock wave in the range of combustion knock. The voltage level is proportional to the severity of the knock. It will read 1.5 or greater megaohms but this is not really an effective test, only the control unit detecting a sensor signal when the conditions would absolutely assure a signal would be made is the real check. The knock sensor test by whacking on block (better than on the intake) next to knock sensor (see Duane's note below) is only effective on early Chrysler systems with the throttle opened as the closed throttle signal is supplied to Chrysler ignition ECU and it cancels knock sensor retard activity. If you have Bosch ignition systems you can't do the whack it and watch it test for knock sensor operation. The Bosch systems are cylinder specific and you would have to knock within a few crank degrees of a given cylinder firing and be monitoring the timing light attached to that cylinder's plug wire. I don't think any of us are that good.



[Tip for Chrysler Ignition Systems from Duane Hoberg] On the right side of the engine, in the area above and to the rear of the oil filter, tap the block with a metal faced hammer while observing the timing with a timing light. The timing should retard 6 degrees then return. If not then the sensor or the circuit in the control box is bad. When installing the new knock sensor, use thread lock. Apply too much torque and the sensor becomes sensitive as it is prestressed and reacts to normal

engine vibration. When this happens you will idle fine but above idle run at retarded timing all the time. Acts like poor fuel delivery and doesn't like hills.

Diagnosis. [Additional Tips from Dave Stevens] Procedures for dealing with suspected knock sensor problems for an LH 2.4 system with EZ116-K ignition. Tests for other systems will be similar. Check the wiring diagram for your particular model and year to verify connector pins and wire colors. When no knock sensor signal is detected the EZK ignition system defaults to full spark retard. (see also [Engine Performance](#))

1. OBD ignition trouble code 1-4-2 Missing signal from knock sensor
2. OBD fuel system trouble code 3-1-2 Missing knock sensor signal
3. The fuel system control unit (FCU) isn't getting the knock sensor signal from the ignition unit (ICU) at start-up.
4. Poor performance and acceleration due to excessively retarded timing
5. Over-sensitive knock sensor possibly due to over-torqued or failed knock sensor.

Cheap gas and heavily carboned engines may cause misfiring to the point that the knock sensor signal is not believed by the ECU. Wiring and the knock sensor itself are by far the most common sources of knock sensor problems. [Les Daniels] If this piezo detector fails, it goes open circuit and the ECU 'thinks' that a massive retarding of ignition called for - hence the drop off in performance. On carb models there can be backfiring as well.

Knock Sensor Testing:

The knock sensor can only be tested dynamically for proper waveform output with an oscilloscope. Unless it makes you feel useful, there is no point in tapping on the block to simulate knock sensor activity. The voltage output of the piezoelectric quartz is too small and brief for normal measurement and, furthermore, the newer ignition systems won't be fooled into changing the timing as they selectively only detect knocking that would coincide with a misfire.

Start by making sure any engine diagnostic codes are for real by resetting the trouble codes (or disconnecting the battery) and wait to see if they reappear. Then do the physical and electrical checks below. If all other tests check out you may want to swap in a known good knock sensor on spec. Failing that an ICU swap may be in order. Only in desperation should the FCU be swapped on spec.

Physical checks:

1. [Les Daniels] One fault with these detectors is that the plastic housing 'cooks' and then the detector basically falls to pieces.
2. Check that the knock sensor (on the block, left side, down below intake runners #2 and #3) is properly connected to the wiring harness. It's easy to leave this connector off if you've been working on the engine.
3. Make sure the wiring connector for the knock sensor (green with black or brown wire) has not been accidentally switched with the block temp sensor connector (red/black with grey/white wire). The connectors are alike.
4. Make sure all connections are making good contact (straighten bent/separated contacts, check pins are fully seated by pushing in from back side). Remember

to check the associated connector block at the strut tower or firewall. Make sure all connections are clean and protected from oxidation. Inspect for deteriorated/damaged wiring. Use an approved type of electrical contact cleaner. Squeeze dielectric grease into both sides of the connectors before re-assembly.

5. [Charles Dinges] Make sure the wiring feed to the knock sensor is not close to the alternator: anecdotal reports of interference and retarded timing upon acceleration were solved by moving this wire. Some electromagnetic interference from the alternator is the likely cause.

Electrical Sensor and Wiring Checks:

Note that testing at the ECU connectors requires the use of a multi-meter and some skill in electronic/electrical testing. Accidents can be very expensive. To avoid connector damage, do not probe connectors from the end, probe only from the sides or back. When working with ECU modules and sensors, always keep the ignition OFF (KPO) and disable power to the electronic unit (by pulling all ECU fuses or disconnecting the battery) except when required during testing. This will help avoid accidental damage due to

1. At the ICU connector (EZ116-K, EZ117-K or RexI ignition control unit) check the wiring from the knock sensor.
 1. Remove the knock sensor connector.
 2. Remove the ICU connector and remove the shell to access the side of the connector for testing (note the pin numbers stamped on the connector).
 3. Measure the resistance between ICU pin 12 and ground and between pin 13 and ground. Both should be infinite (open). Anything else indicates damaged/shorted wiring.
 4. Place a jumper wire at the knock sensor connector (between pins 1 and 2).
 5. Measure the resistance between ICU connector pins 12 and 13. It should be zero ohms. Infinite resistance indicates an open wire or bad connector. Anything else indicates a dirty connector.
6. At the FCU connector (LH 2.4 fuel injection control unit) check the knock sensor signal from the ICU (pin 4). Applies to EZ116-K ignition only.
7. Remove the FCU connector and remove the shell to access the side of the connector for testing (note the pin numbers stamped on the connector).
8. Re-install fuses. Turn the ignition to ON (KPII).
9. Measure the voltage between FCU connector pin 28 and ground. It should be approx +0.7 volts. Anything else indicates a problem with the ICU or its wiring.

Sensor Testing Procedure:

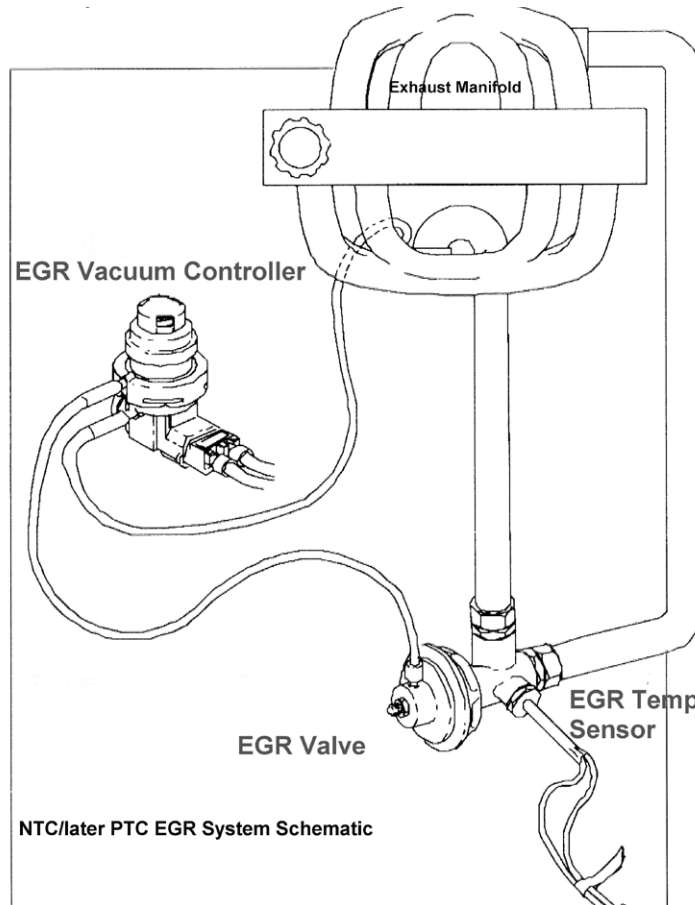
[Rafael Riverol/Andreas Lofgren] Connect test diode Volvo tool #5280 (or LED from Radio Shack connected in series with 750-1500 ohm resistor, which will work just as well for a couple of dollars) black lead to connector on drivers side of the car wheel housing near steering fluid reservoir (RED AND YELLOW LEAD). Connect red lead of tool or LED to battery or ignition coil terminal 15 where you find +12V. Use enough wire to run LED to passenger compartment or at least to hold it with windshield wiper where you can see while driving the car. Turn ignition on and diode should stay lit. Start the engine and run it about 900 rpm. Diode should now

go off. Drive the car under light and heavy engine loads. If diode flashes 4 times, check knock sensor wiring. If wiring checks OK, replace knock sensor and run above check again. If diode continues to flash with road test, you may have to replace the ignition control unit.

EGR Valve Service Requirements.

[Inquiry] What exactly is the EGR?. It is specified in the service manual that it must be checked / cleaned during the 90,000km (~60000 mi) service.

[Response: Tom Irwin] The Exhaust Gas Recirculation (EGR) valve is located underneath the intake manifold. If it gets plugged, you can ruin an O2 sensor or get incorrect fuel metering; basically the engine will run like crap and use a lot of gas. To service the EGR, it will be necessary to remove the air induction apparatus for clearance. Removing the throttle body also helps and it is a good time to clean it out as well. The same is true for the IAC, Idle Air Control valve. Once you remove the EGR valve, Take it to a bench and use a vacuum pump to check operation and hold open the diaphragm and valve, or follow the procedure below. Spray carburetor cleaner through it. Also spray into the tubes. A stiff wire might be useful if there is large debris or a plugged line. The temperature sensor electrical connector should be de-oxidized and protected with silicone dielectric grease.



EGR Valve Removal. [Procedure from Kevin] The EGR intake tube is held to the intake manifold via 2-10mm bolts and a flange. The exhaust side is screwed into the exhaust manifold with a 22mm acorn nut. Once the tubes are separated the valve itself is held in a bracket via a large thin nut, best removed with a large pliers. I found it took a good two-handed pull to break the 22mm acorn nuts free (the nuts that attach the pipes to the valve). Your only option here is to use a 22mm open-ended wrench (unless you happen to have such a thing as a 22mm crows-foot). Be real careful not to have the wrench slip and round off the nut. The valve gets hot in operation, so the nuts tend to seize to the valve fittings and take some persuasion to break loose. I sprayed PBlaster penetrating oil on the fittings and let it sit for 20 minutes before trying. This is a classic knuckle-buster situation, so it is a good idea to put on a pair of gloves. Access is limited with a big wrench like this one, but once the nuts are started you will be able to turn them 1/6-turn at a time till they are off. Once the nuts were off, I had to tap the inlet pipe with a hammer to get it loose from the port on the end of the valve. The compression fitting on the end of the pipe was kind of wedged in the port on the valve and did not want to come off at first. I could not get the outlet pipe off of the side of the

valve, so I took the valve off with this pipe still connected (disconnect the other end of the pipe from the intake manifold first). The valve is held on a bracket with a 25mm nut. I managed to get this off with a 1 inch AF open-ended wrench. Again, it took some force to break it free, and access is limited so it was 1/6 or 1/4 turn at a time to get the nut off. I had a difficult time getting the vacuum hose off the valve. the rubber boot at the end of the hose was in very poor condition (rubber was breaking down and had taken on a tacky/gummy consistency) and was stuck to the vacuum nipple on the valve. I assume this is due to the high temps that this valve sees. I will be looking for a replacement as I do not think it is going to last much longer.

EGR Valve Vacuum Checking/Cleaning. If you don't have a vacuum pump to test operation, improvise: Insert an allen wrench or small screwdriver or other suitable probe into the inlet port (threaded opening on the end of the valve) until it contacts the valve seat. Keep one hand on this probe while maintaining a small force to keep it in contact with the seat. Place vacuum nipple in mouth and suck! You will feel the valve seat opening. The valve should hold open without any additional suction. If the valve fails to open, or if the diaphragm leaks when you do this, then the valve may need to be replaced. If you don't want to put engine parts in your mouth, you can make a more hygienic mouthpiece from a couple of inches of scrap vacuum hose. When I cleaned my valve, it had very little carbon/dirt in the valve. Noticeable build up of carbon on end of the EGR discharge pipe, where it connects to the intake manifold. Cleaned this up with a stiff wire and several squirts of throttle-body cleaner

EGR Valve Reinstallation. I put a little anti-seize on the threads before replacement (don't get any inside the ports though). I am hoping this will make it easier to get the nuts off next time. Place the valve in its bracket. Hand tighten clamping nut that holds it to the bracket. Start the threads on the two acorn nuts. Attach the outlet pipe to the intake manifold and tighten the nuts there all the way. Tighten the bracket clamping nut all the way. Tighten the two acorn nuts all the way. Put a spot of silicone grease on the vacuum nipple and replace the vacuum tube (again, I am hoping this will stop the rubber from gluing itself to the nipple. Reconnect the temp sensor electrical connector.

Pulsair Valve. [Tops from Tom F] Volvo introduced Pulsair system on B200/30A, E, and K-engines and on the US '94-'95 B230FD engines. The Pulsed Secondary Air injection system adds oxygen to the exhaust



manifold to continue the combustion of unburned fuel in the exhaust system and provides additional oxygen for the catalytic converter, thereby lowering harmful



emissions. It is independent of the [EGR system](#) and many cars have both. The pulsed secondary air injection solenoid or PAIR Solenoid

receives a signal from the ECU allowing the vacuum control valve to open via the small diameter tube to the plastic shut-off valve. The solenoid is located on the left strut support between the EGR Converter and the OBD box. The shut off valve is located at the single end of the Y hose opposite the two pulsair valves. The PAIR valve (Pulsair valve), with permission from the ECU, allows oxygen in every time the exhaust valve closes, which causes an instance of negative pressure (the pulse) and introduces oxygen into the manifold. No air pump required. The photo shows the two Pulsar valves feeding the exhaust manifold and a vacuum control valve which get its a signal from the PAIR solenoid to allow air from the air cleaner box to pass through. If a valve fails, it can allow exhaust gas flow back, cooking the rubber hose. The hose is connected to a vacuum operated shutoff valve connected to the air cleaner. To test the pulsair valve, on a cold engine, place your hand over the valves, near enough to verify that air is being taken in and exhaust gas is not escaping. The action of the valve is a quick pulse corresponding to the opening and closing of the exhaust valves. Also, pull the hoses and look down to see the valves: they should be replaced if they are black from soot. They do wear out. [Tom] There are two tubes that come off the manifold that go to the pulsair valves. Inside the pulsair valve there is a stainless steel one-way flapper that allows clean, filtered air into the exhaust using back pressure (every time an exhaust valve closes) and prevents exhaust flow into the intake system. The first sign of a failed pulsair valve is a cooked and cracked hose attached to the pulsair valves. In my case the plastic valve with the small tube going to the pair valve did not fail. There are no disks at the manifold or tubing: the one-way flapper "disks" are in the pulsair valves. I am not sure what causes the failure of the valve but I think exhaust crud is a result of the valve failure. The valve cannot be repaired.

Regina Air Temperature Sensor. The Regina fuel injection system uses air pressure and temperature in the intake system to compute the air mass moving into the engine. The temperature sensor is located in the intake hose or pipe. The air mass passes through holes in the sensor and over a bulb which sends a temperature signal from the incoming air charge to the ECU. Information from this sensor is added to the pressure sensor information to calculate the air mass being sent to the cylinders. The sensor is an NTC (Negative Temperature Coefficient) thermister which means that resistance declines as the temperature increases. This sensor helps the ECU to determine spark timing and air/fuel ratio. You can check this resistance by connecting an ohmmeter between pins to read:

- -20°C (4°F) 15K ohms
- 20°C (68°F) 2.5K ohms
- 100°C (212°F) 160 ohms

Use a heat gun to change temperature. Problems may occur in the sensor, the connector, or the wiring leads.

Regina Manifold Air Pressure (MAP) Sensor. The Regina fuel injection system uses air pressure and temperature in the intake system to compute the air mass moving into the engine. The MAP pressure sensor is located on the driver's strut tower support. It is connected to the intake manifold through a hose and takes a reading of intake pressure. The sensor is piezo-electric and changes a voltage input to an output signal proportional to manifold pressure. The system calibrates

atmospheric pressure when the engine is started and under full load conditions. To test, turn ignition "on" and test the back of the sensor connector or the pins on the back of the ECU connector (do not disconnect with the ignition "on"):

- Connector A or pin 6 is ground
- Connector C is the constant voltage input from pin 7 on the ECU and should read 5 volts to ground
- Connector B is the variable output signal from the pressure sensor to pin 11 on the ECU. Connect a hand vacuum pump to B or 11, apply vacuum, and read the signal. Voltage should drop from 5 volts to a lower number. If it does not drop, replace the sensor.

Problems may also occur in the sensor, the vacuum tube leading to it, the connector, or the wiring leads.

OEM and Replacement Parts. ACDelco makes these sensors with replacement parts as follows:

MAP sensor Volvo 3517892 (\$146)= ACDELCO Part # 2131545 (\$47) or
GM Part #12569240

[Volvo Maintenance FAQ for 7xx/9xx/90 Cars](#)
