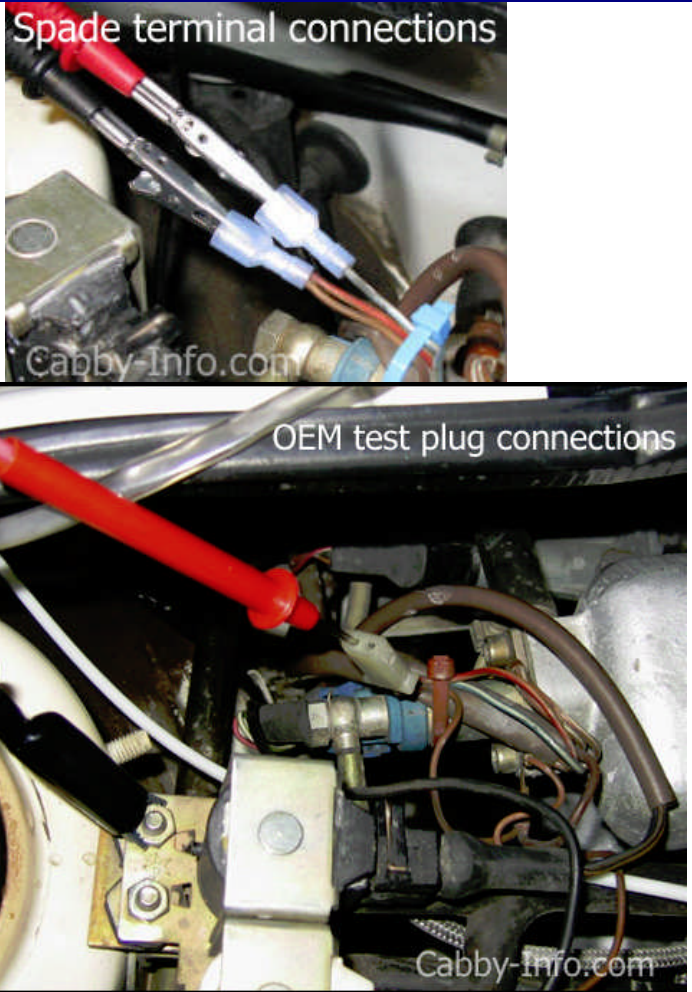


Volkswagen Cabriolet DIY Guide

K-Jetronic: Testing Lambda System & Components

Tools needed:

- Digital or analog volt-ohm meter that measures duty cycle and/or dwell
- New D-cell battery
- Jumper wire using two male spade connectors

Step	Example
<p>Step 1 ~ Connect your meter</p> <p>Pop the engine hood and connect your meter to the test port:</p> <ul style="list-style-type: none">Connect the red positive (+) meter wire to the blue/white wire's female terminal in the two-pin test connector by the cold-start valve. Connect the black negative (-) DVOM wire to any convenient ground*.If using the dwell setting, set meter to "4 cyl".If using the duty cycle setting, set meter to "frequency %" ** <p>Read your meter's instructions; some meters require an additional step, such as pressing a button such as "range".</p> <p>*If you have installed spade terminal disconnects in place of the OEM connector, simply attach the red (+) probe's alligator clip to the blue/white wire terminal and the black (-) probe's alligator clip to the brown wires' terminal.</p> <p>**If using duty cycle, be aware that Cabriolets produce a negative slope reading. Many DVOMs read only in positive slope. Easy test: Connect the test leads as described above. With the engine running, actuate the full-throttle switch. If the reading is 35%, reverse the test leads: red (+) to brown wire, black (-) to blue/white wire. Actuate the full-throttle switch once more; the reading should be 65%.</p>	 <p>Spade terminal connections</p> <p>OEM test plug connections</p>

Perform the next steps in sequential order, one right after the other and starting with a cold engine (cold meaning the engine hasn't been run in several hours). Write down your meter's results as you do the tests so that you can refer to them later; if need be, print [this handy table](#).

If your car is having running problems, these tests will (dis)prove whether your oxygen sensor is faulty, your oxygen sensor thermostwitch is faulty, your Jetronic control unit is faulty, etc.

**** Remember, you are responsible for working on your car; Cabby-Info.com, KamzKreationz, VAG, VWoA, or anyone else are not responsible if anything goes wrong while you are working on, in and under your car! Use this information at your own risk! ****

Step 2 ~ Cold-start enrichment test

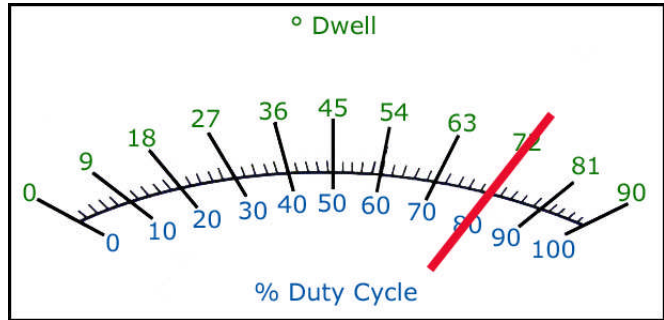
Open loop – cold

- Disconnect the leads from the oxygen sensor thermoswitch (underside of the cylinder head coolant flange on 1.8L) and bridge the terminals using a jumper wire with male spade terminals.
- Start and run the engine.
- 1980-1987:** Duty cycle should be a constant 80% (or 72° dwell) with very little fluctuation.
July 1987-1989: Duty cycle should be a constant 65% (or 58° dwell) with very little fluctuation.

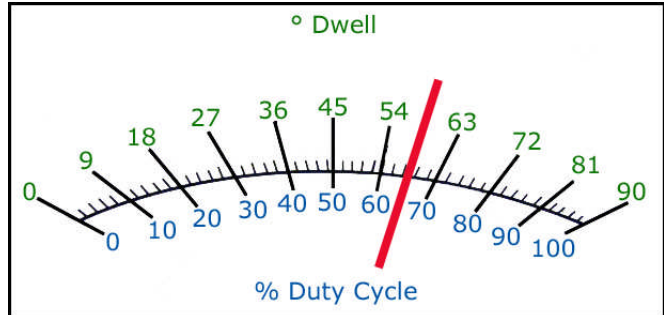
July 1987-1989:

Disconnect the oxygen sensor after doing the above test. Your meter should read 65% duty cycle (or 58° dwell) with very little fluctuation. If the meter reads 50% (or 45°), check the cold-running enrichment vacuum switch. Reconnect the oxygen sensor.

1980-1987:



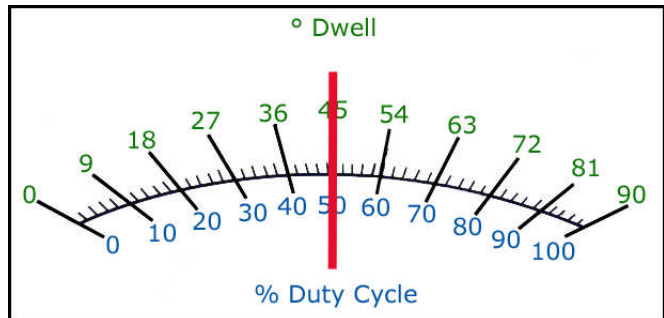
July 1987-1989:



Step 3 ~ Limp-home mode test

Open loop – warm

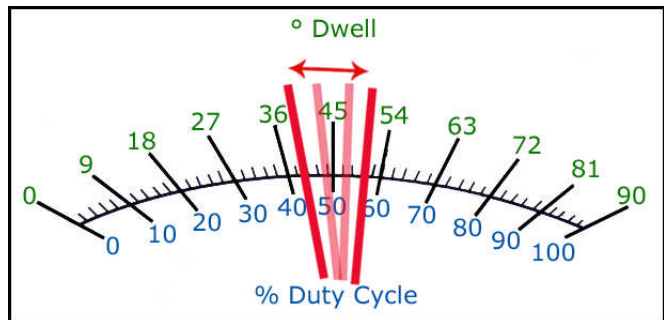
- Leave the engine running.
- Disconnect your jumper wire from Step 1 and leave the thermoswitch disconnected.
- Duty cycle should be a constant 50% (or 45° dwell) with very little fluctuation.



Step 4 ~ Warm-running test

Closed loop

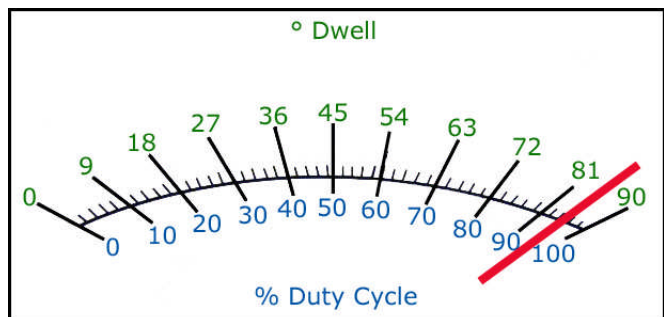
- Leave the engine running.
- Reconnect the oxygen sensor thermoswitch's factory connector.
- Keep an eye on your meter: You should see the duty cycle change from a constant 50% duty cycle (or 45° dwell) to a reading that fluctuates to 50% ±8% duty cycle (45° ±7° dwell). If the meter is already fluctuating when you look at it, turn the engine off, let it cool down for a bit and retry this test.



Step 5 ~ Rich correction test

Rich stop

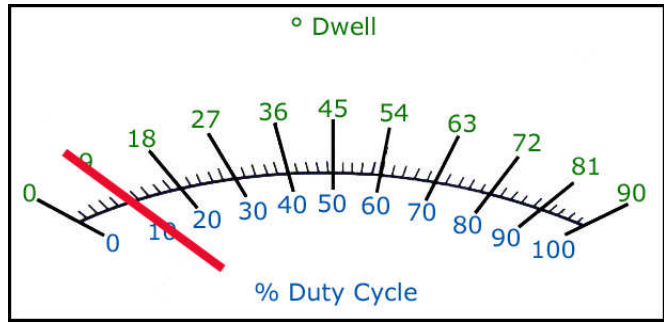
- Disconnect the leads from the oxygen sensor thermoswitch (do not bridge/jump them).
- Disconnect the black oxygen sensor wire from the green control unit wire.
- Run the engine.
- Ground the green wire's spade terminal on bare metal (use a jumper wire if need be).
- Reading: 87% and higher (78° and higher).



Step 6 ~ Lean correction test

Lean stop

- Keep the engine running and the wires in Step 4 disconnected.
- Ground the negative end of the D-cell battery while touching the oxygen sensor control unit's green wire spade terminal to the positive end of the D-cell battery.
- Duty cycle should be 20% and lower (dwell should be 18° and lower). Engine may stall; if the reading is within spec, stalling is normal.



Step 7 ~ Oxygen sensor test

Method 1:

- Start the engine and let it run until it reaches operating temperature (80°C or higher); if it's already warm, let it run for two minutes.
- Clamp off the hose from the idle speed boost valve (white valve, if your car has A/C).
- Disconnect the crankcase ventilation hose.
- Make note of the duty cycle reading.
- Plug the crankcase ventilation hose. The duty cycle should drop, then rise and fluctuate.
- If the duty cycle does not drop, then rise and fluctuate, the oxygen sensor is faulty.

Method 2 (see additional information on next page):

- Start the engine and let it run until it reaches operating temperature (80°C or higher); if it's already warm, let it run for two minutes.
- Disconnect the oxygen sensor wire (black) from the oxygen sensor control unit wire (green).
 - If you have two DVOMs, you can connect the second one as shown in Step 1 to read the duty cycle/dwell at the same time, but this is not necessary.
- Connect the black DVOM lead to any convenient ground and connect the red DVOM lead to the oxygen sensor lead wire (black).
- Set the DVOM dial to 2 DCV (or 4 DCV, if that's the lowest setting on your meter).
- Ground the oxygen sensor control unit lead wire to bare metal to simulate a lean condition. The oxygen sensor's voltage should go high: 0.8 to 1.0 DCV (duty cycle/dwell should go high, 85%/75° or higher).
- Connect the D-cell battery's positive end to the green oxygen control unit lead wire and ground the negative end of the battery against bare metal; this simulates a very rich condition. The oxygen sensor's voltage should go low: 0.15 DCV or lower (duty cycle/dwell should go very low, 10%/9°). Note: The system may go so lean that the engine stalls; this is normal.
- Keep the engine running and leave the meter's black lead connected to ground, but connect the meter's red lead to the green ECU (aka Vref) wire. You should see a steady 0.45 DCV to 0.50 DCV. Flex the green ECU wire; if voltage drops to or near zero there is most likely a short in the green ECU cable that needs to be repaired.

Notes:

- A sluggish oxygen sensor may cause a failed smog inspection while exhibiting absolutely no other drivability issues.
- Should you see an operating range at the oxygen sensor ranging from -0.5 DCV to +0.5 DCV (instead of the normal +0.1 DCV to +0.9 DCV), your sensor has been permanently damaged by chemical contamination and needs replacing.
- Cabriolets built from [July 1987 through 1989](#) have heated (3-wire) oxygen sensors. Should you see 12 DCV (or charging voltage) at the oxygen sensor wire, replace the oxygen sensor immediately -- the heater has shorted to the sensor.
- Should the oxygen sensor control unit happen to be faulty, it will fail to compensate for the simulated lean/rich conditions described above. The oxygen sensor control unit rarely goes bad, but it does happen. Before condemning the control unit as being faulty, verify that the control unit is receiving power and that all ground wires/connections are good. Additionally, if the duty cycle stays at 65% or 80%, disconnect the cold running enrichment switch (if installed) and the full-throttle switch, one at a time, then both together if need be.

Method 2 ~ additional information

What you are measuring in Step 7, Method 2, substep "g" is Vref, or reference voltage:

This Vref is pretty much the heart of this (or any, really) 'closed loop' mixture control system. The ECU sets a steady reference voltage of 0.45 VDC to 0.50 VDC (this voltage is steady, varies slightly between different ECUs) on the green oxygen sensor wire, the black O₂ sensor lead connects to this wire.

The oxygen sensor, once at operating temperature, outputs a voltage between approximately 0.1 VDC (a lean signal), to approximately 0.9 VDC (a rich signal).

When the ECU sees an oxygen sensor voltage higher than its Vref, it correctly interprets that to mean that the mixture is richer than stoichiometric (i.e. 14.7:1 air-fuel ratio), the ECU then leans the mixture to compensate by lowering the duty cycle to the frequency valve below 50%. Once below 50%, it is now too lean; oxygen sensor voltage is now below Vref, so duty cycle goes back up to correct.

On and on goes this continuous correction, the ECU constantly trying and failing to get the oxygen sensor voltage to match Vref. The system is actually designed to strive and fail. There are two reasons it strives and fails. One is built in response delays, the other is that those response delays are built in so that the catalytic converter will always have a slightly fluctuating mixture, something the cat converter requires for its chemical reaction to work properly.

above information provided by tolusina of VWvortex

K-Jetronic ECU Pinouts

(arrows indicate input or output signals)

