May 2010
Technical Newsletter

Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

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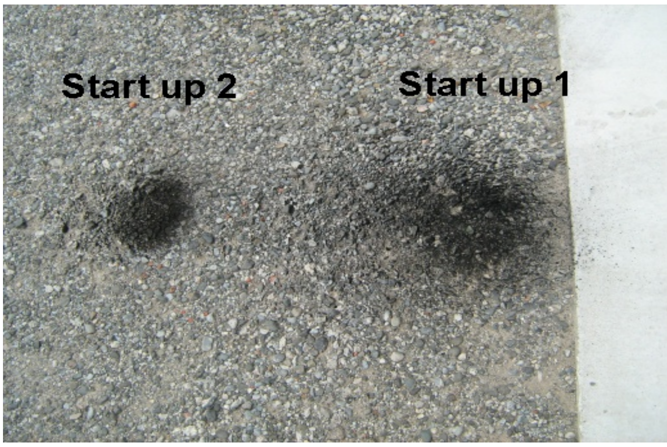
Smoking gun

This article is a true description of an AECS technical help desk problem and how it was solved.

Vehicle:
VW Golf 2001, 2 Ltr Petrol non turbo APK engine.

Problem presented to the help desk
This vehicle was presented to the workshop after it had been to several other workshops. The complaint is, it is almost un-driveable as it is running so rough. It is smoking black and smells badly. Wherever you start the car up it leaves a dirty big black stain on the ground.



Evidence left on a pristine yard

The previous garages had tried everything, they tested all components and found them to be within specifications according to the diagnostic equipment used. As a final move, one garage had the ECU send away to be checked, and the other garage ended up replacing the ECU for a brand new coded controller. All to no avail.

If there is a automotive course you'd like us to run but is not advertised, ring us so we can try to arrange one in your area next season. See our website for the types of training we provide.
www.aecs.net

Did you know…. we are running a

SCAN TOOL Course
1st & 2nd July 2010
Palmerston North.

Have you ever not quite understood, or questioned the data of a scan tool?

Get the most out of your own diagnostic equipment! The Scan tool seminar will provide you with an in depth explanation of how a scan tool works, and how you can get as much information as possible out of the scan tool. You will come away from this seminar with a thorough foundation of scan tool technology.

Ominous sign: The vehicle's original ECU (smoking gun) on the passenger seat

In disgust, the customer took the car away and found a diagnostic garage with appropriate equipment and a reasonable level of diagnostic skill.

I am not sure if the bill from the previous garages got paid, but I would find it unreasonable if those expenses fell back onto the car's owner, as clearly there was nothing achieved by the previous garages.

Where to start?

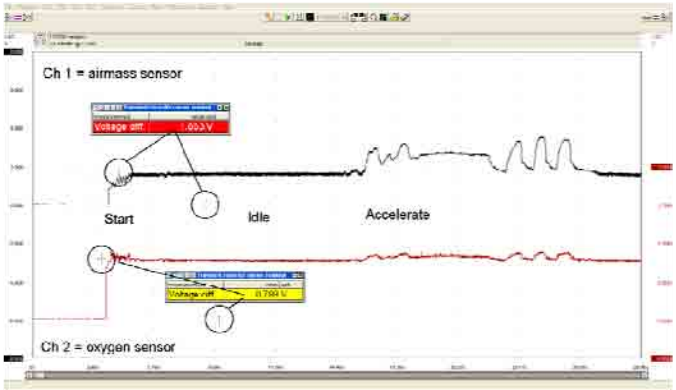
Well it is simple really, first think. The amount of fuel entering the engine is directly related to the injection pulse width and the fuel pressure. Since in my experience fuel pressure on EFI cars is seldom incorrect, we need to look at the injector pulse width.

The pulse width is calculated in the ECU primarily based on air-mass, engine temperature and throttle position. On top of the pulse width calculation an integration is done, based upon the oxygen sensor signal.

With an AVL DiX scan tool the car was scanned for fault codes, none were present. A quick look at air-mass and engine temperature revealed a normal engine temperature at around 40 degrees shortly after start-up. The air-mass live data line showed 45 g/sec. The parameters on the AVL scanner showed that it should be between 15 and 35 g/sec. The scan tool also showed that the system was running in open loop, I presumed because the engine was still cold.

Air-mass sensor

Let's start with the air-mass sensor, as it is the main and most delicate sensor for fuel mixture preparation under the bonnet.
It is unusual for an air-mass sensor to show a value, which is too high! Often when the air-mass signal is lower than what it should be, it is a result of damage or contamination.



Scope Pattern 1: Measuring Air-mass sensor in combination with the oxygen sensor

The diagnostician measured the Air-mass sensor in combination with the oxygen sensor. It became immediately apparent that the oxygen sensor signal was not correct. A cold sensor should start at zero volts (a few exceptions are applicable), this one started straight away at 0.789 Volt and did not rise while warming up. Accelerating hardly made any difference, while all the time the car was pouring out black smoke.

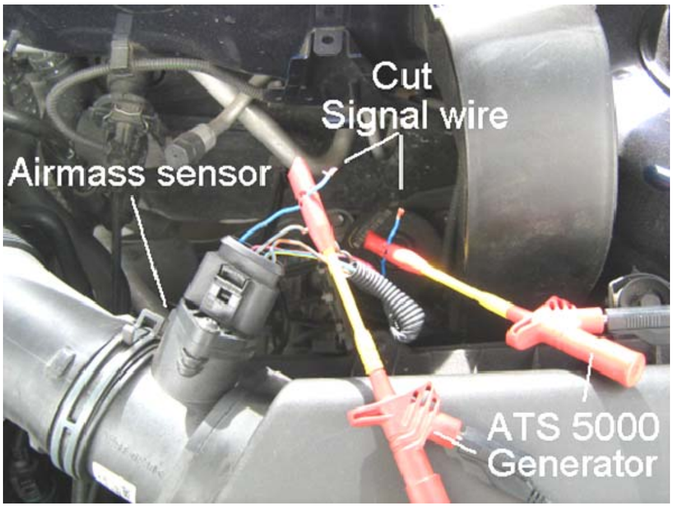
Bring mixture under control!

The next thing that had to be done was to bring the mixture under control, even though the oxygen sensor seemed defect. To fit a new oxygen sensor in such a high emitting vehicle would surely destroy (coat) a new sensor.

The easiest is to reset the adaption values of the vehicle with a scan tool, but this can only be done when the vehicle is at operating temperature and in closed loop…..

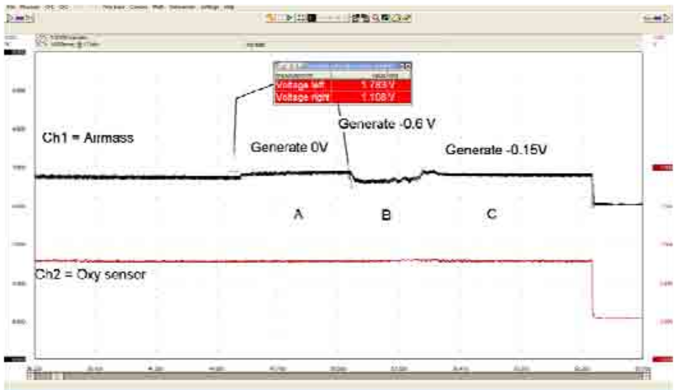
a. we felt uncomfortable leaving the engine run for any period of time as it ran so bad, so letting it properly warm up? No!
b. The oxygen sensor did not respond so it would never go into closed loop. No resetting of adaption values then!

It was decided to use the signal generator of the ATS scope to alter the original air-mass sensor's signal, by placing the signal generator between the air-mass out put and the ECU input.



The ATS 5000 scope's signal generator hooked up to alter the air-mass sensor signal.

The ATS5000 scope can generate any shape signal between +12V and -12V, we needed one of the simplest signals; a DC signal.
We had to lower the air-mass signal to reduce the quantity of fuel so the engine could start to run clean again in preparation for a new oxygen sensor. We sent out a -0.15Volt (negative!) signal, which made it run reasonable. At the same time we recorded the old oxygen sensor signal as by making the mixture lean we should see a difference.



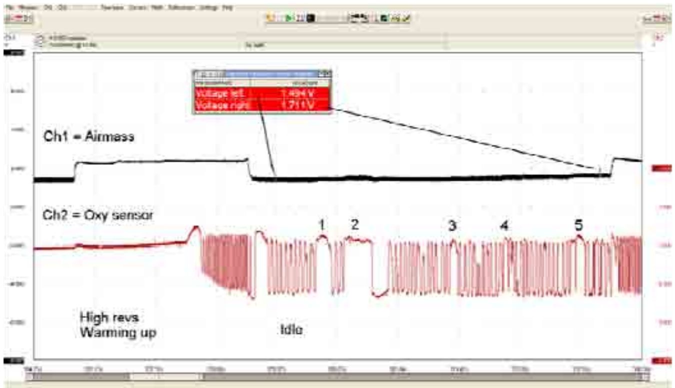
Scope Pattern 2: Air-mass vs oxygen sensor recording while modifying the air-mass sensor signal.

- At section A the engine is smoking black and running how it came in.
- At section B the air-mass sensor signal is lowered by 0.6V, this makes the mixture too lean, the engine struggles, please note that there is no change in the oxygen sensor signal.
- From section B to section C the simulator is slowly brought back to -0.15 Volt. This is where the engine runs reasonable well.

Car ready for a new oxygen sensor

The car was prepared for a new oxygen sensor. To start the engine with the new oxygen sensor

and with the unmodified long fuel trim would have been unwise. The car would have started to smoke black immediately destroying the new sensor.
We just left the signal generator connected at -0.15V, fitted the new sensor and started the vehicle.
Once the oxygen sensor started to cycle the system entered into closed loop. That is when you have 'the fish on the hook'. The short fuel trim will keep the mixture in check and will alter the long fuel trim over a period of time.



Scope Pattern 3: ATS scope recording of the air-mass and oxygen sensor signals, while the air-mass signal is being altered back to original.

So after the system entered closed loop we could slowly bring the air-mass sensor signal back to its original value (generating 0 volt), see step 1,2,3,4 and 5. in Pattern 3

The oxygen sensor indicated that the adaption ability of the ECU was well capable of keeping everything in check without any interference from us. Great! Now we could join up the signal wire of the air-mass sensor again.

A quick look on the scan tool revealed that in live data the long fuel trim was at negative18%, which is large amount away from the ideal (0%). The ECU was clearly still trimming a lot of fuel away. Also the engine had a slight misfire every now and then. The AVL DiX scan tool showed on the misfire detection counter values up to 128! At 400 the injection gets switched off temporarily.

Still something wrong?
Understand that if an engine runs very rich for a period of time the engine oil gets diluted with petrol, please note the car had been over a period of months to various garages.
The fuel in the sump will enter the intake manifold making the mixture too rich (negative trim). BUT also there is now a very real danger that the fuel breathing into the intake manifold takes oil with it. This oil will coat (damage) the new oxygen sensor again! Another problem is that the

oil will coat the catalitic converter, making the emissions unacceptable and leaving the car owner able to seek a conviction under the newly introduced law (Jan 2008) which stops technicians and owners altering emission treatment systems.

The oil and filter were changed and to cover ourselves, plus prove that the repair was effective we preformed a by Emission Testing NZ recognised emission test.

The emission tester showed that the Cat was still working correctly (CO value) and that the Oxygen sensor has the mixture firmly under control (lambda). The low oxygen and CO values show that the emissions from the crankcase are not too bad now. Also the slight misfire was gone.

The scan tool indicted that the system was in closed loop and that the air-mass signal was at 32g/s, below the 35g/s.
Why was at idle the air-mass signal lower than when the vehicle was running bad? The idle control could close almost down with the vehicle running properly.

Conclusion:
This job was real easy, with just an oxygen sensor replacement and an oil change, the 'difficulty' was in the diagnosis and the time consuming part was bringing the fueling under control.
Not every shop is equipped well enough to tackle these sorts of jobs, but realise that it all starts with skill. The preceding shops got into trouble as they did not understand what happened with the car. A high skill level can keep you out of trouble as much as it can assist you in getting the job done correctly.
AECS training seminars are highly regarded throughout the top of the automotive industry, this is where you learn to understand tricks like described in this article.
AECS has been delivering nationwide diagnostic training for ten years now.
Equipment used for the diagnosis and repair: AVL DiX (scan tool and emission tester), ATS 5000 and ATS 5004d scopes.
Invest in your skills and in the best equipment available with great back up from *AECS!* It is the combination of these key elements, which made this, job a success.

Herbert

For **AECS Ltd**:
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(trainer/research)
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Report of emission test

Date: 3/20/2010 11:16:14 AM

AECS

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Procedure:	**Otto CAT with OBD**	**Fuel type:**	**Petrol**	
Vehicle identification data				
Licence plate:	CPW555			
Mileage:				
Registration date:				
Vehicle manufacturer:	VW			
Vehicle type:	GOLF			
Vehicle identification number:				
Engine code:	APK			
Measurement results	**Unit**	**Limit values Min.**	**Limit values Max.**	**Actual values**
Relevant exhaust components				
Visual inspection				i.O.
At increased idle speed				
Speed	RPM	2500	2800	2700
CO	%Vol		0.20	0.01
COcorr	%Vol		0.20	0.01
HC	ppmVol		60	8
CO2	%Vol			15.00
O2	%Vol			0.03
Engine temperature	°C			88
Lambda		0.970	1.030	1.000
Performance test OBD				
Status				EOBD
Readiness codes				Not all readiness tests finished
Supported				011101100101
Performed				000000100100
Trouble codes				
Number of trouble codes				0
Total result				
Emission test	Passed			
Control number:				
Operator:	Herbert Leijen			

	Identification	**Version**	**Edition**	**Manufacturer**
OM software version	AVL DiX OM-INT	V1.6.0.58	04/2006	AVL DiTEST GmbH

Printout of emission test report with AVL emission tester.