AUTOBIZ

Tech Tips

2nd Issue
Dec 2011

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091-523 292

Instructor - Steve Carter

New Technology
Feb 23rd
Galway
CLAYTON — A JOHN GLYNN HOTEL — GALWAY

Electronic Diesel Control
Feb 24th & 25th
Dublin
EUROPA ACADEMY

Course 1 - New Technology

Clayton Hotel, Galway

Where: Clayton Hotel, Galway
When: Thursday 23rd February
9am - 5pm
Cost: €160

Book: Call Autobiz on 091-523 292

Ideal for:
- Mechanics
- Factor employees
- Workshop Owners
- After Sales Managers
- Parts Employees
- Customer Advisors

New Technology - Course Content:

The perfect introductory course for further modules or to get caught up on recent technology. A one day training seminar consisting of a central presentation, discussions and practical information on:

Diesel engines
- Intake throttle • DPF filter
- Piëzo injectors

Petrol engines
- Direct injection • Variable valve timing
- Variable valve lift
- Secondary air injection

Dual Mass Flywheels
- Function & Design
- Diagnosing & Servicing

Engine general
- EGR
- Dual stage turbo & turbo/supercharger
- Electric water pump • Water cooled intercooler integrated in intake manifold

Suspension Geometry
- Camber / Caster • KPI/SAI
- Included angle

Hybrids
- Serial/parallel/combination systems
- Available hybrids
- Motor/generator: Operation and control
- Combustion engine: Atkinson principle
- Safety systems

Comfort
- Electric park brake
- Electrically powered steering (EPS)

Safety
- Electronic stability control (ESC)
- Dual stage airbags
- Pedestrian protection

Course 2 - Electronic Diesel Control-1

Europa Academy, Swords, Co. Dublin

Where: Europa Academy
When: Friday 24th February or
Saturday 25th February
9am - 5pm
Cost: €200
Book: Call Autobiz on 091-523 292

Ideal for:
- Workshop Owners
- Mechanics

Electronic Diesel Control-1 - Course Content:

The course will provide the technician with the knowledge of diesel fuel and electronic circuits required to understand and repair these systems. At the end of this course the technician should be able to demonstrate knowledge of how these systems work and how to use oscilloscopes and meters for the performance of a correct diagnostic.

Diesel fuelled Compression Ignition Engines
- Direct / Indirect Injection

Automotive diesel fuel systems
- Inline and distributor type pumps
- Unit injector
- Common Rail injection

Emissions
- EGR Petrol versus EGR Diesel
- EGR Developments
- Further developments
- Particulate filtration (PAF)

EDC components
- MAF – Mass Air Flow
- MAP – Man Abs Pressure Sensors
- Crank & Cam shaft sensors
- Fuel pressure sensors & control
- Throttle pedal sensors & pedal switches
- Throttle valve
- LP & HP pumps
- Turbos, fixed & variable geometry

Tools and Equipment
- Multi-meters • Oscilloscopes
- Code Reader

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Gates · SKF · MONROE · PIERBURG · SKF · SWF · TRW · Valeo · VARTA BY JOHNSON CONTROLS · WALKER

TECH TIPS

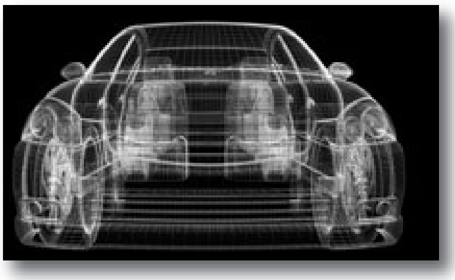
Welcome to the second edition of the Autobiz Tech Tips Supplement

On my travels around the country visiting various garages, I noticed that lots of garages were keeping the first edition of the Autobiz Tech Tips supplement stored in a place that was handy for future reference; in tool box drawers, or on shelves alongside other technical service manuals.

So here at Autobiz, we though it would be a good idea to serialise all the Tech Tips into these booklets, so mechanics can keep it for reference. This second edition has all the Tech Tips published in Autobiz since our last supplement.

There is no doubt that the technical knowledge required to diagnose problems in cars, is something no serious technician can be without. Autobiz, with Tech Tips and through facilitating technical training in conjunction with eXponentia, are going some way towards helping motor mechanics all over Ireland, gain the technical knowledge now essential for the survival of Independent garages.

The next 10 years will see our industry change enormously, as you will see on page 7, a simple battery change will no longer be possible. Start Stop technology will be in 70% of new cars by 2015, which means that the advancement of knowledge is now a priority for technicians.



I look forward to any feedback you may have on this supplement, and also let me know if there are any specific technical issues you would liked to see covered in future issues of Autobiz.

John O'Callaghan, Technical Editor

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A trio of Puzzling cars

Three cars put eXponentia's Steve Carter through his diagnostic paces, but all is not as it seems. Sometimes the real problem is beyond the ability of the ECU to understand, other than to say that something is wrong. That's were knowledge comes in.

In this troubleshooting guide we will be looking at three vehicles from different manufacturers, all with their own unique problems.

A Sluggish Volvo

The first vehicle was a 2000 Volvo S40 1.6L 16 valve. The particular problem with this vehicle was it's frequent, but random, inability to pull away from a standstill. This was not a transmission or clutch problem, but appeared to be the inability of the engine to develop sufficient torque from idle speed. Even applying a significant amount of throttle still made pulling away problematic, and as I stated previously, this problem was not continuous.

This particular engine is equipped with the EMS 2000 engine management system and does not incorporate fly-by-wire, so no throttle body adaption was available. Any idle adjustment is by means of a small grub screw. However, the idle speed, most of the time, appeared to be within specification. As you can see in the photograph, this engine is equipped with continuous variable valve timing. The camshaft actuator receives its instructions from the engine ECM which causes the actuator to channel engine oil, under pressure, to alter the camshaft's position, creating continuous variable valve timing.

On closer inspection of the actuator, significant amounts of solidified engine oil deposits could be seen in the galleries within the actuator. These deposits were cleaned out with a degreasing agent, and the problem was resolved.

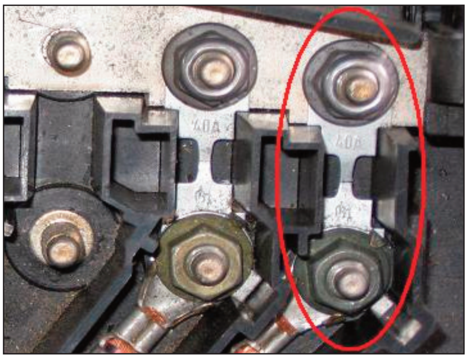
A build-up of oil deposits had intermittently interfered with the variable valve timing

A Polo with Intermittent ABS

The next vehicle, a 2004 VW Polo 1.4, was brought in for it's annual service and pre-NCT inspection. During the service, it was noted that the ABS warning lamp was on. Reading the fault code from the ABS ECM, it merely stated that the ABS pump had failed. This is a very expensive component to replace, and pointless if not necessary.

While obtaining the necessary pin data information, we checked the earth and battery positive supply to the ABS module. While carrying out these checks it was possible on one or two occasions to regain one of the positive battery supplies, which had been lost. This coincided with leaning across the vehicle battery.

You probably remember that some of this vehicle's fuses are housed within the plastic battery cover and these fuses are just thin metal strips between two bolt fixings. A blown fuse can be seen very clearly, but in our case, the fuse had actually cracked and looked more like a scratch than a defective fuse. The fuse was replaced and the ABS was completely functional again.



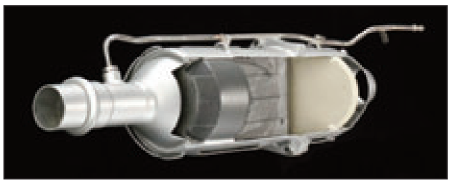
A crack in a strip fuse, circled, can cause an intermittent fault. An observant eye will also suspect that the other strip fuse in this example needs to be replaced as well.

A congested Citroen FAP

The next dilemma was a Citroen C8 2.2HDi FAP. The car had been bought at auction and was being prepared for resale when an anti-pollution fault flagged up on the dash. Unfortunately, the EOBD reader would not reveal sufficient information about this fault, or where to go next in fixing the vehicle.

With the appropriate level of diagnostics, it was possible to view the fault codes in more detail. The first fault related to the overloading of the particulate filter, the second being that the pressure differential sensor was too high on engine start-up. The first fault code is fairly straightforward- the vehicle had covered 58,000 miles and had a counter reading of 98g of soot residue within the DPF, meaning it had reached its design limits and needed replacing. As a consequence of this, the Eolys tank must be nearly empty and required refilling with the appropriate Eolys (remember that there are two types).

The second fault was more interesting, as it indicated excessive backpressure within the now clogged particulate trap before the engine was even running. Viewing the serial live data, it showed a backpressure differential of 993mb with the engine off.



A Citroen FAP

The pressure differential sensors were located close to the DPF itself and with a heavily clogged filter it is possible for soot particles to become lodged within the sensor and cause incorrect pressure differential readings. Naturally, the engine's ECM has to reduce engine performance in order not to generate high levels of backpressure, which would damage the turbo. However, its plausibility routine had determined we had excessive backpressure without the engine running.

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Spinning your wheels

Wheel speed sensors are the eyes and ears of the systems that control ABS and ESP. Joe Clarke, of the Dublin Institute of Technology, explains how to diagnose a problem caused by a fault in the wheel speed sensor's input to the ECU.

Joe Clarke, D.I.T.

In the last decade, active vehicle safety has progressed significantly due to the technological advancements in anti-lock braking systems (ABS) and electronic stability control (ESP). The majority of motor vehicle manufacturers, tend to use the active type wheel speed sensor as opposed to the previous inductive type. These sensors are smaller in size, more accurate at lower speeds, can measure direction and produce a digital signal, which is interpreted directly by the vehicle's electronic control unit (ECU).

Operation

The active wheel speed sensor is typically mounted directly in the hub carrier opposite the wheel bearing. The wheel bearing contains a ring of magnets, commonly known as a phonic wheel, which rotates along with the wheel bearing as the road wheel turns. Hall-effect active wheel speed sensors consist of two wires: a battery voltage power supply from the ABS/ESP ECU and a return signal wire. In order for this sensor to function, it must receive it's power supply from the ECU. When the road wheel is rotated, the magnets pass by the sensor, resulting in the production of a square wave signal. The signal voltage and current, switches from a high state to a low state. The more times the signal goes from high to low, the faster the wheel is spinning. The voltage of the signal may vary in amplitude according to manufacturer.

Testing

In the event of a wheel speed sensor fault, the customer will be notified by the illumination of a malfunction indicator lamp (MIL) on the dash panel, along with a message on the multi-function display (MFD). To identify the fault, the technician's first step is to interrogate the ECU's fault log or memory bank using a diagnostic or scan tool. A fault description, manufacturer's fault code or a generic OBD C-code may be provided, according to the tool used. Another option is the observation of the vehicle's four wheel speeds in the live data or parameter measurement option while driving. All four wheel speed sensors should be indicating the same speed at all times.
Following fault area location, it is necessary to determine the actual faulty component i.e. sensor, ECU, phonic wheel or related wiring. The hall-effect active sensor must remain connected during all measurements. If the active sensor is disconnected, the ECU will interrupt the power supply to protect the system, which could lead to a faulty diagnosis. Measurements are therefore obtained by back probing or using a suitable break out box/connector.

When the ignition is switched on or the engine is running, battery voltage should be present on the supply line to the sensor. This may be measured using a DC voltmeter, or an oscilloscope as shown in Figure 1.

Although a DC voltmeter may be used to determine the sensor's signal high and low state as the road wheel is rotated, true signal verification is only possible with the oscilloscope. Connect the positive oscilloscope probe to the signal wire, while the negative probe is connected to a good chassis earth.

Figure 2 shows the signal produced when the road wheel is rotated slowly at constant speed.
As the distance between the magnets remains constant the duty cycle remains at 50%.

Figure 3 illustrates how the signal varies as the road wheel is accelerated from stand still. The 50% duty cycle remains, the amplitude is constant but the frequency of the waveform increases which is directly proportional to the wheel speed.

Conclusion

If the sensor produces no signal following verification of the wiring, the ECU, sensor or phonic wheel could be at fault. To eliminate the sensor or phonic wheel as the source of the fault, the sensor could be swapped with another location on the vehicle and re-checked. If the fault follows the sensor to it's new location, then the sensor is faulty.

A sticking phonic wheel can cause the signal to be interrupted (faulty) intermittently, causing the ECU to believe that a wheel is rolling at a different speed to the others. This may cause an involuntary ABS or ESP activation as the ECU might think that the vehicle is out of control i.e. in a yaw.

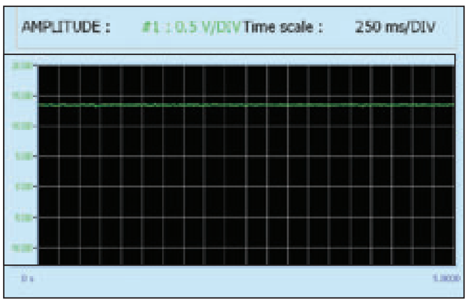


Figure 1: Oscilloscope trace of the supply voltage to the wheel speed sensor

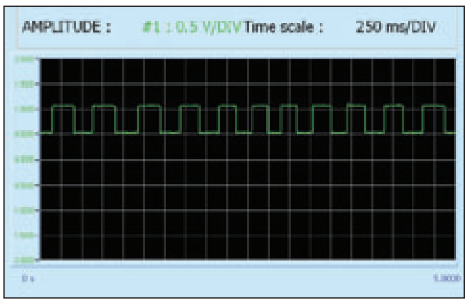


Figure 2: Oscilloscope trace of the signal voltage of the wheel speed sensor as the wheel rotates at constant speed

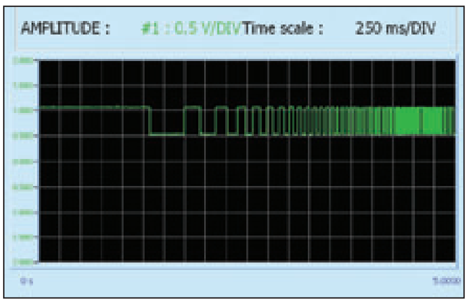


Figure 3: Oscilloscope trace of the signal voltage of the wheel speed sensor as the wheel accelerates from a stop position

Tensioner problems

A VW Golf 16 Valve engine met a premature end when one of the timing belts broke. Gates Technical Support's Andrew Vaux takes us step-by-step, as he examines all of the evidence to determine why the belt failed.

Andrew Vaux, Gates

When Gates technical support received a call about a problem with the drive system on a VW Golf (97-06 1.4 16V), it was a familiar story. The Golf range features a variety of engines with different drive system layouts, but one of the most intriguing is associated with 1.4L 16V engines.

Some of these twin cam engines feature two separate drive belts in two different sizes. One main camshaft belt provides the timing. A smaller cam belt drives the second cam.

Apparently, the main drive had failed prematurely and the engine was beyond repair. Technical assistance was required.

Evidence

Evidence from the broken belt is often the key to the correct diagnosis. Whenever a camshaft stops turning - as this one had - the usual suspect is the timing belt. Closer inspection showed that it was not a problem with the main drive. The smaller secondary belt had failed. Careful examination of the pieces showed that the belt had been significantly reduced in width.

It had been 'worn away' on the edge closest to the engine block, with the result that the narrower belt had been unable to sustain the load. The belt had snapped, allowing piston-valve contact that destroyed the engine.

Debris from the worn belt was abundant inside the drive system cover

A likely cause of reduced width is regular contact with the engine block. This would be clear from a scoured or polished surface on either the drive system cover or the engine block. While no evidence of any such contact could be found, debris from the worn away belt was found inside the drive system cover.

The mystery grew when careful examination of the backplate on the automatic tensioner revealed the kind of damage that had been sought. This would not normally be within the operating plane of the belt.

It was now clear that the reduction in width had been caused by contact with the belt tensioner and not the engine. This failure was a symptom of a very different problem.

Diagnostic procedure

Through careful reassembly and regular inspection of the engine components in situ, the pieces of the puzzle quickly came together. With the automatic tensioner in the correct position, contact with the small secondary belt was impossible.
However, it is possible to install this automatic tensioner upside down.

When the Gates inspector placed the automatic tensioner in this position, contact with the belt was shown to be inevitable. The evidence supported the view that the automatic tensioner had been fitted incorrectly.

Sequence of events

As part of good engineering practice, the VW Golf had had a drive system overhaul, which involves replacement of belts and tensioners. In replacing the automatic tensioner however, a mechanic had installed it upside down, initiating the following sequence of events:

- small drive belt makes contact with backplate of tensioner
- contact begins to 'pare away' the edge of the belt
- width of the belt gradually reduced
- stress increases until the belt snaps
- piston to valve contact
- destruction of the engine

The upside down tensioner left no clearance room for the timing belt, as can be seen by the scoring in this picture

Conclusion

Installing a tensioner upside down is a basic error that any mechanic can make, regardless of the number of times the procedure may have been carried out on a particular model. It's always worth making a note of the position and aspect of a tensioner before it is removed.

While independent technical information sources are often very specific about the way the belt must be installed, information about the installation of tensioners is limited. For those drives where installation of the belt drive may be more complex, Gates belt kits include all the information necessary to install belts and tensioners correctly.

Gates also runs a series of free technical seminars for mechanics in association with local motor factors to make them aware of possible installation problems.

The ever cleaner winds of change

A new European directive to reduce CO2 emissions comes into force in 2012. Bosch looks at measures manufacturers are taking to reduce emissions, and some of the emerging technology that you can expect to see soon.

Starting in 2012, the average CO2 emissions for 65% of all cars registered in the EU, across a manufacturer's entire range of cars sold, can not exceed 130g of CO2 per km, without incurring what could be a substantial financial penalty. The total fleet emissions limits become more restrictive over the following 3 years, while the penalties start high, and go higher every year.

The limits will be introduced with the following schedule: in 2012 65% of each manufacturer's newly EU registered cars must comply with the regulation, rising to 75% in 2013, 80% in 2014 and 100% by 2015.

Manufacturers whose fleet average exceeds the limit from 2012 will have to pay a penalty for each and every car registered, and the penalty will increase over time. The penalty will be €5 for the first g/km in excess of 130, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. From 2019, every g/km over the limit will cost €95. The penalty will be made for all of the cars registered, not just the cars that exceeded the emissions limit. For example, if a manufacturer fails to register at least 65% of their car sales with CO2 emissions less than 130g/km, and their average is a respectively low 140g/km, the total penalty would be €710 for each and every car registered that year.

To reduce the vehicle emissions, manufacturers are taking a variety of steps including petrol downsizing, diesel downsizing, start/stop systems, hybrid & electric vehicles.

Typically, the additional cost of adding technology to a standard internal combustion vehicle is €350 for a start/stop system, €4,000 for a hybrid vehicle (combustion engine with electric motor) and €10,000 for a plug in electric vehicle.

With these new systems, new battery and vehicle technology is required.
The Battery Management System (BMS) has to coordinate the electrical system with the engine management. Its tasks include:

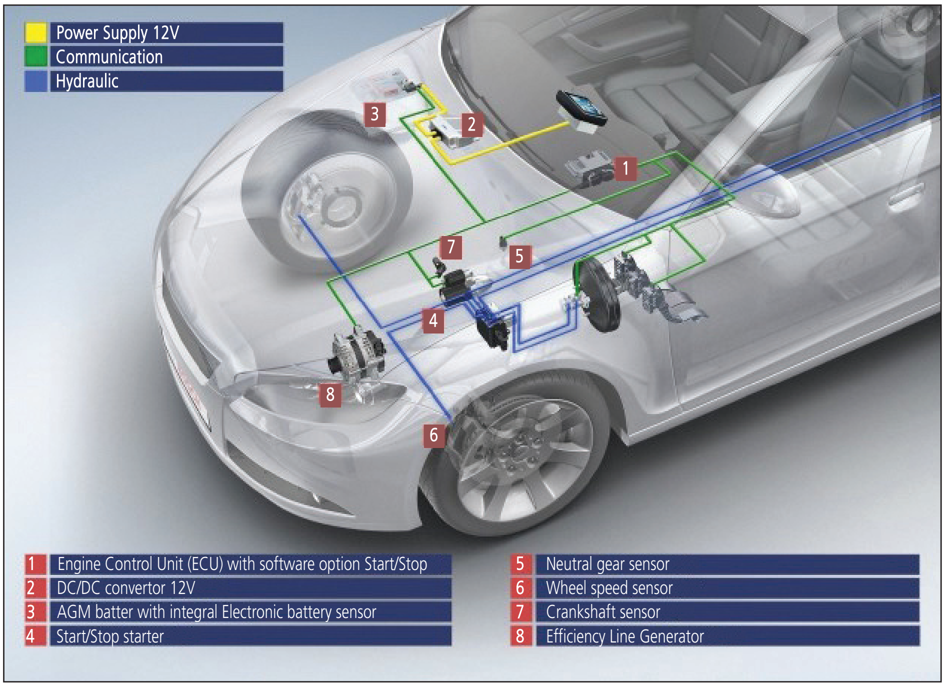
- Engine start/stop
- Managing generator and recuperation/regeneration
- Avoiding power peaks
- Prioritisation of electrical consumers
- Switching off idling consumers

When changing the battery of a start/stop vehicle, exact 'like for like' replacement is required.
Choosing the right battery (e.g. using Bosch ESI, Tecdoc or a battery catalogue) is essential.

The battery has to be replaced by a qualified workshop – DIY battery change is not recommended.
If the wrong battery is fitted or is fitted incorrectly, the start/stop function may not work or will work with lower efficiency and fuel consumption will increase with higher CO2 emissions.

After the installation of the battery, the Battery Management System needs to know a new battery has been installed. The technical data of the newly installed battery e.g. Ah, A and product number (depends on electronic control unit) needs to be programmed into the vehicle. Without this information, the vehicle may refuse to start or may even break down hours or days later.

All Bosch KTS diagnostic tools have the functionality to reprogram the battery management system and also diagnose hybrid and electric vehicles. Bosch also offers training courses for working on high voltage vehicles and also testers specifically designed to work on electric vehicles and carry out 1000v insulation tests on the vehicle wiring (essential after working on these vehicles).



BOSCH

VW belt replacement guide

Large numbers of the VW 2.0L common rail engines (engine code CBDB) are installed in various models. When the timing belt is changed, serious mistakes are often made. To ensure that changing belts goes smoothly, ContiTech Power Transmission Group provides a step by step, detailed installation guide to help prevent problems along the way.

These are detailed instructions for replacing the timing belt on the 2.0 litre common rail engine in the VW Scirocco, Golf V, Golf VI, Golf Plus and Jetta III. These timing belts are found from model year 2008 onwards, and are found on engines that bear the code CBDB.

Volkswagen recommends that the timing belt and tension pulley be replaced as follows:

Scirocco: 2009 and older: every 180,000 km
2010 on: timing belt, tension pulley every 210,000 km
Golf Plus: Timing belt every 180,000 km
Golf V: Timing belt every 180,000 km
Golf VI: Timing belt and tension pulley every 210,000 km
Jetta III: 2009 and older: Timing belt every 180,000 km, tension roller every 360,000 km
2010 on: timing belt and tension pulley every 210,000 km

The working time is 2.2 hours for all engines.

Tip: When the timing belt is changed, the tension pulley, the idler pulley and the water pump should be replaced, too.

Fitters require the following special tools for belt changing:

1. Locking pin for camshaft (OE 3359)
2. Locking pin for high-pressure pump gear (OE 3359)
3. Arrester (OE T 10172, OE T 10172/4)
4. Lock ring tool for crankshaft (OE T 10050)
5. Cap wrench (OE T 10264)
6. Locking tool (OE T 10265)

Safety notes:

Turn the engine in the direction of engine rotation ONLY on the crankshaft gear. The crankshaft sprocket and camshaft sprocket must never be rotated after the timing belt has been removed.

Do not use camshaft locking tool(s) as an arrester when loosening or tightening the camshaft gear.

When turning the camshaft, the crankshaft may not be positioned at top dead center (OT).

The timing belt may not come in contact with oil or cooling water.

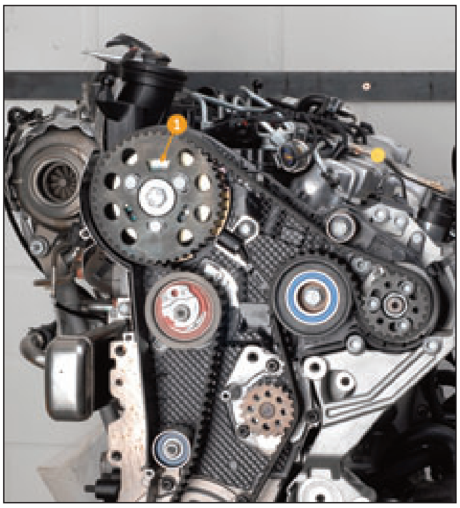


Fig. 1

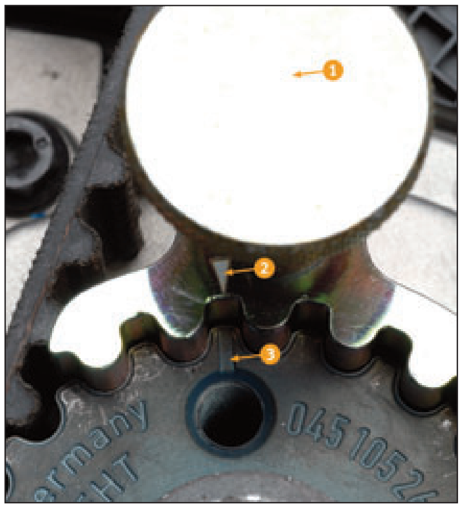


Fig. 2

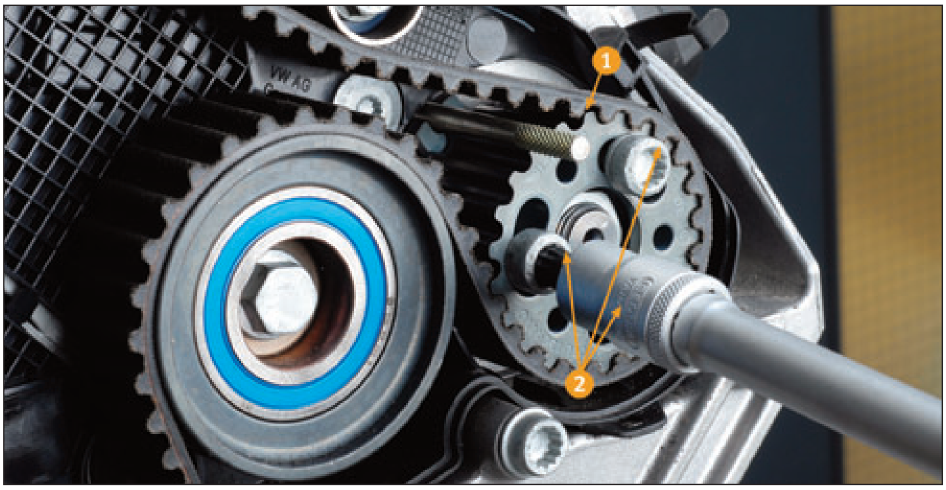


Fig. 3

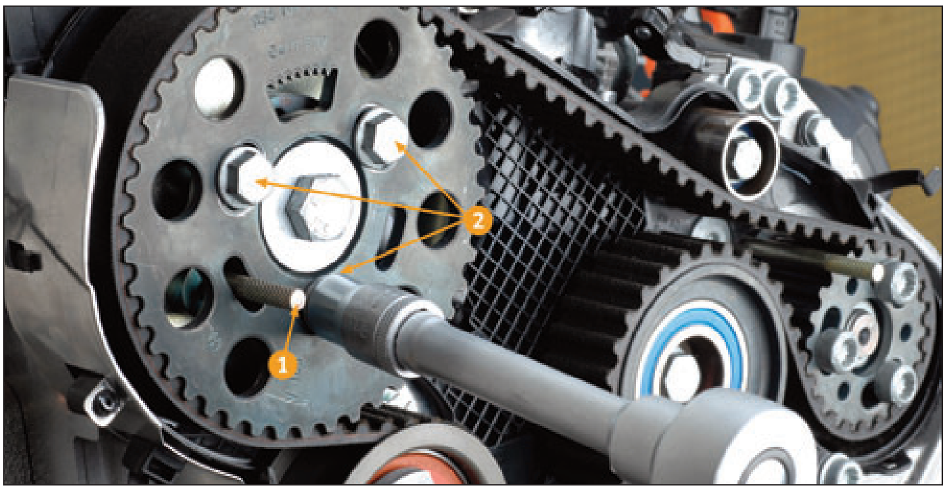


Fig. 4

Adjustment work on the timing belt may be carried out only when the engine is cold.
Make a note of the radio code. Disconnect the battery's negative terminal.
We recommend that, once the timing belt has been removed, it always be replaced and never reused.

Tightening torques:
Note: Self-locking nuts and bolts should always be replaced, even if not always specified by the manufacturer.

According to VW, the following nuts and bolts are to be replaced:

- Bolt(s) on the camshaft gear (tightening torque central bolt: 100 Nm, gear level 1: 20 Nm, gear level 2: 90°)
- Bolt(s) on the high-pressure pump gear (level 1: 20 Nm, level 2: 90°)
- Nut(s) of the tension pulley (level 1: 20 Nm, level 2: 45°)
- Center timing belt guard (10 Nm)
- Lower timing belt guard (10 Nm)
- Bolt(s) on the vibration damper (level 1: 10 Nm, level 2: 90°)
- Idler pulley (50 Nm and turn an additional 90°).

Removal:
Remove engine cover.
Dismantle fuel filter.
Disconnect plug on the coolant temperature sensor.
Open clip(s). Remove the upper timing belt guard.
Remove front right wheel-house liner.
Remove drive unit belt.
Remove vibration damper.
Remove the lower timing belt guard.
Remove the center timing belt guard.
Remove coolant pipe(s).
Position the engine at top dead center cylinder 1.
Note the marking(s) (Fig. 1, No. 1 and Fig. 2, Nos. 2 and 3). The geared segment on the timing belt gear of the camshaft must be at the top (Fig. 1, No. 1).
Use lock ring tool for crankshaft (OE T 10050) (Fig. 2, No. 1).
Markings of the crankshaft and the lock ring tool for crankshaft must align (Fig. 2, Nos. 2 and 3).
Lock ring tool for crankshaft: Pins must be positioned flush in the bore hole.
Use locking pins on the high-pressure pump gear and on the camshaft (Fig. 3, No. 1 and Fig. 4, No. 1).
Loosen the bolts on the high-pressure pump gear (Fig. 3, No. 2)
Loosen the bolts on the camshaft gear (Fig. 4, No. 2)
Use arrester.
Loosen the nut of the tension pulley (Fig. 5, No. 1 and Fig. 6, No. 1).
Using the hex key, turn the eccentric of the tension roller (Fig. 5, No. 3 and Fig. 6, No. 2) counterclockwise, until the tension roller can be disconnected with the special tool (Fig. 5, No. 2).
Cap wrench (OE T 10264).
Locking tool (OE T 10265)
Using the hex key, turn the tension pulley clockwise (max. load stop, Fig. 6, No. 2).
Tighten the nut of the tension pulley slightly (Fig. 5, No. 1 and Fig. 6, No. 1).
Remove the timing belt from the idler pulley first and then from the gear wheels.

Installation:
Adjustment work on the timing belt may be carried out only when the engine is cold.
Tension pulley: The nose of the base plate must be in the recess (Fig. 7, No. 1).
Check the top dead center marking and readjust as required.
The tension pulley must be locked using the locking tool and fixed to the stop on the right (Fig. 6, No. 2).
Turn the camshaft gear clockwise to the stop.
Turn the injection pump gear clockwise to the stop.
Position the timing belt onto the crankshaft, tension pulley, camshaft gear, coolant pump, and high-pressure pump, in that order.
Loosen the nut of the tension pulley.
Remove special tool (locking tool).
Ensure that the tension roller is positioned correctly.
Using the hex key, turn the tension pulley clockwise (in the direction of the arrow).
The pointer of the tension pulley must be flush with the recess in the base plate (Fig. 8, No. 1).
The nut of the tension pulley may not turn while this is being done (Fig. 8, No. 2).
Tighten the nut of the tension pulley (Fig. 8, No. 2).
Hold the camshaft gear to maintain pretension counterclockwise (use the arrester).
Tighten bolt(s) on the camshaft gear (Fig. 4, No. 2)
Tighten the bolt(s) on the high-pressure pump gear (Fig. 3, No. 2)
Remove locking pins on the high-pressure pump gear and on the camshaft pulley (Fig. 3, No. 1 and Fig. 4, No. 1).
Remove crankshaft lock ring tool (Fig. 2, No. 1)
Rotate the crankshaft twice in the direction of engine rotation.
Position the crankshaft right before the TDC of the first cylinder (Fig. 6).
Use lock ring tool for crankshaft (OE T 10050) (Fig. 6, No. 1).
Turn crankshaft until the lock ring tool can be used.
The pin on the crankshaft lock ring tool must be directly in front of the bore hole of the sealing flange (Fig. 6, No. 1).
Turn crankshaft until the lock ring tool can be used (Fig. 6).
Check whether the camshaft can be locked with the lock ring tool.
The pointer of the tension pulley must be flush with the recess in the base plate.
Tighten bolt(s) on the camshaft gear.
Tighten bolt(s) on the injection pump gear.
The rest of the installation procedure takes place as for the disassembly procedure, in the reverse order.
Mount the drive unit belt.
Decode the radio, program the volatile memory.
Start the engine and check for proper function.
Read error memory.
Carry out a test drive.
Document timing belt change.

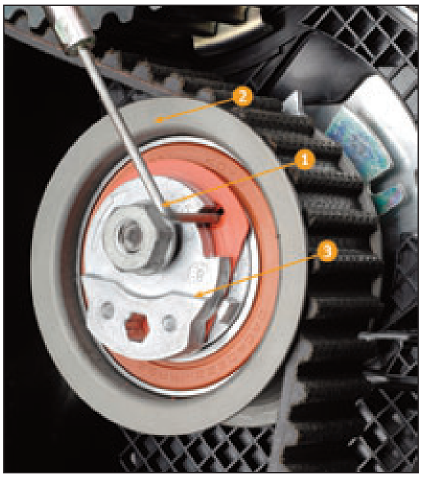


Fig. 5

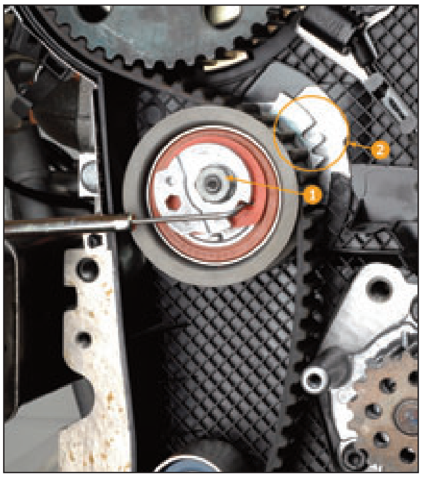


Fig. 6

Fig. 7

Fig. 8

Similar, but not the same

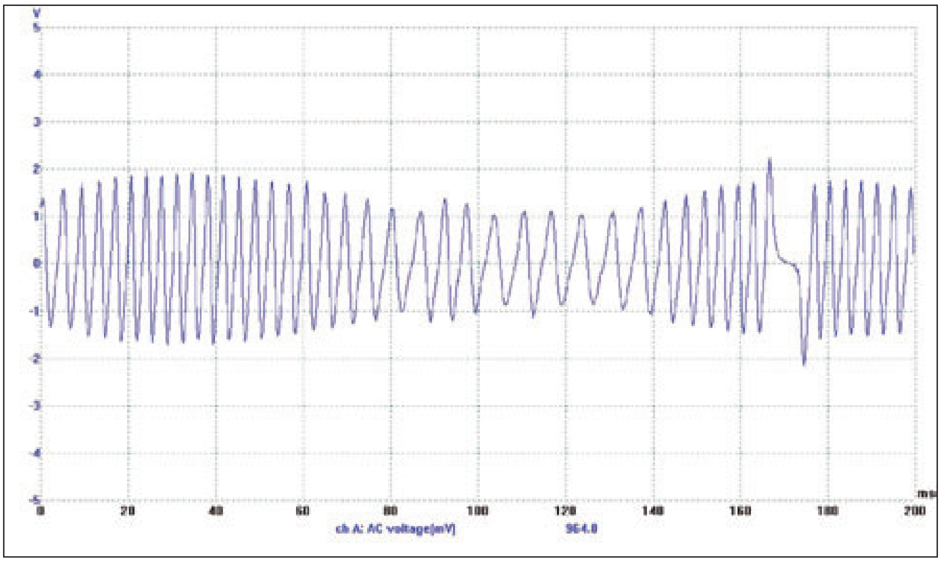
eXponentia's Steve Carter tackles a Fiat that refused to start a replacement engine, thought to be identical to the failed engine. But sometimes things are not as they appear to be, and only knowledge and good diagnostics will get you to a happy ending.

Steve Carter, eXponentia

Common rail diesel engines have been in production for several years now, and many independent garages are probably seeing more and more of these vehicles, as the owners pull away from dealer servicing. This case study involves a Fiat Ducato, but could have also occurred to any common rail diesel powered vehicle.

This particular vehicle had, unfortunately, been driven through a flooded road when the inevitable catastrophic engine failure occurred: the number two con-rod had gone straight through the block.

The garage, who had been tasked with replacing the engine, obtained an identical second-hand engine to replace the failed one. However, when the vehicle refused to start, they had some basic vehicle diagnostics which appeared to interrogate the vehicles engine management system. However, unknown to them, it was in fact using an EOBD protocol to do so, and the scan suggested that there were no fault codes present. The actual system on this vehicle was a Bosch EDC 15c2. They attempted to measure the high-pressure pump output using a sealed rail kit to confirm they had sufficient rail pressure to trigger the injectors. During cranking, they had over 300 bar, more than sufficient pressure to start the engine.



The scope trace of the crankshaft sensor signal showed it was too low, as well as erratic.

At this point, they were beginning to run out of ideas and I became involved with the vehicle. My first thoughts was to attempt to interrogate the vehicle's engine management system using the Bosch EDC specific programme, where upon a fault code was retrieved-"crankshaft position sensor; signal improbable". Note that this is not a P code, so is non-compliant under the EOBD protocol and, for your reference, diesel powered vehicles did not have to conform to EOBD protocol before 2005. Remember EOBD is just for faults which affect emissions of the vehicle.

We proceeded to evaluate the serial live data while cranking the vehicle. I was particularly interested in the engine speed and the high-pressure rail value. Although the garage had confirmed there were sufficient pressure at the pump, it was still worthwhile to confirm that this was being seen by the engine EDC as well. The rail pressure was in line with their previous test figures, confirming that the high-pressure pump, rail sensor and associated wiring to the EDC were in good order. As for the engine speed, this was a different matter; although we had a very stable engine cranking, the actual RPM indicated by the serial diagnostics ranged anywhere from 50 to 200 RPMs, thus confirming the crankshaft sensor as the potential problem.

At that point the garage was ready to order a replacement crankshaft sensor. However, I wasn't so sure and asked for a few more minutes with the vehicle. A quick scoping of the crankshaft sensor provided some useful information.

As you can see in the scope trace image, the output of the sensor is just too low, with the maximum peak-to-peak being just below 2 volts, where in reality there should be at least 4 volts, if not 6. This was obviously the reason why the vehicle would not start and was the reason for those extreme RPM readings on live data. This engine was supplied in good working order from a reputable supplier. On further discussions with the garage, it transpired that although this was the same engine, it had been fitted to a different gearbox, and they were still using the original gearbox.

On further investigation, it became clear that although the engines were nearly identical, they had one main difference - the flywheel. If the engine had been used in conjunction with its original gearbox, then this problem would never have arisen. But they had used it with the vehicle's original gearbox, which had a slightly different fixing/profile for the crankshaft position sensor. This resulted in the sensor being just under 2 mm further away from the flywheel, resulting in the erratic RPM reading and scope trace.

The solution to this problem was to exchange the flywheels. As you can see from this, more diligence and understanding of your diagnostic readings is paramount for modern common-rail diesel engines.

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How training will save you money

Steve Carter from eXponentia, gives an example highlighting how too little knowledge will cost you a lot more than paying for training, by keeping your technicians' skills up-to-date.

Steve Carter, eXponentia

When discussing training requirements for garages, it is often stated that the garage can either not afford the cost of training or, as is more often the case, cannot afford the cost of the lost time when a technician is away from the workshop.

I would argue that a well-trained technician, who is kept up-to-date with modern systems, will be far more efficient and will make the garage owner more money than it will ever cost to maintain this level of knowledge.

An example of just this scenario occurred when I returned from my holiday. A well-respected large workshop with class 4 MOT and seven ramps was having a severe problem with a Saab 9 3 1.9TDi, and asked for my help.

The vehicle had come in for a routine cam belt replacement some eight weeks earlier. This was duly completed and the vehicle left the workshop. Five weeks later the car broke down, the garage recovered the vehicle and interrogated the on-board systems, and found it had a crank sensor fault. This component was replaced, but the vehicle still refused to start and the crank sensor fault was still there.

The garage contacted a local Saab dealer, who informed them that this vehicle apparently suffers from the cam belt jumping a tooth or two. All covers were removed and the timing checked, this revealed that the cam belt had not jumped any teeth at all and everything was perfectly timed. At this point an auto electrician was asked to look at the vehicle and after his various checks, he concluded they should try a manufacturer's crankshaft sensor. This was done and still the vehicle did not start and it still had a crankshaft sensor fault. The auto electrician then suggested the ECU be sent away for testing. The ECU was returned three days later, with no faults having been found.

I started this article talking about training costs and time away from the workshop. Let's just look at the cost incurred to date by this garage for all the work on this Saab:

2 crankshaft sensors	£169
1 ECU testing	£ 65
2 Days investigation work	£300
½ Day engine timing check	£ 75
1 Day Auto electrician	£125
4 weeks of loan car to customer	£550
Total cost	£1,284

The engine still won't start, and everyone is out of ideas.

When I arrived at the workshop, I double-checked the fault code, which was accurate - crankshaft sensor no output. Looking next at the 2 spare crankshaft sensors, it was obvious that this was an inductive type sensor, and as such, generated its own signal from the exciter that would be spinning in front of its magnetic tip. I connected my oscilloscope to the two output wires of the sensor and asked the technician to attempt to start the vehicle, instantly it was obvious that there was no output at all from the sensor, but this of course doesn't mean the sensor was defective. If the exciter has moved or broken, then you would get the same fault. Most exciters are usually some part of the flywheel or ring gear, but on this particular engine it didn't appear that the crankshaft sensor could get close enough to pick up a signal. On checking our data information, it was obviously not getting any signal.

This engine uses an exciter fixed to be crankshaft, one journal in from the flywheel end, by three bolts. Clearly if these bolts come undone, then the exciter will not rotate with the engine.

I removed the crankshaft sensor and by using a boroscope, I peered into the hole and could clearly see that this is exactly what had happened. All three bolts had come undone and the exciter was no longer attached to the crankshaft. Without the bolts, the exciter was not rotating along with the crankshaft, and the sensor could not pick up a signal from the now permanently stationary exciter. The end result was no signal to the ECU that the crankshaft was turning, so no spark at all.

eXponentia, in conjunction with Autobiz, are running two courses at the Europa Academy this November: The highly popular New Technology Seminar and the CAN-BUS & Multiplex-1 course. More details on facing page.

Trouble codes - lost in translation

An older model Mercedes that ran well failed the NCT on excessive emissions. The trouble code was less than straight forward in it's attempt to explain the cause of the fault. A bit of good diagnostics and testing found the problem.

Steve Carter, eXponentia

A 1996 Mercedes E36 AMG was brought into the workshop after it failed the NCT test. Apart from a few minor niggles, its main failure was that the emissions, both CO and HC, were just a bit too high. As a result of these two readings being high, obviously the lambda was wrong as well.

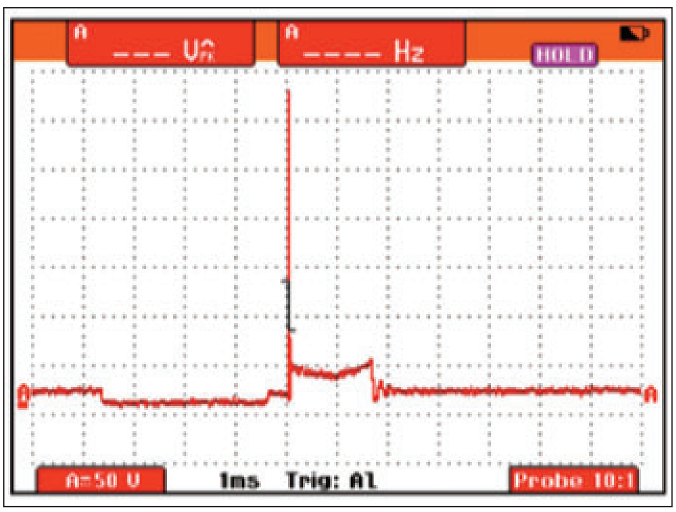
The car appeared to drive well and was not suffering any major misfire, a 10 minute inspection of the engine bay did not reveal anything untoward. It was now time to see if there were any fault codes stored in the vehicle's engine management ECM. The system fitted to the vehicle was a Bosch Motronic M 3.4.2, and although this vehicle is over 14 years old, the on-board diagnostic system seemed quite advanced for its years. The fault code retrieved was somewhat convoluted " dwell angle end of control stop reached". This is a prime example of an engine management system trying to describe the fault in just a few words. My favourite example of this is on many VW models "Multplicative mixture correction at end of control stop." Just try explaining that to the young man, when his VW Golf has failed it's NCT.

Back to our Mercedes, having established our fault code, it was now necessary to drill down further to understand the code definition. The engine management system on this particular vehicle, given its age, controls both fuelling and ignition in one. So the dwell angle, or the amount of time the coils are being charged under the control of the engine ECM, had reached its limits and the engine ECM could not increase this time any further. This engine management system utilises three double ended coils which are mounted directly between the camshafts, leaving very limited access for testing the secondary side of the coils, so instead we focused on the primary side of the coils

As you can see in figure 1, there was a textbook primary wave pattern on two of the coils. Just prior to the firing line you can see the current limiting hump, indicating that the coil had become fully charged, and that the engine ECM had in fact stopped charging this particular coil.

In figure 2, circumstances are much different. You can see straight away that there is no current limiting hump. In fact, 2 ms into the coil charging time, the engine ECM stopped charging this coil, or what was more likely happening was that the insulation on this coil was breaking down. The breakdown of the coil insulation created an earth path, and prevented this one coil from charging properly. Also note that the burn time was only half the time of the other two coils, and that there are no coil oscillations indicating a very discharged coil. The faulty coil was replaced, the code was cleared and the emissions returned to normal.

Although this particular fault was on a 15 year old Mercedes, I'm sure many other vehicles will be suffering similar faults. However, we expect the engine management system can recognize these faults and then give a text description that we can actually comprehend and then work with. I'm sure that as cars get ever more complicated, the text description of the fault code will follow the same pattern.



Two of the coils in the Mercedes were perfect, as can be seen in this textbook coil primary trace.

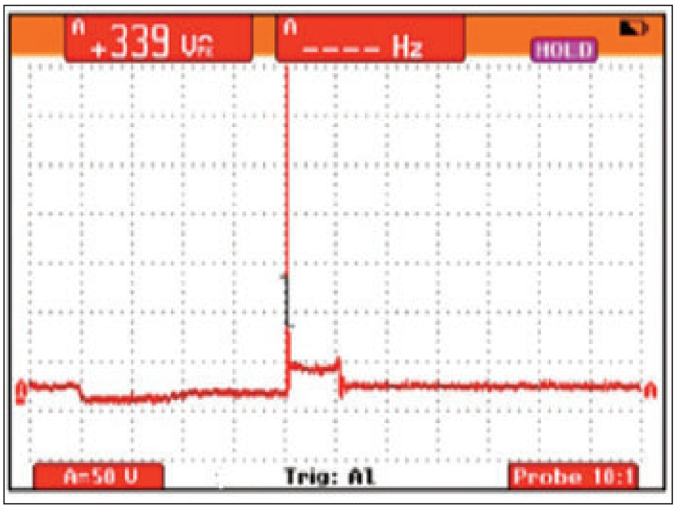


Figure 2. One of the coils in the Mercedes was obviously faulty, the result of a short to earth through the coil insulation.

Not a fun Carnival

When a Kia Carnival's Antilock Brake System (ABS) light came on at speeds greater than 110kph, the problem seemed easy to fix. It was, but only when the proper tools were used to diagnose the problem. A.D.S explains the proper steps needed to find and fix this fault.

The ABS warning light and the trouble codes in the Kia Carnival indicated that there was a fault with the left wheel sensor, so the fault appeared to be easy to solve. The sensor was replaced, but the ABS warning light still went on when the car went above 110 kilometers per hour. The newly installed sensor was itself replaced, thinking that the new sensor was also defective. This did not fix the problem. The car was then brought to A.D.S for investigation because the garage had ran out of ideas, knowledge and diagnostic gear.

Wheel Speed Sensor Function

Most wheel speed sensors work similar to crankshaft and camshaft sensors. The rotating part, in this case the wheel, has a disc with metal teeth firmly attached to it. The sensor is equipped with a coil and a permanent magnet. The coil and magnet react with the teeth on the rotating disk by creating a positive current pulse when a tooth is passing the sensor, and a negative pulse when a gap between teeth passes the sensor. When the wheel is stopped, the voltage drops to a set value. A rotating wheel produces a continuous change in voltage that indicates exactly how fast the wheel is rotating. Shorter times between peaks means that the wheel is rotating faster. The distance between the sensor and the metal teeth is very important, because a larger distance between those two parts produces a smaller magnetic change and a lower signal voltage. In this case the margin was between 0.1 and 1.5 millimeters.

ADS delves deeper

In this case, A.D.S quickly affirmed the fault and saw that a new wheel speed sensor had been installed properly. A multimeter was used to measure the generated voltage (always set the meter to AC) and to check the wiring using the ohm meter setting. Both measurements showed normal results. A multimeter alone did not provide enough information to determine the fault, it was time for something more.

In situations like this, A.D.S specialists always use the ATS 5004D automotive oscilloscope for measuring signals. The scope was used to continuously measures the wheel speed sensor signal in action, but only captured the signal and transfered them to the computer when the mechanic set the trigger. The large internal memory on the scope allowed a long measurement that contained lots of information.

Picture 1 shows the signal of the ABS wheel sensor at 30 kph, and all appears to be normal. The 'peak to peak' value of this alternating current is approximately 3 volts. Typical for this signal is an offset. The signal is not alternating around 0 volts, but at about 0.8 volts. An offset voltage is used so that the Electronic Control Module (ECM) can better recognize a short-circuit fault in the sensor wiring.The offset can be measured with a multimeter when the wheel is not rotating. At higher speeds, the problem became very apparent, as shown in picture 2.

Examining the evidence

The oscilloscope trace showed two strange anomalies in the signal. Since these anomalies appear in a fixed pattern, it could not have been an electronic fault, so it was mechanical. The repetition was caused by particular teeth on the ABS disk teeth when they passed in front of the sensor. The signal also showed a slight amplitude variation. This is not uncommon, and is caused by the fact that the ABS disk is not perfectly round. When the disk was examined the problem was obvious, some of the teeth on the sensor wheel were physically damaged.

The finer details

The only question that remained was why the fault was only reported by the ECU at speeds above 110 kph. The scope trace of the wheel speed sensor signal at 110kph showed that the signal amplitude dropped when the broken teeth passed the sensor was even greater than at low speeds. At low speed, the peak to peak amplitude when the broken teeth passed the sensor was 1.5 Volts. At 110 kph the voltage dropped to below 1.0 volt and was great enough for the ECU to recognise the fault. The ABS ECM sets a limit on the voltage of the signal coming from the ABS wheel sensors. This can be a fixed value, where the signal always must be above or under a defined value, but it is also possible that a limit is set dynamically and depends on the speed of the car. So it can be that at a lower speeds, the limits are less strict then at a high speed.

Conclusion

The ATS 5004D oscilloscope showed more information about the wheel speed sensor signal than could be seen with a multimeter. The irregularities in the sensor signal as shown by the scope were very apparent. The irregularities were rhythmic, not random, leaving only a mechanical fault as the problem. The damaged wheel speed disk was replaced and the ABS system was returned to a fully functional state. Without an oscilloscope, the cause of the fault would have been much harder to determine.

A.D.S
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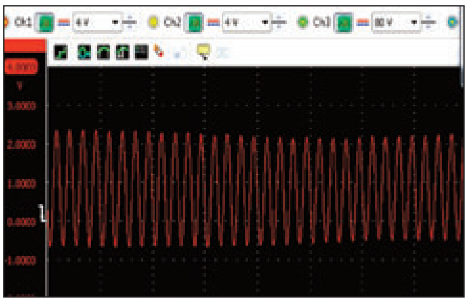


Figure 1: The ABS wheel sensor signal at 30 Kph looked to be perfectly normal

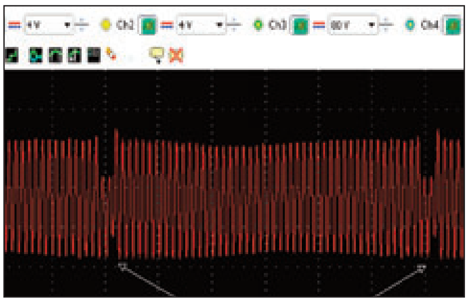


Figure 2: The sensor signal at higher speeds showed an obvious fault, at arrows

Figure 3: Defective teeth on the ABS disk were good enough for lower speeds

An incomplete installation

Replacing a worn out battery in a car, would probably be ranked as one of the easiest repair jobs any mechanic would be asked to do. But in some cases, you would be wrong. New technology has come to most parts of a car, and now it has taken battery replacement to a higher level. eXponentia's Steve Carter gives you all the details, for you to successfully adapt to the new technology.

Steve Carter, eXponentia

Some problems that your customers come to you for help with are very easy to diagnose and the proper solution is easy to carry out. Let's say a customer brings in their late model Citroen/Peugeot, complaining that the engine seems to turn over more slowly in the morning lately, but seems to be fine at any other time. You recall that the nights have been getting colder, and you know they are going to get colder still. Even though you might expect a battery to last longer than this original factory battery apparently has, you suspect that the battery is nearing the end of it's life and needs to be replaced.

A quick load test confirms your suspicions, the battery has lost a good portion of it's original power and will not last long with the coming cold weather. You very appropriately tell your customer that their battery is nearly spent and needs to be replaced. You install a proper sized replacement battery, start up the engine and all seems well. Your customer is happy to pay for the battery and thinks that that is the last they will have to worry about the car starting in the morning. Off they go and everybody is happy, for now.

But the customer and the car will be back in a few days, and your once happy customer will not be happy then. The car will be turning over slowly, or maybe it won't even start at all. These are the worst times for both you and your customer. Each may suspect that the other has done something wrong. The customer might think that either they were sold a poor quality battery, or that the weak battery was only a symptom, not the cause, of the problem with their car. You might think that they left their lights on and that is why the battery is dead again.

Not wanting to offend, you say nothing and recharge the battery. After it has been charged, you load test it and all appears to be well.
At this point you might send them back on their way, but you think that just maybe their is another problem with the car, so you use your trusty multi-meter and quickly discover that at idle, the battery voltage is 12.7V. Even at 2500 rpm the battery voltage is still 12.7V.

You come to the conclusion that there is something wrong with the alternator, so you replace it. But replacing the alternator will not solve this problem. From the moment you replaced the battery, you were sliding down a slope to certain failure.

The original battery was worn out. You correctly diagnosed that, and it was the only problem with the car when it was first brought to you. When the car left your garage the first time, the battery was in good working order, but the alternator was never going to charge it. There was nothing wrong with the alternator.

The problem was that you did not properly install the battery. After you fastened the cables, it is a vital step to attach a scan tool to the car and inform the Engine Control Unit (ECU) that a new battery has been installed. Until that has been done, the charging system will not put any current back into the battery, assuring that the battery will soon be discharged and will not start the car.

Smart Charging

This Citroen/Peugeot, and many more models on the road, are equipped with a 'smart charging' system. In the coming years, most cars will have this technology. Just as many other system and components have been improved and redesigned to increase reliability and reduce emissions, the battery has also been redesigned for modern requirements.

In the battery of a 'smart charging' system, there is a chip that collects data about the current condition of the battery, such as temperature, state of charge, current flow, date of manufacture, etc. The information monitored by the chip is communicated to the ECU. The ECU makes decisions about when to recharge the battery and how quickly to do it. The system is smart enough to turn on and off the alternator to varying degrees, to put back in just what is needed to bring the battery to it's optimum state with the aim of extending the battery life as much as possible, nothing more and nothing less. Providing any more than what is precisely needed would only overheat the battery and take power away from the engine, resulting in a shorter battery life and higher fuel consumption and emissions.

When a new battery is installed, the ECU needs to be told it's new. If not, the new chip and it's data will be ignored because it has abruptly changed. The system sees that the data has changed, it can't reconcile the change with what it expects to see and will err on the side of caution, by not charging the battery at all.

The solution to this problem is simple once you know about this new technology. Technology will effect everything on a car given enough time. We will have more about diagnosing smart charging systems and provide greater detail in a future issue

And that 12.7V at idle or even at 2500 rpm? Perfectly normal.

Tech Tips

Nothing is as good as good information

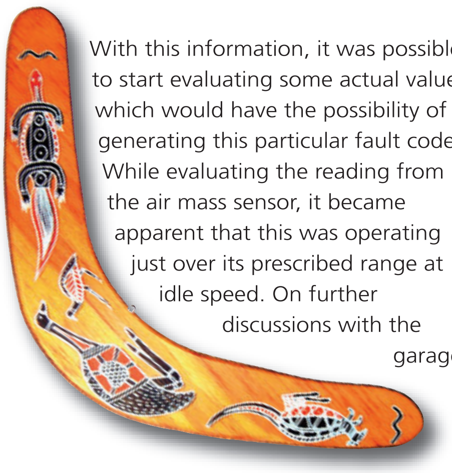
eXponentia's Steve Carter recounts troubleshooting faults on three very different cars with one common key to a succesful repair; the availabilty of vehicle specific information.

Steve Carter, eXponentia

Boomerang BMW

Our first vehicle was a 2003 BMW X5 4.4L V8. This particular garage had quite a busy prestige used car sales area, along with its four ramps and MOT testing bay. The car in question had been sold by them some eight weeks before, but within a few weeks of the sale, the engine management lamp had come on. The customer, having spent a considerable sum of money on this vehicle, went back to the garage straight away, complaining of the appearance of the engine management light, although the car was driving perfectly well. The garage read the fault codes 26 and 27, "multi-adaptive fuel correction at end of control stop". Not truly understanding the definition of this fault code, they cleared the code and sent the customer on her way.

Two weeks later, the customer returned to the garage with the engine management light shining brightly. The garage interrogated the engines ECU, only to reveal exactly the same fault code they had cleared two weeks before. This process went on for another four weeks, with the customer becoming ever more disillusioned with her purchase. The garage was reluctant to change any parts, as they didn't really understand the fault code in the first place. The fault code relates to lambda control, and in particular, attempts to achieve an optimum fuel/air mixture by altering the opening time of the injector.



With this information, it was possible to start evaluating some actual values, which would have the possibility of generating this particular fault code. While evaluating the reading from the air mass sensor, it became apparent that this was operating just over its prescribed range at idle speed. On further discussions with the garage, they confirmed that this part had been changed recently, but not with a patterned part. Replacing the air mass sensor brought the air mass reading into the middle of the prescribed range at idle, curing the fault. As you can see from this example, technical information, whether it is detailed descriptions and explanations of complex fault codes, or specific component values for comparison with actual values, is going to become ever more vital just to stay one step behind the vehicle manufacturers.

Just the thing you need to know

The next two examples show how information plays a vital part in diagnosing and correcting faults. These examples do not require any diagnostic equipment or technical information, just the exchange of information between garages.

Making the right connection

The first was a VW Golf Mk4. When the ignition was switched on, the driver information display showed a warning of low oil level; however this level was satisfactory on

starting the vehicle. The oil warning light would stay on when the engine was running, but only as an orange glow rather than red. Having received several of these puzzling problems, eventually a solution was found whereby the car's ignition is switched off, the battery is disconnected completely and the battery's harnesses are removed from the battery and bridged together.

Putting out a fickering light

The second vehicle in question was a Fiat Punto Marea, and possibly the Stilo (although I have never encountered the latter personally). The common factor here is that they both share the same Marelli engine ECU. The problem is that the engine management light flashes rapidly, but does not present any serial fault codes and the car drives normally. A rapidly flashing engine management light is somewhat disconcerting for the driver of the vehicle.

The solution to this problem is incredibly simple but without this information, a garage could spend many hours trying to correct the fault. The solution? With the engine running and at operating temperature, the engine must be revved past 4000 RPM before allowing to return rapidly to idle RPM. This process must be conducted four times in order for the light to be put out. Why does this simple procedure work? It resets the crankshaft sensor.

As you can see on all of these examples, the one common factor shared is information. Whether this information is gained from technical publications or from real- life experiences, it is imperative that the independent automotive community shares their information in order to help one another but more importantly, to remain one step behind the vehicle manufacturers.

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