TDI Electronic Diagnostics!

Tracing and fixing faults in electronic management systems

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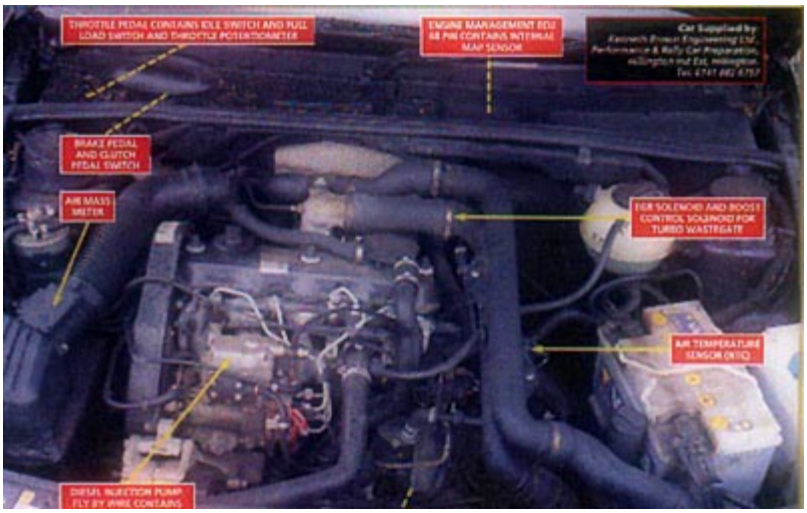


Number 51: This month we take our first and long-awaited look at the diagnostic delicacies of a modern diesel engine. Volkswagen's popular Golf provides the motor, Chris Graham chooses the words.

Most modern diesels operate on the direct injection principle these days, because it provides superior fuel economy and better power output. The system is generally more suited to the use of turbochargers and cylinder heads are cheaper to manufacture too.

We all know how durable modern diesels tend to be, but what of their electronic reliability? The latest examples are literally bristling with state-of-the-art control systems and, in many ways, they are more complicated and trickier to deal with than the equivalent gas models. For some answers I ventured north to the norder to visit independent electronic diagnostic expert William McLaren (tel 0370 7372571).

William is a rare character because he is one of the few tuning and fault-finding specialists with the necessary knowledge and experience to deal competently with diesels. I met him at a windswept and damp Glasgow airport, and we set off to track down our "guinea pig" Golf.

On route he started to explain about the high cost of most diesel components, emphasizing the importance of correct diagnosis if bills are to be kept within reasons. With diesel pumps costing $2,500 - and replacement ECUs $1500 to buy, careless thinking really can cost a fortune.

In general, most components from diesel are two or three times as expensive as the gas equivalent. So, although problems are relatively rare, when they do strike they can be both costly and tricky to put right. Many traditional fuel injection specialists will not touch diesel cars for this very reason.

William advises that it's vital to categorize the type of fault first - be it mechanical or electrical. ALl the basics have to be checked such as whether there is air in the fuel, if the supply is good, if the filters are blocked, etc. Then, having established that all is well, you must switch to an electronic diagnostic approach using code readers, breakout boxes, and oscilloscopes. The cost of the parts means that guessing really isn't a viable option with these systems. If you decide the pump is faulty, for example, it's not simply a matter of paying a high price of the part - fitting and setting up requires special tuning equipment and plenty of experience.

Preparation

With this TDI engine on of the most important factors for good, reliable running (as with any diesel) is that the quality of the fuel remains good. It is important that the air filter is kept clear of obstructions and that the fuel filters are changed regularly, in accordance with the service schedule.

Remember that any reduction in fuel supply, or hole in the pipe work which allows air to enter the system, will lead directly t drivability problems. Although this is strictly a mechanical problem, it can easily be wrongly diagnosed as a serious problem with the pump.

Check the quality and integrity of all connections and inspect the ECU for signs of water damage. There is a splash guard fitted as standard, but sometimes this may go missing and problems will almost certainly result. William has come across ECUs which have been rusted to the mounting on which they sit!

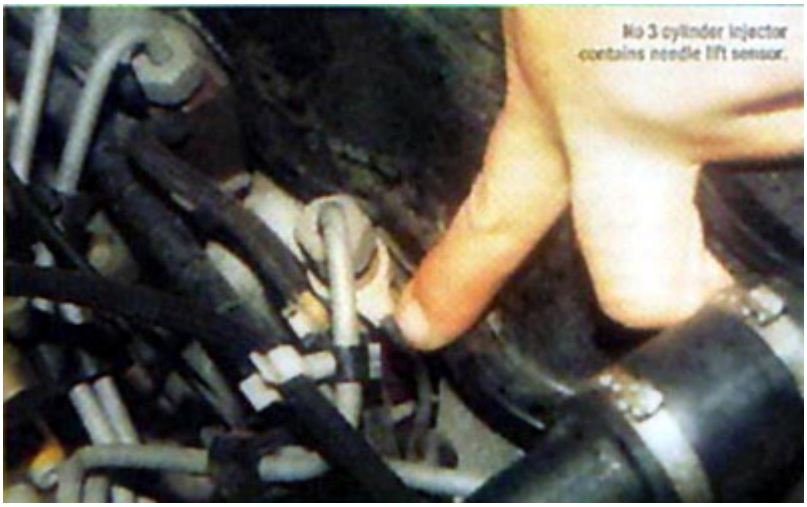
Any normal diesel engine will sweat oil to some extent but this 1.9L unit is no worse than any other. Ideally, the engine should be kept reasonably clean but, if you choose steam cleaning for this, take care.

Be particularly on your guard if you know the car has undergone any major mechanical repair work. William came across an example on which the gearbox had been changed. Unfortunately, a careless technician had managed to pinch some of the wiring loom between the gearbox and the bellhousing and his had shorted out the ECU. The luckless garage replaced the damaged ECU with a brand new one and, of course, the same thing happened again! At this point they decided to check properly for the cause and eventually they found the pinched wires. A lesson to us all I think!

On this application, most of the wiring is covered in a canvas-like insulated wrapping and this can have a tendency to rot. Check this carefully as electrical shorts will wreak havoc!

Diesel Downfalls

Despite being generally reliable, the 1.9L VW TDI engine does have its share of characteristic weaknesses. First, and probably the most common among these is a problem which relates to the needle lift sensor.



This is built into injector number three and its role is to inform the ECU about engine stroke for ignition timing purposes. A small rod is moved within a coil to generate a voltage that can be interpreted by the ECU. The problem is that with age the injector needle becomes inefficient and eventual fails to operate. The upshot is that, although the engine will normally still run, poser and top speed performance are noticeably reduced and the dash light (glow plug light!) is triggered too.

William believes that part of the problem stems from the type of diesel we use here in the UK (and USA). The high levels of sulphur contained within the fuel have a detrimental effect on its lubricating ability, and this can be costly for both the main injection pump and the injectors. Generally, the system is pretty resistant to injector

deterioration, apart from in the case of the No. 3 injector: Once the operation of this one starts to become sluggish, then the signal sent from the lift sensor to the ECU is affected and the system goes down hill rapidly.

Putting the condition right essentially means replacing the No. 3 injector. Unfortunately, this injector and its associated sensor take the form of a single, sealed unit and so have to be replaced as one component, costing about $400. This then throws up the dilemma of whether or not to replace the other three remaining injectors at the same time - might they all be similarly bad? On the basis of good workshop practice it would seem sensible to do so but, of course, there is the cost factor to be considered.

William tends to opt for a compromise here. His suggestion is that the No. 3 injector should be renewed, but that the other three should be removed and mechanically tested for flow rates, spray pattern, and the presence of "dribbling". The conventional injectors can be refurbished if problems are found, and this will save some money.

With this problem in mind, William advises owners always to use the highest quality fuel they can find. It may also be advisable to employ diesel conditioning treatment at regular intervals to help lubricate the pump and injectors.

Unfortunately, this type of injector problem can occur at any time. There seems to be no predictability about the condition, and William has seen cases on cars which have covered just 30k miles, while on others it night not happen for the first 100,000 miles.

Another relatively common failure on the TDI diesel is caused by problems with the crank angle sensor. Root causes can be poor electrical connections, water ingress, or dirt contamination - or a combination of all three! The sensor's location, at the bottom of the bell housing, makes it vulnerable to attack from all the usual undesirables. It can also be damaged by ham-fisted mechanics changing starter motors or clutches. This sensor is of the magnetic type and takes its input from the flywheel, each of which denotes a cylinder.

Any problem with this sensor will throw the management system into "limp home" mode so performance will be noticeably inhibited and the glow plug light on the dash will shine at times. Owners may also notice a reluctance for the engine to start and increased smoke from the exhaust when it eventually does. This will often be grey in color, indicating that the timing is incorrect. Always check the connections first, because this is the simplest thing to put right. If these are OK, then the output must be checked using an oscilloscope and, if a problem is found, replacement is the only solution. New crank angle sensors cost a more reasonable $150 or so, according to William and fitting is a simple operation.

The third fault we've selected concerns the diesel injection pump itself. This is a serious piece of machinery, and not one to be meddled with by the inexperienced! It has a tendency to suffer an internal fault, which presents itself as deterioration in top speed performance - the car simply gets slow. What actually happens inside, according to William, is that a problem develops with the control mechanism for the governor. The upshot is that maximum revs cannot be obtained and so top-end performance suffers.

Unfortunately, the pump is not sensed by the management system, and so no light on the dash is triggered when such a problem occurs. To complicate a matter further, William says that this trouble cannot be detected diagnostically either. Replacement of the pump is the only solution but, with this costing anything from $2,000 to $3,000, it is vital to be sure about your diagnosis before taking the plunge!

In practice, this complaint can be mistaken for a slack throttle cable - except, of course, this engine does not have one! As already mentioned, this engine runs by a "fly-by-wire" throttle system, with no cable at all. The throttle pedal has an idle switch built in, which acts to reduce fuel flow to the pump as the throttle is released. Also, there is a "kick down" switch to tell the ECU when the pedal has been floored, so that more fuel can be supplied to meet the increased demand effectively. By and large, this state-of-the-art system is proving reliable so far.

One other problem which William has encountered concerns the brake pedal switch. The ECU uses inputs from this to activate the fuel cut-off mechanism so that diesel is not wasted during braking. It is important that this switch is correctly set up, otherwise fuel cut-off can be activated at the wrong time and the engine may begin to stall under braking. The switch may also become faulty with the effect that fuel cut-off is being activated at random.

The setting-up procedure is detailed in the workshop manual, but is based essentially around pedal travel. William says that a VAG service tool is required for this important job, unless you are expert with a breakout box and have the relevant data relating to correct switch output, etc.

He adds as a final point, that it is important to monitor the voltage output of the air mass meter. This is a critical factor on this system. The meter is based around a hot wire, which is cooled as the induction air is drawn across it. It is a sensitive component and is easily damaged so take great care if you have to remove it. As with most other components on this engine, replacements are expensive!

Technical Specifications

Component	Voltage Output	ECM pin
Air Mass meter	1V at 950rpm 4V at 3,000rpm	P13
Coolant temperature sensor	4V at 20°C 1.5V hot	P14
Air temperature sensor	3.8V cold 1.7V warm	P64
Crank angle sensor	Digital, 14V peak-to-peak at idle, A/C	P5
Fuel quantity sensor	Digital 12V square wave	P30
Fuel temperature sensor	6V cold 4.2V hot	P53
Main relay	0.8V ignition on 12.4V ignition off	P42
Battery ignition control	-	P38

EGR solenoid	Square wave varying duty cycle	P25
Trigger for injection wave	-	P51
Glow plug relay	-	P6