

ELECTRONIC DIAGNOSTICS!

Part 8: Chris Graham investigates Ford's EEC-IV management system as found on the Granada 2.9i.

Introduced in 1985 with the arrival of the 'new' Granada model, this version of EEC-IV has proved very successful. Frank Massey of Fuel Injection Services (Tel: 0772 201597) considers the system to be extremely robust and thinks that the ECU is virtually bombproof – he's had to change just one in the past eight years!

Having worked on many of these big V6 Granadas, Frank has the following

TYPICAL FAULTS

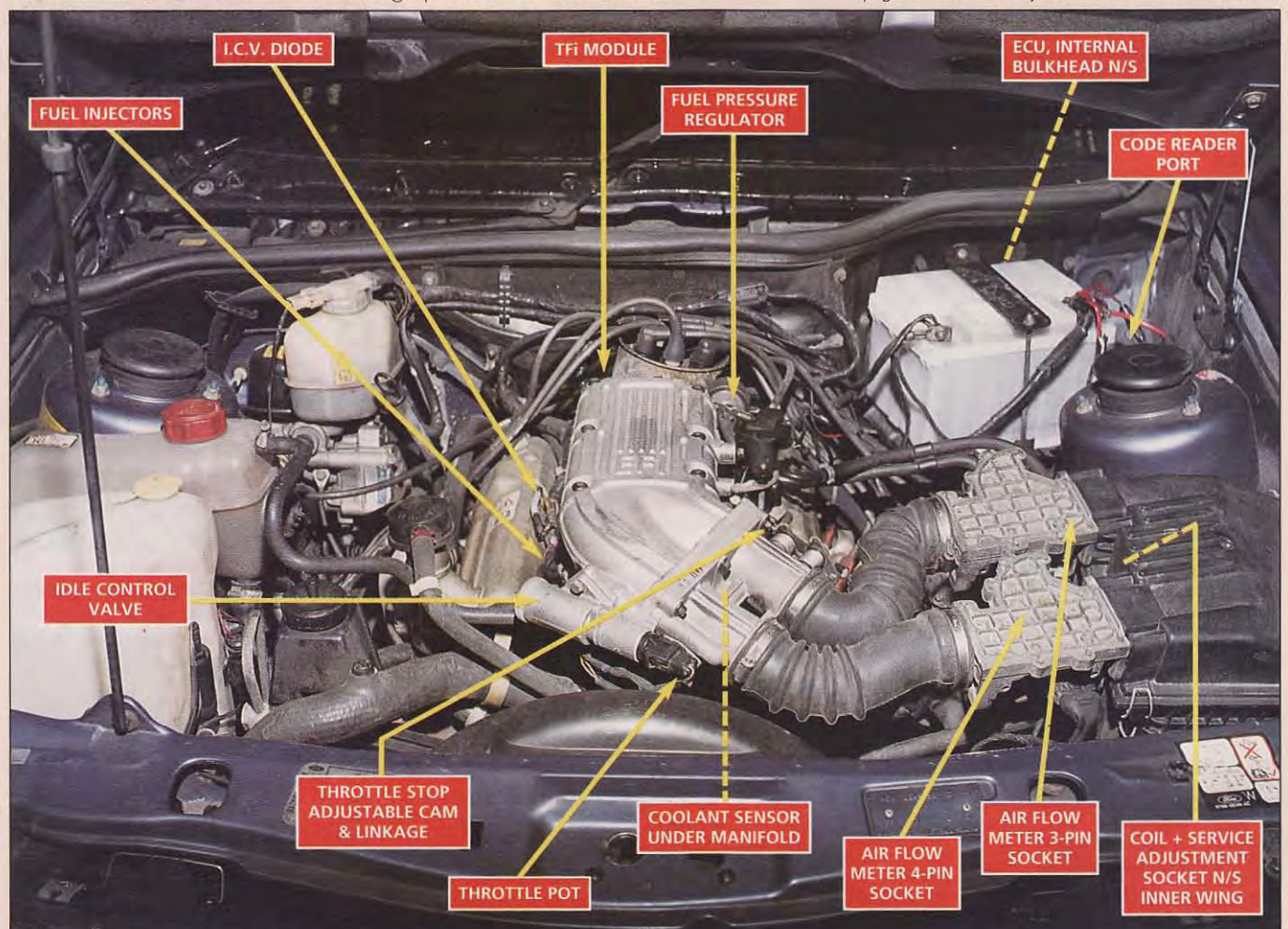
1. *Idle surging*
2. *General hesitation*
3. *Rich mixture*

advice to owners and tuners alike regarding the preparation and basic tuning needed before any serious diagnostics work is carried out.

Basic tune-up

First remove the air induction trunking so that the throttle body can be washed out. This can be badly contaminated (depending on age). Also thoroughly wash out the plunge valve which is part of the idle control mechanism to remove all carbon deposits.

Make sure that the throttle stop is adjusted correctly so that the throttle discs



are not fouling the body. The stop is often wrongly used to provide idle adjustment. Carefully check the throttle potentiometer voltage. This is a five-volt component and has an output which should range from 0.6-4.5V in a very smooth, linear transition. It is not adjustable so, if the reading is incorrect, then it's probably the throttle stop which is at fault (driving the voltage too high). If the voltage is wrong but the stop setting is OK then the throttle pot. is at fault and this is a common failure. Check supply and earth also.

Ensure that both the air flow meters (yes, there are two!) are free from obstruction and are not suffering from water ingress (a common problem on older vehicles). There are also a number of multi-pin sockets towards the rear of the engine which can suffer with water too (often caused by careless steam cleaning), so make sure that all are clean and lubricated.

Check that the distributor cap, rotor arm and HT leads are completely clean. Inspect the leads for chafing because the route they take can promote this. They should normally be clipped but often their fastenings are damaged or missing. Pay attention to the connections on the coil, which is on the n/s inner wing.

Frank says that confusion often arises concerning ignition and mixture adjustments and he offers the following advice. The octane service socket, which is located next to the coil, is a three-wire (red, blue and yellow stripe) device and must be disconnected from the ECU for all tune-up procedures.

When setting the ignition timing the management system must be put into code 60 which represents a service state and puts the ignition timing into a flat or fixed timing mode (the SPOUT sig-

ENGINE MANAGEMENT

EEC-IV is a full engine management system controlling both ignition and fuelling from one control unit. It utilises many of the inputs which have been detailed in previous articles.

It uses two air flow meters, a throttle potentiometer, a coolant sensor, an air temperature sensor (found in one of the air flow meters), two relays feeding the fuel pump and ECU respectively (mounted under the dash on passenger side). Later models feature KAM (keep alive memory) which means that fault codes are retained provided the battery or fuse is not disconnected.

There is a standard fuel rail with six injectors which are wired in two sets of three requiring two outputs from the ECU (pins 58 + 59). All are triggered together. An idle control valve is mounted on the throttle body.

Some models are also fitted with a closed-loop control with a charcoal canister in the tank for emission purposes, while others have power steering and air conditioning fitted which both effect inputs/outputs to the ECU and influence the idle control.

Fuel supply is via a fuel pump which is normally externally mounted at the rear of the vehicle with a separate fuel filter next to it. Some models also feature inertia switches as a safety precaution.

A distributor is fitted at the back of the engine and features a Hall effect trigger (square wave output), mounted on which is the TFi module named after its manufacturing process - Thick Film Integration. This controls the primary coil switching (dwell). The Hall signal output to the TFi provides the PIP (Profile Ignition Pick-up), crankshaft speed and position information and is then sent to the EEC-IV module. Here it is modified with reference

to engine speed, temperature and load signals to provide a SPOUT (spark out signal) back to the TFi (mapped ignition signal). This is used to switch off the coil primary circuit (ignition point).

The distributor signal is referred to as PIP (profile ignition pick-up) and the return signal from the ECU is termed SPOUT (an abbreviation for spark out). There is no knock control as such but Frank says that these engines rarely suffer from pinking.

The system has the ability to withstand certain input failure thanks to a 'limp home' default mode. These include the SPOUT signal. If this stops then the engine will continue to run (with flat ignition timing) on the PIP signal only. The engine will also run if the air flow meters are disconnected.

The ECU itself is mounted in the passenger compartment, on the n/s of the vehicle above the footwell space. It is conveniently clipped into place and the connecting wires are sufficiently long to enable extraction and easy testing.

One important difference between this system and the four-cylinder EEC-IV version detailed earlier in this series (October 1994 issue) is that, although all the injectors are controlled together, they are actually only triggered once per cycle. Consequently, injector duration is twice as long as on the other variants. This amounts to 4-6ms when hot and 10-12ms when cold. During cranking enrichment (only when cold) this can be pushed to 20-30ms!

There is also a frequency modification facility which will trigger the injectors for multiple operation as well as for increased duration under conditions of heavy load. This, according to Frank, effectively eliminates flat spots due to poor fuelling.

nal is removed). This enables the base timing to be set at 12° BTDC and also parks the idle control valve. Achieving code 60 setting officially requires a code

reader but, Frank says there is a short cut. Disconnecting the throttle pot. switch will default the system into code 60 (but will, of course, generate a fault code as well).

With the engine running on code 60 the tickover should be smooth (at about 850rpm) and it will then be possible to set the timing with a strobe light - twisting the distributor body as required. Exiting from code 60 will re-introduce the idle control and ignition map after which the fuel-air ratio must be tackled.

Because there are twin air flow meters there can be a conflict between the two in terms their outputs to the ECU. As a rule of thumb set the air bleed screw on the rear meter to the fully closed position. The one on the front meter should be adjusted normally to produce a CO content of about 1.5%. If this cannot be achieved by adjustments on the front meter alone, then open up the bleed on the rear one progressively until the correct figure is obtained. Frank's personal method is to bleed a little off both meters to achieve the right level.



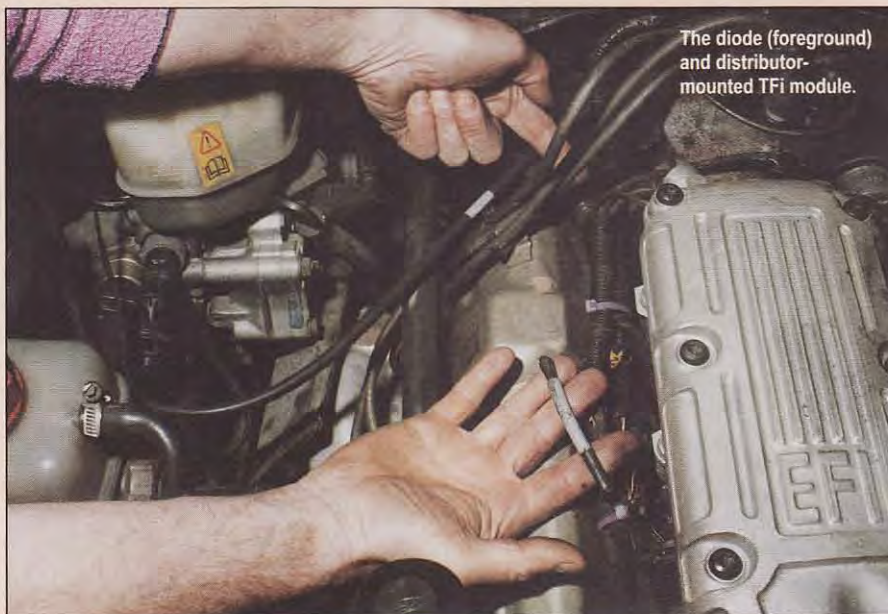
This is the octane or service socket with its red, yellow and blue wires. One or more is cut to achieve ignition/tickover adjustment.

ELECTRONIC DIAGNOSTICS!

Given these adjustments, then the engine should be fuelling and idling satisfactorily. If then you wish to introduce enhancements for unleaded fuel then the octane service socket must be used. The blue wire will retard the ignition by two degrees, the red wire by four degrees and both together by six degrees. To make such adjustments the tool is connected and the wires whose functions are NOT wanted should be cut. Retarding the ignition may well slow the idle speed but by earthing the yellow wire you can increase this by some 60rpm.

With regard to the use of diagnostic equipment, Frank does not think that a code reader is particularly recommended. The codes presented are all simple and EEC-IV does not allow for the extraction of voltages and other calculations in this way. Therefore, it's more worthwhile to work on voltage readings taken conventionally. The code reader, of course, is useful for obtaining code 60.

On later versions, which have a 'keep



The diode (foreground) and distributor-mounted TFI module.

alive memory' (KAM) function, the use of a code reader is more beneficial because historical faults can be viewed.

Fault correction

One of the most common faults with the 2.9-litre Granada engine is idle speed surging. It can both stall or race up to 1,500rpm and this can happen both when hot and cold. We've already

established the importance of keeping the throttle body and idle control valve thoroughly clean but it's also worth remembering the importance of air leaks. There are two rubber hoses from the air flow meters and various other vacuum pipes which may have split, perished or been disconnected. Check all carefully and carry out manifold vacuum checks.

The throttle stop must be set correctly and the voltage output of the throttle potentiometer measured with an accurate voltmeter. The base output of the latter must be no greater than 0.8V; higher values will cause the ECU to disconnect the idle control valve which is bad news. Washing out the idle control valve will normally cure most problems but in some cases it may have to be replaced.

Finally, if idle problems persist it's worth remembering that there is a diode fitted across the idle speed control circuit (in between pin 21 of the ECU and the supply from the main relay). This diode, which prevents a back feed, is taped into the vehicle's wiring harness along the top of the engine in between the two cylinder banks. It's coloured grey and is cylindrical with a diode symbol stamped on it. It can be

TECHNICAL SPECIFICATIONS

Throttle pot. (Wires numbered on socket)	Wire 1 Wire 2 Wire 3	0.6V-4.5V 5V supply 0.25V earth	ECU (pin 47) ECU (pin 26) ECU (pin 46)
Coolant sensor	Earth Output	0.25V 0.5-0.7V hot	4.5V cold (pin 7)
Air flow meter Front (4-wire)	yellow stripe - air temp. red stripe - output	2.7-2.9V @ 25°C (pin 25) 1-1.2V @ 900rpm (pin 27) 1.7-1.9V @ 2,000rpm 4.5V max.	
	black stripe - supply brown wire - earth	5V (pin 26) 0.25V (pin 46)	
Rear (3-wire)	red stripe - output	0.4-0.5V @ 900rpm 1.3-1.5V @ 2,000rpm 4.5V max. (pin 43)	
	black stripe - supply brown - earth	5V (pin 26) 0.25V (pin 46)	
Idle speed valve	Supply - 12V from main relay		
Injectors	Supply - 12V from main relay Duration - 4-6ms hot Acceleration enrichment - 30+ms (full load)	8-12ms cold	
Coil output	30-35KV		
Plug voltage	12-15V at idle	20V snap load	
Alternator	13.5-14.5V		
Ignition timing	12-14° (minus 2/4/6 degrees with service socket)		
CO	1.5% at idle	0.5% at cruise	
HC	200-300ppm at idle	100ppm or less at cruise	
CO2	13%+ at idle	13.5-14% at cruise	
O2	1% at idle	0.5% at cruise	



The throttle stop and roller bearing linkage are important factors when tuning this engine.

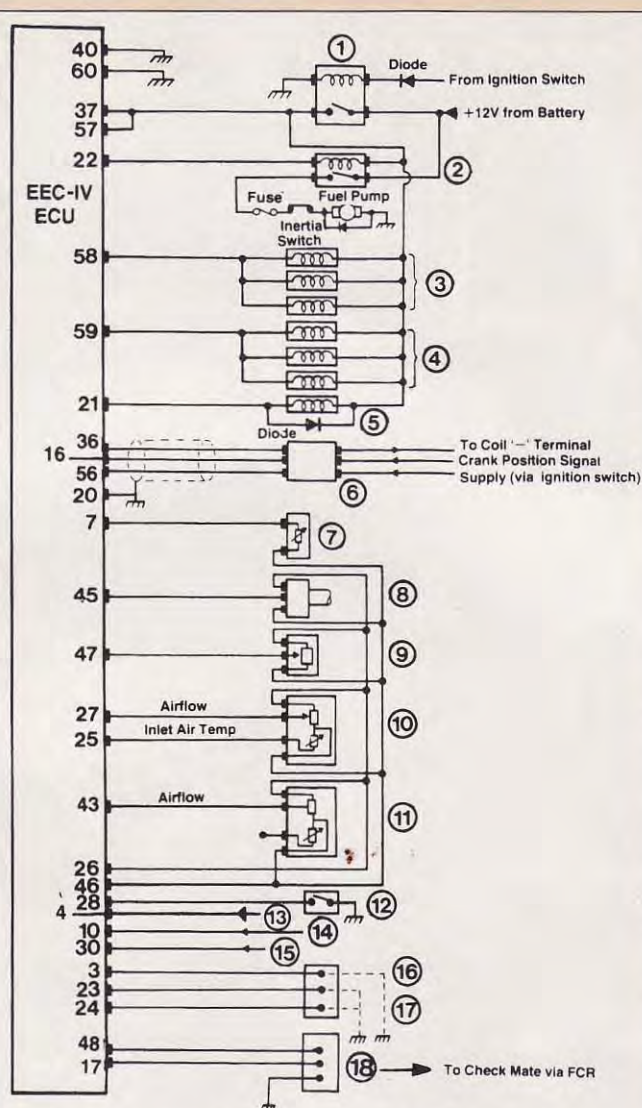
checked with an ohms meter across the diode which will show infinity (a block) one way and a resistance reading the other. This is the correct condition.

Problems with the throttle pot. can also give rise to the second most common problem which is engine hesitation. The output from this single component provides important information for the ECU regarding idle control and fuel enrichment during driving. Faults with the throttle pot. will lead to drivability problems in the form of loss of power and flat spots, particularly through the mid-range.

The way to distinguish this fault simply involves a voltmeter. Attach it to the output from the throttle pot. (central wire - green tracer or green to pin 47 on ECU), and check the voltage range between the open and closed positions. This ideally should be 0.6V when closed and 4.5V fully open. It's important that the progression up this range is smooth and without large jumps and careful observation of the voltmeter is required to check this. Frank advises that this check be made from the accelerator pedal because linkage deficiencies may also be causing problems.

The voltage needs to be correct at the 4.5V end of the range because the full-load enrichment is triggered by a voltage threshold of about 4V so top-end power will be reduced if voltage levels are not high enough. Insufficient fuel will be supplied during hard acceleration. Another important function of this system is that while the motor is being cranked and the throttle pedal is fully depressed (producing 4V+ from the potentiometer), the fuel will be cut off to prevent flooding. This, again, is triggered by the output voltage so it's vital that it reaches the correct upper limit.

The throttle pot. requires a 5V supply and a good earth for accurate performance so check this carefully. Should it need to be replaced this is a simple operation. It's held in place by a couple of small screws and a locking device and no adjustment is required. The cost is about £36. Later versions have gold-plated pins as a measure against corrosion. These must be matched to sockets with similarly treated terminals.



FORD EEC-IV ENHANCED

- | | |
|---|--|
| 1. Main relay | 10. No.1 vane airflow meter |
| 2. Fuel pump relay | 11. No.2 vane airflow meter |
| 3. Injectors (cyls. 1, 2, 4) | 12. Fuel temperature switch |
| 4. Injectors (cyls. 3, 5, 6) | 13. Road speed sensor (varies as rear wheel rotates) |
| 5. Idle speed control valve | 14. Air conditioning clutch signal |
| 6. TFI-IV ignition amplifier module | 15. Neutral/drive signal (automatic gearbox only) |
| 7. Engine coolant temperature sensor | 16. Idle speed adjust |
| 8. Atmospheric pressure sensor (optional) | 17. Octane adjust |
| 9. Throttle potentiometer | 18. Diagnostic connector |

Diagram courtesy of FKI Crypton Ltd.

Another factor which can influence the throttle pot. voltage, apart from the base idle stop, is the throttle body linkage. This incorporates a cam mechanism with a roller bearing and the adjustment of this is important to ensure that the throttle shuts fully and that the correct voltage range is achieved.

A rich mixture which cannot be correctly adjusted is the third common failing of this system. There are potentially two causes of this, one is that the air flow meters have been badly adjusted, suffered water ingestion or have voltage supply and/or earth problems.

Water ingestion can cause the air vane to be hesitant or partially seized

but this is easy to check. With the induction hoses removed, use a soft implement to open the vane smoothly through its operating range to make sure that it is free. Check the voltage supply, the earth (see spec. table) and the voltage output.

The latter is identical to the throttle pot. so the checking procedure is just the same. Use a voltmeter or oscilloscope, switch the ignition on and check that the output of both meters progresses as it should as the vanes are opened. If all is well then the two should then be checked with the engine running.

At this point an important difference develops because the two air flow meters produce slightly different voltages at idle. The front one incorporates the idle control valve circuit and Frank says that its voltage output should be about 1V at idle. The rear one should be slightly less at about 0.6V. At cruising speed (3,000rpm) the two outputs should theoretically be balanced and this can be achieved by carefully adjusting the air bleed screws.

If the voltages of the air flow meters are correct then the second possible cause of mixture richness is excessive fuel pressure. This is governed by a pressure regulator mounted at the rear of the engine near the distributor. The pressure should be 2.5bar without vacuum, 3bar with and, of course, you will need a fuel pressure gauge to check this.

Discrepancies in the pressure, apart from being caused by obvious factors like a blocked filter or tank return, are usually the fault of the pressure regulating valve. Replacements cost about £30.

If the fuelling is still not right, assuming you have also checked injector duration and the inputs from the coolant sensor, air flow meter and throttle pot., then it's worth investigating the condition of the injectors using the services of a specialist with a flow bench. This, though, is not a particularly common problem.

My thanks to Frank Massey, Sykes-Pickavant and FKI Crypton Ltd for their help with the preparation of this feature.

NEXT MONTH
BMW 3-series.