

FORD EEC IV ENGINE MANAGEMENT

ZETEC (ZETA) ENGINES

Service Adjustments

Ignition Timing 10 DEG BTDC
(+/-2 Deg)

The ignition timing is non adjustable

Idle Speed 875 rpm
(+/-50 rpm)

The idle speed is non adjustable

CO Setting, cars are fitted with catalytic converters and Lambda control.

No service adjustment is possible.

CO level should be at 0% with the engine running at around 2,500 rpm and the engine and catalytic converter at normal operating temperature.

At idle speed, a CO reading up to around 0.3 to 0.5% may be measured if the catalytic converter is not at full operating temperature.

Ignition timing and idle speed checks can only be carried out when performing the "service checks" procedure with an appropriate code reader or similar. Refer to equipment manufacturers information noting that the engine running checks procedure allows a set period for "service checks".

Timing and idle speed are non adjustable, however, the base timing setting (10 deg) and base idle setting (1500 rpm) can be checked during the "service checks" period.

The octane adjust connector provides the facility to alter the timing programme to accommodate low octane or poor quality fuels. The octane adjust facility connects to ECU terminal 42 and to ground, bridging the two terminals (a Ford service plug may be used) will result in an alteration in the ignition timing at relevant points throughout the engines operating range.

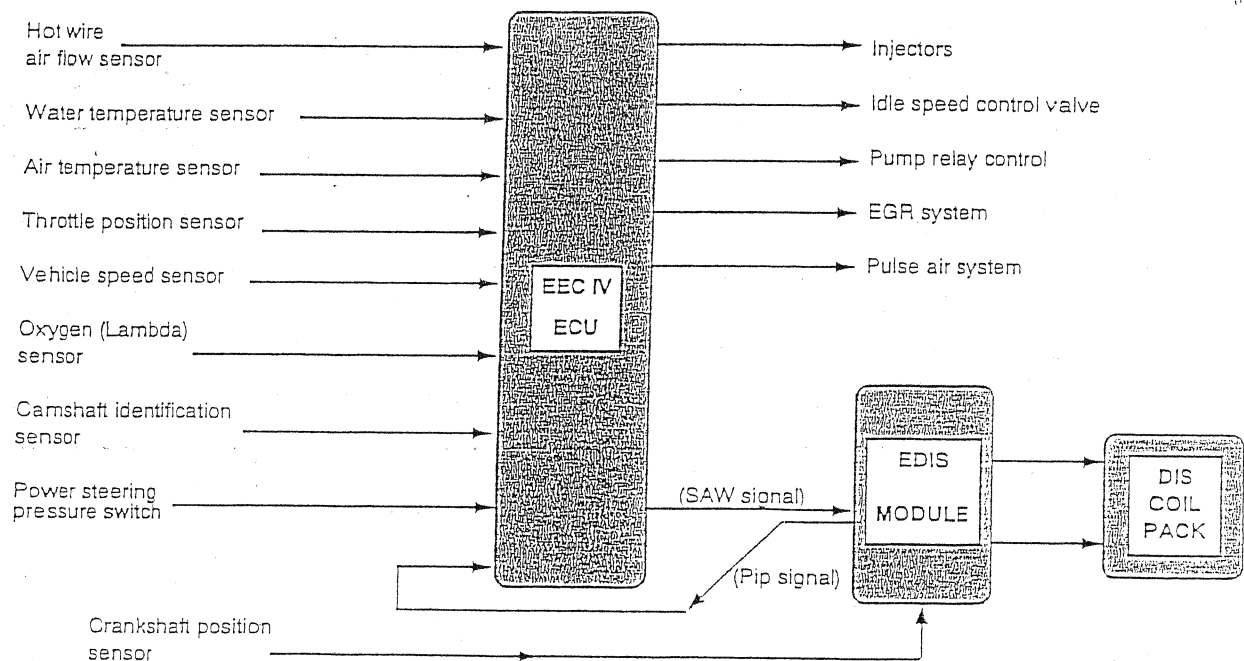
Ideally, the vehicle should be driven so that the engine and catalytic converter are at normal operating temperature. The CO (and other gas readings) should be checked immediately the vehicle is driven back to the workshop. Run the engine at approximately 2,500 rpm for 30 seconds and whilst maintaining this engine speed, check the CO reading.

System Details

The EEC IV fitted to Zeta/Zetec engines makes use of a hot wire air flow sensor rather than a MAP sensor or mechanical type air flow meter. Injectors are operated sequentially in engine firing order, rather than in groups of two or four, therefore a means of identifying the operating strokes of the four cylinders is required. On the Zeta/Zetec engines, a "camshaft identification" sensor is fitted which sends a signal to the ECU indicating camshaft position. The ECU is now able to determine when number one injector should be opened and, the remaining injectors can then be opened at the appropriate intervals of crankshaft rotation.

The Zeta/Zetec engines using the EEC IV system are fitted with catalytic converters and Oxygen (Lambda) sensors. A pulse air system is used which allows air to be pulsed into the exhaust manifold during the warm up phase. The air combines with the unburnt fuel in the exhaust gas (rich mixture during warm up) resulting in an after burning process which accelerates the warm up of the catalytic converter.

An evaporative emission control system is fitted which allows fumes from the fuel tank to collect in a carbon canister, the fumes are then drawn off through to the engine intake manifold under certain driving conditions (not at idle, full load or when the engine is cold). A canister purge valve, controlled by the ECU, is used to control the flow of fumes through to the engine.



MAIN INPUTS

MAIN OUTPUTS

EEC IV Engine management with EDIS distributorless ignition used on Zeta / Zetec engines

System and Component Checks

Injectors

Injector resistance 15 ohms (+/-5 ohms)

(check individually with injector plug disconnected)

The injectors receive a common live feed from the main relay (terminal 87), they are however, switched through to earth by the ECU individually to achieve sequential operation.

IMPORTANT NOTE. The injectors are fed with fuel through the side of the injector body rather than from the top. The injectors sit in the fuel supply rail and therefore receive the fuel directly from the supply rail. If an injector has to be removed from the supply rail, a quantity of fuel will be able to pass from the supply rail into the intake manifold and possibly into a cylinder. This situation could result in damage when the engine is then cranked over.

Injection Duration

NB. Although the injectors are operated individually, it is unlikely that the injectors will receive different duration values from the ECU. Therefore, duration checks can be carried out on one injector only unless it is suspected that a cylinder (or more than one cylinder) is receiving more or less fuel than the others. However, if a cylinder is not running, it will be necessary to check each injector for operation.

If all injectors are operating ie. all cylinders are running, check the injection duration.

NB. If a system fault exists, the EEC IV may operate in a "Limp Home" mode, this can result in a nominal value duration being supplied, which would provide a slightly weak mixture for a cold engine but it would then be rich for hot engine. If the duration is slightly smaller than expected for a cold engine, but larger than expected for a hot engine, it is advisable to use a fault code reader to check whether a system fault has been recorded by the EEC IV ECU.

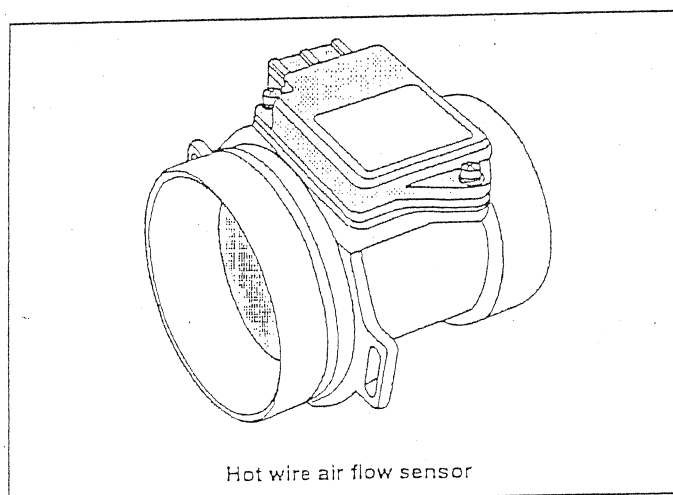
If there is no recorded fault code, but the duration values appear to be incorrect, it is then likely that a sensor is operating incorrectly, but not out of acceptable tolerances eg. a sensor may be providing a signal that is within specification but, incorrect for the driving conditions, such as a water temperature sensor which is providing a cold running signal although the engine is hot. Also note that the sensor circuit fault may cause similar problems.

- (1) If the duration values appear to be correct for a particular temperature range but do not alter as the temperature changes, refer to water temperature sensor checks.

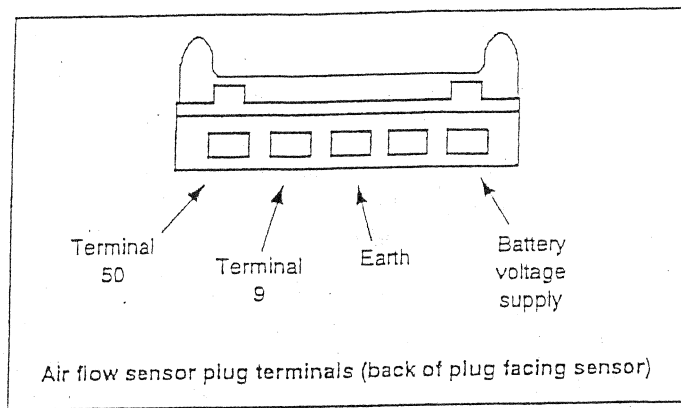
	HOT	COLD
Cranking	starts high but rapidly reduces to idle values	
Idle	3.0 to 3.2	5.4 upwards
3000 rpm	Reduction of approx 0.2 ms from idle value	
Snap open throttle (simulated load)	Increase to at least 10 ms	
Snap close throttle (simulated decel)	Injection pulse reduction and cut off	
INJECTION DURATION VALUES (in milliseconds)		

- (2) If the duration change is not as expected when the throttle is snapped open, check the air flow sensor and throttle position sensor operation. If there is no injection duration reduction or cut off when the throttle is released, check the throttle position sensor idle setting.
- (3) If the duration does not appear correct during cranking or at any other condition, it will be necessary to refer to all sensor and wiring checks.

Air Flow Sensor



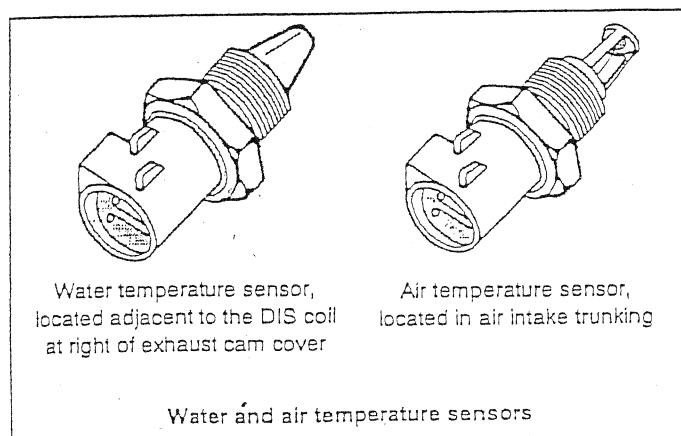
The hot wire air flow sensor used on Zeta/Zetec applications, operates in the same way as other hot wire sensors. The hot wire and an air temperature sensing elements are located in a by pass port in the sensor body. The air flow sensor has two connections to the ECU, as well as a power supply via the main relay and an earth connection.



- (1) Using an oscilloscope or digital volt meter, check the voltage at the sensor plug terminal 50 with the plug remaining connected to the sensor. Alternatively, check at ECU terminal 50.
- (2) Start the engine and note the voltage at terminal 50 should rise due to the air flow passing through the sensor, a typical voltage at idle (warm engine) is around 0.9 to 1 volt.

Increase engine speed and note that the voltage should rise. Snap open the throttle and again note that the voltage should increase. Maximum voltage that would be available from the sensor is just under 5 volts, but this is unlikely to be recorded unless the engine is under full load, but expect a reading of around 3 volts from a snap acceleration check.
- (3) If the voltage does not change when the air flow is increased, it indicates a possible sensor fault but also proceed with the following checks.
- (4) If there is no voltage available at terminal 50, check the supply terminal of the connector plug with the ignition on for battery voltage supply. The supply is via the main relay and if not available, check wiring through to the relay and if necessary carry out relay checks.
- (5) Check at the sensor plug earth terminal for a good connection to earth, preferably by checking the voltage on this circuit which should be no more than 0.25 volts (ignition on or engine cranking/running). Rectify wiring and connections if necessary.
- (6) Check at terminal 9 of the sensor plug (plug connected) for a voltage of typically 0.10 volts.

Water & Air Temperature Sensors

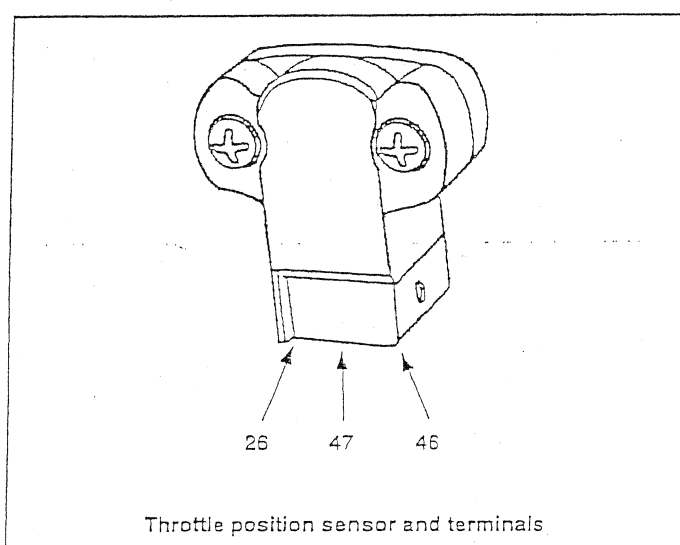


- (1) Switch the ignition on or run the engine and check the voltage readings, compare the reading against the values quoted in the chart. Ideally, check the values at different temperatures.

Temperature Deg C.	Sensor Signal Voltage	Sensor resistance (ohms)
0	3.85	95,000
20	3.1	37,500
40	2.1	16,000
60	1.3	7,450
80	0.75	3,750
100	0.45	2,200
<i>A small variation in voltage or resistance can be allowed</i> Sensor voltage and resistance readings.		

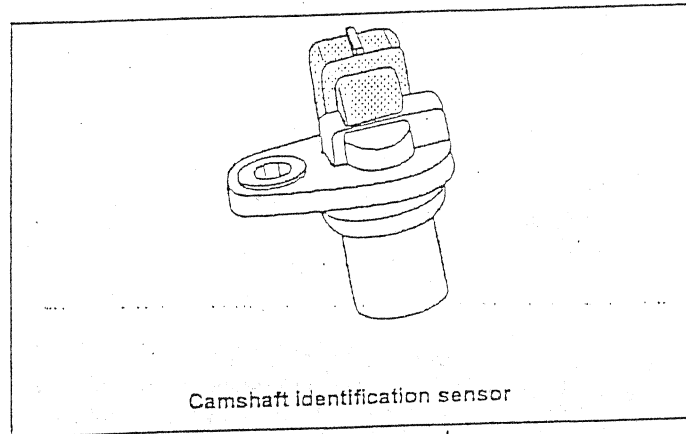
- (2) If the voltage readings appear to be incorrect, check the resistance values of the sensor (refer to the above chart), and also carry out wiring checks through to the ECU. Both sensors are connected to terminal 46 for the earth path. The signal wire is connected to ECU terminal 7 for the water temperature and terminal 25 for the air temperature.

Throttle Position Sensor



Camshaft Identification Sensor

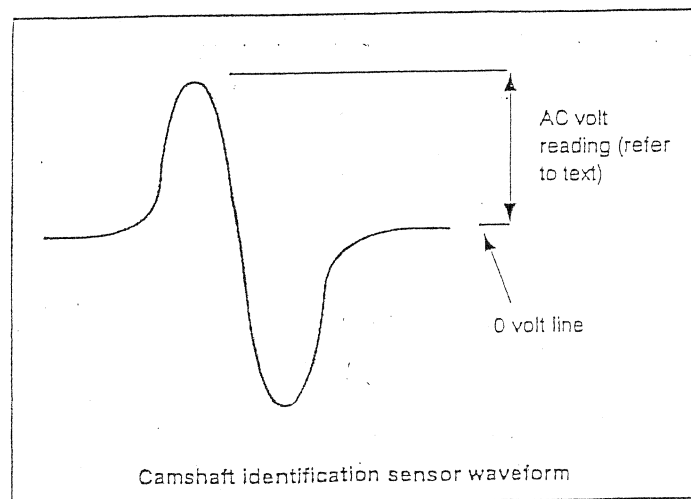
The camshaft identification sensor is located on the intake side of the engine at the flywheel end, and is positioned just beneath the camshaft cover. The sensor is an inductive (magnetic) type sensor which generates an AC type waveform which has a reference used by the ECU to identify the camshaft position thus enabling the sequential operation of the injectors to be timed.



- (1) Gain access to the back of the sensor plug or alternatively access the terminals at the back of the ECU connector plug (plugs remain connected). Connect an oscilloscope or AC voltmeter (or a suitable meter that is able to indicate the presence of AC signals) to the blue/red wire at the plug, or to terminal 24 at the ECU. The test equipment earth connection can be connected to earth or to the remaining wire at the plug (ECU terminal 46).

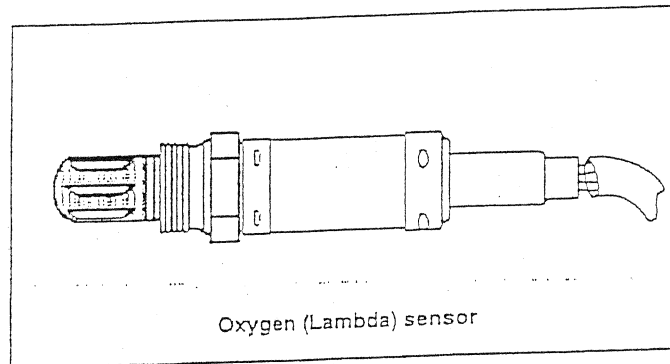
With the engine cranking (or running) check for the sensor signal which should be similar to the illustration on the following page. Note that the voltage (AC volt meter) is typically 1.0 volts cranking and as the engine speed increases, the voltage increases.

- (2) If there is no signal available, check the resistance across the sensor terminals (plug disconnected). A nominal reading of around 550 to 650 ohms should be expected although reading of between 100 to 1,000 ohms is quoted as acceptable. If the reading is short or open circuit, the sensor should be renewed.
- (3) If the sensor reading is correct, check the wiring between the sensor and the ECU plug terminals 24 and 46.



Oxygen (Lambda) Sensor

The oxygen sensor used on this application of the EEC IV system is a heated type (referred to as HEGO sensor). There are 4 connections to the sensor; a signal wire, an earth circuit for the sensor, a heating element power supply and an earth for the heating element. The sensor is located towards the bottom of the exhaust down pipe.



- (1) Locate the connector plug for the sensor (usually adjacent to the left hand side of the exhaust manifold). With the engine running and the plugs connected, check on the blue/white wire for a sensor signal (or at ECU terminal 44). The signal can be checked using a digital volt meter or oscilloscope.

Note that the voltage should oscillate between approximately 0.2 to 0.8 volts at a constant idle or engine cruise speed, but ensure engine is fully warm and that the throttle is not altered during the checks unless stated. The voltage should fluctuate approximately once every second but this may vary with temperature and speed.

- (2) If the voltage does not alter, although it could indicate a sensor fault, engine running problems can cause incorrect sensor readings. If the mixture is too rich, this will cause the sensor to produce a consistently high voltage reading ie. always 0.8 volts or more. If the mixture is too weak (or a misfire results in excessive oxygen in the exhaust gas), the sensor reading will be permanently 0.2 volts or less.
- (3) Also check the earth path for the sensor by checking on the brown wires for no more than 0.25 volts. If the voltage is high check the wiring and connections through to terminal 46 of the ECU and to earth.

Note that the heating element earth wire is also brown and connects to ECU terminal 40 and to earth.

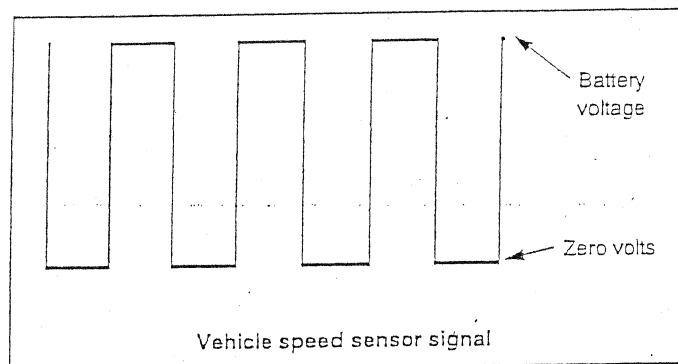
- (4) Quickly snap open the throttle and note that, due to the sudden mixture enrichment, the sensor voltage should rise to 0.8 or more and not fluctuate for a short period, the voltage may then drop to less than 0.2 for a short period until the mixture stabilises.

If there is no change, it indicates a likely sensor fault.

- (5) Check on the black/red wire for battery voltage (engine running). The supply to the heating element is via the main relay. If there is no voltage available, carry out relay checks.

Vehicle Speed Sensor

The transmission driven speed sensor is a Hall Effect unit (similar to those used on many ignition systems); the sensor provides a signal relative to the speed of the vehicle which the ECU then uses to help in the calculations for idle control, mixture control and fuel injection cut off (during deceleration).



- (1) Due to the location, testing the sensor is possibly easier by gaining access to the ECU harness plug. Locate terminal 3 of the plug, and raise the vehicle wheels so that the wheels can be rotated. With the wheels turning, a square wave signal should be available at terminal 3. A rev counter or digital volt meter could also be used to establish that a signal exists. The volt meter reading should oscillate between approximately battery volts and zero volts as the wheels rotate. The rev counter will give a speed signal which is dependant on the speed of wheel rotation. If possible, the wheels should be rotating at a speed of around 20 mph or more to establish a good signal from the sensor.
- (2) If there is no signal, trace the wiring through to the speed sensor on the transmission. If the wiring is good, check at the sensor for a power supply (engine running) to the sensor from the main relay.

The sensor earth should also be checked, which is via the transmission casing.

Power Steering Pressure Switch

The pressure switch is connected to the power steering pump pressure pipe. When pressure is applied (due to steering operation) the pressure forces the switch to operate. The ECU now has a signal of steering operation and is able to control the idle speed as applicable. The switch forms part of an earth path for the ECU and therefore as the switch opens and closes, the available voltage (switch open) will be passed to earth (switch closed) therefore the voltage will drop to zero.

- (1) Connect a volt meter to the back of the ECU terminal 28. Run the engine and operate the steering. The available voltage at terminal 28 should drop to zero when the switch closes.

If there is no voltage at any stage at the ECU terminal it indicates that either the switch is permanently closed (see following checks), or possibly the wiring has a direct short to earth. It is also possible that there is an ECU fault.

- (2) If the voltage is available all the time, it indicates either a wiring fault to the switch, the switch is not closing or there is a poor earth connection at the switch housing.
- (3) Locate the switch on the steering pressure pipe, and disconnect the plug. Note that voltage should now be available at terminal 28. Connect an ohm meter across the switch terminals and run the engine. Turn the steering wheel and then return to the centre position the switch should now close and open as the steering is turned and centred. This should be indicated by an open circuit reading (switch open) and a zero ohms reading (switch closed).

Idle Speed Control Valve

The Ford idle speed control valve is a solenoid type valve which is controlled by varying the current in the circuit. The control signal differs from most types and it can be difficult to detect changes in the signal when the idle valve is being opened or closed to maintain the idle speed.

- (1) Connect an oscilloscope or DC voltmeter to the back of the idle control valve plug (brown/green wire), or alternatively to terminal 21 of the ECU connector plug. All plugs should be connected in both cases. Run the engine and check for a control signal.

If an oscilloscope is being used, the waveform should be similar to the example. If a volt meter is being used a voltage reading of between 6 and 12 volts is likely to be recorded. Note that the voltage reading may vary as the meter measures the different aspects of the control signal. Meters may show an average reading or a peak reading, or some meters may have progressively indicated the maximum then the minimum reading occupied by the waveform.

Note that, when load is applied to the engine eg. switching on all lights, heated rear window and heater fan, the idle valve should be forced to open more by the ECU. This is normally detected by a drop in the voltage reading.

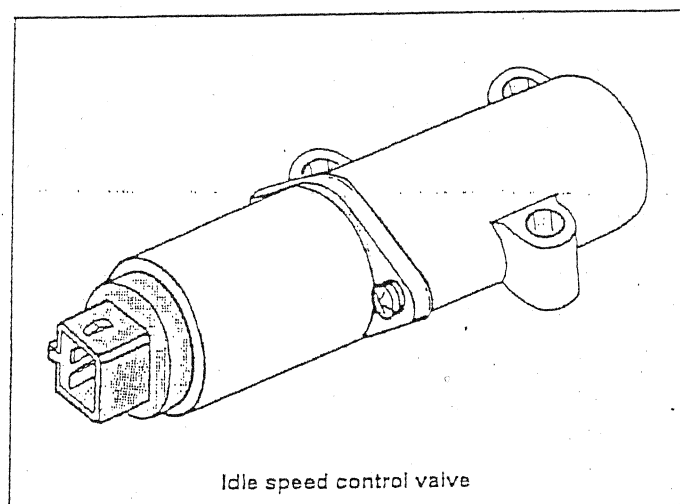


Voltage band V typically peaks at around 11 to 12 volts
and the bottom of the band is around 6 to 7 volts.

When load is applied to the engine so that the idle valve is opened, the whole waveform or voltage band can usually be seen to drop slightly.

Idle Control Valve Waveform

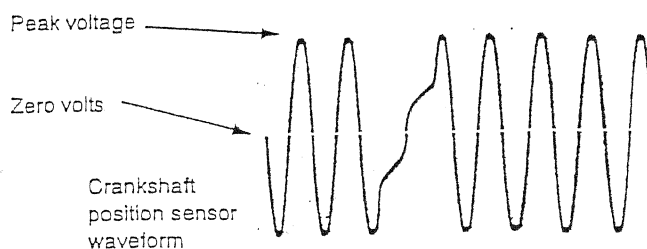
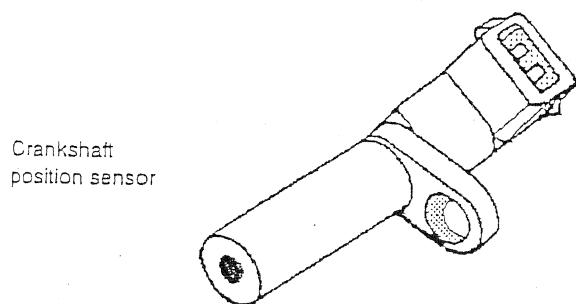
- (2) If there is no voltage reading, check at the other terminal of the valve connector plug for a battery voltage supply. The supply is via the main relay and if necessary carry out wiring and relay checks.
- (3) Check the resistance across the two terminals of the idle control valve (plug disconnected). A typical reading is around 10 ohms although approximately 6 to 20 ohms is acceptable. If the reading is short or open circuit, it indicates a valve fault.



- (4) If the previous checks are all good, but the idle control valve is not operating correctly, also carry out throttle position sensor checks. If the valve does not appear to function correctly it may be caused by contamination in the valve body and it can be removed for cleaning with a suitable solvent if necessary.

Crankshaft Position Sensor

The crankshaft position sensor used on these applications of the EEC IV system is a conventional inductive or magnetic type which is located on the front face of the engine block towards the flywheel. The sensor responds to a series of 36 reference points which are cast into the trigger disc, note that the 36th reference point is missing which provides a master reference point.



Crankshaft position sensor and waveform

- (1) Connect the two leads of an oscilloscope or AC voltmeter across terminals 55 and 56 of the ECU module plug (plug can be disconnected if preferred), or alternatively across the two terminals of the crankshaft sensor (see above note). With the engine cranking or running a waveform or voltage reading should be obtained. The voltage reading will indicate the difference between the zero and peak voltage points, peak voltage should typically be around 1.5 volts or more cranking, rising to around 5 volts or more at idle speed. Note that the voltage will increase with the increase in engine speed.
- (3) Check the resistance of the sensor winding by measuring across the two sensor terminals (plug disconnected) or by disconnecting the ECU module plug and measuring across terminals 55 and 56. The resistance should be approximately 200 to 450 ohms, if it is incorrect (usually short or open circuit), renew the sensor.

ECU Checks

ECU checks consist of ensuring that input signals and power supply/earth connections to the ECU are good, which should result in the output control signals being correct. Check the following ECU terminals for the appropriate connections and if necessary for the correct signals and voltage readings.

When carrying out ECU checks, if an ohm meter is being used for resistance checks, ensure that the multi plugs and connectors to any applicable electronic components are disconnected. When some ohm meters are applied to a circuit that is connected to electronic components, such as the ECU, it may cause damage.

Do not disconnect the ECU module plug when the ignition is switched on, this may result in ECU module damage.

Fuel System Checks

The fuel system consists of an in-tank pump, filter, pressure regulator and 4 sequentially controlled injectors. The pressure regulator operates in the same way as other multi point injection systems, and will regulate the exact pressure delivered to the injectors in conjunction with changes in the intake manifold pressure/vacuum. The result is a fuel pressure that is always at the constant pressure relative to the pressure that exists in the intake manifold.

The injectors are the side feed type, which means that the injectors are located deep into the fuel rail and fuel enters through the side rather than through the top of the injectors.

The fuel pump is controlled by a relay. An inertia switch is connected in the circuit either between the pump relay and the ECU, or the pump relay and the fuel pump.

- (1) Carry out fuel pressure checks by connecting the pressure gauge to the special adaptor located on the left hand side of the fuel rail.

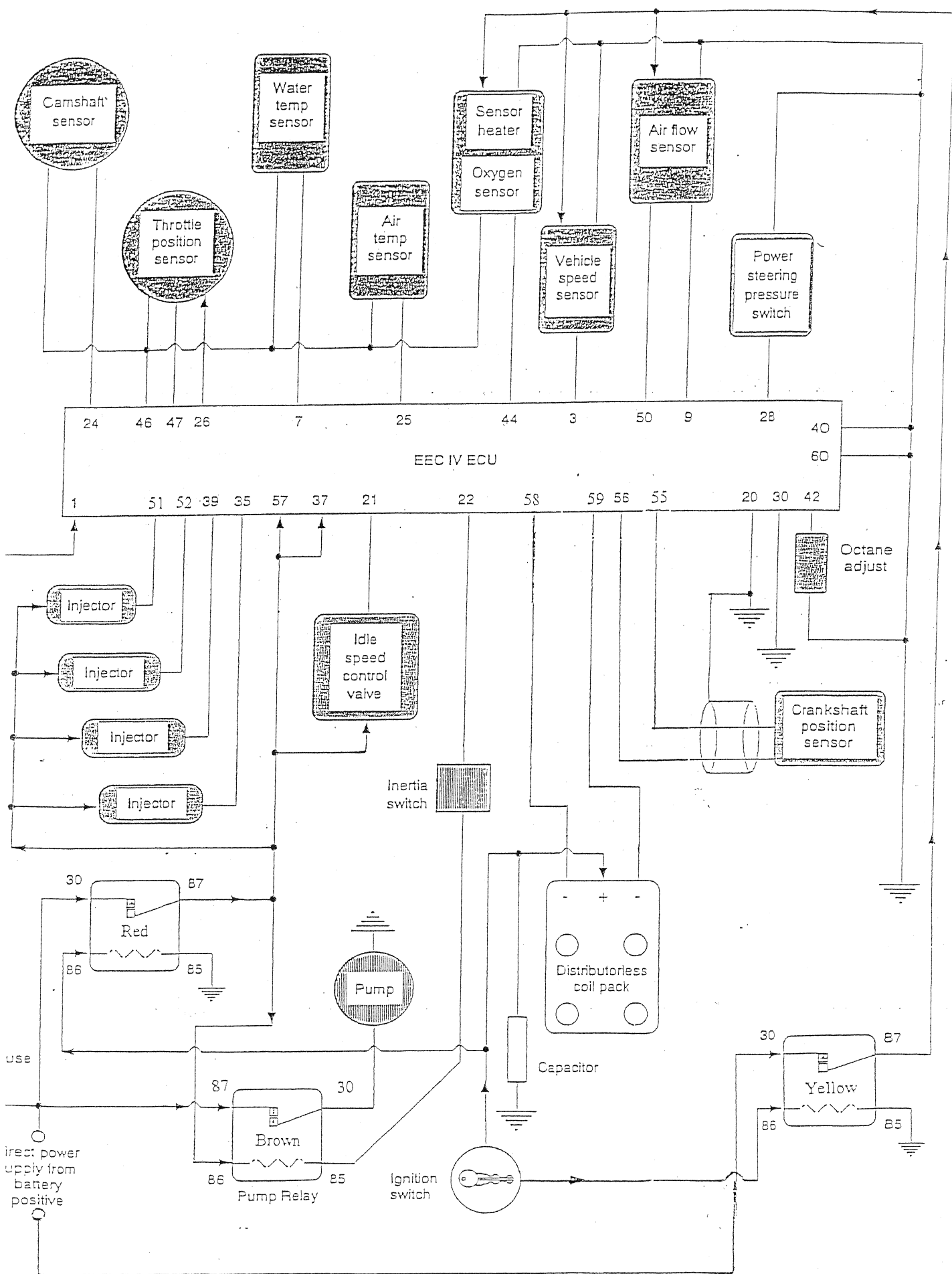
- (2) Either run the engine or, by-pass the pump relay (normally achieved by bridging relay holder terminals 30 and 87 which are the battery supply and the relay output terminals). With the pump running check the pressure which should be approximately 2.7 bar $\pm$ 0.2 bar (engine not running or vacuum pipe disconnected from pressure regulator).

If the pressure is too low, check for blocked supply line and filter. If necessary, block the system return line and note the pressure should now increase. If there is no increase it indicates a likely pump related fault. If the pressure does increase, it indicates a regulator fault.

If the pressure is too high, it is either caused by a blocked return line or faulty pressure regulator. Disconnect the return line and connect a hose to the system to enable excess fuel to be collected in a container. If the pressure is now normal, it indicates a return line blockage. If the pressure is still high it indicates a regulator fault.

- (3) Allow engine to idle, reconnect the vacuum pipe to the regulator and note that the pressure should now reduce by approximately 0.6 to 0.7 bar. If there is little or no change in pressure, ensure that vacuum is able to reach the regulator. If necessary, apply vacuum to the regulator using a vacuum pump and note that as the vacuum increases, the pressure should decrease.

If the pressure does not change with vacuum changes, it indicates a likely regulator fault.



FORD EEC IV ENGINE MANAGEMENTZETEC ENGINE

- | | | |
|-----|--|---|
| 1. | Permanent live from battery (fused). | |
| 2. | -. | |
| 3. | Vehicle speed sensor signal. | |
| 4. | Output to instrument panel (rev counter). | |
| 5. | -. | |
| 6. | -. | |
| 7. | Input from NTC 2. | |
| 8. | -. | |
| 9. | Reference voltage (Temp compensation) from Air Mass Meter. | |
| 10. | Earth - A/C. | |
| 11. | Pulsed (negative) side of tank vent valve. | |
| 12. | -. | |
| 13. | -. | |
| 14. | Pulsed (negative) side of pulse air control valve. | |
| 15. | -. | |
| 16. | Earth. | |
| 17. | Standard Diagnostic Socket. | |
| 18. | Ford Diagnostic Socket. | |
| 19. | Ford Diagnostic Socket. | |
| 20. | Earth. | |
| 21. | Pulsed side of idle control valve. | |
| 22. | Earth for fuel pump via ECU. | |
| 23. | -. | |
| 24. | AC input from camshaft phase sensor. | |
| 25. | Input from NTC 1. | |
| 26. | Voltage supply to throttle potentiometer. | |
| 27. | -. | |
| 28. | Power steering pressure switch. | |
| 29. | -. | |
| 30. | Earth. | |
| 31. | -. | |
| 32. | -. | |
| 33. | -. | 47. Input from throttle potentiometer. |
| 34. | -. | 48. Standard Diagnostic Socket. |
| 35. | Injector No. 4 earth via ECU. | 49. -. |
| 36. | -. | 50. Input from Air Mass Meter. |
| 37. | Ignition supply to ECU. | 51. Injector No. 1 earth via ECU. |
| 38. | -. | 52. Injector No. 2 earth via ECU. |
| 39. | Injector No. 3 earth via ECU. | 53. -. |
| 40. | Earth. | 54. Earth A/C via ECU. |
| 41. | -. | 55. Input from crankshaft sensor. |
| 42. | Octane adjust. | 56. Input from crankshaft sensor. |
| 43. | -. | 57. Ignition supply to ECU. |
| 44. | Lambda signal. | 58. Ignition primary circuit (2 cylinders.) |
| 45. | -. | 59. Ignition primary circuit (2 cylinders.) |
| 46. | Earth. | 60. Earth. |