

## INTRODUCTION

The Fiat Ducato commercial vehicle is equipped with a 2800 cc 4 cylinder in-line Bosch electronic injection turbodiesel engine with two valves per cylinder and one overhead camshafts. It is air turbocharged by means of a turbocharger and intercooler.

The fuel system ensures the engine operates correctly and may be schematically broken down into the following circuits:

- fuel supply circuit with Common Rail injection;
- air supply circuit;
- exhaust circuit;
- crankcase oil vapour recirculation circuit;
- exhaust gas recirculation circuit (EGR).

Operation of the various circuits that make up the fuel system is optimised by an electronic control system managed by a special control unit. The main feature of the fuel system is Common Rail fuel injection.

The Common Rail system is a high pressure electronic injection circuit for fast, direct injection diesel engines.

The main features of the Common Rail system are as follows:

- availability of high pressure (up to 1350 bars);
- possibility of modulating these pressures (from a minimum of 150 bars to a maximum of 1350 bars) independently of engine rotation speed (rpm) and load;
- ability to work at high engine rpms (up to 5000 rpm);
- injection control precision (injection advance and duration);
- reduction in fuel consumption;
- reduction in emissions.

## FUEL SYSTEM MANAGEMENT STRATEGIES

The control unit memory contains a management programme (software) that includes a set of strategies, each of which manages a specific system control function.

Each strategy uses information provided by the various sensors (input) to process a set of parameters that are based on data maps stored in special control unit memory areas. The strategy then controls system actuators (output) that allow the engine to operate.

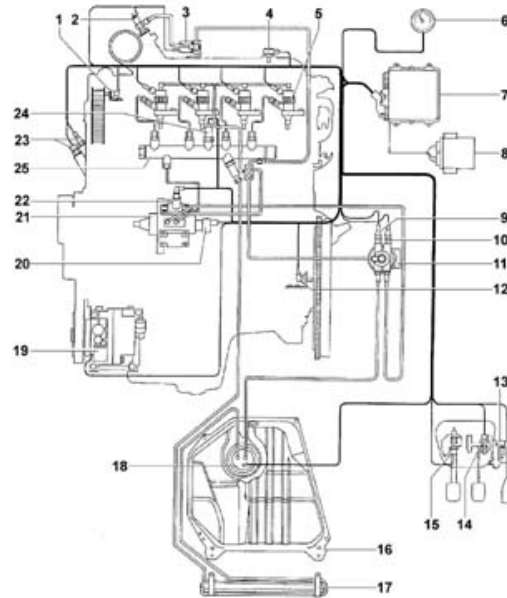
The main purpose of the management strategies is to calculate the exact amount of fuel to be injected into the cylinders. The associated timing (injection advance) and precision are set to ensure the best possible engine performance in terms of power, fuel consumption, fume emissions and vehicle handling.

The main system management strategies are essentially as follows:

- control of injected fuel quantity;
- cylinder balance check when idling;
- injection advance control;
- control of anti-judder function;
- injection pressure control;
- turbocharging control;
- engine coolant temperature control;
- fuel pre-feed pump control;
- exhaust fume control;
- injection control during over-run (cut-off);
- maximum speed limit control;
- idle speed control;
- exhaust gas recirculation control (E.G.R.);
- maximum torque limit control;
- climate control system activation control;
- self-diagnosis;
- engine immobiliser function control.

## FUEL SYSTEM OPERATING DIAGRAM

The following figure shows the fuel system



- 1 - Timing sensor.
- 2 - Thermal starter.
- 3 - Solenoid for thermal starter.
- 4 - Air pressure/temperature sensor.
- 5 - Injector.
- 6 - Signal to rev counter from control unit.
- 7 - Bosch EDC 15C7 engine management unit.
- 8 - FIAT Code control unit.
- 9 - Fuel temperature sensor.
- 10 - Fuel preheater on filter.
- 11 - Fuel filter.
- 12 - Engine rpm sensor.
- 13 - Potentiometer on accelerator pedal.
- 14 - Sensor on brake pedal.
- 15 - Sensor on clutch pedal.
- 16 - Fuel tank.
- 17 - Fuel heating coil.
- 18 - Fuel pre-feed pump;
- 19 - Vehicle air conditioning system compressor.
- 20 - Fuel pressure regulator on high pressure pump.
- 21 - High pressure pump (Radialjet).
- 22 - 3rd pump element cut-out solenoid on high pressure pump.
- 23 - Coolant temperature sensors on thermostat.
- 24 - Fuel pressure sensor.
- 25 - Single manifold (rail).

## CONTROL OF AMOUNT OF FUEL INJECTED

The control unit manages the fuel pressure regulator and injectors on the basis of signals from the accelerator pedal potentiometer, debimeter and rpm sensor.

Injection timing and sequence are determined upon engine start-up using signals from the engine rpm sensor and timing sensor (synchronisation stage). Injection timing is then implemented using the engine rpm sensor signal alone and considering the 1 - 3 - 4 - 2 injection sequence of the 2800 JTD engine.

The control unit inhibits injection in the following cases:

- Fuel pressure value greater than 1500 bar;
- Fuel pressure value lower than 120 bar;
- engine speed greater than 5000 rpm.

When the engine is warm, maximum injection duration (injector opening time) is 1500 % mgr;s. The duration may extend to 3000 %mgr;s during start-up.

## INJECTION ADVANCE CONTROL

The electronic control unit determines injection advance mainly on the basis of the amount of fuel to be injected and engine speed.

Injection advance is then corrected on the basis of engine coolant temperature in order to compensate for the increase in ignition delay due to low temperatures present in the combustion chambers during warm-up.

## INJECTION PRESSURE CONTROL

This control is important because injection pressure influences the following parameters:

- amount of fuel taken into the cylinders for the same injection time duration;
- nebulisation of fuel injected;
- jet penetration;

- delay between electric injector control and the effective start of fuel injection;
- duration of fuel injection in the combustion chamber.

The above parameters influence engine behaviour crucially, particularly in terms of power supplied, exhaust emissions, noise and car handling. The engine control unit controls the pressure regulator as required on the basis of engine load and engine speed to ensure optimal line pressure at all times.

When the engine is cold, injection pressure is corrected on the basis of coolant temperature to meet engine requirements at different service temperatures.

### **CONTROL OF ELECTRIC FUEL PRE-SUPPLY PUMP**

The auxiliary fuel pump submerged in the tank is supplied by the engine control unit via a relay when the ignition key is in MAR position. The pump supply is inhibited under the following circumstances:

- after the ignition key has been in ON position for a certain time and the engine is not operating;
- if the inertia switch has gone off.

### **INJECTION CONTROL DURING OVER-RUN (CUT-OFF)**

The fuel cut-off strategy is implemented when the engine control unit receives information from the potentiometer, which sends a signal to indicate that the accelerator pedal has been released by the user.

Under these conditions, the control unit cuts off the power supply to the injectors and reactivates it before reaching idle speed. It also controls the fuel pressure regulator.

### **IDLE SPEED CONTROL**

The injection control unit controls the pressure regulator and alters injector opening times on the basis of signals from the engine rpm sensor and coolant temperature sensor to keep idle speed stable. Under certain conditions, the control unit takes battery voltage into account to control idle speed.

### **MAXIMUM SPEED LIMIT CONTROL**

The engine control unit intervenes in two ways to limit maximum speed on the basis of rpm:

- as maximum speed approaches (4200 rpm), the amount of fuel injected falls and line pressure is reduced;
- injector operation is inhibited at speeds over 5000 rpm.

### **MAXIMUM TORQUE LIMIT CONTROL**

The injection control unit calculates limit torque and maximum permitted fume index parameters according to rpm. The calculations are based on predefined maps stored in its memory. The control unit corrects the above parameters using engine coolant and vehicle speed data and uses the resulting values to modulate the amount of fuel to be injected by adjusting the pressure regulator and injectors.

### **CONTROL OF FUEL TEMPERATURE**

The injection control unit is constantly informed of fuel temperature by means of a specific sensor in the fuel filter.

If fuel temperature exceeds a certain level (about 85 - 90 °C), the control unit reduces line pressure by adjusting the pressure regulator and leaving the injection times the same.

### **ENGINE COOLANT TEMPERATURE CONTROL**

The injection control unit is constantly informed of coolant temperature by means of a sensor on the thermostat.

If engine coolant temperature exceeds certain levels, the control unit takes the following actions:

- reduces fuel quantity by adjusting the pressure regulator or injectors (power reduction);
- drives the engine radiator cooling fan.

When the ignition key is turned to STOP (if the temperature exceeds the cooling system activation threshold), the fan stays on for a maximum time of 20 seconds to take the temperature below the cooling system activation threshold.

When the ignition key is turned to the ON position. (coolant temperature exceeds the cooling system activation threshold), the fans do not activate until engine rpm exceeds 770 rpm. (engine speed when warm is 780 rpm).

### **EXHAUST FUME CONTROL**

The injection control unit limits any exhaust fumes that could occur during hard acceleration.

To meet this requirement, the control unit processes signals from the accelerator pedal potentiometer, engine rpm sensor and intake air quantity sensor (debimeter); the injection control unit controls the fuel pressure regulator and injectors to modulate the amount of fuel to be injected into the combustion chamber and reduce exhaust fume levels.

### **EXHAUST GAS RECIRCULATION CONTROL (FOR VERSIONS WITHOUT VARIABLE GEOMETRY TURBINE)**

The injection control unit, on the basis of signals supplied: by sensors measuring engine rpm, intake air quantity (debimeter), engine coolant temperature and accelerator pedal position, controls EGR valve activation to achieve partial exhaust gas recirculation only under certain engine service conditions.

### **SUPERCHARGING PRESSURE CONTROL**

- The injection control unit processes the signal from the supercharging pressure, at the various engine operating speeds and determines the quantity of fuel to inject:

- controls the pressure regulator
- alters the injection time
- controls the VGT valve in order to vary the geometry of the turbine in order to guarantee optimum performance in all operating conditions.



There is no exhaust gas recirculation valve (EGR valve) on versions with variable geometry turbines.

## CONTROL OF AIR CONDITIONING SYSTEM ACTIVATION

The engine control unit manages the vehicle air conditioning system compressor electromagnetic coupling by pursuing a strategy that prevents engine performance being penalised while the air conditioner is being used.

When the compressor is activated, the engine control unit increases the amount of fuel at idle speed to adjust the engine to the higher power requirement and cut off power supply to the compressor under conditions of:

- high power demand from the engine (hard acceleration);
- engine coolant overheating.

## ENGINE IMMOBILISER FUNCTION CONTROL

The system is equipped with an engine immobiliser. This function is executed by a control unit (Fiat CODE) able to communicate with the engine control unit and an electronic key with a transmitter that sends out a recognition code. Whenever the key is turned OFF, the Fiat CODE system fully deactivates the engine control unit.

When the key is turned ON, the following operations take place in sequence:

- the engine control unit (with the secret code in its memory) sends the Fiat CODE control unit a secret code request that deactivates the function lock;
- the Fiat CODE control unit responds by sending back the secret code only once it has received, in turn, a recognition code sent by the ignition key.
- secret code recognition allows engine control unit lock deactivation and resumption of normal operation.

## SELF-DIAGNOSIS

Full injection system electronic diagnosis is carried out by connecting an appropriate tester (EXAMINER or SDC station) to the tester input located in the engine bay.

The system also comes with a self-diagnostic function that detects, stores and indicates faults.

If a fault is detected in a sensor or actuator, signal reconstruction strategies (recovery) are immediately activated to ensure the engine operates at an acceptable level without impairing service. The vehicle can therefore be driven to a service outlet for the necessary repairs.

## BOSCH EDC 15C7 ENGINE CONTROL UNIT

The EDC 15C7 processes signals from the sensors by applying software algorithms and controls actuators (particularly the injectors and pressure regulator) to achieve the most effective possible engine operation.

The control unit is flash E.P.R.O.M. type and can be reprogrammed externally without the need to adjust the hardware.

The engine control unit contains a built-in atmospheric pressure sensor and is connected to the wiring by means of 2 connectors that provide a total of 121 pins.

## IDENTIFICATION OF EDC15 C7 ENGINE MANAGEMENT CONTROL UNIT CONNECTIONS

Currently available versions are:

- 2.8 JTD engine with Heat - flange with EGR;
- 2.8 JTD with Heat - flange without EGR;
- 2.8 JTD with thermal starter without EGR.
- 2.8 JTD with thermal starter with EGR.
- 2.8 JTD engine with Heat - flange with VGT, without EGR;
- 2.8 JTD with thermal starter with VGT, without EGR.