



## GESTIONE ELETTRONICA MOTORI DIESEL

290/295 - Ducato FL 2014

# DIESEL ENGINES ELECTRONIC MANAGEMENT - DESCRIPTION

An electronic control system supervises and governs all engine parameters to optimise performance and fuel consumption by means of a real-time response to different operation conditions.

The power unit is available in 2 configurations:

- 130 HP with fixed geometry turbine;
- 150 HP with variable geometry turbine (VGT).

Diesel engines are equipped with a COMMON RAIL type injection system.

This features the use of an electronically controlled high injection pressure. The supply of fuel, known as the pilot injection, is optimised by the electronic control unit by means of the injector, rather than being managed by the pump.

In this version with 4 valves per cylinder, the "COMMON RAIL" injection system uses "MultiJet II" technology.

In the previous MultiJet versions, the injector - capable of carrying out 5 consecutive injections during the same combustion cycle - was based on a hydraulic servo valve with unbalanced shutter, which required reduced sealing diameters and longer travels.

In the new MultiJet II injection system, the injector shutter is hydraulically balanced resulting in greater sealing diameters and reduced shutter travels. Thanks to this new servo valve, the quantity of fuel injected in the combustion chamber can be controlled more precisely and quickly. Up to 8 consecutive injections can be managed with very precise measurement.

This new injection mode ensures considerable advantages in terms of reduction of noise, fuel consumption and emissions.

The throttle body is also controlled electronically by the control unit: the throttle opening is calculated in accordance with a specific logic inside the engine control module.

Depending on the signals received from numerous sensors, the control unit manages the injectors connected to it, handling the following systems:

- fuel supply;
- air delivery;
- glow plugs;
- accelerator pedal;
- engine cooling;
- emission control (oxygen sensor and particulate filter);
- exhaust gas recirculation control (EGR).

To respect the latest emissions control regulation (EURO 5), the most recent electronic on-board management version is used, comprising new components (injectors, pressure regulator and high pressure pump, digital flow meter) and the adoption of an oxygen sensor.

The oxygen sensor improves the air/fuel mixture in the combustion chamber regulating the flow of air: with the throttle open the power supply is at a maximum; closing the throttle gradually reduces the load, the engine rpm and also the emissions.

In addition to the oxygen sensor a DPF (Diesel Particulate Filter) is used: it is a mechanical filter, inserted in the exhaust pipes, which traps the carbon particles present in the Diesel engine exhaust gas. The filter makes it possible to almost totally eliminate the emission of carbon particles in line with current legislation.

## E5070 PARTICULATE FILTER SYSTEM

Thanks to the electronic management described above, this engine carries out a continuous check according to the EOBD system (European On Board Diagnosis): this system allows continuous diagnosis of emission-related car components and notifies the driver if any of the components should deteriorate by turning on a warning light in the instrument panel.

The aim of the system is to:

- monitor system efficiency;
- indicate an increase in emissions due to vehicle malfunction;
- indicate the need to replace damaged components.

For some versions, to increase vehicle efficiency by reducing consumption, harmful gas emissions and noise pollution, a device called Start&Stop has been adopted. This device is managed by the Powertrain Control Module and the Body Computer.

The Start&Stop device makes it possible to automatically switch off the engine when traffic conditions require the vehicle to stop and to restart the power unit when the driver intends to resume driving.

The device is essentially based on a starting system (battery and starter) capable of restarting the engine quickly and quietly. The device can do this a far greater number of times than a normal production system would need to.

In safety conditions, the power unit is switched on and off by appropriate manoeuvres of the accelerator, brake and clutch pedals and the gear lever.

The controls, signals and information necessary to activate the Start&Stop system reach or come from, as described above, the engine control module and the Body Computer through discreet connections or via the CAN.

The two electronic units communicate constantly to establish whether, moment by moment, there are Start&Stop system "integrity" conditions, whether the system is enabled or whether, on the other hand, it is temporarily or permanently

deactivated. The instrument panel allows the operation, inhibition and exclusion conditions of the device to be displayed through the relevant icons, warning lights and messages on the display.

The engine control module is the master control unit which controls the stopping and the restarting of the engine on the basis of the information, acquired directly or indirectly through the CAN, on the status of the vehicle and the components relevant for the Start&Stop system.

The Body Computer, on the other hand, acquires some of the information relating to the status of all the vehicle systems that interact with the Start&Stop system and are not monitored directly by the Powertrain Control Module, summarises the status of this collection of systems and notifies the Powertrain Control Module of the enabling or inhibition (temporary or permanent) in order to switch the engine off, request the restarting of the power unit or, in conditions where safety is at risk, impose the "irreversible" switching off of the power unit on the Powertrain Control Module in the sense that it can only be restarted later using the key.

The system is also controlled by dedicated relay switches in the engine compartment junction control unit. Lines supplying the control unit and various system components (sensors and actuators) are protected by dedicated fuses that are also located inside the engine compartment junction unit.

# DIESEL ENGINES ELECTRONIC MANAGEMENT - FUNCTIONAL DESCRIPTION

Engine management control unit M010 controls and governs the entire electronic ignition and injection system.

The ignition-operated power supply (15/54) arrives through a line protected by fuse F16 of the engine compartment junction unit B001 (pin 9 of connector C) at pin 88 of connector B of M010.

The main injection relay switch T09 of the control unit B001 manages the whole system: its coil is directly supplied by the battery through the line protected by fuse F18 of the engine compartment junction unit. The same supply reaches pin 50 of connector B of M010.

This relay switch is energised by an (earth) control signal from pin 33 of connector B of the Powertrain Control Module M010 and then forwards a power supply:

- to pins 3, 5 and 6 of connector B of the control unit via a line protected by fuse F22 of B001 (pin 18 of connector C);
- to the heater coil for oxygen sensor K040 and flow meter K041 through the line protected by fuse F17 of B001 (pin 31 of connector C);
- to pin 29 of connector B of M010, to pin 6 of the plug preheating control unit M015 and to the variable geometry solenoid valve L036 (only 150 HP versions), through the line protected by fuse F11 of B001 (pin 7 of connector C).

The plug preheating control unit M015 (pin 11) receives a direct battery power supply via the line protected by fuse F02 of the engine compartment junction unit B001 (pin B of connector B).

The electric fuel pump relay switch T10 of junction unit B001 provides a direct battery power supply to the electric fuel pump N040 - pin 1 - along the line protected by fuse F21 of the engine compartment junction unit B001 (pin 16 of connector A).

The coil is energised by pin 94 of connector B of the Powertrain Control Module M010; the coil for relay switch T10 receives a reference earth, via pin 11 of connector C of the engine compartment junction unit B001, coming from the NC contact for the inertia switch I050 (pin 3).

In the case of an impact the inertia switch opens, no longer supplying the reference earth to the coil for relay switch T10 and thereby interrupting the activation of the electric fuel pump N040 and the additional electric heating pump N044.

## E6015 ADDITIONAL HEATER

In the same way, pressing the button for automatic intervention in danger conditions H134 (if present) interrupts this earth signal, energizing the coil and causing the change in status of the internal contact for relay switch T26 of junction unit B046.

The intervention of the inertia switch I050 and/or pressing the button for automatic intervention in danger conditions H134 (if present) also causes the electrical power supply for the injection system to be cut off and the activation of several safety functions.

## E1010 POWER SUPPLY

Pins 1, 2 and 4 of connector B of the Powertrain Control Module M010 are connected to the injection control unit earth C060; the plug preheating control unit M015 (pin 7), the water in diesel filter sensor integrated in filter K101 and the engine oil sensor signal control unit M186 (pin 4) are connected to the same earth.

The casing of the Powertrain Control Module M010 (connector C) is connected to the radio frequency earth on strut C103.

The plug preheating control unit M015 is connected, via pins 1, 2, 3 and 4 to the glow plugs A040 A, B, C and D and via pins 9 and 10 to pins 19 (preheating time/fault detection feedback) and 32 (plug preheating signal) of connector B of the engine management control unit M010.

Powertrain Control Module M010 receives signals from the various sensors, thereby keeping all the engine operating parameters under control.

The Powertrain Control Module M010 controls with an earth signal from pin 73 of connector B, the heater inside the oxygen sensor K040 (pin 3).

The control unit M010 sends a "pumping" current, from pin 65 of connector B, to the oxygen sensor K040 (pin 2), which is compared with the "setting" one received from pin 64 of connector B (at pin 1 of K040). The oxygen sensor receives a reference earth, at pin 6, from pin 87 of connector B of M010 and sends a voltage signal, from pin 4, proportional to the percentage of oxygen measured in the exhaust gases to pin 86 of connector B of control unit M010.

The EGR solenoid valve L030 controls the exhaust gas recirculation. The EGR solenoid valve L030 is controlled by two signals (positive and negative) from pins 45 and 60 of connector B of M010; the position sensor integrated into the solenoid valve L030 receives a power supply and earth from pins 21 and 24 and returns a position signal to pin 43 of connector B of M010.

The engine oil sensor signals control unit M186 receives an ignition-operated power supply (INT) at pin 1, through the line protected by fuse F51 of Body Computer M001 (pin 7 of connector C); it receives the information from the engine oil level sensor K032, at pins 3 (positive) and 6 (negative) and sends these signals, from pins 2 (oil level signal) and 5 (earth signal) to the control unit M010 (pins 12 and 8 of connector A respectively).

The engine rpm sensor K046 supplies, through frequency signals exchanged with pins 14 (negative) and 29 (positive) of connector A of M010, information on engine speed.

Timing sensor K047 is supplied from pin 53 of connector A of M010; this receives a reference earth from pin 7 of connector A, and sends a signal with frequency corresponding to the phase to pin 13 of connector A of the control unit.

The engine coolant sensor K036 receives a reference earth from pin 10 of connector A of control unit M010 and sends a signal proportional to engine coolant temperature to pin 39 of connector A of the control unit.

The control unit M010 receives - at pin 57 of connector A - a signal from the minimum engine oil pressure sensor K030.

The air flow meter K041 receives a reference earth from pin 23 of connector A of control unit M010 and sends a signal proportional to the air flow rate to pin 28 of connector A. An air temperature sensor inside K041 also sends an air temperature signal to pin 44 of connector A of M010.

Accelerator pedal K055 contains two built-in potentiometers (a main one and a safety one). The former receives power and earth respectively from pins 12 and 42 of connector B of M010 and sends a corresponding signal to pin 82 of the same connector. The latter receives power supply and earth respectively from pins 13 and 40 of connector B of M010 and sends a corresponding signal to pin 61 of the same connector.

According to the signal from accelerator pedal K055, control unit M010 controls the throttle opening by means of a motor built into throttle body N075. The internal solenoid valve chokes and closes the throttle, for example when the engine is turned off. It is controlled by two signals from pins 15 and 30 of connector A of M010. Pins 9, 22 and 56 of connector A of M010 manage the solenoid valve control function.

The water in diesel filter sensor, integrated in the diesel filter K101, receives an ignition-operated supply (INT) from fuse F51 of the Body Computer M001 (pin 7 of connector C) and is connected to the earth C060, sending the corresponding signal to pin 26 of connector B of control unit M010.

The fuel temperature sensor, incorporated in the diesel filter K101, detects the temperature of the incoming diesel fuel. It receives a reference earth from pin 56 of connector B of control unit M010 and sends a fuel temperature signal to pin 80.

Sensor K044 measures the air pressure and the temperature in the intake chamber, downstream of the turbocharger. It is supplied by pin 36 of connector A of control unit M010 and receives a reference earth from pin 25 of the same connector. The signal corresponding to the pressure value is sent to pin 55 of connector A of control unit M010. An air temperature sensor, housed in K044, sends a signal to pin 58 of connector A of M010.

Fuel pressure sensor K083 supplies the injection control unit with a feedback signal to modulate injection pressure and duration. It receives power and a reference earth respectively from pins 6 and 20 of connector A of Powertrain Control Module M010 and then sends a pressure signal to pin 42 of the same connector.

The fuel pressure regulator on the N077 pump controls the high pressure produced by the pump itself; the two control signals come from pins 3 and 19 of connector A of control unit M010.

The turbine variable geometry control solenoid valve L036 (only present in the 150 HP version) adjusts turbine operation according to the engine load: it is controlled by a negative signal from pin 51 of connector B of control unit M010.

The turbine variable geometry control solenoid valve is also controlled by a feedback signal from a dedicated sensor K206 which sends the control unit a signal relating to the effective position of the turbine vanes governed by the valve itself.

The variable geometry position sensor K206 receives power supply from pin 37 of connector A of the control unit M010 and receives a reference earth from pin 38 of connector A; it sends a signal relating to the geometry of the turbine to pin 41 of connector A of M010.

The Powertrain Control Module M010 controls the opening of the individual injectors N070, through dedicated signals sent from pins 2-17 (cyl. 1), 32-47 (cyl. 2), 31-36 (cyl. 3), 1-16 (cyl. 4) of connector A.

Pin 83 of connector B of control unit M010 receives an NO signal from the switch on brake pedal I030, provided by an ignition-operated supply (INT) via a line protected by fuse F42 of the Body Computer M001. The latter receives the same signal at pin 57 of connector D.

Body Computer M001 receives an NC signal from the switch on brake pedal I030 at pin 11 of connector D. This also has an ignition-operated supply (INT) via a line protected by fuse F37 of the Body Computer. The latter forwards this signal to the control unit M010 through the C-CAN.

The clutch pedal switch I031, with analogue potentiometer, receives supply and reference earth respectively from pins 36 and 55 of connector B of the Powertrain Control Module M010 and provides the pedal position signal (from maximum extension with pedal pressed to pedal released position) to pin 52 of the same connector.

The control unit M010 is then connected via the CAN - pins 69 and 70 of connector B - to the Body Computer M001 - pins 38 and 37 of connector D - and to the other network nodes; information is sent, via this connection, for the management of the indicators and warning lights in the instrument panel E050, in particular for the management of:

- engine coolant temperature gauge and warning light;
- rev counter;
- minimum engine oil pressure warning light;
- heater plug warning light;
- water in diesel filter sensor;
- Injection system/EOBD failure warning light;
- "general failure" warning light and corresponding icon on display (where provided) lit up for the failure of the engine oil pressure sensor or the operation of the inertia switch.

#### E4010 INSTRUMENT PANEL

The control unit M010 receives a speedometer signal generated by the braking system control unit M051 via the C-CAN.

It is also connected:

- from pins 9, 10 and 74 of connector B to manage the engine cooling fans;

## E5020 ENGINE COOLING

- from pins 35, 41, 81 and 30 of connector B for managing the compressor engagement function;

## E6021 COMPRESSOR ENGAGEMENT

- from pins 14, 43, 54, 57, 39, 58 and 60 of connector B, for the management of the particulate filter function;

## E5070 PARTICULATE FILTER SYSTEM

- from pin 11 of connector A, with the alternator A010 for management of the insufficient battery charge/alternator fault (D+) signal;

## E5010 STARTING AND RECHARGING

- from pins 21, 28, 45, 72, 77 and 85 of connector B for the management of the Start&Stop device;

## E5010 STARTING AND RECHARGING

- from pin 46 of connector B, with the reversing switch I020.

## E2022 REVERSING LIGHTS

- from pins 75 and 24 of connector B for the management of the blow-by oil vapour heating system function.

## E5071 OIL VAPOUR HEATING SYSTEM

# DIESEL ENGINES ELECTRONIC MANAGEMENT - WIRING DIAGRAM





