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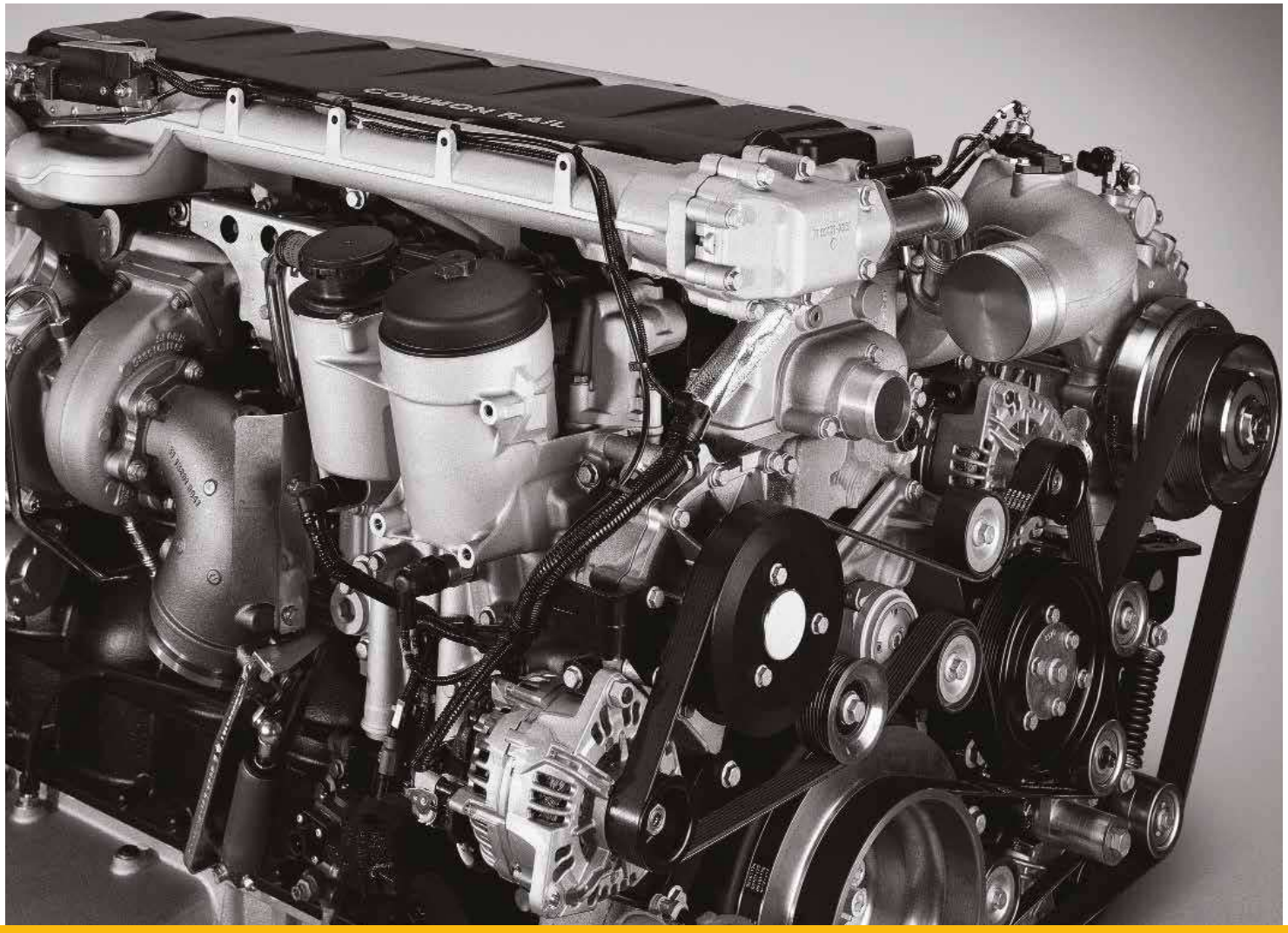
MAN EDC7/C32 Common Rail Engine Management



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Legend:

Warning

Information/Notes

1. EDC 7 SYSTEM APPLIED TO MAN GROUP

The EDC7 system combined with a Common Rail of second generation is today applied to the whole range of MAN road vehicles.

Engine	Displacement	Regulations	Post-treatment	Overboost	Engine Adjustment	High pressure pump
D0834 D0836	4,58 l 6,87 l	Euro 3	with/without AGR	1 stage	EDC+FFR	CP3.3, CP3.4
D0834 D0836	4,58 l 6,87 l	Euro 4 Step 1+ NOx check	AGR + PM-Kat	2 stages	EDC+ FFR	CP3.3
D0834 D0836	4,58 l 6,87 l	Euro 5 Step 2	AGR + PM-Kat	2 stages	EDC+FFR	CP3.3, CP3.3NH
D0834 D0836	4,58 l 6,87 l	Euro 5 EEV Step 2	AGR + PM-Kat or SCR	2 stages with intermediate cooling	EDC+FFR	CP3.3, CP3.3NH
D0836 LOH	6,87 l	Euro 5 EEV Step 2	AGR	2 Stages with intermediate cooling	EDC+FFR	CP3.3
D2066 LOH-LUH	10.52 l	Euro 3	PM-Kat	1 Stage	EDC+FFR	CP3.4 +
D2066LOH-LUH	10.52 l	Euro 4	AGR+ PM-Kat or CRT	1 Stage	EDC+FFR	CP3.4+
D2066 LOH-LUH	10.52 l	Euro 5	AGR+ PM-Kat or CRT	2 Stages with intermediate cooling	EDC+FFR	CP3.4 +
D2066 LOH-LUH	10.52 l	Euro 5 EEV	AGR+PM-Kat or CRT	2 Stages with intermediate cooling	EDC+FFR	CP3.4 +
D2066	10.52 l	Euro 3	AGR	1 stage	EDC+FFR	CP3.4, CP3.4+
D2066	10.52 l	Euro 4 Step 1+ NOx check	AGR+PM-Kat	1 stage	EDC+FFR	CP3.4+
D2066	10.52 l	Euro 5, Euro 5 EEV Step 2	SCR	1 stage	EDC+FFR	CP3.4+
D2676 LOH	12.42 l	Euro 3	AGR+PM-Kat or CRT	1 Stage	EDC+FFR	CP3.4+
D2676 LOH	12.42 l	Euro 4	AGR+PM-Kat or CRT	1 Stage	EDC+FFR	CP3.4+
D2676 LOH	12.42 l	Euro 5	AGR+PM-Kat or CRT	2 Stages with intermediate cooling	EDC+FFR	CP3.4+
D2676 LOH	12.42 l	Euro 5 EEV	AGR + PM-Kat or CRT	2 Stages with intermediate cooling	EDC+FFR	CP3.4+
D2676	12.42 l	Euro 4 Step 1+ NOx check	AGR+PM-Kat	1 Stage	EDC+FFR	CP3.4+
D2676	12.42 l	Euro 5, Euro 5 EEV Step 2	SCR	1 Stage	EDC+FFR	CP3.4+
D2868	16.2 l	Euro 5, Euro 5 EEV Step 2	SCR	1 Stage	EDC+FFR	
D2876	12.80 l	Euro 3	AGR		EDC+FFR	CP3.4
D284x	18.27 l 21.93 l	Euro 3	AGR		EDC+FFR	CP2/4

Table 1: Overview of MAN solutions

D08 engines (150 – 340 HP) for industrial vehicles and D08, D20 and D26 engines (250 – 505 HP) for passengers transport vehicles adopt the Pure Diesel Technology consisting of an EGR with 2-stages overboost and intermediate cooling. On buses it is possible to have the CRT (Continuously regenerating trap) upon request, instead of the PM-Kat.

MAN engine code identifies a series of characteristical data.

Position	Digit	Meaning
1	D	D Diesel E Methane G LPG H Hydrogen M Methanol O Gasoline
2 and 3	20	Cylinder bore = (xx + 100) mm
4	6	Piston stroke = (10x+ 100) mm (3=125 mm, 4=142 mm, 6=155, 7=166 mm)
5	6	Cylinder number (0 = 10, 2 = 12)
6	L	D: 3-way catalytic converter L: with turbocharger and Intercooler T: by payment No character: Suctioned
7	F	H vertical engine for LHD trucks HR vertical engine for RHD trucks HA vertical engine for LHD on-off-road trucks HG vertical engine with special feature for LHD on-off-road trucks F front vertical engine for trucks GF front vertical engine for trucks (special feature only for D08) GFA special feature on-off-road GF FR front vertical engine for RHD trucks FA front vertical engine for LHD GF on-off-road trucks FG vertical engine with special feature for LHD on-off road truck FGR vertical engine with special feature for RHD on-off-road trucks FO front vertical engine for buses OF front vertical engine for LHD buses OFR front vertical engine for RHD buses OH rear vertical engine for buses H horizontal engine for trucks UH rear horizontal engine for buses UM central horizontal engine for buses E vertical engine for other vehicles UE horizontal engine for other vehicles ..L added engine indication only for L2000
8		Usage mode if installed on other vehicles: 1 engine for processing machines 2 engine unit 3 Engine for cogeneration, auxiliary marine engine 4 Marine engine 5 Engine for farming machine 6 Train engine 7 Short engine
9,10	01	Variant

Table 2: Engine code definition. Example of D2066 LF01

Common Rail engines can work with fuels complying with regulation EN590. Operation with fuels as FAME needs to be specifically defined.

1.1 Euro 3 hydraulic circuit

1.1.1 KSC (Kraftstoff Service Center)

On MAN vehicles the KSC is fitted, which represents the fuel management unit. It integrates:

- pre-filter with priming pump;
- main filter;
- water separator;
- fuel pressure sensor;
- heater.

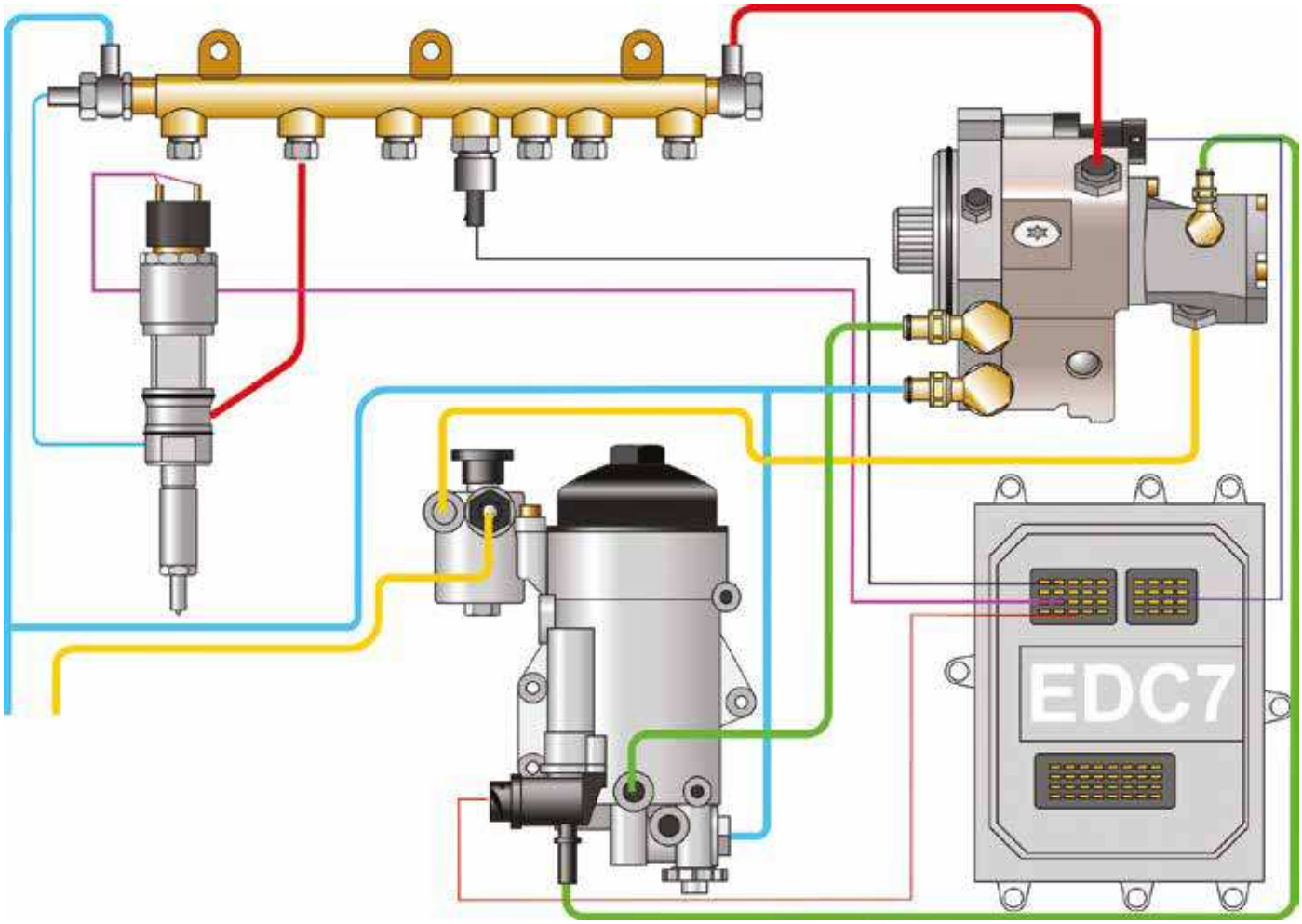

Figure 1

In the lower side we can find the connection of the control solenoid valve of the glow plug, located on the intake manifold for cold start.

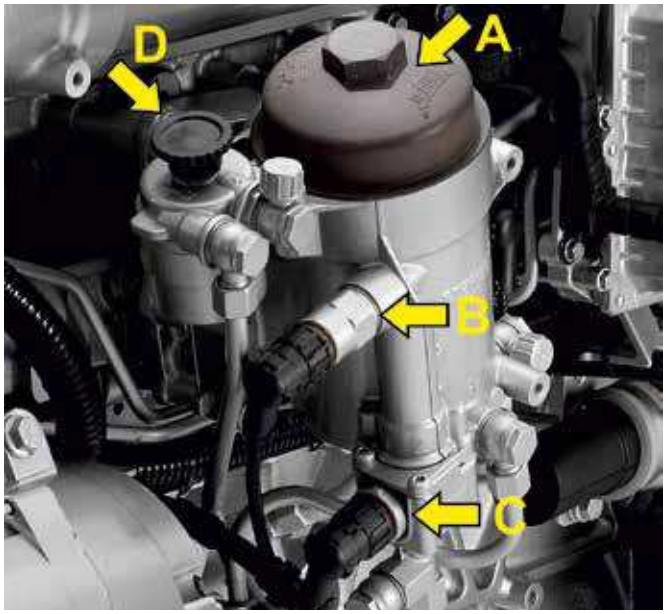

Figure 2: MAN KSC

Legend:
A) Main filter
B) Fuel pressure sensor
C) Heater
D) Pre-filter with priming pump

Legend:
A) From the tank
B) Towards the mechanical transfer pump
C) From the mechanical transfer pump
D) Towards the high pressure pump
E) Return to the tank

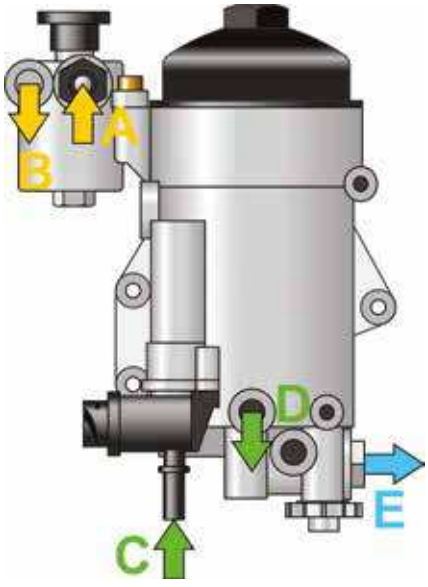

Figure 3: KSC hydraulic connections

D28 series engines are equipped with the KSC already installed on versions with EDC MS6.1 while for D20 and D08 engines a new KSC is fitted. On the KSC lower side of D28 a fitting connects the glow plug with a pressure relief valve towards the return manifold.

This valve has 2 calibrated holes:

- 1 keeps (approx.) 5 bar on the delivery towards the high pressure pump;
- 1 keeps 1.3 – 1.8 bar on the filter return and at the same time supplies the glow plug.

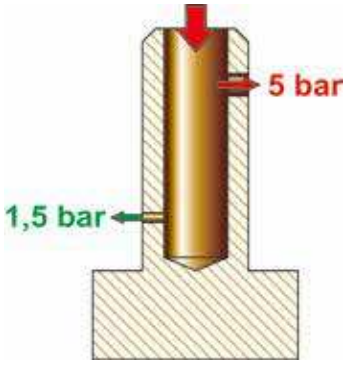

Figure 4: KUV valve of D28 engines

1.1.2 Fuel pump

The fuel pump assembly consists of the transfer pump and the high pressure pump. The pump shaft is connected to the engine timing through a gear wheel. The work pressure varies up to 1400 – 1600 bar. Euro 3 MAN vehicles are equipped with a pump CP3.4 o CP3.4+ (CP2/4 on V10 engines). The pump is located:

- on the rear left side where the inline pump (D28) was fitted;
- on the left front side (D08, D20, D26);
- on the rear side in the center of the V (V10).

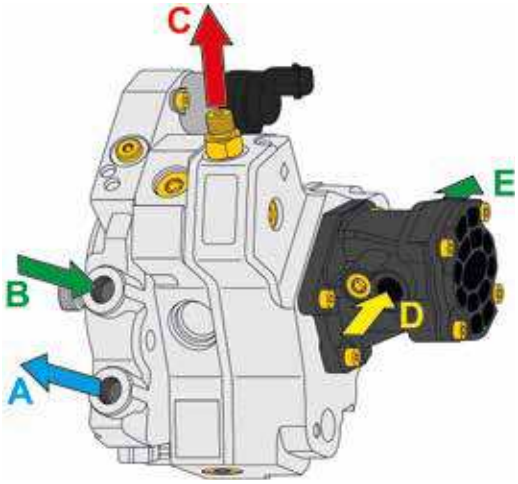

Figure 5: Pump CP3.4

Legend:
A) Return to the tank
B) From the main filter
C) To the high pressure circuit
D) From the pre-filter
E) To the main filter

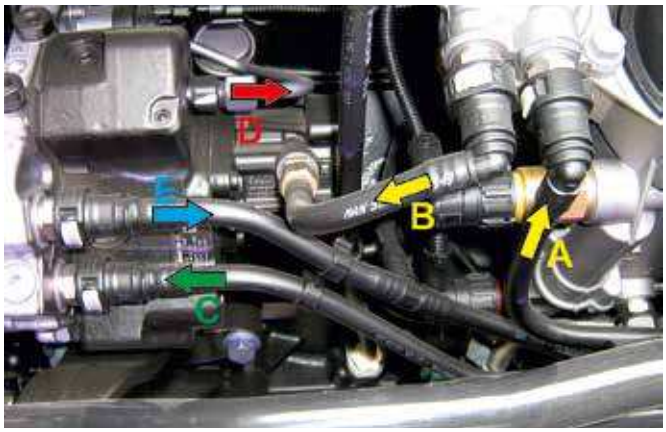

Figure 6: Pump CP3.4+

Legend:
A) From the tank
B) To the transfer pump
C) From the main filter
D) To the high pressure circuit
E) Return circuit

The engine shaft-pump transmission ratio is 1:1.67 for D20 and D28, 1:1.33 for D08 and 2:1 for V10. The lubricating oil returning from the pump is sent to the pre-filter suction of the oil module.

1.1.3 Rail

The Rail, manufactured in forged steel, has different diameters and lenghts according to the kind of engine it is used on. It presents a calibrated volume in order to guarantee:

- a quick pressure increase at start up;
- the pressure compensation due to the pulses generated by pump and injections.

The Rail has also a casing for:

- pressure sensor;
- overpressure valve.

1.1.4 2-stages DBV overpressure valve

The overpressure valve used in MAN engines is a double stage valve. The pressure settings are 1800 and 700-800 bar. Once the second stage is opened, the valve remains open until the pressure falls under 50 bar.

Figure 7: DBV valve in D20 engines

In case of overpressures on the Rail, if the valve doesn't open, the ECU controls the M-Prop in order to increase pressure to speed up the overpressure valve opening. If it doesn't open anyway, the engine shuts down.

1.1.5 Pressure relief valve

The fuel returning from the injectors is conveyed towards the tank through the pressure relief valve that allows to keep the pressure on the return circuit at a value of 1.2 - 1.4 bar. In D08 and D20 engines, a single return manifold is obtained in the head and the valve is screwed on the head itself. In D28 engines, the injector returns are taken outside each cylinder head and are conveyed towards a valve which operates as return manifold and keeps the pressure on the circuit at 1.2 – 1.4 bar (the first version is set at 0.5 bar).

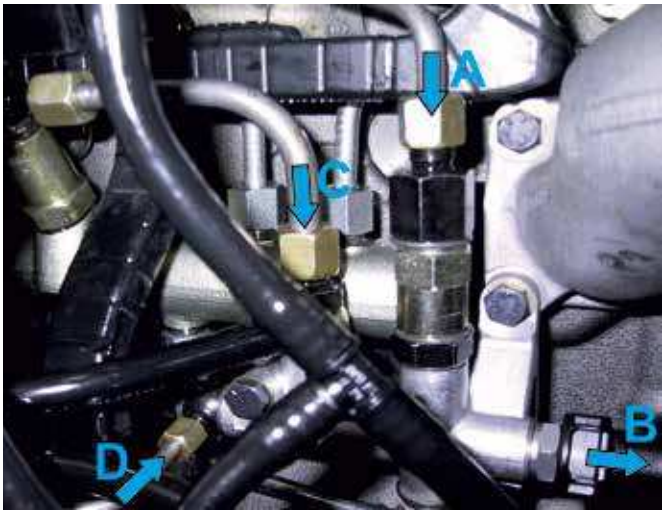

Figure 8: Return manifold in D28 engines

Legend:
A) Return from the injectors
B) Return to the tank
C) Return from DBV valve
D) Return from the glow plug

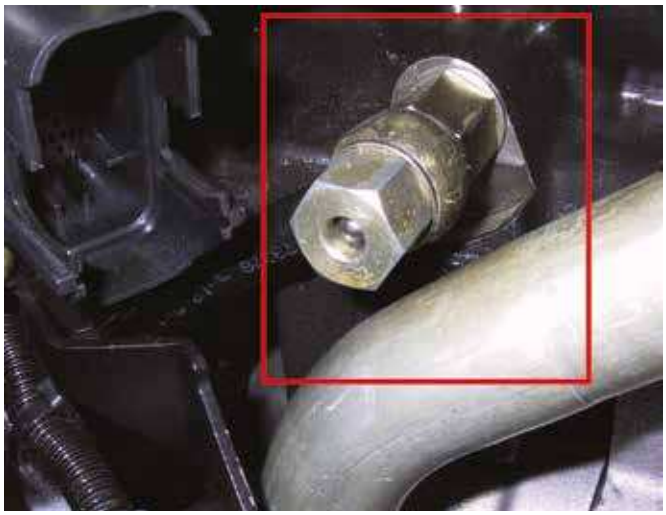

Figure 9: Pressure relief valve in D08 and D20 engines

1.2. EDC7 Euro 3 control unit

The Euro 3 version of EDC7 has the following features:

- pre-heating control at low temperatures;
- rpm/timing synchronization at start up for injection sequential control;
- it manages the injection process by checking the flow regulator, the pre-injection and the main injection. The pre-injection is available for all engine speeds;
- it checks the pressure on the Rail through the feedback signal of the pressure sensor;
- it manages, using the proper mappings, the precise injection point;
- it stabilizes the idle speed correcting the flows on the injectors and the pressure on the Rail;
- it limits the engine speed;
- it controls the Cut-off phase, cancelling the control on the injectors and acting on the flow regulator;
- it controls the exhaust smoke during acceleration by activating the injectors and the flow regulator according to the actual istantaneous engine load;
- activation of the Limp-Home mode when the fuel pressure reaches abnormal values;
- activation of performance limitations according to occurring failures;
- after Run: at engine shutdown the ECU remains powered in order to terminate all existing processes and to store operating parameters.

The control unit can manage max. 6 cylinders, therefore V10 engines use 2 control units (Master/Slave).

Legend:
1) Engine rpm sensor
2) Camshaft sensor
3) Air pressure sensor
4) Engine temperature sensor
5) Air intake temperature sensor
6) Rail pressure sensor
7) Fuel pressure sensor
8) Oil pressure sensor
9) EGR position sensor
10) Intarder/Engine Brake Lever
11) Cruise Control Management
12) Accelerator pedal sensor
13) Clutch travel sensor
14) FGR/FGB switch
15) M-Prop flow regulator
16) Electro-injectors
17) Turbocharger proportional solenoid valve
18) EGR solenoid valve
19) Starter motor IMR relay
20) Engine Brake Solenoid Valve

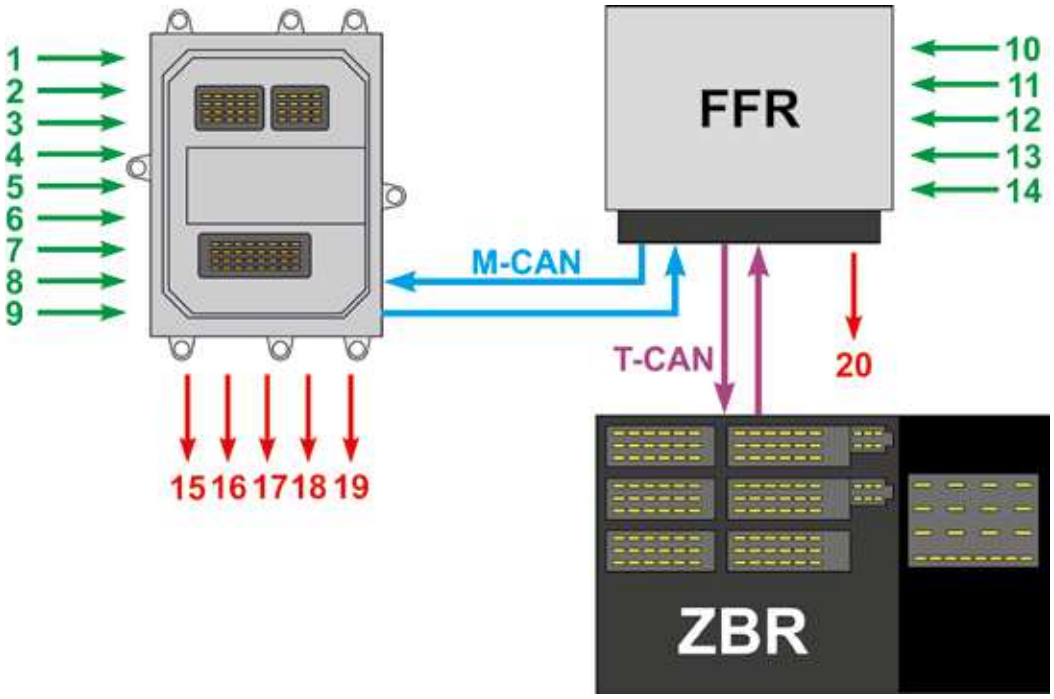

Figure 10: EDC7 Euro3 input/output signals

1.3 Euro 3 version components

1.3.1 ECU

The EDC 7 ECU is directly fitted on the engine, left side (in V10 engines the 2 ECUs are fitted on the frame behind the cabin in 2 protective boxes). The ECU has 3 connectors.

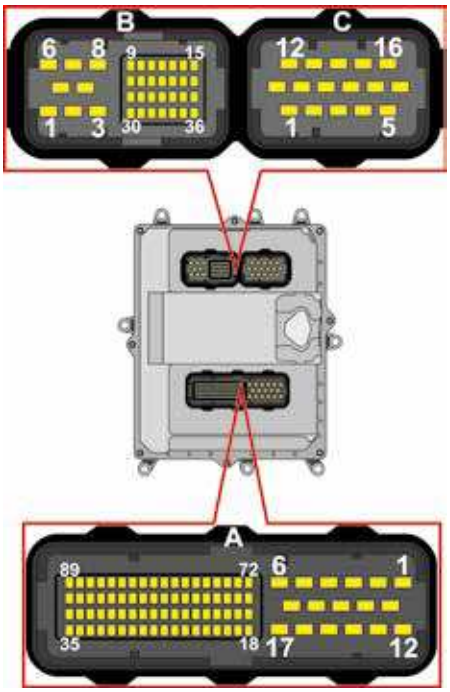

Figure 11: EDC7 ECU connector

Pin	Component	
1	Power supply	+30
2	Turbocharger solenoid valve	Positive control
3	Ground	
4	Turbocharger solenoid valve	Ground
5	--	--
6	--	--
7	Power supply	+30
8	M-Prop regulator	PWM control
9	Ground	
10	M-Prop regulator	Ground
11	AGR solenoid valve	Negative control
12	Power supply	+30
13	Power supply	+30
14	Ground	
15	Ground	
16	IMR relay	Positive control
17	AGR solenoid valve	Positive control
18	--	--
19	IMR relay	Ground
20	Fuel pressure sensor	Signal
21	Engine oil pressure sensor	Signal
22	AGR position sensor	Signal
23	AGR position sensor	Power supply 5 V
24	Engine oil pressure sensor	Power supply 5 V
25	Intake air pressure sensor	Power supply 5 V
26	--	--
27	--	--
28	--	--
29	--	--
30	--	--
31	--	--
32	--	--
33	--	--
34	--	--
35	--	--
36	--	--
37	Fuel pressure sensor	Ground
38	Engine oil pressure sensor	Ground
39	--	--
40	Fuel pressure sensor	Power supply 5 V
41	--	--
42	--	--
43	Rail pressure sensor	Power supply 5 V
44	--	--
45	--	--
46	--	--
47	--	--
48	--	--
49	--	--
50	--	--
51	--	--
52	--	--
53	--	--
54	Camshaft sensor	Ground
55	Engine rpm sensor	Ground
56	--	--
57	Intake air temperature sensor	Ground
58	Engine temperature sensor	Ground
59	--	--
60	--	--
61	Rail pressure sensor	Ground
62	Intake air pressure sensor	Ground
63	--	--
64	--	--
65	--	--
66	--	--
67	--	--
68	--	--
69	--	--
70	--	--
71	--	--
72	Camshaft sensor	Signal
73	Engine rpm sensor	Signal
74	--	--
75	--	--
76	Intake air temperature sensor	Signal
77	Engine temperature sensor	Signal
78	--	--
79	--	--
80	Rail pressure sensor	Power supply 5 V
81	Intake air pressure sensor	Signal

82	--	--
83	--	--
84	--	--
85	--	--
86	--	--
87	--	--
88	--	--
89	--	--

Table 3: ECU EDC7 connector A

Pin	Component		Pin	Component	
1	--	--	19	--	--
2	--	--	20	--	--
3	--	--	21	CAN line	CAN L
4	--	--	22	CAN line	CAN H
5	--	--	23	--	--
6	--	--	24	--	--
7	--	--	25	--	--
8	--	--	26	--	--
9	--	--	27	--	--
10	--	--	28	--	--
11	--	--	29	--	--
12	--	--	30	--	--
13	--	--	31	--	--
14	--	--	32	--	--
15	--	--	33	--	--
16	--	--	34	--	--
17	--	--	35	Diagnostic socket	K line
18	--	--	36	Power supply	+ 15

Table 4: ECU EDC7 connector B

Pin	Component	
1	Cylinder 5 injector	Positive control
2	Cylinder 6 injector	Positive control
3	Cylinder 4 injector	Positive control
4	Cylinder 1 injector	Positive control
5	Cylinder 3 injector	Positive control
6	Cylinder 2 injector	Ground
7	--	--
8	--	--
9	--	--
10	--	--
11	Cylinder 2 injector	Positive control
12	Cylinder 3 injector	Ground
13	Cylinder 1 injector	Ground
14	Cylinder 4 injector	Ground
15	Cylinder 6 injector	Ground
16	Cylinder 5 injector	Ground

Table 5: ECU EDC7 connector C

1.3.2. Intake air pressure sensor

The intake air pressure sensor is used to determine the actual quantity of air entering the cylinders and therefore allows to dose with a higher precision the fuel flow to reduce emissions and consumptions.
The sensor is located on the intake manifold, left front side.
The piezoelectrical sensor and an electronic system for signal amplification and temperature compensation are integrated on a silicon chip.
The chip active surface is exposed to a vacuum reference value. The vacuum pipe pressure is transmitted through an appropriate fitting on the rear side of the membrane that resists the measuring aid.

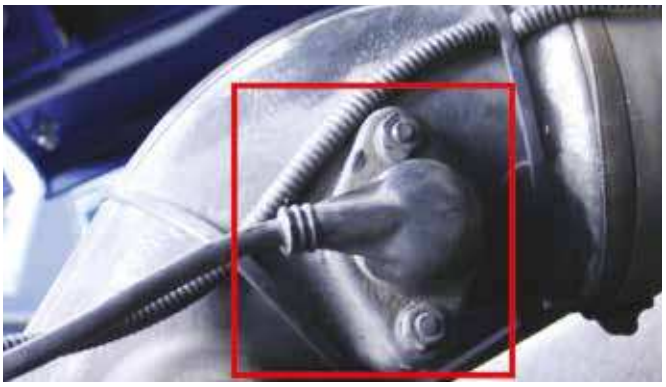

Figure 12: Kavlico intake air pressure sensor (D28)

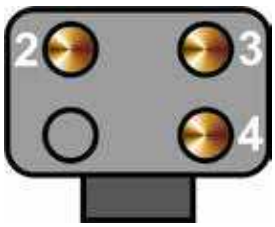

Figure 13: Connections of Kavlico intake air pressure sensor (D28)

In D20 engines the intake air pressure sensor is a Bosch sensor with the same features of the previous sensor.

Figure 14: Connections of Bosch intake air pressure sensor (D20)

Measurement point	Description	Value
Pins 3 and 2 (Kavlico)	Power supply	5 V
Pins 3 and 1 (Bosch)	Power supply	5 V
Pins 4 and 2 (Kavlico)	Signal	See diagram
Pins 4 and 1 (Bosch)	Signal	See diagram

Table 6: Sensor electric controls

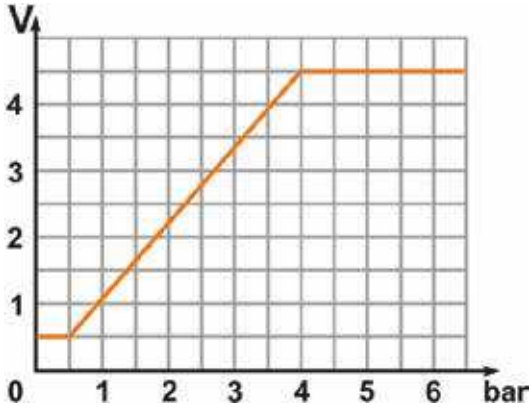

Figure 15: Sensor Pressure/Voltage Diagram

In case of sensor failure a replacement value is preset; this way, there is no operation limitation. The signal is verified through an atmospheric pressure sensor integrated in the ECU, which evaluates the signal when the engine is working at idle speed.

1.3.3 Engine rpm sensor

The engine rpm sensor is an inductive sensor and it is positioned on the rear side of the engine on the flywheel box. It detects the engine rpm through the gear on the flywheel that has 60-2 = 58 holes.

There is therefore 1 hole every 6° and 2 holes are missing in line with the first cylinder.

The distance between sensor and gear is 1 mm (not adjustable value).

Figure 16: Rpm sensor mounting position

Figure 17: Engine rpm sensor

The engine can also be started only with this sensor signal. Near TDC the ECU performs some injections to identify the correct ignition order.

Figure 18: Electrical connections of the engine rpm sensor

Measurement point	Description	Value
Pins 1 and 2	Resistance	750 – 1100 ohm
Pins 1 and 2	Signal	SEE OSCILLOGRAM

Table 7: Reference values of the engine rpm sensor

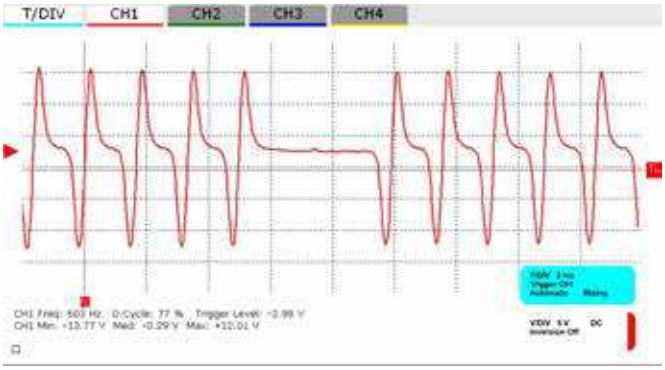

Figure 19: Signal of engine rpm at idle

The first half wave at start up must be positive. If not, error code 3753 is generated.

1.3.4 Camshaft sensor

The camshaft sensor is an inductive sensor. It detects the camshaft rpm through some notches on the camshaft gear. The sensor position differs according to the engine.
In D28 engines where the valves rocker arms operate through rods, the camshaft is on the case.
The sensor here is visible on the engine rear left side, over the high pressure pump.
The reading occurs through 7 pins fixed on the timing gear. The sensor in this case is equipped with a connection cable.
In D20 and D26 engines, with overhead camshaft, the sensor is at the rear left hand on the top, under the valve cover.
In D08 engines, where the valves rocker arm operates through rods, the camshaft is on the case.
The sensor here is visible on the engine front right side, on the camshaft bracket behind the drive belt.
The reading occurs through 5 or 7 protrusions on the timing gear.
In D08, D20 and D26 engines the sensor directly integrates also the connection pin.
In V10 engines the sensor is inside the CP2/4 pump.

Figure 20: Camshaft rpm sensor mounting position

Figure 21: Camshaft sensor

Figure 22: Electrical connections of the camshaft sensor

Measurement point	Description	Value
Pins 1 and 2	Resistance	750 – 1100 ohm
Pins 1 and 2	Signal	SEE OSCILLOGRAM

Table 8: Reference values of the camshaft sensor

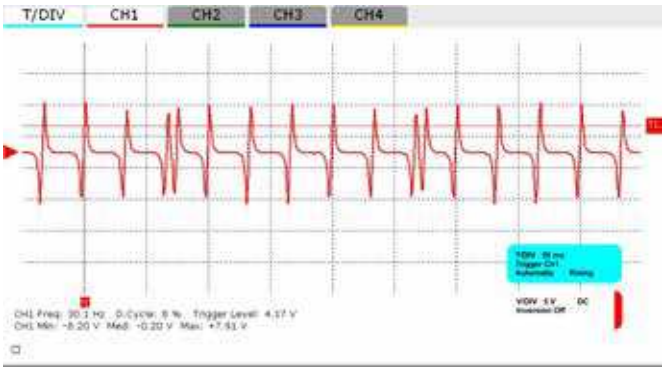

Figure 23: Camshaft rpm signal

The engine can be started also with only this sensor signal.
In the ECU all skew corrections are stored so that the injection point can be calculated without knowing the engine shaft rotation angle.

The first half wave at start up must be positive. If not, error code 3753 is generated.