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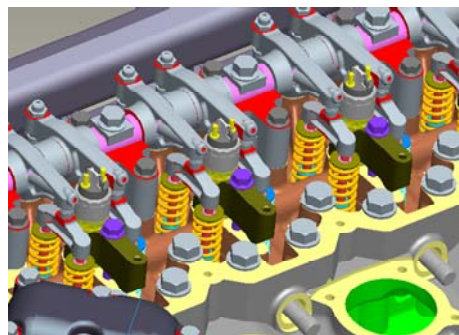
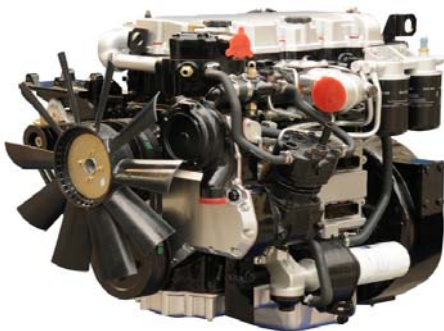
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中重卡车
Medium & Heavy-Duty Trucks

北京福田国际贸易有限公司
Foton International Trade CO., Ltd, Beijing



Electronic Control High Pressure Common Rail Engine Features



- In Compliance with China-III Emission Code, Provided with China-IV Emission Potential
- Environmental Protection Performance, Power Performance, Economic Efficiency, and Reliability able to be Considerably Enhanced, and at the Same Time Engine Noise Reduced
- In the mean time, 4-valve technology is equipped for the electronic control common rail engines.



Electronic Control High Pressure Common Rail 4-Valve Engine Features



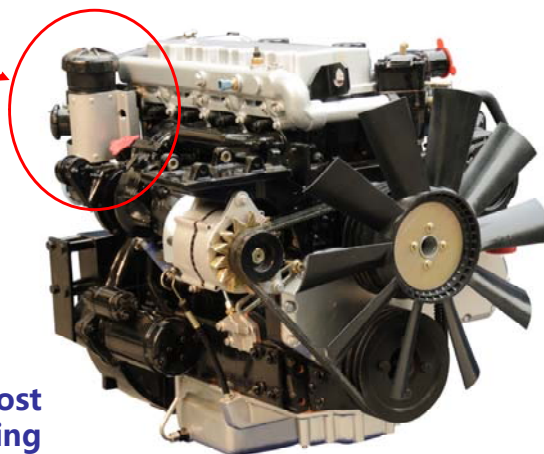
LOVOL Engines and Austrian AVL Company have cooperated with each other, have jointly developed the 4-valve technology, with the original 2-valve structure modified, and the cylinder head re-designed, to increase the cylinder intake volume.

- The flow cross-sectional area for intake and exhaust of the same cylinder-bore engine can be further enlarged through the 4-valve technology, thus to more effectively reduce the engine intake and exhaust resistance, which has effectively increased engine inspiratory volume.
- The issue of rational match between the fuel injector and the combustion chamber can be better settled through the 4-valve technology, for the effect of fuel atomization mixed injection to be better, and fuel combustion to be more sufficient.
- Application of the 4-valve technology has played a remarkable effect on reduction of fuel consumption.



Closed Breathing System

Closed Breathing System



The currently world most advanced closed breathing system is adopted, and the engine blow-by issue has been effectively settled.



Electronic High Pressure Common Rail System Features

- The high pressure fuel injection has been achieved, and the current injection pressure can reach 160MPa, while the developing injection pressure will reach 180MPa.
- Fuel injection pressure is fully independent from engine speed, similarly able to achieve high pressure injection under the low speed and low load condition, to improve the performance of engine at low speed and low load.
- Pre-injection and multiple injections can be achieved, to realize the desirable fuel injection rule, for fuel consumption and emission to be reduced.
- Injection timing and injection fuel volume can be freely adjusted.
- Good injection characteristics are provided, able to optimize the combustion process, for engine fuel consumption, noise, smoke, emission, and other performance indicators to be distinctly improved, which is at the same time beneficial to improving the engine torque characteristics and achieving low speed large torque.



High Pressure Common Rail System Composition

- The electronic control high pressure diesel fuel common rail system comprises the two parts of the electronic control system and the fuel supply system.
- **Electronic Control Portion:**

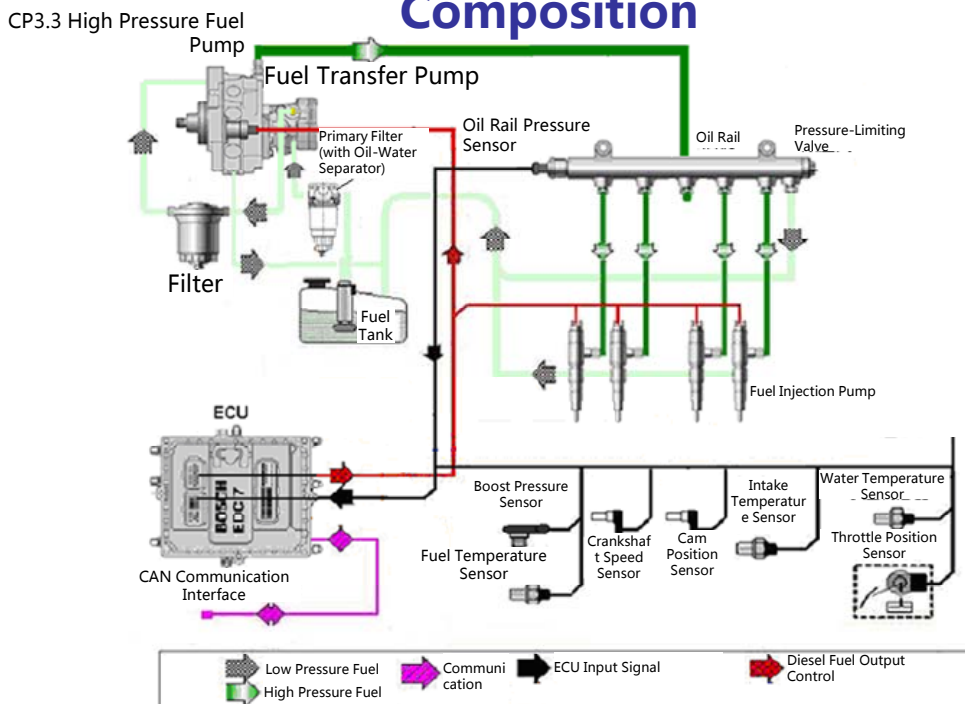
It is comprised of ECU, different sensors, and actuators. The actuators mainly include fuel injector, fuel injection control valve (solenoid valve), pump oil control valve (solenoid valve), and pressure control valve of pressure accumulator.

- **Functions of Electronic Control System:**

ECU figures out the optimum fuel injection time and fuel injection volume are figured out after comparison, operation, and processing according to the its input signals of various sensors, and sends out the opening or closing instruction to the fuel injector control valve (solenoid valve), thus to precisely control the working process of engine.



Electronic High Pressure Common Rail System Composition





High Pressure Common Rail System Composition

- **Fuel Supply Portion:**

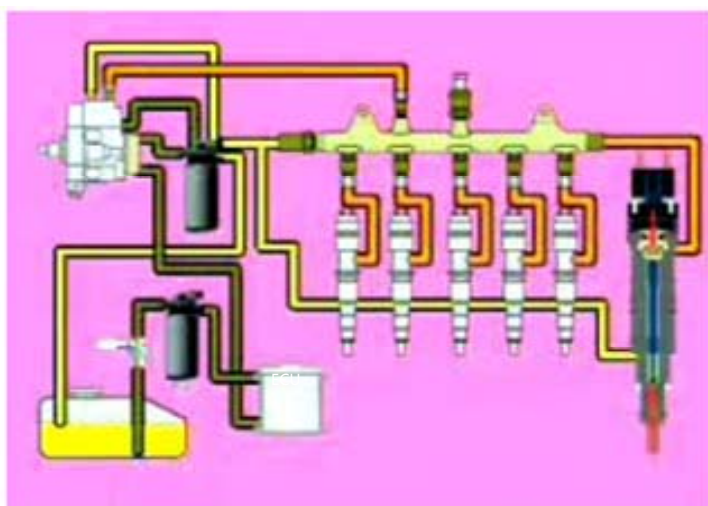
The high pressure common rail system of Lovol diesel engines is the pressure accumulated common rail system, and this system is composed of fuel tank, diesel fuel filter, gear type transfer pump, high pressure fuel pump, high/low pressure fuel pipe, pressure accumulator (oil rail), fuel injector, and oil return pipe, etc.

- **Fuel Supply System Operating Principle:**

The low pressure fuel is input into the high pressure fuel pump through oil-water separator, and diesel fuel primary filter, after it is sucked out from the fuel tank through the gear type transfer pump, and transferred into the pressure accumulator after pressurization through the high pressure fuel pump, with pressure regulated by the pressure-limiting valve, for the fuel pressure in the pressure accumulator to remain always unchanged. The opening and closing of the fuel injector control valve namely the solenoid valve are controlled by ECU according to the signals input through various sensors and switches.



Fuel System Formation



High Pressure Oil Circuit:

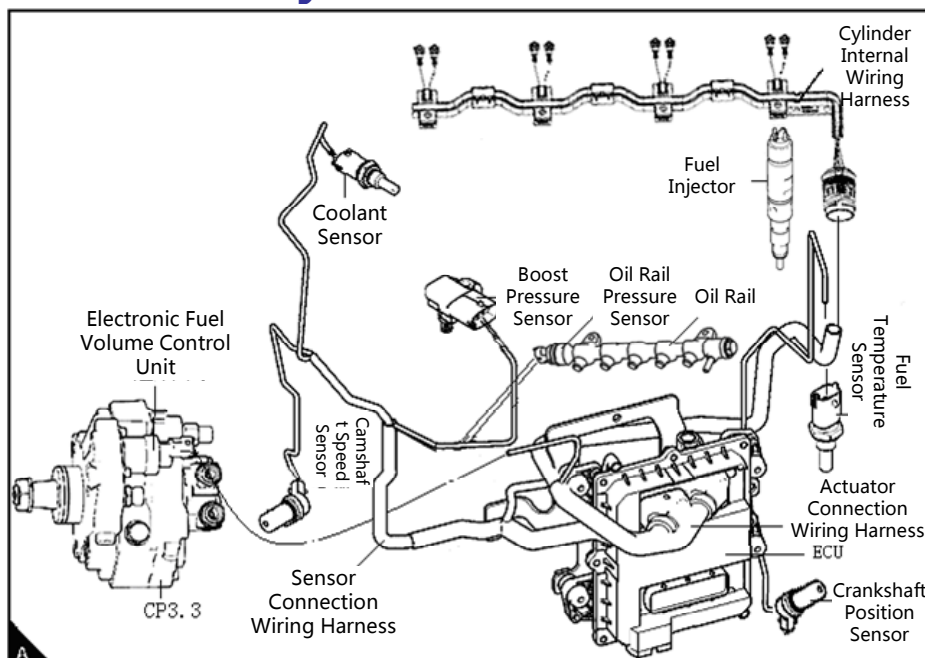
- Fuel Pipelines between High Pressure Oil Pump – Fuel Common Rail Pipe – Electronic Control Fuel Injector

Low Pressure Oil Circuit

- Fuel Pipelines between Fuel Tank – Fuel Primary Filter – ECU – Fuel Transfer Pump – Fuel Fine Filter – High Pressure Oil Pump
- High Pressure Oil Pump Oil Return Pipeline
- Common Rail Pipe Oil Return Pipeline
- Electronic Control Fuel Injector Oil Return Pipeline



Loval Engine Electronic Control Common Rail System Main Parts



High Pressure Fuel Pump

Use of Bosch CP3.3 Oil Pump:

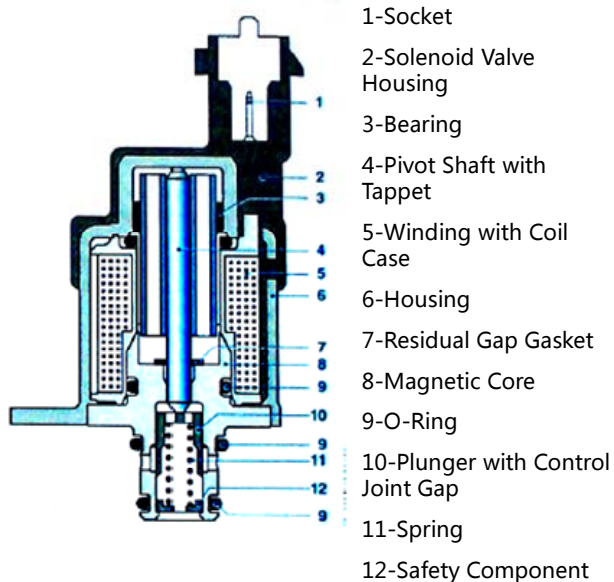
- The work is characterized by transferring the pressurized fuel to the common rail pipe. The fuel injection pump is compact in shape and small in volume, and the driving torque is generally only equivalent to 1/3-1/5 of the inline pump.
- The turning direction of the fuel injection pump CP3.3 is right rotation, clockwise, looking from the gear end of the pump.
- Integrated ZP25.4 Gear Oil Transfer Pump
- Integrated Fuel Measuring Unit

Function of Fuel Volume Measuring Unit:

- The fuel volume measuring unit is installed in the fuel inlet position of the high pressure fuel pump, controlled by ECU. ECU changes the fuel inlet cross-sectional area through pulsing signal to increase or decrease the fuel feed, and controls the volume of fuel entering into the high pressure fuel pump, thus to take control over the fuel supply of the high pressure fuel pump, to meet the requirement of the common rail pressure, and at the same time to avoid the unnecessary heating of the fuel, to effectively reduce power consumption.



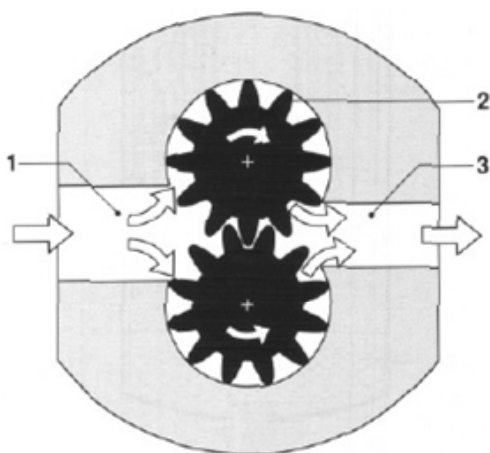
Fuel Volume Measuring Unit



- When the fuel volume measuring unit coil is not powered on, the valve is onstate, namely under the power-off state, the valve is in the fully open position, depending on the spring acting force, able for fuel of maximum flow rate to pass through.
- After it is powered on, the action of solenoid valve overcomes the spring force, to close the valve. When diesel engine is started or under operation, the instruction of ECU is followed to actuate opening and closing of the solenoid valve, to ensure that the pressure inside the high pressure rail is stabilized at the specified requirement.



Gear Oil Transfer Pump

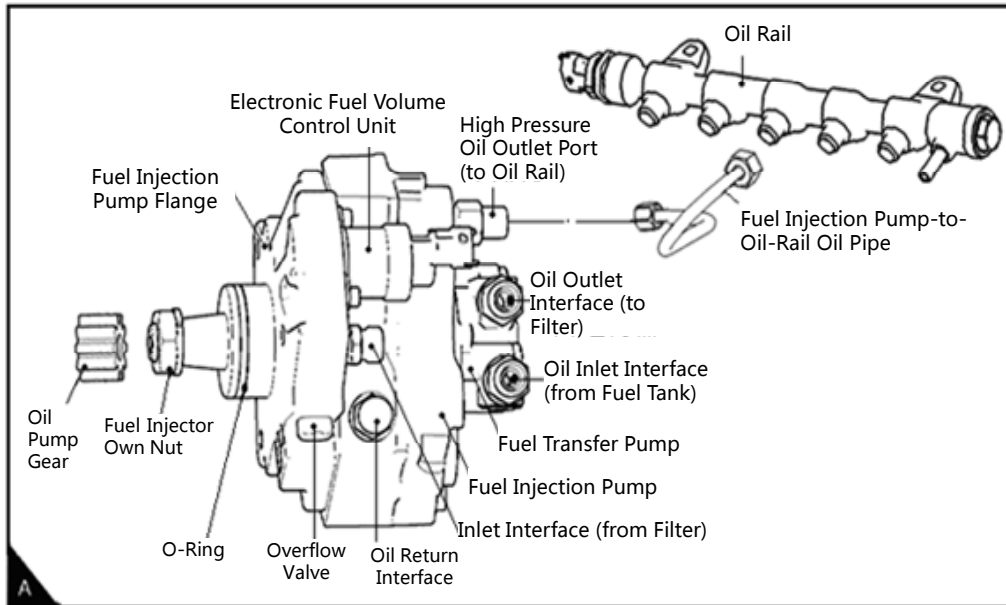


Integrated ZP25.4 Gear Oil Transfer Pump

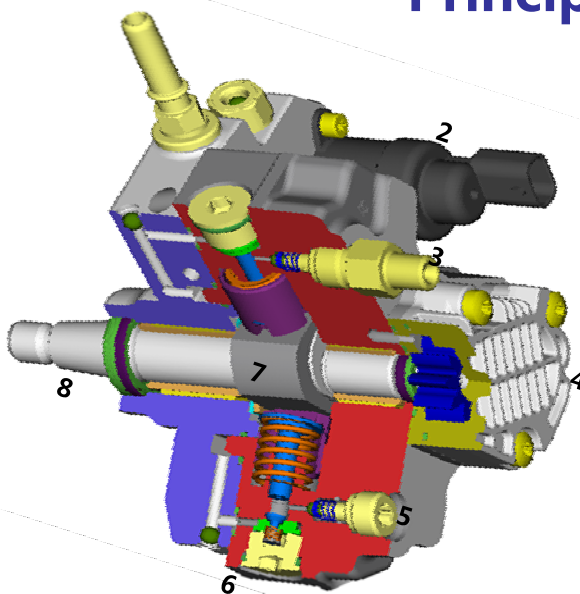
- The gear type fuel transfer pump is driven by the drive shaft of the high pressure oil pump, used to supply fuel of certain pressure for the high pressure fuel injection pump.
- The fuel inlet temperature requirement is: $-25^{\circ}\text{C} \leq T_{\text{Inlet Fuel}} \leq 70^{\circ}\text{C}$



CP3.3 High Pressure Fuel Pump



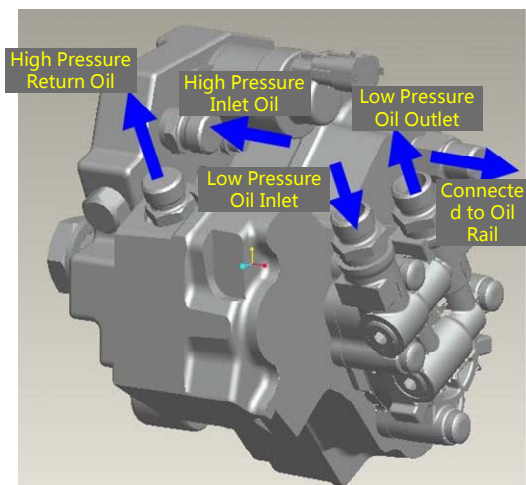
High Pressure Fuel Pump Operating Principle



- The fuel supply pressure reaches 0.5~1.5bar through the fuel transfer pump, and the pressure relief valve is opened for the fuel enters into the high pressure fuel pump.
- At the same time the fuel plays the lubricating and cooling function in the fuel transfer pump and the high pressure fuel pump.



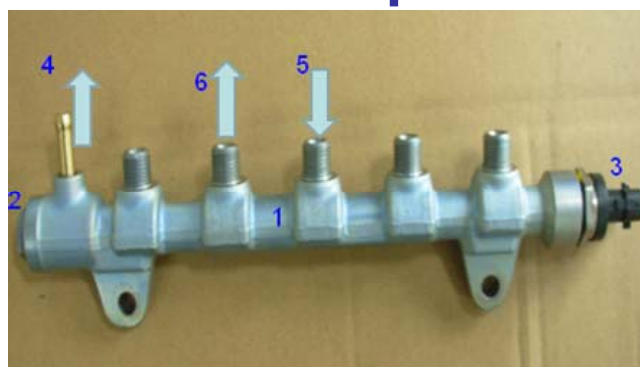
High Pressure Fuel Pump Circuit Schematic Diagram



- **Low Pressure Inlet Oil:**
From Fuel Primary Filter to Fuel Transfer Pump
- **Low Pressure Outlet Oil:**
From Fuel Transfer Pump to Fuel Fine Filter
- **High Pressure Inlet Oil:**
From Fuel File Filter to High Pressure Oil Pump
- **High Pressure Return Oil:**
From High Pressure Oil Pump to Low Pressure Oil Circuit
- **Connected to Oil Rail:**
From High Pressure Pump to Common Rail Pipe Oil Inlet Port



Diesel Fuel High Pressure Common Rail Pipe



1. High Pressure Common Rail Pipe 2. Pressure Control Valve 3. Pressure Sensor 4. Oil Return Valve 5. Oil Supply from High Pressure Oil Pump 6. Oil Outlet to Fuel Injector

- The function of the common rail pipe in the common rail system is to accumulate pressure and supply high pressure fuel to the fuel injector.
- The high pressure fuel supplied by the fuel injector is pressure stabilized and filtered through the common rail pipe, and distributed to respective fuel injectors, to play the function of a pressure accumulator. At the same time the fuel supply pressure fluctuation of the fuel injection pump and the pressure oscillation aroused in the fuel injection process are eliminated, for the pressure fluctuation in the high pressure oil rail to be controlled below 5MPa.



Diesel Fuel High Pressure Common Rail Pipe



1. High Pressure Common Rail Pipe 2. Pressure Control Valve 3. Pressure Sensor 4. Oil Return Valve 5. Oil Supply from High Pressure Oil Pump 6. Oil Outlet to Fuel Injector

- Rail Pressure Sensor: The rail pressure sensor is located on the right side of the common rail, used for measuring fuel pressure inside the oil rail.
- Rail Pressure-Limiting Valve: When common rail pressure exceeds the maximum pressure $>200\text{MPa}$, the rail pressure-limiting valve will automatically open to release pressure, and when pressure drops to $<50\text{MPa}$, it will automatically close.
- High Pressure Oil Inlet: The oil rails for both 4- and 6-cylinder engines have an oil inlet port, respectively connected with the high pressure oil outlet port and the middle oil inlet port of the common rail pipe.



ECU Electronic Control Unit



- Bosch EDC7UC31 controller is used for LOVOL engine high pressure system.
- ECU is referred to as the single chip microcomputer, and it integrates the central processing unit (CPU), program memory (ROM), data saver (RAM), input and output (I/O) interface circuit, and other main computer parts onto a piece of circuit chip, to form the chip microcomputer.



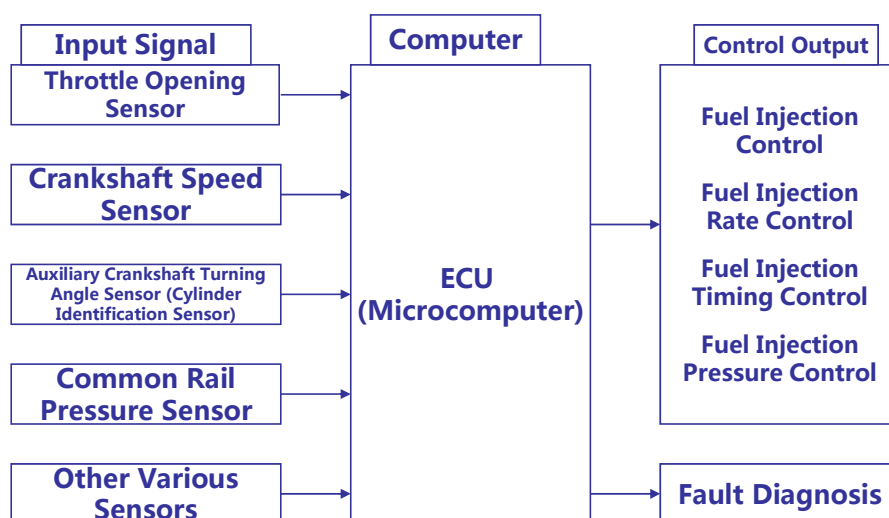
ECU Electronic Control Unit



- ECU is the control center for the entire electronic control system.
- ECU acquires the information about current working status of engine through various sensors and switches, makes analysis and calculation and controls the engine fuel injection volume, fuel injection time, and fuel injection pressure according to the pre-calibrated optimum parameters under this status, thus to adjust the engine working status, to achieve the fuel-saving, high-efficiency, and low-emission purposes.

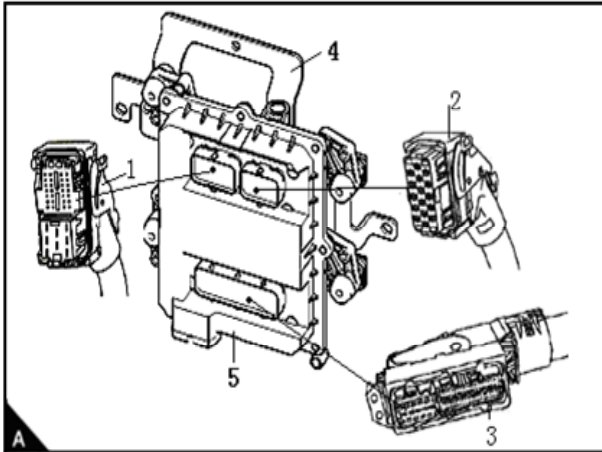


ECU (Electronic Control Unit)





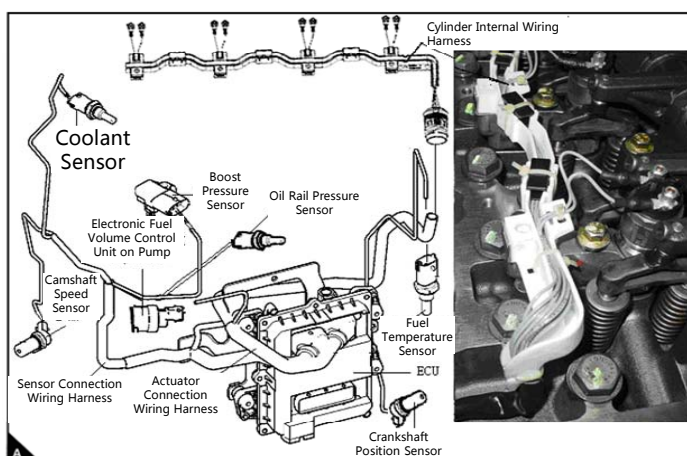
Notices for ECU Maintenance and Use



- When ECU is disassembled or installed, the battery power supply must be cut off.
- When complete vehicle is welded, the battery power supply must be cut off, to prevent damage of ECU arising from too large electric current.
- It is required to ensure a good heat radiation when ECU is working, and it is not permissible to be covered and wrapped, to prevent poor radiation giving rise to damage for high temperature.
- Accumulated water and accumulated liquid shall be avoided for ECU, to prevent failure of short circuit.
- It is strictly forbidden for ECU to be bumped or dropped in the assembling process.



Wiring Harness Assembly

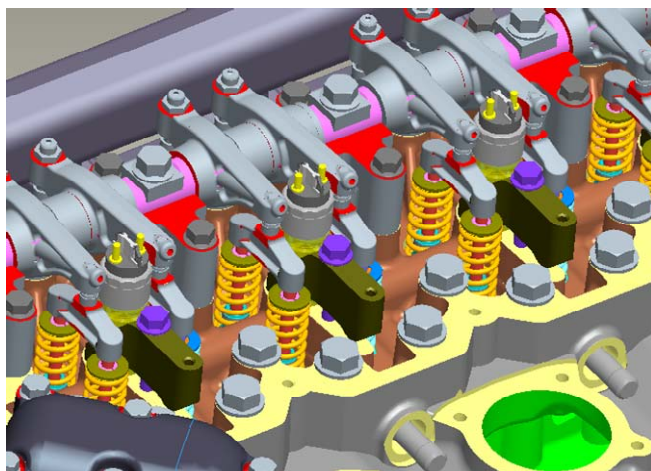


- The portion of wiring harness is divided into two parts for the complete vehicle and the engine.
- The wiring harnesses on engine include cylinder internal wiring harness, sensor connection wiring harness (36-pin connector), and actuator connection wiring harness (16-pin connector).

- If it is found to be difficult to pull off or insert the wiring harness, on no account it is to be forcibly performed, while it is firstly required to examine whether or not the locking device is in place, whether or not extraneous substance has entered into the plug-in unit, and whether or not ECU pins are bended and deformed, and otherwise it may damage ECU or the plug-in unit.
- Attention shall be paid to prevent water accumulation, and liquid accumulation at the joint of the plug-in unit and the wiring harness when the wiring harness part is connected. It is required to maintain the cleanness of the plug-in unit during installation and dismantlement.



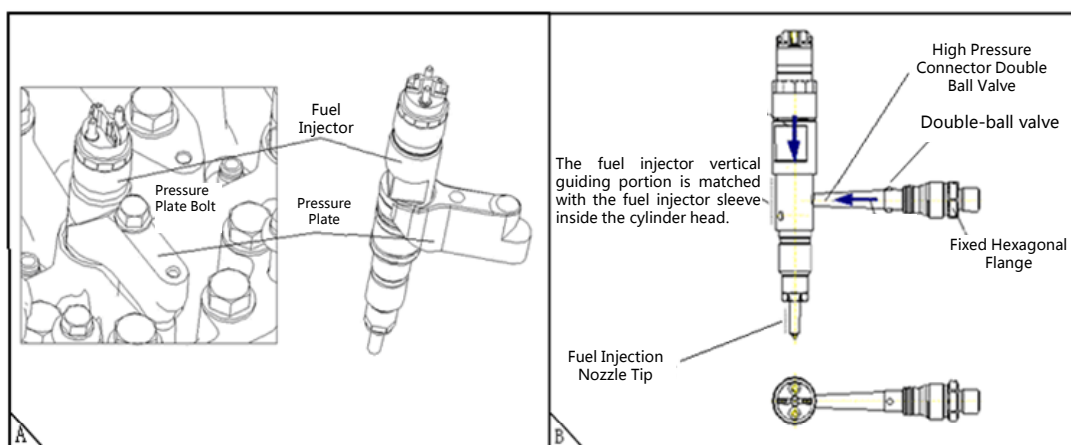
Electronic Control Fuel Injector



- Fuel injector is composed of hole-type nozzle, solenoid valve, and hydraulic servo system.



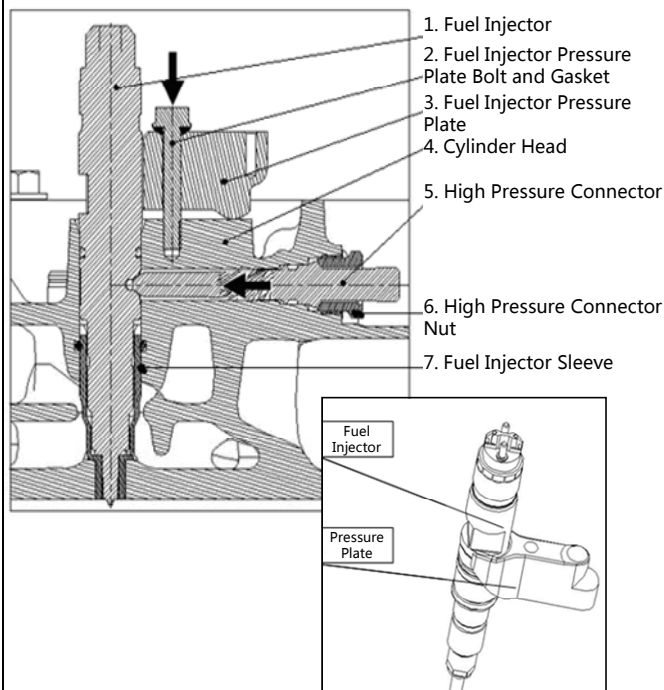
Electronic Control Fuel Injector Installation and Disassembly



- Installation of fuel injector consists of two portions:
 - 1) Installation of Fuel Injector and Fuel Injector Pressure Plate
 - 2) Installation of Fuel Injector and High Pressure Connector



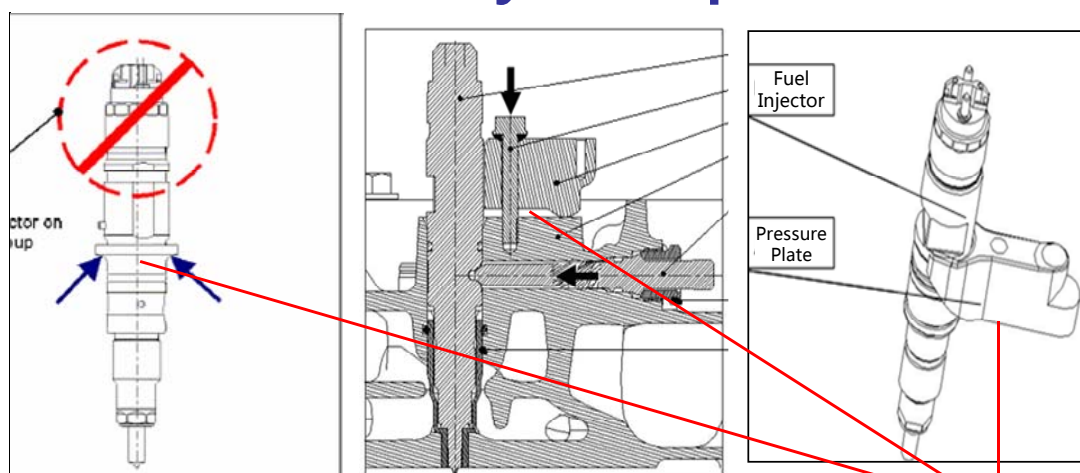
Fuel Injector Installation Description



1. Firstly clip the fuel injector pressure plate on the fuel injector, and then vertically and slowly insert the fuel injector and the pressure plate together into the cylinder head bore.
2. Put the bolt and washer for the fuel injector pressure plate on the fuel injector pressure plate, and manually screw for 2-3 threads.
3. Insert the high pressure connector into the corresponding installation hole of the cylinder head, and rotate it left and right for half a circle, respectively.
4. Mount the nut for the high pressure connector on the high pressure connector, and manually screw for 2-3 threads.
5. Tighten the bolt and washer for the fuel injector pressure plate to 5Nm, and then completely unload the fastening torque, and loosen the bolt.
6. Tighten the nut for the high pressure connector to 15Nm-20Nm.
7. Tighten the bolt and washer for the fuel injector pressure plate to 10Nm, and further tighten for 90°C turning angle.
8. Tighten the nut for the high pressure connector to 50Nm – 55Nm.



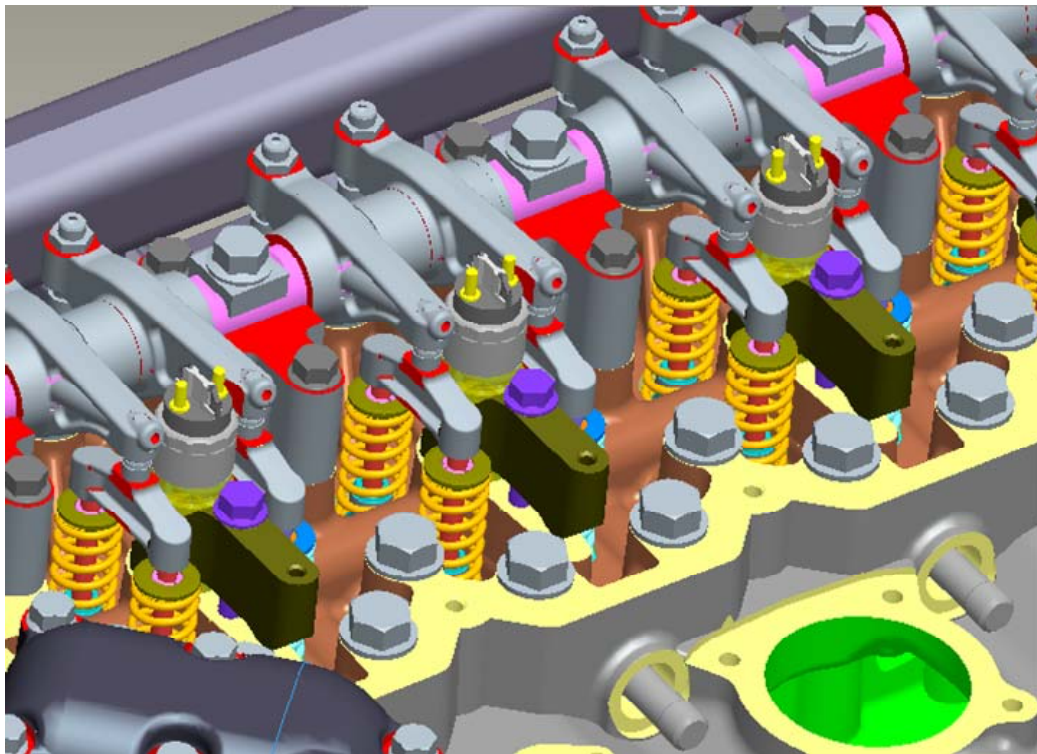
Electronic Control Fuel Injector Disassembly Description



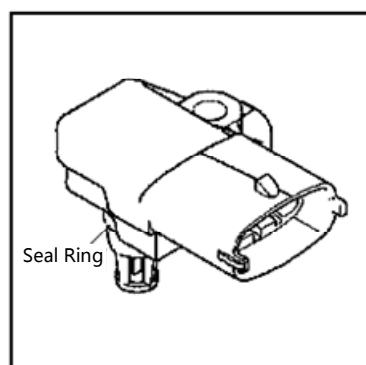
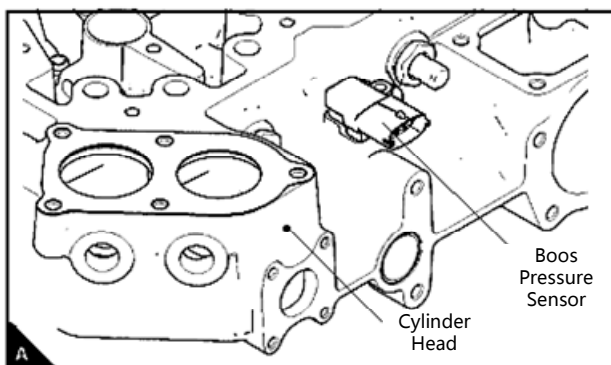
1. It is strictly forbidden to pull the electromagnetic part of the fuel injector, when electronic control fuel injector is disassembled.
2. Note: Dismantle the high pressure connector, before the electronic control fuel injector is removed.
3. Use slotted screwdriver to unclench the fuel injector pressure plate, after the bolts for the pressure plate are removed.

Unclenching Position





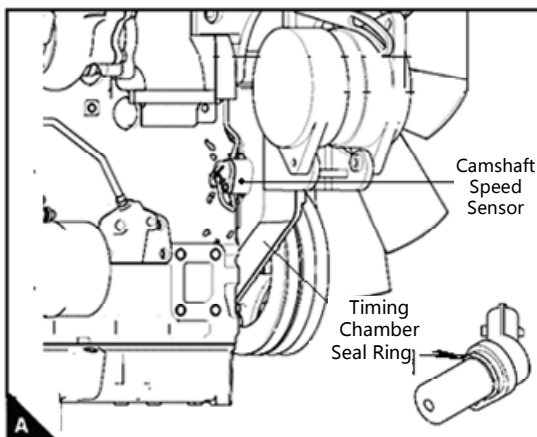
Boost Pressure Sensor



- **Structure:** Piezoresistive Pressure Sensor
- **Installation Position:** Installed on the air inlet pipe
- **Purpose:** Measure the air pressure and the temperature value after the diesel engine is charge inter-cooled, and used to control the air-fuel ratio in combination with intake temperature, and pressure
- **Operating Principle:** Transform the pressure signal into the voltage signal, the voltage is increased along with the pressure rise, to be then transmitted to ECU.



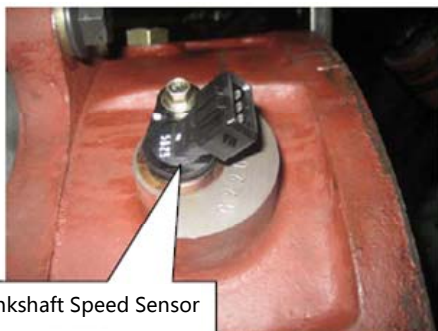
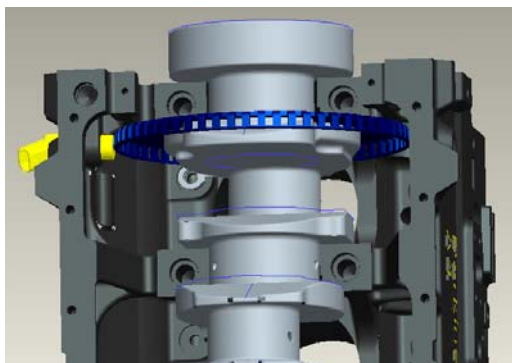
Camshaft Speed Sensor



- **Structure:** Hall Effect Speed and Phase Sensor
- **Installation Position:** Installed on the timing chamber
- **Purpose:** Used to measure the speed of the camshaft, to determine the timing position, and to be involved in determination of fuel injection volume and fuel injection timing
- **Operating Principle:** Determine the TDC position on the engine 1st cylinder compressor, according to N+1 teeth, as the reference signal for fuel injection, and it is able to maintain engine limp home, when failure arises with the crankshaft speed sensor.



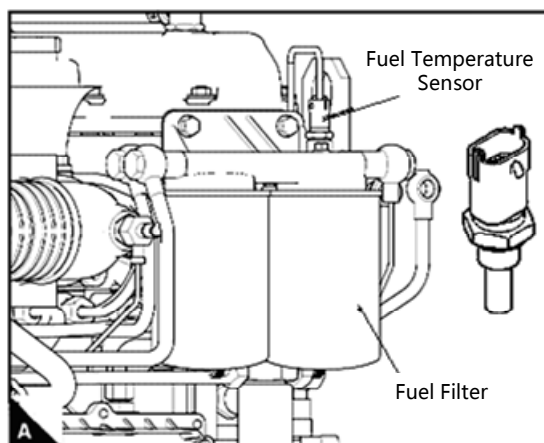
Crankshaft Speed Sensor



- **Structure:** Hall Effect Speed and Phase Sensor
- **Installation Position:** Installed in the rear part of engine block for 4-cylinder engine, and installed on the flywheel housing for 6-cylinder engine
- **Purpose:** Used to measure the speed of the crankshaft, to determine timing position, and to be involved in determination of fuel injection volume and fuel injecting timing.
- **Operating Principle:** 60 signal ports are uniformly distributed in 360° on the signal disc, including 2 ports connected with each other, to determine engine timing. The magnetic flux in the sensor changes along with the clearance of the ports, to generate sine AC voltage, and its wave range changes along with the engine speed. Set to the angle of special port to determine the 1st-cylinder TDC, and to judge the cylinder at the same time in combination with camshaft sensor.



Fuel Temperature Sensor

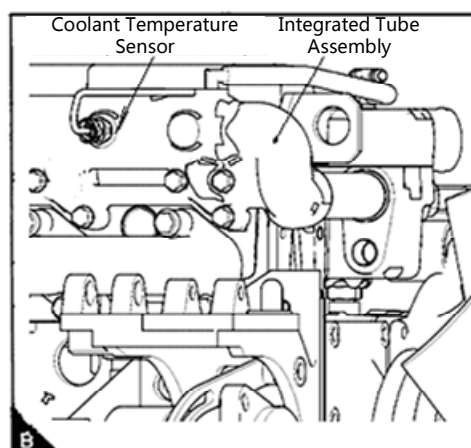


- **Structure:** Thermistor, and temperature measuring range is $-40^{\circ}\text{C} \sim 130^{\circ}\text{C}$.
- **Installation Position:** Installed on the fuel filter
- **Function:** Used to measure engine fuel temperature, count fuel density, thus to further precisely control the fuel injection volume
- **Operating Principle:** Transform the temperature signal into the voltage signal, and the voltage is reduced along with the temperature rise, the two in inverse relation, to be then transmitted to ECU.



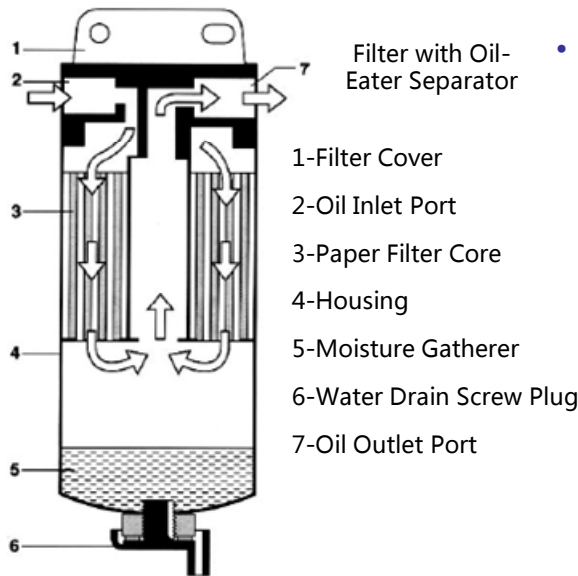
Coolant Temperature Sensor

- **Structure:** Thermistor, and the temperature measuring range is $-40^{\circ}\text{C} \sim 130^{\circ}\text{C}$.
- **Installation Position:** Installed on the cylinder head collector pipe
- **Function:** Used to measure engine coolant temperature, for correction of cold starting and target idle speed, and at the same time for correction the fuel injection advance angle, and maximum power protection
- **Operating Principle:** Transform the temperature signal into the voltage signal, and the voltage is reduced along with temperature rise, the two in inverse relation, to be then transmitted to ECU.





Fuel Filter



- If contaminant is contained in fuel, it will cause high pressure fuel pump, fuel injector, and other parts to be damaged. At the same time if moisture is contained in fuel and enters into the injection system, it will give rise to cavitation of parts with the injection system. Therefore the specified fuel filter must be used, and otherwise, it will be unable to ensure the normal operation of the fuel system and the service life of the related parts.



Electronic Control Engine Failure Maintenance Strategy

- When failure appears in the electronic control engine, it is firstly required to examine whether or not the electronic system self-diagnostic failure indicator light gives warning. If it gives warning after power is non or in the process of engine operation, it indicates that failure is present in the electronic control system, and at this point, the failure cause may be located through diagnostic device or invocation of fault code.
- If failure really exists in engine, while the failure indicator light gives no warning, it indicates that it is not the electronic control system failure, and at this point it is required to locate the mechanical failure, to find out the failure cause in the principle from outside to inside, and from the simple to the complicated. Be sure to keep in mind that the electronic system cannot be randomly disassembled.
- Necessary Preparation for Maintenance of Electronic Control Engine: Diagnostic Device, Engine and Complete Vehicle Circuit Diagram, Multimeter, and Experience in Maintenance of Electronic Control System parts, and Mechanical Parts



Common Rail Engine Common Failure – Failure to Start

1. Engine Fails to Start

Diesel engine is the compression ignition internal combustion engine. The electronic control system is required to supply power normally, for the diesel engine of electronic control system to be smoothly started, while the fuel is injected into cylinder after full atomization, and it is required that certain pressure and temperature are provided inside the cylinder after air is compressed, so that spontaneous combustion of diesel fuel is enabled. On this account, the cause of engine starting failure is generally arisen from electronic control system, starting system, fuel system, intake and exhaust system, as well as fitting clearance.



Common Rail Engine Common Failure – Failure to Start

1. Failure of Electronic System to Supply Power Normally:

The control core of the electronic control system is ECU, and if ECU is kept for normal work, the normal power supply voltage must be input into the circuit of the complete vehicle, generally as 16-28V. If the power supply voltage fails to meet the requirement, ECU will be unable for normal operation, and there will be no way to start the engine. Therefore it is required to understand the complete vehicle circuit configuration and make inspection.

- There are several essential factors during inspection including ECU fuse, relay, starting key switch, and circuit of the complete vehicle.
- Examine whether or not self-inspection is made for the fault diagnostic light on the complete vehicle instrument panel. When starting key switch is turned from OFF to the ON gear, the fault diagnostic light shall turn on, and the turn off after lasting for 2-3s, and at this point it indicates that the self-diagnostic function is ongoing on the electronic control system.
- It indicates that the electronic control system is not supplying power normally, if the fault light does not turn on. It is required to examine the circuit of the complete vehicle, the failures liable to appear therein are with power-on fuse, wiring harness, and starting switch.



Common Rail Engine Common Failure – Failure to Start

2. ECU Failure:

Under the situation of normal power supply voltage on the part of ECU, 5V reference voltage shall be output to respective sensors. It indicates that ECU is damaged or the control module is damaged if respective sensors have no approximately 5V voltage, and at this point ECU shall be wholly replaced, while it is not allowed to dismantle the ECU assembly.

- Examine whether or not the plug-in unit for wiring harness of ECU is reliably connected.
- Examine whether or not there is voltage output from camshaft phase sensor, crankshaft speed sensor, water temperature sensor, diesel fuel temperature sensor, intake pressure/temperature sensor, and electronic throttle pedal sensor.



Common Rail Engine Common Failure – Failure to Start

3. Starter Fails to Work:

General electronic control system engine starter is controlled by ECU, and it is mainly to examine the neutral gear switch signal. Then ECU outputs a current to drive the starting relay, and the battery will actuate the starter to be started, after relay is switched on.

- Examine whether or not it is engaged in neutral position.
- Examine the position of the shutoff switch on vehicle (to be under off state).
- Examine whether or not the neutral gear switch, neutral gear sensor, and wire connection are under good condition.
- Examine whether or not battery voltage is too low, so as to be unable to actuate the starter work or inadequate speed.
- Examine whether or not starting relay and wire connection are under good condition.
- Examine whether or not the starter is damaged.
- Examine whether or not the ignition switch and the starting switch are damaged.

It is required to examine whether or not the starter starting speed is at 200rpm, if starter is to be started for work, and at the same time examine whether or not the battery voltage is smaller than 16V at starting.



Common Rail Engine Common Failure – Fails to Start

4. Failure of Rail to be Created (Starting fails, though starter works normally.)

The common rail system has relatively high requirements for fuel circuit, and it shall be ensured that all low pressure oil circuit (oil tank, primary filter, fine filter, and oil return pipe), high pressure oil circuit (high pressure oil pump, common rail, high pressure oil pipe, and fuel injector) shall be sealed. If problem arises with any link, the rail pressure cannot be normally created, and it is prompted to examine the entire fuel circuit.

- Examine whether or not level of fuel tank is too low.
- Examine whether or not manual oil pump works normally.
- Examine whether or not air is present in the low pressure oil circuit or the circuit is blocked.
- Exhaust Method: Exhaust the air of the low pressure circuit. Loosen the air bleed bolts on the primary and fine filters, use hand to press the manual pressure pump on the primary filter, until oil keeps flowing out at the air bleed bolt.
- It is then determined that air is present in the high pressure oil circuit, and the air in the high pressure oil circuit shall be exhausted, if diesel engine still fails to be started after the air in the low pressure oil circuit is completely drained.
- Exhaust Method: Loosen the high pressure oil pipe, and use the starter to actuate the operation of the diesel engine until the oil in the high pressure oil pipe keeps flowing out.



Common Rail Engine Common Failure – Fails to Start

- Examine whether or not leakage exists in the high pressure circuit.
- Examine whether or not the oil circuit is unobstructed, and examine whether or not the diesel fuel filter is blocked.
- Inspection Method: Loosen the fine filter outlet bolt, and high pressure oil pipe, and use starter to actuate the operation of the diesel engine, to observe whether or not diesel fuel gushes out or flow out. It may be then determined that the filter core is blocked, if only a small volume of diesel fuel flows out.
- Examine whether or not the initial voltage value of the rail pressures sensor is at about 500mv, or whether or not the set rail pressure is 300 - 500bar.
- It is firstly required to examine whether or not the plug-in unit is firmly connected, if it is anomalous. The rail pressure sensor may be pulled off to try restarting, if no inspection device is available.
- Examine whether or not the flow rate measuring valve is under good condition, and pull off the plug-in unit of the connection wiring harness to try restarting.



Common Rail Engine Common Failure – Fails to Start

5. The plug-in units for fuel injector wiring harness, sensor wiring harness, and complete vehicle wiring harness were not properly plugged or the wiring harness is in open circuit or in short circuit.
 - Examine the installation of the plug-in unit, and used multimeter to examine the making or breaking of the circuits according to the definitions of pins in the circuit diagram.
6. The crankshaft signal and the camshaft signal are lost.

Two speed sensors are installed on diesel engine, respectively on the engine block or the flywheel housing and the right side of the timing chamber. The functions are respectively as the crankshaft position sensor and the cylinder identification sensor. Fuel injection timing of the electronic control engine depends on these two sensors. The two signals are both lost, if diesel engine fails to be started.

 - Possible Cause for Loss of Both Two Signals
 - Sensor is damaged, or wiring harness is in short circuit or in open circuit.
 - The sensors are not firmly fixed, giving rise to too large or too small clearance between the sensor and the sensor teeth (generally as $1\pm0.5\text{mm}$).
 - Removal Method: Examine whether or not sensor is damaged, whether or not wiring harness is well connected, and whether or not sensor is loosened, etc.



II. Deficient Diesel Engine Power

1. Limp Home Function: It is one mode of engine operation with failure. It is detected by ECU that failure has arisen with the engine, but the engine will not shut down immediately, while the power of engine will be limited, for the speed of engine to be only increased to 1500rpm, and the driver is able to drive the vehicle to the near maintenance station for maintenance.
2. Occurrence of Failure in Fuel Injector

It is generally divided into mechanical failure and wiring failure, if failure arises with fuel injector.

The mechanical failure is that the needle valve is seized, and the needle valve is seized inside the fuel injector, due to relatively much dirt in the diesel fuel or corrosion for water inlet, unable to act (Notice: ECU may not likely report the error!).

The wiring failure is that the connecting wire is disconnected or directly lapped on the cylinder heat to be in short circuit with ground, due to the causes such as vibration, and wear, etc. ECU will not report the error.

Determination Method:

 - ★ Idle speed is unstable, and anomalous engine sound is heard.
 - ★ It is determined by making use of cylinder deactivation method or high pressure oil pipe tactile sensation method./



III. Deficient Diesel Engine Power

3. Too High Water Temperature, Fuel Temperature, and Intake Temperature

Overheating protection function of ECU will be accessed, when water temperature, fuel temperature, and inlet air temperature are too high, to limit engine power.

Cause of High Water Temperature and Removal Method

- **Too Low Water Tank Level:** Examine whether or not water leaking place exists, and fill water.
- **Blocked Water Tank:** Examine the water tank, for it to be cleaned or rehabilitated.
- **Loosened Water Pump Belt:** Adjust the tension force according to the specification.
- **Separated Water Pump Impeller, Broken Water Pump Shaft:** Examine the impeller and the shaft, for them to be rehabilitated or replaced.
- **Thermostat Failure:** To be replaced
- **Blocked Water Pipe or Air Entry:** Examine the water pipe, joint, and gasket, for the air leaking position to be rehabilitated.



III. Deficient Diesel Engine Power

4. Fuel Volume Measuring Unit Failure:

The fuel volume measuring unit is the actuating mechanism for control over the rail pressure, installed on the high pressure oil pump. After it is confronted with a trouble, the high pressure fuel pump will supply fuel to the common rail pipe in the maximum capacity, and at this point the pressure relief valve on the common rail pipe will generally be opened, while the “click” noise will be heard from the diesel engine. The problem emergence in the rail pressure sensor will also cause the similar effect.

5. Fuel Pipeline Leakage Giving Rise to Anomalous Fluctuation of Rail Pressure

In the vehicle operating process, the unstable vehicle speed will arise, and the effect of one after another forward movement will emerge.

Removal Method: Firstly disconnect the power for one minute for restarting, and examine the sealing property of the fuel pipeline if problem still exists and remove it.



III. Deficient Diesel Engine Power

6. Sensor Failure

The intake pressure sensor is the sensor of ECU used to estimate the air intake volume, while the water temperature sensor is the sensor used to determine the engine thermal load, and the rail pressure sensor is the sensor used to detect the common rail pressure. If failure arises with the electronic control system, it will limit engine power.



Electronic Control Engine Failure Case Analysis

Engine Fails to Start.

Failure Description: The key switch was placed in the starting position, engine did not operate, diagnostic instrument could not be connected, and engine could not be started.

Cause: as the electronic-control engine is controlled by ECU, maybe the whole vehicle circuit fails, leading to no voltage input into the ECU, or neutral gear signal failure or starter relay failure.

Maintenance Method: Multimeter was used to measure the 4 voltage input wires 1.021.031.081.09 for the plug-in unit of the complete vehicle, no voltage was detected. It was found through inspection of the complete vehicle circuit that one 30A fuse for controlling ECU voltage input was burned out. It was replaced with a new fuse, and the engine was normally started.

Comment: Though China-III has been extended for a period of time, the quality of wiring harness in-house made by the complete vehicle factories is still relatively low at large, and the failure arising from the quality problem of wiring harness has still very frequently happened. At the same time this failure was caused by maintainer's reverse connection of the positive and negative poles of ECU power supply, and it was lucky enough that ECU was not burned out.



Electronic Control Engine Failure Case Analysis

Engine Fails to Start.

Failure Description: The key switch was placed in the starting position, the starter did not operate, there is no fault blink code, and engine could not be started.

Failure Cause Analysis: ECU voltage input was examined as to whether or not it was normal, whether or not the neutral signal was normal, and whether or not the starting relay and the starter were normal.

Maintenance Method: Multimeter was used to measure the 4 voltage input wires 1.021.031.081.09 and 1.40 for the plug-in unit of the complete vehicle, 24V voltage was detected. The neutral signal was examined to be normal. Screwdriver was used to connect with the starter in short circuit, and the starter had no reaction. It was preliminarily determined that the starter was damaged. The engine was normally started after the starter was replaced.



Electronic Control Engine Failure Case Analysis

Engine Fails to Start.

Failure Description: The key switch was placed in the starting position, the starter did not operate, the fault light did not perform self-inspection, and the engine could not be started.

Failure Cause Analysis: It proved that the ECU function was lost if the fault light did not perform self-inspection, and possibly ECU was not supplying power normally, or ECU was damaged.

Maintenance Method: Both 1.021.031.081.09 and 1.40 voltages were examined to be 24V, indicating that the voltage input was normal, but the possibility of failure with ECU communication or bad contact existed. It was found through further inspection of the complete vehicle joint wiring harness that 1.40 pin was not completely inserted, giving rise to bad contact. The fault light is normally on after the pin was tightly inserted. 24V voltage was also detected with K line, but the diagnostic instrument had always failed for communication. The 8 wires for power supply of the complete vehicle were all normally plugged in through a further inspection, thereby it could be deduced that ECU was already damaged. The engine was normally started after ECU was replaced and the data was refreshed.



Electronic Control Engine Failure Case Analysis

Engine Fails to Start.

Failure Effect: The user reflected that the engine failed to start in the following morning after it was stopped for operation for one night. It was required to press the manual oil pump for more than 30 times before it could be started.

Inspection:

1. The fault light of this engine did not give warning, while diagnostic instrument was used to locate the failure, it showed that the system was normal, and so the possibility of failure with the electronic control system was eliminated.
2. The oil circuit was examined, and the high pressure oil pipe was opened to examine the fuel status. It was found that a small quantity of air existed in the fuel, while the fuel flow rate was normal. It was determined that there was no cause of fuel blockage, and then the air leaking position in the low pressure oil circuit was carefully examined.
3. Through careful troubleshooting of the parts with the low pressure oil circuit one by one, it was found crack existed at the thread of the oil inlet port for the fuel primary filter, and air entered into the oil circuit there, thus to give rise to failure of normal starting for the diesel engine.

Comment:

Improper assembly or frequent disassembly and assembly have caused the sealing of the fuel low pressure oil circuit to be untight, and it is required to perform troubleshooting one by one. After the failure part is determined, it is to be then maintained, to ensure that the sealing property for the parts of the low pressure oil circuit is under good condition.



Electronic Control Engine Failure Case Analysis

Engine Fails to Start.

Inspection: This test engine was a new engine. There was no oil outlet from the loosened high pressure oil pipe when engine was lugged after air bubbles were manually removed by using primary filter, and starting was unsuccessful. The engine was successfully started after the air was fully drained, but the lugging time was relatively long.

It was found that the crankshaft speed sensor and the fuel temperature sensor reported errors, displayed in open circuit the diagnostic instrument was connected for monitoring.

Wiring harness was examined, and it was found that the crankshaft speed sensor and the fuel temperature sensor were reversely connected. The engine was quickly ignited after the sensors were transposed.

Comment: Full air exhaust is required when new engine is started, to maintain the oil circuit to be filled up with fuel. Additionally, either single-crankshaft speed sensor and single-phase sensor can start the engine.



Electronic Control engine Failure Case Analysis

Engine Fails to Start.

Inspection: This test engine was a new engine, and it still could not be ignited after air was fully drained. The wiring harness and the oil circuit were normal.

After diagnostic instrument was connected for monitoring, it was found that there was no error report on failure, but the speed and phase sensors synchronization monitoring signal displayed that the two were not synchronized. The engine was successfully started through the single phase sensor after the crankshaft speed sensor was pulled off, but the engine failed to be started through the single speed sensor after the phase sensor was pulled off. The maintenance personnel was asked at this point who introduced that the flywheel was replaced not long before, and the flywheel was not assembled according to the timing line, indicating that the problem existed with the crankshaft speed signal, and the error of the synchronization monitoring signal was relatively large.

Comment: As to the 4-valve common rail engine, engine can be started through both single crankshaft speed sensor and single phase sensor. However, if the TDC deviation determined between the two sensors is relatively large, namely synchronization was relatively poor, then engine cannot be ignited on the contrary when the two sensors are put together.



Failure Case

Engine Fails to Start.

- **Failure Description:** Feedback from Auman Heavy Truck was received that the 4-valve engine assembled and adjusted for it could not be started, but this engine was normal during delivery test.
- **Inspection:** This test engine was a new engine, and respective circuits and oil circuits were normally connected. The engine still could not be ignited after air was exhausted for a very long time.
- After the diagnostic instrument was connected for monitoring, it was found that there was no error report on failure, but the displayed rail pressure kept as zero. It was found after inspection of oil circuits one by one that some fuel had entered into the fuel pump high pressure portion, but no fuel entered into the oil rail from the oil outlet port. At the same time, the fuel volume measuring unit sensor on the oil pump for controlling fuel supply was normal. It was determined that the problem existed in the high pressure oil pump, and the engine was normally started after replacement.

It was found that the oil circuit of fuel pump was blocked by extraneous substance when the high pressure oil pump was returned to BOSCH GmbH.

- **Comment:** As to the 4-valve common rail engine, as the two orifices of the fuel pump and the fuel injector are smaller than other engines, it is moreover required to fully ensure the cleanness of the fuel and the oil circuit.



Failure Case

Engine Fails to Start.

- **Failure Description:** Feedback from Auman heavy Truck was received that the 4-valve engine assembled and adjusted could not start. When user was asked, it was found that this vehicle had been parked for period of time without being used. It could not be started when just begun to be used, and a large quantity of white smoke was discharged from the exhaust pipe at starting, after the starting fluid was injected.
- **Inspection:** ECU power supply voltage was examined, and the output voltages were all normal.
- After the diagnostic instrument was connected for monitoring, the rail pressure was displayed. The common rail high pressure oil pipe was opened, and the engine was started, it was found that the fuel flow was normal, the injection status was normal, free from the air inlet effect.
- The oil return status of the electronic control fuel injector was examined, and it was found that the oil return volume was relatively large.
- The failure of the electronic fuel injector was determined, the cylinders were successively disconnected from the high pressure oil pipes for cylinder deactivation test, and no obvious effect of comparative cylinder fuel shortage was found. Engine was normally started, after respective-cylinder fuel injectors were replaced, and the air was exhausted.
- **Comment:** As to the 4-valve common rail engine, its fuel requirement is very high, and at the same time it is required to periodically drain the water from the oil-water separator. This failure indicates that the fuel quality is not good, water is not drained on a long time, and the engine is not used for a long time, giving rise to rust corrosions, clamping stagnation, and damage of the electronic control fuel injector.



Electronic Control Engine Failure Case Analysis

Difficult to Start Engine:

Failure Effect: 25 Euro-V passenger vehicles were purchased by Shenyang Passenger Transport Group, engaged in company bus operation. At the initial service stage, the buses left collectively at 6:30 every morning, and one of them would always be confronted with the starting failure each morning, the manual oil pump must be pressed before it could be started, and the weakness was shown frequently during engine operation, while the rest 25 engines operated normally.

Inspection:

1. The fault light of this engine did not give warning, while diagnostic instrument was used to locate failure, it showed that the system was normal, and the possibility of failure with the electronic control system was eliminated. The rail pressure at starting could not reach the 160bar starting rail pressure.
2. The oil circuit was examined, and no air inlet effect was found, but it showed that the fuel flow rate was slightly inadequate.
3. After the inspection was made aiming at the low pressure fuel pipeline, and the fuel tank, no blocked position was found, and then the fuel filter was replaced.
4. Through operation for several days, the failure still existed. The failure was removed then after the high pressure fuel pump was replaced, and the failure part was returned to the company for evaluation.

Through evaluation of BOSCH GmbH, the high pressure fuel pump was blocked by alloy scrap, as the residue in the fuel fine filter.



Electronic Control Engine Failure Case Analysis

Difficult to Start Engine

- **Failure Description:** The intake heating indicator light was normally on, the key switch was placed at starting gear, it was difficult to start the engine, and accompanied with burst-out of a large quantity of white smoke.
- **Failure Cause Analysis:** The failure of intake temperature sensor or line fault caused the intake heating indicator light to be normally on and give warning.
- **Maintenance Method:** The diagnostic instrument was connected to detect the intake temperature, and the displayed temperature was -40°C , while the air temperature at that time was about 10°C . It was doubted that the trouble existed with the intake temperature sensor or the line, but it was found that the plug-in unit was not firmly inserted through inspection of the intake temperature sensor, the failure was removed after the plug-in unit was tightly inserted, and the engine was smoothly started.
- **Comment:** Inaccurate sensor signal will give rise to erroneous ECU control over the engine, giving rise to unsatisfactory work of engine.



Electronic Control Engine Failure Case Analysis

It was difficult to start the engine, the starting time was relatively long, and the engine shut down after operation for a short time after being started.

- **Failure Description:** No fault code was displayed, starting time was relatively long, and it was required to start for many times. The engine would automatically stop after operation for a period of time after being started.
- **Failure Cause Analysis:** The low pressure oil circuit air inlet or oil circuit was blocked, or the water temperature was high, and caused ECU to take the high temperature protection mode.
- **Maintenance Method:** The low pressure oil circuit was examined to be free from air inlet or oil circuit blockage, while the diagnostic instrument was connected to detect the water temperature, the displayed temperature was 105°C , but no warning was given for the water temperature. It was doubted that problem existed with the water temperature sensor or the line. The water temperature sensor wiring harness and the plug-in part were under good condition through inspection. When the sensor wiring harness was pulled off, the engine was smoothly started.
- **Comment:** Inaccurate sensor signal will give rise to erroneous ECU control over engine, resulted in unsatisfactory work of engine.



Electronic Engine Failure Case Analysis

Noise was heard after engine was started.

- **Failure Description:** Similar gun-firing sound was heard during acceleration after engine was started, and the maximum speed could only reach 1500rpm.
- **Inspection:** After the diagnostic instrument was connected for monitoring, it was found that the rail pressure fluctuated considerably, there was no warning at the initial starting stage, and the speed was limited at 1500rpm, when rail pressure warning was displayed in the operating process.
- It was determined to be the failure with the rail pressure sensor, and the rail pressure sensor could not be individually replaced, only able to be replaced together with the oil rail at the same time.
- The effect still existed, after the oil rail was replaced. The rail pressure became normal, and the gun-firing sound disappeared, after the corresponding connection wiring harness was replaced.
- **Comment:** The final wiring harness inspection has shown that the processing sizes for the plug-in unit terminals on the wiring harness and connected with the rail pressure sensor are incompliant with the requirements.



Electronic Control Engine Failure Case Analysis

Engine speed always stayed at 1100rpm.

- **Failure Description:** Feedback was received from Ollin Factory in Zhucheng City that there was no reaction to release or tension the throttle for the 4-valve engine, and speed always kept at 1100rpm, and at the same time the failure light for the complete vehicle was normally on.
- **Inspection:** Respective lines and oil circuits of the engine were normally connected through this test.

It was found error was reported for the throttle after the diagnostic instrument was connected for monitoring, while error was still reported when the related wiring harness was pulled off to be re-plugged and the throttle pedal was replaced. It was doubted that trouble might exist in the related circuit of the throttle signal output, but the wiring harness from the throttle to the ECU terminal was normal after inspection, indicating that the circuit was not open, but this signal was not correctly transmitted to ECU.
- It was found through inspection of the ECU pins that some pin was bended, and it was exactly the throttle pin through confirmation. The engine turned to be normal after the pin was aligned.
- **Comment:** When the wiring harness for the complete vehicle is plugged in with ECU, it shall be completely aligned before being pressed into the locking buckle, and otherwise, it is liable to cause pin to be bended or broken.



Electronic Control Engine Failure Case Analysis

Weak Engine Acceleration

- **Failure Description:** Feedback was received from the research institute that the acceleration of the 4-valve engine assembled and adjusted for the institute was weak, but it turned for the better at the initial started stage after shutdown for a period of time, while the acceleration was weak again after a while. The failure light for the complete vehicle did not turn on at the initial started stage, while it is normally on when acceleration was weak.
- **Inspection:** Respective lines and oil circuits of the engine were normally connected through this test.

It was found that the engine water temperature quickly rose to 100°C after being started before long, after the diagnostic instrument was connected for monitoring indicating that the water temperature of the complete vehicle was super high, and problem existed with water circuit. It was found through inspection that the water filling volume of the water tank was lesser.

- **Comment:** Oil limit protection is provided when water temperature exceeds 100°C, in order to protect the engine, and oil supply is even cut off when water temperature is too high.

