

Contents

Chapter I Technical Characteristics of Engine	11
Section I Technical Requirements for Fuel, Oils, and Auxiliary Materials	11
Section II Main Technical Specification of Engine	14
Section III Performance Curve of Engine	15
Section IV Main Checking and Adjustment Parameters	16
Section V Tightening Torque for Critical Bolts of Engine	17
Section VI Main Fitting Clearances and Allowable Wear Limits of Engine	21
Section VII Specification of Main Attachments and Accessories	24
Chapter II Maintenance for Main Structures of Engine	25
Section I Disassembly of Engine Assembly	25
Section II Assembly of Engine	43
Section III Crankshaft and Flywheel System	68
Section IV Piston and Connecting Rod Group	69
Section V Valve Distribution Mechanism	70
Section VI Lubrication System	71
Section VII Cooling System	72
Section VIII Turbocharger and Inter-Cooler System	73
Section IX EGR System	75
Section X Exhaust System	76
Chapter III Working Principle of Engine Control and Actuator Units	77
Section I Overview of Diesel Common Rail System	77
Section II Working Principle of Low Pressure Fuel Line System	79
Section III Working Theory of High Pressure Fuel Line	82
Section IV Electronic Control Unit of High Pressure Common Rail System	84
Chapter IV Engine Diagnosis	109
Section I. Precautions	109
Section II. Maintenance Procedures	111
Section III. Fault Diagnosis	113
Section IV. DTC List	115
Section V. Fault Diagnosis for Electronic-Controlled Common Rail Diesel Engines	133

Chapter I Technical Characteristics of Engine

Section I Technical Requirements for Fuel, Oils, and Auxiliary Materials

I. Diesel

HFC4DA1-2C diesel engine adopts electronically controlled, high pressure common rail, fuel injection system and conforms to Euro-IV emission regulation and thus extends higher requirements over the fuel. To guarantee the reliability of the fuel supply system, make sure to use the qualified clean diesel produced by national well-established fuel company, in order to prevent the blockage or early wear of fuel injector due to poor fuel.



Add the fuel only at the well-established gas station. The use of poor diesel or other diesel intended for other than vehicle engine application is strictly prohibited.

Make sure to use the fuel conforming to national standard GB 19147. The grade number of the diesel chosen is related to the temperature of working environment. When the environment temperature is reduced, the paraffins within the diesel will precipitate to block the fuel pipeline, leading to difficult fuel supply and start failure of the engine. Therefore, choose different grade number of diesel depending on the environment temperature in different seasons and regions, in accordance with the table shown below.

Environment temperature	Above 5°C	Above -5°C	Above -10°C	Above -25°C
Recommended grade number of diesel	0# light diesel	-10# light diesel	-20# light diesel	-35# light diesel

Notice!

The cam of the high pressure fuel pump is being lubricated by the fuel. Never cause engine flameout due to depletion of fuel in the fuel tank, or it will lead to serious wear of the high pressure fuel pump. After adding new fuel, make sure to firstly use manual fuel pump to bleed the air from the fuel pipe and high pressure fuel pump and thoroughly fill the fuel pipe and high pressure fuel pump with fuel before starting the engine, in order to prevent the wear of high pressure fuel pump due to fuel shortage.

Procedure for air bleeding and refueling:

1. Loosen the air bleeding screw;
2. Push down the manual fuel pump with hand and then release. Repeat above operation, till there is no air bleeding out from the air bleeding screw;
3. Tighten the air bleeding screw and pump the fuel with manual fuel pump, till the fuel injection pump is thoroughly filled with fuel.

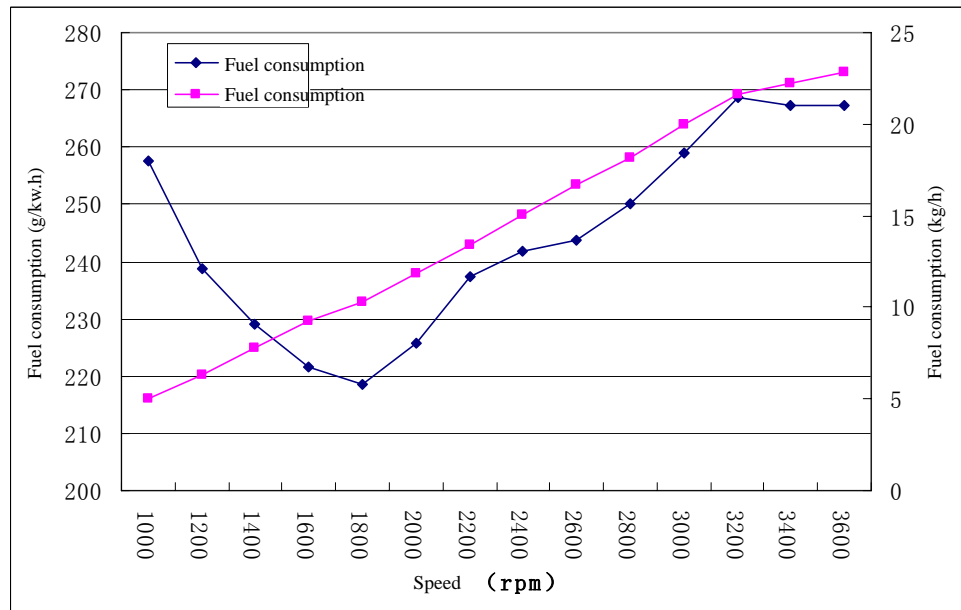
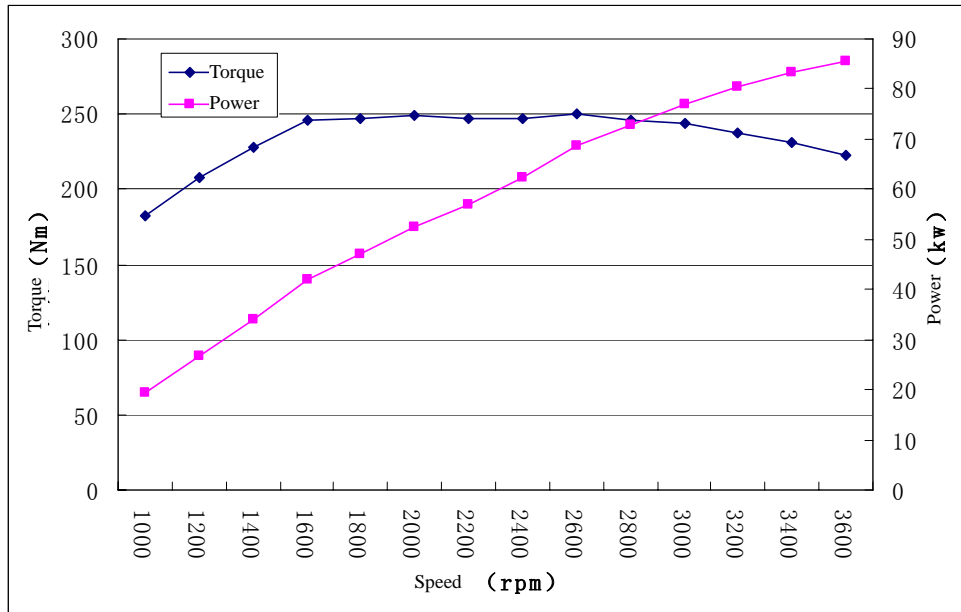
The diesel filter embodies the fuel-water separation function:

The water content in the diesel will bring about great harm to the fuel system. Upon the detection that the diesel filter water level warning lamp on the instrument panel lights up, it indicates the presence of waste water in the diesel filter. The waste water shall be drained timely, or it will lead to the rusting and wear of high pressure fuel pump, high pressure fuel rail, and fuel injector and bring about unnecessary losses.

Procedure for water drainage:






1. Unplug the water level sensor connector;
2. Loosen the water level sensor to drain the waste water, till the diesel flows out.

Section III Performance Curve of Engine






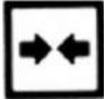



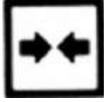

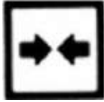

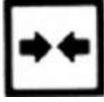

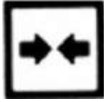
Section VI Main Fitting Clearances and Allowable Wear Limits of Engine

No.	Name	Standard Size (mm)	Fitting nature	Assembly Clearance for New Engine (mm)	Wear Limit (mm)
1	Contact width between valve and seat ring				
	Intake valve	1.7		2.2	
	Exhaust valve	2		2.5	
2	Valve sinkage				
	Intake valve	0.73		1.28	
	Exhaust valve	0.71		1.2	
3	Backlash	0.05-0.13		0.3	
4	Axial run-out clearance of idler gear A	0.07		0.2	
5	Outside diameter of tappet	$\Phi 13_{-0.028}^{-0.010}$	Clearance	0.01~0.046	0.10
	Tappet bore	$\Phi 13_0^{+0.018}$			
6	Radial run-out of push rod			0.3	
7	Deflection of rockshaft			0.3	
8	Outside diameter of rockshaft	$\Phi 19_{-0.02}^0$	Clearance	0.01~0.05	0.20
	Rocker arm bore	$\Phi 19_{+0.01}^{+0.03}$			
9	Rod diameter of intake valve	$\Phi 8_{-0.054}^{-0.039}$	Clearance	0.039~0.071	0.20
	Valve guide bore	$\Phi 8_0^{+0.017}$			
10	Rod diameter of exhaust valve	$\Phi 8_{-0.079}^{-0.064}$	Clearance	0.064~0.096	0.25
	Valve guide bore	$\Phi 8_0^{+0.017}$			
11	Free height of valve spring	48			
	Perpendicularity of valve spring	$\Phi 1.4$			
12	Outside diameter of idler gear A shaft	$\Phi 55_{-0.055}^{-0.025}$	Clearance	0.025~0.080	0.2
	Inside diameter of idler gear A bearing	$\Phi 55_0^{+0.03}$			
13	Cylinder sleeve bore	$\Phi 93_{+0.020}^{+0.065}$			

	 	<p>a. Loosen the conical nut at fuel injector end and the conical nut on fuel injection pump side (one is to reversely tighten the fuel inlet of fuel injector and one is to loosen the nut of high pressure fuel pipe); Loosen the conical nut on fuel injection pump side (Two wrenches are used mainly for disassembly, of which one is to reversely tighten the fuel outlet of fuel injection pump and one is to loosen the nut of high pressure fuel pipe, in order to prevent the fuel outlet of the fuel injection pump from follow-up rotation). Remove the high pressure fuel pipe and install the high pressure fuel pipe protective sleeve;</p> <p>b. Remove the fuel injector return hose.</p> <p>c. Remove the fixing bolts of fuel injector pressure plate, remove the fuel injector body along with its support, and install the fuel injector protective sleeve.</p>
<p>4. Disassemble the fuel-gas separator subassembly</p>		
		<p>a. Remove the crankshaft breathe hose and fuel-gas separator return hose.</p> <p>b. Disassemble the fixing bolts of fuel-gas separator.</p> <p>c. Remove the fuel-gas separator.</p>

II. Illustration for Assembly of Engine

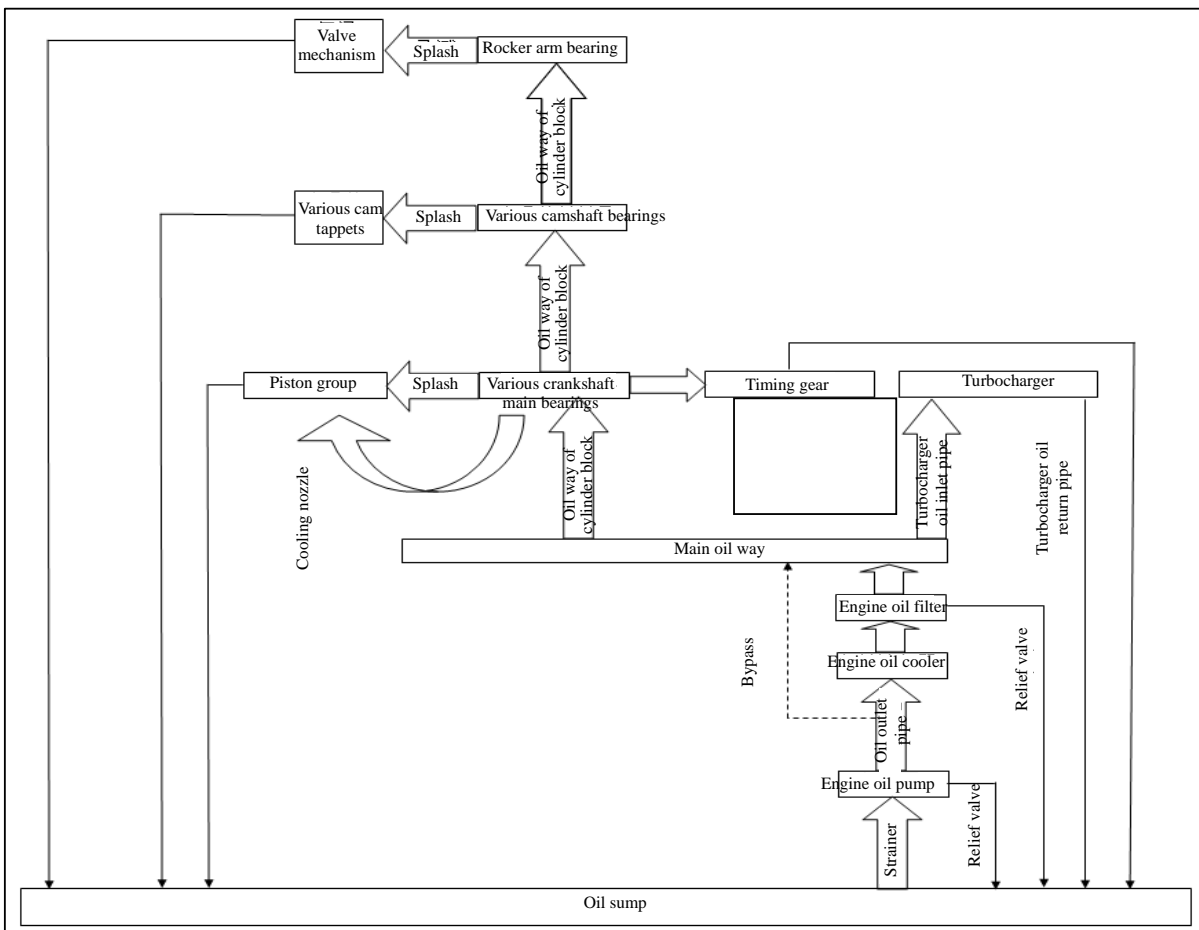
<p>1. Install the piston cooling fuel injector subassembly.</p>		
		<p>a. Install the piston cooling fuel injector subassembly: Install the piston cooling fuel injector subassembly onto the engine block;</p> <p>b. Tighten the hexagon socket screws to $12.5 \pm 2.5 \text{ N.m}$;</p>
<p>2. Install the crankshaft, thrust plates, and main bearing caps.</p>		
		<p>a. Install the upper and lower main bushes: Align the stop opening of upper main bush with the slip groove of the main bearing block bore of engine block and push 5 upper main bushes to place;</p> <p>Notice: While installing the main bushes, make sure to differentiate the upper and lower bushes, of which the upper bush has oil grooves and the lower bush has not. Do not install the bushes reversely.</p>
		<p>a. Apply an appropriate amount of clean engine oil onto the upper bearing bush;</p> <p>b. Lift up and place the crankshaft onto the engine block.</p>

		<p>r. Adjust the tension of alternator belt and tighten the alternator adjustment bolts and clutch fixing nuts.</p> <p>s. Tighten the alternator fixing nuts.</p>
		<p>t. Install the vacuum pump oil inlet pipe fixing bolts I (M8×20) and tighten the fixing bolts to $18\pm 2\text{N.m}$ and $25\pm 5\text{N.m}$ respectively.</p>
		<p>u. Install the exhaust pipe heat shield and install and tighten the fixing bolts.</p>
		<p>v. Install the power steering pump and tighten the fixing bolts of power steering pump.</p>

Section VI Lubrication System

While the engine is working, all motion parts apply one specific force onto another part and generate relatively high speed motion. With the relative motion, the friction is necessarily generated on the part surfaces, which will accelerate the wear. Therefore, to relieve the wear, reduce the friction resistance, and prolong the service life, the engine must be fitted with lubrication system.

- The engine oil filter is functioned to filter out the metallic wear dust, mechanical impurity, and engine oil oxide from the engine oil. The ingress of these impurities into the lubrication system along with the engine oil will speed up the wear of engine parts and may block the oil pipe or oil passage.
- The engine oil pump is of externally engaged gear pump and is driven by the crankshaft.
- The cooling nozzle of piston is arranged on the main oil passage to realize the stable oil spray for cooling. The spray of engine oil into the cold oil passage within the piston can effectively reduce the thermal load of the piston.

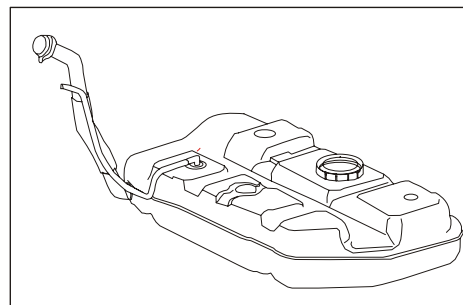


Section II Working Principle of Low Pressure Fuel Line System

I. Composition of low pressure fuel line:

The low pressure fuel line is functioned to supply sufficient fuel to the high pressure fuel line and is composed of:

- Fuel tank (including filter screen)
- Fuel filter (including manual fuel delivery pump)
- Low pressure fuel delivery pump
- Other low pressure fuel hoses



II. Fuel tank

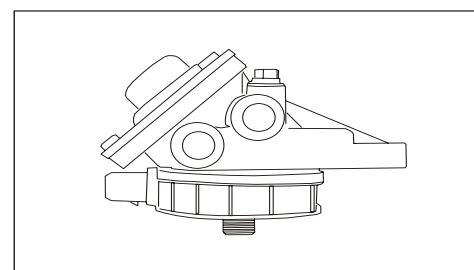
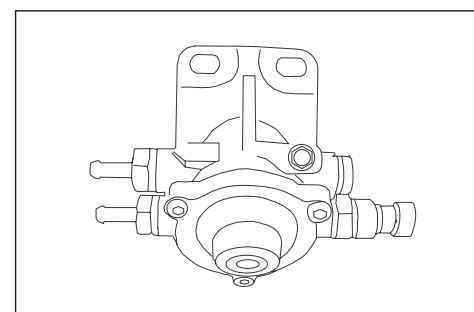
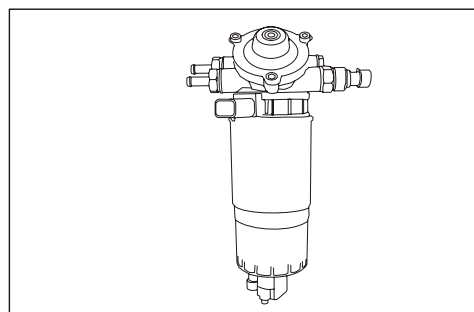
The fuel tank shall be fabricated from anti-corrosion material and shall maintain 0.3bar pressure under all working conditions and be free of fuel leakage under the application of the doubled working pressure. The fuel tank shall also set up appropriate opening or safety valve or adopt appropriate measures to relieve the excessive pressure whenever it's needed. When the motor vehicle is subject to slight vibration, makes turns or travels or parks on a slope, the fuel in the fuel tank shall not leak from the fuel tank cap or the pressure balancing device.

III. Fuel filter (including manual fuel delivery pump)

Sunray long-wheelbase model adopts two-stage diesel filter, including one primary filter and one fine filter. Compared with traditional diesel engines, it requires cleaner fuel supply. The impurities contained in the fuel will damage the fuel system including the high pressure pump, high pressure common rail, and fuel injector. The fuel filter purifies the fuel inputting into the high pressure fuel pump, in order to help the normal functioning of the high pressure pump. The contaminant, impurity, and particle in the fuel will lead to the damage of pump units, fuel supply valve, and fuel injector. Therefore, the use of fuel filter capable of meeting the fuel injector requirements becomes the premise for normal working of the engine and guarantee of service life. The water content in the diesel may exist in non-free radical form (emulsified fuel) or radical form (such as water condensate generated due to variation of temperature). If entering into the fuel injection system, this water content will lead to damage of parts due to corrosion. Similar to other fuel injection systems, common rail system requires the fuel filter with water collection chamber as well as the automatic water content alarm. When the alarm lamp lights up, make sure to drain the water from the water collection chamber.

The fuel filter is composed of fuel temperature sensor, fuel heater, manual fuel pump, fuel-water separator, and water level sensor.

The fuel leakage during traveling or the air ingress into fuel pipeline after replacement of fuel filter may lead to start failure or poor functioning of the engine. Therefore, make sure to bleed the air from the low pressure fuel pipeline after the installation of manual fuel delivery pump. Installed on the fuel filter, the manual fuel delivery pump is the device for supplying fuel to the fuel filter and the device required to guarantee the first start of the engine. In event of the following conditions, press the manual fuel delivery pump, till the manual fuel delivery pump can't be further pressed, before starting the



Section IV Electronic Control Unit of High Pressure Common Rail System

The EDC17 system of HFC4DA1-2C engine belongs to electronically controlled diesel injection system and incorporates the dynamic fuel injection timing system and air and fuel management system. It adopts the BOSCH diesel high pressure common rail system, with the rail pressure up to 1,600bar, and applies new technologies including VNT, electronically controlled EGR, and POC pressure difference control to meet the Euro-IV emission standard, with potential compliance for Euro-V emission standard.

The characteristics of this system is one single ECU, one set of fuel injection control system, and one set of sensor system. It's functioned to inject the fuel into the engine cylinder, with accurate injection timing and fuel amount, so that the fuel is mixed with air in the cylinder to achieve best combustion efficiency.

The electronic control unit of the diesel common rail system is mainly composed of three parts: sensor, ECU, and actuator.

- ① Sensor part: The sensors and rated value transmitters collecting the running state and rated values of the engine and complete vehicle, which convert various types of physical parameters into electric signals.
- ② ECU: It's functioned to process the information as per definite mathematic calculation method and issue the electric signals of the directives.
- ③ Actuator: It's functioned to convert the electric signals of the directives issued by the ECU into mechanical parameters.

I. Sensor part

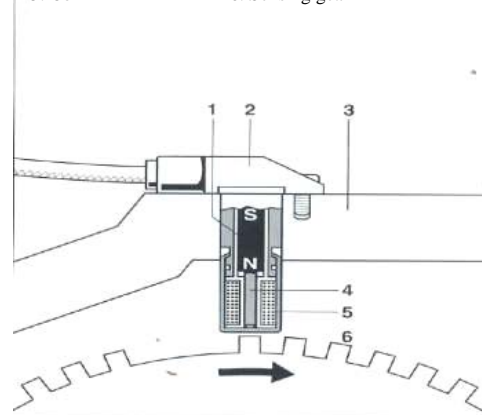
1. Crankshaft position sensor

1) Overview

- The crankshaft position sensor is one electromagnetic sensor.
- The position of piston in the combustion chamber determines the start moment of fuel injection. As the engine piston is connected with crankshaft through connecting rod, the crankshaft position sensor can provide all data information for the piston position and the engine speed determines the revolution per minute of the crankshaft.
- Generation of signal: The crankshaft is connected with one 60-tooth ferromagnetic actuation gear. The actuation gear actually in use has two teeth missing. This large gap corresponds to one specified crankshaft position of 1st cylinder. The crankshaft position sensor records the tooth sequence of the actuation gear. It's composed of one permanent magnet and soft iron core with copper coil. The magnetic flux in the sensor varies along with the gear and gap passing through and generates one sine AC voltage, of which the amplitude rapidly increases following the speed of the engine (crankshaft). It can achieve sufficient amplitude even when the speed is at 50r/min.
- The crankshaft position sensor is situated on the rear clutch housing of the engine;
- Wiring terminals: 1. Signal terminal of crankshaft position sensor; 2. Grounding terminal of crankshaft position sensor;



Crankshaft speed sensor
1. Permanent magnet 2. Sensor housing
3. Engine outer cap 4. Soft iron core
5. Coil 6. Sensing gear



5. Rail pressure sensor

1) Overview

The resistance of the metal film installed on the diaphragm will change accordingly following the change of shape. This change of shape generated by the established system pressure (approximate 1mm under 1,500bar pressure) will change the resistance and lead to the change of voltage between two sides of 5V bridge composed of resistor units. This voltage change range is 0~70mv (depending on the applied pressure) and is amplified to 0.5~4.5V by the evaluation circuit.

The accurate measurement of rail pressure is of great importance to the effective working of the system. This is one of the causes for very strict tolerance over the rail pressure sensor during the pressure measurement. Under the scope of main working conditions, the measurement accuracy is approximately $\pm 2\%$ of the full scale reading.

Wiring terminals: 1. Grounding; 2. Rail pressure sensor signal; 3. +5V power supply.

2) Working Principle

It transmits one voltage signal to the ECU, depending on the fuel pressure. The rail pressure sensor must measure the instant pressure in the fuel rail and embody sufficient accuracy and rapid response capability. The rail pressure sensor is composed of following parts:

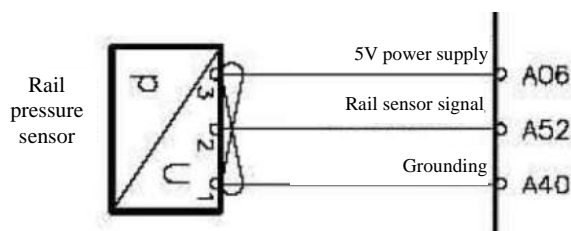
① Integrated sensing unit welded onto the pressure device

② Printed circuit board (PCB) with electric evaluation circuit

sensor housing with electric connector. The fuel flows into the rail pressure sensor via one hole on the common rail and the end of this hole is sealed by one sensor diaphragm. The fuel under high pressure reaches the sensor diaphragm via one blind hole. One sensing unit (semiconductor unit) is arranged on this diaphragm and converts the pressure into electric signal. This signal generated is transmitted via wire to evaluation circuit, which will amplify this signal and transmit to the ECU.

3) Test analysis

Wiring terminals: 1 - Grounding; 2 - Rail pressure sensor signal; 3 - +5V power supply.



4) Malfunction Mode

The malfunction indicator lamp lights up if the voltage is higher or less than this limit. If the voltage is out of the normal working voltage range, but is not out of the limit, the malfunction indicator lamp will not light up.

5) Troubleshooting

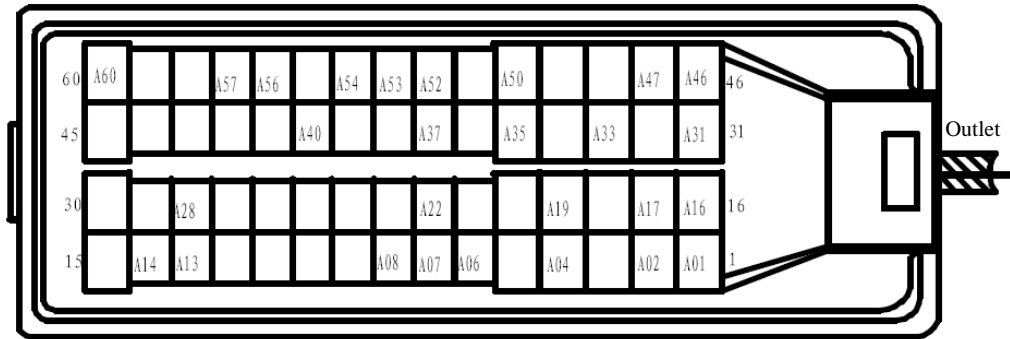
The light-up of the engine malfunction indicator lamp indicates the presence of malfunction in the engine system and it's necessary to diagnose with diagnosis instrument. Use JAC special diagnosis instrument to communicate with ECU of electronic injection system and read out the malfunction data in the ECU.

6. Engine coolant temperature sensor

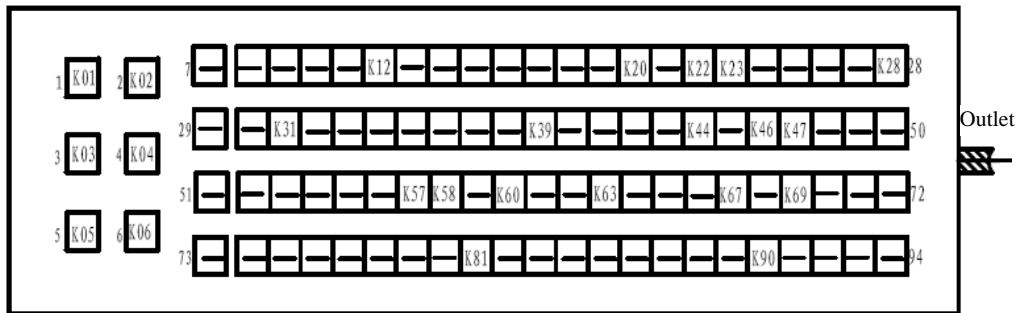
1) Overview

- The sensor is installed on the cylinder head, closing to the water outlet. The body is made of brass to protect the resistor unit fabricated from negative temperature coefficient (NTC) resistor;

3) Measurement analysis



Interface A



Interface K



Definition for ECU pins of EDC17 control system:

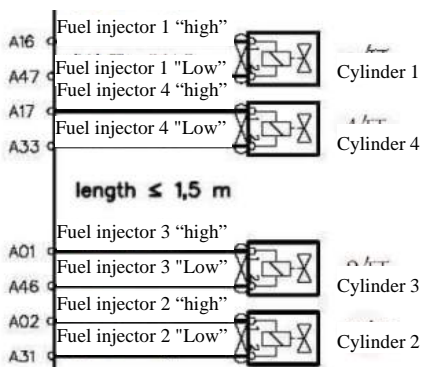
Terminal No.	Description	Terminal No.	Description
Interface A			
A01	High fuel injector of 3 rd cylinder	A31	Low fuel injector of 2 nd cylinder
A02	High fuel injector of 2 nd cylinder	A32	
A03		A33	Low fuel injector of 4 th cylinder
A04	Power supply of EGR actuator	A34	
A05		A35	Earthing of camshaft position sensor
A06	5V power supply of rail pressure sensor	A36	
A07	5V power supply of absolute pressure sensor	A37	High coolant temperature signal

closes the fuel drainage hole. The armature is of two-part design. Though the armature block is guided by the pressure shoulder during the downward movement, it can bounce back following the return spring and thus will not apply downward force onto the armature and the ball valve.

The close of fuel drainage hole enables the entry of fuel via fuel inlet hole into the control chamber for pressure establishment. This pressure is equivalent to the rail pressure and applies additional force onto the end face of the control plunger. The resultant force from this force and spring force overcomes the pressure in the injector nozzle chamber to close the injector nozzle needle valve.

The close speed of the injector nozzle needle valve depends on the flow passing through the fuel inlet hole. Once the injector nozzle needle valve hits its lower seat again, the fuel injection stops.

3) Measurement analysis

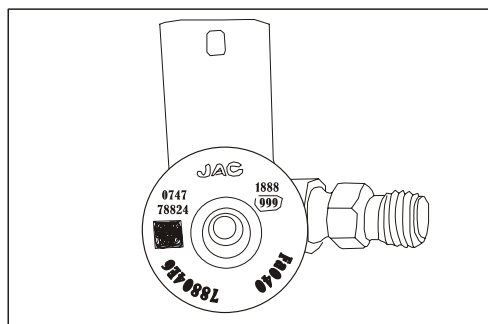


4) Matching of fuel injector

The matching of fuel injector must be performed in event of any of the following conditions:

- Replacement of fuel injector.
- Replacement of ECU
- Confusion of installation serial number before and after the maintenance.

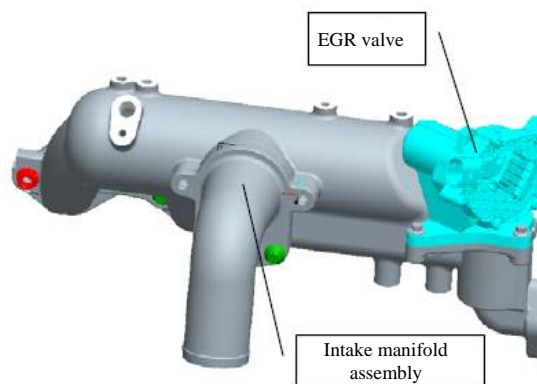
While performing the matching, input the matching code on the fuel injector (as shown in the figure) in order into the diagnosis instrument for matching.



2. EGR valve control system

1) Overview

- The electronically controlled EGR valve controls the open extent of the valve by means of the positive and reverse rotation of the DC motor and performs the close-loop control as per the feedback signal of the position sensor.
- To guarantee the NOx emission of the engine, the ECU measures and calculates the EGR percentage as per the input parameters of the engine (such as speed and intake pressure) and the calibrated MAPs), issues control signal to the EGR valve, and performs the close-loop control via the position sensor.
- The EGR valve is installed on the intake manifold. The constant temperature of the EGR valve inlet emission



Chapter IV Engine Diagnosis

Section I. Precautions

1. Removal/Installation Requirements for Electronic Control Unit (ECU):

- Remove the controller before welding or baking finish;
- When removing the controller, turn off the ignition switch and disconnect the battery from the system at the same time, in order to avoid damaging the ECU.
- It is not allowed to remove power cord from the battery when the engine or the electrical system is working.
- Large-current equipment such as charger is not allowed to be directly connected to the starting motor.
- Note: The ambient temperature of ECU should not be greater than 75 degree.

2. Cleaning Requirements:

Please observe the following rules before the operation of fuel supply system and fuel injection system:

- The removed components should be placed at clean field and properly covered by the cloth other than fiber type (cotton cloth or gauze cloth)

3. All types of harness connectors and the connector for diagnostic instrument should be connected and disconnected only when the ignition switch is turned off:

- When measuring the power voltage or ground wire of the ECU, please ensure the wiring sequence and method is correct.
- Disconnecting the power cord or the ground wire of the battery from the system or removing ECU harness connector will result in the loss of diagnosis and self-learning information stored in ECU. (If the vehicle model is different, the time of retaining Pleas of the ECU is also different after the loss of power.)

4. Please pay attention to the following points when maintaining the fuel supply system (fuel supply pipe, fuel pump and fuel injection system):

- Please be very careful during installation/removal of fuel pump on the fuel tank with fuel.
- Prepare proper materials around the fuel tank opening to absorb a lot of fuel leaked from it timely..
- Avoid the fuel contacting your body.
- Thoroughly clean the part and its surrounding before loosening a connector.
- Please prevent any fuel from splashing from the loose part and place a rug around the connector.
- If the disassembled parts could not be timely repaired or properly treated, store the parts properly.
- Take the spare parts out of the package only when they are needed to be installed. Do not use unpacked spare parts and the spare parts in severe damaged package
- Do not damage the O-ring of return pipe when assembling fuel injector return pipe. Coat a little diesel oil on the O-ring for assembling convenience.
- Do not use the compressed air and do not move the vehicle after the fuel supply system is disassembled.

5. Safety Measures

To prevent the maintenance technicians from being injured and the fuel and ECU being damaged, please pay attention

Section IV. DTC List

S/N	DTC	Meaning
1	P0030	The linear oxygen sensor heater circuit is open.
2	P0031	The linear oxygen sensor heater circuit is short to ground.
3	P0032	The linear oxygen sensor heater circuit is short to battery.
4	P0045	EGR valve circuit is open.
5	P0046	Overtemperature of EGR valve bridge-H chip
6	P0047	EGR valve circuit is short to ground.
7	P0048	EGR valve circuit is short to power supply.
8	P0068	Short-term drifting error in the process of throttle offset self-adaption
9	P0069	The absolute difference between intercooler downstream air pressure and ambient pressure is unreliable.
10	P0070	Reliability check function for ambient temperature
11	P0072	Too low ambient temperature
12	P0073	Too high ambient temperature
13	P0087	The minimum rail pressure is below the lower limit.
14	P0088	The maximum rail pressure is above the upper limit.
15	P0097	The signal level of intercooler downstream temperature is too low.
16	P0098	The signal level of intercooler downstream temperature is too high.
17	P00BE	The original value of fuel rail pressure is incoherent.
18	P0100	The supply voltage of air flow sensor exceeds the limit.
19	P0101	Timeout error of air flow sensor hardware signal
20	P0102	The sensitivity deviation of air flow sensor is below the lower limit.
21	P0103	The sensitivity deviation of air flow sensor is above the upper limit.
22	P010C	The signal level measured by air flow sensor is too low.
23	P010D	The signal level measured by air flow sensor is too high.
24	P0112	The voltage is below the lower limit of intake air temperature sensor.
25	P0113	The voltage is above the upper limit of intake air temperature sensor.
26	P0116	Error reported in dynamic reliability test of coolant temperature sensor
27	P0117	Coolant temperature signal level is too low (downstream).
28	P0118	Coolant temperature signal level is too high (downstream).
29	P0119	Error reported in static reliability test of coolant temperature sensor
30	P0122	The signal level of accelerator pedal position sensor 1 is relatively low.
31	P0123	The signal level of accelerator pedal position sensor 1 is relatively high.
32	P0127	The signal level of air temperature sensor is relatively high.