DI ENGINE

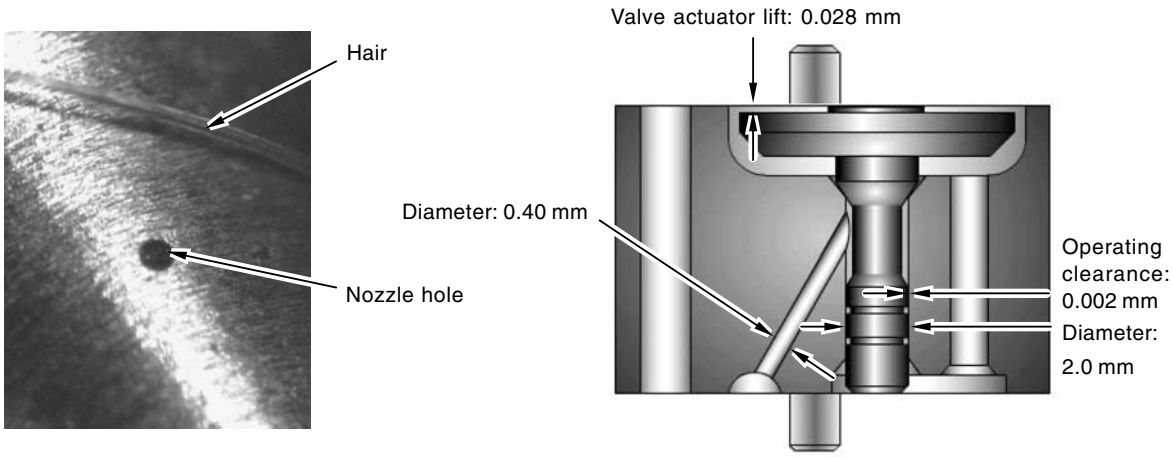
CONTENTS

CLEANNESS

Cleanness of DI Engine Fuel System and Service Procedures

The fuel system for DI engine consists of transfer (low pressure) line and high pressure line. Its highest pressure reaches over 1600 bar. Some components in injector and HP pump are machined at the micrometer 100 μm of preciseness. The pressure regulation and injector operation are done by electric source from engine ECU. Accordingly, if the internal valve is stucked due to foreign materials, injector remains open. Even in this case, the HP pump still operates to supply high pressurized fuel. This increases the pressure to combustion chamber (over 250 bar) and may cause fatal damage to engine.

You can compare the thickness of injector nozzle hole and hair as shown in below figure (left side). The right side figure shows the clearance between internal operating elements.



The core elements of fuel system has very high preciseness that is easily affected by dust or very small foreign material. Therefore, make sure to keep the preliminary works and job procedures in next pages. If not, lots of system problems and claims may arise.

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DI Engine and Its Expected Problems and Remedies Can be Caused by Water in Fuel

SYSTEM SUPPLEMENT AGAINST PARAFFIN SEPARATION.

In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements by region and season. However, above phenomenon can be happened if stations have poor facilities or sell improper fuel for the season.
In case of DI engine, purity of fuel is very important factor to keep internal preciseness of HP pump and injector. Accordingly, more dense mesh than conventional fuel filter is used. To prevent fuel filter internal clogging due to paraffin separation, SYMC is using fuel line that high pressure and temperature fuel injected by injector returns through fuel filter to have an effect of built-in heater (see fuel system).

SYSTEM SUPPLEMENT AND REMEDY AGAINST WATER IN FUEL

As mentioned above, some gas stations supply fuel with excessive than specified water. In the conventional IDI engine, excessive water in the fuel only causes dropping engine power or engine hunting. However, fuel system in the DI engine consists of precise components so water in the fuel can cause malfunctions of HP pump due to poor lubrication of pump caused by poor coating film during high speed pumping and bacterization (under long period parking). To prevent problems can be caused by excessive water in fuel, water separator is installed inside of fuel filter. When fuel is passing filter, water that has relatively bigger specific gravity is accumulated on the bottom of the filter.

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If water in the separator on the fuel filter exceeds a certain level, it will be supplied to HP pump with fuel, so the engine ECU turns on warning light ( ) on the meter cluster and buzzer if water level is higher than a certain level.

Due to engine layout, a customer cannot easily drain water from fuel filter directly, so if a customer checks in to change engine oil, be sure to perform water drain from fuel filter. (See fuel system for details.)

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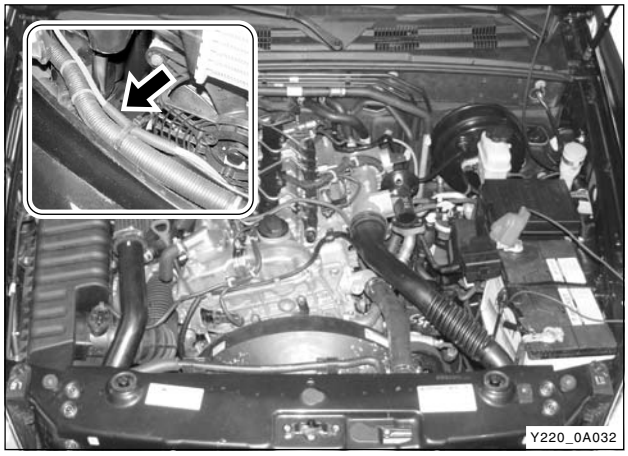
During Service Work for Electric Devices

Notice

Be careful not to modify or alter electrical system and electrical device. Or there can be vehicle fire or serious damage.

1. Be sure to disconnect battery negative (-) terminal during every service work. Before disconnecting battery negative (-) terminal, turn off ignition key.
2. Replace with specified capacity of fuse if there is bad, blown or short circuited fuse. If use electrical wire or steel wire other than fuse, there can be damages on the various electrical systems. If replaced with over-capacity fuse, there can be damages on the related electrical device and fire.
3. Every wire on the vehicle should be fastened securely not to be loosened with fixing clip.
4. If wires go through edges, protect them with tape or other materials not to be damaged.



5. Carefully install the wires not to be damaged during installation/removal of parts due to interference.
6. Be careful not to throw or drop each sensor or relay.
7. Securely connect each connector until hear a “click” sound.

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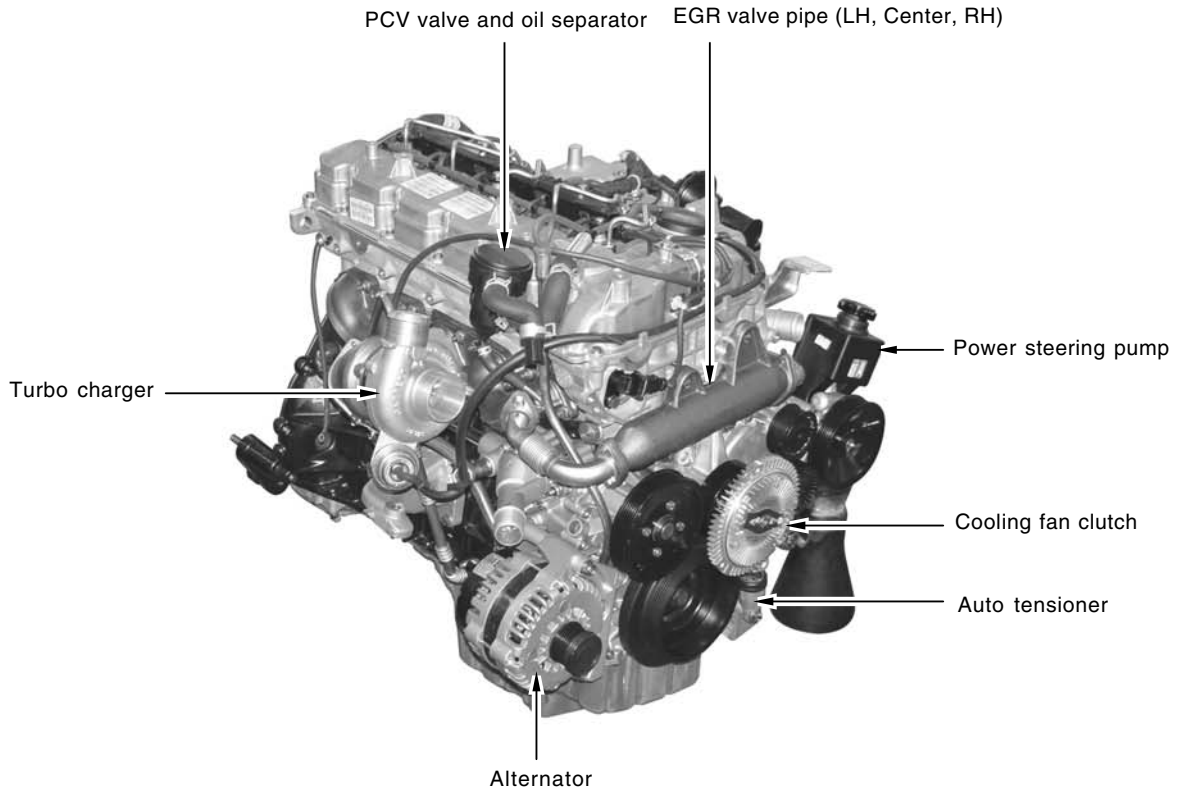
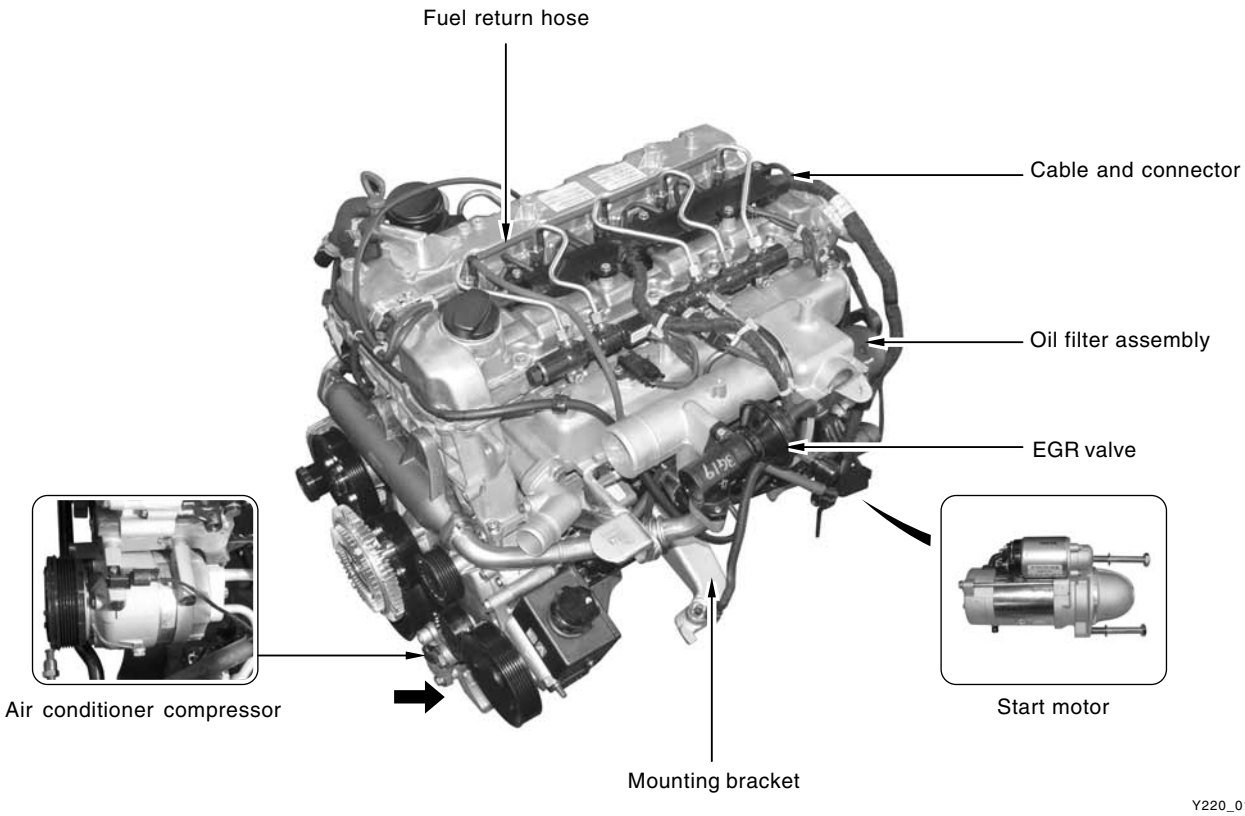
Accessories - Removal and Installation





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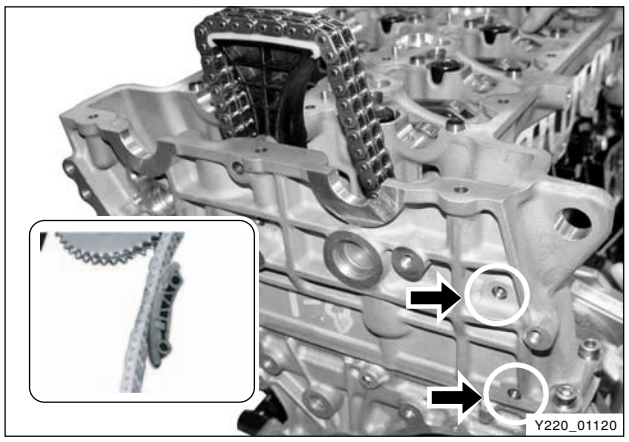
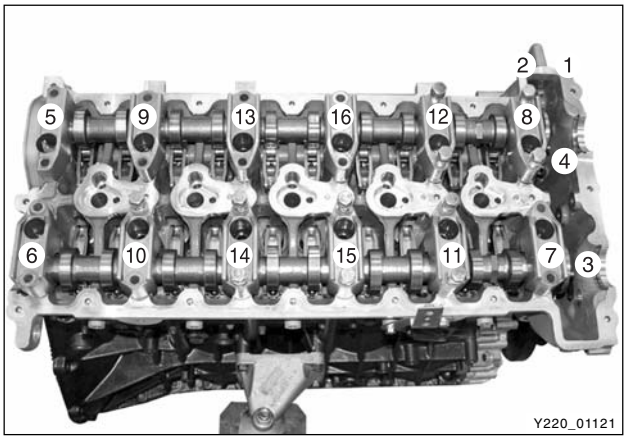


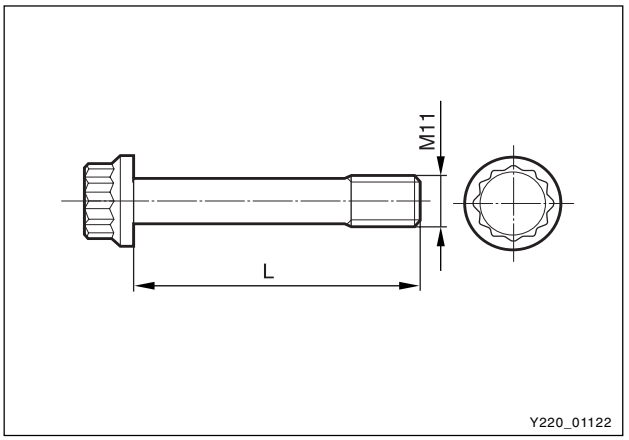
28. Pull out the pin and remove the timing chain guide from the engine.



29. Remove the cylinder head bolts according to the numerical sequence.

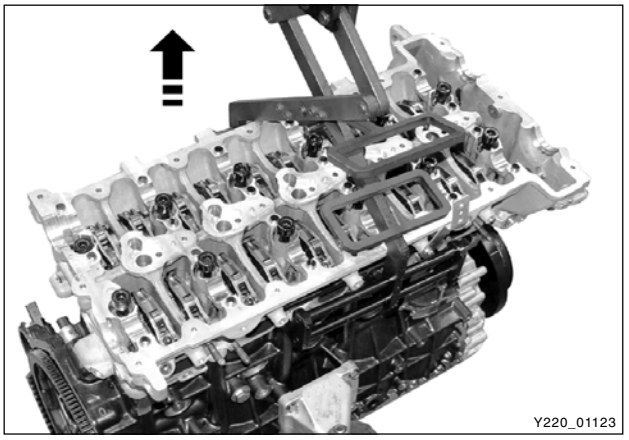
Installation Notice

Tightening torque	Nm
M8 x 25: 2 EA	25 ± 2.5
M8 x 50: 2 EA	25 ± 2.5
M12 x 177: 11 EA	85 ± 5 Nm, 3 x 90° + 10°
M12 x 158: 1 EA (Vacuum pump side)	



30. Measure the length of cylinder head bolts.
    - If the maximum length is exceeded by 2 mm, replace the cylinder head bolt.

Length when new	Maximum Limit
177 mm	179 mm
158 mm	160 mm



31. Remove the cylinder head.

Notice

- ***Inspect the cylinder head surface.***
- ***Store the removed injectors and glow plugs so that they will not be damaged.***

▶ Dimensions of Crankshaft Main Bearing

(mm)

Color	Crankshaft Journal	Upper Main Bearing	Lower Main Bearing
Blue	57.965 ~ 57.960	2.260 ~ 2.255	2.260 ~ 2.255
Yellow	57.960 ~ 57.955	2.265 ~ 2.260	2.265 ~ 2.260
Red	57.955 ~ 57.950	2.270 ~ 2.265	2.270 ~ 2.265
White	57.950 ~ 57.945	-	2.275 ~ 2.270
Violet	57.945 ~ 57.940	-	2.280 ~ 2.275

▶ Bearing Clearance

(mm)

Description		Crankshaft Bearing	Thrust Bearing
Radial clearance	When new	0.027 ~ 0.051	0.026 ~ 0.068
	Wear limit	Max. 0.070	Max. 0.080
Axial clearance	When new	0.100 ~ 0.254	-
	Wear limit	Max. 0.300	-

▶ Matching the Fit Bearing Journal Width to Thrust Washers

(mm)

Fit bearing Journal Width	Thrust Washer Thickness
24.500 ~ 24.533	2.15
24.600 ~ 24.633	2.20
24.70 ~ 24.733	2.25
24.900 ~ 24.933	2.35
25.000 ~ 25.033	2.40

Notice

- ***Measure the crankshaft axial clearance and correct if necessary with appropriate thrust washers.***
- ***Thrust washers of the same thickness must be installed on both sides of the fit bearing.***

▶ Matching the Crankshaft Bearing Shells to Basic Bearing Bore in Crankcase

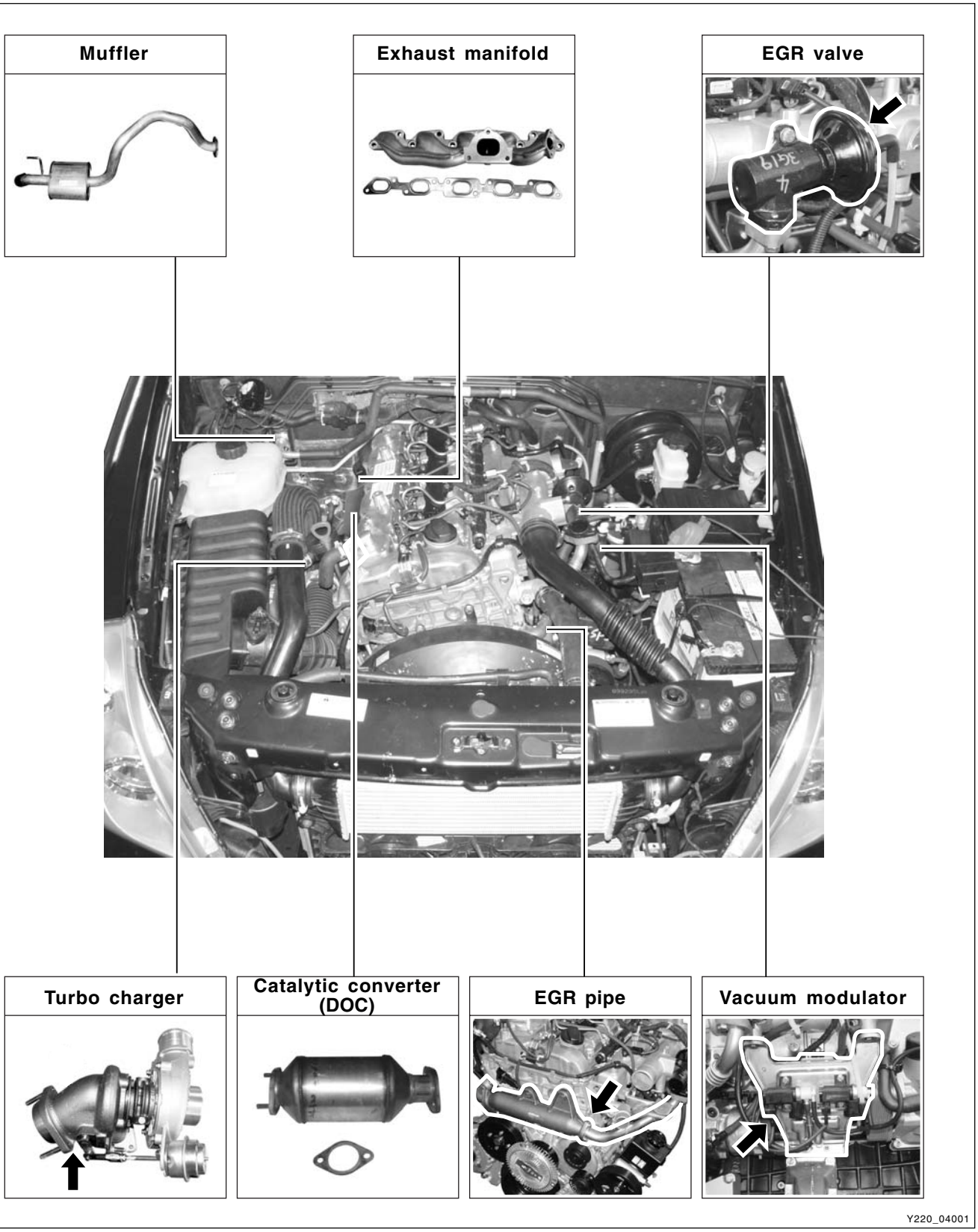
Marking of Basic Bearing Bore in Lower Parting Surface	Relevant Crankshaft Bearing Shell With Color Coding
1 punch mark or blue	blue or white - blue
2 punch marks or yellow	yellow or white - yellow
3 punch marks or red	red or white - red

▶ Matching Crankshaft Bearing Shells to Basic Bearing Journal of Crankshaft

Marking of Bearing journals on Crank Webs	Relevant Crankshaft Bearing Shell With Color Coding
blue or white - blue	blue or white - blue
yellow or white - blue	yellow or white - yellow
red or white - blue	red or white - red

EXHAUST SYSTEM LAYOUT

COMPONENTS LOCATOR



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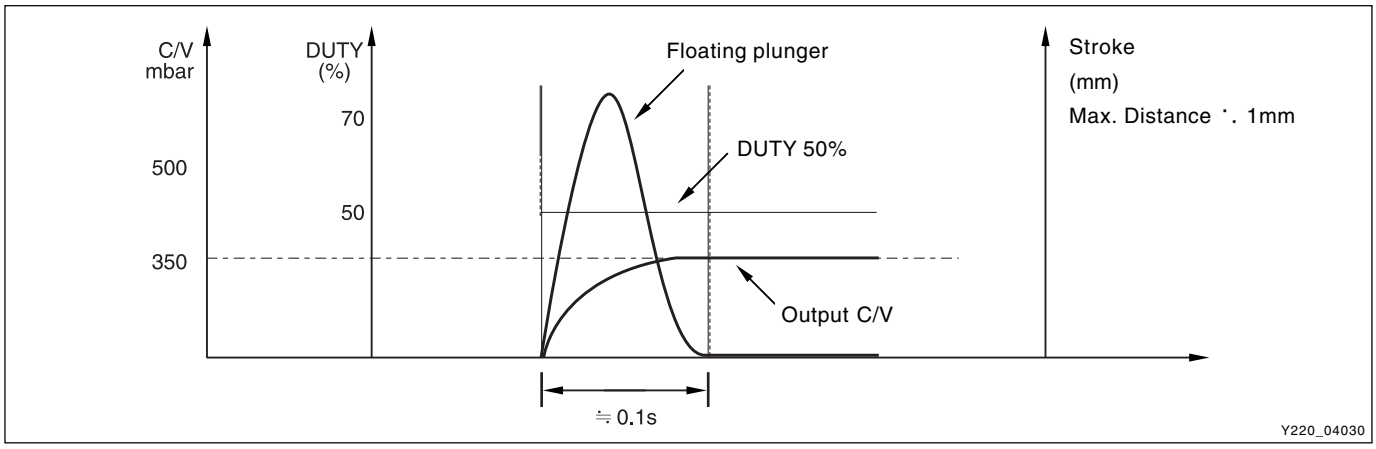
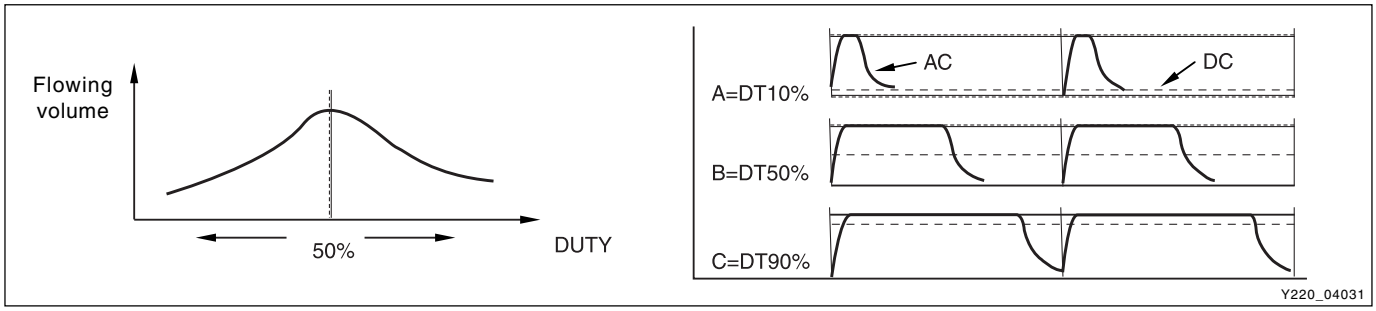
Operating principle: Balance between original vacuum pressure and magnetic force (see above figure)

- Normal state (Fig. A): Original vacuum and seat section, 3 stoppers keep sealing
- Duty up state (Fig. B): Original vacuum pressure is connected to inside of diaphragm chamber
- Duty down state (Fig. C): Increased diaphragm chamber pressure is connected to atmosphere to compensate the pressure.

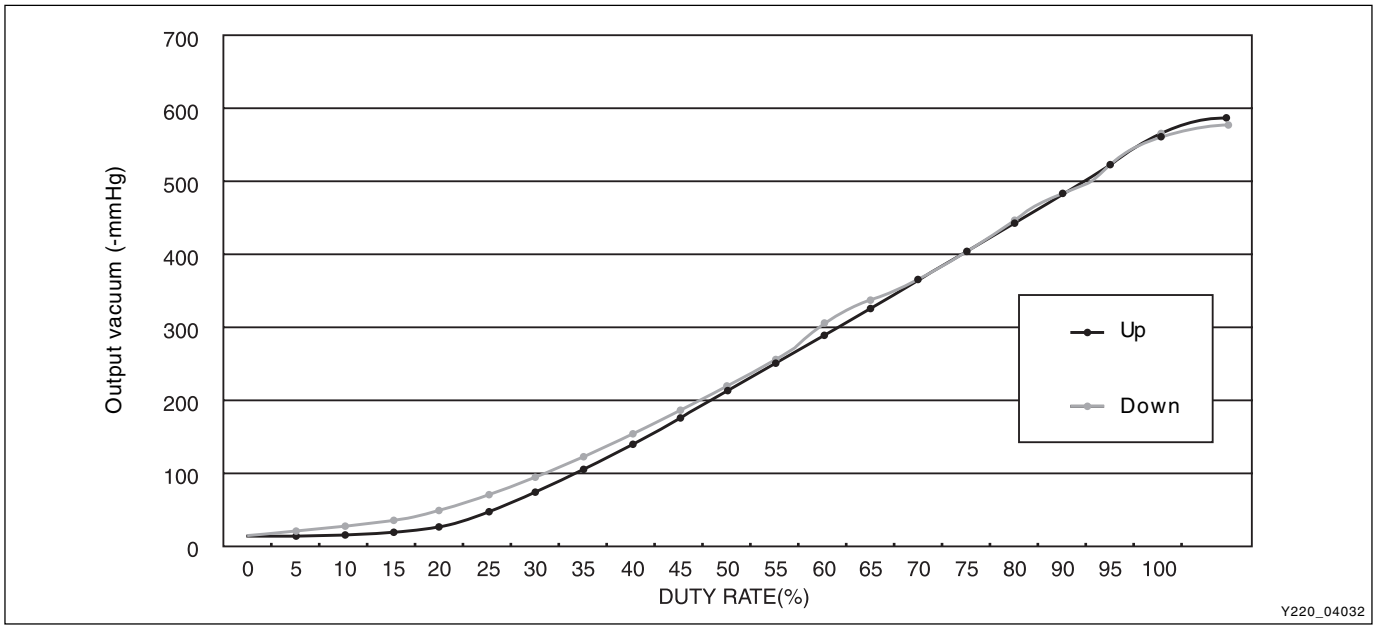


› Operating principles when duty is applied from 0 to 50 %

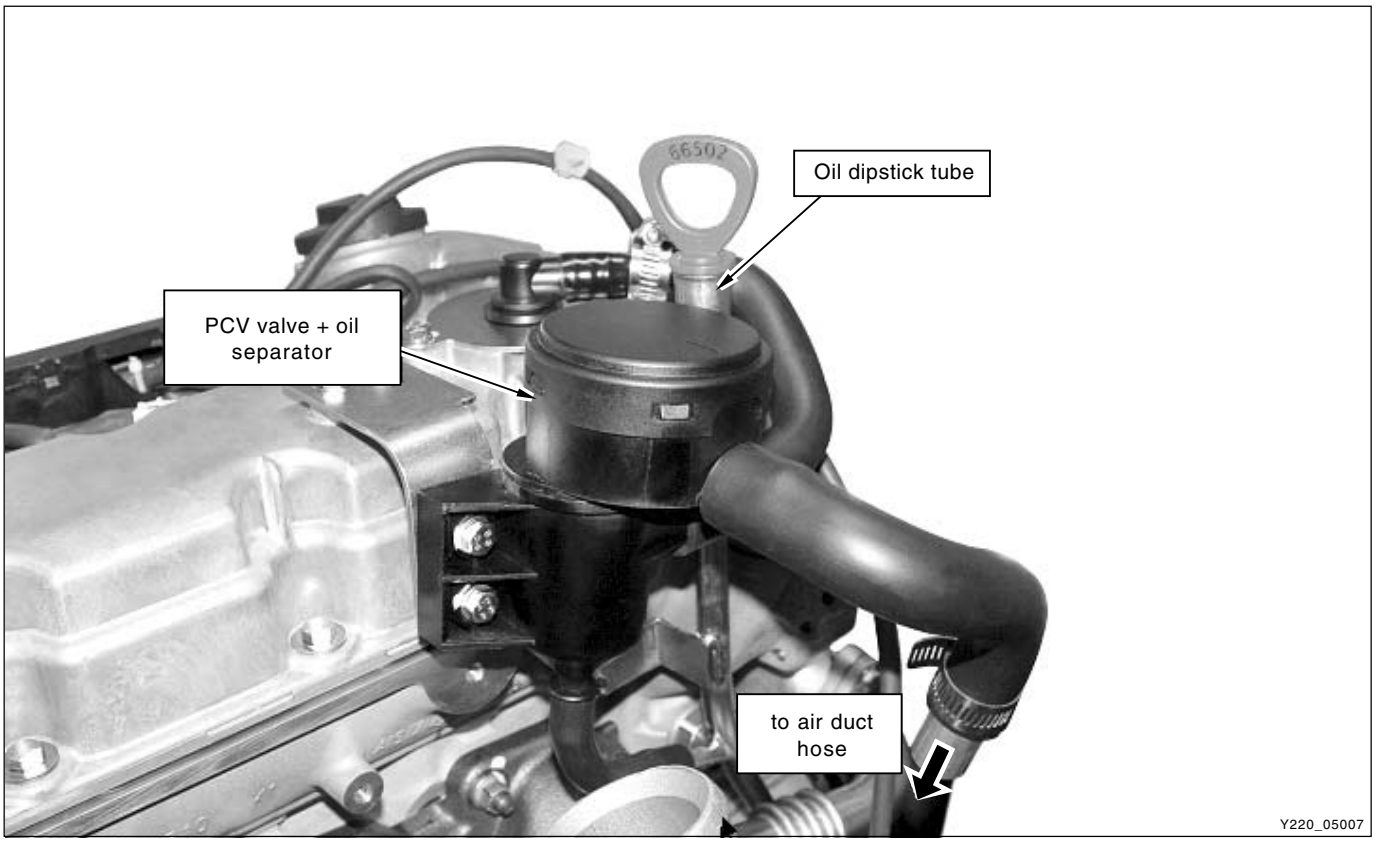
Vacuum consumption: Compared to 50 % of duty, ON/OFF periods are most unstable and vacuum consumption is most high.



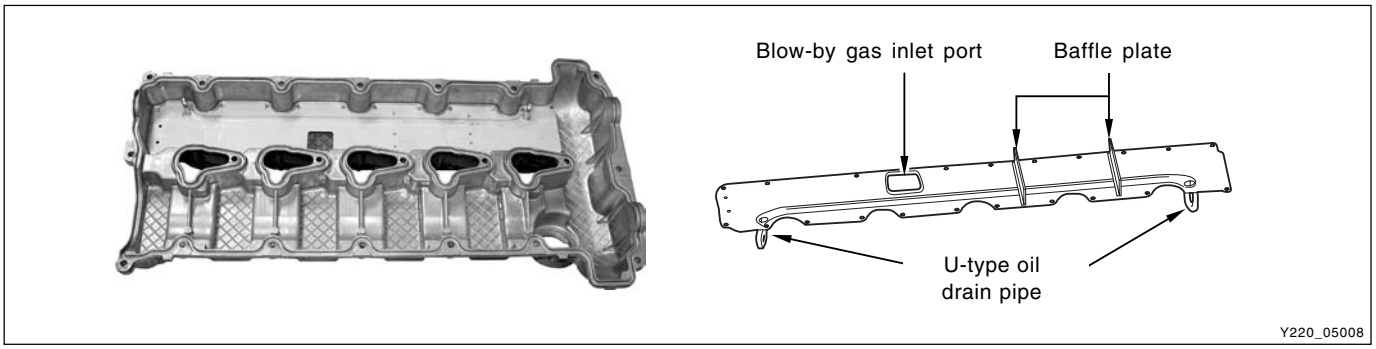
Output Characteristics



▶ Blow-by Gas Reduction Device



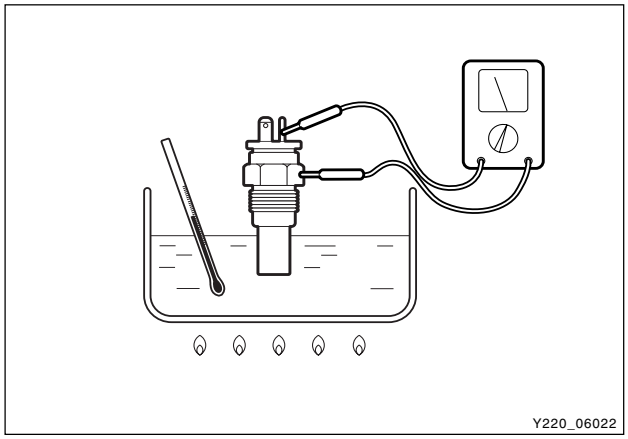
▶ Cylinder Head Cover



Baffle plate assembly: The baffle plates in cylinder head cover separates oil and gas from blow-by gas, and controls the blow-by gas speed to send only gas to separator.

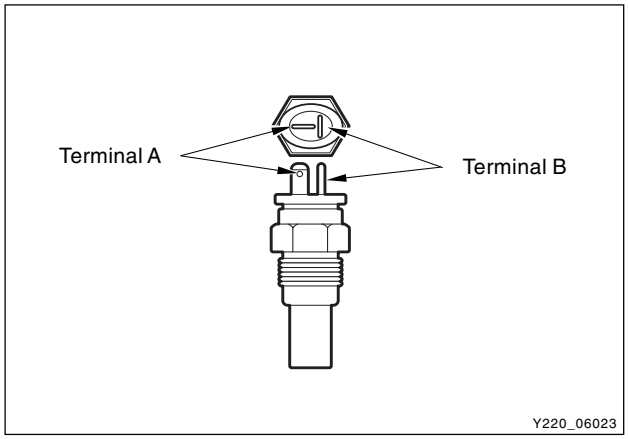
Coolant Temperature Gauge Unit

1. Immerse the senor unit into the water. Heat the water and check the resistance.



2. If the measured resistance is out of specified value, replace the gauge unit.
3. Measure the resistance between terminal A and gauge unit housing, and terminal B and gauge unit housing.

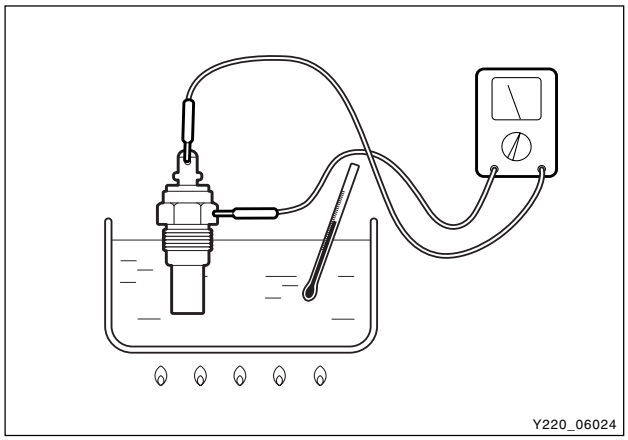
Terminal A (for coolant temp.)	0.4 Ω / 79°C
	23.8 Ω / 115°C
Terminal B (for glow plug)	24.8 Ω / -20°C
	3.25 Ω / 20°C



Thermostat

1. Immerse the thermostat into the oil. Heat the oil until it reaches the specified temperature and check if the coolant temperature switch is turned “OFF”.

Coolant temperature at point A	113 ± 3°C
Coolant temperature at point B	116°C



Notice

Use only engine oil for this inspection. Stir the oil during heating it. Never heat the oil over required temperature.

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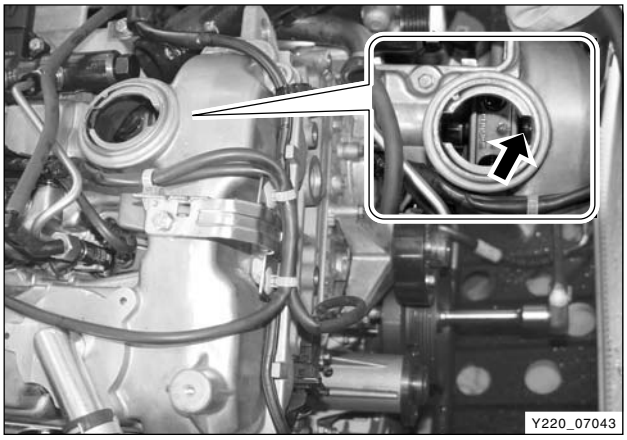
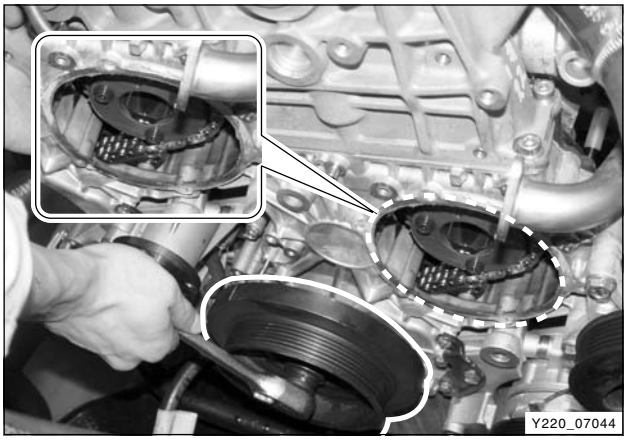
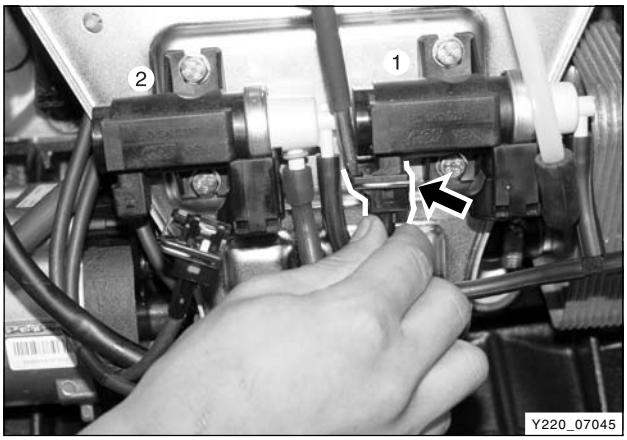


9. Remove the engine oil filler cap and adjust the mark on camshaft to TDC position.



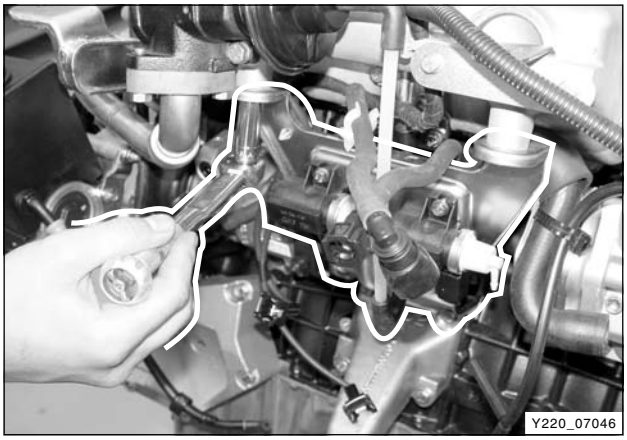
10. Align the TDC mark on the crankshaft pulley to the guide pin and rotate the pulley 720° counterclockwise. Check the mark on the camshaft again.



11. Disconnect the vacuum line of EGR vacuum modulator (1), the vacuum line of turbo charger vacuum modulator (2) vacuum line and connectors.

Notice

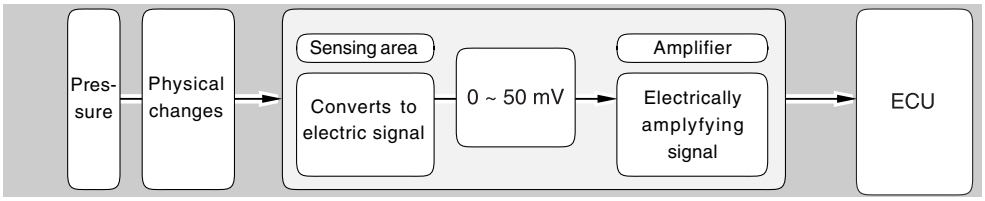
Be careful not to be mixed the lines when installing.



12. Unscrew the bolts and remove the intake manifold mounting bracket.
    - Upper bolts: 13M/ 2EA

      Lower boltes: 5M/ 2EA (Hexagon bolt)

Tightening torque	23 ± 2.3 Nm



<Operation principle of fuel pressure sensor>

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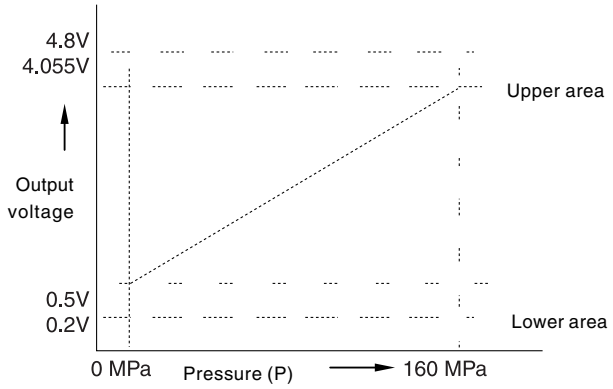

<Sensor voltage>

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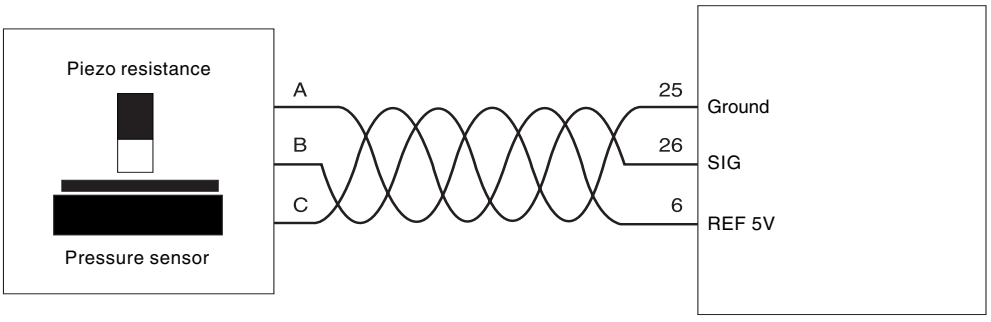

<Circuit diagram of fuel pressuer sensor>

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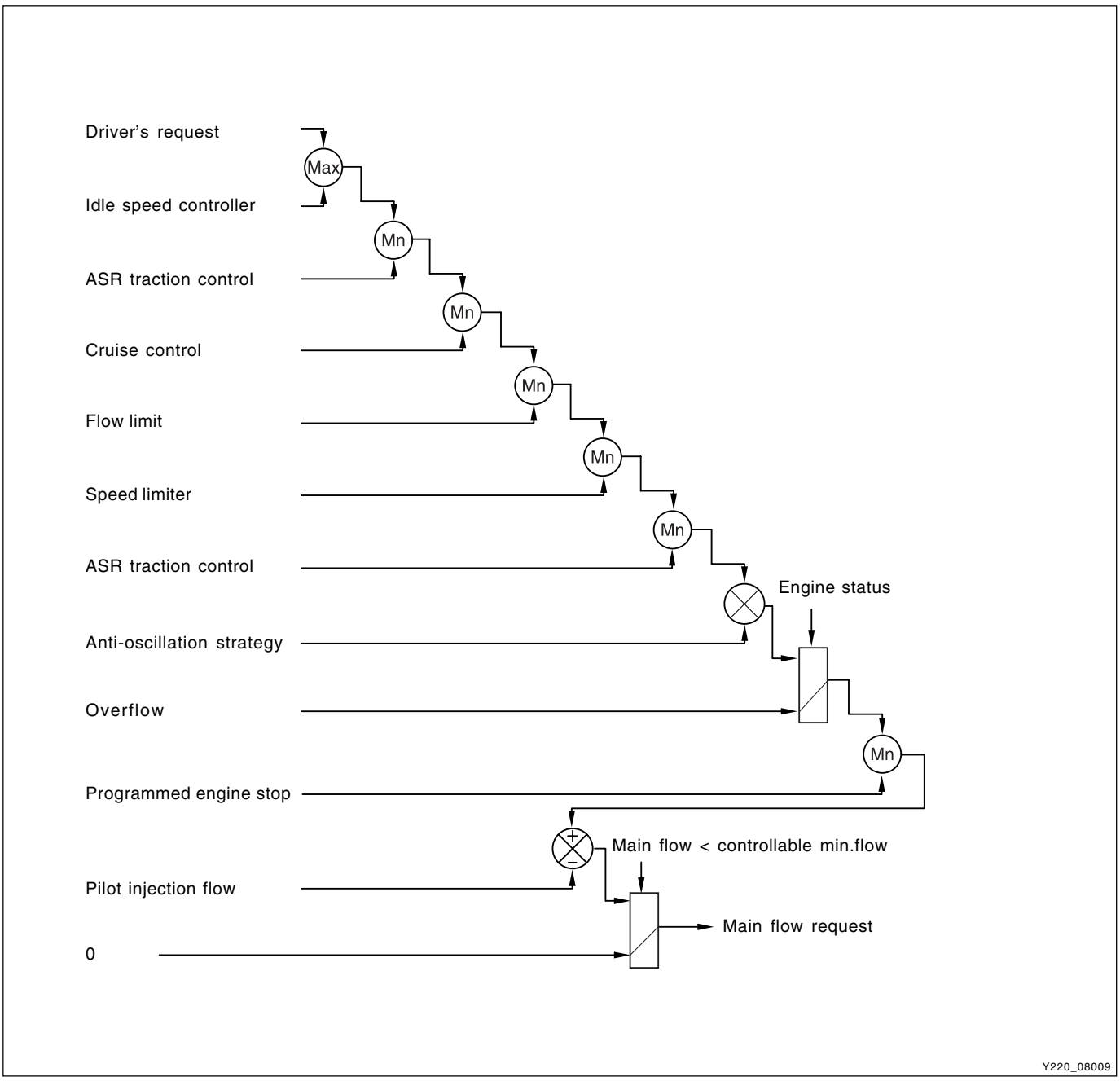

Driver Demand

The driver demand is the translation of the pedal position into the fuel demand. It is calculated as a function of the pedal position and of the engine speed. The driver demand is filtered in order to limit the hesitations caused by rapid changes of the pedal position. A mapping determines the maximum fuel which can be injected as a function of the driver demand and the rail pressure. Since the flow is proportional to the injection time and to the square root of the injection pressure, it is necessary to limit the flow according to the pressure in order to avoid extending the injection for too long into the engine cycle. The system compares the driver demand with this limit and chooses the smaller of the 2 values. The driver demand is then corrected according to the coolant temperature. This correction is added to the driver demand.

DTC	Trouble	Help	Torque Reduction (max.50%)	Torque Reduction (max.20%)	Delayed Engine Stop	Immediately Engine Stop	Limp Home Mode
P0336	Too Large Clearance of Crank Angle Sensor	- Air gap of crank angle sensor is abnormal. - Check the sensor wiring harness for ECU pin #90 and #82 (open, short, poor contact). - Check the resistance of crank angle sensor: 1090 Ω ± 15 %. - Measure the air gap: 0.3 ~ 1.3 mm • 1.3 mm of air gap: outputs 1.0 V at 40 rpm • 0.3 mm of air gap: outputs 150 V at 7000 rpm - Check the teeth condition. • Drive plate (A/T), DMF (M/T) - Replace the ECU if required.					
P0372	Crank Angle Sensor Malfunction	- Even though cam position recognition is normal, no crank angle signal recognition (missing tooth). - Check the sensor wiring harness for ECU pin #90 and #82 (open, short, poor contact). - Check the resistance of crank angle sensor: 1090 Ω ± 15 %. - Measure the air gap: 0.3 ~ 1.3 mm • 1.3 mm of air gap: outputs 1.0 V at 40 rpm • 0.3 mm of air gap: outputs 150 V at 7000 rpm - Check the teeth condition. • Drive plate (A/T), DMF (M/T) - Replace the ECU if required.					
P1107	Barometric Sensor Circuit Short/GND Short	- Out of range about barometric sensor (short to ground). - Actual barometric pressure vs. Output voltages. • 15 Kpa: 0 V 35 Kpa: 1.0 V • 55 Kpa: 2.0 V 80 Kpa: 3.0 V • 100 Kpa: 4.0 V 110 Kpa: 4.5 V - Replace the ECU.					
P1108	Barometric Sensor Circuit Short	- Out of range about barometric sensor (short to B+). - Actual barometric pressure vs. Output voltages. • 15 Kpa: 0 V 35 Kpa: 1.0 V • 55 Kpa: 2.0 V 80 Kpa: 3.0 V • 100 Kpa: 4.0 V 110 Kpa: 4.5 V - Replace the ECU.					
P1105	Barometric Sensor Circuit Short	- Out of range about barometric sensor (over voltage). - Actual barometric pressure vs. Output voltages. • 15 Kpa: 0 V 35 Kpa: 1.0 V • 55 Kpa: 2.0 V 80 Kpa: 3.0 V • 100 Kpa: 4.0 V 110 Kpa: 4.5 V - Replace the ECU.					