



Making Refined Cars for Everyone

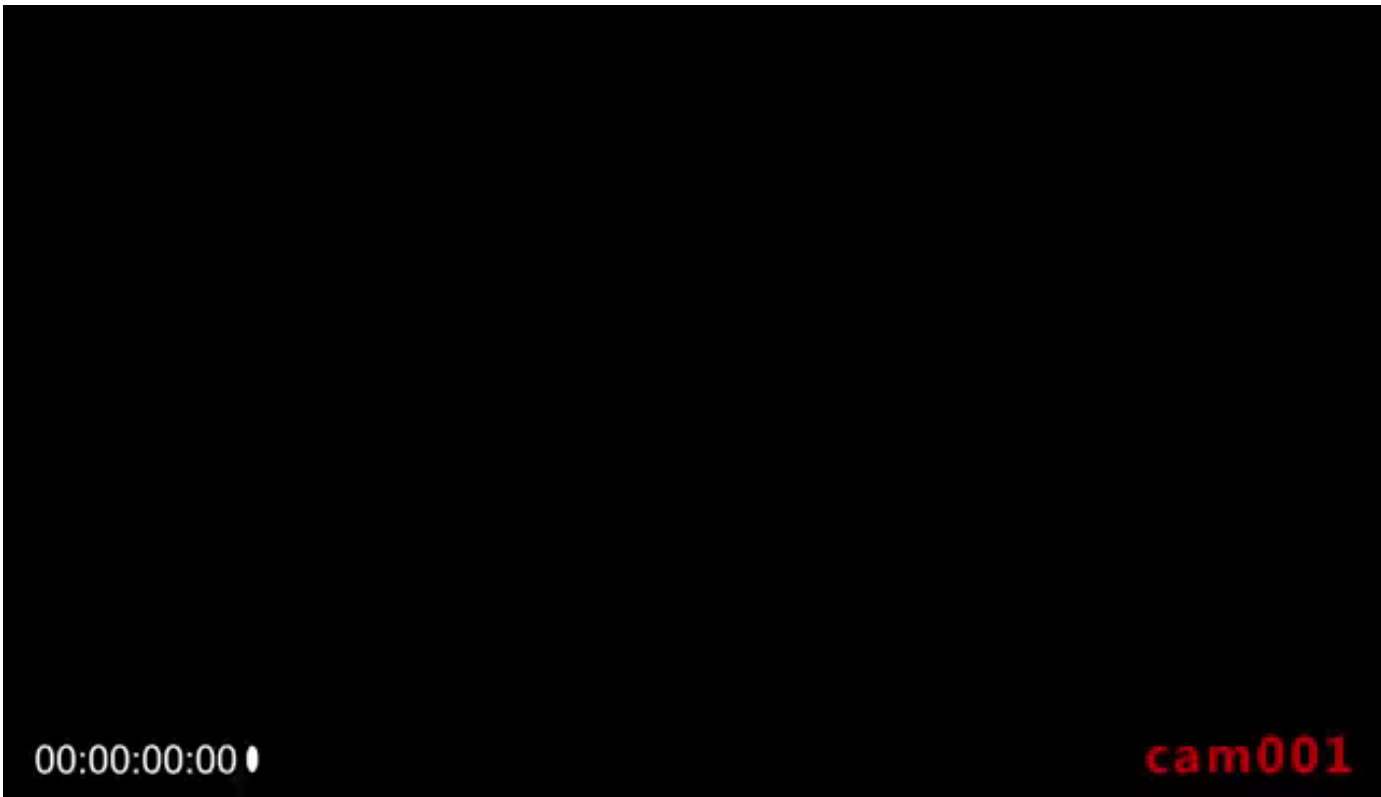
JLH4G20TD Engine

Contents

▶ **Mechanical system**

Electronic control system

After-sales work



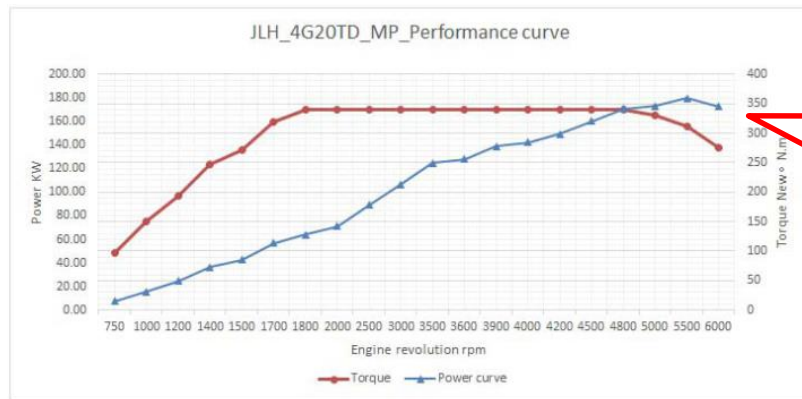


JLH-4G20TD Introduction to external features :



external features

- 4-cylinder all-aluminum gasoline engine
- 95 octane and above
- Meet Euro V emission standards



Max.
output
torque
350Nm

The supercharger start to work at 1000 rpm, and the output torque is 150Nm, the maximum output torque of 1800 rpm can reach 350Nm.



➤ JLH-4G20TD Performance parameters

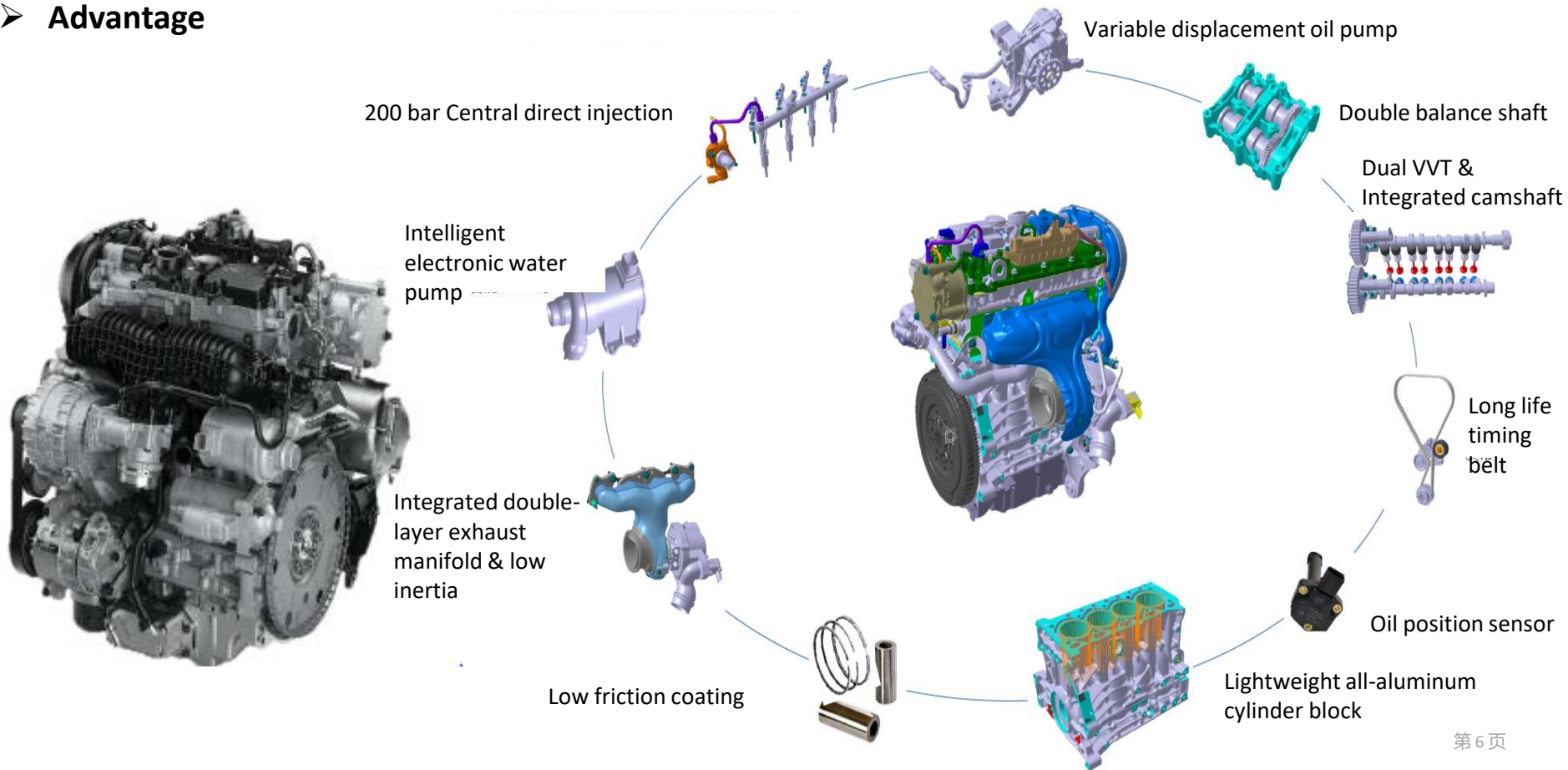


4G20TD

Displacement(L)	1.969
Bore(radius)*Stroke (mm)	82*93.2
Compression ratio	10.8
Max. power(KW)/rpm	175/5500
Max. torque(NM)/rpm	350@1800-4500
Min. Fuel Consumption (g/kW·h)	239
Emission standard	EU V
Idle speed	750±50
Ignition order	1-3-4-2
Engine oil grade/oil filling amount (L)	VCC RBS0-2AE 0W-20/ dry type filling volume 6.8±0.1L, maintenance filling volume 5.6±0.1L (replace the filter), 5.2±0.1L (don't replace the filter)



➤ Advantage

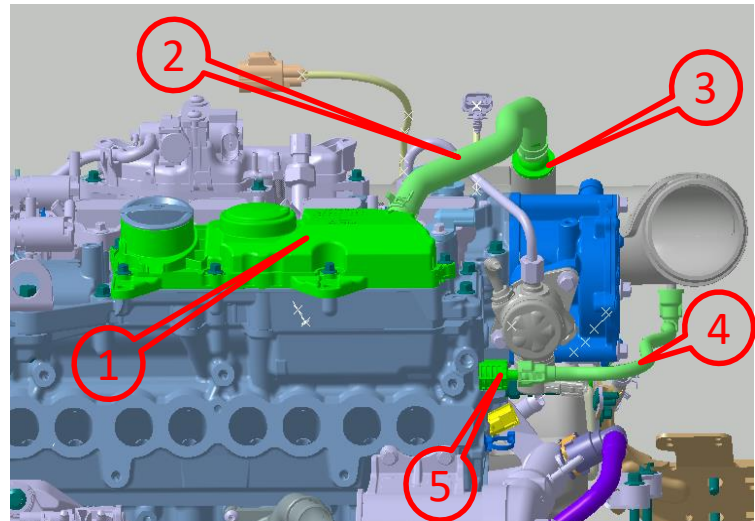




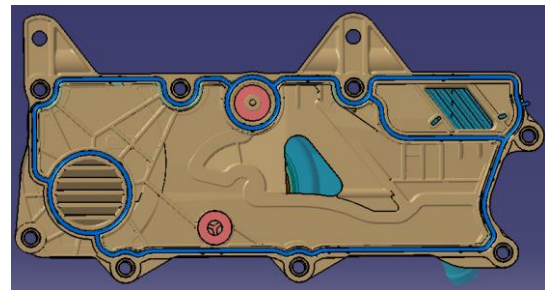
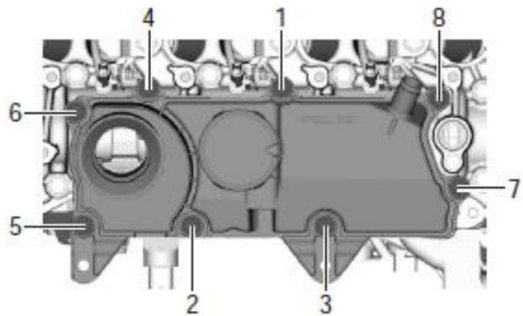
Crankcase ventilation system

Oil-gas separator

1. When disassembling and installing the oil-gas separator, tighten the bolts in order according to the assembly technical conditions;
2. When reinstalling the oil-gas separator, clean the oil stains on the installation surface.

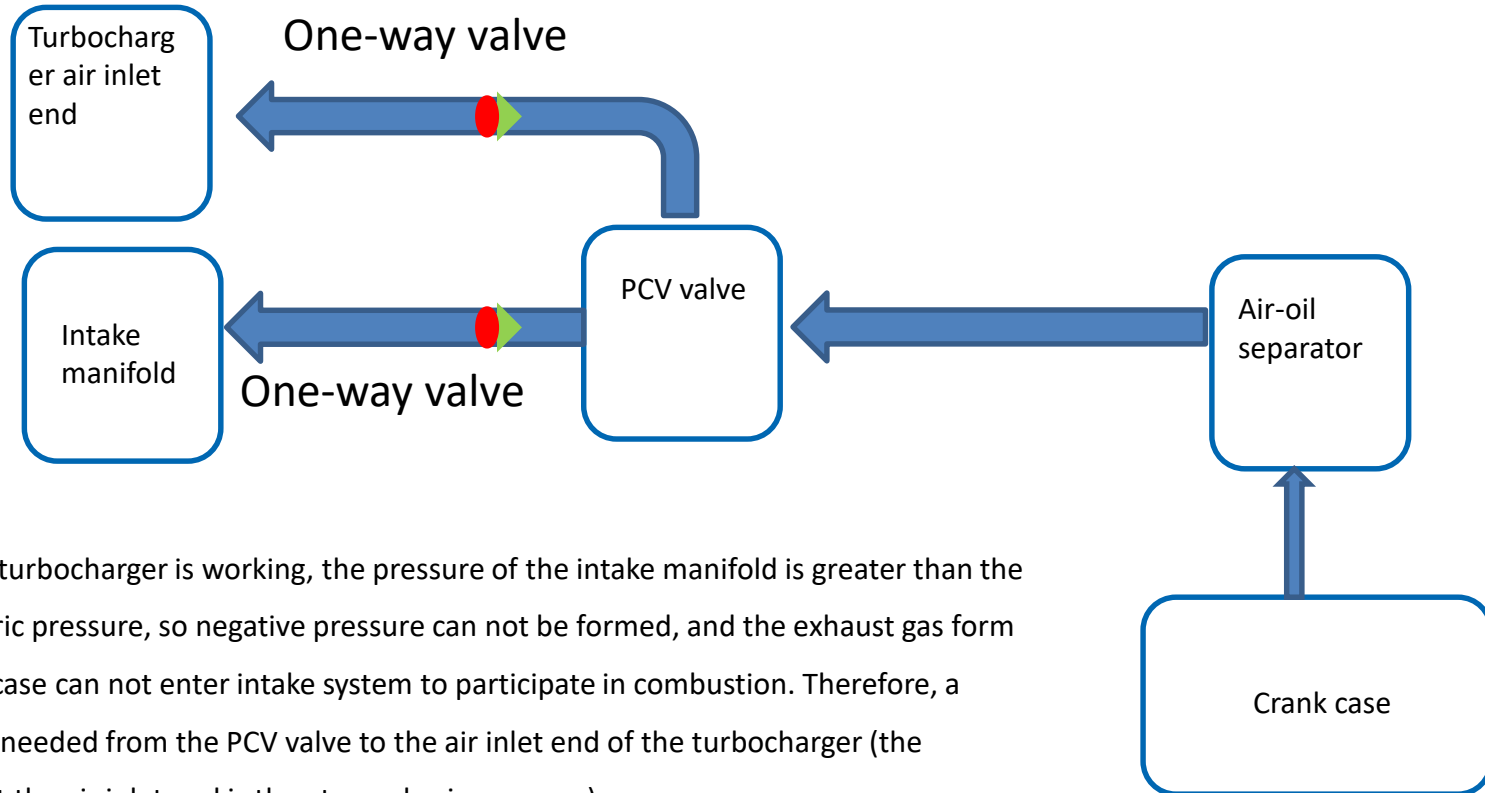


- ①--- oil-gas separator
- ②---natural ventilation hose
- ③---one way valve (external)
- ④---blowdown pipe
- ⑤---vent valve Assy (air admission)





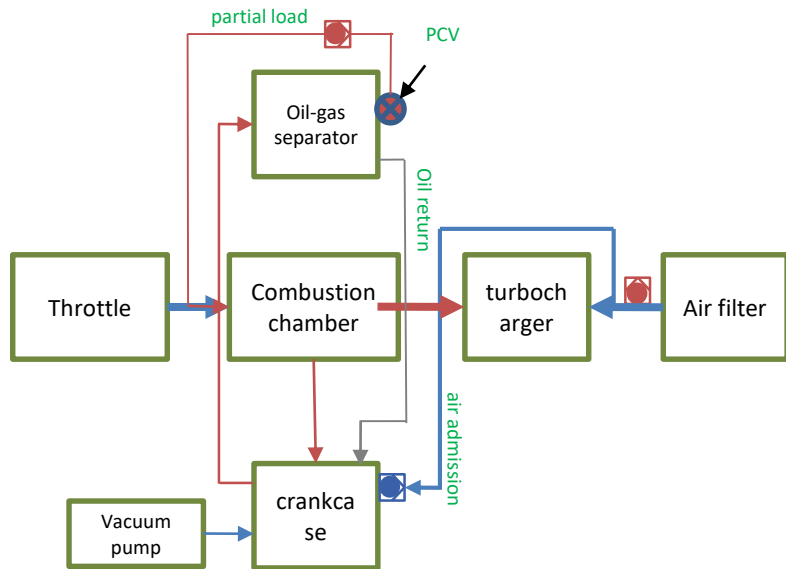
Crankcase ventilation system



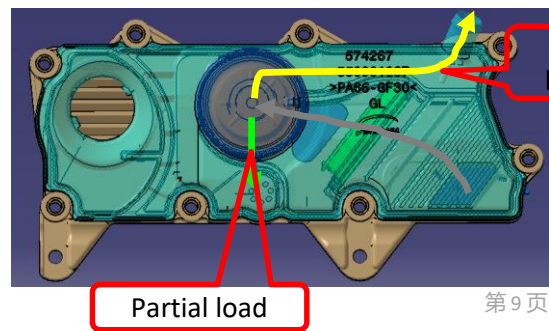
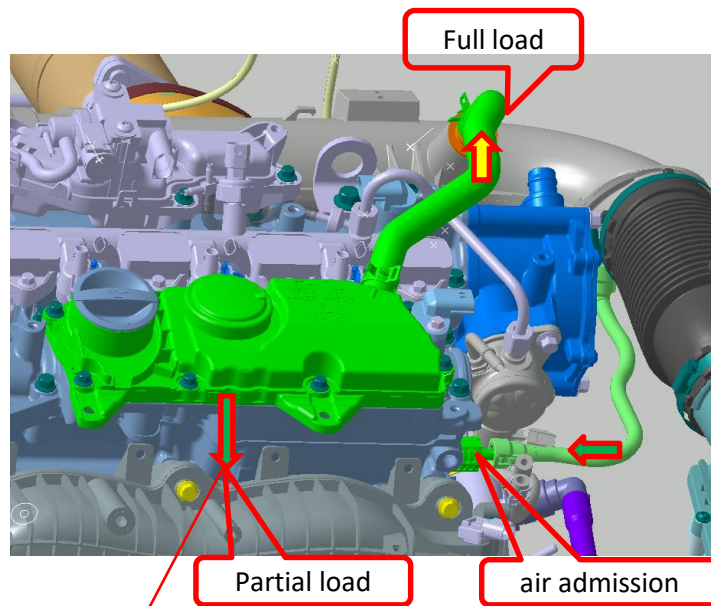
When the turbocharger is working, the pressure of the intake manifold is greater than the atmospheric pressure, so negative pressure can not be formed, and the exhaust gas from the crank case can not enter intake system to participate in combustion. Therefore, a pipeline is needed from the PCV valve to the air inlet end of the turbocharger (the pressure at the air inlet end is the atmospheric pressure).



Crankcase ventilation system

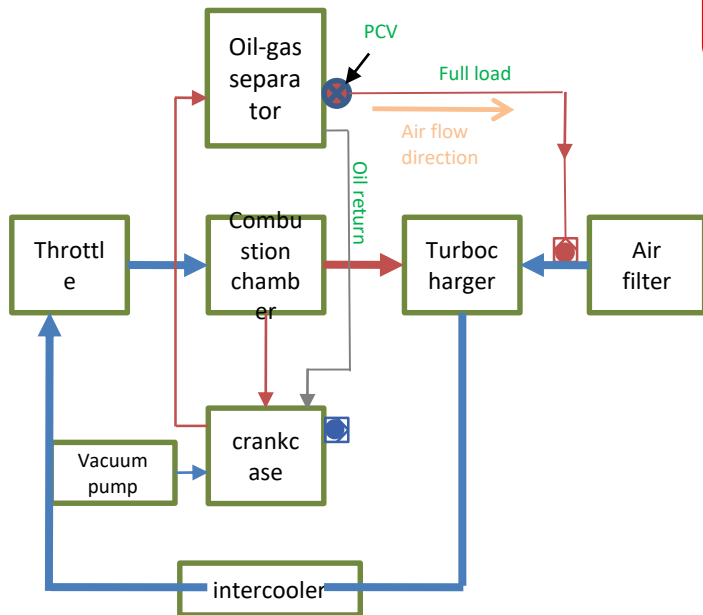


Partial load condition



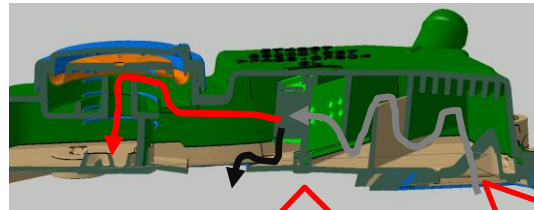
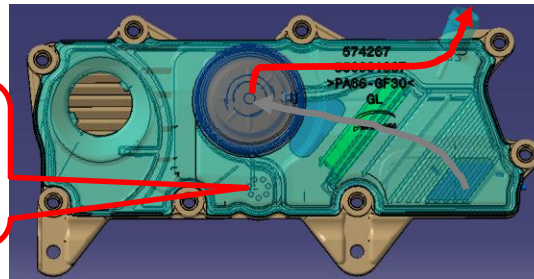


Crankcase ventilation system



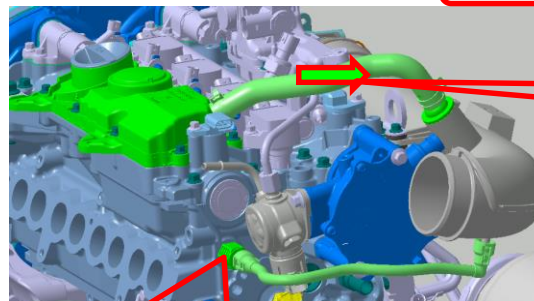
Full load condition

Full load condition- this one way valve close



Oil return

Crankcase blow-by inlet



Full load channel

Full load condition- this one way valve close



Crankcase ventilation system

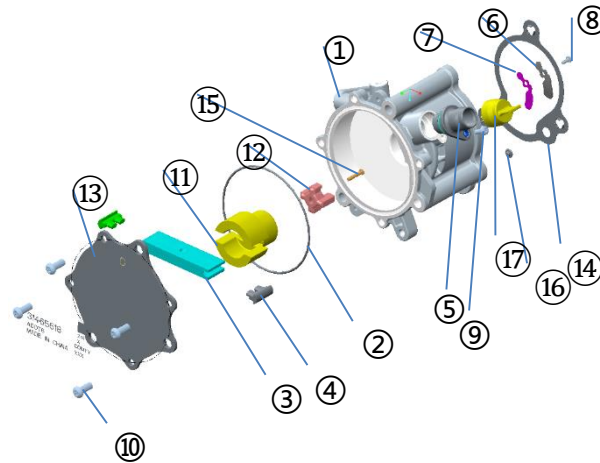
Troubleshooting

Failure	Faulty position	Troubleshooting method
There is oil in intake pipe	Whether some pipeline of crankshaft ventilation is blocked	1. Disassemble the oil-gas separator and check the partial load passage on the cylinder head 2. Check the full load channel, whether the pipeline is collapsed or blocked, and whether the one-way valve is unblocked.
	Whether the one-way valve of the internal control part of the oil-air separator fails	Disassemble the oil and gas separator, blow air to the small load channel, if it passes, it indicates failure.
	Whether the one-way valve on the intake pipe fails	Inhale to the one-way valve pipe joint, if it is open, it indicates failure
	Whether the internal structure of the oil-gas separator is blocked	Replace the oil-gas separator components. If the fault disappears, it indicates that the oil-gas separator components are blocked and failed.
Unstable idle speed	Whether the one-way valve in the air admission pipe fails	Disconnect the air admission pipeline and observe whether it shakes. The shake disappears, indicating that the check valve is invalid.
	Whether the one-way valve on the intake pipe fails	Inhale to the one-way valve pipe joint, if it is open, it indicates failure
	Whether the PCV valve of the oil-air separator fails	Replace the oil-gas separator components. If the jitter disappears, it indicates that the oil-gas separator components have failed.

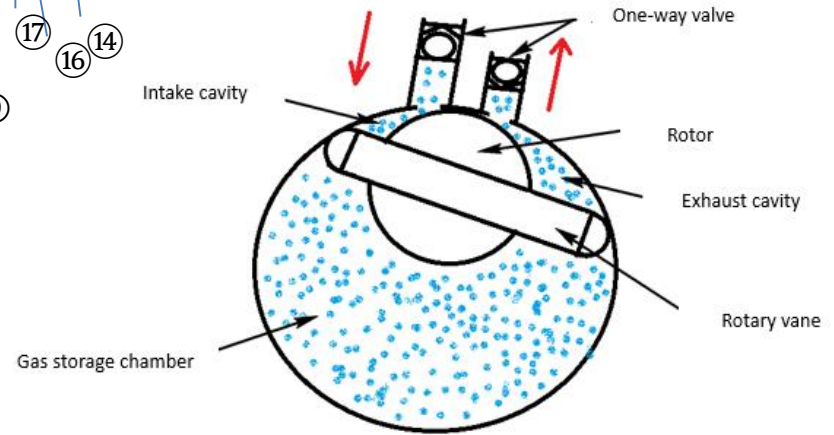


Vacuum control system

Variable volume vacuum pump : The variable volume vacuum pump is a device that uses the periodic change of the pump chamber volume to complete intake and exhaust. The gas is compressed before being discharged;



Exploded view





Vacuum control system

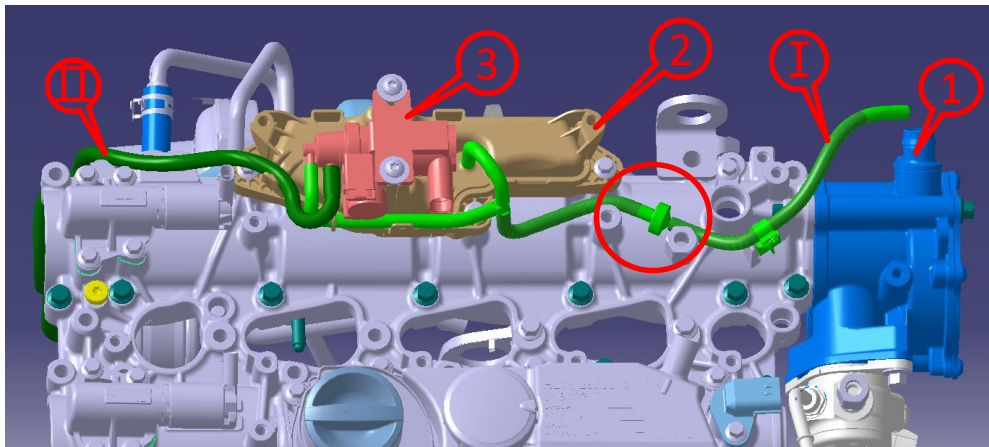
Principle

Component:

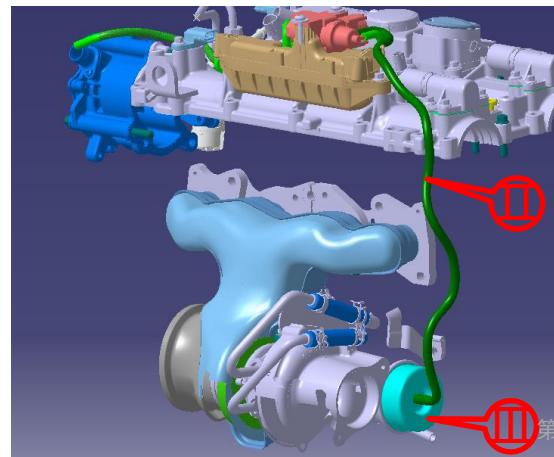
- ①---vacuum pump (generating vacuum)
- ②---vacuum chamber (storage of vacuum)
- ③---vacuum control valve (controlling vacuum)

Critical component:

- I. Vacuum inlet pipe (transfer vacuum)
- II. Supercharger vacuum pipe (transfer vacuum)
- III. Supercharger actuator (Vacuum application device)



Principle explanation	
The supercharger is not working	Vacuum control valve outputs negative pressure, waste bypass valve opens
Supercharger goes into work	The absolute value of the output negative pressure of the vacuum control valve becomes smaller, and the supercharger gradually enters work
Boost pressure is too high	The boost pressure relief valve opens to release the pressure after pressurization to the pressure before pressurization Duty cycle changes to adjust the opening of the bypass valve





Vacuum control system

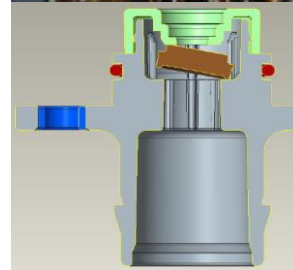
Main failure mode	Reason
Vacuum pump oil leakage	<ol style="list-style-type: none">1. Casting defects of pump body and cover2. Residual oil in seal ring groove
Oil return valve piece and limit valve piece have broken	Casting defect

sliding vane broken :

1. The oil passage is blocked, and dry friction causes breakage.
2. Foreign materials enters the vacuum pump from the oil passage, causing the rotor-sliding vane to jam and break

Oil leakage and failure of the one-way valve:

The valve core is broken, resulting in seal failure and oil leakage.





Vacuum control system

Main failure mode

Rotor and coupling are broken:

1. Rotor and coupling failure - defect of green carbon body
2. Foreign matter stuck between sliding vane and pump body



Rotor broken



Coupling broken

NVH:

The gap between sliding vane and pump body is large (clicking noise)



不响泵.

Normal pump



滤波后.

Whirring



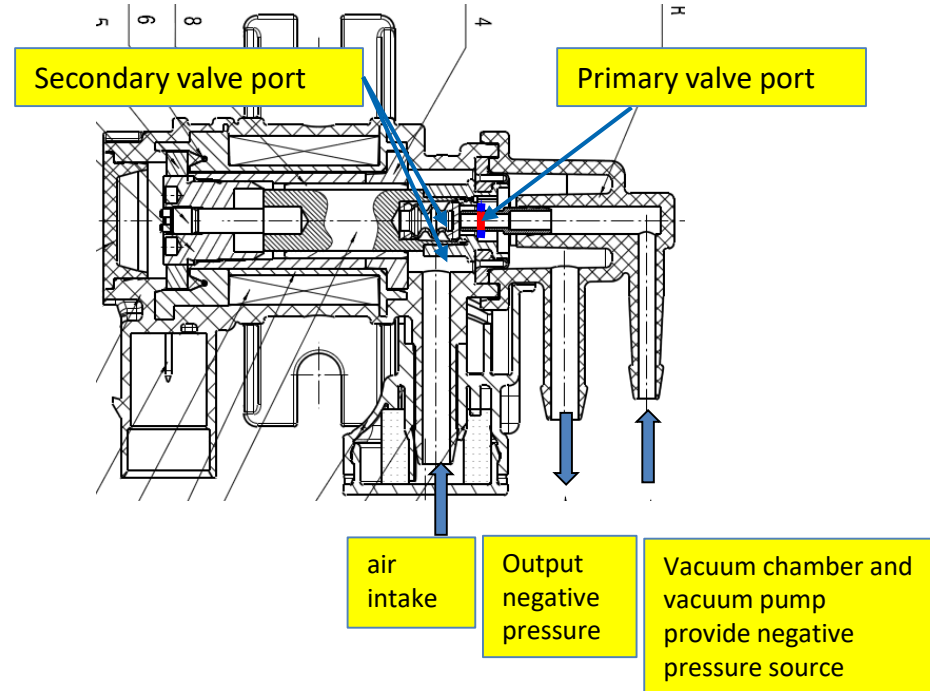
宋总车.

Clicking



Vacuum control system

Vacuum control valve



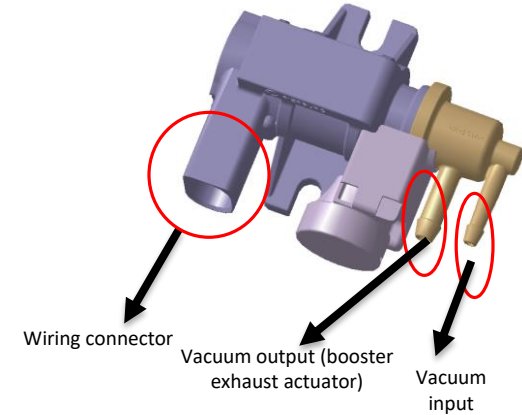


Vacuum control system

VEP4 vacuum control valve

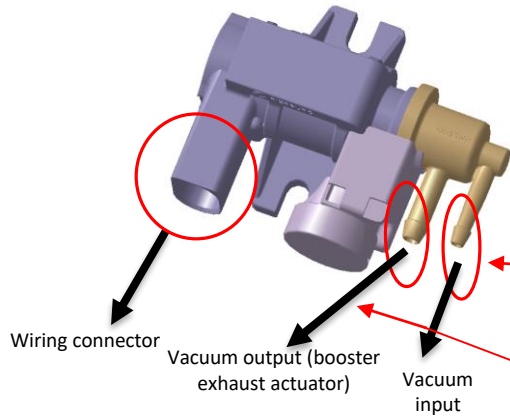
Working principle :

- ◆ The vacuum control valve controls the output vacuum degree according to the change of vacuum input and electromagnetic force (the boosted exhaust gas actuator output pressure);
- 1. **Intermediate position:** After the engine is started, the vacuum pump continues to provide vacuum input. When the coil is not energized, that is, there is no electromagnetic force or the electromagnetic force is equal to the vacuum input, all channels are blocked (at this time, the engine is in a steady state or stopped status);
- 2. **Discharge position:** When the electromagnetic force gradually increases, the plunger moves downward, and the vacuum input and output ends are connected. When the balance of the vacuum force and the electromagnetic force is reached, the plunger returns to the intermediate position (the engine working condition is that the load gradually decreases);
- 3. **Ventilation position:** When there is no electromagnetic force or it is small , the plunger moves upward under the action of vacuum force, and the spring diaphragm seals the air nozzle. Because there is still negative pressure at the output end, the plunger continues upward under the action of this negative pressure, at this time the atmosphere is connected to the output end, the plunger returns to the middle position when a new balance is established (the engine working condition is that the load gradually increases).



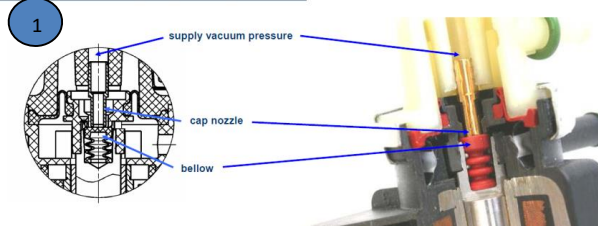


Vacuum control system

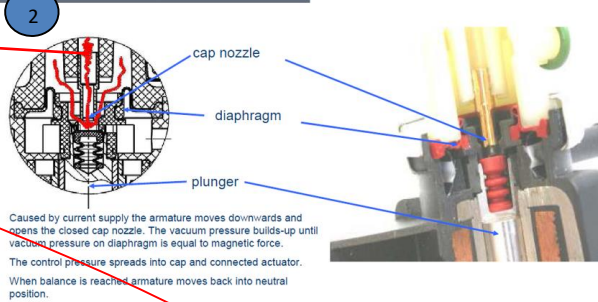


VEP4 vacuum control valve

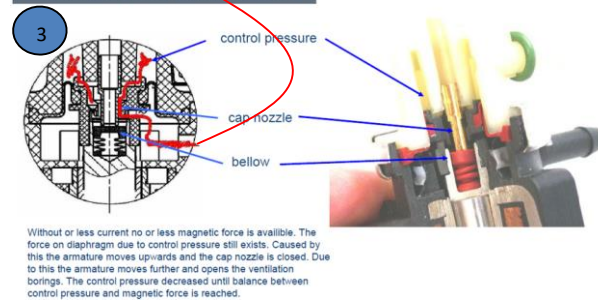
Functional description, neutral position



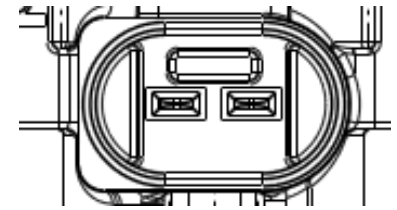
Functional description, evacuation



Functional description, ventilation



Vacuum control valve wiring connector



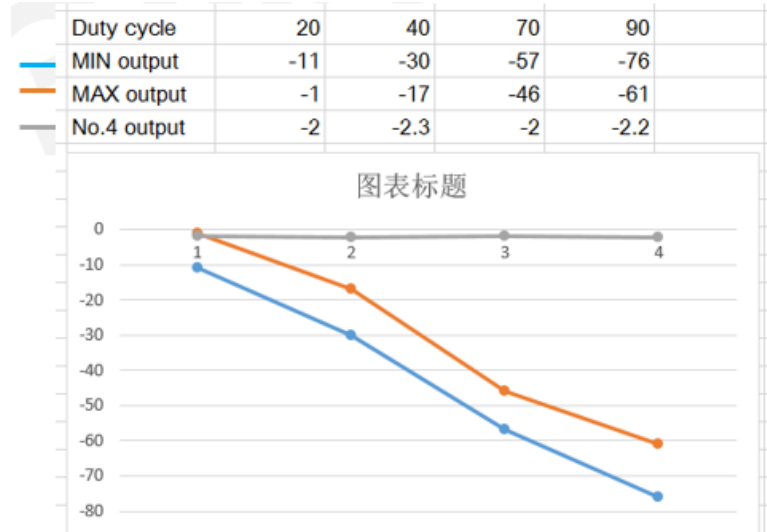
**RD (VW)
(keyways 1, 8)**



Vacuum control system

Main failure mode

Water inlet causes the valve seat to separate from the plunger





Vacuum control system

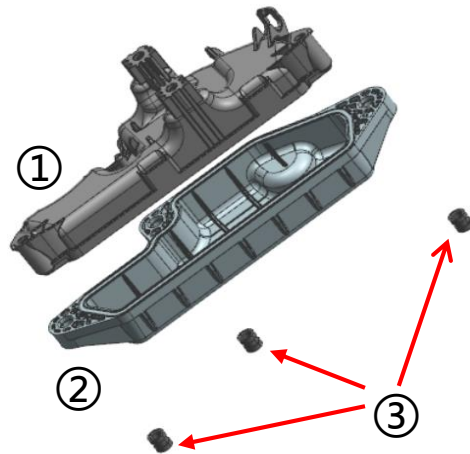
Structure

- ①--- Vacuum chamber upper plate
- ②---Vacuum chamber lower plate
- ③---Bush

Working principle

1. Storage vacuum
2. When the vehicle brakes, the pressure provided by the vacuum pump is not enough to meet the demand of the booster actuator. At this time, vacuum chamber will provide the negative pressure.

Vacuum chamber



Main failure mode

1. Poor welding leads to air leakage
2. External force damage causes air leakage.



1. Unstable pressure output of vacuum control valve
2. Supercharger performance fluctuation
3. Increased crankcase pressure



Crank Mechanism

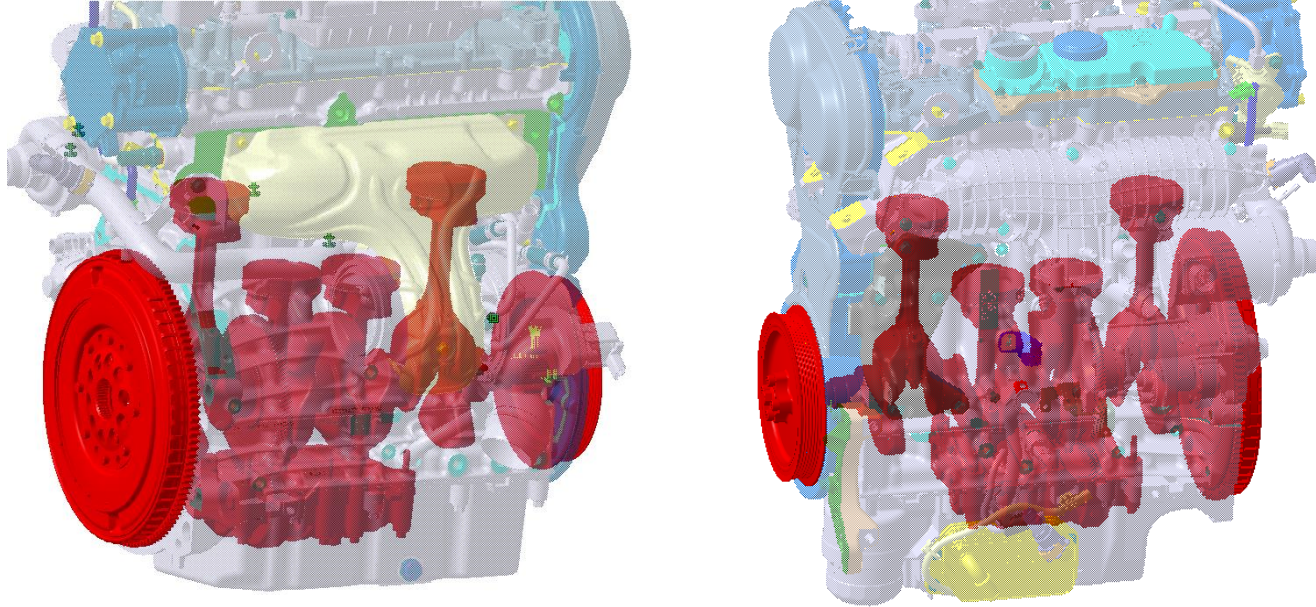
Crank connecting rod mechanism





Crank Mechanism

Crank connecting rod mechanism



The crank connecting rod mechanism—the core of the engine. Withstand the combustion pressure and convert the gas force into the linear motion of the piston, It is converted into rotary power output through connecting rod swing and crankshaft rotation.



Crank Mechanism

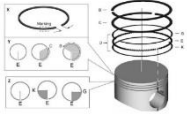
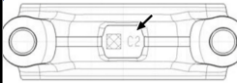


Meaning of engine code marking

JL	H	-	4	G	20	T	D	B	*	J	B	T	B00	0048	...
Geely	H platform		4-Cylinder	Gasoline	2.0 L displacement	Turbocharger	Direct injection	Performance parameter		Productive year	Productive month	Manufacturer	Version code	Serial code	


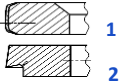

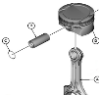


Assembly characteristics of piston connecting rod

Part	Structure	Requirement	Purpose	Wrong installation effect
Piston ASSY		<ul style="list-style-type: none"> The openings of the two air rings are staggered by 120° and cannot be on the main thrust side at the same time Ensure that the maximum allowable opening of the piston ring does not exceed the requirements Place the opening of the oil ring lining spring above the piston pin hole while avoiding the oil return hole. The openings of the two oil ring scrapers are staggered by 180°, and the openings are staggered 90° from the opening of the oil ring lining spring. 	<ul style="list-style-type: none"> Improve sealing performance Improve the scraping effect 	<ul style="list-style-type: none"> Air leakage increase Oil consumption increase
Connection rod		<ul style="list-style-type: none"> The connecting rod mark faces to the front of the engine Same engine connecting rod group in one engine 	<ul style="list-style-type: none"> Avoid the interference between connecting rod and oil pump Ensure a good combination of connecting rod body and cover Ensure that the piston is assembled correctly Ensure stable operation of each cylinder of the engine 	<ul style="list-style-type: none"> Interference between connecting rod and oil pump The body and cover are not well combined, and the body and cover are separated during operation The direction of the piston is reversed and the piston hits the valve Unstable operation of each cylinder, abnormal noise

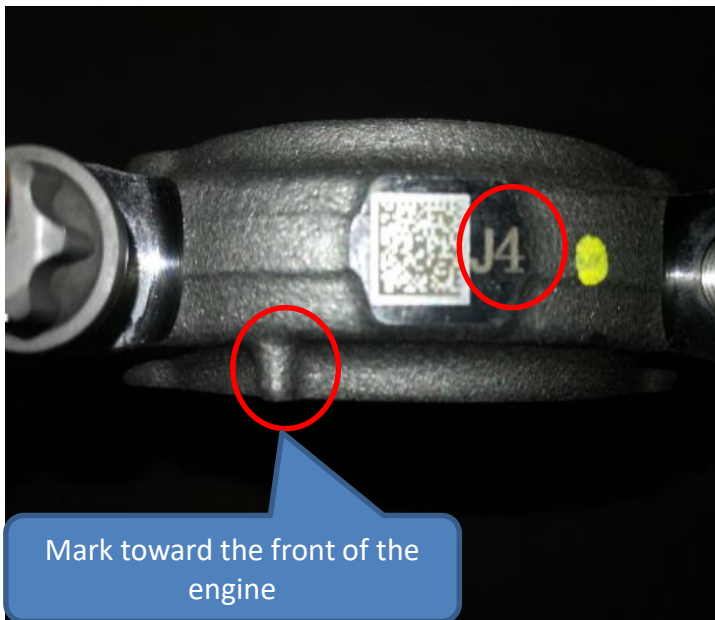


Assembly characteristics of piston connecting rod

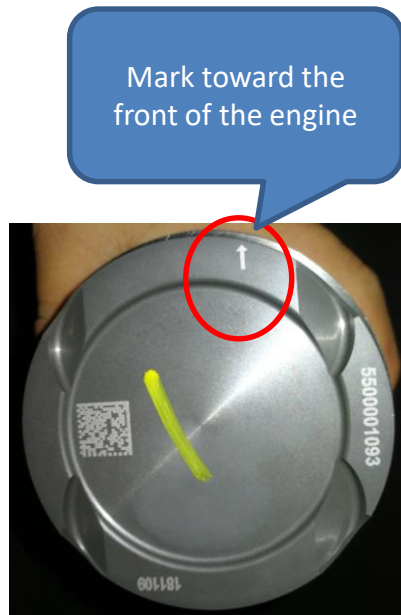
Part	Structure	Requirement	Purpose	Wrong installation effect
Piston		<ul style="list-style-type: none"> Piston arrow direction is towards the front of engine 	<ul style="list-style-type: none"> Ensure that the piston is assembled correctly to avoid piston hitting the valve Ensure the eccentric direction of the pin hole is correct to reduce the knocking noise 	<ul style="list-style-type: none"> Piston hits the valve Piston knock
Air ring		<ul style="list-style-type: none"> 1st ring inner side chamfered edge is on top 2nd ring outer side chamfered edge is on bottom 	<ul style="list-style-type: none"> Improve 1st ring sealing performance Improve the 2nd ring oil return performance 	<ul style="list-style-type: none"> Air leakage increase Oil consumption increase
Combined oil ring		<ul style="list-style-type: none"> The opening of the lining spring is in good contact with no overlap 	<ul style="list-style-type: none"> Ensure the oil scraping function of the oil ring 	<ul style="list-style-type: none"> The oil ring is stuck or broken, and the oil consumption increases
Clamp spring		<ul style="list-style-type: none"> The two clamp springs are installed in place, and there is no problem of missing or improper installation 	<ul style="list-style-type: none"> Ensure that the piston pin does not escape 	<ul style="list-style-type: none"> The piston pin is pulled out and the cylinder is scratched. In severe cases, the piston connecting rod is broken and the cylinder body is broken.



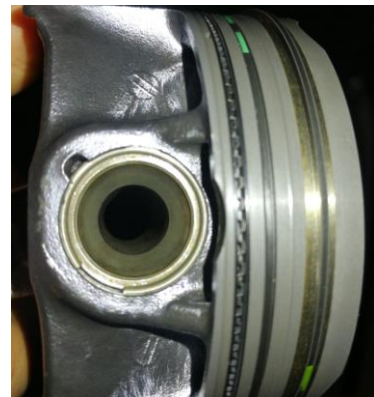
Notes for piston connecting rod installation



The connecting rod weight is divided into five groups (1-5), and the group number is marked on the bottom of the connecting rod. When assembling, ensure that the connecting rod weight of the same engine is the same group.



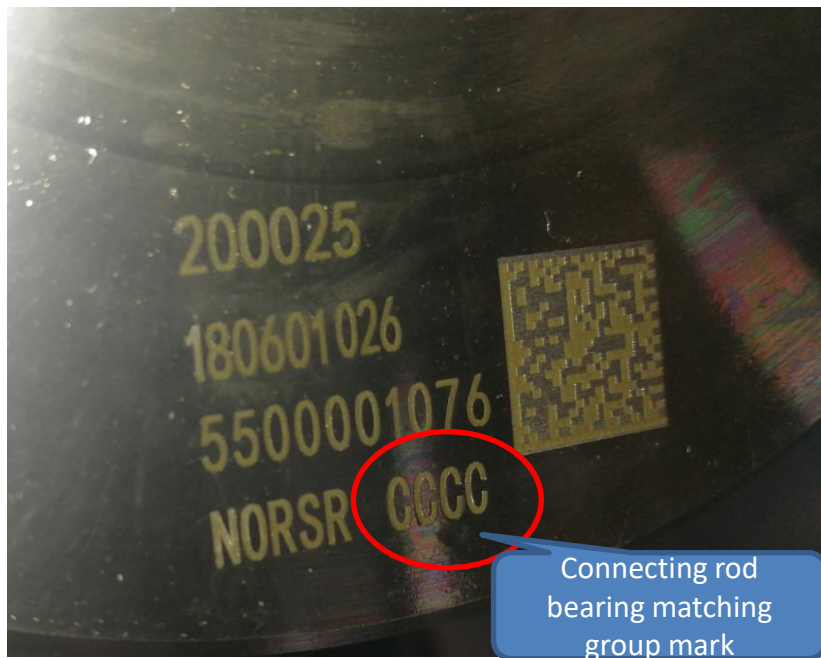
Piston forward marking



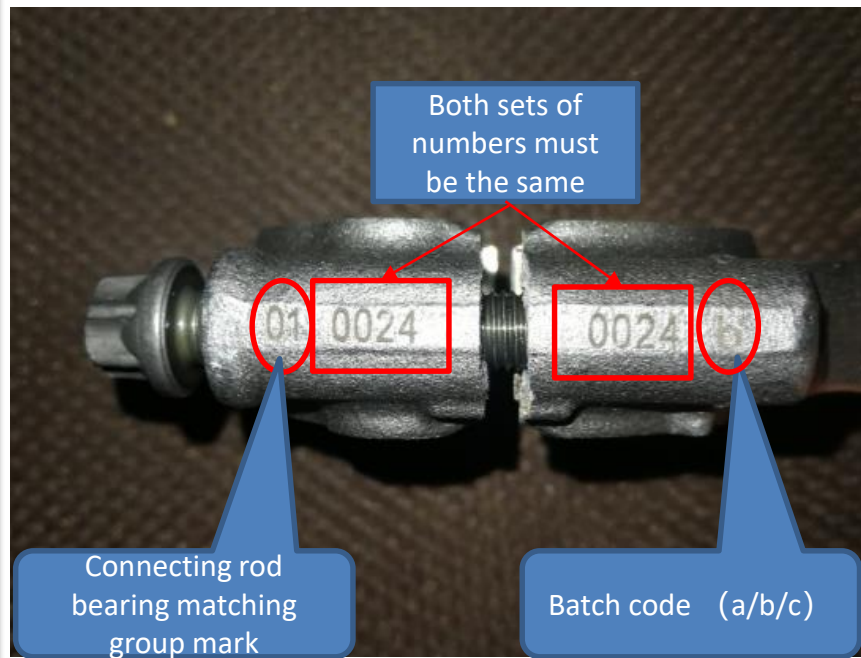
The engine uses a full-floating piston pin



Piston connecting rod assembly



The crank position of the first cylinder of the crankshaft.



The engine adopts cracking type connecting rod and adopts error-proof marking



Piston connecting rod assembly

Connecting rod bearing group assembly table

Connecting rod big end diameter Connecting rod journal			01		02		03	
			53-53.004		53.004-53.008		53.008-53.013	
A	49.981	49.988	Y	Y	Y	B	B	B
B	49.988	49.994	R	Y	Y	Y	B	Y
C	49.994	50	R	R	Y	R	Y	Y
Bearing			Upper	Lower	Upper	Lower	Upper	Lower

Connecting rod bearing thickness classification table

Connecting rod upper bearing	red	1.483	1.487
	yellow	1.487	1.491
	blue	1.491	1.495
Connecting rod lower bearing	red	1.485	1.489
	yellow	1.489	1.493
	blue	1.493	1.497

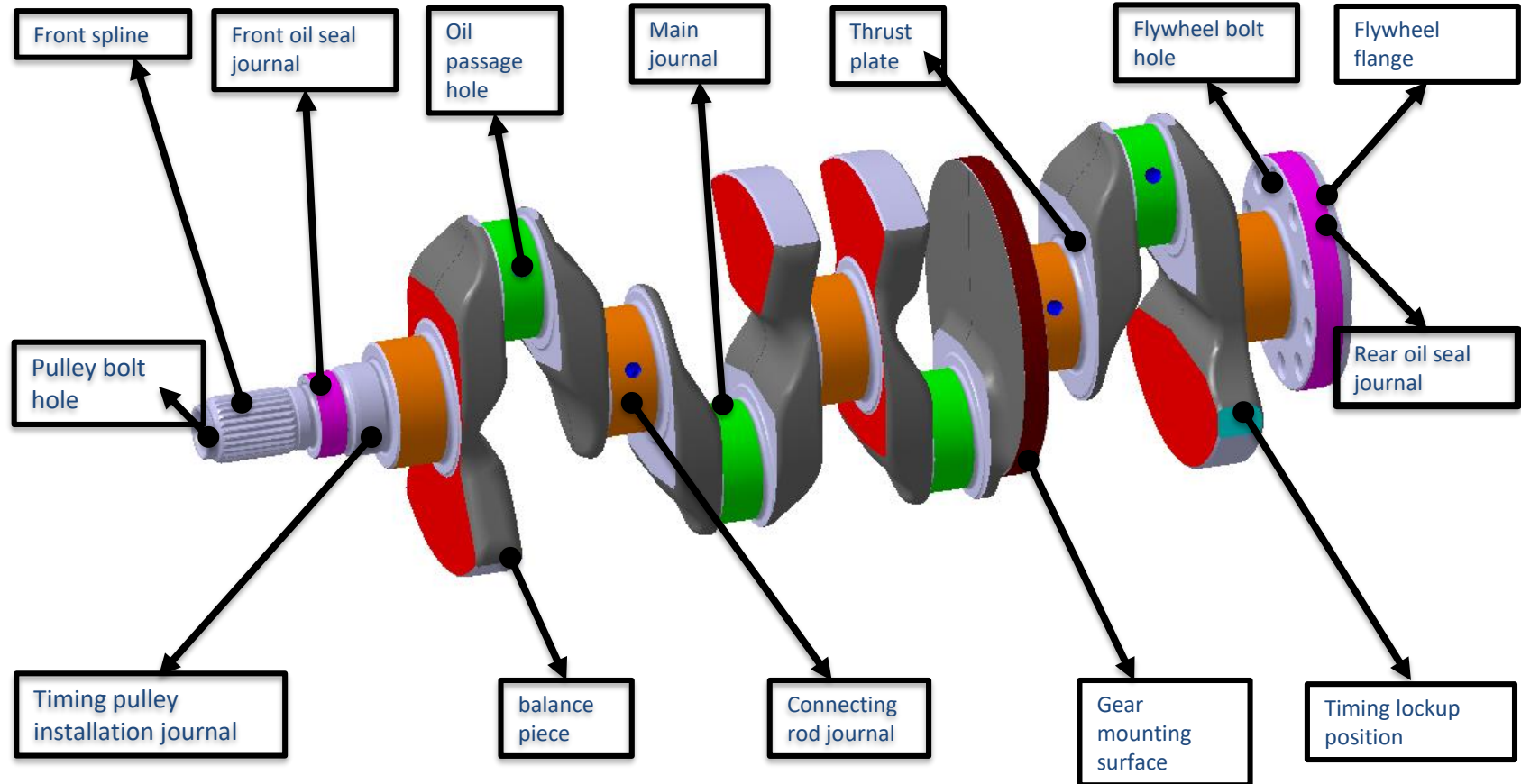
Difference:

LP bearing: No coating on upper and lower bearing

MP bearing: upper bearing with coating, lower bearing without coating



Crankshaft structure





Main shaft bearing matching group mark










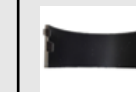


Exhaust side



Crankshaft



Main bearing installation classification (basic model)

Main shaft bearing matching information	1		2		3		4		5	
	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
MP	 <p>Without coating</p>	 <p>With coating</p>								
Remark	No oiling on bearing back									



Main shaft bearing selection form

Cylinder body group

Crankshaft group

		57.0000	57.0010	57.0020	57.0030	57.0040	57.0050	57.0060	57.0070	57.0080	57.0090	57.0100	57.0110	57.0120	57.0130	57.0140
		D	E	F	G	H	J	K	L	M	N	O	P	R	S	T
52.985	D	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
52.986	E	Y	B	B	B	B	B	B	B	B	B	B	B	B	B	B
52.987	F	Y	B	Y	B	B	B	B	B	B	B	B	B	B	B	B
52.988	G	Y	B	Y	B	Y	B	B	B	B	B	B	B	B	B	B
52.989	H	Y	B	Y	B	Y	B	B	B	B	B	B	B	B	B	B
52.990	J	Y	Y	Y	B	Y	B	Y	B	B	B	B	B	B	B	B
52.991	K	Y	Y	Y	Y	B	Y	B	Y	B	B	B	B	B	B	B
52.992	L	Y	Y	Y	Y	Y	Y	B	Y	B	Y	B	B	B	B	B
52.993	M	Y	Y	Y	Y	Y	Y	Y	B	Y	B	Y	B	B	B	B
52.994	N	R	Y	Y	Y	Y	Y	Y	Y	B	Y	B	Y	B	B	B
52.995	O	R	Y	R	Y	Y	Y	Y	Y	B	Y	B	Y	B	B	B
52.996	P	R	Y	R	Y	R	Y	Y	Y	Y	Y	Y	B	Y	B	B
52.997	R	R	Y	R	Y	R	Y	Y	Y	Y	Y	Y	B	Y	B	B
52.998	S	R	R	R	Y	R	Y	R	Y	Y	Y	Y	B	Y	B	B
52.999	T	R	R	R	R	R	Y	R	Y	R	Y	Y	Y	B	Y	B
53.000	V	R	R	R	R	R	R	Y	R	Y	Y	Y	Y	B	Y	B
53.001	X	R	R	R	R	R	R	R	Y	R	Y	R	Y	Y	B	B
53.002	Y	R	R	R	R	R	R	R	Y	R	Y	R	Y	Y	Y	B
53.003	Z	R	R	R	R	R	R	R	R	Y	R	Y	Y	Y	Y	B

Main Bearing thickness grades (mm)


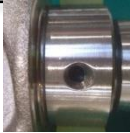

red	1.9900	1.9940
Yellow	1.9940	1.9980
Blue	1.9980	2.0020
Green	2.0020	2.0060

Thrus Bearing thickness grades (mm)

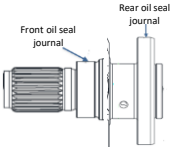
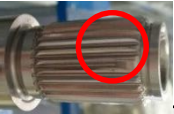
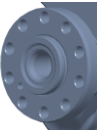
red	1.9930	1.9970
Yellow	1.9970	2.0010
Blue	2.0010	2.0060
Green	2.0050	2.0090



Cranks haft

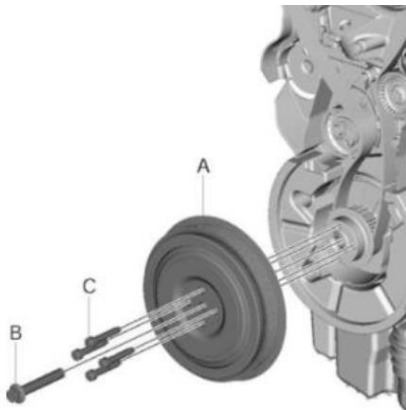
Part	Component	Function	Requirement	Purpose
Cranks haft	 <p>Crank journal</p>	<ul style="list-style-type: none"> ✓ Bear the workload; ✓ Combined with the bearing bush to form a sliding bearing 	<ul style="list-style-type: none"> ◆ Diameter, roundness, straightness, runout, hardness are qualified ◆ Smooth surface, no appearance defects such as scratches, bumps, rust, etc. ◆ Magnetic particle inspection without cracks 	<ul style="list-style-type: none"> • Qualified crankshaft size guarantees the formation of a normal oil film with the bearing to avoid eccentric wear and scratch; • No appearance defects on the surface to avoid damage to the oil film, scratches and burnt bushes • No cracks on the surface ensure the strength of the crankshaft
	 <p>Oil hole Oil passage</p>	<ul style="list-style-type: none"> ✓ Transfer lubricating oil from the main bearing to the connecting rod bearing 	<ul style="list-style-type: none"> ◆ No impurities in the oil passage, no blockage ◆ The oil passage is smooth, without burrs, and not sharp 	<ul style="list-style-type: none"> • No impurities in the oil passage to avoid damaging the oil film and scratching the bearing • There is no burr at the oil passage, and it is not sharp to ensure that the bearing bush will not be scratched, which will cause the bearing and shaft wear
	 <p>Crank journal rolling fillet</p>	<ul style="list-style-type: none"> ✓ Improve the fatigue strength of the crankshaft so that the crankshaft can bear higher alternating bending loads during engine operation 	<ul style="list-style-type: none"> ◆ No surface defects in the fillets rounded rolling depression area ◆ The fillet is carried out according to the locking rolling process ◆ The height of the local deformation of the fillet rolling area is not more than 0.15 	<ul style="list-style-type: none"> • The fillets have no appearance defects to avoid crack sources and weaken the rolling effect • The fillet rolling area and the crank arm are smoothly connected to avoid stress concentration in the junction area



Part	Component	Function	Requirement	Purpose
<h2>Cranks haft</h2>	 <p>Front oil seal journal Rear oil seal journal</p> <p>Front and rear oil seal journal</p>	<p>✓ To seal the oil with the front and rear oil seals of the crankshaft</p>	<ul style="list-style-type: none"> ◆ Diameter, roundness, straightness, runout, roughness are qualified ◆ Smooth surface, no appearance defects such as scratches, bumps, rust, etc. ◆ Magnetic particle inspection without cracks ◆ The guiding chamfer is smooth and without burrs 	<ul style="list-style-type: none"> • Qualified size to ensure normal fitting with oil seal; • No appearance defect on the surface to avoid scratching the oil seal and oil leakage
	 <p>External spline</p>	<p>✓ Transmit drive torque</p>	<ul style="list-style-type: none"> ◆ No bumps, protrusions, rust on the tooth surface ◆ No wrong teeth, multi-tooth phenomenon 	<ul style="list-style-type: none"> • Ensure the normal fitting with the timing pulley;
	 <p>Front and rear thread</p>	<ul style="list-style-type: none"> ✓ Tighten the bolts of the front pulley to provide pre-tightening force for torque transmission at the front end ✓ Tighten the flywheel bolts to provide pre-tightening force for the flywheel torque transmission 	<ul style="list-style-type: none"> ◆ No wrong teeth, partial broken teeth ◆ Position load requirements 	<ul style="list-style-type: none"> • Ensure the pre-tightening force of the front pulley and timing pulley • Ensure the pre-tightening force of the flywheel



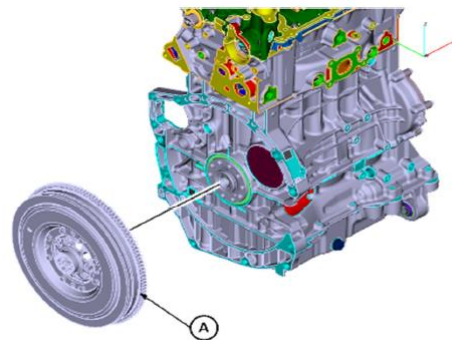
Pulley (TVD) and flywheel



Installation diagram
of TVD

- The damping pulley assembly (TVD) is installed at the front end of the engine and connected to the crankshaft through the damping pulley bolt;
 - The main functions of the damping pulley assembly are as follows:
 1. Reduce crankshaft torsional vibration and reduce crankshaft torsional stress;
 2. Transmit power for engine accessories;
 3. Reduce the vibration of the accessory system (BSG de-coupler);
 - Visual inspection
- The spline teeth is no confusion, bumps, the other area is no bumps, serious scratches, and large-area paint peeling

Installation diagram of dual mass flywheel (DMF)




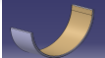


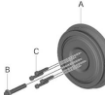



- The dual mass flywheel (DMF) is installed at the rear end of the engine and is connected to the crankshaft through the flywheel bolt;
 - Main functions of dual mass flywheel:

Attenuate the speed fluctuation of the engine output to the gearbox and improve driving comfort;
 - Visual inspection
- No bumps, no deformation, no serious scratches

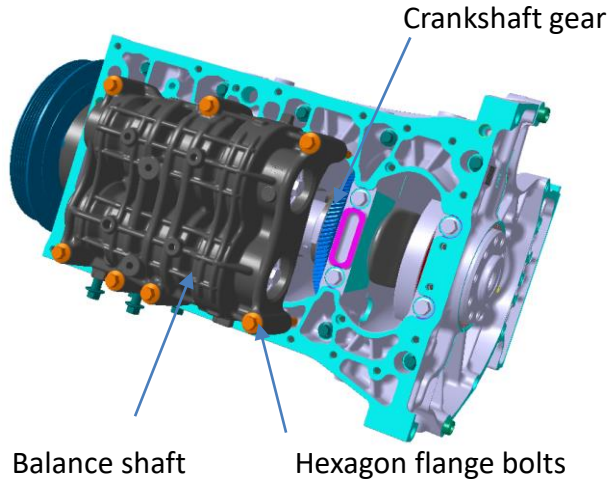


Precautions for installation of pulley (TVD) and flywheel

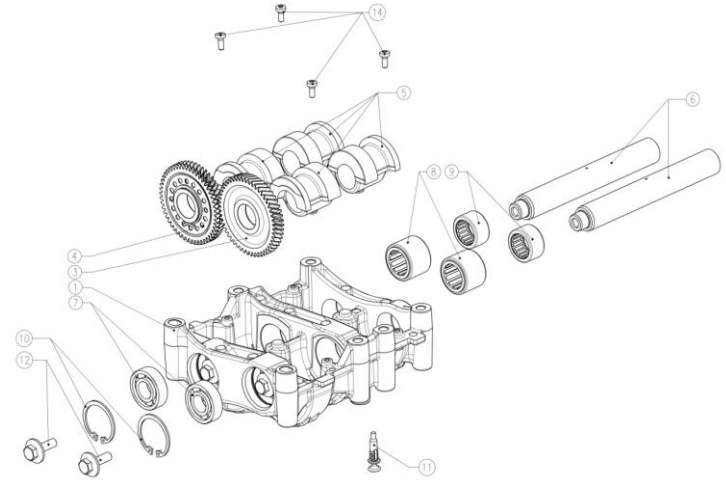
Part	Component	Wrong installation effect	Requirement	Purpose
Upper main bearing		<p>Excessive clearance: engine squeaks and smashes bearings</p> <p>Too small clearance: bearing bush locked, abnormal wear, abnormal noise, etc.</p>	<p>Cleanliness meets requirements</p> <p>No protrusions, rust, bumps, scratches, etc. on the inner surface that affect the appearance of the oil film</p>	<ul style="list-style-type: none"> • Ensure that the bearing bush fits the hole seat with sufficient back pressure • Ensure proper oil film clearance • Control the axial movement of the crankshaft • Ensure that no foreign particles scratch the bearing, causing the bearing wear or burn
Lower main bearing				
Selvedge main bearing				
Upper connecting rod bearing				
Lower connecting rod bearing				
Damping pulley		The damping pulley is loose	<p>Ensure that the friction plate is in the correct position during assembly.</p> <p>Tighten according to the regulations</p>	Ensure reliable torque transmission between pulley and crankshaft
Damping pulley bolts		The damping pulley is loose	<p>Install the damping pulley on the crankshaft, first pre-tighten the center bolt and then pre-tighten the 4 bolts on the damping pulley in a crisscross sequence. Tighten the center bolt of the bolt and then tighten the 4 bolts in a crisscross sequence to the specified torque</p>	Prevent bolts from not entering the plastic zone
Dual mass flywheel		<p>Internal damage of DCT flywheel</p> <p>Damaged driven disk</p> <p>Bad appearance of corrosion</p> <p>Slippery friction surface</p>	<p>The DCT flywheel needs to install the positioning sleeve before it is hot</p> <p>Apply anti-rust oil before packaging the DCT flywheel</p>	The positioning sleeve protects the flywheel during hot test and transportation, preventing vibration from damaging the interior DCT oiling to prevent corrosion during transportation and inventory



Balance shaft assembly



Exploded view of balance shaft



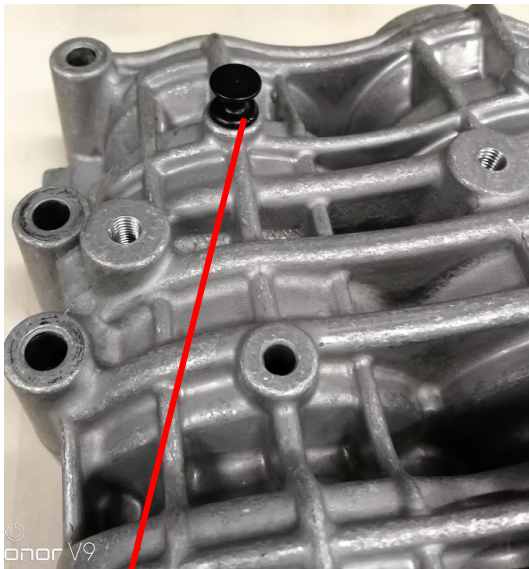
No.	Name	Function
1	Crankshaft gear	Driving balance shaft
2	Balance shaft	Balance the second-order reciprocating inertia force
3	Hexagon flange bolts	Fix the balance shaft assembly on the lower cylinder body

No.	Component name	No.	Component name
1	Balance shaft housing	8	Needle bearing-B
2	Crankshaft gear (press mounted on the crankshaft)	9	Needle bearing-C
3	Right gear	10	Retaining ring
4	Scissors gear	11	Locating pin
5	Unbalanced block	12	Hexagon flange bolts
6	Hollow shaft	13	Oil baffle
7	Ball bearing	14	Bolt



Precautions for installation of balance shaft assembly

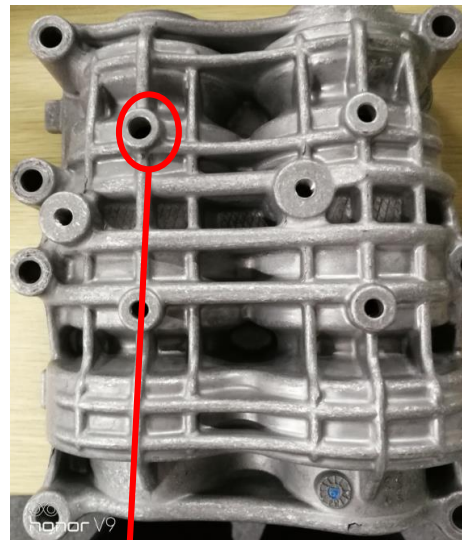
Before installation, check the appearance of the VEP4 balance shaft assembly, and first confirm whether the balance shaft positioning pin meets the requirements. The judgment basis is as follows :



As shown in the figure, the black part is a positioning pin, and the positioning pin of the balance shaft assembly is in contact with the bottom surface of the balance shaft assembly or the distance is less than 1mm. It meets the requirement.



As shown in the figure, the black part is a positioning pin. The positioning pin of the balance shaft assembly is not in contact with the bottom surface of the balance shaft assembly and the distance is greater than 1mm. It doesn't meet the requirement.



There is no positioning pin in the positioning pin hole of the balance shaft assembly, it doesn't meet the requirement.



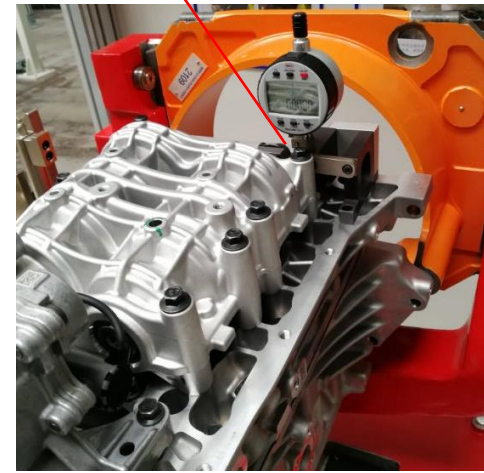
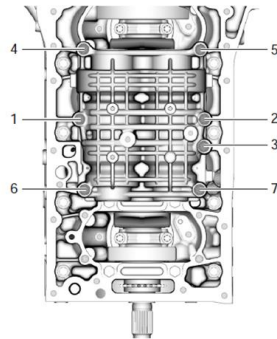
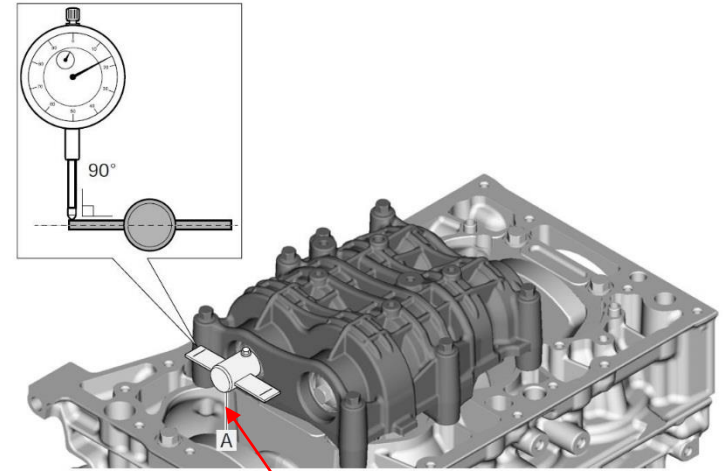
Balance shaft clearance measurement

After the balance shaft is assembled, the balance shaft clearance needs to be measured:

- Measure the balance shaft clearance at the 0 degree position of the crankshaft;
- Measure the balance shaft clearance at 90 degrees of the crankshaft;
- Measure the balance shaft clearance at 180 degrees of the crankshaft;
- Measure the balance shaft clearance at 270 degrees of the crankshaft;

All gap measurements must meet: 0.04mm-0.12mm

Note: Make sure that the dial gauge is stable before measuring the balance shaft.





Specific operation steps for balance shaft clearance measurement

No.	Operation
1	Use tooling to adjust the crankshaft to the zero position. Make sure the stop pin (B) is inserted in this position;
2	The balance shaft assembly (A) is assembled on the crankcase and the bolts are pre-tightened (the balance shaft housing can slide freely)
3	Take out the stop pin (B). First, as shown in Figure B, shake the balance shaft assembly in the direction of the arrow 1 until it stops. Then shake the balance shaft assembly in the direction of the arrow 2 until it stops. At this time, the balance shaft assembly is at the final installation position, and tighten the balance shaft assembly bolt with tightening torque (8 ± 1) N·m
4	Assemble and adjust the balance shaft backlash measurement tool. The measurement tool should be installed at the end of the exhaust balance shaft. The balance shaft backlash is measured at the crankshaft zero position to ensure that the measured value meets $(0.12-0.17)$ mm, and then the rotate crankshaft clockwise 90° , 180° and 270° , respectively measure the backlash of the balance shaft gear and fill in the data into the corresponding position in the second column of Table 1

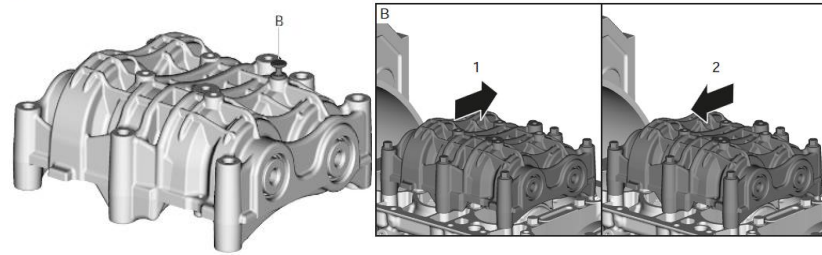


Table 1: Balance shaft backlash measurement record table

Crankshaft angle	8N•m	Tighten 210°
90°		
180°		
270°		

Table 2: Control the backlash value by manual adjustment (example of successful reinstallation)

Crankshaft angle	8N•m	Tighten 210°
90°	0.08 mm	0.05 mm
180°	0.09 mm	0.06 mm
270°	0.07 mm	0.04 mm



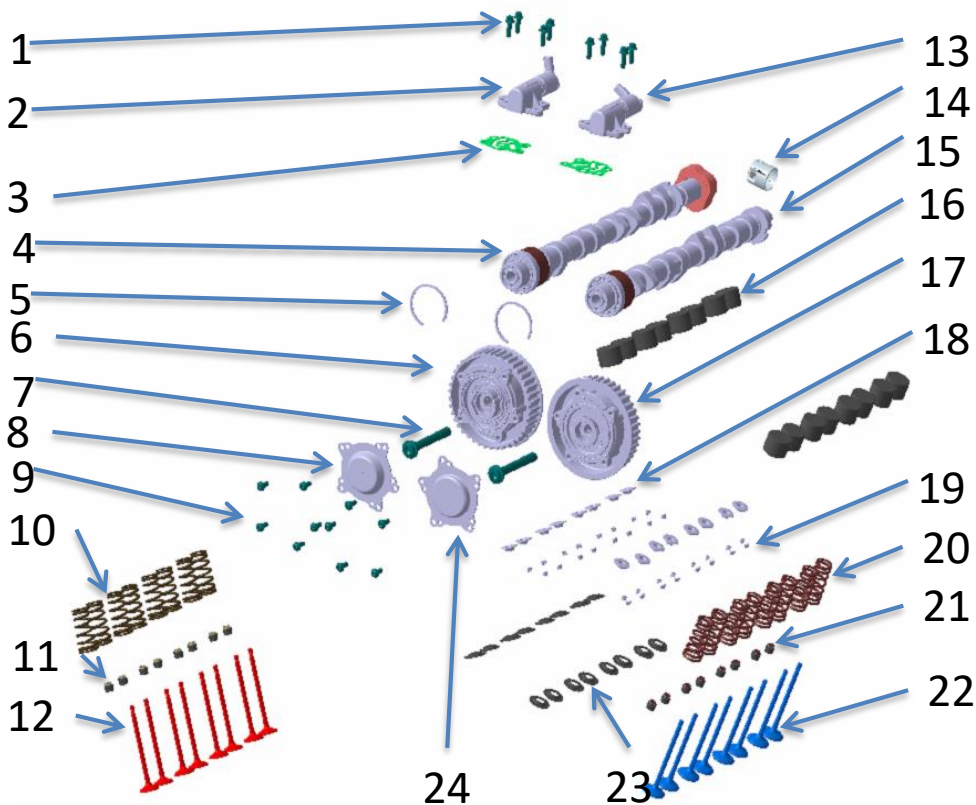
Specific operation steps for balance shaft clearance measurement

No.	Operation
5	If the three measurement data all meet (0.12-0.17) mm, tighten the balance shaft bolts by 210° and record the clearance
6	If the data in the three measurements are not within the reference range, turn the crankshaft to the position where the backlash is measured, loosen the balance shaft bolts, and then tighten the bolts with a torque of 1N•m, use a rubber hammer to gently knock the balance shaft to the exhaust side of the engine and measure the backlash until the measured value meets the requirements. Then tighten the balance shaft bolt to (8 ± 1) N·m and measure the gear backlash. Until all the data meets (0.12-0.17) mm, otherwise repeat step 6 until qualified
7	Measure the backlash of the balance shaft again, and fill in the measured value into the corresponding position in the third column of the table1
8	If the three measurement data all meet (0.04-0.12) mm, the test is qualified and continue to the next step of assembly
9	If the three measurement data fails to meet (0.04-0.12) mm, repeat steps 6, 7, and 8 until it is qualified.

Mechanical system



Air distribution system

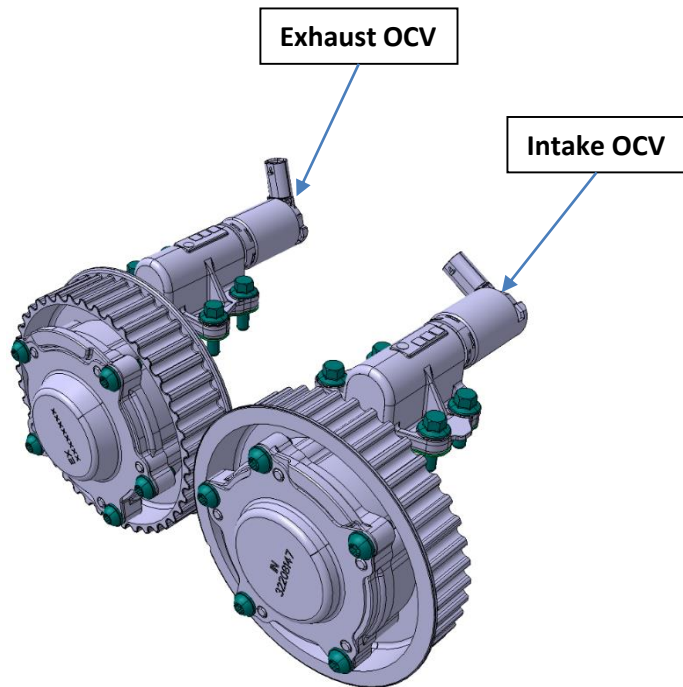


No.	Name	quantity	No.	Name	quantity
1	Hexagon flange bolts	8	13	Intake oil control valve	1
2	Exhaust oil control valve	1	14	Oil pump tappet	1
3	Oil control valve gasket	2	15	Intake camshaft assembly	1
4	Exhaust camshaft assembly	1	16	Valve tappet	16
5	Camshaft bearing retaining ring	2	17	Intake VVT components	1
6	Exhaust VVT components	1	18	Valve spring seat	16
7	VVT bolt	2	19	Valve collet	32
8	Exhaust VVT cover	1	20	Intake valve spring	8
9	Hexagon socket pan head screws	10	21	Intake valve oil seal	8
10	Exhaust valve spring	8	22	Intake valve	8
11	Exhaust valve oil seal	8	23	Valve spring lower seat	16
12	Exhaust valve	8	24	Intake VVT cover	1



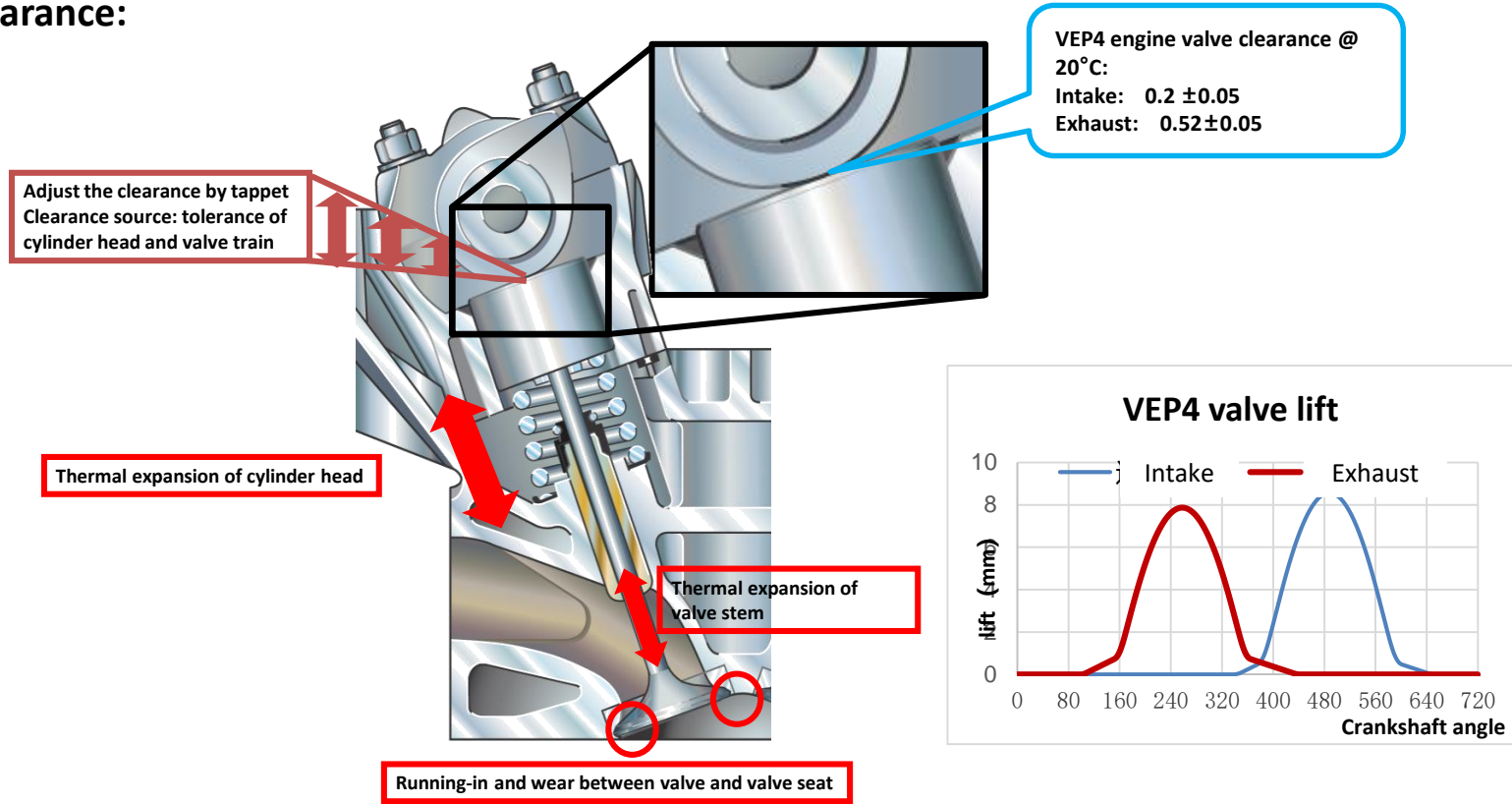
Precautions for assembly of VVT system of VEP4 engine

1. VVT and OCV components have strict requirements for the clearance of each component. If they fall during disassembly and assembly, they cannot be used. Need to replace with new VVT, OCV to ensure qualified flow characteristics
2. The intake and exhaust of the OCV valve cannot be reversed.
3. OCV wiring harness interface is easy to be polluted, the assembly environment should be clean, pay attention to dust protection.
4. The VVT cover plays a role of sealing. Take care to avoid missing the sealing ring between the cover and the VVT.
5. The OCV valve gasket is a one-time part and needs to be replaced every time it is disassembled and assembled.





Valve clearance:

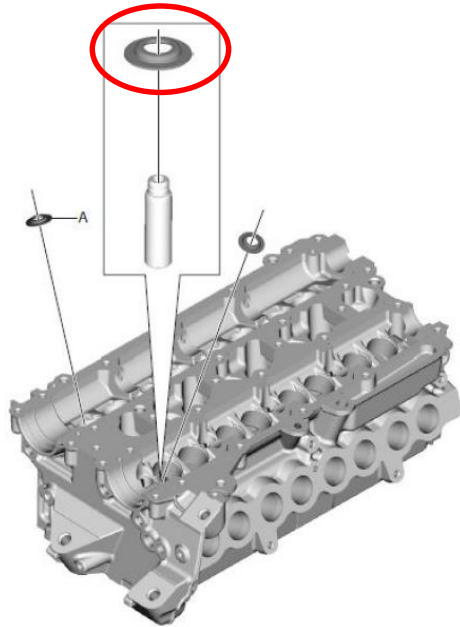


Tappet clearance adjustment is an important guarantee for the valve train to meet engine function and NVH requirements



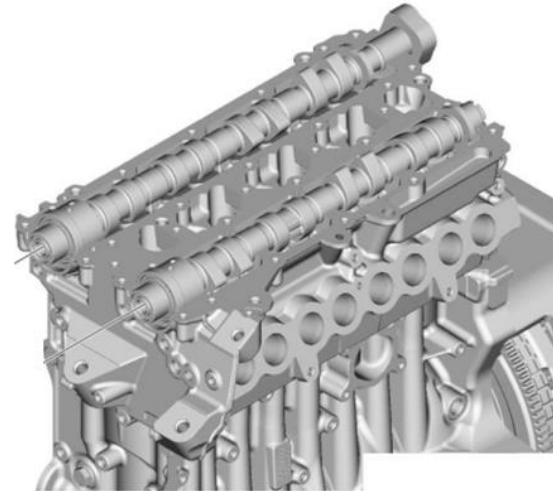
Precautions for disassembly and assembly of valve drive mechanism:

When assembling the valve spring lower seat, the valve spring lower seat need to be installed in the correct direction, as shown in the figure, with the large diameter surface down.



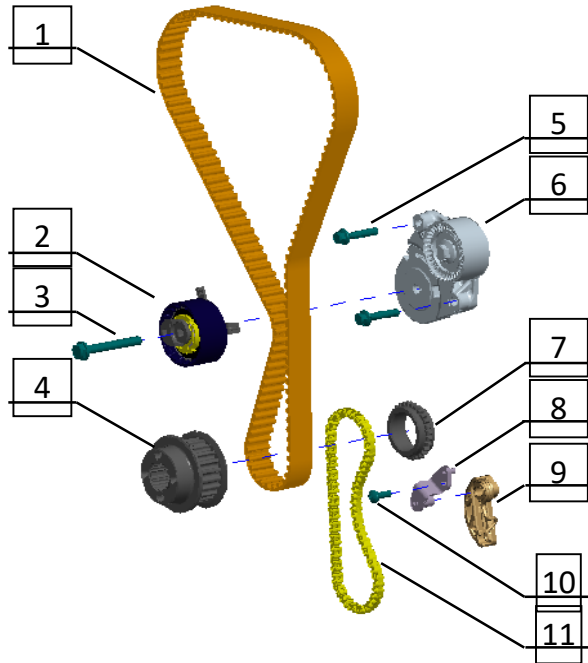
When checking the valve clearance, use tooling to hold the camshaft, adjust the base circle to the valve tappet, measure it with a feeler gauge, and match it.

Ensure the clearance on the intake side: 0.2 ± 0.05 ; clearance on the exhaust side: 0.52 ± 0.05 。





Timing system component

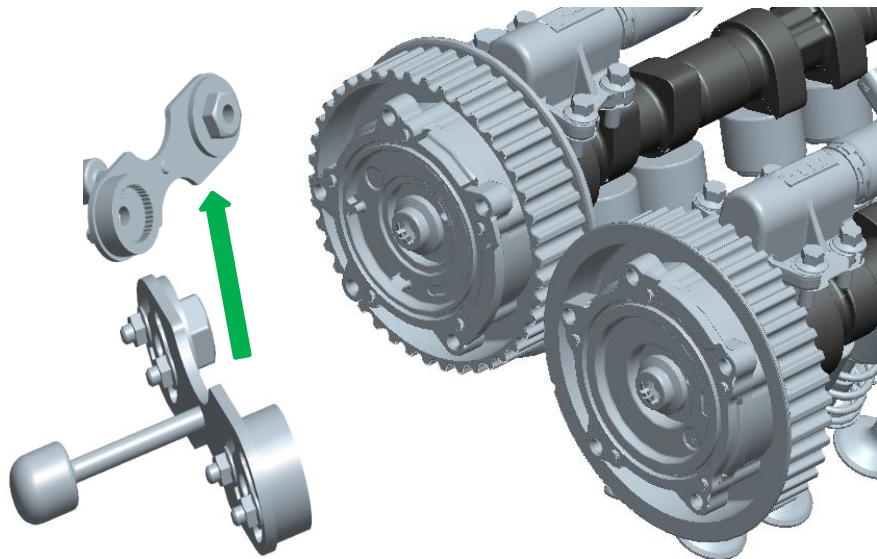


No.	Name	Part code	quantity
1	Timing belt	5500001140	1
2	Timing belt tensioner	5500001145	1
3	Hexagon combination bolt	5500001146	1
4	Crankshaft timing pulley	5500001141	1
5	Hexagon flange bolt	8888006490	2
6	Timing idler	5500001147	1
7	Crankshaft sprocket	5500001148	1
8	Oil pump chain tensioner bracket	5500001151	1
9	Oil pump chain tensioner	5500001150	1
10	Hexagon socket pan head screws	8888006538	1
11	Oil pump chain	5500001149	1



Precautions for assembly of VVT system of VEP4 engine

When installing and removing VVT bolts, the rear end of the camshaft is fixed with a positioning tool, while the front end is fixed with a VVT fixing tool to reduce the force on the camshaft tail groove.



VVT fixing tool

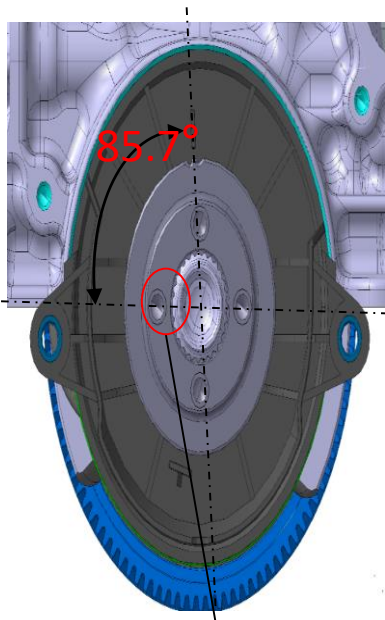


Camshaft fixing tool





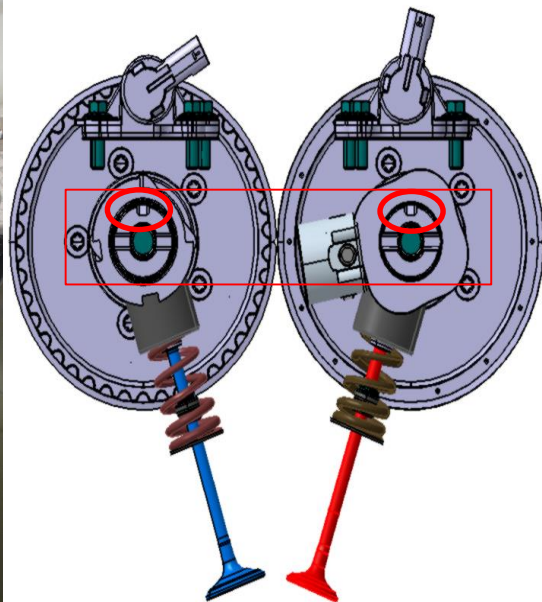
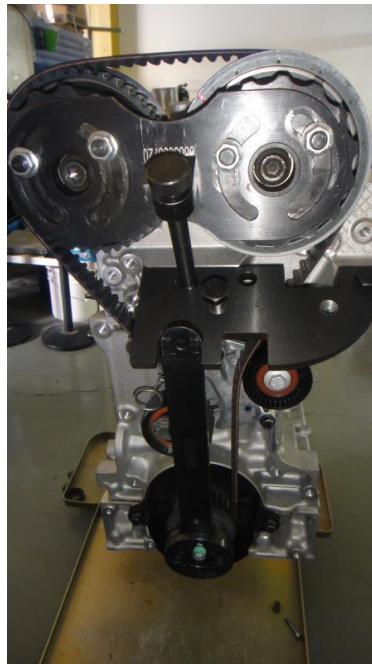
Crankshaft zero position:



Spline missing teeth in horizontal position



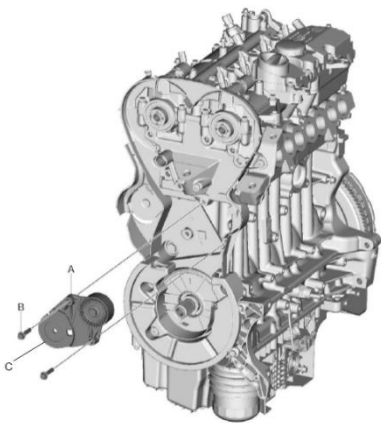
Camshaft zero position:



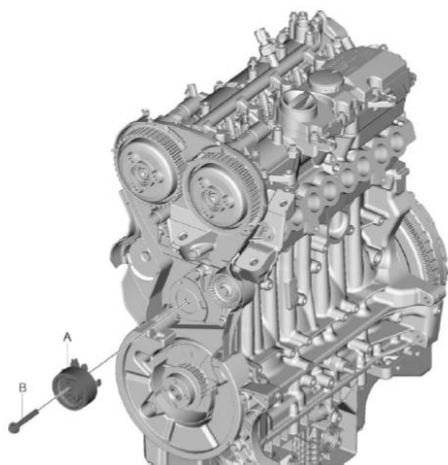
The rear grooves of the two camshafts are horizontal
Notch logo facing up



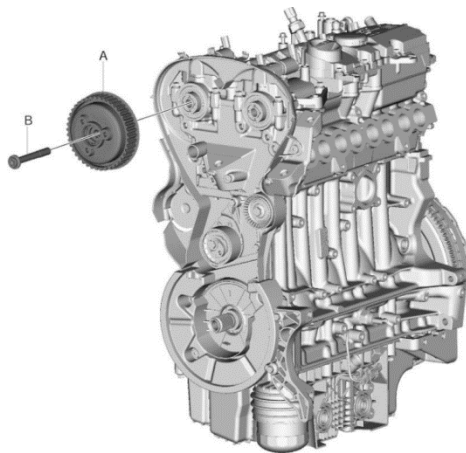
Timing installation steps



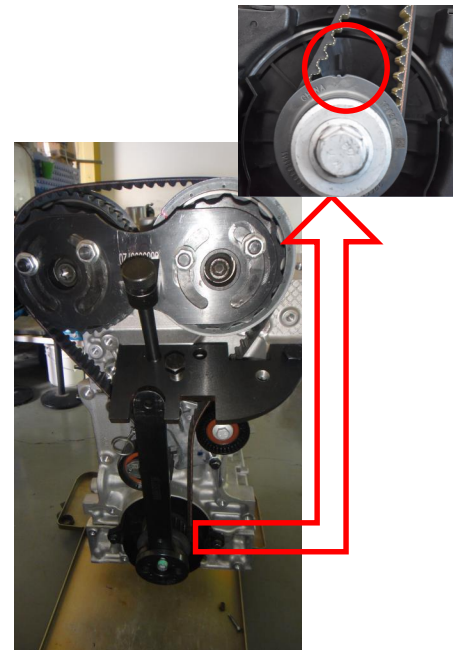
1. Fix the timing idler to the cylinder block with hexagonal flange bolts and tighten as required



2. Fix the timing belt tensioner to the timing idler bracket with hexagonal combination bolts, and pre-tighten the hexagonal combination bolts.
Note: Do not install the timing belt tensioner on a hot or not completely cooled engine. (The temperature remains the same)



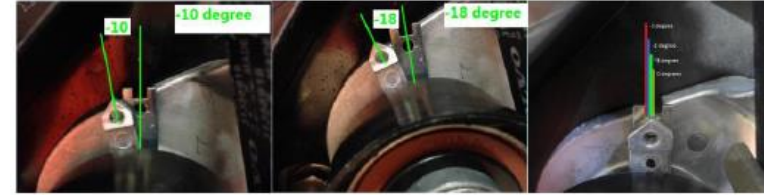
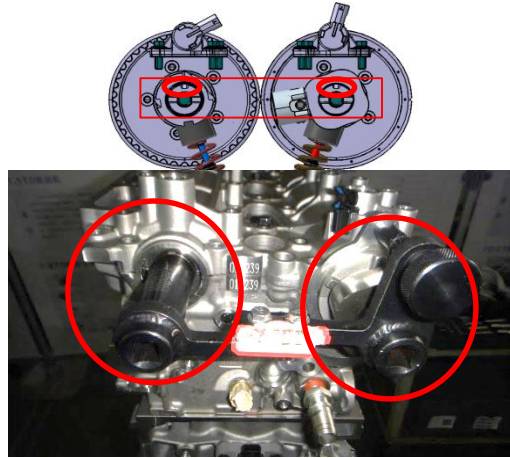
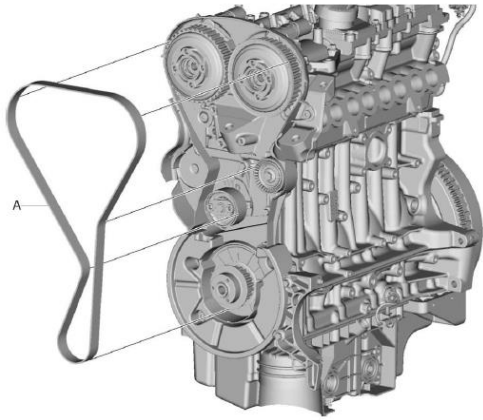
3. Before installing the VVT fixture, manually pre-tighten the inlet and exhaust VVT with VVT bolts. (Do not tighten at this time, when the timing belt tensioner is installed, tighten the VVT bolts according to the specified torque).
Note: The baffle on the exhaust VVT pulley faces the inside of the engine; the baffle on the intake VVT pulley faces the outside; VVT bolts can only be used once, and the tightened bolts cannot be reused.



4. Rotate the crankshaft and use the crankshaft timing tool to ensure that the pointer of the crankshaft timing pulley assembly is aligned with the mark on the front oil seal of the crankshaft.



Timing installation steps



5. Put the timing belt on the crankshaft timing pulley assembly and the VVT pulley to ensure that all the teeth can mesh with the pulley correctly. Tighten the belt counterclockwise from the crankshaft timing pulley assembly until the belt is installed on the timing belt tensioner. After completing the belt assembly, make sure that the belt position is in the middle of the VVT pulley. Note: It is strictly forbidden to twist the timing belt.

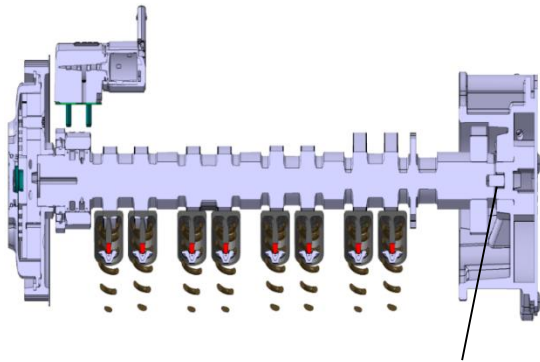
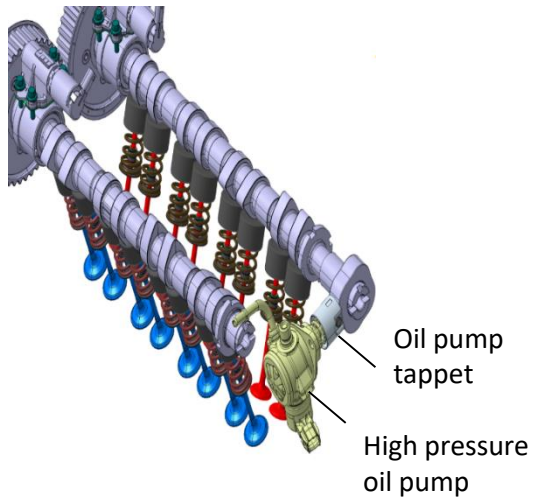
6. Determine the camshaft position through the camshaft fixing tool;
Note: Incorrect adjustment of the camshaft zero position may cause engine failure;
Ensure that the following operations are performed in the locked position and the marks on both camshafts are correct;
1. Use the locking arm of the tooling to locate the camshaft groove;
 2. Move the locking arms up to lock them in the correct position;
 3. Do not remove the zero positioning tooling before completing the VVT adjustment.

7. The specific steps of removing the positioning pin of the tensioner, tightening the VVT bolt and the hexagonal combination bolt:

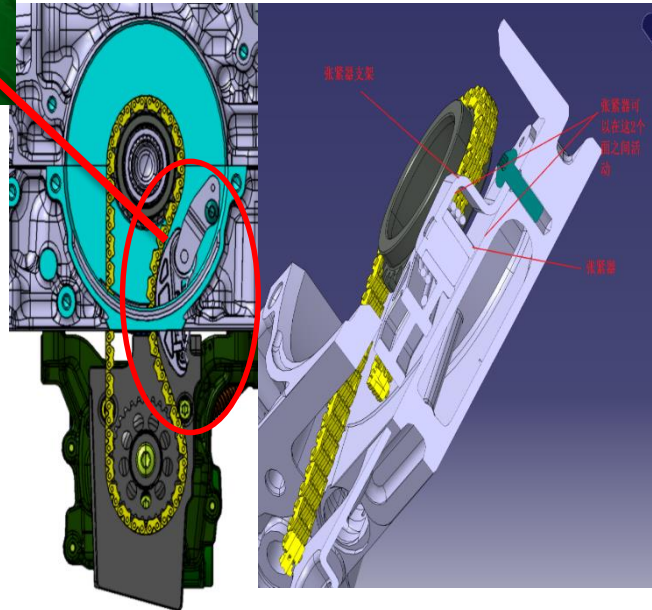
1. Load the tensioner until the pointer of the tensioner cannot rotate;
2. Tighten the VVT bolts with a torque $90 \pm 9 \text{ Nm}$.
3. Manually adjust the tensioner adjustment arm clockwise until the tensioner pointer reaches between $-18^\circ \sim -10^\circ$, and then change the direction to adjust the tensioner adjustment arm counterclockwise until the tensioner pointer reaches -2° . Now the pointer is located in the gap;
4. Lock the tensioner adjustment arm; tighten the tensioner hexagonal combination bolts.
5. Tighten the bolts of the VVT cover.
Note: Ensure that the sealing ring is installed in place before tightening the VVT cover.



Transmission relationship introduction :



The vacuum pump and the exhaust camshaft are connected by a keyway



Drive oil pump function: no phase relationship, speed ratio 29:30

Drive high-pressure oil pump function: the relationship between the phase of the exhaust cam and the phase of the high-pressure oil pump has requirement, which is guaranteed by the exhaust camshaft. The speed ratio is 1:2, the crankshaft rotates 2 times, and the pump rotates 4 times.

Drive vacuum pump function: no phase relationship, speed ratio 2:1.



Timing belt introduction:

The timing belt is composed of canvas, rubber, and tension wire (glass fiber).



- A: tooth cloth
- B: rubber
- C: Glass cord
- D: Back (rubber or rubber + canvas)

No.	Item	Timing belt	Precautions for disassembly and assembly
1	Type	Dry	<p>1. Storage requirements: Temperature: 15-25°C dry environment Can not be directly exposed to sunlight and high temperature In original packaging</p> <p>Keep away from flammable and corrosive fluids, such as lubricants and acidic substances</p> <p>2. Precautions for assembly: Do not bend the belt. The minimum bending radius of the belt shall not be less than 50mm, otherwise the belt cord will be damaged Install the belt according to the operating instructions, and wind the belt on the pulley counterclockwise If there are difficulties in assembly, it is strictly forbidden to use tools to pry, beat the belt and other illegal operations, otherwise it will damage the belt cord Do not allow the belt to come into contact with water, oil, coolant, fuel, cleaning fluid and other chemical agents</p>
2	Tooth number	130	
3	Width	23	
4	Tooth profile		
5	Pitch	9.525mm	

Mechanical system

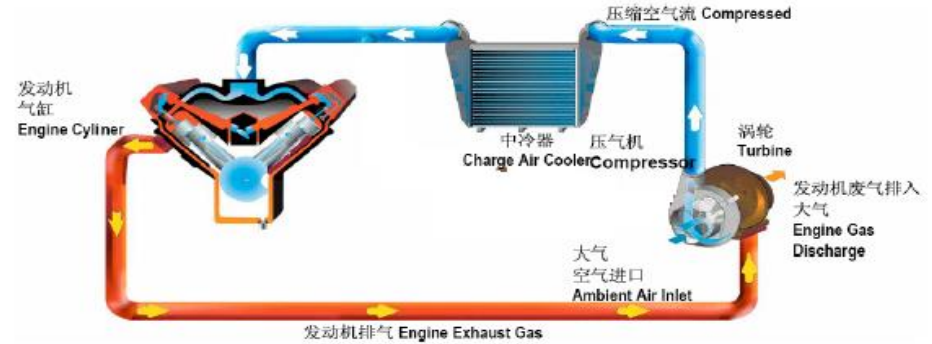


Turbocharger working principle

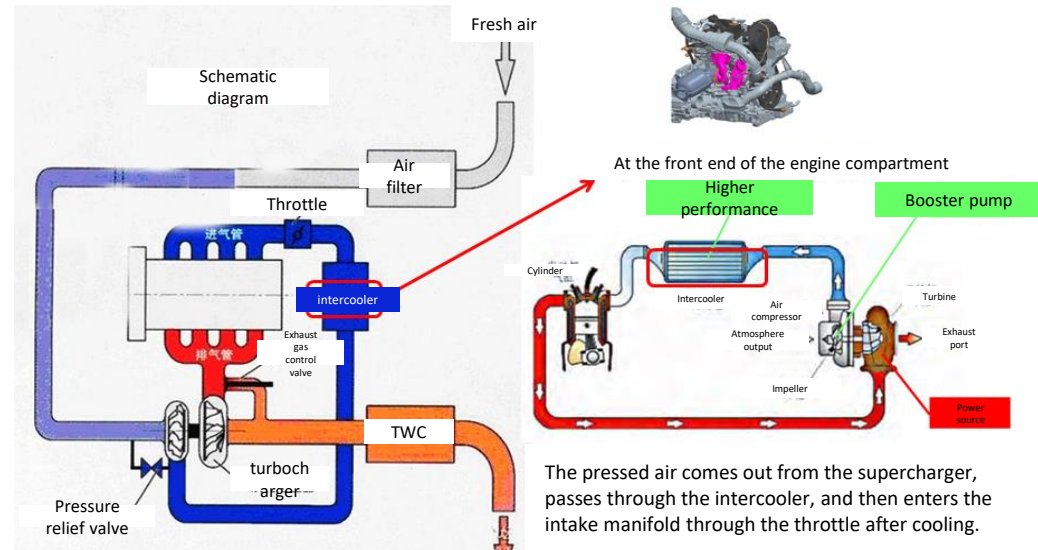
Turbocharger is actually a kind of air compressor, which increases the density of intake air by compressing air, thereby increasing the amount of intake air. It uses the exhaust gas pressure from the engine to drive the turbine in the turbine chamber. The high-pressure exhaust gas impacts the turbine to make it rotate at a high speed. The turbine drives the coaxial impeller, which can operate at high speed to compress the intake air. This speed is very high which is between 100,000 and 240,000 rpm. When the engine speed increases, the exhaust gas discharge speed and the turbine speed also increase simultaneously. Within the boost pressure range, more fresh air is pressed into the cylinder, which effectively improves the fuel utilization rate and outputs higher power.

Air circulation route:

The air circulation status of the turbocharging system. The high-temperature and high-pressure exhaust gas from the exhaust manifold drives the turbocharger turbine; the turbine drives the impeller, which pressurizes the intake pipe air and sends it to the intercooler. The compressed gas has a higher temperature, after being cooled by the intercooler, the high-pressure room temperature air is sent to the engine intake system and finally into the combustion chamber.



Working principle diagram of turbocharger engine



The pressed air comes out from the supercharger, passes through the intercooler, and then enters the intake manifold through the throttle after cooling.



Turbocharger electronic control and pressure control strategy

Control strategy when boost pressure is lower than target value

When the boost pressure is lower than the target, the ECU adjusts the duty cycle, the vacuum control valve works, and the actuator pulls the lever to slowly close the waste gas valve (to the target boost pressure), that is, more exhaust gas is required to enter the turbo to perform work .

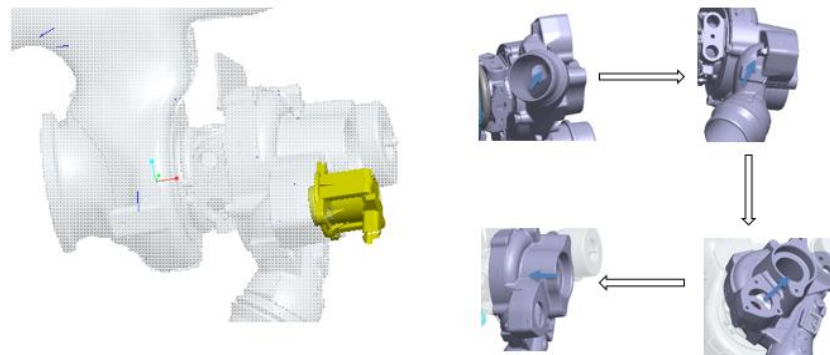
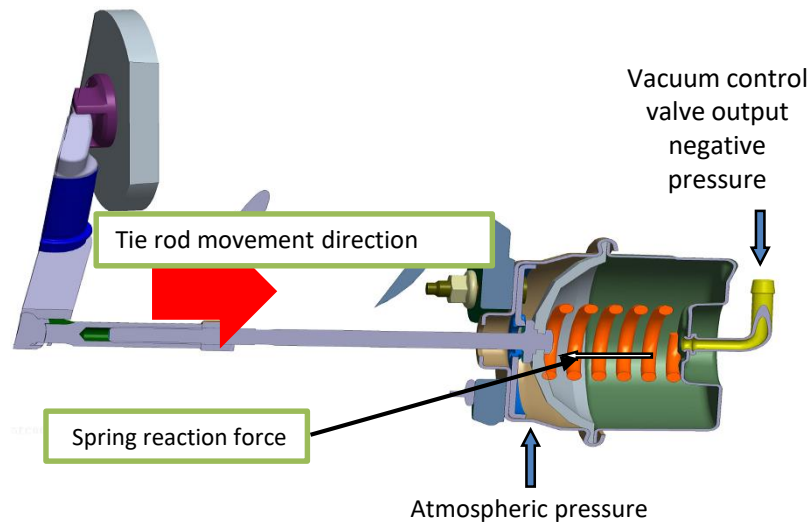
Control strategy when boost pressure exceeds target value

When the engine speed increases and the boost pressure provided by the turbocharger exceeds the specified value (cut-off point), the vacuum control valve work input negative pressure is the maximum, the actuator rod is pulled to the maximum, the exhaust valve is fully opened, and part of the exhaust does not pass through the turbine to adjust the turbine speed and keep the boost pressure around the target value.

Turbocharge protection control:

Intake protection: When the engine is decelerating rapidly, in order to avoid damage caused by high-pressure air directly acting on the electronic throttle, the intake pressure relief valve opens at this time;

Exhaust protection: The control unit controls the opening and closing of the exhaust pressure relief valve according to the working load of the engine to control the supercharging effect of the turbocharger; at the same time, it also protects the turbocharger to avoid damage caused by high speed;



Schematic diagram of pressure relief trend



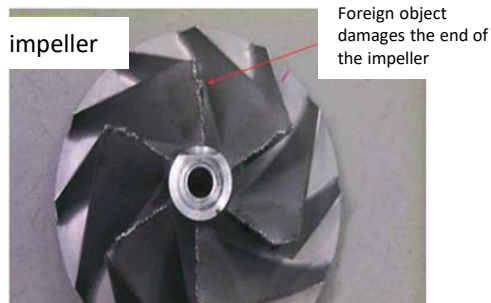
Precautions for turbochargers

Precautions for gear train

- Do not allow foreign objects to enter the volute runner
- Do not allow foreign objects to enter the compressing housing runner
- Do not allow foreign objects to enter the pipeline before pressurization
- Do not allow foreign objects to enter the pipeline after pressurization
- Do not allow to use unqualified and unmatched air filters (Prevent inhalation of foreign objects)

Failure analysis-foreign body damage

Reason: Foreign object comes from the air filter/intake pipe



Impeller damage
The temperature of the outlet gas of the turbocharger increases abnormally (scraping the shell)
Insufficient boost pressure, substandard performance, abnormal noise, etc.



Reason: the object comes from engine
发动机异物吸入

Turbo damage
High-speed rotation is unbalanced, stuck, broken shaft, etc.
Insufficient boost pressure, substandard performance, abnormal noise, etc.

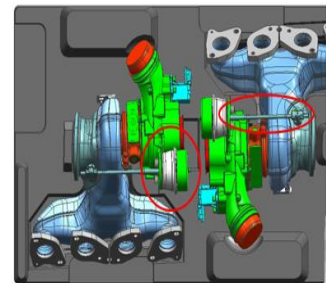
Foreign object destroys the periphery of the turbine



Bypass valve actuator:
The pressure setting and calibration of the bypass valve actuator assembly are carried out on the special setting/calibration organization, and customers and other personnel cannot change it at will



For the bypass turbocharger assembly, do not use the push rod installed outside as a handle to move the turbocharger, so as not to affect the sensitivity and reliability of the bypass valve actuator



The actuator faces upwards and it is not allowed to touch the ground



Precautions for turbochargers

1. There is metal friction sound

Phenomenon: black smoke from exhaust, power drop, and abnormal noise from the supercharger

Reason:

- (1) If there is metal friction sound, it is caused by excessive wear of the turbocharger rotor or thrust bearing, and the friction between the impeller and the turbocharger shell.
- (2) If it is not the sound of metal friction but the sound of airflow, it is the rotating sound produced by the high-speed rotation of the turbocharger rotor, or the air leakage caused by the poor connection at the inlet and exhaust ports.

2. The supercharger bearing is damaged

Phenomenon: The supercharger bearing is damaged, the engine power is reduced, the oil consumption is high, exhaust black smoke, and the supercharger cannot work in severe cases.

Reason:

- (1) Insufficient oil pressure and flow;
 - a. The lubricating oil supply of the turbocharger journal and thrust bearing is insufficient;
 - b. There is insufficient lubricating oil to keep the rotor journal and bearing floating;
 - c. The turbocharger has been running at high speed, but the lubricating oil has not been supplied in time.
- (2) Oxidation and deterioration of engine oil:
 - a. The oil is overheated, and there is too much gas passing between the piston and the cylinder wall;
 - b. Coolant leaks into the oil;
 - c. Improper selection of engine oil, and failure to change engine oil regularly as required.

Handling method:

- (1) Check whether the lubricating oil pressure is normal and whether the oil quantity meets the requirements.
- (2) Regularly replace the lubricating oil according to the specified requirements and ensure that the lubricating oil is clean.
- (3) Use lubricating oil in strict accordance with the specified requirements and not mix them.
- (4) The engine should be avoided to work under high temperature conditions, and the normal operating temperature of the engine should be maintained.



Precautions for turbochargers

3. Improper use of the turbocharger will shorten the life:

- (1) The installation is incorrect. According to the requirements, the floating bearing should be filled with oil before the turbocharger is installed to avoid that the oil cannot be supplied to the floating bearing in time when the engine is started, causing dry grinding and damaging the floating bearing.
- (2) Incorrect startup. After the engine with turbocharger is started, it must be idle for a few minutes to ensure that the supercharger can run at high speed after the oil reaches the floating bearing.
- (3) The shutdown is incorrect. Before stopping, run at idle speed for a few minutes to make the supercharger rotor gradually slow down and cool down. When the engine suddenly stops, the oil supply stops, and the rotor rotates at a high speed under the action of inertia. At this time, the floating bearing will wear out due to the high temperature and lack of oil, or even burnt.
- (4) The oil selection is incorrect. The thermal load and mechanical load of the engine equipped with a supercharger are greatly increased. The lubricating oil is required to have good viscosity-temperature characteristics, oxidation resistance and wear resistance. It is necessary to select high-quality synthetic engine oil.



Precautions for turbochargers

Precautions for startup

- When changing the oil, oil filter, installing a new turbocharger or using an engine that has been out of service for a long time, the turbocharger should be pre-lubricated before starting the engine.
- After starting, the engine should be operated under medium and small load for 3-5 minutes before entering full load operation to ensure good lubrication.

Precautions for running

- If the turbocharger has abnormal noise and obvious vibration during operation, it must not be used continuously.
- It is strictly forbidden for the car to adopt the operation method of "accelerate, flameout and coast in neutral". Because the engine suddenly turns off at full load and high temperature, the oil pump stops working, the lubricating oil cannot take away the heat from the parts in the supercharger, and the supercharger will be damaged due to overheating.

Precautions for parking

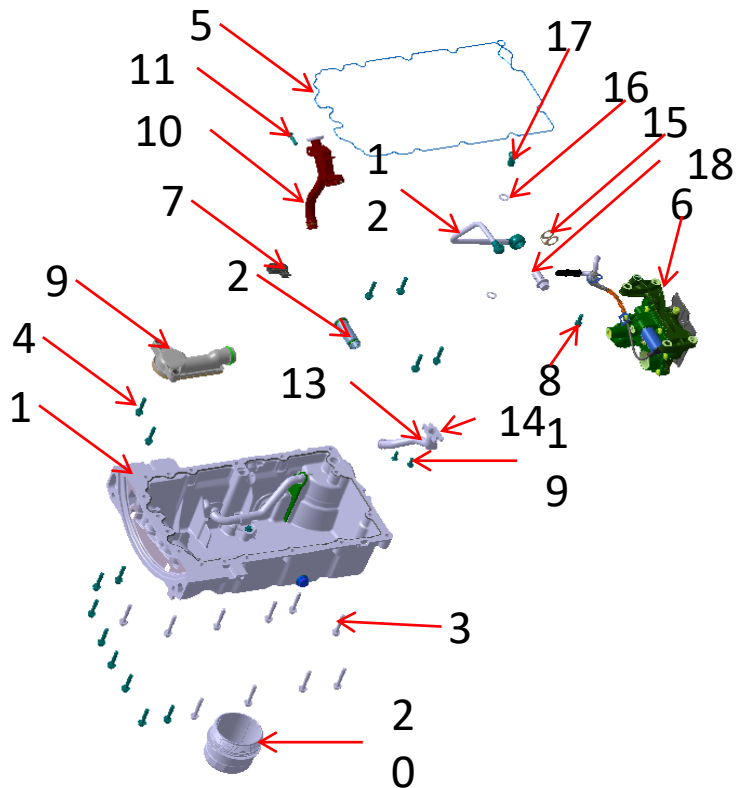
- Avoid immediate shutdown during high-speed and full-load operation. The speed and load should be reduced gradually. Run idling for 3~5 minutes before stopping to prevent damage to the turbocharger due to lack of oil in the bearing or overheating of the mechanical parts.
- Avoid prolonged idling of the engine (the maximum should not exceed 20 minutes).

Precautions for maintenance

- Repair and maintain at Geely designated after-sales service station.
- The pressure setting and verification of the bypass valve actuator assembly are carried out on the special setting/ verification organization, and customers and other personnel cannot change it at will.
- For the bypass turbocharger assembly, do not use the push rod installed outside as a handle to move the turbocharger, so as not to affect the sensitivity and reliability of the bypass valve actuator



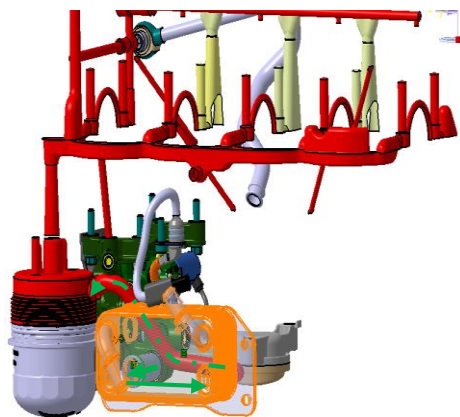
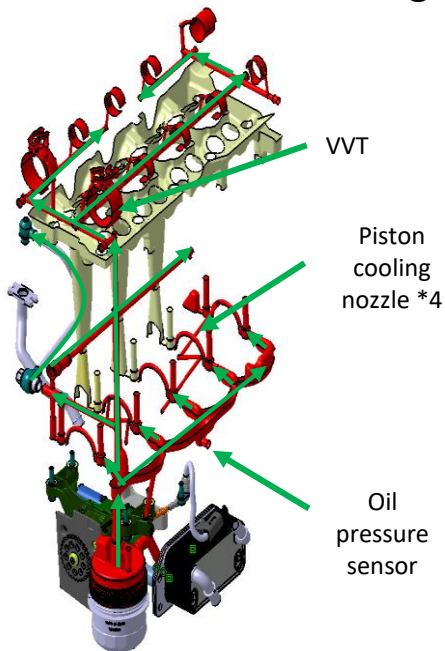
Lubrication system



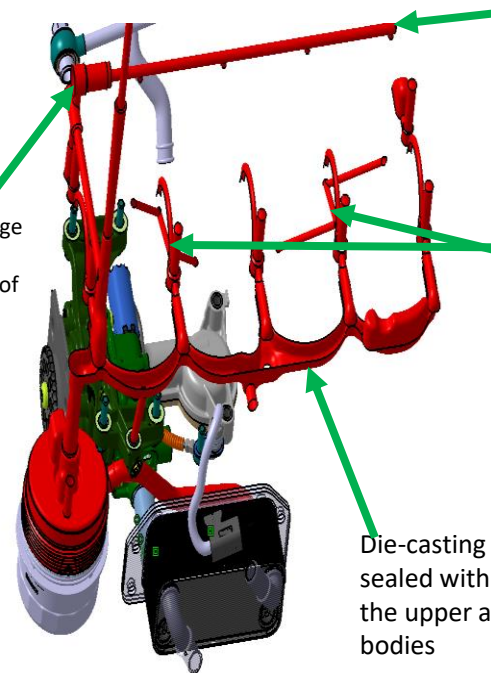
No.	Name	Quantity
01	Oil pan	1
02	Oil tube	1
03	Hexagon flange bolt	10
04	Hexagon flange bolt	14
05	Oil pan glue line	1
06	Oil pump	1
07	Wiring harness buckle	1
08	Hexagon socket head bolt	1
09	Oil strainer	1
10	Dipstick tube	1
11	Hexagon socket pan head screws	1
12	Turbocharger oil inlet pipe	1
13	Turbocharger oil return pipe	1
14	Turbocharger oil drain gasket	1
15	Turbocharger oil inlet pipe gasket	1
16	Gasket	2
17	Hollow bolt	1
18	Hollow bolt	1
19	Hexagon socket pan head screws	2
20	Oil filter	1



Oil circulation diagram



Piston cooling nozzle oil passage control valve, unified control of piston cooling nozzle opening and closing



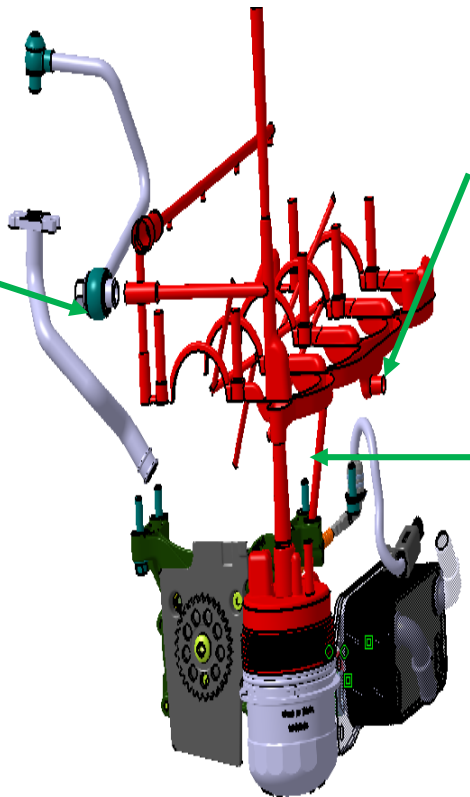
Separate piston cooling nozzle oil passage on the exhaust side, the nozzle can inject to the exhaust side of the piston, which is conducive to the heat dissipation of the piston

The second and fourth crankshaft main journal integrated oil passages supply lubricating oil to the connecting rod bearings of cylinders 1, 2 and 3 and 4 respectively

Die-casting oil passages, sealed with RTV glue between the upper and lower cylinder bodies



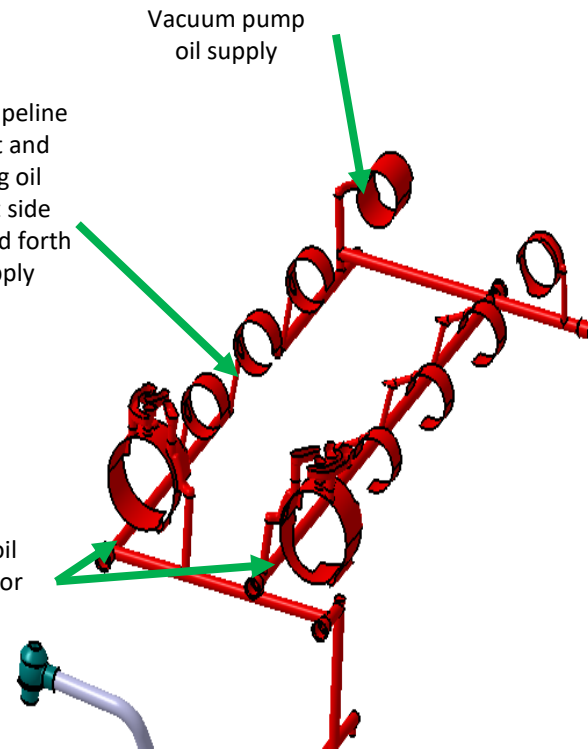
The oil supply of the turbocharger is close to the main oil passage, ensuring that the oil pressure build-up time of the turbocharger will not lag too far behind the main oil passage pressure



The oil pressure sensor is installed on the main oil passage to ensure the accuracy of the oil pump control input signal

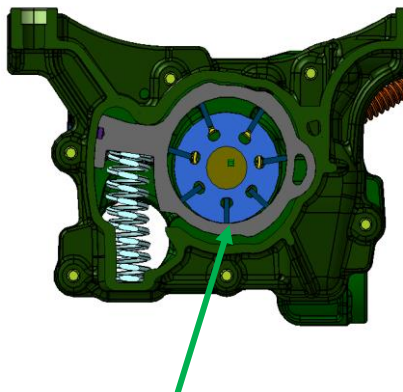
The oil pressure feedback of the oil pump is close to the main oil passage, ensuring accurate control of the main oil passage pressure

There are two-way oil pipeline at exhaust side. The first and second camshaft bearing oil supply form the exhaust side oil pipeline, the third and fourth camshaft bearing oil supply from the intake side oil pipeline.

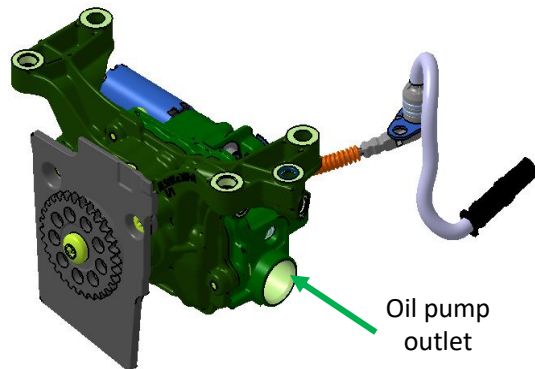
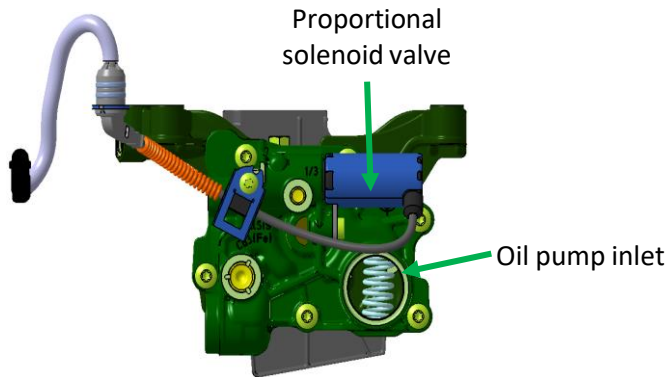




Fully variable displacement oil pump



Variable eccentricity vane pump structure



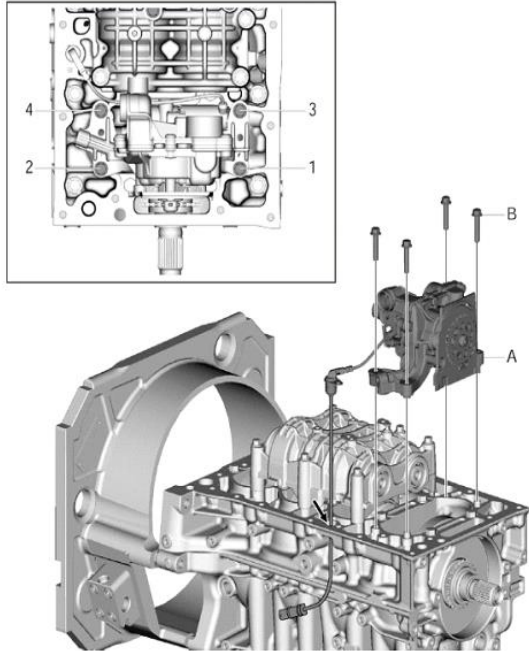
Driven by chain, vane pump, electric control fully variable flow

Note: Failure or abnormal operation of the oil pump will result in complete or partial failure of the lubrication system, and the vehicle may not be able to run!

1. Fixed speed, torque between 10NM~100NM, the oil pressure changes linearly, torque between 100NM~150NM and the oil pressure changes linearly. The torque above 150NM the oil pressure is fixed at 450kpa. ----Failure mode judgment
2. Fixed load, the oil pressure changes linearly in several different intervals of the speed. Above 3950RPM, the oil pressure is fixed at 450kpa.



Oil pump assembly requirements



Installation steps:

Install the oil pump A on the lower cylinder body, tighten the bolt B in the order shown in the figure, and then tighten it to $17 \pm 3 \text{Nm}$.

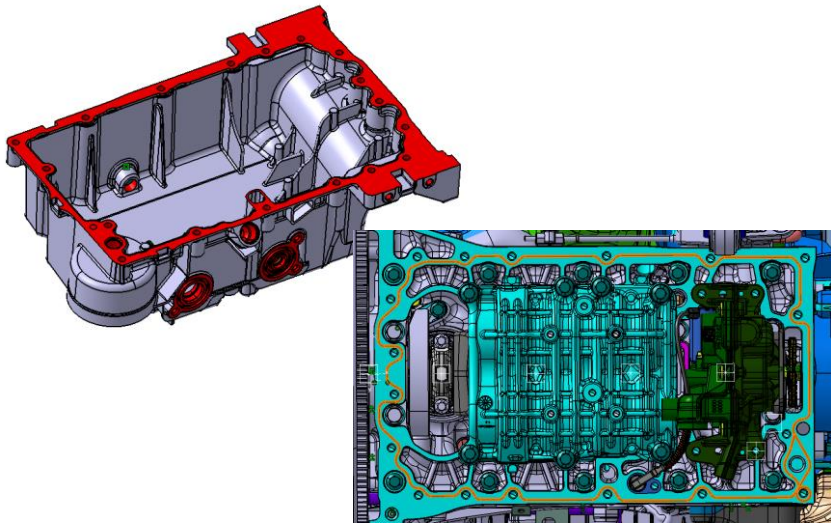
Other considerations:

Lubrication system sealing gaskets and sealing rings are for one-time use. The sealing gaskets and sealing rings must be replaced with new ones when re-assembling.

Pay special attention to that all bolts should be tightened according to the tightening sequence and torque requirements specified in the workshop manual, and any bolt surface damage should be replaced with new ones.



Oil pan and oil filter

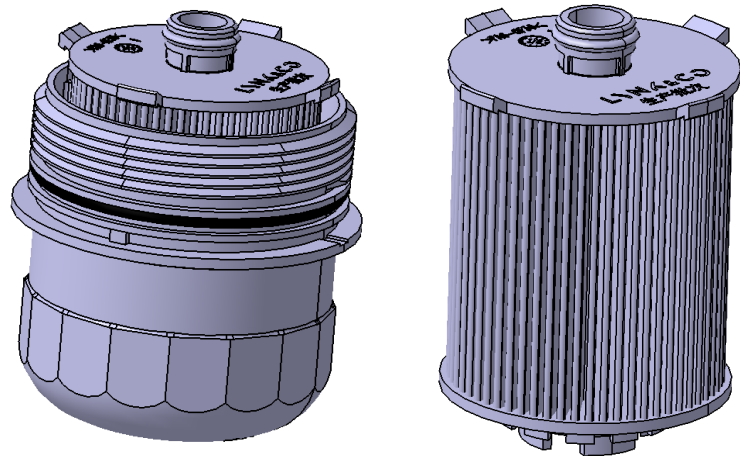


Note: When the oil is changed for maintenance and repair, the oil drain plug gasket must be replaced. The oil drain plug needs to be manually tightened to a torque of 45Nm. Electric and pneumatic tools cannot be used.

Oil pan glue line

Fill the micro gaps to form a reliable seal

Note: The assembly must be completed within 10 minutes after the glue is applied, and the glue line must be continuous, otherwise it needs to be cleaned and repainted.



Oil filter element: Refer to the user manual for regular replacement of the filter element.

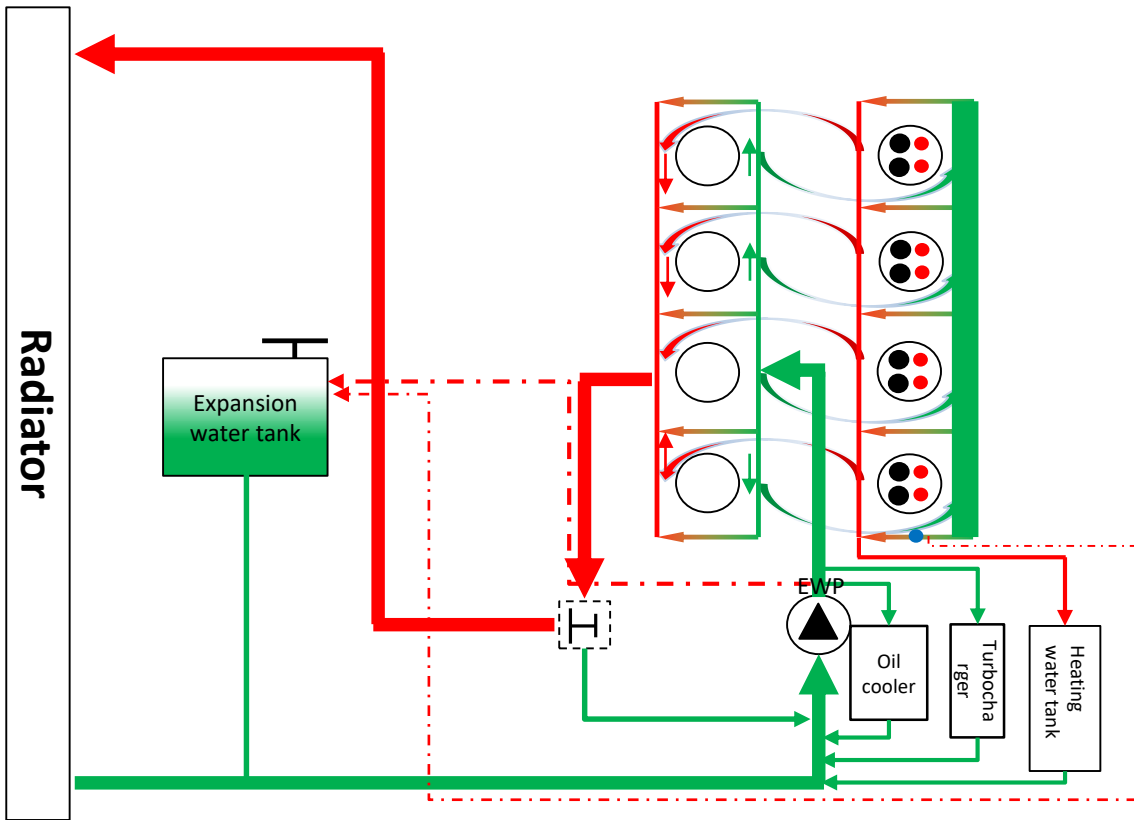
Extension: some oil filters are filled with oil additive slow-release agent to extend the oil life

Assembly precautions: Use tooling to install, tighten the torque to 25 ~ 30 Nm, reverse rotation by 30°, and then tighten to 25 ~ 30 Nm to avoid oil leakage caused by O-ring distortion.



Cooling system

Loop line

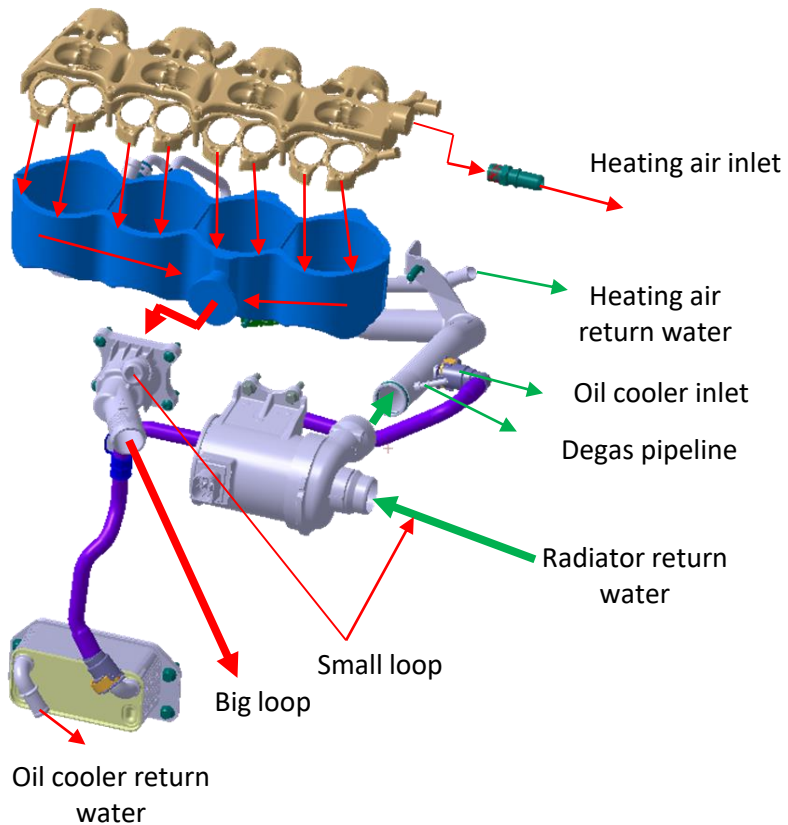


- High-temperature coolant
- Low-temperature coolant
- Water temperature sensor
- - - Degassing circuit

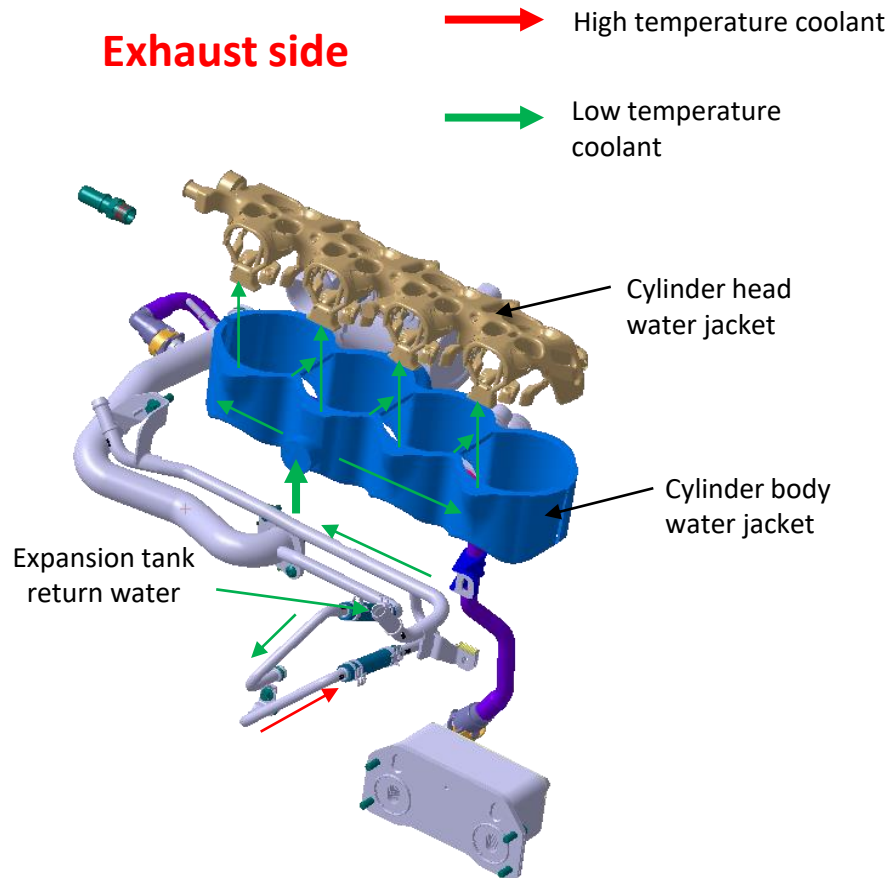


Loop line

Intake side



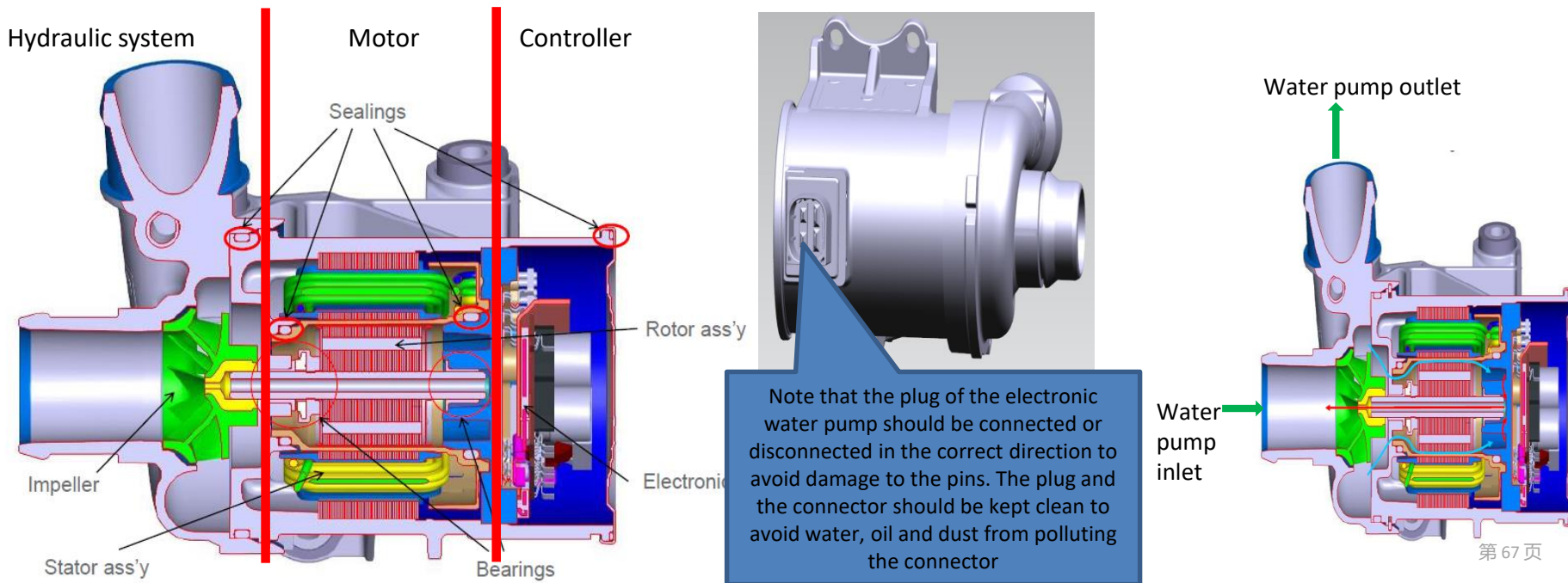
Exhaust side





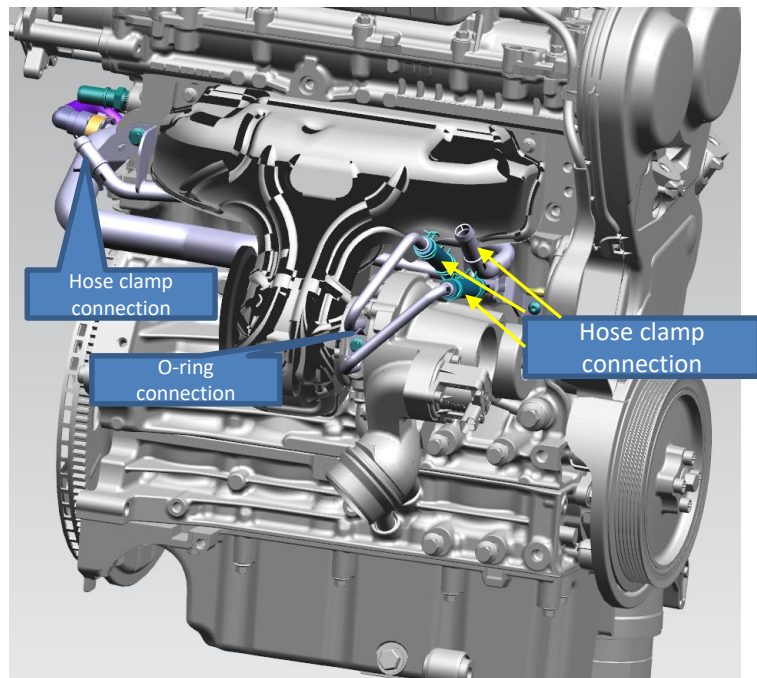
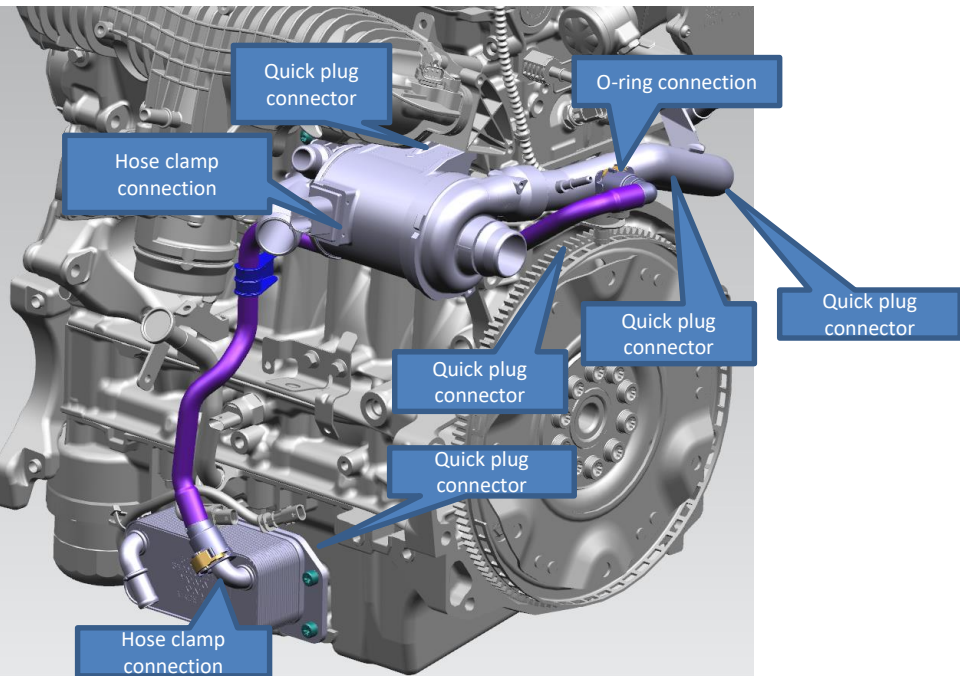
Electronic water pump

The VEP4 cooling system uses an electronic water pump as the main circulating pump. Compared with the traditional mechanical water pump, the electronic water pump provides the necessary flow or achieves zero flow according to the actual demand of the engine, reduces the power consumption of the engine, and shorten the warm-up time, which is more beneficial to the engine for temperature control, the electronic water pump is mainly composed of three parts, as shown below:





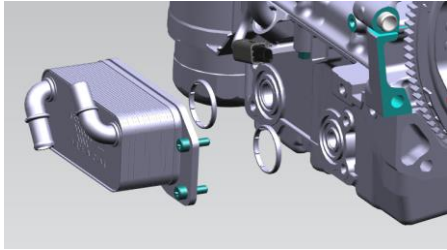
Precautions for assembly



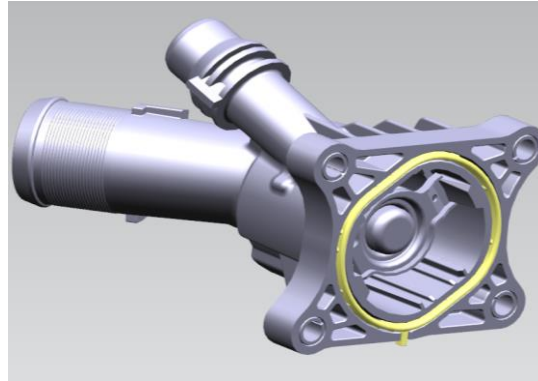
Note: When connecting the quick plug connector, please confirm whether it is installed in; when connecting the hose clamp, it must be aligned with the indication mark, and the clamp cannot be clamped on the metal pipe flange/bulge



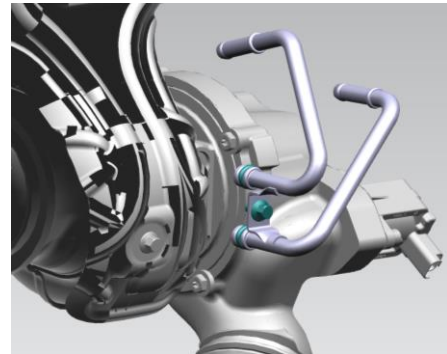
Water pipeline sealing



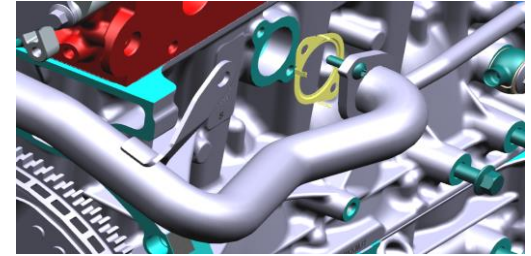
The oil cooler and the oil pan are sealed by two rubber sealing rings



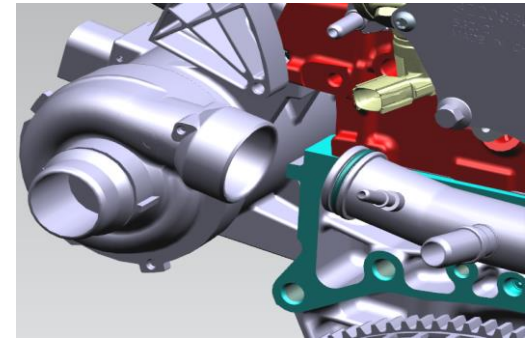
The thermostat and the cylinder are sealed by a sealing ring-integral parts (thermostat, sealing ring, housing)



The turbocharger water pipe and the turbocharger are sealed by 2 O-rings



The cylinder block water inlet pipe and the cylinder block are sealed by a composite gasket



The water inlet pipe of the cylinder block and the electronic water pump are sealed by the O-ring



Fuel rail assembly

Injector wiring harness

Fuel pressure sensor

High pressure fuel pipe

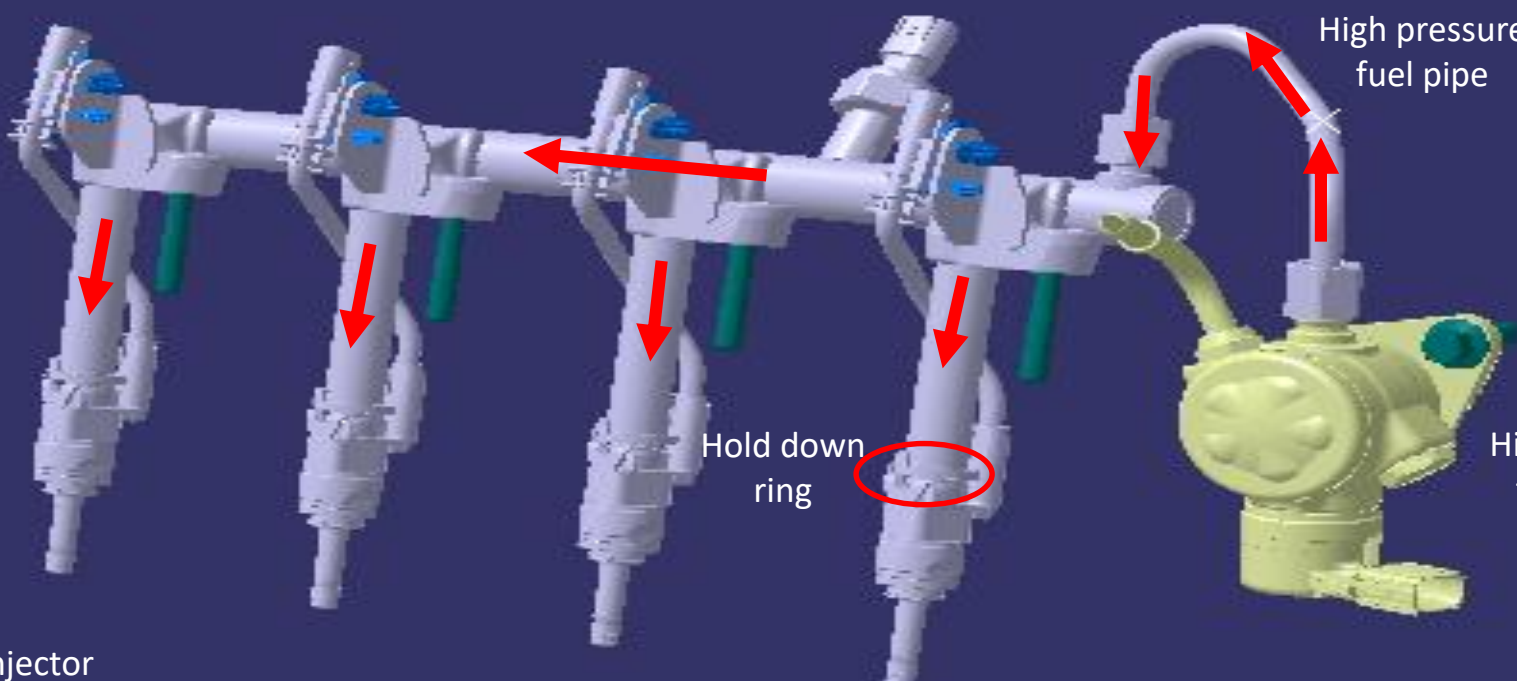
High pressure fuel pump

Hold down ring

Injector
LP、MP

Injector

Fuel supply system





Fuel system component

No.	Name	Quantity
01	High pressure pump	1
02	High-pressure pipeline	3
03	Fuel pressure sensor	3
04	Fuel rail	1
05	Injector wiring harness	4
06	Injector	4
07	Hold down ring	4

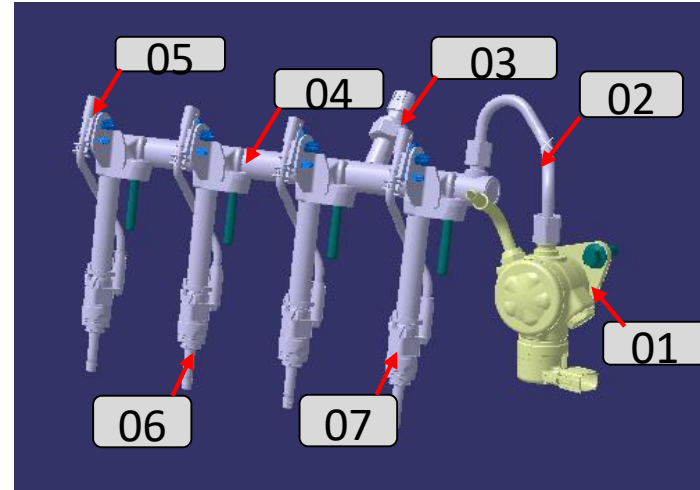
Working principle

The fuel system sends the fuel in the fuel tank to the engine. The high-pressure oil pump provides high fuel pressure for the fuel rail assembly. When the engine is idling, the pressure in the fuel rail is close to 11 Mpa. As the vehicle load changes, the pressure fluctuates between 12 Mpa and 20 Mpa. If the fuel pressure in the fuel rail exceeds 23.5 MPa, the safety valve in the high-pressure fuel pump will open to release fuel into the low-pressure side. The fuel rail delivers fuel to each fuel injector. The fuel injector is controlled by the ECM output electrical signal to turn on, and the fuel is injected into the cylinder for combustion in a predetermined spray pattern, and the fuel injection volume is adjusted according to the air pressure in the intake manifold.

Advantages of direct injection:

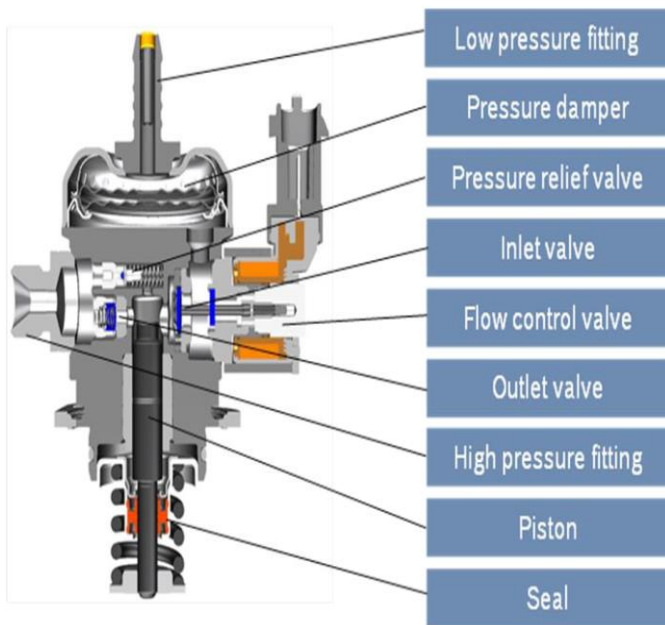
Low fuel consumption, low emissions, high output power.

Structure

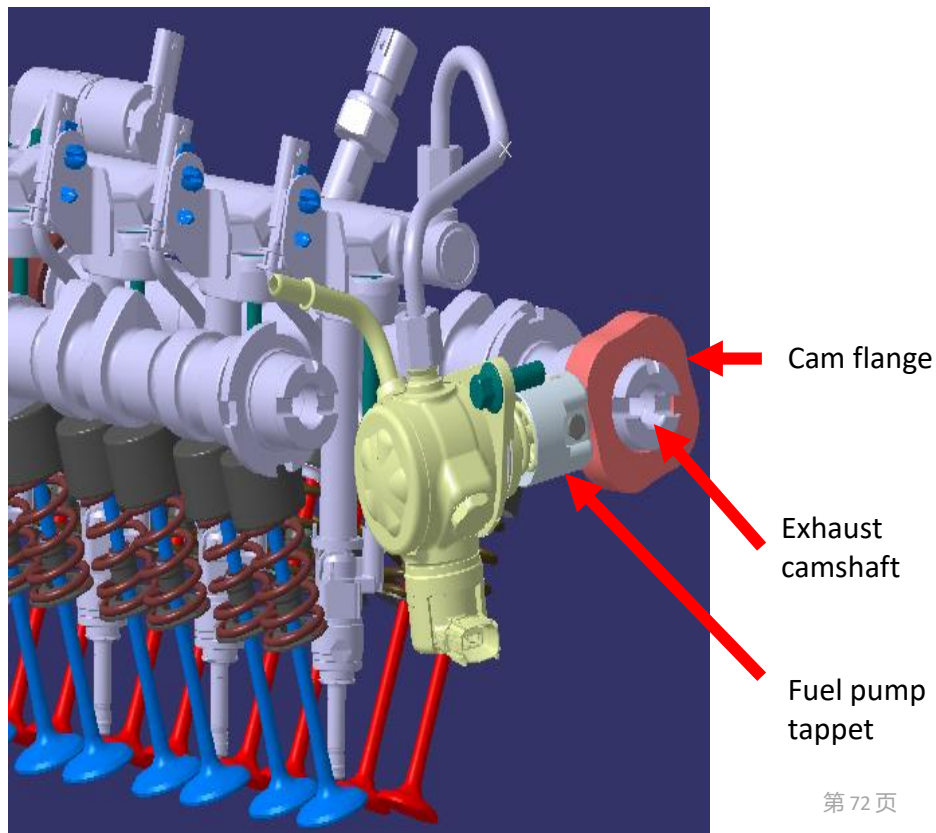




High pressure fuel pump structure (single cylinder plunger)

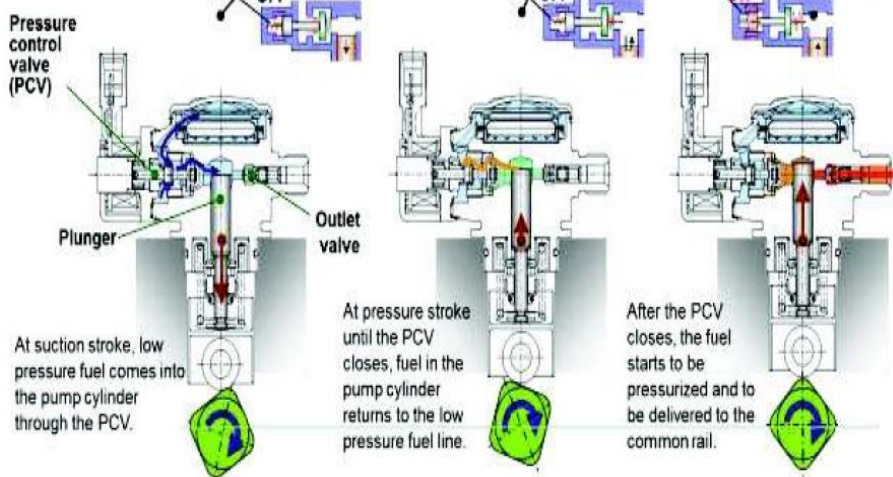
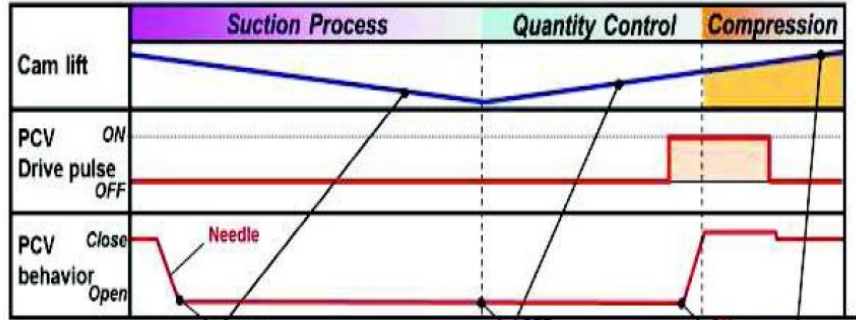


Drive schematic





High pressure fuel pump working principle



Assembly parameter

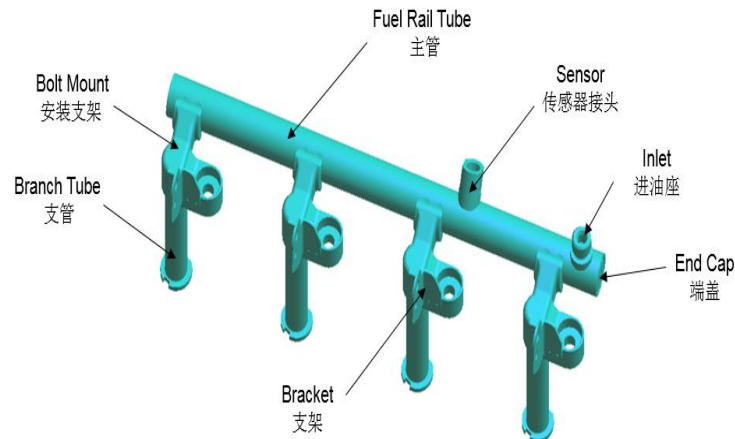
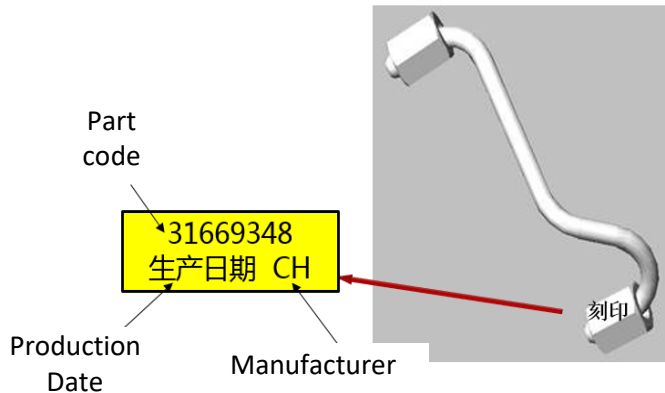
Fuel inlet joint diameter	$\Phi 7.89 \pm 0.06$ mm
Spring seat diameter	$\Phi 23.7 \pm 0.1$ mm
O-ring requirement	No bad appearance, lubrication required before assembly
Fuel outlet joint fitting cone angle	$60^\circ \pm 1^\circ$

Performance parameter

Plunger diameter	$\Phi 9.5$ mm
Coil resistance	0.5 ± 0.05 Ω
Flow control valve control quantity @3000rpm	120 ~ 160mm ³ /stroke
Flow control valve control quantity @300rpm	≥ 195 mm ³ /stroke
Pressure reducing valve opening pressure	23.5 (0, 0.5) MPa
Fuel pump stroke	4mm
Low pressure pump fuel supply pressure	4bar



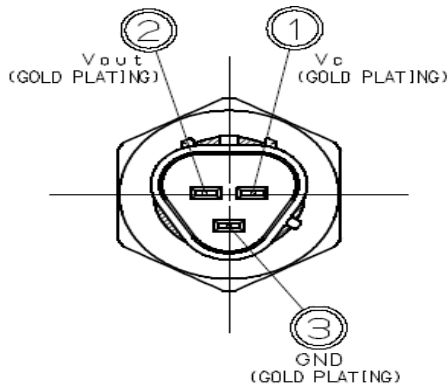
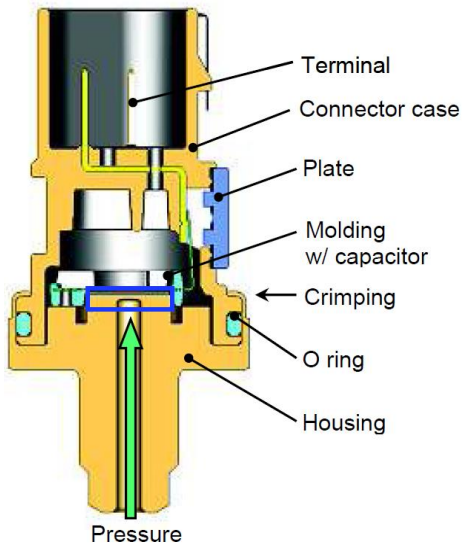
High pressure pipeline and fuel rail



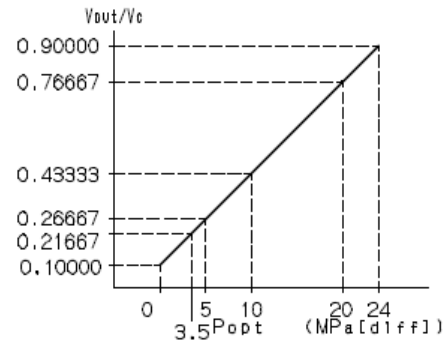
Injector mounting hole diameter	$4 \times \Phi 11.6 \pm 0.025 \text{ mm}$
Angle of fuel inlet joint	$90^\circ \pm 1^\circ$
The distance between the center of the fuel inlet joint and the center of the bracket	$3.2 \pm 0.3 \text{ mm}$
Bracket mounting hole diameter	$4 \times \Phi 8.3(0,0.1) \text{ mm}$
Angle of injector mounting hole and fuel rail axis	$66^\circ \pm 1.5^\circ$
Fuel inlet seat	$60^\circ (0,1^\circ)$
Leakage quantity @20MPa(cc/min)	≤ 0.07



The working principle and installation precautions of fuel pressure sensor



Terminal definition



Pressure and voltage relation curve

working principle:

The fuel pressure in the fuel rail directly acts on the sensor's sensing element (micro-melted silicon strain gauge). The sensing element generates a micro displacement proportional to the fuel pressure, which changes the resistance of the sensor. After processing by the sensor's internal signal processing circuit, output the pressure value which is proportional to the voltage value.

Installation Precautions:

- Apply appropriate lubricating oil SL grade 10W-30 on the mounting thread before the fuel pressure sensor;
- Clean the threads of the fuel pressure sensor before assembly;

Tightening method:

first pre-tighten $5 \pm 1\text{Nm}$, reverse rotation angle $5^\circ \pm 1^\circ$, tighten $5 \pm 1\text{Nm}$, rotation angle $29^\circ \pm 1^\circ$, monitor torque 10 ~ 40Nm.



Assembly requirements of fuel rail assembly

1. Assembly requirements of fuel rail assembly:

- The installation process needs to be in a clean environment, and no impurities are allowed in the sealing surface and the high-pressure fuel pipe interface;
- After the assembly is completed, a leak test is required. The ambient temperature is 20°C, the leak test pressure is 23.5MPa, and the qualified leak rate is 0.25cc/min;
- After the assembly is completed, the continuity test of the injector and the wiring harness is required.

Note:

- The fuel rail injector sub-assembly is a precision part. During the installation process, no damage to the injector end, sensor connector or high-pressure fuel pipe interface should be caused;
- Avoid any parts falling and being impacted. If they fall, they must be replaced with new ones.

2. Requirements for installing the fuel rail assembly to the engine:

No lubrication is required for the injector seals;

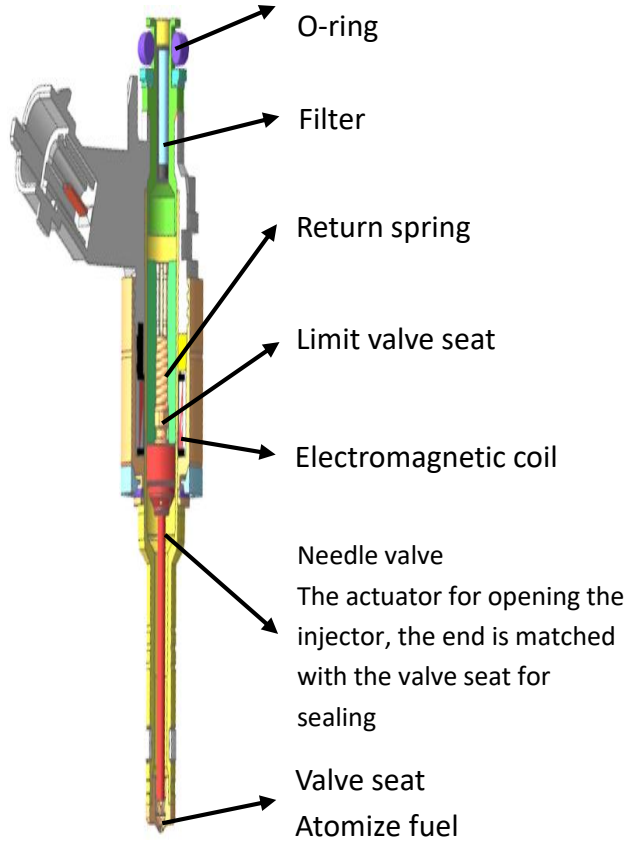
The injector should be aligned with the injector mounting hole, so that the rail injector assembly is installed in place in parallel, and the bolts are installed and tightened to the specified torque of 20 ± 1 Nm. When manually assembling, follow the order of 2nd cylinder, 4th cylinder, 1st cylinder and 3rd cylinder to tighten the bolts step by step, and finally tighten to the specified torque;

Note:

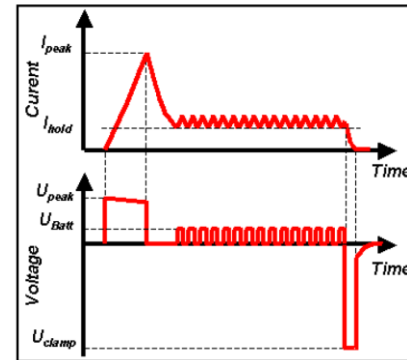
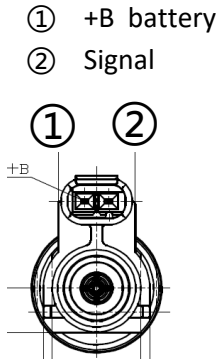
- Do not move the fuel rail injector assembly by holding the fuel injector or fuel pressure sensor, only apply force on the metal part of the fuel rail, not bend the fuel injector;
- When reinstallation is required, the bolts should be replaced;
- If the sealing ring and compression ring are damaged, they must be replaced.



Injector structure



- ① The injector is equivalent to a solenoid valve;
- ② When energized, the electromagnetic coil generates electromagnetic force, the armature and needle valve are attracted, the fuel injector is opened, and the fuel is injected into the combustion chamber through the nozzle hole;
- ③ When the power is off, the electromagnetic force disappears, the armature and needle valve are under the action of the return spring, the needle valve seating nozzle is closed, and the fuel injection is stopped;
- ④ The power-on and power-off of the fuel injector are controlled by ECU with electrical pulses;
- ⑤ The fuel injection quantity is determined by the pulse width;
- ⑥ Generally, the lift of the needle valve is about 0.1mm, the fuel injection duration is 2~10ms, and the VEP4 pulse width range is 0.8~5.6ms.

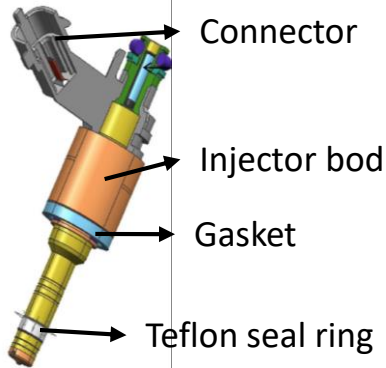


Item	Value (as reference)	
I_{peak}	Fuel Pressure	I_{peak}
	-4Ma MPa	8.7A
	4-10 MPa	9.7A
	10- MPa	10.5A
U_{peak}	65 V	
I_{hold}	3.0 A MIN	
U_{clamp}	65V	

Current-profile will be optimized for engine conditions.



Key parameters and precautions for fuel injection



Assembly requirement

Visual inspection:

1. First assemble the compression ring on the injector;
2. The compression ring and the injector are assembled together and then assembled on the fuel rail assembly. When assembling, ensure that the injector is aligned with the branch pipe of the fuel rail assembly, and ensure that the compression ring positioning bracket is aligned with the branch pipe positioning groove, along the common axis of the injector, lift the injector at a constant speed, the maximum insertion force is 180N.

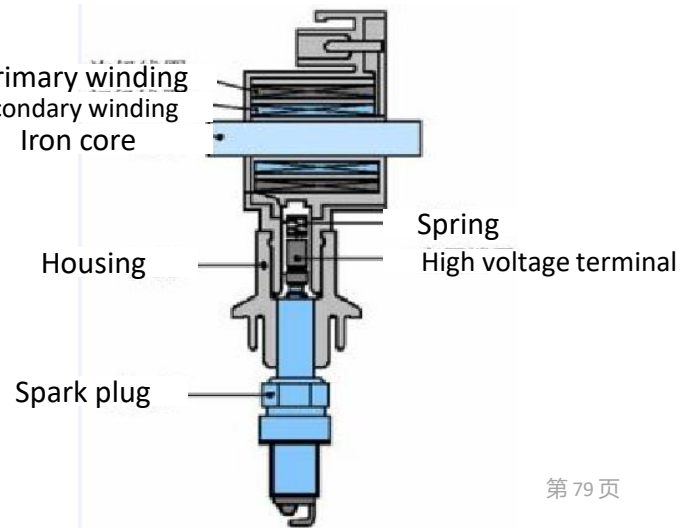
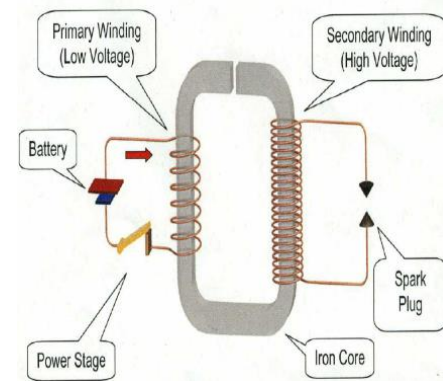
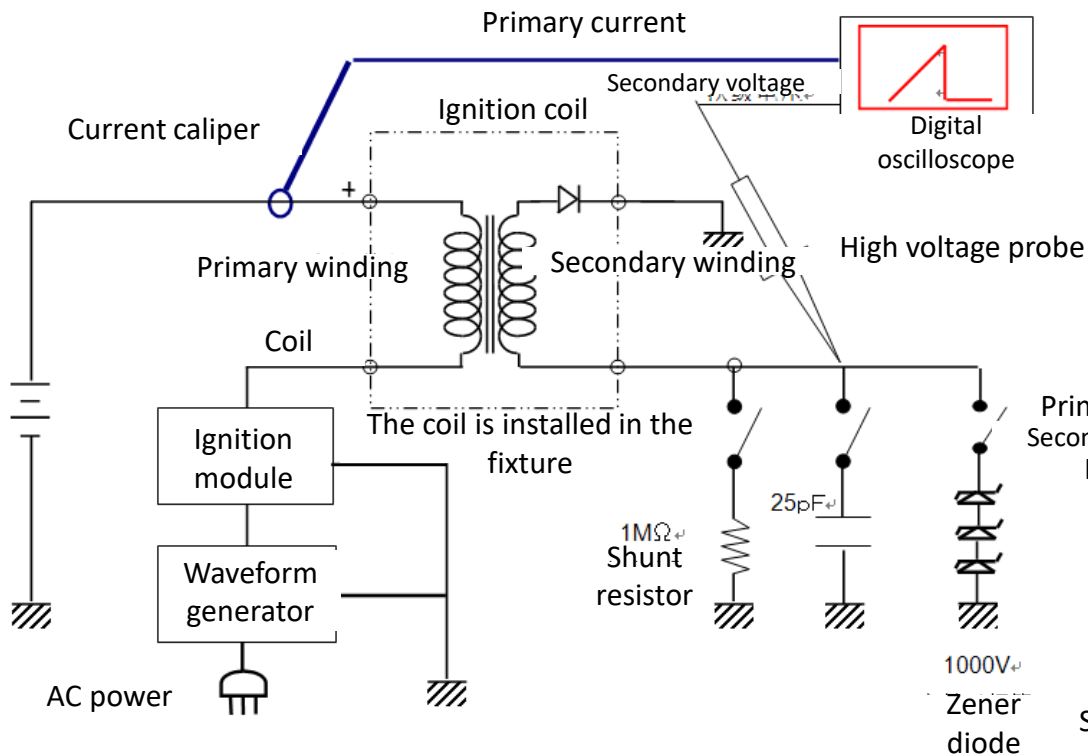
Note:

1. If the O-ring, sealing ring and compression ring are damaged, they must be replaced;
2. O-ring does not need to be oiled;
3. During disassembly and assembly, avoid falling and being shocked;
4. It is strictly forbidden to touch impurities, otherwise it will cause constant fuel injection, resulting in cylinder flooding, poor emission, and lack of power.

System pressure	20 MPa
Number of injector holes	6
Valve seat leakage value @8MPa	$\leq 1.0 \text{ mm}^3/\text{min}$
Housing leakage value @10MPa	$\leq 0.2 \text{ cc}/\text{min}$
Housing leakage value @4.5 ~ 5MPa	$\leq 0.04 \text{ cc}/\text{min}$
Coil resistance	1.49 Ω
Mesh size	40 μm

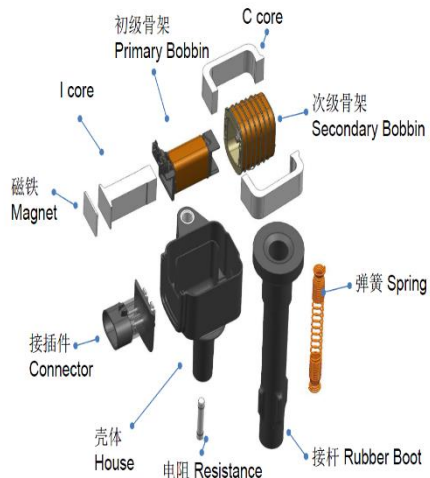


Ignition system





Ignition coil



Suppress resistance, prevent radiation and electromagnetic interference

Item	DENSO
Rated working voltage	14V
Allowable working voltage	(6-16) V
Max. primary current	12.9A
Rated primary current	10±1A
Dielectric strength	≥40KV
Secondary voltage	□≥40 kV under load 20 ±3pF
Ignition energy	≥70mj
Magnetizing time	The primary coil current reaches 10A within 3.4ms
Working temperature	-40~130°C



Precautions for disassembly:

1. Prevent cutting the ignition coil when disassembling;
2. Observe whether there is aging or damage after disassembly

Failure mode recognition:

Appearance judgment: If the above phenomenon (including but not limited to the situation shown in the picture) exists, a new ignition coil must be replaced. In addition, it is necessary to confirm whether the ignition coil function is normal, otherwise it needs to be replaced.

Performance judgment: the ignition performance of the ignition coil can be detected: connect all the system wirings, run the engine to detect the ignition performance, if the spark plug has no spark, it needs to be replaced; if there is spark, but it is yellow, check the system

Contents

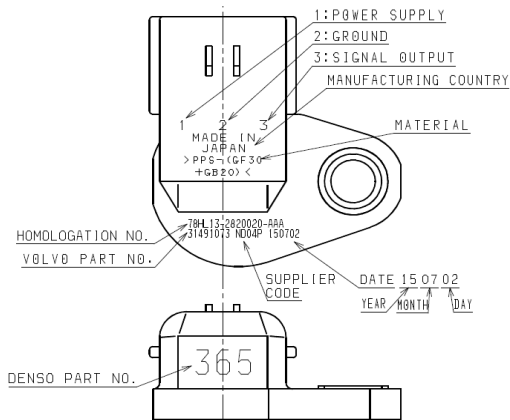
Mechanical system

▶ **Electronic control system**

After-sale work



Camshaft phase sensor



Parameter	DENSO
Maximum speed forward	4000rpm
Clearance (mm)	0.9±0.6
Center distance of mounting hole (mm)	18
Connector type and pin	3 pins
Supply voltage (V)	4.5~7

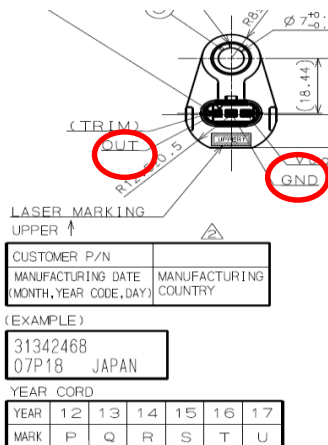
Working principle: With the rotation of the camshaft, the sensor recognizes the convex teeth and concave teeth of the signal wheel on the camshaft and outputs the corresponding voltage signal. The output signal can determine the position and speed of the camshaft; the voltage signal is finally input to the ECU and calculated by the ECU software to determine the engine ignition timing.

Precautions:

1. Installation torque $10 \pm 1.5 \text{Nm}$;
2. Do not drop the sensor;
3. Check whether the O-ring is damaged before installation;
4. After the sensor is disassembled, if the pins and rubber ring are not damaged, it can be used continuously.



Crankshaft position sensor



Working principle: used to measure the speed and position of the engine crankshaft. The sensor detects the N pole and S pole of the crankshaft signal wheel, outputs the corresponding voltage signal, and inputs it to the ECU to determine the engine's speed and top dead center information.

Parameter	DENSO
Maximum speed forward	8000rpm
Maximum speed reverse	2000rpm
Clearance (mm)	0.7±0.4
Center distance of mounting hole (mm)	19
Supply voltage (V)	5±0.5
Connector type and pin	3 pins

Precautions

1. Installation torque $10 \pm 1.5 \text{ Nm}$;
2. Do not drop the sensor;
2. Do not let the sensing end of the sensor contact magnetic substances;
3. After the sensor is disassembled, check the appearance and the pins are not damaged, you can continue to use it.



Crankshaft position sensor wiring harness



Connect to engine wiring harness

Connect to sensor

Working principle:

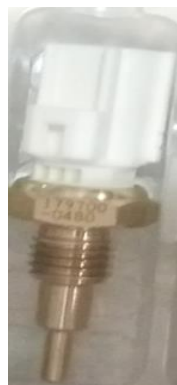
This wiring harness is only an extension cable for transfer. Due to the small space at the crankshaft position sensor side, it is convenient for the engine wiring harness to be plugged in.

Precautions:

1. The connector near the label is plugged into the sensor;
2. Check the color of the wires at the two connectors before installation, they should be exactly the same from left to right. If they are different, it may be a non-conforming product, and a multimeter should be used for retesting.



Water temperature sensor



Parameter	DENSO
Resistance (K Ω)	20°C, 2.45 (+0.18,-0.17) K Ω
Response time (s)	$\leq 7s$
Installation thread	M12X1.5

Working principle: The NTC thermistor is encapsulated in a temperature sensor, and its resistance value changes with the temperature change, so as to accurately and timely measure the environmental temperature change, and measure its output resistance value, which reflects the temperature of the contacting medium. It is used to monitor the coolant temperature of the engine. On the one hand, the ECU can make a judgment on the engine's working condition by the outputted resistance signal, and correct the fuel injection and ignition; on the other hand, it outputs a signal to the relevant instrument so that the operator can make a visual judgment of engine working state.

TABLE 1. INITIAL RESISTANCE CHARACTERISTICS

TEMP. [°C]	RESISTANCE [k Ω]	MEASURE CURRENT [μ A]	ACCURACY [°C]
-40	(44.3)		± 1.7
-30	(25.4)		± 1.7
-20	15.04 ^{+1.28} _{-1.20}	10 MAX	± 1.7
-10	(9.16)		± 1.6
0	(5.74)		± 1.6
10	(3.70)		± 1.5
20	2.45 ^{+0.14} _{-0.13}	10 MAX	± 1.4
30	(1.66)		± 1.4
40	(1.15)		± 1.3
50	(0.811)		± 1.2
60	(0.584)		± 1.1
70	(0.428)		± 1.1
80	0.318 \pm 0.008	100 MAX	± 0.9
90	(0.240)		± 0.8
100	(0.1836)		± 0.7
110	0.1417 \pm 0.0018	100 MAX	± 0.6
120	(0.1108)		± 0.7
130	(0.0877)		± 0.9
140	(0.0703)		± 1.2

Precautions

1. Installation torque 22 ± 2 Nm;
2. Use with gaskets, gaskets are disposable parts, do not reuse.



Knock sensor



Working principle:

The piezoelectric ceramic in the sensor detects the vibration of the engine, outputs the voltage signal to the ECU, and determines whether the engine knocks through the software calculation process to prevent the engine from being damaged due to knocking.

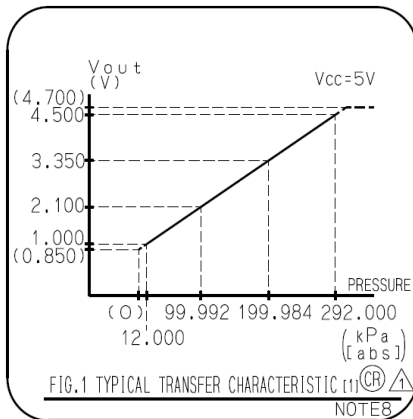
The output standard of the knock sensor currently used by our company is 8kHz: 29mv/g±8mv/g

Precautions

1. Installation torque $20\pm 5\text{Nm}$;
2. Do not drop the sensor .



Intake air pressure sensor



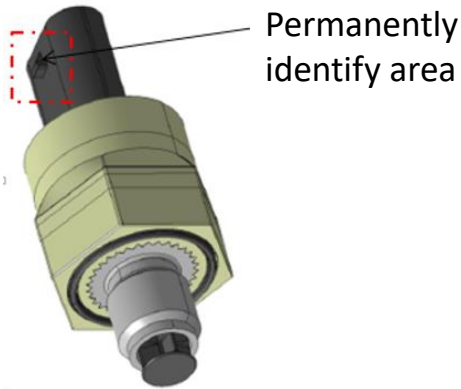
Working principle: The intake air pressure sensor chip can provide the controller "load signal" according to the difference between atmospheric pressure and intake manifold pressure; the controller provides 5V voltage, and feeds back 0-5V voltage to controller according to the difference of intake pressure. So as to achieve the purpose of measuring the absolute pressure of the intake manifold and providing engine load information.

Precautions

1. Use self-tapping screws, torque $3.5 \pm 0.5 \text{ Nm}$;
2. Do not use dropped sensors.
3. Press the sensor vertically during installation to avoid crushing the O-ring;
4. This sensor is an absolute pressure sensor, and the output value of the product under standard atmospheric pressure is about 2.1V. Due to the accurate value of ambient pressure during measurement, this value is for reference only.



Oil pressure sensor



Sensor type	Oil pressure switch	Oil pressure sensor	
Function	Low oil pressure alarm	Measure oil pressure	Measure oil pressure and temperature

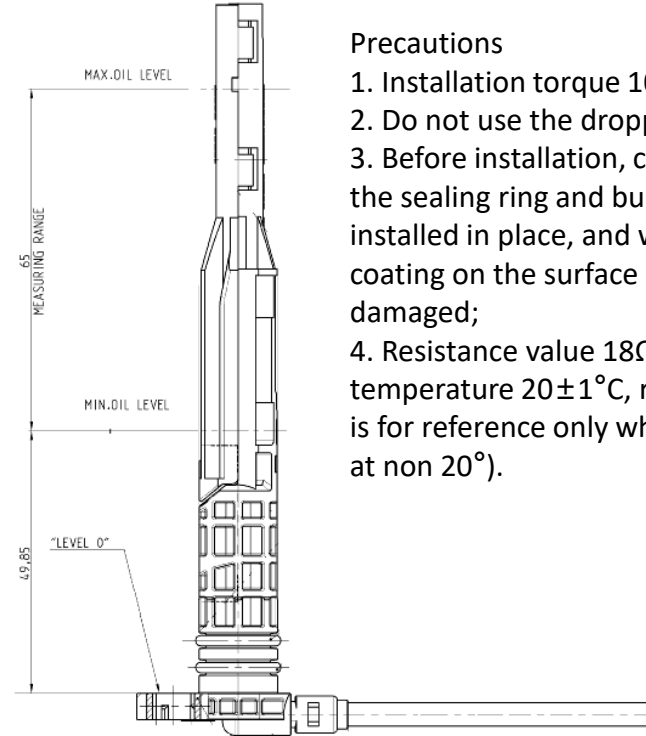
Working principle: The oil pressure and temperature sensor is assembled on the main oil pipeline after the engine oil filter. The sensor's pressure chip and NTC resistance measure the oil pressure and temperature in the main oil pipeline and output the electrical signal to the ECU for software calculation to determine the engine's working state. It can also prevent the engine from being damaged due to high operating temperature.

Assembly and use requirements:

1. Before installation, check whether the O-ring is scratched, peeled off, and whether the coating is intact. Assembly torque 150+1.5Nm;
2. When assembling, it is forbidden to glue the threads, and the flange surface installed with the sensor must be free of burrs, pollutants and lubricants;
3. The oil pressure sensor can only be disassembled and assembled once.



Oil level sensor



Precautions

1. Installation torque $10 \pm 1.5 \text{ Nm}$;
2. Do not use the dropped sensor;
3. Before installation, check whether the sealing ring and buckle are installed in place, and whether the coating on the surface of the O-ring is damaged;
4. Resistance value 18Ω (ambient temperature $20 \pm 1^\circ \text{C}$, resistance value is for reference only when measuring at non 20°).

Working principle: As the height of the resistance wire immersed in the engine oil is different, the pressure drop produced per unit time is different. It is a sensor that measures the oil level when the engine is static.

Contents

Mechanical system

Electronic control system

▶ **After-sale work**



Engine liquid

Engine Oil	Capacity
VCC RBS0-2AE 0W-20 ^①	Dry type: 6.8 ± 0.1L Wet type: 5.6 ± 0.1L



Maintenance interval

System	Item	×10,000 km	1	2	3	4	5	6	7	8	9	10	
		Months	12	24	36	48	60	72	84	96	108	120	
Engine System	Engine Oil *1		R	R	R	R	R	R	R	R	R	R	
	Engine Oil Filter *1		R	R	R	R	R	R	R	R	R	R	
	Air Filter *2		I	R	I	R	I	R	I	R	I	R	
	Engine Cooling System		I	I	I	I	I	I	I	I	I	I	
	Engine Coolant*3		Replace every 48 months or 90,000 km										
	Drive Belt*4		I	I	I	I	I	I	I	I	I	I	R
	Timing Belt		Replace every 100,000 km										
	Fuel System (Tank, Pipes, Connection)		I	I	I	I	I	I	I	I	I	I	I
	Fuel Filter		Replace every 24 months or 30,000 km										
	Spark Plug		-	-	-	R	-	-	-	R	-	-	-
	Check Engine System by Diagnostic Device		I	I	I	I	I	I	I	I	I	I	I

Note:

- I: Inspect: Inspect and clean, repair, adjust, fill up, or replace if necessary.
- R: Replace
- The time and mileage of scheduled maintenance should be based whichever occurs first.



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