

0201 Engine Assembly

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1 General Information

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1.1 Overview

- Engine SQR477F is developed based on SQR480 series and follows the SQR480 series in the product concept and structure, featuring vertical, inline four-cylinder, water cooled, four stroke and single over-head camshaft (SOHC) as well as multi-point sequential electronic fuel injection. The product features advanced performance and stable design.
- The inline four-cylinder engine with 1.5 L displacement has the following features:
 - a. SOHC
 - b. Four valves
 - c. Aluminum cylinder head
 - d. Cast iron cylinder block

Caution

- You should, before installing parts, remove impurities and moisture on the surface of parts and apply clean lubricant to areas that suffer from friction and need lubricating.
- When installing parts, you should not scrape precision contact surface and fitting surface. If parts are found to be scratched and incompatible with installation standards, they should be replaced.

1.2 Service notes

1. You should take care not to cause personal injuries when inspecting engine.
 - When inspecting engine, you should adhere to the following safety standards. Switch off engine and inspect it after it cools down. Smoking and fire are prohibited. Ensure service site is equipped with fire extinguishers.
 - Special tools must be used to remove some parts as the special tools greatly assure safety.
 - You must strictly abide by the safety instructions provided by supplier when chemical products are used.
 - You must take sound insulation protection actions in repairing the electronic ignition system as it can produce over 15,000 V voltage when it works.
 - You should switch off all electrical equipment and ignition switch and disconnect battery negative terminal before inspecting the engine electrical system.
2. You must take care in service to abstain from damage to parts.
 - You should use wooden or resin tools to set apart aluminum bonded parts.
 - You must strictly follow the tightening torque specified in the service manual in service.
 - Disposable gaskets, oil seals, clamps, safety plates, self-locking nuts, bolts and all nonfunctioning parts are replaced in strict accordance with the service manual.
 - You must take dust-proof actions when disassembling engine. Replace nonfunctioning parts with original parts to ensure that parts can work properly.
 - Don't overly bend wirings and never operate in a violent manner to avoid collision so that electric elements such as oxygen sensors can save from damage when they are removed and installed.
 - In a test drive, vehicle diagnostic device must be anchored to rear seats and operated by another person rather than driver. If the vehicle diagnostic device is operated in the front passenger seat, front passenger's airbag will burst in the event of an accident, thus resulting in personal injuries.

1.3 Product specifications

Overview of engine

Engine type	SQR477F
Fuel type	Gasoline with over 93#
Engine layout	Vertical, inline four-cylinder, water cooled, four stroke, SOHC
Fuel supply	Multi-point sequential electronic fuel injection
Displacement	1,497 ml
Bore × stroke	77.4×79.52 mm
Cylinder type	L4
Rated power	80/6000 (kW(ps)/rpm)
Maximum torque	140/4500 N•m/rpm
Ignition order	1-3-4-2
Compression ratio	10.5:1
Minimum specific fuel consumption (total power)	260 g/kWh

Engine service data

Item		Value	
Camshaft	Intake camshaft lifting	5.09 mm	
	Exhaust camshaft lifting	5.34 mm	
	Camshaft diameter	25.974±0.006 mm	
	Camshaft axial clearance	0.124±0.029 mm	
Cylinder head	Lower surface planeness	0.055 mm	
	Overall height	97 mm	
Valve	Valve head margin thickness	Intake valve	0.6 mm
		Exhaust valve	0.4 mm
	Valve stem diameter	Intake valve	5.98±0.008 mm
		Exhaust valve	5.96±0.008 mm
	Sealing strap width	Intake valve	2.83 mm
		Exhaust valve	2.86 mm
	Valve stem clearance	Intake valve	0.027±0.015 mm
		Exhaust valve	0.047±0.015 mm
	Tilt angle	Intake valve	68°
		Exhaust valve	70°
Length	Intake valve	107.998 mm	
	Exhaust valve	117.41 mm	
Valve spring	Free height	47.7 mm	
	Pretension	260±11 N	
	Installation height	41 mm	
Valve guide	Valve guide length	42±0.25 mm	

Item		Value	
	Inner diameter	6.007±0.007 mm	
	Outer diameter	11.045±0.005 mm	
	Press-in height	12.5±0.2 mm	
Piston ring	Side clearance	Top ring	0.06±0.02 mm
		Second ring	0.05±0.02 mm
	Closed gap	Top ring	0.27±0.07 mm
		Second ring	0.47±0.07 mm
	Height	Top ring	1.98 ± 0.01mm
		Second ring	1.48±0.01 mm
Oil ring		1.92±0.05 mm	
Piston ring slot	Height	Top ring	1.24±0.01 mm
		Second ring	1.53±0.01 mm
		Oil ring	2.02±0.01 mm
	Depth	Top ring	70.4±0.1 mm
		Second ring	69.7±0.1 mm
		Oil ring	71.4±0.1 mm
Piston pin	Diameter	W	20.622~20.625 mm
		R	20.625~20.628 mm
		L	20.628~20.631 mm
	Length		61.4±0.4 mm
	Piston pin hole diameter	W	20.635~20.638 mm
		R	20.638~20.641 mm
L		20.641~20.644 mm	
Crankshaft	Axial clearance		0.198±0.105 mm
	Crankshaft main journal	Diameter	48.99.02±0.01 mm
		Radial runout	0.05 mm
		Cylindricity	0.008 mm
		Roundness	0.005 mm
	Conrod journal	Diameter	44.9±0.01 mm
Parallelism to main journals		0.008 mm	
Cylinder block	Overall height		206±0.05 mm
	Cylinder bore roundness/straightness		0.008/0.01 mm
	Upper surface planeness		0.05 mm
Conrod	Radial clearance of conrod bearing shell		0.033±0.027 mm
	Conrod tip axial clearance		0.36±0.027 mm

Main structure features and parameters

Component	Features
Water pump	Centrifugal
Fuel pump	Electrical pump
Engine oil pump	Rotor
Gasoline filter	Integrated spin-on type
Spark plug	FR7DTC
Starter	Permanent-magnet deceleration type
Generator	14V/90A integrate alternator

Torque specifications

Component	Torque (N*m)	Use
Nut	65±5	Fasten accessory brackets to engine
Bolt	55±5	Fasten accessory brackets to engine
Bolt	25±2	Fasten poly V-belt tensioner
Bolt	18±2	Fasten timing belt tension pulley
Bolt	25±2	Fasten idler
Bolt	9±1	Fasten rear crankshaft oil seal
Bolt	110±5	Fasten crankshaft damping pulley
Bolt	21±2	Connect mount bracket of main three-way catalytic converter to body
Lock nut	50±5	Upstream and downstream of the three-way pre-catalytic converter
Lock nut	115±2	Upstream and downstream of the main three-way catalytic converter
Self-tapping screw	8±2	Fasten fuel filter
Bolt	22±2	Fasten fuel tank fixing strap I
Nut	22±2	Fasten fuel tank fixing strap II
Bolt	8±2	Fasten filler pipe bracket II
Bolt	8±2	Fasten activated carbon canister
Bolt	8±2	Fasten filler pipe bracket I
Screw	8±2	Fasten fuel tank guard
1 × Bolt	65±5	Fasten front mount rubber washer to front cross member
2 × Bolt	25±3	Fasten front mount rubber washer to front cross member
Bolt	46±5	Fasten front mount bracket to transaxle
Bolt	46±5	Fasten front mount bracket to engine
Self-locking nut	65±5	Fasten front mount bracket to front mount rubber washer

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Component	Torque (N*m)	Use
Bolt	46±5	Fasten rear mount bracket to engine
Bolt	65±5	Fasten rear mount bracket to rear mount rubber washer
Bolt	65±5	Fasten rear mount rubber washer to subframe
Bolt(long)	65±5	Fasten rear mount rubber washer to subframe
Bolt	46±5	Fasten transaxle side mount bracket to transaxle
Bolt	65±5	Fasten transaxle side mount bracket to transaxle side mount rubber washer
Bolt	30±3	Fasten transaxle side mount rubber washer to subframe
Worm clamp	4±1	Fasten both ends of intake hose
Bolt	10±1	Fasten air filter assembly

Engine capacity specification

Item	Capacity Specification
Fuel type	Gasoline with over 93#
Lubricant type	Summer Lubricant with the viscosity of SAE 10W-40 (SL or above)
	Winter Lubricant with viscosity of SAE 5W-40 (SL or above)
Oil capacity	3.9 L
Coolant category	50% glycol + 50% soft water (volume ratio)

2 Diagnosis and Inspection

2.1 Engine fault list.....69

2.1 Engine fault list

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Symptoms	Possible causes	Maintenance recommendations
The engine cannot start	Low battery voltage	Check the battery and replace it if necessary
	Battery terminals are loose and corrosive	Clean the battery and tighten the connection
	Starter failure	Check engine and replace it if necessary
	Ignition coil failure	Check the ignition coil and replace it if necessary
	Excessive spark plug clearance	Replace spark plugs
	The fuel filter is blocked by excessive impurities in the fuel system	Clean the fuel system and replace the fuel filter
	Fuel pump failure	Test the fuel pump and replace it if necessary
	Timing belt slippage	Reinstall the timing belt
	Other related electrical components cannot work properly	Check related electrical components
Unstable idling speed of the engine	Blockage of air filter	Replace the air filter and clean its housing
	Idling stepper motor is blocked	Clean the idling stepper motor and throttle
	Leakage of the intake manifold	Check intake manifold, manifold gaskets and vacuum hoses
	Ignition coil failure	Check related harnesses and replace the ignition coil if necessary
	Other electrical components cannot work properly	Check other electrical components
Lack of engine power	Excessive spark plug electrode clearance	Replace spark plugs
	The fuel filter is blocked by excessive impurities in the fuel system	Clean the fuel system and replace the fuel filter
	Incorrect valve timing	Reinstall the timing belt
	Leakage of the cylinder head gaskets	Replace cylinder gaskets
	Low cylinder pressure	Measure the cylinder pressure and repair it if necessary
	Defective tightness in valve	Check valve and valve seat ring and replace them if necessary

Symptoms	Possible causes	Maintenance recommendations
	Blockage of the three-way catalytic converter	Refill good fuel and replace the three-way catalytic converter
	Excessive ignition cable resistance	Test the ignition cable resistance and replace it if necessary
	Ignition coil failure	Test the ignition coil and replace it if necessary
	Poor atomization at the fuel injector	Replace the fuel filter and clean the fuel injector, and replace them if necessary
	Poor exhaust in the exhaust system	Check the exhaust system
	Insufficient air into the air intake system	Check the air intake system
	Ignition timing deviation	Check the related components like the knock sensor.
	Other electrical components cannot work properly	Check other electrical components

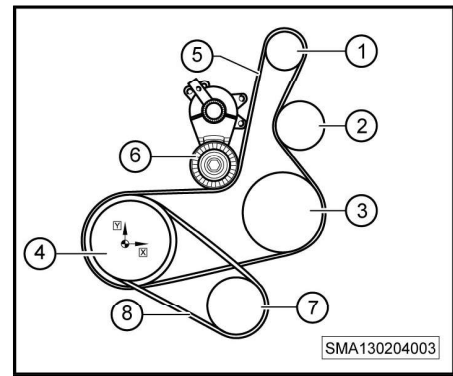
3 Engine Accessories

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3.1 Poly V-belt and accessories

Engine belt arrangement diagram

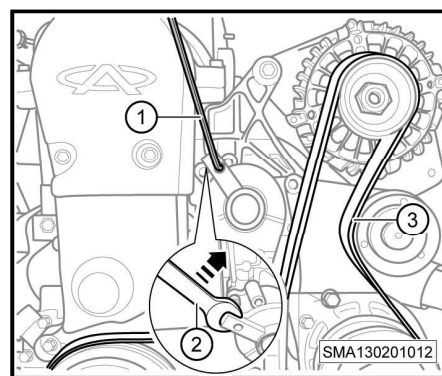
1. Generator pulley
2. Idler
3. Air conditioner compressor pulley
4. Crankshaft damping pulley
5. Poly V-belt
6. Poly V-belt tension pulley
7. Power steering pump pulley
8. Power steering belt



3.2 Removing and installing the poly V-belt

Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Remove the right front wheel. => refer to page 760
3. Remove the right front wheel fender board.
4. Remove the power steering belt.
5. Use wrench (-2-) to pull the poly V-belt tension pulley in the (-arrow-) direction and insert a lock pin bar (-1-) into a lockhole of the tension pulley so as to lock it. After locking it, remove the poly V-belt (-3-).



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

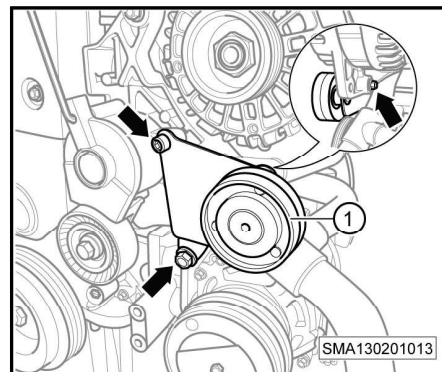
1. Remove oil stain and other impurities from the belt prior to installation.
2. Visually inspect the poly V-belt to check if there are excessively worn or inner cords are pulled out of the poly V-belt.
3. It is permissible that there are cracks on rack sides of the poly V-belt.
4. Replace the poly V-belt with missing racks.
5. After installing the poly V-belt, rotate the crankshaft damping pulley clockwise and check the rotation condition of the belt and ensure that the belt is properly installed into pulley grooves.

3.3 Removing and installing the poly V-belt tensioner and idler

Removal

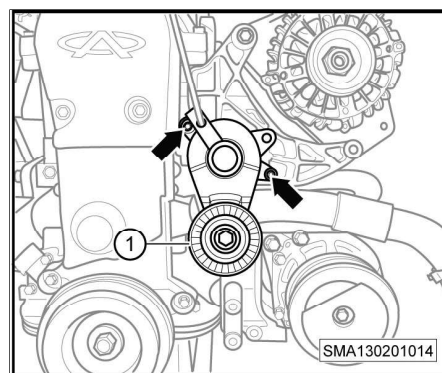
1. Remove the poly V-belt => refer to page 72.
2. Unscrew the fixing bolts (-arrow-) and remove the idler (-1-).

- Tightening torque of the idler fixing bolt: 25 ± 2 N•m



3. Unscrew the fixing bolts (-arrow-) and remove the poly V-belt tensioner (-1-).

- Tightening torque of the tensioner fixing bolt: 25 ± 2 N•m



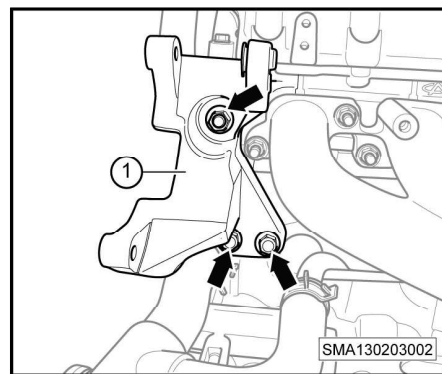
Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Rotate the poly V-belt tension pulley and idler to check whether they can rotate freely.
2. Shake the wheel to check whether the bearing is loose.

3.4 Removing and installing the accessory bracket

Removal

1. Remove the generator. => refer to page 983
2. Remove the poly V-belt tensioner and idler . => refer to page 73
3. Unscrew fixing nuts and bolts (-arrow-) and remove the idler (-1-).
 - Tightening torque of the fixing nut: 65 ± 5 N•m
 - Tightening torque of the fixing bolt: 55 ± 5 N•m



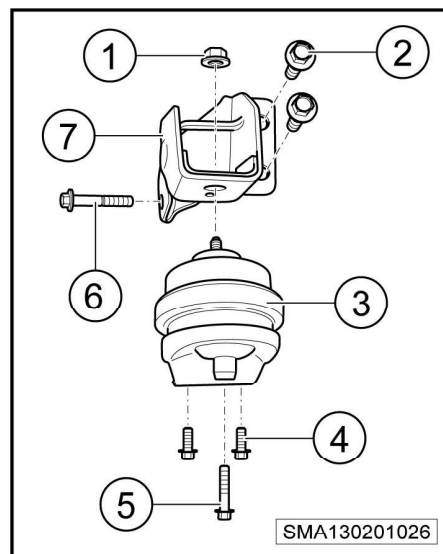
Installation

Installation shall follow the reverse sequence of the removal procedure.

3.5 Engine mount

The engine front mount assembly drawing

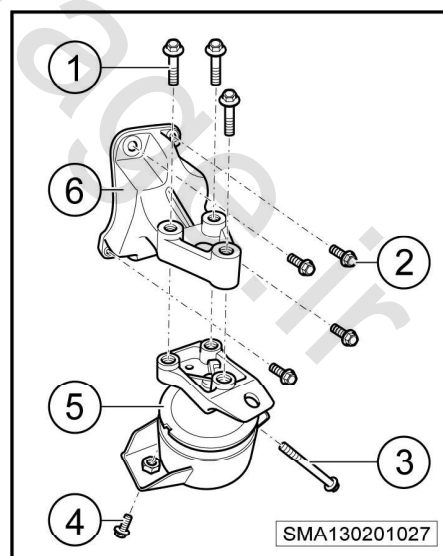
1. Nut
 - To fasten front mount bracket to front mount rubber washer
2. Bolt
 - To fasten front mount bracket to engine
3. Front mount rubber washer
 - To connect front mount bracket to front crossrail
4. Bolt
 - To fasten front mount rubber washer to front crossrail
5. Bolt
 - To fasten front mount rubber washer to front crossrail
6. Bolt
 - To fasten front mount bracket to engine
7. Front mount bracket
 - To connect front mount rubber washer to engine



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The engine rear mount assembly drawing

1. Bolt
 - To fasten rear mount bracket to rear mount rubber washer
2. Bolt
 - To fasten rear mount bracket to engine
3. Bolt
 - To fasten rear mount rubber washer to subframe
4. Bolt
 - To fasten rear mount rubber washer to subframe
5. Rear mount rubber washer
 - To connect rear mount rubber washer to subframe
6. Rear mount bracket
 - To connect rear mount rubber washer to engine



The transaxle side mount assembly drawing**1. Bolt**

- To fasten transaxle side mount bracket to transaxle side mount rubber washer

2. Bolt

- To fasten transaxle side mount rubber washer to subframe

3. Transaxle side mount bracket

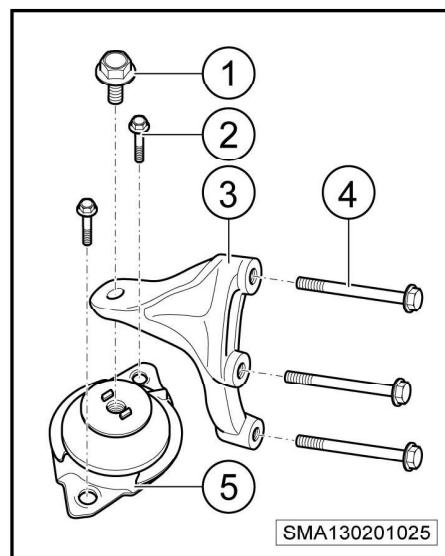
- To connect transaxle to transaxle side mount rubber washer

4. Bolt

- To fasten transaxle side mount bracket to transaxle

5. Transaxle side mount rubber washer

- To connect transaxle side mount bracket to subframe



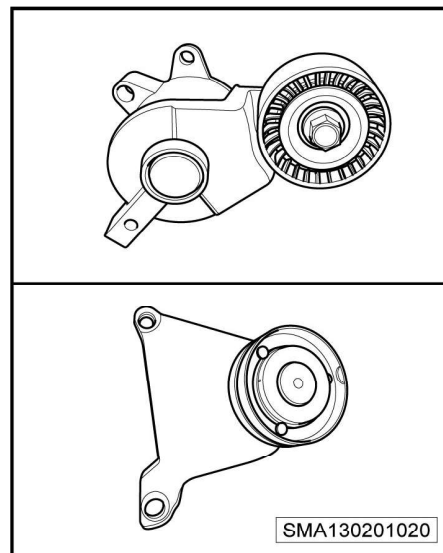
3.6 Inspection

Inspecting the poly V-belt tension pulley and idler

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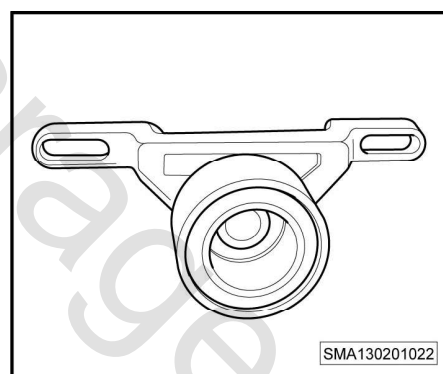
- Check every part of the pulley and idler carefully and replace those parts timely if they fail to meet requirements.

1. Manually rotate the poly V-belt tension pulley and idler to check whether they have abnormal noise and whether they can rotate freely.
2. Shake the poly V-belt tension pulley and idler radially and axially to check if they are too loose.
3. Check if working faces of poly V-belt tension pulley and idler are damaged.
4. Check if the tensioning return of tensioner is properly repositioned and if tensioning force suffices.



Inspecting the timing belt tension pulley

1. Manually rotate the timing belt tension pulley to check whether it has abnormal noise and whether it can rotate freely.
2. Pull the timing belt tension pulley radially and axially to check if it is too loose.
3. Check if the working face of the timing belt tension pulley is damaged.



4 Engine Oil Seal

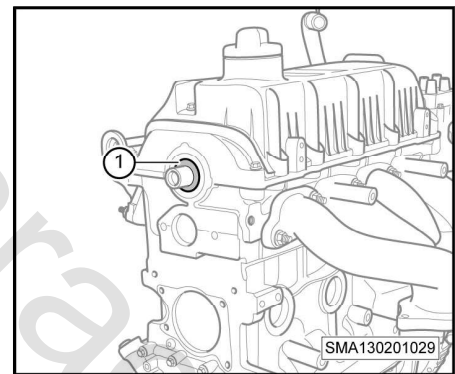
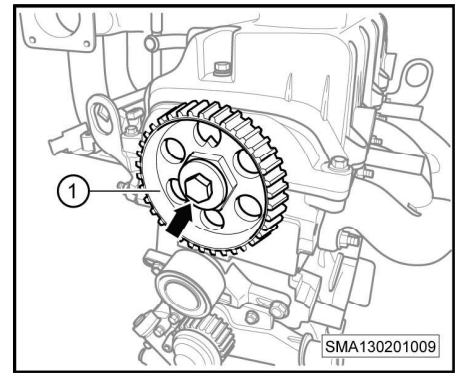
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4.2 Removing and installing the front crankshaft oil seal.....	79
4.3 Removing and installing the rear crankshaft oil seal.....	80

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4.1 Removing and installing the camshaft oil seal

Removal

1. Remove the timing belt .=> refer to page 88
2. Unscrew the fixing bolt (-arrow-) and remove the camshaft timing pulley (-1-).
 - Tightening torque of camshaft timing pulley fixing bolt: 95 ± 5 N•m
3. Wrap some tapes on a flat tip screwdriver and carefully pry off the front camshaft oil seal (-1-).



Installation

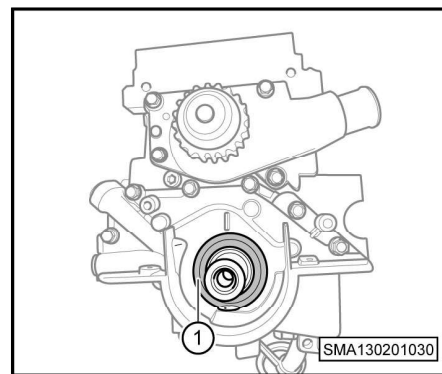
Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Clean impurities such as residual sealant and oil on seal installing surface.
2. Apply oil to the front camshaft oil seal lip to install it properly, otherwise, the seal is likely to be damaged.
3. Apply sealant to seal outer contact area.
4. Other installation shall follow the reverse sequence of the removal procedure.

4.2 Removing and installing the front crankshaft oil seal

Removal

1. Remove the right front wheel and its fender board
.=> refer to page 760
2. Remove the timing belt .=> refer to page 88
3. Wrap some tapes on a flat tip screwdriver and carefully pry off the front camshaft oil seal (-1-).



Installation

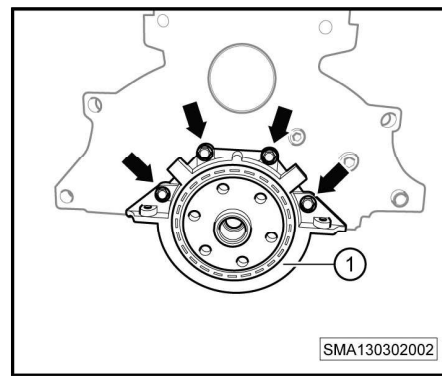
Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Clean impurities such as oil and residual sealant on seal installing surface.
2. Apply oil to the front camshaft oil seal lip to install it properly, otherwise, the seal is likely to be damaged.
3. Apply sealant to seal outer contact area.

4.3 Removing and installing the rear crankshaft oil seal

Removal

1. Discharge the oil .=> refer to page 31
2. Remove the oil pan .=> refer to page 160
3. Remove the transaxle .=> refer to page 920
4. Remove the flywheel .=> refer to page 102
5. Unscrew the fixing bolts (-arrow-) and remove the rear crankshaft oil seal (-1-).
 - Tightening torque of the fixing bolt of the rear crankshaft oil seal: $9\pm 1 \text{ N}\cdot\text{m}$



Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Remove residual sealant and gaskets on the cylinder block.
2. Apply oil to the rear camshaft oil seal lip to install it properly, otherwise, the seal is likely to be damaged.
3. Apply sealant to both sides of the rear crankshaft oil seal.

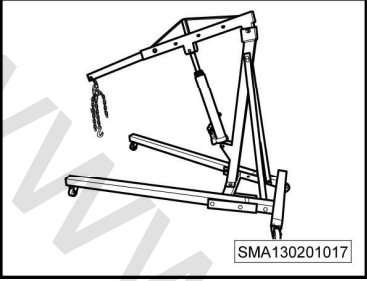
5 Engine Assembly

5.1 Removing and installing the engine assembly.....81

5.1 Removing and installing the engine assembly

02

Maintenance tools and common equipment

	
<p>Engine lifting tools</p> <p>Engine hanger</p>	

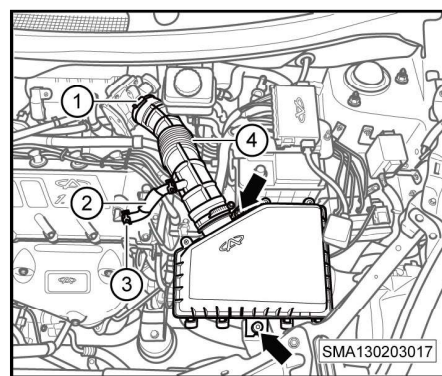
Removal

1. Switch off all electrical equipment and ignition switch and then pull out the ignition key.
2. Disconnect the battery negative terminal.
3. Discharge the oil .=> refer to page 31
4. Discharge the coolant . => refer to page 177
5. Recover the air conditioner refrigerant .=> refer to page 1247
6. Remove the three-way catalytic converter and the front exhaust pipe .=> refer to page 224
7. Remove the battery and the bracket .=> refer to page 976
8. Remove the radiator fans .=> refer to page 185
9. Remove the power steering belt .
10. Disconnect the power steering pump to engine and hang the power steering pump on the front cross member.=> refer to page 662
11. Remove the air conditioner compressor and its brakcet .=> refer to page 1257

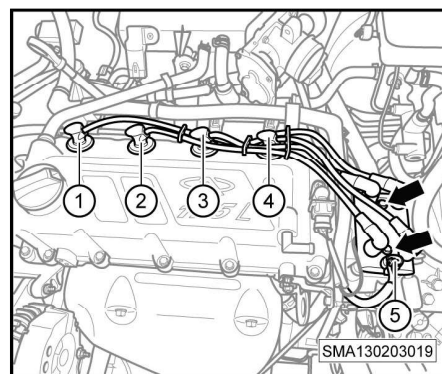
02 - Engine Mechanism

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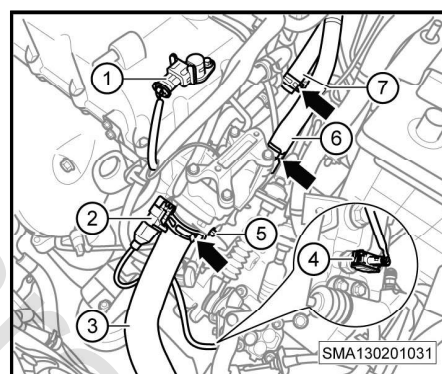
12. Unscrew the fixing bolts (-arrow-), loosen the clamps (-1-) and (-3-) and disengage the hoses (-2-) and (-4-) and then remove the air filter assembly.



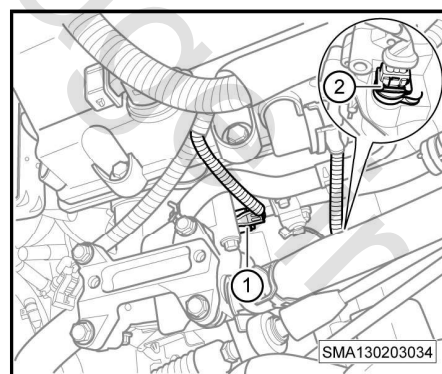
13. Disconnect the ignition coil connector (-5-), unscrew the fixing bolts (-arrow-) and pull out the ignition cable from cylinder (-1-) to cylinder (-4-) and then remove the ignition coil and ignition cable.



14. Disconnect the ignition coil connectors (-1-), (-2-) and (-4-), loosen the clamps (-arrow-), disengage the hoses (-3-), (-6-) and (-7-), unscrew the fixing bolt (-5-) and disconnect the earth cable.

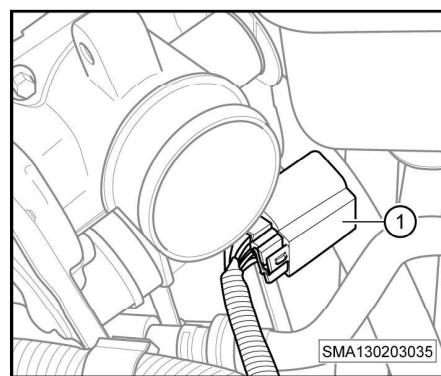


15. Disconnect the coolant temperature sensor connector (-1-) and the vehicle speed sensor connector (-2-).



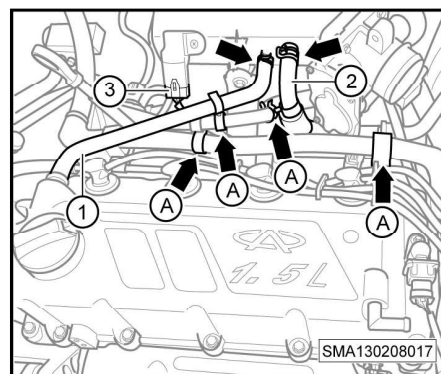
The following steps 16 and 17 are applied to vehicles equipped with electronic throttles

16. Disconnect the electronic throttle connector (-1-).



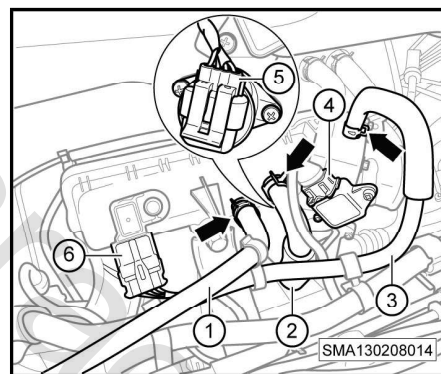
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17. Disconnect the electronic throttle connector (-1-).



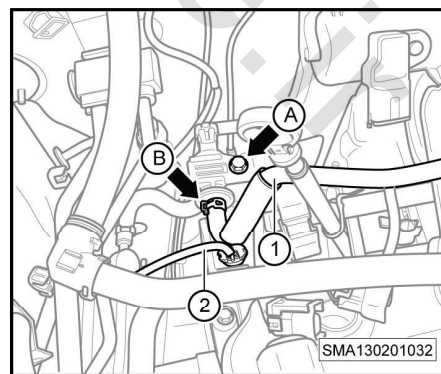
The following step 18 is applied to vehicles equipped with electronic throttles

18. Loosen the clamps (-arrow-), pull out the crankcase ventilation hose (-1-), the vacuum booster hose (-2-) and the activated carbon canister hose (-3-), and then disconnect the throttle position sensor connector (-4-), the stepper motor connector (-5-) and the intake air pressure/temperature sensor connector (-6-).



The following steps 19 to 33 are applied to all vehicles

19. Loosen the clamp (-arrow B-) and pull out the fuel steam pipe (-1-), unscrew the fixing bolt (-arrow A-) and disengage the activated carbon canister solenoid valve from the intake manifold. Disconnect the knock sensor connector (-2-).

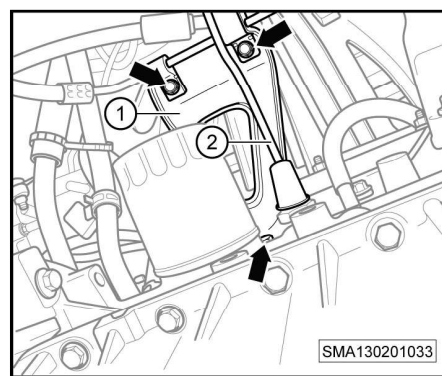


02 - Engine Mechanism

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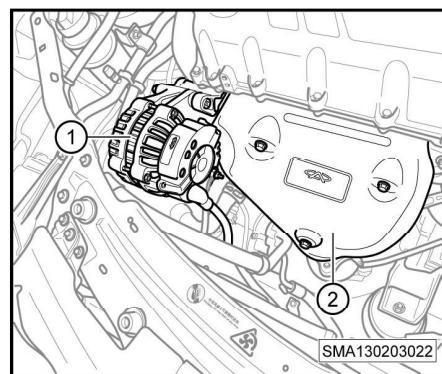
20. Disconnect the engine oil pressure switch connector (-2-), unscrew the fixing bolts (-arrow-) and remove the lower intake manifold bracket (-1-).

- Tightening torque of the fixing bolt of the lower intake manifold bracket (upper): $18 \pm 2 \text{ N}\cdot\text{m}$
- Tightening torque of the fixing bolt of the lower intake manifold bracket (lower): $27 \pm 2 \text{ N}\cdot\text{m}$



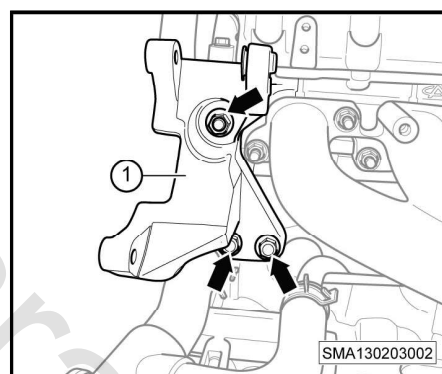
21. Remove the generator (-1-). => refer to page 983

22. Remove the exhaust manifold (-2-). => refer to page 221

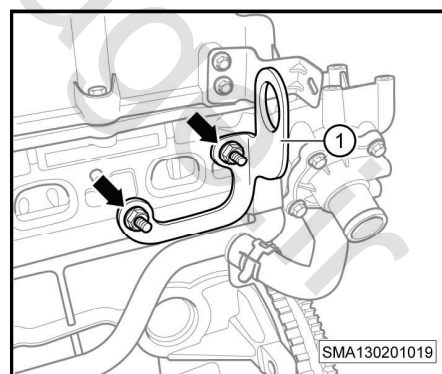


23. Unscrew the bolts (-arrow-) and remove accessory bracket (-1-).

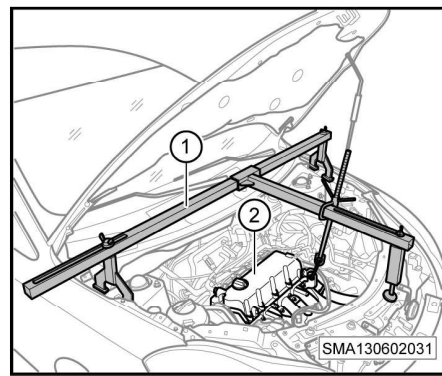
- Tightening torque of the fixing nut: $65 \pm 5 \text{ N}\cdot\text{m}$
- Tightening torque of the fixing bolt: $55 \pm 5 \text{ N}\cdot\text{m}$



24. As shown in the figure, install the engine exhaust manifold side lug (-1-) and screw on nuts (-arrow-).



25. As shown in the figure, use the engine hanger (-1-) to fix the engine assembly (-2-).

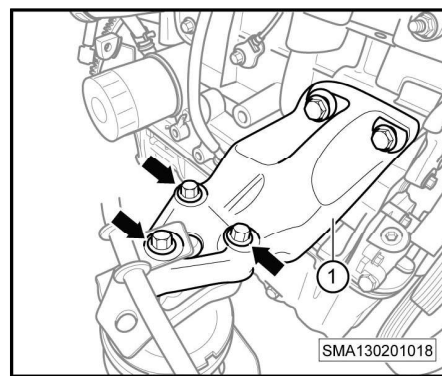


02

26. Remove the transaxle .=> refer to page 920
27. Lower vehicle body and support the engine assembly with a mobile jack and then remove the engine hanger.
28. Use iron chains to fix the engine intake manifold side lug and exhaust manifold side lug respectively and use the engine lifting tools to fix the engine.

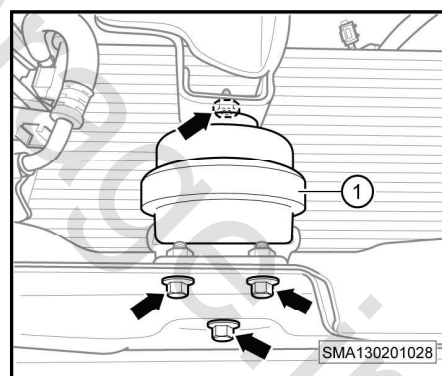
29. Unscrew the fixing bolts (-arrow-) and disengage the rear mount bracket (-1-) from the rear mount rubber washer.

- Tightening torque of the bolt connecting the rear mount bracket to the rear mount rubber washer: $65 \pm 5 \text{ N} \cdot \text{m}$



30. Unscrew the fixing bolts and nuts (-arrow-) and remove the engine front mount rubber washer (-1-).

- Tightening torque of the nut connecting the front mount bracket to the front mount rubber washer: $65 \pm 5 \text{ N} \cdot \text{m}$
- Tightening torque of the (two) bolts connecting the front mount rubber washer to the front cross member: $25 \pm 3 \text{ N} \cdot \text{m}$
- Tightening torque of (one) bolt connecting the front mount rubber washer to the front cross member: $65 \pm 5 \text{ N} \cdot \text{m}$



31. Remove the engine hood.
32. Use the engine lifting tools to lift the engine to a certain height and lift the engine assembly out of engine compartment.

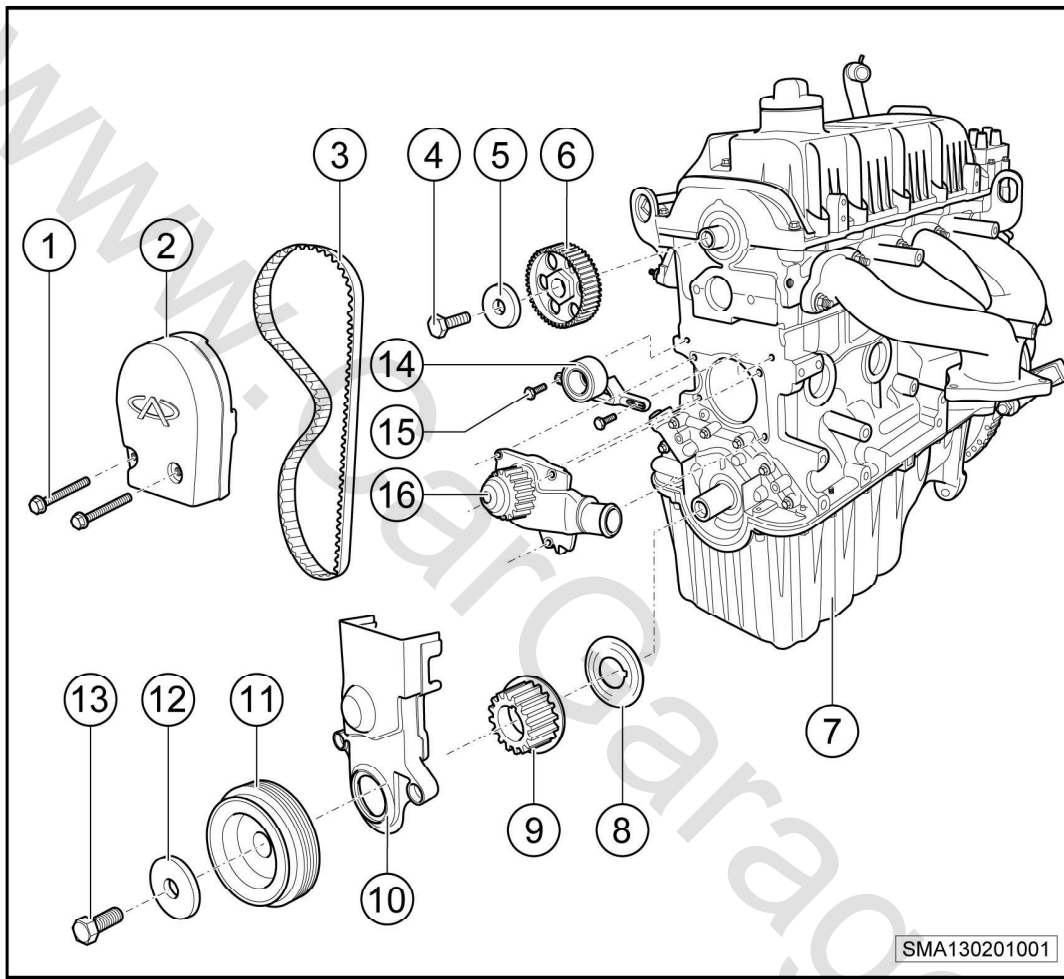
Installation

Installation shall follow the reverse sequence of the removal procedure.

6 Timing Belt

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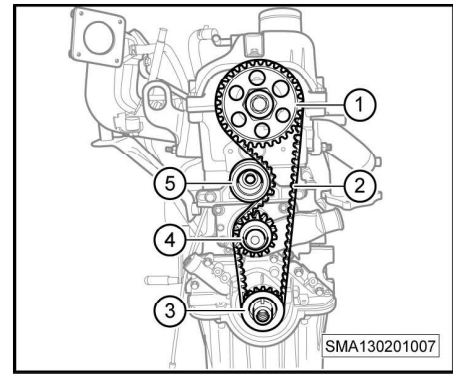
6.1 The timing belt assembly drawing



1. Bolt	2. Timing belt upper guard
3. Timing belt	4. Camshaft timing pulley fixing bolt
5. Gasket	6. Camshaft timing pulley
7. Engine	8. Gasket
9. Crankshaft timing pulley	10. Timing belt lower guard
11. Crankshaft damping pulley	12. Gasket
13. Fixing bolt of the crankshaft damping pulley	14. Timing belt tensioning pulley
15. Bolt	16. Coolant pump

6.2 Timing belt flow chart

1. Camshaft timing pulley
2. Timing belt
3. Crankshaft timing pulley
4. Coolant pump
5. Timing belt tensioning pulley



02

6.3 Removing and installing the timing belt

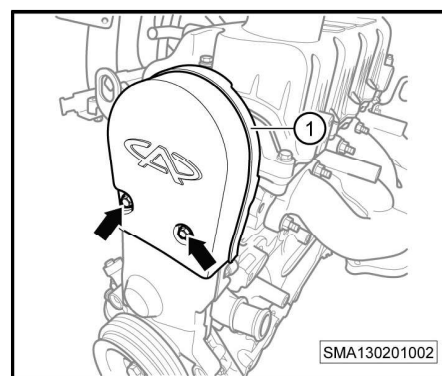
i Note

- You must fasten the crankshaft or flywheel when removing the fixing bolt of the crankshaft damping pulley.

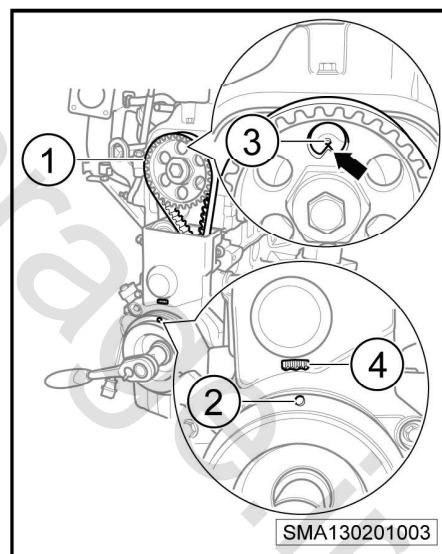
02

Removal

- Remove the right front wheel and its fender board
 .=> refer to page 760
- Remove the power steering belt .
- Remove the poly V-belt .=> refer to page 72
- Unscrew the fixing bolts (-arrow-) and remove the timing belt upper guide (-1-).

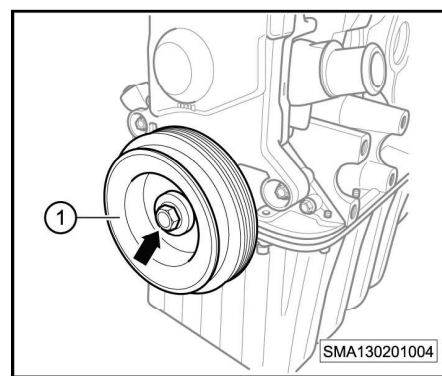


- As shown in the figure, rotate the crankshaft damping pulley so that the mark (-arrow-) on the camshaft timing pulley (-1-) is aligned with the mark (-3-) on the cylinder head. The mark (-2-) on the crankshaft damping pulley should be aligned with the fifth protrudent mark (-4-) on the timing belt lower guide.

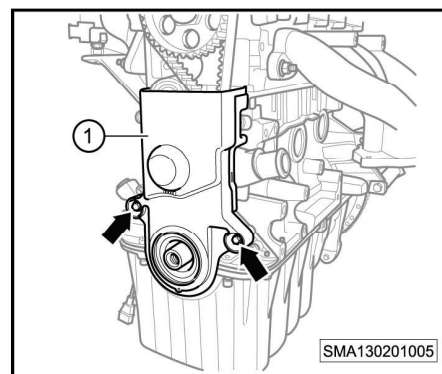


- Engage the reverse gear in the transaxle so that crankshaft is connected with the transaxle. Another technician holds down the brake pedal to lock the crankshaft with the aid of the mechanical drive mechanism.

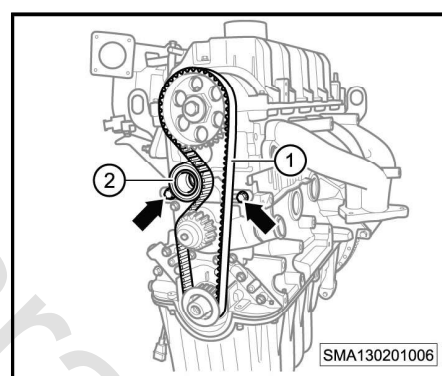
7. Unscrew the fixing bolts of crankshaft damping pulley (-arrow-) and remove the crankshaft damping pulley (-1-).
 - Tightening torque of the fixing bolt of the crankshaft damping pulley: $110 \pm 5 \text{ N} \cdot \text{m}$



8. Unscrew the fixing bolts (-arrow-) and remove the timing belt lower guide (-1-).

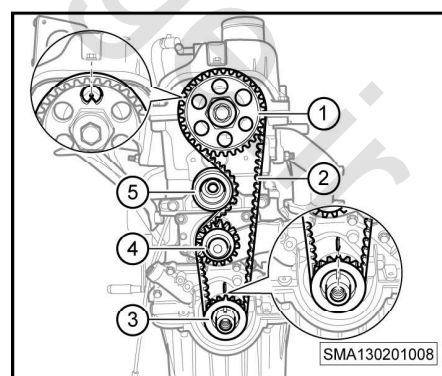


9. Unscrew the fixing bolts (-arrow-), loosen the timing belt tension pulley (-2-) and then remove the timing belt (-1-).



Installation

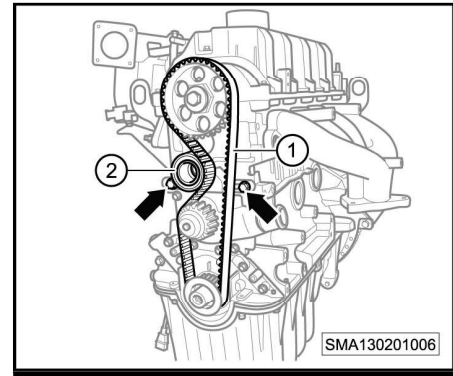
1. Install the timing belt (-2-) and verify that the mark ARROW on the camshaft timing pulley hole is aligned with the mark DOT on the cylinder head (top left sectional drawing) and the raised mark on the crankshaft timing pulley is aligned with the mark on the oil pump housing (bottom right sectional drawing). Check if the timing belt is properly installed in the camshaft timing pulley (-1-), the timing belt tension pulley (-5-), the coolant pump pulley (-4-) and the crankshaft timing pulley (-3-).



02 - Engine Mechanism

2. Adjust the timing belt tension pulley (-2-) and screw on the fixing bolt (-arrow-) so that the timing belt is in a proper tension.

 - Tightening torque of the bolt: $18 \pm 2 \text{ N}\cdot\text{m}$



3. Rotate the crankshaft for one turn to check if the timing mark is deviated. If it is deviated, remove the belt and reinstall it.
4. Other installation shall follow the reverse sequence of the removal procedure.

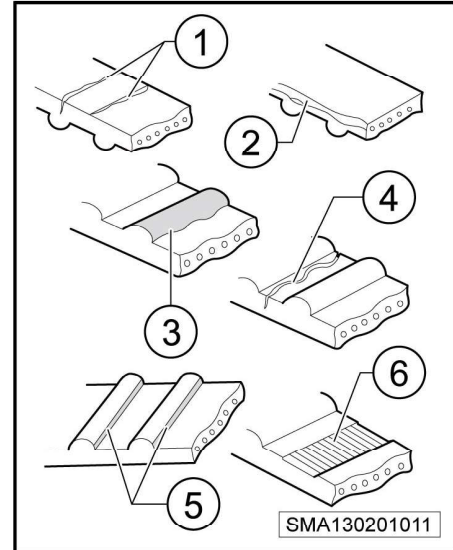
6.4 Inspecting the timing belt

i Note

- A few cracks on the inner tooth of belts are normal.

1. If one of the following occurs to the timing belt, please replace it as soon as possible.

- a. Rubber cracks (-1-4-).
- b. Loosened cord (-2-).
- c. Wear (-3-).
- d. Tooth disengagement (-6-).
- e. Abnormal wear (-5-).



0202 Crank/Conrod Mechanism

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1 General Information

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1.1 Overview

02

1. Crank/conrod mechanism is to transform the thermal energy generated by the fuel combustion into the mechanical energy that fuels the piston alternative motion and then the energy is transmitted through the flywheel during the piston alternative motion into the crankshaft motion of rotation.
2. Crank/conrod mechanism is the main parts that help the engine realize the working cycle and complete the energy conversion.
3. During the power stroke, the mechanism uses the thermal energy generated by the fuel combustion to push the piston for alternative motion and then the piston drives the crankshaft motion of rotation, thus converting it into the mechanical energy and outputting power. During other strokes, the conrod drives the piston to move alternatively by virtue of the revolution inertia of the crank and the flywheel, thus creating conditions for the next work.
4. The crank/conrod mechanism consists of the following parts:
 - a. Cylinder block
 - b. Crankshaft
 - c. Piston
 - d. Piston ring
 - e. Piston pin
 - f. Conrod
 - g. Flywheel

Caution

- Before installing parts, remove impurities and moisture on the surface of parts and apply clean lubricant to areas that suffer from friction and need lubricating.
- When installing parts, do not scrape precision contact surface and fitting surface. If parts are found to be scratched and incompatible with installation standards, they should be replaced.

1.2 Product specifications

Torque specifications

Component	Torque (N*m)
Main bearing cap bolt and stud	95±5
Fixing bolt of the conrod cap	33±3
Fixing bolt of the flywheel	110±5
Cylinder block oil passage screwed plug	22±2

Cylinder block

Item	Standard value (mm)
Upper surface planeness	0.05
Cylinder block wear limit	0.05
Sum of wear limits for cylinder block and cylinder head	0.20
Overall height	206±0.05
Cylinder bore roundness/straightness	0.008/0.01

Crankshaft

Item	Standard value
Axial clearance	0.198±0.105

Crankshaft conrod journal

Item	Standard value
Diameter	44.9±0.01
Parallelism to main journals	0.008

Crankshaft main journal

Item	Standard value (mm)
Diameter	48.99±0.01
Radial runout	0.05
Cylindricity	0.008
Roundness	0.005

Conrod

Item	Standard value (mm)
Radial clearance of conrod bearing shell	0.033±0.027
Conrod tip axial clearance	0.36±0.027

Piston pin

Item		Standard value (mm)
Diameter	W	20.622~20.625

Item		Standard value (mm)
	R	20.625~20.628
	L	20.628~20.631
Piston pin hole diameter	W	20.635~20.638
	R	20.638~20.641
	L	20.641~20.644
Length		61.4±0.4

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Piston

Item	Standard value (mm)
Piston skirt diameter	77.345±0.02

Piston ring

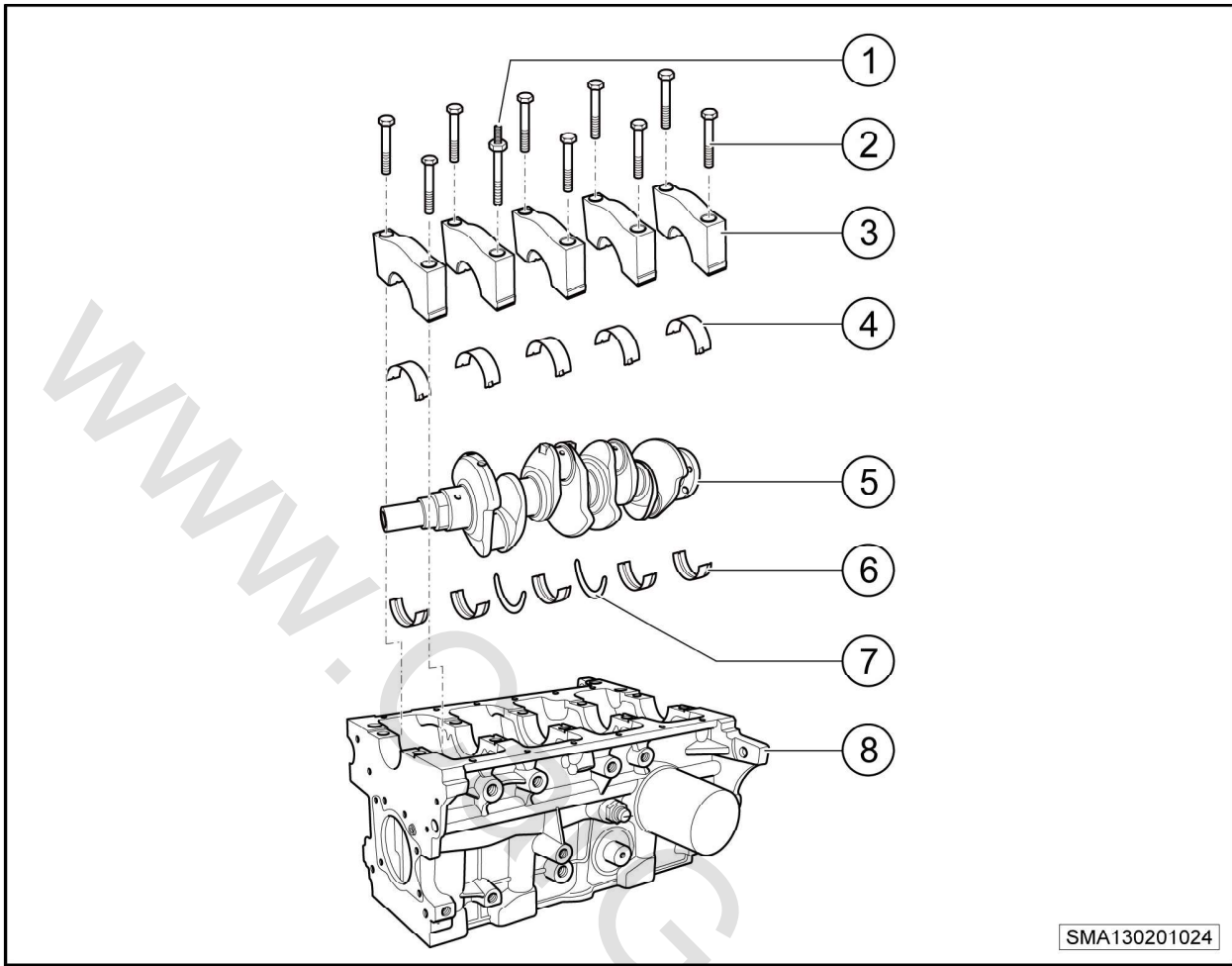
Item		Standard value (mm)
Side clearance	Top ring	0.06±0.02
	Second ring	0.05±0.02
Closed gap	Top ring	0.27±0.07
	Second ring	0.47±0.07
Height	Top ring	1.98±0.01
	Second ring	1.48±0.01
	Oil ring	1.92±0.05

Piston ring slot

Item		Standard value (mm)
Height	Top ring	1.24±0.01
	Second ring	1.53±0.01
	Oil ring	2.02±0.01
Depth	Top ring	70.4±0.1
	Second ring	69.7±0.1
	Oil ring	71.4±0.1

1.3 The crankshaft mechanism assembly drawing

02

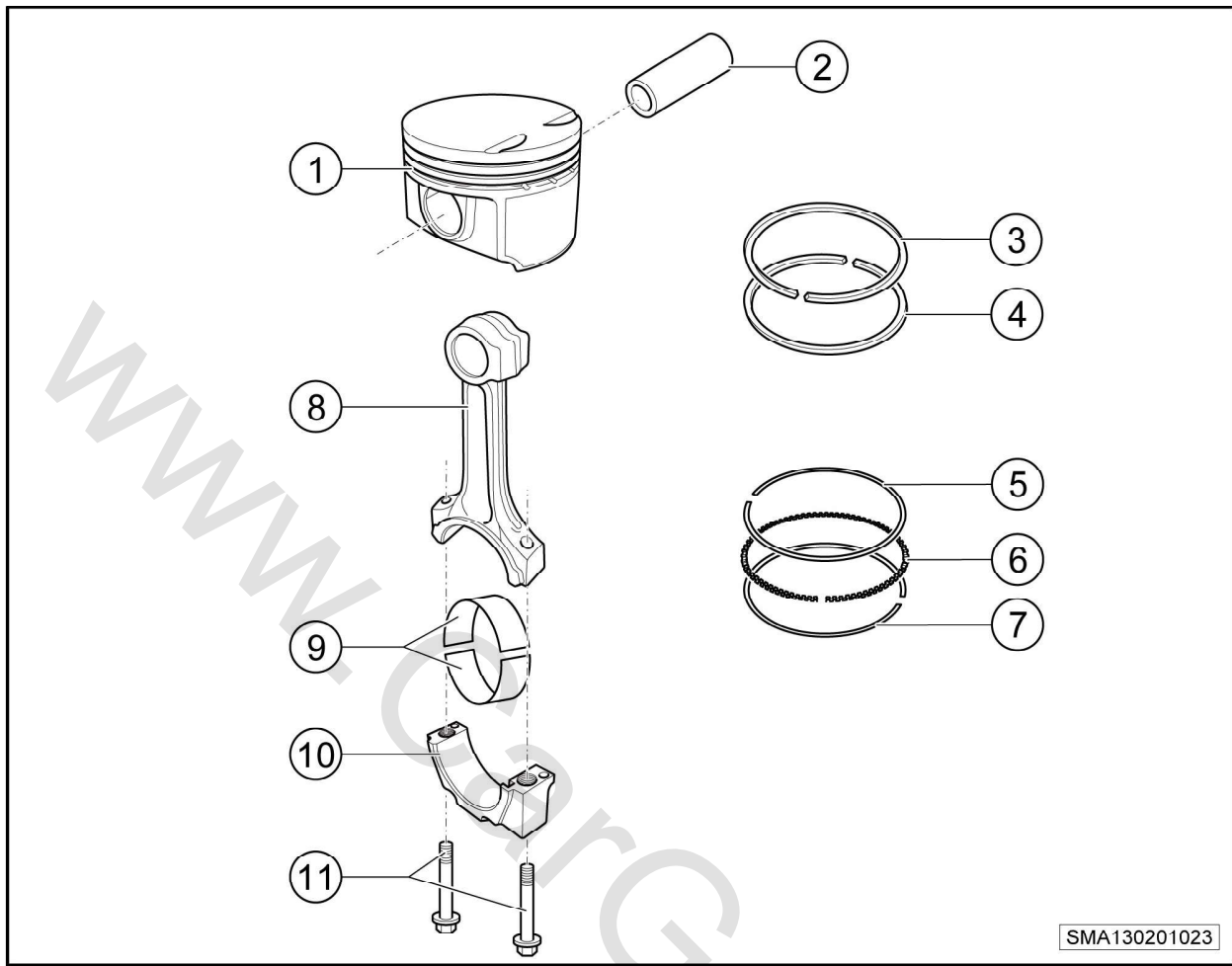


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1. Fixing stud of the crankshaft main bearing cap	2. Fixing bolt of the crankshaft main bearing cap
3. Crankshaft main bearing cap	4. Crankshaft main bearing shell (Upper)
5. Crankshaft	6. Crankshaft main bearing shell (Lower)
7. Thrust washer	8. Cylinder block

1.4 The piston conrod mechanism assembly drawing

02



1. Piston	2. Piston pin
3. Top compression ring	4. Second compression ring
5. Upper oil ring rail	6. Oil ring expander
7. Lower oil ring rail	8. Conrod
9. Conrod bearing shell	10. Conrod cap
11. Bolt	

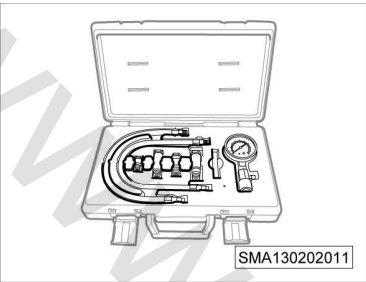
2 Diagnosis and Inspection

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2.1 Inspecting the cylinder pressure

02

Maintenance tools and common equipment

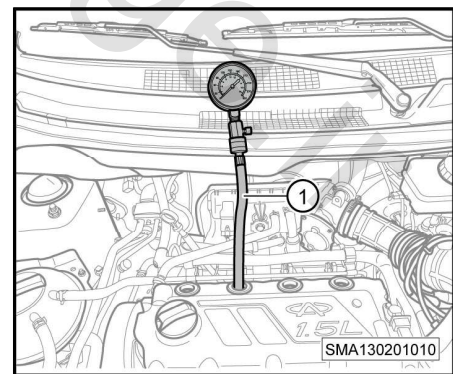
	
Cylinder pressure tester	

Preconditions:

1. Preheat the engine to a normal temperature (cooling fan starts).
2. Oil level is in standard range.
3. Wide-open throttle.
4. Pull out the fuel pump fuses.

Inspection

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Pull out the ignition cable and unscrew all spark plugs.
3. As shown in the figure, install the cylinder pressure tester onto the cylinder to be inspected and preload the instrument.



4. Depress the accelerator pedal fully, start the engine and keep it running for three to five seconds and record the measured pressure indication. Then press the bleed button on the cylinder pressure tester to zero out the instrument. Measure it for three times

with the same method, taking the mean value among them. The standard cylinder compression pressure should be 12 ± 2 bar.

5. If an individual cylinder has a too low pressure, you should first fill 20 to 30 ml oil to the cylinder. The oil will penetrate into the clearance between the piston and the cylinder wall in 1 to 2 min, which can seal the cylinder clearance briefly. You can use the cylinder pressure tester to measure the pressure again. If the cylinder pressure rises significantly, it indicates that the too low cylinder pressure is caused by a too wide clearance of piston rings or pistons and cylinder walls. Conversely, if the cylinder pressure does not change notably, it indicates valve or cylinder gasket faults.

2.2 Crank conrod mechanism fault list

Symptoms	Possible causes	Maintenance recommendations
High cylinder pressure	Poor fuel quality leads to excessive carbon deposit in the combustion chamber	Clean the fuel system, remove the carbon deposit and replace the fuel
	Too thin cylinder gaskets	Replace cylinder gaskets
	Excessive wear on the contact area between cylinder head and cylinder block	Replace cylinder head
Low cylinder pressure	Wrong valve timing	Recorrect valve timing
	Defective tightness or damage in cylinder gasket	Replace cylinder gaskets
	Defective tightness in valve	Replace valve and valve guide
	Defective tightness in clearance between the piston and the cylinder wall	Replace pistons
	Piston ring fracture	Replace the piston ring and check the piston
	Piston ring ends are aligned	Adjust the piston ring ends or replace the piston ring
Abnormal sound in the crankshaft main bearing	Clogged oil conduit and poor lubrication	Clean the oil conduit and repair the engine
	Loose main bearing cap bolts	Replace the bearing shells and bolts
	Excessive wear on main bearing shell	Check the main journal and replace the main bearing shell
	Poor fit between the bearing shell and the journal	Check the main journal and replace the main bearing shell
Abnormal sound in the conrod bearing	Wear on the conrod bearing shell or journal and too wide alignment gap	Check the main journal and replace the main bearing shell
	Low oil pressure, oil deterioration or clogged oil conduit lead to poor lubrication	Replace the oil and check the conrod journal and the conrod bearing shell. Replace them if necessary
	Loose conrod cap bolts	Replace the conrods and the bearing shells
	Excessive wear on the conrod bearing shell	Replace the conrod bearing shell and check the conrod journal
Piston knock	Too wide clearance between the piston and the cylinder wall	Replace the pistons and check the cylinder wall
	Excessive wear between the cylinder wall and the piston	Replace the pistons and check the cylinder wall
	Eccentric wear occurs on the piston due to individual conrod deformation	Replace the conrod, the piston and the cylinder
	Ignition timing fault	Read the fault code and rectify the fault according to the fault code

Symptoms	Possible causes	Maintenance recommendations
Abnormal sound in the piston pin	Excessive wear on the piston pin and the wrist-pin bush leads to loose fit	Repalce the pistons and the conrod
	Excessive wear on the piston leads to loose fit	Repalce the pistons and the conrod

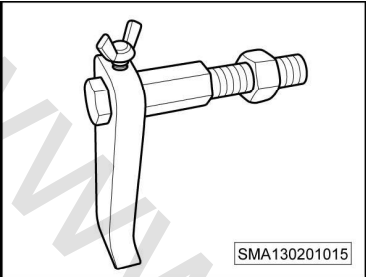
3 Flywheel

3.1 Removing and installing the flywheel assembly.....102

3.1 Removing and installing the flywheel assembly

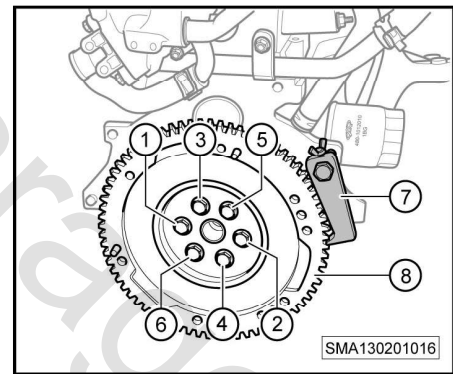
02

Maintenance tools and common equipment

	
Flywheel locking tool	

Removal

1. Remove clutch disc and clutch pressure plate =>
refer to page 899
2. As shown in the figure, using special tool (-7-), lock the flywheel, unscrew the fixing bolts (-1-) to (-6-) and then remove the flywheel (-8-).



Installation

Caution

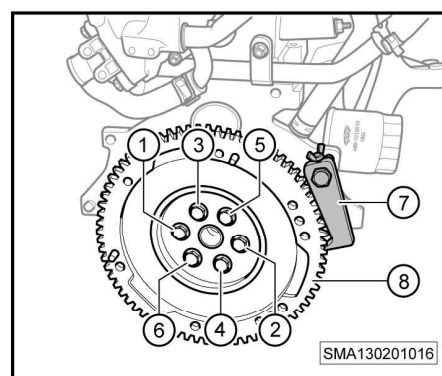
- It is impermissible to reuse the removed flywheel fixing bolts as they are scrapped.

Note

- Six bolt holes of the flywheel are arranged asymmetrically. There are fitting marking holes on the flywheel. When the first cylinder of the engine is at the top dead center, adjust the marking hole on the flywheel over the 12 O'clock position and the flywheel fixing bolts match the crankshaft bolt holes.

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

1. Check if the crankshaft position signal teeth are distorted or deformed. Clean the signal teeth prior to installation.
2. Check if the wear on the starter drive gear rings is normal. Replace them in case of excessive wear.
3. The flywheel installation holes and the crankshaft locating journals employ clearance fit. When installing, try to push them slightly after centering. Do not knock them.
4. As shown in the figure, install the flywheel (-8-) and screw on the bolts firstly. Then using the flywheel locking tool (-7-), lock the flywheel. Finally using the cross method (the tightening sequence for bolts (-1-) to (-6-) shown in the figure), tighten the flywheel fixing bolts in two steps. Step 1: tighten the bolts to the torque $55 \pm 5 \text{ N}\cdot\text{m}$; Step 2: tighten the bolts to the torque $110 \pm 5 \text{ N}\cdot\text{m}$.



4 Conrod

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4.6 Inspecting the conrod axial clearance.....	109

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i Note

- The conrod small end hole and the piston pin adopt interference fit.
- The conrod body and conrod cap are fixed via dowel pins.
- When selecting the conrod bearing shell, two thicknesses are available.
- When assembling, be sure to face the label "F" on the conrod toward the belt pulley direction.

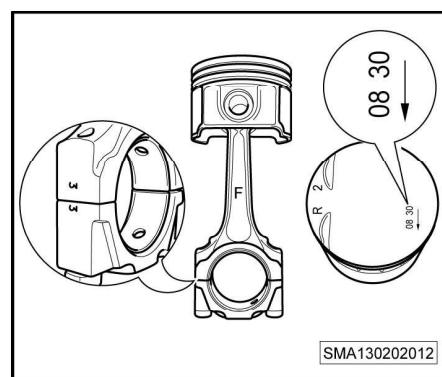
4.1 Product specifications

Product specifications

Item	Standard value
Crankshaft conrod journal diameter	44.9±0.01 mm
Parallelism of the crankshaft conrod journal to the main journals	0.008 mm
Radial clearance of the conrod bearing shell	0.006~0.06 mm
Conrod assembly mass (excluding bearing shells)	550±6.5 g
Conrod tip axial clearance	0.092~0.268 mm

4.2 Assembling relationship of conrod

1. As shown in the figure, install the letter "F" on the conrod and the forward-facing mark "Arrow" on the piston crown toward the belt pulley.
2. The numeral at one side of the conrod is in the same direction as that on the conrod cap. The numerals represent the number of cylinder to be installed. For example, the numeral "3" means the conrod is installed in the third cylinder.



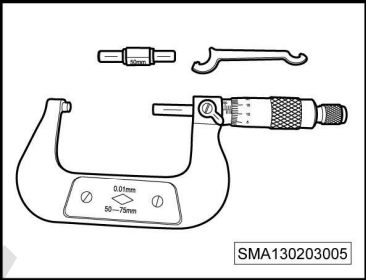
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4.3 Selecting method of conrod bearing shell

1. There are two types of conrod bearing shells. The first one has the wear value of the crankshaft conrod journal of less than 0.25 mm and a green mark "0.25 mm" is etched on the back of the conrod bearing shell. The second one is used to correct the conrod bearing shell with bearing clearance and a yellow mark "0.025 mm" is etched on the back of the conrod bearing shell.
2. The upper bearing shell and lower bearing shell of the conrod are universal. An oil hole rather than an oil channel is present. On one and the same engine should be used a set of conrod bearing shell and main bearing shell that are manufactured by one supplier. Apply engine lubricant on the internal surfaces of the conrod bearing shell and the main bearing shell prior to the installation. Oil and impurities should be removed from the back of the shells when assembling.
3. The conrod and the conrod cap are fixed using dowel pins. The dowel pins and the dowel pin holes adopt interference fit.
4. When assembling, some engine lubricant should be sprayed onto the joint face of the conrod and the conrod cap dowel pin holes and on the dowel pins.
5. After the dowel pins are installed, some lubricant should be sprayed onto the joint face of the conrod and the conrod cap and into the threaded holes. Manually drive in the conrod nuts. Then using the torque wrench, tighten nuts in two steps. Tighten them to the torque $20 \pm 1.0 \text{ N}\cdot\text{m}$ in the first step and then tighten them to the torque $33 \pm 3 \text{ N}\cdot\text{m}$ in the second step.

4.4 Inspecting the mainshaft conrod journal

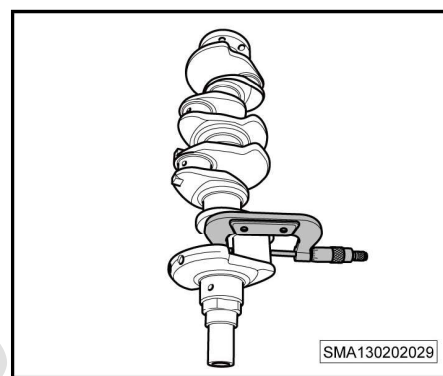
Maintenance tools and common equipment

	
Outer diameter micrometer	

02

Inspection

1. Clean the mainshaft conrod journal.
2. As shown in the figure, using the outer diameter micrometer, measure the mainshaft conrod journal. The standard value of the mainshaft conrod journal should be 44.9 ± 0.01 mm.



4.5 Inspecting the conrod bearing shell

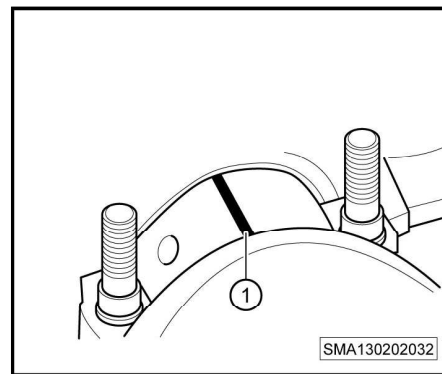
Caution

- When measuring, do not rotate the crankshaft!

02

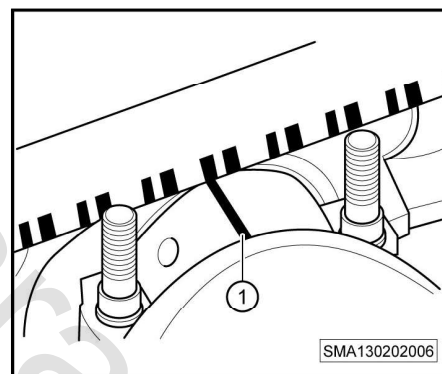
Inspection

- Clean the conrod journal and the conrod bearing shell. Place the clearance gauge (-1-) on the journal. Install the conrod bearing shell and the conrod cap and tighten the fixing bolts of the conrod cap to the specified torque.



- Loosen the conrod cap bolts and remove the conrod cap.

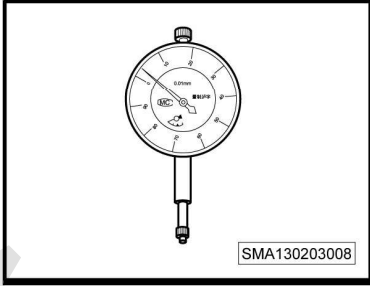
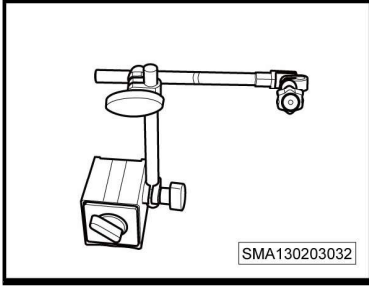
- As shown in the figure, using the measuring scale on the packet of the clearance gauge, measure the width of the widest part of the flattened gauge (-1-) and then produce the clearance value.



Item	Standard value (mm)
Conrod journal diameter	44.9±0.01
Parallelism of the conrod journal to the main journals	0.008
Radial clearance of conrod bearing shell	0.006~0.06

4.6 Inspecting the conrod axial clearance

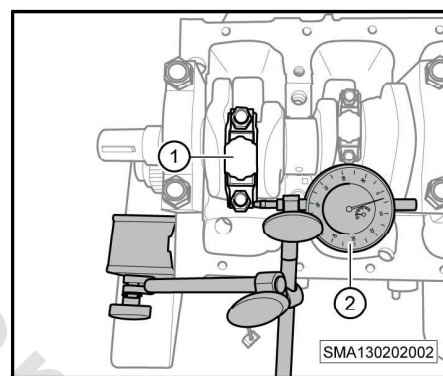
Maintenance tools and common equipment

 <p>SMA130203008</p>	 <p>SMA130203032</p>
Dial indicator	Bracket

02

Inspection

1. Tighten the fixing bolts of the conrod cap to the specified torque.
2. As shown in the figure, install a dial indicator (-2-) onto the bracket.
3. Hold the measuring rod of the dial indicator against the side end of the conrod (-1-) and zero out the dial indicator.
4. Push the conrod backwards and forwards (do not rotate the crankshaft) and read the axial clearance value on the dial indicator. The axial clearance should be 0.36 ± 0.027 mm.



5 Piston and Piston Ring

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5.3 Assembling relationship of pistons.....	113
5.4 Inspection.....	115

02

5.1 Product specifications

Piston

Item	Standard value (mm)
Piston skirt diameter	77.345±0.02

Assembly of the piston and piston pin

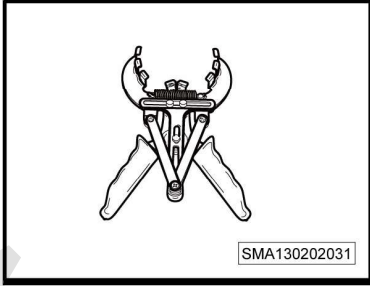
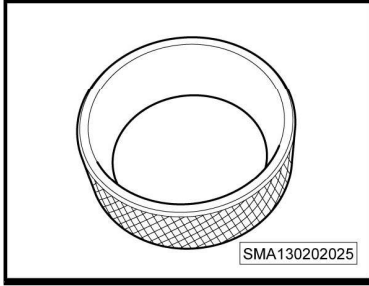
Group	Piston pin outer diameter group (mm)	Piston pin hole internal diameter (mm)	Piston pin group identification
1	20.622~20.625	20.635~20.638	W
2	20.625~20.628	20.638~20.641	R
3	20.628~20.631	20.641~20.644	L

Matching between pistons and cylinders

Piston diameter (mm)	Cylinder bore diameter (mm)	Matching cylinder clearance (mm)
77.325~77.335	77.36~77.37	0.025~0.045
77.335~77.345	77.37~77.38	
77.345~77.355	77.38~77.39	
77.355~77.365	77.39~77.40	

5.2 Removing and installing the piston rings

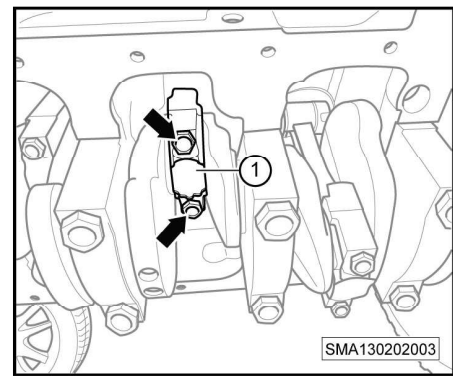
Maintenance tools and common equipment

 <p>SMA130202031</p>	 <p>SMA130202025</p>
Piston ring remover	Piston mounting tool

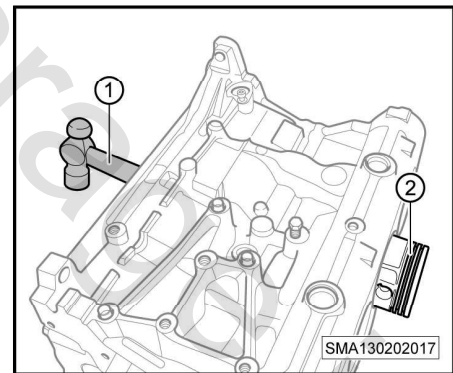
02

Removal

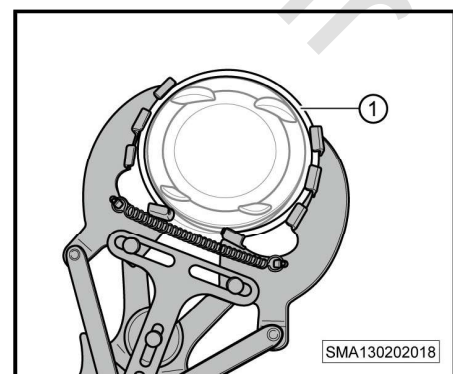
1. Unscrew the fixing bolts (-arrow-) and remove the conrod cap (-1-).
 - Tightening torque of fixing bolts of the conrod cap: $33\pm 3 \text{ N}\cdot\text{m}$



2. As shown in the figure, using soft materials (such as wooden or rubber hammer handle (-1-)), push out the piston component (-2-).

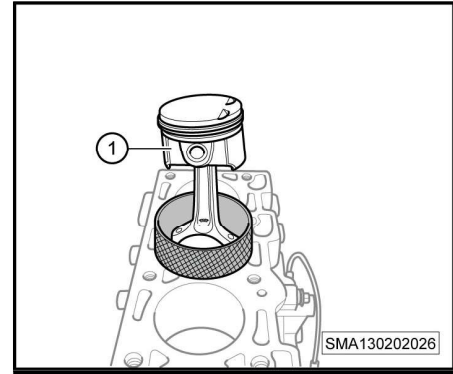


3. As shown in the figure, using the piston ring remover, remove the piston ring (-1-).



Installation

1. Install the piston ring. => refer to page 113
2. Apply engine lubricant on the piston surface and the cylinder wall.
3. As shown in the figure, using the piston mounting tool, install the piston (-1-) into the cylinder.

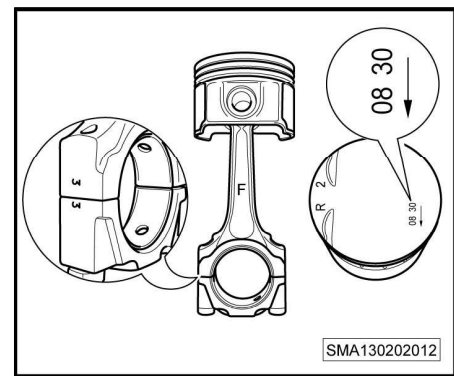


4. Other installation shall follow the reverse sequence of the removal procedure.

5.3 Assembling relationship of pistons

Assembling relationship between the piston and the conrod

1. The conrod small end hole and the piston pin adopt interference fit. Before installing the piston pin, spray some engine lubricant on the piston pin circumference and into the piston pin hole. Heat the conrod small end to 130~200°C firstly and then press the piston pin into the conrod small end hole and the piston pin hole. After the piston pin is installed into the piston pin hole, the distance from one end of the piston pin to the piston pin boss outer edge indent must be less than 0.5 mm.
2. As shown in the figure, install the letter "F" on the conrod and the forward-facing mark "Arrow" on the piston crown toward the belt pulley.
3. The numeral at one side of the conrod is in the same direction as that on the conrod cap. The numerals represent the number of cylinder to be installed. For example, the numeral "3" means the conrod is installed in the third cylinder.



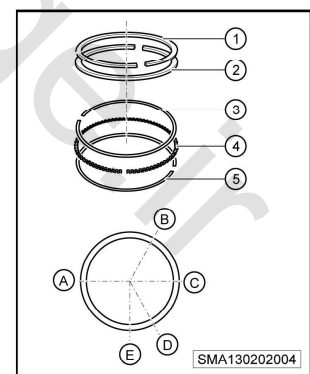
Assembling relationship between the piston and the piston ring

Caution

- The piston ring ends must not face toward the piston pin.
- The piston ring must rotate freely in the ring slot and abstain from blockage.
- When installing the piston ring, spray some engine lubricant into the piston ring slot and the piston.
- The opening between two adjacent rings should form 120°.

As shown in the figure:

1. Top compression ring (-1-) is rectangular and the side marked with a letter should face forward the piston crown when installing. Second compression ring (-2-) is a tapered ring and the side marked with a letter should face forward the piston crown when installing.
2. Oil ring, a steel strip ring, consists of the upper rail (-3-), the lower rail (-5-) and the expander (-4-).
3. When installing, be sure to keep the opening between two adjacent rings at 120°. Apply engine lubricant on the pistons and the piston ring surface. Installation order is as follows:
 - a. Install the oil rings. Install the expander (-4-) into the oil channel firstly and then install two rails. The expander overlap gap (-E-) and the upper rail opening (-A-) form 90°. The expander overlap gap (-E-) and the lower rail opening (-C-) form



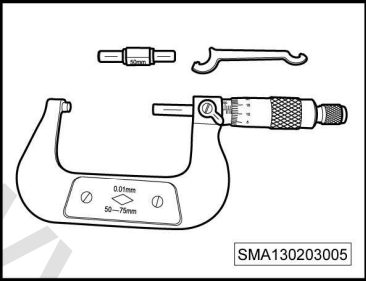
90°. The upper rail opening (-A-) and the lower scraper opening (-C-) form 180°.

- b. Install the second compression ring (-2-). When installing, the side marked with a letter should face forward the piston crown. The second compression ring end (-B-) and the upper rail opening (-A-) form 120°.
- c. Install the top compression ring (-1-). When installing, the side marked with a letter should face forward the piston crown. The top compression ring end (-D-) and the second compression ring end (-B-) form 120°.

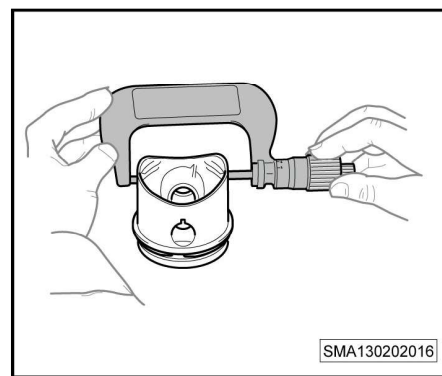
5.4 Inspection

Inspecting the piston diameter

Maintenance tools and common equipment

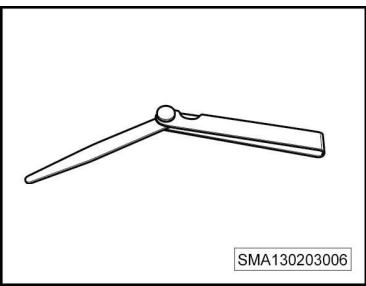
	
Outer diameter micrometer	

1. Using the outer diameter micrometer, measure in the vertical direction of the piston pin at a position 11 mm from the lower end of the piston skirt.
2. In accordance with the matching between the piston and the cylinder, four different diameters of pistons are available.



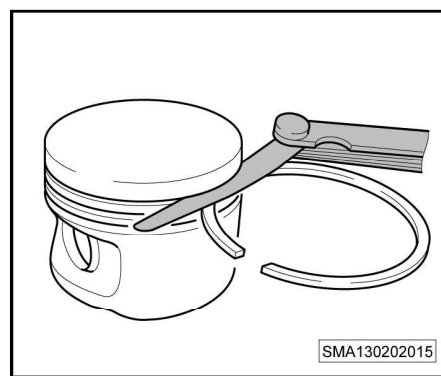
Inspecting the clearance between the piston ring and the ring slot

Maintenance tools and common equipment

	
Clearance gauge	

02 - Engine Mechanism

1. Remove the carbon deposit in the ring slot. As shown in the figure, using the clearance gauge, inspect the clearance between the piston ring and the ring slot.



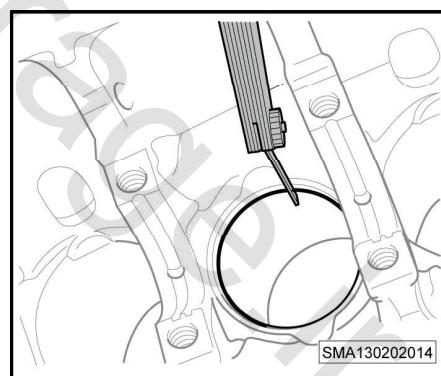
Clearance between the piston ring and the ring slot	Standard value (mm)
Top piston ring slot	0.06 ± 0.02
Second piston ring slot	0.05 ± 0.02

Inspecting the piston ring closed gap

Maintenance tools and common equipment

Clearance gauge	

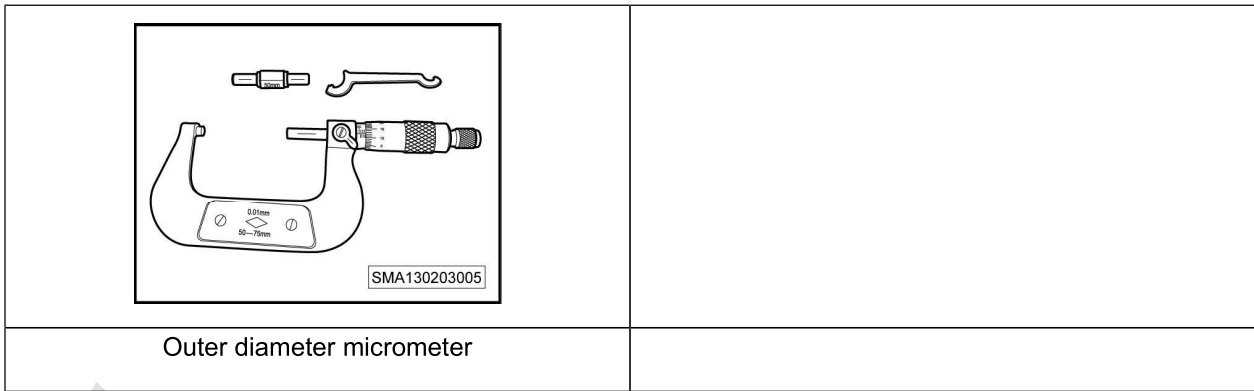
1. Using the piston without ring, push it along the cylinder wall into the cylinder vertically until it reaches a position 45 mm from the cylinder bottom.
2. Using the clearance gauge, measure the piston ring closed gap.



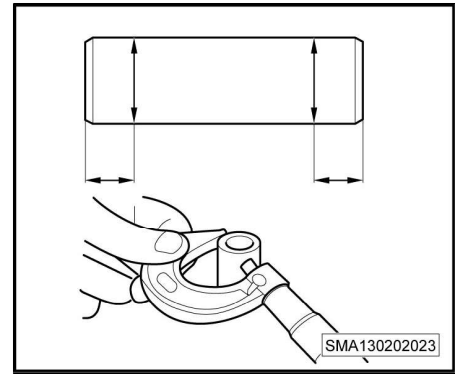
Piston ring closed gap	Standard value (mm)
Top ring	0.27 ± 0.07
Second ring	0.47 ± 0.07

Inspecting the piston pin diameter

Maintenance tools and common equipment

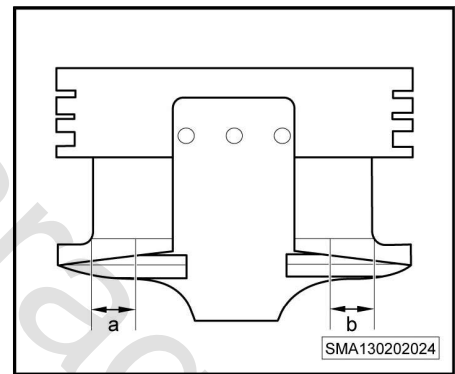


- Using the outer diameter micrometer, measure the circumference of the piston pin according to the locations illustrated in the following figure. The maximum value is taken as the dimension of the piston pin diameter.



Inspecting the piston pin hole internal diameter

- As shown in the figure, measure the piston pin hole internal diameter from every side in the range a and b and take the minimum value as the dimension of the piston pin hole internal diameter.



Group	Piston pin outer diameter (mm)	Piston pin hole internal diameter (mm)	Piston pin group identification
1	20.622~20.625	20.635~20.638	W
2	20.625~20.628	20.638~20.641	R
3	20.628~20.631	20.641~20.644	L

6 Crankshaft

6.1 Product specifications.....	118
6.2 Tightening order of the crankshaft main bearing cap bolts.....	119
6.3 Assembling relationship of the crankshaft main bearing cap.....	120
6.4 Selecting method of crankshaft main bearing shell.....	121
6.5 Installing the thrust washer.....	122

02

6.1 Product specifications

Crankshaft

Condition	Standard value (mm)
Axial clearance	0.198±0.105

Crankshaft main journal

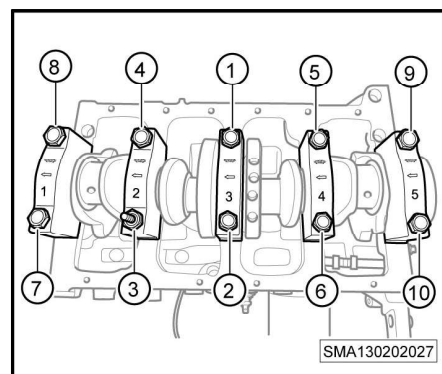
Condition	Standard value (mm)
Diameter	48.99±0.01
Radial runout	0.05
Cylindricity	0.008
Roundness	0.005

6.2 Tightening order of the crankshaft main bearing cap bolts

Caution

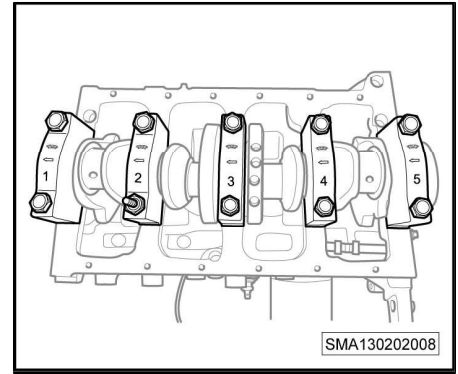
- When failing to manually drive in the bolts, unscrew them and spot the reason or replace them or check the threaded holes.

1. Manually tighten the bolts firstly.
2. Then tighten them in the order from (-1-) to (-10-) for several times.
 - Tightening torque for fixing bolts of the crankshaft main bearing cap: $95 \pm 5 \text{ N}\cdot\text{m}$



6.3 Assembling relationship of the crankshaft main bearing cap

1. As shown in the figure, letters (-1-2-3-4-5-) and an arrow are cast on the crankshaft main bearing cap. When assembling, start from the side of the timing belt and install it in order with the arrow pointing to the crankshaft pulley.

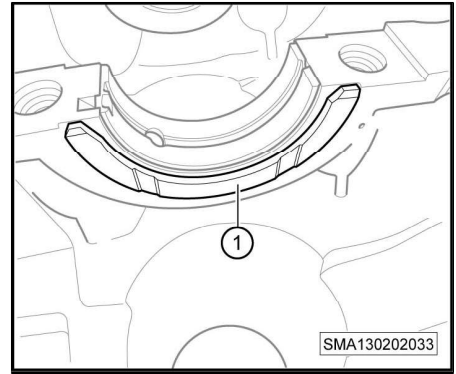


6.4 Selecting method of crankshaft main bearing shell

1. During production, the 477F engine uses a "standard" crankshaft main bearing shell, which are marked with "STD" on the shell back instead of any colour.
2. There are three types of main bearing shells for service. The first one is the mainshaft shell for the main bearing hole with an enlargement of 0.4 mm of the cylinder block and a black mark "0.4" is etched on the back of the main bearing shell. The second one is the crankshaft journal with less than 0.25 mm wear and a green mark "0.25" is etched on the back of the shell. The third one is used to correct the main bearing shell with bearing clearance and a yellow mark "0.02" is etched on the shell back.
3. The crankshaft main bearing shell consists of an upper main bearing shell and a lower main bearing shell. The upper shell has oil channels and oil holes. When assembling, the oil holes in the upper main bearing shell must be aligned with the oil holes in the cylinder block. The lower shell does not have oil holes.

6.5 Installing the thrust washer

1. Before installing, clean the thrust washer and the cylinder face that matches with the thrust washer.
2. As shown in the figure, the surface of the thrust washer (-1 -) with two grooves should face toward outside and the other surface without any groove should stick on the cylinder face.



7 Cylinder Block

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7.2 Inspection.....	124

7.1 Product specifications

Cylinder block

02

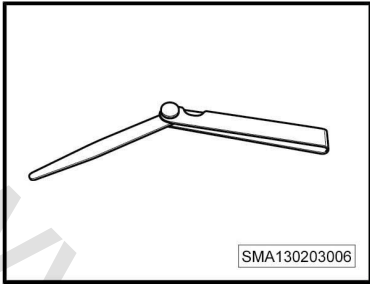
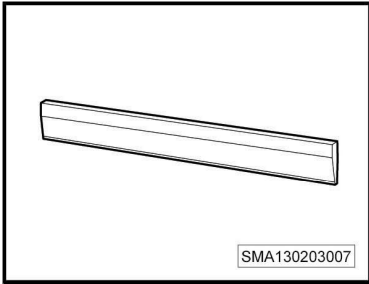
Item	Standard value (mm)
Upper surface planeness of the cylinder block	0.05
Permissible maximum wear thickness on the cylinder block (wear limit)	0.05
Sum of permissible maximum wear thicknesses for cylinder block and cylinder head (wear limit)	0.20
Cylinder block overall height	206±0.05
Cylinder bore roundness/straightness	0.008/0.01

7.2 Inspection

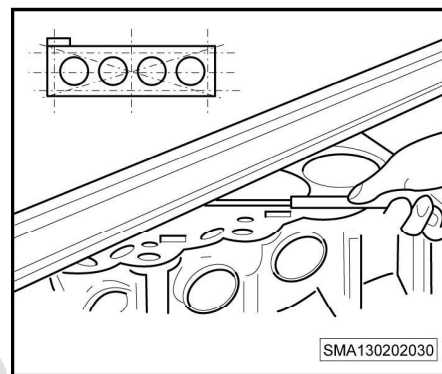
Inspecting the upper surface planeness of the cylinder block

Maintenance tools and common equipment

02

 <p>SMA130203006</p>	 <p>SMA130203007</p>
Clearance gauge	Precision ruler

1. Clean the cylinder block upper surface.
2. As shown in the figure, using the precision ruler and the clearance gauge, inspect the upper surface planeness of the cylinder block.
3. Permissible maximum wear thickness on the cylinder block (wear limit) is 0.05 mm. The sum of maximum wear thicknesses for cylinder block and cylinder head (wear limit) is 0.20 mm.

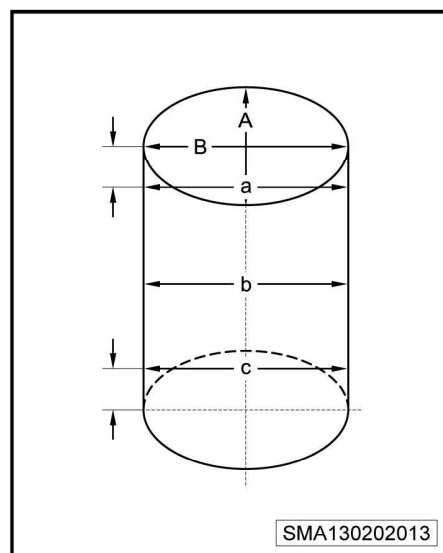


Item	Standard value (mm)
Upper surface planeness	0.05

Inspecting the cylinder internal diameter roundness

1. Check the cylinder wall for scratches. If scratches are present, inspect or replace the cylinder block.

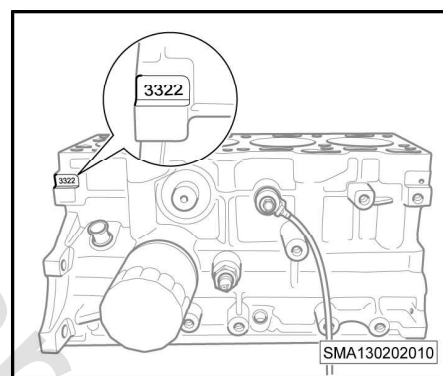
2. Using the an internal diameter dial indicator, measure the internal diameters of the cylinder bores at three different heights (plane a, b and c, see the figure for the heights) on the cylinder block and take the maximum and minimum values. Roundness = (Maximum diameter - Minimum diameter)/2. The standard roundness of the cylinder internal diameter should be less than 0.008 mm.



02

Standard diameter and service dimension of the cylinder bore

- In normal operation, the cylinder diameter tolerance should be 0.04 mm and falls into four groups.
- As shown in the figure, the group marks of cylinder bores are printed on the small rough datum plane on the back end surface of the cylinder intake side and labelled with Arabic numerals, impressing the cylinder bore class numbers (-4-3-2-1-) from left to right.



- It is permissible to enlarge the cylinder bore diameter to rework in special cases. The cylinder bore diameter tolerance for production and service is 0.03mm and falls into three groups.
- When a cylinder bore is reworked to the service dimension, other three cylinder bores should be machined to the dimension for production and service.

Production situation	Group No.	Cylinder	Cylinder bore diameter (mm)
Normal production	1	4th cylinder	77.36~77.37
	2	3rd cylinder	77.37~77.38
	3	2nd cylinder	77.38~77.39
	4	1st cylinder	77.39~77.4
Production and service	A	77.63~77.64	
	B	77.64~77.65	

02 - Engine Mechanism

Production situation	Group No.	Cylinder	Cylinder bore diameter (mm)
	C		77.65~77.66

02

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0203 Valve Train

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2 Valve Train Troubleshooting.....	133
3 Cylinder Head	134
4 Camshaft and Rocker Shaft	141
5 Valve and Valve Spring.....	149

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1 General Information

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1.3 The valve train assembly drawing.....	131
1.4 The crankshaft assembly drawing.....	132

1.1 Overview

02

1. Depending on engine operation, the valve train opens and closes the intake and exhaust valves of all cylinders in the order of ignition at regular intervals, allowing the entry of flammable gas mixture into the cylinder and the discharge of exhaust gases.
2. When the valve is opened for air exchange during the operation of cylinder, the crankshaft drives the camshaft to rotate via the timing belt, causing the lobes on the camshaft to push one end of the rocker upwards, which makes the other end press the valve downwards and open it to further compress the spring. When the dead center of the lobes does not reach the rocker, the thrust force on the rocker will gradually decrease. The opening of the valve will become gradually narrower and finally closed under the spring tension. The valve would therefore be tightly closed during the compressing and working stroke.
3. The valve train consists of the following components:
 - a. Valve
 - b. Valve guide
 - c. Valve seat
 - d. Valve spring
 - e. Valve oil seal
 - f. Spring seat
 - g. Lock plate
 - h. Rocker
 - i. Rocker shaft
 - j. Camshaft
 - k. Cylinder head

1.2 Product specifications

Torque specifications

Component	Value
Fixing bolt of the cylinder head	42.5±2.5 N•m+90°+90°
Fixing bolt of the rocker shaft	30±1.5 N•m
Fixing bolt of the camshaft timing gear	95±5 N•m
Fixing bolt of the camshaft cap 1	9.5±1 N•m
Fixing bolt of the cylinder head cover	7±1 N•m
Fixing bolt of the thermostat seat	9.5±1.5 N•m
Fixing bolt of the camshaft position sensor	8±0.5 N•m

02

Cylinder head

Item	Value (mm)
Overall height	97
Lower surface warpage degree	0.055±0.025
Surface warpage degree of the intake manifold side	0.04
Surface warpage degree of the exhaust manifold side	0.04

Camshaft

Item	Value (mm)
Intake camshaft lifting	5.09
Exhaust camshaft lifting	5.34
Camshaft diameter	25.974±0.007
Crankshaft axial clearance	0.124±0.029

Valve spring

Item	Value
Free height	47.7 mm
Pretension	260±11 N
Installation height	41 mm

Valve

Valve head edge thickness	Intake valve	0.6 mm
	Exhaust valve	0.4 mm
Valve stem diameter	Intake valve	5.98±0.008 mm
	Exhaust valve	5.96±0.008 mm
Seal width	Intake valve	2.83 mm
	Exhaust valve	2.86 mm
Clearance between the valve stem and the valve guide	Intake valve	0.027±0.015 mm
	Exhaust valve	0.047±0.015 mm

02 - Engine Mechanism

Tilt angle	Intake valve	68°
	Exhaust valve	70°
Height	Intake valve	107.998 mm
	Exhaust valve	117.41 mm

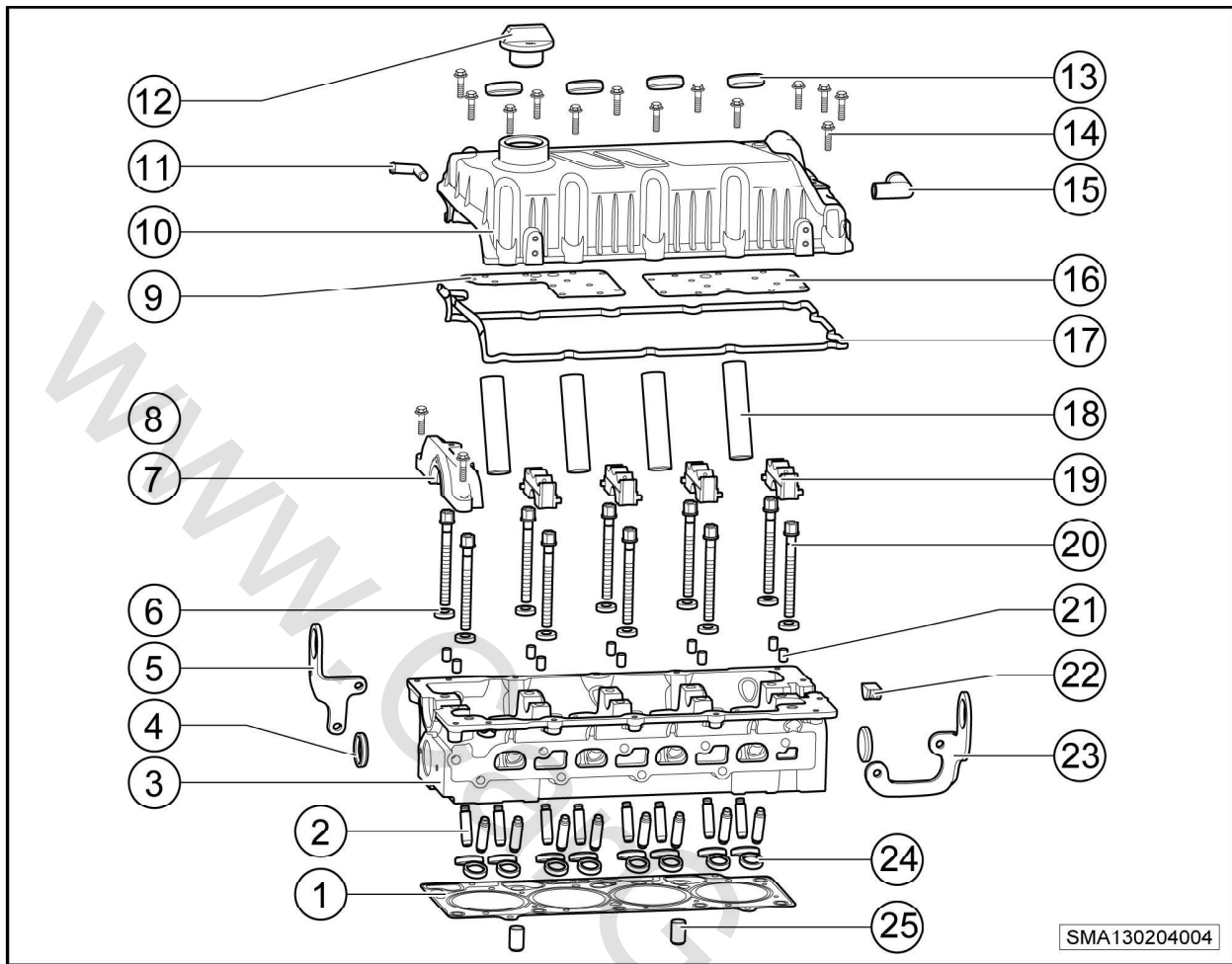
Valve guide

Item	Value (mm)
Valve guide length	42±0.25
Inner diameter	6.007±0.007
Outer diameter	11.045±0.005
Press-in height	12.5±0.2

Valve opening angle

Item	Value (°)
Crankshaft angle as the intake valve is open (before TDC)	15
Crankshaft angle as the intake valve is closed (after BDC)	61
Crankshaft angle as the exhaust valve is open (before BDC)	17
Crankshaft angle as the exhaust valve is closed (after TDC)	35

1.3 The valve train assembly drawing

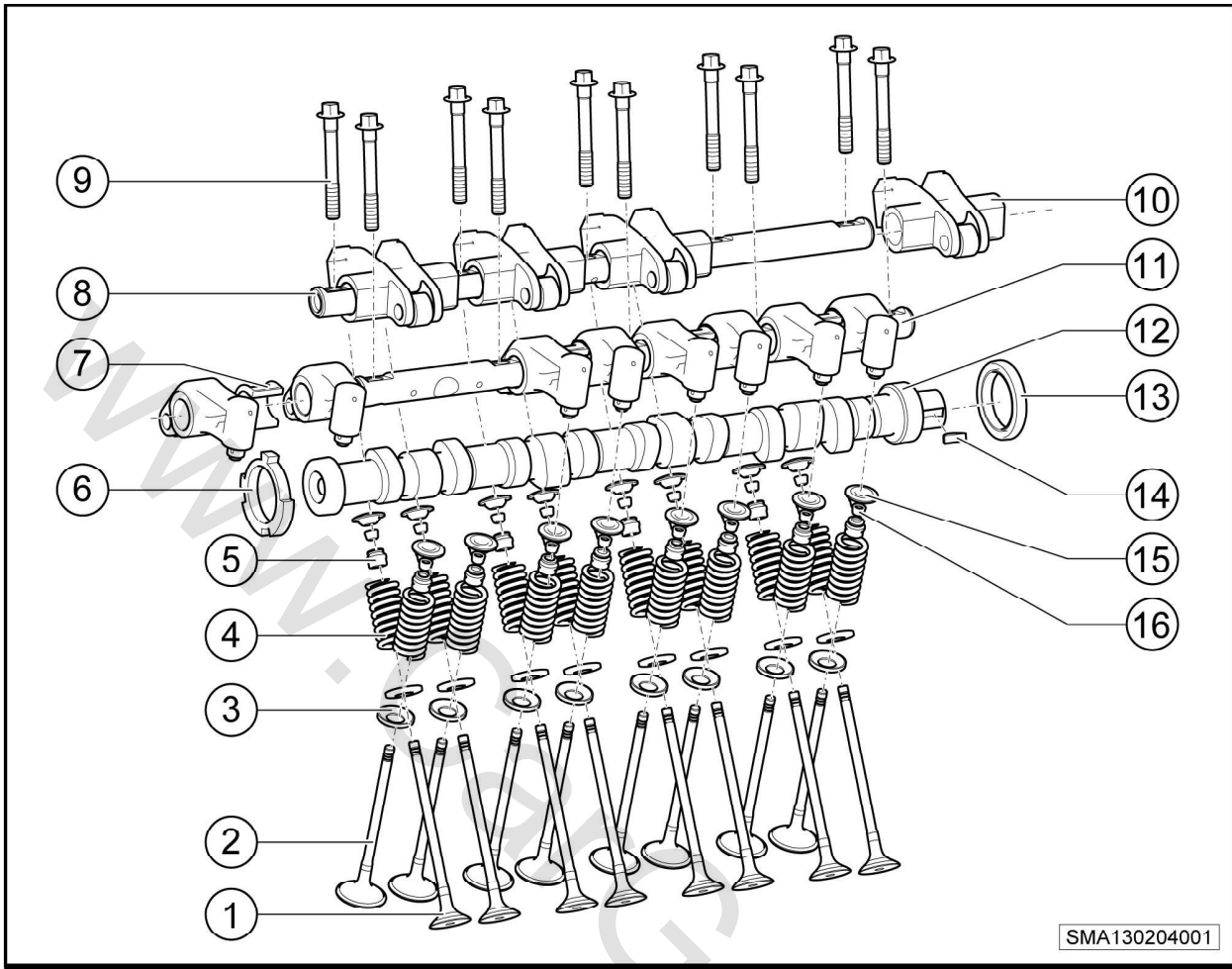


02

1. Cylinder gasket	2. Valve guide
3. Cylinder head	4. Water block
5. Lug	6. Washer
7. Camshaft cap 1	8. Bolt
9. Plate	10. Cylinder head cover
11. Elbow	12. Oil filler cap
13. Seal ring	14. Bolt
15. Square elbow	16. Plate
17. Gasket	18. Spark plug socket
19. Camshaft cap	20. Cylinder head bolt
21. Dowel pin	22. Semi-circular rubber block
23. Lug	24. Valve seat ring
25. Locating sleeve	

1.4 The crankshaft assembly drawing

02



1. Exhaust valve	2. Intake valve
3. Lower valve spring seat	4. Valve spring
5. Valve oil seal	6. Camshaft phase ring
7. Rocker spacer sleeve	8. Exhaust rocker shaft
9. Rocker shaft bolt	10. Exhaust rocker
11. Intake rocker shaft	12. Camshaft
13. Oil seal	14. Woodruff key
15. Upper valve spring seat	16. Valve cotter

2 Valve Train Troubleshooting

2.1 The valve train fault list.....133

2.1 The valve train fault list

Symptoms	Possible causes	Maintenance recommendations
Abnormal noise of the crankshaft	Excessive camshaft axial clearance causing shift back and forth	Check the camshaft axial clearance and replace the worn parts if necessary
	Camshaft distortion	Replace the camshaft
	Excessive camshaft radial clearance	Check the camshaft radial clearance and replace the cylinder head if necessary
Abnormal noise of the valve seat ring	Improper installation of the valve oil seal	Replace the valve oil seal and reinstall it
	Upside-down installation of the valve seat ring	Replace the cylinder head
	Valve seat ring distortion	Replace the valve seat ring
	Improper installation depth of the valve guide	Adjust the installation depth of the valve guide
	Improper installation angle of the valve guide	Replace the valve guide and the cylinder head
Abnormal noise of the rocker	Damage to the rocker retainer	Replace the rocker
	Damage to the tappet ball joint	

02

3 Cylinder Head

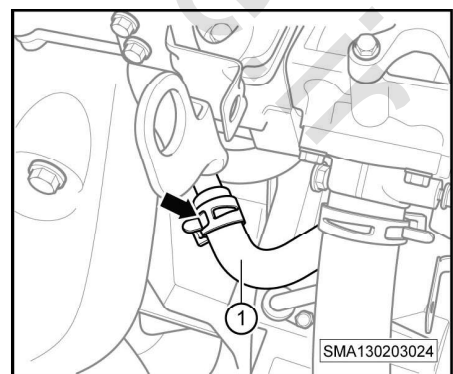
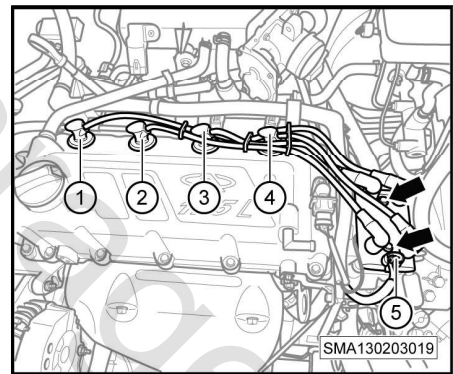
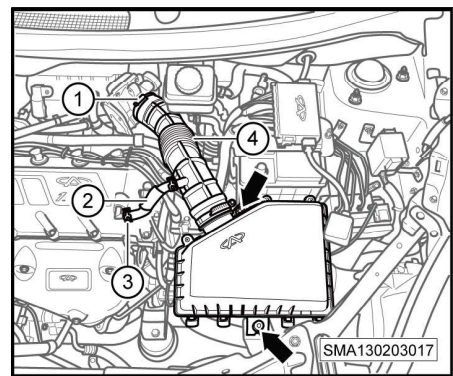
3.1 Removing and installing the cylinder head.....134

3.1 Removing and installing the cylinder head

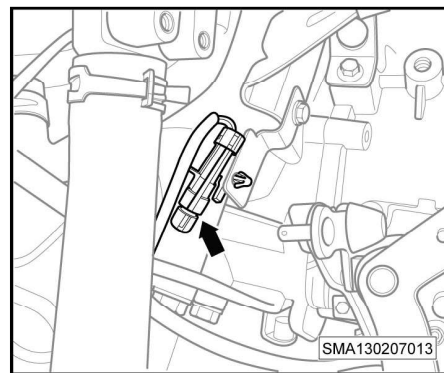
Removal

02

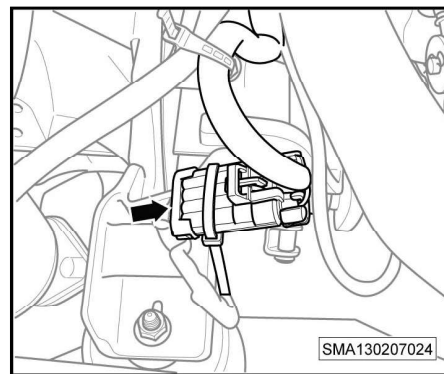
1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal.
3. Discharge the coolant. => refer to page 177
4. Discharge the oil. => refer to page 31
5. Unscrew the fixing bolts (-arrow-) and the worm clamp bolt (-1-), loosen the clamp (-3-), pull out the hose (-2-) and (-4-), and remove the air filter assembly.
6. Disconnect the ignition coil connector (-5-), pull out the ignition cables from (-1-) to (-4-), unscrew the fixing bolts (-arrow-), and remove the ignition coil and the ignition cables.
7. Release the clamp (-arrow-) and pull out the coolant hose (-1-).



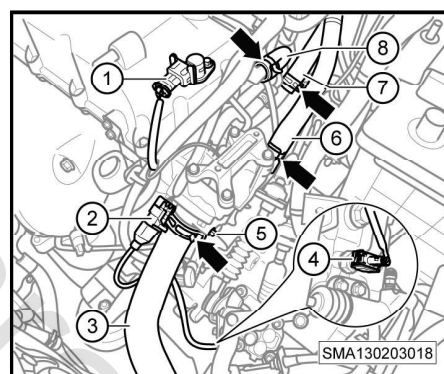
8. Disconnect the front oxygen sensor connector (-arrow-).



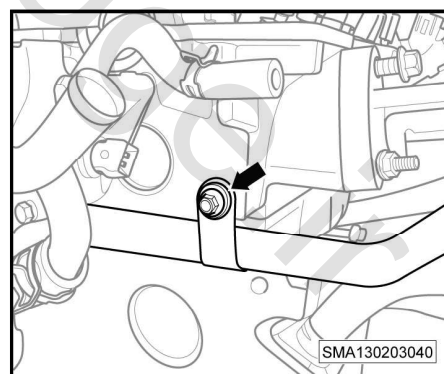
9. Disconnect the rear oxygen sensor connector (-arrow-).



10. Disconnect the camshaft position sensor connector (-1-), the crankshaft position sensor connector (-2-) and the reverse gear switch connector (-4-); disengage the fixing clamps (-arrow-), the radiator inlet hose (-3-), the heater tank inlet hose (-6-), the heater tank outlet hose (-7-) and the crankcase ventilation hose (-8-); and unscrew the earth wire bolt (-5-) and release the earth wire.

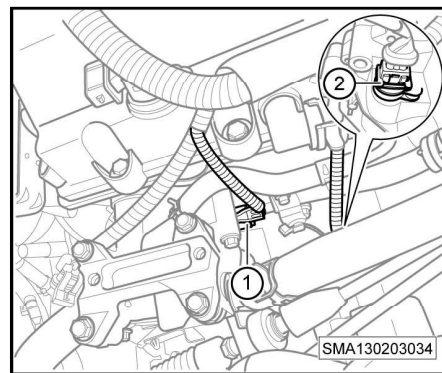


11. Unscrew the fixing bolt (-arrow-) and disconnect the coolant pipe assembly from the cylinder head.



02 - Engine Mechanism

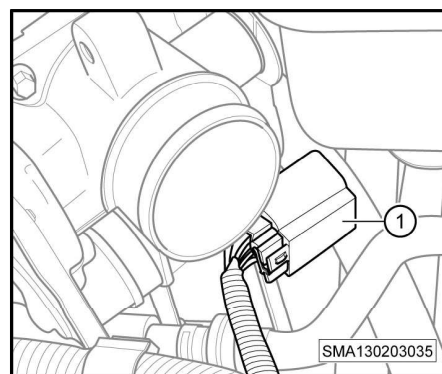
12. Disconnect the coolant temperature sensor connector (-1-) and the speed sensor connector (-2-).



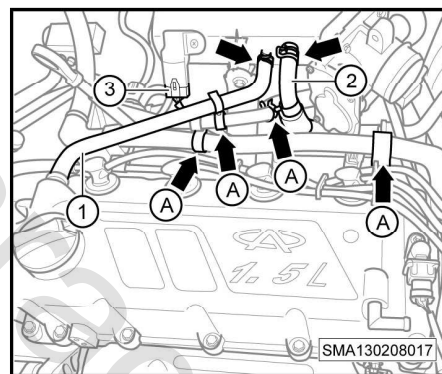
02

The following steps 13 and 14 are applied to vehicles equipped with electronic throttles

13. Disconnect the electronic throttle connector (-1-).

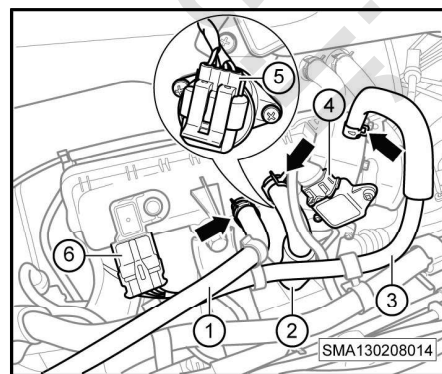


14. Loosen the clamps (-arrow-) and clips (-arrow A-), pull out the crankcase ventilation hose (-1-) and the vacuum booster hose (-2-), and then disconnect the intake air pressure/temperature sensor connector (-3-).



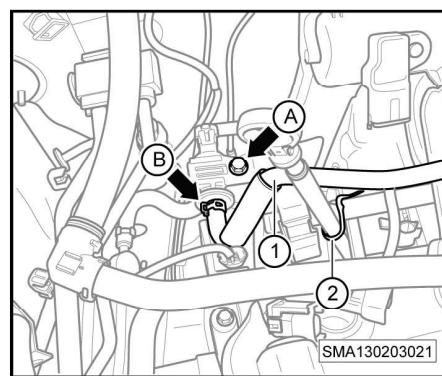
The following step 15 is applied to vehicles equipped with mechanical throttles

15. Loosen the clamps (-arrow-); pull out the crankcase ventilation hose (-1-), the vacuum booster hose (-2-) and the activated carbon canister hose (-3-); and disconnect the throttle position sensor connector (-4-), the idling stepper motor connector (-5-) and the intake air pressure/temperature sensor connector (-6-).



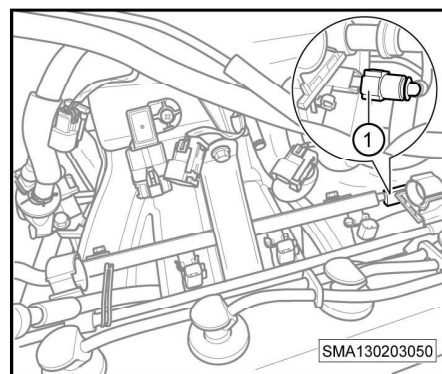
The following steps 16 to 23 are applied to all vehicles

16. Unscrew the fixing bolt (-1-), disconnect the activated carbon canister solenoid valve from the intake manifold, loosen the clamp (-2-), pull out the hose (-4-), disconnect the knock sensor connector (-3-) and the oil dipstick tube retainer (-5-), and pull out the oil dipstick (-arrow-).

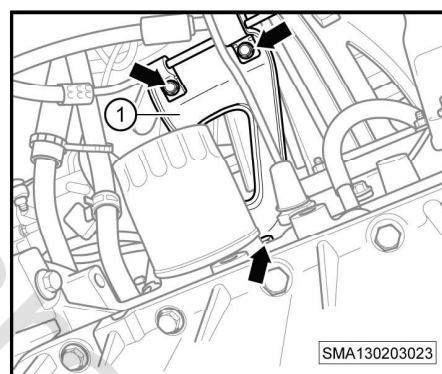


02

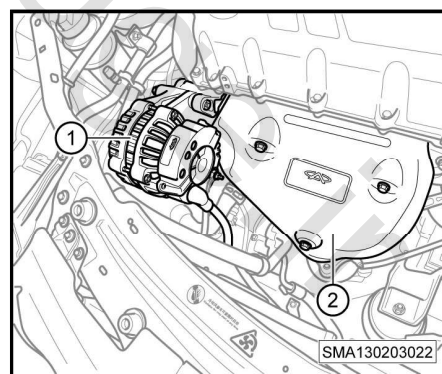
17. As shown in the figure, press the lock pin of pipeline connector (-1-) and pull out the fuel pipe.



18. Unscrew the fixing bolts (-arrow-) and remove the lower intake manifold bracket (-1-).



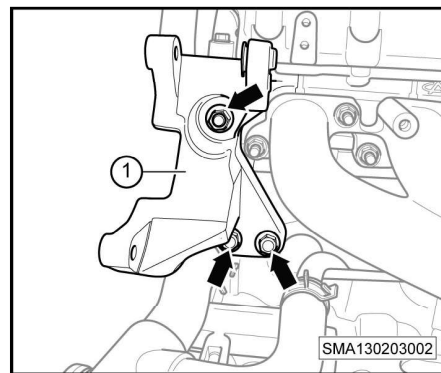
19. Remove the generator (-1-) and the exhaust manifold (-2-). => refer to page 983 => refer to page 221



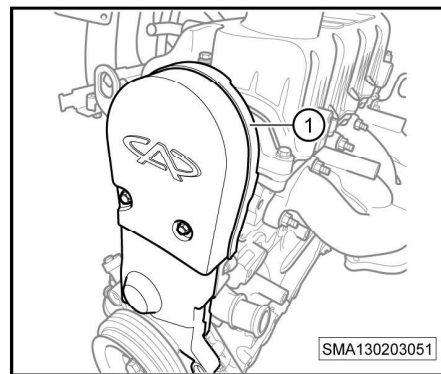
02 - Engine Mechanism

02

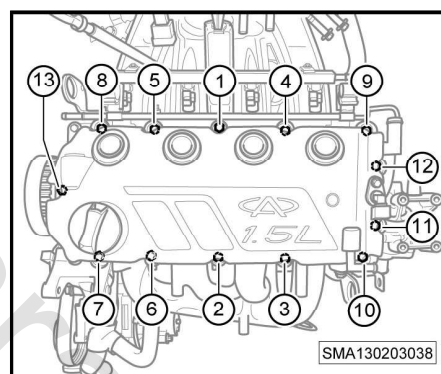
20. Unscrew the fixing bolts (-arrow-) and remove the engine accessory bracket (-1-).



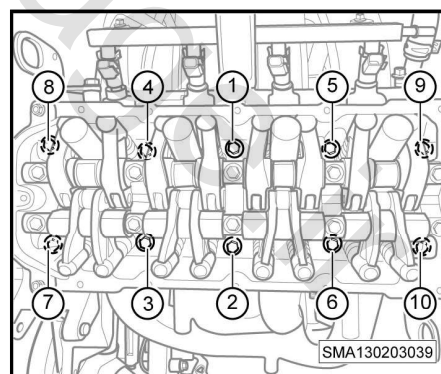
21. Remove the timing belt housing (-1-) and the timing belt. => refer to page 88



22. Unscrew the fixing bolts in the sequence from (-13-) to (-1-), and remove the cylinder head cover and the gasket.



23. Unscrew the fixing bolts in the sequence from (-10-) to (-1-), and remove the cylinder head and the cylinder gasket. Cover the cylinder block with a glabrous cloth to prevent the entry of dust and foreign matters.



Installation

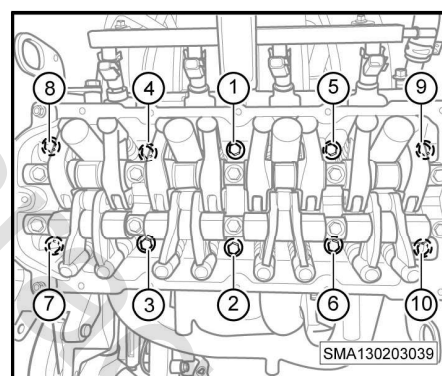
i Note

- Remove the sealant residue on the cylinder head and block.
- The cylinder head bolts are disposable and must be replaced in every removal.
- Replace the O-rings, the seals, the cylinder head gasket, the self-locking nuts and other disposable parts.
- Check the cylinder head gasket that shall be clean and smooth and free of bumps or scratches. The side with the part number shall be placed upwards.
- Install the cylinder gasket on the surface of the cylinder block with dowel pins.
- Align the oil hole of the cylinder head gasket with that of the cylinder block.
- Install two dowel pins on the surface of the cylinder block. The dowel pins located in the 2nd and 4th threaded holes on the left side (seen from the front) are elastic dowel pins. The assembly of the dowel pin and the cylinder block is interference fit, while the assembly of the dowel pin and the cylinder head is transition fit.
- Wipe the joint surface of the combustion chamber and the cylinder head, and the surface and the threaded holes of the cylinder block. The threaded holes shall be free of oil.
- Install the washers to 10 cylinder head bolts respectively with their bevel upwards.
- The piston shall not be placed at the TDC of the cylinder head during installation to avoid the conflict between the opened valve and the piston during rocker installation.

02

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

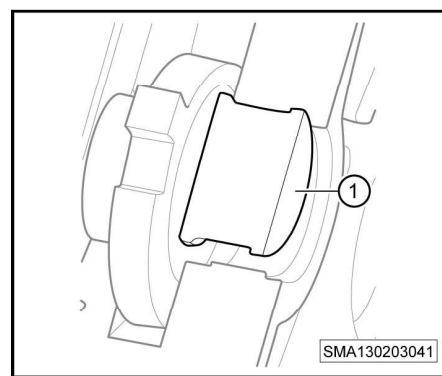
1. Check the surface warpage degree of the cylinder block and head .
2. As shown in the figure, tighten the bolts in the sequence from (-1-) to (-10-) according to the following procedures:
 - a. First install the cylinder head bolts and manually tighten them.
 - b. Tighten the cylinder head bolts in the tightening order with the common tool.
 - c. Tighten the cylinder head fixing bolts in the tightening order by a torque wrench with the torque of $22.5 \pm 2.5 \text{ N} \cdot \text{m}$.
 - d. Tighten the cylinder head fixing bolts again in the tightening order with the torque of $42.5 \pm 2.5 \text{ N} \cdot \text{m}$.
 - e. Then turn the cylinder head fixing bolts by 90 degrees in the tightening order.
 - f. Finally, turn the cylinder head fixing bolts again by 90 degrees in the tightening order.



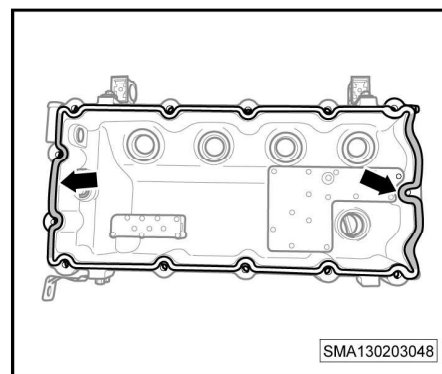
02 - Engine Mechanism

02

3. Apply sealant on the contact surface between the semi-circular rubber block (-1-) and the cylinder head, and then install the block on the cylinder head. When installing, align the limit groove of the semi-circular rubber block with the top dead center of the cylinder head and press it down.



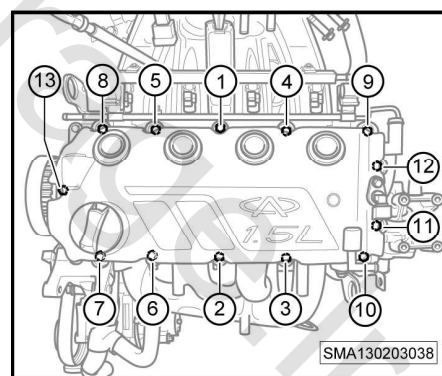
4. Install the cylinder head cover gasket into the groove of the cylinder head cover, and then apply sealant on the connection area between the front end of the cylinder head cover and the bearing cap and the area between the two rear bolts, i.e. the grey part of the gasket (-arrow-).



5. Hold the cylinder head cover with both hands; align and install it on the cylinder cover, making the spark plug sleeve pass through the gasket; then press it down to match the cylinder head cover with the bolt hole. Install carefully to prevent the cylinder head cover gasket from separation. Make sure the gasket is installed in place at a time to avoid it from dislocation.

6. As shown in the figure, tighten the bolts in the sequence from (-1-) to (-13-) according to the following procedures:

- Screw in all of the cylinder head cover fixing bolts.
- Tighten the cylinder head cover fixing bolts with a torque of $4 \pm 1 \text{ N} \cdot \text{m}$ in the tightening order.
- Tighten the cylinder head cover fixing bolts again with a torque of $7 \pm 1 \text{ N} \cdot \text{m}$ in the tightening order.



7. Other installation shall follow the reverse sequence of the removal procedure.

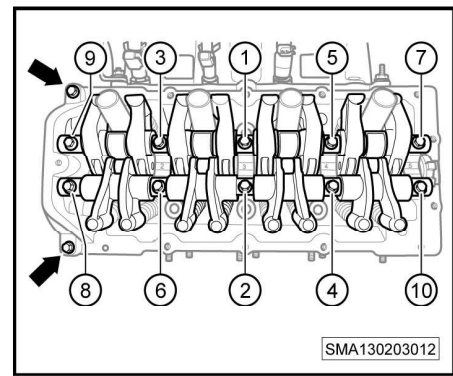
4 Camshaft and Rocker Shaft

4.1 Removing and installing the rocker shaft and camshaft	141
4.2 Checking the valve rocker.....	145
4.3 Checking the camshaft.....	146
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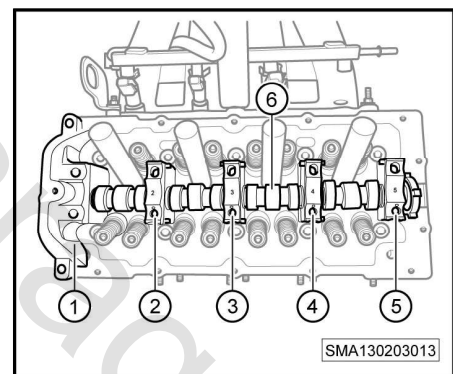
4.1 Removing and installing the rocker shaft and camshaft

Removal

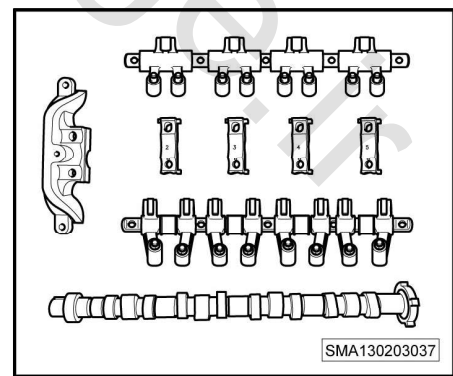
1. Remove the cylinder head cover.
2. As shown in the figure, unscrew the fixing bolts respectively in the sequence from (-10-) to (-1-) and unscrew the fixing bolts of the camshaft cap 1 (-arrow-). Remove the intake and exhaust rockers and rocker shafts.



3. Remove the camshaft caps in the sequence from (-1-) to (-5-) and the camshaft (-6-).

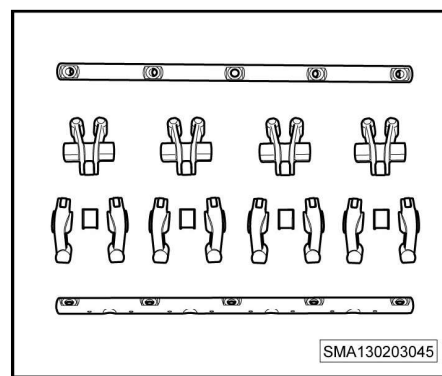


4. As shown in the figure, place the removed parts neatly on the workbench.



02 - Engine Mechanism

5. As shown in the figure, place the disassembled intake and exhaust rockers and rocker shafts neatly on the workbench.

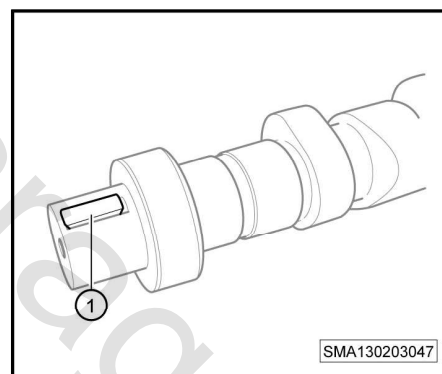


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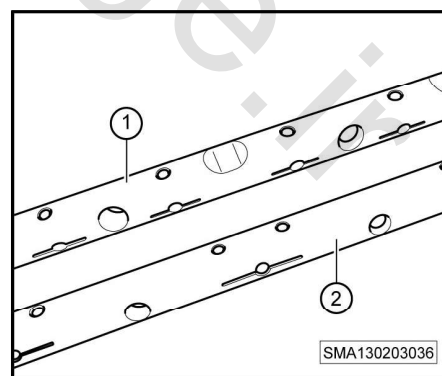
Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

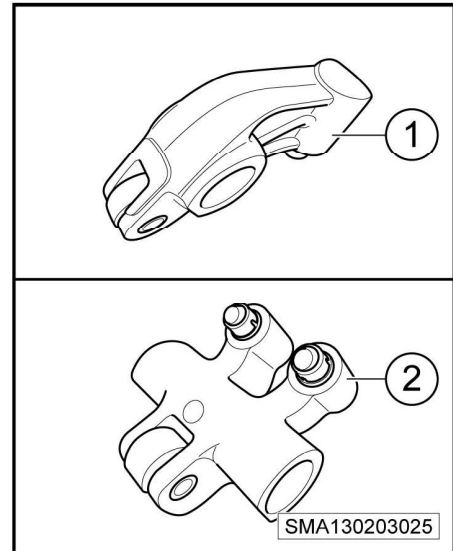
1. Check the valve rockers and the camshaft.
2. Check the camshaft bearing shell holes and the cam surface for scratches.
3. Check the camshaft caps for blisters, cracks, etc..
4. Clean the intake and exhaust rocker shafts, camshafts, camshaft bearing shells, etc. with detergent.
5. Remember to replace the lubricant inside the valve rocker tappet when installing the valve rocker.
6. Check if the assembly of camshaft woodruff key (-1-) and the camshaft key slot is transition fit widthwise. After inserting the woodruff key, check if the projection height is 1.875 ± 0.235 mm.



7. Check the oil holes and the oil grooves of the rocker shaft and make sure there are no residues or foreign matters. Check the intake and exhaust rocker shafts. (-1-) is the intake rocker shaft with four grooves (to keep away from the spark plug sleeve). And (-2-) is the exhaust rocker shaft.

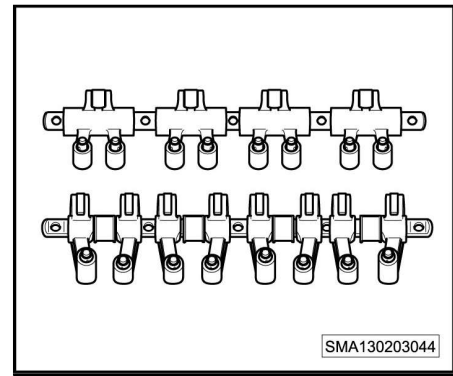


8. Check the ball joints and retainers of the intake and exhaust rockers, and apply engine oil on the rocker shafts.

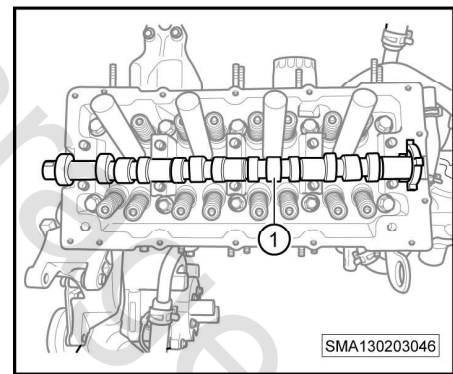


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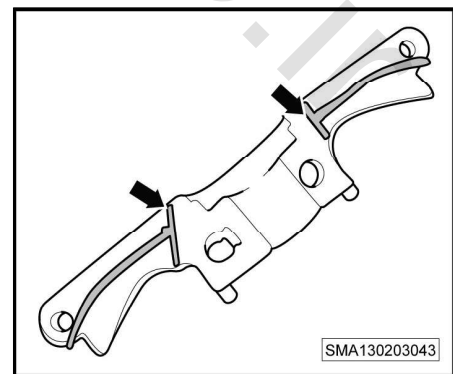
9. As shown in the figure, install the rockers to the rocker shafts.



10. Apply engine oil on the contact surface of the camshaft (-1-) and then install the camshaft.

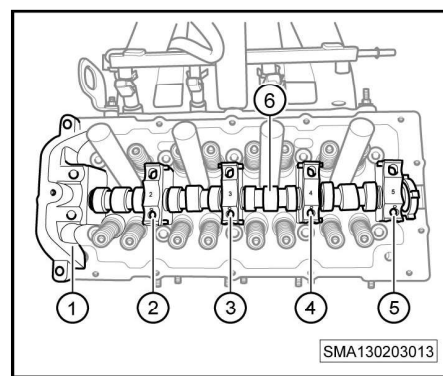


11. Clean all of the camshaft caps. As shown in the figure, apply sealant on the grey part of the camshaft cap 1 (-arrow-).



02 - Engine Mechanism

12. Apply a small amount of engine oil on the surfaces of the cams and the journals of the camshaft, and then install the camshaft caps in the sequence from (-1-) to (-5-). The installation of dowel pins of the camshaft caps and the cylinder head is clearance fit. Manually position the camshaft cap upright before installing, and then knock it gently with a rubber hammer till it fits properly. Turn the camshaft (-6-) manually to feel the engagement.



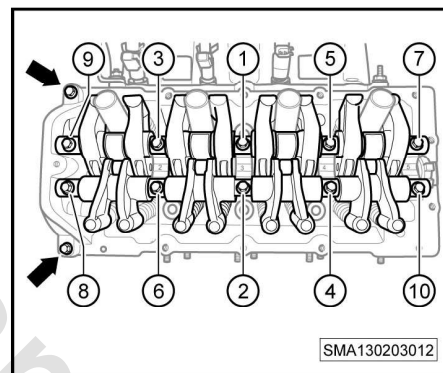
02

13. Install the intake rocker shaft assembly. Adjust the position of each rocker. Turn the camshaft slightly if necessary to make the rocker shaft contact the camshaft caps. Never press or pull with brute force. Check the intake rockers for engagement.

14. Install the exhaust rocker shaft assembly. Adjust the position of each rocker without turning the camshaft. Make the rocker shaft contact the camshaft caps and make sure no exhaust rockers interfering with the bearing seat or the intake rocker.

15. Install the rocker shaft bolts. As shown in the figure, tighten the rocker shaft fixing bolts in the sequence from (-1-) to (-10-) according to the following procedures:

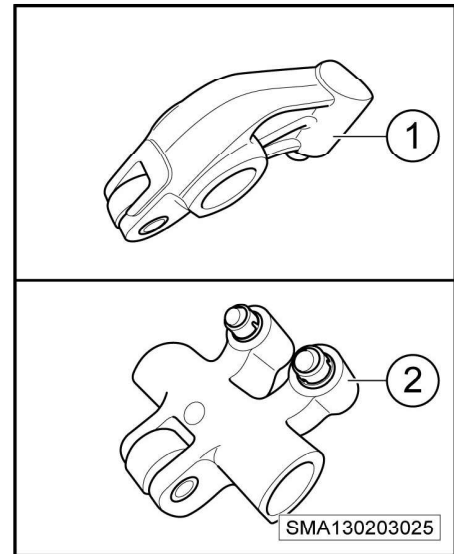
- First, manually screw the bolts into the cylinder head.
- Tighten the rocker shaft fixing bolts by a torque wrench with the torque of $15 \pm 2 \text{ N}\cdot\text{m}$ in the tightening order.
- Tighten the rocker shaft fixing bolts again by a torque wrench with the torque of $30 \pm 1.5 \text{ N}\cdot\text{m}$ in the tightening order.



16. Tighten the camshaft cap 1 fixing bolts (-arrow-) by a torque wrench with the torque of $9.5 \pm 1 \text{ N}\cdot\text{m}$.

4.2 Checking the valve rocker

1. Check the rocker retainer for damage and if the rocker tappet ball joint falls off. Replace the rocker if necessary.
2. Check if the roller rotates smoothly. Replace the valve rocker if it becomes loose or rotates unsmoothly.
3. Check the inner diameter of the valve rocker hole and replace the rocker if there is any damage or blockage.

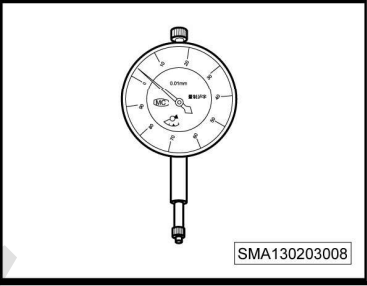
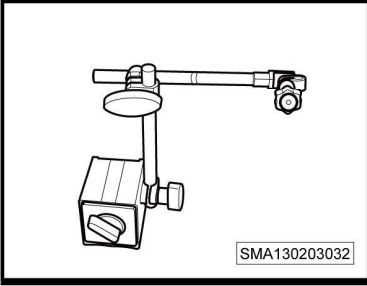
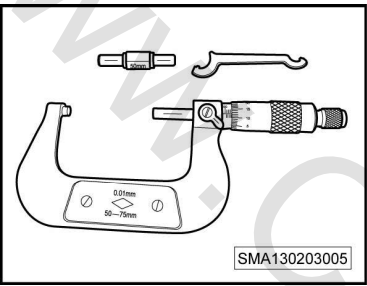


02

4.3 Checking the camshaft

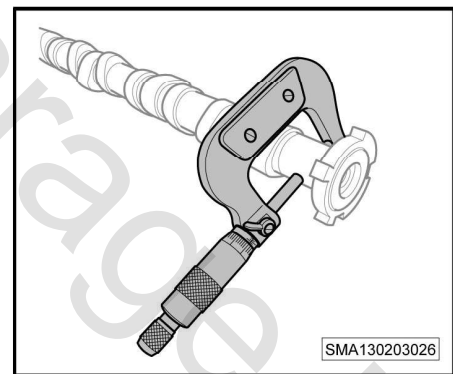
Maintenance tools and common equipment

02

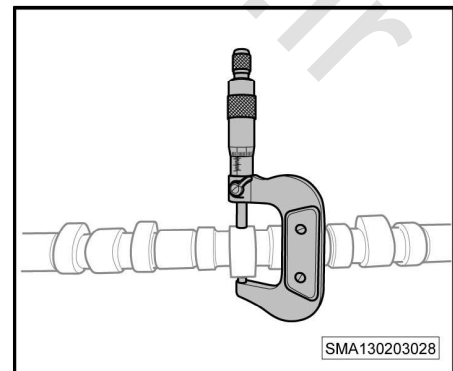
 <p>SMA130203008</p>	 <p>SMA130203032</p>
Dial indicator	Bracket
 <p>SMA130203005</p>	
Outer diameter micrometer	

Inspection

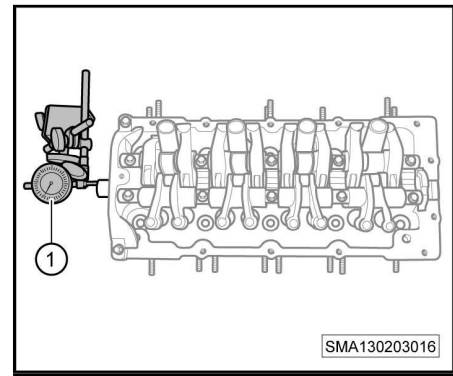
1. As shown in the figure, measure the camshaft radial diameter with an outer diameter micrometer. The measured value shall be 25.974 ± 0.007 mm.



2. As shown in the figure, measure the camshaft lifting height with an outer diameter micrometer. The measured lifting heights of the intake and exhaust camshafts shall be 5.09 mm and 5.34 mm respectively.



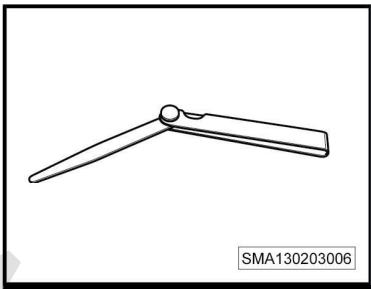
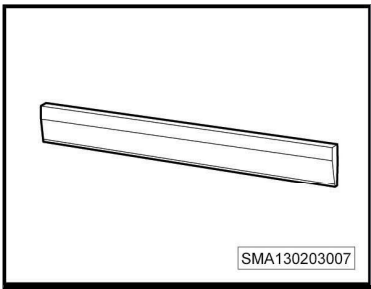
3. As shown in the figure, measure the axial clearance of the camshaft. Hold the dial indicator bracket against the front end of the camshaft, and reset the dial indicator to zero. Push the camshaft back and forth (without turning it) and read out the axial clearance value. The measured value shall be 0.124 ± 0.029 mm.



4.4 Checking the cylinder head

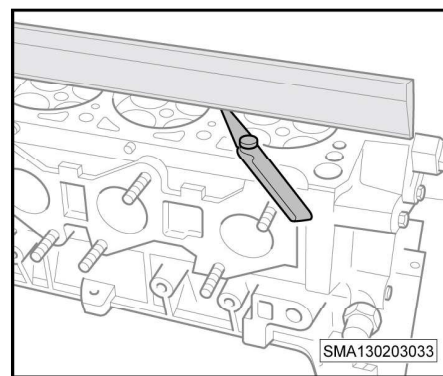
Maintenance tools and common equipment

02

 <p>SMA130203006</p>	 <p>SMA130203007</p>
Clearance gauge	Precision ruler

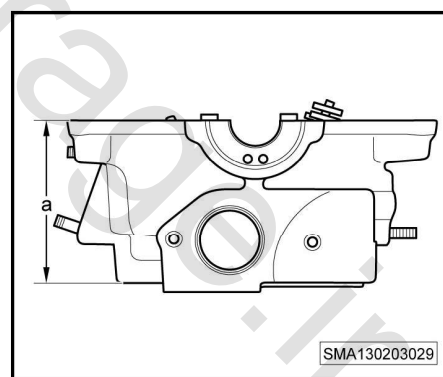
Checking the lower surface warpage degree of the cylinder head

- As shown in the figure, measure the warpage degree of the cylinder head with a precision ruler and a clearance gauge. The measured value shall be 0.055 ± 0.025 mm. You shall repair the surface if the value fails to meet the standard.



Checking the cylinder head height

- As shown in the figure, the measured value of the cylinder head height (-a-) shall be 97 mm.

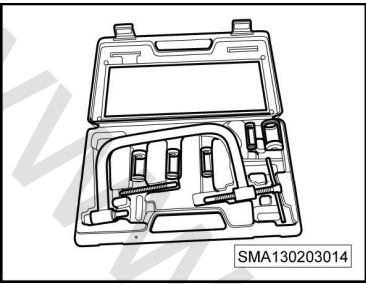


5 Valve and Valve Spring

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5.2 Inspection.....	151

5.1 Removing and installing the valve and valve spring

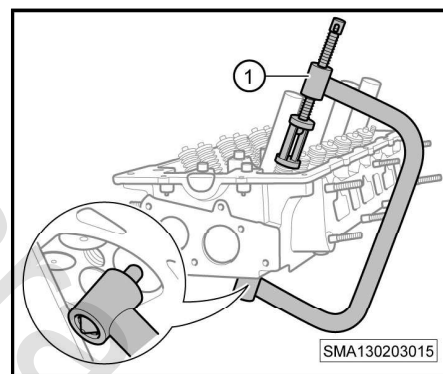
Maintenance tools and common equipment

	
Tools for removing and installing valve springs	

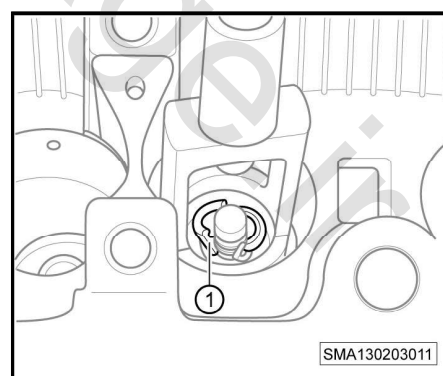
02

Removal

1. As shown in the figure, install the tool (-1-) on the valve spring, turn the compression screw of the tool to compress the valve spring.

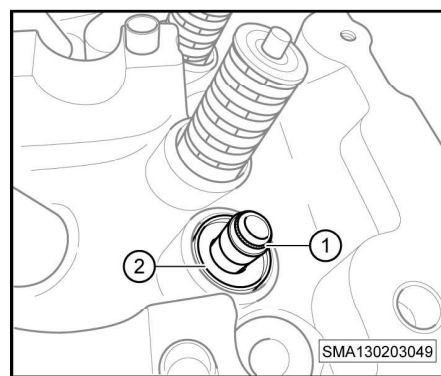


2. As shown in the figure, remove the valve cotter (-1-) from the valve with a plier or a magnetic bar. Remove the tool and take off the upper valve spring seat, the valve spring and the valve.



02 - Engine Mechanism

3. Remove the valve oil seal (-1-) and take out the lower valve spring seat (-2-).

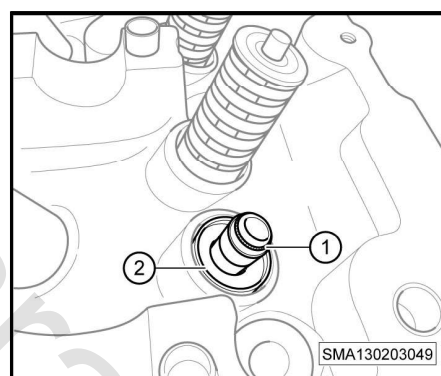
**02****i Note**

- Soak the new oil seal in engine oil for several minutes before installing.
- Check if the lower valve spring seat has been properly installed before installing the valve spring.
- The valve spring is the variable pitch spring, whose painted end must face the lower valve spring seat.

Installation

Installation shall follow the reverse sequence of the removal procedure. Please pay attention to the following notes:

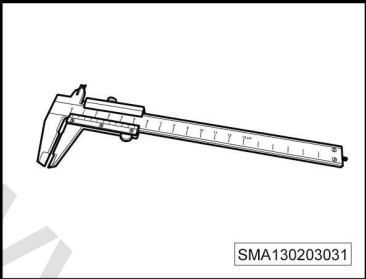
1. As shown in the figure, slide the lower valve spring seat (-2-) (with the bottom facing the cylinder head) into the valve guide. The bottom surface of the lower valve spring seat shall be fit to the processing surface of the lower valve spring seat of the cylinder head. Then apply engine oil on the lip of the valve oil seal (-1-), install the valve oil seal on the valve guide with a pressing sleeve, and check if the valve oil seal fits well with the valve guide.



5.2 Inspection

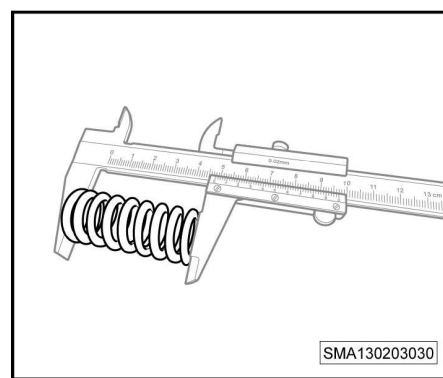
Checking the valve spring

Maintenance tools and common equipment

 <p style="text-align: right;">SMA130203031</p>	
<p style="text-align: center;">Vernier</p>	

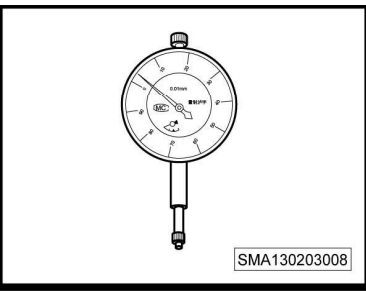
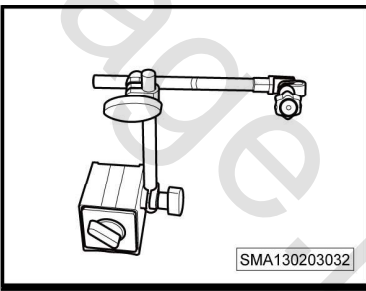
02

1. As shown in the figure, measure the free height and the pretension height of the valve spring with a vernier. The measured value of free height shall be 47.7 mm, and the installation height shall be 41 mm under the pretension of 260 ± 11 N.



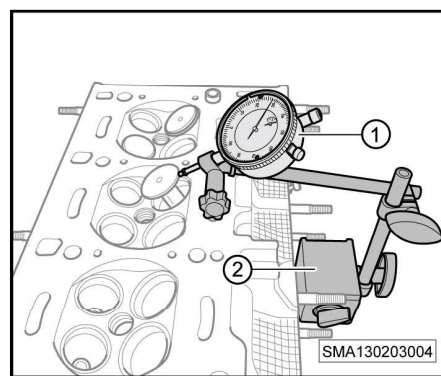
Checking the clearance between the valve and the valve guide

Maintenance tools and common equipment

 <p style="text-align: right;">SMA130203008</p>	 <p style="text-align: right;">SMA130203032</p>
<p style="text-align: center;">Dial indicator</p>	<p style="text-align: center;">Bracket</p>

02 - Engine Mechanism

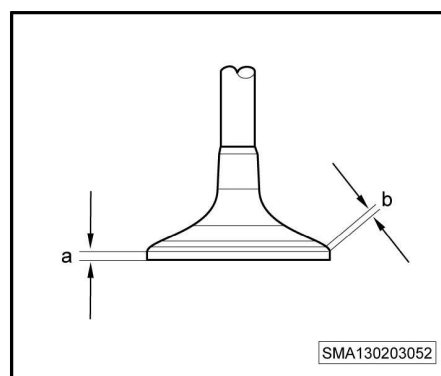
1. As shown in the figure, install the dial indicator (-1-) on the (magnetic) bracket (-2-), and install the intake or exhaust valve into the valve guide to be inspected.
2. Pull the valve out of the cylinder head for about 10 mm, rock the valve gently, and measure the clearance between the valve and the valve guide. The standard clearance between the intake valve and the valve guide shall be 0.027 ± 0.015 mm. The standard clearance between the exhaust valve and the valve guide shall be 0.047 ± 0.015 mm.



02

Checking the valve dimensions

Item	Standard value (mm)
Intake valve head thickness	0.6
Exhaust valve head thickness	0.4
Intake valve seal width	2.83
Exhaust valve seal width	2.26



0204 Lubrication System

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1 General Information

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1.1 Overview

- The lubrication system is used to supply lubricant to the surfaces of the parts that are in relative motion to realize liquid friction and reduce the friction resistance and wear of parts, and to clean and cool the parts surface.
- When the gas mixture starts burning in the engine combustion chamber, the fuel energy is converted to pressure that operates the crankshaft. However, not all energy is used to operate the engine, because the friction between operating engine parts could consume the energy produced by the engine which is then converted to heat. In order to reduce frictions and protect the engine, the lubrication system is a must to lubricate the engine.
- Most of the engine oil is reserved in the oil pan. When the engine is operating, the crankshaft drives the oil pump that sucks oil out of the oil pan. The oil sucked out is then filtered by the oil filter, flows via the engine oil passage to lubricate or cool different parts of the engine, and finally returns to the oil pan.
- The lubrication system consists of following components:
 - a. Engine oil pump
 - b. Engine oil strainer
 - c. Engine oil pressure switch
 - d. Engine oil filter
 - e. Oil pan

Caution

- The used oil potentially contains harmful substances; thus, contacting with the oil for a long time may cause the skin dry and painful.
- When replacing the engine oil, you shall take effective measures to protect your skin, e.g. wearing protective clothing or gloves.
- After replacing the engine oil, please immediately use soap or soap solution to wash your hands thoroughly. Do not use chemical solvents like gasoline or diluting agents to wash your hands.
- Dispose the waste oil according to the local regulations.

1.2 Product specifications

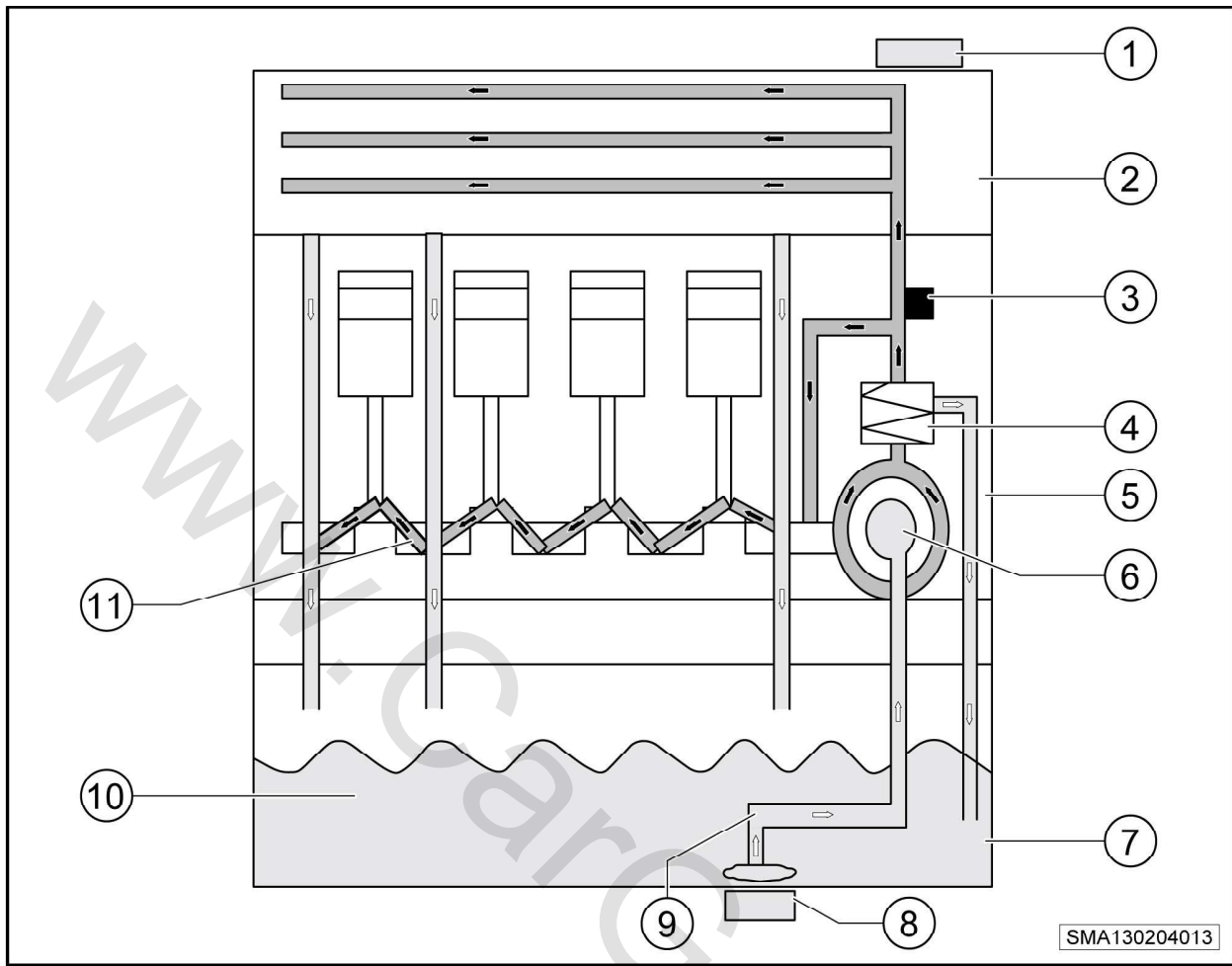
System pressure

Condition	Value (bar)
Idling speed (rev 800±50 r/min) (oil temperature 90°C)	> 1.5
High speed (rev 4000 r/min) (oil temperature 100°C)	> 3.5

Engine oil specifications

Condition	Value
Summer	Lubricant with the viscosity of SAE 10W-40 (SL or above)
Winter	Lubricant with viscosity of SAE 5W-40 (SL or above)
Filling capacity	3.9 L

1.3 Lubrication system flow chart

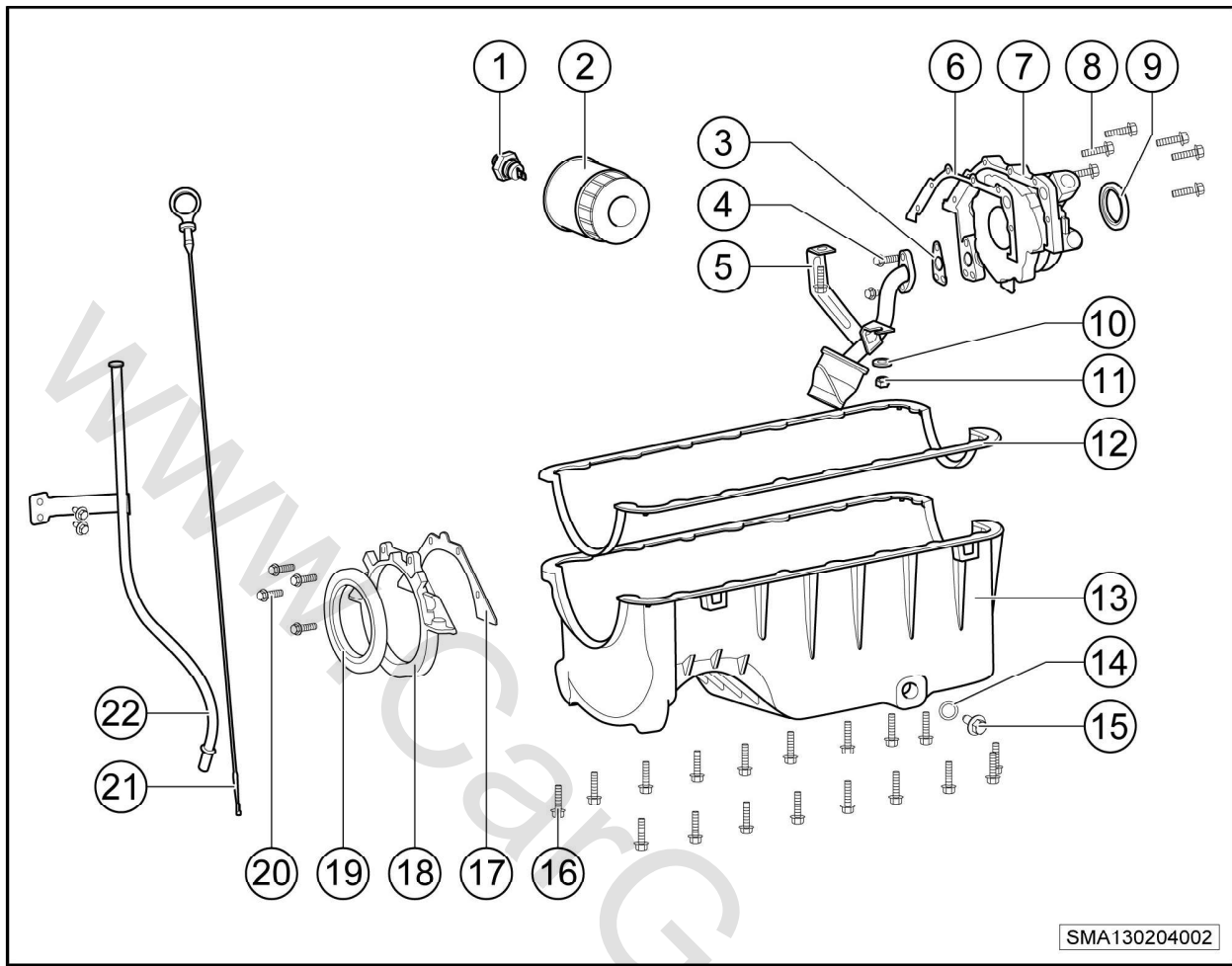


1. Oil filler cap	2. Cylinder head
3. Engine oil pressure switch	4. Engine oil filter
5. Cylinder block	6. Engine oil pump
7. Oil pan	8. Oil drain bolt
9. Engine oil strainer	10. Engine oil
11. Crankshaft	

Illustrations:

1. Solid arrow: indicates the flow of high-pressure lubricant.
2. Hollow arrow: indicates the flow of low-pressure lubricant.
3. Dark area: indicates the high-pressure lubricant.
4. Light area: indicates the low-pressure lubricant.

1.4 The lubrication system assembly drawing



1. Engine oil pressure switch	2. Engine oil filter
3. Engine oil strainer gasket	4. Fixing bolt
5. Engine oil strainer	6. Engine oil pump gasket
7. Engine oil pump	8. Bolt
9. Front crankshaft oil seal	10. Gasket
11. Nut	12. Oil pan gasket
13. Oil pan	14. Copper gasket
15. Oil drain bolt	16. Oil pan fixing bolt
17. Rear crankshaft oil seal gasket	18. Rear oil seal bracket
19. Rear crankshaft oil seal	20. Fixing bolt
21. Oil dipstick	22. Oil dipstick tube

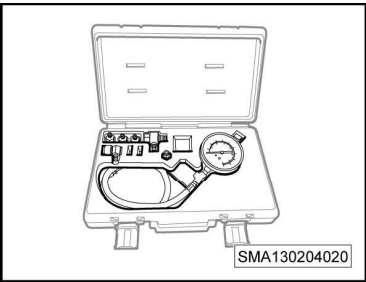
2 Diagnosis and Inspection

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2.1 The lubrication system fault list

Symptoms	Possible causes	Maintenance recommendations
Inadequate engine oil pressure	Low engine oil level	Add oil to the standard scale
	Blockage of the engine oil strainer screen	Clean the engine oil strainer screen
	Loosening of the engine oil strainer bolts	Replace the gasket and tighten the bolts
	Failure of the engine oil pump seal	Replace the engine oil pump
	Damage to the engine oil pump	
	Excessive bearing shell clearance	Check the engine bearing shell and the crankshaft and replace worn parts if necessary.
	Failure of the engine oil pressure switch	Replace the engine oil pressure switch
Inadequate engine oil	Thin engine oil viscosity	Replace the engine oil
	Leakage of front and rear crankshaft oil seal, camshaft oil seal, engine oil pressure switch, oil filter, oil drain bolt and oil pan, etc.	Inspect the leak parts
	Engine oil burning resulting in high oil consumption	Inspect the cylinder pressure and the valve oil seal, repair the engine if necessary.

2.2 Testing the lubrication system pressure

	
Engine oil pressure tester	

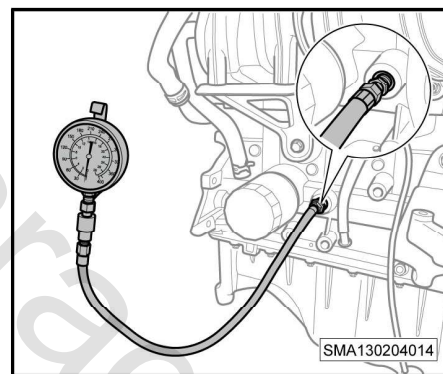
02

Preconditions:

1. The engine oil level is normal.
2. The engine oil filter is used within 5000 Km.
3. The engine reaches the normal operating temperature.

Inspection

1. Disconnect the engine oil pressure switch connector and unscrew the engine oil pressure switch .=> refer to page 165
2. As shown in the figure, screw the engine oil pressure tester into the engine oil pressure switch threaded hole.
3. Start the engine. When the engine meets the inspection condition, read the engine oil pressure value at idling speed and high speed respectively. If the lubrication system pressure is low, please clean the oil pan and the engine oil strainer screen, and then test again. If the lubrication system pressure is still low, there must be a fault in the engine oil pump.
 - Idling speed (800±50 r/min) Engine oil pressure: > 1.5 bar
 - High speed (4000 r/min) Engine oil pressure: > 3.5 bar



3 Oil Pan

3.1 Removing and installing the oil pan160

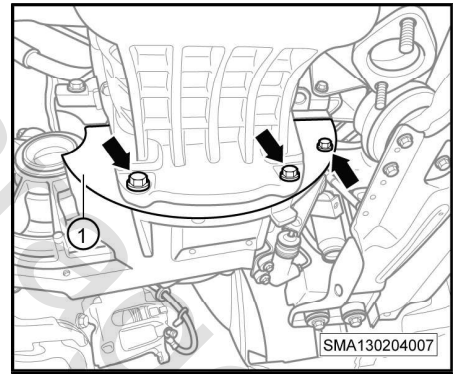
3.1 Removing and installing the oil pan

i Note

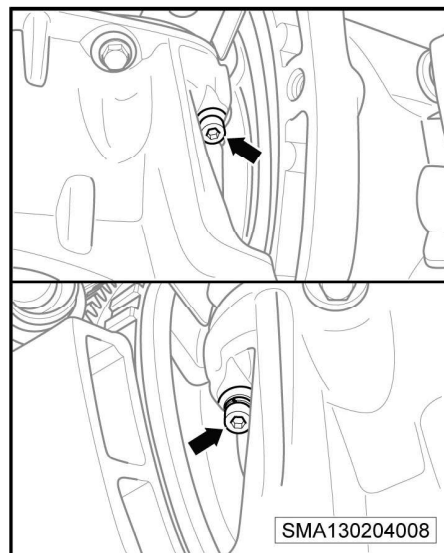
- Check the sealant type and validity of when applying sealant.
- The sealant shall not be applied too thick; otherwise, the sealant will overflow into the oil pan due to squeezing, and thus block the engine oil strainer.
- Install the oil pan within the specified time after applying the sealant according to the instructions.
- After installing the oil pan, do not add engine oil until the sealant becomes dry.

Removal

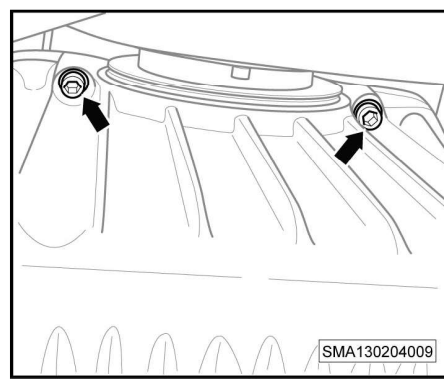
1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Remove the main three-way catalytic converter . => refer to page 231
3. Discharge the oil . => refer to page 31
4. Loosen but do not unscrew the fixing bolts between the engine and the transaxle to allow a small gap between them.
5. Unscrew the fixing bolts (-arrow-) and remove the clutch clapboard (-1-).



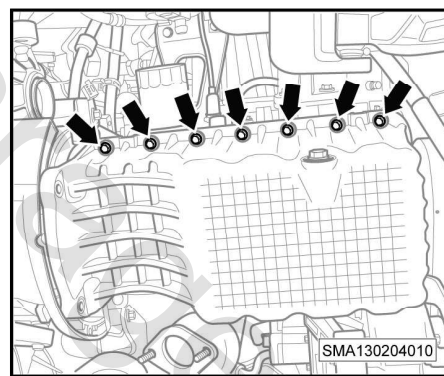
6. Unscrew the transaxle side oil pan fixing bolts (-arrow-).



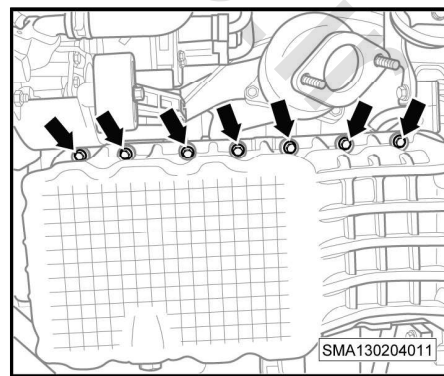
7. Unscrew the timing belt side oil pan fixing bolts (-arrow-).



8. Unscrew the intake pipe side oil pan fixing bolts (-arrow-).



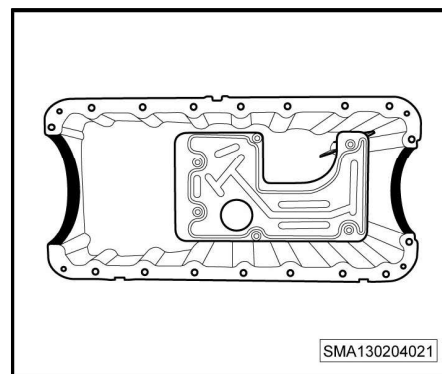
9. Unscrew the exhaust pipe side oil pan fixing bolts (-arrow-), and remove the oil pan and oil pan gasket.



Installation

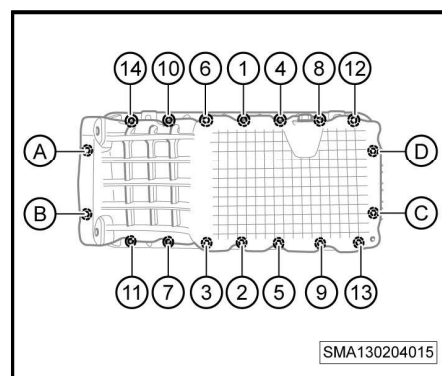
02 - Engine Mechanism

1. Clean the engine oil strainer screen.
2. Remove the impurities, iron chips and residual sealant in the oil pan.
3. Remove the residual sealant on the cylinder block with a flat scraper.
4. Remove the oil stain and residual sealant on the threaded hole of the cylinder block oil pan.
5. As shown in the figure, apply sealant on the semicycle interface between the oil pan gasket and the oil pan (the black part) and replace with a new gasket.

02

6. As shown in the figure, when installing the oil pan, tighten the bolts in the sequence from 1 to 14, and then tighten the four inner hexagonal bolts in the sequence of A, B, C and D.

- Tightening torque of the oil pan fixing bolt: 7 ± 1 N•m



7. Other installation shall follow the reverse sequence of the removal procedure.

4 Engine Oil Pump and Engine Oil Strainer

4.1 Removing and installing the engine oil pump and strainer.....163

4.1 Removing and installing the engine oil pump and strainer

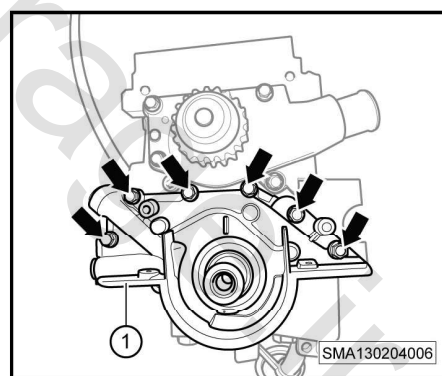
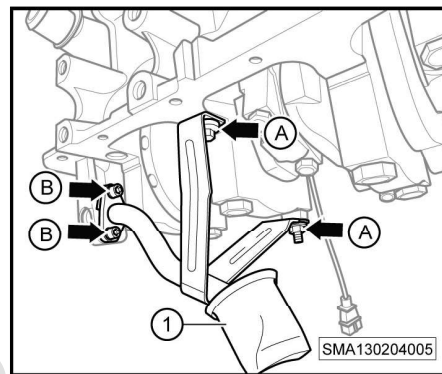
Warning

- After cleaning or replacing the engine oil pump, you shall add engine oil via the oil inlet, and rotate the pump rotor until the oil flows out of the outlet; otherwise, no vacuum can be rapidly produced between the inner and outer pump rotors and the pump body to pump out the engine oil, which may damage the bearings and bearing shells.

02

Removal

1. Discharge the oil . => refer to page 31
2. Remove the oil pan .=> refer to page 160
3. Unscrew the engine oil strainer bracket fixing bolts and nuts (-arrow A-), the engine oil strainer flange bolts (-arrow B-), and remove the engine oil strainer (-1-) and its gasket.
 - Tightening torque of the engine oil strainer bracket fixing bolts and nuts: $20\pm 3 \text{ N}\cdot\text{m}$
 - Tightening torque of the engine oil strainer flange fixing bolts: $10\pm 2 \text{ N}\cdot\text{m}$
4. Unscrew the engine oil pump fixing bolts (-arrow-) and remove the engine oil pump (-1-) and its gasket.
 - Tightening torque of the oil pump fixing bolts: $10\pm 2 \text{ N}\cdot\text{m}$



Installation

1. Clean the gaskets and residual sealant on the surface of the cylinder block and the engine oil pump.
2. Remove the residual sealant in the oil pan and the engine oil strainer.
3. Add oil via the inlet and rotate the pump rotor until the oil is pumped out from the outlet.

02 - Engine Mechanism

4. Replace the engine oil pump gasket, apply sealant on the pump bottom and the cylinder bottom, and install the engine oil pump.
5. Replace the engine oil strainer gasket and install the engine oil strainer.
6. Replace the oil pan gasket and install the oil pan .
7. Other installation shall follow the reverse sequence of the removal procedure.

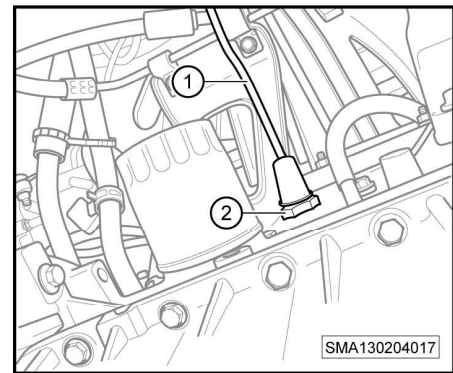
5 Engine Oil Pressure Switch

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5.2 Inspecting the engine oil pressure switch.....	166

5.1 Removing and installing the engine oil pressure switch

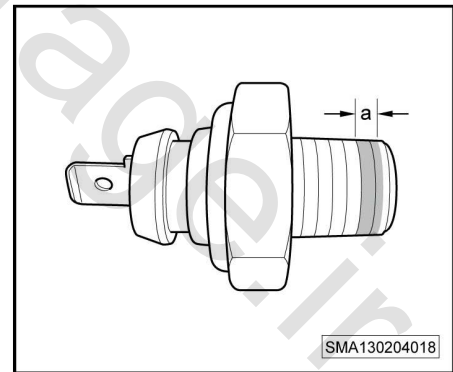
Removal

1. Switch off all electrical equipment and the ignition switch, and pull out the key.
2. Disconnect the battery negative terminal and wait until the engine cools down.
3. Disconnect the engine oil pressure switch connector (-1-) and unscrew the engine oil pressure switch (-2-).



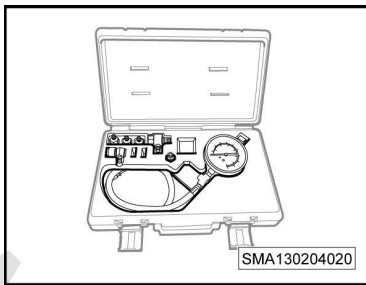
Installation

1. Remove the oil and impurities on the engine oil pressure switch and its threaded hole.
2. As shown in the figure, apply a few sealant within the scope of thread "a" when installing the engine oil pressure switch.
 - Tightening torque of the engine oil pressure switch: $27 \pm 2 \text{ N} \cdot \text{m}$
 - Width of a: about 3 mm



5.2 Inspecting the engine oil pressure switch

Maintenance tools and common equipment



Engine oil pressure tester

i Note

- Before inspecting the engine oil pressure switch, please make sure that the engine oil level is normal, the coolant temperature reaches above 90°C, the oil filter is used within 5000 Km and the electric fan stops operating.

1. Remove the engine oil pressure switch . => refer to page 165
2. As shown in the figure, screw the engine oil pressure tester into the engine oil pressure switch threaded hole (-4-).
3. Install the engine oil pressure switch (-2-) on the tester (-1-) and insert the engine oil pressure switch connector into the engine oil pressure switch.
4. Earth the engine oil pressure tester to the vehicle body.
5. Start the engine to observe the tester pressure readout. The engine oil pressure warning light (-3-) lights up. When the engine oil pressure is lower than 75 Kpa, the warning light will light up; otherwise, you shall replace the engine oil pressure switch.

