SQRD4T20 ENGINE MECHANICAL

05

05

GENERAL INFORMATION

Overview

Operation

- SQRD4T20 engine adapts a design of vertical, in-line 4-cylinder, 4-stroke, four valves per cylinder, DOHC, boost intercooled, VVT, electronic controlled sequential multi-port fuel injection. The engine adapts independent ignition.
- SQRD4T20 engine adapts aluminum cylinder block. Aluminum oil pan is fixed to aluminum frame with bolts. The aluminum cylinder head is secured onto cylinder block by bolts. The camshaft is installed onto cylinder head. Power output from crankshaft drives camshaft through timing belt to rotate, thus making camshaft interact with valve tappet to open and close valve. Piston assembly is an aluminum piston with cast iron connecting rod. This engine has the characteristics of reliable structure and excellent performance.

Specifications

Engine Specifications

Item	Specifications	
Engine Type	Vertical, in-line 4-cylinder, 4-stroke, DOHC, boost intercooled	
Model	SQRD4T20	
Valve Number Per Cylinder	4	
Cylinder Diameter (mm)	83.5	
Piston Stroke (mm)	90	
Working Volume (ml)	1971	
Compression Ratio	9.5: 1	
Ignition Type	Independent	
Ignition Sequence	1 - 3 - 4 - 2	
Rated Power (kW)	125	
Max. Torque (N·m)	250	
Max. Torque Speed (r/min)	2000 - 4500	
Rated Power Speed (r/min)	5500	
Fuel Octane Number (Not Less Than)	Unleaded gasoline, octane number 92	
Oil Grade	SM SAE-5W-30 SM SAE-5W-40 SM SAE-10W-40	
Oil Capacity (L)	4.7 ± 0.2	
Starting Type	Electrical starting	
Cooling Type	Forced circulation type antifreeze cooling	
Lubrication Type	Compound type (pressure, splash lubrication)	
Cylinder Compression Pressure (bar) (180 - 250) r/min	7 - 10	
Oil Pressure (bar)	Idling speed (700 ± 50 r/min)	60 kPa
	High speed (2000 r/min)	160 kPa

Engine Mechanical Specifications

Item				Specifications
Camshaft	Cam height		Intake cam (mm)	8.74
			Exhaust cam (mm)	8.71
	Camshaft Diameter (intake and exhaust valves are the same) (mm)		1st Journal	32
			2nd - 5th Journal	24
	Camshaft axial clearance		Intake cam (mm)	0.15 - 0.20
			Exhaust cam (mm)	0.15 - 0.20
Cylinder Head	Lower surface flatness (mm)			0.04
	Overall height (mm)			139.83
Valve	Valve head margin thickness		Intake valve (mm)	2.5
			Exhaust valve (mm)	2.7
	Valve Stem Diameter		Intake valve (mm)	5.98
			Exhaust valve (mm)	5.96/5.95
	Valve face sealing width		Intake valve (mm)	2.26
			Exhaust valve (mm)	2.83
	Clearance between valve stem and guide		Intake valve (mm)	0.012 - 0.043
			Exhaust valve (mm)	0.033 - 0.062/ 0.043 - 0.072
	Inclination Angle (°)		Intake valve	25°
			Exhaust valve	22°
	Height		Intake valve (mm)	108
			Exhaust valve (mm)	106.3
Valve Spring	Free height (mm)			48.3
	Operating preload (N)/operating height (mm)			250/41
Valve Guide	Inner diameter (mm)			6
	Outer diameter (mm)			11
Piston	Piston skirt diameter (mm)			83.64
Piston Ring	Piston ring side clearance (mm)		First ring	0.1
			Second ring	0.1
	Piston ring end gap (mm)		First ring	0.2 - 0.35
			Second ring	0.2 - 0.35
Piston Pin	Diameter (mm)			21
	Length (mm)			60
	Piston pin hole diameter			21
Crankshaft	Crankshaft main journal		Diameter (mm)	54
			Coaxially (mm)	0.05
			Cylindricity (mm)	0.008
			Roundness (mm)	0.005
	Connecting rod journal		Diameter (mm)	47.9
			Parallelism to main journal (mm)	0.008
	Bore roundness/straightness (mm)			0.008
	Upper surface flatness (mm)			0.04
	Surface grinding limit			0.05
Connecting Rod	Connecting rod big end hole axial clearance (mm)			0
	Connecting rod bearing shell radial clearance (mm)			0

Engine Torque Specifications

Description	Torque (N·m)
Idler Pulley Fixing Bolt	40 + 5
Tensioner Fixing Bolt	40 + 5
Cylinder Head Cover Fixing Bolt	1st step: 3 + 2 2nd step: 8 + 3
Crankshaft Pulley Fixing Bolt	1st step: 130 ± 10 2nd step: 65° ± 5°
Flywheel Assembly Fixing Bolt	1st step: 35 ± 5 2nd step: 45° ± 5°
Crankshaft Main Bearing Cap Fixing Bolt	1st step: 45 + 3 2nd step: 90°± 5°
Connecting Rod Bearing Cap	1st step: 25 ± 5 2nd step: 180°± 10°
Timing Chain Upper Housing Cover Fixing Bolt	7 + 2
Phaser Fixing Bolt	120 ± 5
Variable Timing Control Valve Fixing Bolt	6 + 2
Through Bolt Between Rear Mounting Upper Body and Lower Body	105 ± 5
Coupling Bolt Between Rear Mounting Upper Body and Transmission	80 ± 5
Coupling Bolt Between Rear Mounting Lower Body and Sub Frame	150 ± 10
Coupling Bolt Between Left Mounting Cushion and Left Rail Wheel House	60 ± 5
Coupling Bolt Between Left Mounting Cushion and Transmission	80 ± 5
Fixing Nut Between Right Mounting Cushion and Bracket	80 ± 5
Right Mounting Cushion Fixing Bolt	60 ± 5/80 ± 5
Rear Mounting Bracket Fixing Bolt	60 ± 5
Oil Deflector Fixing Bolt	8 + 3
Piston Cooling Nozzle	20 + 5

Lubrication Areas During Engine Assembly

Lubrication Area	Note
Valve Guide Bottom Hole	Use same type of lubricant as engine
Intake Valve Retainer Bottom Hole	Use same type of lubricant as engine
Exhaust Valve Retainer Bottom Hole	Use same type of lubricant as engine
Valve Stem Part	Use same type of lubricant as engine
Valve Oil Seal Lip	Use same type of lubricant as engine
Valve Tappet Periphery and Tappet Hole	Use same type of lubricant as engine
Camshaft Journal and Bearing Seat Hole	Use same type of lubricant as engine
Cam Surface	Use same type of lubricant as engine
Cylinder Bore	Use same type of lubricant as engine
Main Bearing Cap Bolt	Use same type of lubricant as engine
Connecting Rod Bearing Shell and Connecting Rod Journal	Use same type of lubricant as engine
Main Bearing Shell and Crankshaft Main Journal	Use same type of lubricant as engine
Piston Pin Periphery	Use same type of lubricant as engine
Crankshaft Front and Rear Oil Seal Journal and Oil Seal Lip	Use same type of lubricant as engine
Piston Ring Groove	Use same type of lubricant as engine
Cylinder Bore Inner Wall	Use same type of lubricant as engine
Crankshaft Front and Rear Oil Seal Periphery	Use same type of lubricant as engine
Collector O-ring	Use same type of lubricant as engine
Oil Pump Inlet	Use same type of lubricant as engine
Oil Filter Module Inlet on Cylinder Block	Use same type of lubricant as engine

Oil Filter O-ring	Use same type of lubricant as engine
Dipstick O-ring	Use same type of lubricant as engine

Areas with seal gum applied during engine assembly

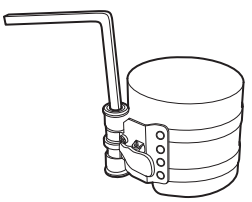
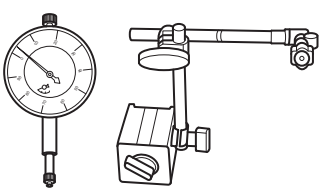
Area with Seal Gum Applied	Seal Gum
Coolant Temperature Sensor	Loctite 243
Bowl Plug	Loctite 11747
"T" Shaped Area Between Timing Chain Cover and Cylinder Block	Loctite 5900H
Timing Chain Cover	Loctite 5900H
Cylinder Block Screw Plug	Loctite 577
Cylinder Block Frame Assembly	Loctite 518/5182
Deflector Mounting Bolt Thread	Loctite 243
Collector Mounting Bolt Thread	Loctite 243
Oil Pump Mounting Bolt Thread	Loctite 243
Oil Pan Mounting Surface Frame	Loctite 5900H
Oil Pressure Switch Thread	Loctite 577

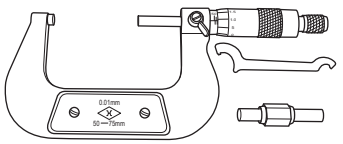
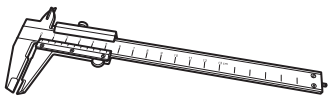
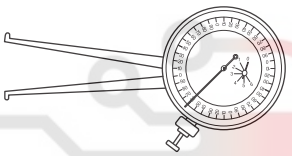
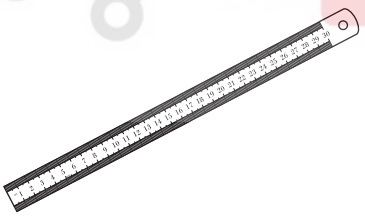
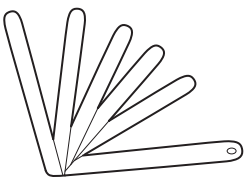
Non-reusable Part

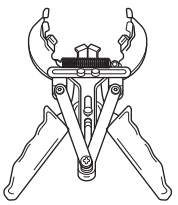
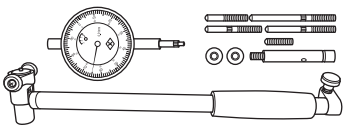
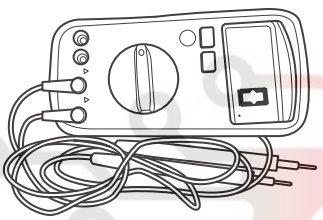
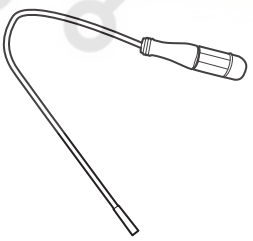
Non-reusable Part	
Valve Oil Seal	Needs to be replaced
Cylinder Head Cover Bolt and Gasket	Needs to be replaced
Cylinder Head Gasket	Needs to be replaced
Crankshaft Rear Oil Seal	Needs to be replaced
Crankshaft Front Oil Seal	Needs to be replaced
Camshaft Oil Seal	Needs to be replaced
Connecting Rod Bearing Cap Fixing Bolt	Needs to be replaced
Flywheel Fixing Bolt	Needs to be replaced
Main Bearing Cover Fixing Bolt (Frame)	Needs to be replaced
O-ring Rubber Ring (Mounting Surface Between Frame and Cylinder Block)	Needs to be replaced

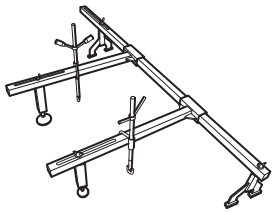
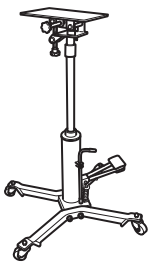
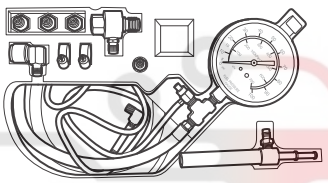
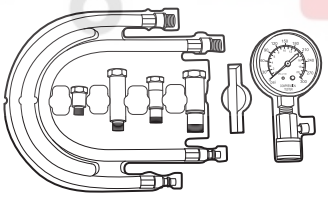
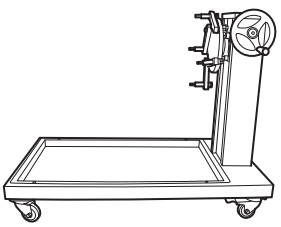
Tools

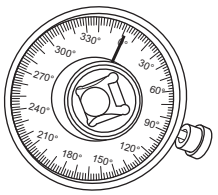
General Tools

Piston Installer	-	 039
Dial Indicator and Magnetic Holder	-	 023

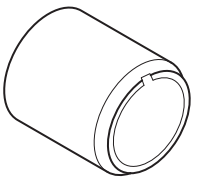
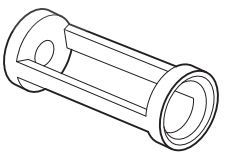
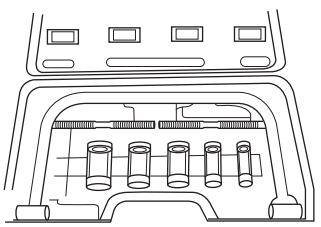
Outer Diameter Micrometer	-	 064
Vernier Caliper	-	 019
Inner Diameter Micrometer	-	 069
Precision Straightedge	-	 RCH0063006
Feeler Gauge	-	 RCH0060006

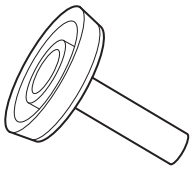
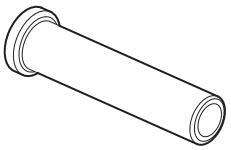
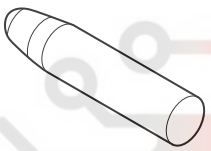
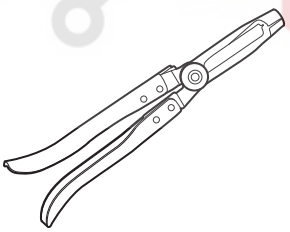
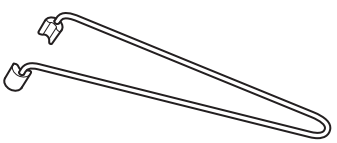
Piston Ring Remover	Part No.: CH-20080	 066
Cylinder Gauge	-	 065
Digital Multimeter	-	 002
Flexional Magnetic Rod	Part No.: CH-20053	 042
Engine Hoist	-	 043

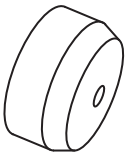
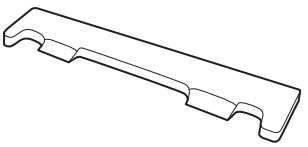
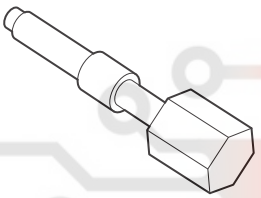
Engine Equalizer	Part No.: CH-30040	 026
Transmission Carrier	-	 005
Fuel System Pressure Tester	-	 048
Cylinder Pressure Gauge	-	 044
Engine Service Platform	-	 057

Angle Gauge	-	 091

Special Tools

Crankshaft Front Oil Seal Guide Tool	Part No.: CH-20007	 049
Crankshaft Front Oil Seal Installer	Part No.: CH-20008	 067
Valve Spring Compression Adapter	Part No.:CH-20018-B	 050
Valve Spring Compressor	Part No.: CH-20017-A	 028

Crankshaft Rear Oil Seal Installer	Part No.: CH-20006	 031
Valve Oil Seal Installer	Part No.: PCH-20011-A	 034
Valve Oil Seal Guide Sleeve	Part No.: CH-20012	 035
Valve Oil Seal Remover	Part No.: CH-20013-A	 037
Valve Cotter Installer	Part No.: CH-20017-A	 029

Crankshaft Rear Oil Seal Installer	Part No.: CH-20005-A	 070
Camshaft Timing Tool	Part No.: CH-20010	 033
Crankshaft Timing Tool	Part No.: CH-20089	 027

DIAGNOSIS & TESTING

Problem Symptoms Table

Hint:

Use symptoms table below to help determine cause of problem. Check each suspected area in sequence. Repair, replace or adjust faulty components as necessary.

Symptom	Suspected Area
Valve mechanism noise	Engine oil (oil level high or low, oil lean or rich)
	Cam
	Valve spring seat (excessive runout)
	Valve (excessive clearance between valve and guide)
Connecting rod noise	Engine oil (low pressure)
	Engine oil (diluted)
	Connecting rod bearing cap (fixing nut loosened)
	Connecting rod (misaligned)
	Connecting rod bearing shell (excessive radial clearance)
	Connecting rod journal (out-of roundness)
Main bearing noise	Engine oil (low pressure)
	Oil (diluted)
	Main bearing shell (excessive clearance)
	Crankshaft axial clearance (excessive)
	Crankshaft journal (out-of roundness or worn)
	Flywheel or clutch (loose)

Oil loss or spark plug blockage	Piston ring (worn, scratched or damaged)
	Piston ring groove (carbon deposited)
	Valve oil seal (worn or damaged)
	Valve (excessive clearance between valve and guide)
Engine power loss	Spark plug (dirty, burnt or incorrect gap)
	Electric fuel pump assembly
	Ignition coil
	Incorrect valve timing
	Cylinder head (leaked)
	Valve (burnt, deformed or excessive gap)
	Low cylinder pressure
	Fuel system (dirty)
	Exhaust system (blocked)
Water in engine	Cylinder head gasket (leaked)
	Cylinder liner (cracked)
	Wade driving
	Oil filter module (internal leakage)

Inspection

1. Check the coolant (See page 10-6).
2. Check the engine oil (See page 11-7).
3. Check the battery (See page 14-7).
4. Check the air filter element.
   (a) Remove the air filter element (See page 08-8).
   (b) Visually check that there is no dirt, blockage or damage in the air filter element.
   Hint:
   - If there is any dirt or blockage in air filter element, clean it with compressed air.
   - If any dirt or blockage remains, even after cleaning air filter element with compressed air, replace it.
5. Check the spark plug (See page 12-9).
6. Test the cylinder compression pressure.
   - Cylinder pressure is the main index to judge engine operation and also can be used to definitely judge whether some system of engine operates well or not. Therefore, it is necessary to perform cylinder pressure measurement when servicing engine.
   - Ensure battery is fully charged and engine starter is in good operating condition. Otherwise, indicated compression pressure used for diagnosis may be invalid.

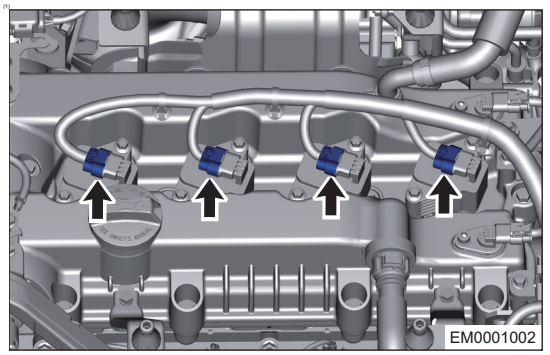
   Caution:
   - Recommended compression pressure is only used as a guide for diagnosing engine malfunction.
   - Never determine cause of low pressure by disassembling engine unless there are some malfunctions.

   Measurement procedures:
   Caution:
   - Use a cylinder pressure gauge with accurate reading and reset it to zero, or it will influence accuracy of reading.

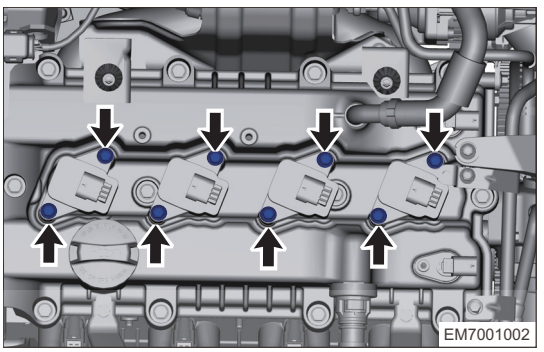
   (a) Turn off all electrical equipment and the ignition switch.
   (b) Remove the engine trim cover.

(c) Remove the ignition coil.

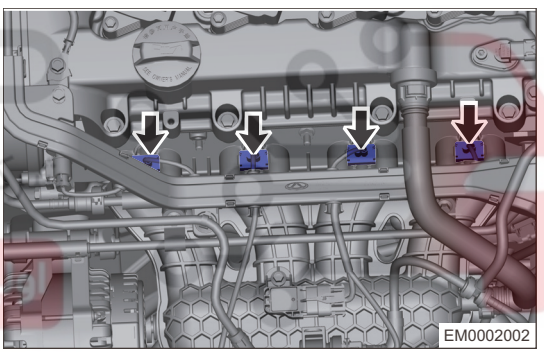
- Disconnect the ignition coil connector (arrow).



- Remove 8 fixing bolts (arrow) from ignition coil, and then remove 4 ignition coils.

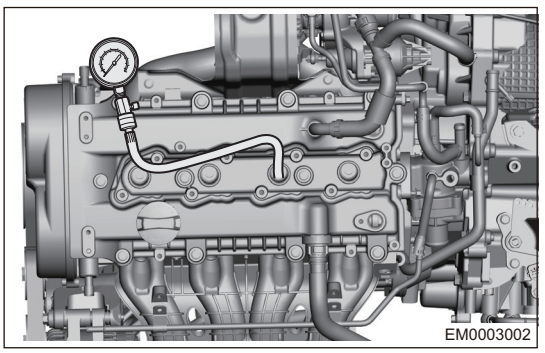


(d) Disconnect all injector connectors (arrow).



(e) Remove spark plug in each cylinder

(f) Slowly screw the cylinder pressure gauge connector vertically into the spark plug mounting hole. Do not tighten it excessively to prevent difficult removal.



(g) With transmission in P/N position, depress accelerator pedal fully, then start engine and keep it racing for 3 to 5 seconds; record the measured pressure value.

(h) Press the bleeder button of cylinder pressure gauge to reset it to zero. Use same method to repeat this test three times and then calculate average value.
Cylinder pressure value is within 7 - 10 bar (180 - 250 r/min).
Caution:

- DO NOT screw the cylinder pressure gauge excessively to prevent difficult removal.
- During measurement, do not turn ignition switch to "START" for more than 10 seconds. Otherwise, engine may be damaged.

- Ensure battery is fully charged when cranking engine. Correct cylinder pressure can be measured only when engine is running at 180 - 250 r/min.
- Use same method to measure pressure of other cylinders.

Cylinder pressure value judgment:

Correct cylinder pressure

Standard cylinder pressure value is within 7 - 10 bar (180 - 250 r/min). The value will drop slightly with usage of engine, but lowest value cannot be below 9 bar and pressure difference between each cylinder should not be above 3 bar.

If engine cylinder pressure is lower than standard value, it indicates that cylinder pressure is insufficient. Add a small amount of engine oil to cylinder through spark plug hole and perform measurement again.

If pressure increases after adding oil, piston ring or cylinder bore may be worn or damaged.

If pressure remains low, the valve may be stuck or damaged, or there may be air leakage in cylinder head gasket.

(i) Install the spark plug (See page 12-9).

Caution:

- Be sure to check spark plugs, and apply a proper amount of lubricant to spark plug mounting threads before installing spark plugs. During installation, do not put spark plugs directly through mounting holes, as high dropping may cause the side electrode to deform, thus reducing the gap. Spark jump may affect the engine operation. Installation torque: 20 ± 3 N·m.

(j) Connect all injector connectors.

(k) Install the ignition coil (See page 12-7).

7. Test cylinder head gasket for leakage.

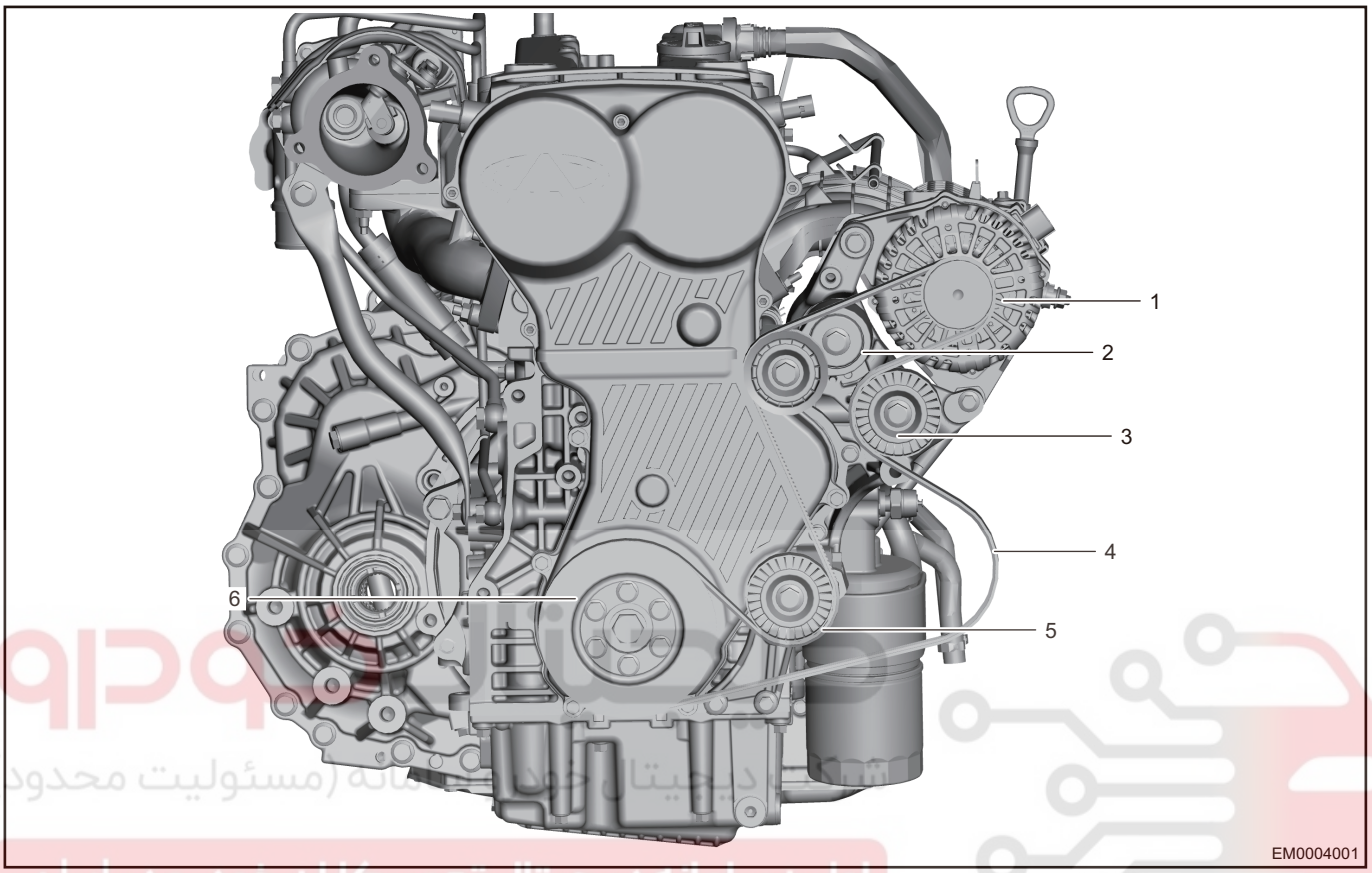
Cylinder head gasket leakage may be present between adjacent cylinder and water jacket or from an oil passage to the external of engine.

- Possible trouble symptoms caused by cylinder head gasket leakage between adjacent cylinders are as follows:
  - Engine power loss.
  - Engine stall.
  - Low fuel economy.
- Possible trouble symptoms caused by cylinder head gasket leakage between cylinder and adjacent water jacket are as follows:
  - Engine overheats.
  - Coolant loss.
  - Excessive steam (white smoke) emitted from exhaust system.
  - Coolant foaming.

ON-VEHICLE SERVICE

Accessory Pulley

Description

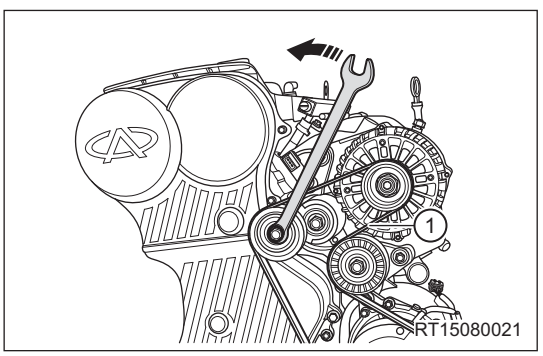


1 - Alternator Assembly	2 - Tensioner Assembly
3 - Idler Pulley Assembly	4 - Accessory Drive Belt
5 - Idler Pulley Assembly	6 - Water Pump Pulley

Removal

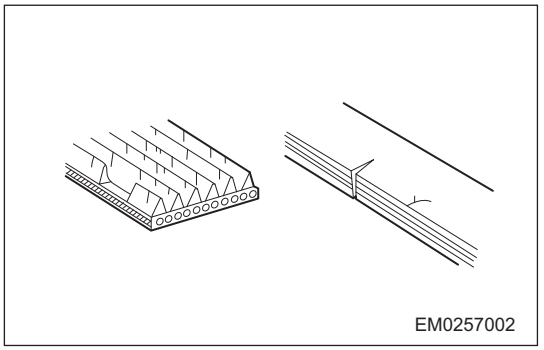
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt.
   (a) Tighten tensioner pulley bolts with wrench and lift it up in direction of arrow, then release it carefully to remove accessory drive belt (1).

   Caution:
   - Prevent hand from contacting belt tensioner when raising it upward.



Inspection

1. Visually check accessory drive belt for excessive wear and cords for wear, etc. If any of these defects is found, replace accessory drive belt.



Hint:

- If accessory drive belt has chunks missing from ribs, it should be replaced.
- After installing accessory drive belt, check that it fits properly in the ribbed grooves. Check that belt has not slipped out of grooves on bottom of the crankshaft pulley by hand.

Installation

Warning/Caution/Hint

Caution:

- Before installation, remove the dirt from accessory drive belt.
- Rotate crankshaft after installation, make sure that accessory drive belt is installed in place and does not contact with other separate parts.

1. Installation is in the reverse order of removal.

Idler Pulley Assembly

Removal

Warning/Caution/Hint

Caution:

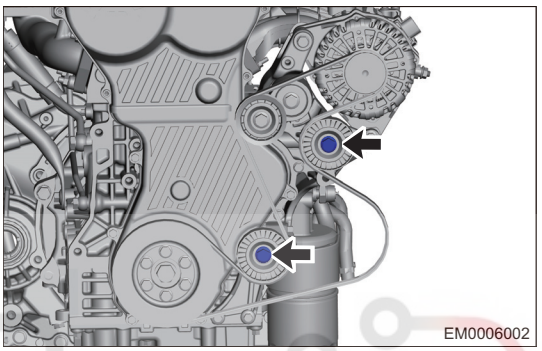
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (See page 05-16).
5. Remove the idler pulley assembly.

(a) Remove fixing bolts (arrow) from idler pulley assembly.

Tightening torque

40 + 5 N·m



(b) Remove the idler pulley assembly.

Inspection

1. Rotate idler pulley by hands and check if rotation is smooth and if abnormal noise occurs.
2. Wiggle idler pulley in axial and radial directions to check bearing for looseness.
3. Check if there is damage on idler pulley assembly operating surface.

Installation

Warning/Caution/Hint

Caution:

- After installation, turn crankshaft to run accessory drive belt several circles, and check if crankshaft turns smoothly and belt runs well. If it does not turn smoothly, reinstall accessory drive belt.
- Make sure to correctly install accessory drive belt, and it does not interfere with other components.

1. Installation is in the reverse order of removal.

Tensioner Assembly

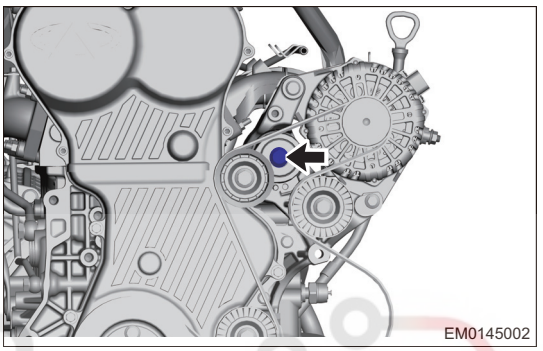
Removal

Warning/Caution/Hint

Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (See page 05-16).
5. Remove the tensioner assembly.
   (a) Remove the tensioner assembly fixing bolt (arrow).
   Tightening torque
   40 + 5 N·m



   (b) Remove the tensioner assembly.

Inspection

1. Rotate tensioner pulley assembly by hands and check if rotation is smooth and if abnormal noise occurs.
2. Wiggle tensioner pulley assembly in axial and radial directions to check for looseness.
3. Check if there is damage on tensioner pulley operating surface.

Installation

Warning/Caution/Hint

Caution:

- After installation, turn crankshaft to run accessory drive belt several circles, and check if crankshaft turns smoothly and belt runs well. If it does not turn smoothly, reinstall accessory drive belt.
- Make sure to correctly install accessory drive belt, and it does not interfere with other components.

1. Installation is in the reverse order of removal.

Cylinder Head Cover

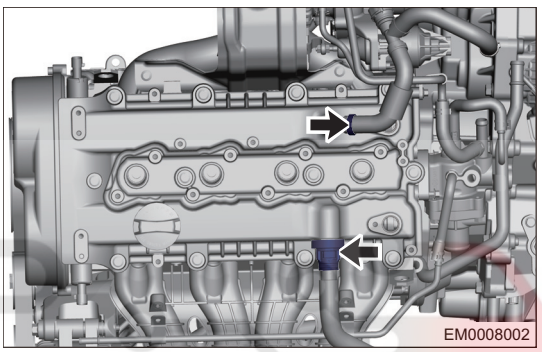
Removal

Warning/Caution/Hint

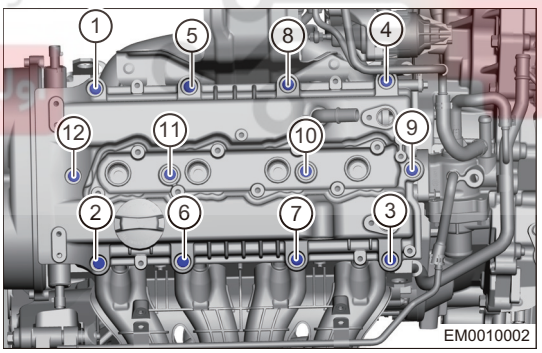
Caution:

- Blow dirt and debris away from surface of cylinder head cover with compressed air.
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coil.
5. Remove the cylinder head cover.
   (a) Disconnect the crankshaft position sensor connector and remove crankshaft position sensor.
   (b) Disconnect connection between crankcase vent duct (arrow) and cylinder head cover.



   (c) Remove engine wire harness from cylinder head cover.
   (d) Remove 12 cylinder head cover fixing bolts in order shown in illustration.



   (e) Remove the cylinder head cover assembly.
   (f) Remove fuel filler cap and cylinder head cover gasket from cylinder head cover assembly.

Installation

Warning/Caution/Hint

Caution:

- Remove oil stains and sealant remaining on cylinder head cover and cylinder head before installation.
- Check gasket for damage or loss of elasticity. If so, replace the gasket.

1. Install the cylinder head cover assembly.
   (a) Apply sealant to "T" shaped area between timing chain cover and cylinder head.
   Hint:
   - Note that sealant surface should not be too thick to prevent excessive sealant from entering engine when the cylinder head cover is pressed for installation.

- After sealant is applied, wait 15 minutes and then install the cylinder head cover assembly.

  Sealant line diameter

  2.5 - 5 mm

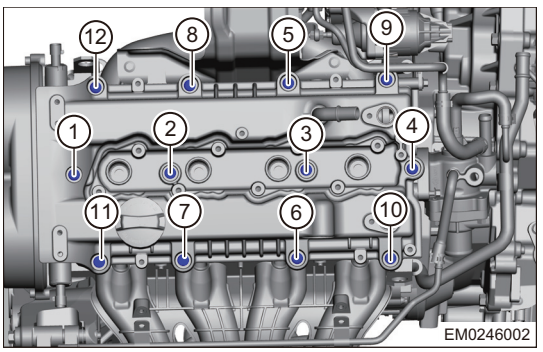
(b) Install cylinder head cover and install bolts by 1 - 2 s.

(c) Tighten 12 cylinder head cover fixing bolts in order shown in illustration.

Tightening torque

1st step: 3 + 2 N·m

2nd step: 8 + 3 N·m



2. Other installation procedures are in the reverse order of removal.

Crankshaft Front Oil Seal

Removal

Warning/Caution/Hint

Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (See page 05-16).
5. Remove the idler pulley (See page 05-18).
6. Remove the tensioner assembly (See page 05-19).
7. Remove the engine timing belt.
8. Remove the crankshaft front oil seal assembly.

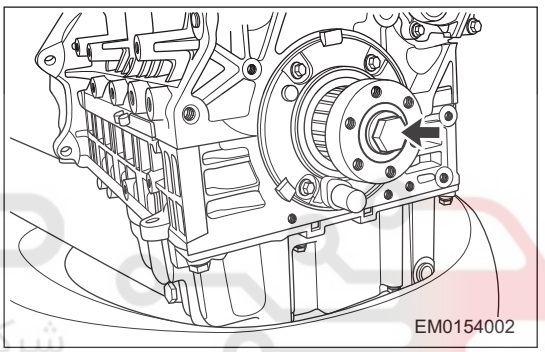
(a) Remove the crankshaft eccentric gear fixing bolt (arrow).

Tightening torque

1st step: 130 ± 10 N·m
2nd step: 65 ° ± 5°

Hint:

- Before the crankshaft eccentric gear fixing bolt loosens, the transmission (CVT model) "D" position, the other technicians depresses the brake pedal, locks the crankshaft through mechanical transmission device, and release the crankshaft eccentric gear fixing bolt.

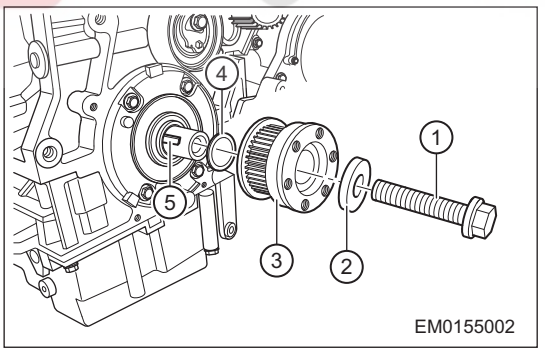


(b) Remove the crankshaft pulley.

(c) Remove crankshaft eccentric gear fixing bolt (1), washer (2), crankshaft eccentric gear assembly (3), driven disc (4) and woodruff key (5) in order.

Hint:

The woodruff key is easy to be ignored, as it is very small. Do not forget to install it during installation.



(d) Using a flat tip screwdriver wrapped with protective tape, pry out crankshaft front oil seal.

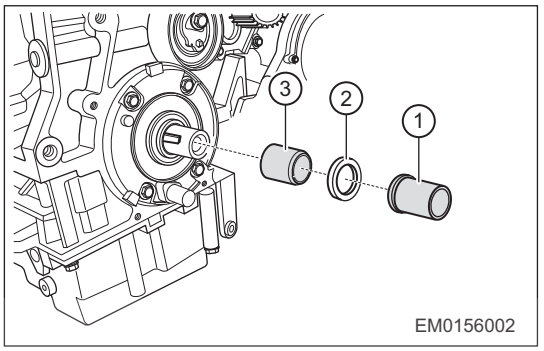
Installation

Warning/Caution/Hint

Caution:

- Apply a coat of engine oil to the crankshaft front oil seal guide tool before installing a new oil seal.
- Remove dirt on junction surface and apply a coat of engine oil to junction surface and oil seal lip (except the oil seal with surface applied wax) before assembly.
- Be sure to prevent the lip of crankshaft front oil seal from being scratched during installation. If it is damaged, replace it immediately.

1. Install the crankshaft front oil seal.
   (a) Install crankshaft front oil seal guide tool (3) to crankshaft.
   (b) Install new oil seal (2) to crankshaft front oil seal guide tool, then install new oil seal evenly and fully into oil seal retainer with a crankshaft front oil seal installer (1).



Caution:

- The oil seal surface should be lower than timing chain cover oil seal hole end surface by 0 ~ 1 mm.
- Ensure that oil seal lip should have no damage during assembly.
- During oil seal installation, deflection of 5° or more is not allowed and there should be no breakage and flanges in oil seal outer rubber.

   (c) Other installation procedures are in the reverse order of removal.

Flywheel

Removal

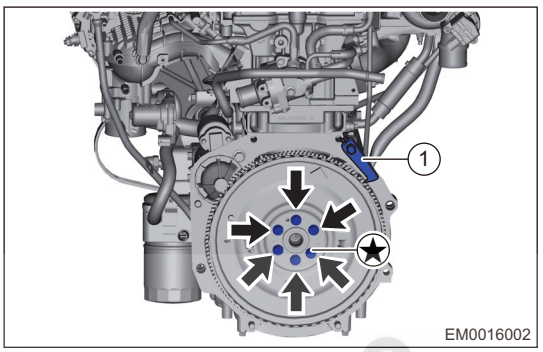
Warning/Caution/Hint

Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the automatic transmission assembly (See page 15-99).
4. Remove the flywheel assembly.

(a) Install flywheel holding tool (1) to lock flywheel.



(b) Remove 6 fixing bolts (arrow) from flywheel assembly, and remove flywheel assembly.

★
Non-reusable Part

Tightening torque
1st step: 35 ± 5 N·m
2nd step: 45°± 5°

Warning:

- Pay attention to personal safety during operation.
- DO NOT remove all fixing bolts without any auxiliary measures.

Caution:

- Flywheel fixing bolts must be disposed after removal. Never reuse them.

Inspection

1. Check if crankshaft position signal gear is distorted or deformed. If damaged, replace flywheel. Clean signal gear before installation.
2. Check if starter driven gear ring is worn. If excessively worn, replace flywheel.

Installation

Warning/Caution/Hint

Warning:

- Never reuse flywheel fixing bolts after removal.

Caution:

- Six bolt holes on the flywheel have asymmetrical positions. During installation, pay attention to that flywheel fixing bolts are aligned with crankshaft bolt holes.

1. Install the flywheel.

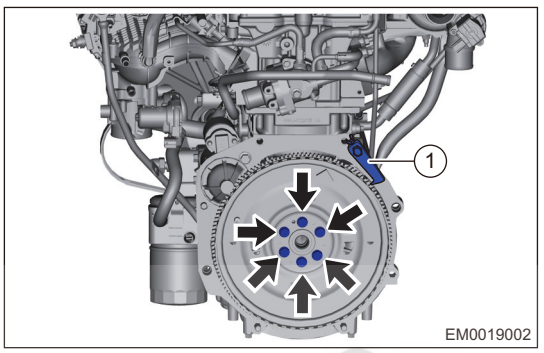
   Caution:

   - Lightly push flywheel after alignment during assembly. Do not tap flywheel with a hammer.
   - Replace flywheel fixing bolts with new ones.

   (a) When installing flywheel assembly, pretighten fixing bolts (arrow), and install flywheel holding tool (1), then tighten each flywheel bolt diagonally in order.

   Tightening torque

   1st step: 35 ± 5 N·m
   2nd step: 45°± 5°



Crankshaft Rear Oil Seal

Removal

Warning/Caution/Hint

Caution:

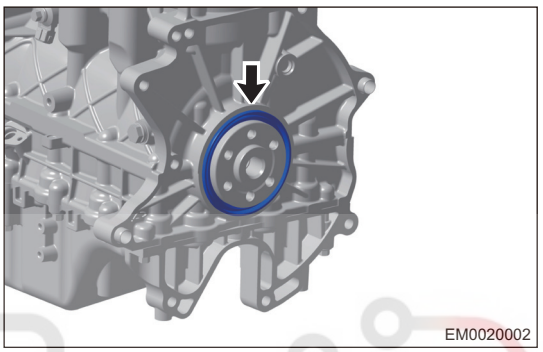
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 15-99).
4. Remove the flywheel assembly (See page 05-24).
5. Remove the crankshaft rear oil seal.

(a) Using a screwdriver with the tip wrapped with tape, remove crankshaft rear oil seal (arrow).

Caution:

- Be careful not to scratch cylinder block, when removing oil seal.



Installation

Warning/Caution/Hint

Caution:

- Be sure to clean dirt around oil seal retainer and on inside wall before installation.
- Check oil seal for damage before installation. If there is any damage, replace it.
- Be sure to prevent the lip of crankshaft rear oil seal from being scratched during installation.
- Be careful not to damage oil seal retainer during installation.

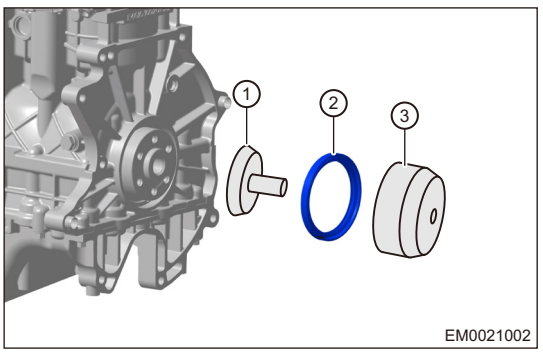
1. Install the crankshaft rear oil seal.

(a) Apply engine lubricant to crankshaft oil seal outer retainer and lip.

Hint:

Oil seal with surface applied with wax cannot be applied.

(b) Install guide tool (1) to crankshaft.



(c) Install new oil seal (2) to crankshaft rear oil seal guide tool, then install new oil seal evenly and fully into oil seal retainer with a crankshaft rear oil seal installer (3).
Caution:
- The oil seal surface should be lower than cylinder block mounting seat hole rear end surface by 0 ～ 1 mm.
- Ensure that oil seal lip should have no damage during assembly.
- During oil seal installation, deflection of 5° or more is not allowed and there should be no breakage and flanges in oil seal outer rubber.

2. Other installation procedures are in the reverse order of removal.

Camshaft Oil Seal

Removal

Warning/Caution/Hint

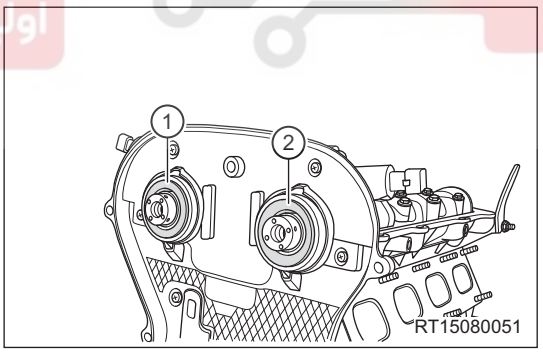
Caution:

- Blow dirt and debris away from surface of cylinder head cover with compressed air.
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coil (See page 12-7).
5. Remove the cylinder head cover (See page 05-40).
6. Remove the accessory drive belt (See page 05-16).
7. Remove the idler pulley assembly (See page 05-18).
8. Remove the tensioner assembly (See page 05-19).
9. Remove the crankshaft pulley (See page 05-22).
10. Use an engine equalizer to hang engine assembly.

    Hint:

    Use engine equalizer to hang lifting eye of engine when supporting the engine oil pan with jack. Avoid engine tilting to right side for easy removal of engine right mounting cushion assembly.
11. Remove the engine right mounting cushion assembly (See page 05-52).
12. Remove the right mounting lower body (See page 05-52).
13. Remove the timing belt.
14. Remove the camshaft oil seal.
    (a) Remove intake and exhaust phaser assemblies.
    (b) Using a flat tip screwdriver wrapped with protective tape, pry out camshaft oil seal (1) and intake camshaft oil seal (2).



Installation

Warning/Caution/Hint

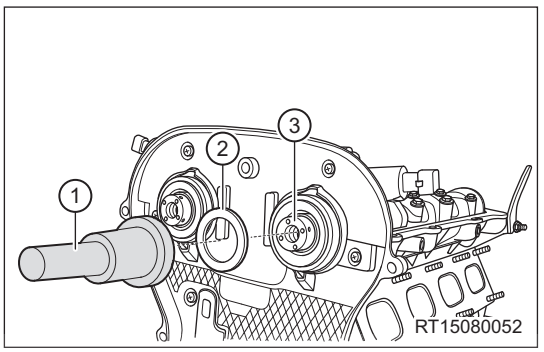
Caution:

- Be sure to clean dirt around oil seal retainer and on inside wall before installation.
- Check oil seal for damage before installation. If there is any damage, replace it.
- Be careful not to damage oil seal retainer during installation.

1. Install the camshaft oil seal.

   The installation of intake camshaft oil seal is the same as that of exhaust camshaft. The following is installation of intake camshaft oil seal.

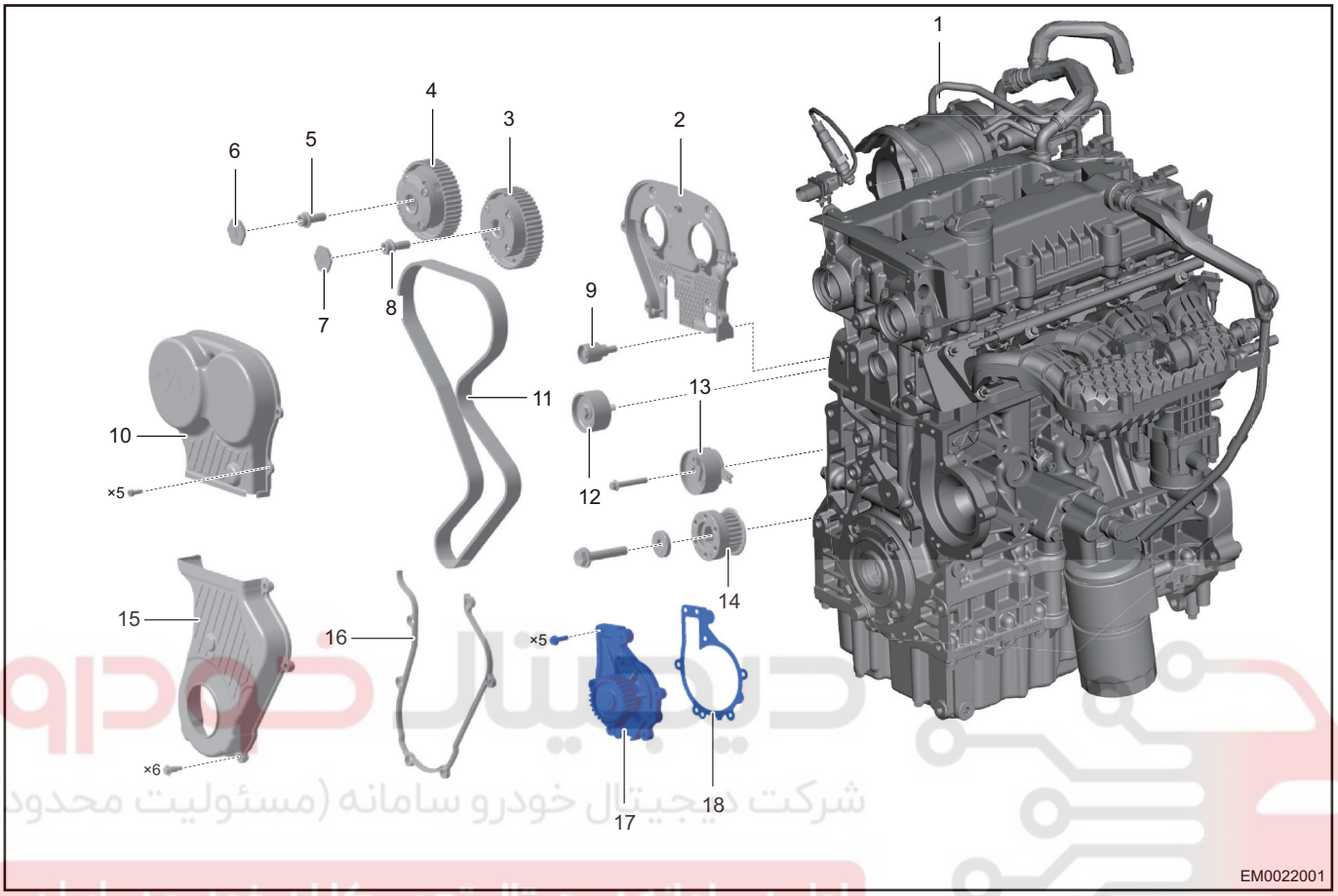
   (a) Using camshaft oil seal installer (1), install camshaft oil (2) to camshaft (3).



2. Other installation procedures are in the reverse order of removal.

Engine Timing Belt

Description



1 - Engine Assembly	2 - Timing Gear Rear Cover
3 - Intake Phaser Assembly	4 - Exhaust Phaser Assembly
5 - Exhaust Phaser Fixing Bolt	6 - Exhaust Phaser Cover
7 - Intake Phaser Cover	8 - Exhaust Phaser Fixing Bolt
9 - Contact Idler Pulley Assembly	10 - Timing Gear Cover Upper Body
11 - Timing Belt Assembly	12 - Idler Pulley Assembly
13 - Timing Tensioner Assembly	14 - Crankshaft Timing Eccentric Gear
15 - Timing Gear Cover Lower Body	16 -Timing Gear Cover Lower Body Gasket
17 - Water Pump Assembly	18 - Water Pump Assembly Gasket

Removal

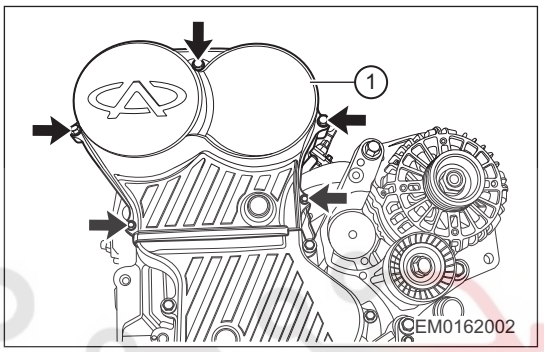
Warning/Caution/Hint

Caution:

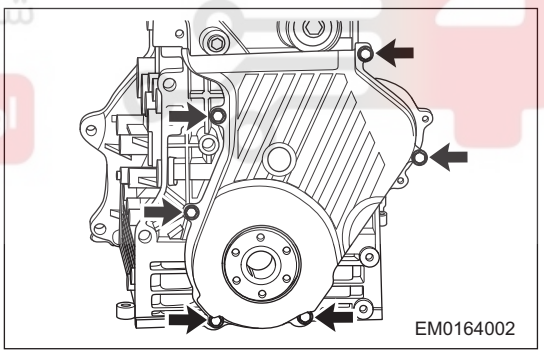
- Blow dirt and debris away from surface of cylinder head cover with compressed air.
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coil (See page 12-7).
5. Remove the cylinder head cover (See page 05-40).
6. Remove the accessory drive belt (See page 05-16).

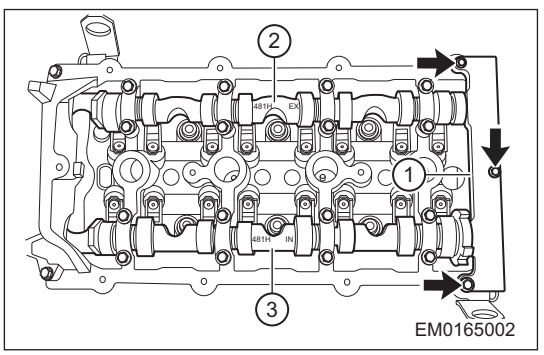
7. Remove the idler pulley assembly (See page 05-18).
8. Remove the tensioner assembly (See page 05-19).
9. Remove the crankshaft pulley (See page 05-22).
10. Use an engine equalizer to hang engine assembly.
    Hint:
    Use engine equalizer to hang lifting eye of engine when supporting the engine oil pan with jack. Avoid engine tilting to right side for easy removal of engine right mounting cushion assembly.
11. Remove the engine right mounting cushion assembly (See page 05-52).
12. Remove the right mounting lower body (See page 05-52).
13. Remove the timing chain upper housing cover.
    (a) Remove 5 fixing bolts (arrow) from timing chain upper housing cover.
    Tightening torque
    7 + 2 N·m
    (b) Remove the timing chain upper housing cover (1).



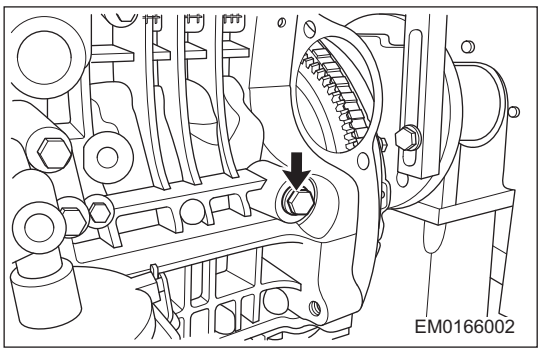
14. Remove the timing chain lower housing cover
    (a) Remove 6 fixing bolts (arrow) and timing chain lower housing cover.



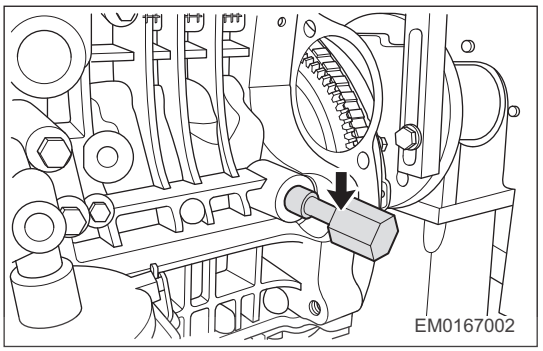
15. Remove the timing belt assembly.
    (a) Rotate camshaft, install camshaft timing tool (1), tighten fixing bolts (arrow), lock exhaust camshaft (2) and intake camshaft (3).



(b) Remove crankshaft timing tool installation hole fixing bolt (arrow) from engine block.



(c) Screw into crankshaft timing tool (arrow) carefully until crankshaft is clamped completely.

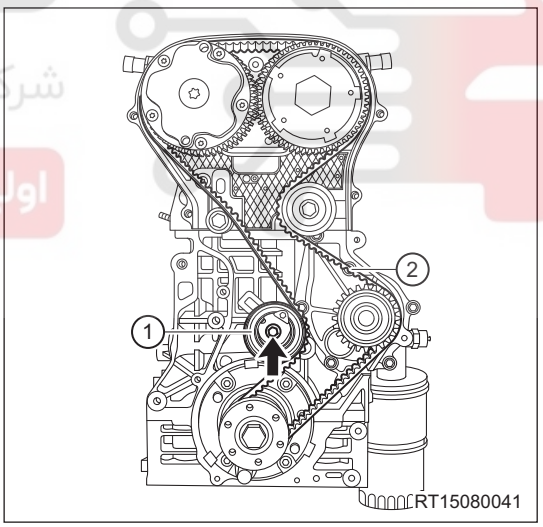


(d) Remove fixing bolt (arrow) and timing tensioner (1).

Tightening torque

25 + 5 N·m

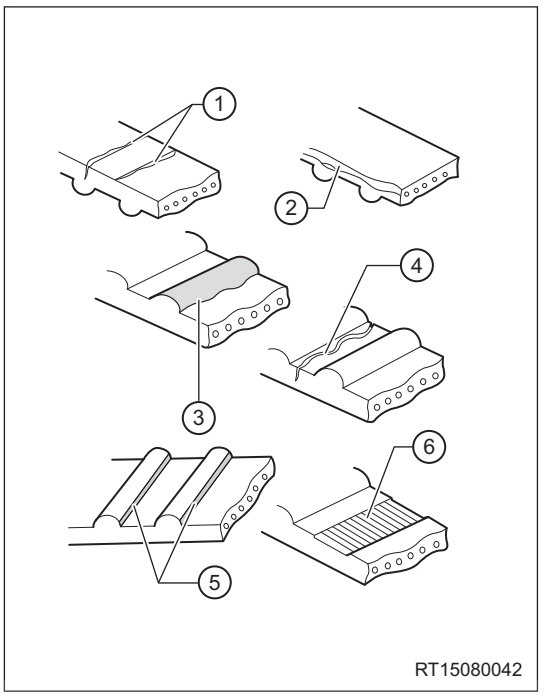
(e) Remove the timing belt (2).



Inspection

1. Check timing belt carefully before installation. If any following symptom occurs, replace timing belt assembly.
   (a) As shown in illustration (1), there are cracks on back side of timing belt.
   (b) As shown in illustrations (2), (3) and (5), there are cracks on bottom or cord fabric of timing belt.
   (c) As shown in illustration (6), there are wear on timing belt.

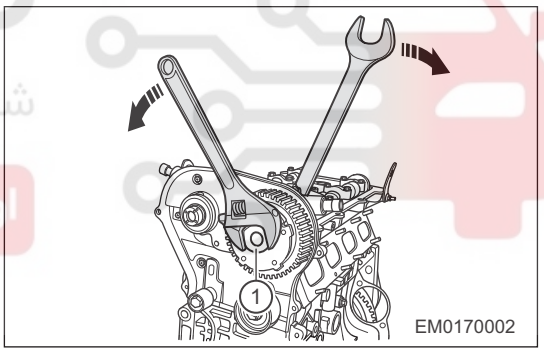
(d) As shown in illustrations (4) and (6), there are gear missing or damage on timing belt.



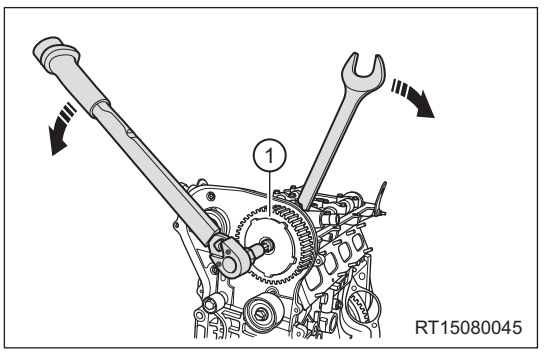
Installation

1. Install the timing belt.

(a) Use a proper wrench to hold intake camshaft and loosen intake phaser (1).



(b) Use a adjustable wrench to hold intake shaft and use torque wrench to loosen intake phaser fixing bolt (1) in direction of arrow.



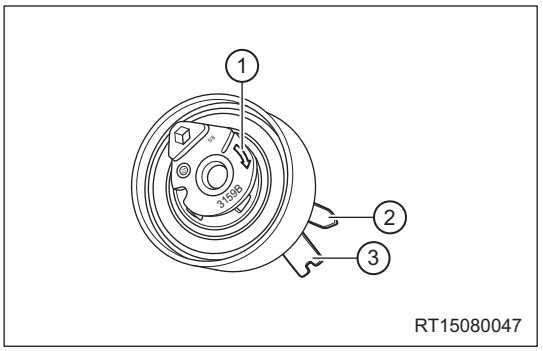
(c) Loosening method for exhaust phaser fixing bolt is the same as that of intake phaser fixing bolt.
Hint:
It is only necessary to loosen intake and exhaust phaser fixing bolts without removing phaser.

(d) Install the timing belt.
Caution:
- Ensure that exhaust phase, intake phaser, crankshaft timing pulley and water pump assembly are in good contact with timing belt teeth.

(e) Install the timing tensioner.

(1) When installing the timing tensioner, first install bolt manually.

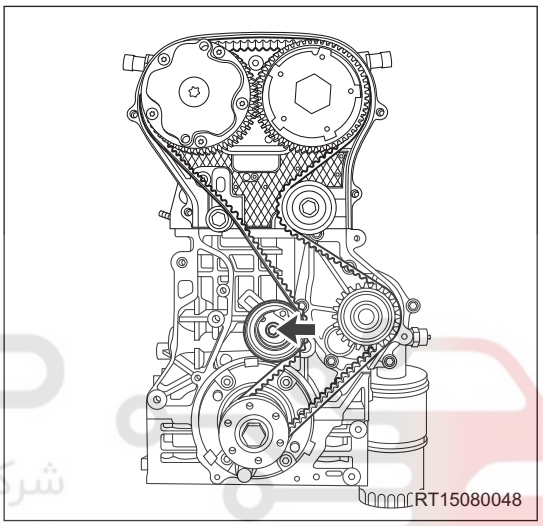
(2) Using internal hexagonal wrench, adjust tensioner clockwise in direction indicated by arrow in illustration, confirm that arrow (2) on tensioner is aligned with timing notch (3) of seat while tightening fixing bolt with wrench.



(3) Tighten the tensioner fixing bolt (arrow).

Tightening torque

25 + 5 N·m



(f) Tighten intake and exhaust phaser assembly fixing bolts.

Tightening torque

120 ± 5 N·m

Warning:

- Tighten exhaust phaser fixing bolt first, and then tighten intake phaser fixing bolt.

(g) Remove crankshaft timing tool and camshaft timing tool, then rotate crankshaft clockwise 2 turns at least, to check if timing system can operate normally.

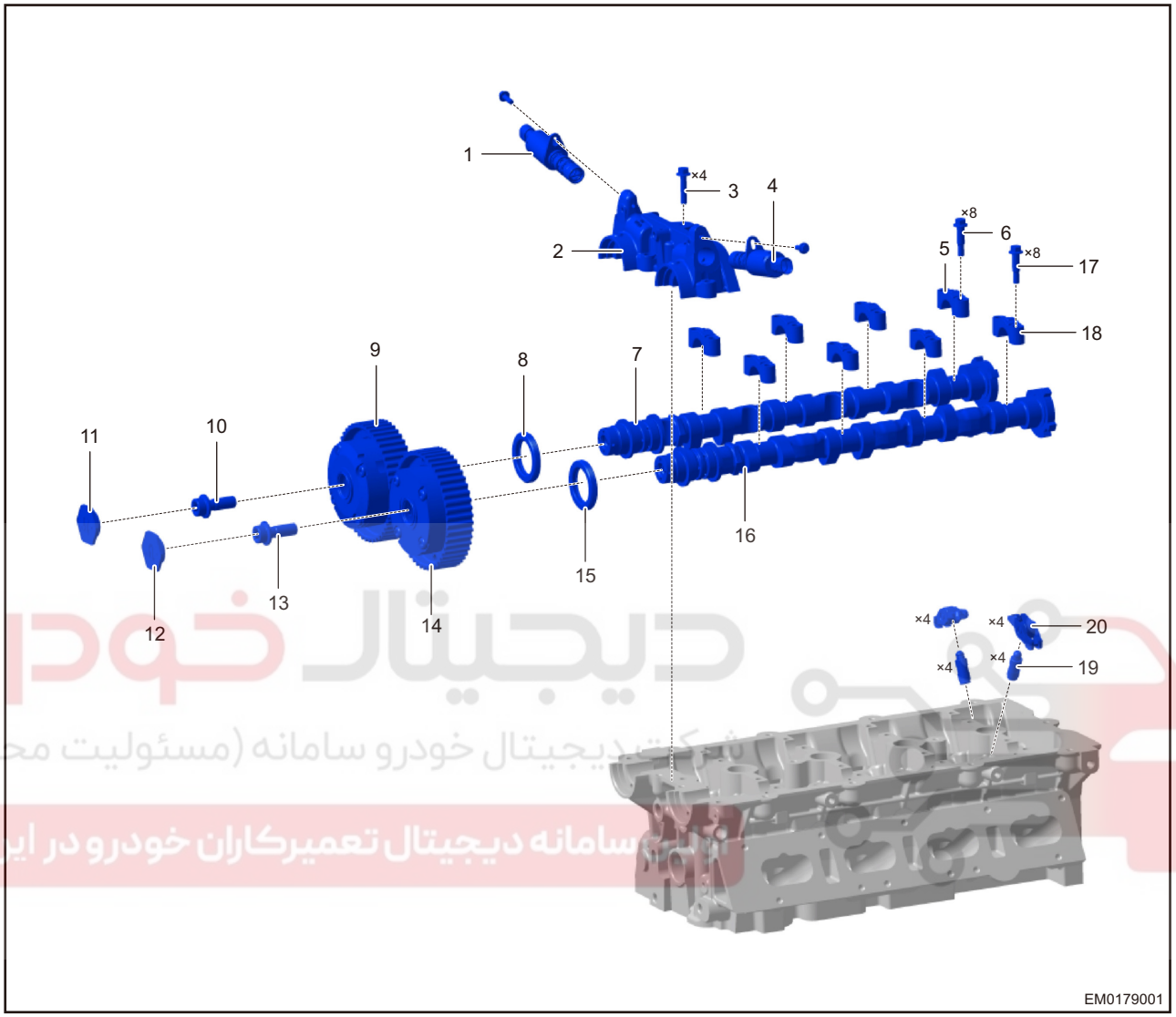
Caution:

- Never rotate crankshaft counterclockwise.

2. Other installation procedures are in the reverse order of removal.

Camshaft & Rocker Arm

Description



1 - Exhaust Variable Timing Control Valve	2 - Camshaft 1st Bearing Cap
3 - Camshaft 1st Bearing Cap Fixing Bolt	4 - Intake Variable Timing Control Valve
5 - Exhaust Camshaft Bearing Cap	6 - Exhaust Camshaft Bearing Cap Fixing Bolt
7 - Exhaust Camshaft Assembly	8 - Exhaust Camshaft Oil Seal
9 - Exhaust Phaser Assembly	10 - Exhaust Phaser Fixing Bolt
11 - Exhaust Phaser Cover	12 - Intake Phaser Cover
13 - Intake Phaser Fixing Bolt	14 - Intake Phaser Assembly
15 - Intake Camshaft Oil Seal	16 - Intake Camshaft Assembly
17 - Intake Camshaft Bearing Cap Fixing Bolt	18 - Intake Camshaft Bearing Cap
19 - Hydraulic Lifter	20 - Rocker Arm

Removal

Warning/Caution/Hint

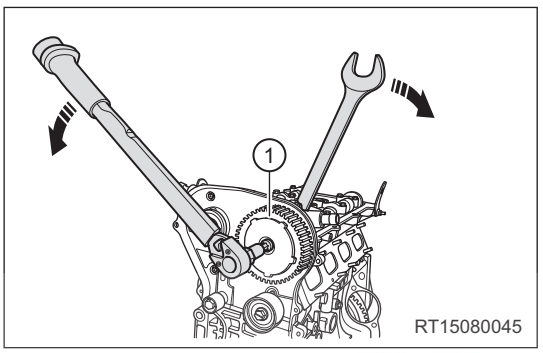
Caution:

- Blow dirt and debris away from surface of cylinder head cover with compressed air.
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coil (See page 12-7).
5. Remove the cylinder head cover assembly (See page 05-40).
6. Remove the accessory drive belt (See page 05-16).
7. Remove the tensioner assembly (See page 05-19).
8. Remove the idler pulley assembly (See page 05-18).
9. Remove the timing belt assembly (See page 05-30).
10. Remove intake and exhaust phaser assemblies.

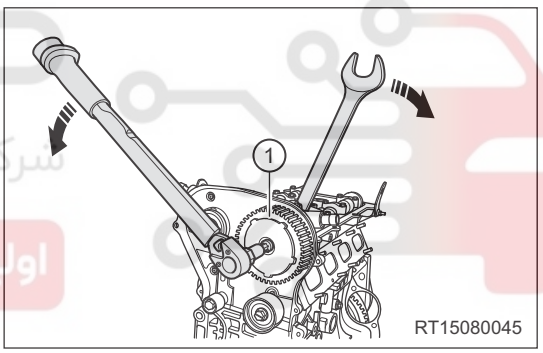
(a) As shown in illustration, use a proper wrench to hold intake camshaft, and remove fixing bolt from intake phaser assembly in direction of arrow.

Tightening torque
120 ± 5 N·m



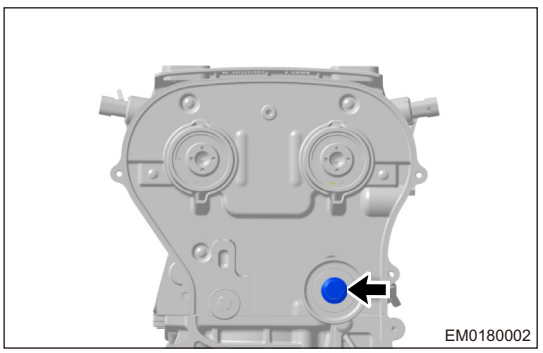
(b) Removal method for exhaust phaser assembly is the same as that of intake phaser assembly.

Tightening torque
120 ± 5 N·m

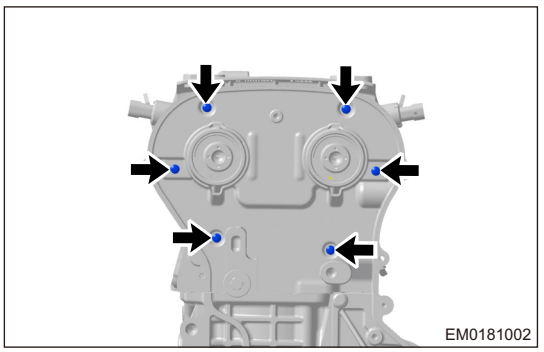


11. Remove the timing gear rear cover.

(a) Remove fixing bolt (arrow) and idler pulley assembly.

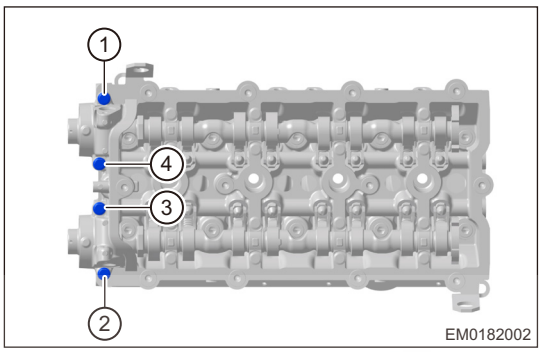


(b) Remove 6 fixing screws (arrow) and timing gear rear cover.

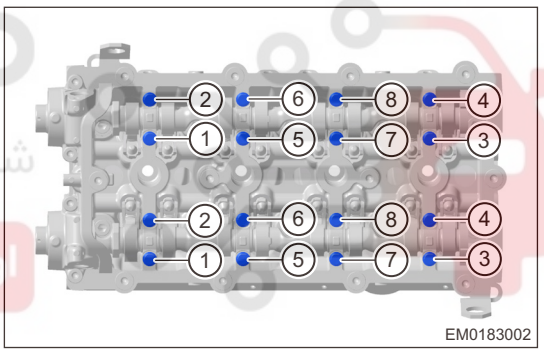


12. Remove intake and exhaust camshafts.

(a) Remove 4 1st bearing cover fixing bolts in order shown in illustration.



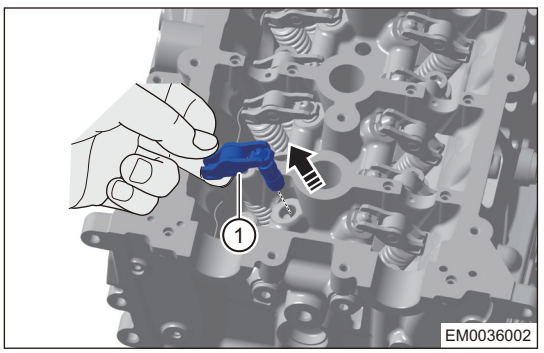
(b) Remove intake and exhaust camshaft bearing cap fixing bolts in order shown in illustration.
Hint:
During removal, loosen fixing bolts in order shown in illustration first, and then remove bolts thoroughly in order.



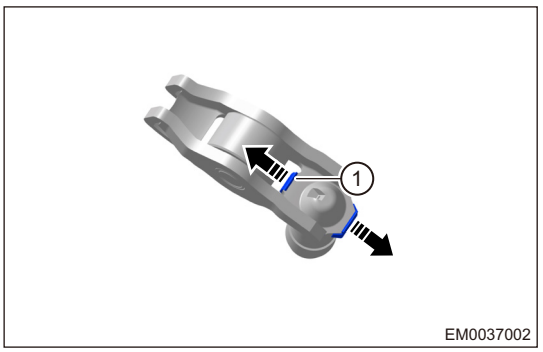
(c) Remove intake and exhaust camshaft bearing caps.
(d) Remove intake and exhaust camshaft assemblies.

13. Remove rocker arm and hydraulic lifter.

(a) Remove rocker arm and hydraulic lifter set (1) in direction of arrow.



(b) Remove elastic clip (1) and separate rocker arm and hydraulic lifter in direction of arrow as shown in illustration.



Inspection

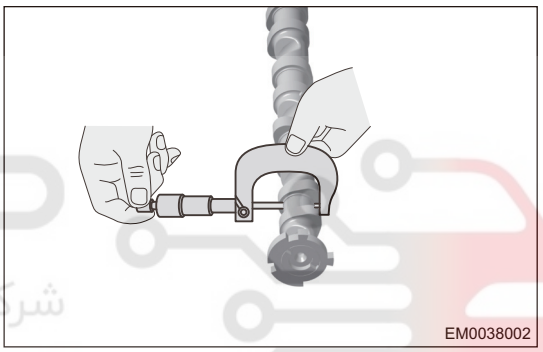
1. Check the camshaft.

(a) Check the appearance.

- Check if there are scratches on camshaft surface. If there are scratches, replace camshaft.
- Check if there are leaking holes and cracks on camshaft bearing caps. If there are leaking holes or cracks, replace camshaft.

(b) Check the camshaft journal diameter.
Measure camshaft journal diameter with a micrometer.

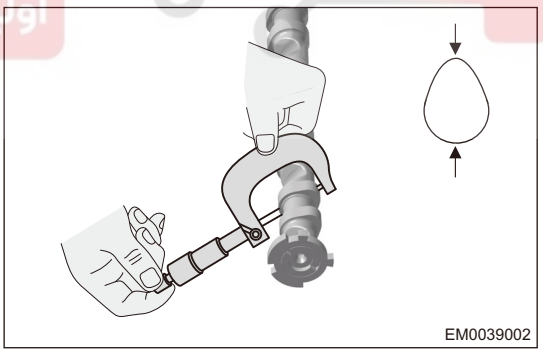
Measurement Item	Specification (mm)
1st Journal Diameter (intake and exhaust sides are the same)	32
2nd-5th Journal Diameter (intake and exhaust sides are the same)	24



If camshaft journal diameter is not within specified range, replace intake/exhaust camshaft assembly.

(c) Check the cam height.
Measure highest point of cam with a micrometer.

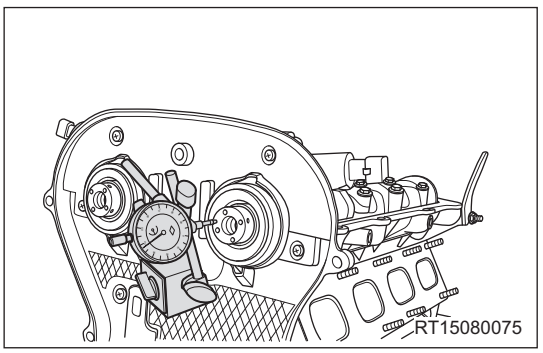
Measurement Item	Specification (mm)
Cam Flange Height (Highest Point)	8.74
	8.71



If cam height is not within specified range, replace intake/exhaust camshaft assembly.

(d) Check the camshaft axial clearance.

- Reinstall intake and exhaust camshaft assemblies.
- Keep dial indicator plunger contact with front end of camshaft, and reset dial indicator to zero.
- Push camshaft forward and backward lightly (do not rotate camshaft), then read value on dial indicator.



Measurement Item	Specification (mm)
Intake Camshaft Axial Clearance	0.15 - 0.20
Exhaust Camshaft Axial Clearance	0.15 - 0.20

If camshaft axial clearance is not within specified range, replace intake/exhaust camshaft assembly.

2. Check the hydraulic lifter.
   (a) Check whether the end face of hydraulic taut and cylinder working face are normal.
   (b) Check whether the hydraulic tappet slides normally in cylinder head guide hole.
   (c) Check if the hydraulic tappet is soft. If so, remove the part and soak it in 15W-30 oil for 24 hours. Press the hydraulic tappet plunger. If the plunger can be clearly pushed, it means that the tappet is "soft" and the hydraulic tappet can be replaced.

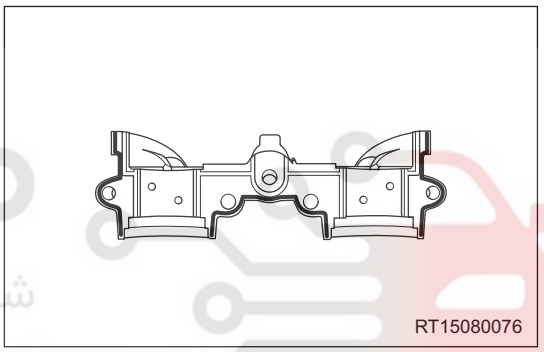
Installation

Warning/Caution/Hint

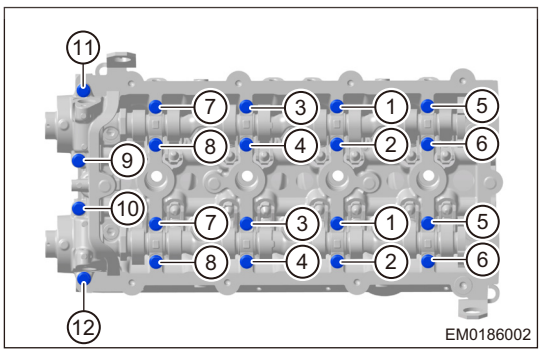
Caution:

- Adjust timing and adjust 4 pistons to same level before installing camshaft.
- When installing intake and exhaust phaser assemblies, tighten bolts on exhaust side first, and then tighten bolts on intake side.

1. Install the camshaft.
   (a) Clean intake and exhaust camshafts and camshaft bearing caps.
   (b) As shown in illustration, apply sealant evenly to bottom of camshaft 1st bearing cover.


RT15080076

   (c) Apply a small amount of engine oil to the outer surface of cam and journal, meanwhile, apply a small amount of engine oil to cylinder head bearing holes and roller rocker arms, and install the intake and exhaust camshaft assemblies on cylinder head.
   (d) Install intake and exhaust camshaft fixing bolts by hand.
   (e) Tighten intake and exhaust camshaft bearing cap fixing bolts in order shown in illustration.

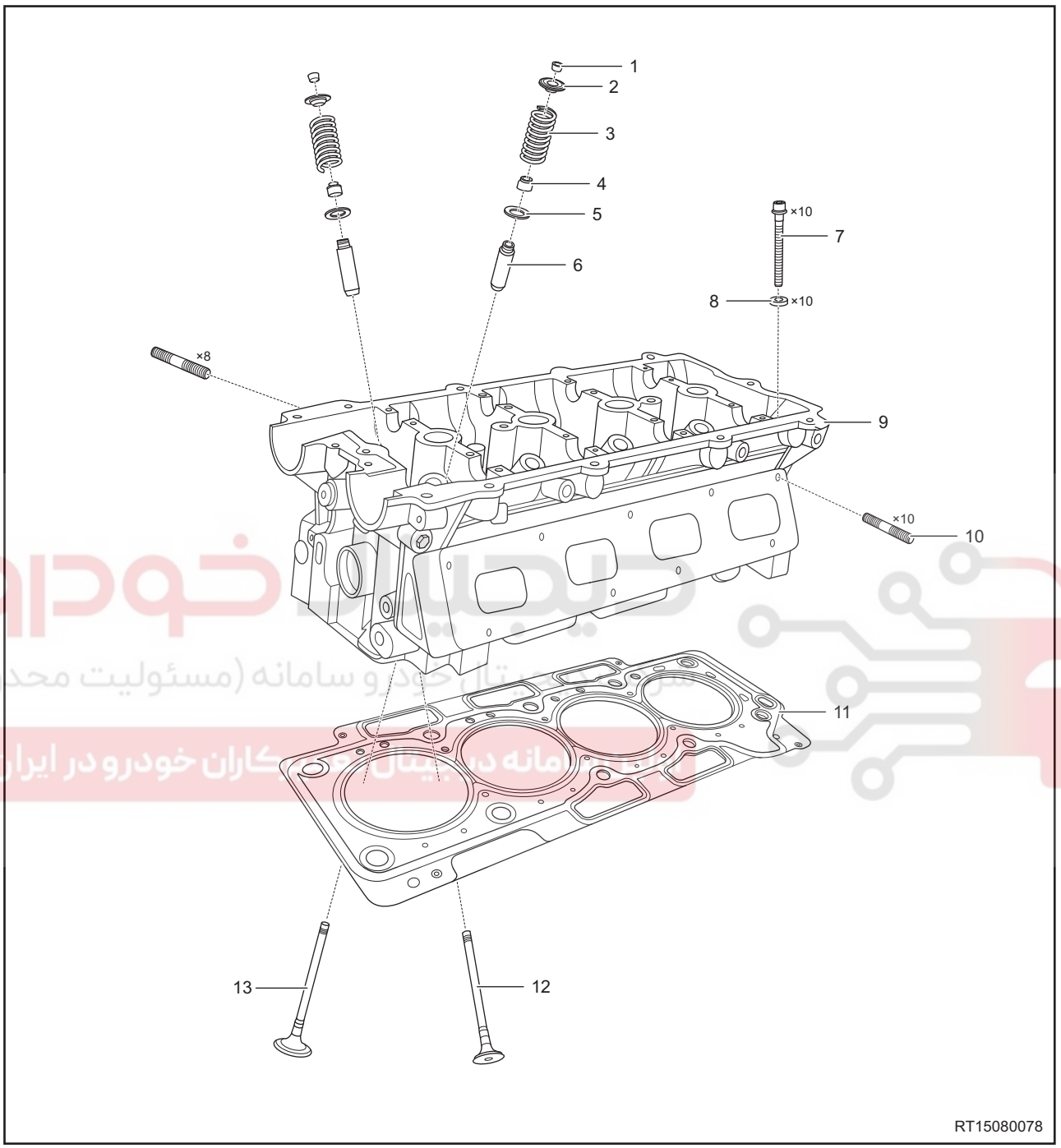


EM0186002

2. Other installation procedures are in the reverse order of removal.

Cylinder Head

Description

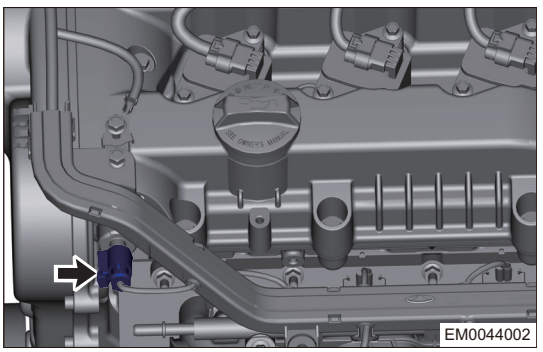


1 - Valve Cotter	2 - Valve Spring Upper Seat
3 - Valve Spring	4 - Valve Oil Seal
5 - Valve Spring Lower Seat	6 - Valve Guide
7 - Cylinder Head Fixing Bolt	8 - Cylinder Head Fixing Bolt Washer
9 - Cylinder Head	10 - Stud
11 - Cylinder Head Gasket	12 - Intake Valve
13 - Exhaust Valve	

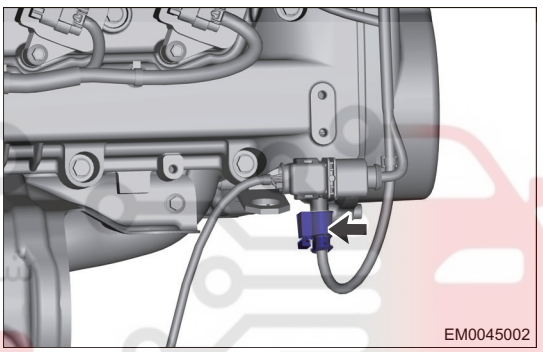
Removal

1. Release the fuel system pressure (See page 06-11).
2. Turn off all electrical equipment and the ignition switch.
3. Disconnect the negative battery cable.
4. Drain the engine oil (See page 11-9).
5. Drain the coolant (See page 10-8).
6. Disconnect the wire harness connector.

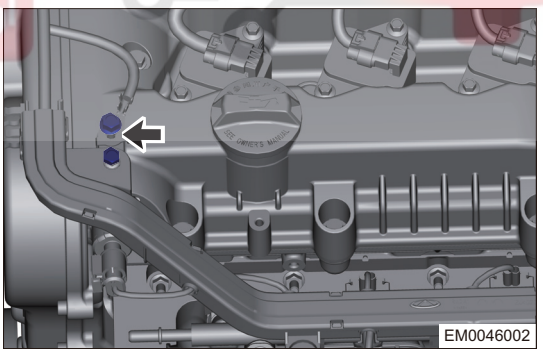
(a) Disconnect the intake variable timing control valve connector (arrow).



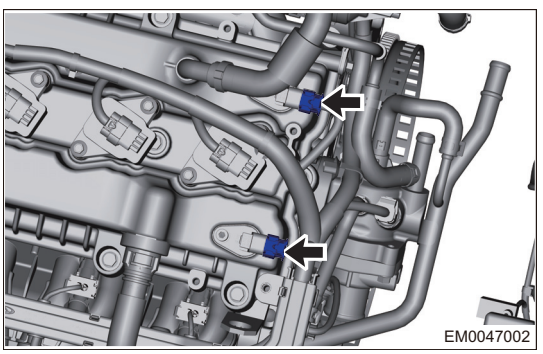
(b) Disconnect the exhaust variable timing control valve connector (arrow).



(c) Remove the engine wire harness fixing bolt (arrow).



(d) Disconnect the camshaft position sensor connector (arrow).



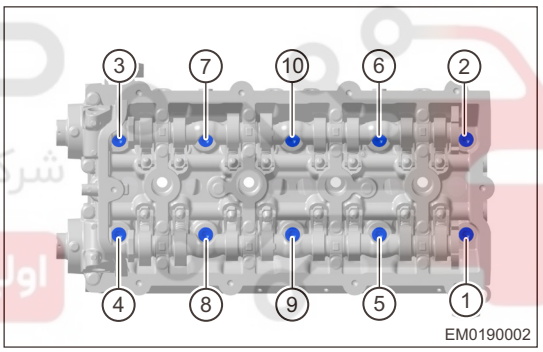
7. Remove the air filter assembly (See page 08-9).
8. Remove the battery assembly (See page 14-8).
9. Remove the battery tray (See page 14-10).

10. Remove the ignition coil (See page 12-7).
11. Remove the spark plug (See page 12-9).
12. Remove the fuel rail injector assembly (See page 04-250).
13. Remove the engine discharge steel pipe assembly.
14. Remove the intake manifold assembly (See page 08-15).
15. Remove the thermostat seat (See page 10-16).
16. Remove the turbocharger assembly (See page 09-9).
17. Remove the accessory drive belt (See page 05-16).
18. Remove the idler pulley assembly (See page 05-18).
19. Remove the tensioner assembly (See page 05-19).
20. Remove the cylinder head cover assembly (See page 05-40).
21. Use an engine equalizer to hang engine assembly.

    Hint:
    Use an engine equalizer to hang engine assembly. while supporting engine oil pan with a jack. Avoid engine tilting to right side.
22. Remove the engine timing belt (See page 05-30.
23. Remove camshaft and rocker arm (See page 05-35).
24. Remove the engine equalizer.
25. Remove the cylinder head assembly.

    (a) Remove 10 cylinder head assembly fixing bolts in order shown in illustration.

    Caution:
    - If cylinder head is removed and installed when the engine is in a high temperature, deformation may occur, so it should be carried out at room temperature.
    - Remove cylinder head fixing bolts in order shown in illustration, deformation on cylinder head may occur.
    - Disposal mark may be made on removed bolt and gasket. It cannot be reused.



    (b) Remove cylinder head and cylinder head gasket.

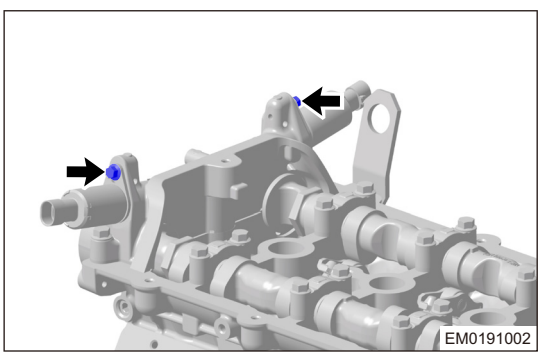
    Caution:
    - DO NOT reuse the removed cylinder head gasket, and it is necessary to replace it with new one. Be careful not to lose cylinder head mounting dowel pin during removal.

Disassembly

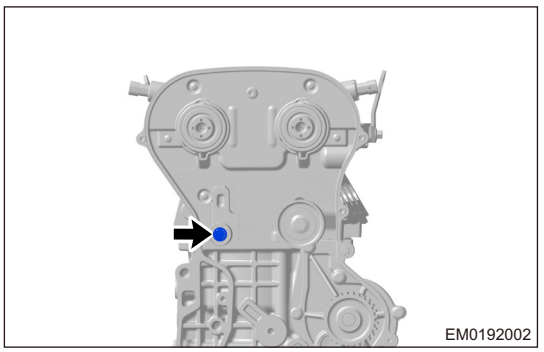
1. Disassemble the cylinder head.

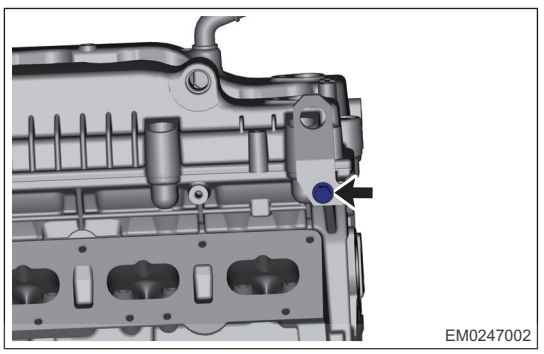
    (a) Remove exhaust variable timing control valve fixing bolt (arrow), and remove exhaust variable timing control valve assembly.

    Tightening torque
    6 + 2 N·m

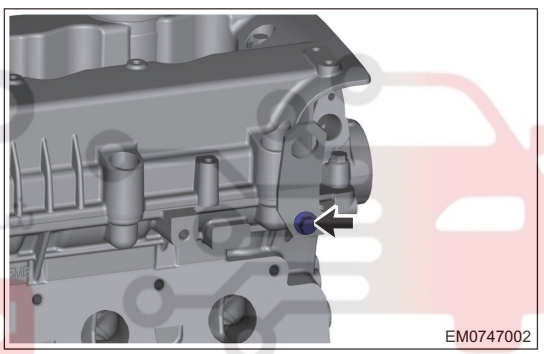


(b) Remove 1 fixing bolt (arrow) and idler pulley.

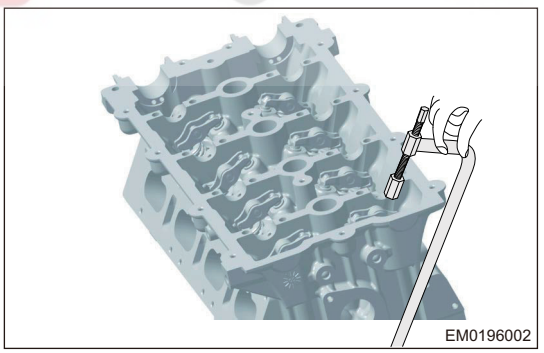

EM0192002


EM0247002

(c) Remove 2 fixing bolts (arrow) from lifting lug.


EM0747002

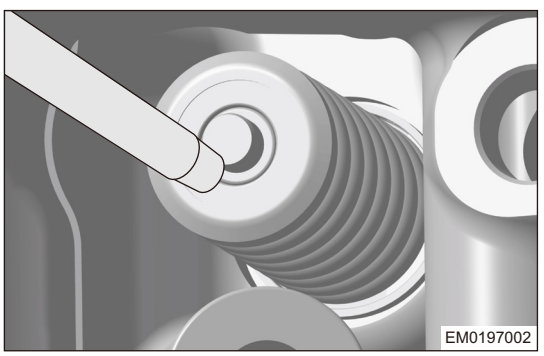
(d) Using a valve spring compressor, compress valve spring to a position so that valve cotter can be removed.


EM0196002

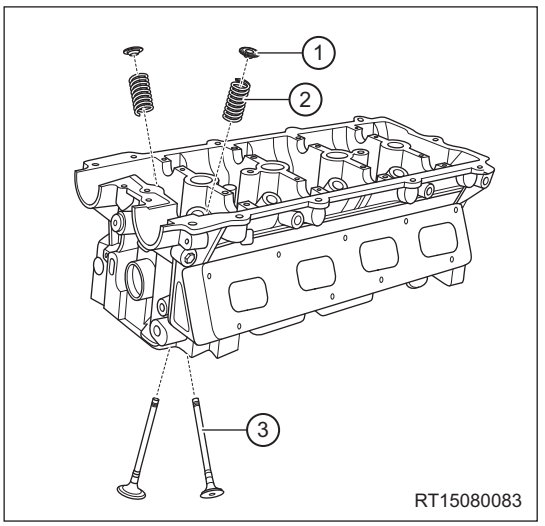
(e) Using a magnetic rod, remove valve cotter.

Caution:

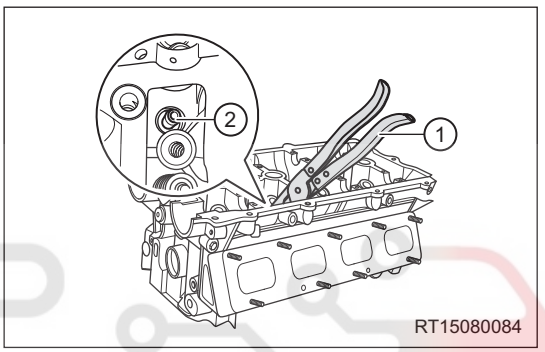
- Due to the valve cotter is small, please operate carefully when removing it to avoid loss.


EM0197002

(f) Remove valve spring upper seat (1), valve spring (2) and intake and exhaust valve (3) from cylinder head.



(g) Using a valve oil seal remover (1), remove the valve oil seal (2).



(h) Using a magnetic rod, remove valve spring lower seat.

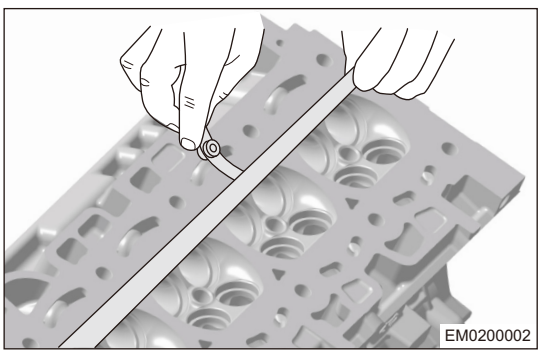
Inspection

1. Check the cylinder head assembly.
   (a) Check the appearance.
   - Check if there are scratches on camshaft bearing journals.
   - Remove carbon deposits inside valve guides with cleaner.
   - Make sure valve stem can move and rotate freely in its mounting hole.

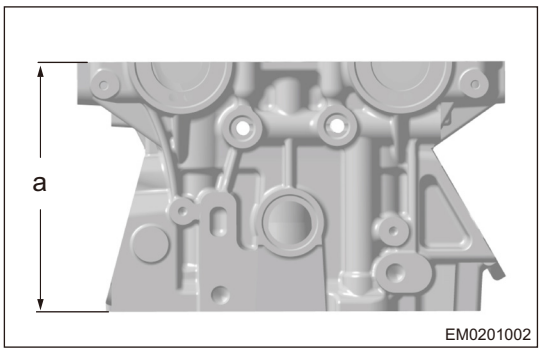
   (b) Check the cylinder head flatness.
   Using a precision straightedge and feeler gauge, check cylinder head flatness.

Measurement Item	Specification (mm)
Cylinder Head Flatness	0.04

If cylinder head flatness is not within specified range, replace cylinder head assembly.



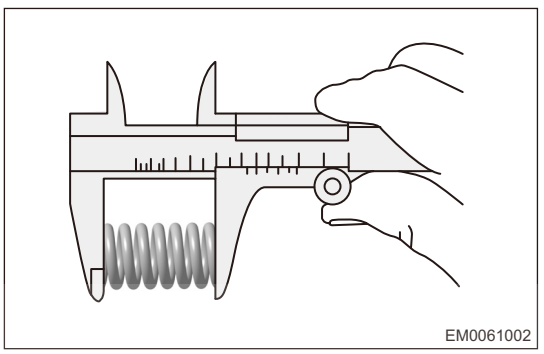
(c) Check the cylinder head height.
Using a precision straightedge, measure cylinder head height.



Measurement Item	Specification (mm)
Cylinder Head Height	139.83

If cylinder head height is not within specified range, replace cylinder head assembly.

2. Check the valve spring.
Using a vernier caliper, measure free length of valve spring and length of valve spring under the pre-pressure (205 N).



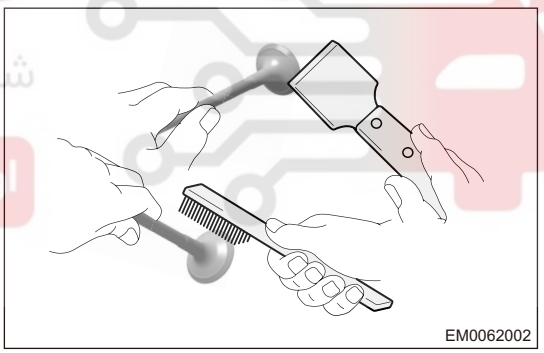
Measurement Item	Specification (mm)
Valve Spring Free Length	48.3
Valve Spring Length Under Pre-pressure of (205 N)	41

If valve spring length is not within specified range, replace valve spring.

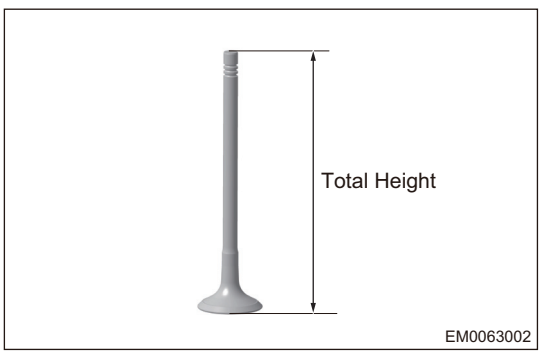
3. Check the valve.

(a) Clean the valve.

- Using a scraper, remove carbon deposited on valve head.
- Using a wire brush, clean the valve thoroughly.



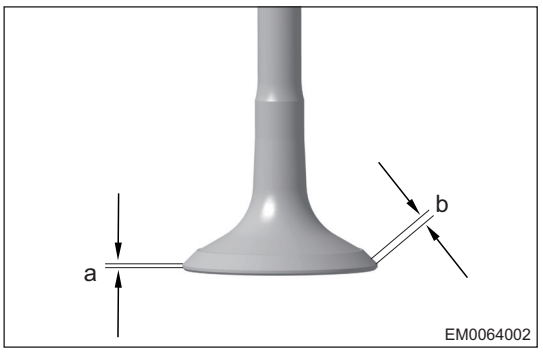
(b) Check the valve height.
Using a micrometer, measure the valve height.



Measurement Item	Specification (mm)
Intake Valve Height	108
Exhaust Valve Height	106.3

If valve height is less than specified value, replace valve.

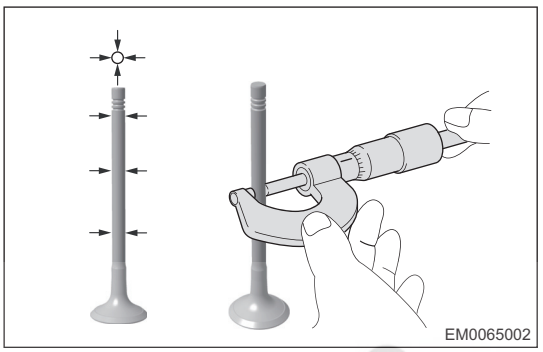
(c) Check the valve head.
- Measure margin thickness (a) of valve head.
- Measure width (b) of valve face.



Measurement Item	Specification (mm)
Margin thickness of intake valve head	2.5
Margin thickness of exhaust valve head	2.7
Width of intake valve face	2.26
Width of exhaust valve face	2.83

If valve head margin thickness and face width are not within specified range, replace valve.

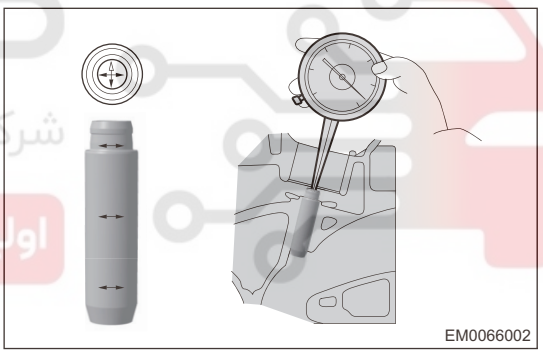
(d) Check the valve stem diameter.
Using a micrometer, measure the valve stem diameter.



Measurement Item	Specification (mm)
Intake Valve Stem Diameter	5.98
Exhaust Valve Stem Diameter	5.96/5.95

If valve stem diameter is not within specified range, check clearance between valve stem and valve guide.

(e) Check clearance between valve stem and valve guide.
Using a caliper gauge, measure inner diameter of valve guide.



Measurement Item	Specification (mm)
Valve Guide Inner Diameter	6

- Clearance between valve stem and valve guide = Valve guide inner diameter - Valve stem diameter

Measurement Item	Specification (mm)
Clearance Between Intake Valve and Valve Guide	0.012 - 0.043
Clearance Between Exhaust Valve and Valve Guide	0.033 - 0.062/0.043 - 0.072

If clearance between valve and valve guide is not within specified range, replace valve or valve guide.

Assembly

Warning/Caution/Hint

Caution:

- Soak valve oil seal in oil for several minutes before installing valve oil seal.
- Check if valve spring lower seat is installed properly before installing valve spring.

Hint:

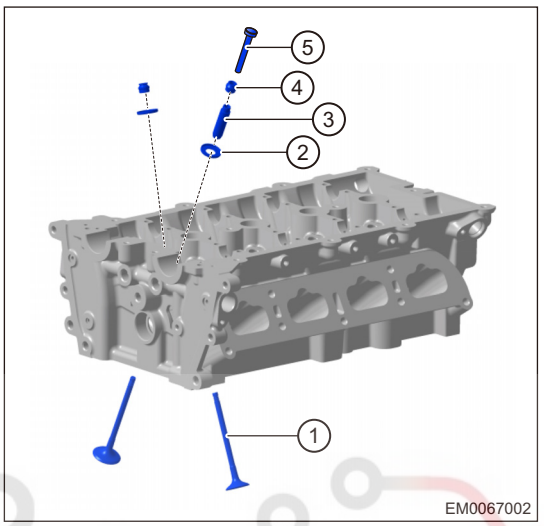
Clean all components to be assembled thoroughly before assembly.

1. Assemble the cylinder head.

(a) Install valve (1) into cylinder head.

Hint:

- Distinguish intake valves and exhaust valves during installation. Diameter of intake valve head is larger than that of exhaust valve head.
- Apply engine oil to valve stem end, when assembling valve.



(b) Install new valve spring lower seat (2) if necessary.

Caution:

- Bottom plane of valve spring lower seat should contact with cylinder head with flange facing upward.

(c) Install the valve oil seal.

Hint:

Apply engine oil to valve oil seal lip, when assembling valve oil seal.

(1) Install valve oil seal guide sleeve (3) to valve.

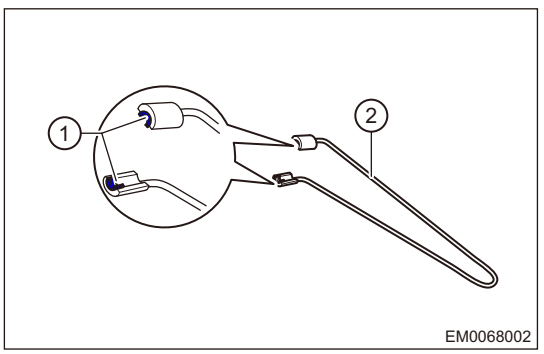
(2) Install valve oil seal (4) to valve oil seal guide sleeve.

(3) Press valve oil seal installer (5) lightly by hand to install valve oil seal (4) in place.

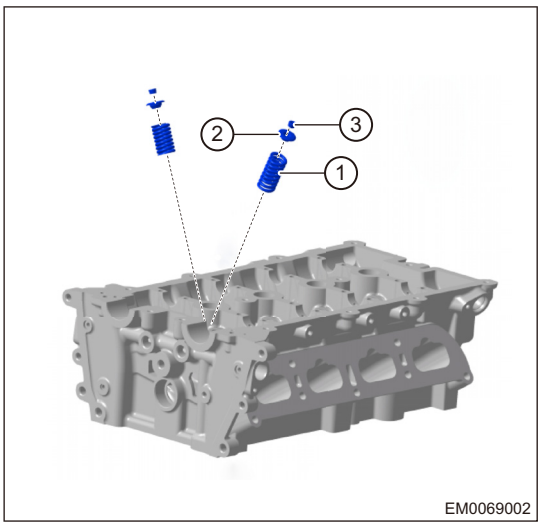
Caution:

- Check valve spring lower seat and valve oil seal for wrong installation, neglected installation and over installation.

(d) Install valve cotter (1) to valve cotter installer (2).



(e) Install valve spring (1) and valve spring upper seat (2). Using a valve spring compressor, compress valve spring to a position so that valve cotter can be installed. Using a valve cotter installer, install valve cotter (3) in place.



(f) Tap tip of valve stem lightly with a rubber hammer to make sure valve cotter is installed in place after assembly.

Installation

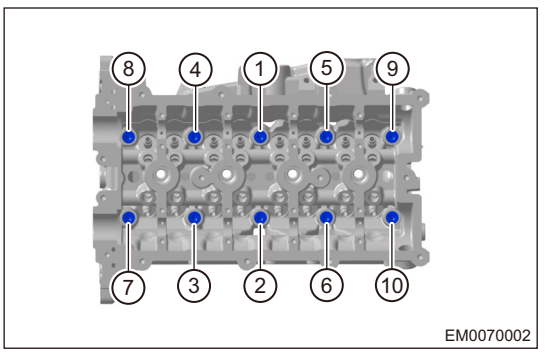
Warning/Caution/Hint

Caution:

- DO NOT damage or lose dowel pin on cylinder block.
- Remove residual seal gum and oil on cylinder head and cylinder block.
- Replace the cylinder head gasket.
- Check that cylinder head gasket is neat and clean without any chips and scratches, and the side stamped with part number faces upward.
- Install cylinder head gasket to flat surface of cylinder block with a dowel pin.
- Clean junction surface between cylinder head and combustion chamber, and remove any accumulated oil at bottom of cylinder block thread hole.
- During installation, piston should not be located at the top dead center, in order to prevent it from being impacted by opening valve, when installing the camshaft.
- Replace cylinder head fixing bolt and washer, and make scraping marks on removed bolt.
- Install the cylinder head bolt washer with chamfering surface facing upward and flat side facing cylinder head.

1. Tighten cylinder head fixing bolts in order from (1) to (10) shown in illustration:

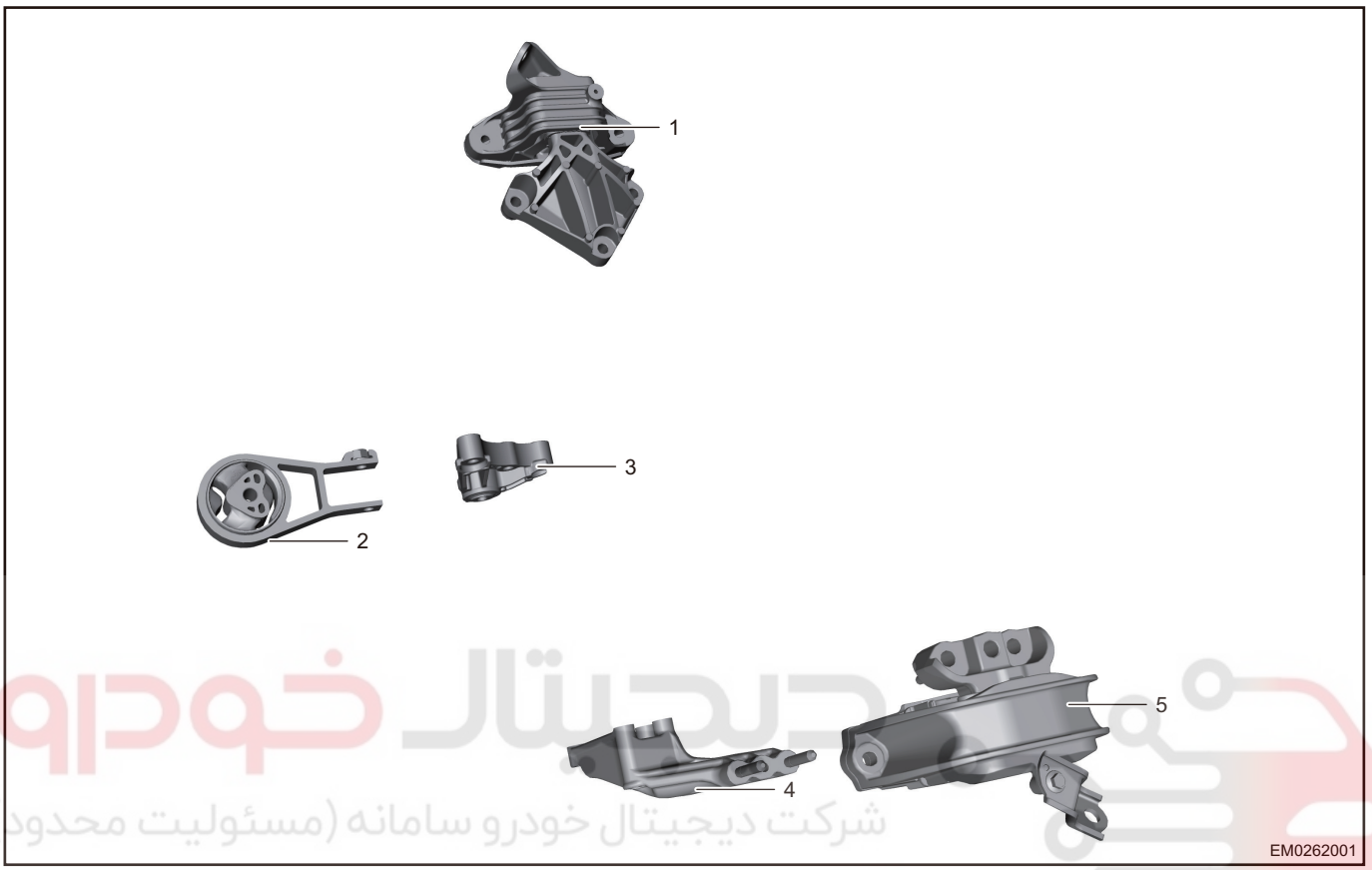
(a) Tighten bolts in place by hands.



(b) Tighten cylinder head fixing bolts according to following procedures:
(1) 1st step: Tighten bolts to 40 ± 5 N·m in order from (1) to (10) shown in illustration.
(2) 2nd step: Rotate bolts clockwise by 90° ± 5° in tightening order.
(3) 3rd step: Rotate bolts clockwise by 90° ± 5° in tightening order again.
Caution:
- Check cylinder head fixing bolts before installation. If damaged, replace them immediately.
- Be sure to tighten cylinder head bolts strictly according to operating procedures above, to achieve the technology standard for vehicle usage.

2. Other installation procedures are in the reverse order of removal.

Engine Mounting Assembly



1 - Right Mounting Cushion	2 - Rear Mounting Lower Body
3 - Rear Mounting Upper Body	4 - Left Mounting Bracket
5 - Right Mounting Cushion	

Removal & Installation - Rear Mounting Assembly

Warning/Caution/Hint

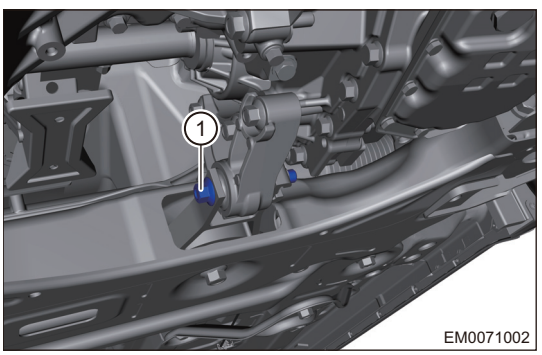
Caution:

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the rear mounting upper body.
   (a) Remove coupling bolt (1) between rear mounting upper body and lower body.

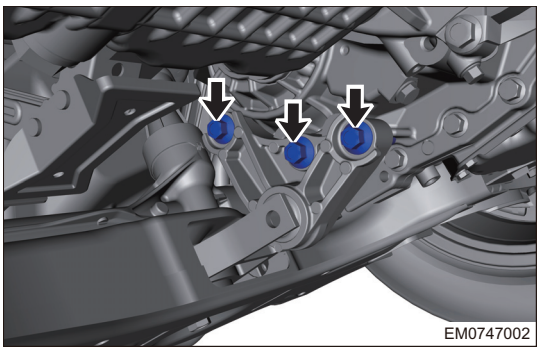
   Tightening torque

   105 ± 10 N·m



(b) Remove 3 coupling bolts (arrow) between rear mounting upper body and transmission.

Tightening torque
80 ± 5 N·m

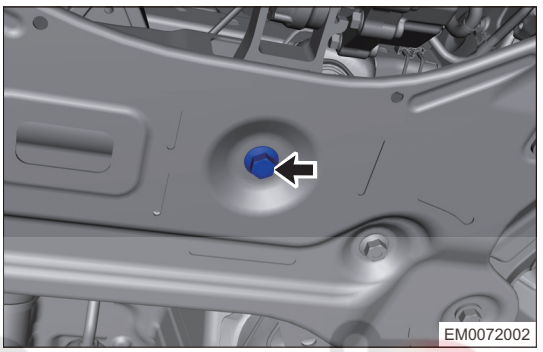


(c) Remove the rear mounting upper body.

4. Remove the rear mounting lower body.

(a) Remove coupling bolt (arrow) between rear mounting lower body and sub frame.

Tightening torque
150 ± 10 N·m



(b) Remove the rear mounting lower body.

Installation

1. Installation is in the reverse order of removal.

Caution:
- Pre-tighten 2 or 3 threads manually first during assembly of bolts and nuts, then pre-tighten and tighten it to specified torque with a tool.

Installation

1. Installation is in the reverse order of removal.

Caution:
- Pre-tighten 2 or 3 threads manually first during assembly of bolts and nuts, then pre-tighten and tighten it to specified torque with a tool.

Removal & Installation - Left Mounting Assembly

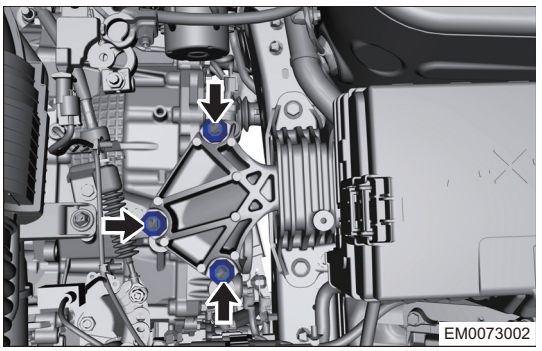
Warning/Caution/Hint

Caution:
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Use an engine equalizer to hang engine assembly.
4. Remove the air filter assembly (See page 08-9).
5. Remove the battery assembly (See page 14-8).
6. Remove the battery tray (See page 14-10).
7. Remove the left mounting cushion assembly.

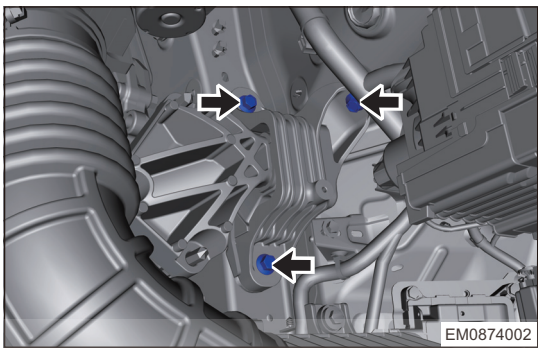
(a) Remove 3 fixing nuts (arrow) between left mounting cushion assembly and transmission assembly.

Tightening torque
80 ± 5 N·m


EM0073002

(b) Remove 3 fixing bolts (arrow) between left mounting cushion assembly and left side rail wheel house assembly.

Tightening torque
60 ± 5 N·m


EM0874002

(c) Remove the left mounting cushion assembly.

Installation

1. Installation is in the reverse order of removal.

Caution:
- When installing the left suspension cushion assembly to left rail wheel cover assembly, tighten the positioning bolt on rail first, then tighten another bolt on the rail, and finally tighten the bolt on wheel cover.
- Pre-tighten 2 or 3 threads manually first during assembly of bolts and nuts, then pre-tighten and tighten it to specified torque with a tool.

Installation

1. Installation is in the reverse order of removal.

Caution:
- When installing the left suspension cushion assembly to left rail wheel cover assembly, tighten the positioning bolt on rail first, then tighten another bolt on the rail, and finally tighten the bolt on wheel cover.
- Pre-tighten 2 or 3 threads manually first during assembly of bolts and nuts, then pre-tighten and tighten it to specified torque with a tool.

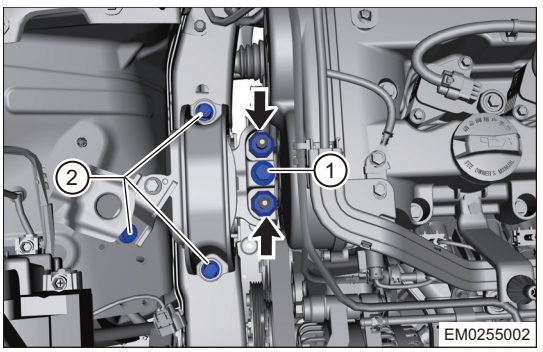
Removal & Installation - Right Mounting Assembly

Warning/Caution/Hint

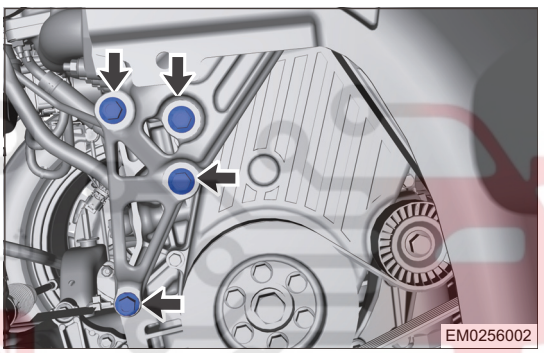
Caution:
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Drain the coolant (See page 10-8).
5. Remove the expansion tank assembly (See page 10-12).

6. Use an engine equalizer to hang engine assembly.
7. Remove the engine right mounting cushion assembly.
   (a) Remove 2 fixing nuts (arrow) and 1 fixing bolt (1) between right mounting cushion assembly and bracket.
   Tightening torque
   80 ± 5 N·m
   (b) Remove 3 coupling bolts (2) between right mounting cushion assembly and body.
   Tightening torque
   60 ± 5 N·m



   (c) Remove the engine right mounting cushion assembly.
8. Remove the engine right mounting cushion bracket.
   (a) Remove 4 fixing bolts (arrow) from engine right mounting cushion bracket.
   Tightening torque
   60 ± 5 N·m

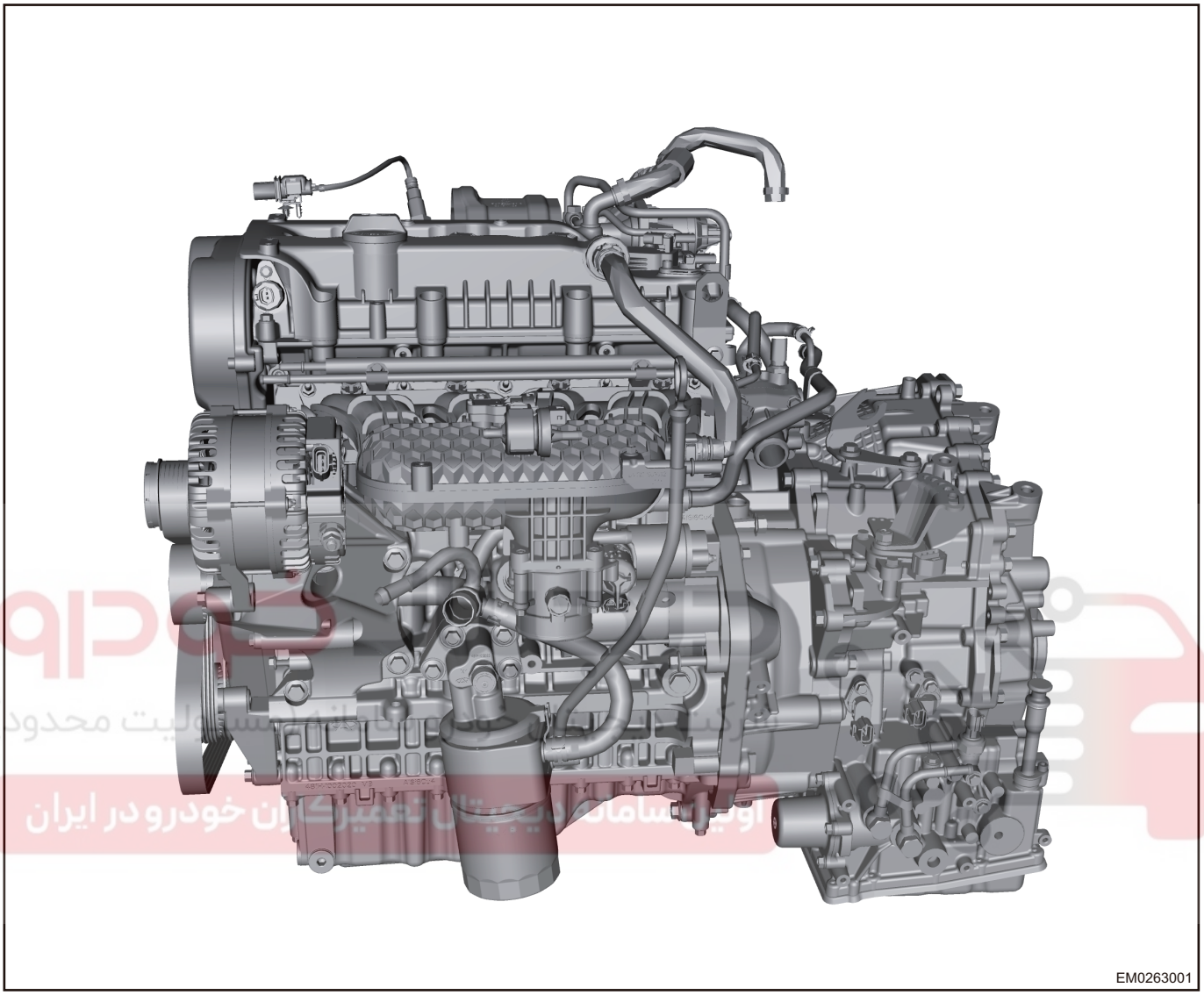


   (b) Remove the engine right mounting cushion bracket.

Installation

1. Installation is in the reverse order of removal.
   Caution:
   - When installing the right mounting cushion assembly to right rail wheel cover assembly, tighten the positioning bolt on rail first, then tighten another bolt on the rail, and finally tighten the bolt on wheel cover.
   - Pre-tighten 2 or 3 threads manually first during assembly of bolts and nuts, then pre-tighten and tighten it to specified torque with a tool.

Engine Assembly



Removal

Warning/Caution/Hint

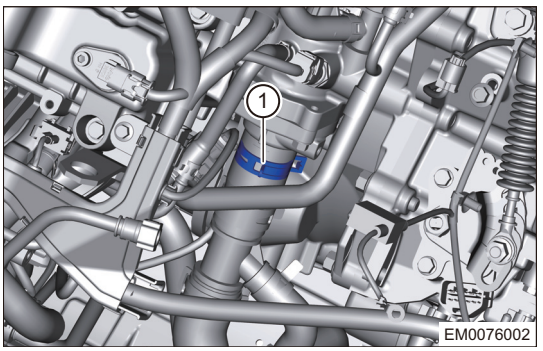
Caution:

- Remove engine and transmission as an assembly.
- Install protector to prevent body from being scratched.
- Plug inlet port of intake pipe to prevent foreign matter from entering after removing intake system components. Or the foreign matter will block cylinder intake passage when starting to seriously damage the engine.

1. Remove the engine trim cover.
2. Release the fuel system pressure (See page 06-11).
3. Turn off all electrical equipment and the ignition switch.
4. Remove the battery assembly (See page 14-8.
5. Remove the battery tray (See page 14-10).
6. Remove the air filter assembly.
7. Remove the pre-catalytic assembly (See page 09-14).

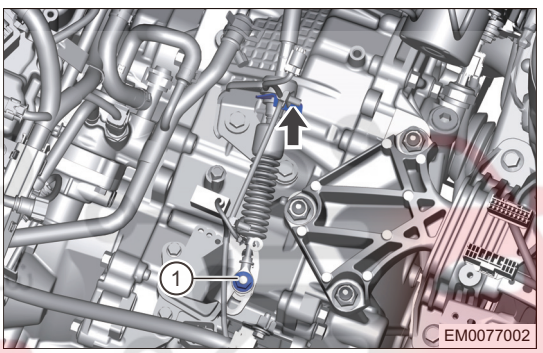
8. Remove the front sub frame assembly (See page 19-19).
9. Drain the engine oil (See page 11-9).
10. Drain the transmission oil (See page 15-82).
11. Drain the coolant (See page 10-8).
12. Recover the refrigerant.
13. Disconnect engine inlet and outlet hoses.

(a) Loosen elastic clamps (1) and disconnect connections between engine inlet and outlet hoses and thermostat seat.



14. Disconnect connection between shift cable and transmission.

(a) Loosen fixing nut (1), meanwhile disconnect connection (arrow) between shift cable and outer shift lever.



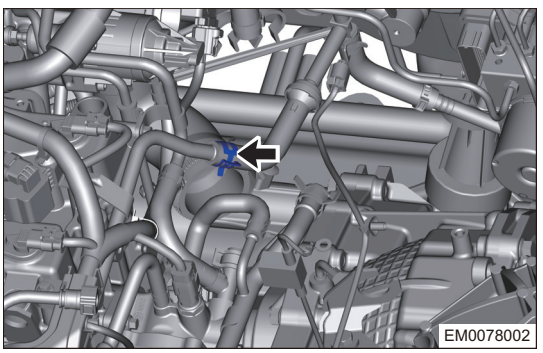
(b) Disengage shift cable damper from bracket limit hole.
(c) Then move shift cable to one side.

Caution:

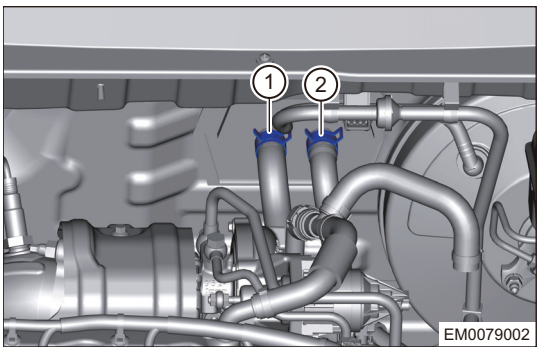
- For detailed removal and installation, see Transmission section.

15. Disconnect the vacuum pipe.

(a) Loosen elastic clamp (arrow) and disconnect connection between brake vacuum hose and brake vacuum steel pipe.

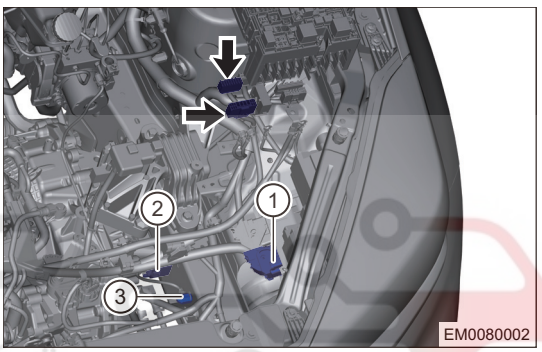


16. Disconnect connection between hose and heater core.
    (a) Loosen elastic clamp (1) and disconnect connection between heater core inlet hose and heater core.



    (b) Loosen elastic clamp (2) and disconnect connection between heater core outlet hose and heater core.

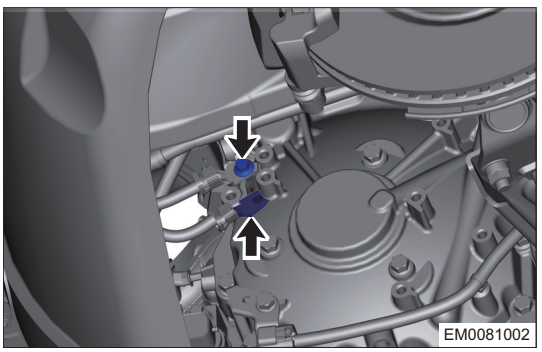
17. Remove the expansion tank assembly.
18. Disconnect the engine wire harness.
    (a) Disconnect the ECU connector (1).



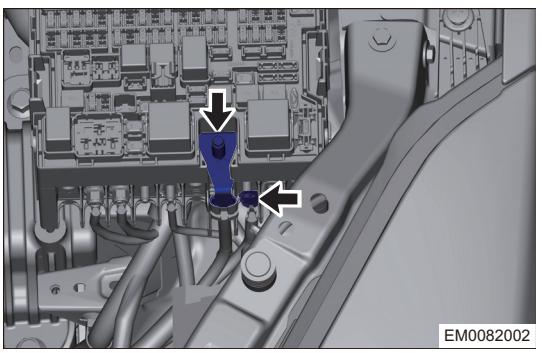
    (b) Disconnect connector (arrow) between engine wire harness and front compartment fuse and relay box.
    (c) Disconnect connector (2) between engine wire harness and instrument panel wire harness.
    (d) Remove the engine ground wire fixing nut (3).

Tightening torque
15 ± 2.5 N·m

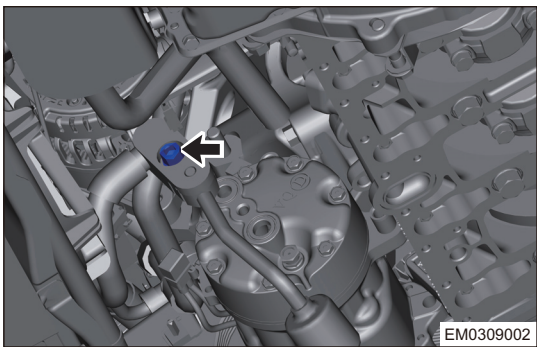
    (e) Remove the power assembly ground wire fixing bolt (arrow).



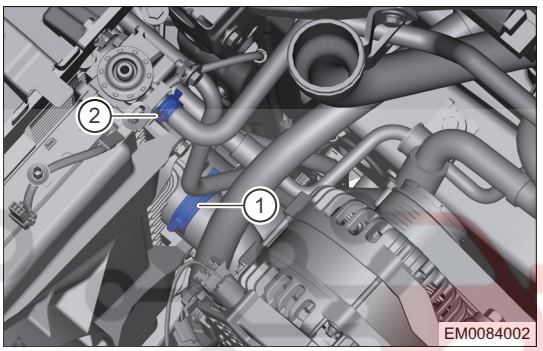
    (f) Remove fixing nut (arrow) between front compartment fuse and relay box and battery wire harness and disconnect them.



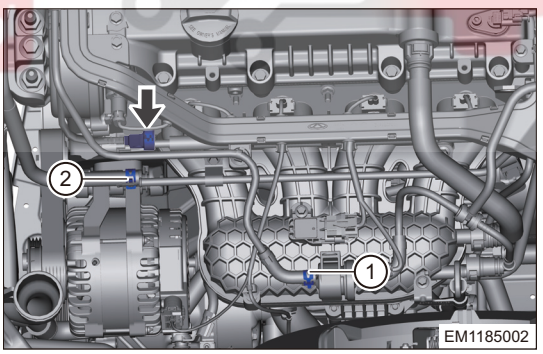
19. Remove the front wheel (See page 20-8).
20. Remove the drive shaft (See page 16-5).
21. Remove A/C compressor high and low pressure pipes.
    (a) Remove coupling bolt (arrow) between A/C pipeline and compressor assembly.
    Tightening torque
    25 ± 3 N·m



22. Disconnect the pipeline.
    (a) Loosen elastic clamp (1) and disconnect engine inlet hose and radiator.
    (b) Loosen elastic clamp (2) and disconnect discharge pipe and radiator.



    (c) Loosen elastic clamp (1) and disconnect fuel vapor pipe V.
    (d) Loosen elastic clamp (2) and disconnect water pipe.
    (e) Disconnect the oil inlet pipe II (arrow).



23. Disconnect the transmission wire harness.
24. Use an engine equalizer to hang engine assembly.
25. Remove the rear mounting assembly.
26. Remove the left mounting assembly.
27. Remove the right mounting assembly
28. Check that engine assembly is separated with external components.
29. Hang out engine assembly from engine compartment.
30. Remove engine wire harness and battery wire harness from engine.
31. Separate engine assembly and transmission assembly.
32. Install engine assembly to engine service platform.

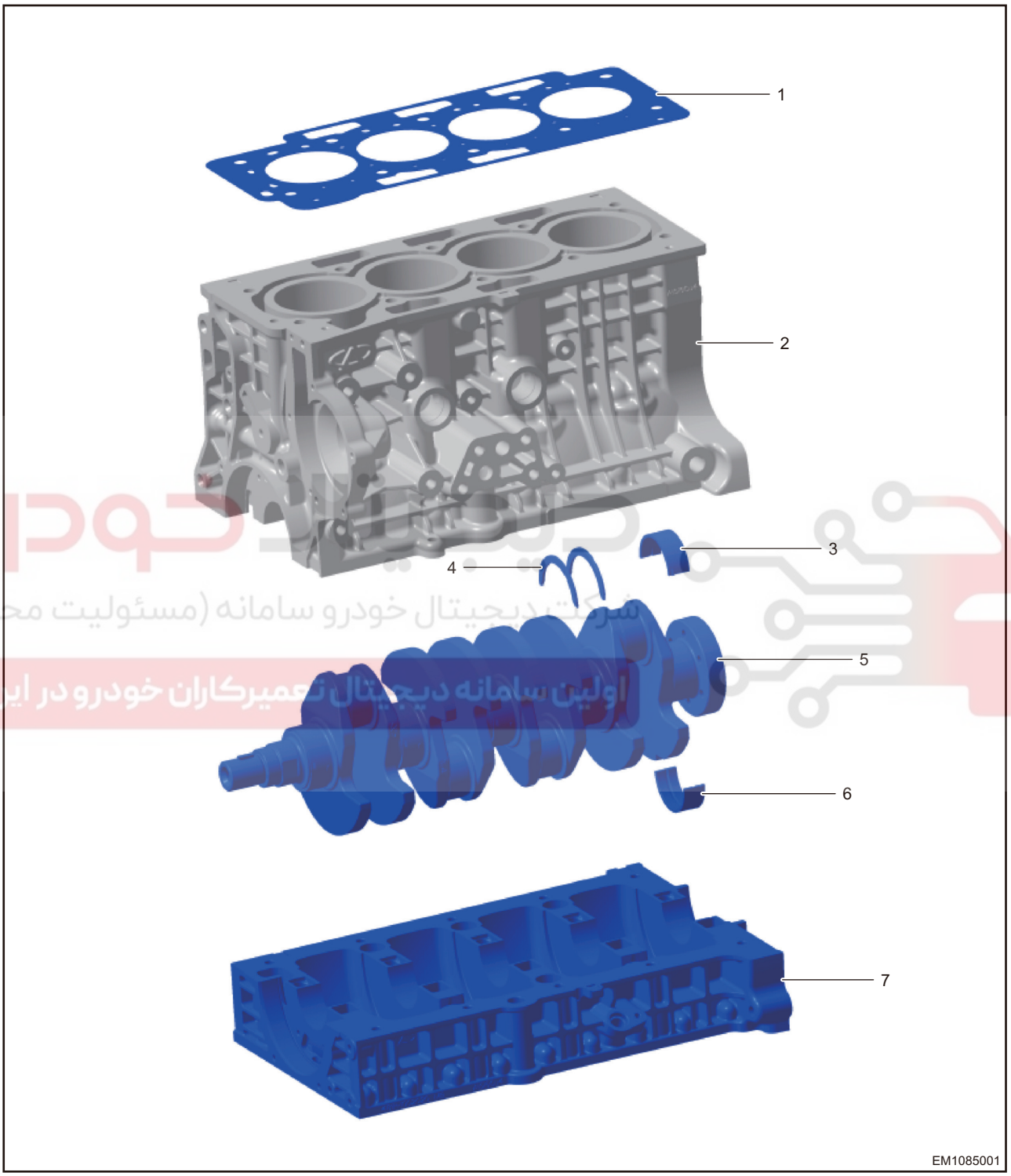
Installation

1. Installation is in the reverse order of removal.

CYLINDER BLOCK UNIT REPAIR

Engine Block

Description



1 - Cylinder Head Gasket	2 - Cylinder Block
3 - Crankshaft Main Bearing Upper Shell	4 - Thrust Washer
5 - Crankshaft	6 - Crankshaft Main Bearing Lower Shell
7 - Cylinder Block Frame Assembly	

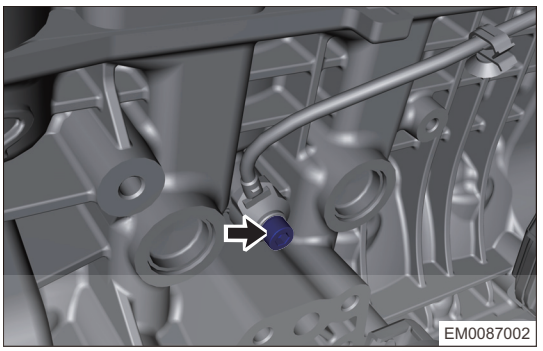
Description

1 - Piston	2 - Piston Pin (Semi-floating)
3 - Elastic Circlip	4 - Connecting Rod Assembly
5 - Connecting Rod Bearing Upper Shell	6 - Connecting Rod Bearing Lower Shell
7 - Connecting Rod Bearing Cap	8 - Connecting Rod Bearing Cap Fixing Bolt
9 - First Compression Ring	10 - Second Compression Ring

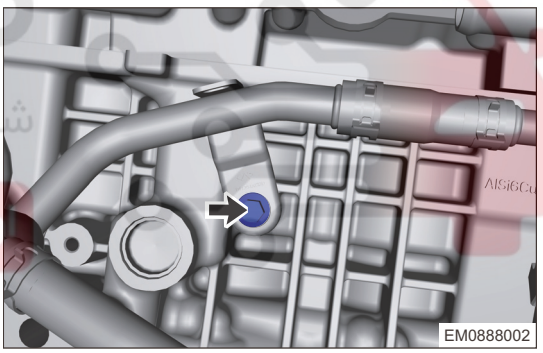
11 - Upper Rail	12 - Expander
13 - Lower Rail	

Disassembly

1. Remove the accessory drive belt (See page 05-16).
2. Remove the idler pulley assembly (See page 05-18).
3. Remove the tensioner assembly (See page 05-19).
4. Remove the thermostat assembly (See page 10-14).
5. Remove the thermostat seat assembly (See page 10-16).
6. Remove the knock sensor.
   (a) Remove knock sensor fixing bolt (arrow), and remove knock sensor.
   Tightening torque
   20 ± 5 N·m



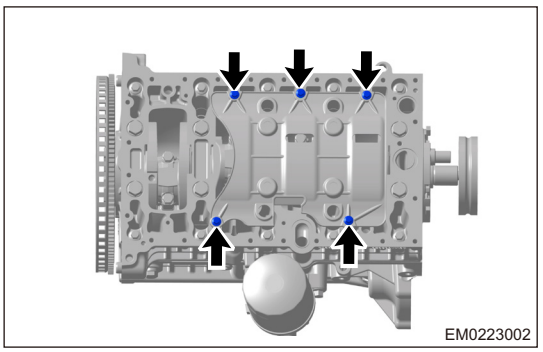
7. Remove the coolant pipe.
   (a) Remove 1 fixing bolt (arrow) from coolant pipe.



8. Remove alternator assembly and mounting bracket.
9. Remove A/C compressor assembly and mounting bracket (See page 25-89).
10. Remove the engine discharge pipe.
11. Remove the oil filter module.
12. Remove the crankshaft front oil seal (See page 05-22).
13. Remove the flywheel assembly (See page 05-24).
14. Remove the crankshaft rear oil seal (See page 05-26).
15. Remove the cylinder head cover assembly (See page 05-40).
16. Remove the oil pan assembly (See page 11-16).
17. Remove the timing belt (See page 05-30).
18. Remove intake and exhaust camshaft assemblies (See page 05-35).
19. Remove the cylinder head assembly (See page 05-40).
20. Remove the oil pump assembly (See page 11-19).
21. Remove the oil deflector assembly.

(a) Remove 6 oil deflector fixing bolts (arrow).

Tightening torque
8 + 3 N·m

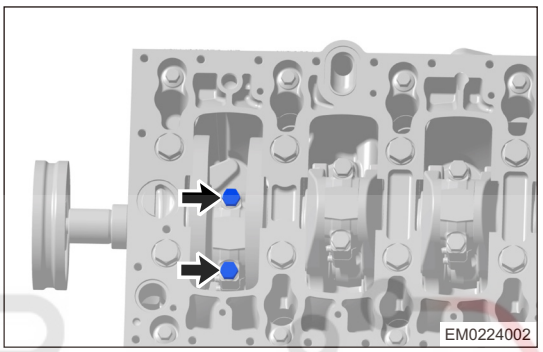


(b) Remove the oil deflector assembly.

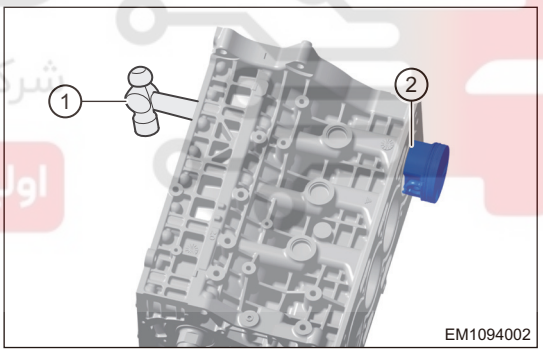
22. Remove the piston connecting rod assembly.

(a) Using a ridge reamer or equivalent, remove all the carbon deposit from top of cylinder.

(b) Turn crankshaft, so that pistons of cylinders 1 and 4 are at bottom dead center, remove fixing bolts (arrow) from connecting rod bearing caps of cylinders 1 and 4, and remove connecting rod bearing caps of cylinders 1 and 4.



(c) Using a hammer handle (1), push out piston connecting rod assembly (2) of cylinders 1 and 4 from cylinder block.



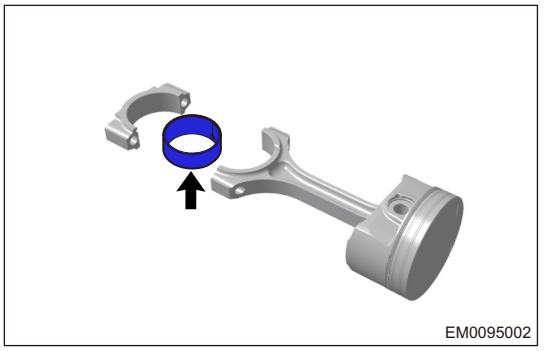
(d) Removal procedures for piston connecting rod assembly of cylinders 2 and 3 are the same as above.

Caution:

- Please operate carefully when pushing out piston, to avoid cylinder liner damage.
- Mark the removed piston connecting rod assemblies, so as to distinguish them.
- Connecting rod bolts and connecting rod bolt holes must correspond one to one without exchange.
- Replace with new bolts during assembly.

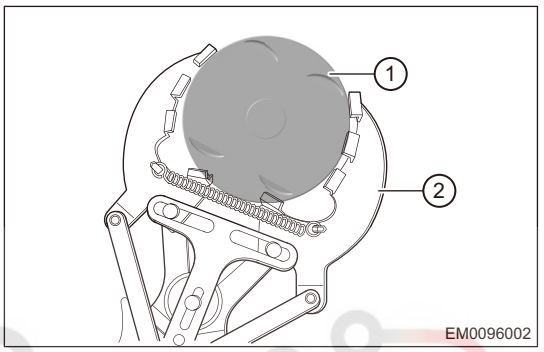
23. Remove the connecting rod bearing shell.

(a) Remove the connecting rod bearing shell (arrow).
Hint:
Arrange removed parts in correct order.


EM0095002

24. Remove the piston rings.

(a) Using a piston ring remover (1), remove 2 compression rings (2).
Caution:
- Before removing piston ring, check piston ring side clearance. If it is necessary to be reused, be sure to mark piston ring position.

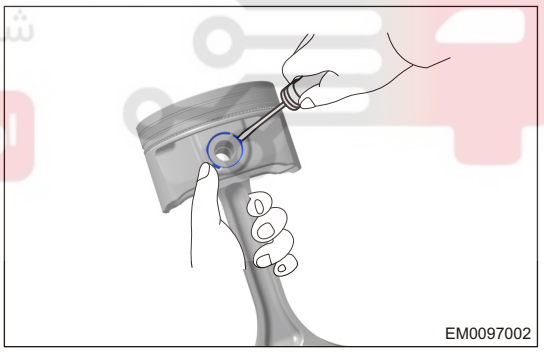


EM0096002

(b) Remove oil ring rail and expander by hands.

25. Separate piston and connecting rod.

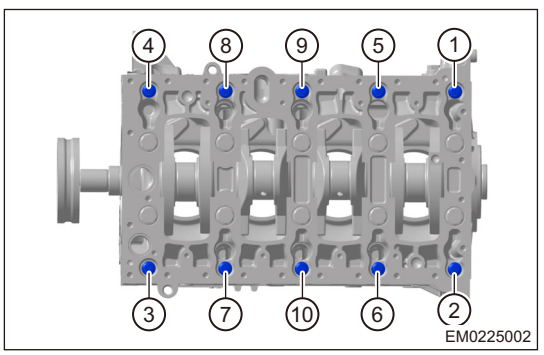
(a) Using a flat tip screwdriver, pry out elastic circlips at both sides of piston pin carefully from the notch. Carefully pry out elastic circlips on both ends of piston pin.
Caution:
- Elastic circlip has a large tensile force. Be careful during removal to prevent personal injury.


EM0097002

(b) Remove the piston pin assembly.

26. Remove the crankshaft.

(a) Evenly loosen and remove crankshaft frame fixing bolts in order shown in illustration.
Tightening torque
27 + 3 N·m



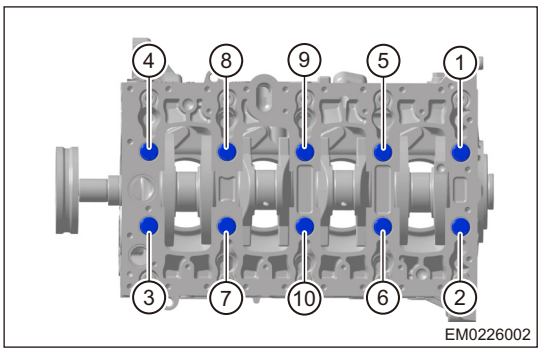
EM0225002

(b) Evenly loosen and remove crankshaft main bearing cap fixing bolts in order shown in illustration.

Tightening torque

1st step: 45 ± 5 N·m

2nd step: 180 ° ± 10 °



(c) Remove the crankshaft frame assembly.

Hint:

If it is difficult to remove crankshaft frame due to seal gum, lightly tap it with a rubber hammer to loosen it. Be sure not to damage surrounding components.

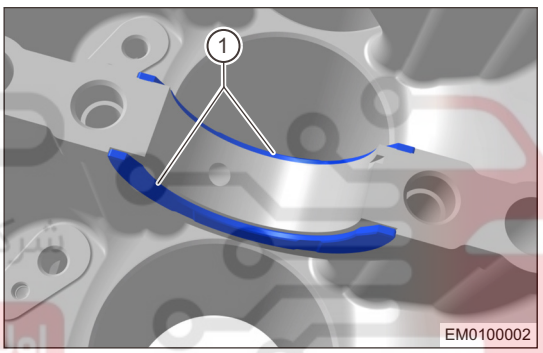
(d) Remove the crankshaft assembly.

Caution:

- Take care when removing crankshaft, as it is heavy. If necessary, ask other operators to assist. Avoid scratching contact surfaces between crankshaft and bearing shell.

27. Remove the thrust washers.

(a) Remove crankshaft thrust washers (1) from cylinder block.

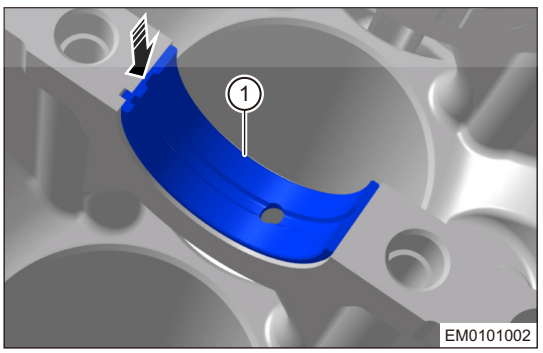


28. Remove the crankshaft main bearing shell.

(a) Push out crankshaft main bearing upper shell (1) slightly in direction of arrow to remove it.

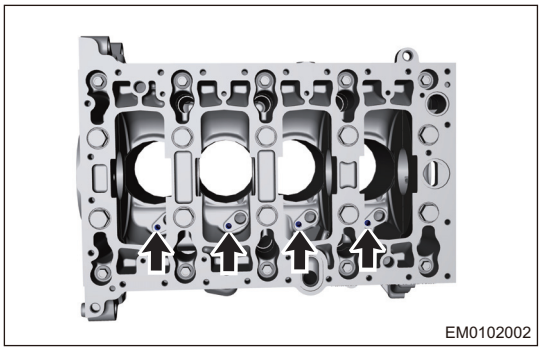
Hint:

- Remove other crankshaft main bearing upper shells from cylinder block in the same way.
- Pay attention to the notch position. Push out bearing shell carefully as shown in illustration. It is difficult to push out bearing shell and parts may be damaged if pushing in opposite direction.



(b) Remove crankshaft main bearing lower shell from crankshaft frame in the same way.

29. Remove the piston cooling nozzles.
    (a) Remove piston cooling nozzle fixing bolts (arrow), and remove piston cooling nozzles from cylinder block.
    Tightening torque
    20 + 5 N·m


EM0102002

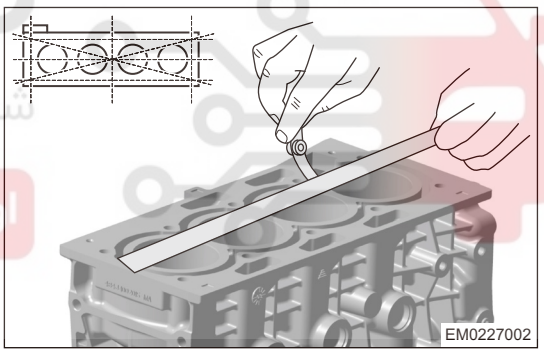
Inspection

1. Check the cylinder block.
    - Clean engine block thoroughly and check all hole passages for leakage.
    - Check cylinder liner for cracks.
    - Check cylinder block for cracks.

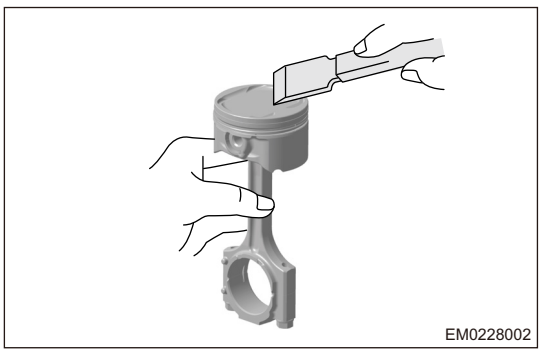
    Caution:
    - DO NOT wash cylinder at high temperature; otherwise, cylinder liner will stick out beyond cylinder block.
2. Check the cylinder block upper surface flatness.
    (a) Clean the cylinder block upper surface.
    (b) Using precision straightedge and feeler gauge, measure cylinder block upper surface flatness.

Measurement Item	Specification (mm)
Cylinder Block Upper Surface Flatness	0.04

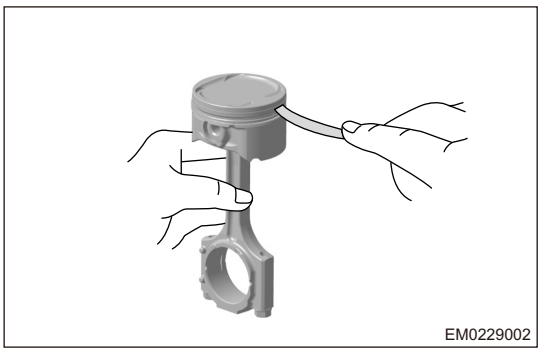
Never grind the cylinder block upper surface. If the flatness of engine block upper surface exceeds the limit, replace engine block.


EM0227002

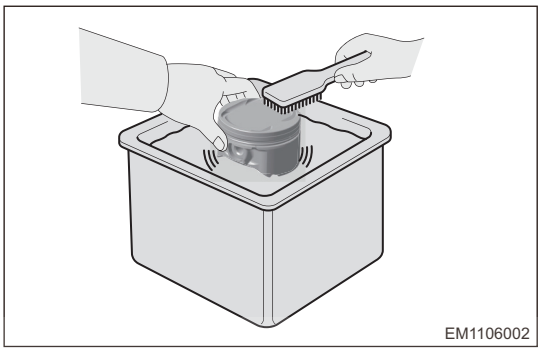
3. Check the piston.
    (a) Using a scraper, remove carbon deposits on piston top.


EM0228002

(b) Using a piston ring, remove carbon deposits from piston ring grooves.


EM0229002

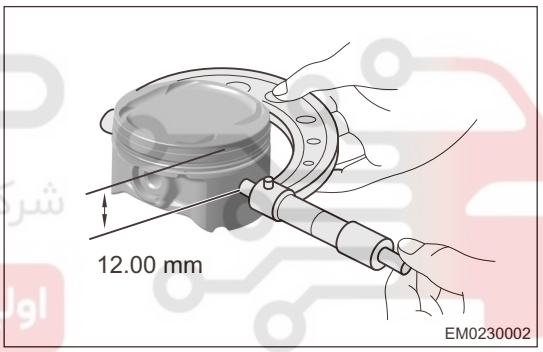
(c) Using a brush and solvent, thoroughly clean piston.
Caution:
- DO NOT use a wire brush to clean.


EM1106002

(d) Using micrometer, measure the piston diameter in vertical direction of piston at position where is 28.45 mm from piston skirt part.

Measurement Item	Specification (mm)
Piston Diameter	83.64

If piston diameter is not within specified range, replace the piston connecting rod assembly.



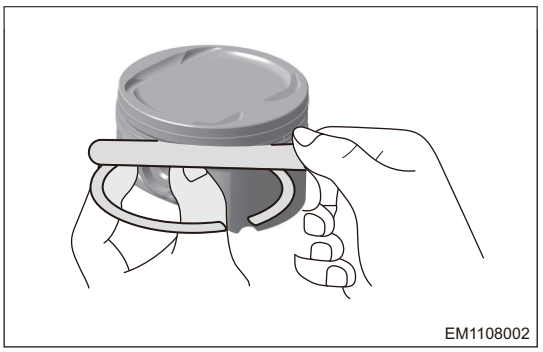
EM0230002

4. Check clearance between piston ring and ring groove side.

(a) Using a feeler gauge, measure clearance between new piston ring and ring groove side.

Measurement Item	Specification (mm)
1st compression ring groove side clearance	0.1
2nd compression ring groove side clearance	0.1

If piston ring side clearance exceeds specified range, replace piston ring and piston assembly.


EM1108002

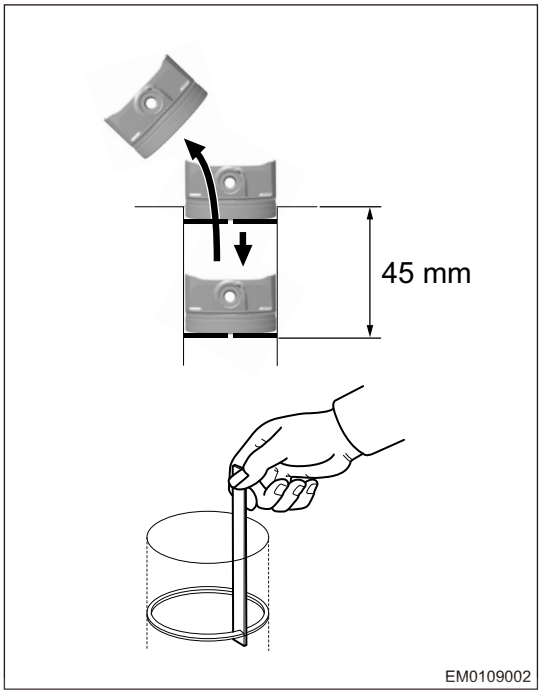
5. Check the piston ring end gap.

(a) Using a piston, push piston ring from top of cylinder to a position, that is 45 mm from bottom of cylinder bore. Keep the piston ring level.

(b) Measure at the specified position, which has the minimum piston ring wear with a feeler gauge.

Measurement Item		Specification (mm)
Piston Ring End Gap	First ring	0.2 - 0.35
	Second ring	0.3 - 0.35

If piston ring end gap is not within specified range, replace piston ring with a new set.
If end gap is still not within specified range after replacement, replace cylinder block assembly.



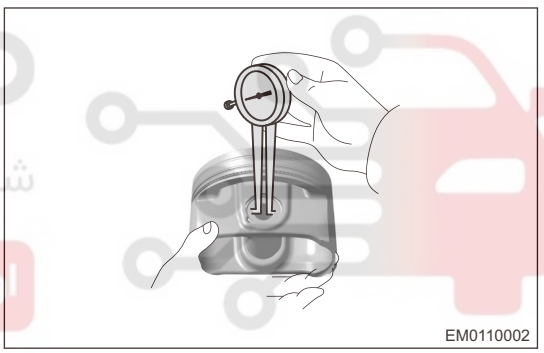
EM0109002

6. Check the piston pin.

(a) Using a feeler gauge, measure diameter of piston pin hole.

Measurement Item	Specification (mm)
Piston Pin Hole Diameter	21

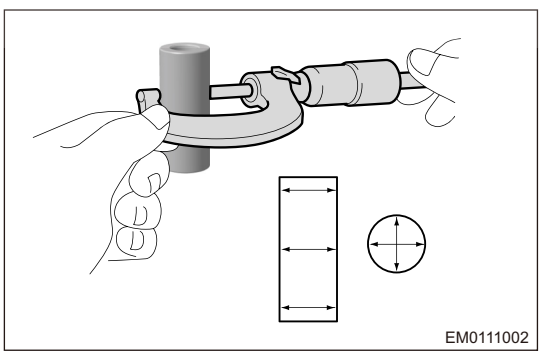
If piston pin hole diameter is not within specified range, replace piston.


EM0110002

(b) Using an outer micrometer, measure piston pin diameter.

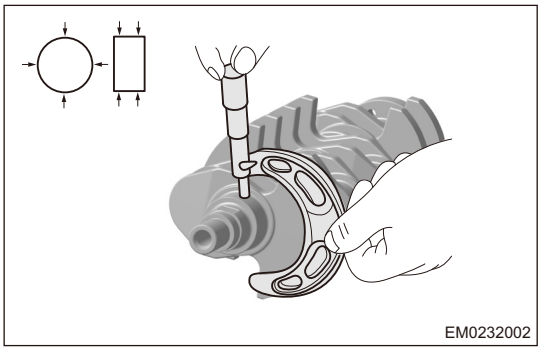
Measurement Item	Specification (mm)
Piston Pin Diameter	21

If piston pin diameter is not within specified range, replace piston pin.


EM0111002

7. Check the crankshaft main journal diameter.

(a) Measure crankshaft main journal diameter with an outer micrometer, and measure again after rotating the crankshaft 90°.


EM0232002

Measurement Item	Specification (mm)
Crankshaft Main Journal Diameter	54
Cylindricity	0.008

If crankshaft main journal diameter is not within specified range, replace main bearing shells with new ones and check matching clearance of crankshaft main bearing.
If matching clearance of main bearing is still not within specified range after replacing with new main bearing shells, replace crankshaft.

8. Check the crankshaft axial clearance.

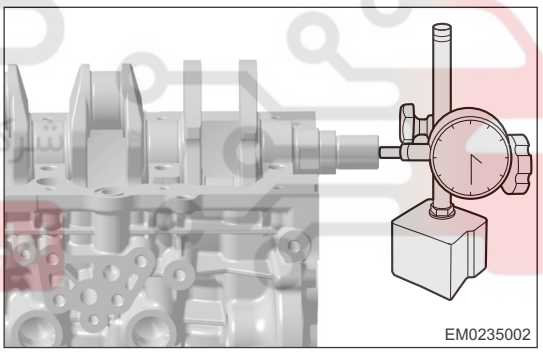
(a) Clean crankshaft main journals and main bearing shells.

(b) Install crankshaft frame and tighten main bearing cap fixing bolts to specified torque in order.

Tightening torque

1st step: 45 ± 5 N·m
2nd step: 180 ° ± 10 °

(c) Using a flat tip screwdriver, pry crank position left and right, and read value on dial indicator.


EM0235002

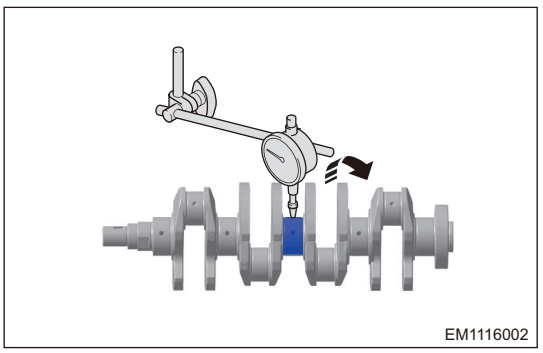
Measurement Item	Specification (mm)
Crankshaft Axial Clearance	0

If crankshaft axial clearance is not within specified range, replace the thrust washers as a set.

9. Check the crankshaft main journal coaxiality.

(a) Install crankshaft onto tester and keep it level as shown in illustration.

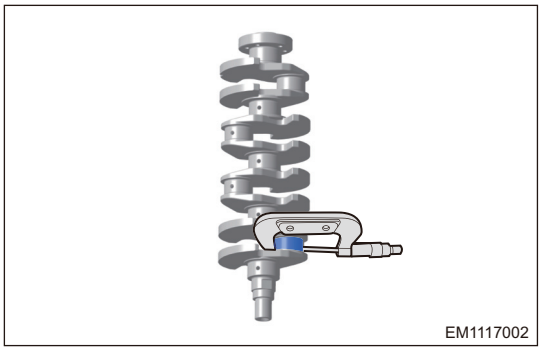
(b) Rotate crankshaft slowly and read maximum change value from dial indicator. (Readings on dial indicator)/2 is the coaxiality of crankshaft main journal.


EM1116002

Measurement Item	Specification (mm)
Crankshaft Main Journal Coaxiality	0.05

If crankshaft main journal coaxiality is not within specified range, replace crankshaft assembly.

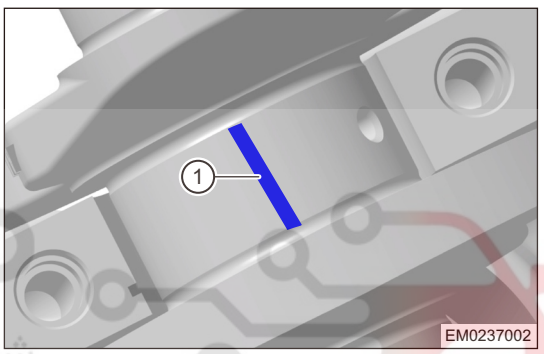
10. Check diameter of crankshaft connecting rod journal.
    (a) Using an outer micrometer, measure diameter of crankshaft connecting rod journal.



Measurement Item	Specification (mm)
Crankshaft Connecting Rod Journal Diameter	47.9

If connecting rod journal diameter is not within specified range, replace connecting rod bearing shells with new ones, and check radial clearance of connecting rod bearing shell.
If radial clearance of connecting rod bearing shell is still not within specified range after replacement, replace crankshaft.

11. Check radial clearance of crankshaft connecting rod bearing shell.
    (a) Clean connecting rod journals and connecting rod bearing shells.
    (b) Place a feeler gauge (1) on connecting rod journal as shown in illustration.

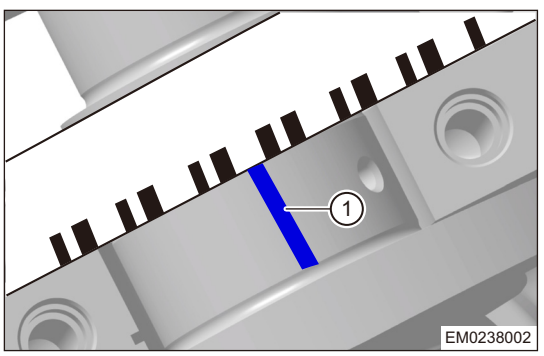


    (c) Install connecting rod bearing caps, and tighten connecting rod bearing cap fixing bolts to specified torque.

Tightening torque
1st step: 25 + 3 N·m
2nd step: 90° ± 5°

Caution:
- DO NOT turn crankshaft during installation.

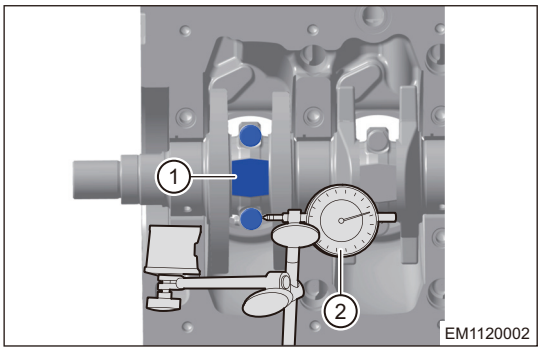
    (d) Remove the connecting rod bearing cap.
    (e) Using gauge scale of feeler gauge, measure the widest part of compressed feeler gauge to obtain radial clearance of connecting rod bearing shell as shown in illustration.



Measurement Item	Specification (mm)
Connecting Rod Bearing Shell Radial Clearance	0.026 - 0.065

If radial clearance of connecting rod bearing shell is not within specified range, replace connecting rod bearing shells. Replace crankshaft assembly if necessary.

12. Check axial clearance of connecting rod.
    (a) Install connecting rod bearing caps, and tighten connecting rod bearing cap fixing bolts to specified torque.
    Tightening torque
    1st step: 25 + 3 N·m
    2nd step: 90° ± 5°
    (b) Install a dial indicator (2) with its plunger contacting the side of connecting rod cap (1).
    (c) Reset dial of dial indicator to zero.
    (d) Push connecting rod cap forward and backward (do not move crankshaft forward and backward) and read value on dial indicator.

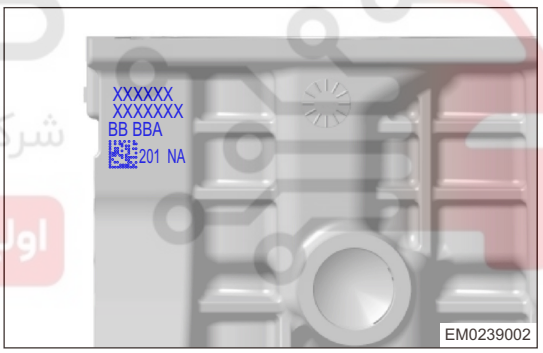


Measurement Item	Specification (mm)
Connecting Rod Axial Clearance	0

If axial clearance of connecting rod is not within specified range, replace piston connecting rod assembly. Replace crankshaft assembly if necessary.

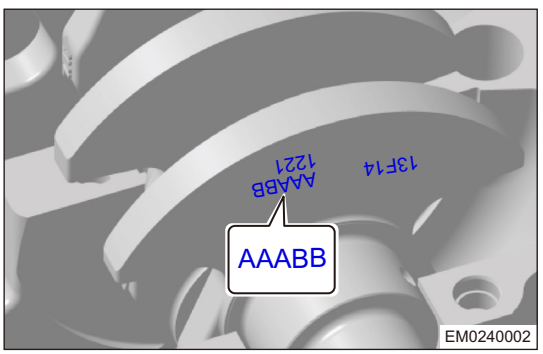
Selection of Main Bearing Shell

1. Selection of crankshaft main bearing upper shell
    (a) Related letter marks are available on cylinder block (consisting of A and B). Such as "BBBBA" in illustration, each letter from left to right is for one type of crankshaft main bearing upper shell. First letter "B" is for upper shell type of crankshaft main bearing first journal, and so on; fifth letter "A" is for upper shell type of crankshaft main bearing fifth journal.



Name	Type	Letter Mark
Crankshaft Main Bearing Upper Shell	Red shell	A
	Blue shell	B

2. Selection of crankshaft main bearing lower shell
    (a) Related marks are available on first balancer at front end of crankshaft (consisting of A and B). Such as "BBBBA" on first balancer at front end of crankshaft shown in illustration, first letter "B" is for first journal of crankshaft main bearing lower shell, and so on; fifth letter "A" is for fifth journal of crankshaft main bearing lower shell.



Name	Type	Letter Mark
Crankshaft Main Bearing Lower Shell	Red shell	A
	Blue shell	B

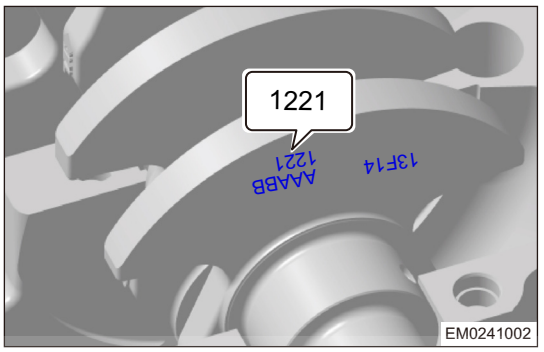
3. Precautions for crankshaft main bearing shell assembly:
    Caution:
    - There is a shell groove and oil hole on the main bearing upper shell, and oil hole should be aligned with that on the engine block, but the main bearing lower shell has no oil hole.

- Apply a coat of engine oil to inner surface of main bearing shell before installation. Back side of bearing shell should be clean without any oil or foreign matter during assembly, and make sure that back side and inner surface are clean.

Selection of Connecting Rod Bearing Shell

1. Selection of connecting rod bearing upper shell
   (a) Connecting rod bearing upper shells are divided into red shell and blue shell. Related marks are available on connecting rod bearing shell cap. Select related connecting rod bearing shell according to marks.
   (b) As shown in illustration, among mark "BC" on connecting rod, "B" indicates blue shell.

Name	Type	Letter Mark
Connecting Rod Bearing Upper Shell	Red shell	A
	Blue shell	B



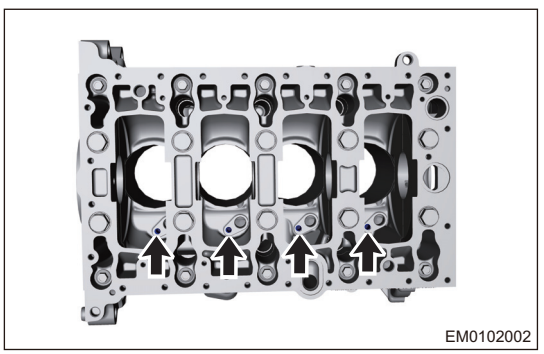
2. Selection of connecting rod bearing lower shell
   (a) Related digital marks are available on first balancer at front end of crankshaft (consisting of 1 and 2). Such as "1221" on first balancer at front end of crankshaft shown in illustration, first digit "1" is for lower shell type of cylinder 1 piston connecting rod bearing, and so on; fourth digit "1" is for lower shell type of cylinder 4 piston connecting rod bearing.

Name	Type	Digital Mark
Connecting Rod Bearing Lower Shell	Red shell	1
	Blue shell	2

3. Precautions for connecting rod bearing shell assembly:
   Caution:
   - Connecting rod upper and lower bearing shells without oil grooves are universal, but one of the connecting rod bearing shells has an oil hole.
   - It is necessary to use a set of connecting rod bearing shells that are provided by the same manufacturer on the same engine.
   - Apply a coat of engine oil to inner surface of connecting rod bearing shell before installation. Back side of bearing shell should be clean without any oil or foreign matter during assembly, and make sure that back side and inner surface are clean.

Assembly

1. Install the piston cooling nozzles.
   (a) Install piston cooling nozzles and tighten fixing bolts (arrow).
   Tightening torque
   20 + 5 N·m

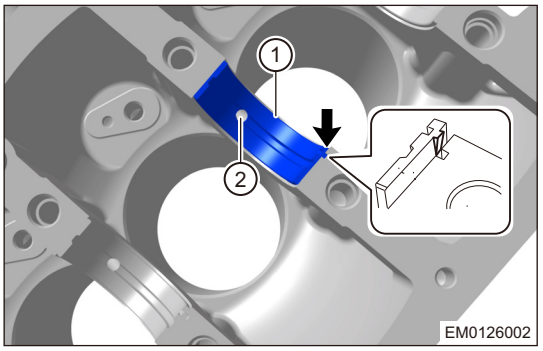


2. Install the crankshaft main bearing shells.

(a) Carefully install crankshaft main bearing upper shell (1) in direction of arrow, and notch of each main bearing upper shell should be aligned with cylinder block. Oil passage hole (2) on crankshaft main bearing upper shell should be aligned with passage hole on cylinder block after installation.

Caution:

- Apply a coat of engine oil to inner surface of the main bearing shell before installation.



(b) Install crankshaft main bearing lower shell to crankshaft frame in the same way.

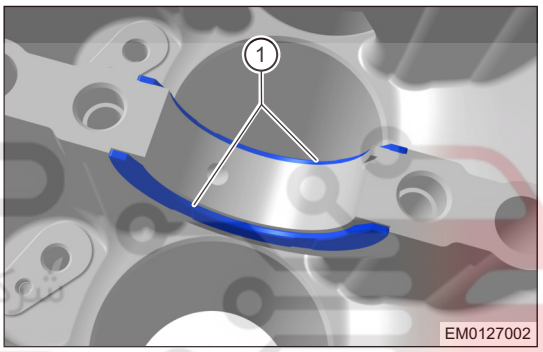
3. Install the thrust washers.

(a) Clean thrust washers and cylinder block inner wall before installation.

(b) Apply engine oil to thrust washers.

(c) There are 2 thrust washers on the cylinder, which are installed on the front and rear thrust surfaces of 3rd main bearing seat respectively.

(d) As shown in illustration, the side of crankshaft thrust washers (1) without groove should face cylinder block side while the other side with groove should face crankshaft side.



4. Install the crankshaft.

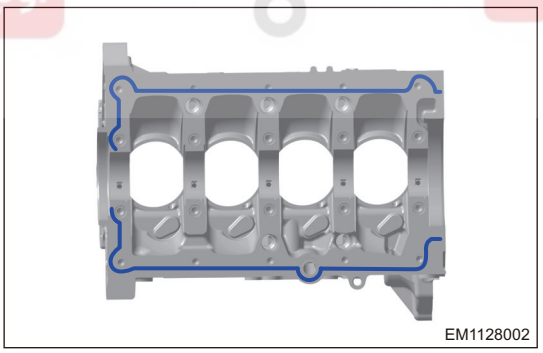
(a) Apply seal gum to installation surface of crankshaft frame before installation.

Sealant line diameter

1.5 - 3mm

Caution:

- DO NOT apply seal gum to bearing shell when applying seal gum.
- Seal gum should not be applied too thick. Avoid seal gum entering bearing shell installation area due to compression.



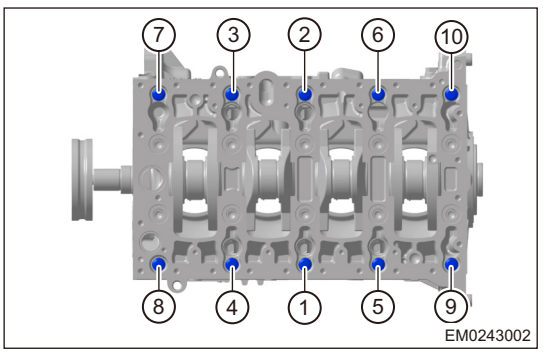
(b) Place crankshaft on cylinder block carefully.

(c) Install crankshaft main bearing cap fixing bolts in place by hands, and then tighten 10 crankshaft main bearing cap fixing bolts in order shown in illustration.

Tightening torque

1st step: 45 ± 5 N·m

2nd step: 180 ° ± 10 °



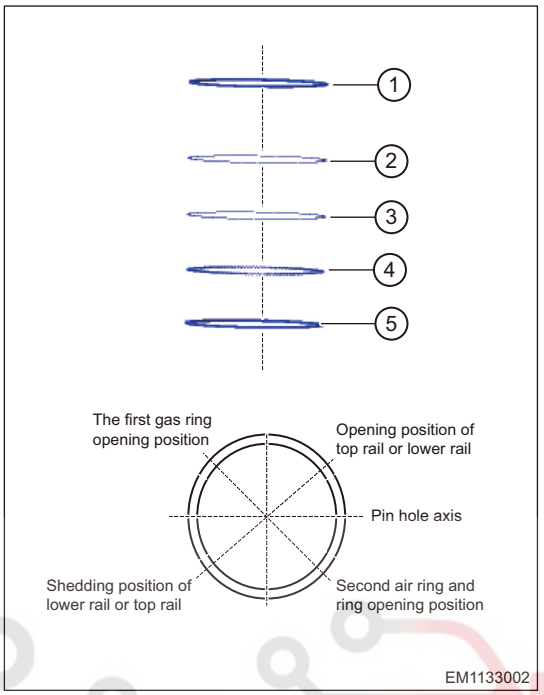
(d) Evenly tighten 10 crankshaft frame fixing bolts in order shown in illustration.

Tightening torque

27 + 3 N·m

5. Install the piston rings.

(a) Apply a small amount of engine oil to piston ring groove and piston. Pay attention that the sides with words of first compression ring (1) and second compression ring (2) should face upward.



(b) Oil ring is steel band combination oil ring and composed of upper rail (3), lower rail (5) and expander (4). When installing the oil ring, first install the expander into oil groove, then install upper and lower rails with opening staggered by 90° from the expander closed gap, and the upper and lower rails at 180°. Then install the second compression ring, and install the first compression ring finally with two compression rings staggered by 90° from upper rail opening. The piston ring should rotate in the ring groove freely without any stuck condition.

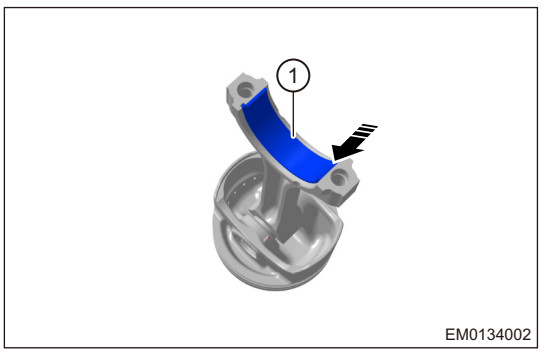
(c) Rotate piston ring several turns after addling engine oil to piston ring groove, and note that the position of ring notch should be the same with that described above; clean crankshaft connecting rod journal and cylinder with a non-woven fabric cloth.

6. Install the connecting rod bearing shells.

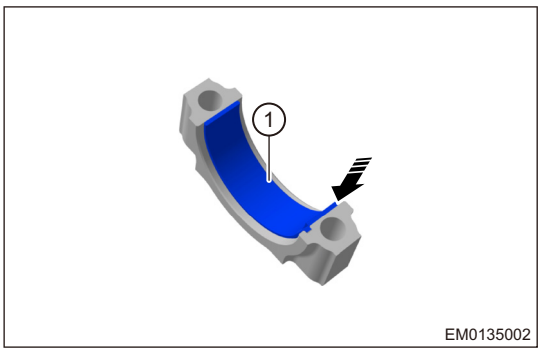
Caution:

- Apply a coat of engine oil to inner surface of connecting rod bearing shell before installation.
- Back side of connecting rod bearing shell should be clean without any foreign matter during assembly.

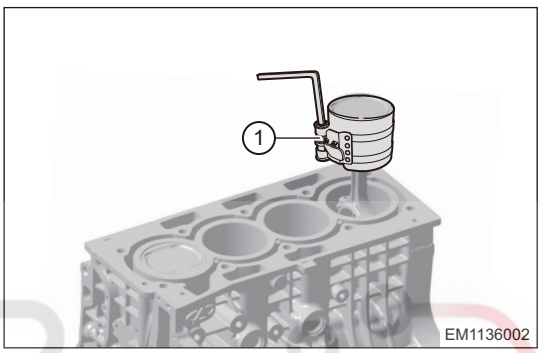
(a) Carefully install the connecting rod bearing upper shell (1) in direction of arrow, and keep notch of each connecting rod bearing upper shell face the cutout of connecting rod bearing.



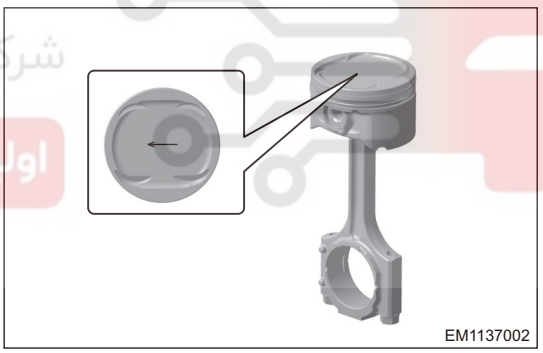
(b) Carefully install connecting rod bearing lower shell (1) in direction of arrow, and keep notch of each connecting rod bearing lower shell face the cutout of connecting rod bearing cap.



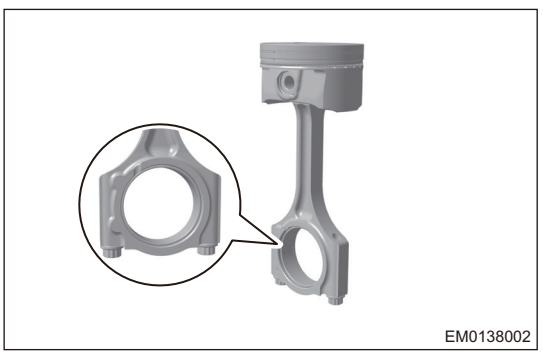
7. Install the piston connecting rod assembly.
   (a) Rotate crankshaft to top dead center of cylinder 1 and cylinder 4.
   (b) Apply a coat of engine oil to piston surface and cylinder inner wall.
   (c) As shown in illustration, install piston connecting rod assembly to cylinder with piston installer (1).



Caution:
- Pay attention to front marks on piston and connecting rod during assembly, without being reversed.



8. Install the connecting rod bearing cap.
   Hint:
   Protrusion points on connecting rod and connecting rod bearing cap are in same side.



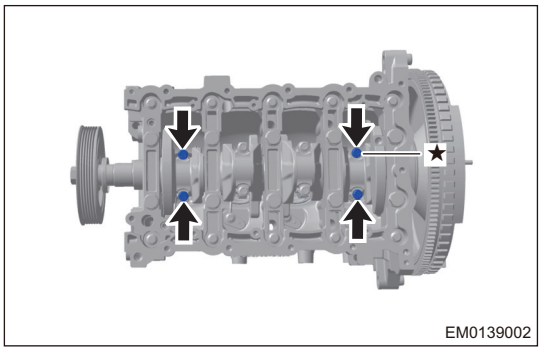
(a) Install connecting rod bearing caps in place, and screw connecting rod bearing cap fixing bolts (arrow) by hands, then tighten connecting rod bearing cap fixing bolts in 2 steps with a torque wrench.

Tightening torque

1st step: 25 + 3 N·m
2nd step: 90° + 5°

Caution:

- Apply a small amount of engine lubricant to connecting rods, connecting rod bearing caps and thread joint surfaces.



9. Other assembly is in the reverse order of disassembly.

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