Engine Mechanical System

Specifications

Description		Specifications	Limit
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		77mm (3.0315in)	
Stroke		85.44mm (3.3638in)	
Total displacement		1,591 cc (97.09 cu.in)	
Compression ratio		9.5 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens	ATDC 10°/BTDC 40°	
	Closes	ABTC 59°/ABDC 9°	
Exhaust valve	Opens	BBDC 36°/ABDC 4°	
	Closes	ATDC 3°/ATDC 43°	
Cylinder head			
Flatness of gasket surface		Less than 0.05mm (0.0020in) for total area Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in)	
Camshaft			
Cam height	Intake	43.55mm (1.7145in)	
	Exhaust	42.60mm (1.6771in)	
Journal outer diameter (Intake, Exhaust)		22.964 - 22.980mm (0.9041 - 0.9047in)	
Camshaft cap oil clearance		0.027 - 0.058mm (0.0011 - 0.0023in)	0.1mm (0.0039in)
End play		0.10 - 0.20mm (0.0039 - 0.0079in)	
Valve			
Valve length	Intake	93.15mm (3.6673in)	
	Exhaust	92.60mm (3.6457in)	
Stem outer diameter	Intake	5.465 - 5.480mm (0.2152 - 0.2157in)	
	Exhaust	5.458 - 5.470mm (0.2149 - 0.2154in)	
Face angle		45.25° - 45.75°	
Thickness of valve head (margin)	Intake	1.10mm (0.0433in)	0.8mm (0.0315in)
	Exhaust	1.26mm (0.0496in)	1.0mm (0.0394in)
Valve stem to valve guide clearance	Intake	0.020 - 0.047mm (0.0008 - 0.0019in)	0.10mm (0.0039in)
	Exhaust	0.030 - 0.054mm (0.0012 - 0.0021in)	0.15mm (0.0059in)
Valve guide			
Length	Intake	40.3 - 40.7mm (1.5866 - 1.6024in)	
	Exhaust	40.3 - 40.7mm (1.5866 - 1.6024in)	
Valve spring			
Free length		45.1mm (1.7756in)	
Out of squareness		Less than 1.5°	
Cylinder block			
Cylinder bore		77.00 - 77.03mm (3.0315 - 3.0327in)	
Flatness of gasket surface		Less than 0.05mm (0.0020in) for total area Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in)	
Piston			
Piston outer diameter		76.97 - 77.00mm (3.0303 - 3.0315in)	
Piston to cylinder clearance		0.020 - 0.040mm (0.0008 - 0.0016in)	
Ring groove width	No. 1 ring groove	1.23 - 1.25mm (0.0484 - 0.0492in)	1.26mm (0.0496in)
	No. 2 ring groove	1.53 - 1.55mm (0.0602 - 0.0610in)	1.26mm (0.0496in)
	Oil ring groove	2.01 - 2.03mm (0.0791 - 0.0799in)	2.05mm (0.0807in)
Piston ring			
Side clearance	No.1 ring	0.04 - 0.08mm (0.0016 - 0.0031in)	0.1 mm (0.0039in)

	No.2 ring	0.04 - 0.08mm (0.0016 - 0.0031in)	0.1 mm (0.0039in)
	Oil ring	0.02 - 0.06mm (0.0008 - 0.0024in)	0.2 mm (0.0079in)
End gap	No. 1 ring	0.14 - 0.24mm (0.0055 - 0.009in)	0.30mm (0.0118in)
	No. 2 ring	0.30 - 0.45mm (0.0118 - 0.0177in)	0.50mm (0.0197in)
	Oil ring	0.20 - 0.40mm (0.0079 - 0.0157in)	0.80mm (0.0315in)
Piston pin			
Piston pin outer diameter		19.997 - 20.000mm (0.7872 - 0.7874in)	
Piston pin hole inner diameter		20.004 - 20.010mm (0.7875 - 0.7877in)	
Piston pin hole clearance		0.004 - 0.013mm (0.0001 - 0.0005in)	
Connecting rod small end hole inner diameter		20.005 - 20.016mm (0.7875 - 0.7880in)	
Connecting rod			
Connecting rod big end inner diameter		45.000 - 45.018mm (1.7717 - 1.7724in)	
Connecting rod bearing oil clearance		0.018 - 0.036mm (0.0007 - 0.0014in)	0.060mm (0.0024in)
Side clearance		0.10 - 0.25mm (0.0039 - 0.0098in)	0.35m (0.0138in)
Crankshaft			
Main bearing oil clearance	No. 1, 2, 3, 4, 5	0.0006 - 0.024mm (0.0002 - 0.0009in)	0.05mm (0.0020in)
End play		0.05 - 0.25mm (0.0020 - 0.0098in)	0.3mm (0.0118in)
Engine oil			
Oil quantity	Total	4.6L - 4.9L (1.21 U.S.gal., 4.86 U.s.qt., 4.04 Imp.qt. - 1.29U.S.gal., 5.17 U.S.qt., 4.30 Imp.qt.)	When replacing a short engine or a block assembly
	Oil pan	4.2L (1.10 U.S.gal., 4.43 U.S.qt., 4.30 Imp.qt.)	
	Drain and refill	4.5L (1.18 U.S.gal., 4.75 U.S.qt., 3.95 Imp.qt.)	Including oil filter
Oil grade	Recommended	ACEA A5 or above / 5W-30	
	Allowed	ILSAC GF-3, GF-4 (API SL, SM) or above ACEA A3, A5 or above For information on SAE viscosity grades based on ambient temperatues, refer to the "Lubrication System".	Usable if the recommended engine oil is not available
Oil pressure (at 1000rpm)		100kPa (1.0kg/cm², 14.5psi) or above	Oil temperature in oil pan : 110±2°C (230± 36°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		MT : Approx. 6.1 L (1.61 U.S.gal., 6.44 U.S.qt., 5.36 Imp.qt.) AT : Approx. 5.7 L (1.50 U.S.gal., 6.02 U.S.qt., 5.01 Imp.qt.)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82 ± 1.5°C (179.6 ± 2.7°F)	
	Full opening temperature	95°C (203°F)	
Radiator cap	Main valve opening pressure	93.16 - 122.58kpa (0.95 - 1.25kgf/cm², 13.51 - 17.78psi)	
	Vacuum valve opening pressure	MAX. 6.86 kpa(0.07kgf/cm², 1.00 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.45±0.14 kΩ	
	80°C (176°F)	0.3222 kΩ	

Tightening Torques

Item	Quantity	N·m	kgf·m	lb·ft
Engine mounting				
Engine mounting bracket to body fixing bolt	3	49.0 - 63.7	5.0 - 6.5	36.2 - 47.0
Engine mounting support bracket to engine mounting insulator fixing nut	1	88.3 - 107.8	9.0 - 11.0	65.1 - 79.5
Engine mounting support bracket to engine support bracket fixing bolt	1	58.8 - 73.5	6.0 - 7.5	43.4 - 54.2
Engine mounting support bracket to engine support bracket fixing nut	2	58.8 - 73.5	6.0 - 7.5	43.4 - 54.2

Transaxle mounting bracket to body fixing bolt	3	49.0 - 63.7	5.0 - 6.5	36.2 - 47.0
Transaxle mounting insulator to transaxle mounting support bracket fixing bolt	2	88.3 - 107.9	9.0 - 11.0	65.1 - 79.6
Roll rod bracket to sub frame fixing bolt	2	49.0 - 63.7	5.0 - 6.5	36.2 - 47.0
Roll rod insulator to roll rod mounting support bracket fixing nut	1	107.9 - 127.5	11.0 - 13.0	79.6 - 94.0
Timing system				
Timing chain and oil pump assembly cover bolt (M6×20)	10	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain and oil pump assembly cover bolt (M6×38)	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain and oil pump assembly cover bolt (M6×70)	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain and oil pump assembly cover bolt (M8×22)	3	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Idler pulley assemlby bolt	1	42.2 - 53.9	4.3 - 5.5	31.1 - 39.8
Timing chain tensioner arm bolt	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain guide bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Crankshaft pulley bolt	1	[46.1 - 51.9] + [38°- 42°]	[4.7 - 5.3] + [38°- 42°]	[34.0 - 38.3] + [38°- 42°]
Engine support bracket bolt	4	29.4 - 41.1	3.0 - 4.2	21.6 - 30.3
Timing chain tensioner bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Cylinder head				
Ignition coil bolt	4	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
High pressure fuel pipe nut	2	26.4 - 32.3	2.7 - 3.3	19.5 - 23.8
High pressure fuel pump bolt	2	12.7 - 14.7	1.3 - 1.5	9.4 - 10.8
Cylinder head cover bolt	19	[3.9-5.9] + [7.8-9.8]	[0.4-0.6] + [0.8-1.0]	[2.9-4.3] + [5.8-7.2]
Camshaft bearing cap bolt (M6)	18	[5.9] + [11.8-13.7]	[0.6] + [1.2-1.4]	[4.3] + [8.7-10.1]
Camshaft bearing cap bolt (M8)	4	[9.8] + [18.6 - 22.6]	[1.0] + [1.9 - 2.3]	[7.2] + [13.7 - 16.6]
Cylinder head bolt	10	[29.4] + [90°] + [90°]	[3.0] + [90°] + [90°]	[21.7] + [90°] + [90°]
CVVT assembly mounting bolt	2	63.7 - 73.5	6.5 - 7.5	47.0 - 54.2
OCV (Oil control valve) bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Exhaust OCV (Oil control valve) adaptor bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Cylinder block				
Engine support bracket bolt	4	29.4 - 41.2	3.0 - 4.2	21.7 - 30.4
Ladder frame bolt	13	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Connecting rod cap bolt	8	[17.7-21.6] + [88-92°]	[1.8-2.2] + [88-92°]	[13.0-15.9] + [88-92°]
Crankshaft main bearing cap bolt	10	[17.7-21.6] + [88-92°]	[1.8-2.2] + [88-92°]	[13.0-15.9] + [88-92°]
Flywheel bolts (M/T)	6	71.6 - 75.5	7.3 - 7.7	52.8 - 55.7
Lubrication system				
Oil filter	1	11.8 - 15.7	1.2 - 1.6	8.7 - 11.6
Oil pan bolt	11	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Oil pan drain plug	1	34.3 - 44.1	3.5 - 4.5	25.3 - 32.5
Oil screen nut	2	24.5 - 31.3	2.5 - 3.2	18.0 - 23.1
Oil pressure switch	1	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7
Oil level gauge assembly mounting bolt	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Cooling system				
Water pump pulley bolt	4	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water pump bolt	5	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water temperature control assembly mounting bolt	3	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water inlet fitting nut	2	18.6 - 23.5	1.9- 2.4	13.7 - 17.4
Heater pipe mounting bolt (M6)	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Heater pipe mounting nut	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Heater pipe mounting bolt (M8)	1	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Engine coolant temperature sensor (ECTS)	1	29.4 - 39.2	3.0 - 4.0	21.7 - 28.9
Intake and exhaust system				
Air intake hose clamp bolt	2	2.9 - 4.9	0.3 - 0.5	2.2 - 3.6
Air cleaner asembly bolt	2	7.8 - 9.8	0.8 - 1.0	5.8 - 7.2
Electronic throttle control (ETC) module bolt	4	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Intake manifold nut	2	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4

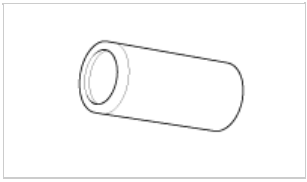
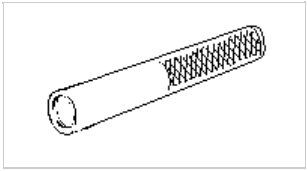
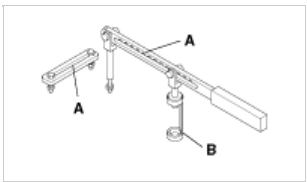
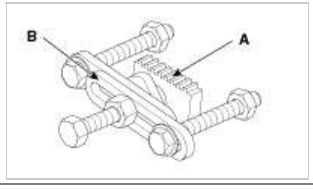
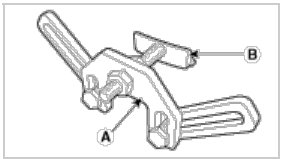
Vacuum pipe mounting bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo manifold module heat protector mounting bolt	3	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Cylinder head cover heat protector mounting bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo charger oil drain pipe bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo charger oil drain pipe nut	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo charger oil feed pipe bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo charger oil feed pipe eyebolt	1	11.7 - 17.6	1.2 - 1.8	8.6 - 13.0
Turbo charger pipe & hose bolt	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Turbo charger water pipe & hose eyebolt	2	26.4 - 32.3	2.7 - 3.3	19.5 - 23.8
Turbo manifold module mounting nut	9	35.3 - 41.1	3.6 - 4.2	26.0 - 30.3
Turbo charger coupler mounting nut	3	35.3 - 41.1	3.6 - 4.2	26.0 - 30.3
Intake pipe stay mounting bolt (M8)	6	18.6 - 23.5	1.9 - 2.4	13.7 - 17.3
Intake pipe stay mounting bolt(M10)	1	29.4 - 34.3	3.0 - 3.5	21.6 - 25.3
Intake pipe mounting bolt	1	29.4 - 34.3	3.0 - 3.5	21.6 - 25.3
Intake pipe mounting nut	2	35.3 - 41.1	3.6 - 4.2	26.0 - 30.3
Intercooler inlet pipe mounting bolt	2	19.6 - 26.4	2.0 - 2.7	14.4 - 19.5
Catalytic convertor mounting nut	2	49.0 - 53.9	5.0 - 5.5	36.1 - 39.7
Muffler monting nut	4	39.2 - 58.8	4.0 - 6.0	28.9 - 43.4

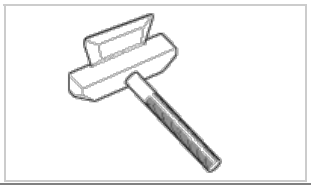
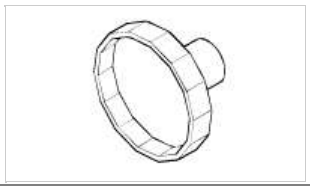
NOTICE

Torque-to-yield cylinder head, connecting rod cap and crankshaft main bearing cap bolts must be replaced once removed because the bolts are designed to be permanently elongated beyond the state of elasticity when torqued.
If the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.

Engine Mechanical System

Special Service Tools

Tool Name / Number	Illustration	Description
Crankshaft front oil seal installer 09455-21200		
Valve stem oil seal installer 09222-2B100		
Valve spring compressor A : 09222-3K000 (Compressor) B : 09222-3K100 (Holder)		Used for removing / installing intake or exhaust valve
Ring gear stopper A : 09231-3N100 B : 09231-2B100		Used for keeping ring gear from rotating when removing / installing crankshaft pulley bolt
Ring gear stopper A : 09231-3D100 B : 09231-2W100		Used for keeping ring gear from rotating when removing / installing crankshaft pulley bolt

Torque angle adapter 09221-4A000		Used for tightening torque-to-yield fasteners to a specified angle
Oil pan remover 09215-3C000		
Oil filter wrench 09263-2E000		Used for removing / installing oil filter

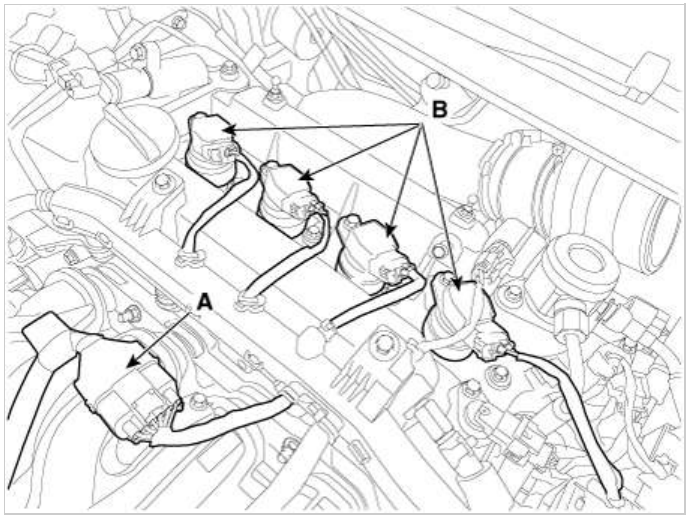
Engine Mechanical System

Compession Pressure Inspection

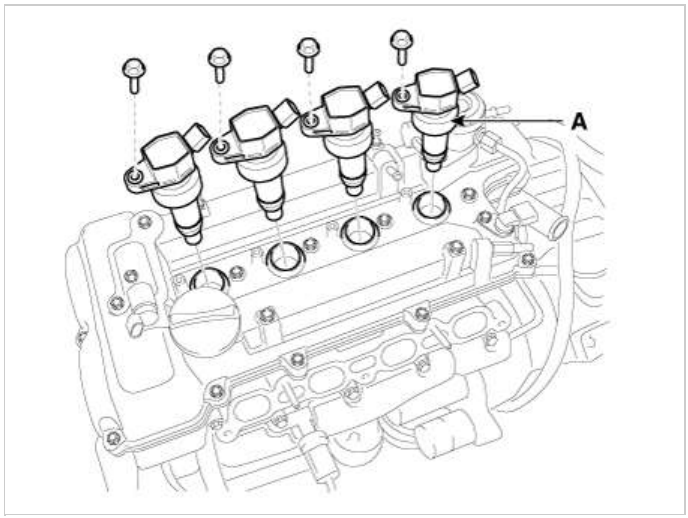
NOTICE

If the there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

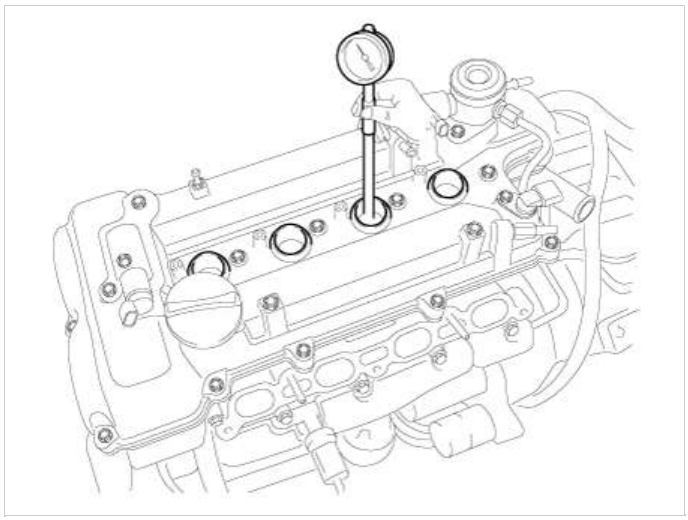
1. Make sure the oil in the crankcase is of the correct viscosity and at the correct level and that the battery is correctly charged. Operate the vehicle until the engine is at normal operating temperature. Turn the ignition switch to the OFF position.
2. Remove the engine cover.
3. Disconnect the injector extension connector (A) and the ignition coil connectors (B).



4. Remove the ignition coils (A).



5. Remove the spark plugs.
   Using a 16mm plug wrench, remove the 4 spark plugs.
6. Check the cylinder compression pressure.
   (1) Insert a compression gauge into the spark plug hole.



   (2) Set the throttle plate in the wide-open position.
   (3) While cranking the engine, measure the compression pressure.

> **NOTICE**
> Always use a fully charged battery to obtain engine speed of 250rpm or more.

   (4) Repeat step 1) through 3) for each cylinder.

> **NOTICE**
> This measurement must be done in as short time as possible.

Compression pressure
Standard : 1225.83kPa (12.5kg/cm², 177.79psi) (200-250 rpm)
Minimum : 1078.73kPa (11.0kg/cm², 156.46psi)
Difference between each cylinder :
98kPa (1.0kg/cm², 14psi) or less

   (5) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat step 1) through 3) for cylinders with low compression.
   - If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
   - If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

7. Install the spark plugs.

Tightening torque :
14.7 - 24.5 N·m (1.5 - 2.5 kgf·m, 10.8 - 18.0 lb·ft)

8. Install the ignition coil.

Tightening torque :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)

9. Connect the injector extension connector and the ignition coil connectors.
10. Install the engine cover.

Engine Mechanical System

Troubleshooting

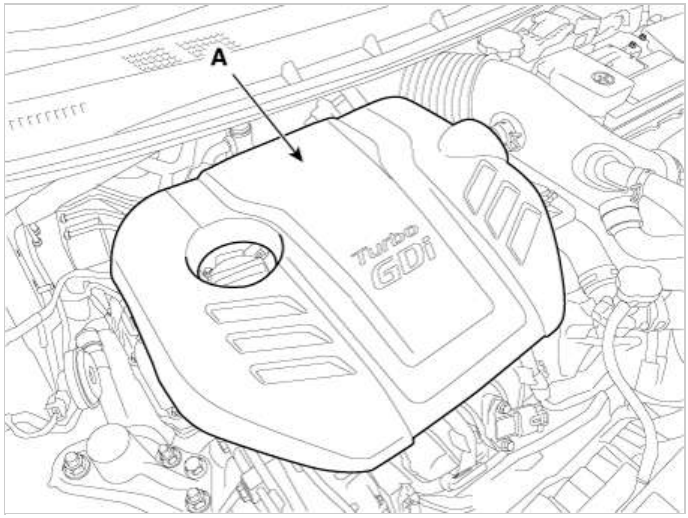
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Loose or improperly installed engine flywheel.	Repair or replace the flywheel as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression . Repair or replace as required.
	Worn crankshaft thrust bearings.	Replace the crankshaft and bearings as required.
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem can cause the valve not to close properly.)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and MLA.
Engine misfire with coolant consumption.	• Faulty cylinder head gasket and/or cracking or other damage to the cylinder head and engine block cooling system. • Coolant consumption may or may not cause the engine to overheat.	• Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.
Engine misfire with excessive oil consumption.	Worn valves, valve guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	Inspection the cylinder for a loss of compression. Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity.	Drain the oil. Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	Inspect the thrust bearing and crankshaft. Repair or replace as required.
Upper engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	Inspect the camshaft lobes. Replace the camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves. (Carbon on the valve stem or valve seat may cause the valve to stay open.)	Inspect the valves and valve guides, then repair as required.
Lower engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace damaged components as required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	Inspect the oil pan. Inspect the oil pump screen. Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	Inspect the oil pump screen. Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	Inspect the piston and cylinder bore. Repair as required.
	Excessive piston pin-to-bore clearance.	Inspect the piston, piston pin and the connecting rod. Repair or replace as required.
	Excessive connecting rod bearing clearance.	Inspect the following components and repair as required. • The connecting rod bearings. • The connecting rods. • The crankshaft. • The crankshaft journal.
	Excessive crankshaft bearing clearance.	Inspect the following components and repair as required. • The crankshaft bearings. • The crankshaft journals.
	Incorrect piston, piston pin and connecting rod installation.	Verify the piston pins and connecting rods are installed correctly. Repair as required.

Engine noise under load.	Low oil pressure.	Repair or replace as required.
	Excessive connecting rod bearing clearance.	Inspect the following components and repair as required. • The connecting rod bearings. • The connecting rods. • The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components and repair as required. • The crankshaft bearings. • The crankshaft journals. • The cylinder block crankshaft bearing bore.
Engine will not crank. (crankshaft will not rotate)	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	Remove spark plugs and check for fluid. Inspect for broken head gasket. Inspect for cracked engine block or cylinder head. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain gears.	Inspect timing chain and gears. Repair as required.
	Foreign material in cylinder. • Broken valve. • Piston material. • Foreign material.	Inspect cylinder for damaged components and/or foreign materials. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	Inspect crankshaft and connecting rod bearing. Repair or replace as required.
	Bent or broken connecting rod.	Inspect connecting rods. Repair or replace as required.
	Broken crankshaft.	Inspect crankshaft. Repair or replace as required.

Engine Mechanical System

Removal and Installation

1. Remove the engine cover (A).



2. Install in the reverse order of removal.

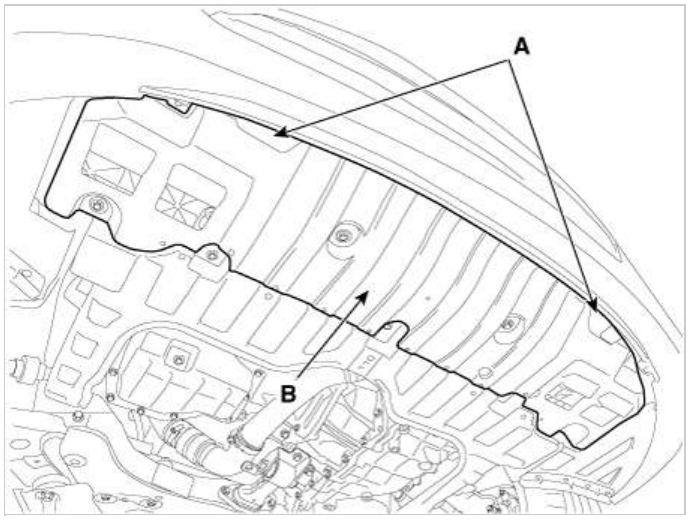
Engine Mechanical System

Removal and Installation

Engine Room Front Under Cover

1. Loosen the fasteners (A) and bolts.
2. Remove the engine room front under cover (B).

Tightening torque :
3.9 - 5.9 N·m (0.4 - 0.6 kgf·m, 2.9 - 4.3 lb·ft)

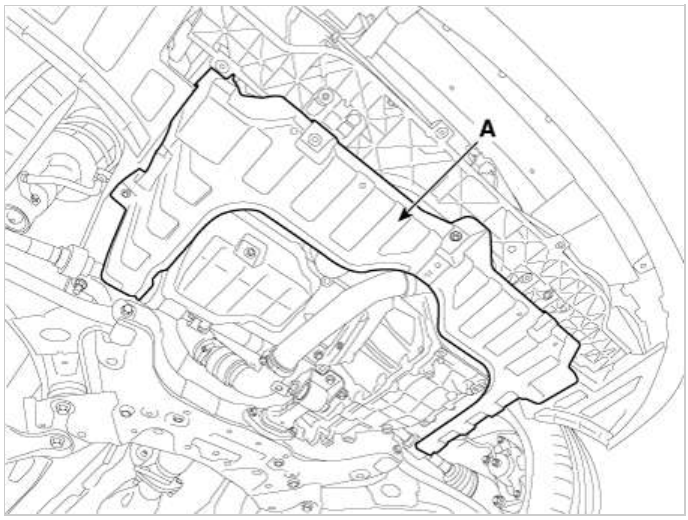


3. Install in the reverse order of removal.

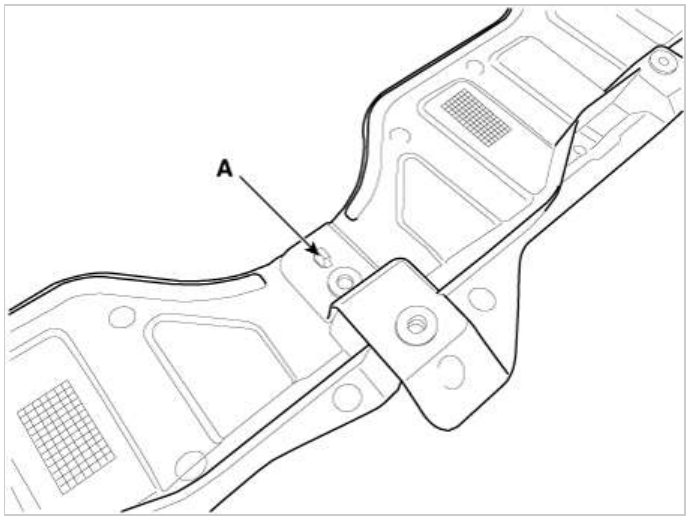
Engine Room Side Cover

1. Remove the engine room front under cover.
2. Remove the engine room side cover assembly (A).

Tightening torque :
3.9 - 5.9 N·m (0.4 - 0.6 kgf·m, 2.9 - 4.3 lb·ft)



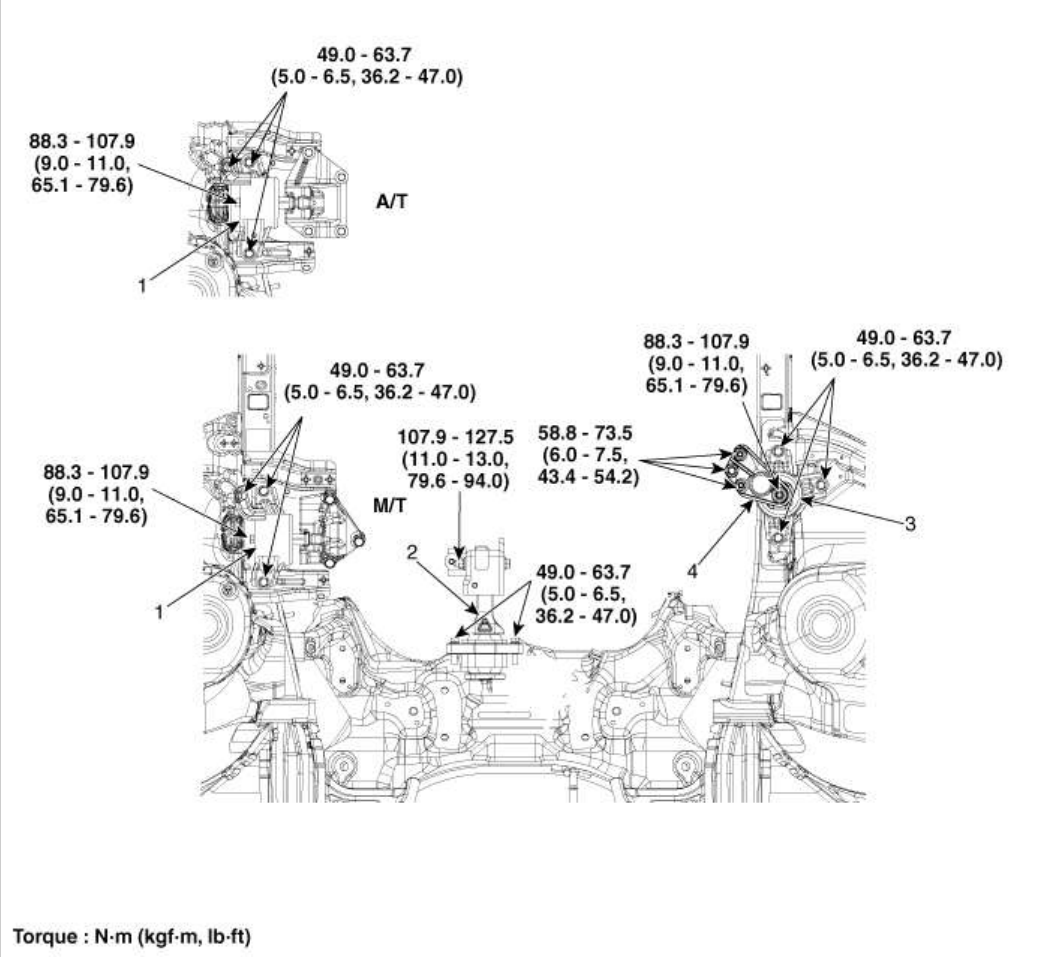
3. Unfasten the hook (A) and then disassemble the engine room side cover assembly.



4. Install in the reverse order of removal.

Engine Mechanical System

Components



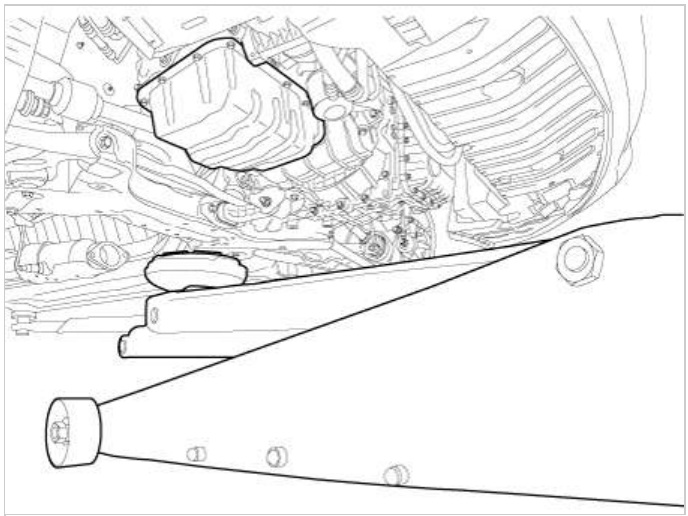
1. Transaxle mounting bracket
2. Roll rod bracket
3. Engine mounting bracket
4. Engine mounting support bracket

Engine Mechanical System

Removal and Installation

Engine Mounting Bracket

1. Install the jack to the edge of oil pan to support the engine.



NOTICE

Insert the rubber block between jack and oil pan.

2. Remove the engine mounting support bracket (A).

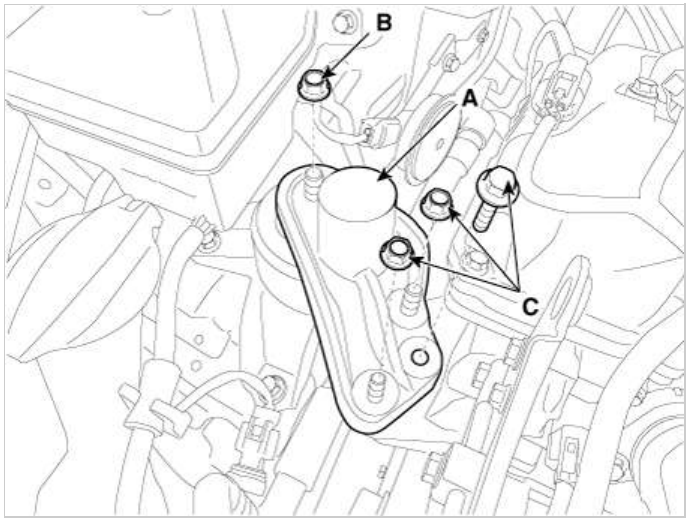
Tightening torque

Nut (B):

88.3 - 107.9 N·m (9.0 - 11.0 kgf·m, 65.1 - 79.6 lb·ft)

Bolt and nuts (C):

58.8 - 73.5 N·m (6.0 - 7.5 kgf·m, 43.3 - 54.2 lb·ft)

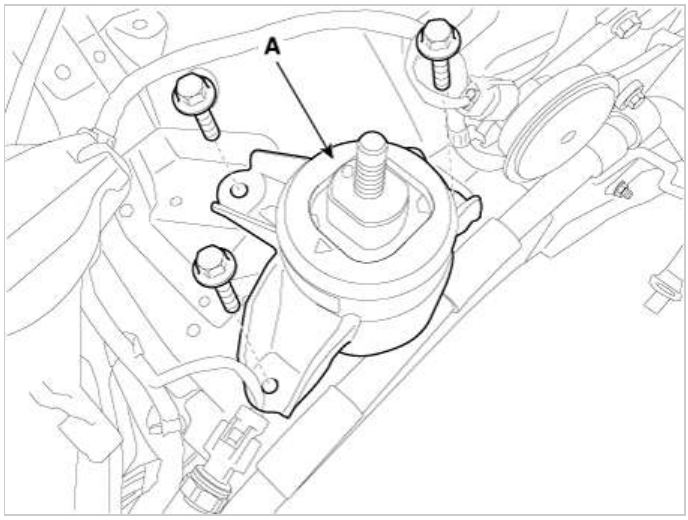


3. Remove the reservoir tank .
(Refer to Cooling System - "Reservoir tank")

4. Remove the engine mounting bracket (A).

Tightening torque :

49.0 - 63.7 N·m (5.0 - 6.5 kgf·m, 36.2 - 47.0 lb·ft)



5. Install in the reverse order of removal.

Roll Rod Mounting Bracket

1. Remove the roll rod bracket (A).

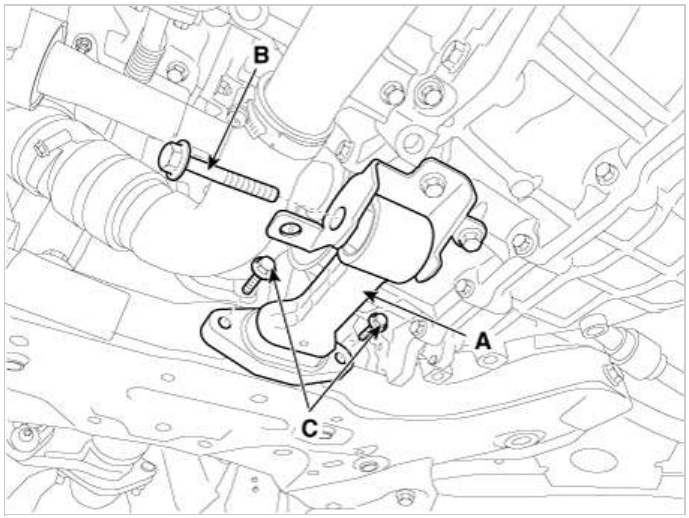
Tightening torque

Bolt (B) :

107.9 - 127.5 N·m (11.0 - 13.0 kgf·m, 79.6 - 94.0 lb·ft)

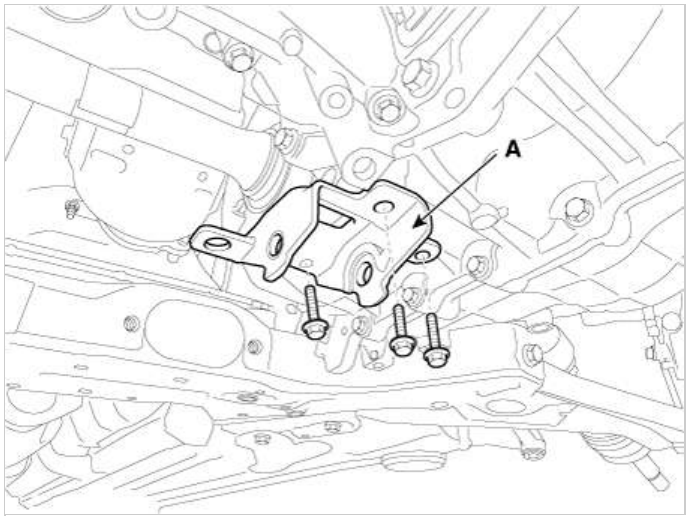
Bolt (C) :

49.0 - 63.7 N·m (5.0 - 6.5 kgf·m, 36.2 - 47.0 lb·ft)



2. Remove the roll rod support bracket (A).

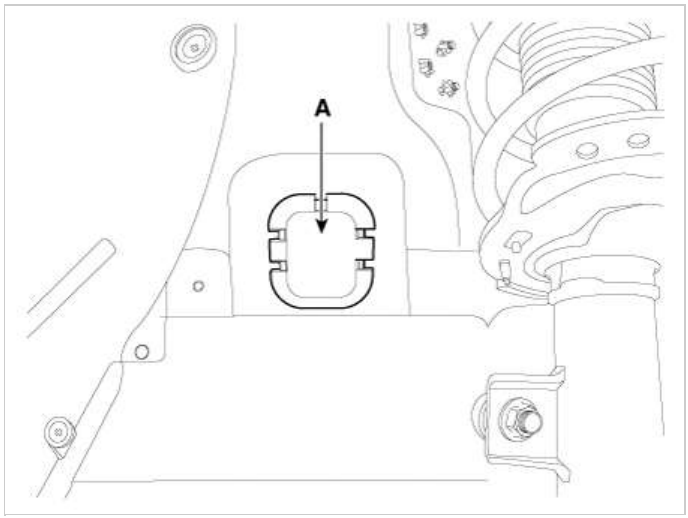
Tightening torque :
49.0 - 68.6 N·m (5.0 - 7.0 kgf·m, 36.2 - 50.6 lb·ft)



3. Install in the reverse order of removal.

Transaxle Mounting Bracket

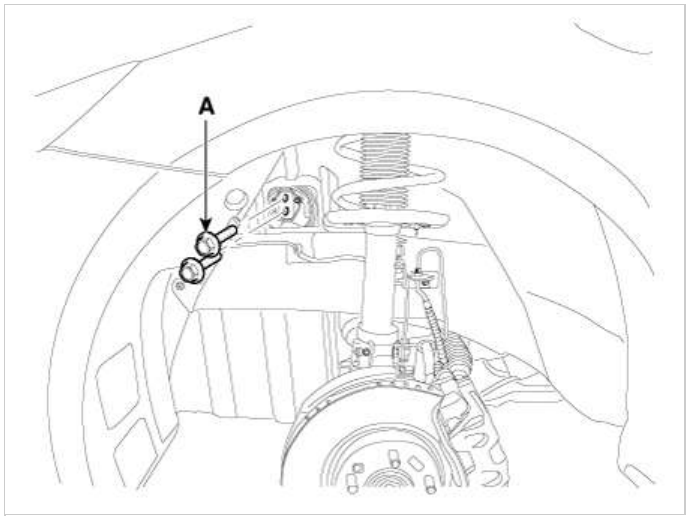
1. Remove the battery and battery tray.
   (Refer to Engine Electrical System - "Battery")
2. Remove the engine room under cover.
   (Refer to Engine and Transmission Assembly - "Engine Room Under Cover")
3. Install the jack to the edge of transaxle.
4. Remove the cover (A).



5. Remove the transaxle support mouting bracket bolt (A).

Tightening torque :

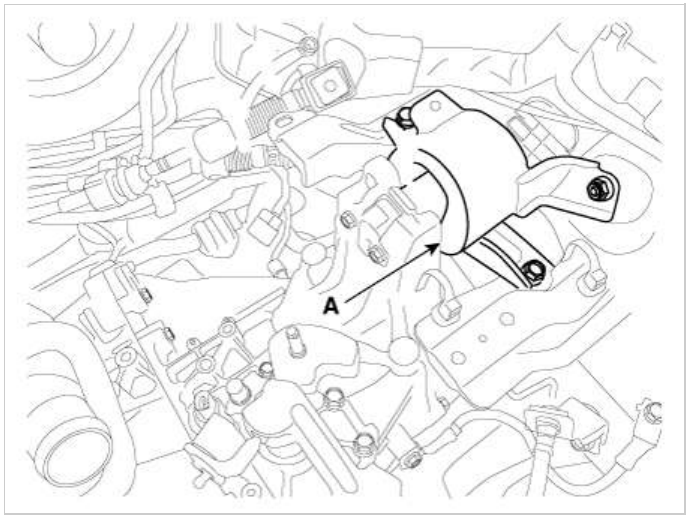
88.3 - 107.9 N·m (9.0 - 11.0 kgf·m, 65.1 - 79.6 lb·ft)



6. Remove the transaxle mounting bracket (A).

Tightening torque :

49.0 - 63.7 N·m (5.0 - 6.5 kgf·m, 36.2 - 47.0 lb·ft)



7. Install in the reverse order of removal.

Engine Mechanical System

Removal

⚠ CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

- Mark all wiring and hoses to avoid misconnection.
- For release the fuel system pressure before remove the engine assembly, start the engine without fuel pump relay. And then turn off the ignition switch after engine stops.

1. Remove the engine cover.
2. Remove the battery and battery tray.
   (Refer to Engine Electrical System - "Battery")
3. Remove the air duct and air cleaner assembly.
   (Refer to Intake and Exhaust System - "Air Cleaner")
4. Remove the engine room under cover.
   (Refer to Engine And Transaxle Assembly - "Engine Room Under Cover")
5. Drain the engine coolant.
   (Refer to Cooling System - "Coolant")
6. Remove the intercooler inlet hoses & pipe (A).

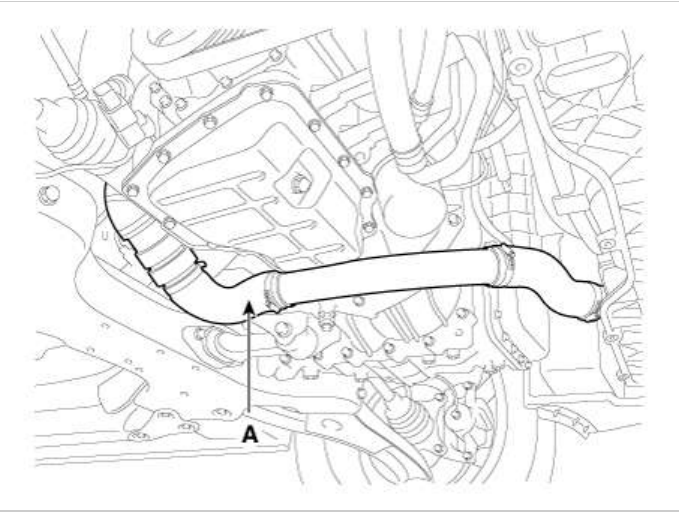
   Tightening torque

   Bolt :

   19.6 - 26.4 N·m (2.0 - 2.7 kgf·m, 14.4 - 19.5 lb·ft)

   Clamp :

   4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)

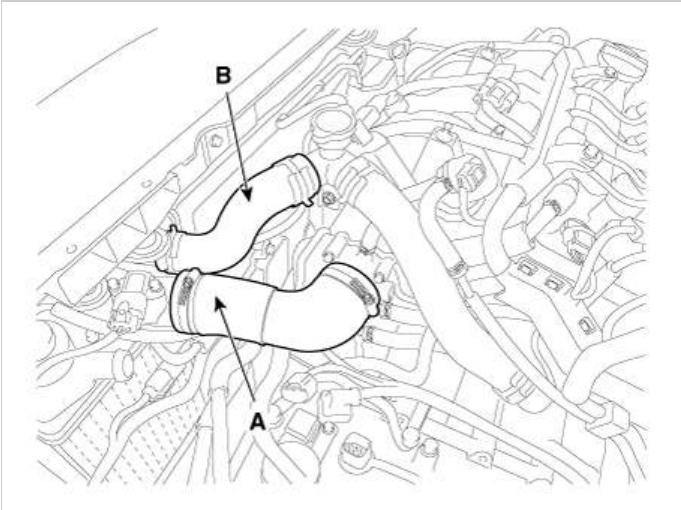


7. Remove the intercooler outlet hose (A).

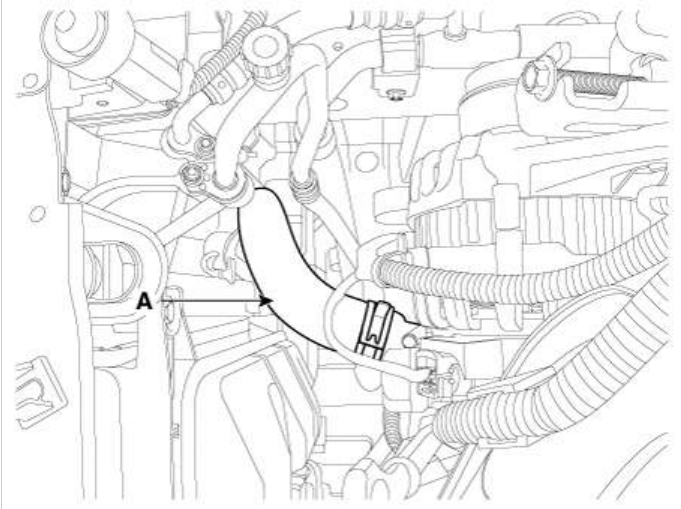
   Tightening torque:

   4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)

8. Disconnect the radiator upper hose (B).

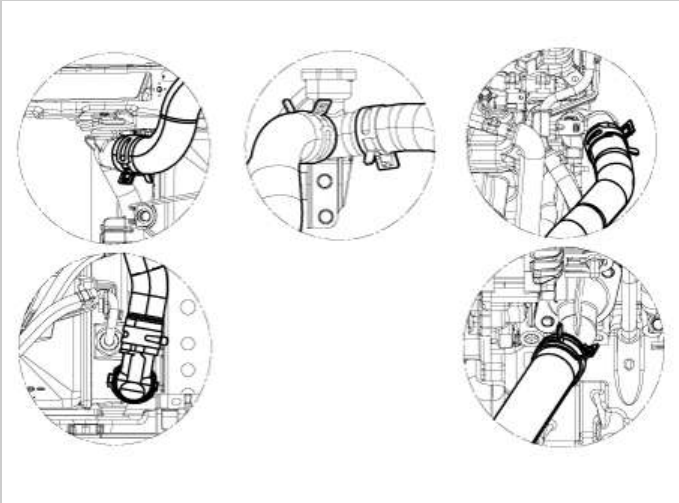


9. Disconnect the radiator lower hose (A).



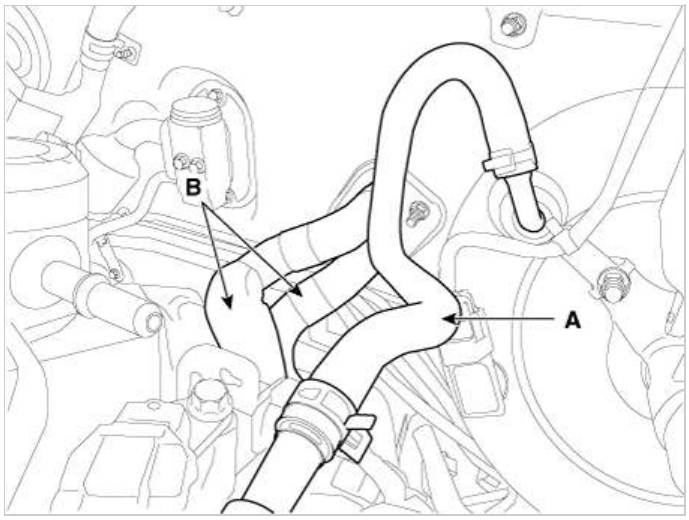
NOTICE

When installing radiator hoses, install as shown in illustrations.



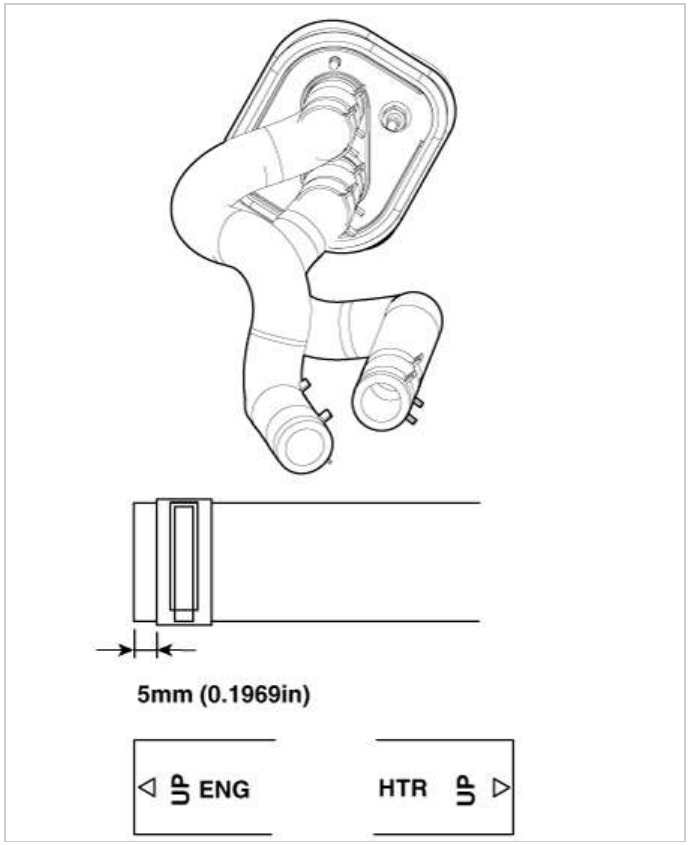
10. Recover the refrigerant and then remove the high pressure pipe and low pressure pipe.
    (Refer to Heating, Ventilation Air conditioning - "Compressor")
11. Remove the transaxle wire harness connectors and control cable from the transaxle.
    (Refer to Manual Transaxle System - "Manual Transaxle")
    (Refer to Automatic Transaxle System - "Automatic Transaxle")

12. Disconnect the brake booster vacuum hose (A) and the heater hoses (B).

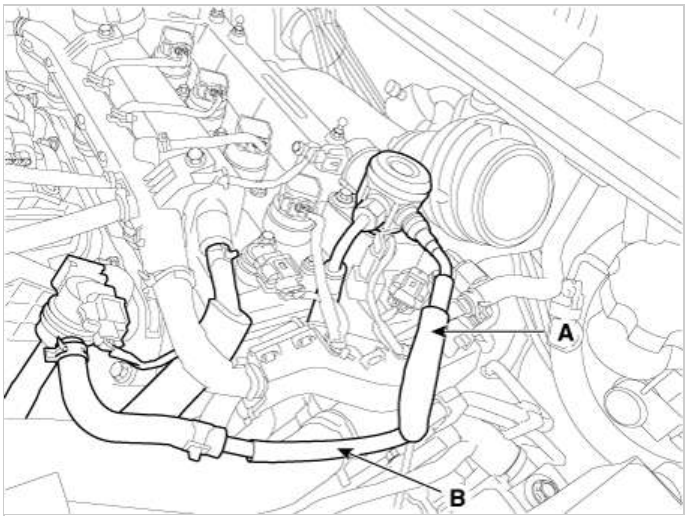


NOTICE

When installing the heater hoses, install as shown in illustrations.



13. Disconnect the fuel hose (A) and the purge control solenoid valve (PCSV) hose (B).



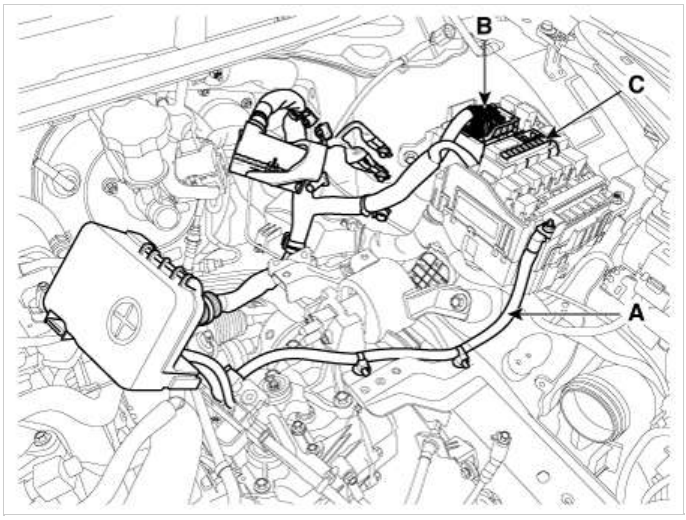
14. Remove the engine wirings from the engine room.
    (1) Remove the (+) cable nut (A).

    Tightening torque:
    6.9 - 10.8 N·m (0.7 - 1.1 kgf·m, 5.1 - 8.0 lb·ft)

    (2) Disconnect the EMS block (B).

    (3) Disconnect the fuse box connector (C).

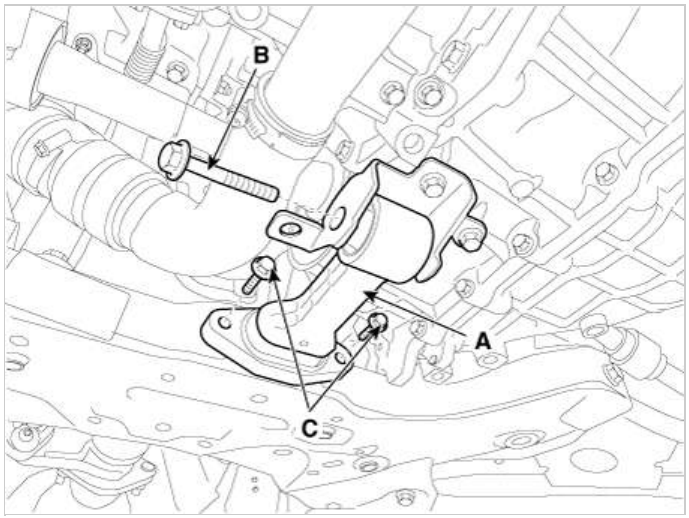
    (4) Remove the engine wirings from the engine room.



15. Remove the front muffler.
    (Refer to Intake And Exhaust System - "Muffler")

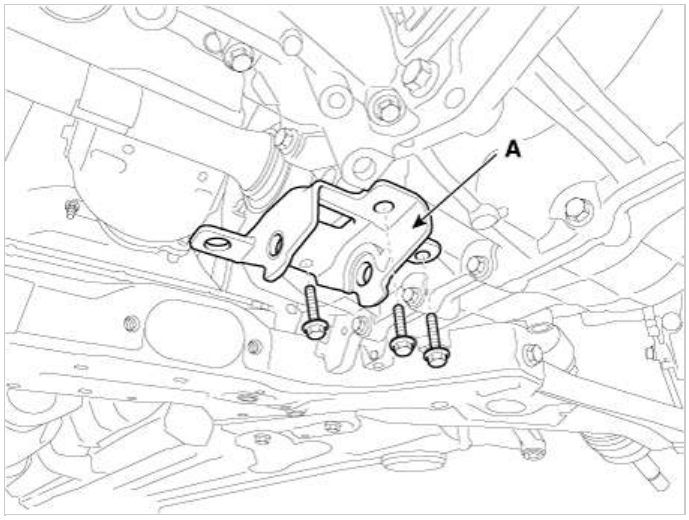
16. Remove the roll rod bracket (A).

    Tightening torque
    Nut (B) :
    107.9 - 127.5 N·m (11.0 - 13.0 kgf·m, 79.6 - 94.0 lb·ft)
    Bolts (C) :
    49.0 - 63.7 N·m (5.0 - 6.5 kgf·m, 36.2 - 47.0 lb·ft)



17. Remove the roll rod mounting support bracket (A).

Tightening torque:
49.0 - 68.6 N·m (5.0 - 7.0 kgf·m, 36.2 - 50.6 lb·ft)

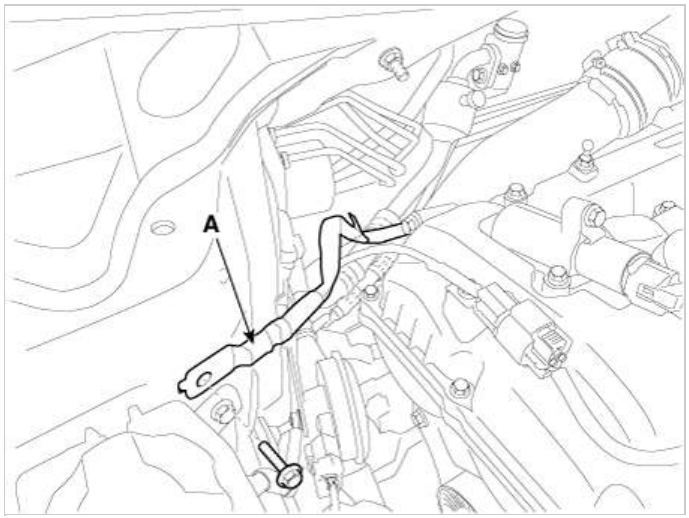


18. Remove the sub frame.
(Refer to Suspension system - "Sub frame")

> **NOTICE**
> After removing the sub frame mounting bolt, the engine and transaxle assembly may fall downward, and so support them securely with floor jack.

19. Disconnect the engine ground cable (A).

Tightening torque :
10.8 - 13.7 N·m (1.1 - 1.4 kgf·m, 8.0 - 10.1 lb·ft)



20. Remove the engine mounting support bracket (A).

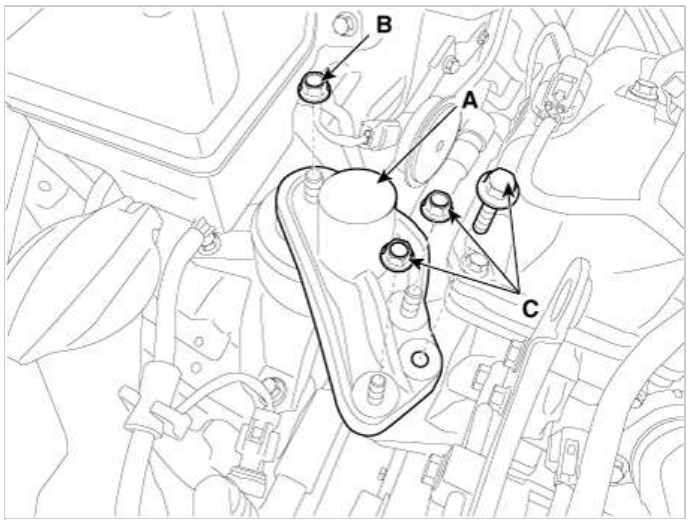
Tightening torque

Nut (B):

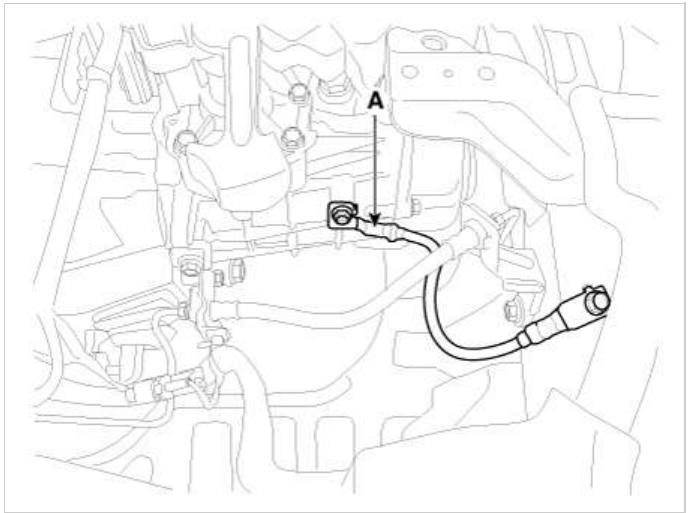
88.3 - 107.9 N·m (9.0 - 11.0 kgf·m, 65.1 - 79.6 lb·ft)

Bolt and nuts (C):

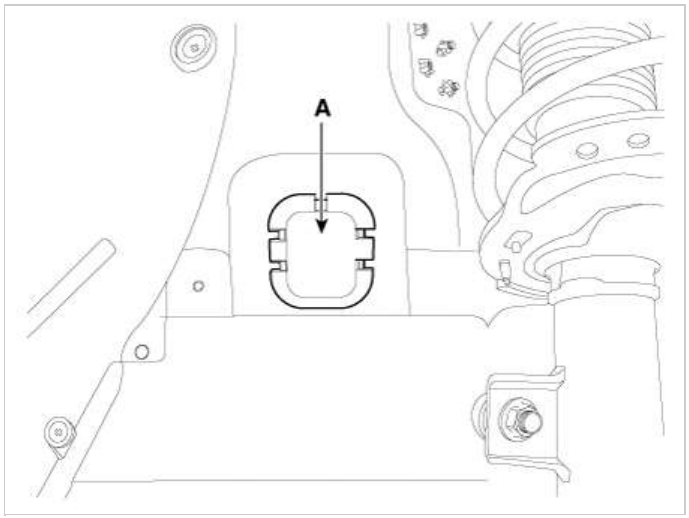
58.8 - 73.5 N·m (6.0 - 7.5 kgf·m, 43.4 - 54.2 lb·ft)



21. Disconnect the transaxle ground line (A).

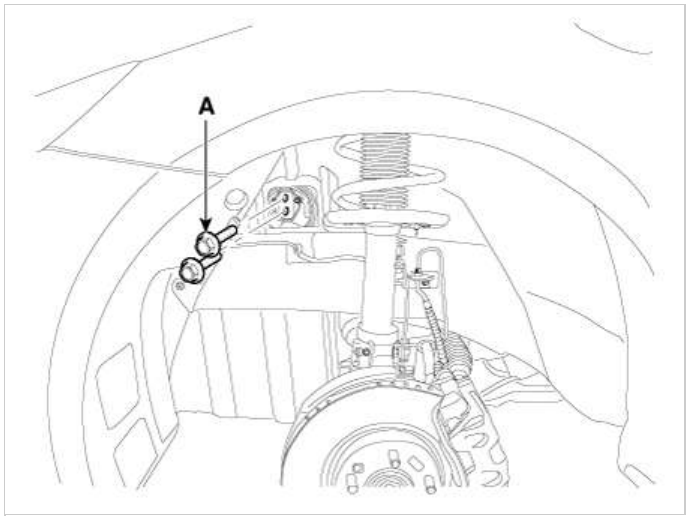


22. Remove the service cover (A).

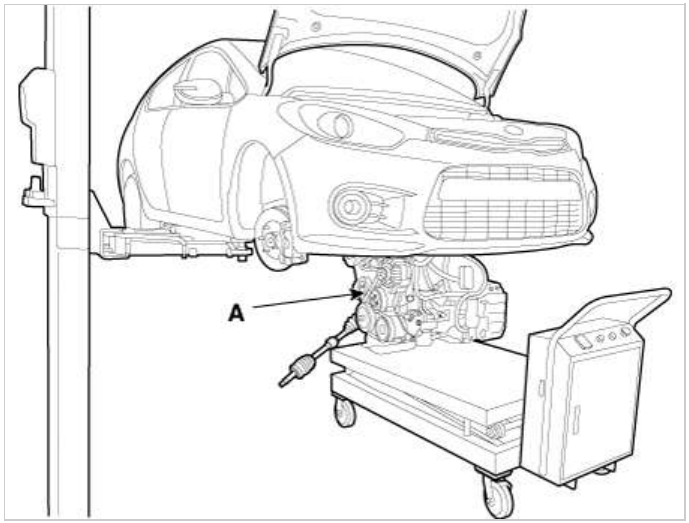


23. Remove the transaxle mounting bolts (A).

Tightening torque :
88.2 - 107.8 N·m (9.0 - 11.0 kgf·m, 65.1 - 79.5 lb·ft)



24. Remove the engine and transaxle assembly (A) by lifting vehicle.



NOTICE
Verify that the hoses and connectors are disconnected before removing the engine and transaxle assembly.

CAUTION

When remove the engine and transaxle assembly, be careful not to damage any surroundings parts or body components.

Installation

Installation is in the reverse order of removal.
Perform the following :

- Adjust a shift cable.
- Adjust the throttle cable.
- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill power steering fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- Place a heater control knob on "HOT" position.
- Clean battery posts and cable terminals and assemble.
- Inspect for fuel leakage.

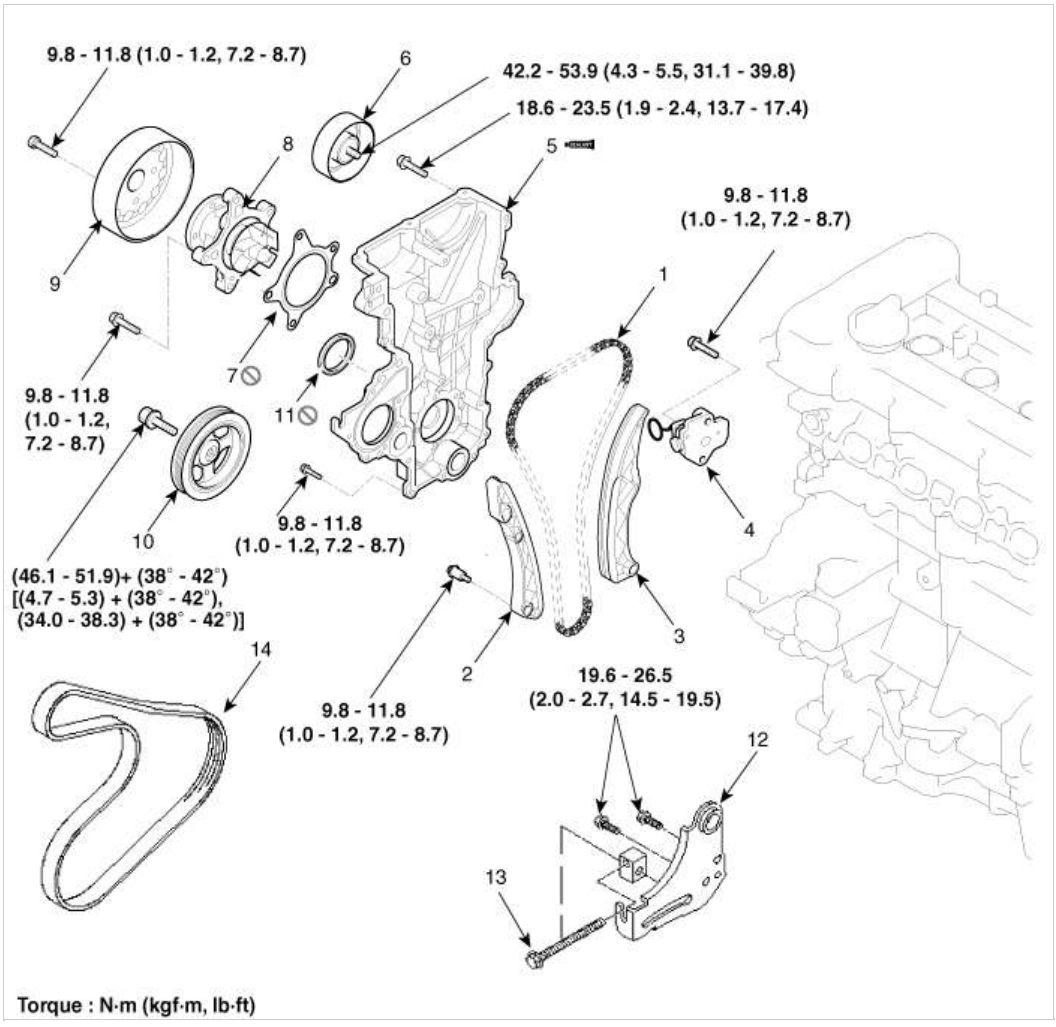
– After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
– Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.

- Bleed air from the cooling system.

– Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
– Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.

Engine Mechanical System

Components

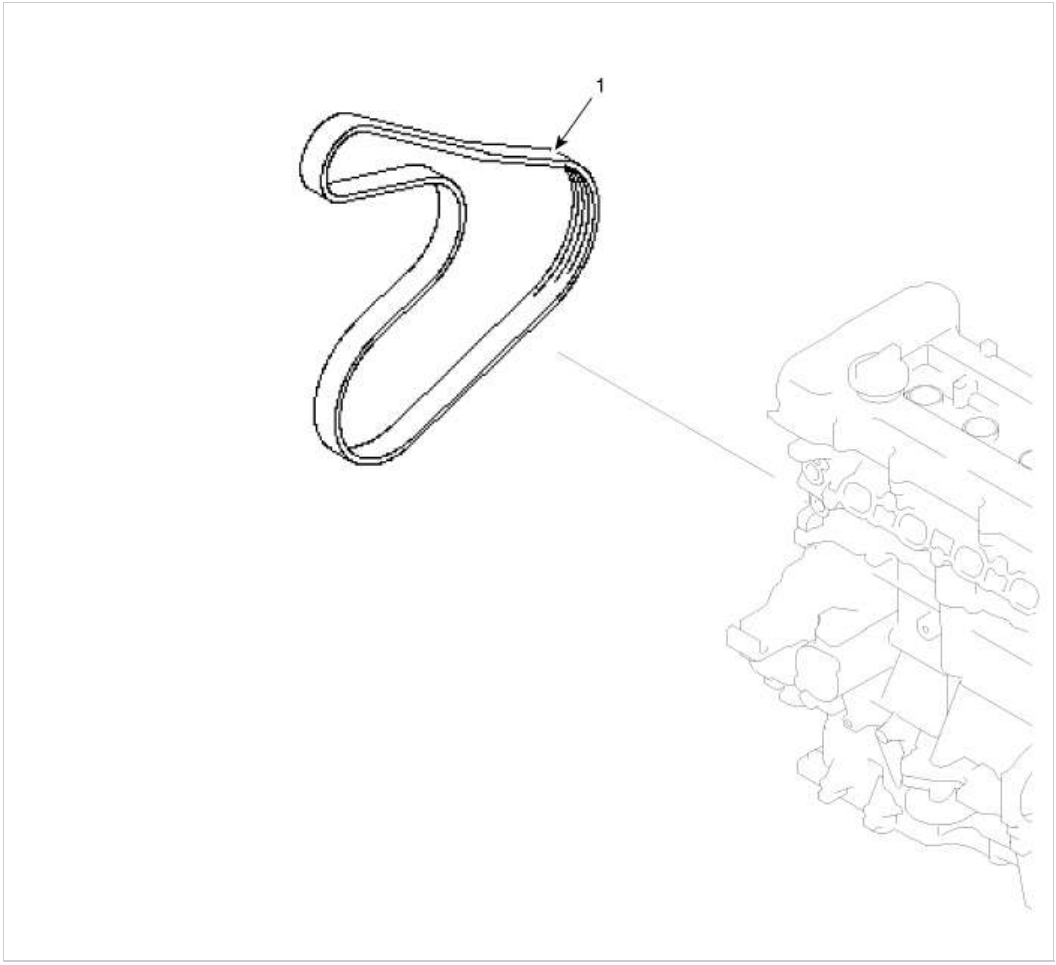


1. Timing chain
2. Timing chain guide
3. Timing chain arm
4. Timing chain auto tensioner
5. Timing chain cover
6. Drive belt idler
8. Water pump
9. Water pump pulley
10. Crankshaft pulley
11. Front oil seal
12. Alternator bracket
13. Tension adjust bolt

7. Water pump gasket
14. Drive belt

Engine Mechanical System

Components

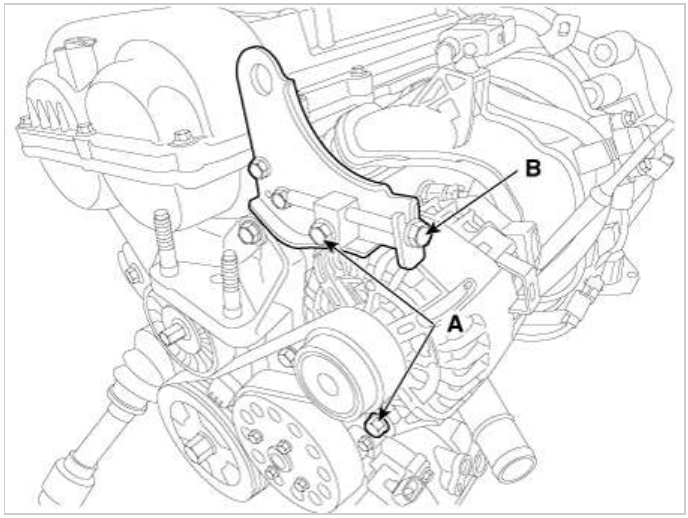


1. Drive belt

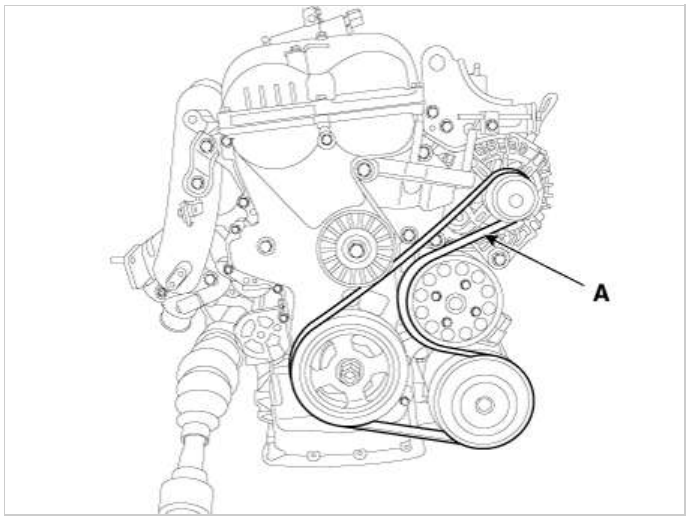
Engine Mechanical System

Removal

1. Disconnect the battery negative terminal.
2. Loosen the bolts (A).
3. Loosen the drive belt tension by loosening the adjusting bolt (B).



4. Remove the drive belt (A).



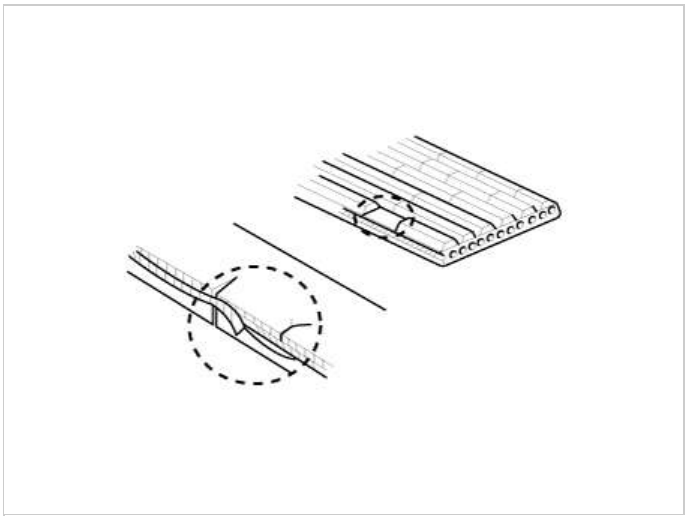
Inspection

Drive Belt Inspection

Visually check the belt for excessive wear, frayed cords etc.
If any defect has been found, replace the drive belt.

NOTICE

Cracks on the rib side of a belt are considered acceptable. If the belt has chunks missing from the ribs, it should be replaced.



Adjustment

Drive belt tension measurement and adjustment

Belt tension measurement

Measure the belt tension using a mechanical tension gauge or a sonic tension meter.

Tension

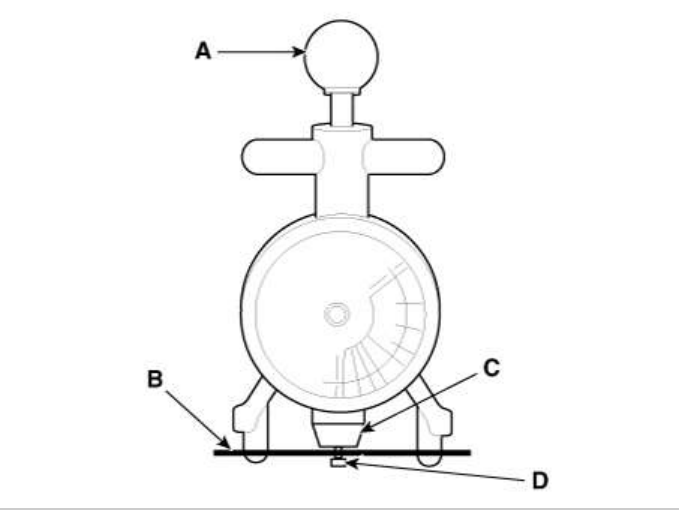
New Belt :
882.6 - 980.7 N (90.0 - 100.0 kgf, 650.9 - 723.3 lbf)
Used Belt :
637.4 - 735.5 N (65.0 - 75.0 kgf, 470.1 - 542.5 lbf)

⚠ CAUTION

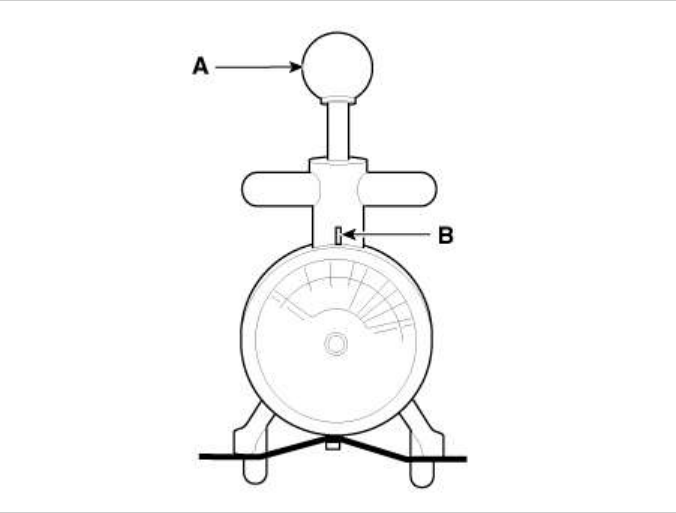
- If the engine has run for 5 minutes or more, the belt tension must be adjusted as a used belt.
- When installing the V-ribbed belt, all grooves on the pulley should be covered with belt ribs.
- A loose belt causes slip noise.
- Too tight belt cause bearing of alternator and water pump to damage.

Using a mechanical tension gauge

1. While pressing the handle (A) of the gauge, insert the belt (B) between pulley and pulley (or idler) into the gap between spindle (C) and hook (D).



2. After releasing the handle (A), read a value on the dial pointed by the indicator (B).



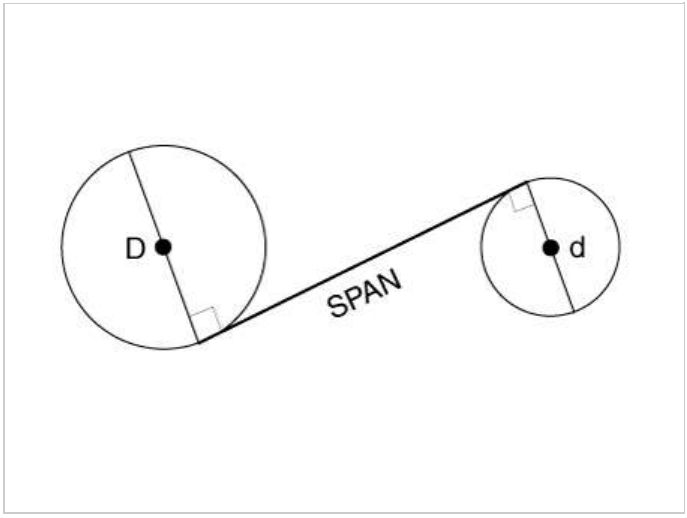
Using a sonic tension meter

1. Input the belt specifications into the tension meter.

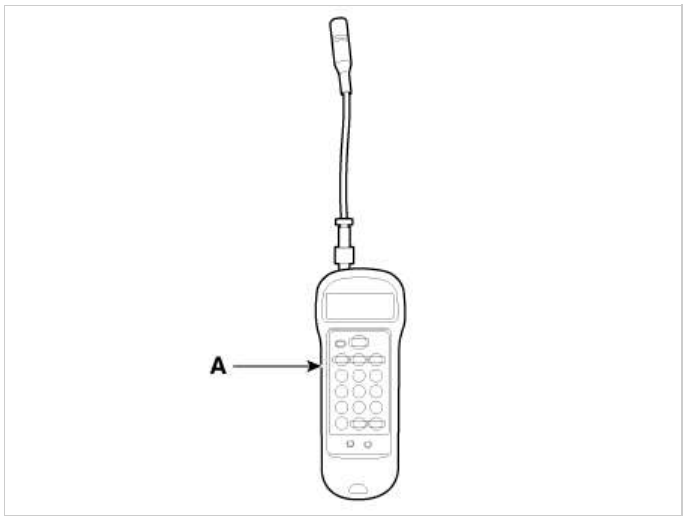
Belt type	Location of measurement	Input data		
		M (Mass, g/m.rib)	W (Width, rib)	S (Span, mm)
With A/C	Crankshaft pulley to A/C compressor pulley	13.4	6	178.9
Without A/C	Idler to alternator pulley	13.4	6	Actual measurement value

NOTICE

Measurement of S (Span) : Caculate average value after measuring the distance 3-4 times.

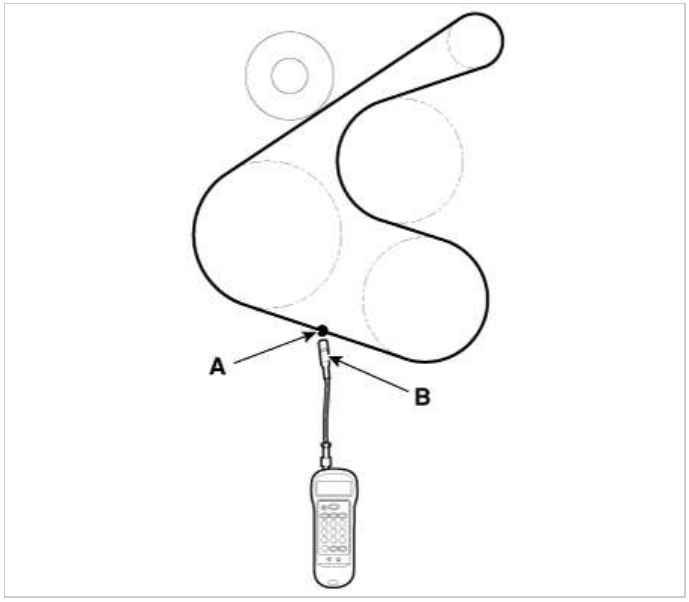


D : Idlerd
d : Alternator pulley

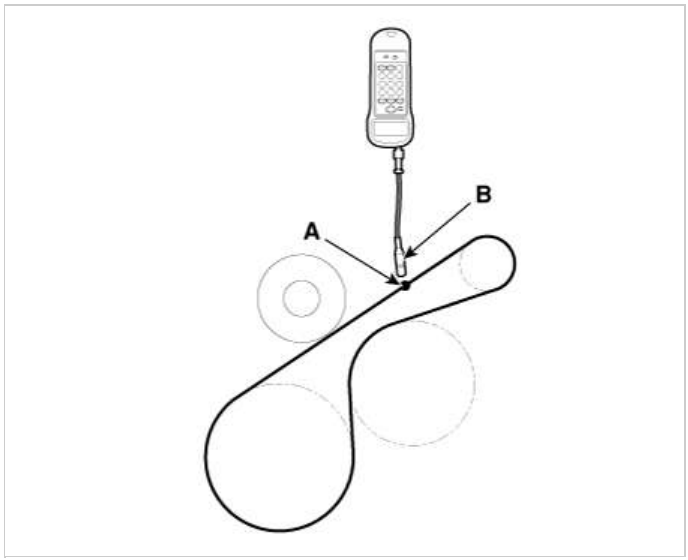


2. Locate the micro phone (B) close to the center of belt span (A) and bounce the belt by finger 2-3 times. Read a value on the display.

[With A/C]

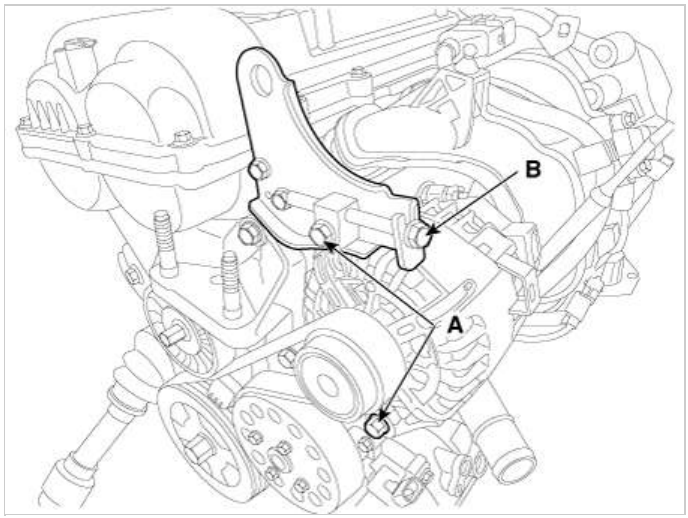


[Without A/C]



If adjustment is necessary:

1. Loosen the mounting bolts (A).
2. Tighten the adjusting bolt(B) clockwise in loose tension ; loosen the bolt counterclockwise in high tension.



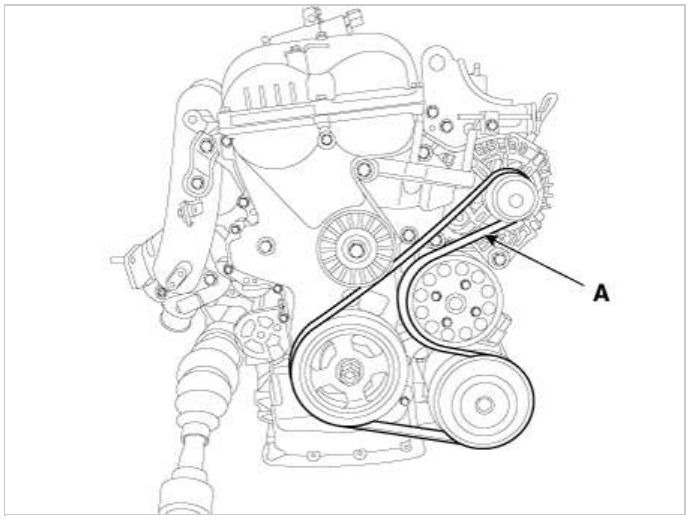
3. Recheck tension of the belt.
4. After adjusting tension, tighten the through bolts.

Tightening torque

12mm (0.47in) bolt :
19.6 - 26.5 Nm (2.0 - 2.7 kgf·m, 14.5 - 19.5 lb-ft)
14mm (0.55in) bolt :
29.4 - 41.2 Nm (3.0 - 4.2 kgf·m, 21.7 - 30.4 lb-ft)

Installation

1. Install the drive belt (A).



2. Adjust tension by tightening the alternator tension adjust bolt (B) and then install the mounting bolts(A).

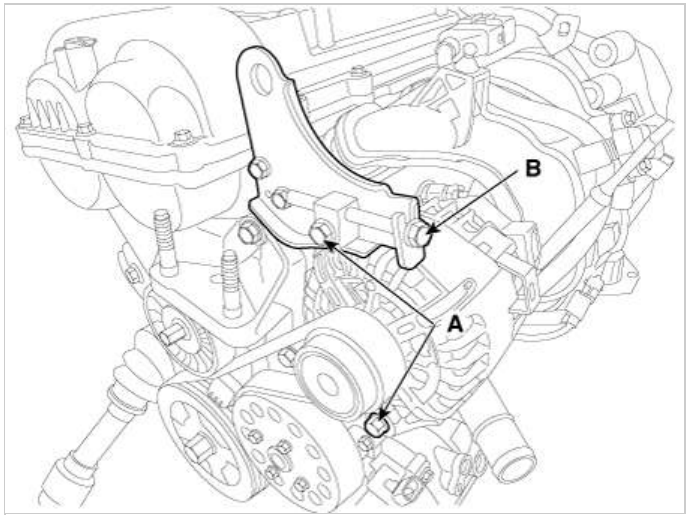
Tightening torque

12mm (0.47in) bolt :

19.6 - 26.5 Nm (2.0 - 2.7 kgf·m, 14.5 - 19.5 lb-ft)

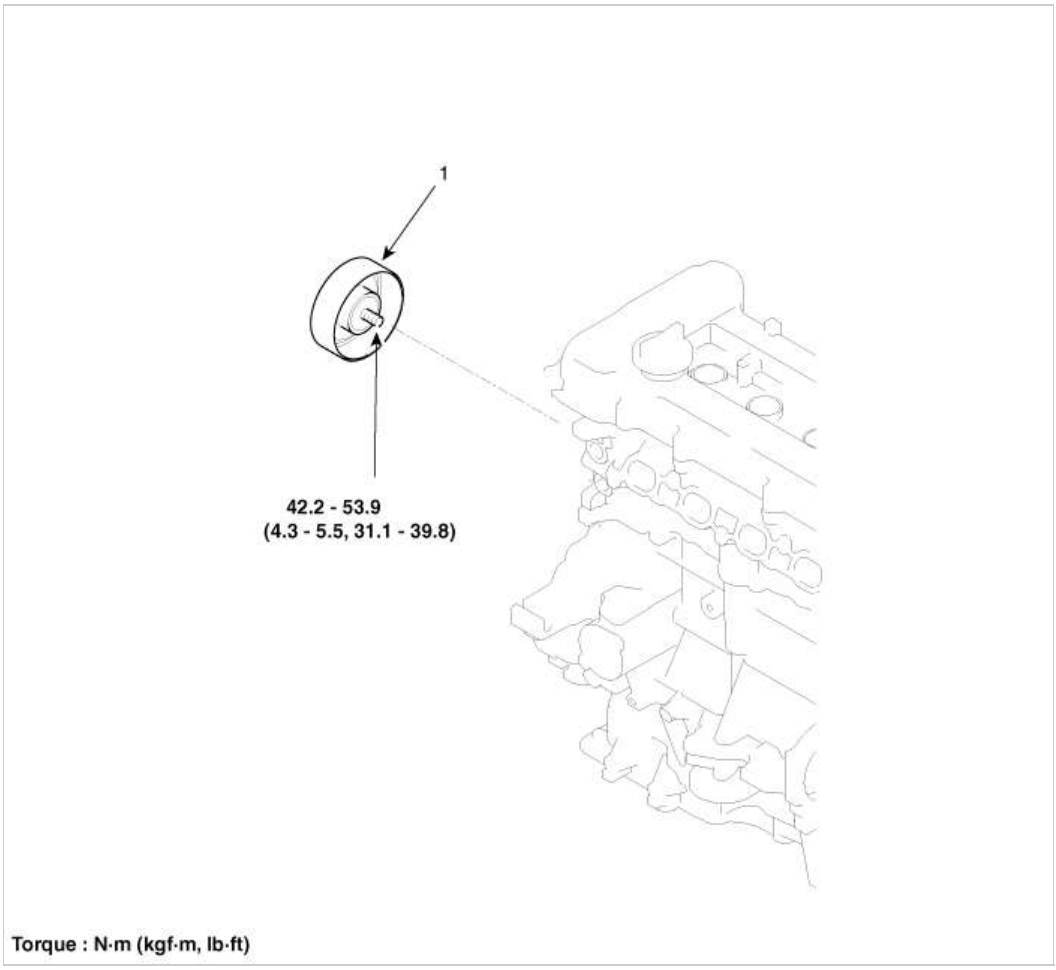
14mm (0.55in) bolt :

29.4 - 41.2 Nm (3.0 - 4.2 kgf·m, 21.7 - 30.4 lb-ft)



Engine Mechanical System

Components



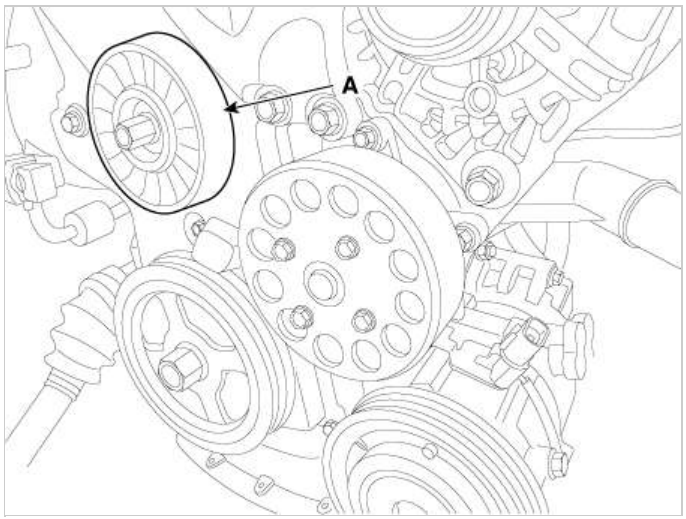
1. Idler

Engine Mechanical System

Removal and Installation

1. Remove the drive belt.
   (Refer to Timing System - "Drive Belt")
2. Remove the idler(A).

Tightening torque :
42.2 - 53.9 N·m (4.3 - 5.5 kgf·m, 31.1 - 39.8 lb·ft)



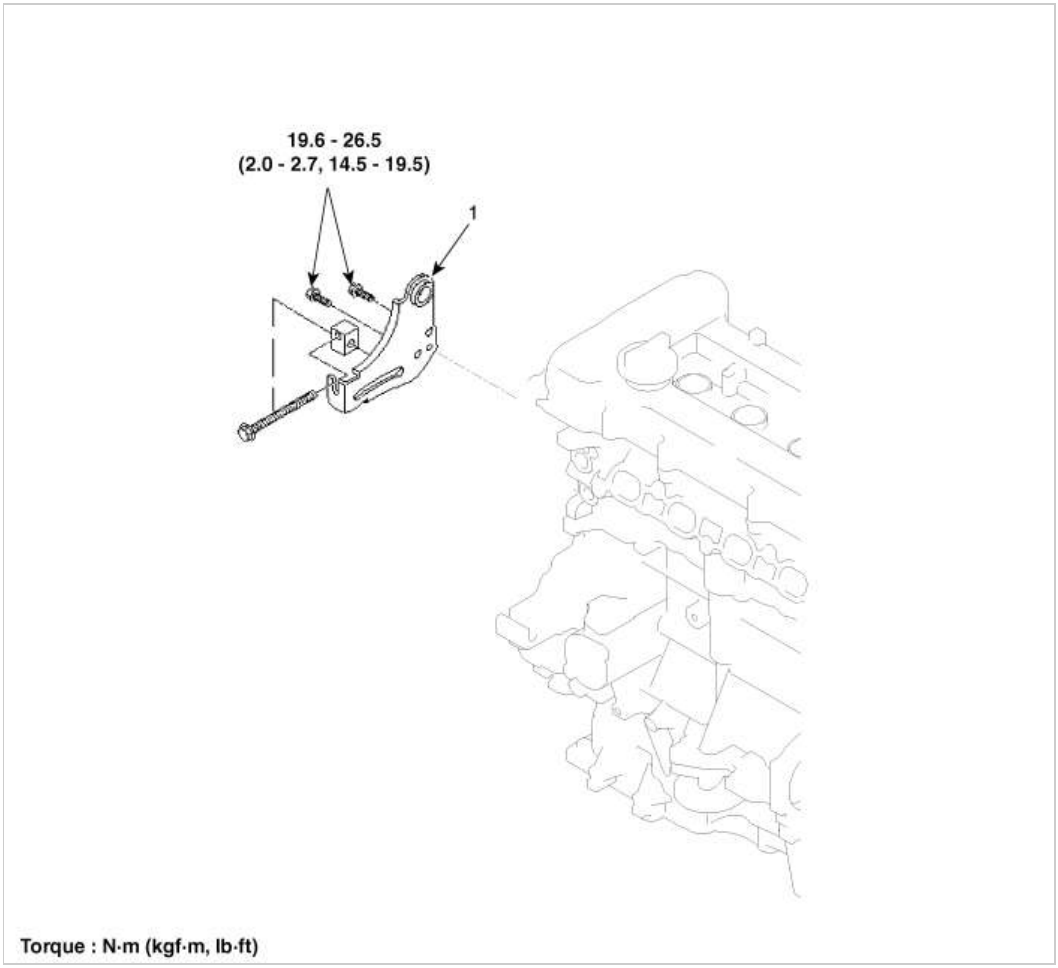
3. Install in the reverse order of removal.

Inspection

Check the idler for grease leak, abnormal rotation and vibration. Replace if necessary

Engine Mechanical System

Components



1. Drive belt tensioner

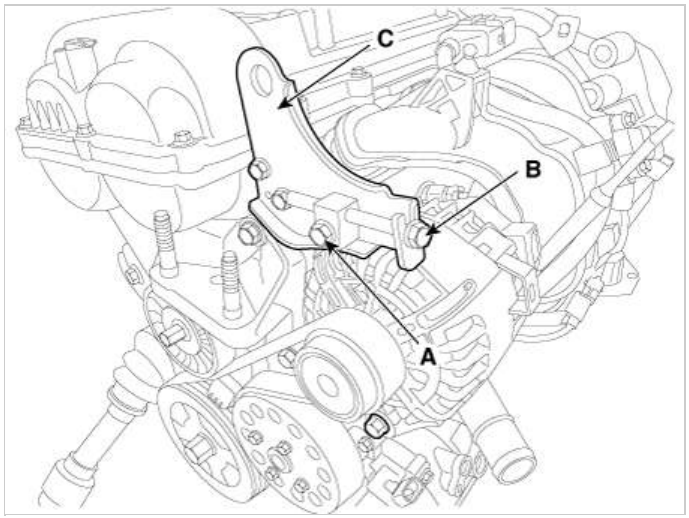
Engine Mechanical System

Removal and Installation

1. Remove the drive belt.
   (Refer to Timing System - "Drive belt")
2. Loosen the alternator upper mounting bolt (A).

   Tightening torque :
   19.6 - 26.5 N·m (2.0 - 2.7 kgf·m, 14.5 - 19.5 lb·ft)
3. Loosen the adjusting bolt (B).
4. Remove the alternator bracket (C).

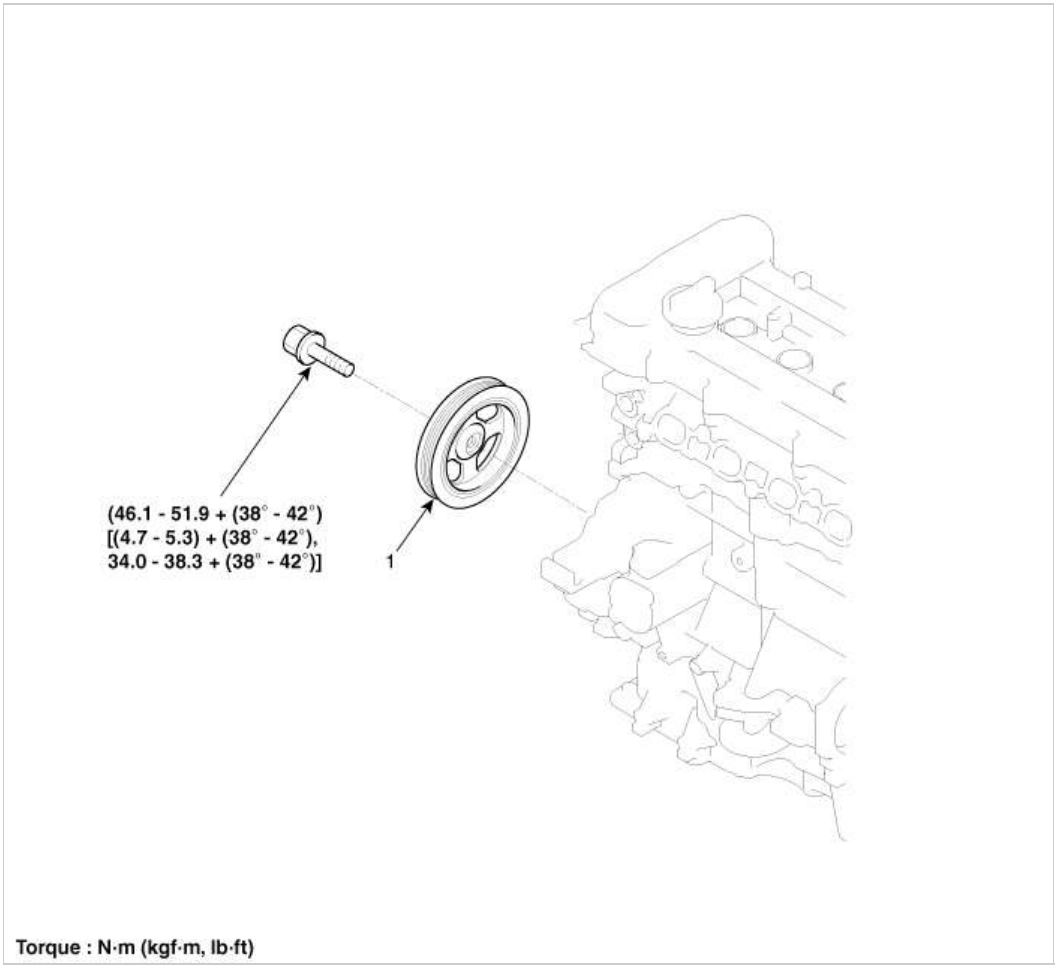
   Tightening torque :
   19.6 - 26.5 N·m (2.0 - 2.7 kgf·m, 14.5 - 19.5 lb·ft)



5. Install in the reverse order of removal.
6. After installing the alternator bracket, adjust the drive belt tension by tightening adjusting bolt.
   (Refer to Timing System - "Drive Belt")

Engine Mechanical System

Components



1. Crankshaft damper pulley

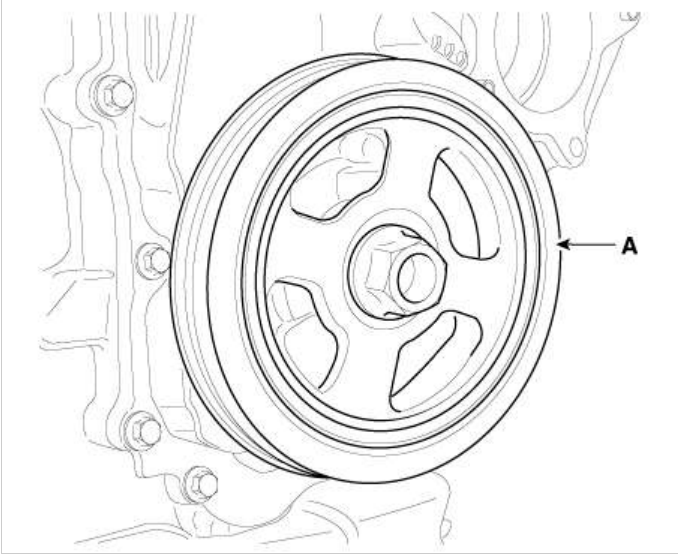
Engine Mechanical System

Removal and Installation

1. Remove the drive belt.
   (Refer to Timing System - "Drive Belt")

2. Remove the engine room under cover.
   (Refer to Engine And Transaxle Assembly - "Engine Room Under Cover")
3. Remove the passenger side front tire.
4. Remove the crankshaft damper pulley (A).

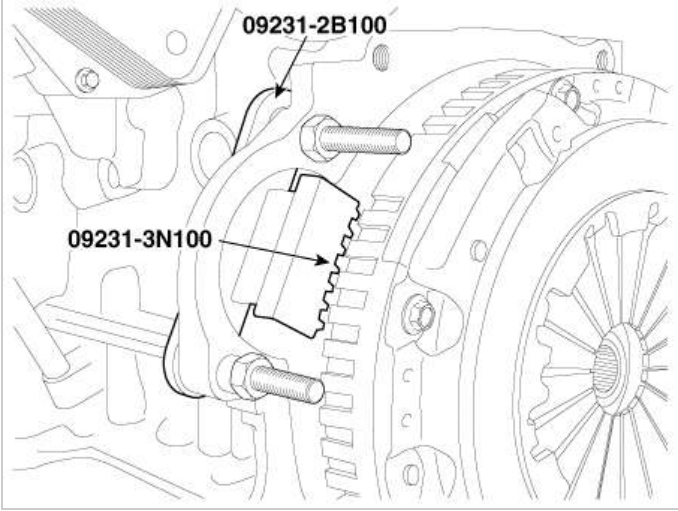
Tightening torque :
46.1 - 52.0 N·m (4.7 - 5.3 kgf·m, 34.0 - 38.3 lb·ft) + 38 - 42°



NOTICE

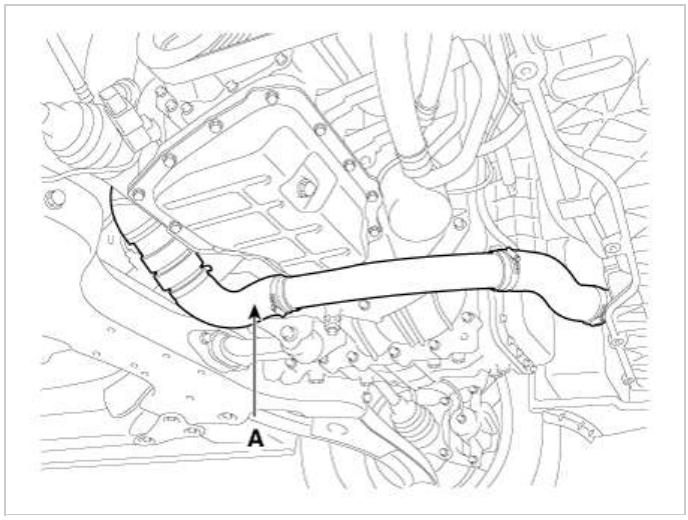
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

- Install the SST (09231-2B100, 09231-3N100) to hold the ring gear after removing the starter.

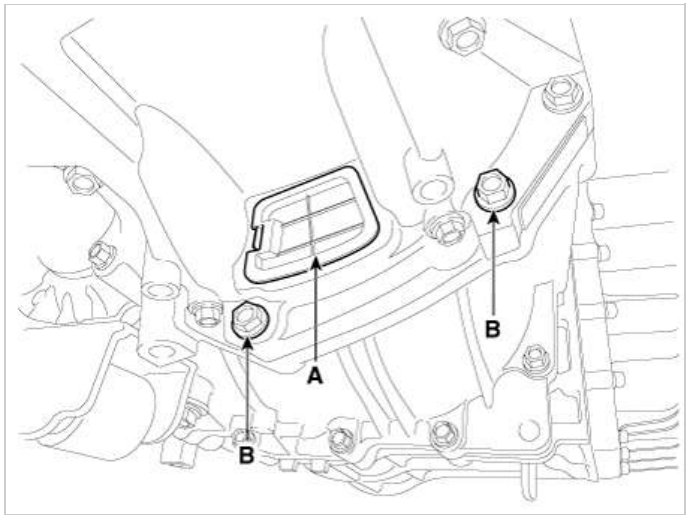


- Install the SST (09231-3D100, 09231-2W100) to hold the ring gear after removing the dust cover.

1) Remove the intercooler inlet pipe & hoses (A).

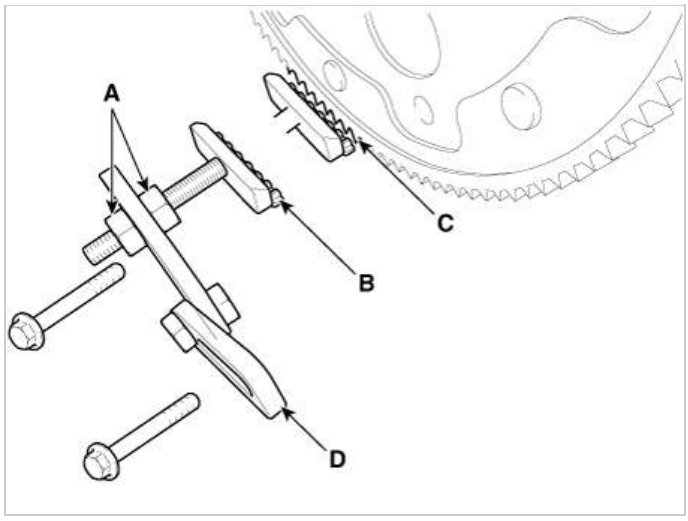


2) Remove the dust cover (A) and unfasten the transaxle mounting bolt (B).

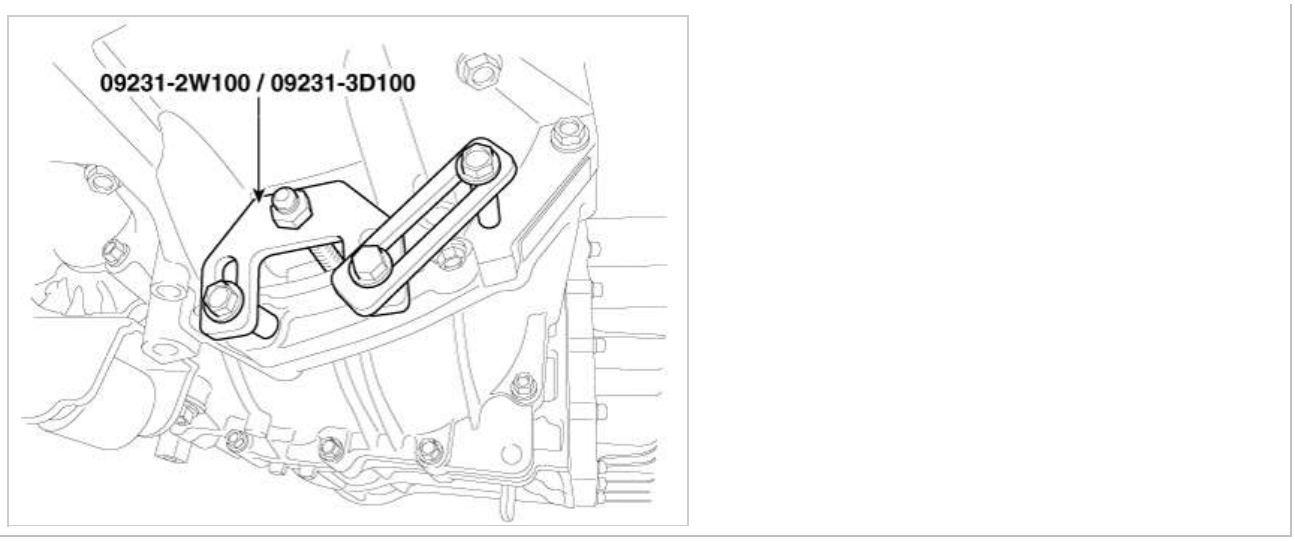


3) Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.

4) Adjust the angle of the links (D), and fasten the bolt 70mm(2.7559in) in the original mounted hole.



5) Tighten the bolts and nuts of the holder and links securely.



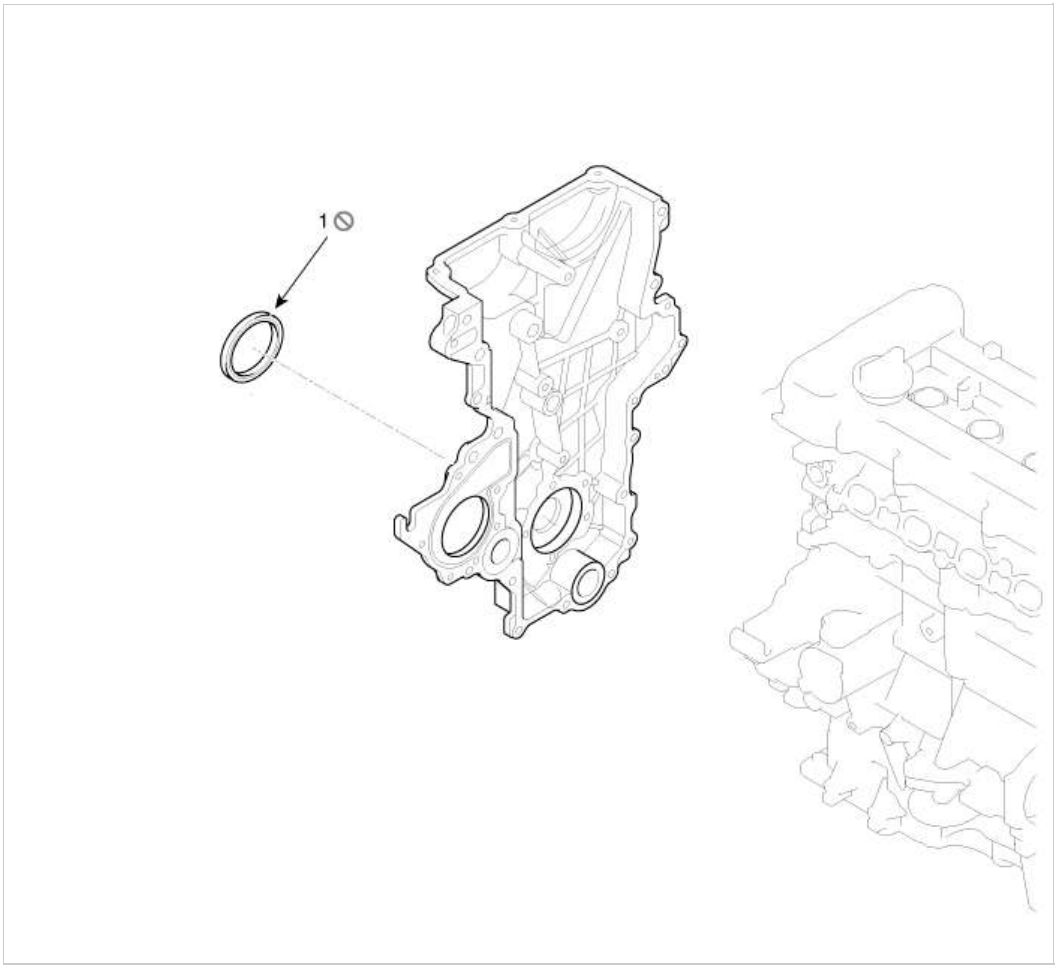
5. Install in the reverse order of removal.

Inspection

Check the crankshaft damper pulley for vibration in rotation, oil dust deposit of V-ribbed part. Replace if necessary.

Engine Mechanical System

Components

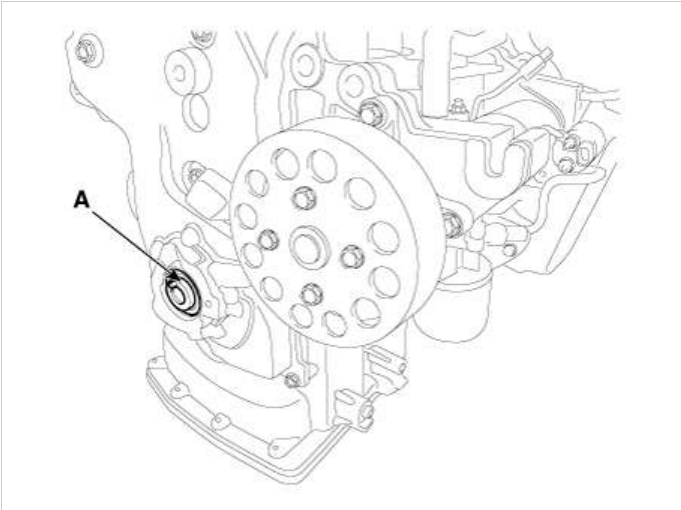


1. Front oil seal

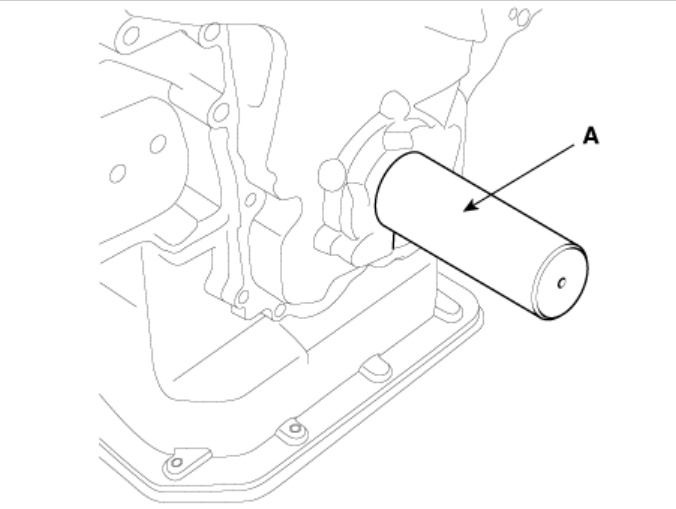
Engine Mechanical System

Replacement

1. Remove the crankshaft damper pulley.
   (Refer to Timing System - "Crankshaft Damper Pulley")
2. Remove the front oil seal (A).



3. Using the SST (09455-21200) (A), install a new front oil seal.

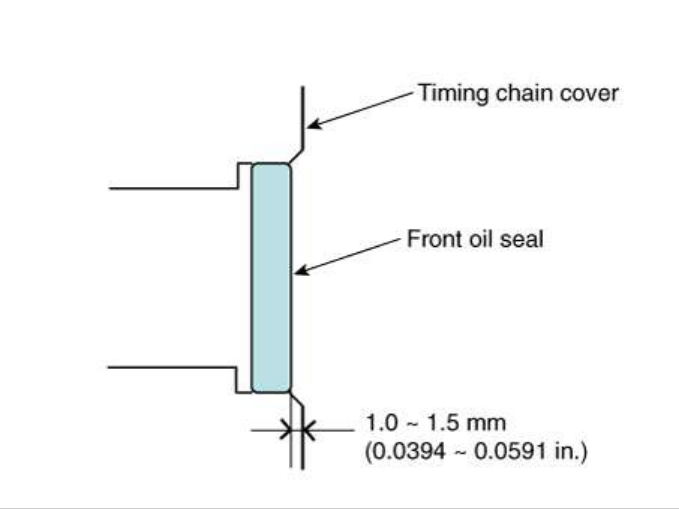


NOTICE

Do not reuse the front oil seal.

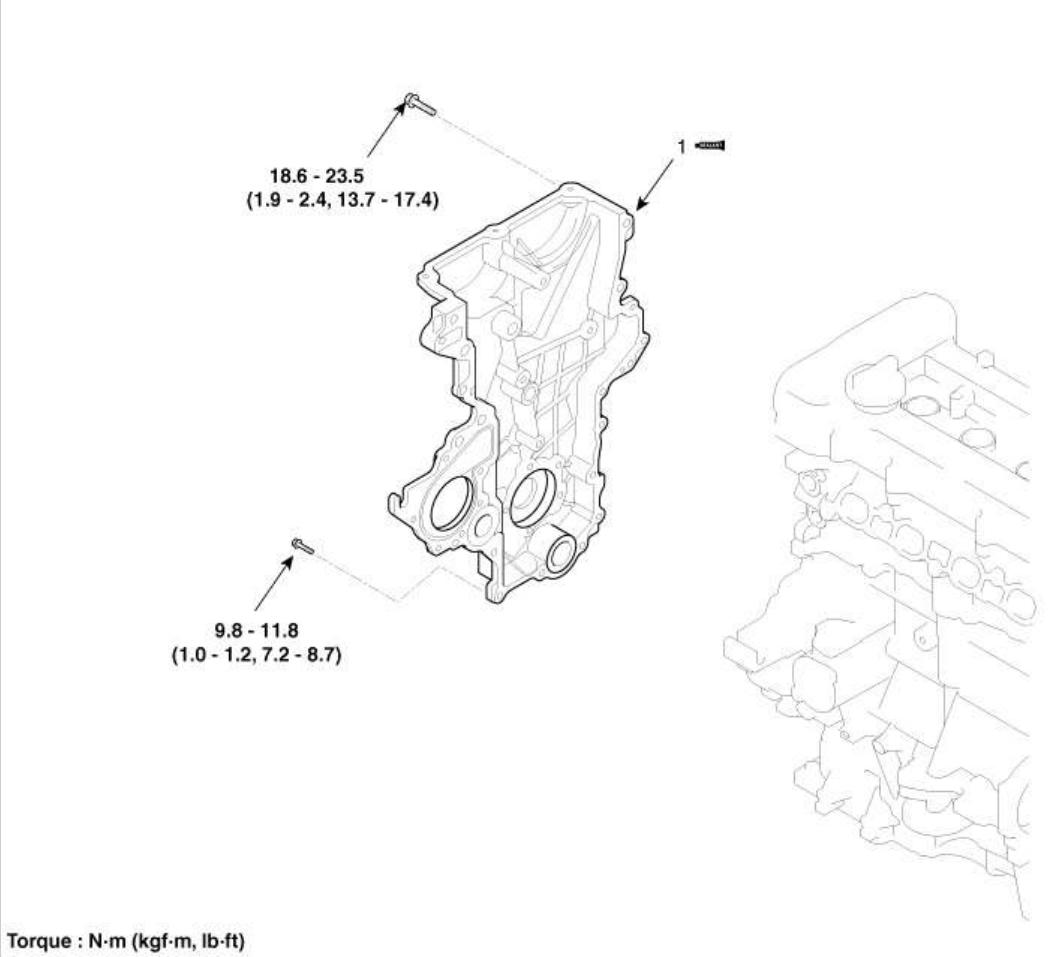
NOTICE

Insert the oil seal into the timing chain cover as shown in illustration.



Engine Mechanical System

Components



1. Timing chain cover

Engine Mechanical System

Removal

CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

Mark all wiring and hoses to avoid misconnection.

WARNING

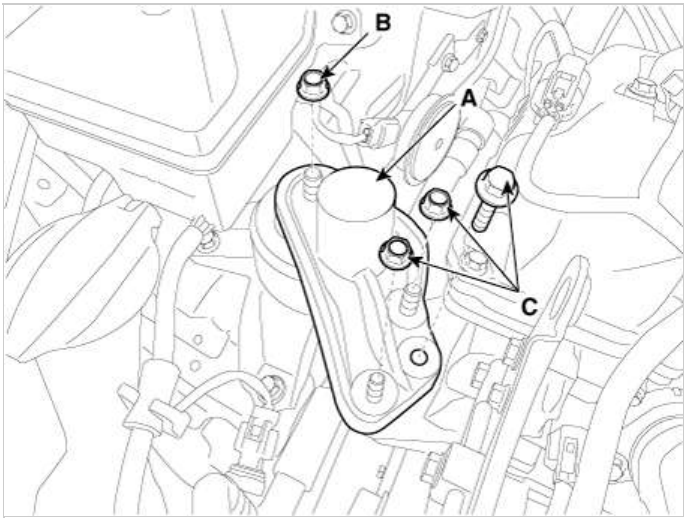
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Remove the drive belt.
   (Refer to Timing System - "Drive Belt")
2. Remove the drive belt idler.
   (Refer to Timing System - "Idler")
3. Remove the alternetor.
   (Refer to Engine Electrical System - "Alternator")
4. Remove the alternetor bracket.
   (Refer to Engine Electrical System - "Alternator")
5. Remove the engine room under cover.
   (Refer to Engine And Transaxle Assembly - "Engine Room Under Cover")

6. Remove the crankshaft damper pulley.
   (Refer to Timing System - "Crankshaft Damper Pulley")
7. Remove the water pump.
   (Refer to Cooling System - "Water Pump")
8. Remove the air cleaner assembly.
   (Intake and Exhaust System - "Air Cleaner")
9. Remove the high pressure fuel pump.
   (Refer to Engine Control / Fuel System - "High Pressure Fuel Pump")
10. Remove the cylinder head cover.
    (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
11. Remove the engine mounting support bracket (A).

Tightening torque

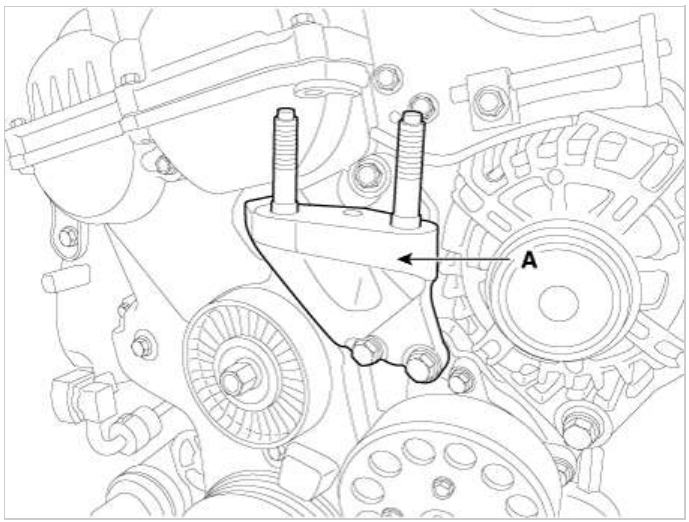
Nut (B):
63.7 - 107.8 N·m (6.5 - 11.0 kgf·m, 47.0 - 79.5 lb·ft)
Bolt and nuts (C):
58.8 - 73.5 N·m (6.0 - 7.5 kgf·m, 43.3 - 54.2 lb·ft)



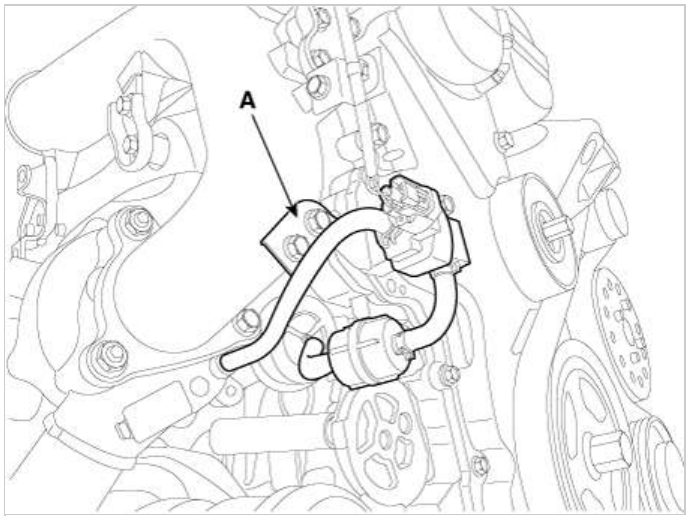
12. Remove the engine support bracket (A).

Tightening torque

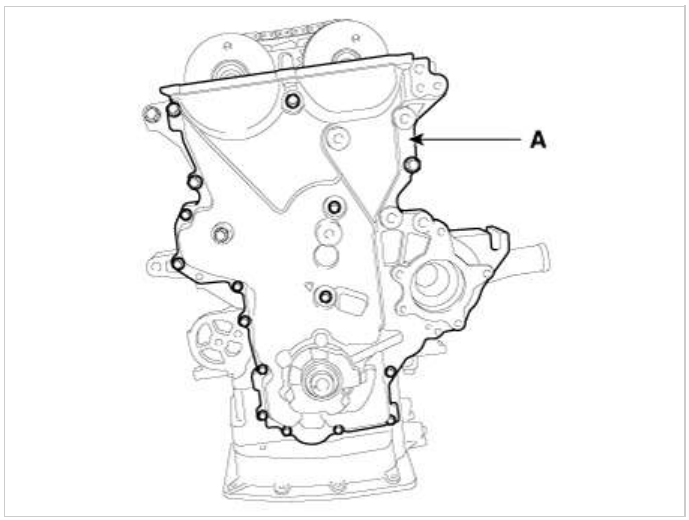
Bolts:
29.4 - 41.2 N·m (3.0 - 4.2 kgf·m, 21.7 - 30.4 lb·ft)



13. Remove the turbo charger actuator solenoid valve bracket (A).

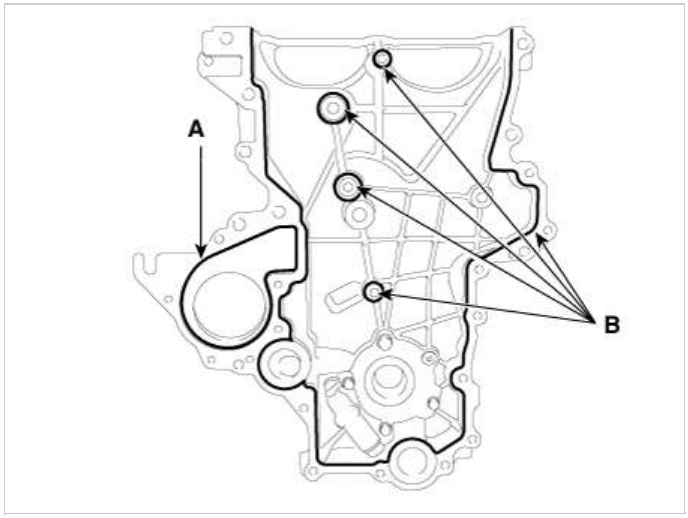


14. Remove the timing chain cover(A).



Installation

1. Install the timing chain cover.
   (1) Before installing, remove the hardened sealant from the cylinder block and ladder frame surface.
   (2) Apply the liquid gasket(TB 1217H or LOCTITE 5900H) on the surface between the cylinder head and the cylinder block.
   Width :3 - 5 mm (0.1181 - 0.1969 in.)



   (3) Apply the liquid gasket, THREE BOND 1282B or THREE BOND 1216E on the water pump contact parts (A) of the timing chain cover and THREE BOND 1217H or LOCTITE 5900H on the rest parts (B).
   Reassemble the cover within 5 minutes.

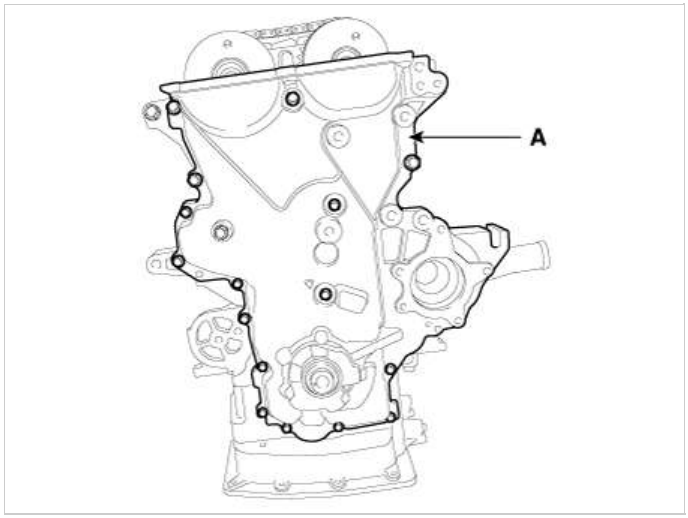
Width :3.5 - 4.5 mm (0.1378 - 0.1772 in)

> **CAUTION**
> Remove oil or dust on the surface surely.

(4) Align the dowel pin of the cylinder block and the holes of the oil pump.

(5) Tighten the bolts to install the timing chain cover (A).

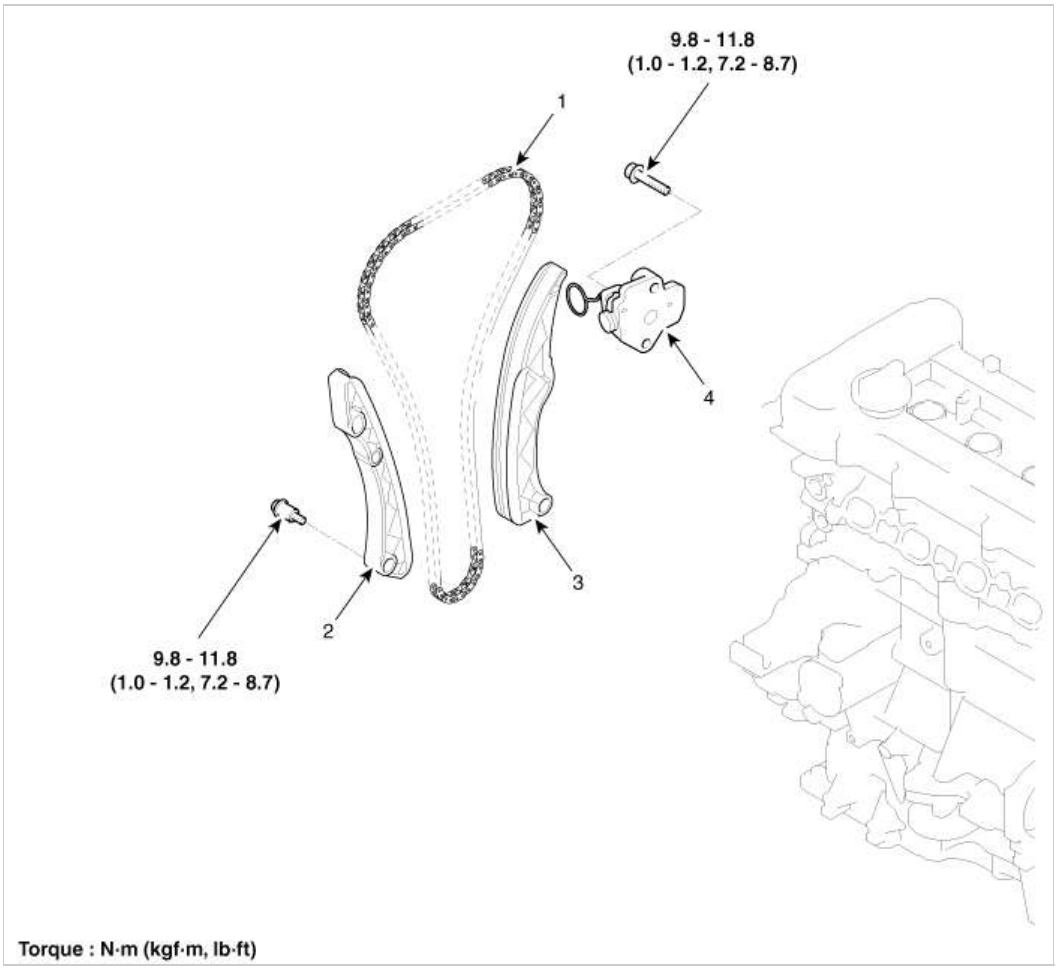
Tightening torque
M8 bolts :
18.6 - 23.5 N·m (1.9 - 2.4 kgf·m, 13.7 - 17.4 lb·ft)·
M6 bolts :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



2. Install the other parts in the reverse order of removal.

Engine Mechanical System

Components

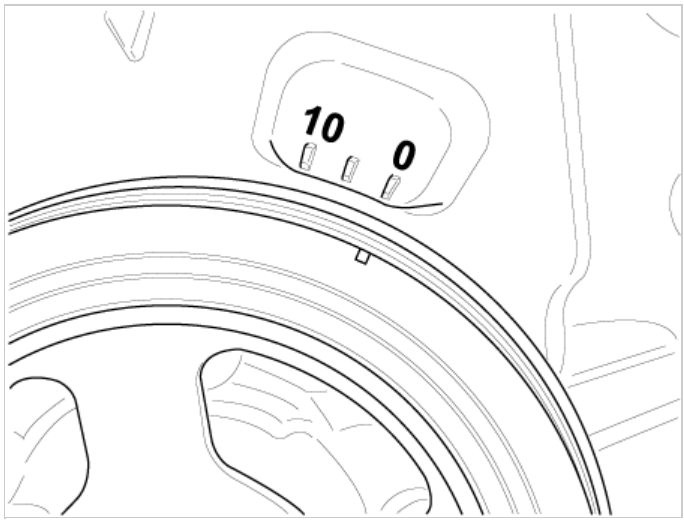


1. Timing chain
2. Timing chain guide
3. Timing chain arm
4. Timing chain auto tensioner

Engine Mechanical System

Removal

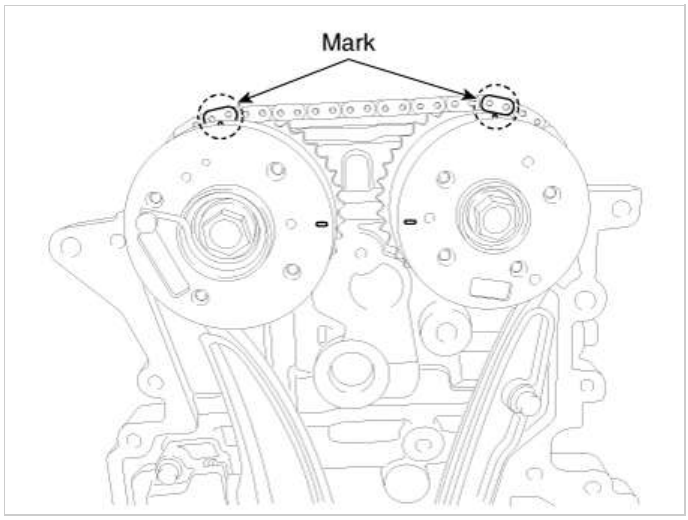
1. Turn the crankshaft pulley clockwise, and align its groove with the timing mark of the timing chain cover.

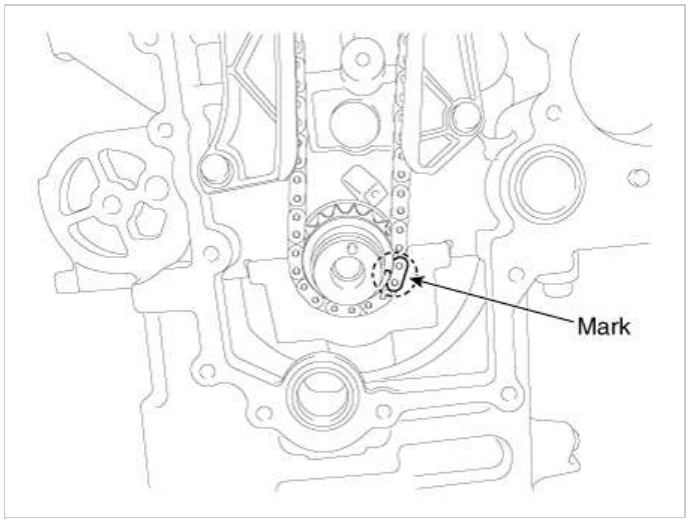


2. Remove the timing chain cover.
   (Refer to Timing System - "Timing Chain Cover")
3. Align the timing marks of the CVVT sprockets with the upper surface of the cylinder head to make No.1 cylinder be positioned at TDC.

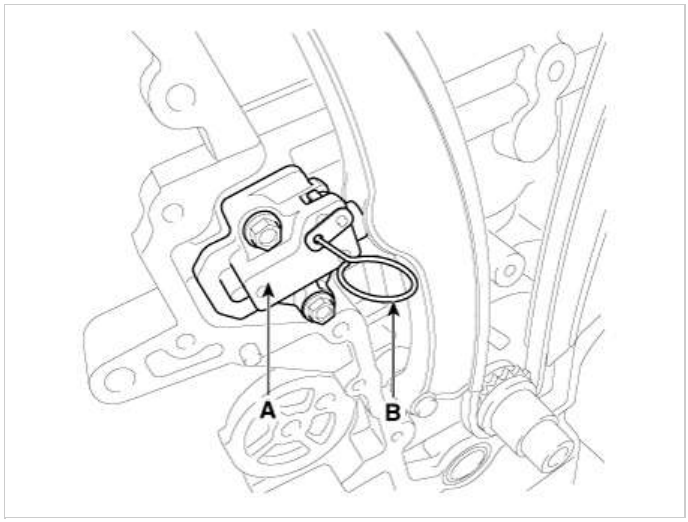
⚠ CAUTION

Check the dowel pin of the crankshaft for facing upside of the engine at this monent.





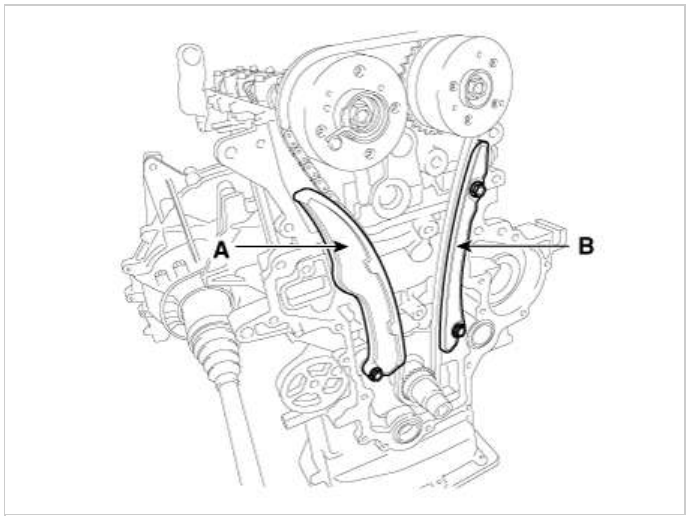
4. Remove the timing chain auto tensioner (A).



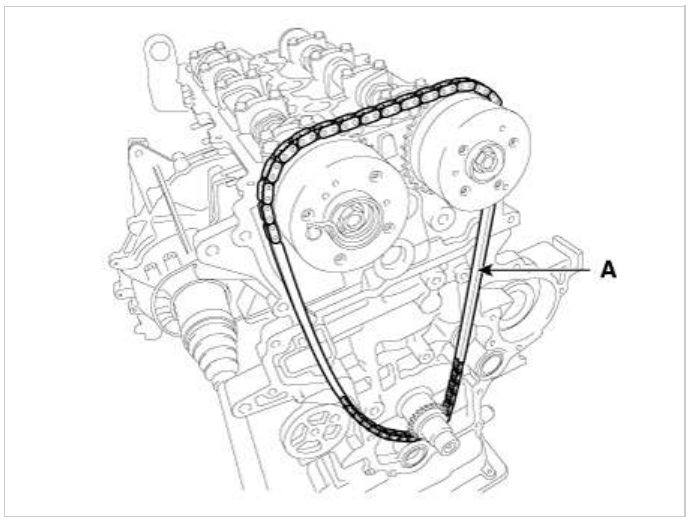
⚠ CAUTION

Before removing the tensioner, fix the piston of the tensioner with a pin through the hole(B) at compressed position.

5. Remove the timing chain tensioner arm (A) and guide (B).



6. Remove the timing chain (A).



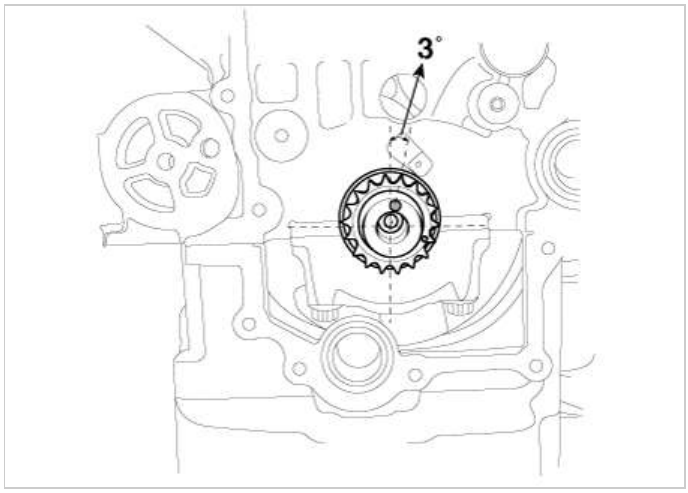
Inspection

Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm, Timing Chain

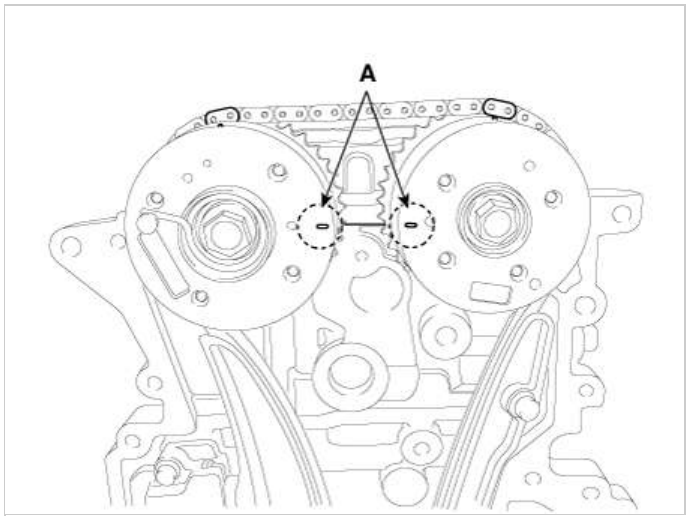
1. Check the CVVT sprocket, crankshaft sprocket teeth for abnormal wear, cracks or damage. Replace if necessary.
2. Check a contact surface of the chain tensioner arm and guide for abnormal wear, cracks or damage. Replace if necessary.
3. Check the hydraulic tensioner for its piston stroke and ratchet operation. Replace if necessary.
4. Check the timing chain for its elongation, abnormal wear or damage. Replace if necessary.

Installation

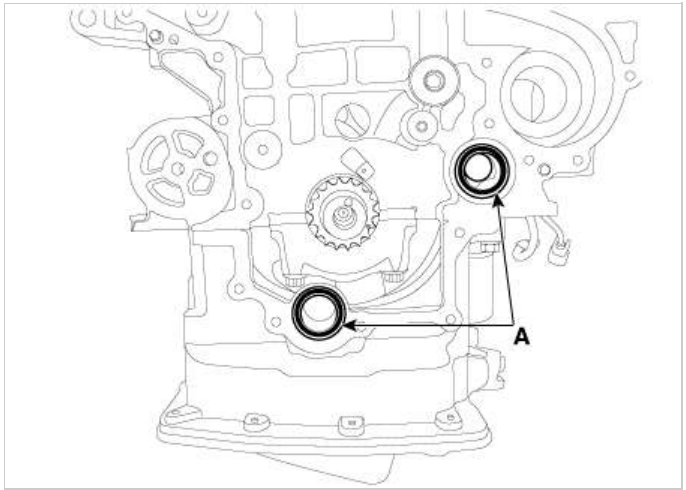
1. Dowel pin of crankshaft should be positioned at 3° in relation to vertical center line.



2. Align the TDC marks (A) of the CVVT sprockets with the upper surface of the cylinder head to make No.1 cylinder be positioned at TDC.



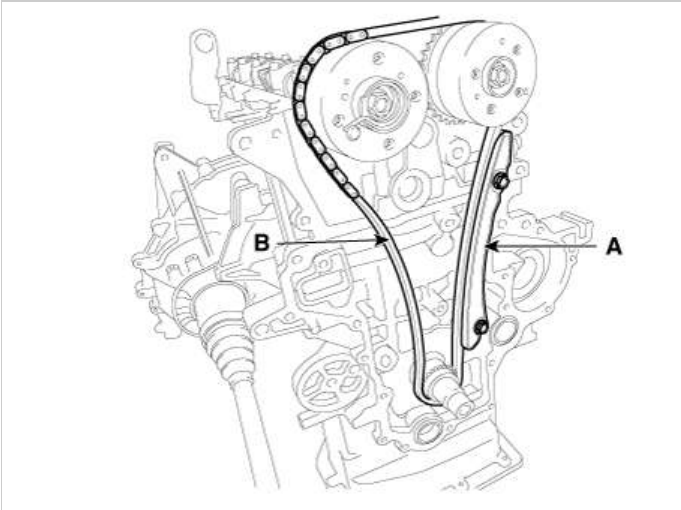
3. Install the new O-rings (A).



4. Install the timing chain guide (A) and the timing chain (B).

Tightening torque :

9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)

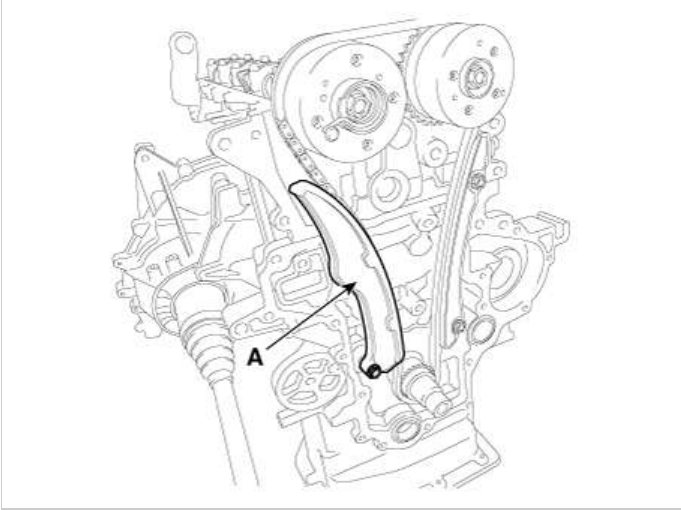


NOTICE

- When installing a timing chain, align the timing marks on the sprockets with paint marks of the chain.
- Order : Crankshaft sprocket → Timing chain guide → Intake CVVT sprocket → Exhaust CVVT sprocket.

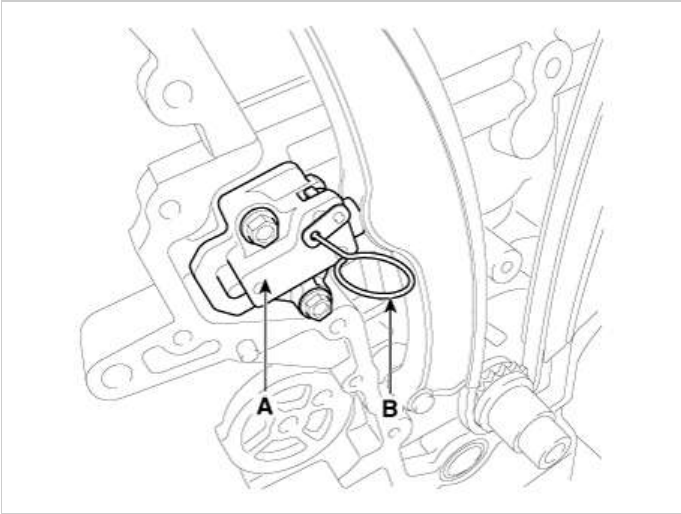
5. Install the chain tensioner arm (A).

Tightening torque :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



6. Install the timing chain auto tensioner (A) and remove the pin (B).

Tightening torque :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



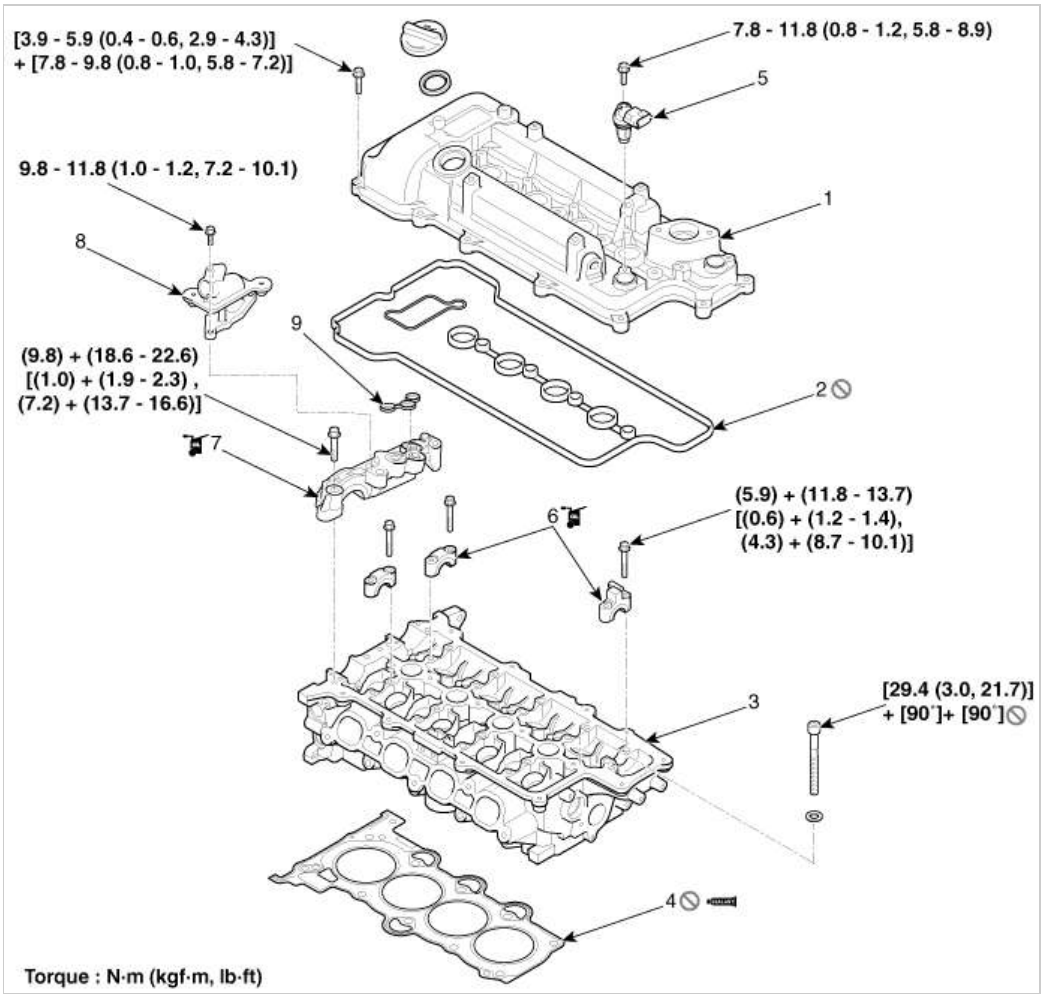
NOTICE

Recheck the top dead center (TDC) marks on the crankshaft and camshaft.

7. Install the other parts in the reverse order of removal.

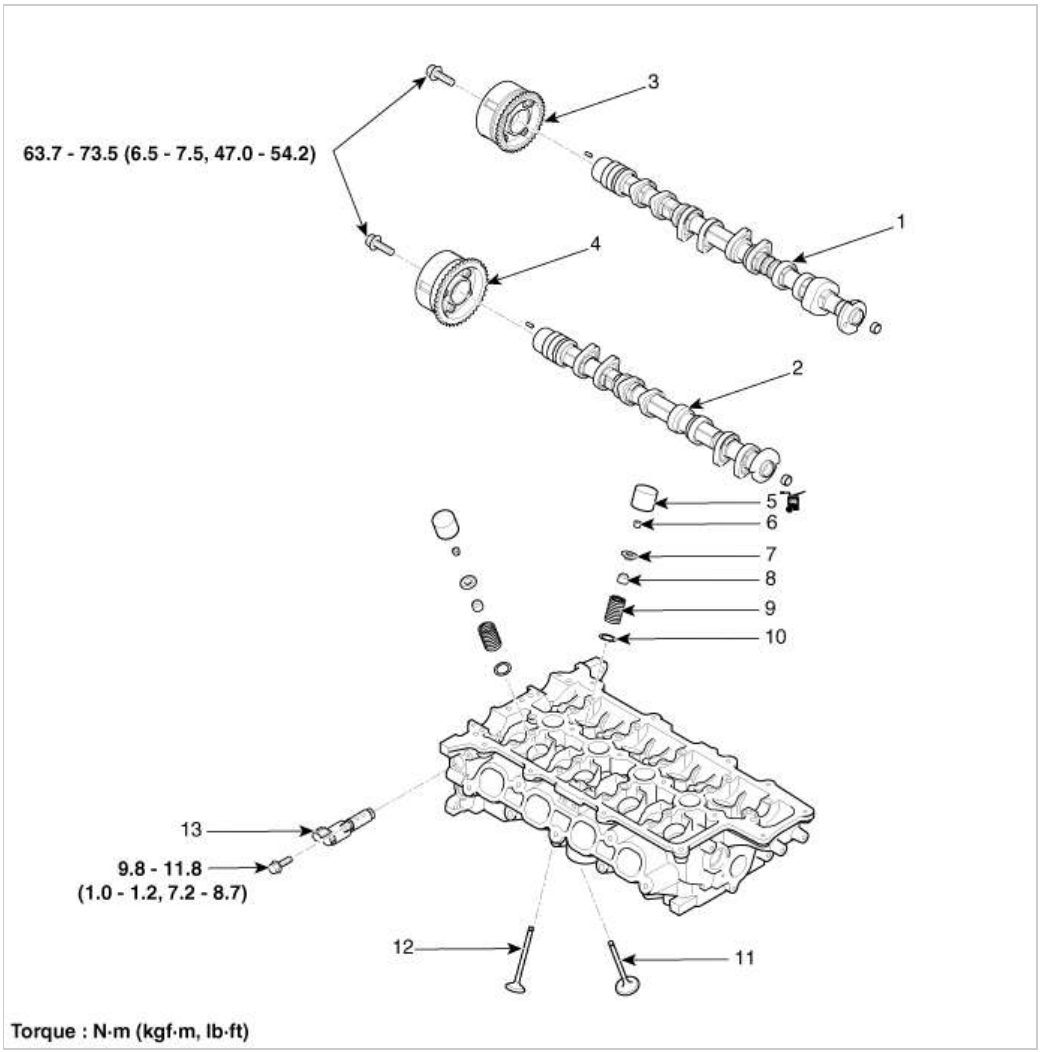
Engine Mechanical System

Components



1. Cylinder head cover
2. Cylinder head cover gasket
3. Cylinder head assembly
4. Cylinder head gasket
6. Camshaft bearing cap
7. Camshaft front bearing cap
8. OCV (Oil Control Valve) adapter
9. O-ring

5. Camshaft position sensor



1. Exhaust camshaft
2. Intake camshaft
3. Exhaust CVVT assembly
4. Intake CVVT assembly
5. Mechanical Lash Adjuster (MLA)
6. Retainer lock
7. Retainer
8. Valve stem seal
9. Valve spring
10. Valve spring seat
11. Intake valve
12. Exhaust valve
13. Oil Control Valve (OCV)

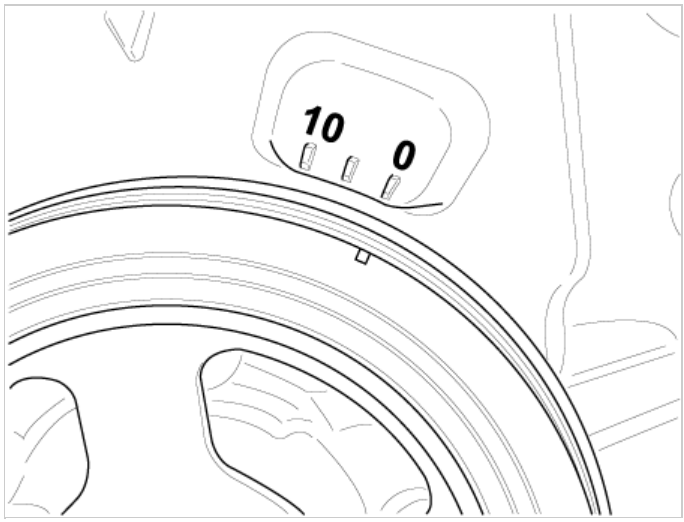
Engine Mechanical System

Valve Clearance Inspection And Adjustment

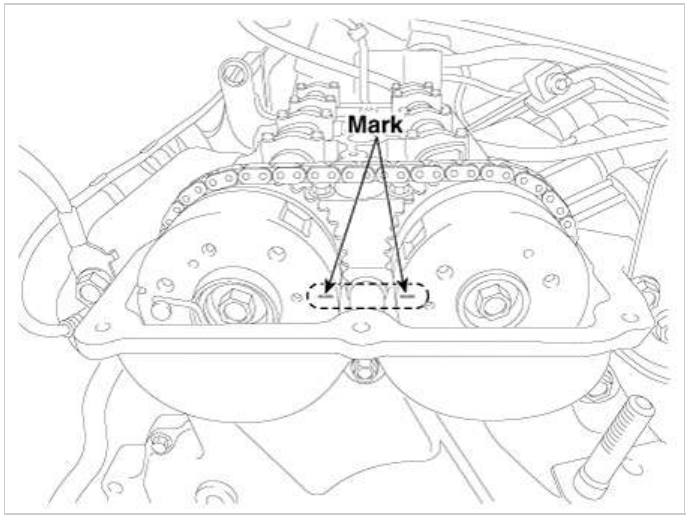
NOTICE

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C) and cylinder head is installed on the cylinder block.

1. Remove the cylinder head cover.
   (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
2. Set No.1 cylinder to TDC/compression.
   (1) Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover.



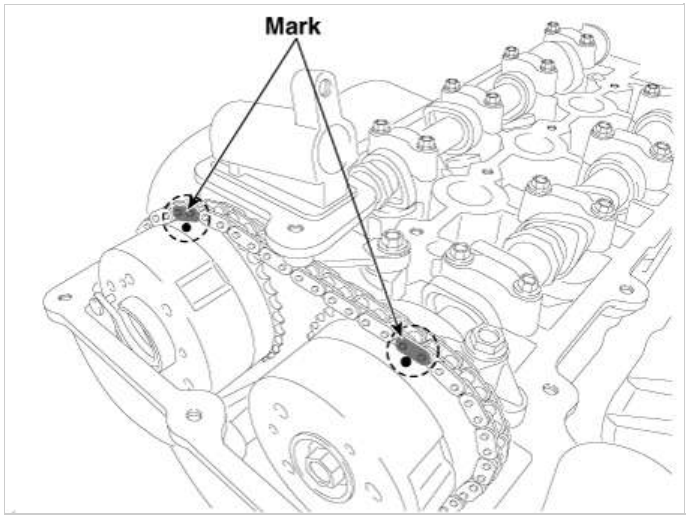
(2) Check that the marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft one revolution (360°).



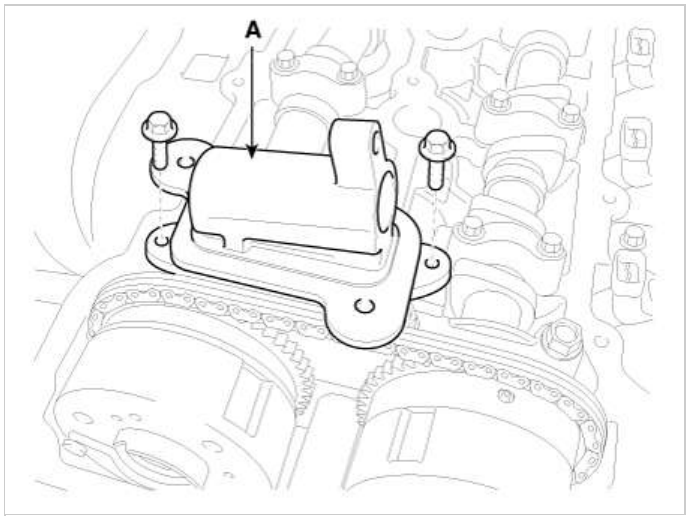
NOTICE

Do not turn the crankshaft damper pulley counterclockwise.

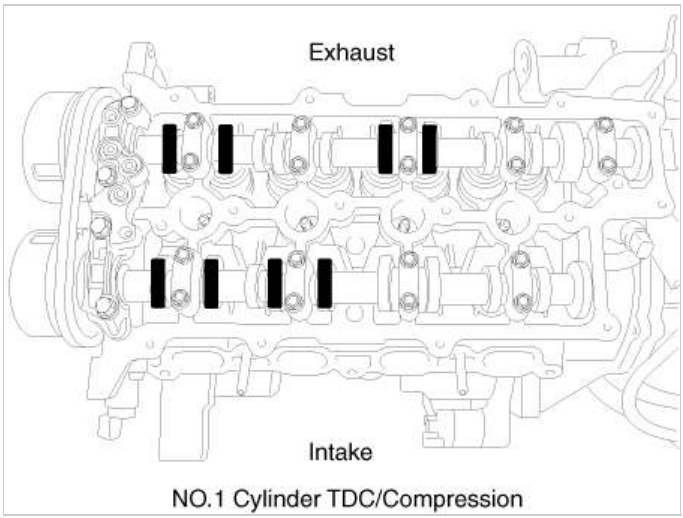
(3) Mark the timing chain links corresponding to the timing marks on the CVVT sprockets with a indelible marker.



3. Remove the exhaust oil control valve (OCV) adaptor (A).



4. Inspect the valve clearance.
   (1) Check only the intake valves of the 1st and 2nd cylinders and exhaust valves of the 1st and 3rd cylinders for their clearance.
   - Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.

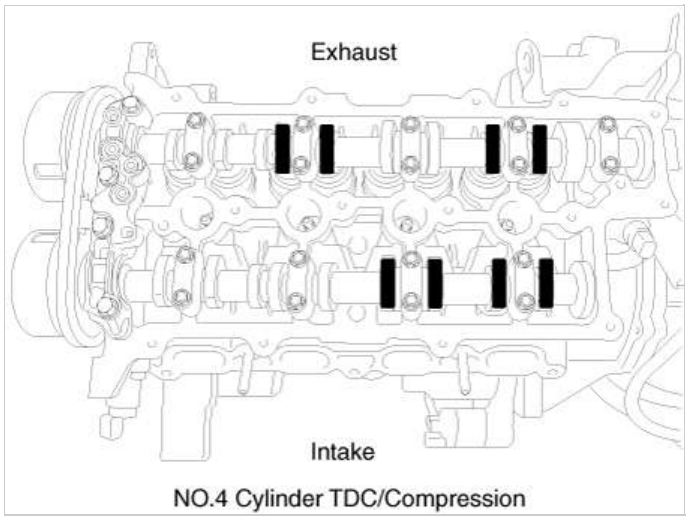


   - Record the out-of-specification valve clearance measurements. They will be used later to determine the required tappet for adjusting.

Valve clearance specification (Engine coolant temperature : 20°C [68°F])
Limit
Intake : 0.17 - 0.23mm (0.0067 - 0.0091in.)
Exhaust : 0.22 - 0.28mm (0.0087 - 0.0110in.)

   (2) Turn the crankshaft pulley one revolution (clockwise 360°) and align its groove with timing mark of the timing chain cover.

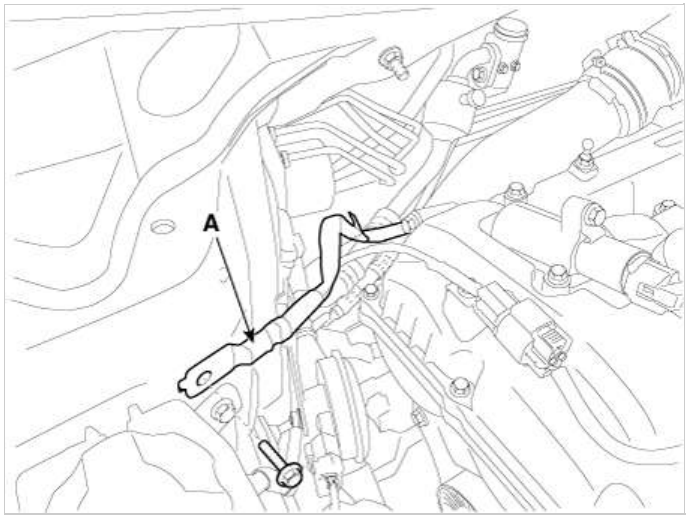
   (3) Check the intake valves of the 3rd and 4th cylinders and exhaust valves of the 2nd and 4th cylinders for their clearance.



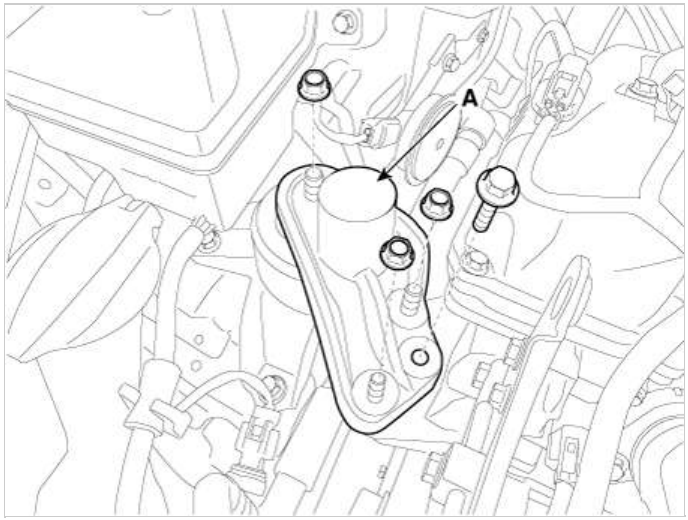
5. Remove the engine mounting support bracket.
   (1) Put a jack under the oil pan.

> **NOTICE**
> Place a wooden block between the jack and the oil pan to prevent damage to the oil pan.

   (2) Disconnect the engine ground cable (A).

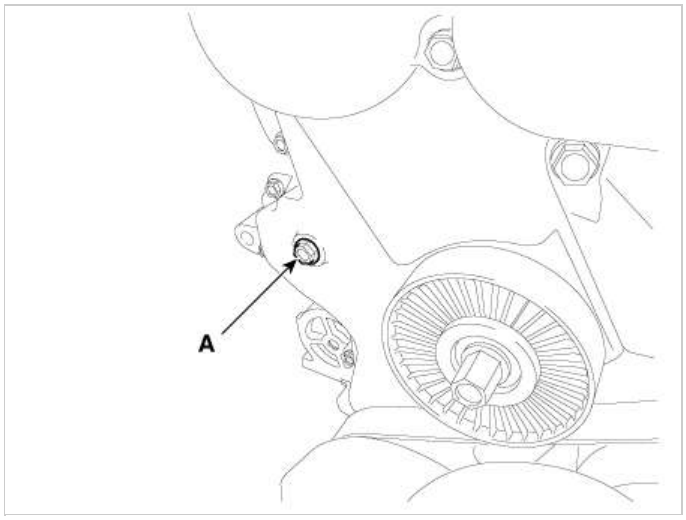


   (3) Remove the engine mounting support bracket (A).



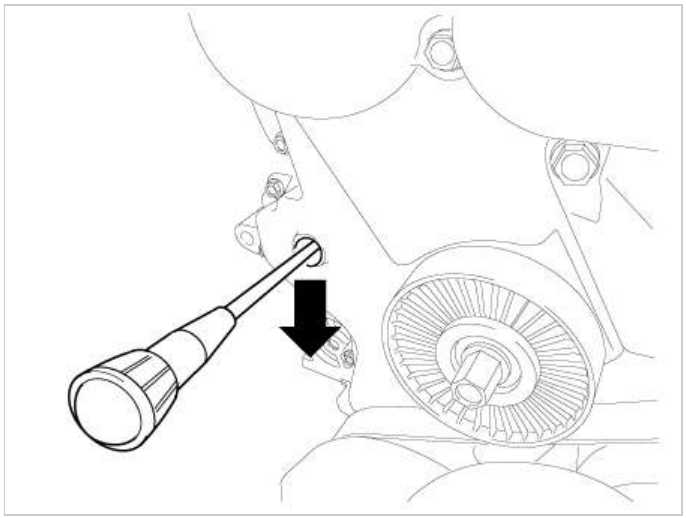
   (4) Lift the engine slightly using the jack to obtain space for releasing the timing chain tensioner.

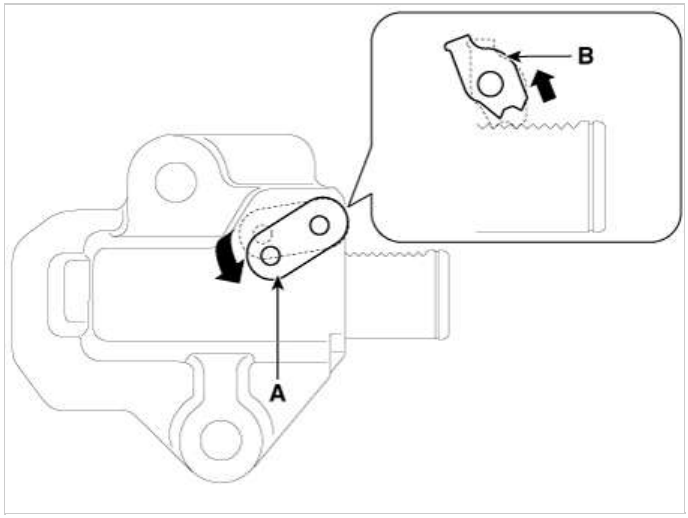
6. Adjust the intake and exhaust valve clearance.
   (1) Remove the bolt (A) from the service hole in the timing chain cover.



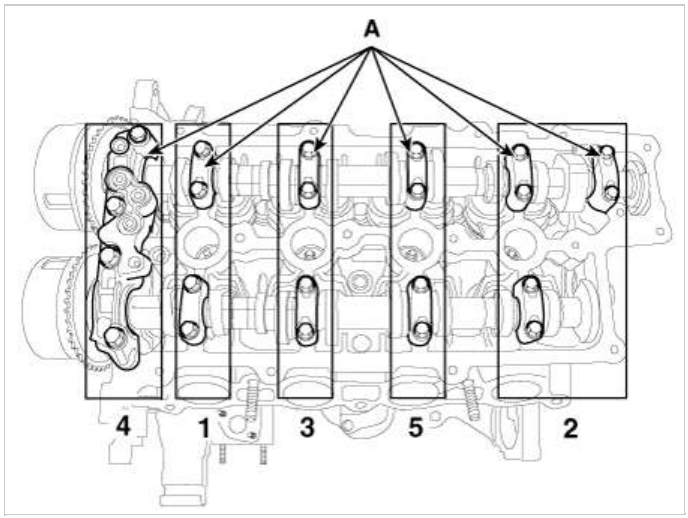
(2) Lock the timing chain tensioner in the fully retracted position.

Insert a pick into the service hole in the timing chain cover and lower the hole in the left side of the ratchet plate (A) on the tensioner to allow the pawl (B : located inside the tensioner behind the rachet plate) to be lifted.

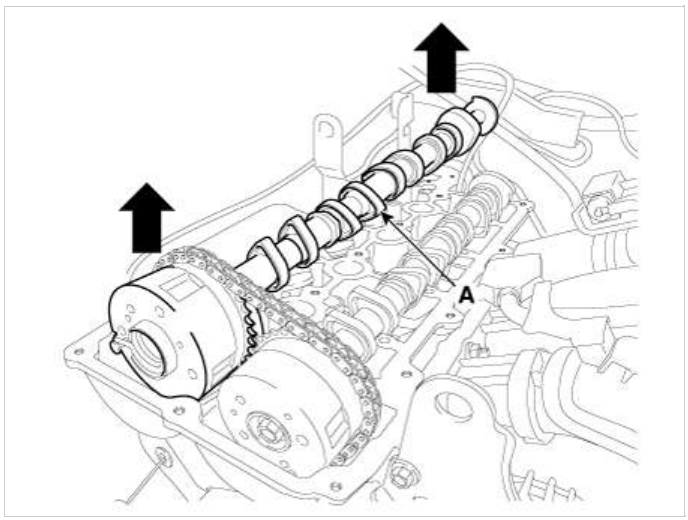


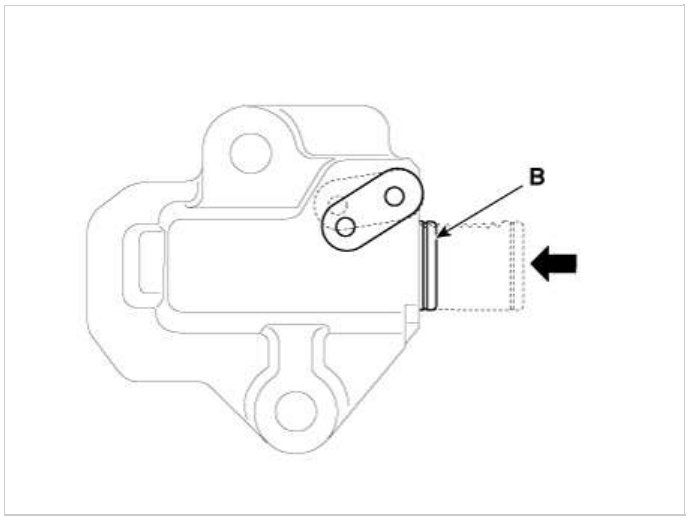


(3) Remove the camshaft bearing caps (A) with the order below.

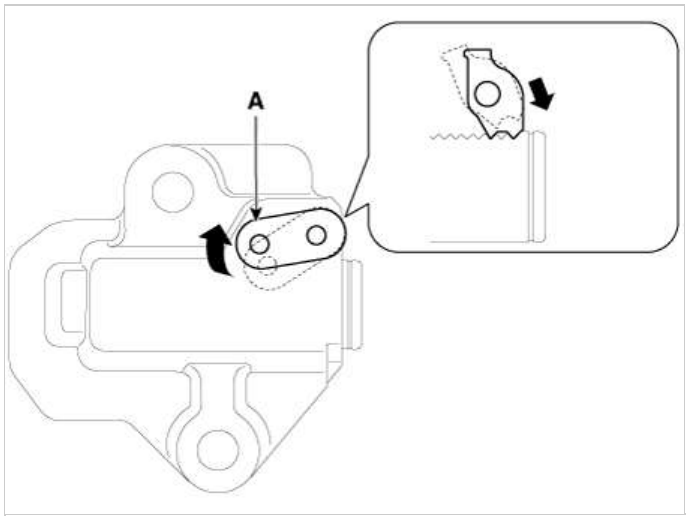


(4) With the pawl lifted, have a helper pull up the exhaust CVVT & camshaft (A) to allow the tensioner plunger (B) to retract.

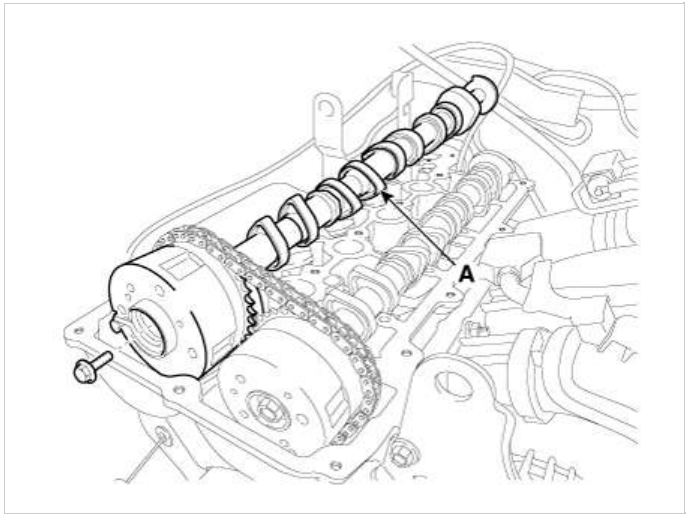




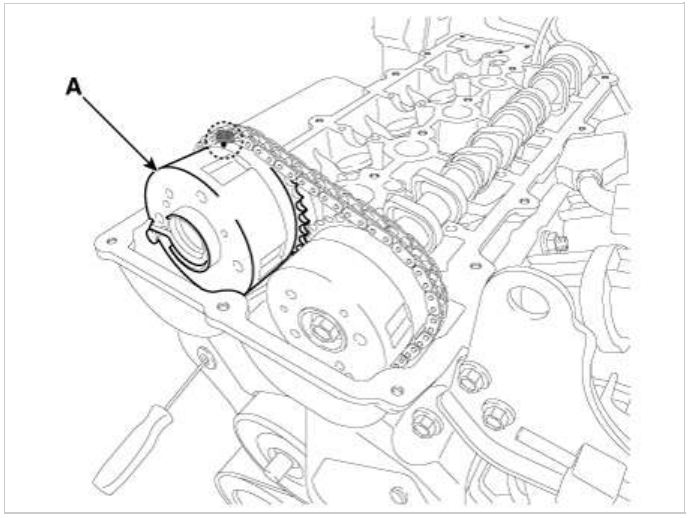
(5) With the tensioner plunger in the fully retracted position, raise the hole in the left side of the ratchet plate (A) again through the service hole in the chain cover to align the ratchet plate hole with the hole in the tensioner body behind the ratchet plate, then lock the tensioner by inserting the pick through the ratchet plate and tensioner body holes.



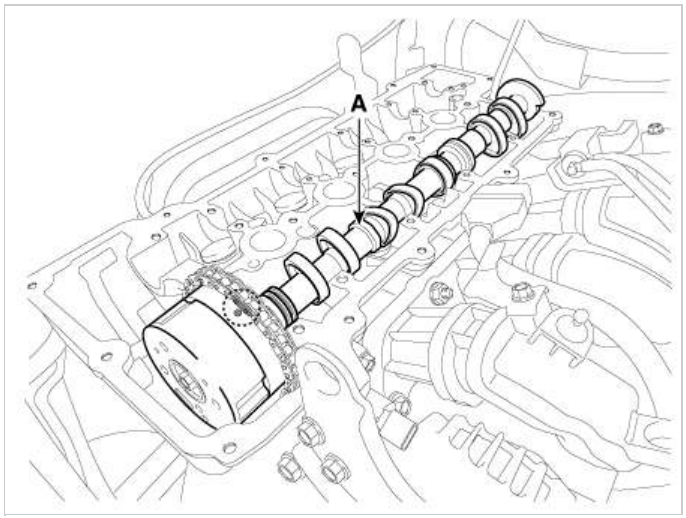
(6) Separate the exhaust camshaft (A) from the exhaust CVVT by removing the bolt.



(7) Remove the exhaust CVVT (A) from the timing chain.

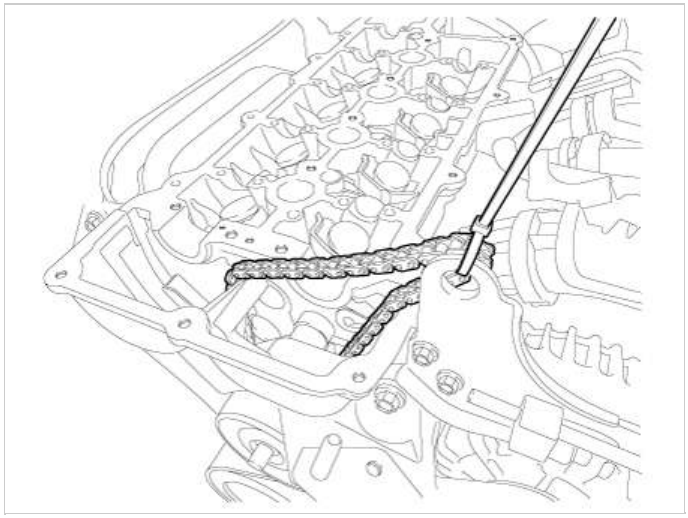


(8) Remove the intake CVVT & camshaft (A).

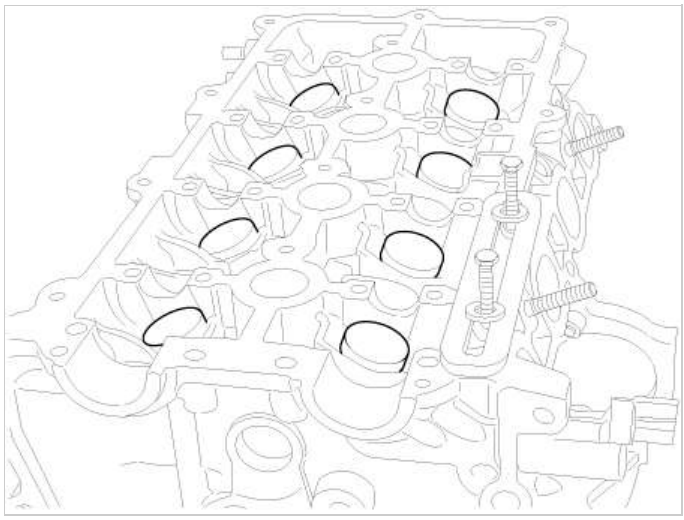


NOTICE

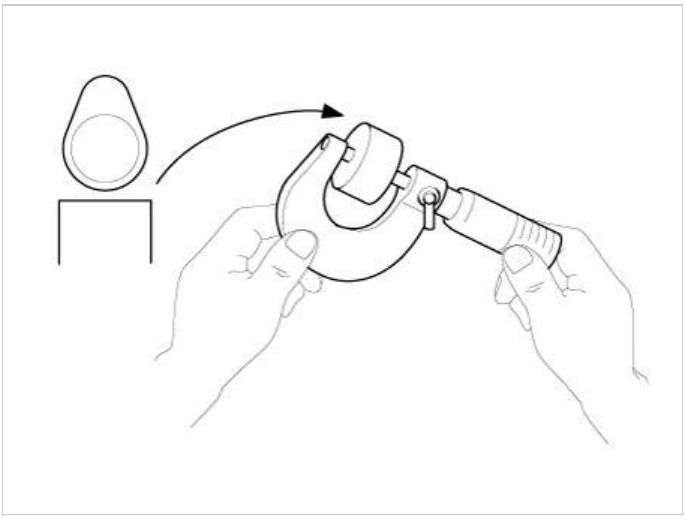
Fasten the timing chain to the engine hanger with a cable tie or strap not to allow the timing chain to fall down when removing the intake CVVT & camshaft.



(9) Remove the tappet(s) in out-of-specification valve clearance from the cylinder head.



(10) Measure the thickness of the removed tappet using a micrometer.



(11) Calculate the thickness of a new tappet so that the valve clearance comes within the specificified value.

Valve clearance (Engine coolant temperature : 20°C)
T : Thickness of removed tappet
A : Measured valve clearance
N : Thickness of new tappet
Intake : N = T + [A - 0.20mm(0.0079in.)]
Exhaust : N = T + [A - 0.25mm (0.0098in.)]

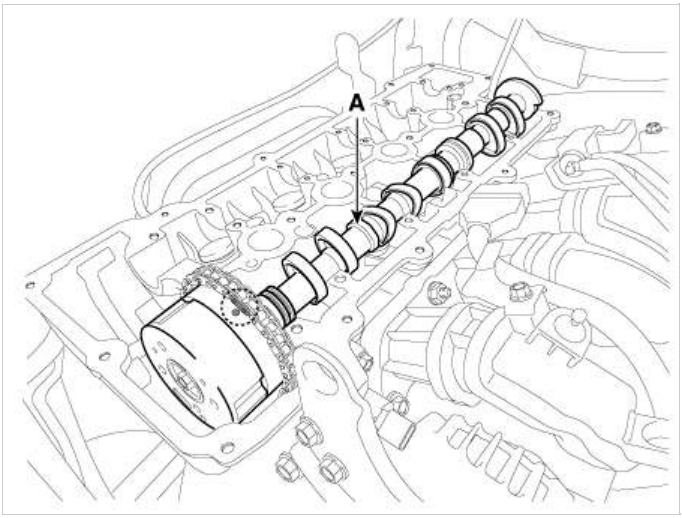
(12) Select a new tappet with a thickness as close as possible to the caculated value.

NOTICE

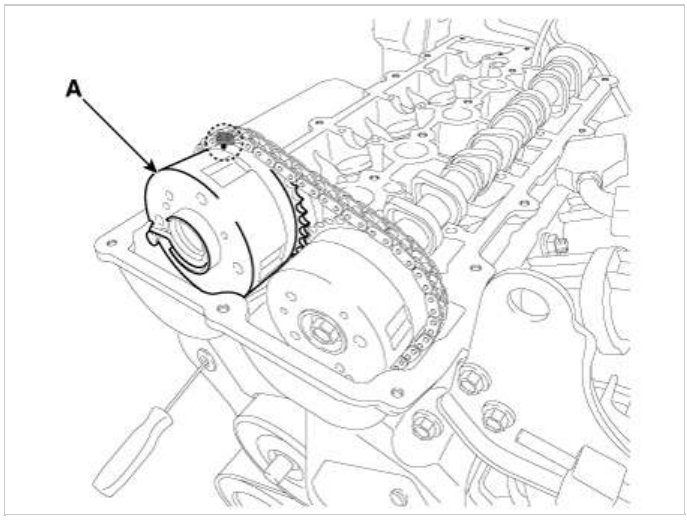
Shims are available in 41 size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1417in.)

(13) Place a new tappet on the cylinder head.

(14) Install the intake CVVT & camshaft (A), with the timing mark on the intake CVVT sprocket aligned with the mark (painted link) on the timing chain.



(15) Install the exhaust CVVT (A), with the timing mark on the exhaust CVVT sprocket aligned with the mark (painted link) on the timing chain.

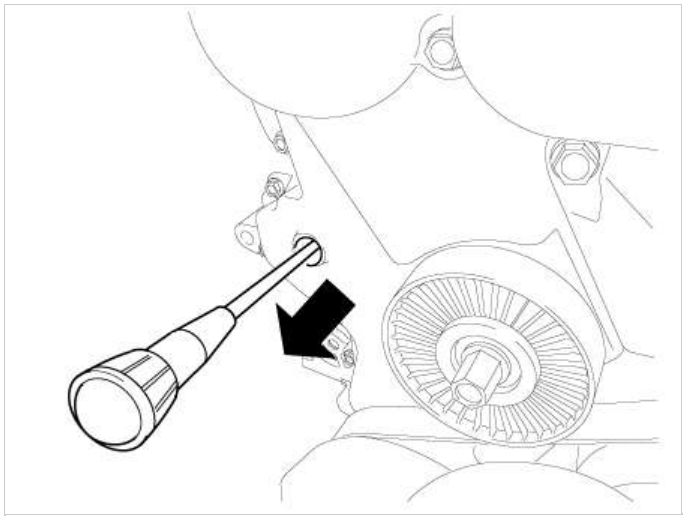


(16) Install the exhaust camshaft (A) to the exhaust CVVT.

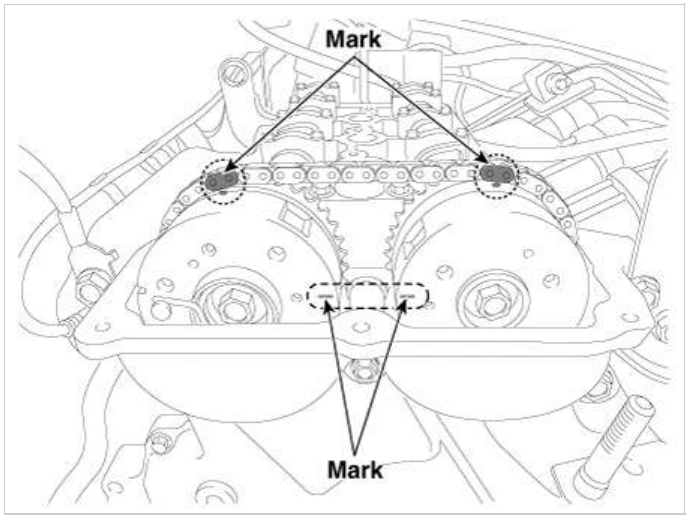
Tightening torque :

63.7 - 73.5 N·m (6.5 - 7.5 kgf·m, 47.0 - 54.2 lb·ft)

(17) Remove the pick from the service hole in the timing chain cover.



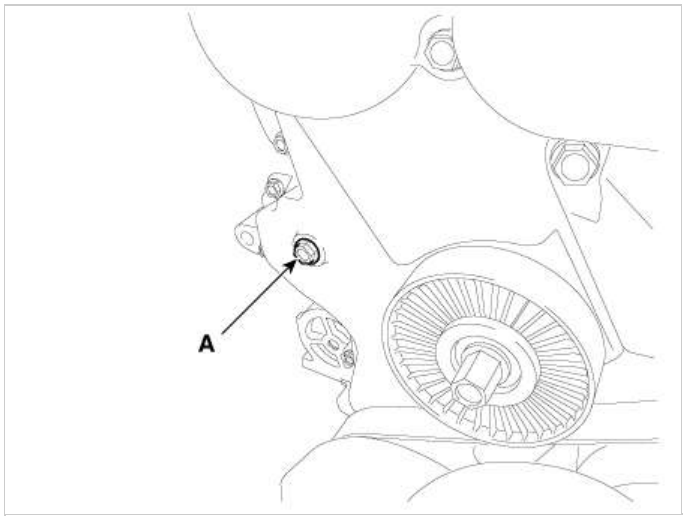
(18) Check that each timing mark of the intake and exhaust CVVT sprockets is aligned as shown in the picture.



(19) Install the bolt (A) to the service hole in the timing chain cover.

Tightening torque :

27.5 - 30.4 N·m (2.8 - 3.1 kgf·m, 20.3 - 22.4 lb·ft)



(20) Install the engine mounting support bracket.

(1) Install the engine mounting support bracket (A).

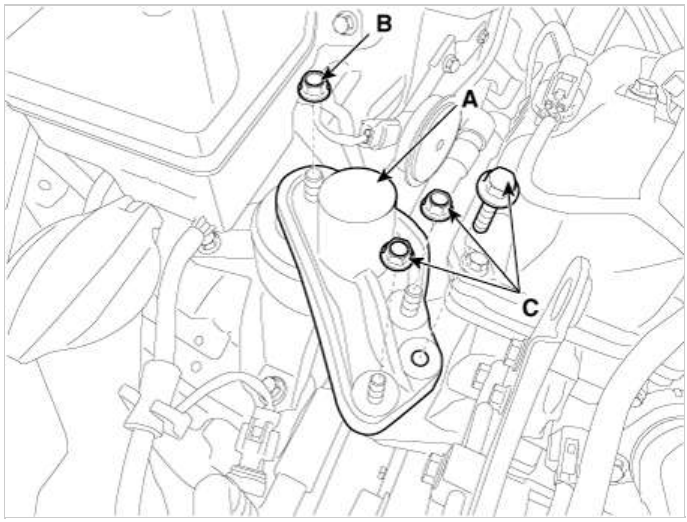
Tightening torque

Nut (B) :

63.7 - 107.8 N·m (6.5 - 11.0 kgf·m, 47.0 - 79.5 lb·ft)

Bolt and Nuts (C) :

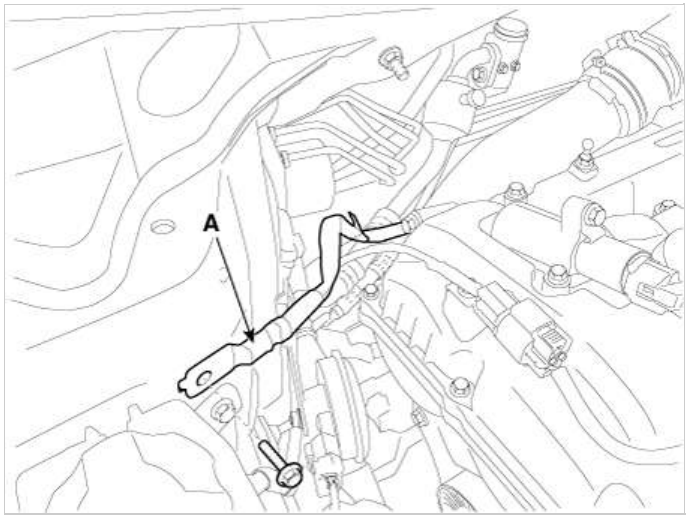
58.8 - 73.5 N·m (6.0 - 7.5 kgf·m, 43.4 - 54.2 lb·ft)



(2) Connect the engine ground cable (A).

Tightening torque :

10.8 - 13.7 N·m (1.1 - 1.4 kgf·m, 8.0 - 10.1 lb·ft)



(3) Remove the jack from the oil pan.

(21) Install the camshaft bearing caps with the order below.

Tightening torque :

1st step

M6 bolt :

5.9 N·m (0.6 kgf·m, 4.3 lb·ft)

M8 bolt :

9.8 N·m (1.0 kgf·m, 7.2 lb·ft)

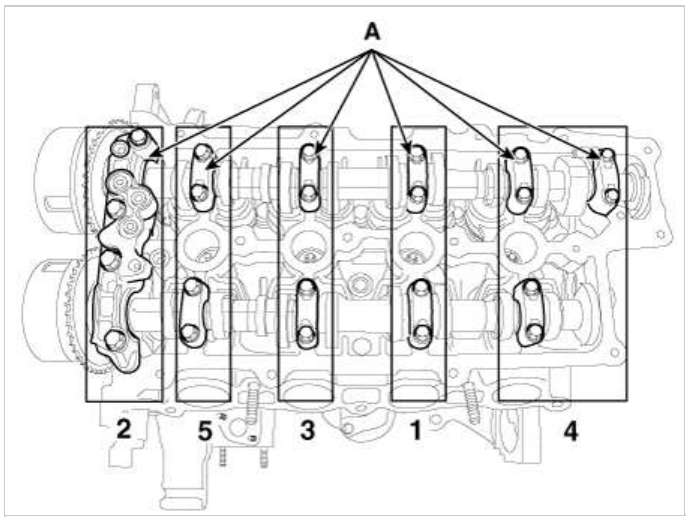
2nd step

M6 bolts :

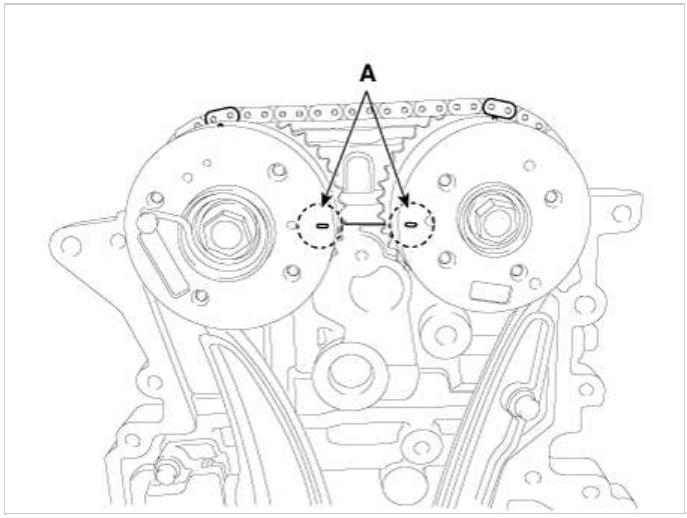
11.8 - 13.7N·m (1.2 - 1.4kgf·m, 8.7 - 10.1lb·ft)

M8 bolts :

18.6 - 22.6N·m (1.9 - 2.3kgf·m, 13.7 - 16.6lb·ft)



(22) Turn the crankshaft two turns in the operating direction(clockwise) and check that the marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface.



(23) Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C)

[Specification]

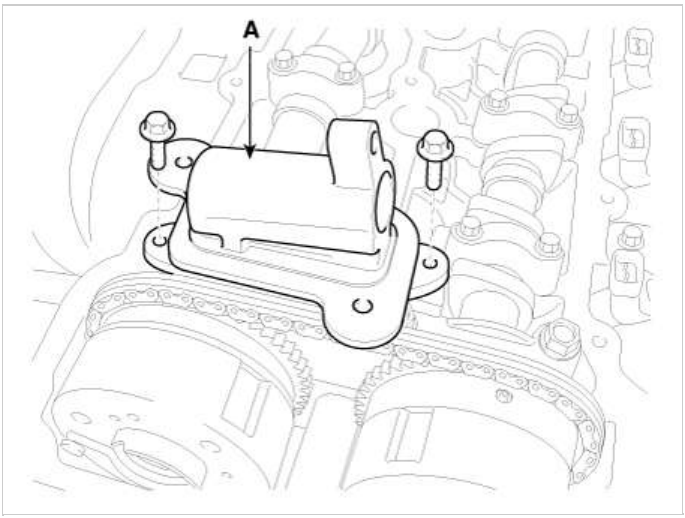
Intake : 0.17 - 0.23mm (0.0067 - 0.0091in.)

Exhaust : 0.22 - 0.28mm (0.0087 - 0.0110in.)

(24) Install the exhaust oil control valve (OCV) adaptor (A).

Tightening torque :

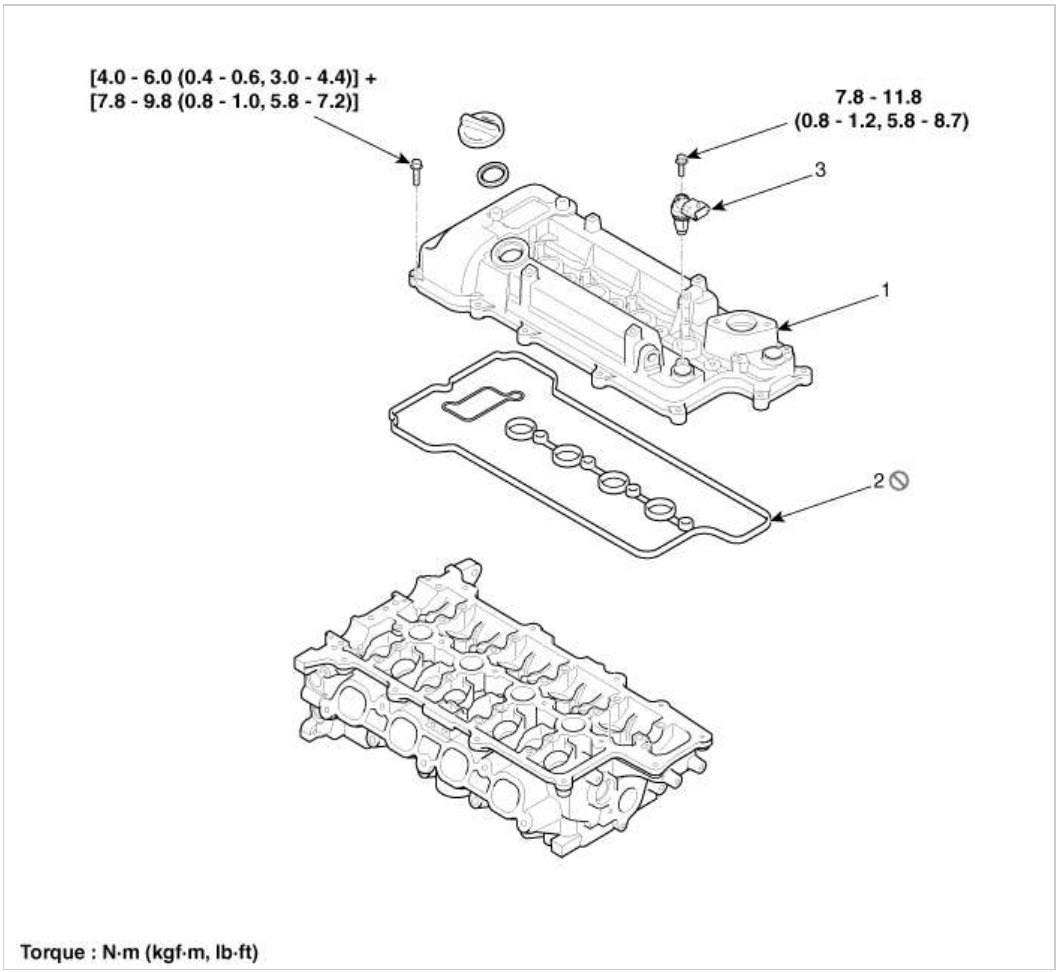
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



(25) Install the cylinder head cover.
(Refer to Cylinder Head Assembly - "Cylinder Head Cover")

Engine Mechanical System

Components



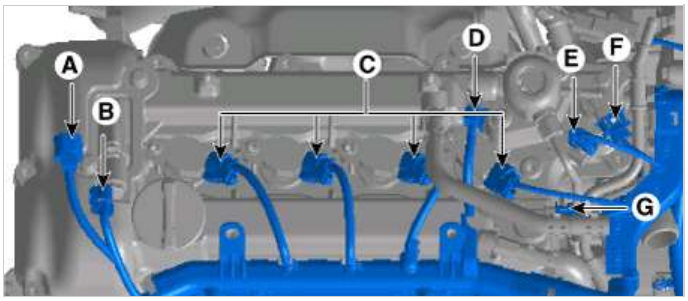
1. Cylinder head cover
2. Cylinder head cover gasket
3. Cam position sensor

Engine Mechanical System

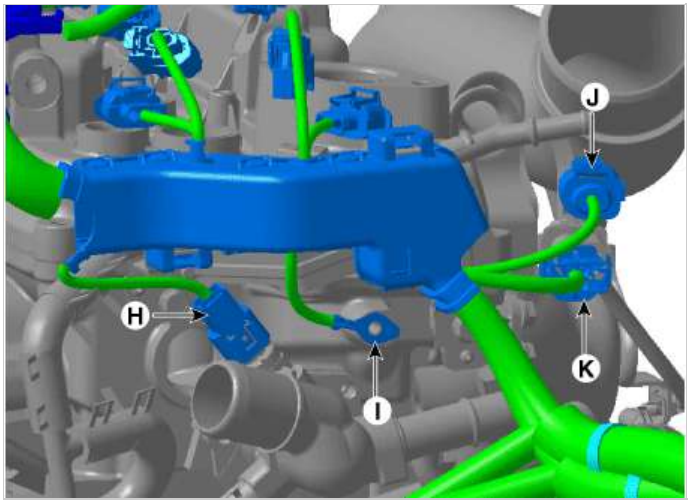
Removal

1. Remove the engine cover.

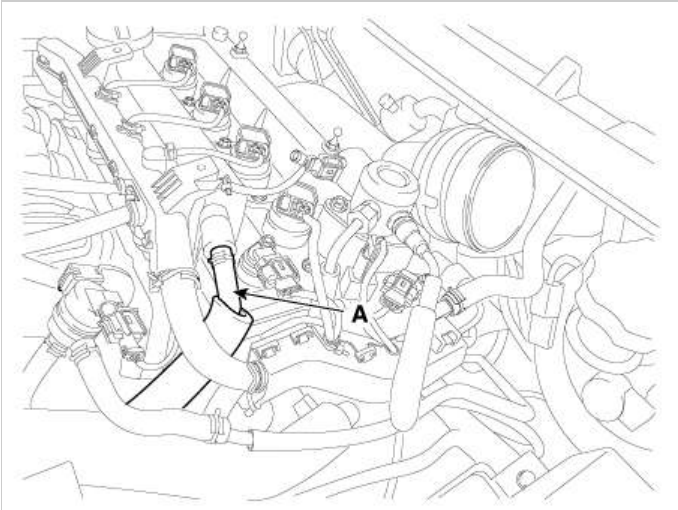
2. Disconnect the battery negative terminal.
3. Remove the air cleaner intake hose.
   (Refer to Intake and Exhaust System - "Air Cleaner")
4. Disconnect the engine wiring connector and haness clamp and then remove the cylinder head protector and wiring from engine.
   A. Turbo charger solenoid valve connector
   B. Exhaust OCV(Oil Control Valve) connector
   C. Ignition connector # 1,2,3,4
   D. FPCV(Fuel Pressure Control Valve) connector
   E. Condenser connector
   F. Exhaust CMPS(Cam position Sensor) connector
   G. Intake CMPS(Cam Positoin Sensor) connector



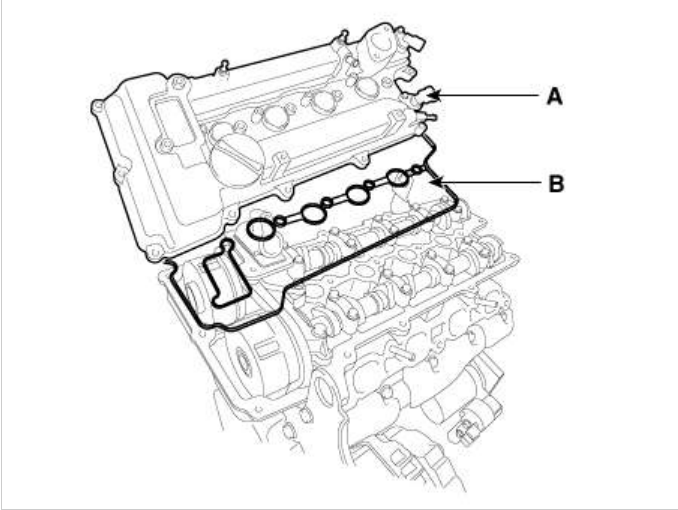
   H. WTS(Water Temperature Sensor) connector
   I. Ground Cable
   J. Front Oxygen Sensor connector
   K. Rear Oxygen Sensor connector



5. Disconnect the exhaust OCV(Oil Control Valve) connector.
   (Refer to Engine Control / Fuel System - "CVVT Oil Control Valve")
6. Disconnect the ignition coil.
   (Refer to Engine Electrical System - "Ignition Coil")
7. Remove the PCV(Positiv Crankcase Ventilation) hose(A).

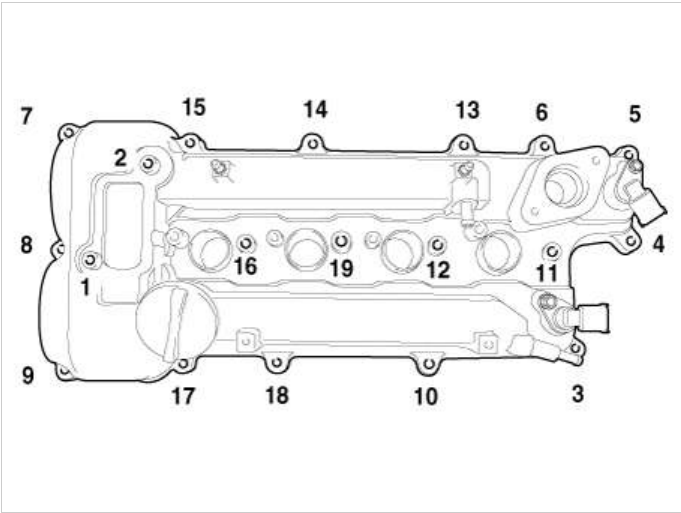


8. Remove the high pressure fuel pump.
   (Refer to Engine Control / Fuel System - "High Pressure Fuel Pump")
9. Remove the cylinder head cover(A), gasket(B).



NOTICE

Loosen the cylinder head cover bolts with the order and steps.

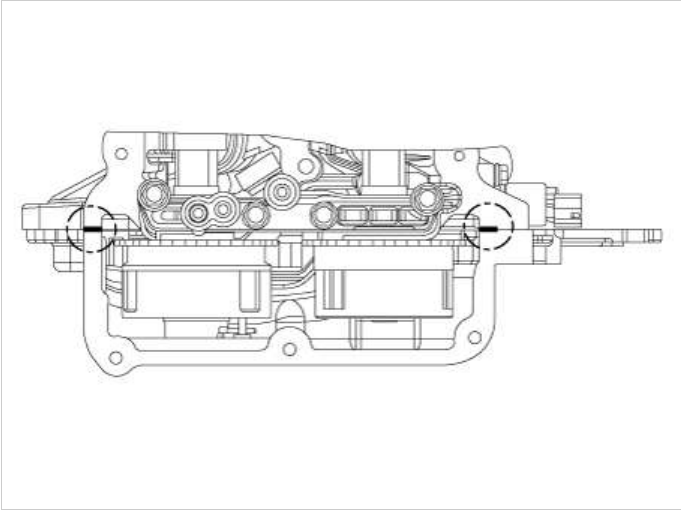


Installation

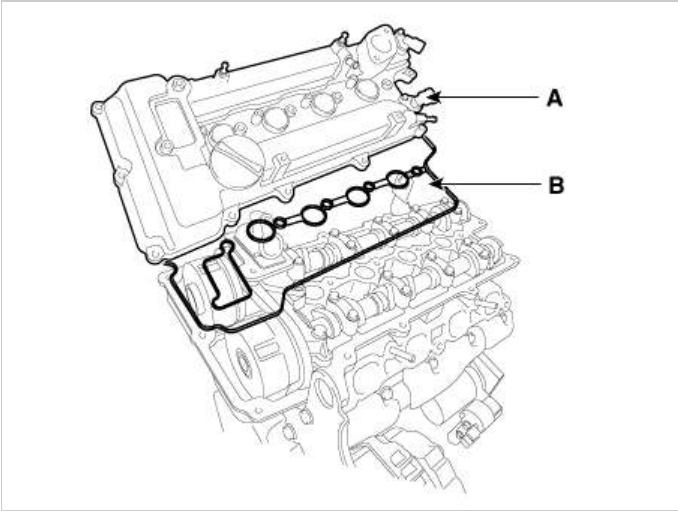
1. Install the cylinder head cover.
   (1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

(2) After applying sealant, it should be assembled within 5 minutes.

Bead width :2.0 - 3.0mm(0.07 - 0.11 in.)
Sealant :LOCTITE 5900H



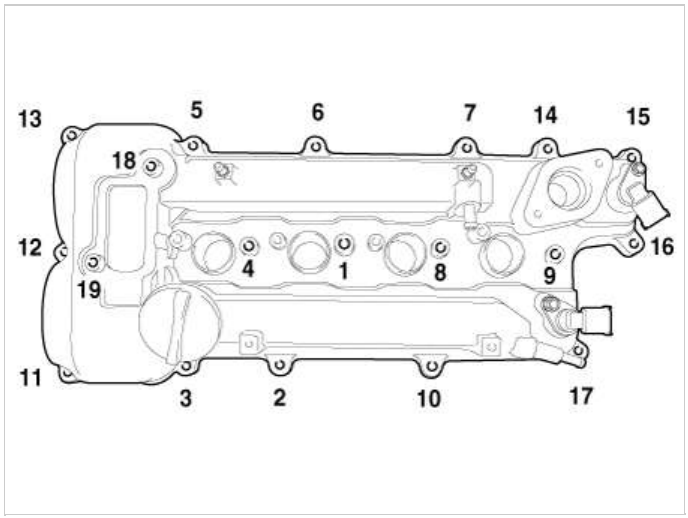
(3) Install the cylinder head cover (A) with a new gasket (B).



⚠ CAUTION
Do not reuse the disassembled gasket.

(4) Tighten the cylinder head cover bolts with the order and steps.

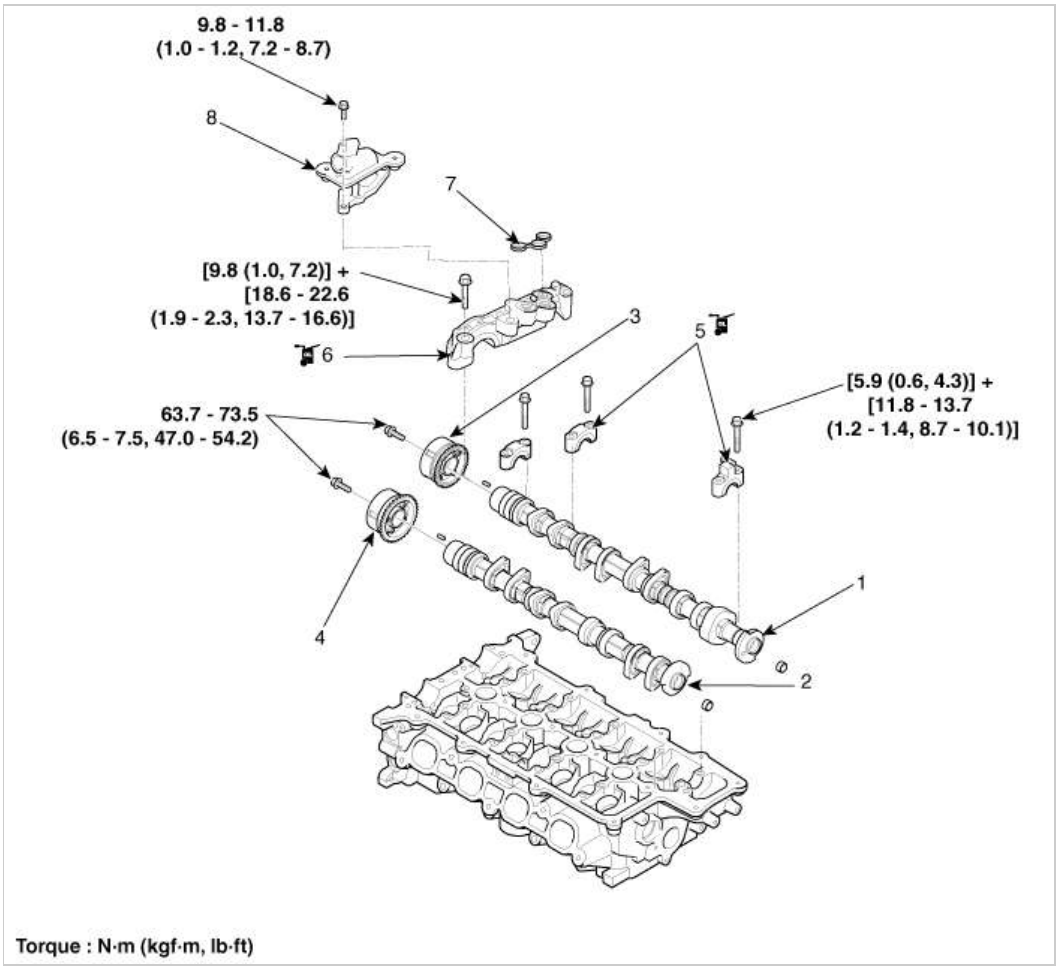
Tightening torque
1st step:
3.9 - 5.9 N·m (0.4 - 0.6 kgf·m, 2.9 - 4.3 lb·ft)
2nd step: 7.8 - 9.8 N·m (0.8 - 1.0 kgf·m, 5.8 - 7.2 lb·ft)



2. Install in the reverse order of removal.

Engine Mechanical System

Components



1. Exhaust camshaft
2. Intake camshaft
3. Exhaust CVVT
4. Intake CVVT
5. Camshaft bearing cap
6. Camshaft front bearing cap
7. O-ring
8. OCV (Oil Control Valve) adapter

Engine Mechanical System

Description

Continuous Variable Valve Timing (CVVT) system advances or retards the valve timing of the intake and exhaust valve in accordance with the ECM control signal which is calculated by the engine speed and load.

By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase of expansion work.

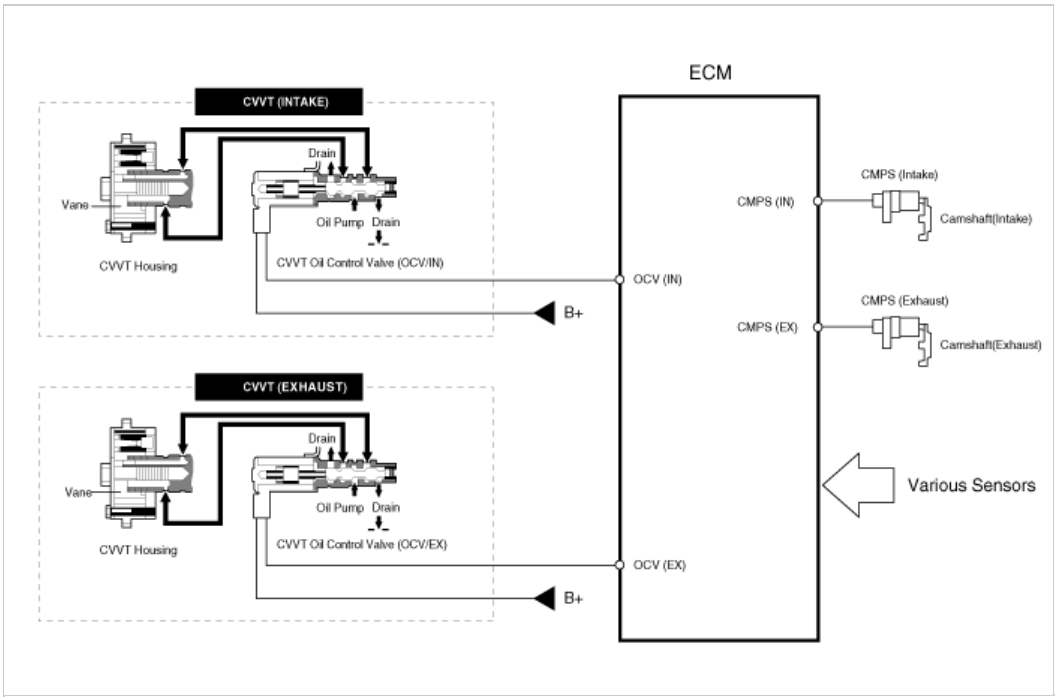
This system consist of

– the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,

– the CVVT Oil Temperature Sensor (OTS) which measures the engine oil temperature,

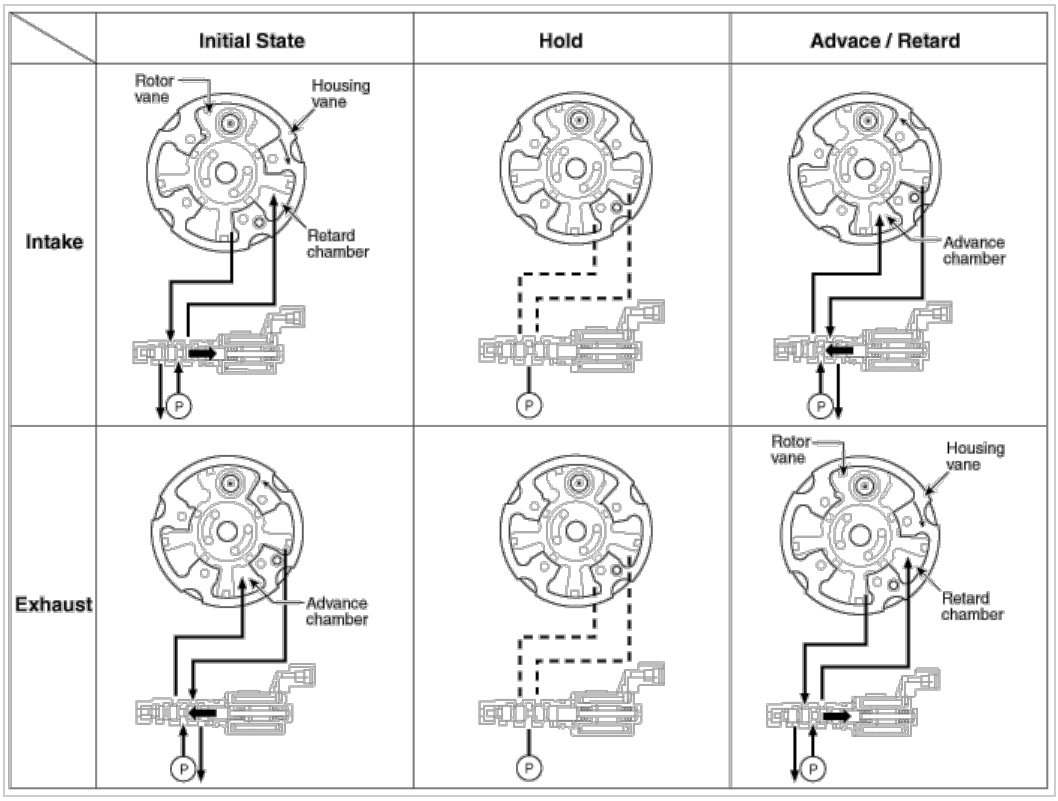
– and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.

The engine oil getting out of the CVVT oil control valve varies the cam phase in the direction (Intake Advance/Exhaust Retard) or opposite direction (Intake Retard/Exhaust Advance) of the engine rotation by rotating the rotor connected with the camshaft inside the cam phaser.

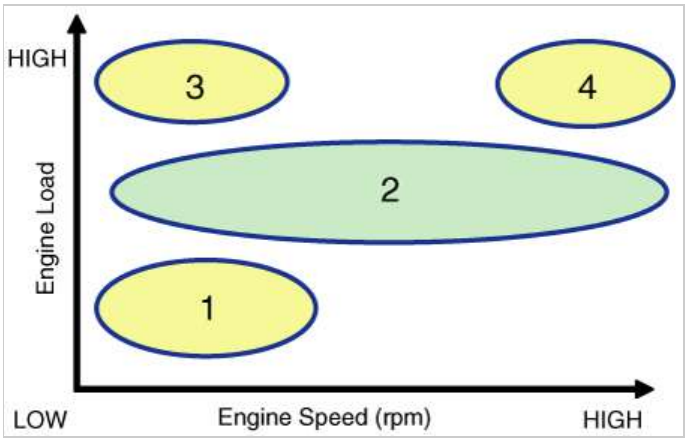


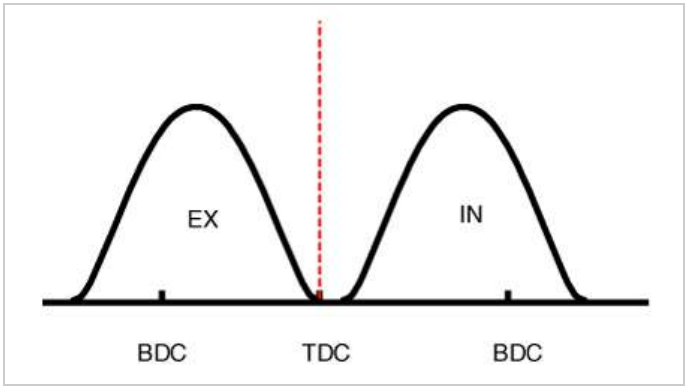
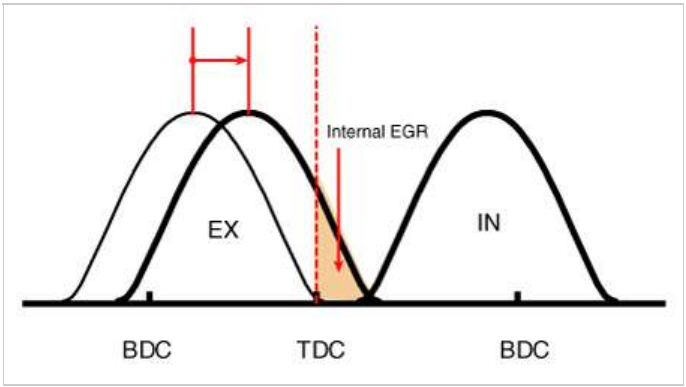
Operation Principle

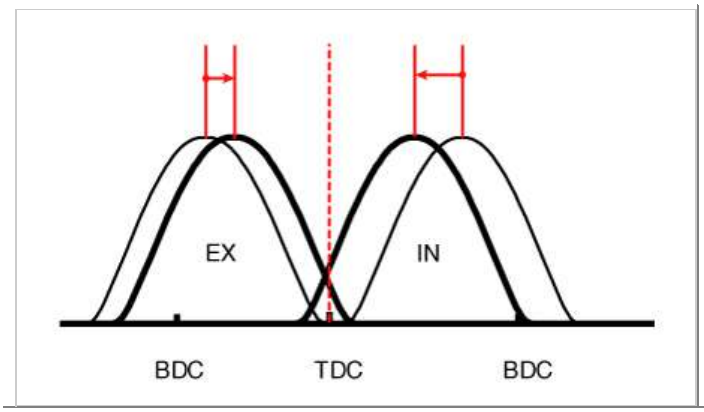
The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.

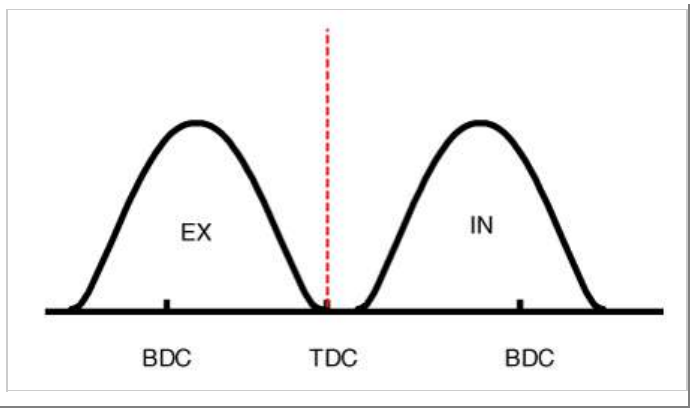


[CVVT System Mode]



(1) Low Speed / Low Load	(2) Part Load
	
(3) Low Speed / High Load	(4) High Speed / High Load



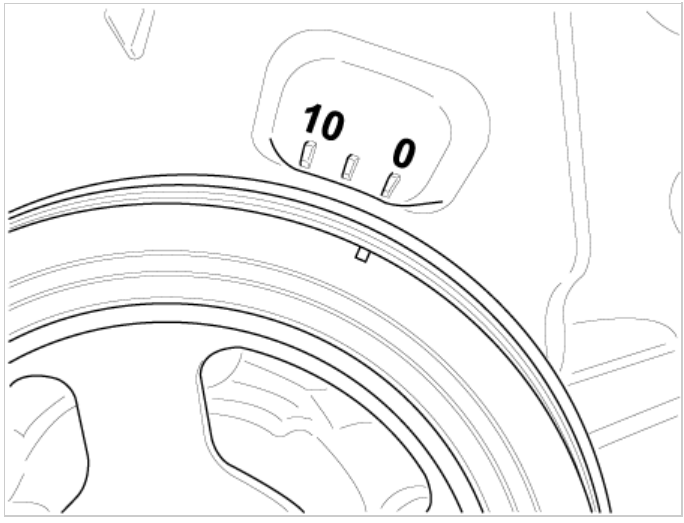


Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect
(1) Low Speed /Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase of expansion work * Reduction of pumping loss * Reduction of HC	Retard	* Reduction of pumping loss
(3) Low Speed /High Load	Retard	* Increase of expansion work	Advance	* Prevention of intake back flow (Improvement of volumetric efficiency)
(4) High Speed /High Load	Advance	* Reduction of pumping loss	Retard	* Improvement of volumetric efficiency

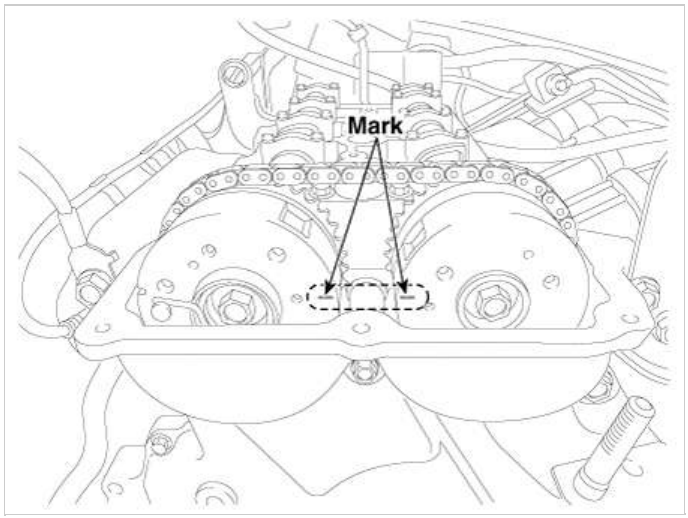
Engine Mechanical System

Removal

1. Remove the cylinder head cover.
   (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
2. Turn the crankshaft damper pulley so that No. 1 piston is at top dead center.
   (1) Turn the crankshaft damper pulley and align its groove with the timing mark on the timing chain cover (0° mark on the timing scale).



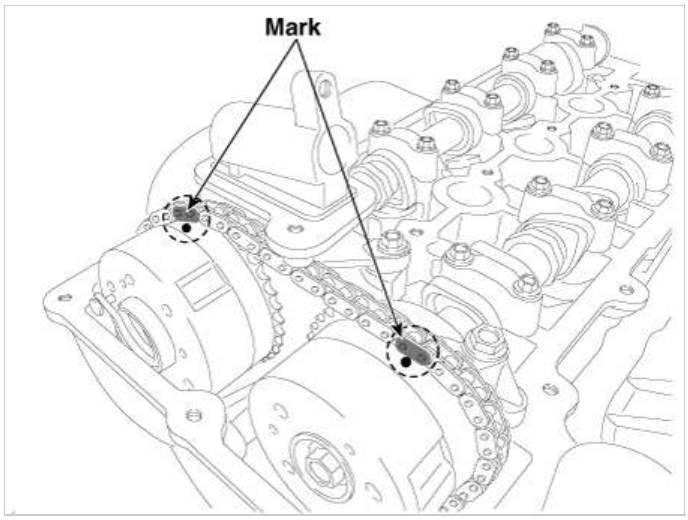
   (2) Check that the TDC timing marks on the intake and exhaust CVVT sprockets are in a straight line on the cylinder head surface as shown in the picture. If not, turn the crankshaft damper pulley by one revolution (360°).



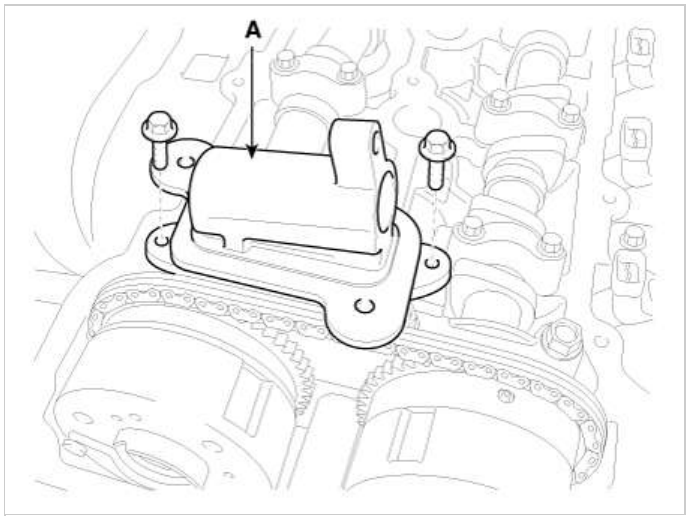
NOTICE

Do not turn the crankshaft damper pulley counterclockwise.

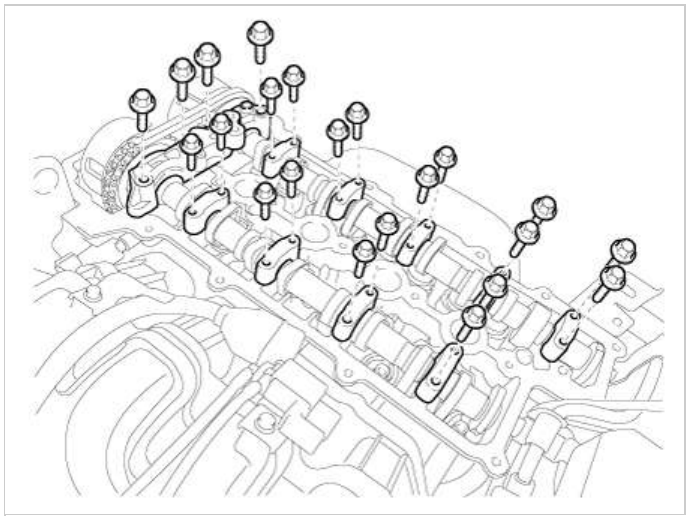
(3) Mark the timing chain links corresponding to the timing marks on the CVVT sprockets with a indelible marker.

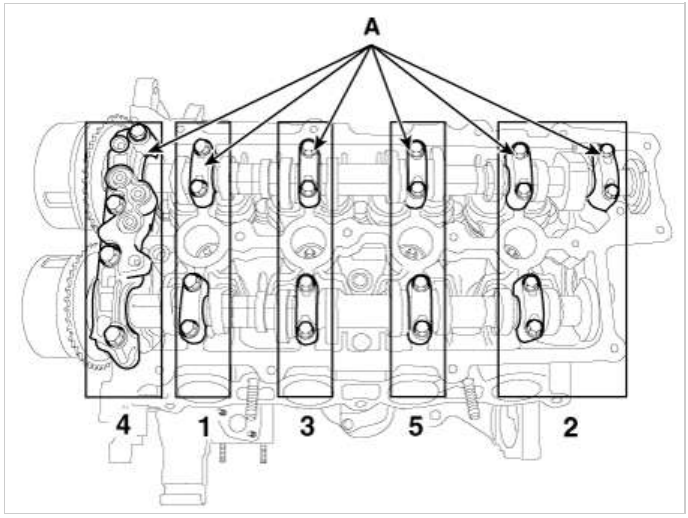


3. Remove the exhaust oil control valve (OCV) adaptor (A).



4. Remove the camshaft bearing caps (A) in the order shown in the picture.

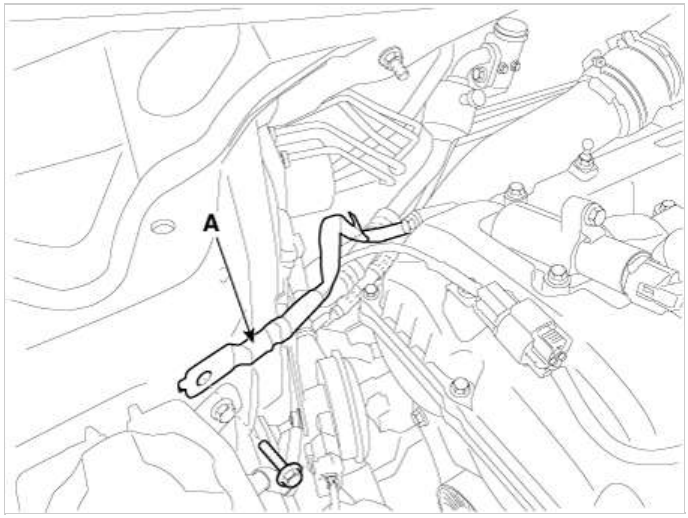




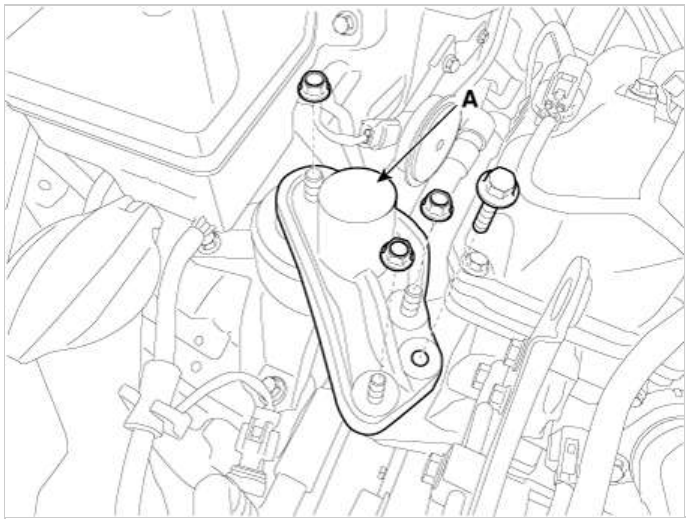
5. Remove the engine mounting support bracket.
   (1) Put a jack under the oil pan.

> **NOTICE**
> Place a wooden block between the jack and the oil pan to prevent damage to the oil pan.

   (2) Disconnect the engine ground cable (A).

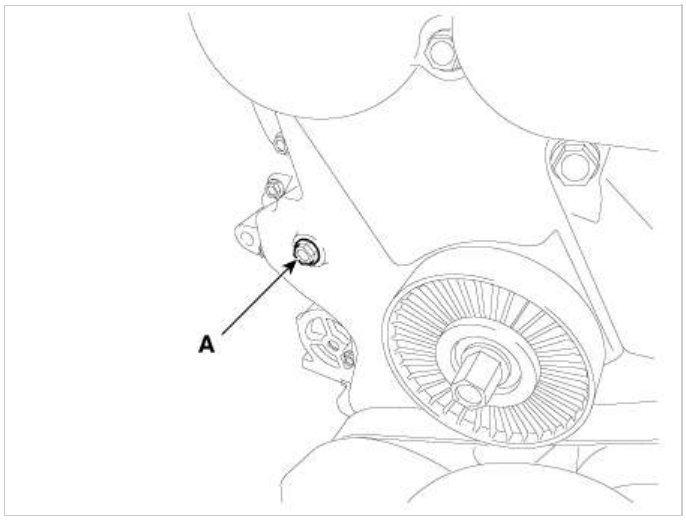


   (3) Remove the engine mounting support bracket (A).

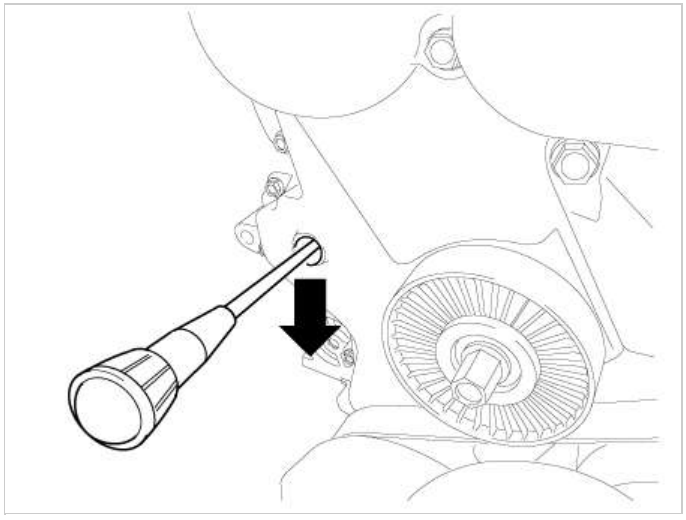


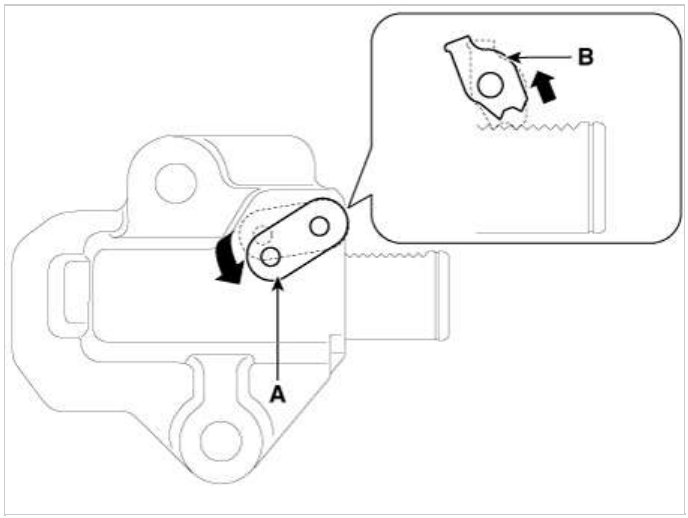
(4) Lift the engine slightly using the jack to obtain space for releasing the timing chain tensioner.

6. Remove the bolt (A) from the service hole in the timing chain cover.

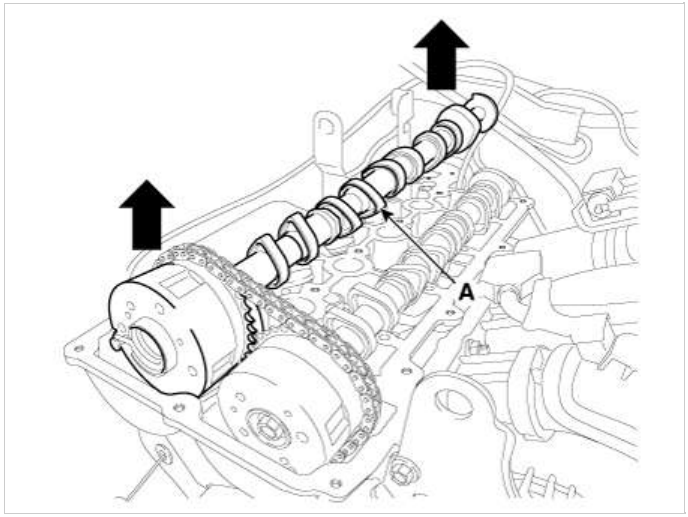


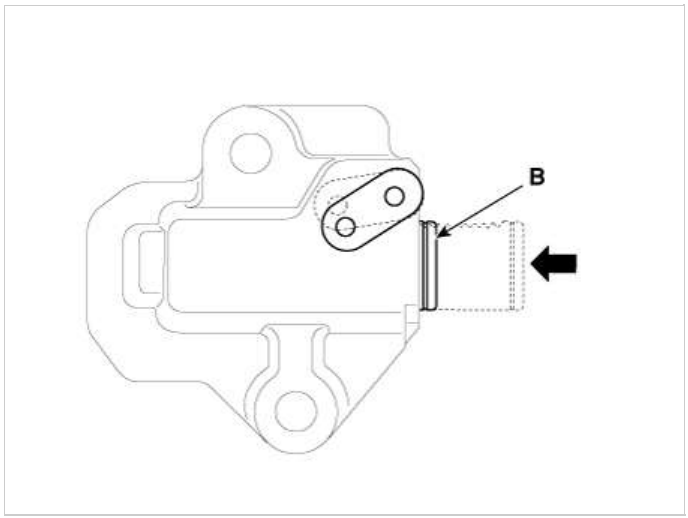
7. Lock the timing chain tensioner in the fully retracted position.
   (1) Insert a pick into the service hole in the timing chain cover and lower the hole in the left side of the ratchet plate (A) on the tensioner to allow the pawl (B : located inside the tensioner behind the rachet plate) to be lifted.



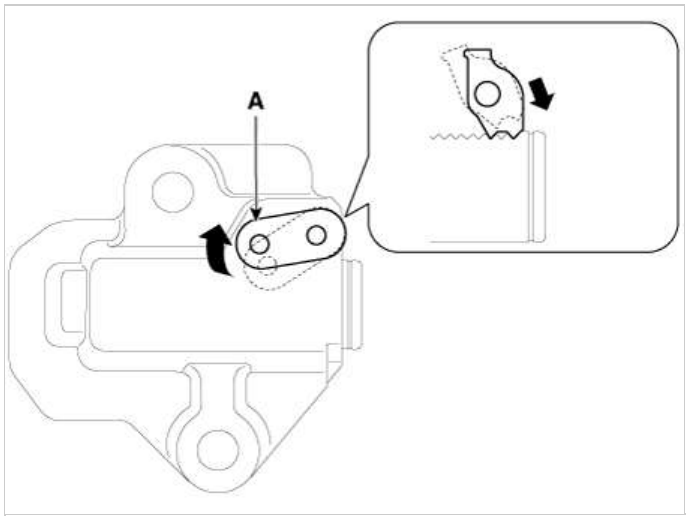


(2) With the pawl lifted, have a helper pull up the exhaust CVVT & camshaft (A) to allow the tensioner plunger (B) to retract.

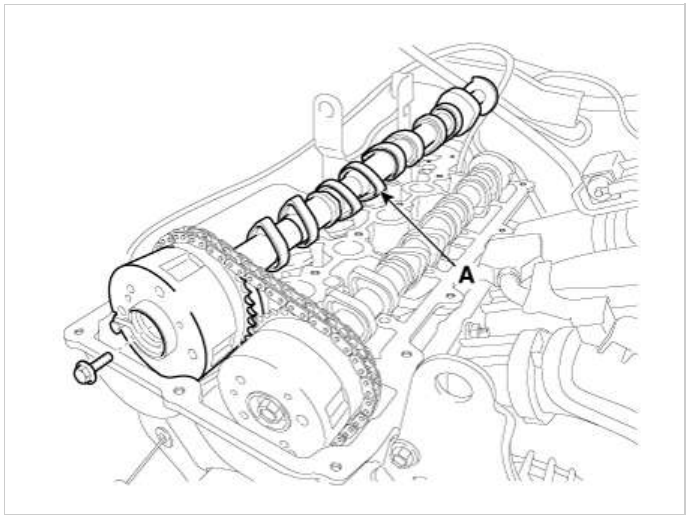




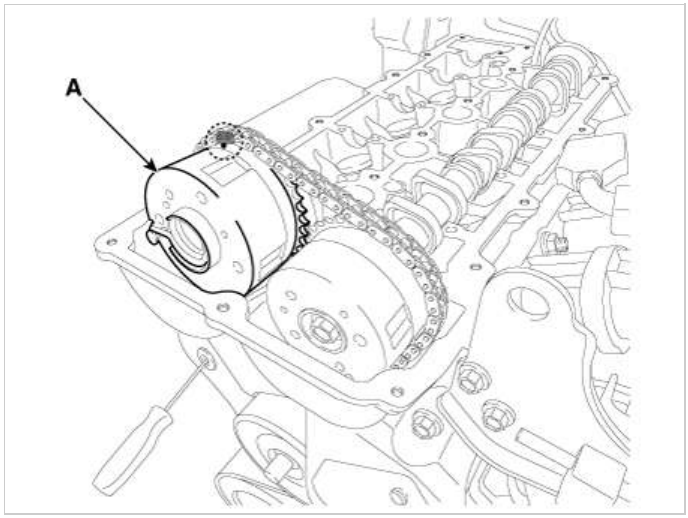
(3) With the tensioner plunger in the fully retracted position, raise the hole in the left side of the ratchet plate (A) again through the service hole in the chain cover to align the ratchet plate hole with the hole in the tensioner body behind the ratchet plate, then lock the tensioner by inserting the pick through the ratchet plate and tensioner body holes.



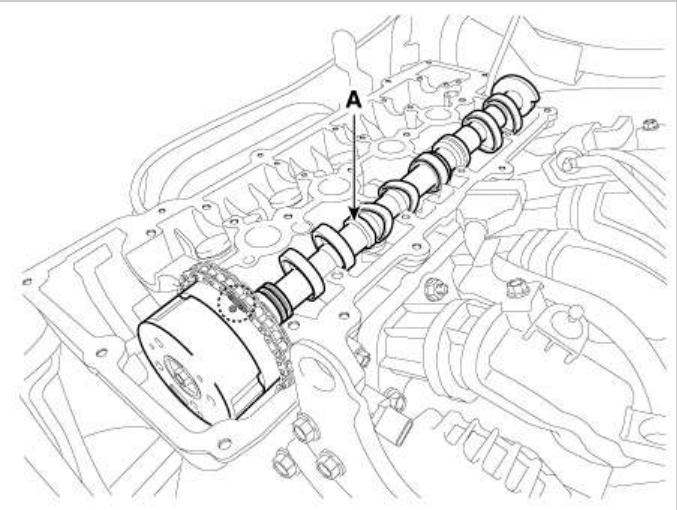
8. Separate the exhaust camshaft (A) from the exhaust CVVT by removing the bolt.



9. Remove the exhaust CVVT (A) from the timing chain.

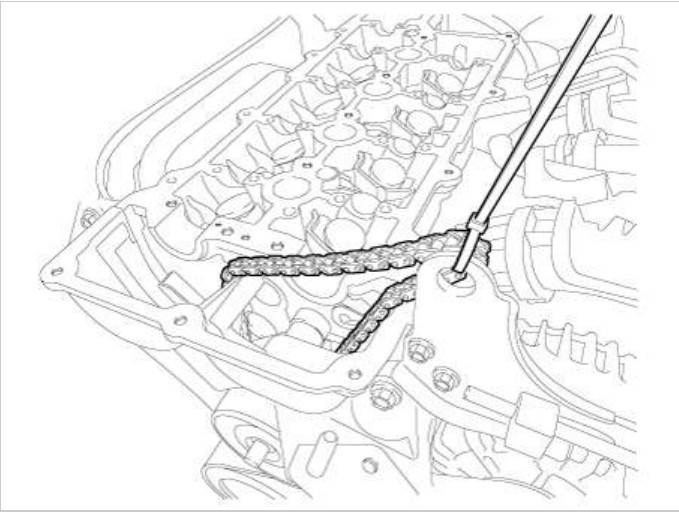


10. Remove the intake CVVT & camshaft (A).

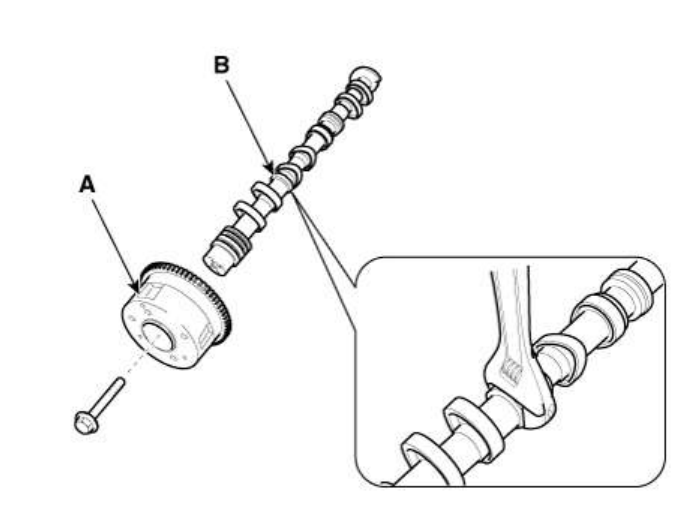


NOTICE

Fasten the timing chain to the engine hanger with a cable tie or strap not to allow the timing chain to fall down when removing the intake CVVT & camshaft.



11. Remove the intake CVVT (A) from the intake camshaft (B).



Information

When removing the CVVT bolt, hold the hexagonal portion (B) on the camshaft with a wrench to prevent the camshaft from rotating.

Inspection

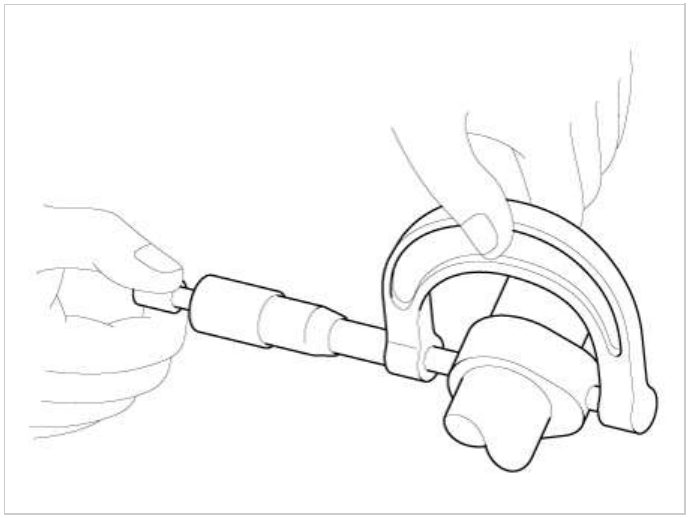
Camshaft

1. Measure the height of the cam lobe using a micrometer and check the surface of the cam lob for wear and tear. If necessary, replace the camshaft.

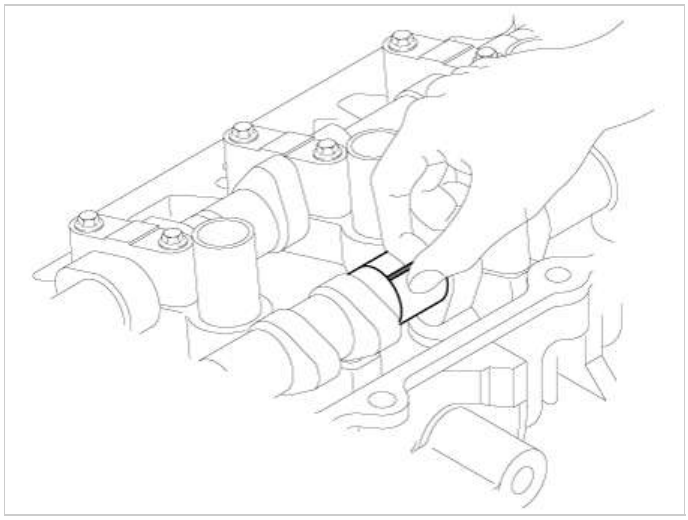
Cam height

Intake : 44.15 mm (1.738 in.)

Exhaust : 43.55 mm (1.715 in.)



2. Check the surface of the camshaft journal for wear and tear. If the camshaft journal is excessively damaged, replace the camshaft.
3. Inspect the camshaft journal clearance.
   (1) Clean the camshaft journals and bearing caps.
   (2) Place the camshafts in the cylinder head.
   (3) Lay a strip of plastigauge across each of the camshaft journals.



   (4) Install the bearing caps and tighten the bolts to the specified torque.

Tightening torque

1st step

M6 bolt : 5.9 N·m (0.6 kgf·m, 4.3 lb·ft)

M8 bolt : 9.8 N·m (1.0 kgf·m, 7.2 lb·ft)

2nd step

M6 bolts :

11.8 - 13.7N·m (1.2 - 1.4kgf·m, 8.7 - 10.1lb·ft)

M8 bolts :

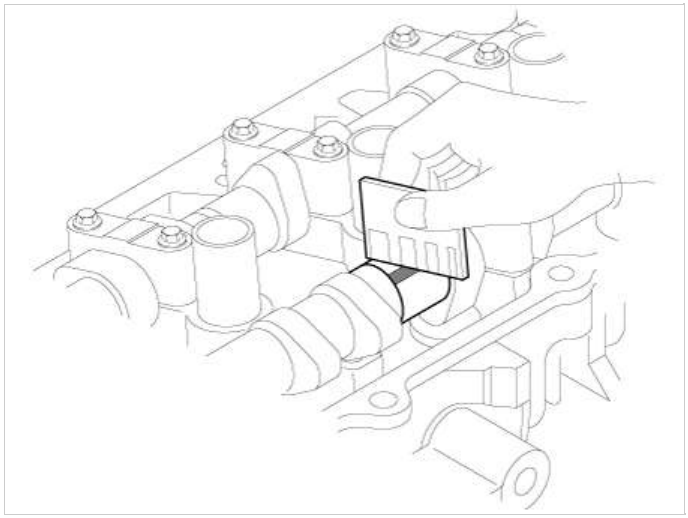
18.6 - 22.6N·m (1.9 - 2.3kgf·m, 13.7 - 16.6lb·ft)

NOTICE

Do not turn the camshaft.

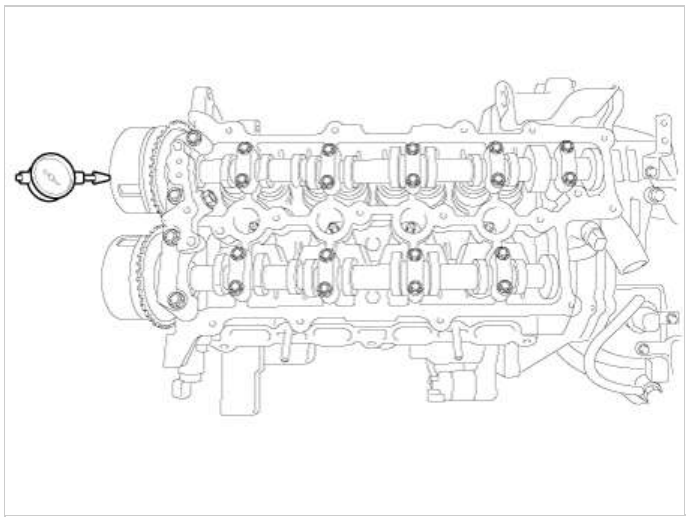
   (5) Remove the bearing caps.
   (6) Measure the plastigauge at the widest point. If the clearance is greater than the specification, replace the camshaft. If necessary, replace the bearing caps and the cylinder head as a set.

Camshaft bearing cap oil clearance
Standard :
0.027 - 0.058 mm (0.0011 - 0.0023 in.)
Limit : 0.1 mm (0.0039 in.)



4. Inspect the camshaft end play.
   (1) Inspect the camshaft end play.
   (2) Measure the end play while moving the camshaft back and forth using a dial gauge. If the end play is greater than the specification, replace the camshaft. If necessary, replace the bearing caps and the cylinder head as a set.

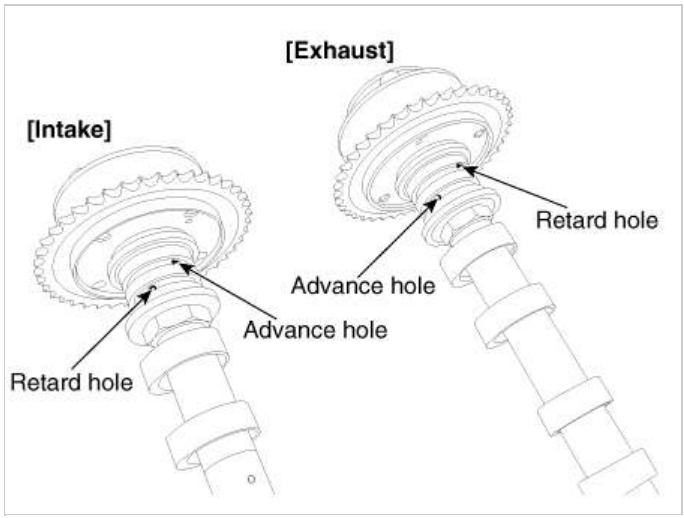
Camshaft end play
Standard : 0.1 - 0.2 mm (0.0039 - 0.0079 in.)



   (3) Remove the camshafts.

CVVT (Continuously Variable Valve Timing) Assembly

1. Inspect the CVVT for smooth rotation.
   (1) Clamp the camshaft using a vise. Be careful not to damage the cam lobes and journals in the vise.
   (2) Check that the CVVT is locked by turning it clockwise or counterclockwise. It must not rotate.
   (3) Intake CVVT : Seal one of the two advance holes in the camshaft journal with tape.
   Exhaust CVVT : Seal one of the two retard holes in the camshaft journal with tape.

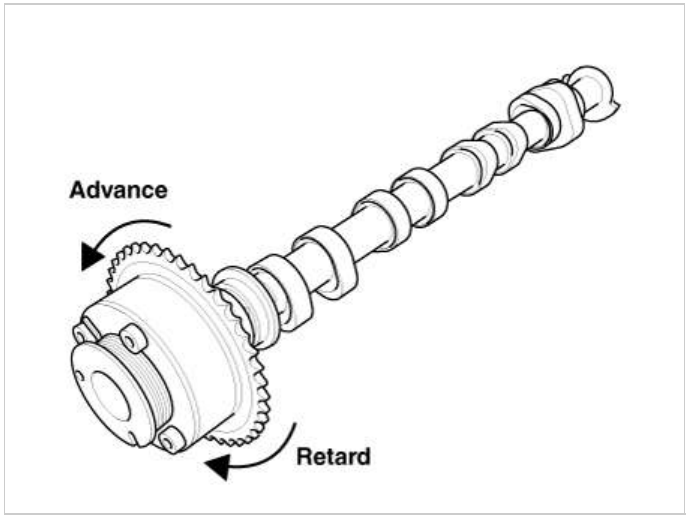


(4) Intake CVVT : Apply approx. 150 kPa (1.5 kgf/cm², 21 psi) of compressed air into the unsealed advance hole to release the lock.
Exhaust CVVT : Apply approx. 150 kPa (1.5 kgf/cm², 21 psi) of compressed air into the unsealed retard hole to release the lock.

Information
Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying.

(5) Intake CVVT : With compressed air applied, rotate the CVVT into the advance direction (counterclockwise) within its phasing range and check that the CVVT turns smoothly.
Exhaust CVVT : With compressed air applied, rotate the CVVT into the retard direction (clockwise) and check that the CVVT turns smoothly.

CVVT phasing range
Intake : 25°±1° (from the most retarded position to the most advanced position)
Exhaust : 20°±1° (from the most advanced position to the most retarded position)

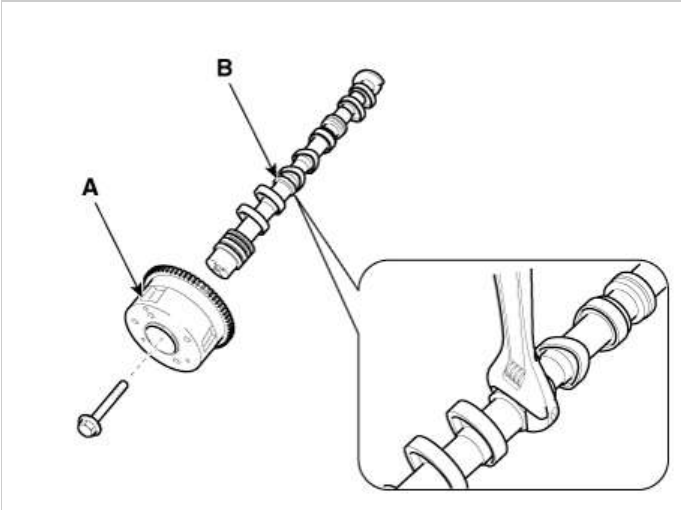


(6) Intake CVVT : Rotate the CVVT into the most retarded position (clockwise) and then check that the CVVT is locked.
Exhaust CVVT : Rotate the CVVT into the most advanced position (counterclockwise) and then check that the CVVT is locked.

Installation

1. Install the intake CVVT (A) to the intake camshaft.

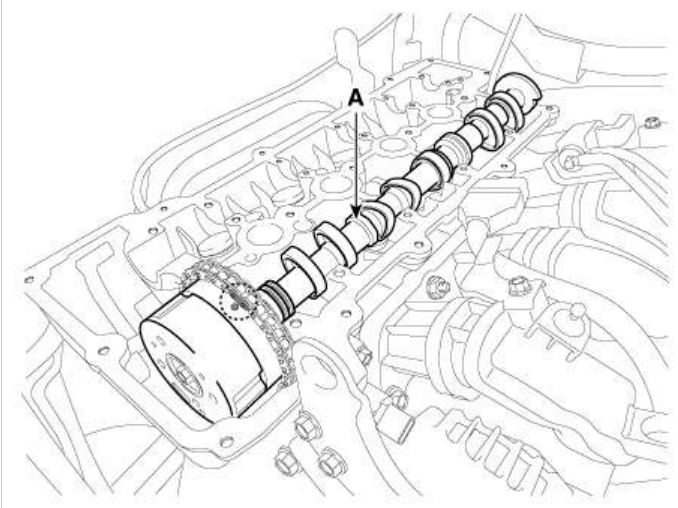
Tightening torque :
63.7 - 73.5 N·m (6.5 - 7.5 kgf·m, 47.0 - 54.2 lb·ft)



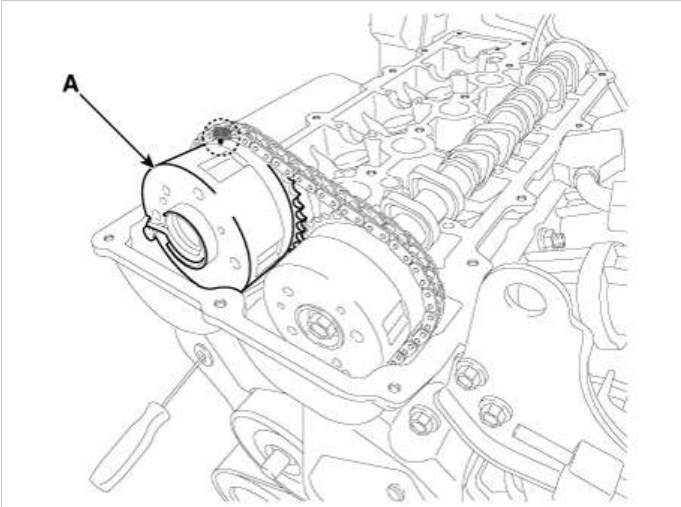
Information

When installing the CVVT bolt, hold the hexagonal portion (B) on the camshaft with a wrench to prevent the camshaft from rotating.

2. Install the intake CVVT & camshaft (A), with the timing mark on the intake CVVT sprocket aligned with the mark (painted link) on the timing chain.



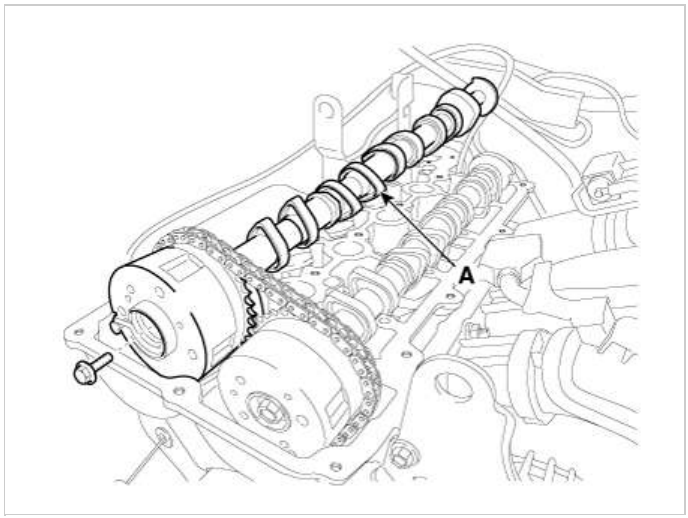
3. Install the exhaust CVVT (A), with the timing mark on the exhaust CVVT sprocket aligned with the mark (painted link) on the timing chain.



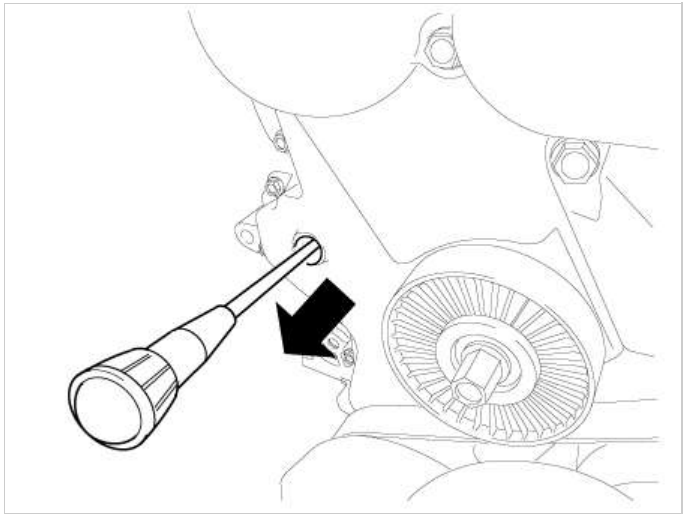
4. Install the exhaust camshaft (A) to the exhaust CVVT.

Tightening torque :

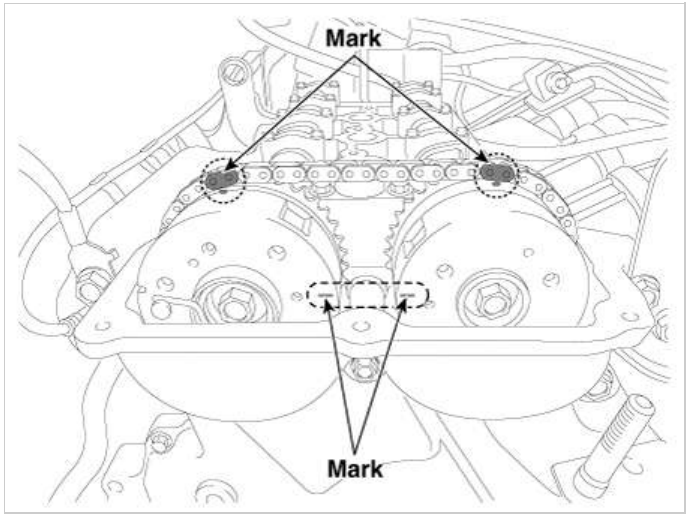
63.7 - 73.5 N·m (6.5 - 7.5 kgf·m, 47.0 - 54.2 lb·ft)



5. Remove the pick from the service hole in the timing chain cover.

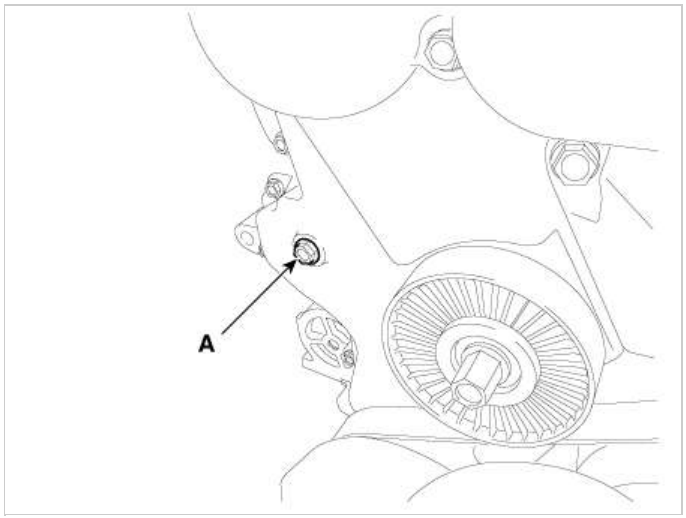


6. Check that each timing mark of the intake and exhaust CVVT sprockets is aligned as shown in the picture.



7. Install the bolt (A) to the service hole in the timing chain cover.

Tightening torque :
27.5 - 30.4 N·m (2.8 - 3.1 kgf·m, 20.3 - 22.4 lb·ft)



8. Install the engine mounting support bracket.
   (1) Install the engine mounting support bracket (A).

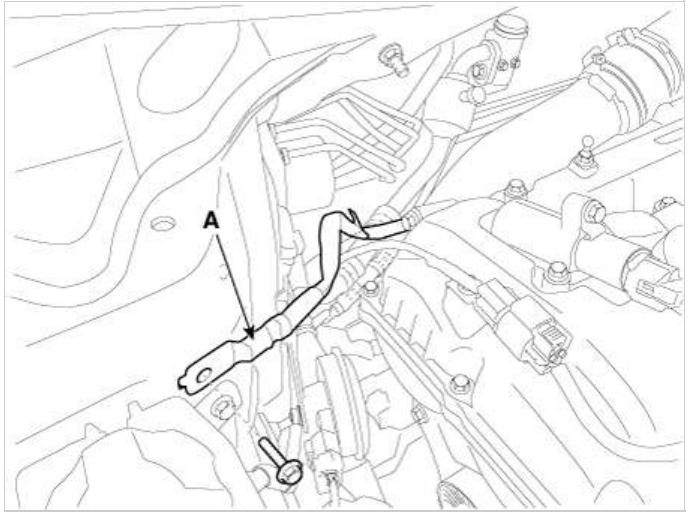
Tightening torque

Nut (B) :
63.7 - 107.8 N·m (6.5 - 11.0 kgf·m, 47.0 - 79.5 lb·ft)
Bolt and nuts (C) :
58.8 - 73.5 N·m (6.0 - 7.5 kgf·m, 43.4 - 54.2 lb·ft)

   (2) Connect the engine ground cable (A).

Tightening torque :

10.8 - 13.7 N·m (1.1 - 1.4 kgf·m, 8.0 - 10.1 lb·ft)



(3) Remove the jack from the oil pan.

9. Install the camshaft bearing caps (A) in the order shown in the picture and tighten the bolts to the specified torque.

Tightening torque

1st step

M6 bolt : 5.9 N·m (0.6 kgf·m, 4.3 lb·ft)

M8 bolt : 9.8 N·m (1.0 kgf·m, 7.2 lb·ft)

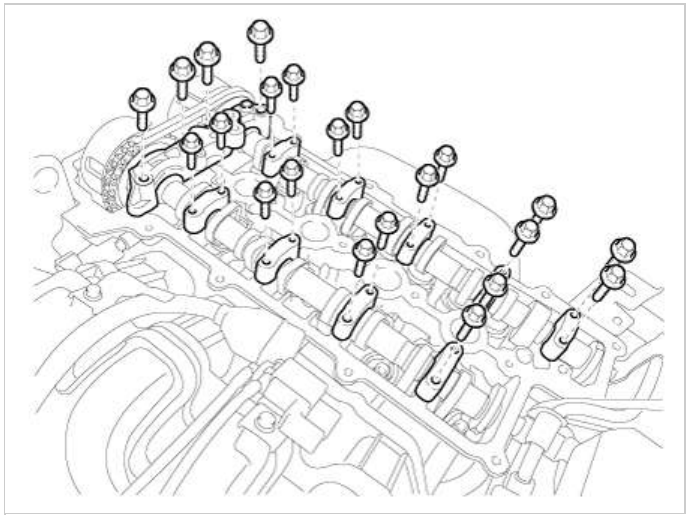
2nd step

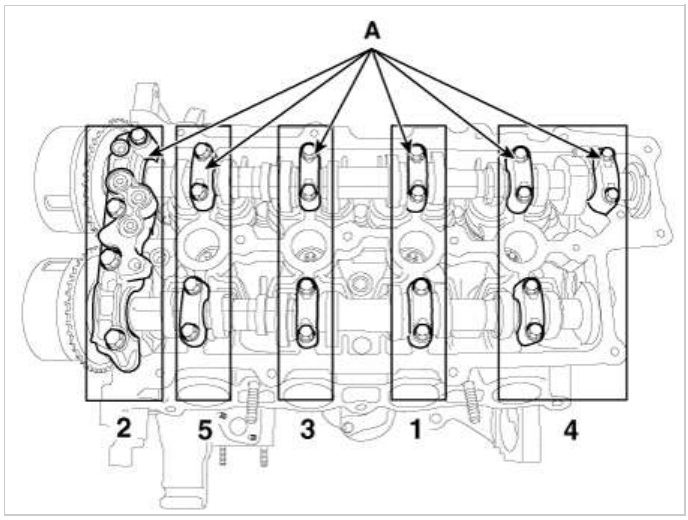
M6 bolts :

11.8 - 13.7N·m (1.2 - 1.4kgf·m, 8.7 - 10.1lb·ft)

M8 bolts :

18.6 - 22.6N·m (1.9 - 2.3kgf·m, 13.7 - 16.6lb·ft)

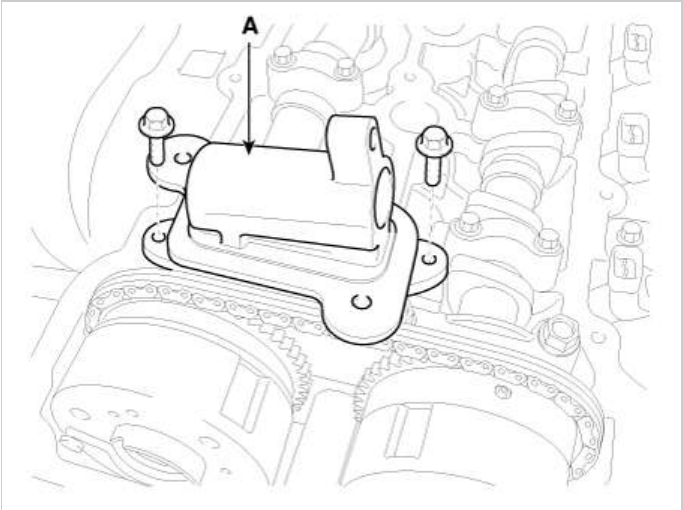




10. Install the exhaust oil control valve (OCV) adaptor (A).

Tightening torque :

9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



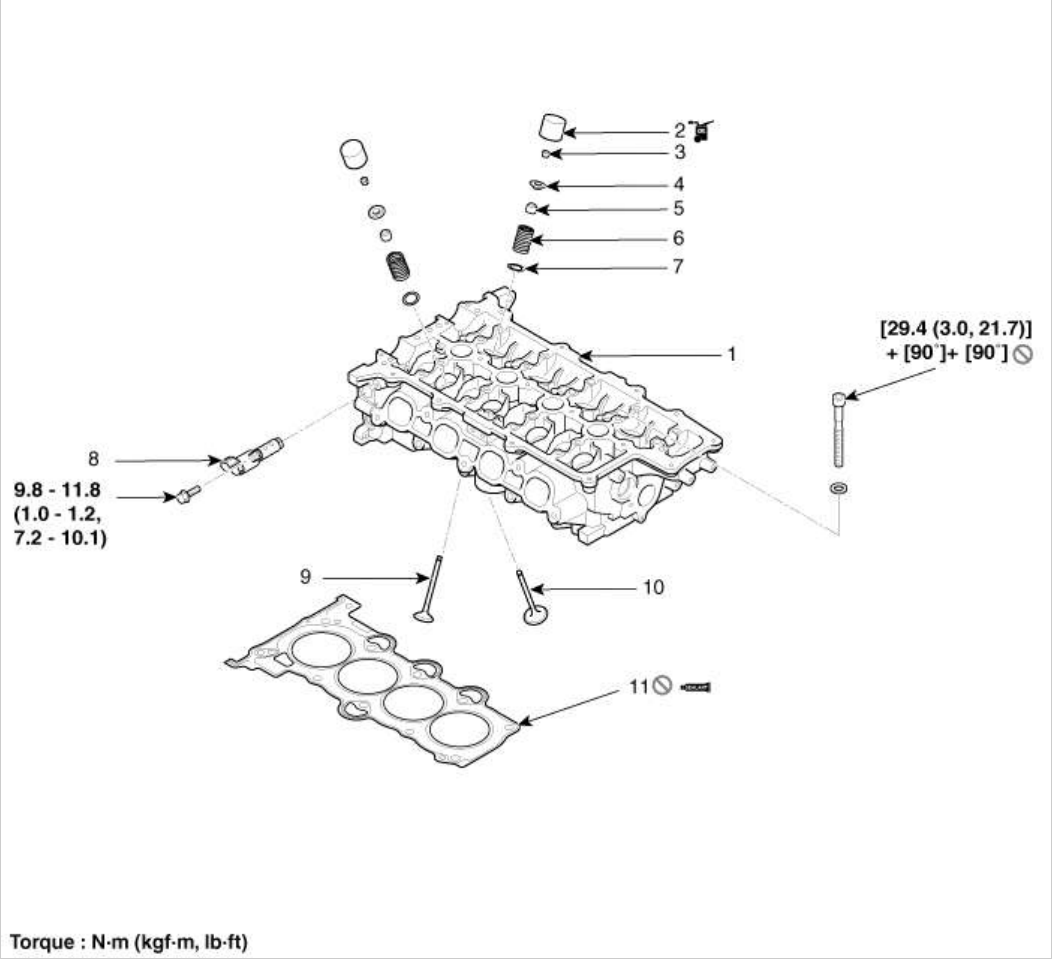
NOTICE

Check that the front camshaft bearing cap O-ring is properly seated in place when installing the OCV adaptor.

11. Install the cylinder head cover.
    (Refer to Cylinder Head Assembly - "Cylinder Head Cover")

Engine Mechanical System

Components



1. Cylinder head assembly
2. Mechanical Lash Adjuster (MLA)
3. Retainer lock
4. Retainer
5. Valve stem seal
7. Valve spring seat
8. Oil Control Valve (OCV)
9. Exhaust valve
10. Intake valve
11. Cylinder head gasket

6. Valve spring

Engine Mechanical System

Removal

Engine removal is not required for this procedure.

⚠ CAUTION

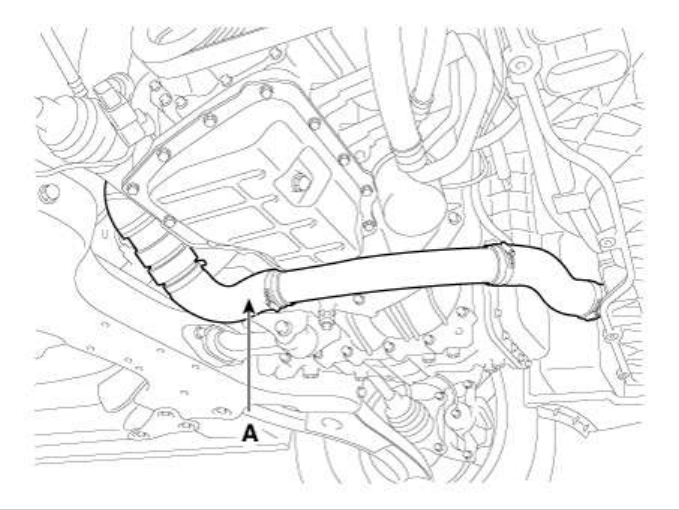
- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTICE

Mark all wiring and hoses to avoid misconnection.

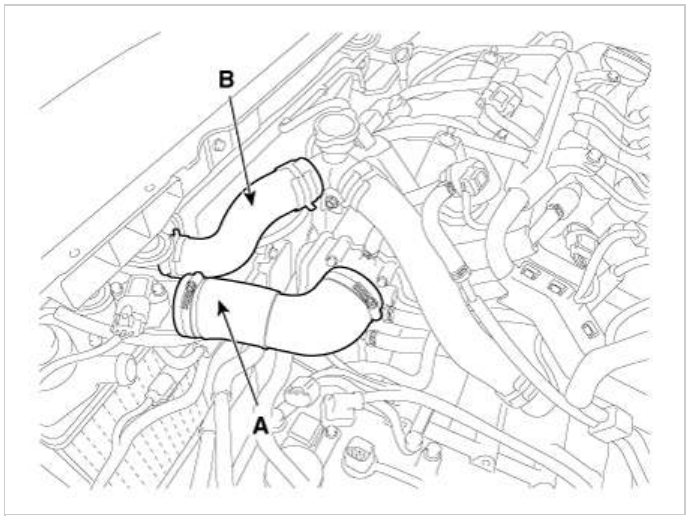
1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Remove the air duct and air cleaner assembly.
   (Refer to Intake and Exhaust System - "Air Cleaner")
4. Remove the battery and battery tray.
   (Refer to Engine Electrical System - "Battery")
5. Remove the engine room under cover.
   (Refer to Engine And Transmission Assembly - "Engine Room Under Cover")
6. Loosen the drain plug and drain the coolant. Open the radiator cap to make rapid draining.
   (Refer to Cooling System - "Coolant")
7. Remove the intercooler inlet hoses & pipe (A).

   Tightening torque
   Bolt :
   19.6 - 26.4 N·m (2.0 - 2.7 kgf·m, 14.4 - 19.5 lb·ft)
   Clamp :
   4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)

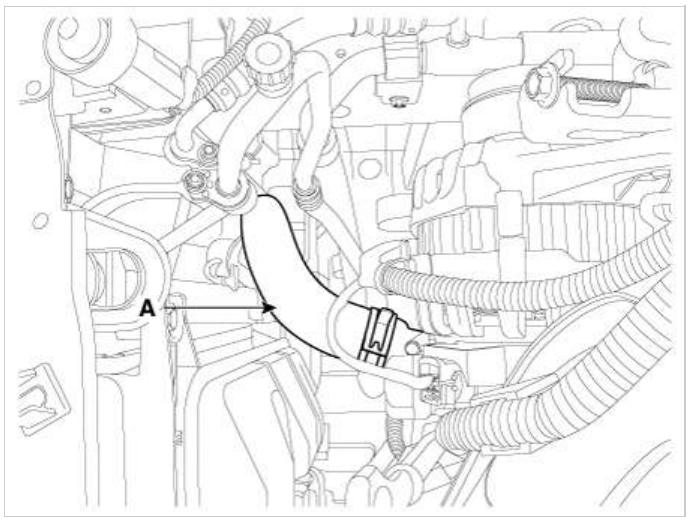


8. Remove the intercooler outlet hose (A).

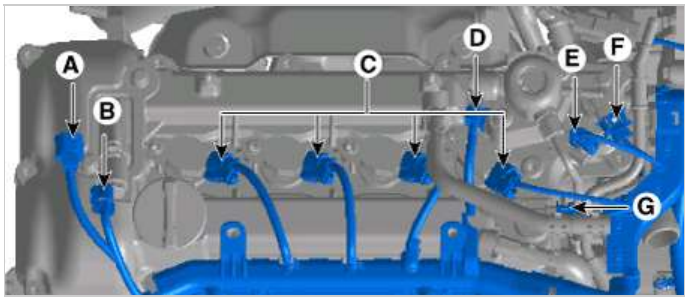
   Tightening torque:
   4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)
9. Disconnect the radiator upper hose (B).



10. Disconnect the radiator lower hose (A).

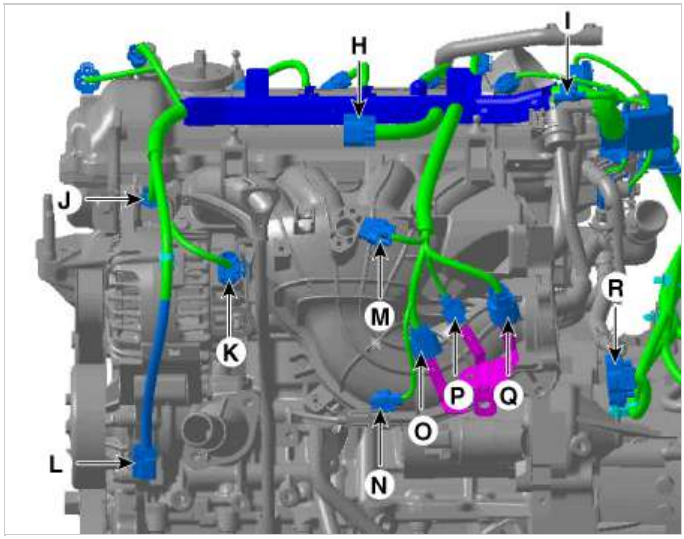


11. Disconnect the engine wiring connector and harness clamp and then remove the cylinder head protector and wiring from engine.
    A. Turbo charger solenoid valve connector
    B. Exhuast OCV(Oil Control Valve) connector
    C. Ignition coil connector # 1,2,3,4
    D. FPCV(Fuel Pressure Control Valve) connector
    E. Condenser connector
    F. Exhuast CMPS(Cam position Sensor) connector
    G. Intake CMPS(Cam Positoin Sensor) connector

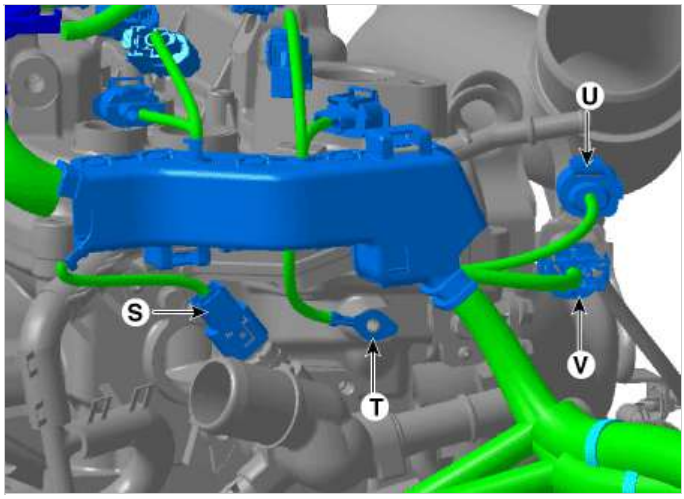


    H. Injector Extension connector
    I. PCSV(Purge Control Solenoid Valve) connector
    J. Intake OCV(Oil Control Valve) connector
    K. Alternator connector
    L. A/C compressor switch connector
    M. MAPS (Map Sensor) connector
    N. Knock Sensor connector
    O. Front connector

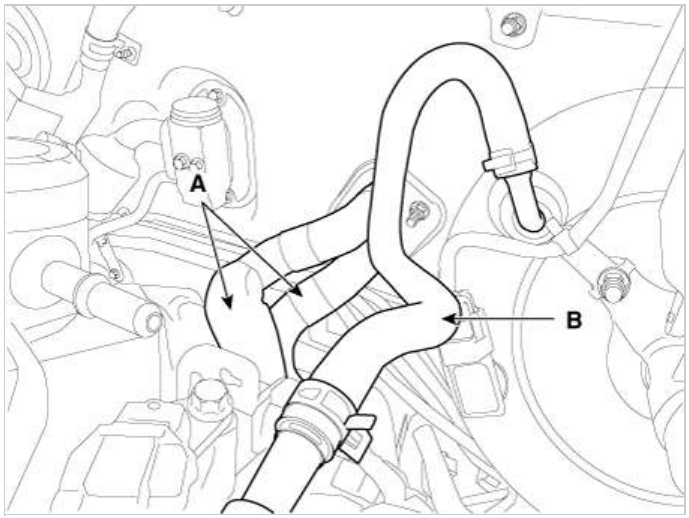
P. CKPS(Crank Shaft Position Sensor) connector
Q. Vacuum Pump Extension connector
R. ETC(Electric Throttle Control) Module connector



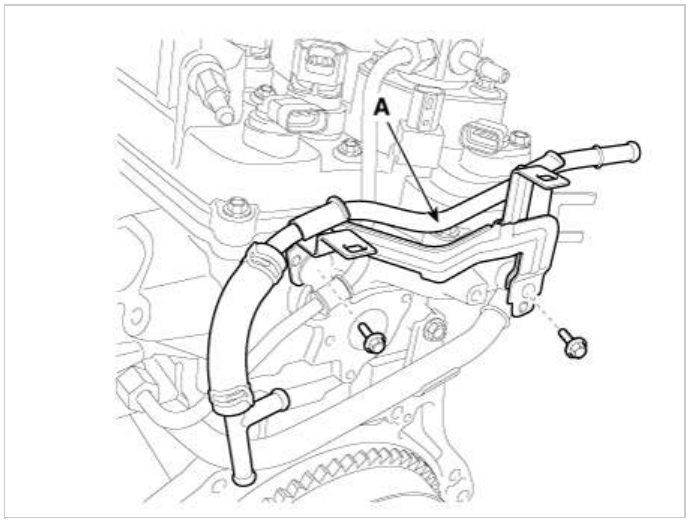
S. WTS(Water Temperature Sensor) connector
T. Ground Cable
U. Front Oxygen Sensor connector
V. Rear Oxygen Sensor connector



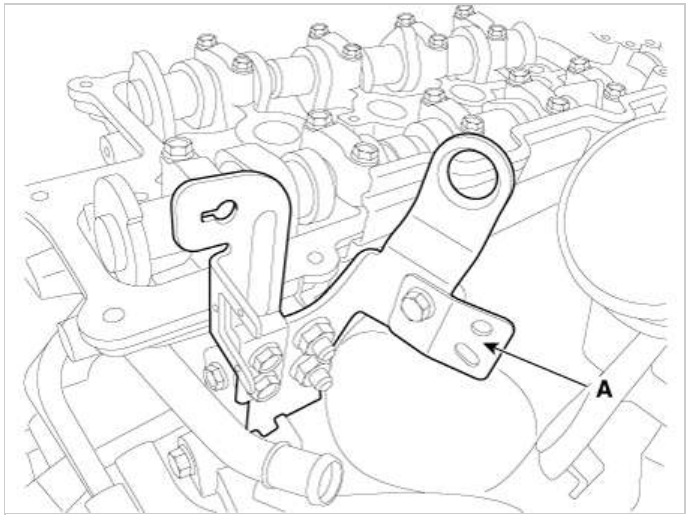
12. Disconnect the heater hoses (A) and brake booster vacuum hose(B).



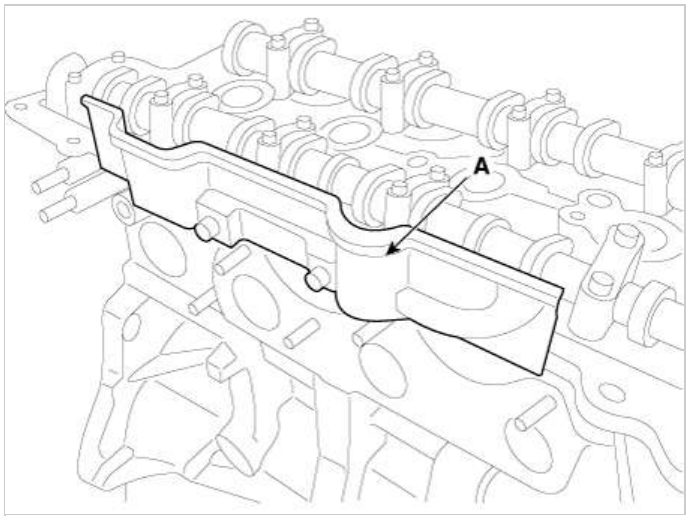
13. Remove the vaccum pipe assembly (A).



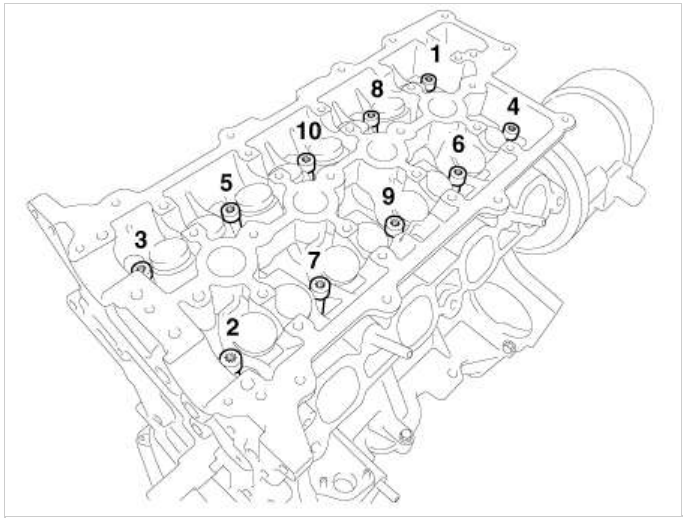
14. Remove the cylinder head cover.
    (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
15. Remove the timing chain cover.
    (Refet to Timing System - "Timing Chain Cover")
16. Remove the timing chain.
    (Refer to Timing System - "Timing Chain")
17. Remove the camshaft.
    (Refer to Cylinder Head Assembly - "Camshaft")
18. Remove the intake manifold.
    (Refer to Intake And Exhaust System - "Intake Manifold")
19. Remove the turbo manifold.
    (Refer to Intake And Exhaust System - "Exhaust Manifold")
20. Remove the delivery pipe assembly.
    (Refer to Engine Control / Fuel System - "Delivery Pipe")
21. Disconnect the bypass hose, and then remove the water temperature control assembly.
    (Refer to Cooling System - "Water Temperature Control Assembly")
22. Remove the heater pipe.
    (Refer to Cooling System - "Water Temperature Control Assembly")
23. Remove the intake OCV(Oil Control Valve).
    (Refer to Engine Control / Fuel System - "CVVT Oil Control Valve")
24. Remove the rear hanger (A).



25. Remove the cylinder head cover heat protector (A).



26. Remove the cylinder head bolts, then remove the cylinder head.
    (1) Uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.



> **CAUTION**
> Head warpage or cracking could result from removing bolts in an incorrect order.

    (2) Lift the cylinder head from the cylinder block and put the cylinder head on wooden blocks.

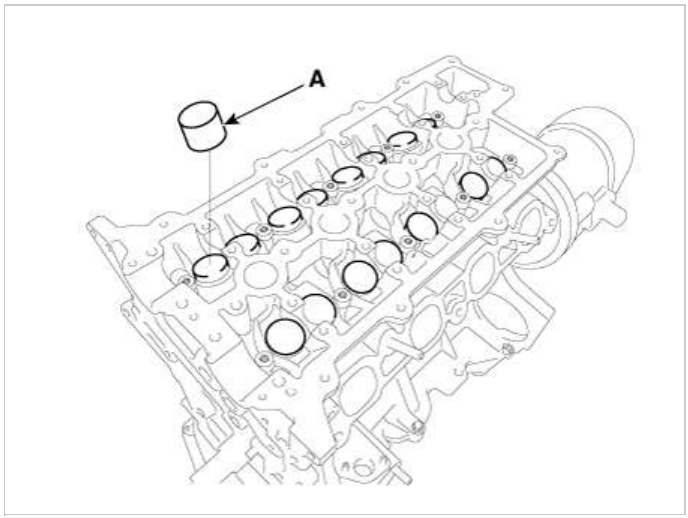
> **CAUTION**
> Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

Disassembly

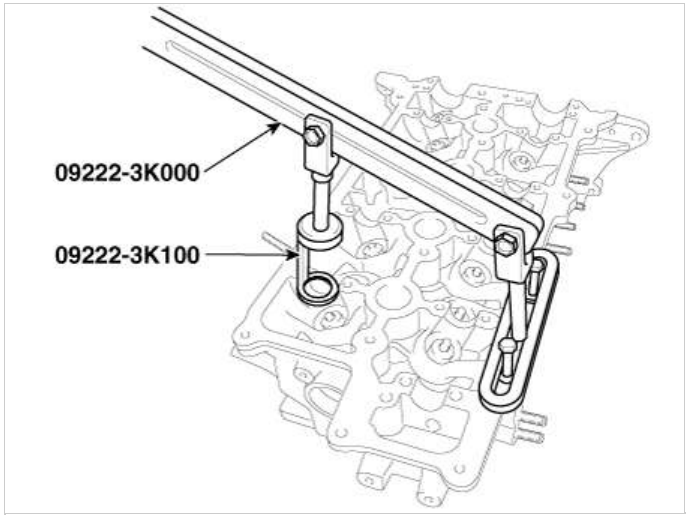
> ***NOTICE***
> Identify MLA(Mechanical lash adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove the MLAs (A).

> **CAUTION**
> When removing MLAs, mark all the MLAs for their rearrangement.



2. Remove the valves.
   (1) Using the SST (09222 - 3K000, 09222 - 3K100), compress the valve spring and remove the retainer lock.



   (2) Remove the spring retainer.
   (3) Remove the spring.
   (4) Remove the valve.
   (5) Remove the valve stem seal.
   (6) Using a magnetic pickup tool, remove the spring seat.

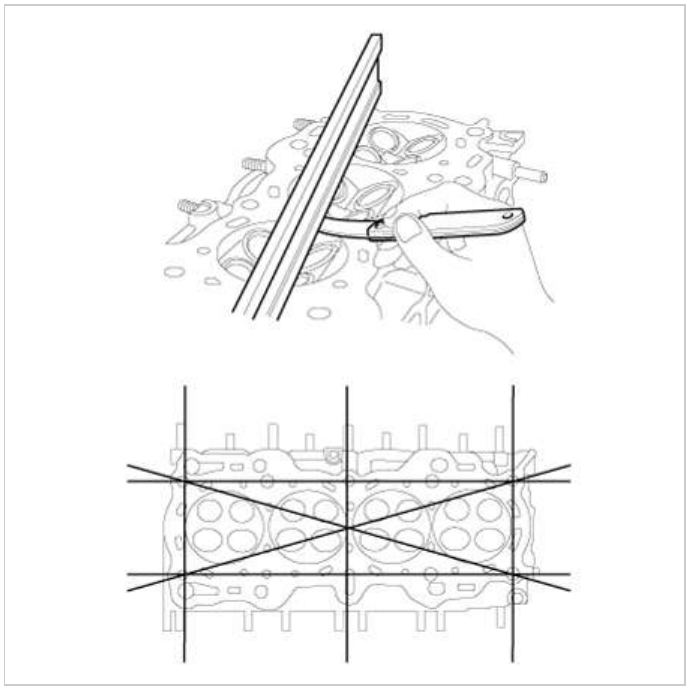
> **⚠ CAUTION**
> Do not reuse the valve stem seals.

Inspection

Cylinder Head

1. Inspect for flatness.
   Using a precision straight edge and feeler gauge, measure the surface the contacting the cylinder block and the manifolds for warpage.

   Flatness of cylinder head gasket surface
   Standard :
   Less than 0.05mm (0.0020in) for total area
   Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in)

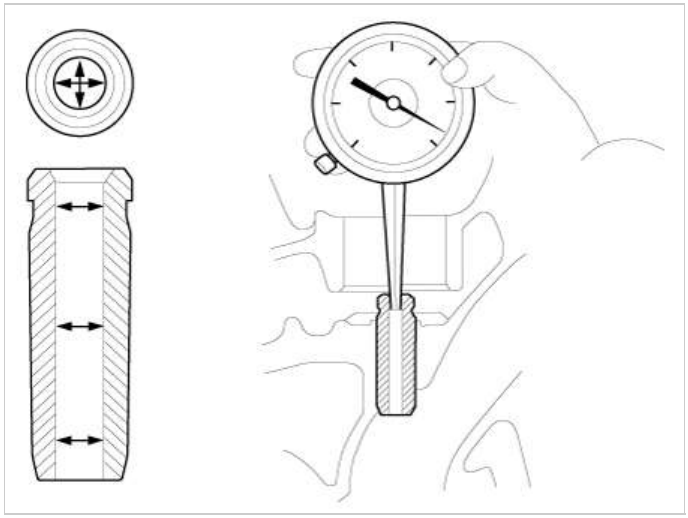


2. Inspect for cracks.
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

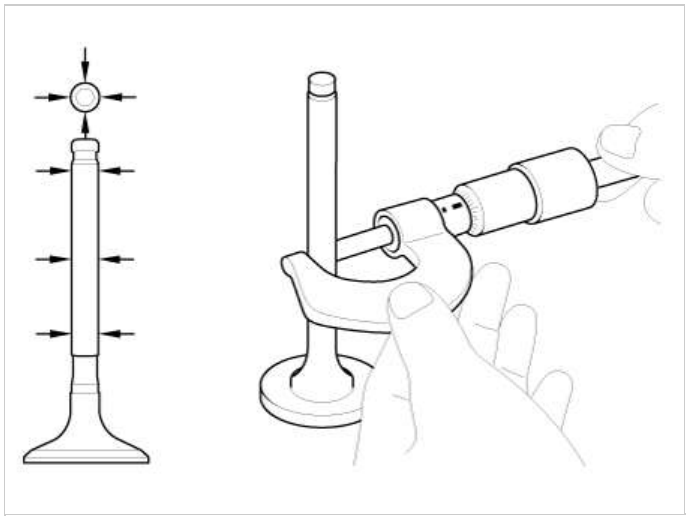
1. Inspect the valve stems and valve guides.
   (1) Using a caliper gauge, measure the inner diameter of valve guide.

   Valve guide inner diameter :
   5.500 - 5.512mm (0.2165 - 0.2170in)



   (2) Using a micrometer, measure the outer diameter of valve stem.

   Valve stem outer diameter
   Intake : 5.465 - 5.480mm (0.2152 - 0.2157in)
   Exhaust : 5.458 - 5.470mm (0.2149 - 0.2154in)



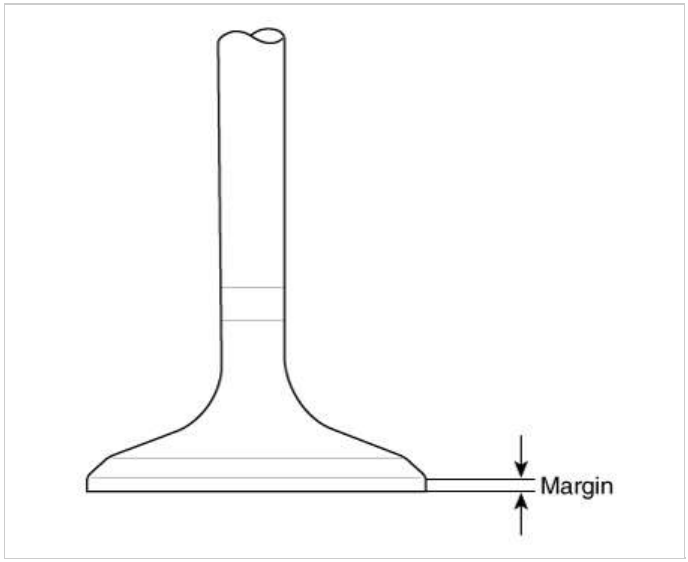
(3) Subtract the valve stem outer diameter measurement from the valve guide inner diameter measurement.

Valve stem- to-guide clearance
Intake : 0.020 - 0.047mm (0.0008 - 0.0019in)
Exhaust : 0.030 - 0.054mm (0.0012 - 0.0021in)

If the clearance is greater than specification, replace the valve or the cylinder head.

2. Inspect the valves.
   (1) Check the valve is ground to the correct valve face angle.
   (2) Check that the surface of valve for wear. If the valve face is worn, replace the valve.
   (3) Check the valve head margin thickness.
   If the margin thickness is less than minimum, replace the valve.

Margin
Standard
Intake : 1.10mm (0.0433in)
Exhaust : 1.26mm (0.0496in)



(4) Check the length of valve.

Valve length
Standard
Intake : 93.15mm (3.6673 in)
Exhaust : 92.60mm (3.6457 in)

(5) Check the surface of valve stem tip for wear. If the valve stem tip is worn, replace the valve.

3. Inspect the valve seats.
   (1) Check the valve seat for evidence of overheating and improper contact with the valve face. If the valve seat is worn, replace the cylinder head.
   (2) Check the valve guide for wear. If the valve guide is worn, replace the cylinder head.

4. Inspect the valve springs.

(1) Using a steel square, measure the out-of-square of valve spring.

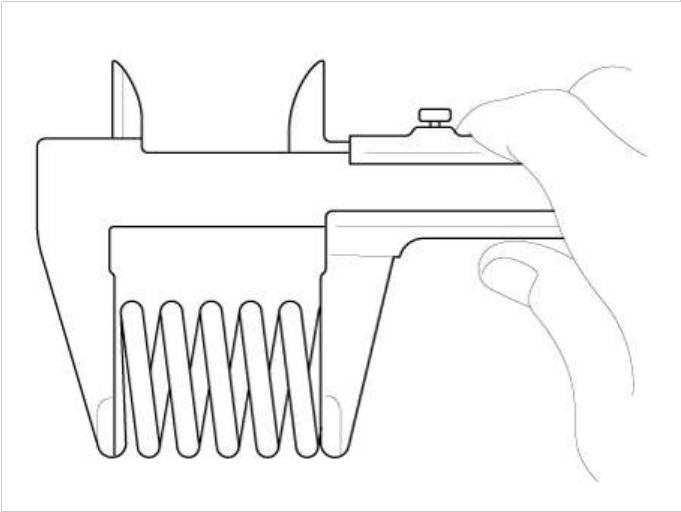
(2) Using a vernier calipers, measure the free length of valve spring.

Valve spring

Standard

Free height : 45.1mm (1.7756in)

Out of square : Less than 1.5°



Reassembly

NOTICE

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surface.
- Replace oil seals with new ones.

1. Install the valves.

(1) Install the spring seats.

(2) Using the SST (09222 - 2B100), push in a new oil seal.

NOTICE

- Do not reuse old valve stem oil seals.
- Incorrect installation of the seal could result in oil leakage past the valve guides.

⚠ CAUTION

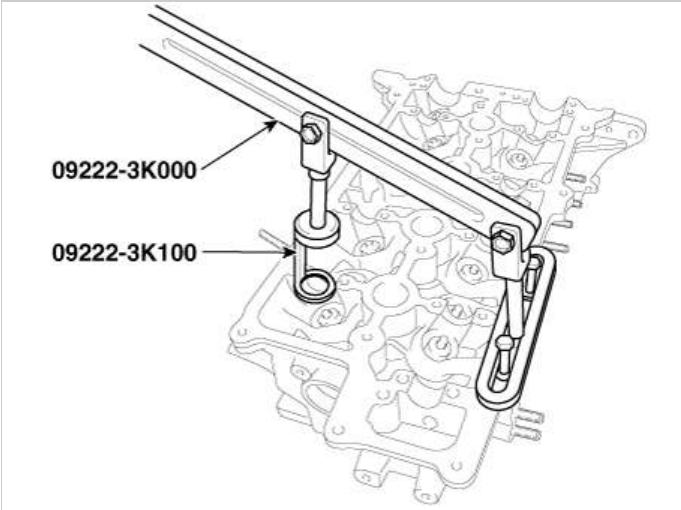
Intake valve stem seals are different from exhaust ones in type.
Do not reassembly ones in the other"s places.

(3) Install the valve, valve spring and spring retainer, after applying engine oil at the end of each valve.

NOTICE

When installing valve springs, the enamel coated side should face the valve spring retainer.

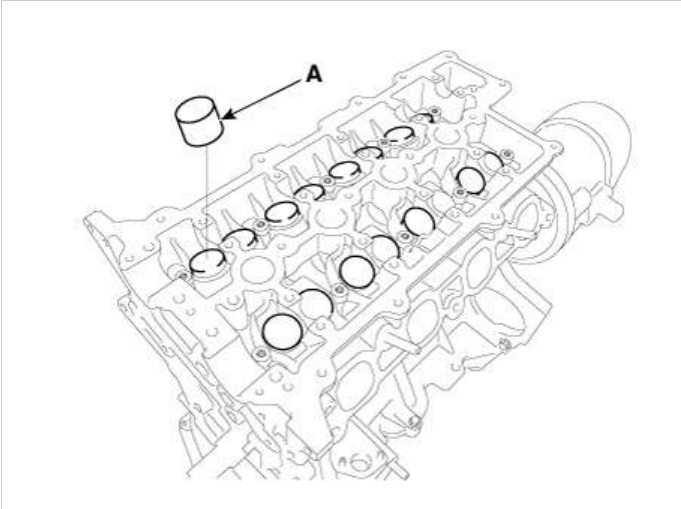
2. Using the SST(09222 - 3K000, 09222 - 3K100), compress the spring and install the retainer locks.
After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



CAUTION

When installing the SST, use the torque, 1.2kgf·m or less.

3. Lightly tap the end of each valve stem two or three times with the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.
4. Install the MLA(Mechanical lash adjuster)s.
   Check that the MLA (A) rotates smoothly by hand.



NOTICE

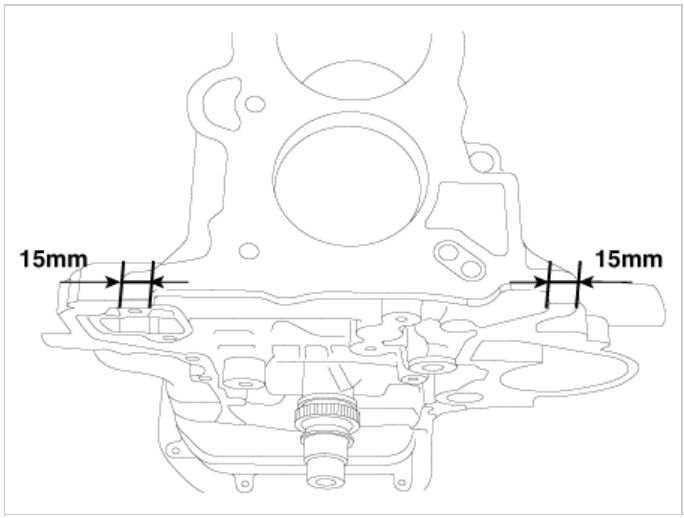
All the MLAs must be installed in its original position.

Installation

NOTICE

- Thoroughly clean all parts to be assembled.
- Always use a new cylinder head and manifold gasket.
- Always use new cylinder head bolts. Cylinder head bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.
- The cylinder head gasket is a metal gasket. Take care not to bend it.
- Rotate the crankshaft, set the No.1 piston at TDC.

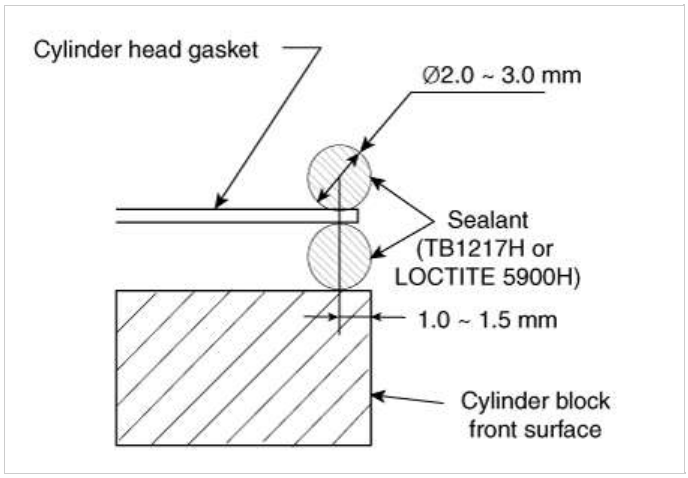
1. Install the cylinder head assembly.
   (1) Before installing, remove the hardened sealant from the cylinder block and cylinder head surface.
   (2) Before installing the cylinder head gasket, apply sealant on the upper surface of the cylinder block and reassemble the gasket within five minutes.



NOTICE

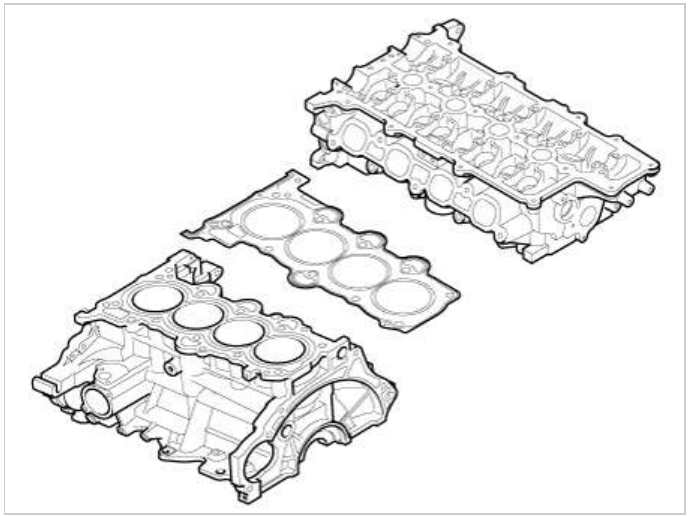
Refer to the illustration for applying sealant.

Width :2.0 - 3.0mm(0.0787 -0.1181in.)
Position :1.0 - 1.5mm(0.0394 - 0.0591in.)
Specification :TB 1217H or LOCTITE 5900H



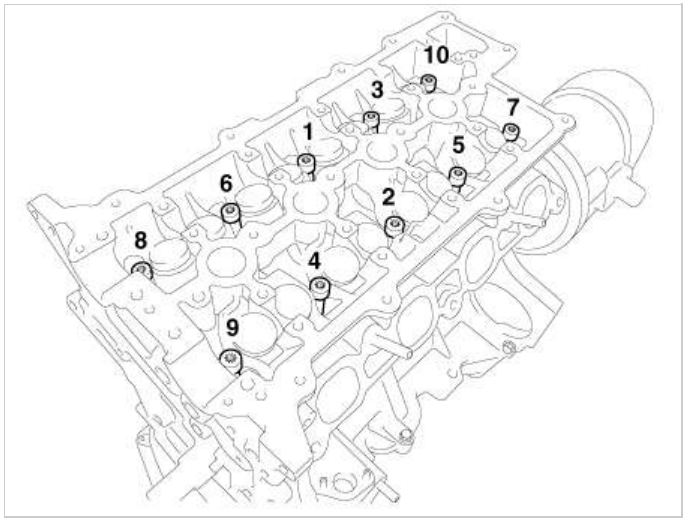
(3) After installing the cylinder head gasket on the cylinder block, apply sealant on the upper surface of the cylinder head gasket and reassemble in five minutes.

2. Place the cylinder head carefully not to damage the gasket.



3. Install the cylinder head bolts with washers.
(1) Tighten the 10 cylinder head bolts, in several passes, in the sequence shown.

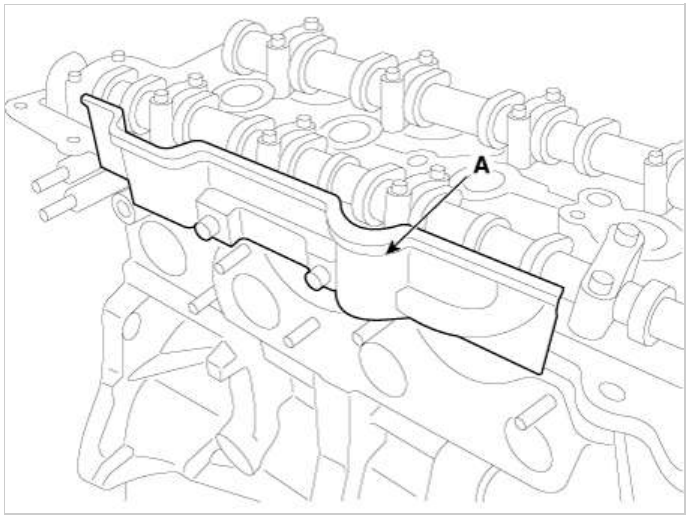
Tightening torque :
29.4 N·m (3.0 kgf·m, 21.7 lb·ft) + 90° + 90°



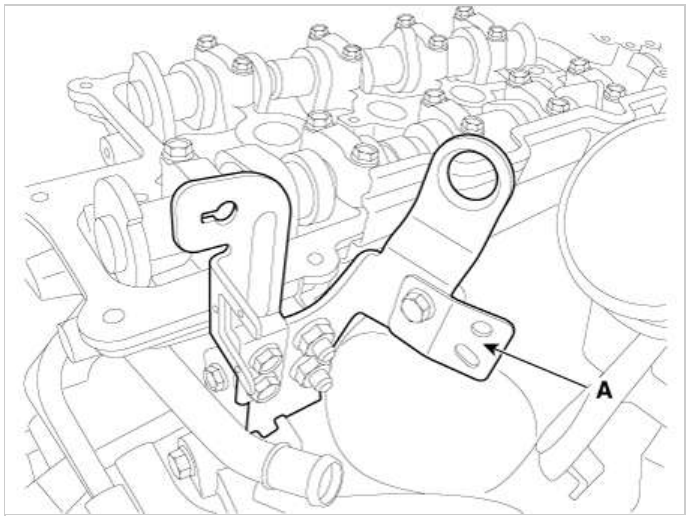
NOTICE
Always use new cylinder head bolts. Cylinder head bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.

4. Install the head cover heat protector (A).

Tightening torque :
9.8 - 11.8N·m (1.0 - 1.2kgf·m, 7.2 - 8.7lb·ft)



5. Install the rear hanger (A).

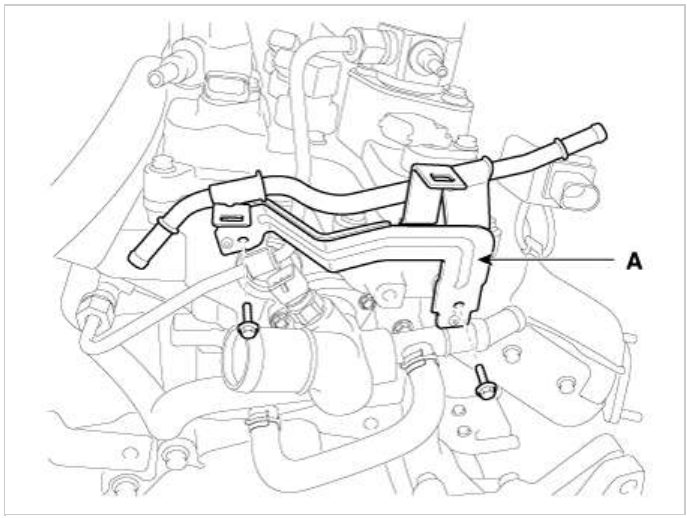


6. Install the oil control valve(OCV).
   (Refer to Engine Control / Fuel System - "CVVT Oil Control Valve (OCV)")
7. Install the heater pipe.
   (Refer to Cooling System - "Water Temperature Control Assembly")
8. Install the weter control assembly, and bypass hose.
   (Refer to Cooling System - "Water Temperature Control Assembly")
9. Install the delivery pipe assembly.
   (Refer to Engine Control / Fuel System - "Delivery Pipe")
10. Install the intake manifold.
    (Refer to Intake And Exhaust System - "Intake Manifold")
11. Install the turbo manifold.
    (Refer to Intake And Exhaust System - "Exhaust Manifold")
12. Install the cam shaft.
    (Refer to Cylinder Head Assembly - "Cam Shaft")
13. Install the timing chain.
    (Refer to Timing System - "Timing Chain")
14. Install the timing chain cover.
    (Refer to Timing System - "Timing Chain Cover)
15. Install the cylinder head cover.
    (Refer to Cylinder Head Assembly - "Cylinder Head Cover")

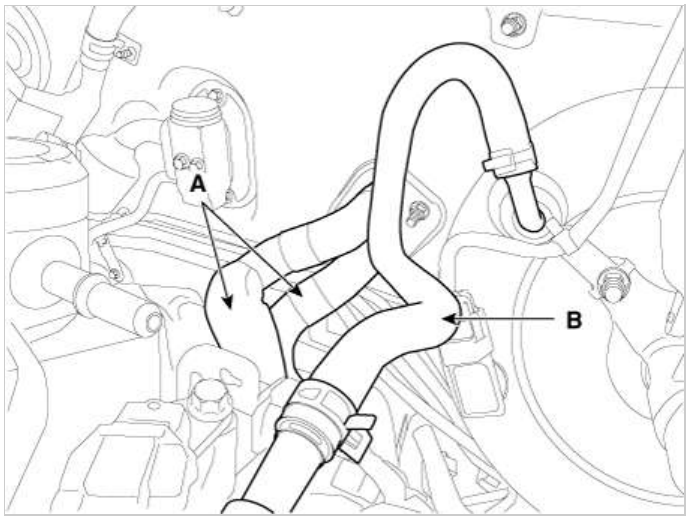
> **⚠ CAUTION**
> Do not reuse the disassembled gasket.

16. Install the vacuum pipe assembly (A).

Tightening torque :
9.8 - 11.8N·m (1.0 - 1.2kgf·m, 7.2 - 8.7lb·ft)



17. Connect the heater hoses (A) and brake booster vacuum hose (B).



18. Install in the reverse order of removal.

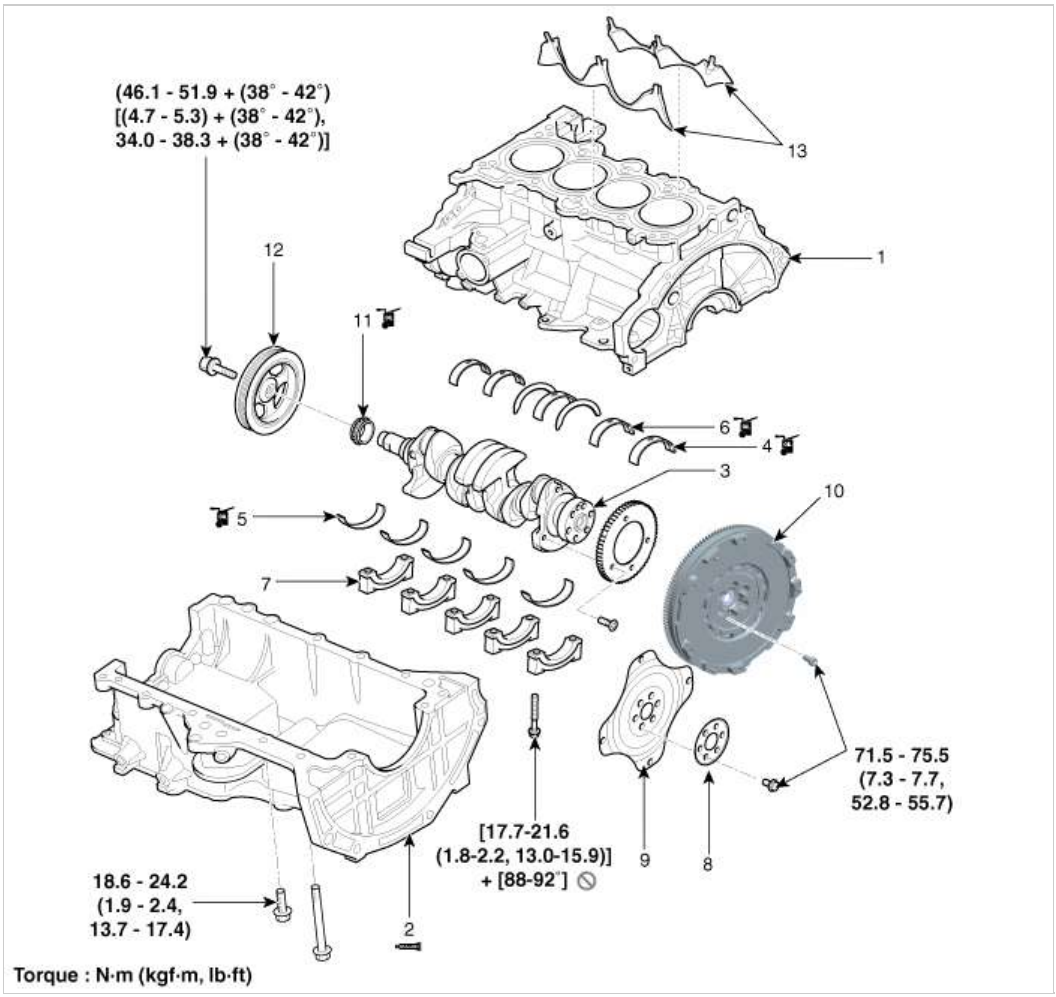
NOTICE

Perform the following :

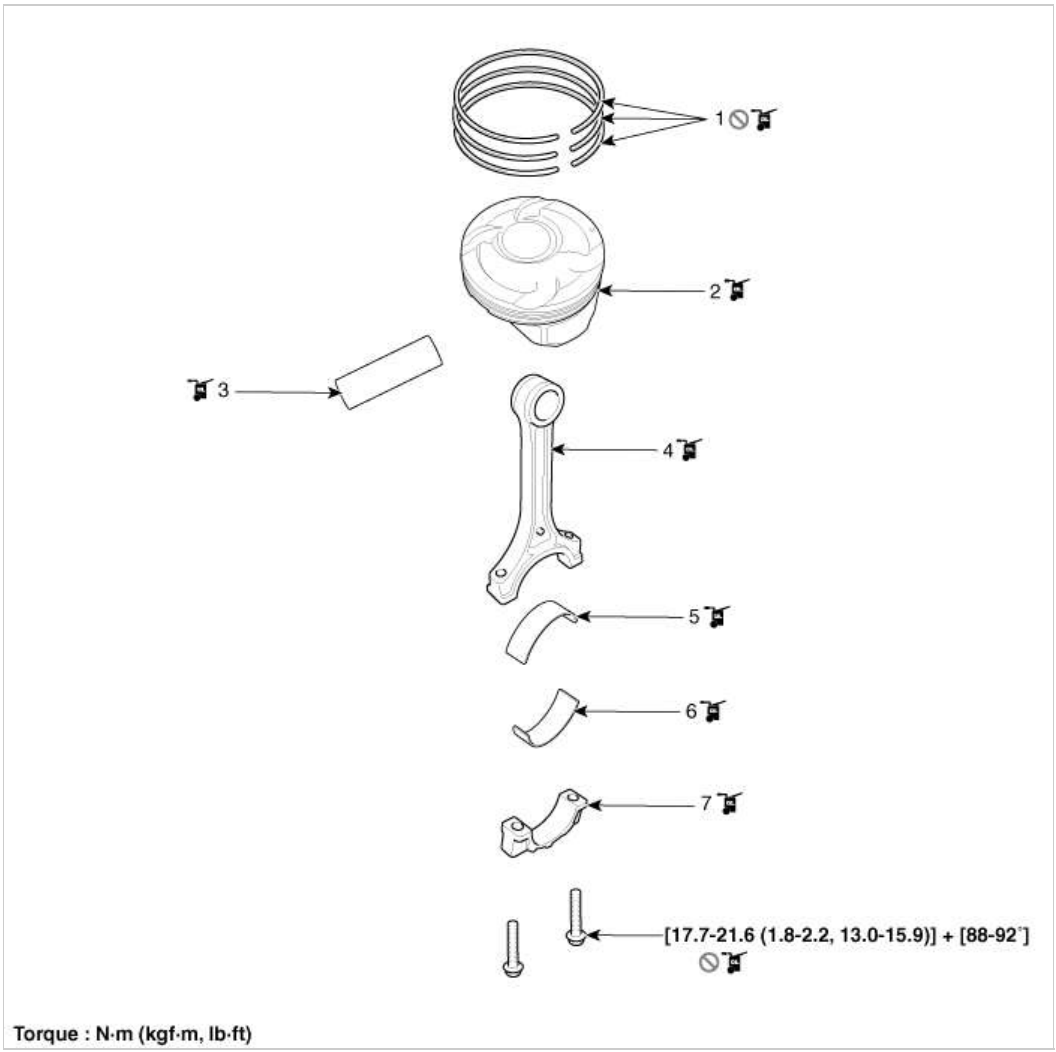
- Refill engine with engine oil.
- Refill a radiator and a reservoir tank with engine coolant.
- Inspect for fuel leakage.
  - After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
  - Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.
- Bleed air from the cooling system.
  - Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
  - Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
  - Put radiator cap on tightly, then run the engine again and check for leaks.

Engine Mechanical System

Components



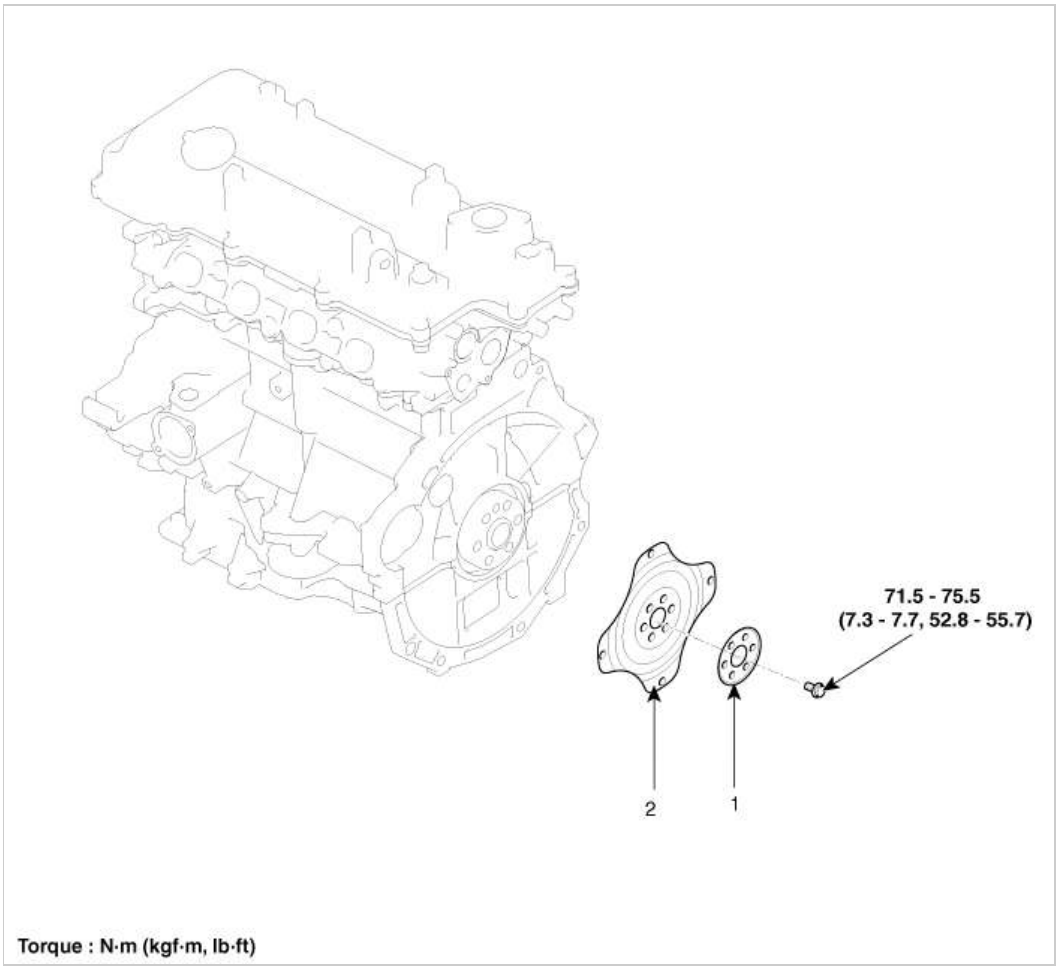
1. Cylinder block
2. Ladder frame
3. Crankshaft
4. Crankshaft upper bearing
5. Crankshaft lower bearing
6. Thrust bearing
7. Main bearing cap
8. Adapter plate
9. Drive plate
10. Dual Mass Flywheel (DMF)
11. Crankshaft sproket
12. Crankshaft pulley
13. Water jacket insert



1. Piston ring
2. Piston
3. Piston pin
4. Connecting rod
5. Connecting rod upper bearing
6. Connecting rod lower bearing
7. Connecting rod bearing cap

Engine Mechanical System

Components



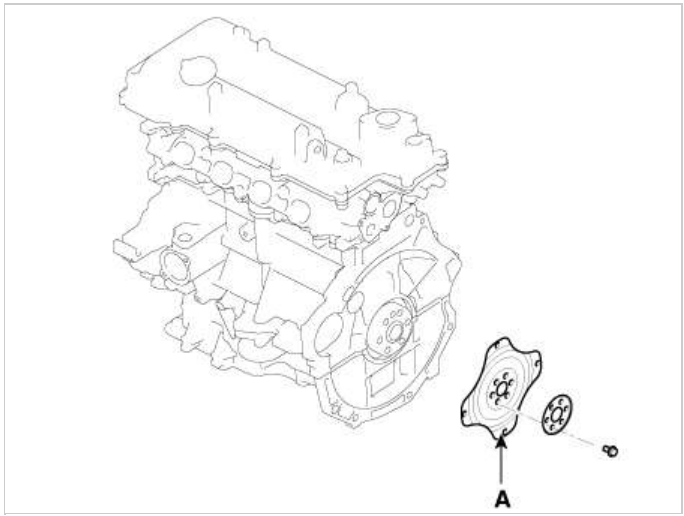
1. Adapter plate
2. Drive plate

Engine Mechanical System

Removal and Installation

1. Remove the automatic transaxle .
   (Refer to Automatic Transaxle System - "Automatic Transaxle")
2. Remove the drive plate(A).

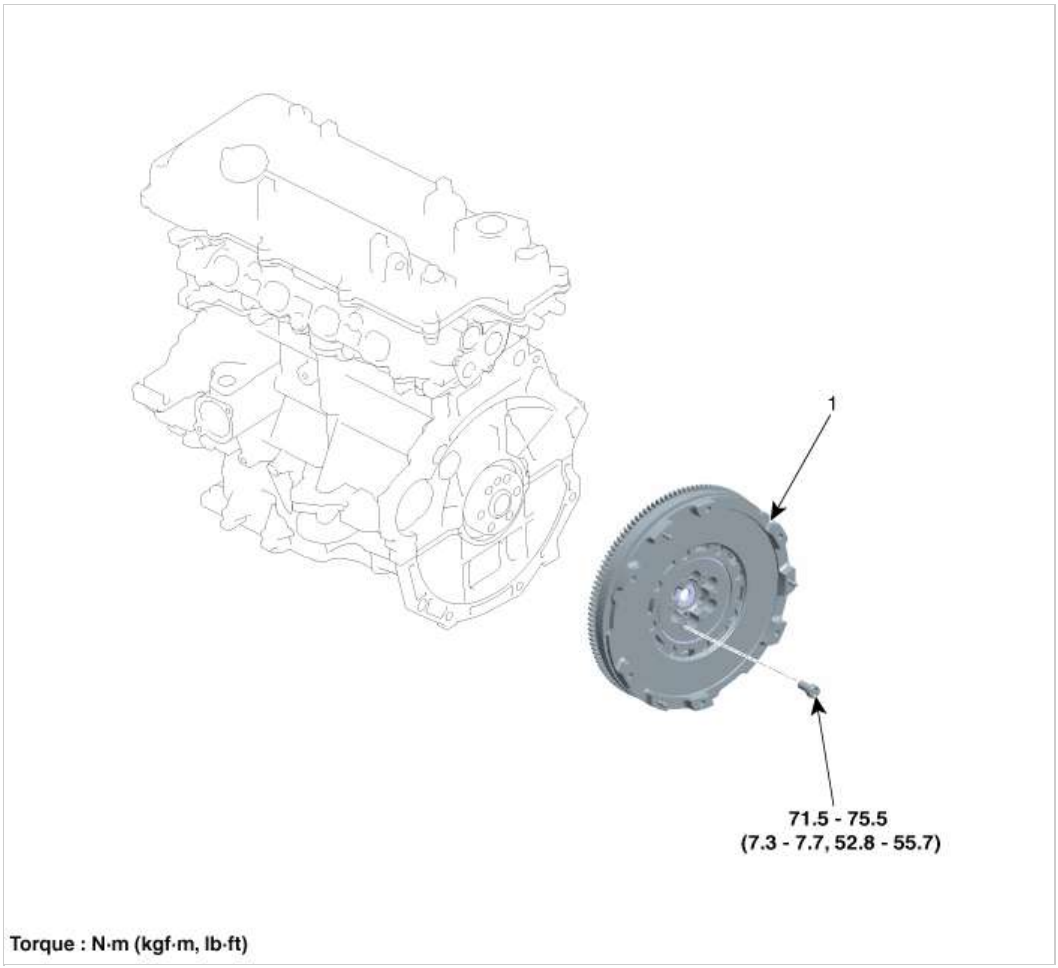
Tightening torque :
71.5 - 75.5N·m (7.3 - 7.7kgf·m, 52.8 - 55.6 lb·ft)



3. Install in the reverse order of removal.

Engine Mechanical System

Components



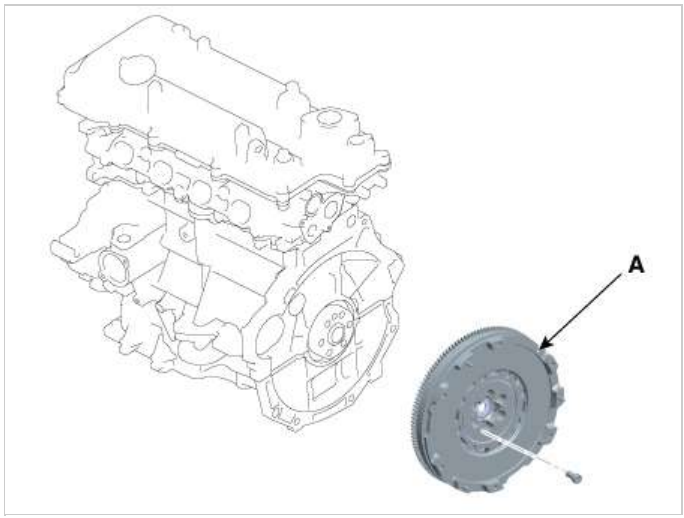
1. Dual Mass Flywheel (DMF)

Engine Mechanical System

Removal and installation

1. Remove the manual Tranaxle.
   (Refer to Manual Transaxle System - "Manual Transaxle ")
2. Remove the dual mass flywheel (A).

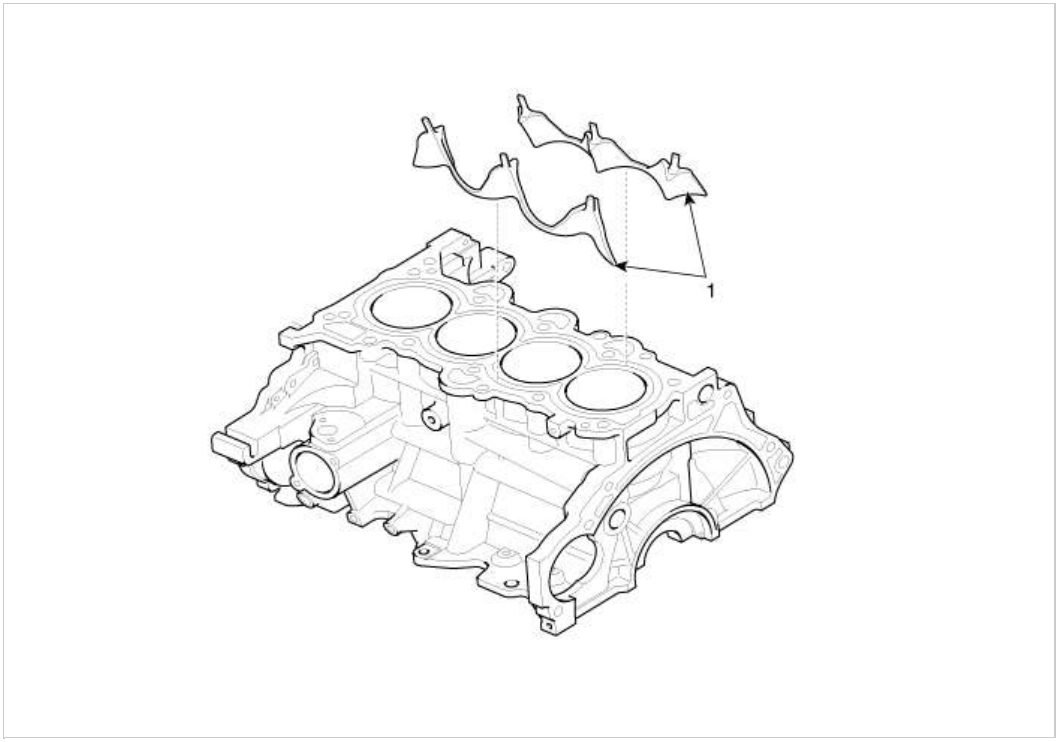
Tightening torque :
71.5 - 75.5N·m (7.3 - 7.7kgf·m, 52.8 - 55.6 lb·ft)



3. Install in the reverse order of removal.

Engine Mechanical System

Components

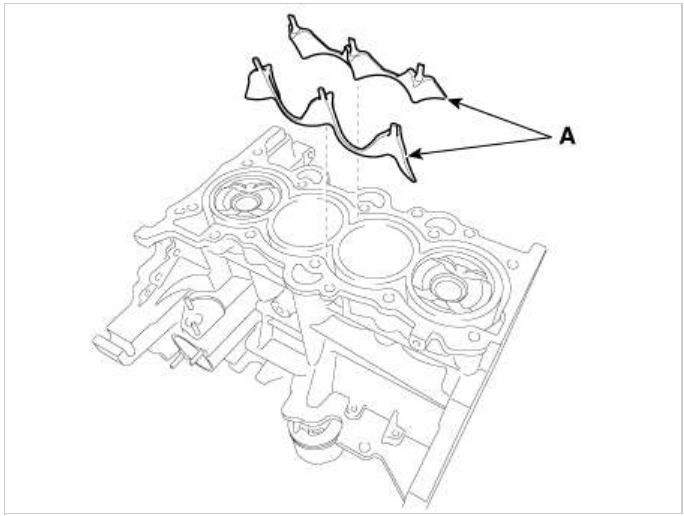


1. Water Jacket Seperator

Engine Mechanical System

Remove and Installation

1. Remove the cylinder head assembly.
   (Refet to Cylinder Head Assembly - "Cylinder Head")
2. Remove the water jacket seperator (A).



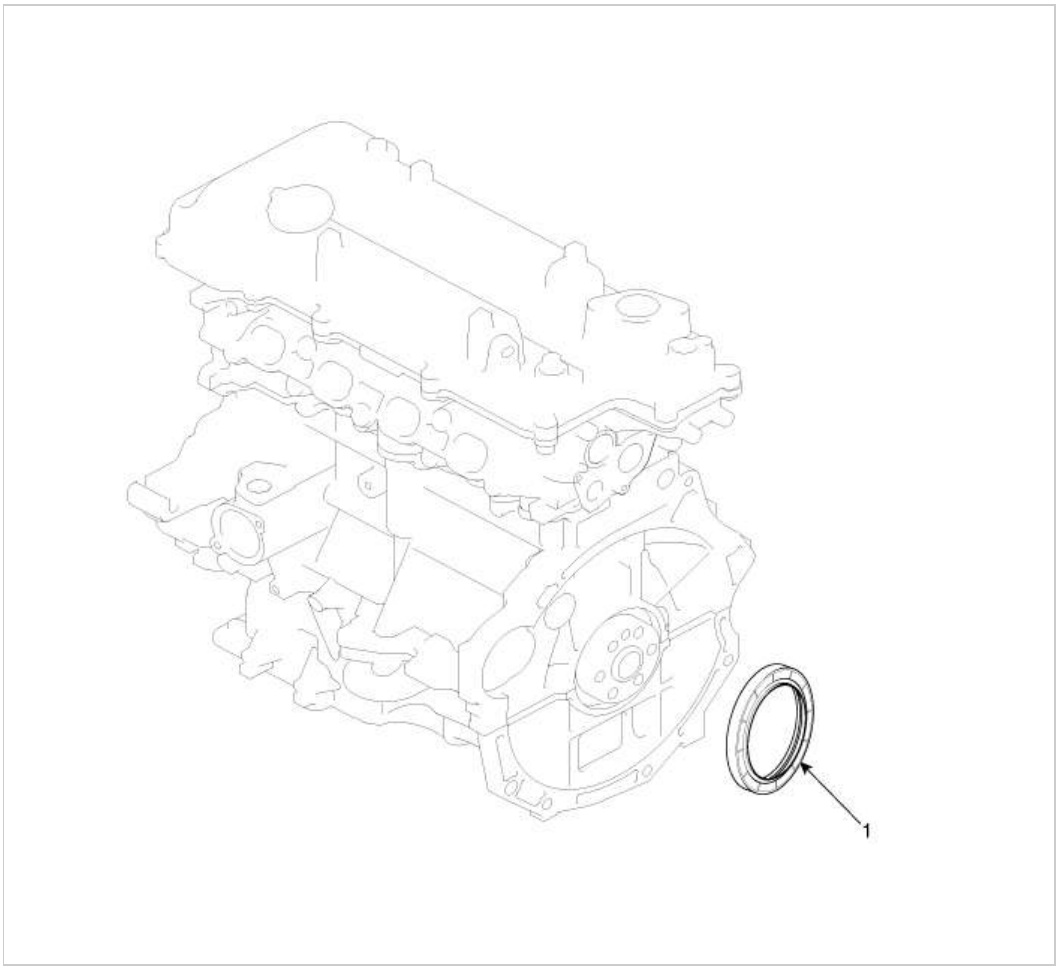
⚠ CAUTION

Be careful not to deform or damage it when removing.

3. Install in the reverse order of removal.

Engine Mechanical System

Components

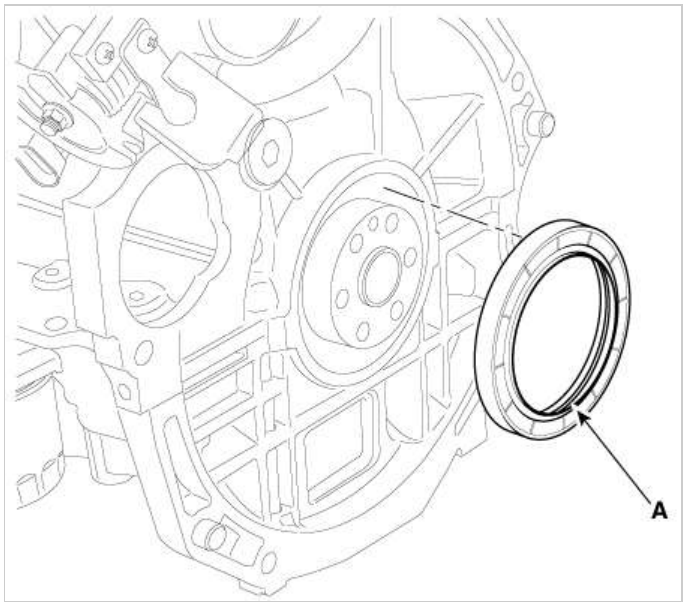


1. Rear oil seal

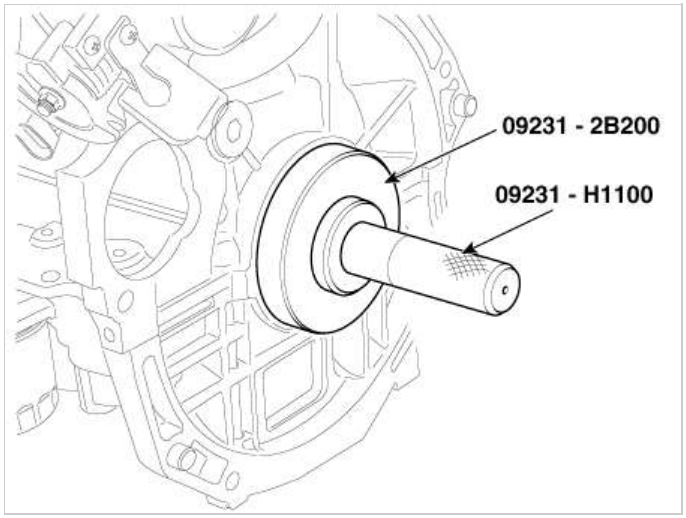
Engine Mechanical System

Replacement

1. Remove the transaxle assembly.
   (Refer to Manual Transaxle System - "Manual Transaxle")
   (Refer to Automatic Transaxle System - "Automatic Transaxle")
2. MT : Remove the flywheel.
   (Refet to Cylinder Block - "Flywheel")
   AT : Remove the drive plate.
   (Refet to Cylinder Block - "Drive Plate")
3. Remove the rear oil seal (A).



4. Install a new rear oil seal.
   (1) Apply engine oil to a new oil seal lip.
   (2) Using the SST(09231-H1100, 09231-2B200) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.



5. Install the other parts in the reverse order of removal.

Engine Mechanical System

Disassembly

NOTICE

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature (20°C [68°F]) before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

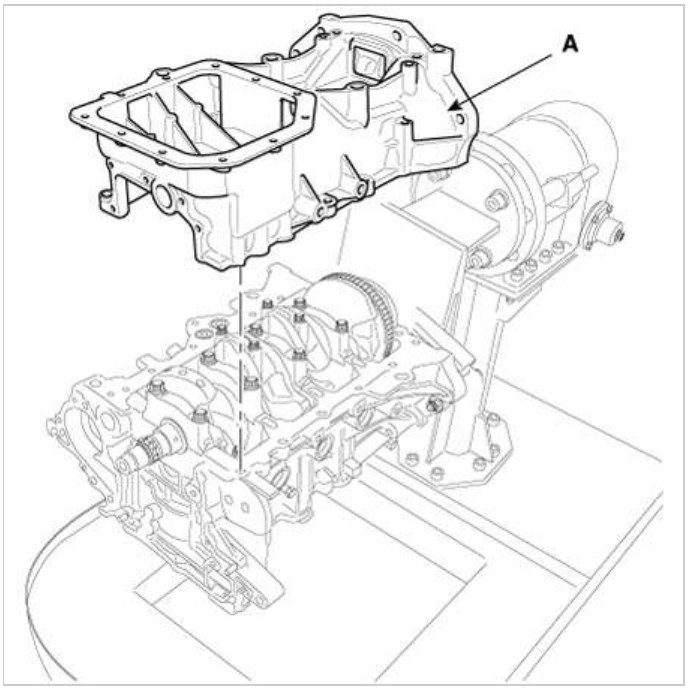
Information

- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft damper pulley so that the piston of No. 1 cylinder is at TDC (top dead center) on compression stroke.

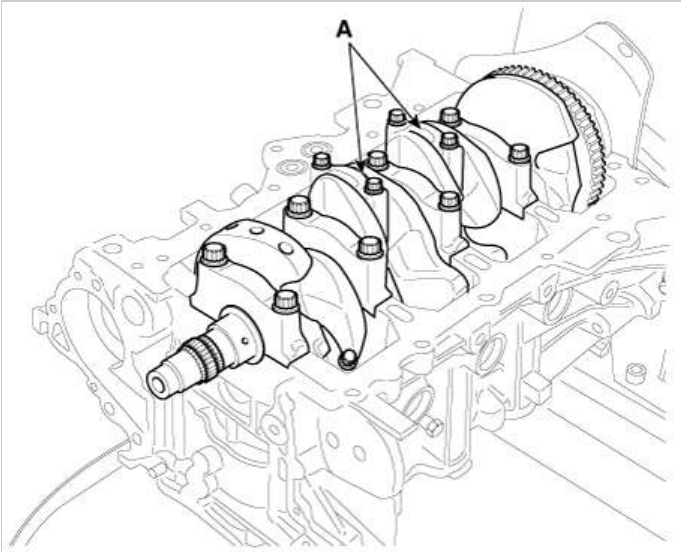
1. Remove the engine and transaxle assembly from the vehicle.
   (Refer to Engine and Transaxle Assembly - "Engine and Transaxle Assembly")
2. Remove the transaxle assembly from the engine assembly.
   (Refer to Manual Transaxle System - "Manual Transaxle")
   (Refer to Automatic Transaxle System - "Automatic Transaxle")
3. MT : Remove the flywheel.

(Refet to Cylinder Block - "Flywheel")
AT : Remove the drive plate.
(Refet to Cylinder Block - "Drive Plate")

4. Remove the rear oil seal.
   (Refer to Cylinder Block Assembly - "Rear Oil Seal")
5. Install the engine assembly to engine stand for disassembly.
6. Remove the intake manifold.
   (Refer to Intake And Exhaust System - "Intake Manifold")
7. Remove the exhaust manifold.
   (Refer to Intake And Exhaust System - "Exhaust Manifold")
8. Remove the timing chain.
   (Refer to Timing System - "Timing Chain")
9. Remove the cylinder head assembly.
   (Refer to Cylinder Head Assembly - "Cylinder Head")
10. Remove the oil cooler.
    (Refer to Lubrication System - "Oil Cooler")
11. Remove the oil pan and the oil screen.
    (Refer to Lubrication System - "Oil Pan")
12. Remove the ladder frame (A).



13. Check the connecting rod side clearance.
14. Check the connecting rod bearing cap oil clearance.
15. Remove the piston and connecting rod assembly.
    (1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    (2) Remove the connecting rod bearing caps (A).



Information

Mark the connecting rod and bearing caps to be able to reassemble in the original position and direction.

(3) Push the piston and connecting rod assembly with upper bearing through the top of the cylinder block.

Information

- Keep the connecting rod and caps with the bearings assembled together.
- Arrange the piston and connecting rod assemblies in the correct order.
- Mark the piston and connecting rod assembly to be able to reassemble in the original position.

16. Check fit between piston and piston pin.
    Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and pin as a set.
17. Disassemble the piston rings.
    (1) Using a piston ring expender, remove the two compression rings.
    (2) Remove the two side rails and coil spring.

Information

Arrange the piston rings in the correct order.

18. Disassemble the connecting rod from the piston.
    Using a hydraulic press, remove the piston pin from piston.

Inspection

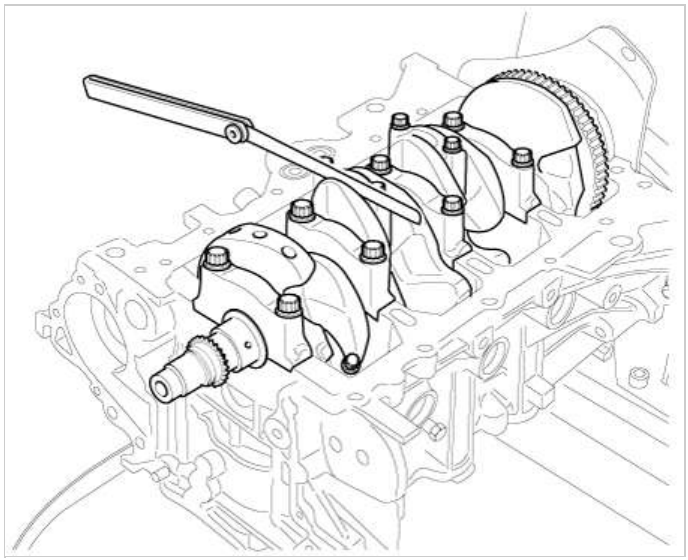
Connecting Rod

1. Check the side clearance between piston and connecting rod.
   Using filler gauge, measure the side clearance while moving the connecting rod back and forth.

Side clearance

Standard : 0.1 - 0.25 mm (0.0039 - 0.0098 in)
Maximum : 0.35 mm (0.0138 in)

- If out-of-tolerance, install a new connecting rod.
- If still out-of-tolerance after connecting rod replacement, replace the crankshaft.



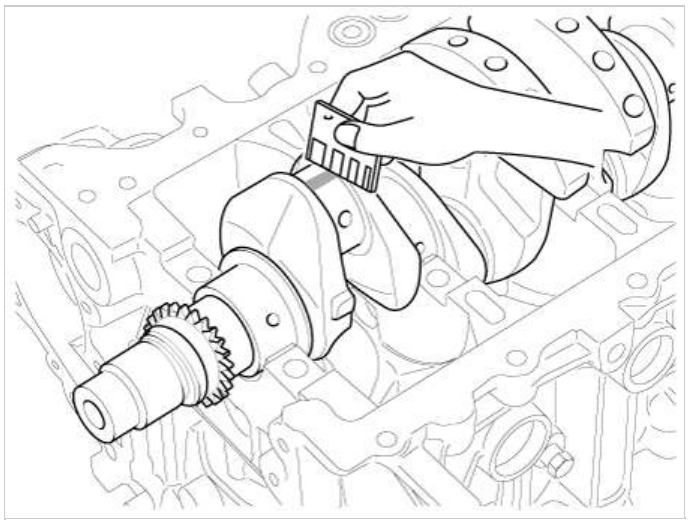
2. Check the connecting rod bearing oil clearance.
   (1) Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
   (2) Remove the 2 connecting rod cap bolts.
   (3) Remove the connecting rod cap and lower bearing.
   (4) Clean the crankshaft pin journal and bearing.
   (5) Place a plastigage across the crankshaft pin journal.
   (6) Reinstall the lower bearing and cap, and tighten the bolts.

   Tightening torque :
   17.7 - 21.6 N·m (1.8 - 2.2 kgf·m, 13.0 - 15.9 lb·ft) + 88°-92°

   NOTICE
   - Do not turn the crankshaft.
   - Always use new connecting rod cap bolts. Connecting rod cap bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.

   (7) Remove the connecting rod cap and lower bearing.
   (8) Measure the plastigage at its widest point.

   Bearing oil clearance :
   0.018 - 0.36 mm (0.0007 - 0.0014 in)



   (9) If the measurement from the plastigage is too wide or too narrow, remove the upper and lower bearing and then install a new bearings with the same color mark. Recheck the oil clearance.

   NOTICE
   Do not file, shim on scrape the bearings or the caps to adjust clearance.

(10) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing. Recheck the oil clearance.

NOTICE

If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

NOTICE

If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

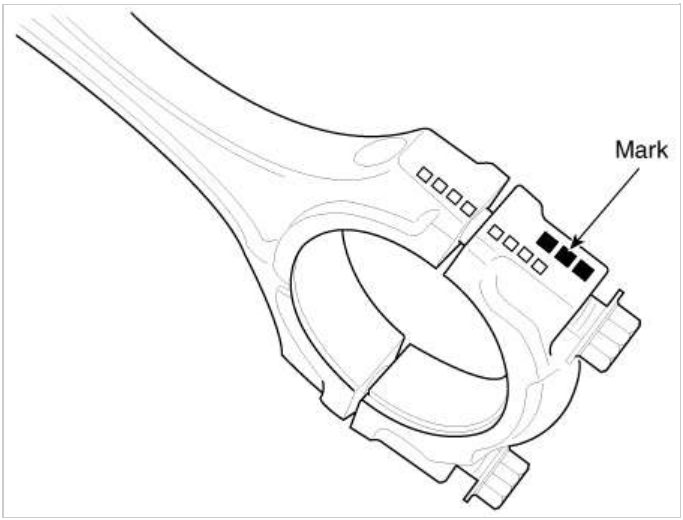
(11) Select the bearing by using the selection table.

Connecting Rod Bearing Selection Table

Connecting rod bearing		Connecting rod mark		
		A, 0	B, 00	C, 000
Crank shaft pin journal mark	1	E (Pink)	D (Light Green)	C (White)
	2	D (Light Green)	C (White)	B (Black)
	3	C (White)	B (Black)	A (Light Blue)

Discrimination Of Connecting Rod

Mark	Connecting rod big-end inner diameter
A, 0	45.000 - 45.006 mm (1.7717 - 1.7719 in)
B, 00	45.006 - 45.012 mm (1.7719 - 1.7721 in)
C, 000	45.012 - 45.018 mm (1.7721 - 1.7724 in)

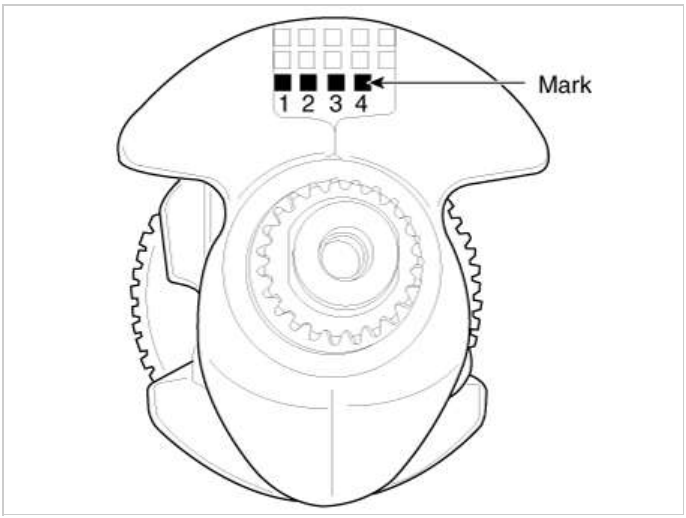


Discrimination Of Crankshaft Pin Journal

Mark	Crankshaft pin journal outer diameter
1	41.966 - 41.972 mm (1.6522 - 1.6524 in)
2	41.960 - 41.966 mm (1.6520 - 1.6522 in)
3	41.954 - 41.960 mm (1.6517 - 1.6520 in)

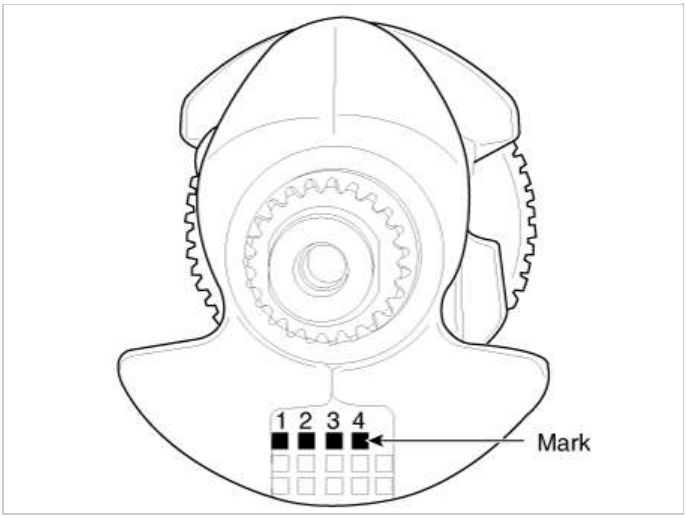
[Type A]

Top surface stamp



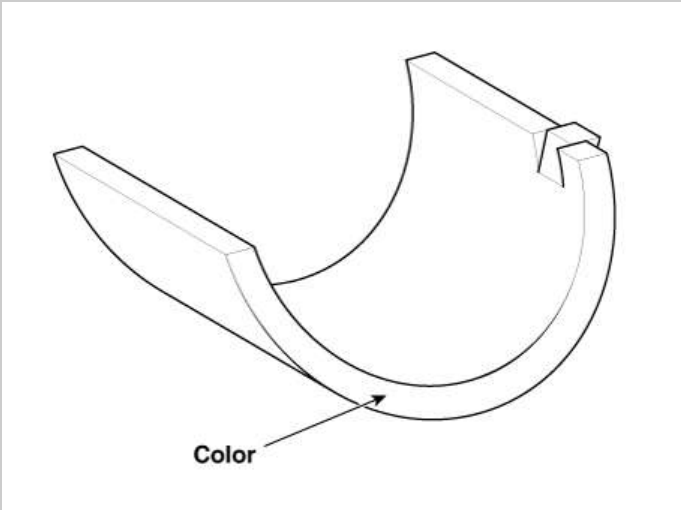
[Type B]

Bottom surface stamp



Discrimination Of Connecting Rod Bearing

Class	Color	Connecting rod bearing thickness
A	Light Blue	1.514 - 1.517 mm (0.0596 - 0.0597 in)
B	Black	1.511 - 1.514 mm (0.0595 - 0.0596 in)
C	White	1.508 - 1.511 mm (0.0594 - 0.0595 in)
D	Light Green	1.505 - 1.508 mm (0.0593 - 0.0594 in)
E	Pink	1.502 - 1.505 mm (0.0591 - 0.0593 in)



3. Check the connecting rods.
   (1) When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.
   (2) Replace the connecting rod if it is damaged on the thrust faces at either end. Also if step wear or a severely rough surface of the inside diameter of the small end is apparent, the rod must be replaced as well.
   (3) Using a connecting rod aligning tool, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

Allowable bend of connecting rod :
0.05 mm (0.0020 in) or less / 100 mm (3.94 in)
Allowable twist of connecting rod :
0.1 mm (0.0039 in) or less / 100 mm (3.94 in)

Piston

1. Clean the piston.
   (1) Using a gasket scraper, remove the carbon from the piston top.
   (2) Using a groove cleaning tool or broken ring, clean the piston ring grooves.
   (3) Using solvent and a brush, thoroughly clean the piston.

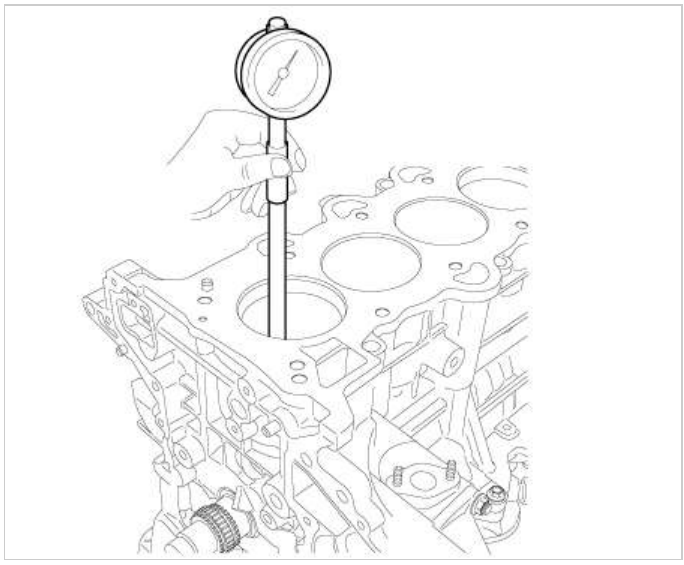
> **NOTICE**
> Do not use a wire brush.

2. Check the piston-to-cylinder clearance by calculating the difference between the cylinder bore inner diameter and the piston outer diameter.

Piston-to-cylinder clearance :
0.02 - 0.04 mm (0.0008 - 0.0016 in)

   (1) Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial direction.

Cylinder bore diameter :
77.00 - 77.03 mm (3.0315 - 3.0327 in)



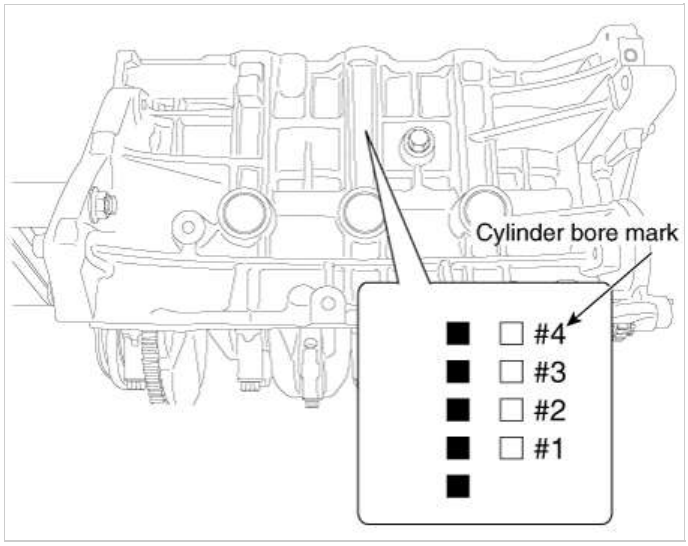
(2) Measure the piston outside diameter at 33.9 mm (1.5697 in) from top land of the piston.

Piston outside diameter :
76.97 - 77.00 mm (3.0303 - 3.0315 in)

3. Select the piston matching with cylinder bore class.

Piston-to-cylinder clearance :
0.02 - 0.04 mm (0.0008 - 0.0016 in)

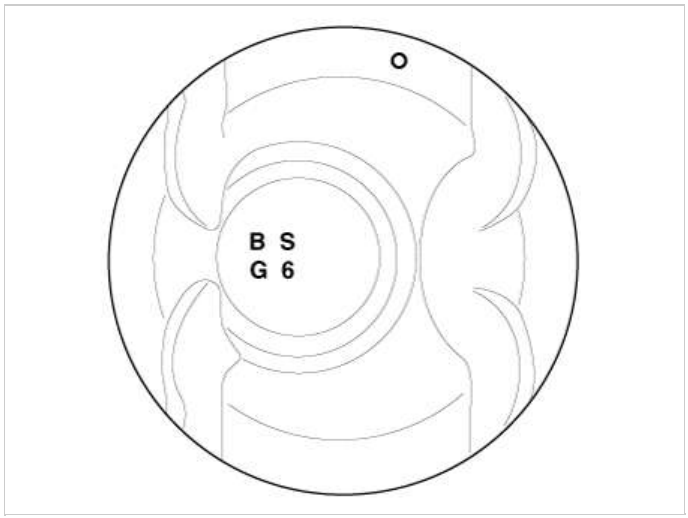
(1) Check the cylinder bore size mark on the side of the cylinder block.



Discrimination Of Cylinder Bore

Mark	Cylinder bore inner diameter
A	77.00 - 77.01 mm (3.0315 - 3.0319 in)
B	77.01 - 77.02 mm (3.0319 - 3.0323 in)
C	77.02 - 77.03 mm (3.0323 - 3.0327 in)

(2) Check the piston size mark on the piston top face.



A : Grade
S : ISG type
G : Gasoline engine
6 : 1.6L

Discrimination Of Piston Outer Diameter

Mark	Piston outer diameter
A	76.97 - 76.98 mm (3.0303 - 3.0307 in)
B	76.98 - 76.99 mm (3.0307 - 3.0311 in)
C	76.99 - 77.00 mm (3.0311 - 3.0315 in)

Piston Rings

1. Inspect the piston ring side clearance.
   Using a feeler gauge, measure the clearance between new piston ring and the wall of ring groove.

Piston ring side clearance
[Standard]
No.1 ring : 0.04 - 0.08 mm (0.0015 - 0.0031 in)
No.2 ring : 0.04 - 0.08 mm (0.0015 - 0.0031 in)
Oil ring : 0.06 - 0.135 mm (0.0024 - 0.0053 in)
[Limit]
No.1 ring : 0.1 mm (0.0039 in)
No.2 ring : 0.1 mm (0.0039 in)
Oil ring : 0.2 mm (0.0079 in)

If the clearance is greater than maximum, replace the piston.

2. Inspect the piston ring end gap.
   To measure the piston ring end gap, insert a piston ring into the cylinder bore. Position the ring at right angles to the cylinder wall by gently pressing it down with a piston. Measure the gap with a feeler gauge.

Piston ring end gap

[Standard]

No.1 ring : 0.14 - 0.28 mm (0.0079 - 0.0138 in)

No.2 ring : 0.30 - 0.45 mm (0.0118 - 0.0177 in)

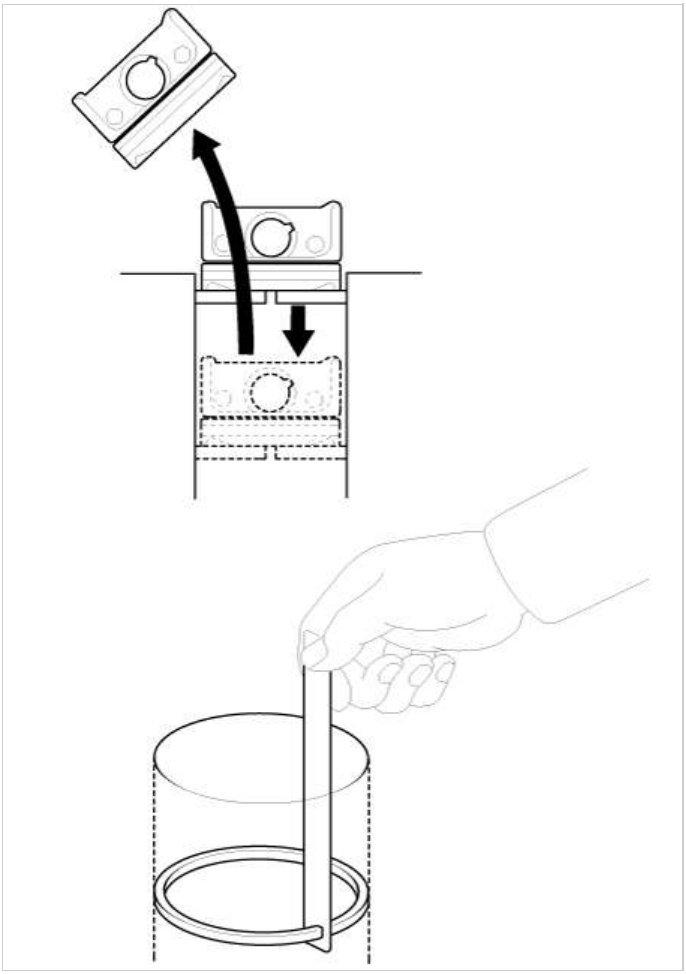
Oil ring : 0.20 - 0.50 mm (0.0079 - 0.0276 in)

[Limit]

No.1 ring : 0.3 mm (0.0118 in)

No.2 ring : 0.5 mm (0.0197 in)

Oil ring : 0.8 mm (0.0315 in)



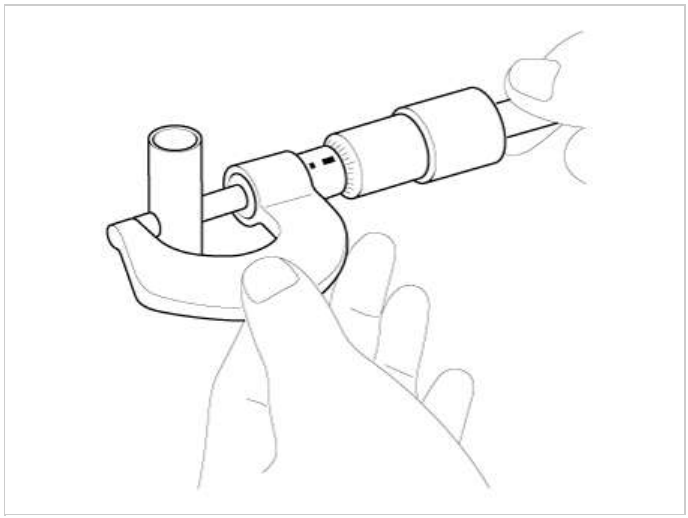
If the gap exceeds the specifications, replace the piston rings. If the gap is too large, recheck the cylinder bore inner diameter. If the bore is over the specifications, the cylinder block must be rebored.

Piston Pins

1. Measure the outer diameter of piston pin

Piston pin diameter :

18.001 - 18.006 mm (0.7087 - 0.7089 in)



2. Measure the piston pin-to-piston clearance.

Piston pin-to-piston clearance :
0.010 - 0.020 mm (0.0004 - 0.0008 in)

3. Check the difference between the piston pin outer diameter and the connecting rod small end inner diameter.

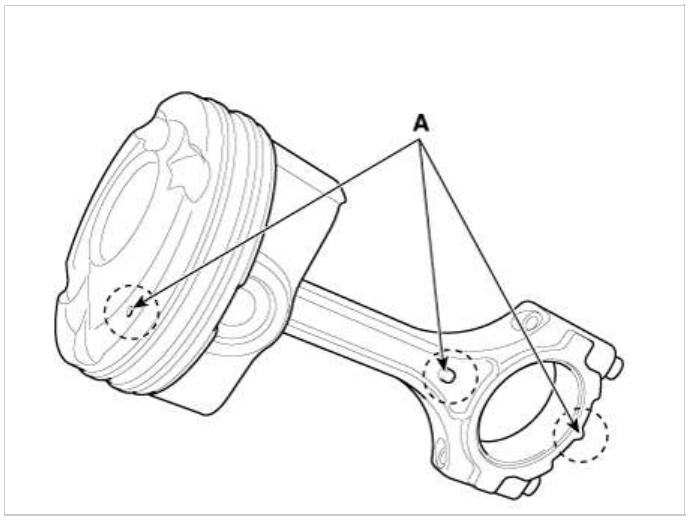
Piston pin-to-connecting rod interference :
-0.032 to -0.016 mm (-0.0013 to -0.0006 in)

Reassembly

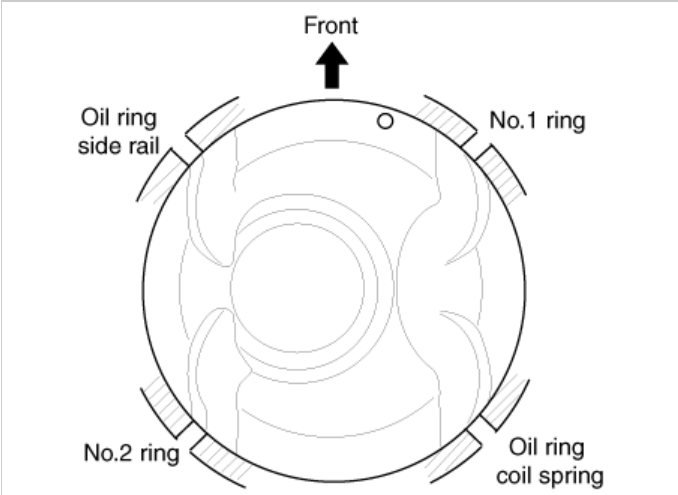
NOTICE

- Thoroughly clean all parts to assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

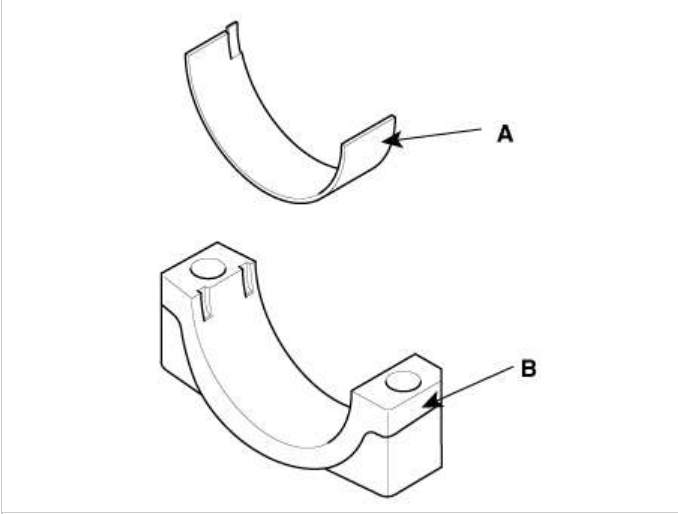
1. Assemble the piston and the connecting rod.
   (1) Use a hydraulic press for installation.
   (2) The piston front mark (A) and the connecting rod front mark (A) must face the timing chain side of the engine.
   Pressing load :500 - 1,500 kg (1,102 - 3,306 lb)



2. Assemble the piston rings.
   (1) Install the oil ring coil spring and two side rails by hand.
   (2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
   (3) Position the piston rings so that the ring ends are as shown.



3. Assemble the connecting rod bearings.
   (1) Align the bearing (A) claw with the groove of the connecting rod and cap (B).
   (2) Install the bearings (A) in the connecting rod and cap (B).

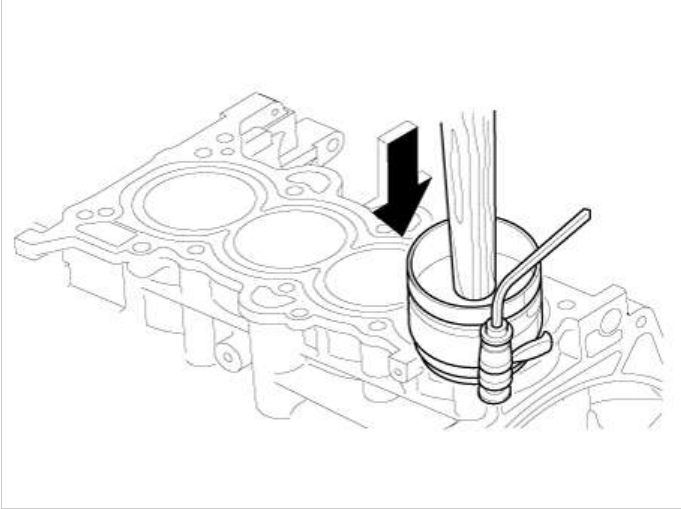


4. Insert the piston and connecting rod assemblies into the cylinder bores.

NOTICE

Before installing the piston, apply a sufficient amount of engine oil to the ring grooves and cylinder bores.

   (1) Press the piston rings with a ring compressor and check that the rings are securely in place. Then insert the piston into the cylinder bore, and tap it in using the wooden handle of a hammer.



(2) Stop after the ring compressor pops free, and check the connecting rod-to-crank journal alignment before pushing the piston into place.

(3) Install the rod caps with bearings, and tighten the bolts.

Tightening torque :

17.7 - 21.8 N·m (1.8 - 2.2 kgf·m, 13.0 - 15.9 lb·ft) + 88 - 92°

NOTICE

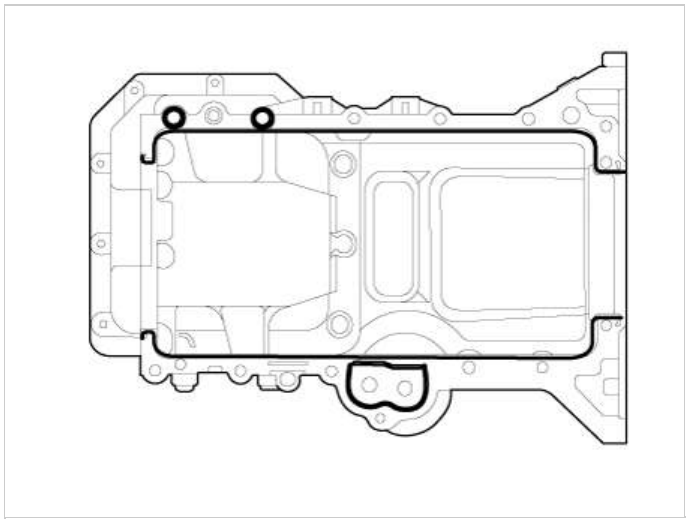
Always use new connecting rod cap bolts. Connecting rod cap bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.

5. Check the side clearance between piston and connecting rod.

6. Install the ladder frame.

(1) Apply the liquid gasket on the ladder frame.

Bead width :2.5 - 3.5 mm (0.0984 - 0.1378 in)



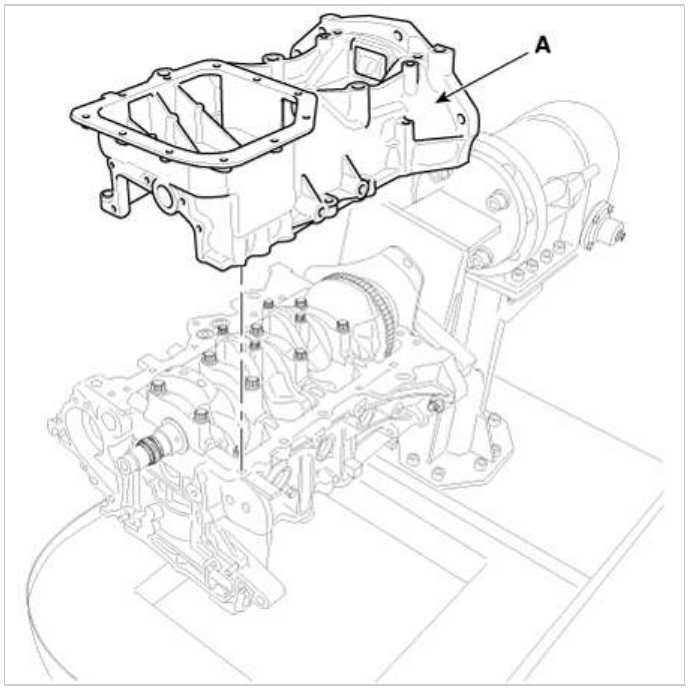
NOTICE

- Apply the sealant, THREE-BOND 1217H or LOCTITE 5900H on the ladder frame rail portion and install it within five minutes. If sealant is applied to cylinder block bottom position, the sealant position should be the same as that of the ladder frame rail.
- Apply sealant along the inner line of the bolt holes.

(2) Install the ladder frame (A).

Tightening torque :

18.6 - 23.5 N·m (1.9 - 2.4 kgf·m, 13.7 - 17.4 lb·ft)



7. Assemble the other parts in the reverse order of disassembly.

Engine Mechanical System

Disassembly

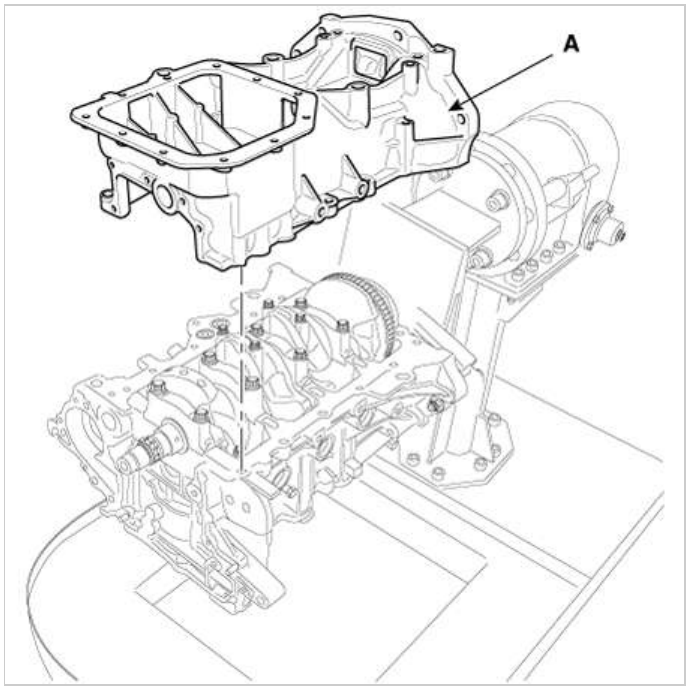
NOTICE

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature (20°C [68°F]) before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

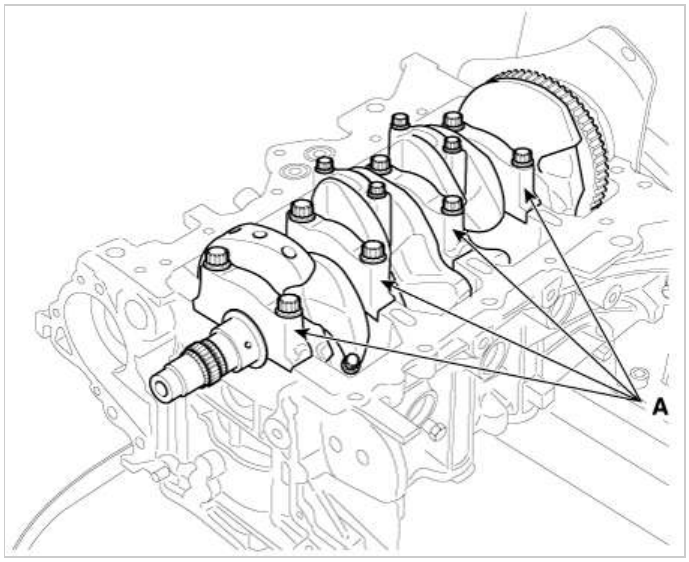
Information

- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft damper pulley so that the piston of No. 1 cylinder is at TDC (top dead center) on compression stroke.

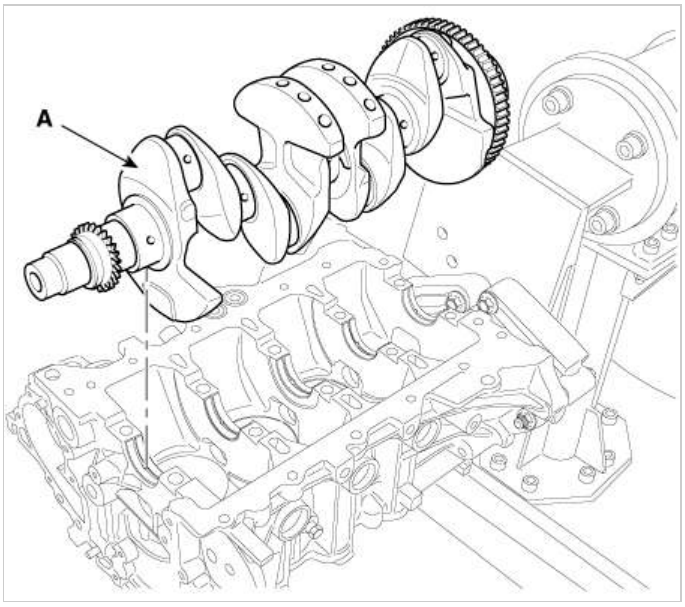
1. Remove the engine and transaxle assembly from the vehicle.
   (Refer to Engine and Transaxle Assembly - "Engine and Transaxle Assembly")
2. Remove the transaxle assembly from the engine assembly.
   (Refer to Manual Transaxle System - "Manual Transaxle")
   (Refer to Automatic Transaxle System - "Automatic Transaxle")
3. MT : Remove the flywheel.
   (Refet to Cylinder Block - "Flywheel")
   AT : Remove the drive plate.
   (Refet to Cylinder Block - "Drive Plate")
4. Remove the rear oil seal.
   (Refer to Cylinder Block Assembly - "Rear Oil Seal")
5. Install the engine assembly to engine stand for disassembly.
6. Remove the intake manifold.
   (Refer to Intake And Exhaust System - "Intake Manifold")
7. Remove the exhaust manifold.
   (Refer to Intake And Exhaust System - "Exhaust Manifold")
8. Remove the timing chain.
   (Refer to Timing System - "Timing Chain")
9. Remove the cylinder head assembly.
   (Refer to Cylinder Head Assembly - "Cylinder Head")
10. Remove the oil cooler.
    (Refer to Lubrication System - "Oil Cooler")
11. Remove the oil pan and the oil screen.
    (Refer to Lubrication System - "Oil Pan")
12. Remove the ladder frame (A).



13. Remove the piston and connecting rod assembly.
    (Refer to Cylinder Block Assembly - "Piston and Connecting Rod")
14. Check the main bearing oil clearance.
15. Remove the main bearing caps (A).



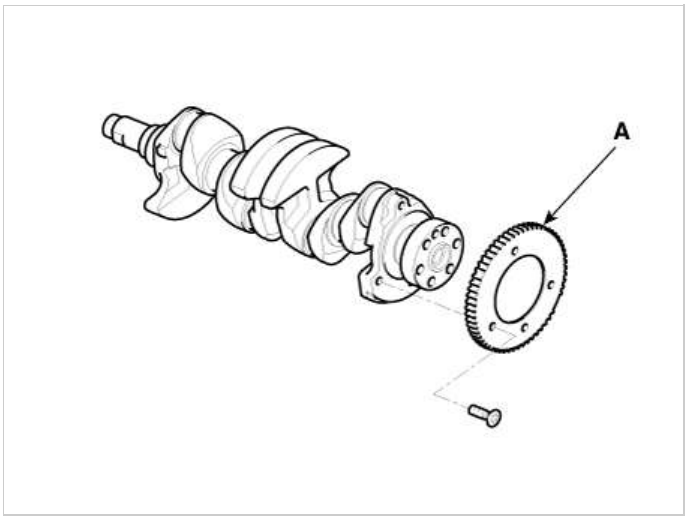
16. Check the crankshaft end play.
17. Lift the crankshaft (A) out of the cylinder block, being careful not to damage journals.



Information

- Arrange the main bearings and thrust bearings in the correct order.
- Keep the main bearing caps with their bearings assembled together.

18. Remove the CKPS wheel (A) from the crankshaft.



Inspection

1. Check the crankshaft main bearing oil clearance.
   (1) To check main bearing-to-journal oil clearance, remove the bearing caps with their lower bearings.
   (2) Clean each main journal and lower bearing with a clean shop towel.
   (3) Place one strip of plastigage across each main journal.
   (4) Reinstall the bearing caps with their lower bearings, then tighten the bolts.

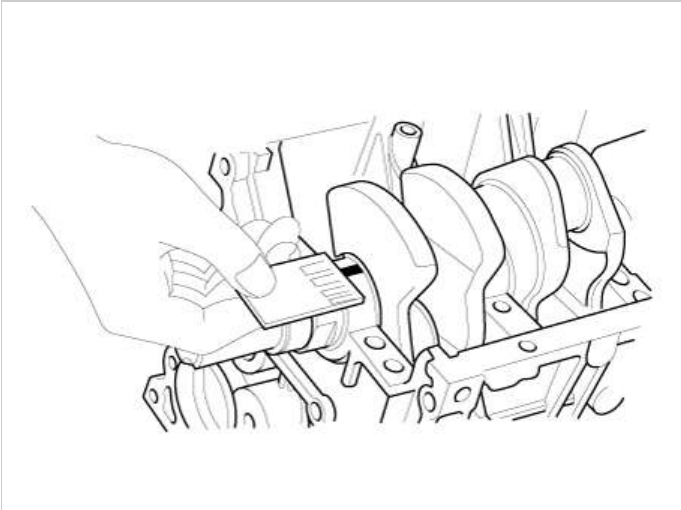
Tightening torque :
17.7 - 21.6 N·m (1.8 - 2.2 kgf·m, 13.0 - 15.9 lb·ft) + 88 - 92°

NOTICE

- Always use new crankshaft main bearing cap bolts. Crankshaft main bearing cap bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.
- Do not turn the crankshaft.

   (5) Remove the bearing caps with their lower bearing again, and measure the widest part of the plastigage.

Oil clearance
No.1, 2, 3, 4, 5 : 0.021 - 0.042 mm (0.0008 - 0.0017 in)



(6) If the plastigage measures too wide or too narrow, remove the upper and lower bearing and then install a new bearings with the same color mark. Recheck the oil clearance.

NOTICE

Do not file, shim, or scrape the bearings or the caps to adjust clearance.

(7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing. Recheck the oil clearance.

NOTICE

If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

NOTICE

If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

(8) Select the bearing by using the selection table.

Letters have been stamped on the side of block as a mark for the size of each of the 5 main journal bores.

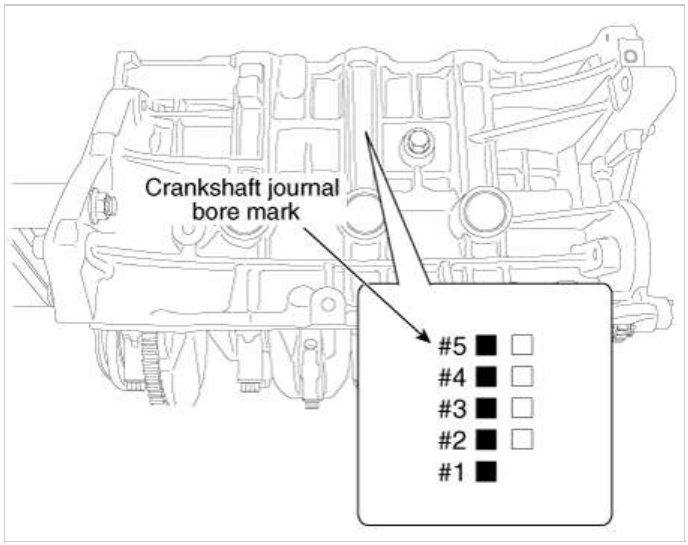
Use them, and the numbers or letters stamped on the crank (marks for main journal size), to choose the correct bearings.

Crankshaft Main Bearing Selection Table

Crankshaft main bearing		Cylinder block crankshaft journal bore mark		
		A	B	C
Crankshaft main journal mark	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

Discrimination Of Cylinder Block Crankshaft Journal Bore

Mark	Cylinder block journal bore inner diameter
A or 1	52.000 - 52.006 mm (2.0472 - 2.0475 in)
B or 2	52.006 - 52.012 mm (2.0475 - 2.0477 in)
C or 3	52.012 - 52.018 mm (2.0477 - 2.0479 in)

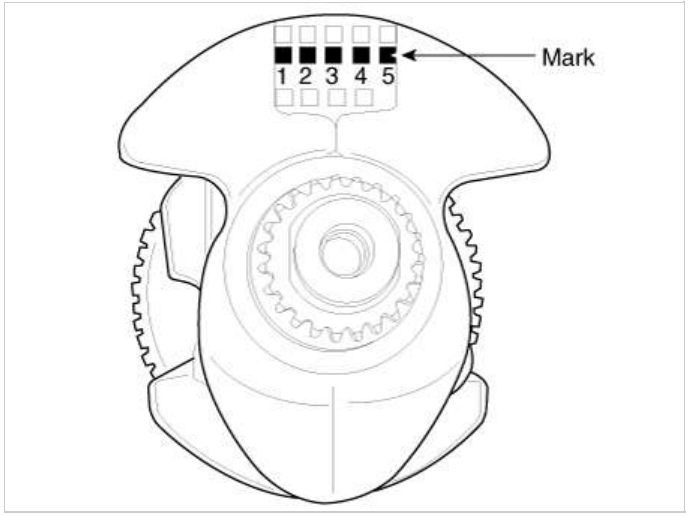


Discrimination Of Crankshaft Main Journal

Mark	Crankshaft main journal outer diameter
1	47.954 - 47.960 mm (1.8879 - 1.8882 in)
2	47.948 - 47.954 mm (1.8877 - 1.8879 in)
3	47.942 - 47.948 mm (1.8875 - 1.8877 in)

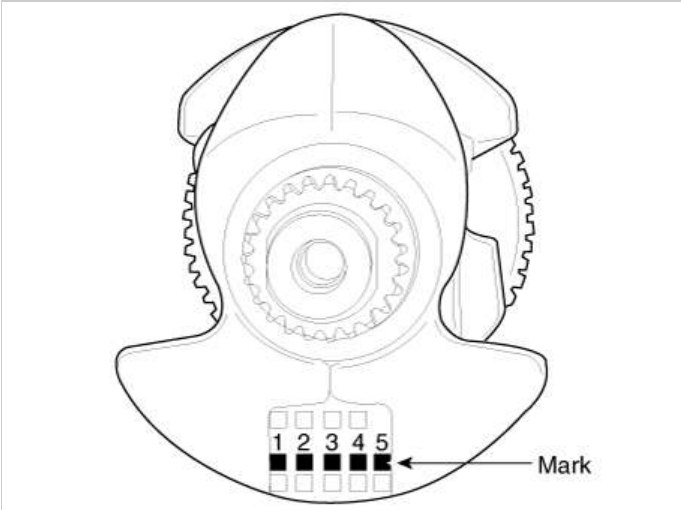
[Type A]

Top surface stamp



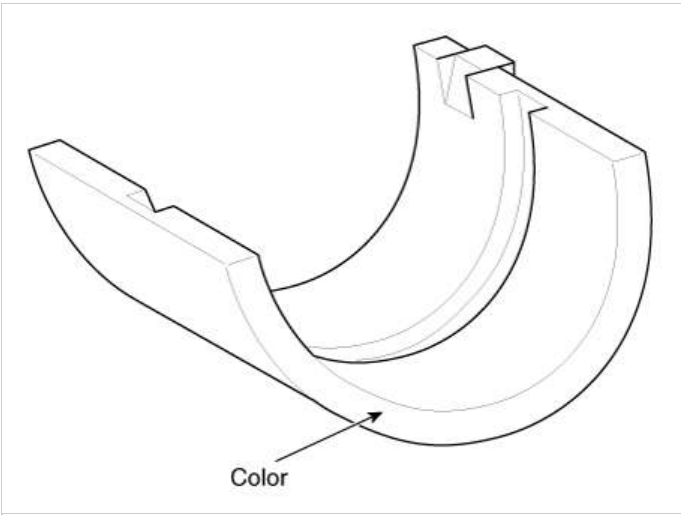
[Type B]

Bottom surface stamp



Discrimination Of Crankshaft Main Bearing

Color	Crankshaft main bearing thickness
Blue	2.026 - 2.029 mm (0.0798 - 0.0799 in)
Black	2.023 - 2.026 mm (0.0796 - 0.0798 in)
None	2.020 - 2.023 mm (0.0795 - 0.0796 in)
Green	2.017 - 2.020 mm (0.0794 - 0.0795 in)
Red	2.014 - 2.017 mm (0.0793 - 0.0794 in)



2. Check the crankshaft end play.
   Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

   Crankshaft end play
   Standard : 0.05 - 0.25 mm (0.0020 - 0.0098 in)
   Limit : 0.30 mm (0.0118 in)

   If the end play is greater than specification, replace the center bearing.

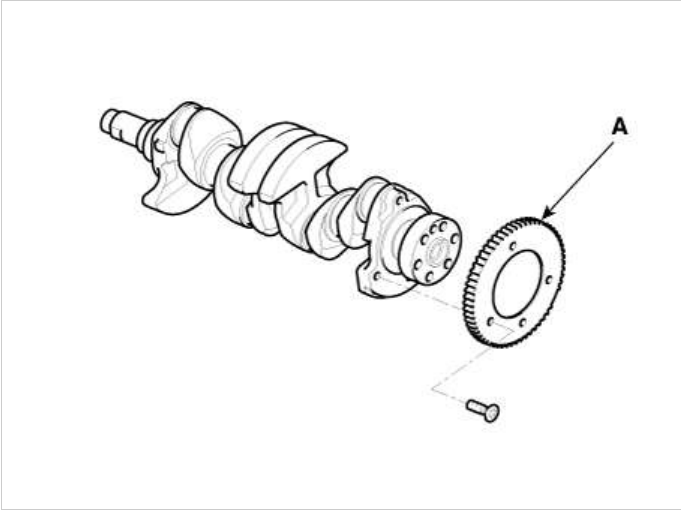
Reassembly

NOTICE

- Thoroughly clean all parts to assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

1. Install the CKPS wheel (A).

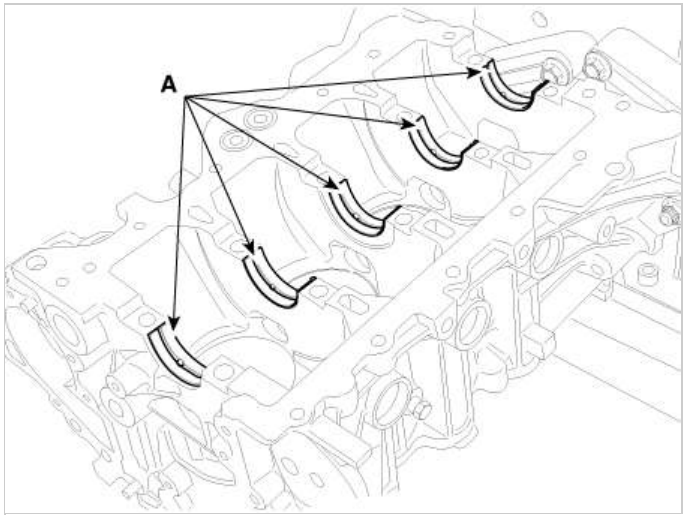
Tightening torque :
9.8 - 10.7 N·m (1.0 - 1.1 kgf·m, 7.23 - 7.95 lb·ft)



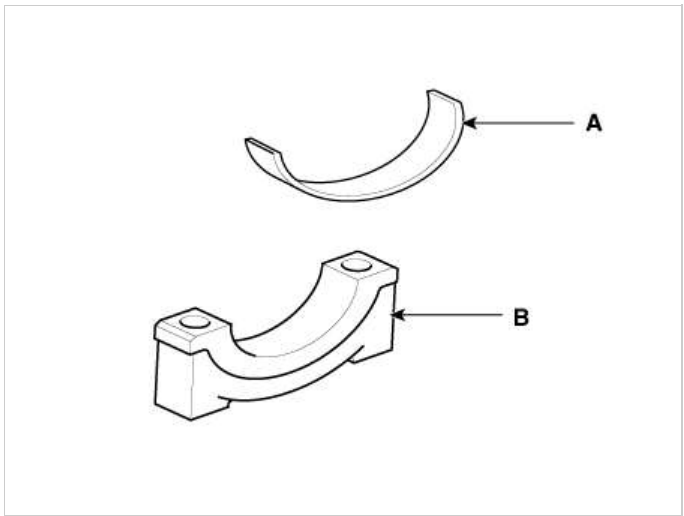
2. Install the crankshaft main bearings.

Information
Upper bearings have an oil groove of oil holes ; Lower bearings do not.

(1) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings (A).

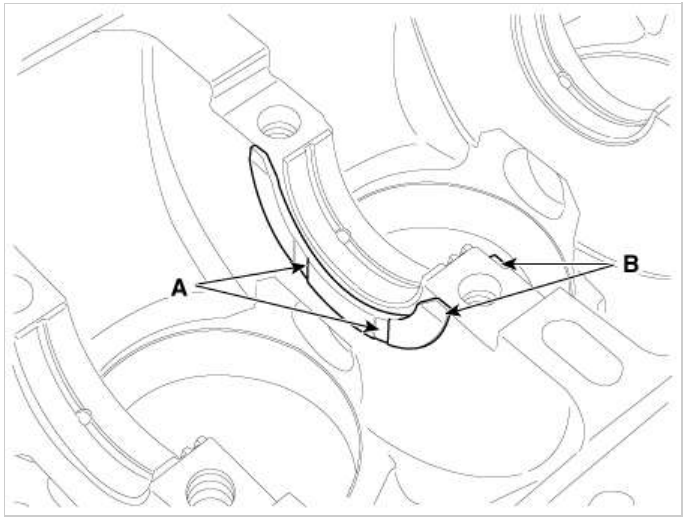


(2) Align the bearing claw with the claw groove of the main bearing cap (B), and push in the 5 lower bearings (A).



(3) Apply a coat of engine oil after assembling the main bearings.

3. Install the thrust bearings (No.3 journal).
   Install the 2 thrust bearings (B) on both sides of the No.3 journal of the cylinder block with the oil groove (A) facing out.



4. Place the crankshaft on the cylinder block.
   Apply a coat of engine oil to the pin and main journals after assembling the crankshaft.
5. Install the main bearing caps and tighten the cap bolts.

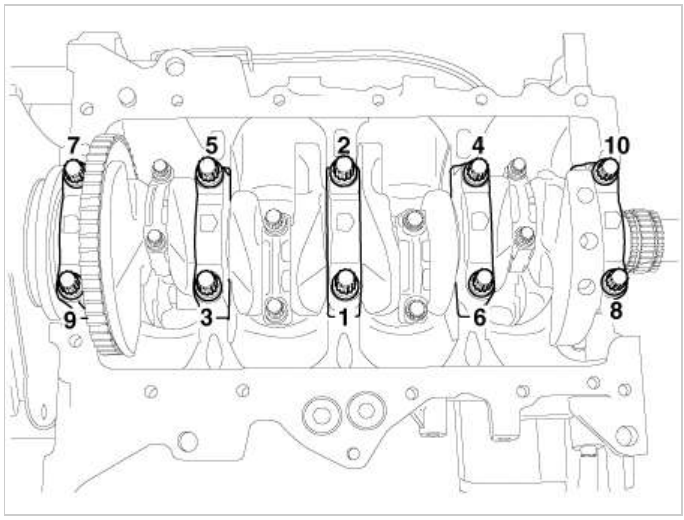
NOTICE

- Always use new crankshaft main bearing cap bolts. Crankshaft main bearing cap bolts are toque-to-yield bolts designed to be permanently elongated beyond the state of elasticity when torqued, so if the bolts are removed and reused, it may cause the bolts to break or fail to maintain clamping force.
- Be sure to assemble the main bearing caps in correct order.
- Install the main bearing cap with the arrow facing the front of the engine.
- Tighten all the main bearing cap bolts with the specified torque first, and then retighten all the bolts with the specified angle.

(1) Apply a light coat of engine oil on the threads of the bolts. Tighten all the bolts with the specified torque in numerical order first, then tighten all the bolts with the specified angle in numerical order.

Tightening torque :
17.7 - 21.6 N·m (1.8 - 2.2 kgf·m, 13.0 - 15.9 lb·ft) + 88° - 92°

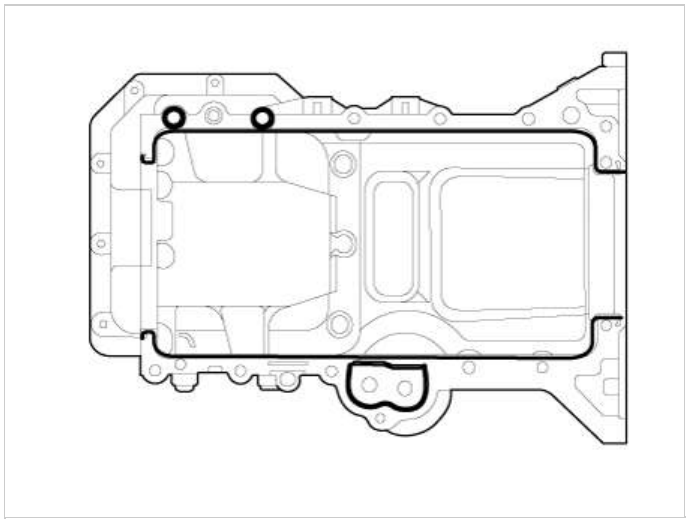
Tighten the main bearing cap bolts (A).



(2) Check that the crankshaft turns smoothly.

6. Check the crankshaft end play.
7. Install the piston and connecting rod assemblies.
   (Refer to Cylinder Block Assembly - "Piston and Connecting Rod")
8. Install the ladder frame.
   (1) Apply the liquid gasket on the ladder frame.

Bead width :2.5 - 3.5 mm (0.0984 - 0.1378 in)



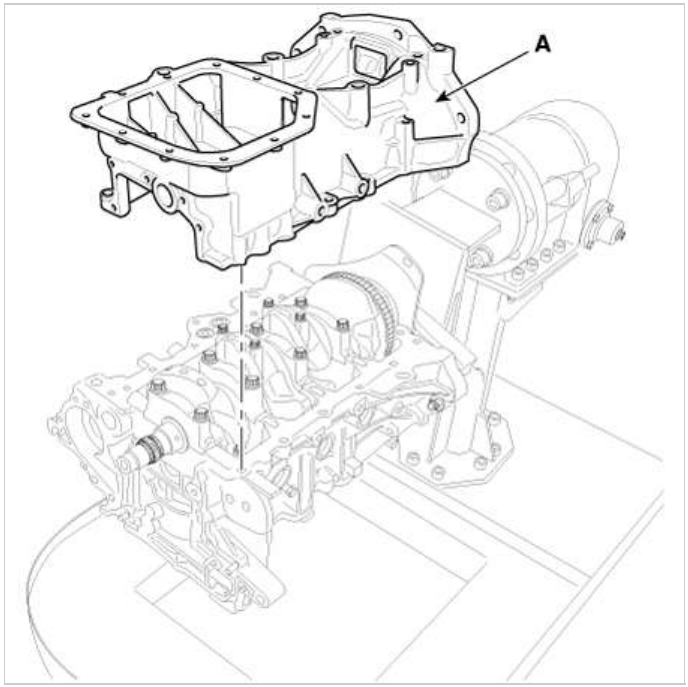
CAUTION

- Apply the sealant, THREE-BOND 1217H or LOCTITE 5900H on the ladder frame rail portion and install it within five minutes. If sealant is applied to cylinder block bottom position, the sealant position should be the same as that of the ladder frame rail.
- Apply sealant along the inner line of the bolt holes.

(2) Install the ladder frame (A).

Tightening torque :

18.6 - 23.5 N·m (1.9 - 2.4 kgf·m, 13.7 - 17.4 lb·ft)



9. Install the other parts in the reverse order of disassembly.

Information

In case the crankshaft is replaced with a new one, select the proper connecting rod bearing according to the pin journal mark on the crankshaft.

- Connecting rod bearing selection
  (Refer to Cylinder Block Assembly - "Piston and Connecting Rod")

Engine Mechanical System

Disassembly

NOTICE

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature (20°C [68°F]) before removing it.

- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

Information

- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft damper pulley so that the piston of No. 1 cylinder is at TDC (top dead center) on compression stroke.

1. Remove the engine and transaxle assembly from the vehicle.
   (Refer to Engine and Transaxle Assembly - "Engine and Transaxle Assembly")
2. Remove the transaxle assembly from the engine assembly.
   (Refer to Manual Transaxle System - "Manual Transaxle")
   (Refer to Automatic Transaxle System - "Automatic Transaxle")
3. MT : Remove the flywheel.
   (Refet to Cylinder Block - "Flywheel")
   AT : Remove the drive plate.
   (Refet to Cylinder Block - "Drive Plate")
4. Remove the rear oil seal.
   (Refer to Cylinder Block Assembly - "Rear Oil Seal")
5. Install the engine assembly to engine stand for disassembly.
6. Remove the intake manifold.
   (Refer to Intake And Exhaust System - "Intake Manifold")
7. Remove the exhaust manifold.
   (Refer to Intake And Exhaust System - "Exhaust Manifold")
8. Remove the timing chain.
   (Refer to Timing System - "Timing Chain")
9. Remove the cylinder head assembly.
   (Refer to Cylinder Head Assembly - "Cylinder Head")
10. Remove the oil cooler.
    (Refer to Lubrication System - "Oil Cooler")
11. Remove the oil pressure switch.
    (Refer to Lubrication System - "Oil Pressure Switch")
12. Remove the crankshaft position sensor.
    (Refer to Engine Control / Fuel System - "Crankshaft Position Sensor (CKPS)")
13. Remove the oil pan and the oil screen.
    (Refer to Lubrication System - "Oil Pan")
14. Remove the ladder frame.
    (Refer to Cylinder Block Assembly - "Piston And Connecting Rod")
15. Check the connecting rod side clearance.
    (Refer to Cylinder Block Assembly - "Piston And Connecting Rod")
16. Check the connecting rod bearing cap oil clearance.
    (Refer to Cylinder Block Assembly - "Piston And Connecting Rod")
17. Remove the piston and connecting rod assemblies.
    (Refer to Cylinder Block Assembly - "Piston And Connecting Rod")
18. Check the main bearing oil clearance.
    (Refer to Cylinder Block Assembly - "Crankshaft")
19. Check the crankshaft end play.
    (Refer to Cylinder Block Assembly - "Crankshaft")
20. Remove the crankshaft.
    (Refer to Cylinder Block Assembly - "Crankshaft")
21. Remove the water inlet fitting and thermostat.
    (Refer to Cooling System - "Thermostat")
22. Remove the knock sensor.
    (Refer to Engine Control / Fuel System - "Knock Sensor (KS)")

Inspection

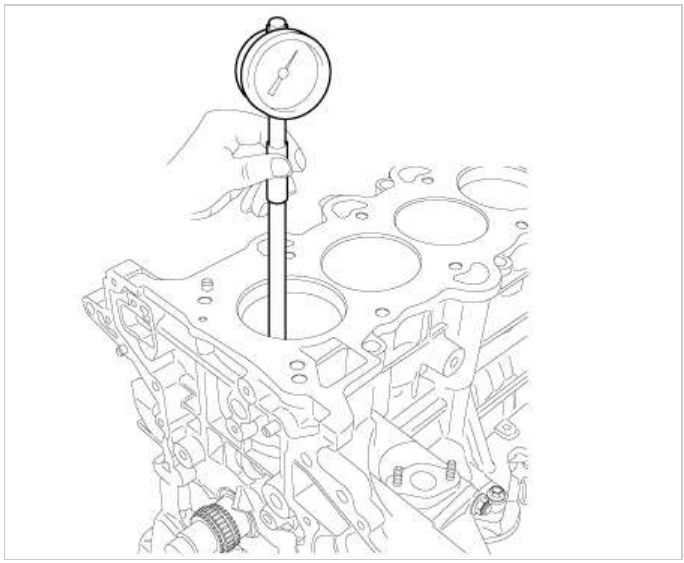
1. Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
2. Using a soft brush and solvent, thoroughly clean the cylinder block.
3. Inspect the top surface of cylinder block for flatness.
   Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

Flatness of cylinder block gasket surface :

Less than 0.05 mm (0.0020 in) for total area
Less than 0.02 mm (0.0008 in) for a section of 100 mm x 100 mm (3.9370 in x 3.9370 in)

4. Inspect the cylinder bore.
   Visually check the cylinder for vertical scratchs.
   If deep scratchs are present, replace the cylinder block.
5. Inspect the cylinder bore diameter.
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial direction.

Cylinder bore diameter :
77.00 - 77.03 mm (3.0315 - 3.0327 in)



Reassembly

1. Install in the reverse order of disassembly.

Information

In case the cylinder block is replaced with a new one, select the proper crankshaft main bearing and the piston according to the crankshaft journal bore mark and the cylinder bore mark on the cylinder block.

- Crankshaft main bearing selection
  (Refer to Cylinder Block Assembly - "Crankshaft")
- Piston selection
  (Refer to Cylinder Block Assembly - "Piston and Connecting Rod")

Engine Mechanical System

Engine Overheat Troubleshooting

Inspection		Remedy
Visual inspection	Inspect for shortage of coolant in reservoir tank .	Reinspect after replenishing coolant.
	Inspect for coolant pollution after removing radiator cap. **CAUTION** Be careful when removing radiator cap from overheated vehicle.	Reinspect after replacing coolant.
	Inspect for leakage and loose coolant hoses (radiator hose, heater hose, oil cooler hose, etc.).	Reinspect for leakage after reinstalling hoses and clamps.
	Inspect for leakage on water inlet fitting mounting part.	Reinspect for leakage after replacing O-ring.
		Reinspect for leakage after tightening to the specified torque.
	Inspect drive belt (for normal operation of water pump).	Adjust drive belt tension or replace.
	Inspect for leakage on water pump gasket mounting part.	Reinspect for leakage after replacing gasket.
		Reinspect for leakage after tightening to the specified torque.
	Inspect for loose coolant temperature sensor, cooling fan connector and pin.	Reinstall loose connector.
		Replace relevant part if connector pin is damaged.
	Inspect operation status of cooling fan. - Check operation status by switching ON/OFF the heater control A/C. **Information** Will not operate in cold ambient temperature.	Check mounting status of ground cable.
Diagnostic device	Inspect self-diagnostic code using KDS/GDS.	Check coolant temperature sensor, wiring, connector, etc.
Unit inspection	Inspect water pump impeller.	Replace water pump.
	Inspect for foreign materials and status of thermostat valve.	Inspect unit after removing foreign materials.
	Inspect for stuck thermostat valve. - Immerse thermostat in water heated to over 95°C (203°F), then heat for at least 3 minutes to check valve lift. **NOTICE** • Do not use water below 95°C (203°F). • Do not directly heat unit as this will damage thermostat.	Check valve lift. - Replace thermostat if valve lift is below specification or valve is stuck.

Engine Mechanical System

Replacement And Air Bleeding

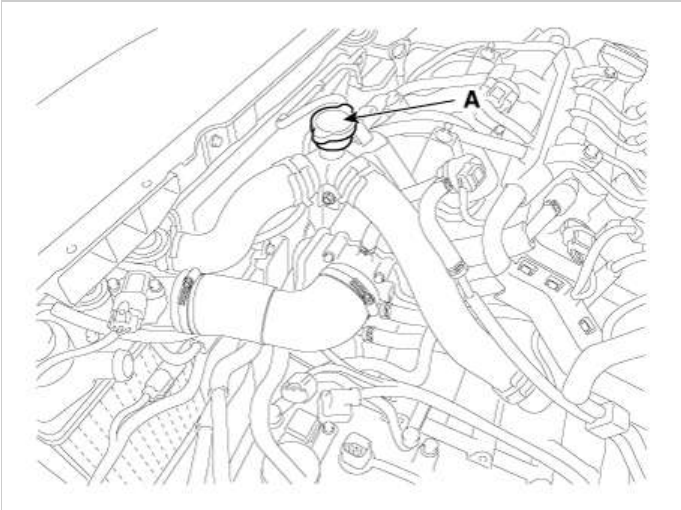
CAUTION

Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

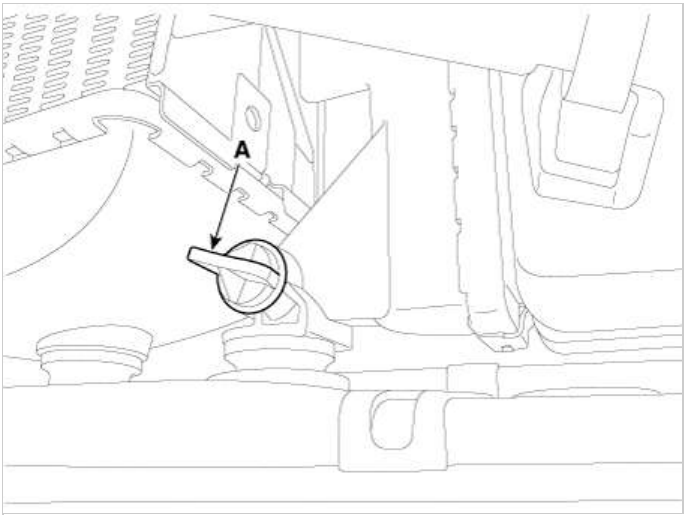
NOTICE

When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

1. Make sure the engine and radiator are cool to the touch.
2. Remove the radiator cap (A).



3. Remove the engine room under cover.
   (Refer to Engine And Transmission Assembly - "Engine Room Under Cover")
4. Loosen the drain plug (A), and drain the coolant.



5. Tighten the radiator drain plug securely.
6. After draining engine coolant in the reservoir tank, clean the tank.
7. Fill the radiator with water through the radiator cap and tighten the cap.

> **Information**
> To most effectively bleed the air, pour the water slowly and press on the upper/lower radiator hoses.

8. Start the engine and allow to come to normal operating temperature. Wait for the cooling fans to turn on several times. Accelerate the engine to aid in purging trapped air. Shut engine off.
9. Wait until the engine is cool.
10. Repeat steps 1 to 8 until the drained water runs clear.
11. Fill fluid mixture with coolant and water (55-60%) (except for North America, Europe and China : 45-50%) slowly through the radiator cap.
    Push the upper/lower hoses of the radiator so as bleed air easily.

> **NOTICE**
> - Use only genuine antifreeze/coolant.
> - For best corrosion protection, the coolant concentration must be maintained year-round at 55% (except for North America, Europe and China : 45%) minimum. Coolant concentrations less than 55% (except for North America, Europe and China : 45%) may not provide sufficient protection against corrosion or freezing.
> - Coolant concentrations greater then 60% will impair cooling efficiency and are not recommended.
> - Do not mix different brands of antifreeze/coolants.
> - Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.

12. Start the engine and run until coolant circulates.
    When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.

13. Repeat step.11 until the cooling fan 3 - 5times and bleed air sufficiently out of the cooling system.
14. Install the radiator cap and fill the reservoir tank to the "MAX" (or "F") line with coolant.
15. Run the vehicle under idle until the cooling fan operates 2 - 3 times.
16. Stop the engine and wait coolant gets cool.
17. Repeat 10 to 15 until the coolant level doesn"t fall any more, bleed air out of the cooling system.

> **NOTICE**
> It takes time to bleed out all the air in the cooling system. Refill coolant when coolant gets cool completely, when recheck the coolant level in the reservoir tank for 2-3 days after replacing coolant.

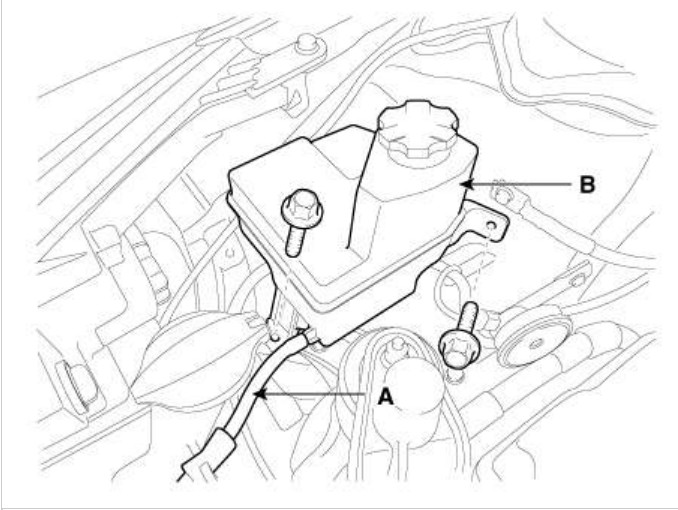
Coolant capacity :
MT : Approx. 6.1 L (1.61 U.S.gal., 6.44 U.S.qt., 5.36 Imp.qt.)
AT : Approx. 5.7 L (1.50 U.S.gal., 6.02 U.S.qt., 5.01 Imp.qt.)

Engine Mechanical System

Removal and Installation

1. Disconnect the over flow hose (A).
2. Remove the reservoir tank (B).

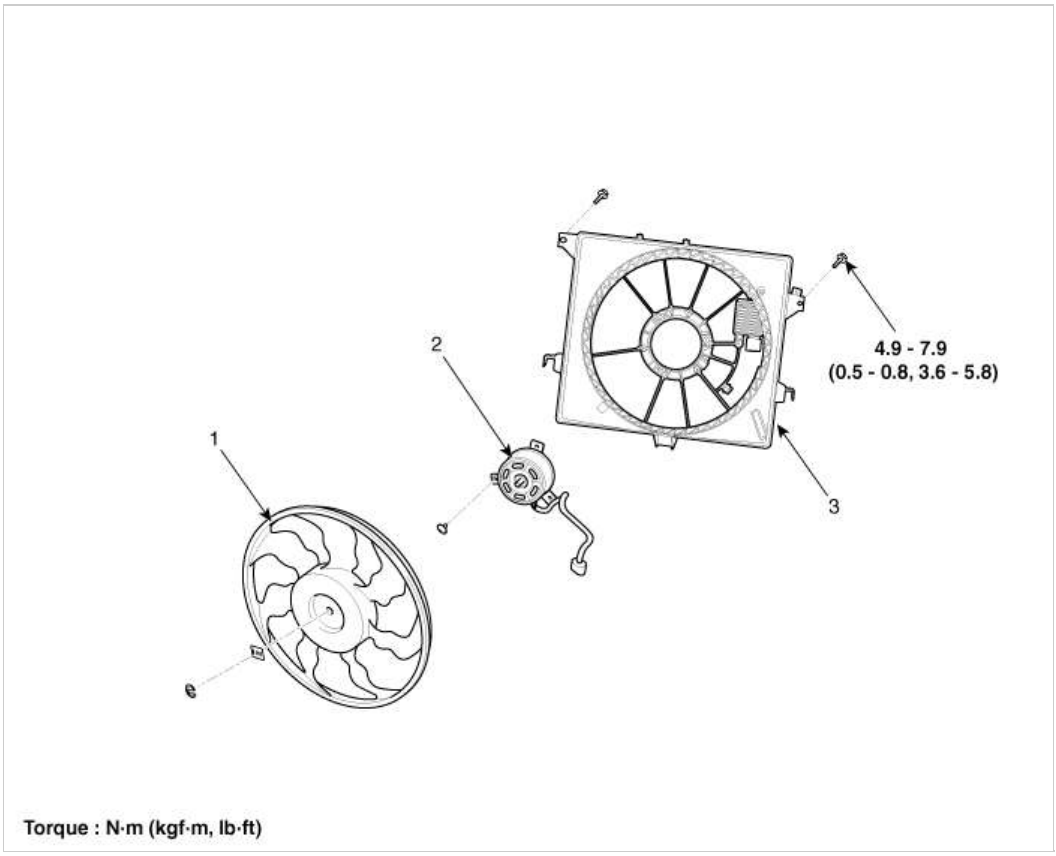
Tightening torque :
3.9 - 5.9 N·m (0.4 - 0.6 kgf·m, 2.9 - 4.3 lb·ft)



3. Install in the reverse order of removal.

Engine Mechanical System

Components

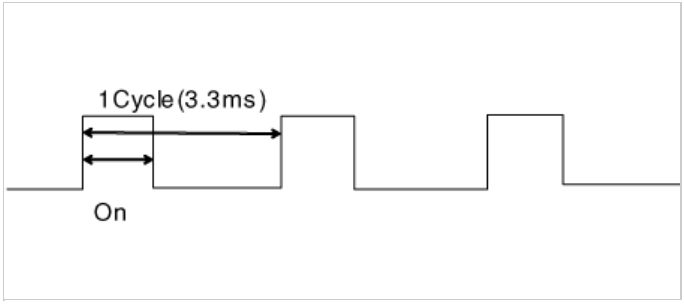


1. Cooling fan
2. Fan motor
3. Fan shroud

Engine Mechanical System

Description

Control the cooling motor voltage in according to the duty(300Hz) of ECM.
[ECU → PWM Input Signal(SI : 300Hz)]



Signal Input Duty (%)	Motor Voltage (V)
10	0
30	4.1 ± 0.65
60	8.2 ± 0.65
70	9.57 ± 0.65
90	Min. 12.5
Signal open	Min. 12.5
Signal short	Min. 12.5

[Cooling Fan Operation Condition]

A/C Switch	A/C Pressure (Kgf/cm² G)	Vehicle Speed (Km/h)	Coolant Temp (°C)	Duty (%)
OFF	–	V < 45	98 above	35
		45 ≤ V < 80	101 above	40

		80 ≤ V	105 above	80
ON	A/C Pressure < 6	ALL	105 above	90
	6 ≤ A/C Pressure < 12	V < 45	82 above	30
		45 ≤ V < 80	96 above	40
		80 ≤ V	96 above	60
	12 ≤ A/C Pressure < 15.5	V < 45	101 above	70
		45 ≤ V < 80	-30 above	40
		80 ≤ V	82 above	60
	15.5 ≤ A/C Pressure	V = 0	-30 above	60
		0 < V	-30 above	90

Engine Mechanical System

Specifications

[Cooling fan control module]

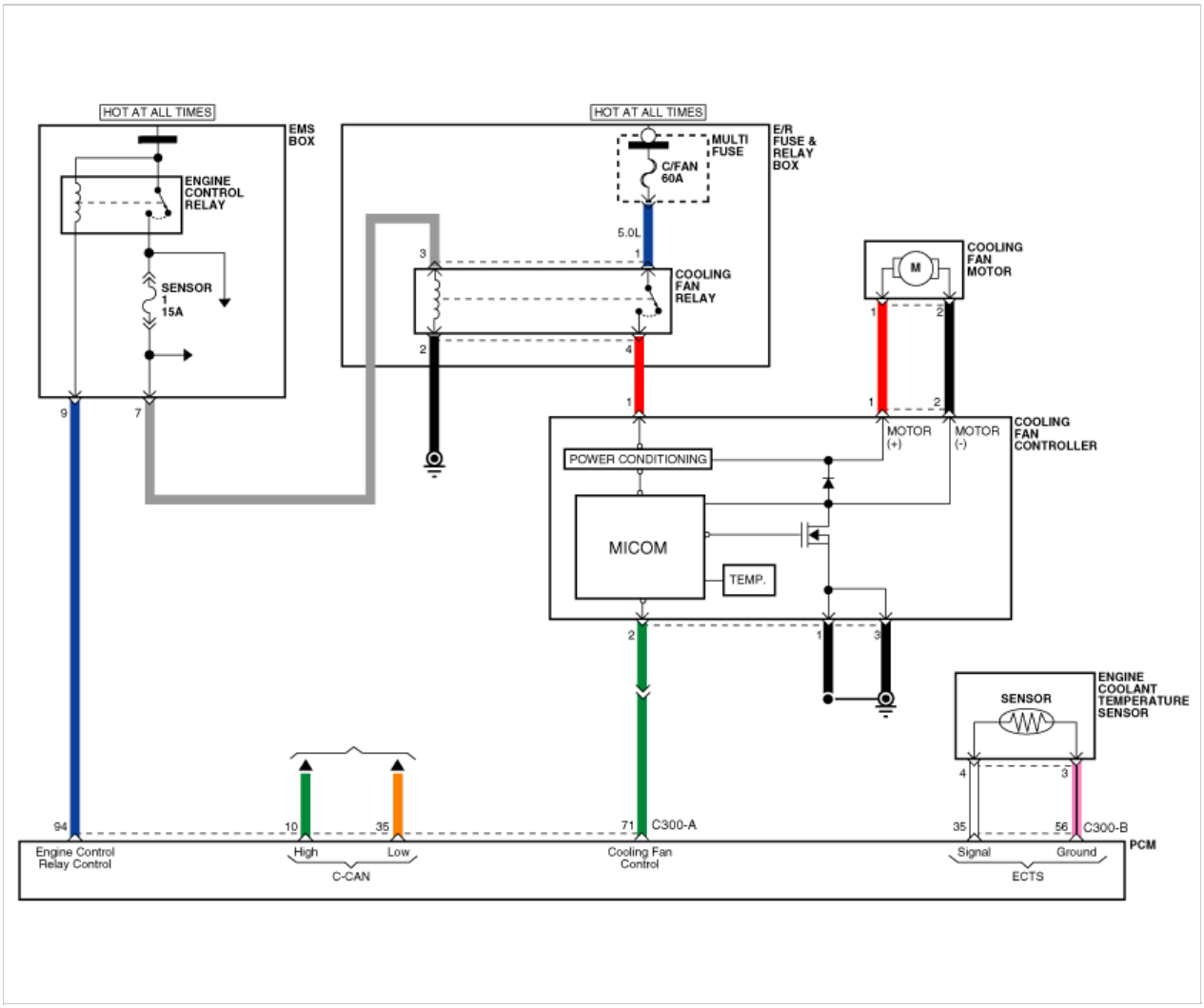
Items		Specification	
Input	Signal Frequency (Hz)	300 ± 5%	
	Duty (%)	OFF	10
		Normal	30 - 90
		Max.	90
	Voltage level (V)	HI	Upper Vbat 0.7
		LOW	0 - 1.9
Max, Load current consumption (A)		23.3 + 10% [Ref = 12V]	

[Fan motor]

Items	Specification [Ref = 12V]
Fan type	PULLER
Fan speed control method	PWM
Air flow rate (m³/h)	1,920 - 10% min.
Fan speed (rpm)	2,420 ± 10%
Current (A)	23.3 + 10% max.

Engine Mechanical System

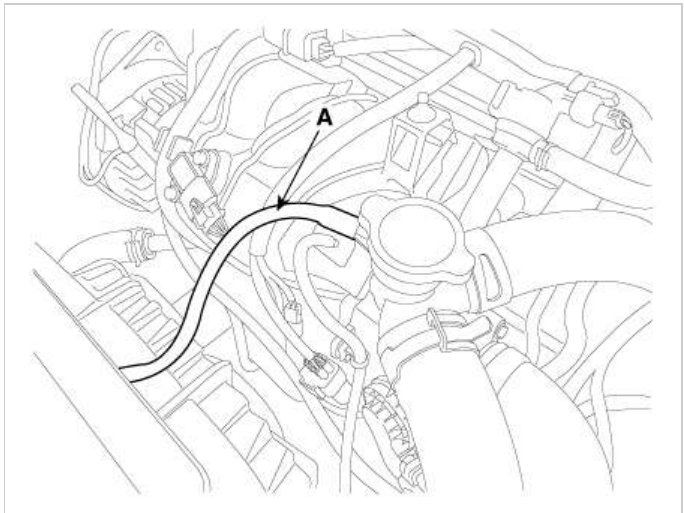
Circuit Diagram



Engine Mechanical System

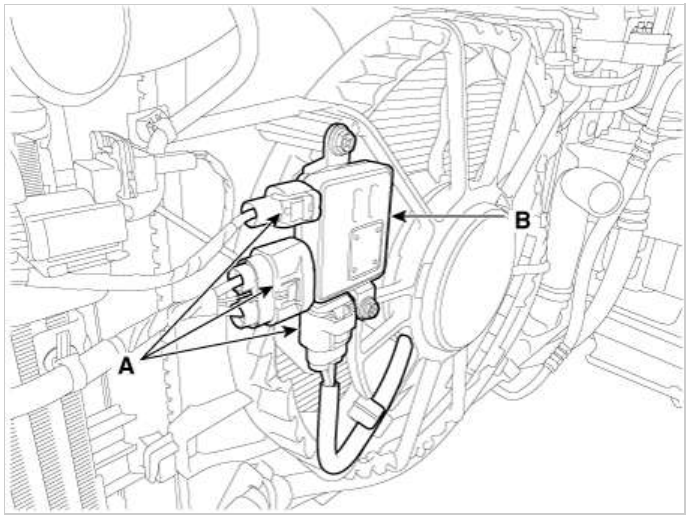
Removal and Installation

1. Disconnect the battery negative (-) terminal.
2. Remove the air duct and RCV hose.
   (Refer to Intake and Exhaust System - "Air Cleaner")
3. Disconnect the over flow hose (A) from radiator.

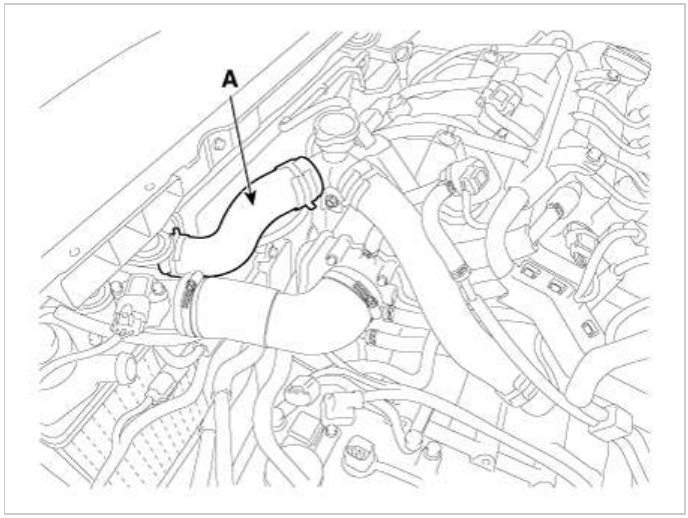


4. Disconnect the fan controller connectors (A).
5. Remove the fan controller assembly (B).

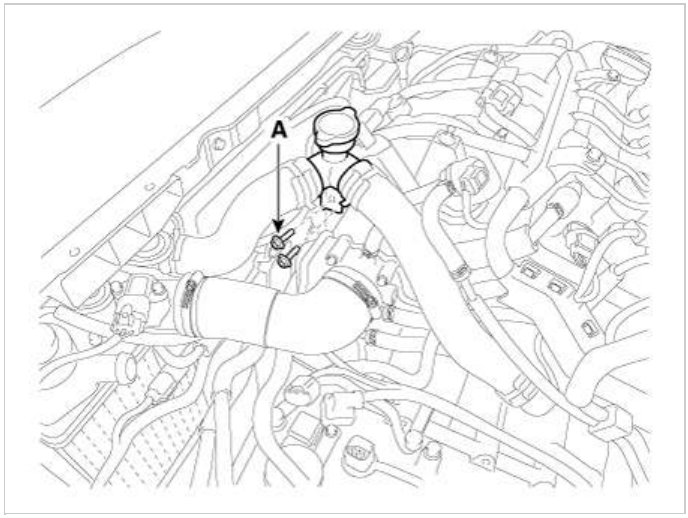
Tightening torque :
4.9 - 8.3 N·m (0.5 - 0.85 kgf·m, 3.6 - 6.1 lb·ft)



6. Disconnect the radiator upper hose (A).



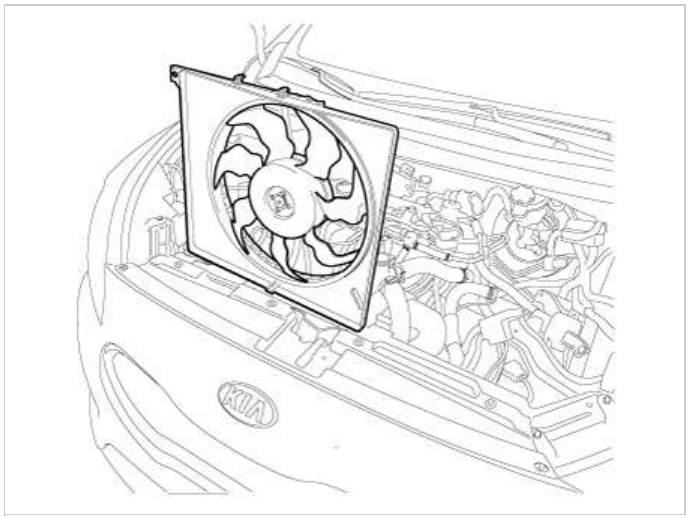
7. Remove the filler neck assembly bolts (A).



8. Remove the MAPS.
(Refer to Engine Control / Fuel System - "Manifold Absolute Pressure Sensor(MAPS)")

9. Remove the cooling fan assembly.

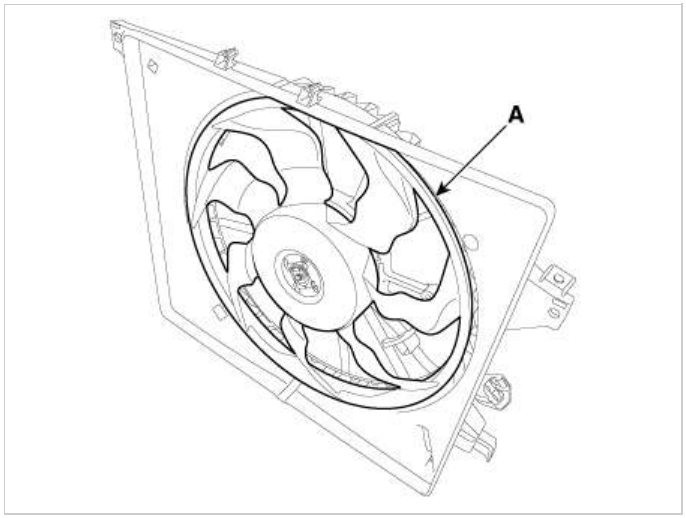
Tightening torque :
4.9 - 7.9 N·m (0.5 - 0.8 kgf·m, 3.6 - 5.8 lb·ft)



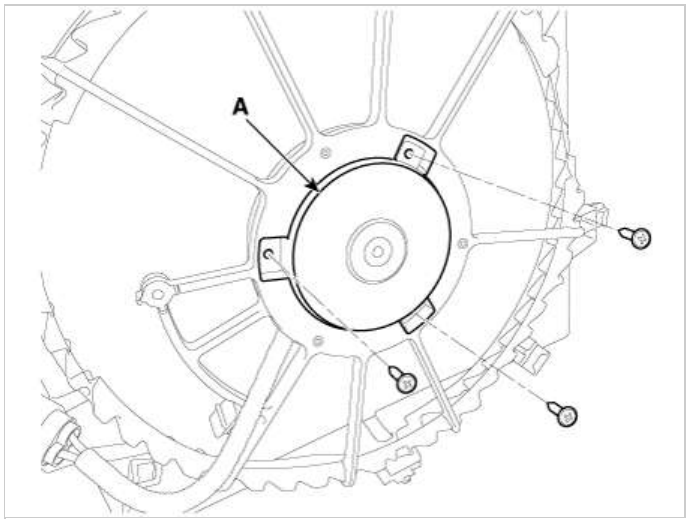
10. Install in the reverse order of removal.

Disassembly

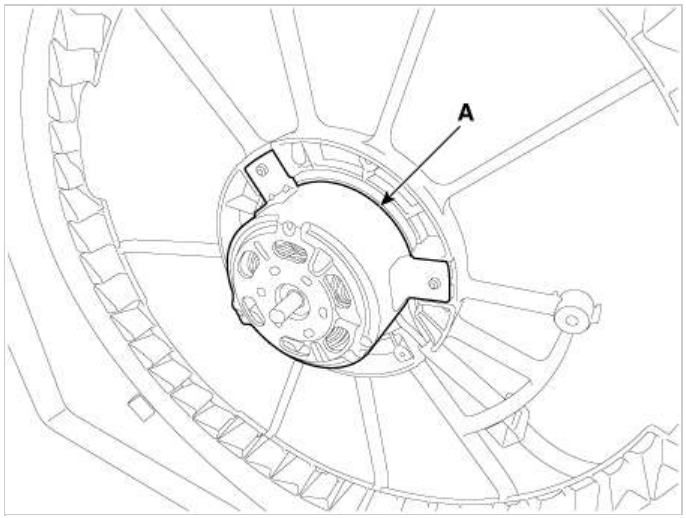
1. Remove the cooling fan from the cooling fan assembly (A).



2. Remove the cover (A).



3. Remove the fan motor (A) from the cooling fan shroud.



4. Assemble in the reverse order of disassembly.

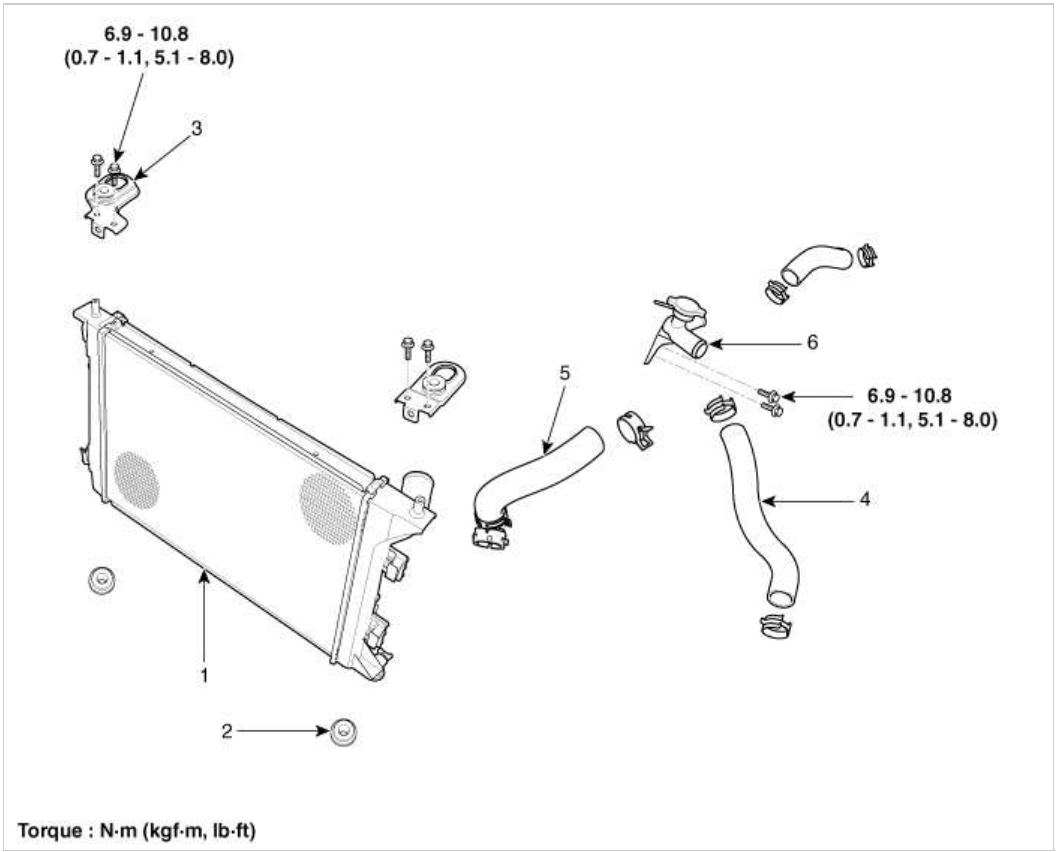
Inspection

Fan Motor

1. Disconnect the fan motor connector from the resistor.
2. Connect the battery voltage to the "+" terminal and ground to "-" terminal.
3. Check the cooling fan motor operates well.

Engine Mechanical System

Components

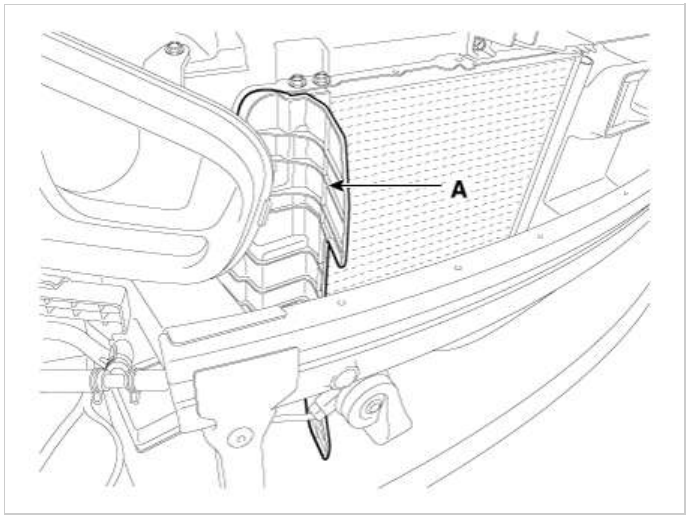


1. Radiator
2. Mounting insulator
3. Radiator upper mounting bracket
4. Radiator upper hose
5. Radiator lower hose
6. Filler neck assembly

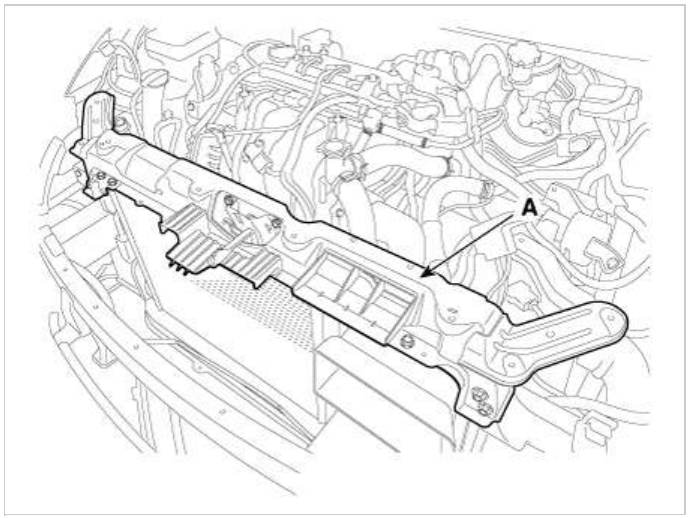
Engine Mechanical System

Removal and Installation

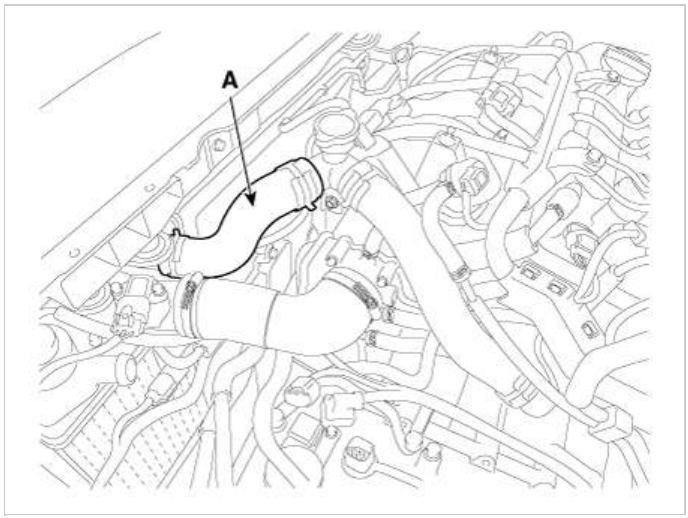
1. Disconnect the battery negative (-) terminal.
2. Remove the engine room under cover.
   (Refer to Engine And Transmission Assembly - "Engine Room Under Cover")
3. Remove the air duct.
   (Refer to Intake and Exhaust System - "Air Cleaner")
4. Remove the front bumper.
   (Refer to Body(Interior and Exterior) - "Front Bumper")
5. Remove the air guard (A).



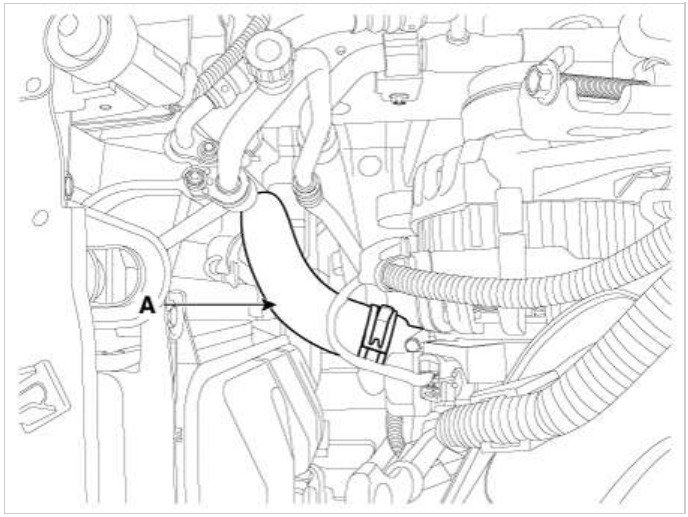
6. Remove the radiator upper member assembly (A).



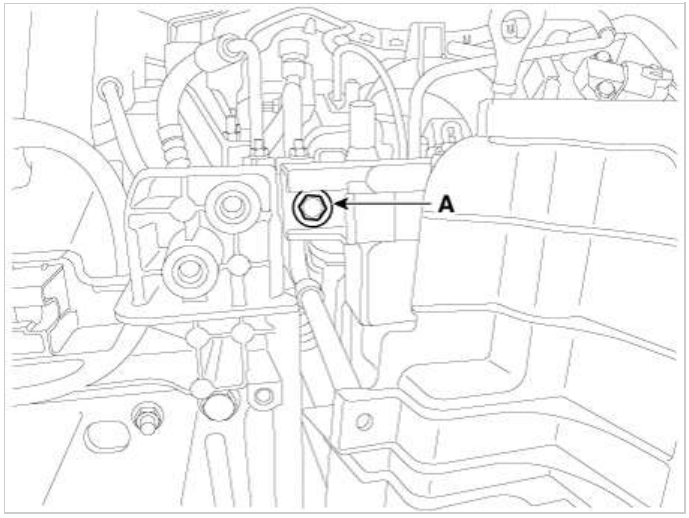
7. Disconnect the radiator upper hose (A).



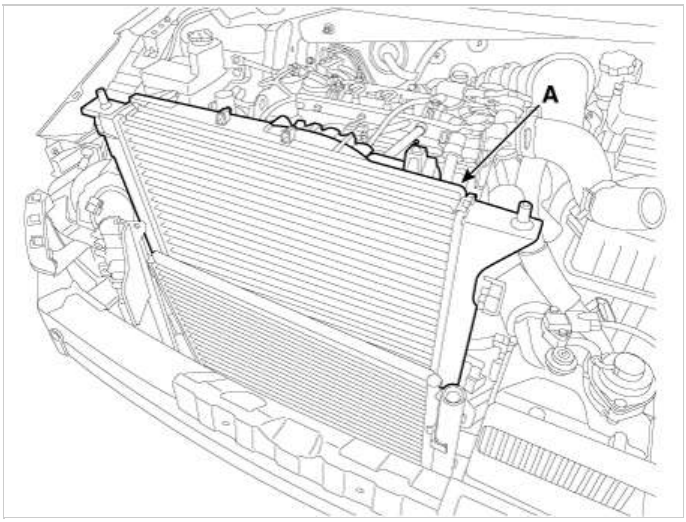
8. Disconnect the radiator lower hose (A).



9. Remove the left and right headlight assembly.
   (Refer to Body Electrical System - "Head Lamps")
10. Loosen the bolt (A) to separate the condenser from radiator.

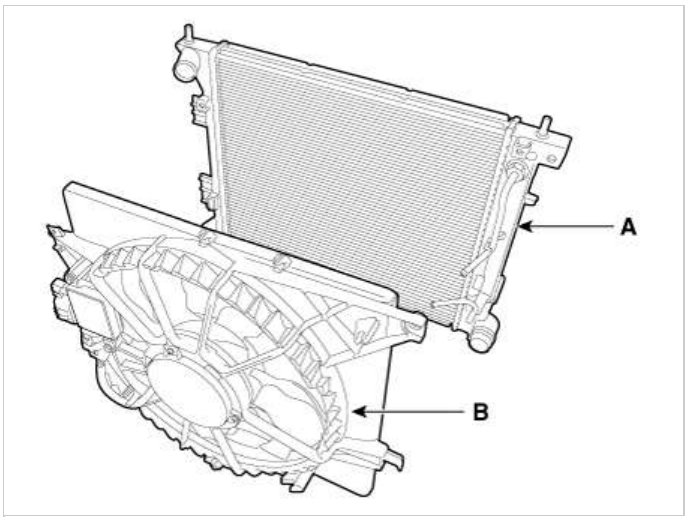


11. Pull the radiator (A) upward and remove it from engine room.



12. Remove the radiator (A) from cooling fan assembly (B).

Tightening torque :
4.9 - 7.9 N·m (0.5 - 0.8 kgf·m, 3.6 - 5.8 lb·ft)

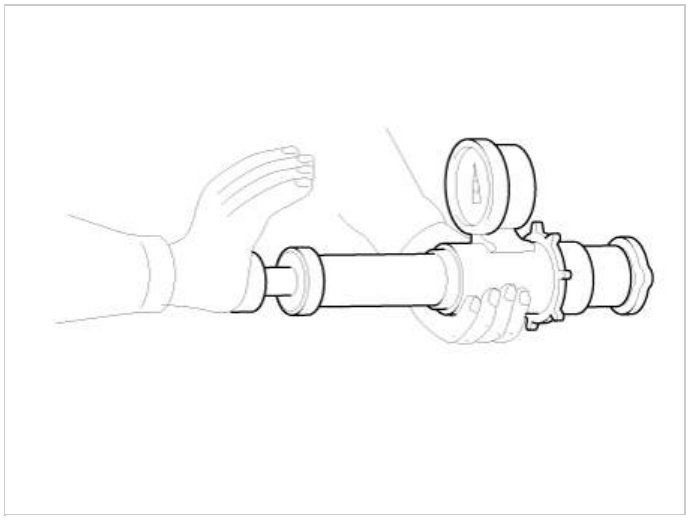


13. Install in the reverse order of removal.

Inspection

Radiator Cap Testing

1. Remove the radiator cap, wet its seal with engine coolant, and then install it on a pressure tester.

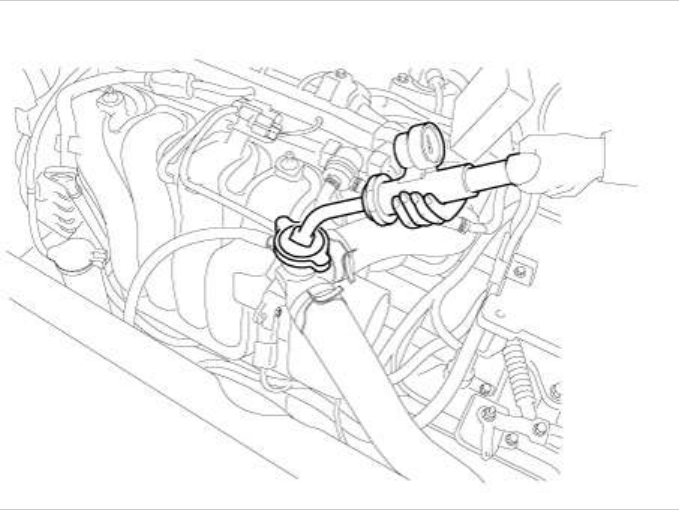


2. Apply a pressure of 93.16 - 122.58kpa (0.95 - 1.25kg/cm², 13.51 - 17.78psi).

3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

Radiator Leakage Test

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install a pressure tester on it.

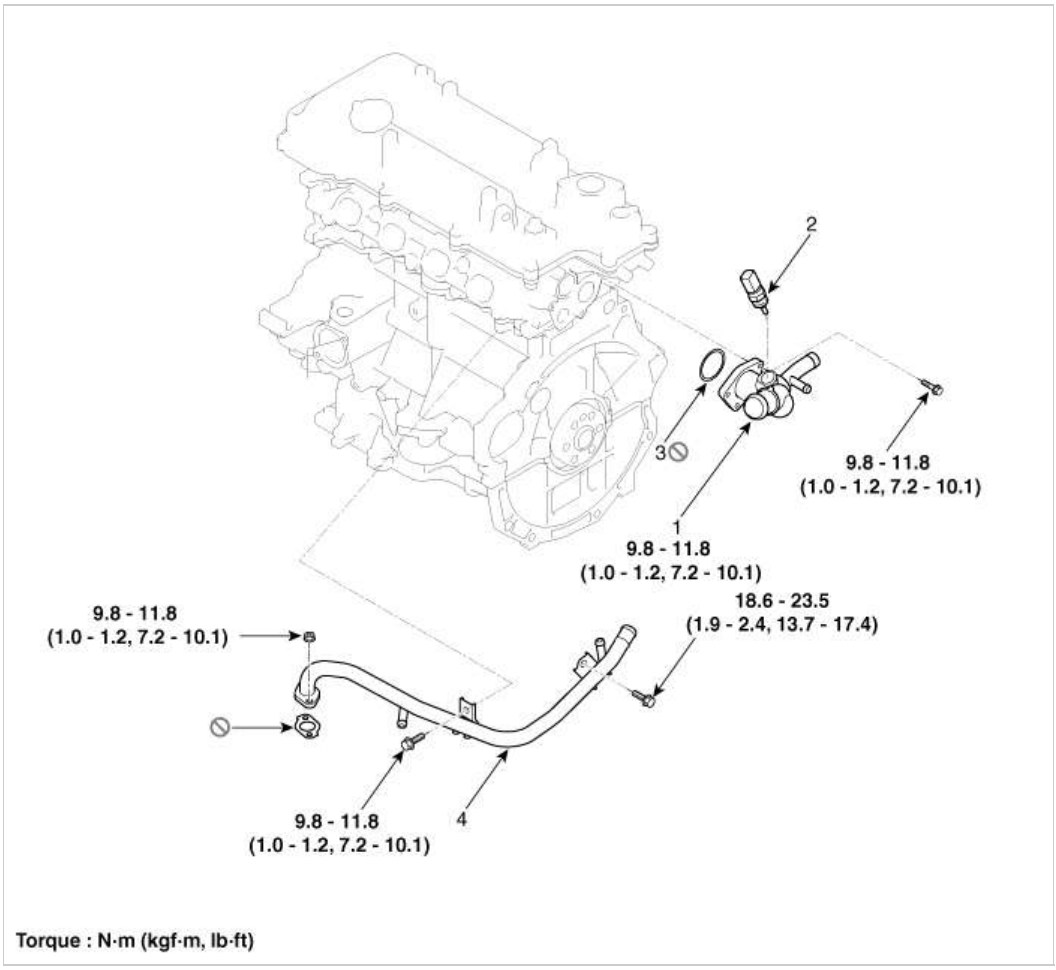


2. Apply a pressure of 93 - 123kPa (0.95 - 1.25kgf/cm², 14 - 19psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. If the pressure drops, check hoses, the radiator and the water pump for leakage. If there is no leakage, inspect the heater core, the cylinder block and the cylinder head.
5. Remove the tester and reinstall the radiator cap.

> **NOTICE**
> Check for engine oil in coolant and/or coolant in engine oil.

Engine Mechanical System

Components



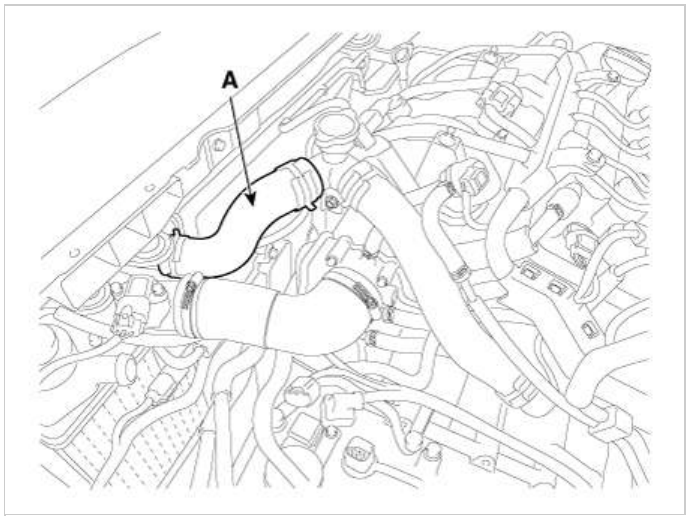
1. Water temperature control assembly
2. Water temperature sensor
3. Gasket
4. Water pipe

Engine Mechanical System

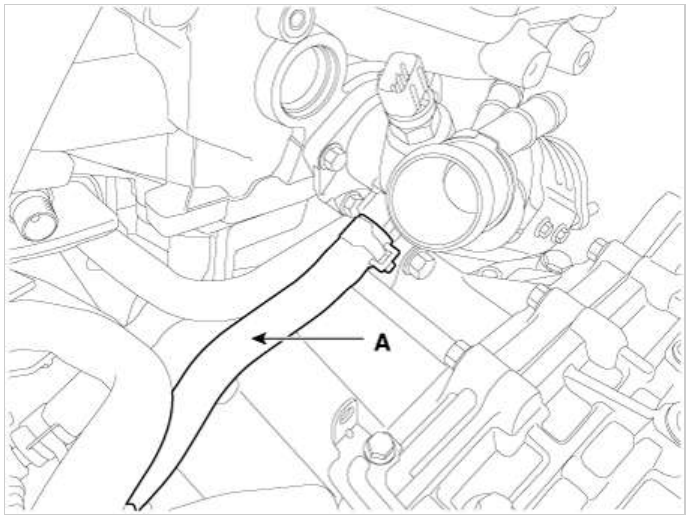
Removal and Installation

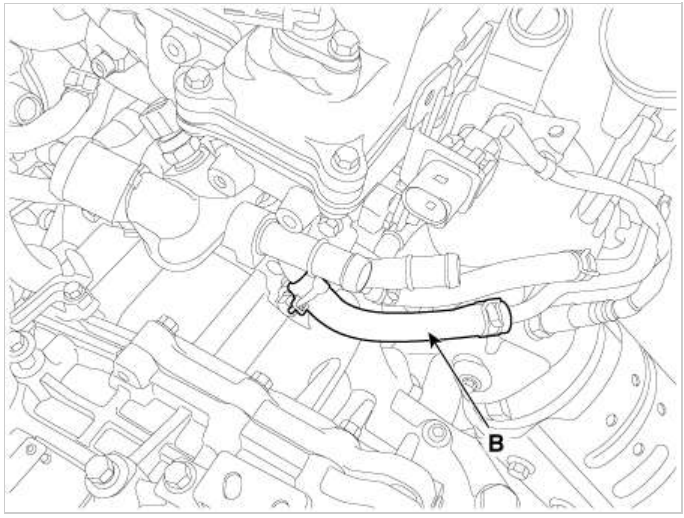
Water Temperature Control Assembly

1. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to drain with speed.
2. Disconnect the battery negative terminal.
3. Remove the air cleaner assembly.
   (Refer to Intake and exhaust system - "Air Cleaner")
4. Disconnect the water temperature sensor connector.
   (Refer to Engine Control / Fuel System - "Engine Control System")
5. Disconnect the radiator upper hose (A).



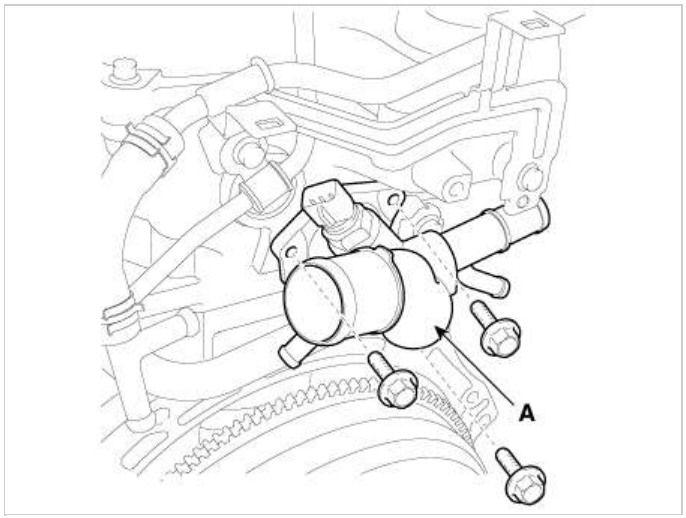
6. Remove the heater hose.
7. Disconnect water hose (A) and turbo charger water hose (B).





8. Remove the water temperature control assembly (A).

Tightening torque :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 10.1 lb·ft)

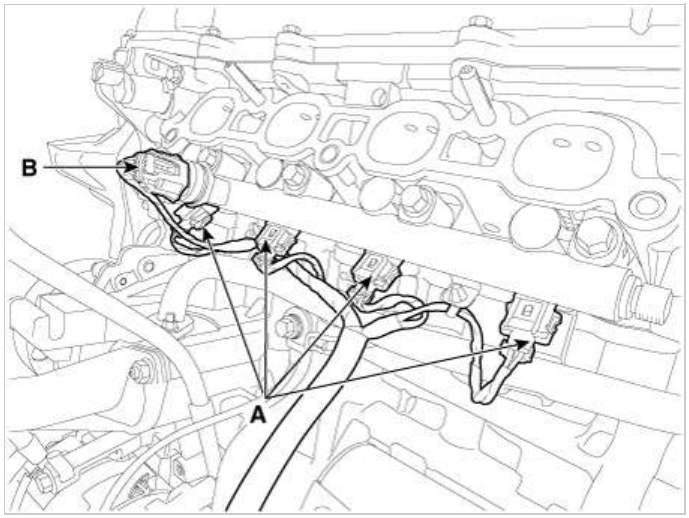


9. Install in the reverse order of removal.

> **⚠ CAUTION**
> Clean the surface of the water temperature control assembly before insatalling.

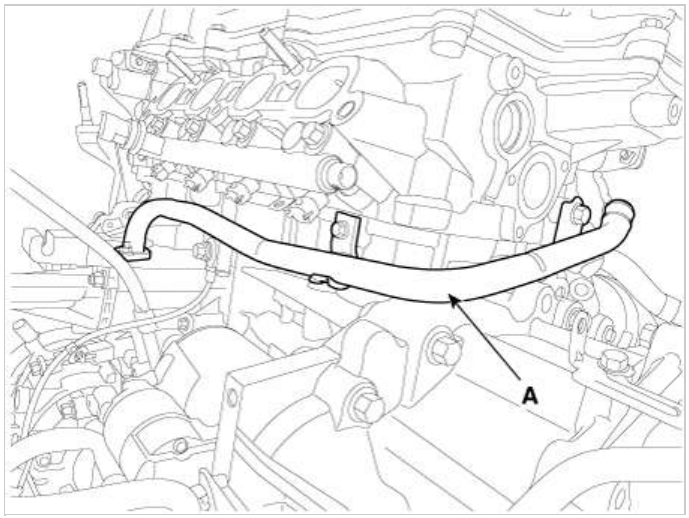
Water Pipe

1. Remove the water temperature control assmebly.
2. Remove the intake manifold.
   (Refer to Intake And Exhaust System - "Intake Manifold")
3. Disconnect the injector connectors (A).
4. Disconnect the rail pressure sensor (RPS) connector (B).



5. Remove the water pipe (A).

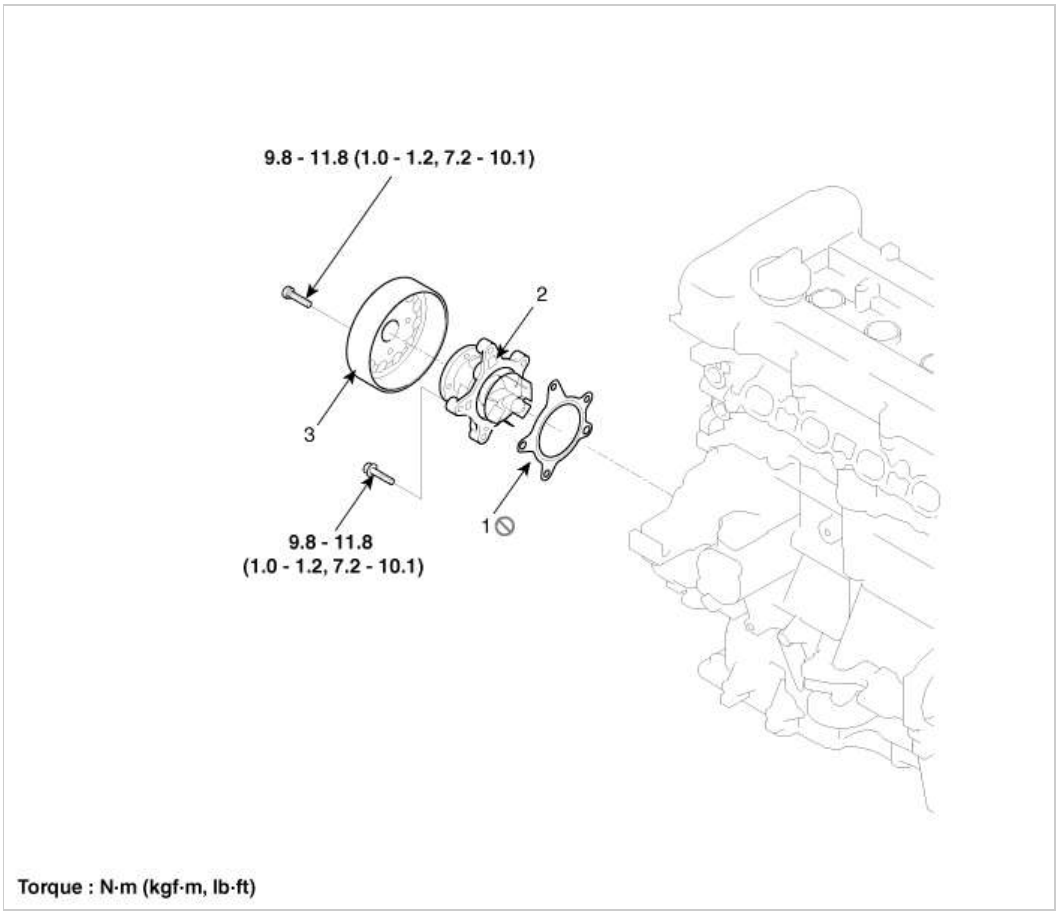
Tightening torque
M6 bolt:
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)
M8 bolt:
18.6 - 23.5 N·m (1.9 - 2.4 kgf·m, 13.7 - 17.4 lb·ft)



6. Install in the reverse order of removal.

Engine Mechanical System

Components



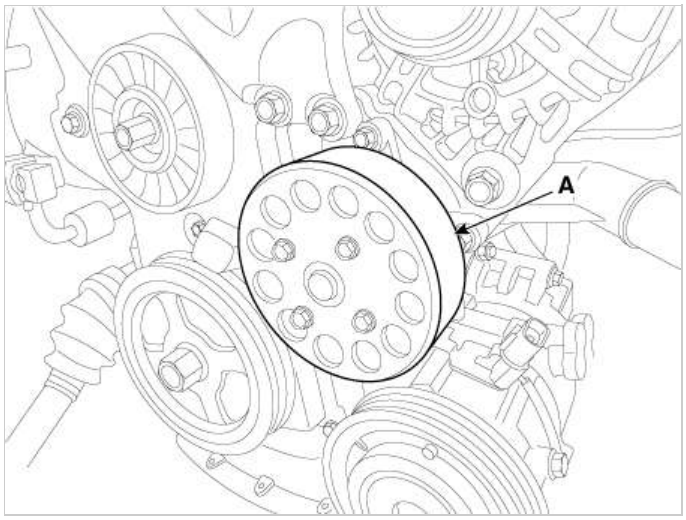
1. Gasket
2. Water pump
3. Water pump pulley

Engine Mechanical System

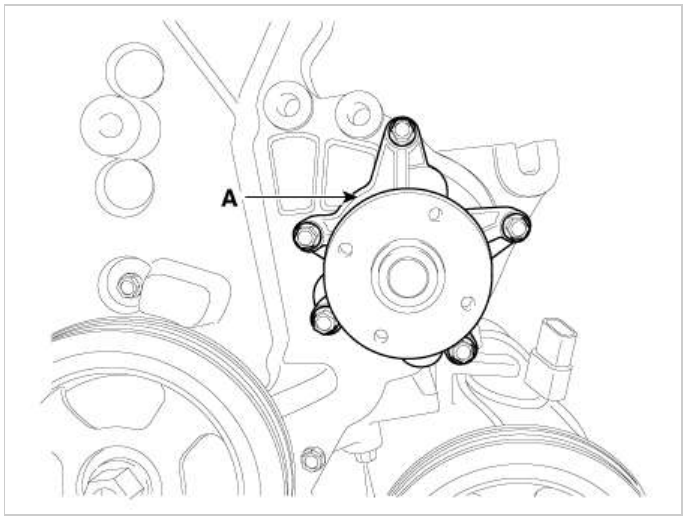
Removal

1. Drain the engine coolant.
   (Refer to Cooling System - "Coolant")
2. Remove the drive belt.
   (Refer to Timing System - "Drive Belt")

3. Remove the water pump pulley(A).



4. Remove the water pump(A).



Inspection

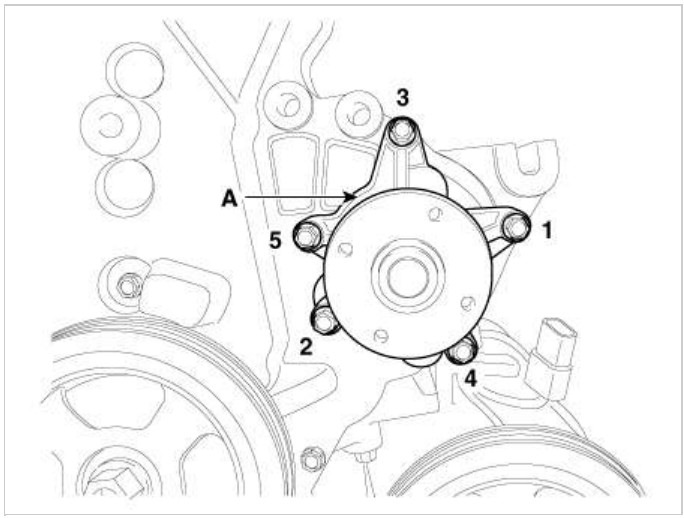
1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective. Replace the coolant pump assembly and gasket.

> **NOTICE**
> A small amount of “weeping” from the bleed hole is normal.

Installation

1. Install the new gasket and water pump(A).
   Tighten the bolts with the order below.

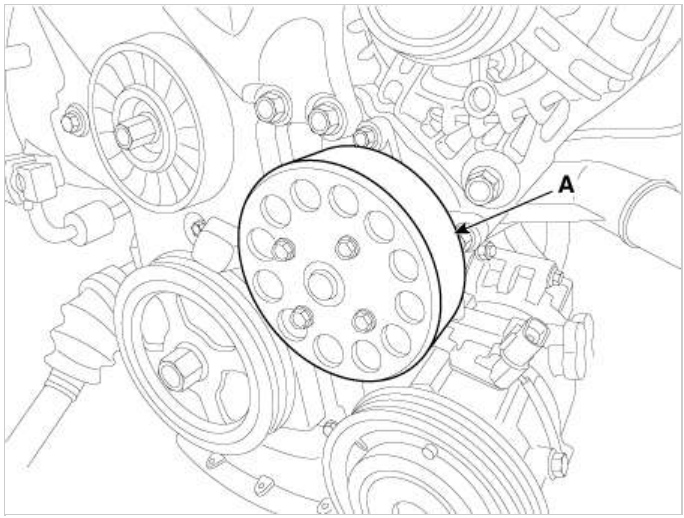
Tightening torque :
9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



2. Install the water pump pulley (A).

Tightening torque :

9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



NOTICE

Tighten the bolts diagonally when installing.

3. Install the drive belt.
   (Refer to Timing System - "Drive Belt")
4. Fill with engine coolant.
5. Start engine and check for leaks.
6. Recheck engine coolant level.

Engine Mechanical System

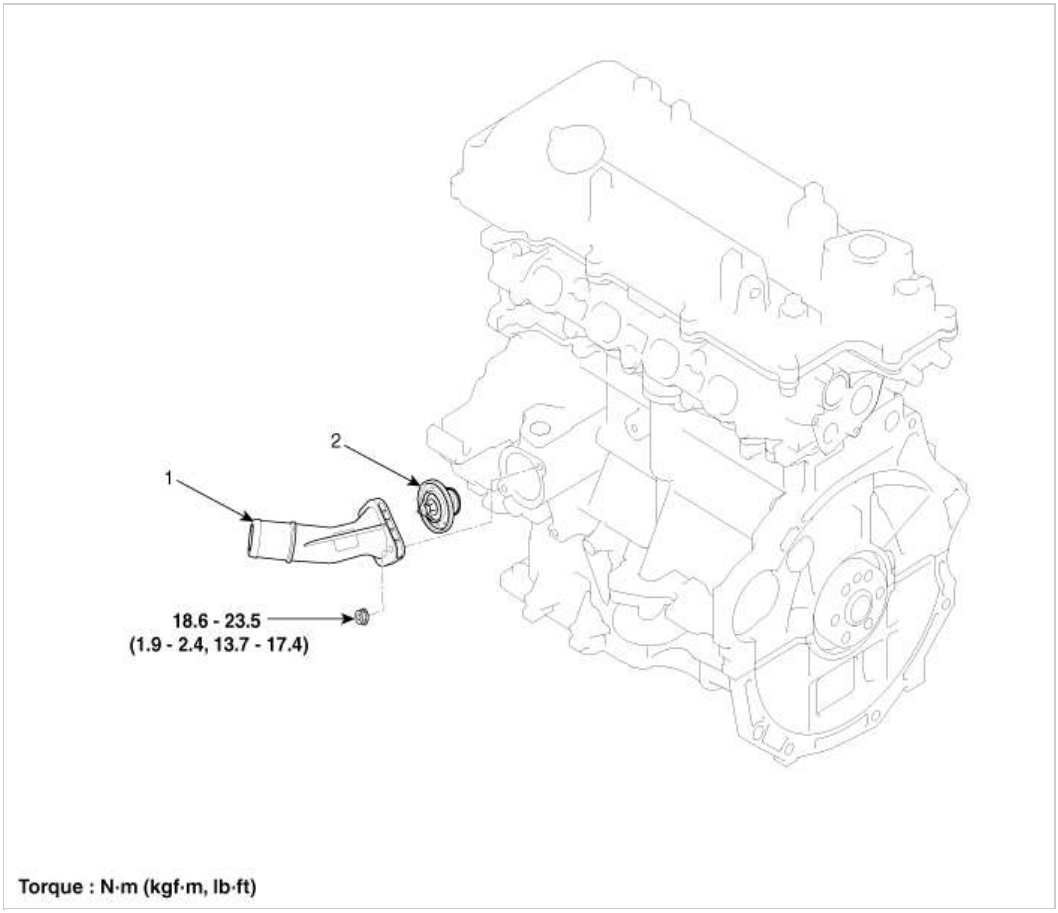
Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the bleed hole of the water pump	Visually check	• Check leaks after about ten-minute warming up.	• If coolant still leaks, replace a water pump.
				• If leakage stops, reuse the water pump (Do not replace the pump with a new one).
	• From gaskets or bolts		• Check the tightening of the water pump mounting bolts.	• Retighten the mounting bolts.
			• Check damage of gaskets or inflow of dust.	• Replace the gasket and clean dust off.
	• From outer surface of water pump		• Check the material or any cracks of the water pump.	• Poor material. If any crack found, replace the water pump.

Noise	• From bearings • From mechanical seals • Impeller interference	Inspection with a stethoscope	• After starting the engine, check noise with a stethoscope.	• If there is no noise, reuse the water pump(do not replace it).
				• If there is any noise from the water pump, remove the drive belt and recheck.
		Inspection after removing a drive belt	• After removing a water pump and a drive belt, check noise again.	• If there is noise, reuse the water pump. Check other drive line parts.
				• If there is no noise, replace the water pump with a new one.
		Inspection after removing a water pump	• After removing a water pump and a drive belt, check noise again.	• If there is any interference between them, replace the water pump with a new one.
Overheating	• Damaged impeller • Loosened impeller	Loosened impeller	• Corrosion of the impeller wing	• Check engine coolant. • Poor coolant quality / Maintenance check
			• Impeller seperation from the shaft	• Replace the water pump.

Engine Mechanical System

Components



1. Water inlet fitting
2. Thermostat

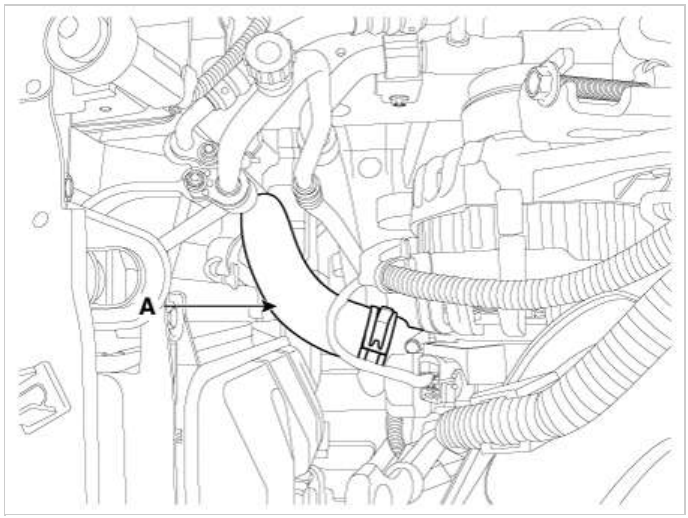
Engine Mechanical System

Removal

NOTICE

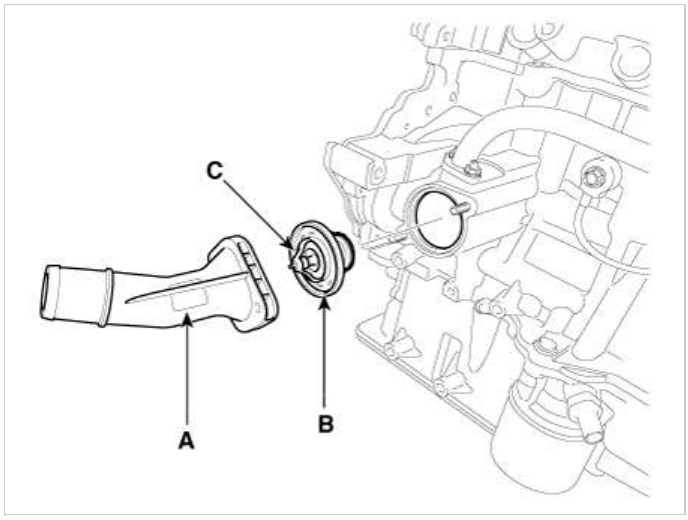
Disassembly of the thermostat would have an adverse effect, causing a lowering of cooling efficiency.

1. Drain the engine coolant so that its level would be under the thermostat height.
   (Refer to Cooling System - "Coolant")
2. Remove the radiator lower hose (A).



3. Remove the water inlet fitting (A) and thermostat (B).

Tightening torque :
18.6 - 23.5 N·m (1.9 - 2.4 kgf·m, 13.7 - 17.4 lb·ft)



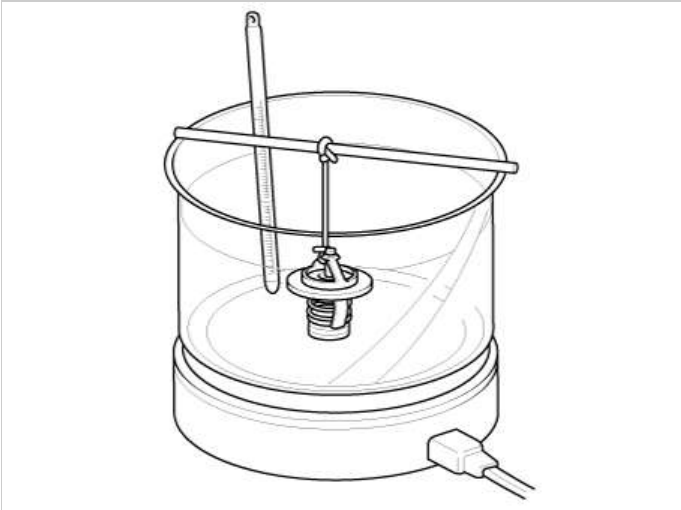
4. Install in the reverse order of removal.

> **NOTICE**
> Place the thermostat with the jiggle valve (C) upward.

5. Fill with the engine coolant.
(Refer to Cooling System - "Coolant")
6. Start engine and check for leaks.

Inspection

1. Immerse thermostat in water heated to over 95°C (203°F), then heat for at least 3 minutes to check valve lift.



NOTICE

- Do not use water below 95°C (203°F).
- Do not directly heat unit as this will damage thermostat.

2. Check the valve opening temperature.

Valve opening temperature:
82±1.5°C (179.6±2.7°F)
Full opening temperature:95°C (203°F)

If the valve opening temperature is not as specified, replace the thermostat.

3. Check the valve lift.

Valve lift :8mm(0.3in) or more at 95°C (203°F)

If the valve lift is not as specified, replace the thermostat.

Engine Mechanical System

Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the thermostat gasket	Check the mounting bolts	• Check the torque of the mounting bolts	• Retighten the bolts and check leakage again.
		Check the gasket for damage	• Check gasket or seal for damage	• Replace gaskets and reuse the thermostat.
Cooled excessively	• Low heater performance (cool air blowed-out) • Temperature gauge indicates "LOW"	Visually check after removing the radiator cap.	• Insufficient coolant or leakage.	• After refilling coolant, recheck.
		GDS check&Starting engine	• Check DTCs • Check connection of the fan clutch or the fan motor. ※ If the fan clutch is always connected, there will be a noise at idle.	• Check the engine coolant sensor, wiring and connectors. • Replace the componants.
		Remove the thermostat and inspect	• Check if there are dusts or chips in the thermostat valve. • Check adherence of the thermostat.	• Clean the thermostat valve and reuse the thermostat. • Replace the thermostat, if it doesn"t work properly.
Heated excessively	• Engine overheated • Temperature gauge indicates "HI"	Visually check after removing the radiator cap.	• Insufficient coolant or leakage. ※ Be careful when removing a radiator cap of the overheated vehicle. • Check air in cooling system.	• After refilling coolant, recheck. • Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.
		GDS check&Starting engine	• Check DTCs • Check the fan motor performance as temperature varies. • Check if the fan clutch slips. • Check the water pump adherence or impeller damaged.	• Check the engine coolant sensor, wiring and connectors. • Check the fan motor, the relay and the connector. • Replace the fan clutch, if it doesn"t work properly. • Replace the water pump, if it doesn"t work properly.

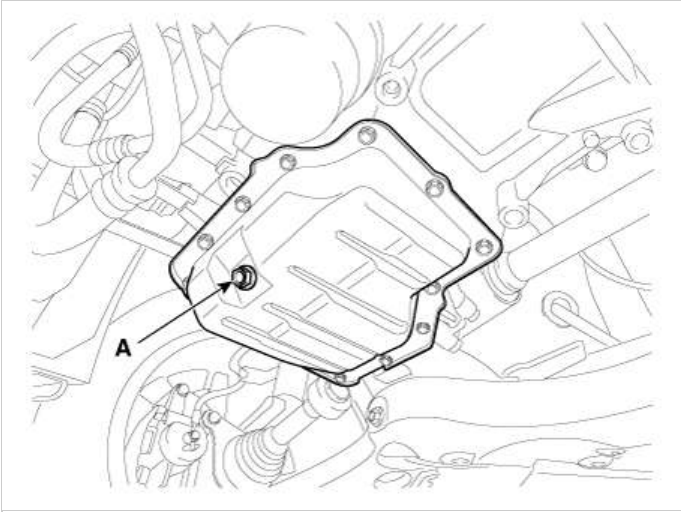
		Immerse the thermostat in boiling water and inspection.	• After removing the thermostat, check it works properly. ※ Check the thermostat opens at the valve opening temperature.	• Replace the thermostat, if it doesn"t work properly.

Replacement

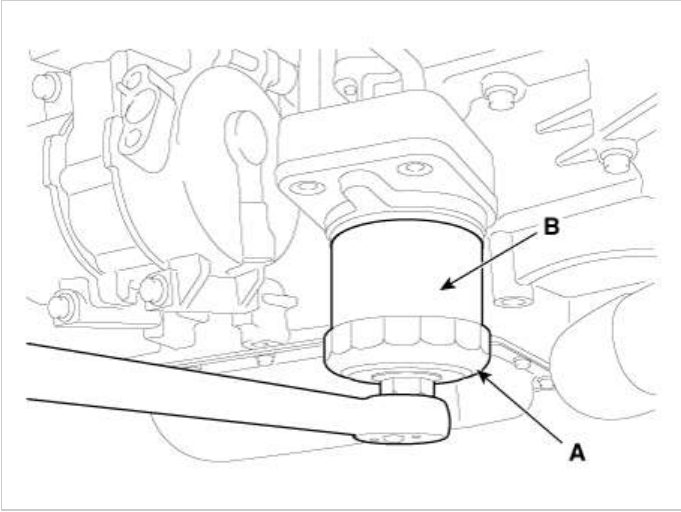
⚠ CAUTION

- Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.
- Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.
- In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.

1. Drain the engine oil.
   (1) Remove the oil filler cap.
   (2) Remove the oil drain plug (A), and drain the oil into a container.



2. Remove the oil filter(B) with the SST(09263-2E000 (A), the oil filter wrench).
   (1) Remove the oil filter.



   (2) Check and clean the oil filter installation surface.
   (3) Check the part number of the new oil filter is as same as old one.
   (4) Apply clean engine oil to the gasket of a new oil filter.
   (5) Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.
   (6) Tighten it with the torque below.

Tightening torque :
11.8 - 15.7N·m (1.2 - 1.6kgf·m, 8.7 - 11.6lb·ft)

3. Refill with engine oil.
   (1) Clean and install the oil drain plug with a new gasket.

   Tightening torque :
   34.3 - 44.1N·m (3.5 - 4.5kgf·m, 25.3 - 32.5lb·ft)

   (2) Fill with fresh engine oil.

   Capacity
   Total :
   4.6 L - 4.9 L (1.21 U.S.gal., 4.86 U.s.qt., 4.04 Imp.qt. - 1.29U.S.gal., 5.17 U.S.qt., 4.30 Imp.qt.)
   Oil pan : 4.2 L (1.10 U.S.gal., 4.43 U.S.qt., 1.10 Imp.qt.)
   Drain and refill in cluding oil filter :
   4.5 L (1.18 U.S.gal., 4.75 U.S.qt., 3.95 Imp.qt.)

   (3) Install the oil filler cap.

4. Start engine and check for oil leaks.
5. Recheck the engine oil level.

Inspection

Engine Oil

1. Check the engine oil quality.
   Check the oil deterioration, entry of water, discoloring of thinning.
   If the quality is visibly poor, replace the oil.
2. Check the engine oil level.
   After warning up the engine and then 5 minutes after the engine stop, oil level should be between the "L" and "F" marks in the dipstick.
   If low, check for leakage and add oil up to the "F" mark.

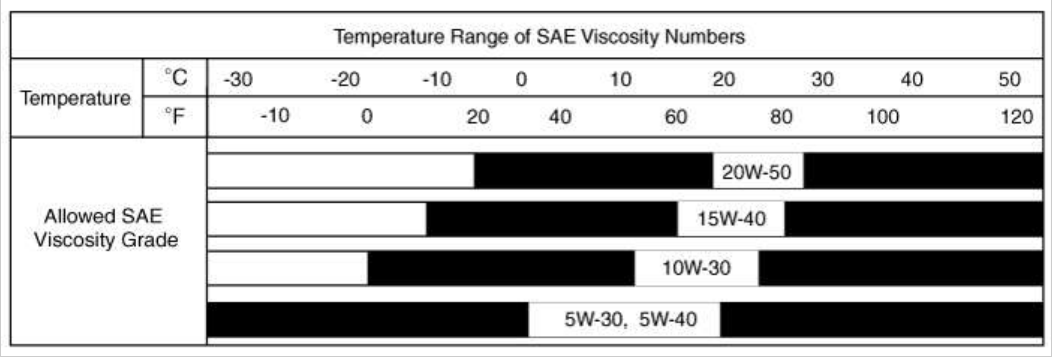
> **NOTICE**
> Do not fill with engine oil above the "F" mark.

Selection Of Engine Oil

Recommendation
- ACEA A5 or above/5W-30

Allowed Oil Grade
- ILSAC GF-3, GF-4 (API SL, SM) or above
- ACEA A3, A5 or above

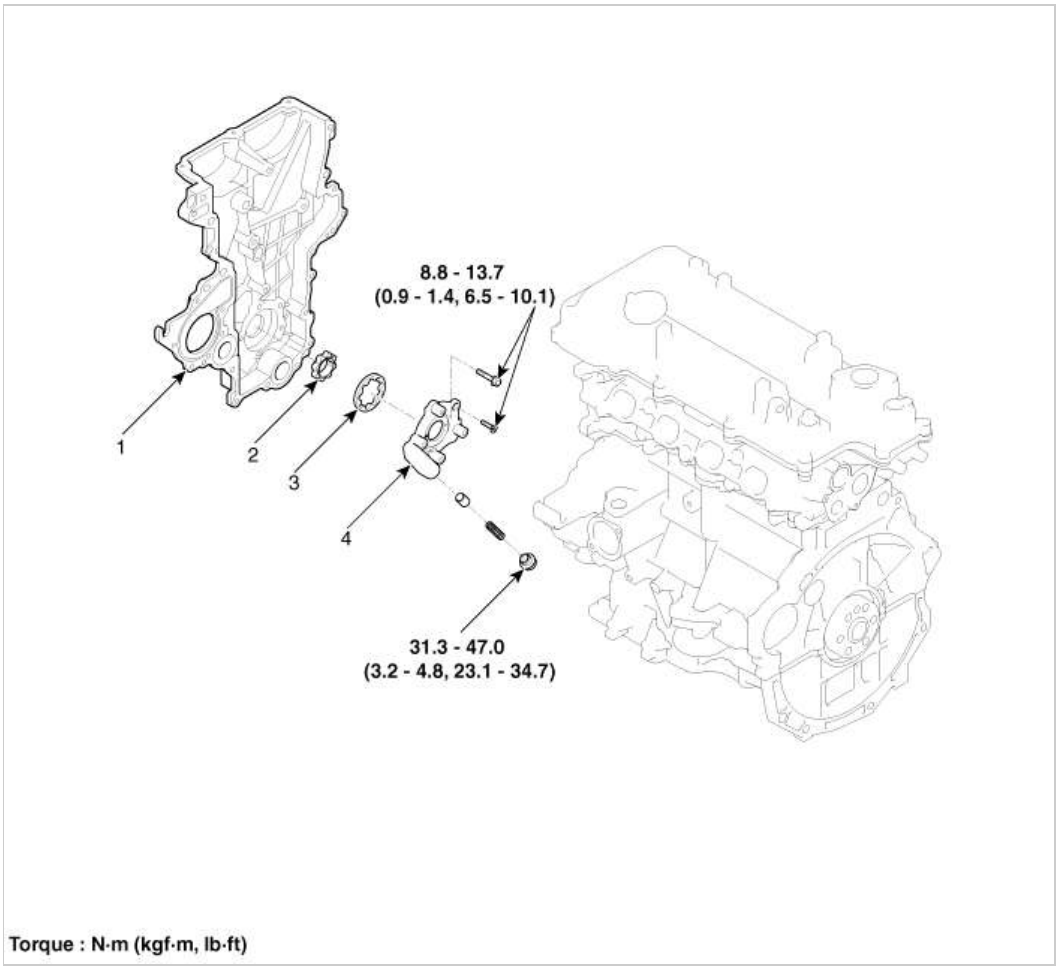
Allowed SAE Viscosity



> **NOTICE**
> For best performance and maximum protection of all types of operation, select only those lubricants which :
> 1) Satisfy the requirement of the ACEA classification.
> 2) Have proper SAE grade number for expected ambient temperature range.
> 3) Lubricants that do not have both an SAE grade number and ACEA service classification on the container should not be used.

Engine Mechanical System

Components



Torque : N·m (kgf·m, lb·ft)

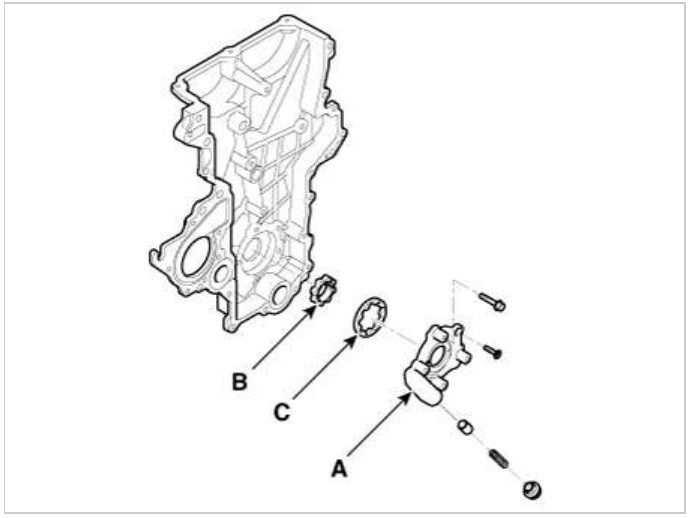
1. Timing chain cover
2. Inner rotor
3. Outer rotor
4. Pump cover

Engine Mechanical System

Removal and Installation

1. Remove the timing chain cover.
   (Refer to Timing System - "Timing Chain Cover")
2. Remove the pump cover (A).

   Tightening torque :
   8.8 - 13.7N·m (0.9 - 1.4kgf·m, 6.5 - 10.1 lb·ft)
3. Remove the inner rotor (B) and outer rotor (C).

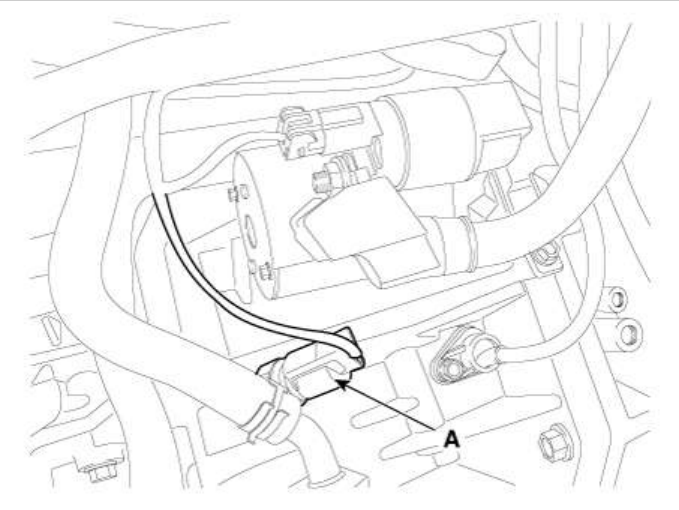


4. Install in the reverse order of removal.

Engine Mechanical System

Removal and Installation

1. Remove the engine room under cover.
   (Refer to Engine And Transmission Assembly - "Engine Room Under Cover")
2. Remove the oil drain plug, and drain the oil into a container.
3. Disconnect the connector and remove the oil pressure switch (A).



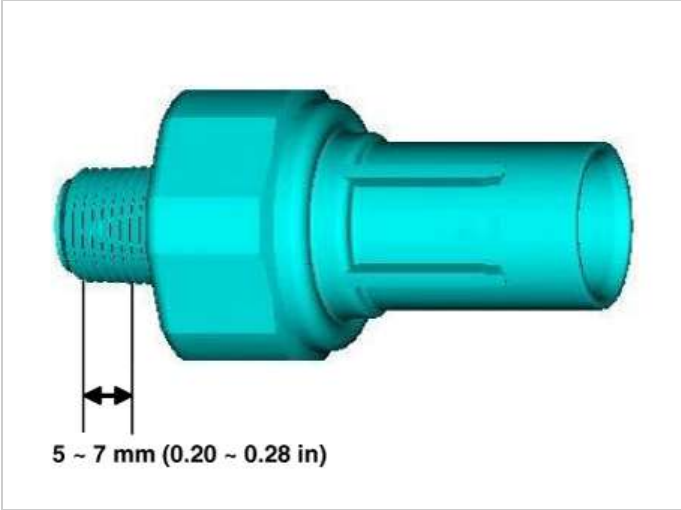
4. Install in the reverse order of removal.

NOTICE

When installing the oil pressure switch, apply seal lock to the thread.

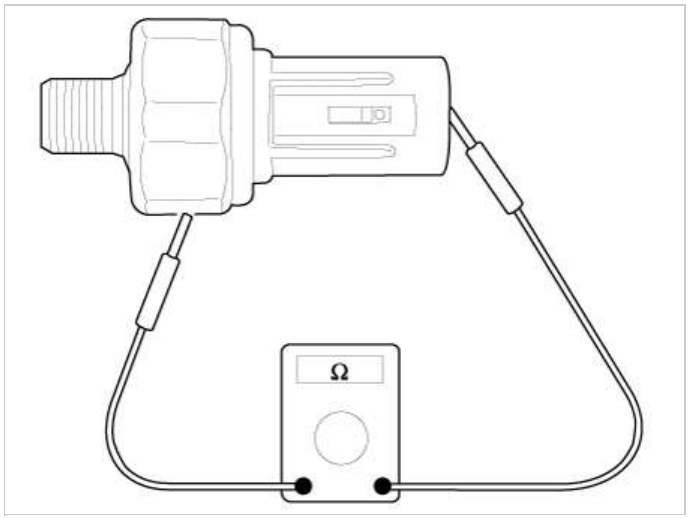
Seal lock: THREEBOND 2403

Thickness: 0.2 - 0.4 mm (0.008 - 0.016 in.)

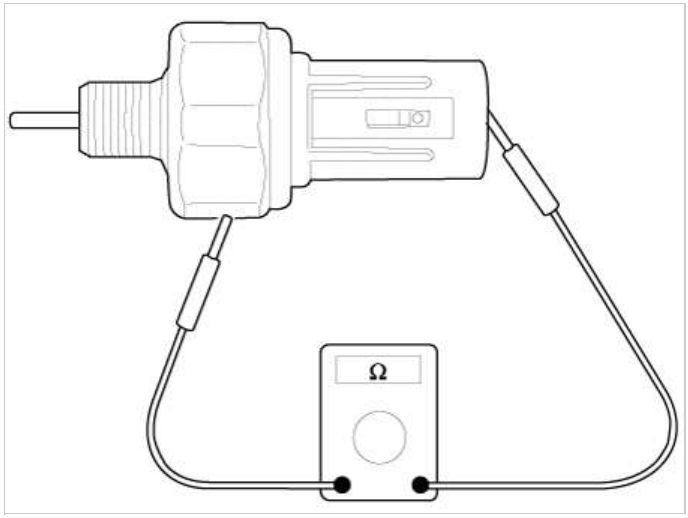


Inspection

1. Check the continuity between the terminal and the body with an ohmmeter.
   If there is no continuity, replace the oil pressure switch.



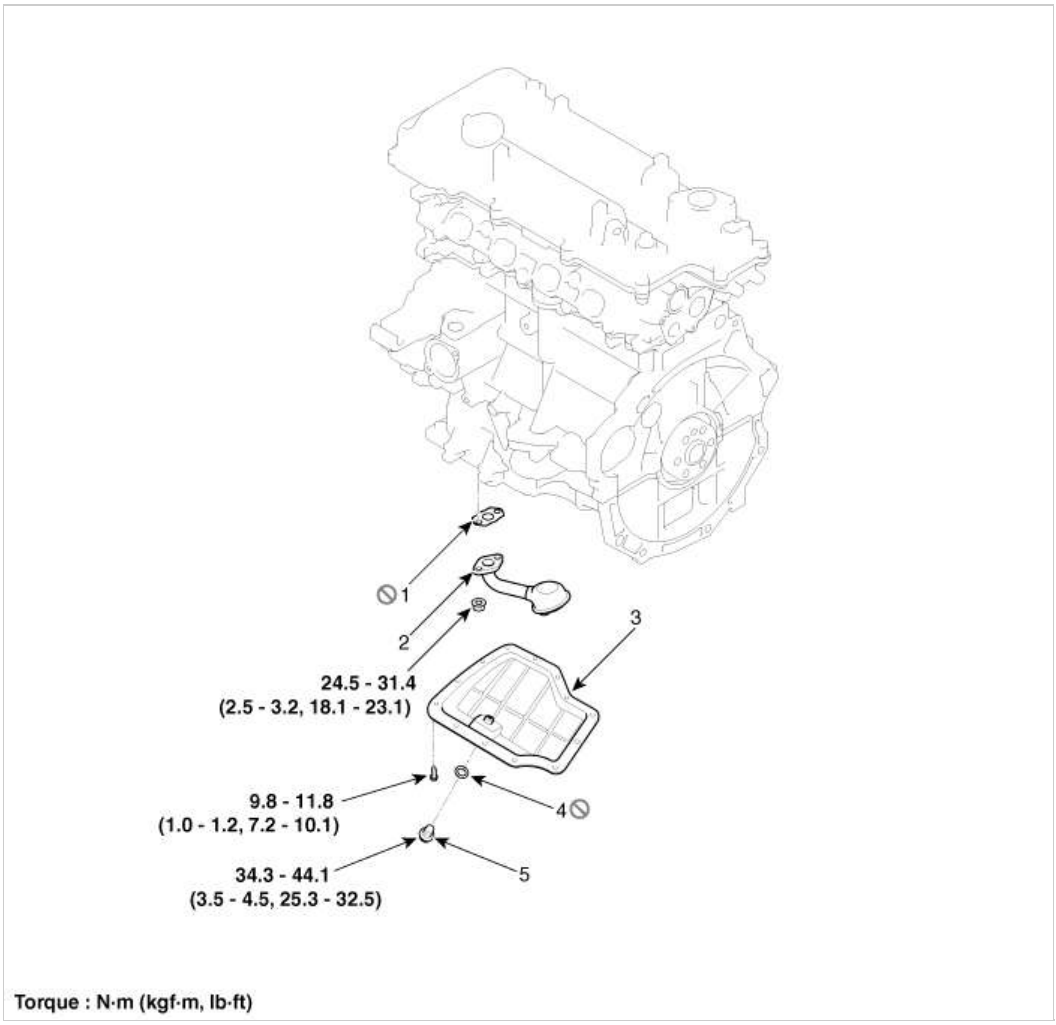
2. Check the continuity between the terminal and the body when the fine wire is pushed.
   If there is continuity even when the fine wire is pushed, replace the switch.



3. If there is no continuity when a 19.6 - 39.2kpa (0.2 - 0.4kg/cm², 2.8 - 5.6 psi) is applied through the oil hole, the switch is operating properly.
   Check for air leakage. If air leaks, the diaphragm is broken.
   Replace it.

Engine Mechanical System

Components

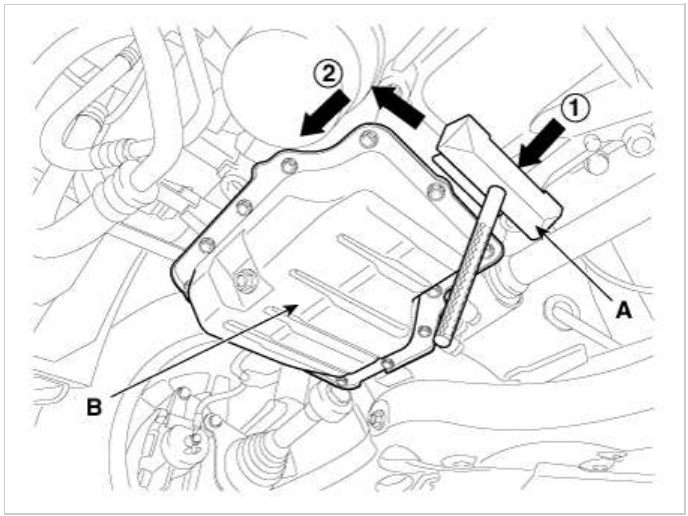


1. Gasket
2. Oil screen
3. Oil pan
4. Drain plug gasket
5. Drain plug

Engine Mechanical System

Removal

1. Remove the engine room under cover.
   (Refer to Engine And Transmission Assembly - "Engine Room Under Cover")
2. Drain engine oil.
3. Using the SST(09215-3C000) and remove the oil pan.



NOTICE

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.
- After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not turn over the SST abruptly without tapping. It be result in damage of the SST.

Installation

1. Install the oil pan.
   (1) Using a razor blade and gasket scraper, remove all the old packing material from the gasket surfaces.

   NOTICE

   Check that the mating surfaces are clean and dry before applying liquid gasket.

   (2) Apply liquid gasket as an even bead, centered between the edges of the mating surface.

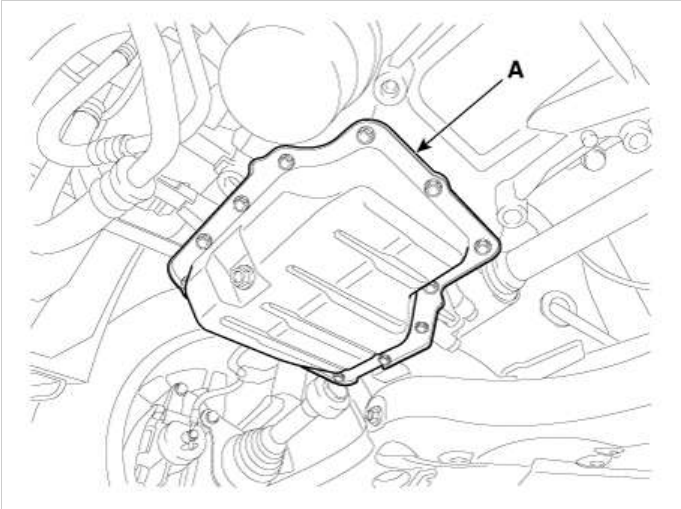
   Liquid gasket :TB 1217H or LOCTITE 5900H

   NOTICE

   - To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.
   - Do not install the parts if five minutes or more have elapsed since applying the liquid gasket. Instead, reapply liquid gasket after removing the residue.
   - After assembly, wait at least 30 minutes before filling the engine with oil.

   (3) Install the oil pan (A) with the bolts.
   Uniformly tighten the bolts in several passes.

   Tightening torque :
   9.8 - 11.8N·m (1.0 - 1.2kgf·m, 7.2 - 8.7lb·ft)



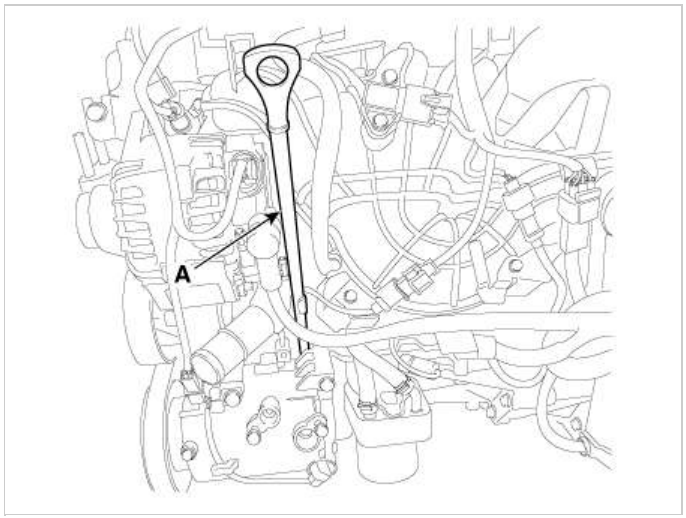
2. Refill engine oil.

Engine Mechanical System

Removal and Installation

1. Remove the oil lever gauge (A).

   Tightening torque:
   9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)

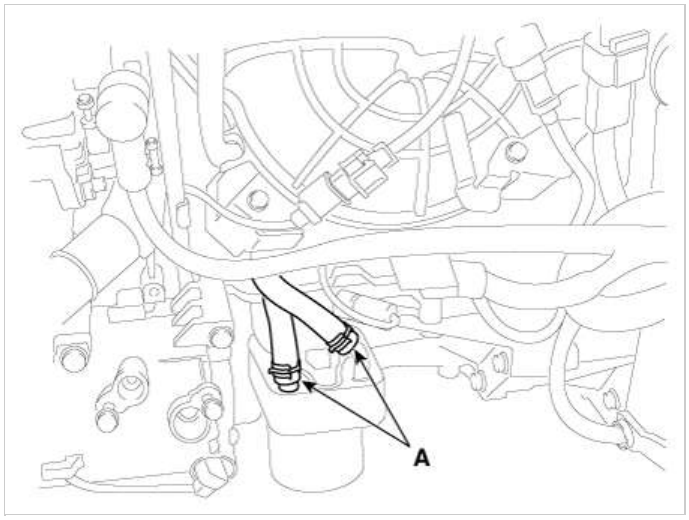


2. Install in the reverse order of removal.

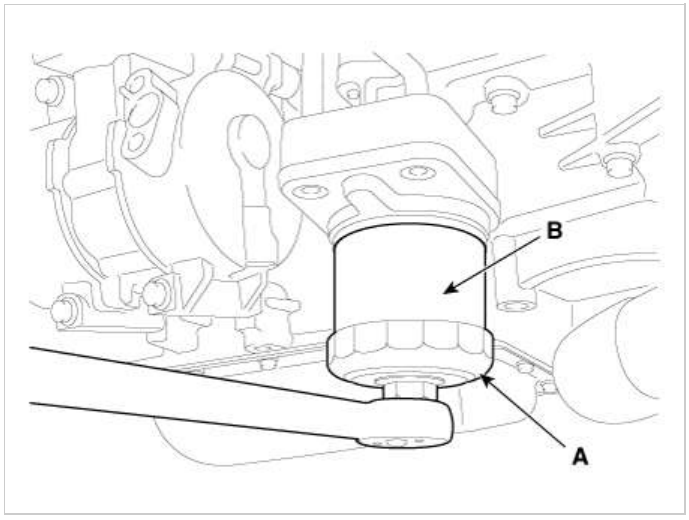
Engine Mechanical System

Removal

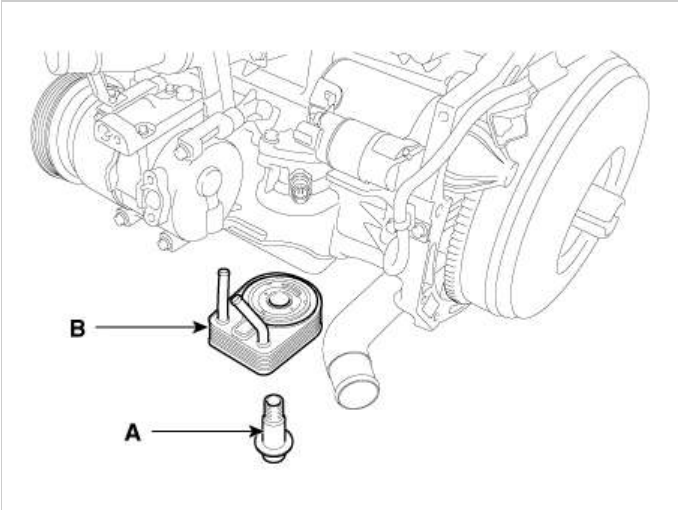
1. Loosen the drain plug and drain the coolant. Open the radiator cap to make rapid draining. (Refer to Cooling System - "Coolant")
2. Disconnect the oil cooler hose(A).



3. Remove the oil filter(B) with the SST(09263-2E000 (A), the oil filter wrench).



4. Loosen the mounting bolt(A), and then remove the oil cooler(B).

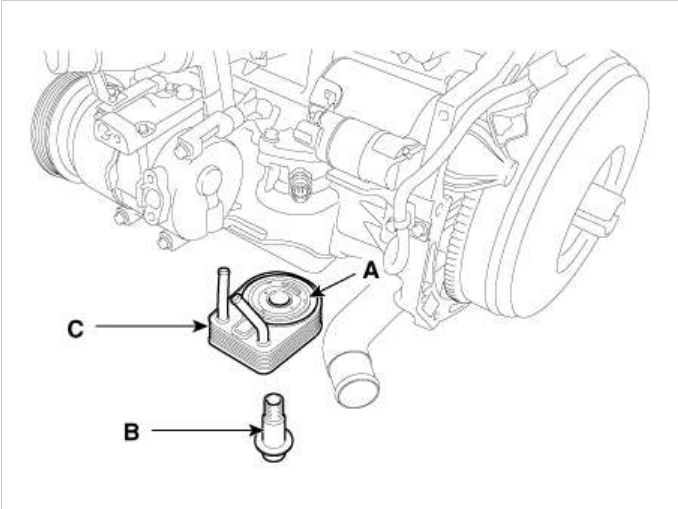


Installation

1. Apply a light coat of engine oil to the oil cooler packing surface (A), and then install the oil cooler(C) with fix bolt (B).

Tightening torque :

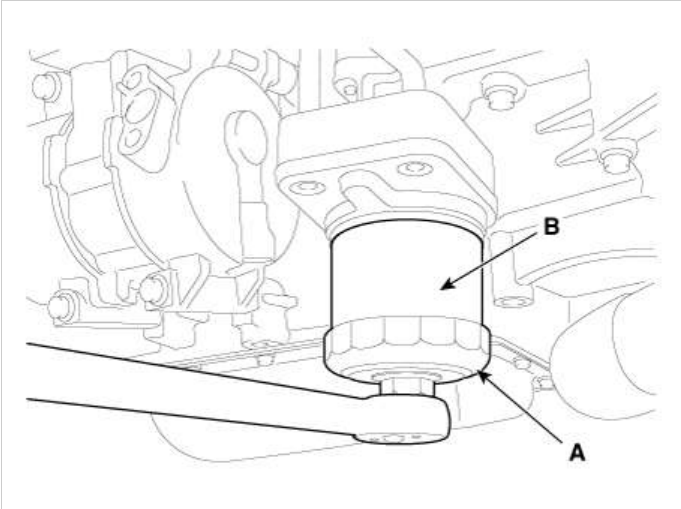
50.0 - 55.8 N·m (5.1 - 5.7kgf·m, 36.8 - 41.2 lb·ft)



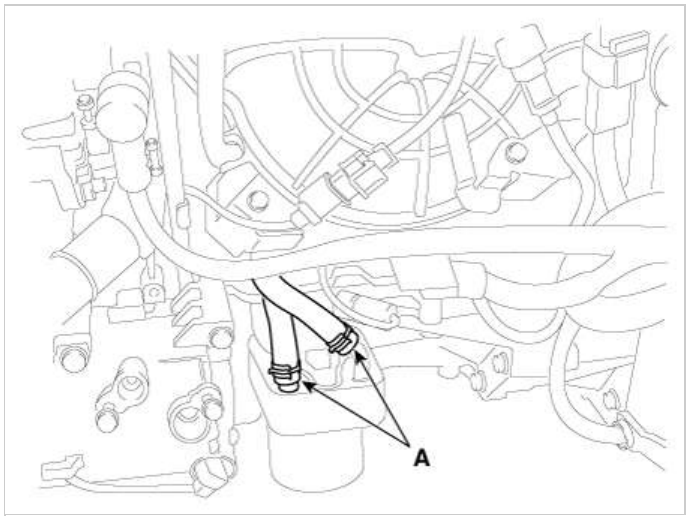
2. Install the oil filter(B) with the SST(09263-2E000 (A), the oil filter wrench).

Tightening torque :

11.7 - 15.6 N·m (1.2 - 1.6kgf·m, 8.6 - 11.5 lb·ft)



3. Install the oil cooler(A).

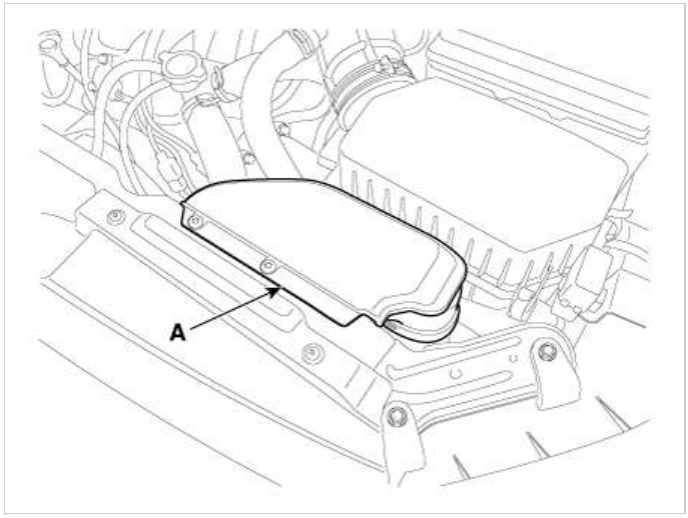


4. Fill the radiator with coolant and check for leaks.

Engine Mechanical System

Removal and Installation

1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Remove the air duct (A).



4. Remove the air cleaner assembly.

Tightening torque

Hose clamp bolt:

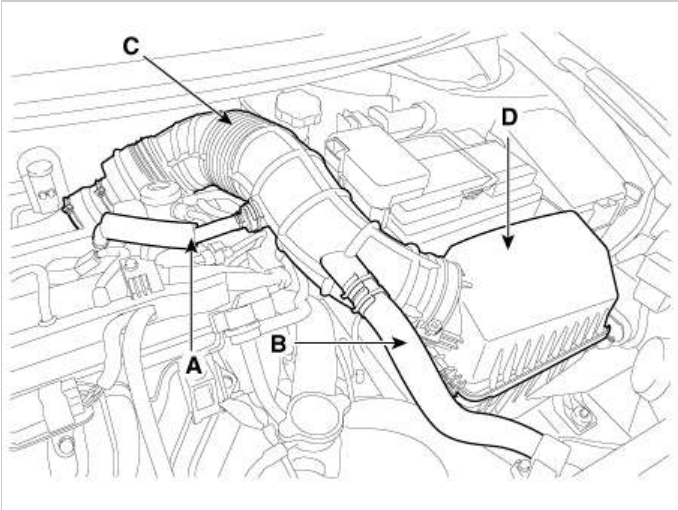
2.9 - 4.9 N·m (0.3 - 0.5 kgf·m, 2.2 - 3.6 lb·ft)

Air cleaner assembly bolts:

3.9 - 5.9 N·m (0.4 - 0.6 kgf·m, 2.9 - 4.3 lb·ft)

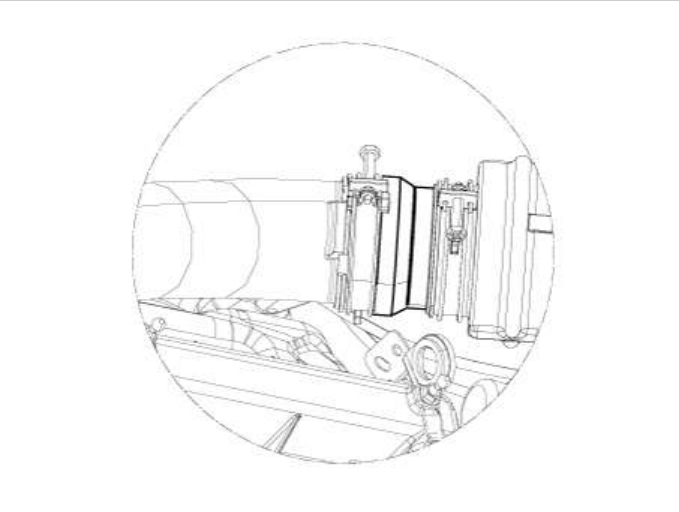
(1) Disconnect the breather hose (A), RCV hose (B) and air intake hose (C).

(2) Remove the air cleaner assembly (D).



NOTICE

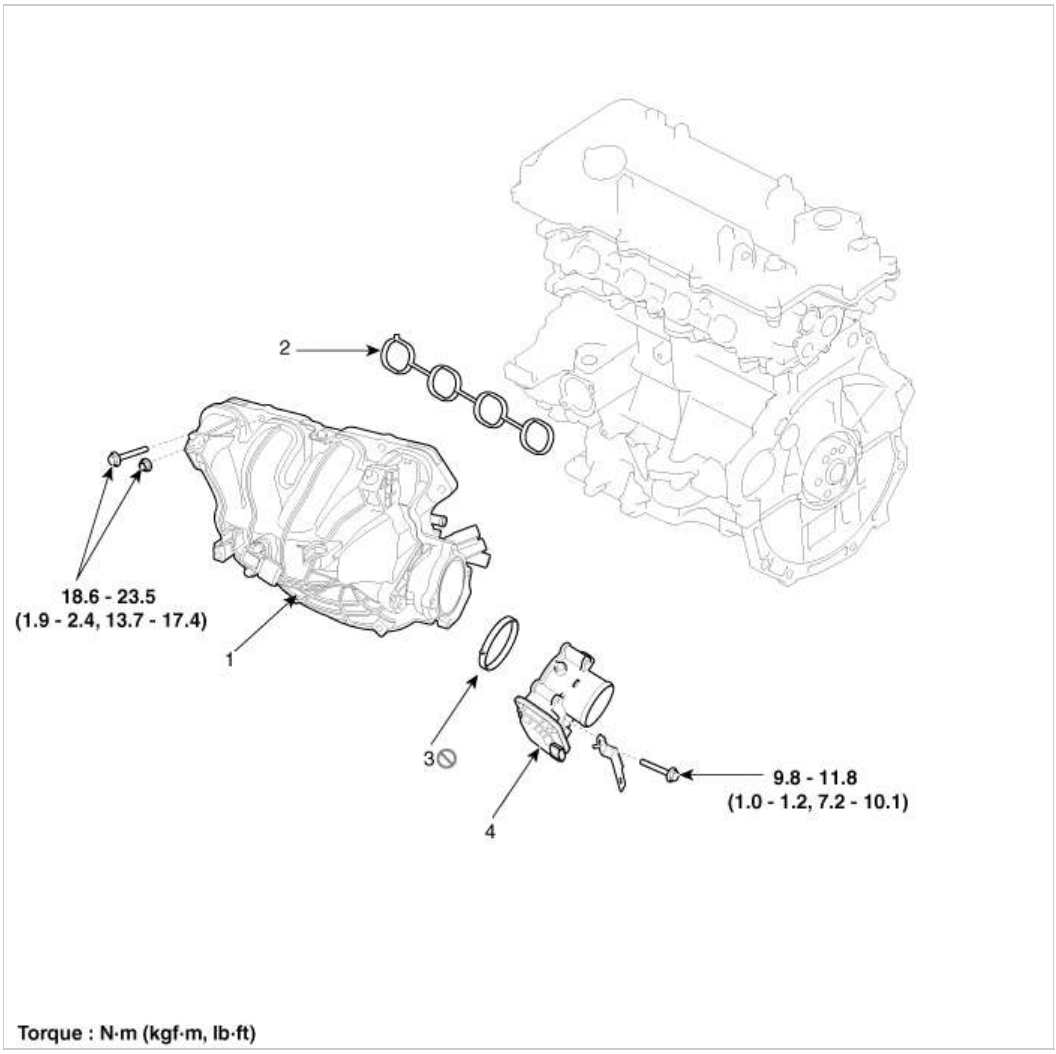
Hose clamp is fitted by matching from the hose stopper plate.



5. Install in the reverse order of removal.

Engine Mechanical System

Components

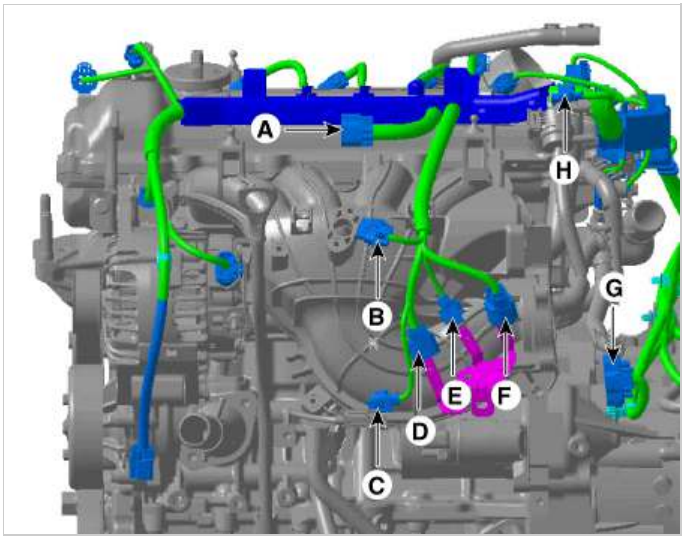


1. Intake manifold assembly
2. Intake manifold gasket
3. Electronic throttle body gasket
4. Electronic throttle body

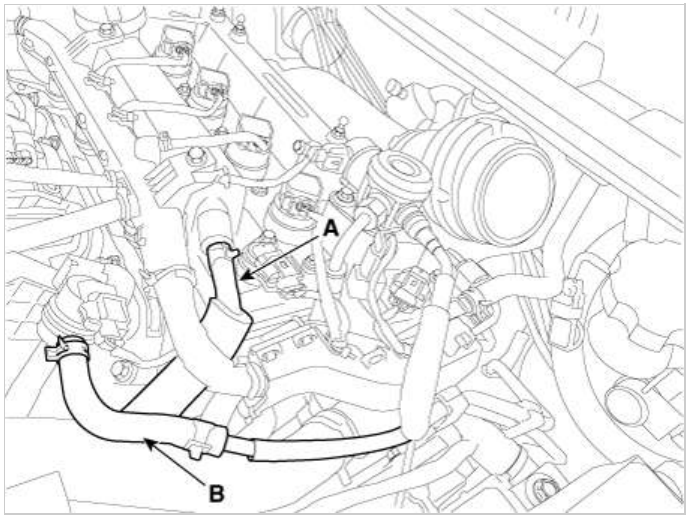
Engine Mechanical System

Removal and Installation

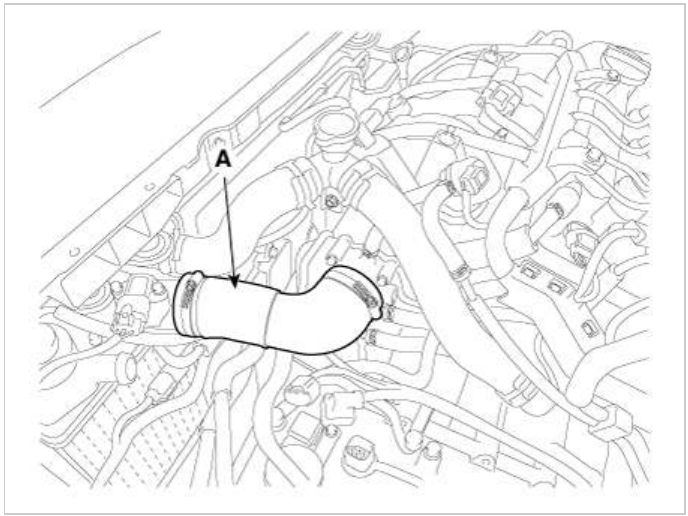
1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Disconnect the engine wiring connector and haness clamp and disconnect the wiring from intake manifold.
   A. Injector extention connector
   B. MAPS (Map Sensor) connector
   C. Knock Sensor connector
   D. Front connector
   E. CKPS(Crank Shaft Position Sensor) connector
   F. vacuum pump extention connector
   G. ETC(Electric Throttle Control) Module connector
   H. PCSV(Purge Control Solenoid Valve) connector



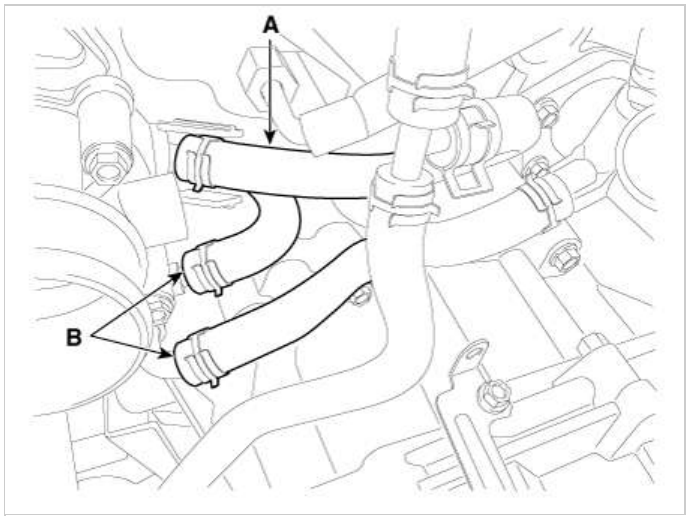
4. Disconnect the PCV (Positive crankcase ventilation) hose (A) and the PCSV (Purge control solenoid valve) hose (B).

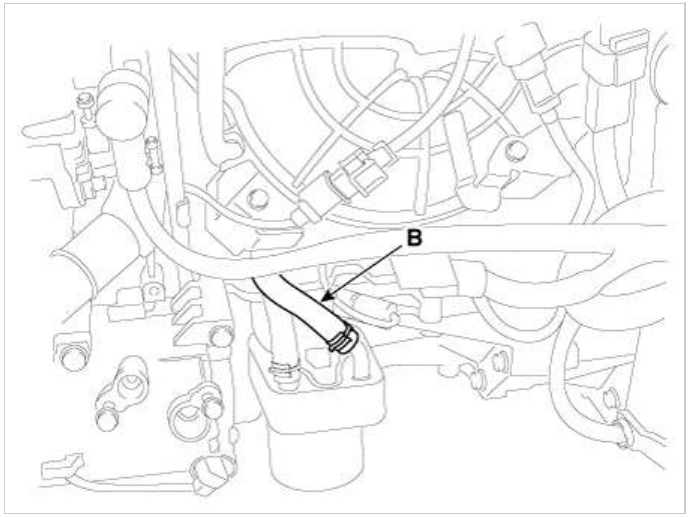


5. Remove the intercooler outlet hose (A).



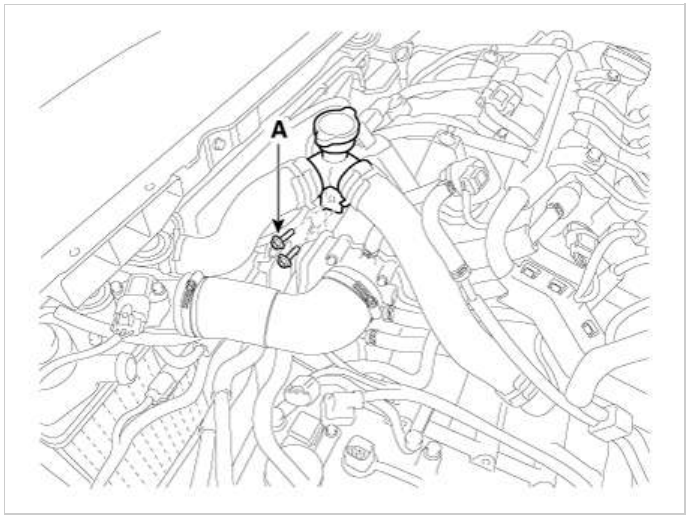
6. Disconnect the vacuum hose (A) and the throttle body coolant hoses (B).



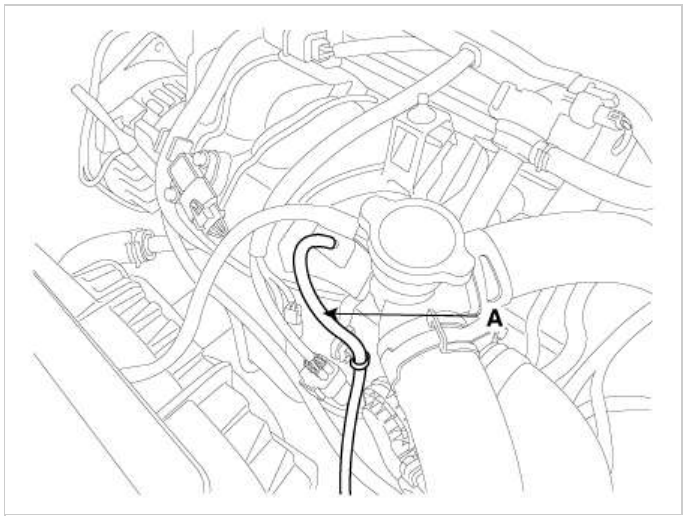


7. Unfasten the filler neck assembly mounting bolts (A).

Tightening torque :
6.9 - 10.8 N·m (0.7 - 1.1 kgf·m, 5.1 - 8.0 lb·ft)



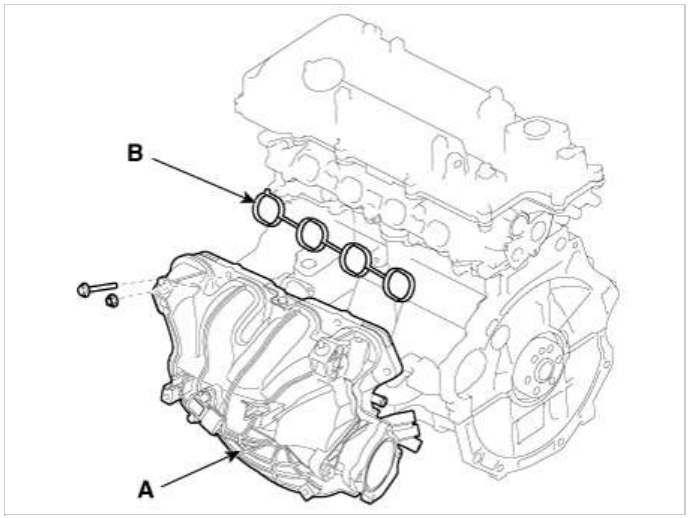
8. Disconnect the vacuum hose (A).



9. Remove the intake manifold (A) with the gasket (B).

Tightening torque :

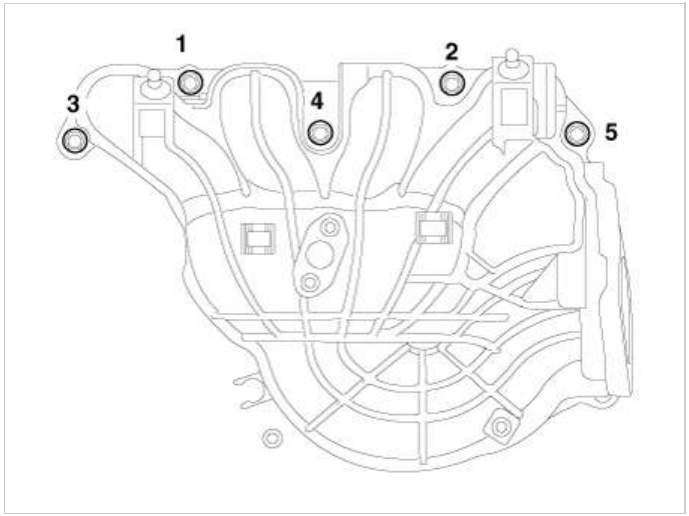
18.6 - 23.5N·m (1.9 - 2.4kgf·m, 13.7 - 17.4lb·ft)



NOTICE

When installing, replace with new gaskets.

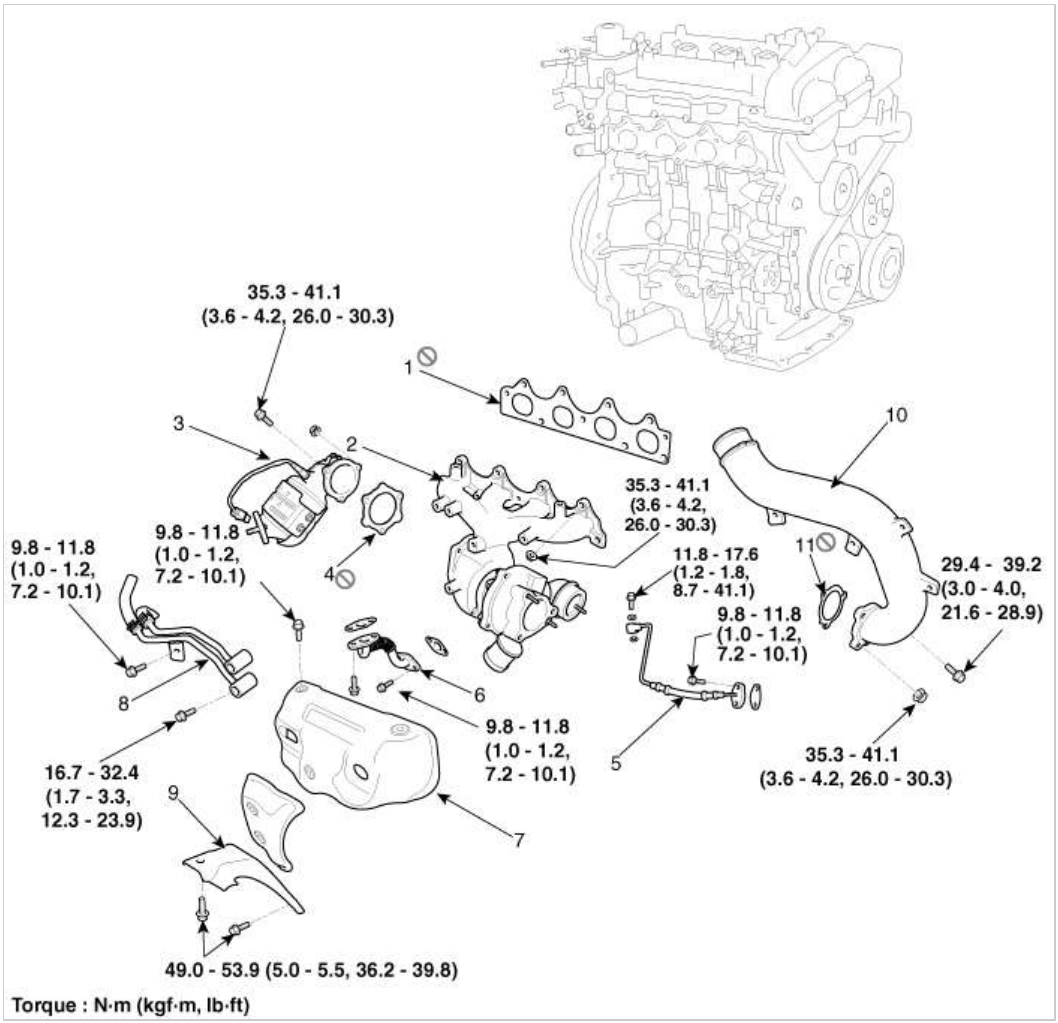
When installing the intake manifold, tighten the bolts and nuts with pre-torque first, and then tighten the bolts and nuts with specified torque in the sequence shown.



10. Install in the reverse order of removal.

Engine Mechanical System

Components

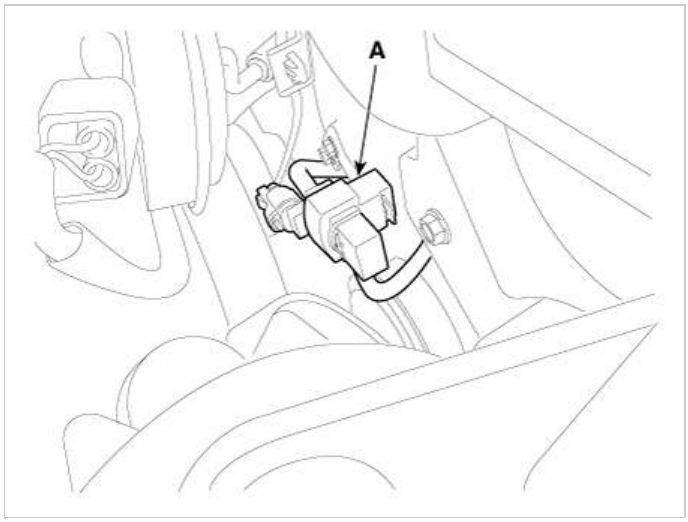


1. Turbo manifold gasket
2. Turbo manifold module
3. Catalytic converter
4. Turbo charger coupler & gasket
5. Oil feed pipe & hose assembly
6. Oil drain pipe assembly
7. Turbo manifold module heat protector
8. Turbo charger water pipe & hose assembly
9. Turbo charger stay
10. Intake pipe
11. Intake pipe gasket

Engine Mechanical System

Removal and Installation

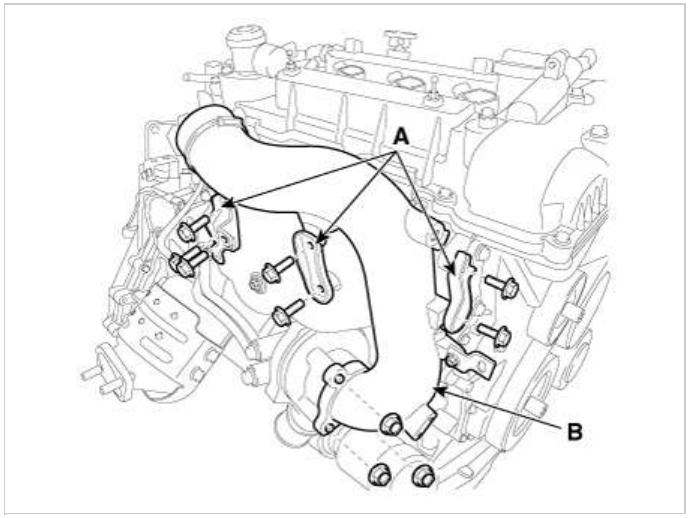
1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Disconnect the air intake hose.
   (Refer to Intake And Exhaust System - "Air Cleaner")
4. Remove the waste gate valve (WGV) (A).



5. Remove the front muffler.
   (Refer to Intake and Exhaust System - "Muffler")
6. After installing the jack on the edge of oil pan, remove the engine mounting support bracket and drop the engine down a little bit.
7. Remove the intake pipe stay(A).

   Tightening torque
   M8 Bolt :
   18.6 - 23.5 N·m (1.9 - 2.4kgf·m, 13.7 - 17.4 lb·ft)
   M10 Bolt :
   29.4 - 34.3 N·m (3.0 - 3.5kgf·m, 21.6 - 25.3 lb·ft)
8. Remove the intake pipe(B) and gasket.

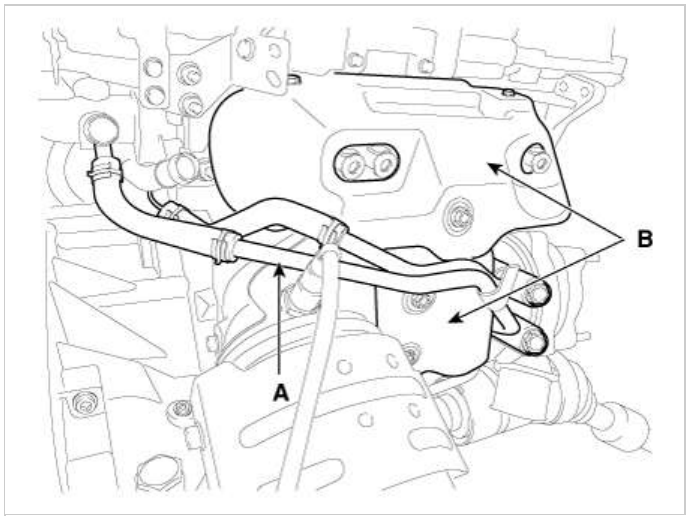
   Tightening torque
   Bolt :
   29.4 - 39.2N·m (3.0 - 4.0 kgf·m, 21.6 - 28.9 lb·ft)
   Nut :
   35.3 - 41.1 N·m (3.6 - 4.2 kgf·m, 26.0 - 30.3 lb·ft)



9. Remove the turbo charger water pipe & hose (A).

   Tightening torque
   Flange Bolt :
   9.8 - 11.8N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)
   Eye Nut :
   26.4 - 32.3 N·m (2.7- 3.3 kgf·m, 19.5 - 32.3 lb·ft)
10. Remove the turbo manifold module heat protector (B).

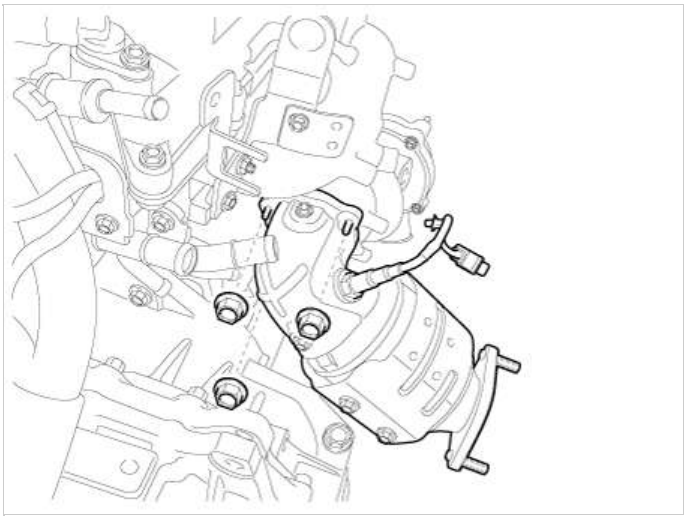
    Tightening torque
    Falnge Bolt:
    9.8 - 11.8 N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



11. Remove the catalytic converter.

Tightening torque :

35.3 - 41.1N·m (3.6 - 4.2 kgf·m, 20.0 - 30.3 lb·ft)



12. Remove the turbo charger oil feed pipe(A).

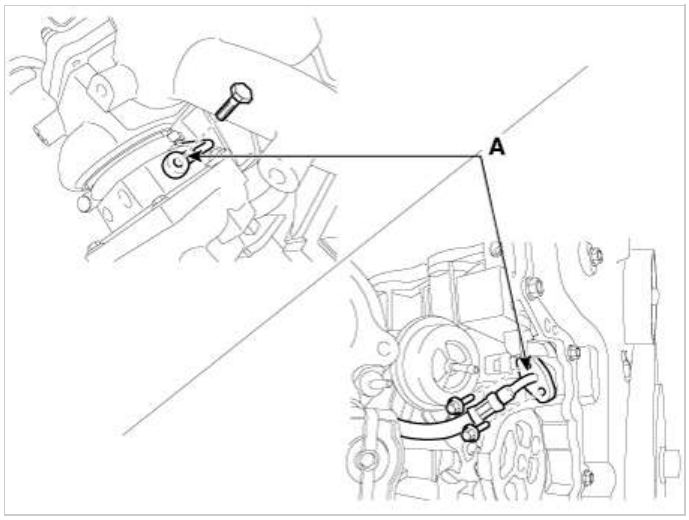
Tightening torque

M6 Bolt :

9.8 - 11.8N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)

Eye Nut :

11.8 - 17.6 N·m (1.2 - 1.8 kgf·m, 8.7 - 41.1 lb·ft)



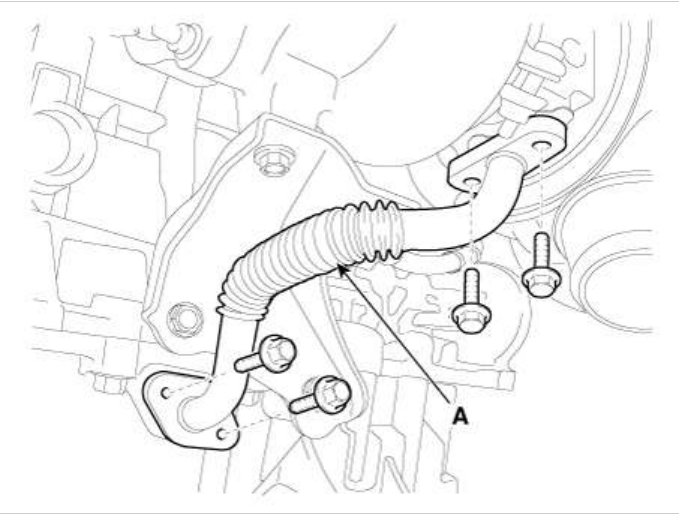
NOTICE

When installing, completely remove the oil from assembly part and be careful not to enter any dust.
When installing the eye bolt, be careful to not contact with the stopper to the compressor housing.

13. Remove the turbo charger oil drain pipe(A).

Tightening torque :

9.8 - 11.8N·m (1.0 - 1.2 kgf·m, 7.2 - 8.7 lb·ft)



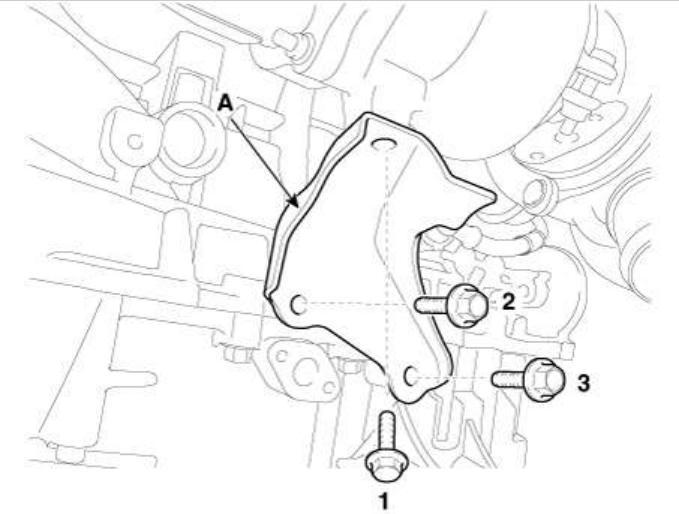
NOTICE

When installing, completely remove the oil from assembly part.

14. Remove the turbo charger stay(A).

Tightening torque :

49.0 - 53.9N·m (5.0 - 5.5 kgf·m, 36.1 - 39.7 lb·ft)



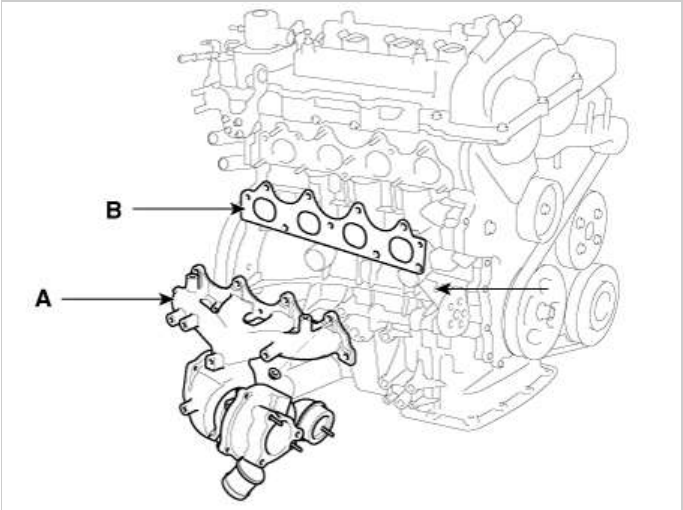
NOTICE

When installing, temporarily tighten the bolt in picture order and completely tighten the bolt as specified torque in order.

15. Remove the turbo manifold module (A) and gasket (B).

Tightening torque :

35.3 - 41.1N·m (3.6 - 4.2 kgf·m, 26.0 - 30.3 lb·ft)

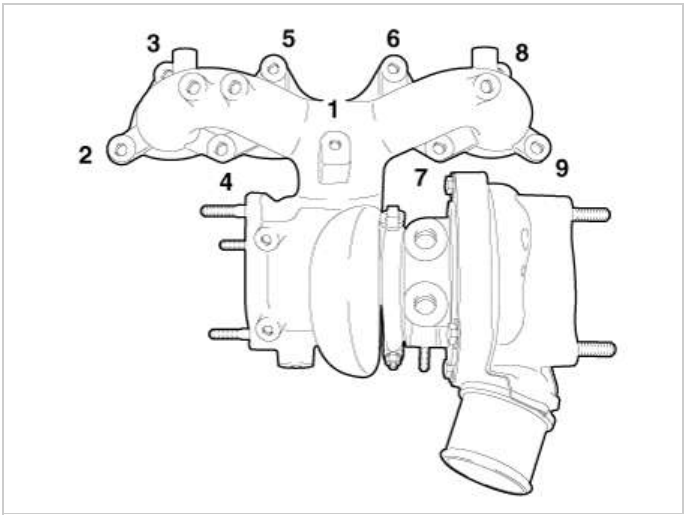


NOTICE

When installing, you should assemble it toward the coating side(black).

NOTICE

When installing, temporarily tighten the nut in picture order and completely tighten the bolt as specified torque in order.



16. Install in the reverse order of removal.

CAUTION

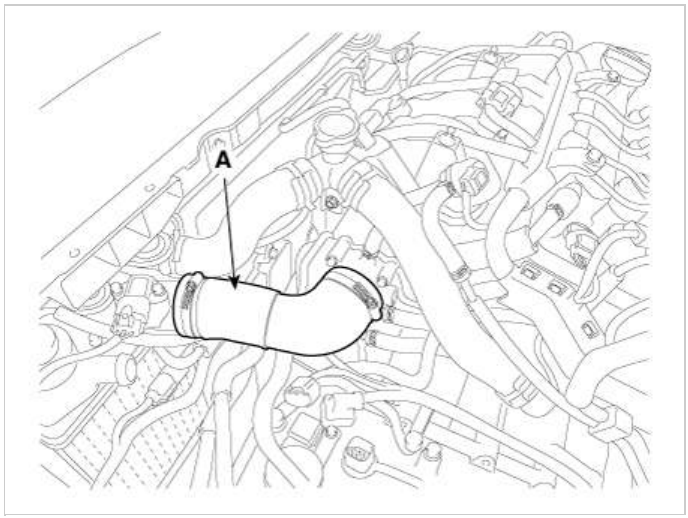
When installing, replace with a new gasket.
If the oil feed pipe and hose is damaged, the turbocharger could be damaged because turbocharger oil supply is not good. Be careful to not crush.

Engine Mechanical System

Removal and Installation

1. Disconnect the battery negative (-) terminal.
2. Remove the air duct and air cleaner assembly.
   (Refer to Intake and Exhaust System - "Air Cleaner")
3. Remove the intercooler outlet hose (A).

Tightening torque:
4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)



4. Remove the intercooler inlet hose & pipe (A).

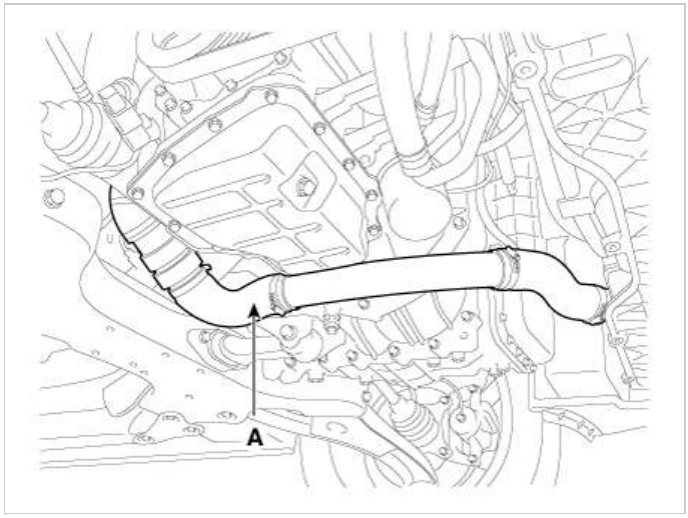
Tightening torque

Bolt :

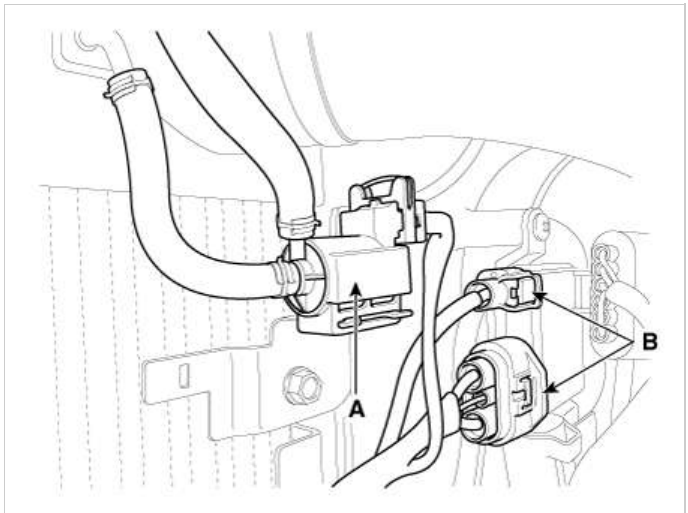
19.6 - 26.4 N·m (2.0 - 2.7 kgf·m, 14.4 - 19.5 lb·ft)

Clamp :

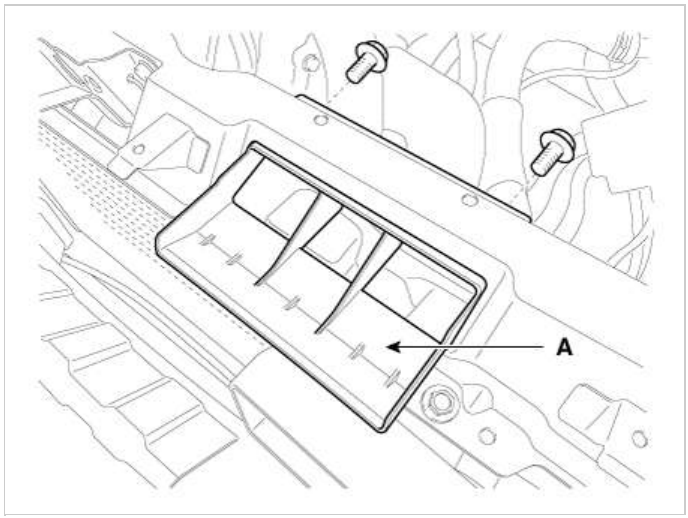
4.9 - 6.8 N·m (0.5 - 0.7 kgf·m, 3.6 - 5.0 lb·ft)



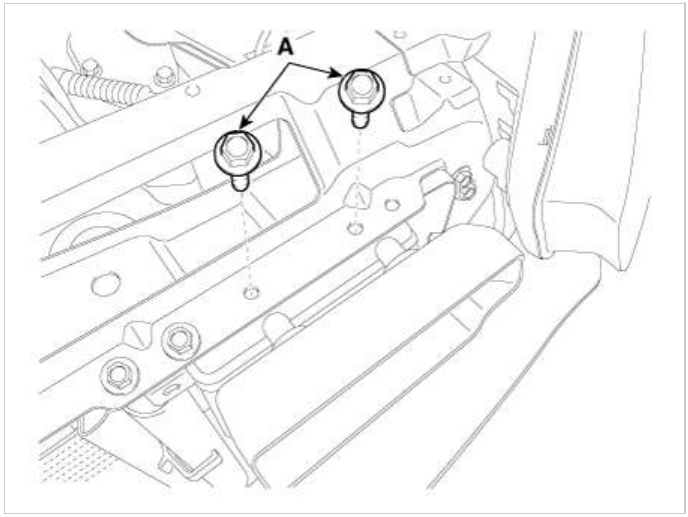
5. Disconnect the boost pressure sensor connector, RCV solenoid valve connector (A) and cooling fan controller connector (B).



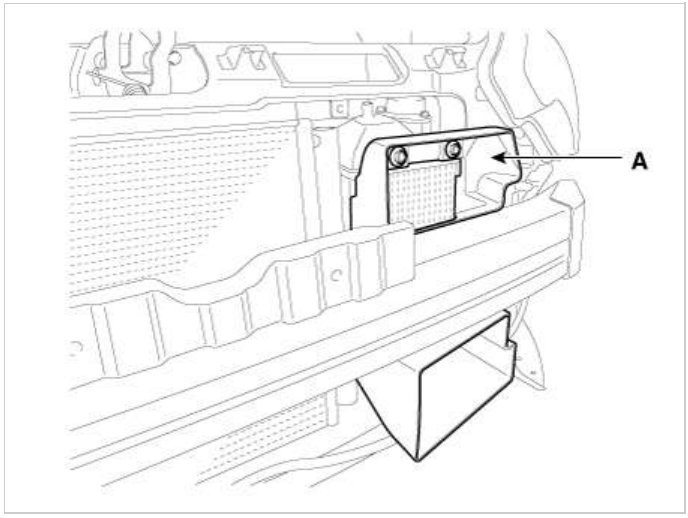
6. Remove the front bumper.
   (Refer to Body (Interior And Exterior) - "Front Bumper")
7. Remove the intake shield (A).



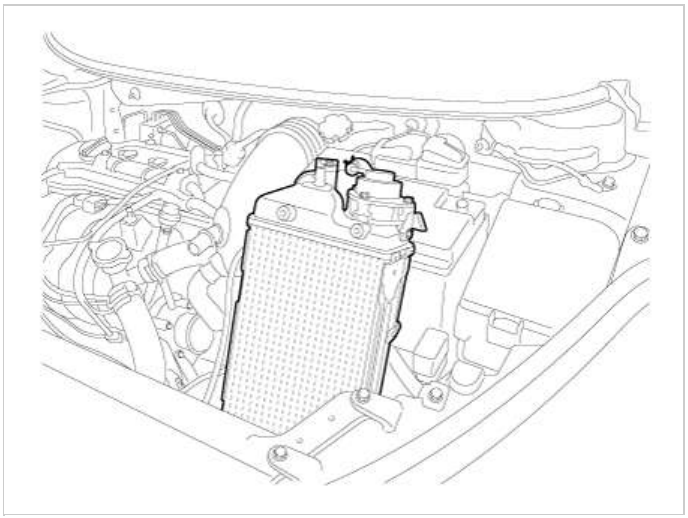
8. Remove the intercooler upper mounting bolts (A) and then remove the intercooler upper mounting bracket.



9. Remove the air guide (A).



10. Remove the intercooler.



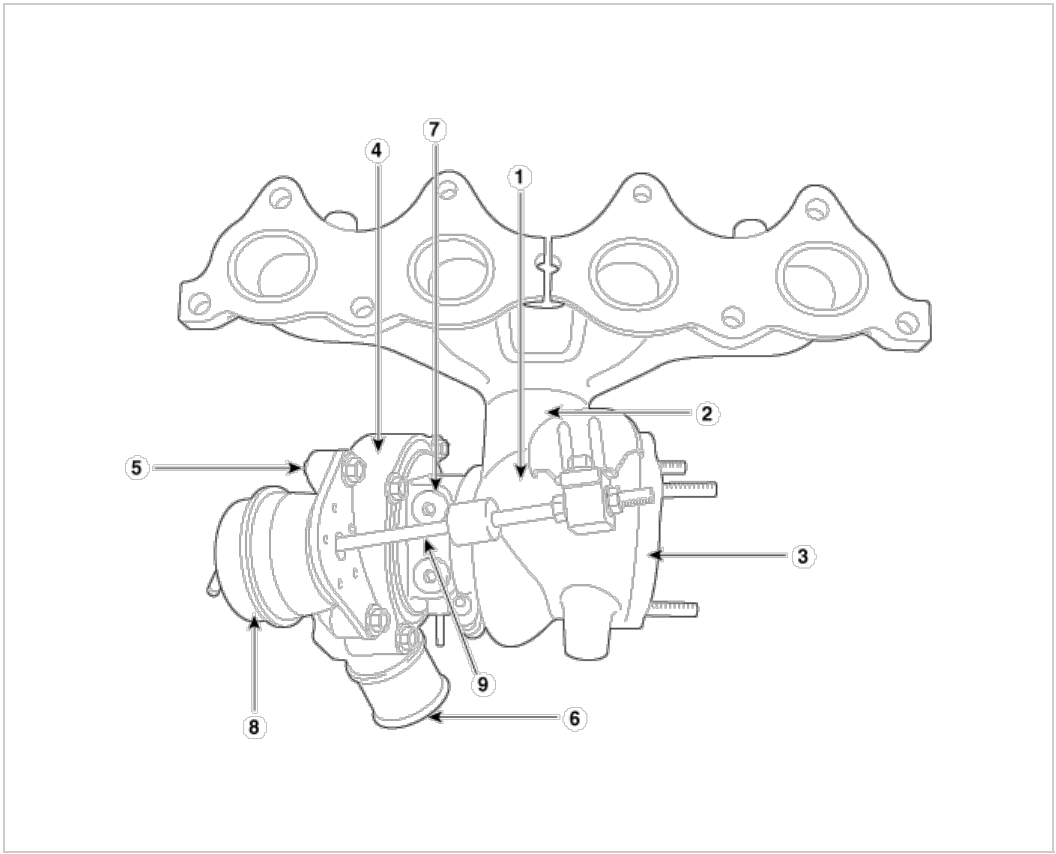
11. Install in the reverse order of removal.

NOTICE

- Match the marking part of hose and marking part of throttle body, compressor.
- Match the pipe stopper and hose marking.
- When the band part is placed on the position mark of hose, install not to exceed the mark.
- Tighten until the torque control cap is released. If there is no torque control cap, tighten as specified torque.

Engine Mechanical System

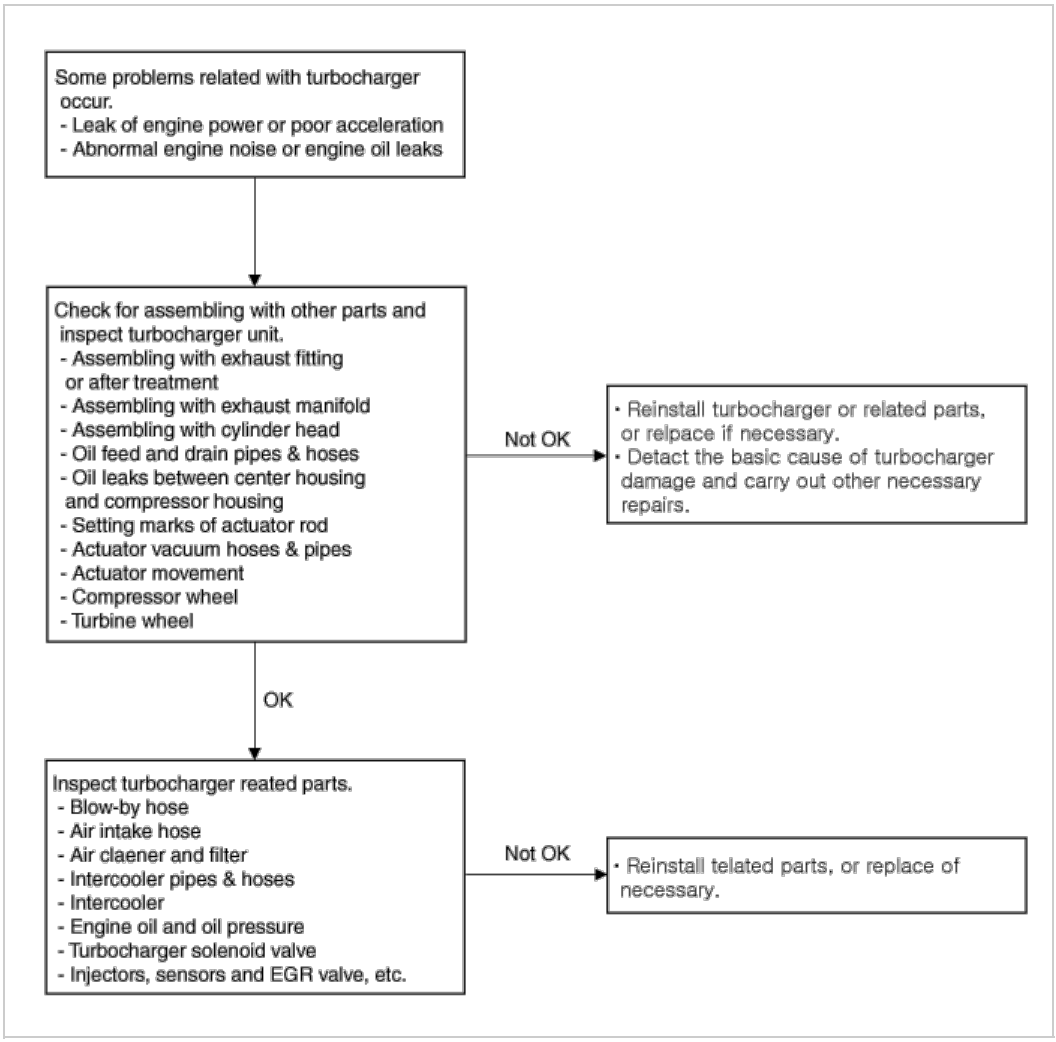
Components



1. Turbine housing
2. Turbine inlet
3. Turbine outlet
4. Compressor housing
5. Compressor inlet
6. Compressor outlet
7. Center housing
8. Actuator
9. Actuator rod

On-vehicle Inspection

Turbocharger Diagnostic Flow



If any problem related with turbocharger, such as lack of engine power, poor acceleration, abnormal engine noise or oil leaks, may occur, check the turbocharger according to the procedure as follows.

1. Check for assembling of the turbocharger and the exhaust fitting (or the after treatment).
   – Check if a gasket is installed.
   – Check if mounting bolts (or nuts) are tightened properly.
   – Check if there is a gas leak.
   – Check if there is any damage, such as crack, on the parts.

   If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise.
   If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.
2. Check for assembling of the turbocharger and the exhaust manifold.
   – Check if a gasket is installed.
   – Check if the mounting bolts (or nuts) are tightened properly.
   – Check if there is a gas leak.
   – Check if there is any damage, such as crack, on the parts.

   If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise.
   If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.
3. Check for assembling of the exhaust manifold and the cylinder head.
   – Check if a gasket is installed.
   – Check if the mounting bolts (or nuts) are tightened properly.
   – Check if there is a gas leak.

   If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise.
   If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or install a new gasket if necessary.
4. Check the turbocharger oil feed pipe & hose and oil drain pipe & hose.
   – Check if a gasket is installed.

– Check if the mounting bolts are tightened properly.

– Check if the clamps are positioned in place.

– Check if the oil pipes & hoses are damaged (bent, crushed, torn or cracked).

If a gas leak occur as a gasket was not installed or mounting bolts were tightened inadequately, it may cause oil leaks.

If the oil feed pipe & hose is damaged, engine oil is not supplied sufficiently to the turbocharger then it may damage the turbocharger. If the oil drain pipe & hose is damaged and clogged, engine oil is not drained smoothly then it may cause oil leaks from the turbocharger.

If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.

5. Check for oil leaks between center housing and compressor housing.

– Check if the mounting bolts are tightened properly.

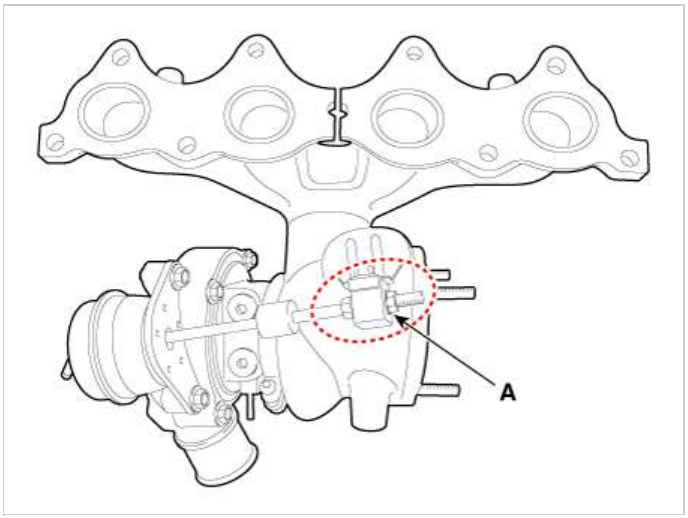
– Check if there is an oil leak.

If the O-ring (gasket) between the center housing and the compressor housing is damaged, it may cause oil leaks.

If an oil leak is detected, replace the turbocharger with a new one.

6. Check the setting marks of the turbocharger actuator rod.

– Check if the actuator rod setting mark (A) is aligned in line.



If the setting marks are not aligned in line, the engine performance is changed by an arbitrary tune-up of the turbocharger after delivery.

If the setting marks are not aligned in line, replace the turbocharger with a new one.

7. Check the turbocharger actuator vacuum hoses & pipes.

– Check if the vacuum hose is connected to the actuator properly.

– Check if the vacuum hoses & pipes are damaged (bent, detached or torn).

– Check if there is any damage, such as crack, on the vacuum pipes.

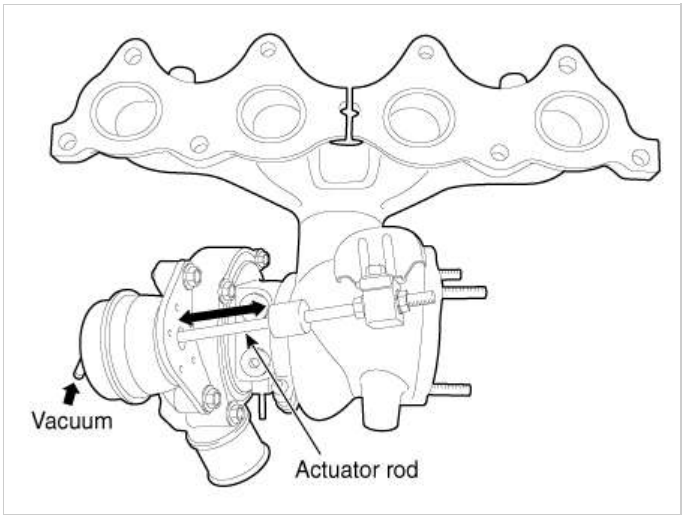
– Check if the vacuum hoses are connected to inlet or outlet of the solenoid valve correctly.

If the vacuum pipes & hoses are damaged or disconnected, the actuator does not work properly then it may cause lack of engine power and poor acceleration.

If the vacuum hoses & pipes are damaged, replace them with new ones.

8. Check the turbocharger actuator.

– Vacuum type actuator : Check for movement of the actuator rod when a vacuum of 62.6kPa (470mmHg, 9.08psi) is applied to the actuator.



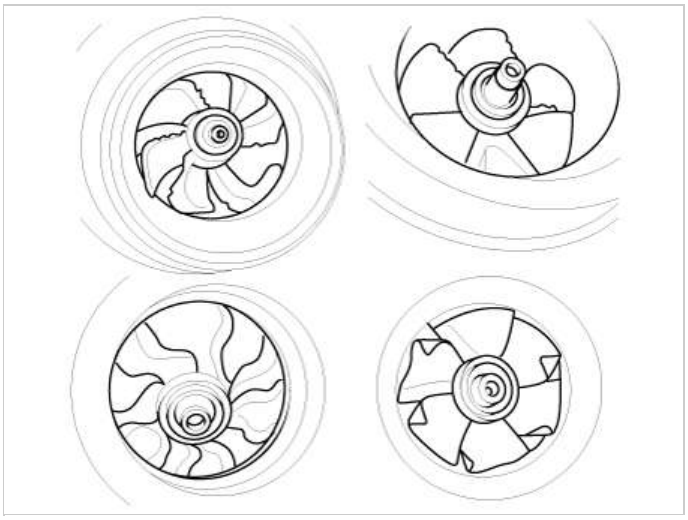
If the turbocharger actuator is damaged, it may cause lack of engine power and poor acceleration.

If the actuator rod does not move, replace the turbocharger with a new one.

9. Check the turbocharger compressor wheel.

– Check if the compressor wheel is damaged (bent or deformed).
– Check if the compressor wheel rotates smoothly.

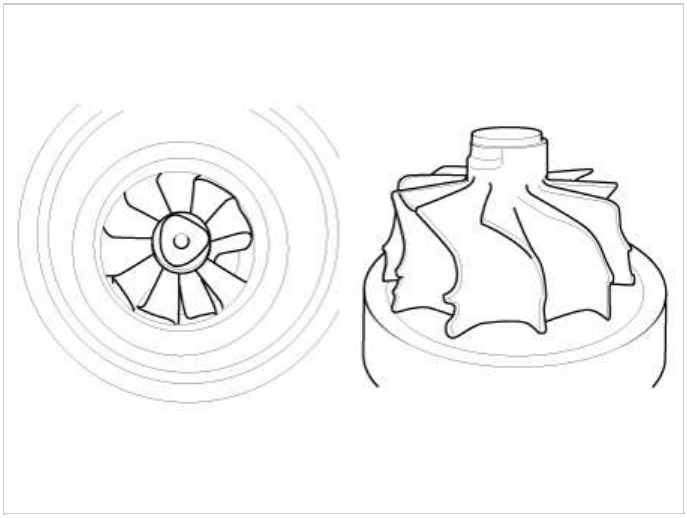
EX)



If the compressor wheel are damaged, it may cause abnormal noise from the turbocharger and poor acceleration.
If the compressor wheel are damaged or deformed, replace the turbocharger with new ones.

10. Check the turbocharger turbine wheel.
    – Check if the turbine wheel is damaged.
    – Check if the turbine wheel rotates smoothly.

    EX)



If the turbine wheel are damaged, it may cause abnormal noise from the turbocharger and poor acceleration.
If the turbine wheel are damaged or deformed, replace the turbocharger with new ones.

If any problem is not detected in the turbocharger, check the turbocharger-related parts according to the procedure as follows.

1. Check the blow-by hose.
   – Check if the breather hose is damaged (bent, clogged).
   – Check if the positive crankcase ventilation (PCV) valve is clogged.

   If the breather hose is bent or clogged, the internal pressure in the engine increases then engine oil is not supplied smoothly to the turbocharger. So it may cause damage of the turbocharger and oil leaks.
   If the cause of the problem is detected, replace the breather hose or the related parts with new ones.
2. Check the air intake hose connected to the turbocharger.
   – Check if the air intake hose is damaged (bent, crushed, detached or torn).

   If a cross-section of the hose diminishes as the air intake hose is bent or crushed, intake air to the turbocharger reduces and the pressure in front of turbocharger drops. So it may cause damage of the turbocharger and oil leaks. If the air intake hose is detached or torn, a foreign substance goes into the turbocharger and causes damage of it.
   If the air intake hose is damaged, replace it with a new one.
3. Check the air cleaner.
   – Check the air cleaner filter for pollution state.
   – Check the air cleaner filter for water influx.
   – Check the air cleaner cover for dirtiness.
   – Check if the air cleaner filter is a genuine part..

If the air cleaner filter is moistened or polluted excessively or a non-genuine part is used, intake air to the turbocharger reduces and the pressure in front of turbocharger drops. So it may cause damage of the turbocharger and oil leaks. .

If the air cleaner filter is moistened or polluted excessively, replace it with a new one.

> **NOTICE**
> Replace the air cleaner filter according to the maintenance schedule.

4. Check the intercooler hoses & pipes.
   – Check if the intercooler hoses & pipes are connected properly.
   – Check if the intercooler hoses & pipes are damaged (bent, detached or torn).
   – Check if there is any damage, such as crack, on the intercooler pipes.
   – Check if the clamps are positioned in place.

   If the intercooler hoses & pipes are damaged or disconnected, oil leaks may occur from the hoses & pipes and the turbocharger may exceed the permissible speed then it may cause damage of the turbocharger.

   If the intercooler hoses & pipes are damaged, replace them with new ones.

   > **NOTICE**
   > Use new clamps when replacing the hoses & pipes.

5. Check the intercooler.
   – Check if the intercooler tubes and tanks are damaged (oil leak or crack).

   If the intercooler is damaged, the turbocharger may exceed the permissible speed then it may cause damage of the turbocharger.

   If the intercooler is damaged, replace them with a new one.

   > **NOTICE**
   > Use new clamps when replacing the intercooler.

6. Check the engine oil.
   – Check the engine oil level.
   – Check the engine oil for discoloration, water influx and viscosity degradation.
   – Check the engine oil grade.

   If the engine oil level is low, amount of engine oil fed to turbocharger reduces then the bearings in the turbocharger may adhere due to insufficient lubrication and cooling.

   If the cause of the problem is detected, add or change engine oil.

   > **NOTICE**
   > Change the engine oil according to the maintenance schedule.

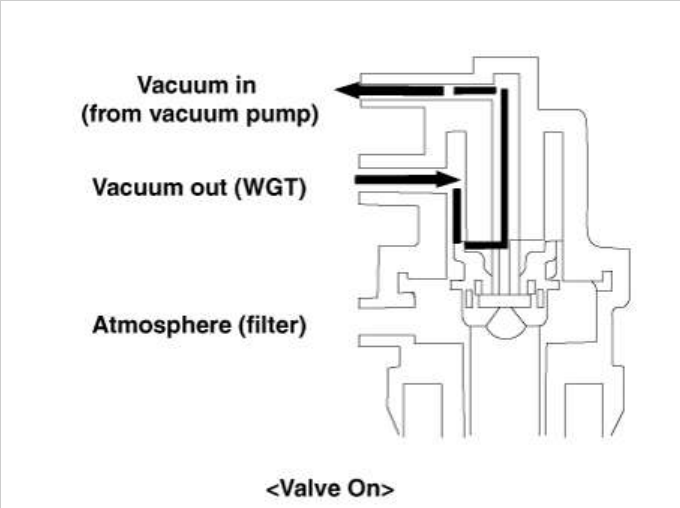
7. Check the engine oil pressure.
   – Engine oil pressure: Check the oil pressure using an oil pressure gauge after removing the oil pressure switch on the cylinder block.
   – Check the engine oil screen in the oil pan if the engine oil level is low. Then check the injectors for gas leaks if foreign substances are accumulated on the oil screen.

   If the engine oil level is low, amount of engine oil fed to turbocharger reduces then the bearings in the turbocharger may adhere due to insufficient lubrication and cooling.

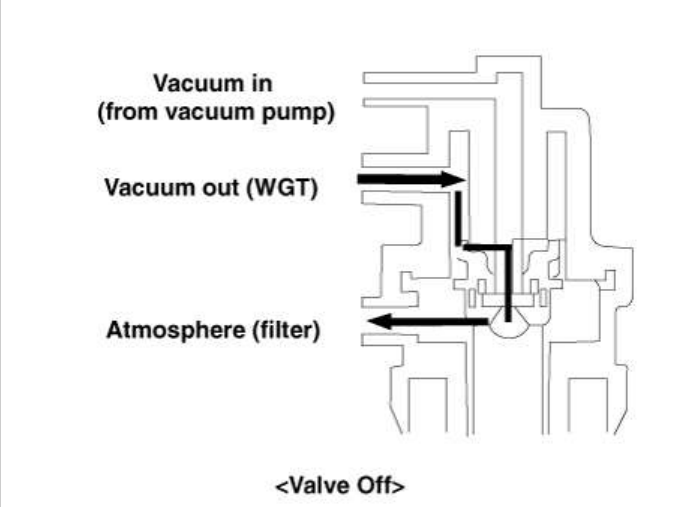
   If the cause of the problem is detected, add or change engine oil. If foreign substances are accumulated on the oil screen, wash the oil screen and replace the injector's washer with a new one after checking the injectors for gas leaks. Check the engine oil-related parts, such as oil pump, if necessary.

   > **NOTICE**
   > As the turbocharger rotates at high speed of 100,000 rpm or above, deterioration of engine oil can cause damage of the turbocharger bearings. Check engine oil for discoloration, water influx, viscosity degradation and oil pressure lowering.

8. Check the solenoid valve of turbocharger. (Refer to DTC guide)
   – Damage of the solenoid valve: Check if vacuum is generated at the disconnected vacuum hose from the actuator when a forced actuator operating mode is performed by GDS..
   – Clog of the solenoid valve filter: Check if vacuum is released when a forced actuator operating mode is performed from max. duty (95%) to min. duty (5%) by GDS. (If the solenoid valve filter is clogged, the vacuum won't be released or it will take a long time to be released.)



<Valve On>



<Valve Off>

If the solenoid valve is damaged, the actuator does not work properly then it may cause lack of engine power and poor acceleration. If the solenoid valve filter is clogged, vacuum is not released then it may cause damage of the turbocharger by overrunning.

If the solenoid valve is damaged, replace it with a new one.

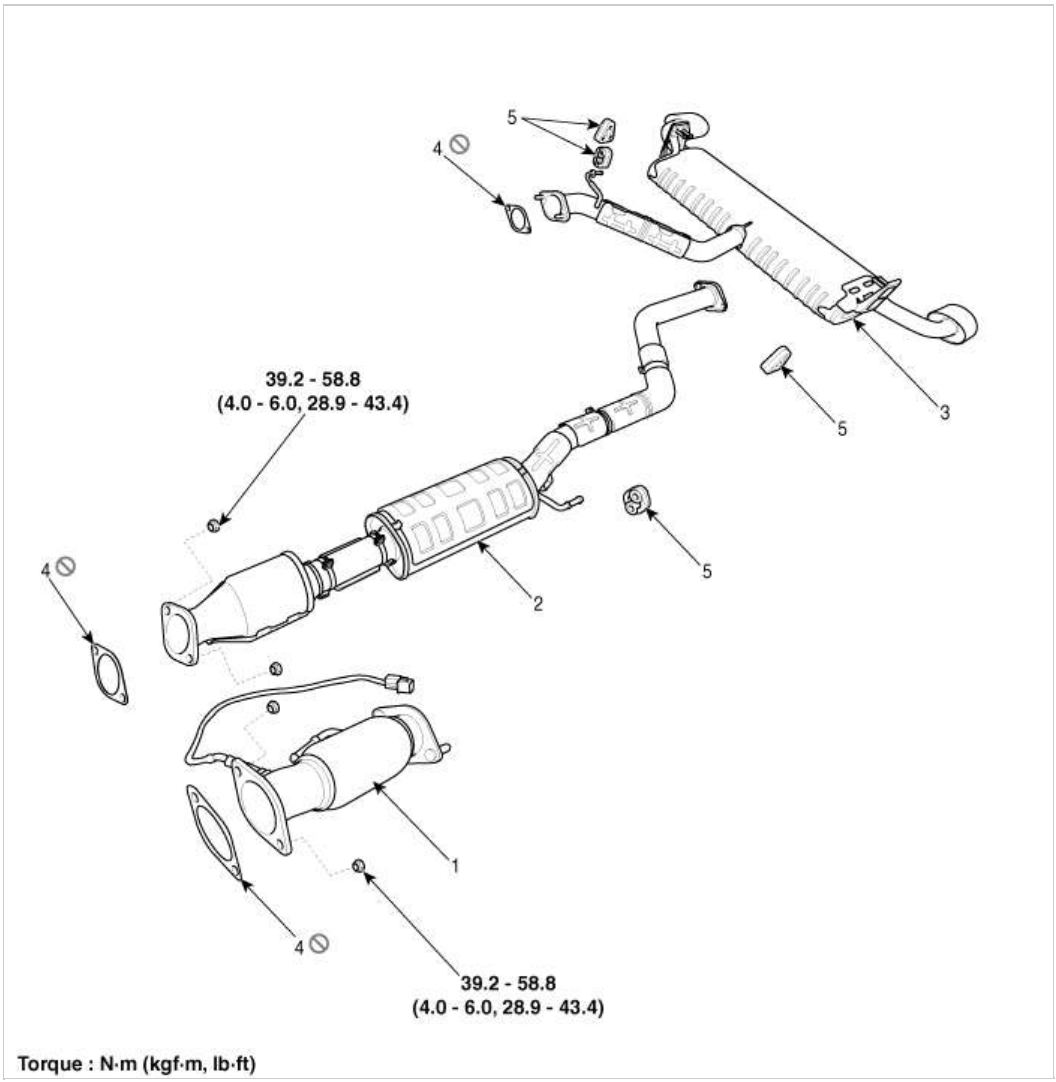
9. Check the injectors, sensors, EGR valve, etc. (Refer to FL group)
   - Check if the injectors operate properly.
   - Check if the sensors, such as the mass air flow sensor (MAFS), intake air temperature sensor (IATS), boost pressure sensor (BPS), operate properly.
   - Check if the exhaust gas recirculation (EGR) valve operates properly.

   If the injectors, sensors, EGR valve and etc. don't work properly, it may cause lack of engine power.

   If the cause of the problem is detected, replace the related parts with new ones.

Engine Mechanical System

Components



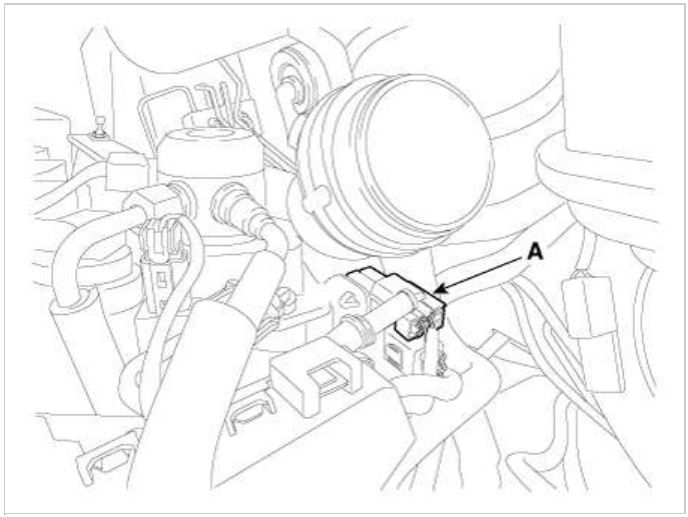
Torque : N·m (kgf·m, lb·ft)

1. Front muffler
2. Catalytic converter & Center muffler assembly
3. Main muffler
4. Gasket
5. Hanger

Engine Mechanical System

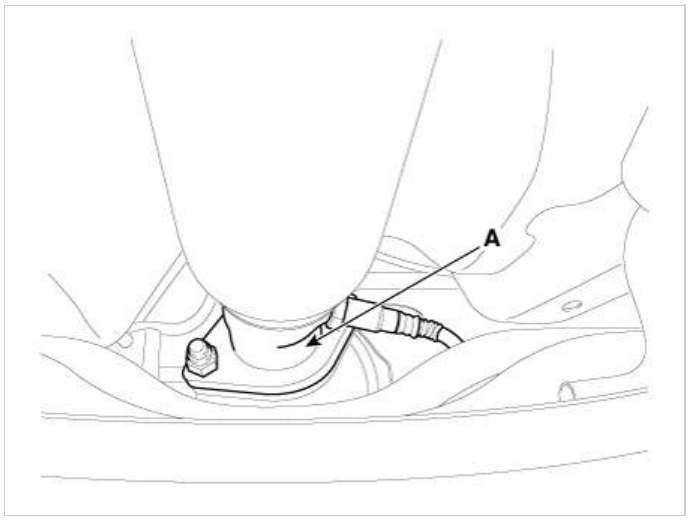
Removal and Installation

1. Disconnect the battery negative terminal.
2. Disconnect the rear oxygen sensor connector (A).



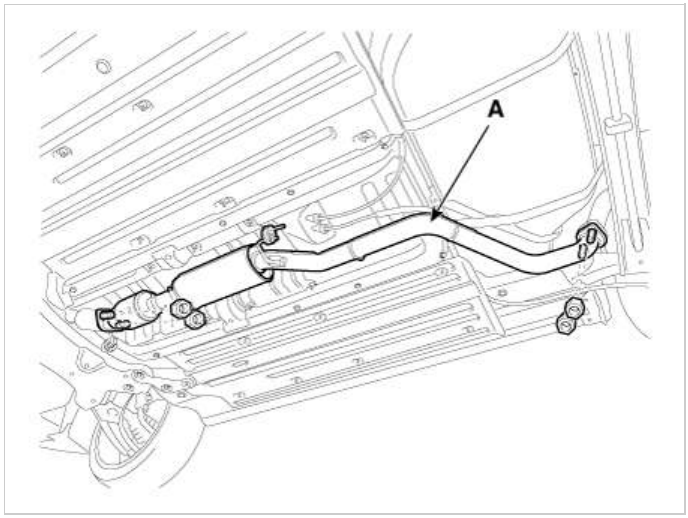
3. Remove the rear oxygen sensor.
   (Refer to Engine Control / Fuel System - "Oxygen Sensor")
4. Remove the front muffler (A).

Tightening torque:
39.2 - 58.8 N·m (4.0 - 6.0 kgf·m, 28.9 - 43.4 lb·ft)



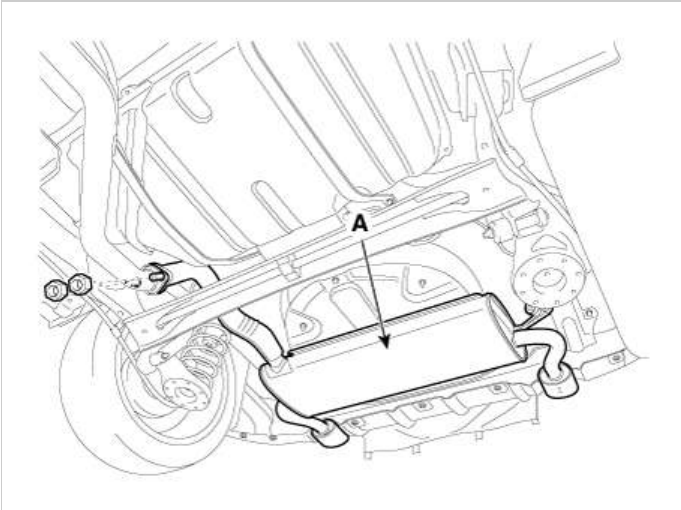
5. Remove the center muffler (A).

Tightening torque :
39.2 - 58.8 N·m (4.0 - 6.0 kgf·m, 28.9 - 43.4 lb·ft)



6. Remove the main muffler (A).

Tightening torque :
39.2 - 58.8 N·m (4.0 - 6.0 kgf·m, 28.9 - 43.4 lb·ft)



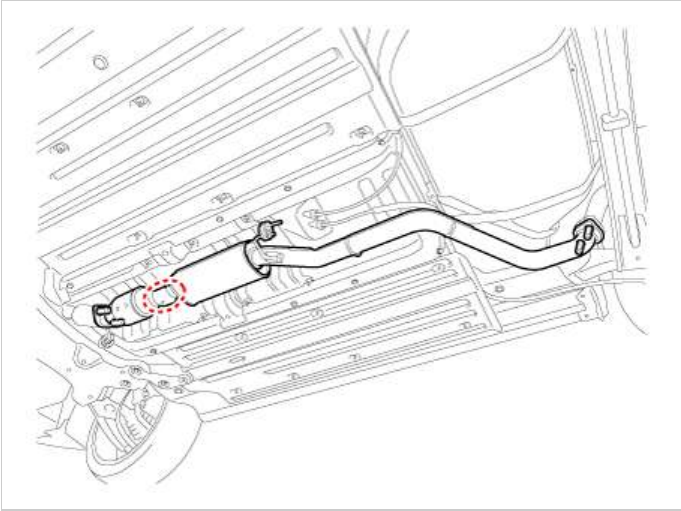
7. Install in the reverse order of removal.

> **NOTICE**
> When installing, replace with new gaskets.

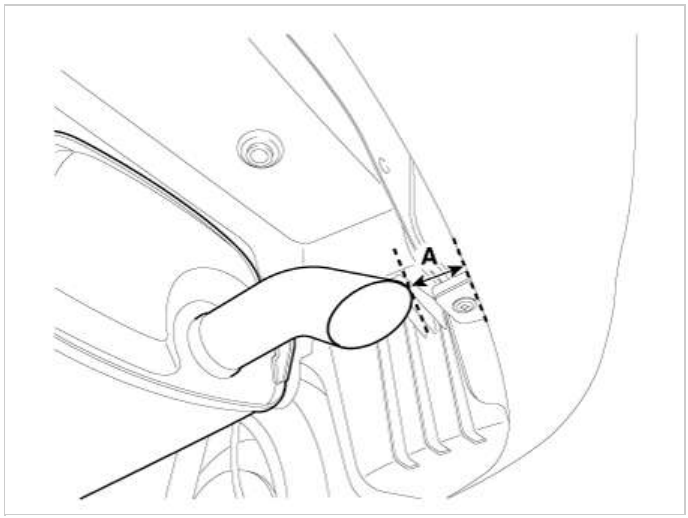
Replacement procedure of center muffler using clamp

Under warranty : Replace the center muffler assembly.
Out of warranty : It is available to replace the center muffler as the procedure below.

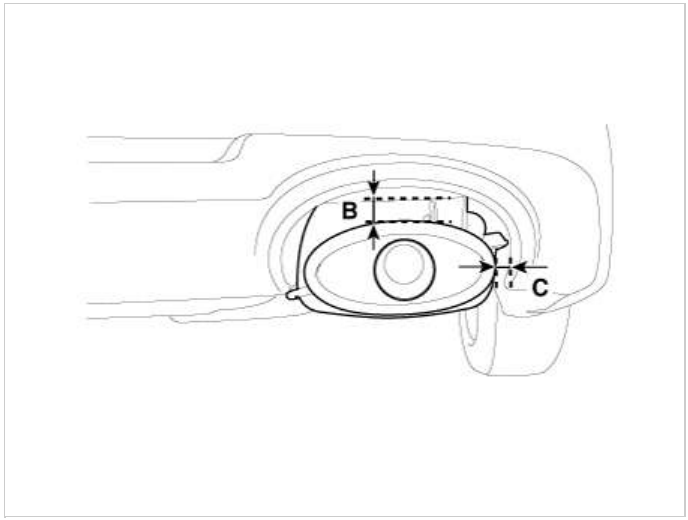
1. Check that the clamping part of the center muffler assembly is damaged or deformed.
   If the muffler is too corroded to clamp, replace the center muffler assembly.



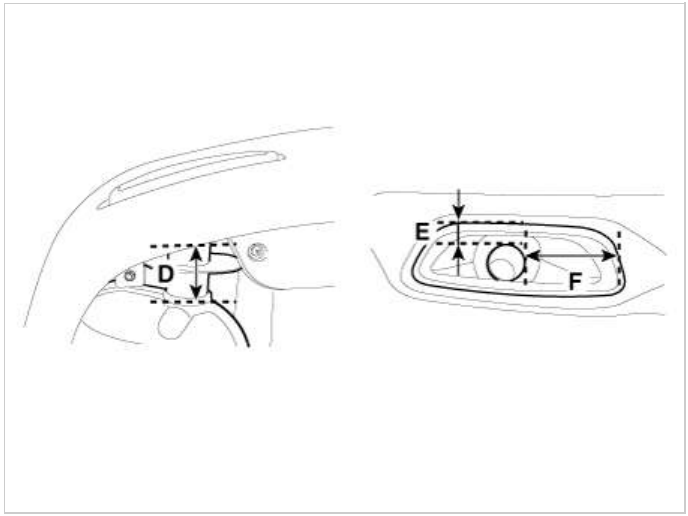
2. Record the gap (A, B, C, D, E, F) between the tail pipe (or tail trim) and the rear bumper.
   [Pipe type]



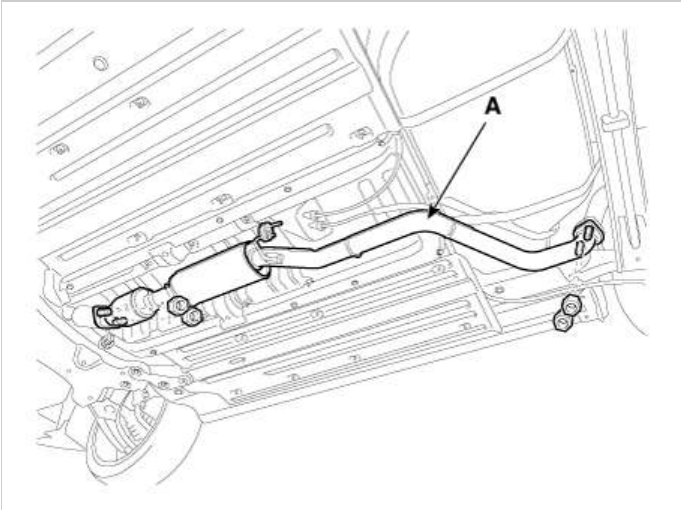
[Trim type]



[Bumper-integrated trim type]



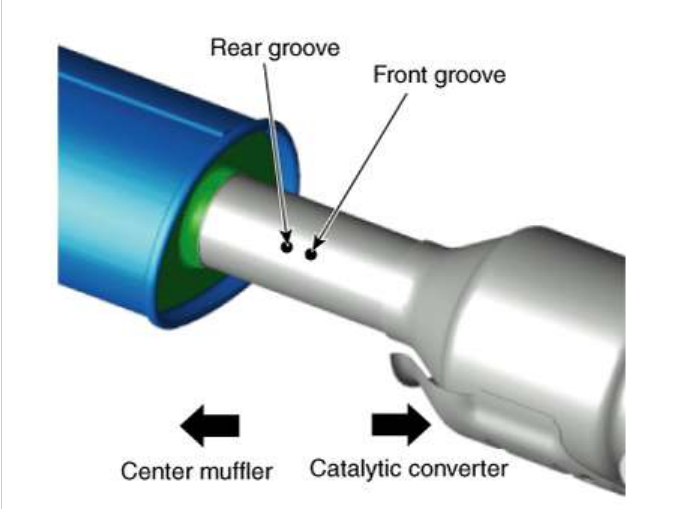
3. Remove the catalytic converter & center muffler (A).



4. Cut the center muffler as the instruction below.

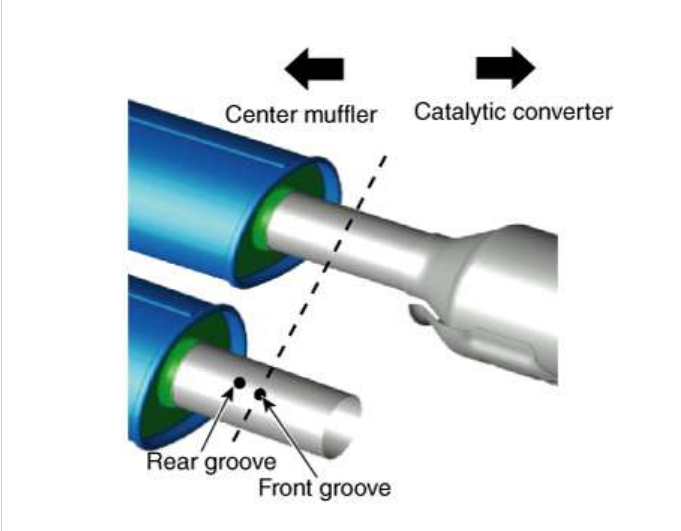
[With groove]

– Cut the front groove of the muffler.



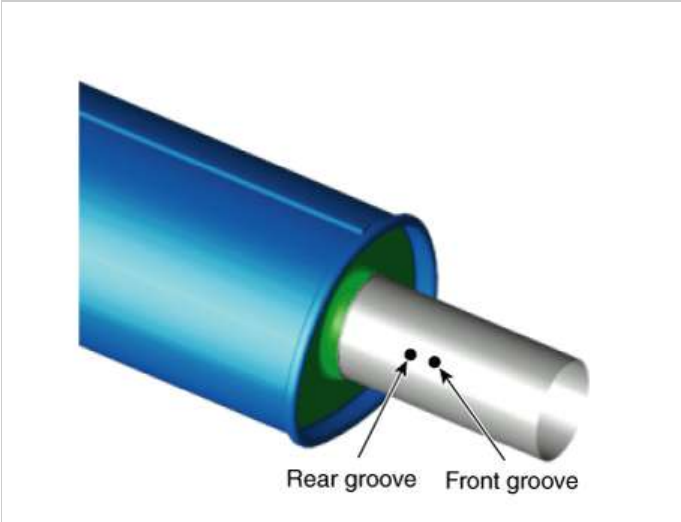
[Without groove]

– Cut the muffler by reffering to the front groove of replacement muffler as shown in the image below.



[Replacement muffler]

– Cut the rear groove of the replacement muffler.



NOTICE

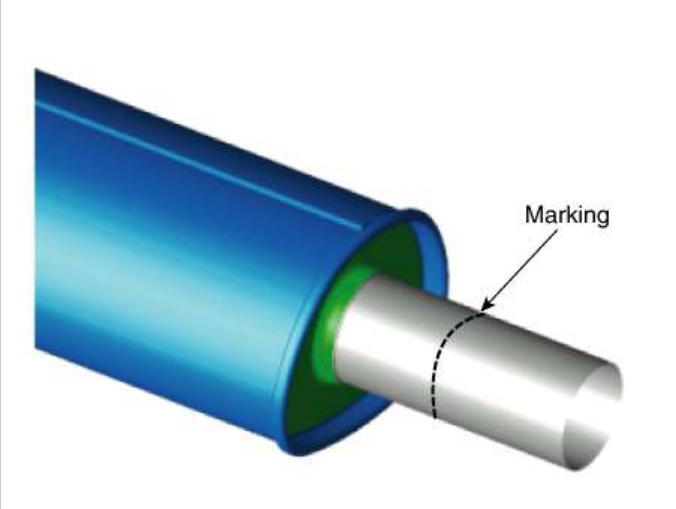
- To prevent a leak, remove the rust on the clamping part or the burr on the cutting part.
- Cut the pipe vertically.

Information

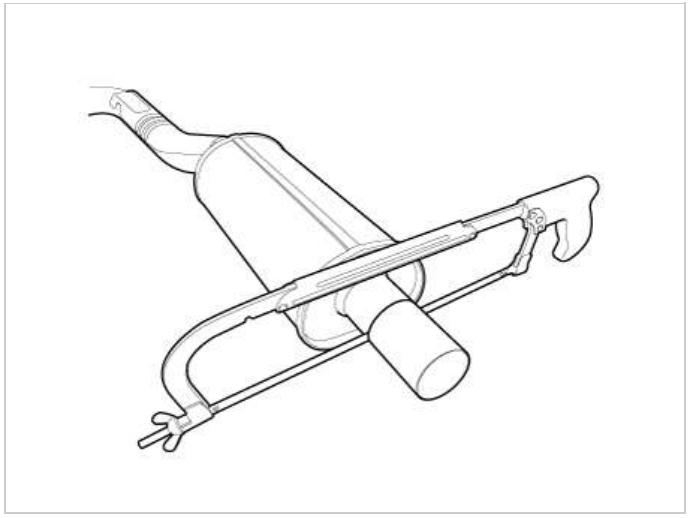
- Pipe cutter available to cut the pipe vertically .

- Use a hacksaw as the procedure below, if a pipe cutter is unavailable.

1) Mark the cutting position to cut the pipe vertically.

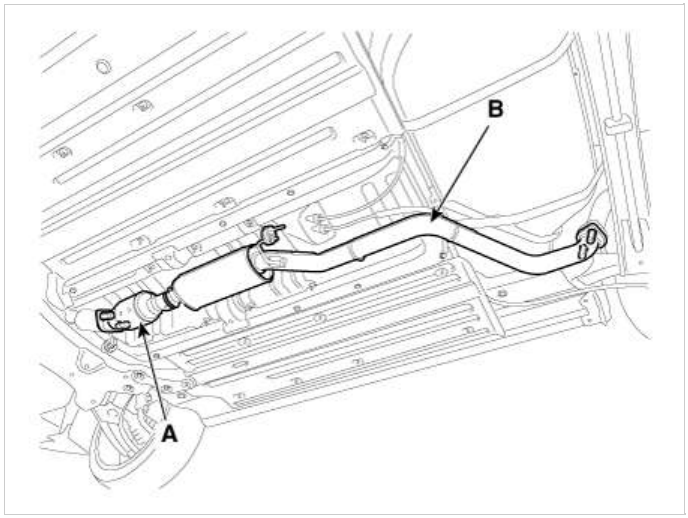


2) Cut the pipe along the marking line by using hacksaw.



5. Install the center muffler.

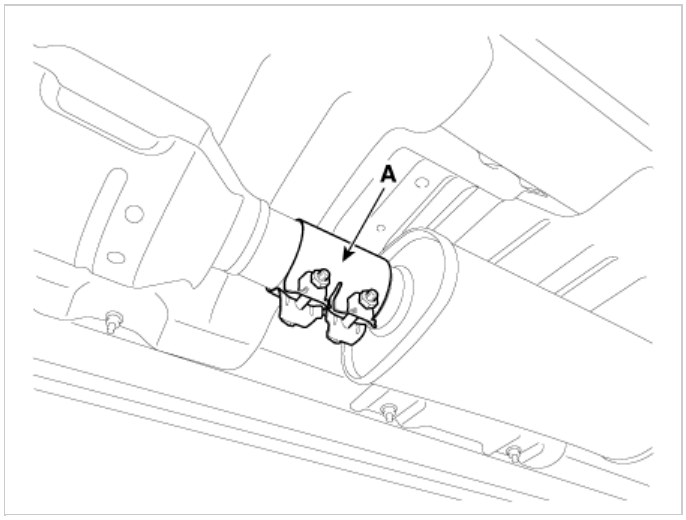
(1) Install the catalytic converter (A) and the center muffler (B) for replacement by tightening the nuts lightly, not completely.



NOTICE

When installing the muffler, replace the gasket with new one.

(2) Put the clamp (A) between the cutting part of each pipe and tighten the clamp lightly, not completely.



(3) Tighten the catalytic converter and the center muffler with specified torque.