

# VELOSTER(FS) > 2013 > G 1.6 T-GDI > Engine Mechanical System

## Engine Mechanical System > General Information > Specifications

### Specifications

Description		Specifications	Limit
		Except Europe	
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 8°/BTDC 42°	
	Closes	ABDC 69°/ABDC 19°	
Exhaust valve	Opens	BBDC 40°/BBDC 0°	
	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	44.15mm (1.7382in)	
	Exhaust	42.90mm (1.6889in)	
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)
<b>Valve guide</b>			
Length	Intake	40.3 ~ 40.7mm (1.5866 ~ 1.6024in)	
	Exhaust	40.3 ~ 40.7mm (1.5866 ~ 1.6024in)	
<b>Valve spring</b>			
Free length		45.1mm (1.7756in)	
Out of squareness		Less than 1.5°	
<b>Cylinder block</b>			
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)	
<b>Piston</b>			
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)
<b>Piston ring</b>			
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 ~ 0.28mm (0.0055 ~ 0.0110in)	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)
<b>Piston pin</b>			
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)	
<b>Connecting rod</b>			
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)
<b>Crankshaft</b>			

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)
<b>Engine oil</b>			
Oil quantity	Total	4.9 L (1.29 U.S.gal., 5.17 U.S.qt., 4.30 imp.qt.)	When replacing a short engine or a block assembly
	Oil pan	4.2 L (1.10 U.S.gal., 4.43 U.S.qt., 1.10 imp.qt.)	
	Drain and refill	4.5 L (1.18 U.S.gal., 4.75 U.S.qt., 3.95 imp.qt.)	Including oil filter
Oil grade	Recommendation	ACEA A5 or above	(ZIC LD 5W-30, KIXX G1 LL, QUARTZ HKS G-310, QUARTZ INEO MC3 5W-30, HELIX ULTRA AH-E 5W-30, HELIX ULTRA 5W-40, TITAN SUPERSYN LONG LIFE 5W-30/40)
	SAE viscosity grade	5W-30, 5W-40	
Oil pressure (at 1000rpm)		100kPa (1.0kg/cm <sup>2</sup> , 14.5psi) or above	Oil temperature in oil pan : 110±2°C (230± 36°F)
<b>Cooling system</b>			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		6.1 L (1.61 U.S.gal., 6.44 U.S.qt., 5.36 imp.qt.) 5.9 L (1.55 U.S.gal., 6.23 U.S.qt., 5.18 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/cm <sup>2</sup> , 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	MAX. 6.86 kpa(0.07kgf/cm <sup>2</sup> , 1.00 psi)	
<b>Water temperature sensor</b>			
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
<b>Engine mounting</b>				
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	63.7 ~ 83.4	6.5 ~ 8.5	47.0 ~ 61.5
Engine mounting support bracket to engine support bracket fixing bolt	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Engine mounting support bracket to engine support bracket fixing nut	2	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
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
<b>Timing system</b>				
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 assembly 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	[47.0 ~ 50.9] + [38° ~ 42°]	[4.8 ~ 5.2] + [38° ~ 42°]	[34.7 ~ 37.6] + [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
<b>Cylinder head</b>				
Ignition coil bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
High pressure fuel pipe nut	2	25.5 ~ 31.4	2.6 ~ 3.2	18.8 ~ 23.1

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	18.6 ~ 22.6	1.9 ~ 2.3	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
<b>Cylinder block</b>				
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	[19.6] + [90°]	[2.0] + [90°]	[14.5] + [90°]
Flywheel bolts (M/T)	6	71.6 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Drive plate bolts (A/T)	6	71.6 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
<b>Lubrication system</b>				
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 bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
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
<b>Cooling system</b>				
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

<b>Intake and exhaust system</b>				
Air intake hose clamp bolt	2	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Air cleaner assembly 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 converter mounting nut	2	49.0 ~ 53.9	5.0 ~ 5.5	36.1 ~ 39.7
Muffler mounting nut	4	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4

## Engine Mechanical System > General Information > Repair procedures

### Compression Pressure Inspection

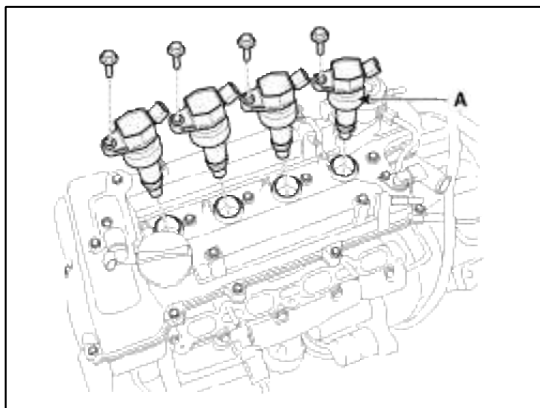
#### NOTE

If 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).

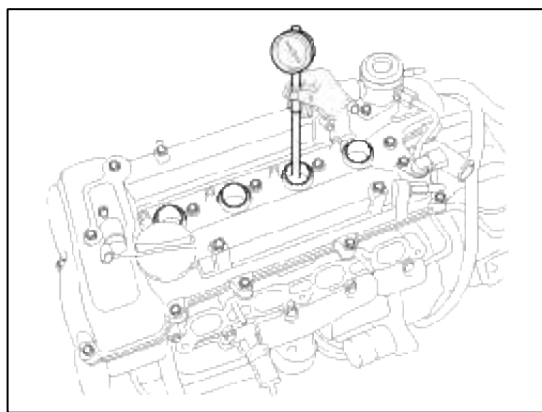


5. Remove the spark plugs.

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.

**NOTE**

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

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

**NOTE**

This measurement must be done in as short time as possible.

### Compression pressure

Standard : 1225.83kPa (12.5kg/cm<sup>2</sup>, 177.79psi) (200~250 rpm)

Minimum : 1078.73kPa (11.0kg/cm<sup>2</sup>, 156.46psi)

Difference between each cylinder :

98kPa (1.0kg/cm<sup>2</sup>, 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.

A. If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.

B. 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 :**

7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-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.

**Valve Clearance Inspection And Adjustment**

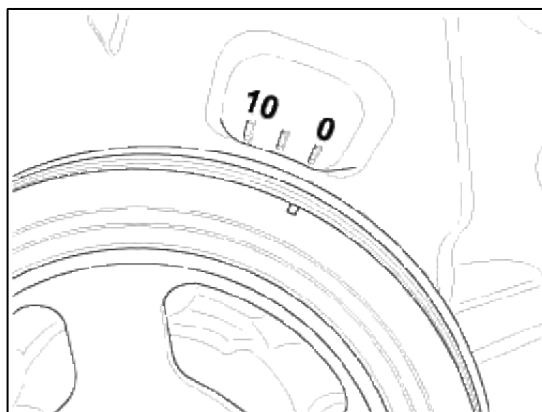
**NOTE**

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.

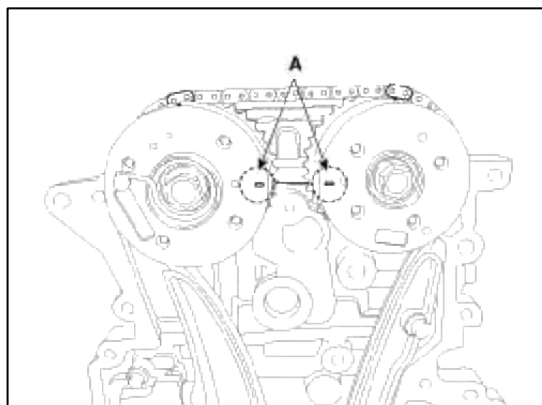
1. Remove the cylinder head cover. (Refer to Timing system)

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°).

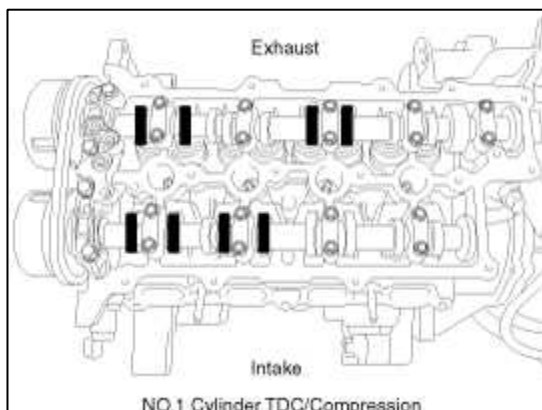




### 3. Inspect the valve clearance.

- (1) Check only the intake valves of the 1st and 2nd cylinders and exhaust valves of the 1st and 3rd cylinders for their clearance.

A. Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.



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

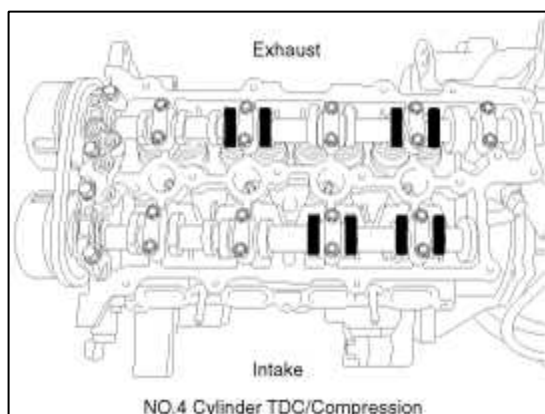
#### **Valve clearance specification (Engine coolant temperature : 20°C [68°F])**

Limit

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

Exhaust : 0.32 ~ 0.38mm (0.0125 ~ 0.0149in.)

- (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.



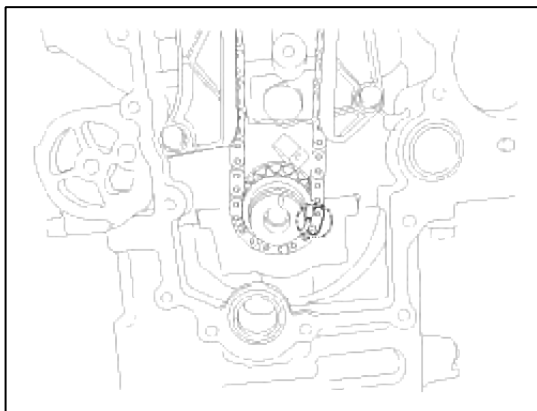
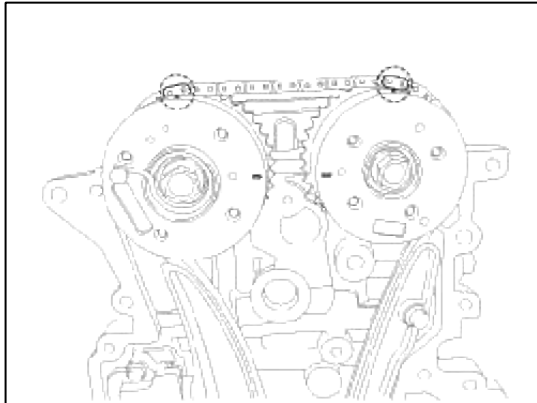
### 4. Adjust the intake and exhaust valve clearance.

- (1) Set the No.1 cylinder to the TDC/compression position.

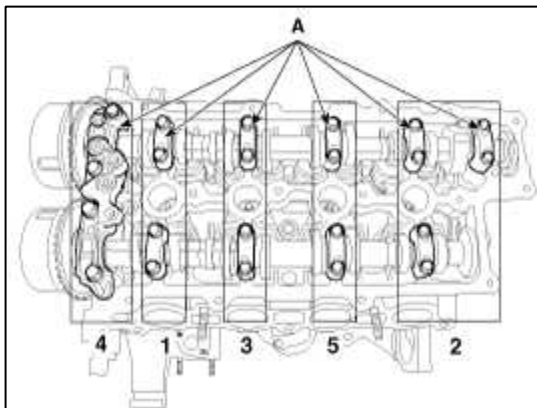
(2) Remove the timing chain. (Refer to Timing system)

**CAUTION**

Put paint marks on the timing chain links (2 places) that meet with the timing marks of the intake and exhaust CVVT sprockets.



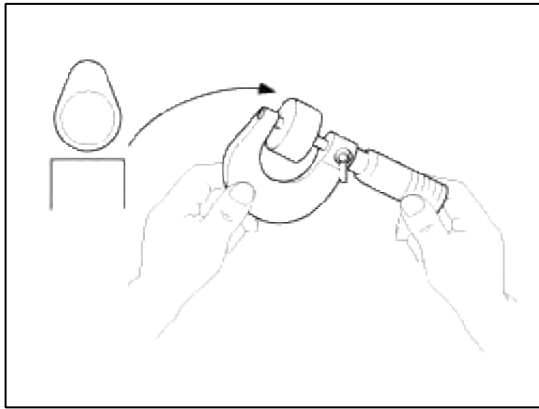
(3) Remove the camshaft bearing caps (A) with the order below.



(4) Remove the intake camshaft assembly.

(5) Remove the exhaust camshaft assembly.

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



- (7) Calculate the thickness of a new tappet so that the valve clearance comes within the specified value.

**Valve clearance (Engine coolant temperature : 20°C)**

T : Thickness of removed tappet

A : Measured valve clearance

N : Thickness of new tappet

Intake :  $N = T + [A - 0.20\text{mm}(0.0079\text{in.})]$

Exhaust :  $N = T + [A - 0.25\text{mm}(0.0098\text{in.})]$

- (8) Select a new tappet with a thickness as close as possible to the calculated value.

**NOTE**

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

- (9) Place a new tappet on the cylinder head.  
 (10) Install the exhaust camshaft assembly.  
 (11) Install the intake camshaft assembly.  
 (12) 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)

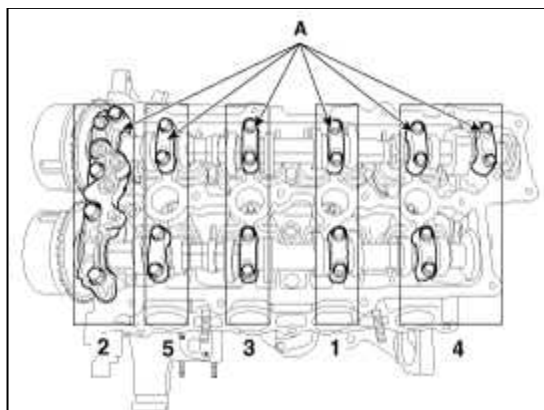
2nd step

M6 bolts :

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

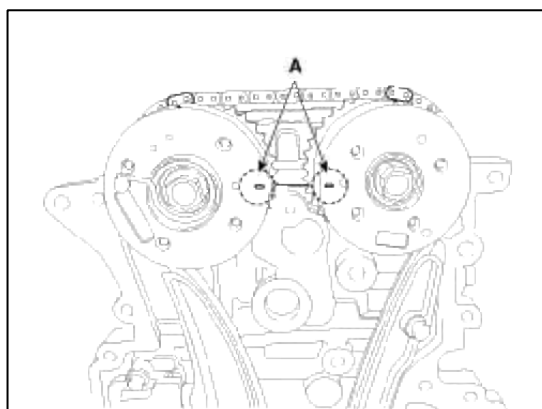
M8 bolts :

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



(13) Install the timing chain. (Refer to Timing system)

(14) 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.



(15) 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.)

## Engine Mechanical System > General Information > Troubleshooting

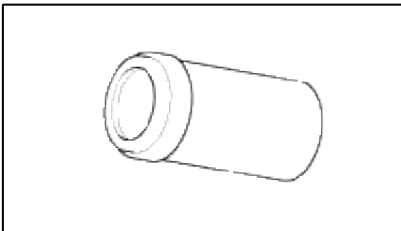
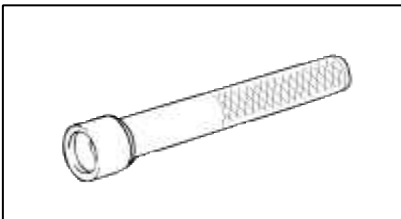
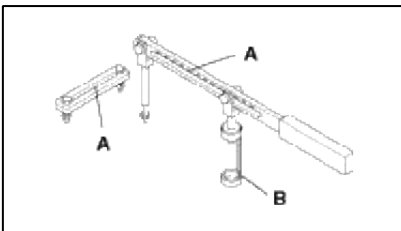
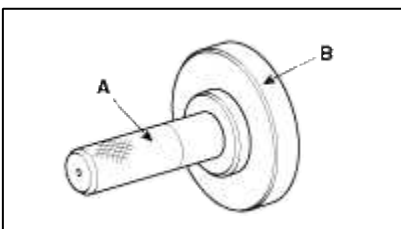
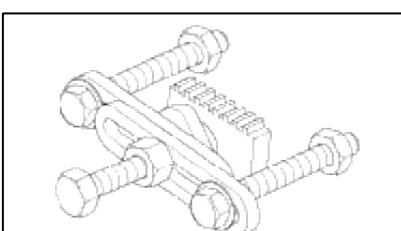

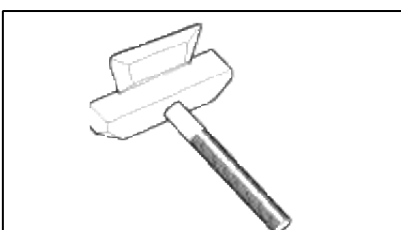
### Troubleshooting

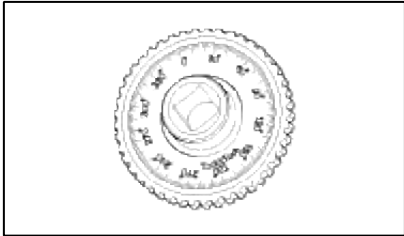

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Loose or improperly installed engine flywheel.	Repair or replace the flywheel as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression . 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.	<ul style="list-style-type: none"> <li>Faulty cylinder head gasket and/or cracking or other damage to the cylinder head and engine block cooling system.</li> <li>Coolant consumption may or may not cause the engine to overheat.</li> </ul>	<ul style="list-style-type: none"> <li>Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket.</li> <li>Repair or replace as required.</li> </ul>
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)	Inspect 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.	<p>Inspect the following components and repair as required.</p> <ul style="list-style-type: none"> <li>• The connecting rod bearings.</li> <li>• The connecting rods.</li> <li>• The crankshaft.</li> <li>• The crankshaft journal.</li> </ul>
	Excessive crankshaft bearing clearance.	<p>Inspect the following components and repair as required.</p> <ul style="list-style-type: none"> <li>• The crankshaft bearings.</li> <li>• The crankshaft journals.</li> </ul>
	Incorrect piston, piston pin and connecting rod installation.	<p>Verify the piston pins and connecting rods are installed correctly. Repair as required.</p>
Engine noise under load.	Low oil pressure.	Repair or replace as required.
	Excessive connecting rod bearing clearance.	<p>Inspect the following components and repair as required.</p> <ul style="list-style-type: none"> <li>• The connecting rod bearings.</li> <li>• The connecting rods.</li> <li>• The crankshaft.</li> </ul>
	Excessive crankshaft bearing clearance.	<p>Inspect the following components and repair as required.</p> <ul style="list-style-type: none"> <li>• The crankshaft bearings.</li> <li>• The crankshaft journals.</li> <li>• The cylinder block crankshaft bearing bore.</li> </ul>
Engine will not crank. (crankshaft will not rotate)	<p>Hydraulically locked cylinder.</p> <ul style="list-style-type: none"> <li>• Coolant/antifreeze in cylinder.</li> <li>• Oil in cylinder.</li> <li>• Fuel in cylinder.</li> </ul>	<p>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.</p>
	Broken timing chain and/or timing chain gears.	<p>Inspect timing chain and gears. Repair as required.</p>
	<p>Foreign material in cylinder.</p> <ul style="list-style-type: none"> <li>• Broken valve.</li> <li>• Piston material.</li> <li>• Foreign material.</li> </ul>	<p>Inspect cylinder for damaged components and/or foreign materials. Repair or replace as required.</p>
	Seized crankshaft or connecting rod bearings.	<p>Inspect crankshaft and connecting rod bearing. Repair or replace as required.</p>
	Bent or broken connecting rod.	<p>Inspect connecting rods. Repair or replace as required.</p>
	Broken crankshaft.	<p>Inspect crankshaft. Repair or replace as required.</p>

**Engine Mechanical System > General Information > Special Service Tools**
**Special Service Tools**

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09455-21200)		Installation of the front oil seal
Valve stem oil seal installer (09222-2B100)		Installation of the valve stem oil seal
Valve spring compressor and holder A : (09222-3K000) B : (09222-3K100)		Removal and installation of the intake or exhaust valve
Crankshaft rear oil seal installer A : (09231-H1100) B : (09231-2B200)		Installation of the crankshaft rear oil seal
Ring gear stopper (09231-2B100)		Removal and installation of crankshaft pulley bolt.
Ring gear stopper (09231-3D100)		Removal and installation of crankshaft pulley bolt.
Oil pan remover (09215-3C000)		Removal of oil pan

Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method
Oil filter wrench (09263-2E000)		Remove and installation of oil filter

### Engine Mechanical System > Engine And Transmission Assembly > Engine Cover > Repair procedures

#### Removal and Installation

1. Remove the engine cover (A).



2. Install in the reverse order of removal.

### Engine Mechanical System > Engine And Transmission Assembly > Engine Room Under Cover > Repair procedures

#### Removal and Installation

1. Loosen the mounting clip and bolt and then remove the under cover(A).

#### Tightening torque:

6.8 ~ 10.7N.m (0.7 ~ 1.1kgf.m, 5.0 ~ 7.9 lb-ft)



2. Install in the reverse order of removal.

### Engine Mechanical System > Engine And Transmission Assembly > Engine Mounting > Components and Components Location

#### Components



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

### Engine Mechanical System > Engine And Transmission Assembly > Engine Mounting > Repair procedures

#### Removal and Installation

#### Rollroad Mounting



# 1. Rollroad bracket mounting bolts and rollroad bracket(A).

## Tightening torque

Nut (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 rollroad supprt bracket(D).

## 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.

## Engine Mounting Support Bracket

### 1. Disconnect the ground cable.

## Tightening torque

Ground line bolt :

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

# 2. Install the jack to the edge of upper oil pan to support the engine.

### NOTE

Insert the rubber block between jack and oil pan.

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

## Tightening torque

Nut (B) :

63.7 ~ 83.4 N.m (6.5 ~ 8.5 kgf.m, 47.0 ~ 61.5 lb-ft)

Bolt and nuts (C) :

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



# 4. Install in the reverse order of removal.

## Engine Mechanical System > Engine And Transmission Assembly > Engine And Transmission Assembly > Repair procedures

### Removal

### CAUTION

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

**NOTE**

- 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. Disconnect the battery negative terminal.
3. Remove the air duct and air cleaner assembly.  
(Refer to Intake and Exhaust System - "Air Cleaner")
4. Disconnect the mounting bracket and then remove the battery.  
(Refer to Engine Electrical System - "Battery")
5. Disconnect the ECM connector and then remove the battery tray.  
(Refer to Engine Electrical System - "Battery")
6. Remove the battery tray.  
(Refer to Engine Electrical System - "Battery")
7. Remove the engineroom under cover.
8. Loosen the drain plug and drain the coolant. Open the radiator cap to make rapid draining.  
(Refer to Cooling System - "Coolant")
9. Remove the radiator upper hose and lower hose.  
(Refer to Cooling System - Radiator Hose")
10. Remove the intercooler inlet and outlet hose.  
(Refer to Intake and Exhaust System - "Intercooler Pipe and Hose")
11. Recover the refrigerant and then remove the high pressure pipe and low pressure pipe.  
(Refer to Heating, Ventilation Air conditioning - "Compressor")
12. Disconnect the wiring connector and cable from trasaxle.  
(Refer to Automatic Transaxle System - "Automatic Transaxle")
13. Remove the ATF cooler hose.  
(Refer to Automatic Transaxle System - "Automatic Transaxle")
14. Remove the heater hose(A) and booster vacuum hose (B).



15. Disconnect the fuel hose(A) and PCSV(Purge control solenoid valve)(B).



16. Disconnect the ground cable (A).



17. 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. 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 Position 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



18. Disconnect the (+) cable(A) from fuse box.

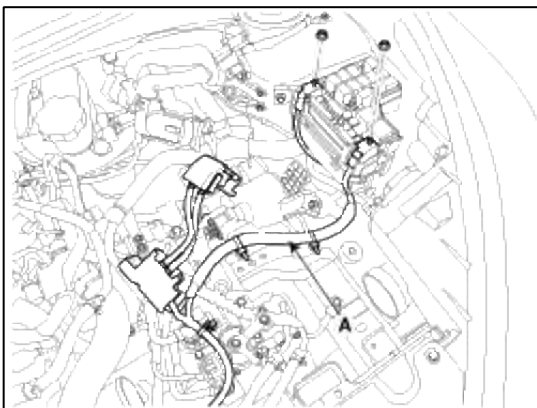
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### Tightening torque

Nut (A) :

6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)

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19. Remove the catalytic convertor.

(Refer to Intake and Exhaust System - "Muffler")

20. Remove the steering U-joint bolt.  
(Refer to Suspension System - "Steering Gear Box")
21. Remove the front tire.
22. Remove the lower arms.  
(Refer to Suspension System - "Front Lower Arm")
23. Remove the stabilizer links with the front strut assembly after loosening the nut.  
(Refer to Steering System - "Steering Gear Box")
24. Loosen the nut and then remove the tie-rod end with the front axle.  
(Refer to Steering System - "Steering Gear Box")
25. Remove the drive shaft assemble.  
(Refer to Driveshaft and axle - "Front Driveshaft")
26. Remove the roll rod bracket.  
(Refer to Engine And Transaxle Assembly - "Engine Mounting")
27. Remove the roll rod support bracket.  
(Refer to Engine And Transaxle Assembly - "Engine Mounting")
28. Support the sub frame with a floor jack and then remove the sub frame mounting bolts and nuts.  
(Refer to Suspension System - "Sub frame")

**NOTE**

- After removing the engine and transaxle mounting bolts and nuts, the engine and transaxle assembly may be fallen downward. Support them securely with floor jack.
- Verify that the hoses and connectors are disconnected before removing the engine and transaxle assembly.

29. Using a floor jack, support the engine and transaxle assembly.
30. Disconnect the ground cable, and then remove the engine support mounting bracket.  
(Engine and Transaxle Assembly - "Engine Mounting")
31. Disconnect the ground (A), and then remove the transmission mounting bracket bolts.  
(Refer to Automatic Transaxle System - "Automatic Transaxle")
32. Remove the engine and transaxle assembly(A) in the forward direction from the vehicle.

**CAUTION**

When remove the engine and transaxle assembly, be careful not to damage any surrounding 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 > Timing System > Components and Components Location

### Components



1. Timing chain	8. Water pump
2. Timing chain guide	9. Water pump pulley
3. Timing chain arm	10. Crank shaft pulley
4. Timing chain auto tensioner	11. Front oil seal
5. Timing chain cover	12. Alternator bracket
6. Drive belt idler	13. Tension adjust bolt
7. Water pump gasket	14. Drive belt

## Engine Mechanical System > Timing System > Drive Belt > Components and Components Location

### Components



1. Drive belt	
---------------------	--

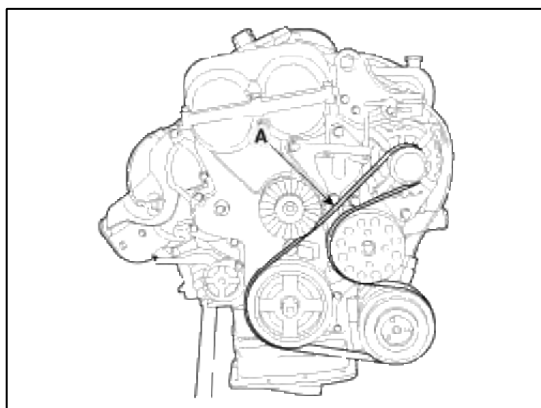
## Engine Mechanical System > Timing System > Drive Belt > Repair procedures

### Removal

1. Disconnect the battery negative terminal.
2. Loosen the alternator tension adjusting bolt (A) to loosen tension.



### 3. Remove the drive belt (A).



#### Inspection

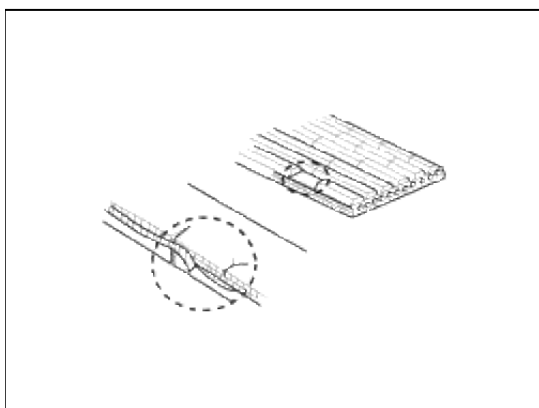
##### Drive Belt Inspection

Visually check the belt for excessive wear, frayed cords etc.

If any defect has been found, replace the drive belt.

#### NOTE

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 :

961.0 ~ 980.7 N (98.0 ~ 100.0 kgf, 216.1 ~ 220.5 lbf)

Used Belt :

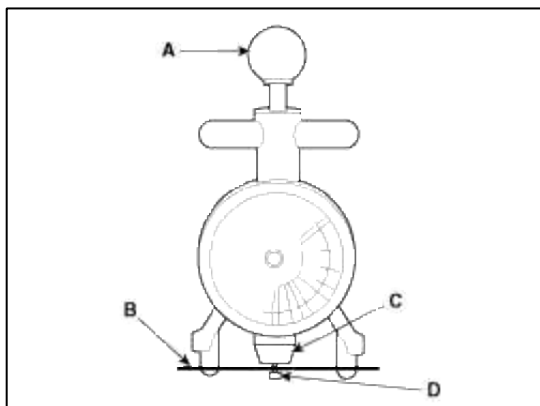
637.4 ~ 735.5 N (65.0 ~ 75.0 kgf, 143.3 ~ 165.3 lbf)

**CAUTION**

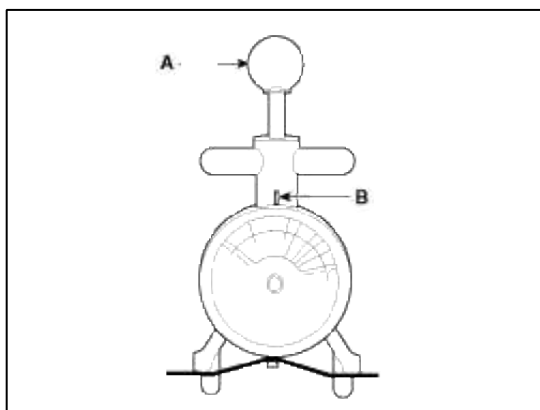
- If the engine has run for 5 minutes or more, the belt tension must be adjusted as a used belt.
- When installing the V-ribbed belt, all grooves on the pulley should be covered with belt ribs.
- A loose belt causes slip noise.
- Too tight belt cause bearing of alternator and water pump to damage.

**Using a mechanical tension gauge (BT-33-73F, BTG-2 type)**

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).

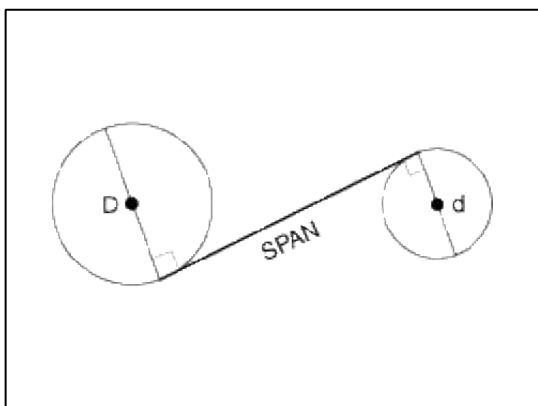
**Using a sonic tension meter (U-505/507 type)**

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

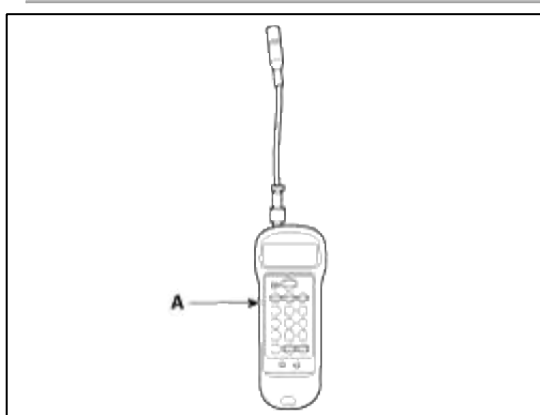
**NOTE**

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



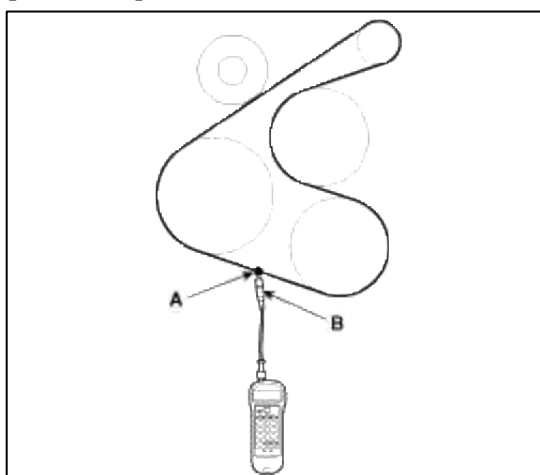
D : Idler

d : Alternator pulley



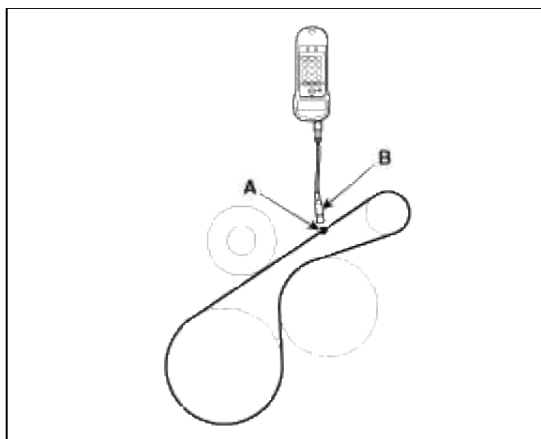
2. Locate the micro phone (B) close to the center of belt span (A) and bounce the belt by finger 2~3 times. Read a value on the display.

[With A/C]



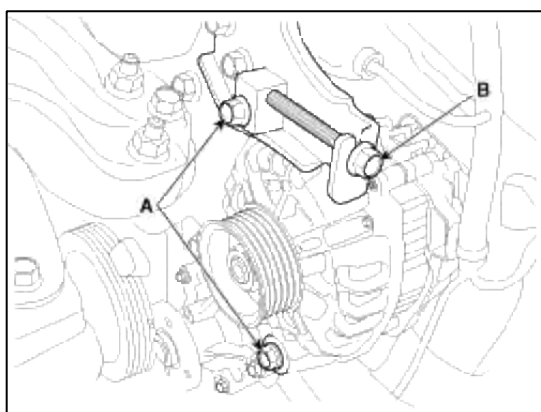
[Without A/C]





### 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 :

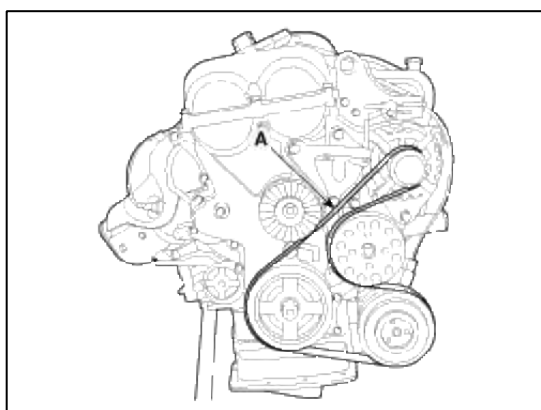
19.6 ~ 26.5 Nm (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)

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).

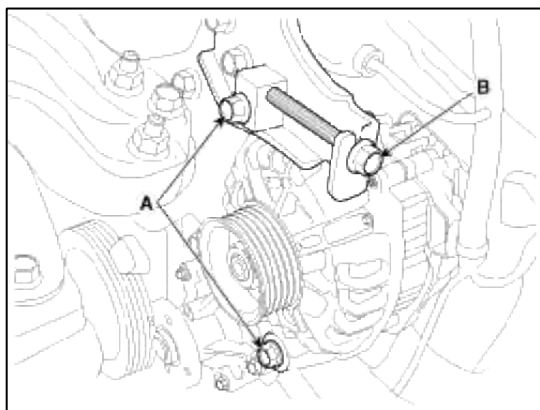
### Tightening torque

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)



3. Connect the battery negative terminal.

## Engine Mechanical System > Timing System > Idler > Components and Components Location

### Components



1.	
Idler	

## Engine Mechanical System > Timing System > Idler > Repair procedures

### 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.

## Engine Mechanical System > Timing System > Drive Belt Tensioner > Components and Components Location

### Components



1. Drive belt tensioner	
-------------------------	--

### Engine Mechanical System > Timing System > Drive Belt Tensioner > Repair procedures

#### Removal and Installation

1. Remove the drive belt.  
(Refer to Timing System - "Drive Belt")
2. Remove the alternator.  
(Refer to Engine Electrical System - "Alternator")
3. Remove the alternator bracket(belt tensioner)(A).

#### Tightening torque :

19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)



4. Install in the reverse order of removal.

### Engine Mechanical System > Timing System > Crankshaft Damper Pulley > Components and Components Location

#### Components



1. Crankshaft damper pulley	
-----------------------------	--

### Engine Mechanical System > Timing System > Crankshaft Damper Pulley > Repair procedures

#### Removal and Installation

1. Remove the drive belt.  
(Refer to Timing System - "Drive Belt")
2. Remove the engine room under cover.
3. Remove the passenger side front tire.
4. Remove the crankshaft damper pulley (A).

#### Tightening torque :

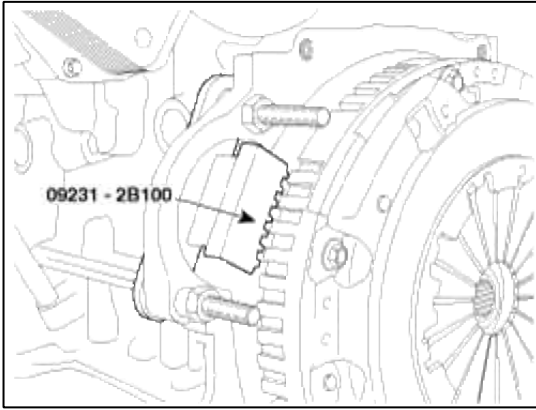
(47.0 ~ 50.9 N.m) + (38° ~ 42°) [(4.8 ~ 5.2 kgf.m) + (38° ~ 42°), (34.7 ~ 37.6 lb-ft) + (38° ~ 42°)]



#### NOTE

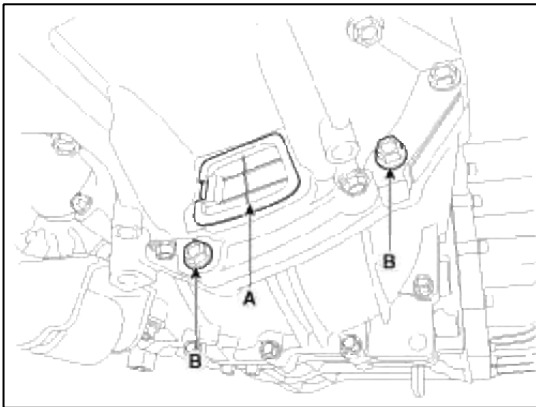
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

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

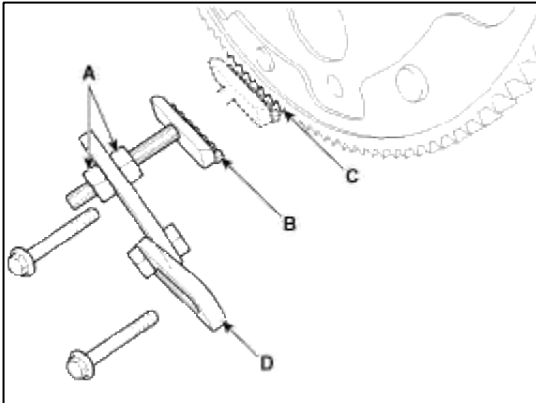


- Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.

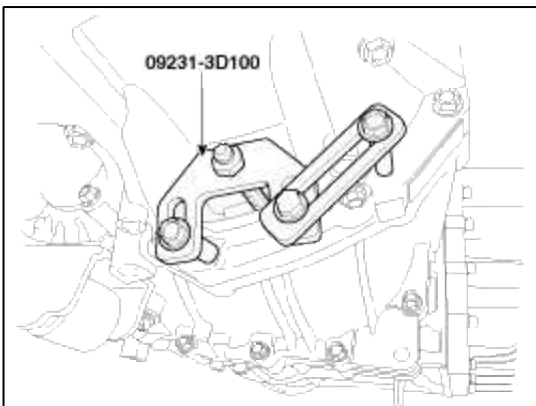
1. Remove the bracket (A).



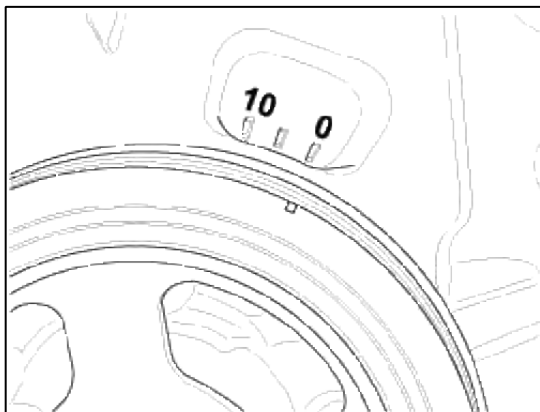
2. Remove the dust cover (A) and unfasten the transaxle mounting bolt (B).
3. Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.
4. Adjust the angle of the links (D), and fasten the bolt 70mm(2.7559in) in the original mounted hole.



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



5. When installing the pulley, the groove on the pulley should be positioned outside.



## Engine Mechanical System > Timing System > Front Oil Seal > Components and Components Location

### Components



1.	
Front oil seal	

## Engine Mechanical System > Timing System > Front Oil Seal > Repair procedures

### Removal and Installation

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

#### NOTE

Using the SST(09455-21200), reassemble the timing chain cover oil seal.



3. Install in the reverse order of removal.

## Engine Mechanical System > Timing System > Timing Chain Cover > Components and Components Location

### Components



1. Timing chain cover	
-----------------------	--

## Engine Mechanical System > Timing System > Timing Chain Cover > Repair procedures

## Removal

**CAUTION**

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

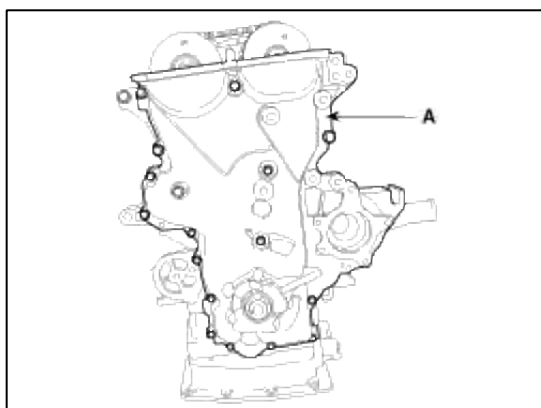
**NOTE**

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 alternator.  
(Refer to Engine Electrical System - "Alternator")
4. Remove the alternator bracket.  
(Refer to Engine Electrical System - "Alternator")
5. Remove the engineroom 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 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.  
(Refer to Engine And Transaxle Assembly - "Engine Mounting")
12. Remove the timing chain cover(A).

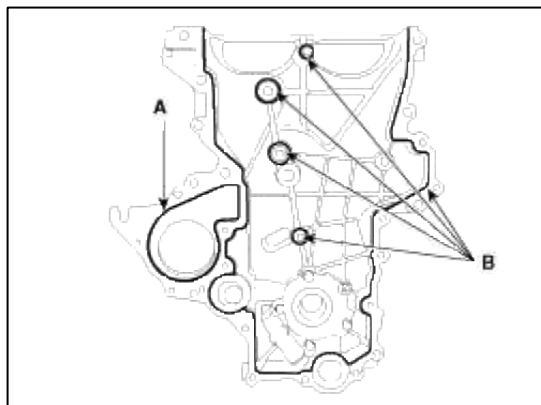


## Installation

## 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 ~ 5mm (0.1181~0.1969in.)



- (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).

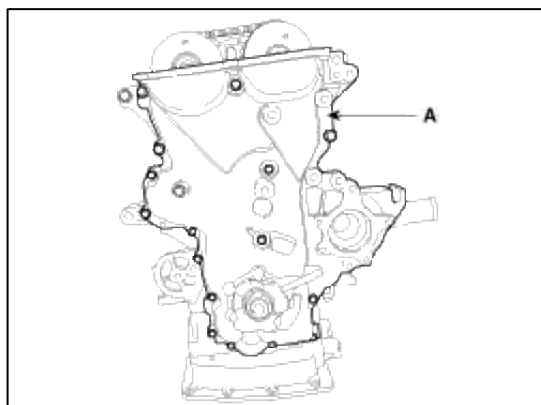
### Tightening torque

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 Nm (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



## 2. Install in the reverse order of removal.

**Engine Mechanical System > Timing System > Timing Chain > Components and Components Location**

## Components

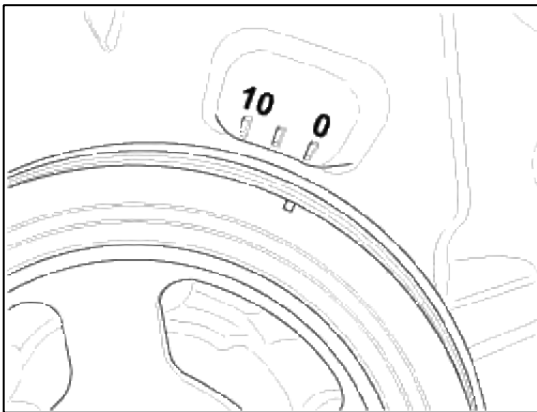


- |                       |                                |
|-----------------------|--------------------------------|
| 1. Timing chain       | 3. Timing chain arm            |
| 2. Timing chain guide | 4. Timing chain auto tensioner |

**Engine Mechanical System > Timing System > Timing Chain > Repair procedures**

## 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.

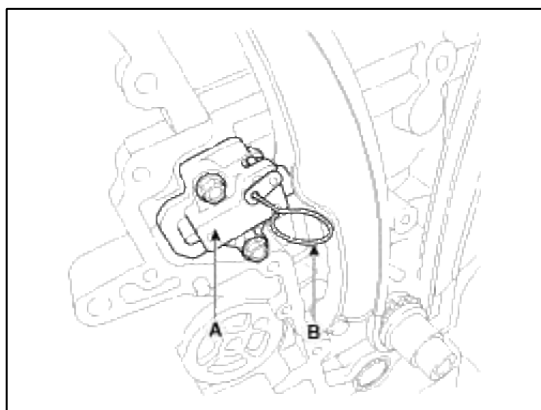
**CAUTION**

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



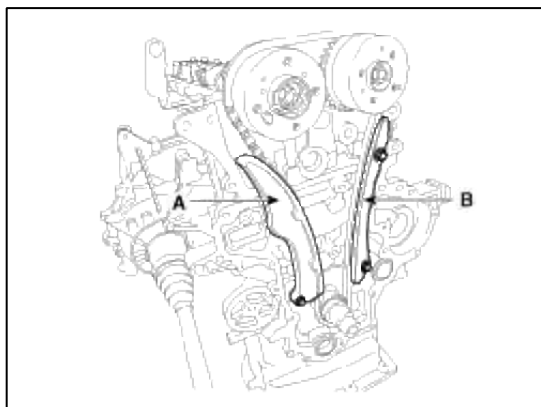


## 4. Remove the timing chain (A).

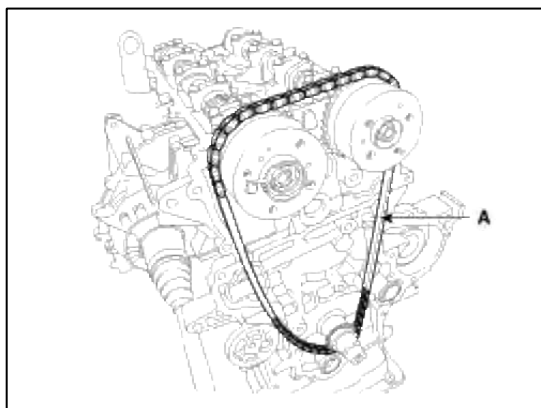
**CAUTION**

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).



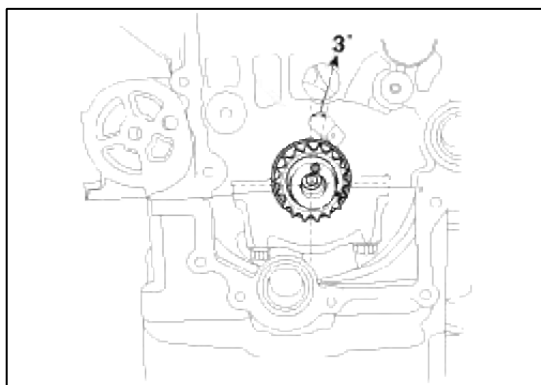
## Inspection

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

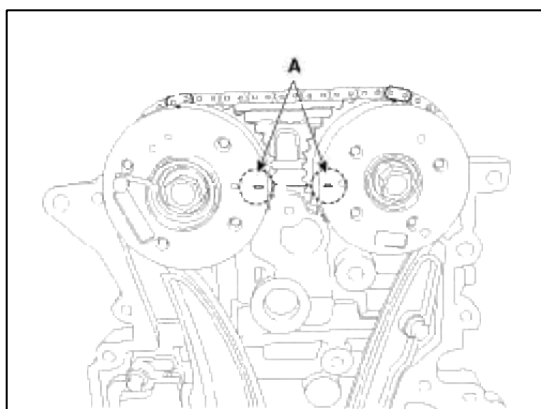
1. Check the CVVT sprocket, crankshaft sprocket teeth for abnormal wear, cracks or damage. Replace if necessary.
2. Check a contact surface of the chain tensioner arm and guide for abnormal wear, cracks or damage. Replace if necessary.
3. Check the hydraulic tensioner for its piston stroke and ratchet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

## Installation

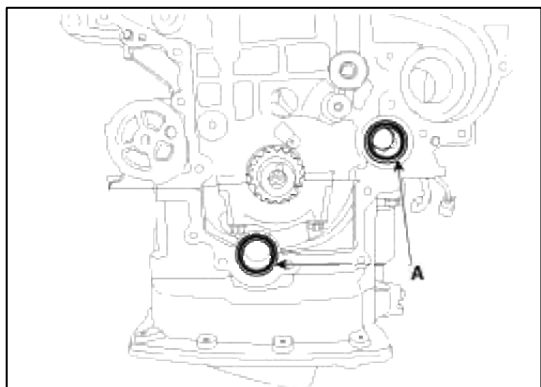
1. Dowel pin of crankshaft should be positioned at 3° in relation to vertical center line.



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).



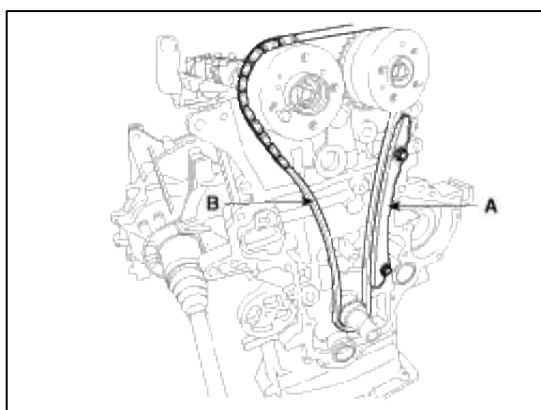
4. Install the timing chain guide (A) and the timing chain (B).

---

### **Tightening torque :**

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

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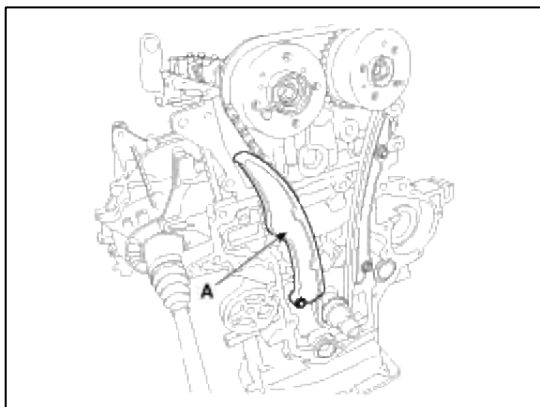
**NOTE**

- 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 :**

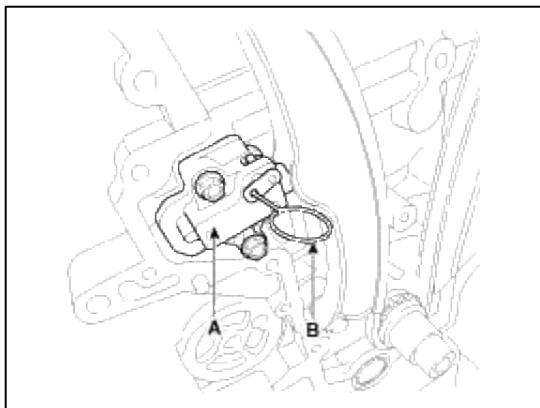
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



6. Install the hydraulic 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)

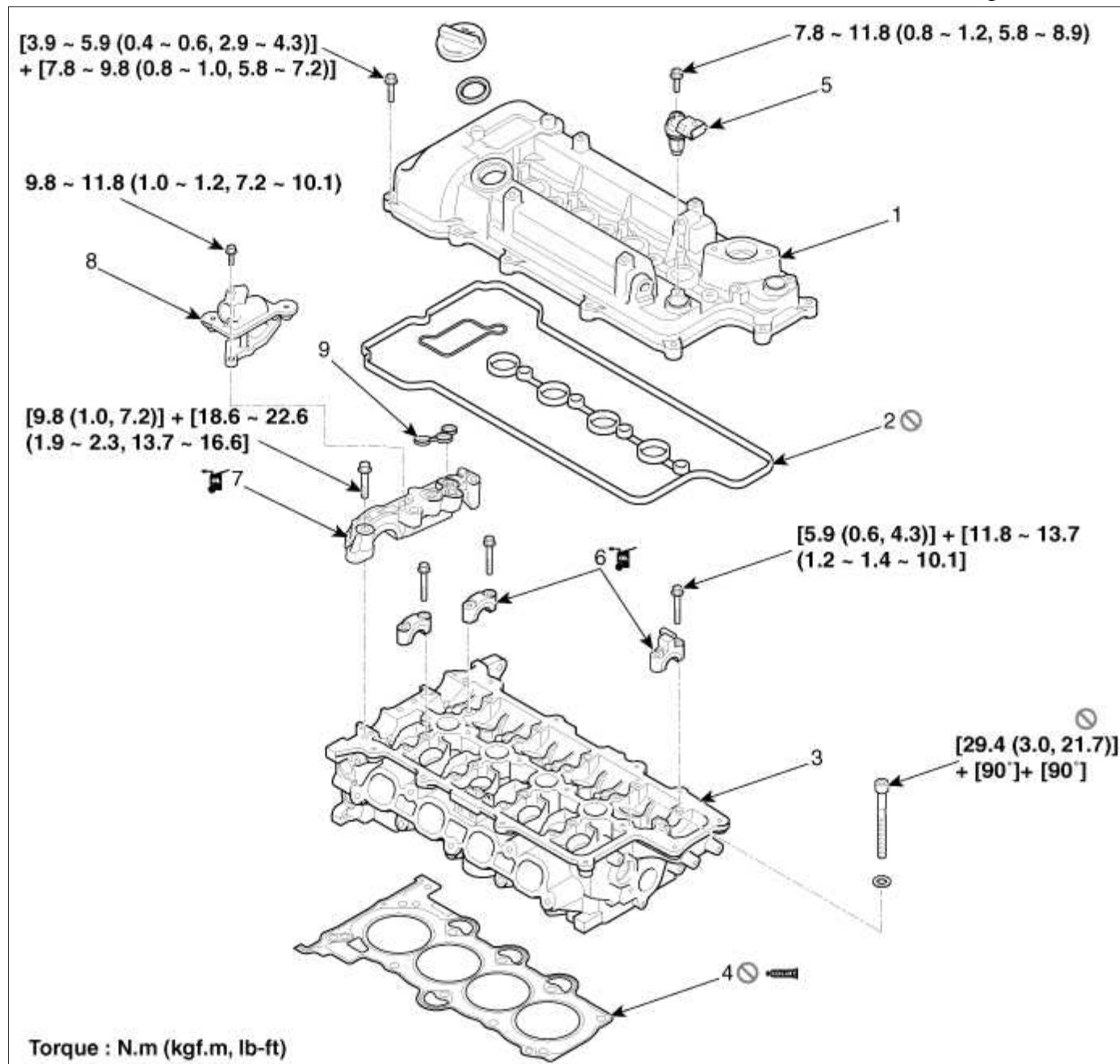
**NOTE**

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

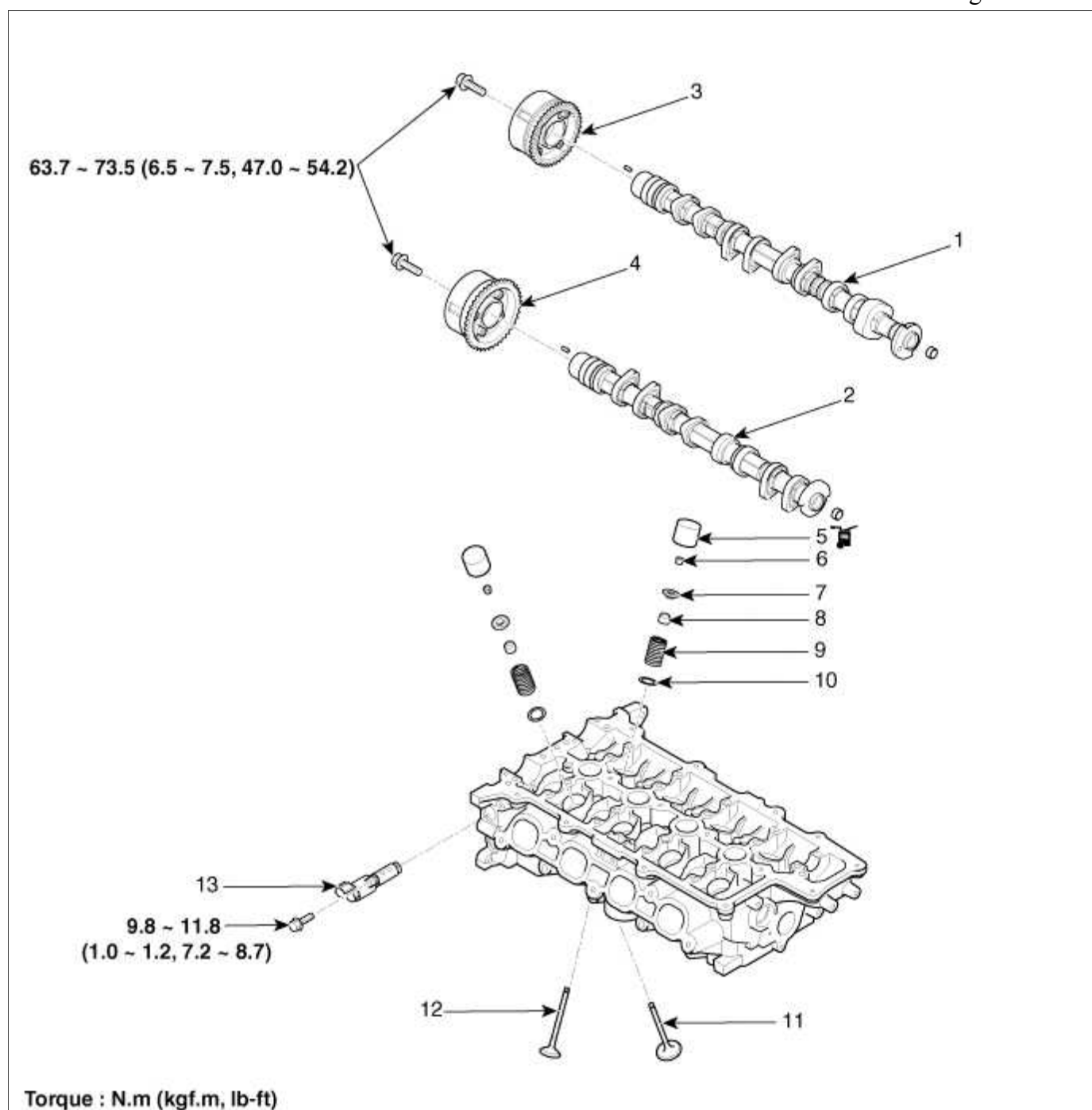
7. Install the timing chain cover.

## Engine Mechanical System > Cylinder Head Assembly > Components and Components Location

### Components



- |                               |                                    |
|-------------------------------|------------------------------------|
| 1. Cylinder head cover        | 6. Camshaft bearing cap            |
| 2. Cylinder head cover gasket | 7. Camshaft front bearing cap      |
| 3. Cylinder head assembly     | 8. OCV (Oil Control Valve) adapter |
| 4. Cylinder head gasket       | 9. O-ring                          |
| 5. Camshaft position sensor   |                                    |



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

### Engine Mechanical System > Cylinder Head Assembly > Cylinder Head Cover > Components and Components Location

#### Components



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

### Engine Mechanical System > Cylinder Head Assembly > Cylinder Head Cover > Repair procedures

#### Removal

1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Remove the air clean hose.  
(Refer to Intake and Exhaust System - "Ari Cleaner")
4. 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. 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 Position Sensor) connector



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

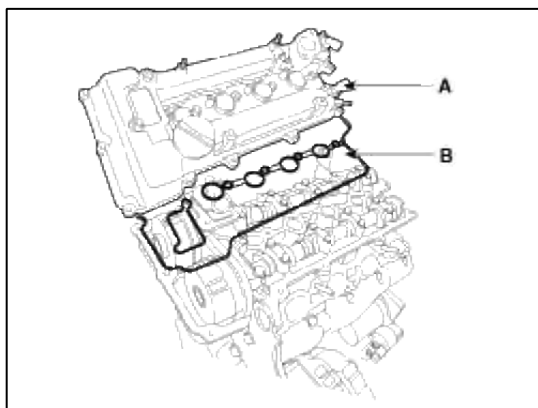


5. Disconnect the exhaust OCV(Oil Control Valve) connector.  
(Refer to Fuel System - "CVVT Oil Control Valve")
6. Disconnect the ignition coil.  
(Refer to Engine Electrical System - "Ignition Coil")
7. Remove the PCV(Positive Crankcase Ventilation) hose(A).



8. Remove the high pressure fuel pump.  
(Refer to Fuel System - "High Pressure Fuel Pump")

9. Remove the cylinder head cover(A), gasket(B).



**NOTE**

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.

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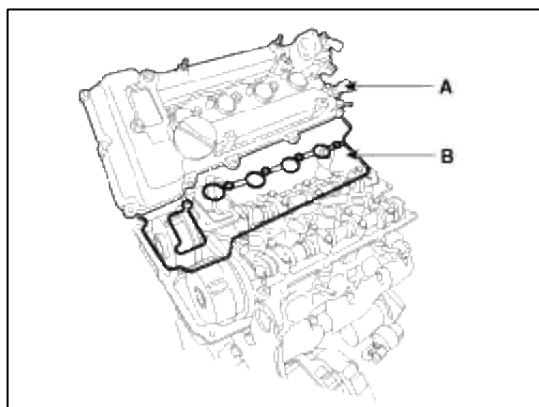
**Bead width :** 2.0 ~ 3.0mm(0.07 ~0.11 in.)

**Sealant :** LOCTITE 5900H

---



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



**CAUTION**

Do not reuse the disassembled gasket.

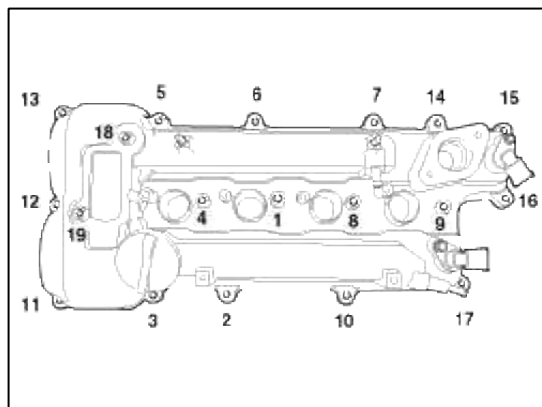
(4) Tighten the cylinder head cover bolts with the order and steps.

### 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 > Cylinder Head Assembly > CVVT Assembly > Components and Components Location

### Components



1. Exhaust CVVT
2. Intake CVVT

## Engine Mechanical System > Cylinder Head Assembly > CVVT Assembly > Description and Operation

### 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.

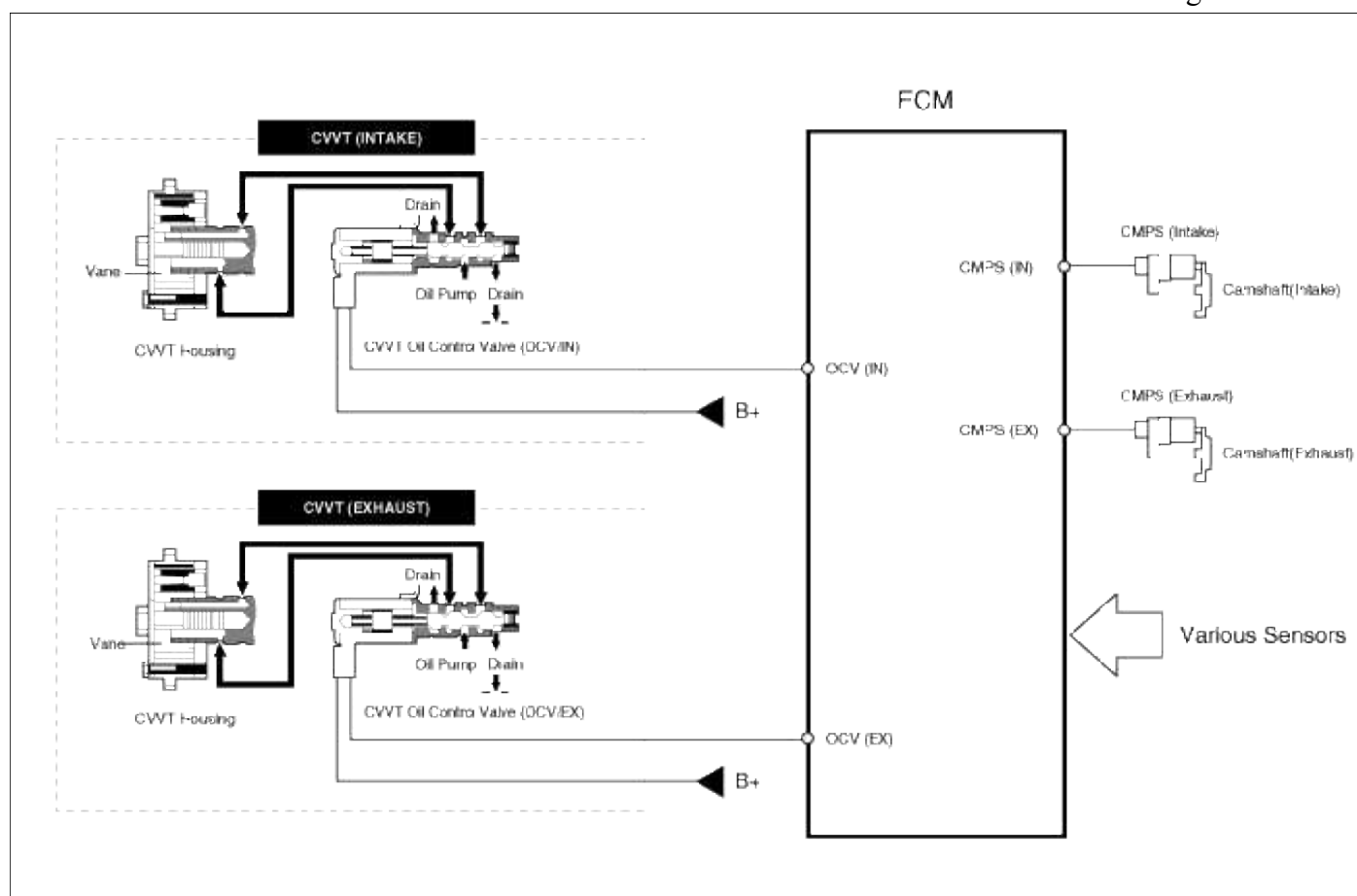
By controlling CVVT, the valve over-lap or under-lap occurs, which makes better fuel economy and reduces exhaust gases (NOx, HC) and improves engine performance through reduction of pumping loss, internal EGR effect, improvement of combustion stability, improvement of volumetric efficiency, and increase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



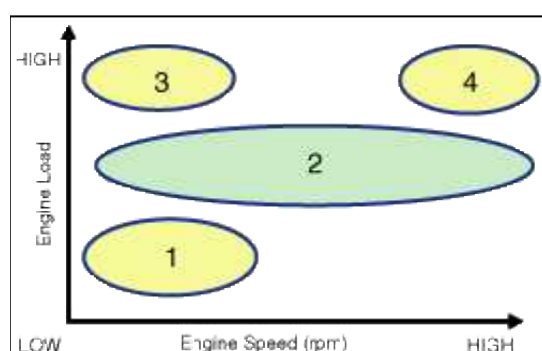


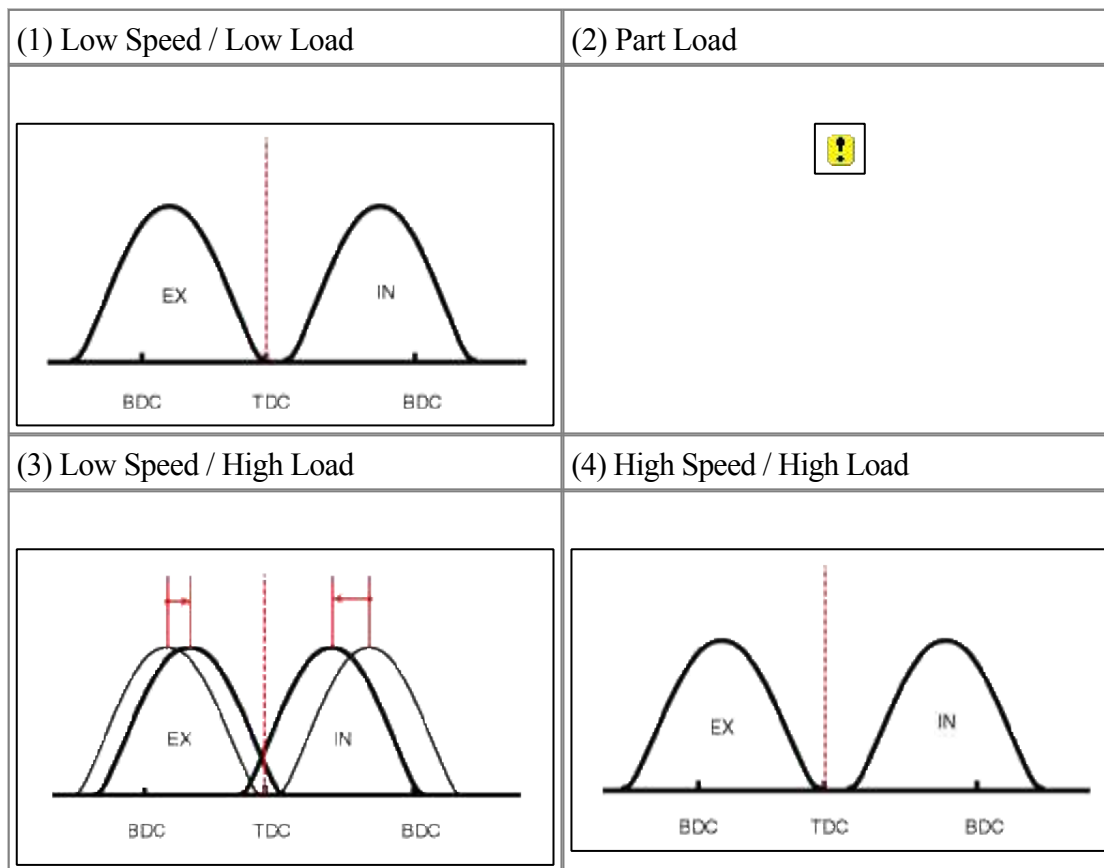
### Operation Principle

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]





Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect
(1) Low Speed /Low Load	Completely Advance	<ul style="list-style-type: none"> <li>* Valve Under-lap</li> <li>* Improvement of combustion stability</li> </ul>	Completely Retard	<ul style="list-style-type: none"> <li>* Valve Under-lap</li> <li>* Improvement of combustion stability</li> </ul>
(2) Part Load	Retard	<ul style="list-style-type: none"> <li>* Increase of expansion work</li> <li>* Reduction of pumping loss</li> <li>* Reduction of HC</li> </ul>	Retard	<ul style="list-style-type: none"> <li>* Reduction of pumping loss</li> </ul>
(3) Low Speed /High Load	Retard	<ul style="list-style-type: none"> <li>* Increase of expansion work</li> </ul>	Advance	<ul style="list-style-type: none"> <li>* Prevention of intake back flow (Improvement of volumetric efficiency)</li> </ul>
(4) High Speed /High Load	Advance	<ul style="list-style-type: none"> <li>* Reduction of pumping loss</li> </ul>	Retard	<ul style="list-style-type: none"> <li>* Improvement of volumetric efficiency</li> </ul>

### Engine Mechanical System > Cylinder Head Assembly > CVVT Assembly > Repair procedures

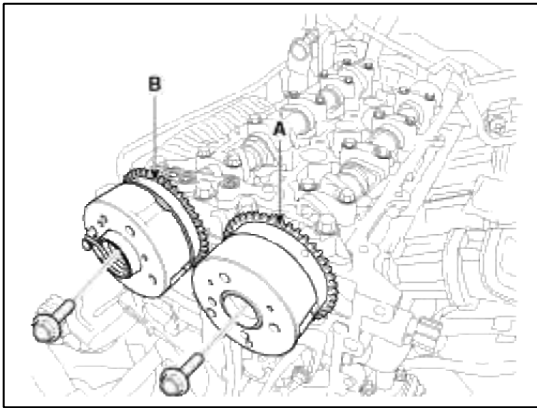
#### Removal

1. Remove the cylinder heae cover.  
(Refer to Cylinder Heae Assembly - "Cylinder Heae Cover")
2. Remove the timing chain cover.  
(Refer to Timing System - "Timing Chain Cover")

3. Remove the timing chain.

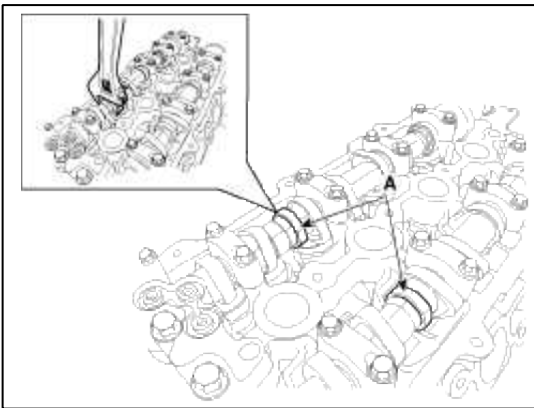
(Refer to Timing System - "Timing Chain")

4. Remove the intake CVVT assembly (A) and exhaust CVVT assembly (B).



#### CAUTION

When removing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).



### Inspection

#### Continuous Variable Valve Timing (CVVT) Assembly

1. Inspect the Continuous variable valve timing (CVVT) assembly.

- (1) Fix the Continuous variable valve timing (CVVT) with its camshaft in a vice.
- (2) Check that the CVVT assembly will not turn. If it is not turned, it is in normal condition.
- (3) Apply vinyl tape to all the parts except the one hole.
- (4) Using an air gun, apply the pressure, 147.10kpa (1.5kg/cm<sup>2</sup>, 21.33psi) in the hole.  
This makes the lock pin in maximum retarded state released.

#### NOTE

- Using an air gun, apply the pressure, 147.10kpa (1.5kg/cm<sup>2</sup>, 21.33psi) in the hole. This makes the lock pin in maximum retarded state released.
- After releasing the pin, you can turn the CVVT assembly for advance by hand.
- If there was too much air leakage, the pin can not be released.

(5) Under the condition of 3), turn the CVVT assembly to the advance angle side with your hand.

Depending on the air pressure, the CVVT assembly will turn to the advance side.

Also, if the air pressure that was applied was insufficient because of the air leakage from the port, the lock pin may not release properly.

(6) Except the position where the lock pin meets at the maximum delay angle, let the CVVT assembly turn back and forth and check the movable range and that there is no interference.

Standard : Movable smoothly in the range about 25°

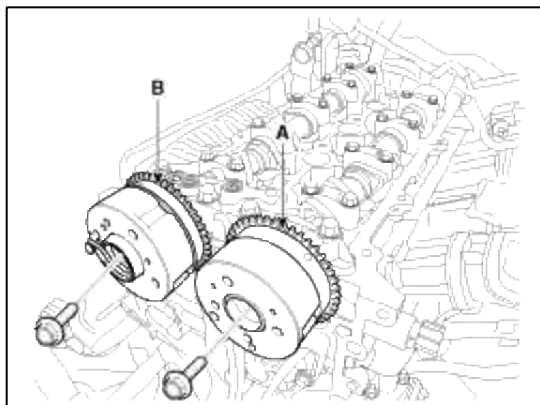
(7) Turn the CVVT assembly with your hand counterclockwise and lock it at the maximum delay angle position.

## Installation

1. Install the intake CVVT assembly (A) and exhaust CVVT assembly (B).

### Tightening torque :

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



### CAUTION

When installing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).

2. Install the timing chain.

(Refer to Timing System - "Timing Chain")

3. Install the timing chain cover.

(Refer to Timing System - "Timing Chain Cover")

4. Install the cylinder head cover.

(Refer to Cylinder Head Assembly - "Cylinder Head Cover")

## Engine Mechanical System > Cylinder Head Assembly > Camshaft > Components and Components Location

### Components

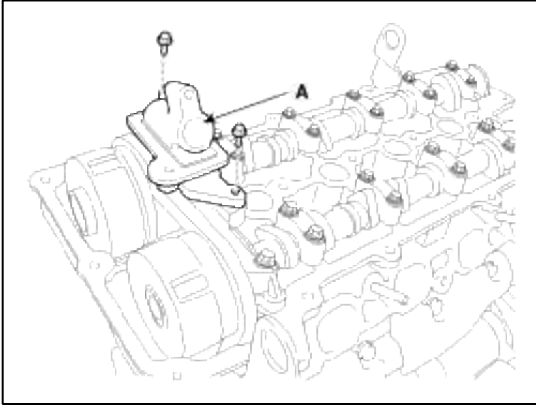


1. Exhaust camshaft	5. OCV (Oil Control Valve) adapter
2. Intake camshaft	6. O-ring B
3. Camshaft bearing cap	7. O-ring A
4. Camshaft front bearing cap	

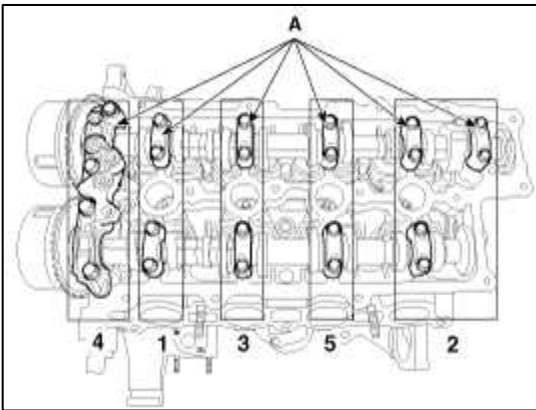
## Engine Mechanical System > Cylinder Head Assembly > Camshaft > Repair procedures

### Removal

1. Remove the cylinder head cover.  
(Refer to Cylinder Head Assembly - "Cylinder Head Cover")
2. Remove the timing chain cover.  
(Refer to Timing System - "Timing Chain Cover")
3. Remove the timing chain.  
(Refer to Timing System - "Timing Chain")
4. Remove the intake CVVT assembly and exhaust CVVT assembly.  
(Refer to Cylinder Head Assembly - "CVVT Assembly")
5. Remove the exhaust OCV (Oil control valve) adaptor (A).



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



### Inspection

1. Inspect the cam height.  
Using a micrometer, measure the cam height.

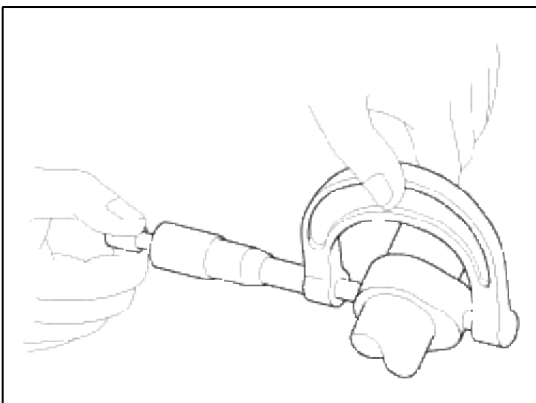
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#### Cam height

Intake : 44.15mm (1.7382in)

Exhaust : 42.90mm (1.6889in)

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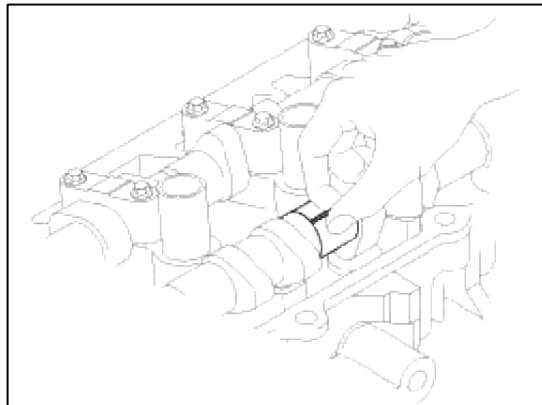
If the cam lobe height is less than specified, replace the camshaft.

2. Check the crankshaft journal for wear.

If the journal is worn excessively, replace the camshaft.

3. Inspect the camshaft journal clearance.

- (1) Clean the bearing caps and camshaft journals.
- (2) Place the camshafts on the cylinder head.
- (3) Lay a strip of plastigage across each of the camshaft journal.



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

---

**Tightening torque**

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)

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**CAUTION**

Do not turn the camshaft.

- (5) Remove the bearing caps.
- (6) Measure the plastigage at its widest point.

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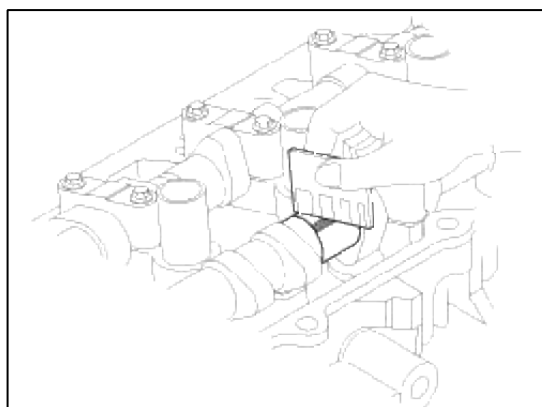
**Bearing oil clearance**

Standard :

0.027 ~ 0.058mm (0.0011 ~ 0.0023in)

Limit : 0.1mm ( 0.0039in)

---



If the oil clearance is greater than specified, replace the camshaft.

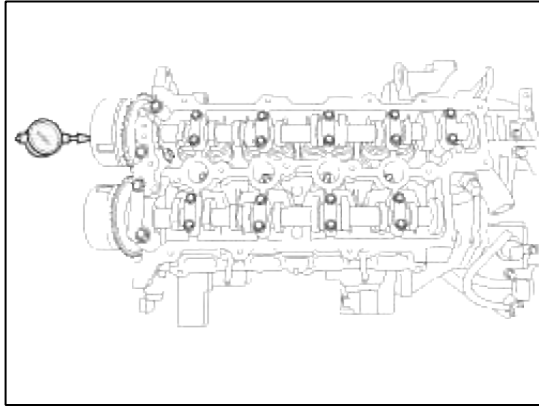
If necessary, replace the bearing caps and cylinder head as a set.

#### 4. Inspect the camshaft end play.

- (1) Install the camshafts.
- (2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

#### Camshaft end play

Standard : 0.1 ~ 0.2mm (0.0039 ~ 0.0079in)



If the end play is greater than specified, replace the camshaft.

If necessary, replace the bearing caps and cylinder head as a set.

- (3) Remove the camshafts.

#### Installation

1. Apply a light coat of engine oil on camshaft journals.
2. Install the camshaft bearing caps(A) with the order below.

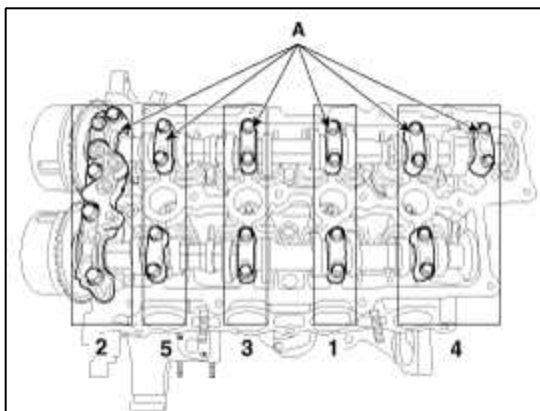
#### Tightening torque

M6 bolts :

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

M8 bolts :

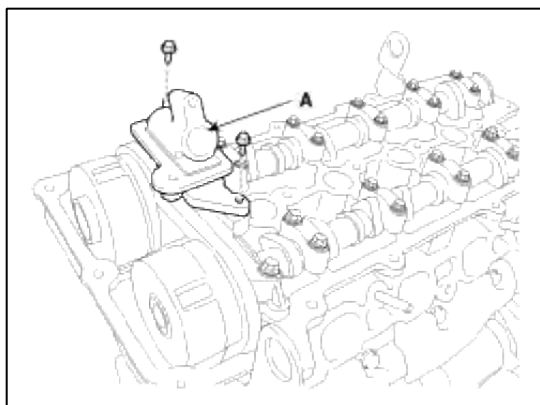
18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



3. Install the exhaust OCV (Oil control valve) adaptor (A).

**Tightening torque :**

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



4. Install the intake CVVT assembly and exhaust CVVT assembly.  
(Refer to Cylinder Head Assembly - "CVVT Assembly")
5. Install the timing chain.  
(Refer to Timing System - "Timing Chain")
6. Install the timing chain cover.  
(Refer to Timing System - "Timing Chain Cover")
7. Install the cylinder head cover.  
(Refer to Cylinder Head Assembly - "Cylinder Head Cover")

### Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Components and Components Location

#### Components



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

### Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Repair procedures

#### 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.



**NOTE**

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. Disconnect the mounting bracket and then remove the battery.  
(Refer to Engine Electrical System - "Battery")
  5. Disconnect the ECM connector and then remove the battery tray.  
(Refer to Engine Electrical System - "Battery")
  6. Remove the battery tray.  
(Refer to Engine Electrical System - "Battery")
  7. Remove the engineroom under cover.
  8. Loosen the drain plug and drain the coolant. Open the radiator cap to make rapid draining.  
(Refer to Cooling System - "Coolant")
  9. Remove the radiator upper hose and lower hose.  
(Refer to Cooling System - Radiator Hose")
  10. Disconnect the intercooler inlet and outlet hose.  
(Refer to Intake and Exhaust System - "Intercooler Pipe and Hose")
  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. 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 Position 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 hose(A) and brake booster vacuum hose(B).



13. Remove the vacuum pipe assembly(A).



14. Remove the cylinder head cover.

(Refer to Cylinder Head Assembly - "Cylinder Head Cover")

15. Remove the timing chain cover.

(Refer 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 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 Pipe")

23. Remove the intake OCV(Oil Control Valve).

(Refer to Fuel System - "CVVT Oil Control Valve")

24. Remove the rear hanger (A).

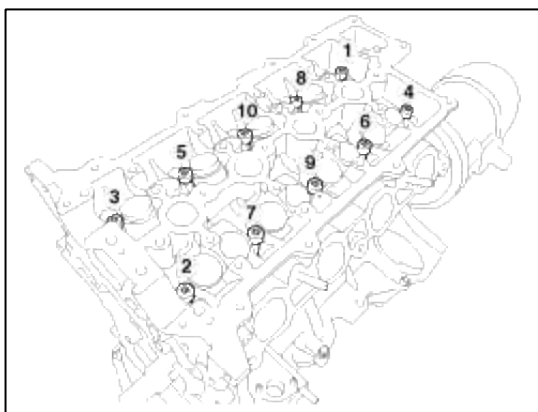


25. Remove the cylinder head cover heat protector (A).



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

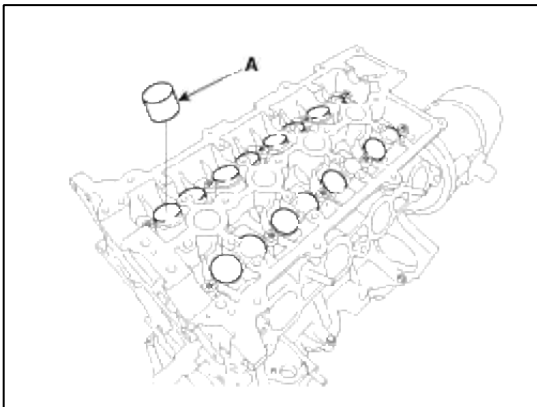
**NOTE**

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).

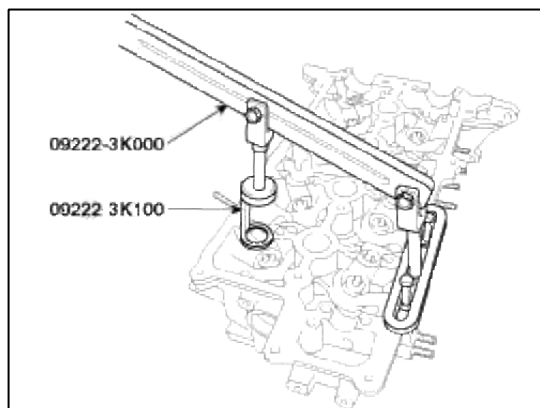
**CAUTION**

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 retainer.
- (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.

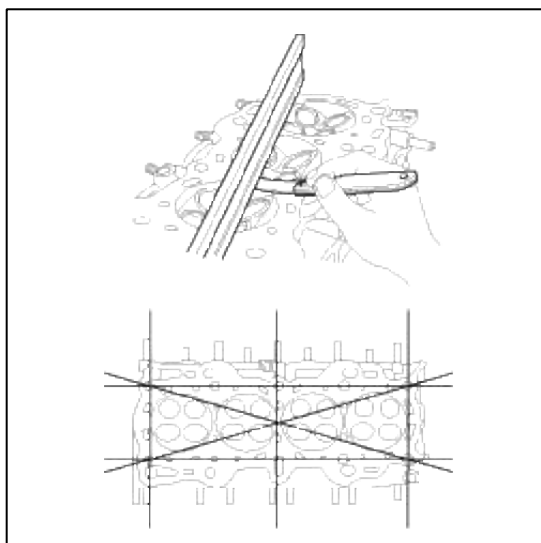
Using a precision straight edge and feeler gauge, measure the surface the contacting the cylinder block and the manifolds for warpage.

**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.

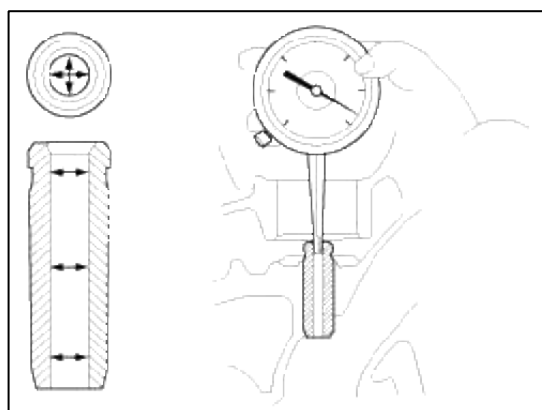
**Valve And Valve Spring**

## 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)

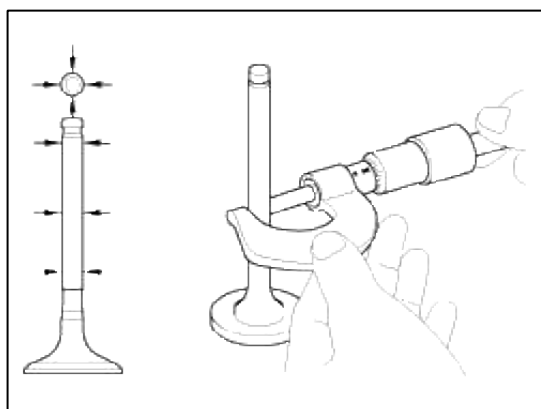


- (2) Using a micrometer, measure the outer diameter of valve stem.

### 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.

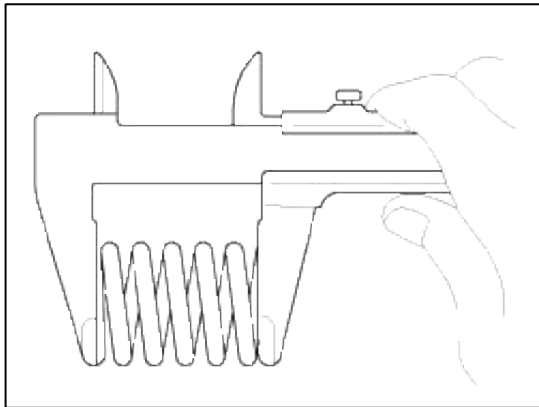
- (1) Using a steel square, measure the out-of-square of valve spring.
- (2) Using a vernier calipers, measure the free length of valve spring.

#### Valve spring

Standard

Free height : 45.1mm (1.7756in)

Out of square : Less than 1.5°



### Reassembly

#### NOTE

- 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.

#### NOTE

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

#### CAUTION

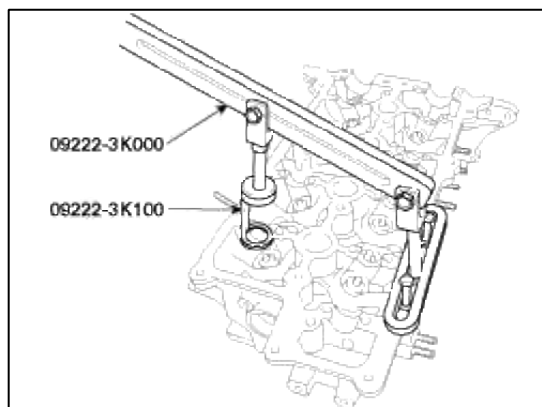
Intake valve stem seals are different from exhaust ones in type.  
Do not reassembly ones in the other's places.

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

#### NOTE

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

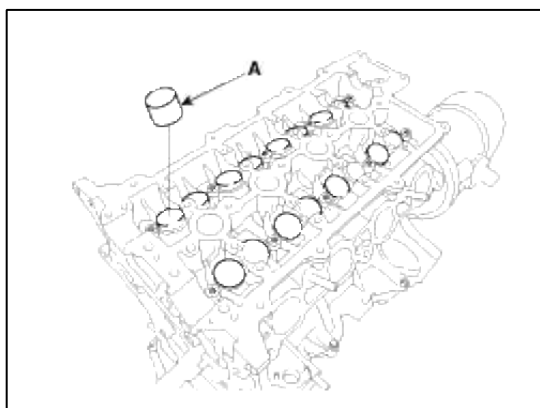
2. Using the SST(09222 - 3K000, 09222 - 3K100), compress the spring and install the retainer locks.
- After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



#### 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.



#### NOTE

All the MLAs must be installed in its original position.

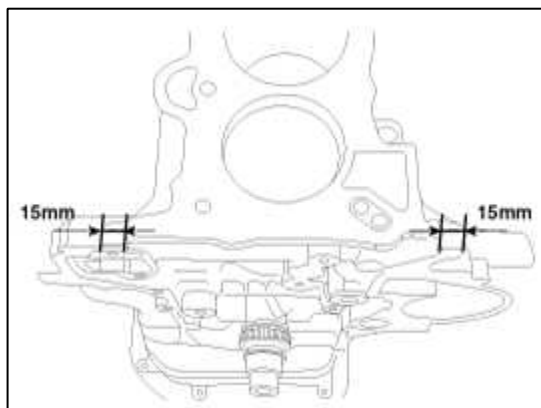
### Installation

#### NOTE

- Thoroughly clean all parts to be assembled.
- Always use a new cylinder head and manifold gasket.
- Always use a new cylinder head bolt.
- 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.



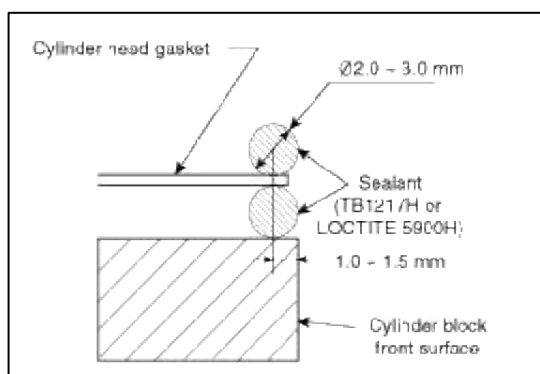
**NOTE**

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.



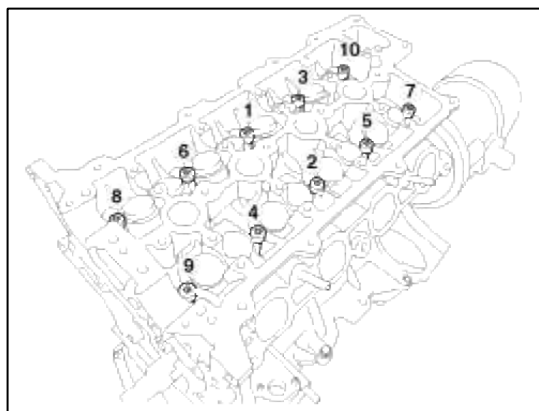


### 3. Install the cylinder head bolts with washers.

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

#### **Tightening torque :**

29.4Nm (3.0kgf.m, 21.7lb-ft) + 90° + 90°



#### **CAUTION**

Always use new cylinder head bolts.

### 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 Fuel System - "CVVT Oil Control Valve (OCV)")

### 7. Install the heater pipe.

(Refer to Cooling System - "Water Pipe")

### 8. Install the water control assembly, and bypass hose.

(Refer to Cooling System - "Water Control Assembly")

### 9. Install the delivery pipe assembly.

(Refer to 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 brake booster vacuum hose (A) and heater hose (B).



18. Install in the reverse order of removal.

**NOTE**

Perform the following :

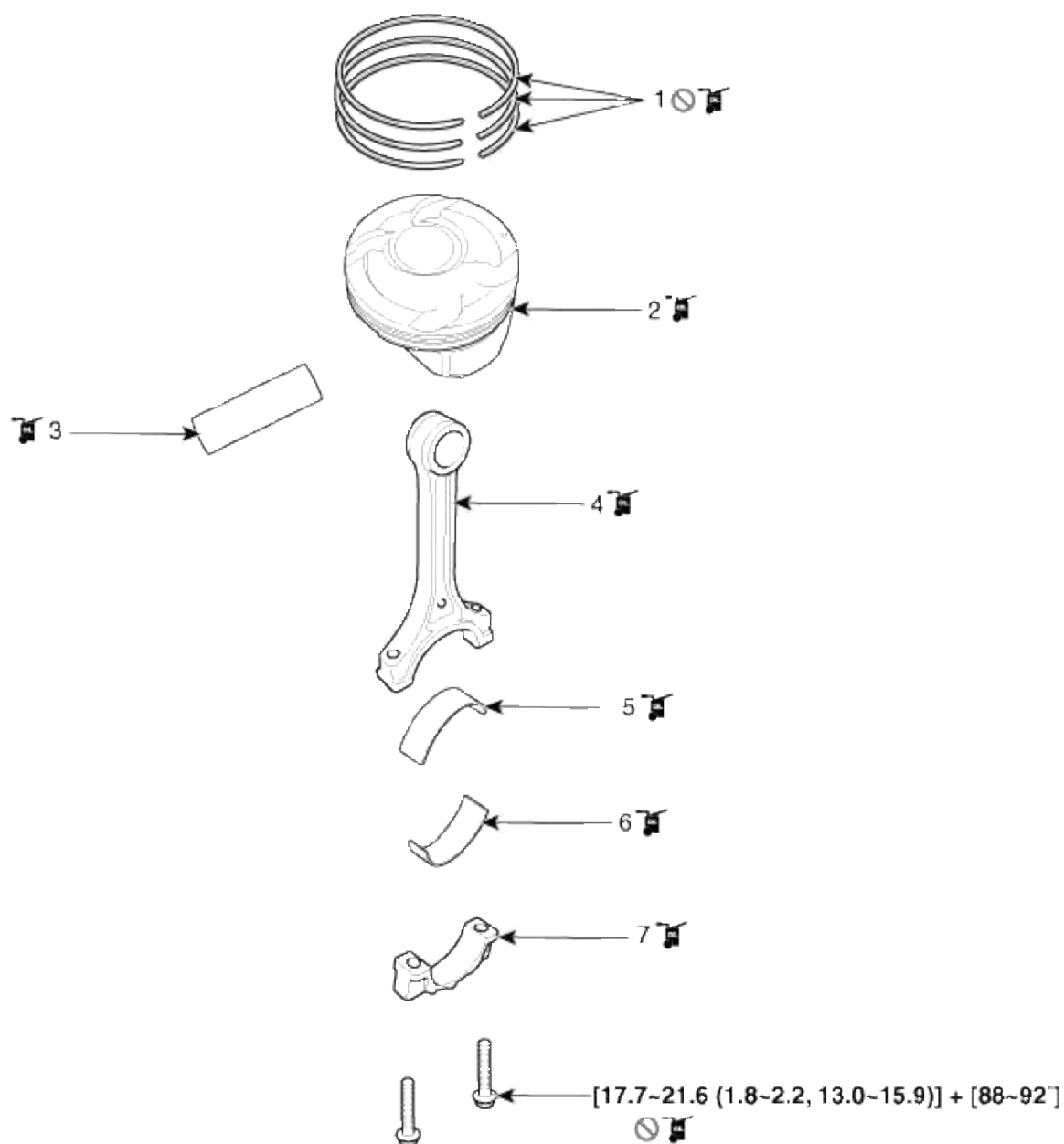
- Refill engine with engine oil.
- Refill a radiator and a reservoir tank with engine coolant.
- Inspect for fuel leakage.
- After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat 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 > Cylinder Block > Components and Components Location

### Components



1. Cylinder block	5. Crankshaft lower bearing	9. Drive plate
2. Ladder frame	6. Thrust bearing	10. Fly wheel
3. Crankshaft	7. Main bearing cap	11. Crankshaft sprocket
4. Crankshaft upper bearing	8. Adapter plate	12. Crankshaft pulley
		13. Water jacket insert



Torque : N.m (kgf.m, lb-ft)

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

## Engine Mechanical System > Cylinder Block > Drive Plate > Components and Components Location

### Components



1. Adapter plate	2. Drive plate
------------------	----------------

## Engine Mechanical System > Cylinder Block > Drive Plate > Repair procedures

### 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 > Cylinder Block > Flywheel > Components and Components Location

### Components



1. Fly Wheel

## Engine Mechanical System > Cylinder Block > Flywheel > Repair procedures

### Removal and installation

1. Remove the manual Tranaxle.  
(Refer to Manual Transaxle System - "Manual Transaxle ")
2. Remove the 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 > Cylinder Block > Water Jacket Seperator > Components and Components Location

### Components

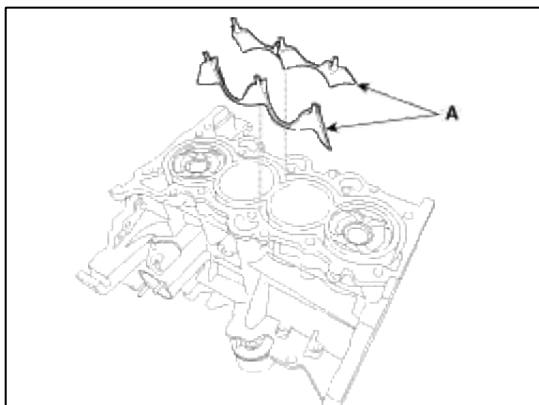


1. Water Jacket Seperator

## Engine Mechanical System > Cylinder Block > Water Jacket Separator > Repair procedures

### Remove and Installation

1. Remove the cylinder head assembly.  
(Refet to Cylinder Head Assembli - "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 > Cylinder Block > Rear Oil Seal > Components and Components Location

### Components



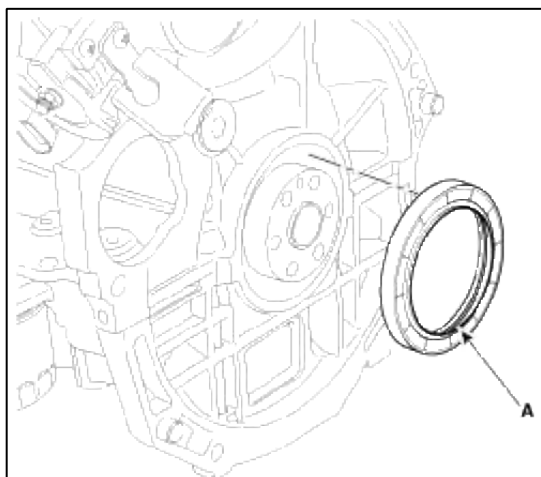
1. Rear oil seal

## Engine Mechanical System > Cylinder Block > Rear Oil Seal > Repair procedures

### Removal

1. Remove the transaxle assembly.  
(Refer to transaxle - "Manual Transaxle assembly, Auto Transaxle assembly")
2. MT : Remove the flywheel.  
(Refet to Cylinder Block - "Flywheel")
3. AT : Remove the drive plate.  
(Refet to Cylinder Block - "Drive Plate")

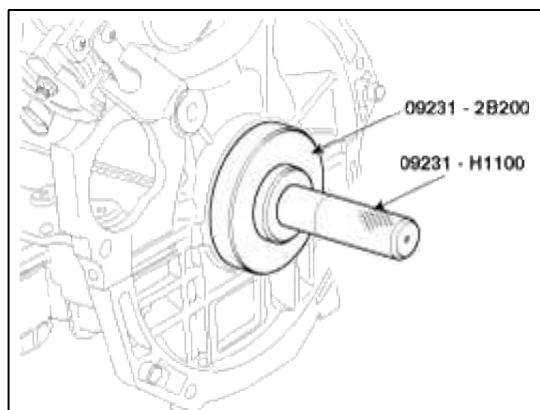
#### 4. Remove the rear oil seal(A).



#### Installation

##### 1. Install the 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.



##### 2. MT : Install the flywheel.

(Refet to Cylinder Block - "FlyWheel")

##### 3. AT : Install the drive plate.

(Refet to Cylinder Block - "Drive Plate")

##### 4. Install the transaxle assembly.

(Refer to transaxle - "Manual Transaxle assembly, Auto Transaxle assembly")

### Engine Mechanical System > Cylinder Block > Cylinder Block > Components and Components Location

#### Components



1. Cylinder block	6. Thrust bearing	11. Piston
2. Ladder frame	7. Main bearing cap	12. Connecting rod
3. Crank shaft	8. Crank shaft sproket	13. Connecting rod upper bearing
4. Crank shaft upper bearing	9. Crank shaft pulley	14. Connecting rod lower bearing
5. Crank shaft lower bearing	10. Piston ring	15. Connecting rod bearing cap

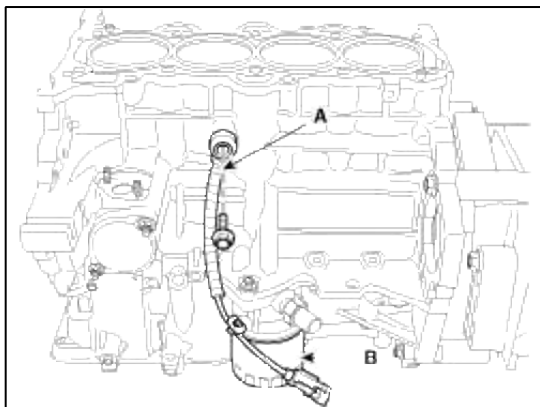
## Engine Mechanical System > Cylinder Block > Cylinder Block > Repair procedures

### Removal

Engine removal is required for this procedure.

(Refer to Engine and transaxle assembly removal in this group)

1. MT : Remove the flywheel.  
(Refet to Cylinder Block - "Flywheel")
2. AT : Remove the drive plate.  
(Refet to Cylinder Block - "Drive Plate")
3. Remove the engine to engine stand for disassembly.
4. Remove the timing chain.  
(Refet to Timing System - "Timing Chain")
5. Remove the cylinder head.  
(Refet to Cylindet Head Assembly - "Cylinder Head")
6. Remove the water jacket.  
(Refer to Cylinder Block - "Water Jacket")
7. Remove the oil level gauge tube.
8. Remove the knock sensor (A) and the oil filter (B).



9. Remove the oil pressure switch.  
(Refet to Lubrication System - "Oil Pressure Switch")
10. Remove the oil pan.  
(Refer to Lubrication System - "Oil Pan")
11. Remove the oil screen (A).



12. Remove the rear oil seal.  
(Refet to Cylinder Block - "Rear Oil Seal")
13. Remove the ladder frame(A).



14. Check the connecting rod end play.
15. Remove the connecting rod caps and check oil clearance.
16. Remove the piston and connecting rod assemblies.
  - (1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
  - (2) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

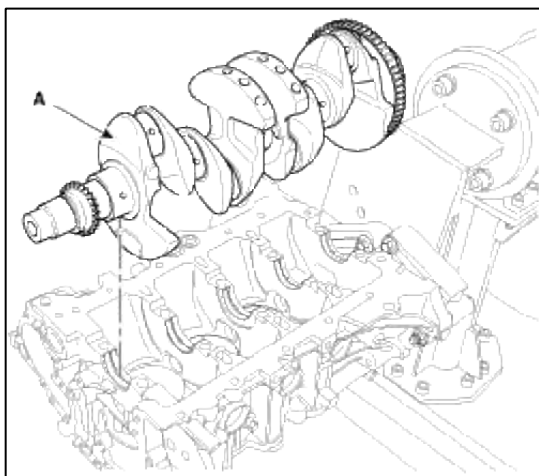
#### NOTE

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in the correct order.

17. Remove the crankshaft bearing cap and check oil clearance.
18. Check the crankshaft end play.
19. Lift the crankshaft (A) out of the engine, being careful not to damage journals.

**NOTE**

Arrange the main bearings and thrust bearings in the correct order.



20. Remove the piston cooling jet (A).



21. 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.
22. Remove the piston rings.
  - (1) Using a piston ring expander, remove the 2 compression rings.
  - (2) Remove the 2 side rails and coil spring.

**NOTE**

Arrange the piston rings in the correct order only.

23. Remove the connecting rod from the piston.  
Using a press, remove the piston pin from piston.  
(Press-in load : 500 ~ 1,500kg(1,102 ~ 3,306lb))

## Inspection

### Connecting Rod And Crankshaft



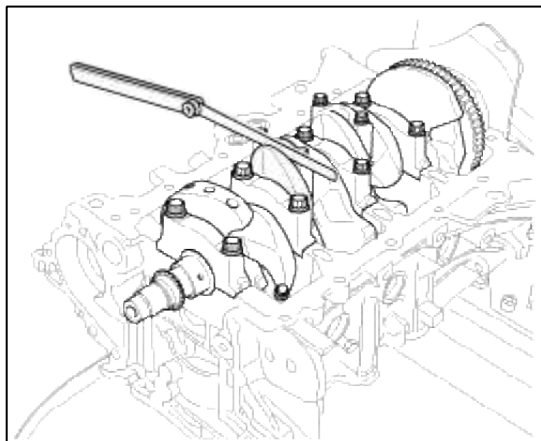
# 1. Check the connecting rod end play.

Using feeler gauge, measure the end play while moving the connecting rod back and forth.

## End play

Standard : 0.10 ~ 0.25mm (0.0039 ~ 0.0098in)

Maximum : 0.35mm (0.0138in)



### NOTE

- If out-of-tolerance, install a new connecting rod.
- If still out-of-tolerance, 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. Do not reuse the bolts.

## Tightening torque :

17.7 ~ 21.6N.m (1.8 ~ 2.2kgf.m, 13.0 ~ 15.9lb-ft) + 88 ~ 92°

### NOTE

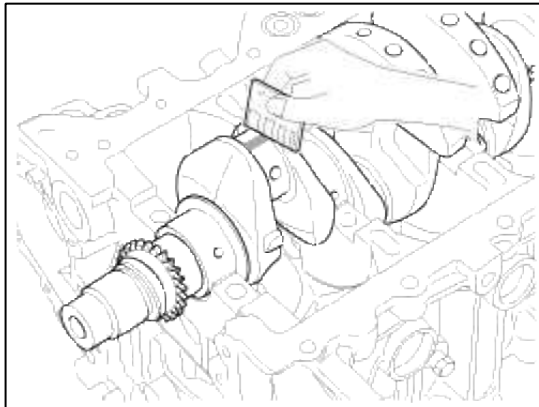
Do not turn the crankshaft.

- (7) Remove the 2 bolts, connecting rod cap and lower bearing .

(8) Measure the plastigage at its widest point.

### Standard oil clearance

0.032 ~ 0.052mm (0.0013 ~ 0.0020in)



(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.

#### CAUTION

Do not file, shim, or 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.

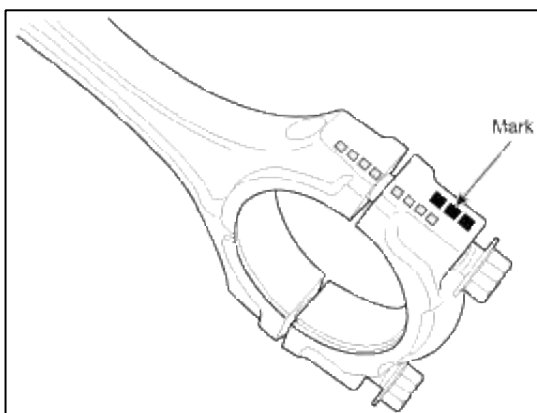
#### NOTE

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

#### CAUTION

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.

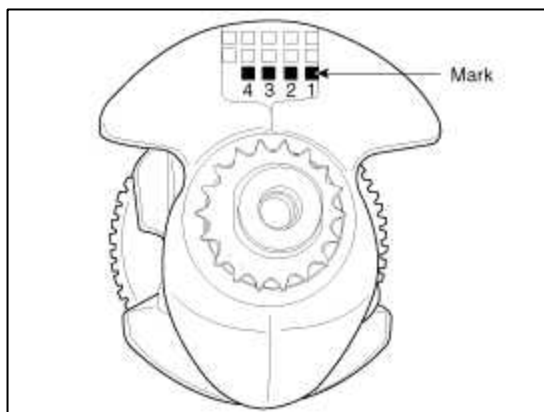
### Connecting Rod Mark Location



### Discrimination Of Connecting Rod

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

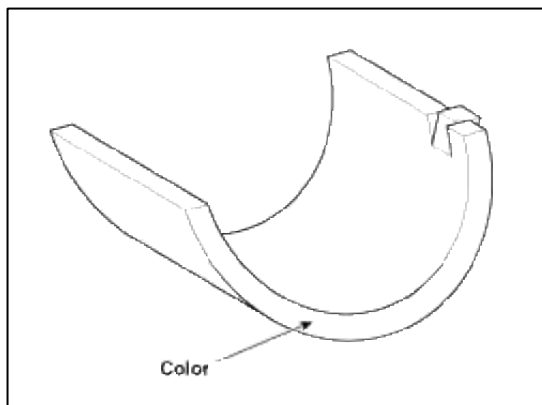
#### Crankshaft Pin Diameter Mark Location



#### Discrimination Of Crankshaft Pin Diameter

Mark	Crankshaft pin outer diameter
1	41.954 ~ 41.960mm (1.6517 ~ 1.6520in)
2	41.966 ~ 41.960mm (1.6522 ~ 1.6520in)
3	41.960 ~ 41.954mm (1.6520 ~ 1.6517in)

#### Connecting Rod Bearing Color Location



#### Discrimination Of Connecting Rod Bearing

Mark	Color	Connecting rod bearing thickness
A	Blue	1.514 ~ 1.517mm (0.0596 ~ 0.0597in)
B	Black	1.511 ~ 1.514mm (0.0595 ~ 0.0596in)
C	None	1.508 ~ 1.511mm (0.0594 ~ 0.0595in)
D	Green	1.505 ~ 1.508mm (0.0593 ~ 0.0594in)
E	Red	1.502 ~ 1.505mm (0.0591 ~ 0.0593in)

(11) Select the bearing by using selection table.

**Connecting Rod Bearing Selection Table**

		Connecting rod mark		
		A, 0	B, 00	C, 000
<b>Crank shaft pin journal mark</b>	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

### 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 :**

0.05mm / 100mm (0.0020in / 3.94in ) or less

#### **Allowable twist of connecting rod :**

0.10mm / 100mm (0.0039in / 3.94in) or less

#### **NOTE**

When the connecting rods installed without bearings, there should be no difference on side surface.

### 4. Check the crankshaft bearing oil clearance.

- (1) To check main bearing-to-journal oil clearance, remove the main bearing caps and 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 lower bearings and caps, then tighten the bolts.

#### **Tightening torque :**

17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

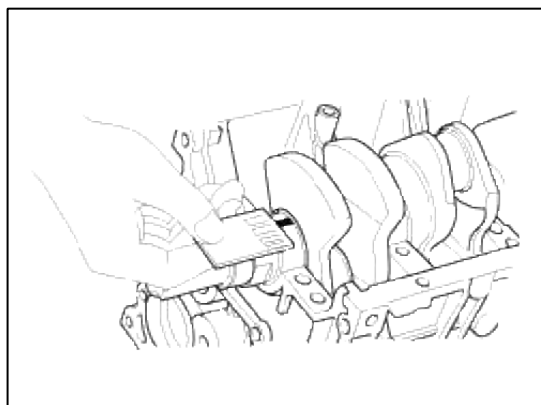
#### **NOTE**

Do not turn the crankshaft.

- (5) Remove the cap and lower bearing again, and measure the widest part of the plastigage.

### Standard oil clearance :

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



- (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. (Refer to crankshaft main bearing selection table in this Group). Recheck the oil clearance.

### CAUTION

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

- (7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing. (Refer to crankshaft main bearing selection table in this Group). Recheck the oil clearance.

### NOTE

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

### CAUTION

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.

### Cylinder block crankshaft journal bore mark location

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

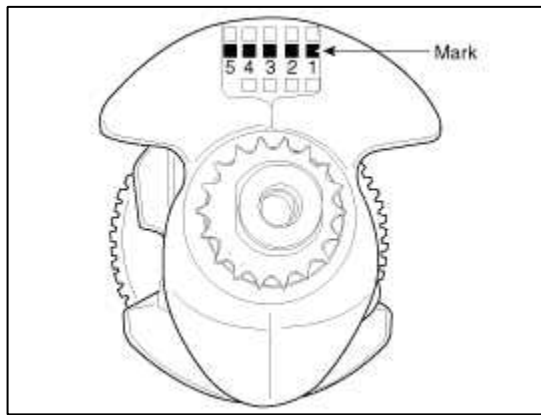
Use them, and the numbers or letters stamped on the crank (marks for main journal size), to choose the correct bearings.



### Discrimination Of Cylinder Block Crankshaft Journal Bore

Mark	Cylinder block crankshaft journal bore inner diameter
A	52.000 ~ 52.006mm (2.0472 ~ 2.0475in)
B	52.006 ~ 52.012mm (2.0475 ~ 2.0477in)
C	52.012 ~ 52.018mm (2.0477 ~ 2.0479in)

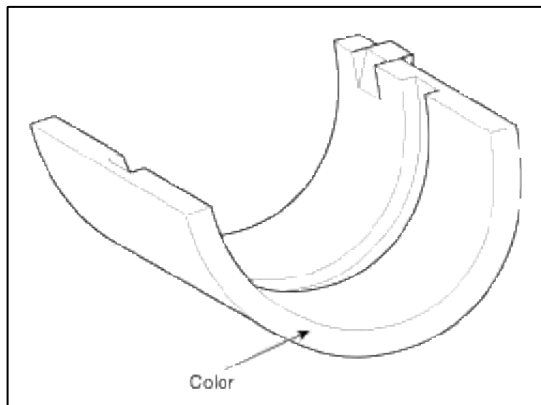
## Crankshaft Main Journal Mark Location



## Discrimination Of Crankshaft Main Journal

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

## Crankshaft Main Bearing Color Location



## Discrimination Of Crankshaft Main Bearing

Mark	Color	Crankshaft main bearing thickness No.1, 2, 3, 4, 5
A	Blue	2.026 ~ 2.029mm (0.0798 ~ 0.0799in)
B	Black	2.023 ~ 2.026mm (0.0796 ~ 0.0798in)
C	None	2.020 ~ 2.023mm (0.0795 ~ 0.0796in)
D	Green	2.017 ~ 2.020mm (0.0794 ~ 0.0795in)
E	Red	2.014 ~ 2.017mm (0.0793 ~ 0.0794in)

(8) Select the bearing by using selection table.

**Crankshaft Main Bearing Selection Table**

		Cylinder block crankshaft journal bore mark		
		A	B	C
<b>Crank shaft main journal mark</b>	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

5. Check the crankshaft end play.

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

#### **End play**

Standard: 0.05 ~ 0.25mm (0.0020 ~ 0.0098in)

Limit : 0.30mm (0.0118in)

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

#### **Cylinder Block**

1. Remove the gasket material.

Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

2. Clean the cylinder block

Using a soft brush and solvent, thoroughly clean the cylinder block.

3. Inspect the top surface of cylinder block for flatness.

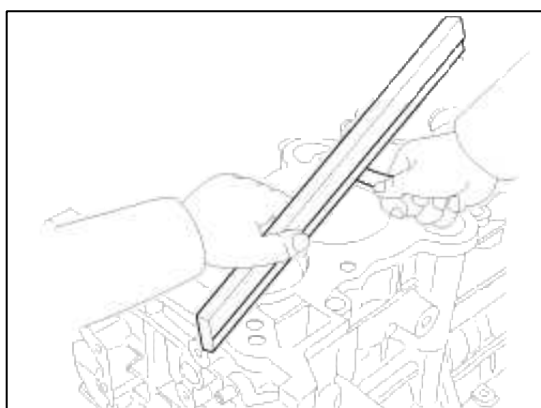
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

#### **Flatness of cylinder block gasket surface**

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)



4. Inspect the cylinder bore.

Visually check the cylinder for vertical scratches.

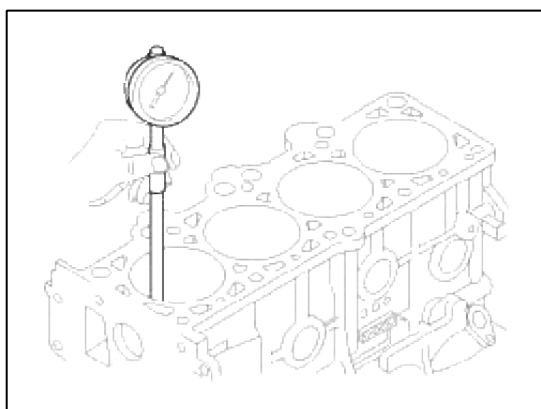
If deep scratches are present, replace the cylinder block.

## 5. Inspect the cylinder bore diameter.

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

**Standard diameter :**

77.00 ~ 77.03mm (3.0315 ~ 3.0327in)



## 6. Check the cylinder bore size code on the cylinder block side surface.

**Discrimination Of Cylinder Bore Size**

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

## 7. Check the piston size mark (A) on the piston top face.



A : Grade

T : Gasoline engine (T-GDI)

6 : 1.6L

**Discrimination Of Piston Outer Diameter**

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

## 8. Select the piston related to cylinder bore class.

**Piston -to-cylinder clearance :**

0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

## Piston And Piston Rings



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.

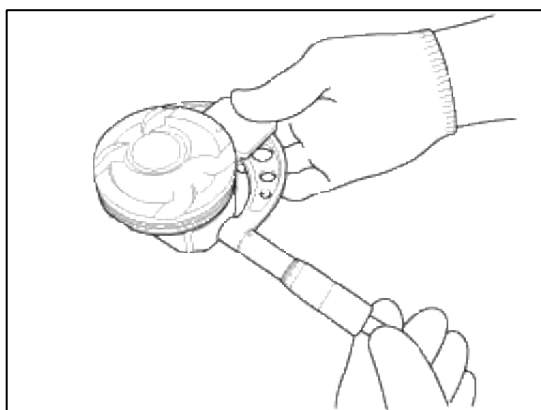
**NOTE**

Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 12mm(0.4724in) from bottom land of the piston.

**Standard diameter :**

76.97 ~ 77.00mm (3.0303 ~ 3.0315in)



3. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

**Piston-to-cylinder clearance :**

0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

4. 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**

No.1 ring : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)

No.2 ring : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)

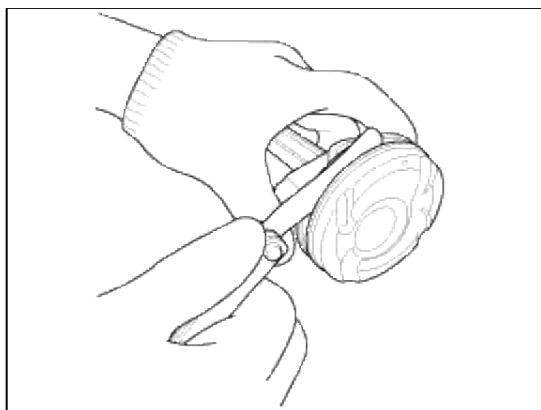
Oil ring : 0.02 ~ 0.06mm (0.0008 ~ 0.0024in)

Limit

No.1 ring : 0.1mm (0.0039in)

No.2 ring : 0.1mm ( 0.0039in)

Oil ring : 0.2mm ( 0.0079in)



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

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

### Piston ring end gap

#### Standard

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

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

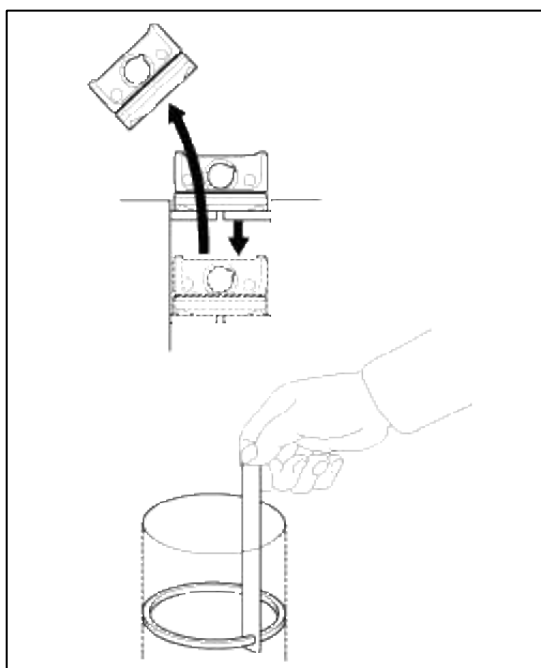
Oil ring : 0.20 ~ 0.40mm(0.0079 ~ 0.0157in)

#### Limit

No.1 ring : 0.3mm(0.0118in)

No.2 ring : 0.5mm(0.0197in)

Oil ring : 0.8mm(0.0315in)

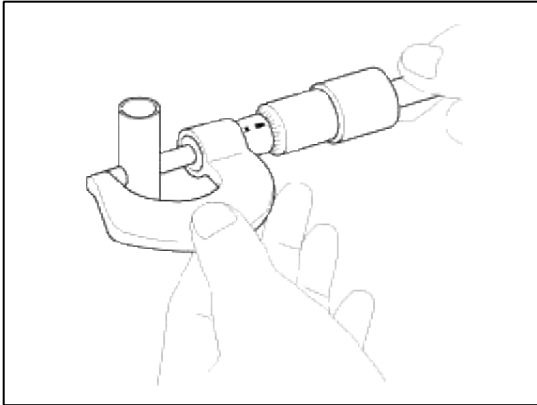


Piston Pins

### 1. Measure the outer diameter of piston pin

#### **Piston pin diameter :**

19.997 ~ 20.000mm (0.7872 ~ 0.7874in)



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

#### **Piston pin-to-piston clearance :**

0.004 ~ 0.013mm (0.0001 ~ 0.0005in)

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

#### **Piston pin-to-connecting rod interference :**

0.005 ~ 0.019mm (0.0001 ~ 0.0007in)

### Installation

#### **NOTE**

- 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 piston cooling jet (A).

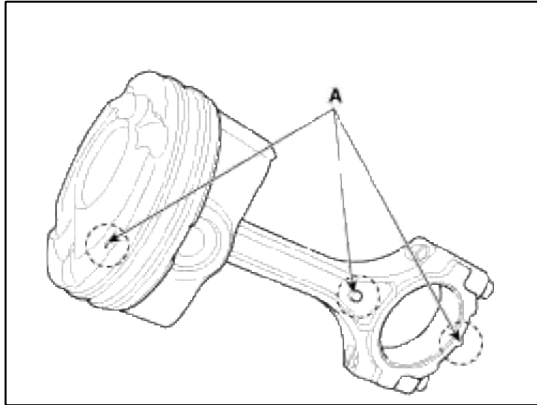
#### **Tightening torque :**

7.8 ~ 12.7N.m (0.8 ~ 1.3kgf.m, 5.8 ~ 9.4lb-ft)



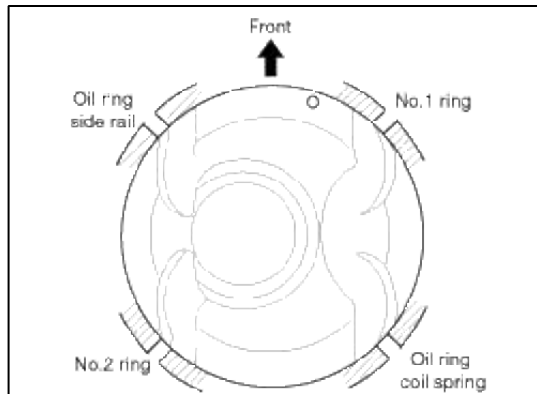
## 2. Assemble the piston and connecting rod.

- (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.



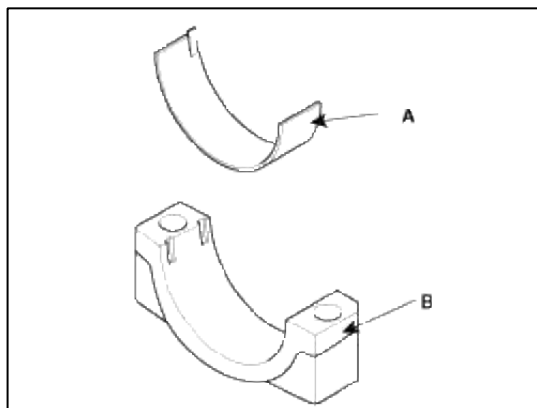
## 3. Install the piston rings.

- (1) Install the oil ring coil spring and 2 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.



## 4. Install the connecting rod bearings.

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

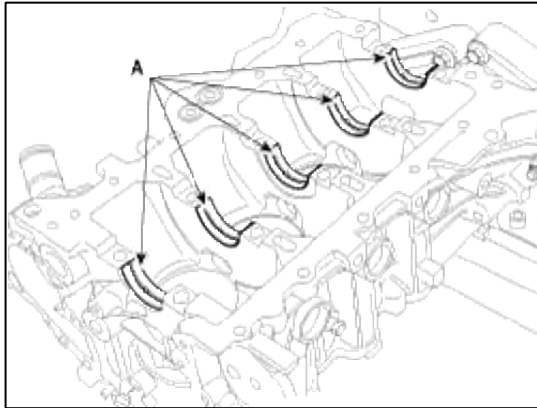


## 5. Install the crankshaft main bearings.

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

**NOTE**

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



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

## 6. Install the thrust bearing.

Install the thrust bearing (A) on the No.3 journal position of the cylinder block with the oil grooves facing outward.



## 7. Place the crankshaft on the cylinder block.

## 8. Place the main bearing caps on the cylinder block.

## 9. Install the main bearing cap bolts.

**NOTE**

The main bearing cap bolts are tightened in 2 progressive steps.  
If any of the bearing cap bolts is broken or deformed, replace it.

- (1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.
- (2) Install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

**Tightening torque :**

17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

**CAUTION**

Do not reuse the main bearing cap bolts.

- (3) Check that the crankshaft turns smoothly.

## 10. Check the crankshaft end play.

## 11. Install the piston and connecting rod assemblies.

**NOTE**

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

- (1) Install the ring compressor, check that the rings are securely in place, then position the piston in the cylinder, 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) Stop after the ring compressor pops free, and check the connecting rod-to-crank journal alignment before pushing the piston into place.

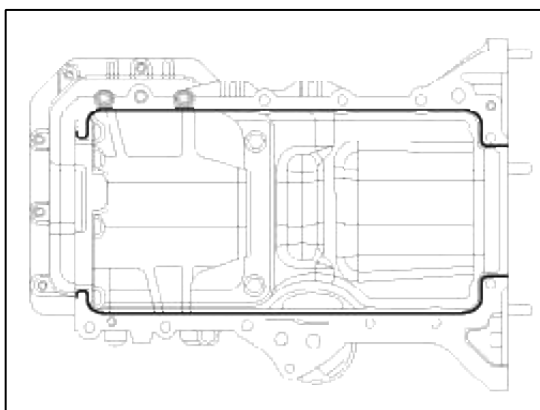
**Tightening torque :**

17.7~21.8Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

**CAUTION**

Do not reuse the connecting rod cap bolts.

## 12. Apply the sealant on the ladder frame.

**NOTE**

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

## 13. Install the ladder frame (A).

**Tightening torque :**

18.6 ~ 24.2N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



## 14. Install the rear oil seal.

(Refer to Cylinder Block - "Rear Oil Seal")

15. Install the oil screen (A).  
Install a new gasket and oil screen with 2 bolts.

**Tightening torque :**

19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)



16. Install the oil pan.  
(Refer to Lubrication System - "Oil Pan")
17. Install the oil pressure switch.  
(Refer to Lubrication System - "Oil Pressure Switch")
18. Install the knock sensor and the oil filter.  
(Refer to Lubrication System - "Oil Filter")
19. Install the oil level gauge tube.
20. Install the water jacket.  
(Refer to Cylinder Block - "Water Jacket Separator")
21. Install the timing chain.  
(Refer to Timing System - "Timing Chain")
22. Install the cylinder head.  
(Refer to Cylinder Head Assembly - "Cylinder Head")
23. Disconnect the engine stand.
24. AT : Install the drive plate.  
(Refer to Cylinder Block - "Drive Plate")
25. MT : Install the flywheel.  
(Refer to Cylinder Block - "Flywheel")
26. Install the engine.  
(Refer to Engine and transaxle assembly- "Engine and transaxle Assembly")

## Engine Mechanical System > Cooling System > Coolant > Repair procedures

### 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.

#### NOTE

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 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.

**NOTE**

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.

**NOTE**

- 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 than 60% will impair cooling efficiency and are not recommended.

**CAUTION**

- 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.

**NOTE**

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 :**

6.1 L (1.61 U.S.gal., 6.44 U.S.qt., 5.36 Imp.qt.)

5.9 L (1.55 U.S.gal., 6.23 U.S.qt., 5.18 Imp.qt.)

**Engine Mechanical System > Cooling System > Heater Hose > Repair procedures**

**Removal and Installation**

1. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to drain with speed.
2. Disconnect the mounting clamp and then remove the heater hose(A).



3. Remove the heater hoses (A).


**NOTE**

Install the heater hoses as shown illustrations.



4. Install in the reverse order of removal.

**Engine Mechanical System > Cooling System > Radiator Hose > Repair procedures**
**Removal and Installation**

1. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to drain with speed.
2. Disconnect the radiator upper hose (A) and lower hose (B).


**NOTE**

Install the radiator hoses as shown illustrations.



3. Install in the reverse order of removal.

**Engine Mechanical System > Cooling System > Radiator > Components and Components Location**
**Components**


- |                         |                           |
|-------------------------|---------------------------|
| 1. Radiator lower hose  | 5. Filler neck            |
| 2. Air guard            | 6. Upper mounting bracket |
| 3. Radiator upper cover | 7. Radiator               |
| 4. Radiator upper hose  | 8. Mounting insulator     |

**Engine Mechanical System > Cooling System > Radiator > Repair procedures**
**Removal and Installation**

1. Disconnect the battery negative terminal.
2. Remove the air cleaner assembly.  
(Refer to Intake and exhaust system - "Air Cleaner")
3. Loosen the drain plug, and drain the engine coolant.  
Remove the radiator cap to drain with speed.
4. Disconnect the over flow hose (A) from the radiator.



5. Disconnect the radiator upper hose (A) and lower hose (B).

6. Disconnect the ATF cooler hoses.  
(Refer to Auto Transaxle System - "Auto Transaxle")
7. Remove the front bumper.  
(Refer to Body - "Front Bumper")
8. Remove the head lamp.  
(Refer to Body Electrical System - "Head Lamp")
9. Remove the upper mounting bracket (A).



10. Disconnect the cooling fan controller connector (A).



11. Remove the air guard (A) and then disconnect the A/C condenser (B) from radiator.



12. Disconnect the radiator assembly from vehicle.

13. Remove the cooling fan & reservoir tank (A) from the radiator (B).

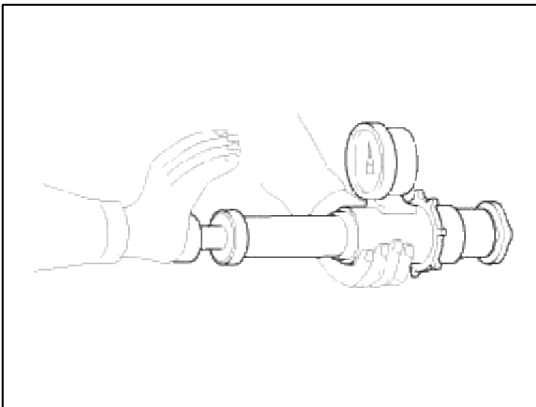


14. Install in the reverse order of removal.
15. Fill the radiator with coolant and check for leaks.
16. Put the radiator cap on tightly, then run engine again and check for leaks.

### Inspection

#### Radiator Cap Testing

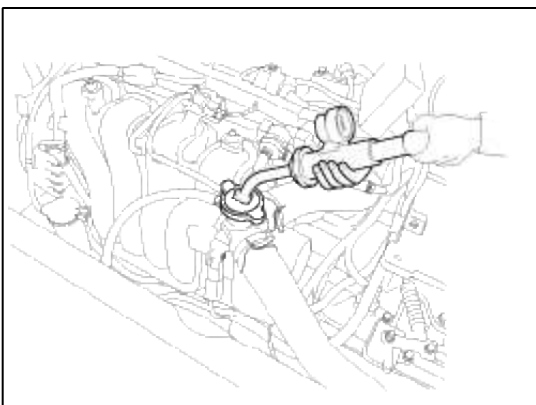
1. Remove the radiator cap, wet its seal with engine coolant, and then install it on a pressure tester.



2. Apply a pressure of 93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm<sup>2</sup>, 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/cm<sup>2</sup>, 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.

**NOTE**

Check for engine oil in coolant and/or coolant in engine oil.

## Engine Mechanical System > Cooling System > Cooling Fan > Components and Components Location

### Components



- |                                 |                       |
|---------------------------------|-----------------------|
| 1. Cooling fan controller (PWM) | 3. Cooler fan         |
| 2. Fan motor                    | 4. Cooling fan shroud |

## Engine Mechanical System > Cooling System > Cooling Fan > Schematic Diagrams

### Diagrams



## Engine Mechanical System > Cooling System > Cooling Fan > Repair procedures

### Removal and Installation

1. Disconnect the battery negative terminal.
2. Remove the air cleaner assembly.  
(Refer to Intake and exhaust system - "Air Cleaner")
3. Disconnect the over flow hose (A) from the radiator.



4. Disconnect the ATF cooler hose from cooling fan.
5. Remove the front bumper.  
(Refer to Body - "Front Bumper")
6. Remove the head lamp.  
(Refer to Body Electrical System - "Head Lamp")
7. Remove the radiator upper bracket (A).



8. Disconnect the cooling fan controller connector (A).



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



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

---

**Tightening torque :**

4.9 ~ 7.8 N.m (0.5 ~ 0.8 kgf.m, 3.6 ~ 5.7 lb-ft)

---



11. Install in the reverse order of removal.

**Engine Mechanical System > Cooling System > Water Temperature Control Assembly > Components and Components Location**

Components



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

**Engine Mechanical System > Cooling System > Water Temperature Control Assembly > Repair procedures**

Removal and Installation

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 (A).
5. Disconnect the radiator upper hose (B).
6. Remove the heater hose (C).
7. Disconnect the water hose (D).



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

---

**Tightening torque :**

9.8 ~ 11.7N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

---



9. Install in the reverse order of removal.

**CAUTION**

Clean the surface of the water temperature control assembly before installing.

**Engine Mechanical System > Cooling System > Water Pipe > Components and Components Location**

## Components



## 1. Water pipe

**Engine Mechanical System > Cooling System > Water Pipe > Repair procedures**

## Removal and Installation

1. Remove the water temperature control assembly.  
(Refer to Colling System - "Water Temperature Control Assembly")
2. Remove the water pipe(A).

**Tightening torque**

M6 bolt and nuts :

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

M8 bolt :

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



3. Install in the reverse order of removal.

**Engine Mechanical System > Cooling System > Water pump > Components and Components Location**

## Components



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

**Engine Mechanical System > Cooling System > Water pump > Repair procedures**

## Removal

1. Loosen the drain plug (A), and drain the engine coolant. Remove the radiator cap to drain with speed.

**WARNING**

System is under high pressure when the engine is hot. To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

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

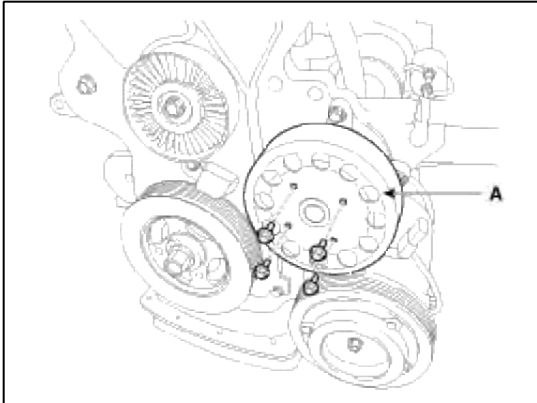
### 3. Remove the water pump pulley(A).

---

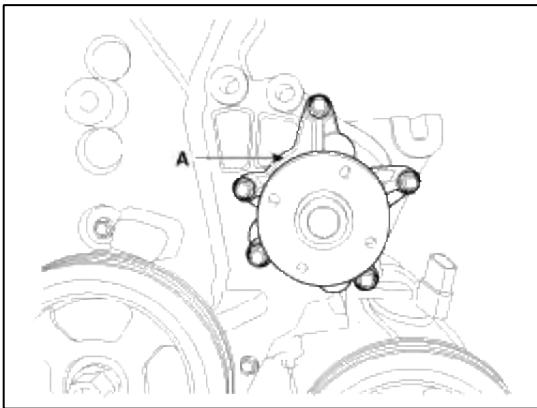
**Tightening torque :**

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

---



### 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.

**NOTE**

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

#### Installation

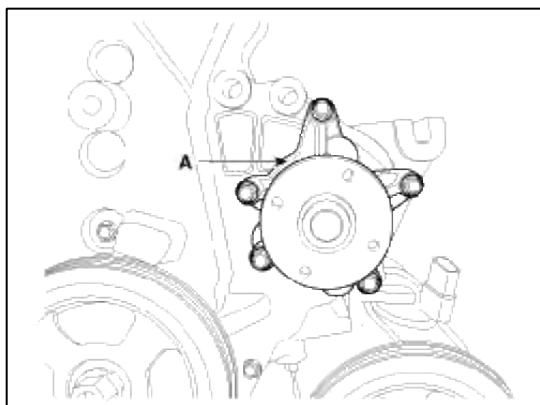
1. Install the new gasket and water pump(A).

---

**Tightening torque :**

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

---



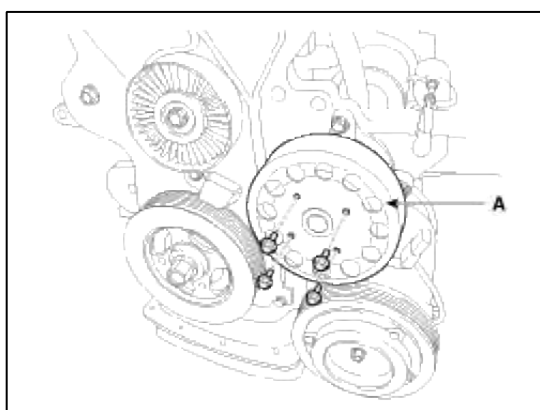
2. Install the water pump pulley (A).

---

**Tightening torque :**

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

---

**NOTE**

Tighten the bolts diagonally when installing.

3. Remove 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 > Cooling System > Water pump > Troubleshooting****Troubleshooting**

Symptoms		Possible Causes		Remedy
Coolant leakage	<ul style="list-style-type: none"> <li>From the bleed hole of the water pump</li> </ul>	Visually check	<ul style="list-style-type: none"> <li>Check leaks after about ten-minute warming up.</li> </ul>	<ul style="list-style-type: none"> <li>If coolant still leaks, replace a water pump.</li> <li>If leakage stops, reuse the water pump (Do not replace the pump with a new one).</li> </ul>
	<ul style="list-style-type: none"> <li>From gaskets or bolts</li> </ul>		<ul style="list-style-type: none"> <li>Check the tightening of the water pump mounting bolts.</li> </ul>	<ul style="list-style-type: none"> <li>Retighten the mounting bolts.</li> </ul>
			<ul style="list-style-type: none"> <li>Check damage of gaskets or inflow of dust.</li> </ul>	<ul style="list-style-type: none"> <li>Replace the gasket and clean dust off.</li> </ul>
	<ul style="list-style-type: none"> <li>From outer surface of water pump</li> </ul>		<ul style="list-style-type: none"> <li>Check the material or any cracks of the water pump.</li> </ul>	<ul style="list-style-type: none"> <li>Poor material. If any crack found, replace the water pump.</li> </ul>
Noise	<ul style="list-style-type: none"> <li>From bearings</li> <li>From mechanical seals</li> <li>Impeller interference</li> </ul>	Inspection with a stethoscope	<ul style="list-style-type: none"> <li>After starting the engine, check noise with a stethoscope.</li> </ul>	<ul style="list-style-type: none"> <li>If there is no noise, reuse the water pump(do not replace it).</li> <li>If there is any noise from the water pump, remove the drive belt and recheck.</li> </ul>
		Inspection after removing a drive belt	<ul style="list-style-type: none"> <li>After removing a water pump and a drive belt, check noise again.</li> </ul>	<ul style="list-style-type: none"> <li>If there is noise, reuse the water pump. Check other drive line parts.</li> <li>If there is no noise, replace the water pump with a new one.</li> </ul>
		Inspection after removing a water pump	<ul style="list-style-type: none"> <li>After removing a water pump and a drive belt, check noise again.</li> </ul>	<ul style="list-style-type: none"> <li>If there is any interference between them, replace the water pump with a new one.</li> </ul>
Overheating	<ul style="list-style-type: none"> <li>Damaged impeller</li> <li>Loosened impeller</li> </ul>	Loosened impeller	<ul style="list-style-type: none"> <li>Corrosion of the impeller wing</li> </ul>	<ul style="list-style-type: none"> <li>Check engine coolant.</li> <li>Poor coolant quality / Maintenance check</li> </ul>
			<ul style="list-style-type: none"> <li>Impeller separation from the shaft</li> </ul>	<ul style="list-style-type: none"> <li>Replace the water pump.</li> </ul>

### Engine Mechanical System > Cooling System > Thermostat > Components and Components Location

#### Components





1. Water inlet fitting
2. Thermostat

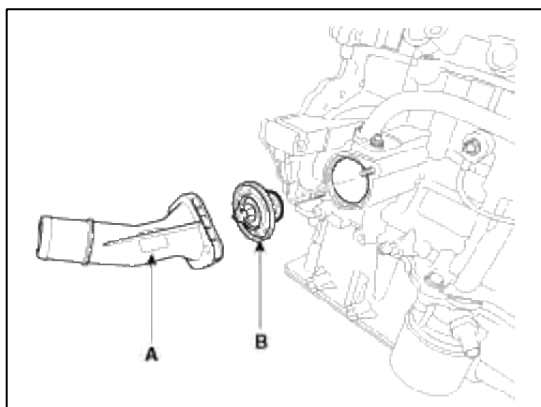
## Engine Mechanical System > Cooling System > Thermostat > Repair procedures

### Removal

#### NOTE

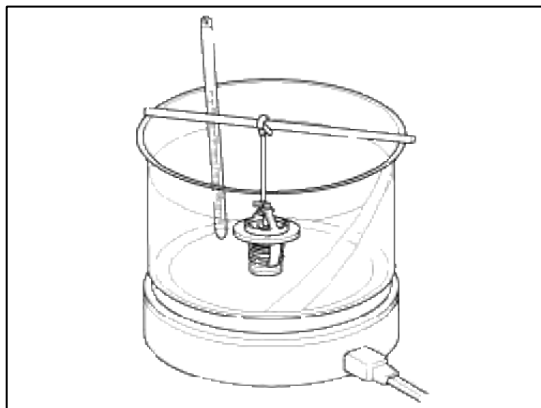
Disassembly of the thermostat would have an adverse effect, causing a lowering of cooling efficiency.

1. Drain engine coolant so that its level would be under the thermostat height.
2. Remove the radiator lower hose.  
(Refer to Cooling System - "Radiator Hose")
3. Remove the water inlet fitting (A) and thermostat (B).



### Inspection

1. Immerse the thermostat in water and gradually heat the water.



2. Check the valve opening temperature.

#### Valve opening temperature:

$82 \pm 1.5^{\circ}\text{C}$  ( $179.6 \pm 2.7^{\circ}\text{F}$ )

**Full opening temperature:**  $95^{\circ}\text{C}$  ( $203^{\circ}\text{F}$ )

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  $95^{\circ}\text{C}$  ( $203^{\circ}\text{F}$ )

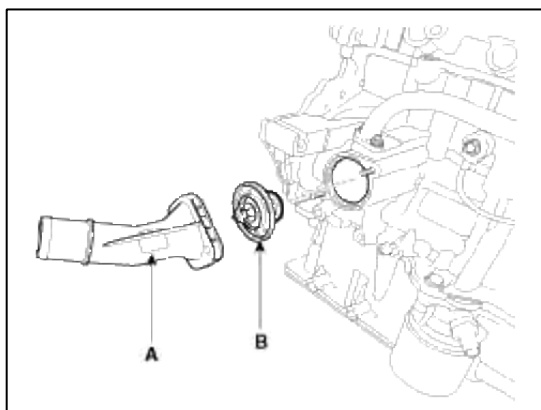
If the valve lift is not as specified, replace the thermostat.

## Installation

1. Place the thermostat in the block.  
Install the thermostat (B) with the jiggle valve upward.
2. Install the water inlet fitting (A).

### Tightening torque :

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



3. Fill with engine coolant.
4. Start engine and check for leaks.

## Engine Mechanical System > Cooling System > Thermostat > Troubleshooting

### Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	<ul style="list-style-type: none"> <li>From the thermostat gasket</li> </ul>	Check the mounting bolts	<ul style="list-style-type: none"> <li>Check the torque of the mounting bolts</li> </ul>	<ul style="list-style-type: none"> <li>Retighten the bolts and check leakage again.</li> </ul>
		Check the gasket for damage	<ul style="list-style-type: none"> <li>Check gasket or seal for damage</li> </ul>	<ul style="list-style-type: none"> <li>Replace gaskets and reuse the thermostat.</li> </ul>
Cooled excessively	<ul style="list-style-type: none"> <li>Low heater performance (cool air blowed-out)</li> <li>Temperature gauge indicates 'LOW'</li> </ul>	Visually check after removing the radiator cap.	<ul style="list-style-type: none"> <li>Insufficient coolant or leakage.</li> </ul>	<ul style="list-style-type: none"> <li>After refilling coolant, recheck.</li> </ul>
		GDS check&Starting engine	<ul style="list-style-type: none"> <li>Check DTCs</li> <li>Check connection of the fan clutch or the fan motor.</li> </ul> <p>If the fan clutch is always connected, there will be a noise at idle.</p>	<ul style="list-style-type: none"> <li>Check the engine coolant sensor, wiring and connectors.</li> <li>Replace the componants.</li> </ul>
		Remove the thermostat and inspect	<ul style="list-style-type: none"> <li>Check if there are dusts or chips in the thermostat valve.</li> <li>Check adherence of the thermostat.</li> </ul>	<ul style="list-style-type: none"> <li>Clean the thermostat valve and reuse the thermostat.</li> <li>Replace the thermostat, if it doesn't work properly.</li> </ul>

Heated excessively	<ul style="list-style-type: none"> <li>• Engine overheated</li> <li>• Temperature gauge indicates 'HI'</li> </ul>	Visually check after removing the radiator cap.	<ul style="list-style-type: none"> <li>• Insufficient coolant or leakage. Be careful when removing a radiator cap of the overheated vehicle.</li> <li>• Check air in cooling system.</li> </ul>	<ul style="list-style-type: none"> <li>• After refilling coolant, recheck.</li> <li>• Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.</li> </ul>
		GDS check&Starting engine	<ul style="list-style-type: none"> <li>• Check DTCs</li> <li>• Check the fan motor performance as temperature varies.</li> <li>• Check if the fan clutch slips.</li> <li>• Check the water pump adherence or impeller damaged.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the engine coolant sensor, wiring and connectors.</li> <li>• Check the fan motor, the relay and the connector.</li> <li>• Replace the fan clutch, if it doesn't work properly.</li> <li>• Replace the water pump, if it doesn't work properly.</li> </ul>
		Immerse the thermostat in boiling water and inspection.	<ul style="list-style-type: none"> <li>• After removing the thermostat, check it works properly. Check the thermostat opens at the valve opening temperature.</li> </ul>	<ul style="list-style-type: none"> <li>• Replace the thermostat, if it doesn't work properly.</li> </ul>

## Engine Mechanical System > Lubrication System > Engine Oil > Repair procedures

### 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, and drain the oil into a container.



2. Remove the oil filter(A) with the SST(09263-2E000, 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 : 4.9 L (1.29 U.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 including 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 or thinning.

If the quality is visibly poor, replace the oil.

2. Check the engine oil level.

After warming 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.

**NOTE**

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

**Selection Of Engine Oil**

**Recommendation**

ACEA A5 or above

SAE viscosity grade : 5W-30, 5W-40

Supplier	Product
SK	ZIC LD5W-30
Chevron	KIXX G1 LL
Total	QUARTZ HKS G-310
	QUARTZ INEO MC3 5W-30
Shell	HELIX ULTRA AH-E 5W-30 HELIX ULTRA 5W-40
Fuchs	TITAN SUPERSYN LONG LIFE 5W-30/40

**NOTE**

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 > Lubrication System > Oil Pump > Components and Components Location**

## Components



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

**Engine Mechanical System > Lubrication System > Oil Pump > Repair procedures**

## 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 > Lubrication System > Oil Pressure Switch > Repair procedures**

## Removal and Installation

1. Remove the under cover.
2. Remove the oil drain plug, and drain the oil into a container.

3. Remove the oil pressure switch(A).

### Tightening torque :

7.8 ~ 11.7 N.m (0.8 ~ 1.2 kgf.m, 5.7 ~ 8.6 lb-ft)

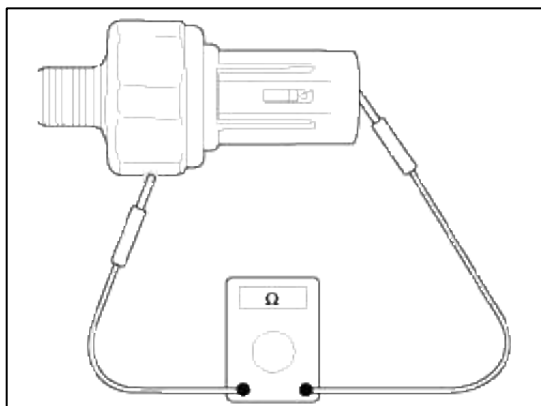


4. Install in the reverse order of removal.

### Inspection

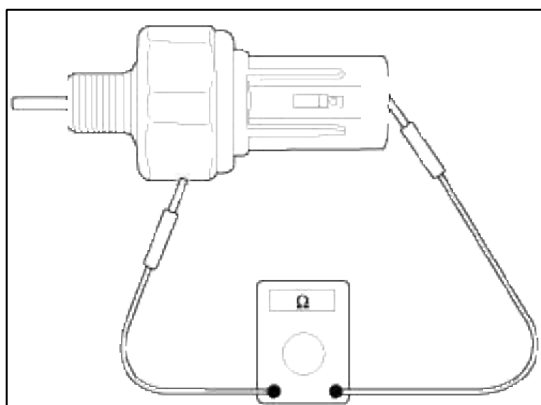
1. Check the continuity between the terminal and the body with an ohmmeter.

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 49.0kpa (0.5kg/cm<sup>2</sup>, 7.1psi) 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 > Lubrication System > Oil Pan > Components and Components Location

### Components



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

## Engine Mechanical System > Lubrication System > Oil Pan > Repair procedures

### Removal

1. Remove the under covers.
2. Drain engine oil.
3. Using the SST(09215-3C000) and remove the oil pan.



#### CAUTION

- 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.

#### NOTE

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

---

#### NOTE

- 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 > Lubrication System > Oil Level Gauge & Pipe > Repair procedures

### Removal and Installation

1. Remove the oil level gauge(A).

---

**Tightening torque:**

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

---



2. Install in the reverse order of removal.

**Engine Mechanical System > Lubrication System > Oil Cooler > Repair procedures**
**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(A) with the SST(09263-2E000, 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(A) with the SST(09263-2E000, 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 > Intake And Exhaust System > Air Cleaner > Repair procedures**
**Removal and Installation**

1. Remove the engine cover.
2. Disconnect the battery negative terminal.



### 3. Remove the air duct and air cleaner assembly.

#### Tightening torque

Hose clamp bolt:

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

Air cleaner assembly bolts:

7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

- (1) Remove the air duct(A).
- (2) Disconnect the breather hose (B), RCV hose (C) and air intake hose (D).
- (3) Remove the air cleaner assembly (E).



#### NOTE

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



### 4. Install in the reverse order of removal.

## Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Components and Components Location

### Components



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

## Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Repair procedures

### Removal and Installation

1. Remove the engine cover.
2. Disconnect the battery negative terminal.
3. Disconnect the engine wiring connector and harness clamp and disconnect the wiring from intake manifold.
  - A. Injector extension connector
  - B. MAPS (Map Sensor) connector
  - C. Knock Sensor connector
  - D. Front connector
  - E. CKPS(Crank Shaft Position Sensor) connector
  - F. vacuum pump extension 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.

#### **Tightening torque :**

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



#### **NOTE**

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 > Intake And Exhaust System > Exhaust Manifold > Components and Components Location**

#### **Components**



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

## Engine Mechanical System > Intake And Exhaust System > Exhaust Manifold > Repair procedures

### Removal and Installation

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

#### Tightening torque :

2.9 ~ 4.9 N.m (0.3 ~ 0.5kgf.m, 2.0 ~ 3.6 lb-ft)



4. Remove the turbo charger actuator solenoid valve(A).



5. Remove the catalytic convertor.  
(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. Install the jack to the edge of upper oil pan to support the engine.
8. 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)

9. 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)



10. 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)



## 11. Remove the turbo manifold module heat protect(A).

**Tightening torque :**

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

**NOTE**

When installing, temporarily tighten the bolt and then completely tighten to specified torque.

## 12. Remove the turbo charger coupler(A).

**Tightening torque :**

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



## 13. 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)

**NOTE**

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.

## 14. 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)

**NOTE**

When installing, completely remove the oil from assembly part.

## 15. 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)

**NOTE**

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

## 16. Remove the turbo manifold module and gasket.

**Tightening torque :**

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

**NOTE**

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

**NOTE**

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



## 17. 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 > Intake And Exhaust System > Intercooler Pipe & Hose > Repair procedures

## Removal and Installation

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

**Tightening torque :**

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



### 3. Remove the intercooler inlet hose & pipe(A).

#### Tightening torque

Bolt :

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

Clamp :

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



### 4. Install in the reverse order of removal.

#### NOTE

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

## Engine Mechanical System > Intake And Exhaust System > Intercooler > Repair procedures

### Removal and Installation

1. Disconnect the battery negative terminal.
2. Disconnect the boost pressure sensor connector(A) RCV solenoid valve connector(B) cooling fan controller connector(C).
3. Disconnect the vacuum hose(D).



4. Disconnect the intercooler outlet hose.  
(Refer to Intake and Exhaust System - "Intercooler pipe & hose")
5. Disconnect the intercooler inlet hose.  
(Refer to Intake and Exhaust System - "Intercooler pipe & hose")
6. Remove the radiator upper bracket(A).



7. Disconnect the RCV hose(A) and then remove the intercooler(B).



8. Install in the reverse order of removal.

## Engine Mechanical System > Intake And Exhaust System > Turbo Charger > Components and Components Location

### Components



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

## Engine Mechanical System > Intake And Exhaust System > Turbo Charger > Repair procedures

### 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).

A. Check if a gasket is installed.

A. Check if mounting bolts (or nuts) are tightened properly.

A. Check if there is a gas leak.

A. 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.

A. Check if a gasket is installed.

B. Check if the mounting bolts (or nuts) are tightened properly.

C. Check if there is a gas leak.

D. 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.

A. Check if a gasket is installed.

B. Check if the mounting bolts (or nuts) are tightened properly.

C. 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.

- A. Check if a gasket is installed.
- B. Check if the mounting bolts are tightened properly.
- C. Check if the clamps are positioned in place.
- D. 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.

- A. Check if the mounting bolts are tightened properly.
- B. 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.

- A. 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.

- A. Check if the vacuum hose is connected to the actuator properly.
- B. Check if the vacuum hoses & pipes are damaged (bent, detached or torn).
- C. Check if there is any damage, such as crack, on the vacuum pipes.
- D. 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.

- A. 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.

- A. Check if the compressor wheel is damaged (bent or deformed).
- B. 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.
  - A. Check if the turbine wheel is damaged.
  - B. 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.
  - A. Check if the breather hose is damaged (bent, clogged).
  - B. 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.
  - A. 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.
  - A. Check the air cleaner filter for pollution state.
  - B. Check the air cleaner filter for water influx.
  - C. Check the air cleaner cover for dirtiness.
  - D. 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.

**NOTE**

Replace the air cleaner filter according to the maintenance schedule.

4. Check the intercooler hoses & pipes.
  - A. Check if the intercooler hoses & pipes are connected properly.
  - B. Check if the intercooler hoses & pipes are damaged (bent, detached or torn).
  - C. Check if there is any damage, such as crack, on the intercooler pipes.
  - D. 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.

**NOTE**

Use new clamps when replacing the hoses & pipes.

## 5. Check the intercooler.

A. 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.

**NOTE**

Use new clamps when replacing the intercooler.

## 6. Check the engine oil.

A. Check the engine oil level.

B. Check the engine oil for discoloration, water influx and viscosity degradation.

C. 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.

**NOTE**

Change the engine oil according to the maintenance schedule.

## 7. Check the engine oil pressure.

A. Engine oil pressure: Check the oil pressure using an oil pressure gauge after removing the oil pressure switch on the cylinder block.

B. 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.

**NOTE**

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)

A. 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..

B. 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.)



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)
  - A. Check if the injectors operate properly.
  - B. Check if the sensors, such as the mass air flow sensor (MAFS), intake air temperature sensor (IATS), boost pressure sensor (BPS), operate properly.
  - C. 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 > Intake And Exhaust System > Muffler > Repair procedures

#### 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 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 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



6. Remove the main muffler (A).

#### Tightening torque :

39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



7. Install in the reverse order of removal.

#### NOTE

When installing, replace with new gaskets.